# 2018

# Mid-Atlantic Commercial Vegetable Production Recommendations

456-420

VT/0218/456-420/AREC-232P

Virginia Cooperative Extension
Virginia Tech • Virginia State University

# 2018
# Mid-Atlantic Commercial Vegetable Production Recommendations


**Delaware**
University of Delaware Cooperative Extension (EB137)

**Maryland**
University of Maryland Extension (EB-236)

**New Jersey**
Rutgers Cooperative Extension (E001)

**Pennsylvania**
Penn State Extension (AGRS-028)

**Virginia**
Virginia Cooperative Extension (456-420)

**West Virginia**
West Virginia University Extension Service

# For Immediate Medical Attention

# Call 911

# For a Pesticide Exposure Poisoning

# Emergency Call

**POISON Help®**

**1-800-222-1222**

# For All States

This number will automatically connect you to the poison center nearest you.
**Anyone with a poisoning emergency can call the toll-free telephone number for help.** Personnel at the Center will give you frst-aid information and direct you to local treatment centers if necessary.

## For Pesticide Spills

**Small Spills:** See the product label for cleanup advice.
**Large spills:** Call the National Response Center at 1-800-424-8802 or CHEMTREC at 800-424-9300 (24 hours) - Industry assistance with emergency response cleanup procedures for large, dangerous spills.
**Be aware of your responsibility to report spills to the proper state agency.**

# Preface

## NOT TO BE USED BY HOME GARDENERS

This copy of the **Mid-Atlantic Commercial Vegetable Production Recommendations for 2018** replaces all previous editions of the Commercial Vegetable Production Recommendations published individually for Delaware, Maryland, New Jersey, Pennsylvania, Virginia, and West Virginia. Information presented in this publication is based on research results from the University of Delaware, the University of Maryland, Rutgers - The State University of New Jersey, The Pennsylvania State University, Virginia Polytechnic Institute and State University, West Virginia University, and the U.S. Department of Agriculture, combined with industry and grower knowledge and experience.

This vegetable production guide is intended for the **commercial vegetable grower** who has to make numerous managerial decisions. Although the proper choices of variety, pesticides, equipment, irrigation, fertilizer, and cultural practices are the individual vegetable grower's responsibility, it is intended that these recommendations will facilitate decision-making. Recommended planting dates will vary across the six-state region. Local weather conditions, grower experience, and variety may facilitate successful harvest on crops planted outside the planting dates listed in this guide. This can be evaluated in consultation with the local agents and state specialists. Government agencies and other organizations administrating crop insurance programs or other support programs should contact local Extension agents and/or vegetable specialists for guidance.

**The publication will be revised annually or as is necessary to include new information that evolves in the rapidly changing vegetable industry**. Important updates will be communicated through local Extension agents and vegetable specialists. The Editors welcome constructive criticism and suggestions from growers and industry personnel who may wish to help improve future editions of this publication.

**DISCLAIMER**
- The label is a legally-binding contract between the user and the manufacturer.
- The user MUST follow all rates and restrictions as per label directions.
- The use of any pesticide inconsistent with the label directions is a violation of Federal law.

### Pesticide User Responsibility

Always follow the label and use pesticides safely. For special Local-Needs Label 24(c) registrations or Section 18 exemptions, do not use the material without a copy of the special label or written instructions from your Extension Agent or another recognized authority.**The user is always responsible for the proper use of pesticides, residues on crops, storage and disposal, as well as for damage caused by drift.**

State and federal pesticide regulations are constantly under revision. Be sure to determine if such changes apply to your situation. Using pesticides inconsistent with label directions is illegal.

### Days Between Last Application and Harvest

The minimum number of days between the last application and harvest (**PHI**, Pre-Harvest Interval, in days) and reentry information (**REI**, Restricted Entry Interval, in hours) are listed in the herbicide, insecticide and fungicide recommendation tables in chapter F. Commodity Recommendations. This information is also listed by chemical in chapter D. Pesticide Safety (Table D-6. Acute Toxicity of Chemicals). Always follow the label to avoid the occurrence of deleterious chemical residues on harvested crops.

### Trade or Brand Names

The trade or brand names given herein are supplied with the understanding that no discrimination is intended and no endorsement is implied. Furthermore, in some instances the same compound may be sold under different trade names, which may vary as to label clearances. For the convenience of our users, both product names and active ingredients are provided and any product name omissions are unintended

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# 2018 Mid-Atlantic Commercial Vegetable Production Recommendations


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New Jersey Agricultural Experiment Station: *http://njaes.rutgers.edu/ag/*
Fact Sheets and Bulletins: *http://goo.gl/PyBwOb*
Plant & Pest Advisory: *http://plant-pest-advisory.rutgers.edu*
Mid-Atlantic Commercial Vegetable Production Recommendations:
*http://njaes.rutgers.edu/pubs/publication.asp?pid=E001*
Pesticide Applicator Certification Information, NJ DEP Pesticide Control Program
*http://www.nj.gov/dep/enforcement/pcp/bpo-appprivate.htm#part2*

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Penn State Vegetable Production: *https://extension.psu.edu/forage-and-food-crops/vegetables*
Vegetable and Small Fruit Gazette newsletter, click on the "Get Connected" button at:
*https://extension.psu.edu/forage-and-food-crops/vegetables*

**Penn State Vegetable Team Directory**
For complete listing and contact information see:
*https://extension.psu.edu/forage-and-food-crops/vegetables/vegetables-experts*

**Plant Diagnostic Clinic:** *http://plantpath.psu.edu/facilities/plant-disease-clinic*
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# State Extension Information

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**Virginia Tech & Virginia State University**
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Virginia Tech Pesticide Programs (VTPP): *http://vtpp.ext.vt.edu*

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# Listing of Tables

# Abbreviations and Acronyms

## Units of Measurement

| | |
|---|---|
| /A | per acre |
| bu | bushel(s) |
| °C | degrees Celsius |
| cc | cubic centimeter(s) |
| cu ft | cubic foot (feet) |
| cu yd | cubic yard(s) |
| cwt | hundredweight |
| d | day(s) |
| °F | degrees Fahrenheit |
| ft | foot (feet) |
| fl oz | fluid ounce(s) |
| g | gram(s) |
| gal | gallon(s) |
| gpm | gallons per minute |
| in | inch |
| lb | pound(s) |
| mph | miles per hour |
| oz | ounce(s) |
| ppm | parts per million |
| psi | pounds per square inch |
| pt | pint(s) |
| qt | quart(s) |
| sq ft | square foot (feet) |
| tbs | tablespoon(s) |
| tsp | teaspoon(s) |
| wk | week(s) |
| yr | year(s) |

## Product Formulations

| | |
|---|---|
| COC | crop oil concentrate |
| D | dust |
| DF | dry flowable |
| DP | dry prill |
| DS | dry salt |
| E | emulsion |
| EC | emulsifiable concentrate |
| ES | emulsifiable suspension |
| EW | emulsion in water |
| F | flowable |
| FC | flowable concentrate |
| FL | fluid |
| FM | flowable micro-encapsulated |
| G | granule |
| L | liquid |
| LC | liquid concentrate |
| LF | liquid flowable |
| ME | micro-encapsulated |
| OF | oil formulation |
| OLF | other labeled formulations |

*Product Formulations - continued*

| | |
|---|---|
| SC | spray concentrate, soluble concentrate |
| SG | soluble granules |
| SP | soluble powder |
| W | wettable |
| WBE | water-based emulsion |
| WDG | water-dispersible granules |
| WDL | water-dispersible liquid |
| WP | wettable powder |
| WSB | water-soluble bag |
| WSP | water-soluble packet |

## Diseases

| | |
|---|---|
| AMV | alfalfa mosaic virus |
| EBDC | early blight disease control |
| FR | Fusarium wilt resistance |
| LR | leaf roll resistant |
| MT | mosaic tested |
| PMR | powdery mildew resistant |
| PMT | powdery mildew tolerant |
| PR | Phytophthora resistance |
| PT | Phytophthora tolerant |
| PVX | potato virus X |
| PVY | potato virus Y |
| WMV | watermelon mosaic virus |
| WMV2 | watermelon mosaic virus race2 |
| WRR | white rust resistance |
| ZYMV | zucchini yellow mosaic virus |

## Other

| | |
|---|---|
| ai | active ingredient |
| AP | at planting |
| ALS | acetolactate synthase |
| AMS | ammonium sulfate |
| FRAC | Fungicide Resistance Action Committee |
| IRAC | Insecticide Resistance Action Committee |
| K | potassium |
| $K_2O$ | available potash |
| N | nitrogen |
| OMRI | Organic Materials Research Institute |
| P | phosphorus |
| $P_2O_5$ | available phosphoric acid |
| PHI | Pre Harvest Interval (in days) |
| REI | Restricted Entry Interval (in hours) |
| WSSA | Weed Science Society of America |

# A. General Production Recommendations

## 1. Varieties

New varieties are constantly being developed throughout the world and it is impossible to list and describe all; only those that are available and adapted to the mid-Atlantic region are listed in this publication (see crop sections in chapter F). While all efforts are made to have comprehensive lists, not all varieties may be listed. New varieties or varieties with a limited release will have the designation "trial"; they should be evaluated in smaller plantings first. The ultimate value of a variety for a particular purpose is determined by the grower: performance under his or her management adaptation to specific environmental conditions, as well as having desired horticultural characteristics.

**Some Variety Selection Criteria:**
**Yield**: The variety should have the potential to produce crops at the same or better yield and quality to those already grown. Harvested yield may be much less than potential yield depending on markets and quality factors.

**Days to Harvest**: Choose varieties that meet market requirements based on days to harvest. Earliness is a major selection factor for first spring plantings and days to harvest is a critical selection factor for late summer and fall maturing crops, especially in shorter season areas of the region. Days to harvest in seed guides are based on the most common planting date and may be considerably longer in cooler periods or shorter in warmer periods. A more accurate guide to maturity will be Growing Degree Days (GDD), which are calculated for a specific crop using daily highs and lows and a base temperature. GDD information for different vegetable crops such as peas and sweet corn are available from seed suppliers and breeders.

**Disease and Insect Resistance, Herbicide Resistance**: The most economical and effective means of pest management is through the use of varieties that are resistant or tolerant to diseases caused by fungi, bacteria, viruses, or nematodes. When all other factors are equal, select a variety with needed disease resistance or tolerance. In some vegetables, such as sweet corn, insect resistant varieties are also available and should be considered where they fit your requirements. Herbicide resistant varieties of sweet corn are also available to allow for the use of post emergence non-selective herbicides for weed control. The continuous or intense production of herbicide or pest-resistant varieties can potentially lead to herbicide-tolerant weeds and new, more virulent pest strains. Adherence to vender or Extension recommendations and a long-term crop rotation plan should minimize this risk.

**Resistance to Adverse Environmental Conditions**: Choose varieties that are resistant to environmental conditions that are likely to be encountered. This includes heat or cold tolerance (disorder such as tuber heat necrosis); drought tolerance; resistance to wet weather (disorders such as cracking and edema); and resistance to low nutrient levels (disorders such as blossom end rot, leaf tip burn and hollow stem).

**Horticultural Quality**: Choose varieties that meet market quality requirements. Quality attributes such as taste, texture, size, shape, color, uniformity, and defects will often dictate variety selection. Grades, percentage by grade, or pack-outs are key quality attributes for some markets. Variety test data such as soluble solids (sugars or sweetness), acidity, pungency, fiber content and consumer taste panel information can assist in variety selection where available. Processing performance is of major concern for frozen, canned or pickled vegetables. Other considerations include the ability to handle mechanical harvest or the ability to be packed and shipped distances with minimum damage in contrast to vegetables that are adapted only to hand harvest and local sales or short distance shipping. Other quality characteristics to consider include holding or storage ability, ripening characteristics, nutritional content, and culinary qualities.

**Plant Characteristics**: Plant characteristics that may be considered in variety selection include plant form such as bush, upright, or vining; plant height; plant size; location of harvested part on the plant; and ease of harvest.

**Adaptability**: Successful varieties must perform well under the range of environmental conditions and production practices commonly encountered on individual farms. Seasonal adaptation is another selection consideration.

**<u>Market Acceptability</u>**: The harvested plant product must have characteristics desired by both you and your buyers. Consider the requirements or desires of consumers, packers, shippers, wholesalers, retailers, or processors. Included among these qualities are flavor, pack out, size, shape, color, culinary qualities, nutritional quality or processing quality. Specialty markets such as ethnic markets, restaurants, or gourmet sales will have very specific variety requirements. Many vegetable seed companies offer varieties that are transgenic or "GMO" (genetically modified organism). GMO varieties feature a small amount of DNA from a source outside of the crop species gene pool; another plant species, bacterium, virus, or even animal. This foreign DNA is either the direct source of a new trait such as herbicide, or disease or insect resistance or is needed to assist the gene insertion process. GMO products in the food chain are highly controversial, and effects are ongoing to regulate and label them. Be aware of current and pending regulations and adverse public sentiment before growing and marketing GMO varieties of vegetable crops.

**Variety selection is a very dynamic process**. Some varieties retain favor for many years, whereas others might be used only a few seasons. Companies frequently replace varieties with newer ones. In the mid-Atlantic, variety selection often requires special regional consideration due to the wide range of climatic variations.

**There are many sources of information for growers to aid in choosing a variety**. University trials offer unbiased comparisons of varieties from multiple sources. Commercial trials from seed distributors also offer multiple source comparisons. Seed company test results offer information about that company's varieties. Check results from replicated trials and multiple sites, if available. Trials conducted in similar soils and environments and local trials are the most reliable indicators of what will have the potential to perform well on your farm. Visits to local trials can provide good visual information for making decisions. Where quality is a prime concern, look for trials with quality data. Small trial plantings for 2 to 3 years are suggested for any variety or strain not previously grown. For a true comparison, always include a standard variety, one with proven consistent performance in the same field or planting.

**<u>Plant Resistance or Tolerance Listed in Tables</u>**

If a specific disease (or insect) is a serious threat to a vegetable crop, genetic resistance is an effective and often low-cost strategy of disease avoidance. Pathogens are highly changeable, and a resistant variety that performs well in one year may not necessarily continue to do so. On rare occasions, purported resistance to pathogens breaks down. This may be due to different strains and races of disease-causing organisms and environmental conditions that favor the organism or reduce natural plant resistance. In the chapter F variety tables, disease (and insect) resistances and tolerances are listed in the tables and footnotes. The disease, insect or insect reactions listed in this book are from source seed companies or from University trials as noted and are not necessarily verified by Cooperative Extension.

## 2. Seed Storage and Handling

Both high temperature and high relative humidity will reduce seed germination and vigor over time. Do not store seeds in areas that have a combined temperature and humidity value greater than 110, for example 50°F (12.8°C) + 60% relative humidity. Ideal storage conditions for most seeds are at a temperature of 35°F (2°C) and less than 40% relative humidity. In addition, primed seeds pretreated with salt or another osmoticum do not usually store well after shipment to the buyer. Seed coating/pelleting may or may not reduce germination rate. If you do not use all coated/pelleted seed, perform a germination test to assess viability before using in subsequent seasons.

Corn, pea, and bean seed are especially susceptible to mechanical damage due to rough handling. Seed containers of these crops should not be subjected to rough handling since the seed coats and embryos can be damaged, resulting in nonviable seeds. If you plan to treat seeds of these crops with a fungicide, inoculum, or other chemical application, apply the materials gently to avoid seed damage.

## 3. Specialty Vegetables

Specialty vegetables are grown for specific markets and include: unique varieties or types within standard vegetable categories, varieties that are harvested at different stages than conventional (baby types), vegetables grown for ethnic markets, "heirloom vegetables", "gourmet" vegetables, and others grown for niche or specialty markets. In general, market demand for "heirloom" vegetables and types of commodities that cater to the special needs and preferences of ethnic groups have expanded. **See "Specialty Vegetables" in chapter F for more details.**

# 4. Organic Production

You may wish to consider organic production. The initial investment can be high, due mainly to certification costs, but returns can be higher than for conventional production. The United States Department of Agriculture (USDA) regulates the term 'organic' to protect the sector from unscrupulous profiteers. To become certified organic, you must follow production and handling practices contained in the National Organic Standards (NOS; see *https://www.ams.usda.gov/rules-regulations/organic*) and be certified by a USDA-accredited agency such as the New Jersey Department of Agriculture (*http://www.state.nj.us/agriculture/*) or Pennsylvania Certified Organic (PCO; *http://www.paorganic.org/*). If annual gross income from organic products is $5,000 or less, a farm can be exempted from certification, but production and handling practices must be in accordance with the NOS and some restrictions regarding labeling and combination with other organic products apply. Certified organic production is typically preceded by a 3-year transition phase during which soil and farming practices are adapted to NOS.

Successful organic production is a long-term proposition. It usually takes a couple of years, and may take as many as four years, for a site managed organically to reach full potential for profitability. Organic production is knowledge- and management-intensive, and requires careful attention to the maintenance of a biological equilibrium favorable for crop production. Organic certification can increase market access, but requires learning new production methods and documenting production practices through careful record keeping. However, when implemented well, organic methods can improve soil fertility and tilth through increased soil microorganisms and improved organic matter recycling. Test new products and methods on a small scale prior to large-scale adoption. Consider the following questions before initiating organic production:

- Does a market for organic vegetables exist?
- Are adequate resources available?
- Would you be able to ride out possible reduced yields without premium prices during the 3-year transition phase?
- Are you willing to devote more time to monitoring pests?
- Are you willing to devote more time to managing soil fertility?
- Are you willing to devote more time to record keeping?

If you answered "yes" to all of the above questions, then organic production may be for you. If you are beginning the transition phase from non-organic to organic production consider a pre-transition phase if pest pressures are high in the planting area. A pre-transition phase is intermediate between organic and non-organic production. During the pre-transition phase conventional pest management tactics are used along with organic tactics to reduce pest pressures. Once pest pressures are reduced, organic pest management tactics are used exclusively.

The steps for becoming certified organic can be found in the publication "Organic Vegetable Production" at *http://pubs.cas.psu.edu/FreePubs/pdfs/ua391.pdf*.

# 5. Transplant Production

**These recommendations apply only to plants grown under controlled conditions in greenhouses or hotbeds. Field-grown plants are covered under the specific crop in chapter F.**

Producing quality transplants starts with disease free seed, a clean greenhouse and clean planting trays. Many vegetable disease problems including bacterial spot, bacterial speck, bacterial canker, gummy stem blight, bacterial fruit blotch, tomato spotted wilt virus, impatiens necrotic spot virus, and Alternaria blight can start in the greenhouse and be carried to the field. A number of virus diseases are transmitted by greenhouse insects.

Buy disease-indexed seeds if available. To reduce bacterial seed-borne diseases in some crops (e.g., tomatoes, peppers, cabbages), seeds can be hot water treated. For some crops, chlorine treatment can also be useful but this will not kill pathogens inside the seed. For more detailed seed treatment recommendations, see chapter E, Disease Management (4.3. Disease Control in Seeds, Plant Growing Mix and Plant Beds). Prior to seeding in greenhouse areas, remove any weeds and dead plant materials and clean floors and benches thoroughly of any organic residue.

Transplants are affected by many factors, e.g., temperature, fertilization, water, and spacing. A good transplant is grown under the best possible conditions. A poor transplant usually results in poor crop performance, though in certain instances the timely exposure of transplants to specific stresses can enhance crop performance in the field.

Table A-1 presents optimum and minimum temperatures for seed germination and plant growth, the time and spacing (area) required to produce a desirable transplant, and number of plants per square foot. Seedless watermelon transplant production has specific requirements (See "Watermelons" in chapter F).

**Table A-1. Temperature, and Planting Recommendations for Transplant Production**

| Crop | Optimum Day Temperature (F°) | Minimum Night Temperature (F°) | Weeks to Grow | Square Inch per Plant | Number of Plants per Square Foot |
|---|---|---|---|---|---|
| **Broccoli** | 65-70 | 60 | 6-7 | 3 | 48 |
| **Cabbage** | 65 | 60 | 6-7 | 3 | 48 |
| **Cauliflower** | 65-70 | 60 | 6-8 | 3 | 48 |
| **Celery** | 65-70 | 60 | 9-12 | 3 | 48 |
| **Cucumber**[1] | 70-75 | 65 | 2-3 | 4 | 36 |
| **Eggplant** | 70-85 | 65 | 7-9 | 6-9 | 24 |
| **Endive, Escarole** | 70-75 | 70 | 5-7 | 2 | 72 |
| **Lettuce** | 60-65 | 40 | 5-6 | 1 | 144 |
| **Melon**[1] | 70-75 | 65 | 2-3 | 6 | 24 |
| **Onion** | 65-70 | 60 | 9-12 | – | – |
| **Pepper** | 70-75 | 60 | 8-9 | 4-6 | 36 |
| **Summer squash**[1] | 70-75 | 65 | 2-3 | 4 | 36 |
| **Sweet potato** | 75-85 | 70 | 4-5 | in bed | in bed |
| **Tomato** | 65-75 | 60 | 5-6 | 6-9 | 24 |

[1]Seed directly in container; do not transplant prior to setting in the field.

**Making a Plant-Growing Mix**: Pre-mixed growing media are available commercially (see below), but a good, lightweight, disease-free, plant-growing material can also be made from peat and vermiculite. The main advantage of making one's own mix is uniform and consistent composition, but it can also be less costly. Formulas for simple mixes can be found in chapter G Records and Resources (Section 2.4 and Tables G4 and G5).

**Commercial Plant Growing Mixes**: Commercial media are available for growing transplants. Most of these mixes will produce high quality transplants when used with good management practices. However, these mixes can vary greatly in composition, particle size, pH, aeration, nutrient content, and water-holding capacity. Commercial growing media will have added lime and may or may not have a starter nutrient charge (added fertilizer). Plants grown in those without fertilizer will require supplemental liquid feedings after seedling emergence. Plants grown in those with added fertilizers will require liquid feeding starting 3-4 weeks after emergence. If you experience problems with transplant performance, the growing medium (soil) should be sent to a soils laboratory for testing. It is recommended to mix 3 to 4 bags of commercial product together before filling trays.

**Treatment of Flats and Trays**: Flats used in the production of transplants should be new to avoid pathogens that cause damping-off and other diseases. If flats and trays are reused, they should be thoroughly cleaned after use and disinfested as described below. Permit flats to dry completely prior to use. One of the following methods of disinfestation should be used:

***Chlorine***: Dip flats or trays in a labeled chlorine sanitizer at recommended rates (3.5 fl oz. of a 5.25% sodium hypochlorite equivalent product per gal of water) several times. Cover treated flats and trays with a tarp to keep them moist for a minimum of 20 minutes. Wash flats and trays with clean water or a Q-salts solution (see below) to eliminate the chlorine. It is important that the bleach solution remains in the pH 6.5-7.5 range and that a new solution is made up every 2 h or whenever it becomes contaminated (the solution should be checked for free chlorine levels at least every hour using test strips). Organic matter will deactivate the active chlorine ingredients quickly.

***Q-salts*** (Quaternary ammonium chloride salts) : Compounds such as Greenshield, Physan and Prevent can be applied in the final wash of flats and trays during the chlorine treatment. Additionally, they can be used to wash exposed surfaces (e.g., benches, frames) in greenhouses.

**Transplant Trays and Containers**: Most transplants are grown in plastic trays with individual cells for each plant. Standard 10 x 20 inch trays can have 32 to over 500 cells. Larger cell sizes (32, 50, or 72) are best used for vine crops and for rooting strawberry tips. 72-cell and 128-cell trays are suitable for tomatoes, peppers, eggplant, and cole crops. Smaller cell sizes (128, 200, 288) may be appropriate for lettuce and onions. Larger Styrofoam transplant trays are also available in similar cell sizes. Larger cells hold more growing mix/soil and result in better transplant survival in the field, but use more greenhouse space and it takes longer to produce the root ball. Individual plant-growing containers may also be used for vine crops and early market crops of tomatoes, peppers, and eggplant. Various types of fiber or plastic pots or cubes are available for this purpose. If plastic pots or trays are reused, disinfest as described for flats.

**Seed Germination**: Normally, one seed is planted per cell. Seeds that are over-sown in flats to be "pricked out" (thinned to a uniform stand) at a later date should be germinated in 100% vermiculite (horticultural grade, coarse sand size) or a plant growing mix. It is recommended that no fertilizer is included in the mix or the vermiculite until the seed leaves (cotyledons) are fully expanded and the true leaves are beginning to unfold. Fertilization should be in the liquid form and at one-half the rate for any of the ratios listed in the Liquid Feeding paragraph below. Seedlings can be held for 3 to 4 weeks if fertilization is withheld until 3 to 4 days before "pricking out." Seed that is sown in tray cells, pots or other containers that will not be "pricked out" later can be germinated in a mix that contains fertilizer.

For earlier, more uniform emergence, germinate and grow seedlings on benches with bottom heat or in a floor-heated greenhouse. Germination rooms or chambers also insure even germination where higher temperatures can be maintained for the first 48 h. Trays may be stacked in germination rooms during this period but must be moved to the greenhouse prior to seedling emergence.

**Plant Growing Facilities**: Good plant-growing facilities (greenhouses) provide maximum light to the seedling crop. The greenhouse cover material (glass, plastic, fiberglass) should be clean, clear, and in good repair. The ideal greenhouse will also have floor-on or bottom-heating capabilities, either on the benches or on the floor, and provide good heating and ventilation systems for effective environmental control. Proper growing medium temperature ensures uniformity of the crop throughout the greenhouse by moderating normal temperature variations experienced with hot air heating systems. Bottom heating provides for a significant energy savings because the greenhouse does not have to be operated 10°F higher than the required growing medium temperatures for good germination and seedling growth. Internal combustion heating units located inside the greenhouse must be vented and have outside fresh-air intake and exhaust systems to provide air to and from the heater. Ventilation units must be adequate in size, providing 1.2 to 1.4 sq ft of opening for each 1,000 cubic feet per minute (cfm) fan capacity. Seedlings should not be grown or held in areas where pesticides are stored.

**Liquid Feeding of Transplants**: In most instances, additional nutrients will be needed by growing transplants. Commercially available 100% water soluble greenhouse fertilizer formulations are recommended (see also chapter C Irrigation Management, section 3. Fertigation). For most crops use a formulation with lower P than N and K levels (e.g., 21-5-20, 13-2-13, 20-10-20, 17-5-17, 18-9-18). If you plan to fertilize with every watering, begin with N concentrations in the 30 to 50 ppm range and modify the concentration as needed. Use higher rates for tomato, pepper and cole crops and lower rates for cucurbits (e.g., watermelon, squash). Use higher rates when temperatures are high (late spring and summer) and lower rates when temperatures are cooler. Fertilizer requirements may vary substantially with crop and growing conditions. For example, if fertigation is scheduled only once a week, N concentrations of 200 to 250 ppm may be required. Some growers may use a growing medium with no starter fertilizer. If that is the case, use 50 ppm N from emergence to first true leaf every 3 days, and 200 ppm N every other day from first true leaf to second true leaf.

For a less sophisticated way of applying nutrients, the following materials can be used for general use on transplants. Over an area of 20 sq ft, use 1 to 2 oz of 20-20-20 dissolved in 5 gal of water, or 2 oz of 20-10-15 dissolved in 5 gal of water. Rinse leaves after liquid feeding. Applications should be made weekly using these rates.

When using starter solutions for field transplanting, follow manufacturer's recommendation. If concentrations are above recommended levels, they can cause excessive growth and reduce transplant quality. Highly concentrated nutrient solutions often can cause plant salt injury and leaf burning. Over-fertilized transplants will often "stretch" and have impaired field survival. **Caution: High rates of starter solution can become concentrated and burn transplant roots when the soil becomes dry.**

**Watering**: Keep mix moist but not continually wet. Water less in cloudy weather. Watering in the morning allows plant surfaces to dry before night and reduces the possibility of disease.

**Transplant Height Control**: One of the most important considerations is managing "stretch" or height of transplants. The goal is to produce a transplant with a size that can be handled by mechanical transplanters or hand without damage, and that is tolerant to wind.

Most growth regulators that are used for bedding plants are not registered for vegetable transplants. One exception is Sumagic® which is currently registered for use as a foliar spray on tomato, pepper, eggplant, groundcherry, pepino and tomatillo transplants. The recommended label rate is 0.52 to 2.60 fl oz/gal (2 to 10 ppm) and 1 gal should be sprayed so it covers 200 sq ft of transplant trays (use 2 qt per 100 sq ft). The first application can be made when transplants have 2 to 4 true leaves. One additional application may be made at the low rate, 0.52 fl oz/gal (2 ppm), 7-14 days later, but do not exceed 2.60 fl oz per 100 sq ft for a season. Growers are advised to perform small-scale trials on a portion of their transplants under their growing conditions before large scale use.

For other crops alternative methods for height control must be used, e.g., the use of temperature differential or DIF; the difference between day and night temperatures in the greenhouse. In most heating programs, a greenhouse will be much warmer during the day than the night. The critical period during a day for height control is the first 2-3 hours after sunrise. By lowering the temperature during this 3-h period, plant height in many vegetables can be modulated. Drop air temperature to 50-55°F for 2-3 h starting just before dawn, and then return to 60-70°F. Crops vary in their response to DIF, e.g., tomatoes are very responsive, while curcurbits are much less responsive.

Mechanical movement can also reduce transplant height. This may be accomplished by brushing over the tops of transplants twice daily with a pipe or wand made of soft or smooth material. Crops responding to mechanical height control include tomatoes, eggplant, and cucumbers. Peppers are damaged by this method.

For some vegetables, managing water can be a tool for controlling stretch. After plants have reached sufficient size, expose them to stress cycles, allowing plants to approach the wilting point before watering again. Be careful not to stress plants so much that they are damaged.

Managing greenhouse fertilizer programs is another method for controlling transplant height. Most greenhouse growing media come with a starter nutrient charge, good for about 2-3 weeks after emergence. After that, apply fertilizers, usually with a liquid feed program. Fertilizers that are high in phosphorus will promote transplant stretch.

Exposing plants to outside conditions is used for the hardening off process prior to transplanting. You can also use this for transplant height control during the production period. Roll-out benches or wagons that can be moved outside of the greenhouse for a portion of the day can be used for this purpose (see below).

**Hardening**: It is recommended that transplants be subjected to a period of "hardening" prior to incorporation in the production field. Reducing the amount of water, lowering temperatures, and limiting fertilizers causes a check in growth (hardening) which prepares plants for field settings. When hardening vine crops, tomatoes, peppers, or eggplants, do not lower temperature more than 5°F (3°C) below the recommended minimum growing temperatures listed in Table A-1. Too low temperature may injure plants and delay regrowth after transplanting.

**Common Problems**: Poor growth and yellow or stunted plants are often attributable to the greenhouse growing medium. Greenhouse media manufacturers use good quality control measures but things can go wrong, e.g., through: inadequate mixing, missing or the wrong proportions of critical components (wetting agents, fertilizers, lime), or defective components (poor quality). Media can also be affected by poor handling and storage, most commonly when media are stored outside and bales or bags get wet, or if stored past the shelf life. Old media often are dried out and hard to rehydrate. If the medium is over a year old or possibly compromised, it should not be used (contact your supplier for inspections and tests on any suspect media). Avoid using overly dry or caked media, media that are difficult to loosen, media with a bad odor, water logged media or media that are resistant to wetting.

Most (but not all) media include a starter lime and fertilizer charge. The fertilizer is designed to provide 3-4 weeks of nutrients. If the fertilizer is missing, improperly mixed, or in the wrong proportions, seeds will germinate but seedlings will remain stunted. In this case, liquid fertilizer applications should start early.

Peat-based media are acidic in nature. Plants will perform well from pH 5.4 to 6.4. Lime is added to peat- based media and reacts over time with water to increase pH. Above pH 6.4, iron deficiencies in transplants are common. This also occurs if irrigation water is alkaline (has high carbonates).

In high pH situations (over 7.5), use an acidifying fertilizer (high ammonium content) for liquid feeds. Use of iron products such as chelated iron as a foliar application on transplants can accelerate plant recovery prior to the pH drop with the acid fertilizer. In cases with very high media pH, use of iron sulfate solutions may be needed to more rapidly drop the pH. Addition of dilute acid solutions to greenhouse irrigation water may also be considered in cases of excess alkalinity (for example diluted muriatic acid).

If lime is missing or inadequate from the growing medium, and pH is below 5.2, plants may exhibit magnesium deficiencies or iron or manganese toxicities. This also occurs in media that have been saturated for long periods of time. To correct this situation, apply a liquid lime solution to the medium and irrigate liberally.

Media that are difficult to hydrate may not have sufficient wetting agent or the wetting agent may have deteriorated; additional greenhouse grade wetting agent may be needed.

If the initial medium fertilizer charge is too high, or if excessive liquid or slow-release fertilizer feed is used, high salt concentrations can build up and stunt or damage plants (possible symptoms: leaf edge burn, “plant burn”, plant desiccation). Test the media for electrical conductivity (EC) to see if salt levels are too high. The acceptable EC will depend on the type of test used (saturated paste, pour through, 1:1, 1:2) so the interpretation from the lab will be important. If salts are too high, then leaching the growing media with water will be required.

Poor transplant growth or injury can also result from the following:

- Heater exhaust in the house caused by cracked heat exchanger, inadequate venting, use of non-vented heaters.
- Phytotoxicity from applied pesticides.
- Use of paints, solvents, wood treatments, or other volatiles inside the greenhouse.
- Use of herbicides in the greenhouse or near greenhouse vents.
- Low temperatures due to inadequate heater capacity or heater malfunction or excessively high temperatures due to inadequate exhaust fan capacity or fan malfunction.

**Grafting Vegetables**: Utilizing rootstocks for grafting has resulted in increased yields, fruit quality, and tolerance to abiotic and biotic stresses. Research on annual vegetable crops was limited until the last decade when the grafting movement started in Asia and Europe. Japan utilizes extensive grafting in the production of watermelon, cucumber, melon, tomato and eggplant. Grafting can overcome tissue damage and/or plant mortality caused by the soil-borne diseases Fusarium and Verticillium wilt, bacterial wilt, and nematodes. Grafting may reduce or eliminate the use of certain pesticides (especially soil fumigants) because the appropriate rootstocks will provide tolerance to many soil insect and disease pests. Grafting is also used to impart additional vigor to plants and to increase yields. Specific rootstocks have been developed for grafting the vegetables listed above. Selection of rootstocks will depend on the specific goals for grafting. There are often many rootstocks available. Consult your seed suppliers for more information.

Some commercial nurseries are starting to feature grafted transplants. As a rule, they are substantially more expensive than conventional transplants, so there should be reasonable assurance of the economic benefit. Any grower seeking to perform large-scale grafting should first consult technical resources, such as the websites in this section. Upgraded facilities and employee training will likely be necessary.

Two successful and easily performed grafts are the tube and cleft graft. The tube graft uses a 45° cut in the rootstock and the scion. The two pieces are subsequently joined together with the angles complimenting each other and held together with a clip. The cleft graft utilizes a 90° cut in the rootstock perpendicular to the soil surface. The rootstock stem is then cut in half down the center; this cut should be around ½ inch depending on the size of the rootstock stem and scion. The base of the scion is then cut to form a “V” that will fit the notch that was cut into the rootstock. A grafting clip is secured around the graft junction. This type of graft often requires a larger grafting clip than the tube graft. It is important that both the scion and rootstock stem diameter are similar. Several trial seedlings should also be grown prior to any large grafting operation to insure that the rootstock and scion seedlings grow at the same rate; if not, the stem diameters may not coincide, which can lead to a poor graft union.

Cucurbits such as watermelons, cucumbers, and muskmelons are often grafted using the one-cotyledon splice graft method. In this method, rootstock seedlings should have at least one true leaf and scion seedlings should have one or two true leaves. With a single angled cut, remove one cotyledon with the growing point attached. It is important to remove the growing point and the cotyledon together so that the rootstock seedling is not able to grow a new shoot of its own after being grafted. Cut the scion and match the rootstock and scion cut surfaces, and hold in place with a grafting clip.

One of the most crucial aspects of producing grafted seedlings is healing the graft junctions. After the grafts are clipped back together they need to be placed in a high humidity environment known as a healing chamber. A healing chamber can be constructed in various ways using wooden or metal frames and a plastic covering. The goal is to create a closed environment in which the humidity can increase and the temperature can be controlled. Open water pans or commercial humidifiers can be used to increase humidity. Propagation heat mats can be placed on the floor to control temperature and warm water pans to increase humidity. For the first several days in the healing chamber, light should be excluded as much as possible. The increase in humidity and decrease in light slow transpiration to keep scions from desiccating while vascular tissue reconnects the scion and rootstock. After 5 to 7 days in the healing chamber, seedlings can harden off in a greenhouse for several weeks before moving to the field. Grafting generally adds 2 weeks to seedling production. Grafting can be performed at various plant growth stages ranging from the 2 true leaf stage on.

## 6. Conservation Tillage Crop Production (No-Till Crop or Strip-Till Production)

Conservation tillage crop production systems are beneficial for a variety of reasons; but they require different management than conventionally tilled soils. Some benefits from no-tillage can be observed quickly such as reducing soil erosion, conserving soil moisture, and reduction in fuel and labor costs. Others benefits occur over time, such as reduction in soil compaction, improved soil structure, and increased soil organic matter. Eliminating tillage can also influence weed and disease severity.

Conservation tillage crop production systems can also pose several crop management challenges. Soil temperatures do not warm up as quickly in the spring; and this in turn can affect seed germination, nutrient cycling from crop residues, slower fumigation volatilization, and reduced transplant vigor. Type of crop residue, residue amount, and desiccation timing all impact soil temperature and should be taken into consideration. Modifications to planters and heavier equipment may be needed to accommodate no-till production. Small-seeded species may be more difficult to plant with no-tillage systems.

Conservation tillage systems may eliminate mechanical weed controls. Since tillage used for seedbed preparation is eliminated, and this tillage also controlled weeds and unwanted vegetation, most fields receive additional herbicide treatments. Tillage is replaced with non-selective herbicides (such as glyphosate) to control weeds and unwanted vegetation. Thermal weed control (such as flamers) may also be an option. Most other options, such as roller/crimpers, are not effective. Interrow cultivation with no-till cultivators have also been used with some success in conservation tillage programs for weed management; but these implements are not readily available. Flamers for interrow weed control is effective for small broadleaf weeds.

Nitrogen fertilizer must be managed properly when utilizing a conservation tillage production system. Crop residues typically contain an enzyme, urease, which can increase nitrogen volatilization from urea-containing fertilizer sources such as urea, liquid urea ammonium nitrate, or a variety of blends currently available. Management practices such as banding or incorporating nitrogen fertilizer with irrigation or rainfall should be considered to reduce urea-containing fertilizer contact with urease.

Nitrogen management in conservation tillage systems must account for microbial “tie-up”. High levels of crop residue (or unwanted vegetation) on the soil surface will result in microbes assimilating nitrogen and immobilizing it (not available to the crop). Research has shown that 25% or more nitrogen fertilizer may be necessary in the initial conversion years from conventional to conservation tillage until the soil reach an equilibrium. Previous crop residue (type and amount), current soil nitrogen concentrations, fertilizer sources, application timing, and application methods all need to be considered when making necessary nitrogen rate calculations.

Maintaining proper soil pH is one of the most important crop production consideration in conservation tillage and has significant impact on nutrient availability and toxicity. Mixing lime into the soil with tillage is not an option with no-tillage systems, so consider adjusting pH to the optimal level prior to initiating a continuous conservation tillage system. Lime has relatively low water solubility and leaches slowly through the soil profile. Eventually, fertilizer, organic matter decomposition, and rain will lower soil surface pH, but changes to subsoil pH will take a longer time. Continued liming based on soil test recommendations will maintain the proper pH.

Strip-tillage is a blend of tillage and no-tillage within the same field. A narrow strip of soil is mechanically tilled with specialized tools to incorporate fertilizers and plant residues, warm soils, and improve soil to seed contact. The area between the crop rows is managed as no-till.

Cover crops have been used extensively in the region and with conventional tillage the plant residue is incorporated into the soil. However, with no-tillage systems, the cover crops may add additional plant residue that needs to be considered with management decisions such as pre-plant vegetation control, slower soil warming, plant residue management at planting, and fertility management. The amount of cover crop biomass (determined by when the cover crop is terminated) will dictate whether additional management is necessary.

## 7. Mulches and Row Covers

A favorable environment for plant root systems can be achieved with the use of plastic mulches and trickle irrigation. Early in the season, additional advantages can be obtained by the use of row covers, which increase daytime air temperatures and hold ground heat during the night. This improvement in temperature can speed plant growth resulting in earlier harvest. Mulches also discourage weeds and, depending on the type used, insect pests.

**Plastic Mulches**: Black and white-on-black polyethylene film (0.75-1.25 mil) are the most popular mulches. Other mulches include blue, red, green IRT and metalized. Black mulches are generally used to warm the soil and white-on-black mulches are generally used to cool the soil. Different mulch colors and compositions impart new functional properties to mulch. Green 'IRT' types of plastic mulch increase soil temperatures more than black plastic and also suppresses most weed growth. Other color mulches such as red and blue are available. Results with these mulches have been inconsistent. Metalized or aluminized mulches repel certain insect pests (aphids, thrips, whiteflies) early in the crop growing cycle due to the reflectance of UV rays. This benefit is lost once the crop canopy covers the mulch. This can be useful in cucurbit and tomato crops to delay the onset of certain virus diseases vectored by thrips, aphids, and whiteflies. Yellow mulches attract cucumber beetles and may also attract other insect pests. Note that planting date and environmental conditions influence crop responses to color of mulch films.

Soil fumigation may be used in conjunction with any type of plastic for weed, disease, and insect management, depending on the fumigant label. As the cost of soil fumigation increases, growers will likely need to reduce application rates to maintain profitability. New mulches have been developed that have decreased permeability to fumigants. These "virtually impermeable film" (VIF) mulches keep the fumigant in the ground longer which allows for reduced application rates while maintaining efficacy. VIF mulches come in various colors for fall and spring plantings. Consult the fumigant label for the allowable reduction in use rate under VIF mulch. Consult the label for the plant-back period. The cost of VIF mulches is higher than that of low density mulches but this increase is usually offset by the savings gained from reduced fumigant rates. Another type of mulch has been developed that is more retentive than VIF mulch, i.e., "totally impermeable film" or TIF. Soil fumigant use rates may be further decreased if used in combination with TIF, consult the fumigant label (see also chapter E, section 1.5 Soil Fumigation).

**Fertilization**: Measure soil pH before considering a fertilization program for mulched crops. If a liming material is needed to increase the soil pH, the material should be applied and incorporated into the soil as far ahead of mulching as practical. For most vegetables, the soil pH should be at or near 6.5. If the pH is below 5.5 or above 7.5 nutrients may be present in the soil, but not available to the plants.

Ideally a drip irrigation system is used with plastic mulch. When using plastic mulch **without** drip irrigation, all plant nutrients recommended for standard cultural practices should be incorporated in the top 5 to 6 inches of soil before laying the mulch. If equipment is available, apply all the fertilizer required to grow the crop to the soil area that will be covered with mulch. This is more efficient and effective than a broadcast application over the entire field. Non-localized nutrients may promote weed growth.

All essential plant nutrients, including major nutrients (N, P, K) as well as secondary and micronutrients, should be applied according to needs from soil test results and recommendations and incorporated in the manner described above. Placing some of the required N under the mulch and then side dressing the remainder of the needed N along the edge of the mulch or in the row alleys after the crop becomes established has been found to be ineffective.

Applying some of the required N under the mulch and the remainder through the drip irrigation system is an effective way to fertilize. If using drip irrigation, see "Drip/Trickle Fertilization" in the crop sections in chapter F (i.e., eggplants, muskmelons, peppers, and tomatoes) for specific application rates.

**Soil Conditions for Laying Mulch**: Soil texture should be even and plastic should be laid so that it is tight against the soil in a firm bed for effective heat transfer. Prepare the soil by incorporating crop residues, minimizing large soil clods, and removing rocks and other debris that could interfere with good contact between the soil and plastic. Plastic can be laid flat against the ground or on raised beds. Raised beds offer additional soil drainage and early warming. Use of a bed shaper prior to laying plastic allows for fertilizer and herbicide incorporation and can assist in forming a firm bed. Combination bedder-plastic layers are also widely used.

Before any mulch is applied, check the soil moisture level. Optimally the soil moisture level is at or near field capacity (field capacity is the amount of moisture left after a rain or irrigation event after surplus water has moved out of the root zone by gravity). Ideally drip irrigation is used with plastic mulch. Being at field capacity is extremely important when drip irrigation is not used because this moisture is critical for early growth of the crop plants as soil moisture cannot be effectively supplied by rain or overhead irrigation to small plants growing on plastic mulch.

**Biodegradable Mulches**: Biodegradable plastic mulches have many of the same properties, and provide comparable benefits as conventional plastic mulches. They are made from plant starches such as corn or wheat. These mulches are weakened by exposure to sunlight, but are designed to degrade into carbon dioxide and water by soil microorganisms when soil moisture and temperatures are favorable for biological activity. Soil type, organic matter content, and weed pressure are other factors affecting breakdown. Unlike petroleum-based mulches, biodegradable mulches will usually be retained on the surface of the soil rather than be blown away from the application site. Most of the biodegradable mulch will eventually degrade or fragmentize, including the buried tucked edges. However, biodegradation is often unpredictable and incomplete. It is recommended that biodegradable mulch be incorporated into the soil at the end of the harvest or growing season. Cover crops can be planted the day after biodegradable mulch has been disked into the soil. In 2012, the National Organic Standards Board passed a motion allowing the use of 'biodegradable bio-based mulch film' provided that the mulch is 'produced without organisms or feedstocks derived from excluded methods' and meet certain degradation standards (at least 90% degraded in 2 yr or less). However, currently no biodegradable mulches meet the organic requirements

Field research has demonstrated that crop yields are comparable between biodegradable and non-degradable plastic mulches. Growers may be apprehensive about the cost of biodegradable mulch and the unpredictability of degradation rate. However, the initial cost is somewhat offset because disposal costs are eliminated. Below are some tips on using biodegradable mulch (excerpted from A. Rangarajan, Cornell University):

| | |
|---|---|
| **Storage** | Buy what you need each year. Product performance will be best with new product.<br>More rapid degradation may be seen with older product.<br>Store mulch rolls upright, on ends.<br>Pressure created from stacking may lead to the mulch binding together or to degradation.<br>Store mulch rolls in a cool, dark and dry location.<br>These products will start to degrade if stored warm, in sunlight and if rolls get wet. |
| **Application** | Do not stretch biodegradable mulch as tightly over the bed as standard plastic mulches (contrary to recommendations for standard plastic that performs best when laid tightly over the bed).<br>Stretching starts the breakdown of the biodegradable mulch. and will increase the rate of breakdown.<br>The product will mold to the bed like commercial food wrap soon after application.<br>Apply immediately prior to planting.<br>If applied too far in advance of planting, the mulch may not last as long as needed.<br>Sunlight and moisture will start breakdown. |
| **Incorporation into Soil** | Chisel or till the mulch into the soil as soon as possible after harvest to maximize breakdown.<br>Breakdown requires warm soil temperature and moisture.<br>If mulch is incorporated after soil temperatures have dropped it may still be visible in the spring.<br>However, as the soil warms, the product will further degrade and fragment.<br>Rototilling will result in smaller mulch pieces that breakdown faster.<br>Mulches will break down more quickly in soils with higher organic matter content. |

**Floating Row Covers and Low Tunnels**: These materials are being used for frost protection, hail protection, wind protection, to hasten the maturity of the crop and also to effectively exclude certain insect pests. Vented clear and translucent plastic covers are being used in low tunnels and are supported by wire hoops placed at 3- to 6-foot intervals in the row. Porous floating row covers are made of lightweight spun fibers (polyester or polypropylene). They may be supported with wire hoops, PVC pipes or metal conduit hoops for plants that require higher volume to grow or they can be placed loosely over the plants without wire hoops for low growing plants such as vine crops and strawberries. Upright plants have been injured by abrasion when the floating row covers rub against the plant.

Clear plastic can greatly increase air temperatures under the cover on warm sunny days, resulting in a danger of heat injury to crop plants. Therefore, vented materials are recommended. Even with vents, clear plastic has produced heat injury, especially when plants have filled a large portion of the air space in the tunnel. Heat injury has not been observed with translucent materials.

Row covers are usually installed over plastic mulch using a combination of mechanical application and hand labor. Equipment that will cover the rows in one operation is available. However, farmer-made equipment in conjunction with hand labor is currently the most prevalent method used.

When considering mulches, drip irrigation, and/or row covers weigh the economics involved. Does the potential increase in return justify the additional costs? Are the odds of getting the most benefit in terms of earliness and yield from the mulch, drip irrigation, or row covers favorable? Does the market usually offer price incentives for the targeted earlier time window? Are you competing against produce from other regions? Determine the costs for your situation, calculate the potential return, and come to a decision as to whether these strategies are beneficial.

**Plastic Mulch Removal**: Several methods of plastic mulch removal have been tried, but on small acreages it is removed by hand by running a coulter down the center of the row and picking it up from each side. Commercial tractor mounted mulch removal equipment is also available. High-quality, plastic mulch can be used for two successive crops during the same season when care is taken to avoid damage to the film. Thin wall (4 to 8 mil) trickle irrigation tape cannot be removed and reused. However, high-quality, 16-mil trickle tubing can be used a second season provided that damage is minimal and particles are excluded, allowing pores to be open when carefully removed. Crop foliage and weeds may hamper mulch removal. Prior to replanting or removing mulch, vegetation may be eliminated by using herbicides (see specific crop sections in chapter F), or delay removal until after frost.

**Plastic Mulch Disposal**: Dispose of plastic in an environmentally responsible manner. Disposal regulations vary between states and municipalities. Contact your local solid waste authority for recommended methods of disposal in your area. Some states have developed recycling programs for agricultural plastics; consult state authorities.

## 8. Staking and Trellising

Many vegetable crops benefit from the addition of structural supports in the field. The benefits include: 1) better use of the available space and light; 2) improved air flow and more rapid drying of foliage; 3) reduction in certain disease pathogens; 4) protection against plant breakage; 5) protection of developing fruits and other plant parts against rain, dew, and sun; 6) ease of harvest, and 7) possible higher net yields. The disadvantages include the cost of materials and installation, and disposal. Assess on a case-by-case basis if a structural support system is desirable.

Structural support systems have been used successfully for fresh market grape and cherry tomatoes, peppers, eggplants, cucumbers, climbing beans, and peas. The types of materials and how they are assembled differ for each crop. Specifics of the design and installation are included in chapter F. If materials fail during the growing phase, the resulting damage can be catastrophic. Use high quality construction materials and adhere to minimum size and spacing recommendations. For wooden stakes, it is recommended that a clear hard wood source be used.

It is a common practice to re-use wooden stakes over many seasons. Because stakes are in contact with the environment and plant material, there is a significant probability that surfaces will become infested with pathogens, especially bacteria. If left untreated, infested stakes may re-introduce diseases into the field, although the extent of this problem has not been determined. It is recommended that stakes are thoroughly disinfested before re-use.

The preferred (and most expensive) method of stake disinfestation is heat treatment. Pathogens are completely eliminated from wooden stakes with exposure to ≥ 220°F for ≥ 15 minutes. This can be accomplished in a large capacity autoclave, or seed dryer. It is unlikely that most growers will have access to such equipment. Alternatively, therefore, stakes may be exposed to disinfectants such as commercial chlorine solutions (sodium hypochlorite) or Oxidate® (hydrogen dioxide; see below). Research has shown that a 20-minute soak in a solution made of 5 to 20 parts by volume sodium hypochlorite (commercial bleach) to 80 to 95 parts by volume water is effective in eliminating pathogens **only from the surface** of wooden stakes. It is crucial to maintain the pH of the bleach solution within the 6.0 to 6.5 range, as effectiveness decreases at lower and higher pH levels.

Studies on stakes treated with bleach solutions show that pathogens may still be present beneath the surface at depths ≥ $1/16^{th}$ inch. Pathogens embedded within the stake may be able to migrate back to the surface and re-infest plants, although this has not yet been demonstrated. To improve the effectiveness of procedures for removing microbial pathogens from stakes, consider the following: Add a non-ionic surfactant to the disinfesting solution; increase the soaking time to ≥ 1 h; apply a vacuum during the stake soak; use a higher concentration or more potent source of hypochlorite (such as "heavy duty" or swimming pool grade chlorine); or use stakes comprised of non-absorbent stake materials (such as plastic or metal). Many growers have successfully used the commercial product Oxidate® or chlorine dioxide to disinfest stakes. Oxidate® is OMRI certified and had been demonstrated to be an effective control agent for several important plant pathogens. However, data on the efficacy of this treatment as compared to using heat or commercial chlorine solutions are not available.

## 9. High Tunnels

High tunnels are designed to improve growing conditions during the early spring and late fall growing seasons and to accommodate workers and equipment. In the mid-Atlantic region, year-round production of specialty crops is possible using freestanding high tunnels (Table A2). High tunnels are either freestanding or connected at the gutters to cover larger areas. Freestanding tunnels are generally between 14-30 ft wide and up to 100 ft long. High tunnels are typically tall enough for a person to stand straight up in at least part of the structure. While high tunnels are not greenhouses (generally no heat or automatic ventilation), the greenhouse principle is the basis for their function and design.

Taking the time to level the tunnel site prior to construction will make subsequent steps much easier. Spacing between high tunnels should be at least the width of the tunnels to facilitate snow removal, to provide for cross ventilation, and to reduce mutual shading. For freestanding high tunnels, metal bows approximately 1.75-2 inches in diameter are used as the support frame for a single layer of polyethylene covering (typically 6 mil greenhouse plastic that lasts 3-4 years). These bows are spaced 4 feet apart and are connected to metal posts, which are driven at least 2 feet deep into the ground. End walls can have removable framing to allow the use of power tillage and bed maker/mulch layer equipment within the tunnel.

Once the high tunnel is covered with plastic film, prepare the soil, apply and incorporate lime and pre-plant fertilizer as recommended for the intended crop or crops (See section F). High tunnels can considerably increase yield potential, thereby increasing nutrient requirements. Plant tissue testing should be conducted at important growth stages during the season to ensure adequate fertility requirements are maintained. See the Soil and Nutrient Management chapter for more details. Make beds, if needed, and install drip irrigation to supply moisture. Using a small bed maker/mulch layer, cover soil or beds with black or clear polyethylene to warm soil for spring crops. When transplanting crops into tunnels during July and August, use white or silver polyethylene mulch on the soil or beds rather than black polyethylene to reduce soil temperature and excessive heat buildup in tunnels.

For freestanding high tunnels, snow removal from the top of the tunnels may be necessary after heavy snowfalls. Snow may need to be removed from the sides of the tunnels as well to reduce/eliminate outside water intrusion into tunnels and collapse of tunnel sidewalls. Gutter-connected high tunnels are constructed with much lighter posts and bows and cannot be used for crop production during the winter. During the winter season, the plastic on gutter-connected high tunnels must be bundled and moved to the gutters for storage. Hence, freestanding high tunnels allow for year-round production while gutter-connected tunnels do not.

The keys to successful production of vegetable and other horticultural crops in high tunnels are crop scheduling, ventilation and moisture control. Table A-2 provides a relative planting and harvesting schedule for some vegetable crops produced using freestanding high tunnels in the mid-Atlantic region. When planting high tunnel crops in the spring, it is generally recommended to transplant vegetable crops 2-4 weeks earlier than the earliest planting date in the field on bare ground. If unusually cold night temperatures are experienced several days to weeks after planting vegetable crops in high tunnels, floating row covers, low tunnels, thermal blankets and/or portable clean burning propane heaters (11,000 to 44,000 Btu per hour) can be placed in high tunnels until more seasonal temperatures return.

The most critical component of the system is ventilation. In freestanding high tunnels, ventilation is accomplished by rolling up the side walls to the batten boards, approximately 5-6 ft above the ground on each side of the tunnel. In gutter-connected high tunnels, ventilation is accomplished by sliding the plastic covering aside creating ventilation openings in the roof bows, as well as by opening the end walls. Maintaining optimum growing conditions inside high tunnels without having extreme fluctuations in temperature and/or high humidity conditions can lead to early, high yielding and high quality crops. Checking and adjusting high tunnel internal temperature and humidity conditions several times a day will help ensure increased crop yields and profitability.

Depending on the crop to be grown, there are several production systems that can be used in high tunnels. Conventional tillage and establishment of crops may be efficient for cool season crops that can be direct seeded or transplanted such as, Swiss chard, spinach, collards or kale. For warm season crops, especially cucurbits (cucumbers, squash, cantaloupe and watermelon) and solanaceous crops, (potato, tomato, pepper and eggplant) use of raised beds with plastic mulch and drip irrigation is required for optimum yield, maturity and quality. Warm season vegetable crops dramatically benefit from higher soil temperatures in early spring in high tunnels. In addition, multiple cropping is possible from the initial raised bed/plastic mulch – drip irrigation system established in the spring. Permanent raised beds with a width of 24 inches may also be constructed in high tunnels using wooden boards measuring 2 by 12 inches. Use of permanent raised beds may limit crops grown on them depending on the distance between raised beds (center-to-center) within the high tunnel. Some growers successfully use 30-36 quart potting soil bags that are drip irrigated to grow high tunnel crops. These bags are placed end-to-end in rows and on a landscape fabric. Either one or two drip irrigation lines are inserted in planting holes in each bag. Additionally, small holes are cut on the bottom of the bags for drainage. High tunnel culture minimizes some diseases by reducing splash dispersal. In addition, appropriate adjustment of the plastic sides also will minimize leaf wetness duration.

Some diseases are prevalent in high tunnel environments. Leaf mold, powdery mildew, timber rot and Fusarium wilt can become problematic. Cultural practices such as sanitation (removal of plant refuse), grafting and compost amendment can minimize disease. Fumigants can be used to reduce levels of soilborne pathogens. Conventional fungicides and several fungicides approved for organic production are available for in-season management. When high tunnel sides are raised, fungicides and bactericides labeled for field use are allowed. When sides are lowered, fungicides and bactericides labeled for greenhouse use should be used (see Table E-10 "Selected Fungicides and Bactericides Labeled for Greenhouse Use" for specific disease and crop recommendations). See also Rutgers Cooperative Extension Fact Sheet No. 358 titled: "Important Diseases of Tomatoes Grown in High Tunnels and Greenhouses in New Jersey" (available at *http://njaes.rutgers.edu/pubs/publication.asp?pid=fs358*). This information is applicable to all states in the mid-Atlantic U.S. region.

**Table A-2. Planting and Harvesting Schedule for Freestanding High Tunnel Vegetable Crop Production**
Abbreviations: TRP=Transplanting, DS=Direct Seeding.

| Crop | Method | Average High Tunnel Planting Dates | Average High Tunnel Harvest Dates |
|---|---|---|---|
| Beet | TRP or DS | February-April; August-October 15 | October-May |
| Bean (Snap) | TRP or DS | April-September 1 | June-October |
| Bok Choi | TRP or DS | February-November | Year-round |
| Broccoli | TRP or DS | March-April; August | May-June; October- November |
| Cabbage (Green) | TRP or DS | March 15-May 15; August 1-15 | May-December |
| Cabbage (Chinese) | TRP or DS | February 15-April 15 | April-June; October-December 10 |
| Carrot | DS | February 1-April 15; August-October | March-June; November-April |
| Cauliflower | TRP or DS | March 15-April 15; August | May-June; October-December 10 |
| Chard | TRP or DS | Year-round | Year-round |
| Cucumber | TRP or DS | April-September 1 | May-October |
| Eggplant | TRP | April 15-August 15 | July-October |
| Garlic | DS | October-November | June-August |
| Kale | TRP or DS | January-April 15; August-November 1 | February-June; September-January |
| Kohlrabi | TRP or DS | August | October-December |
| Leek | TRP or DS | February 15-November 1 | Year-round |
| Lettuce | TRP or DS | February 1-October 15 | Year-round |
| Onion (Bunching Green) | TRP or DS | October-December; February-June | March-December |
| Onion (Bulb) | TRP | February-March; October-November | May-July |
| Pea | TRP or DS | February 14-April 15; August-September 10 | May-June; October-November |
| Pepper (Bell) | TRP | April-July 20 | June-November |
| Potato (Irish) | DS | February 14-March 15; August | May-June; October-November |
| Radish | DS | February-April; October-December | February-May; November-January |
| Spinach | DS | January 1-May 1; August-December | January-May; October-December |
| Summer Squash | TRP or DS | April-May | May-June |
| Tomato | TRP | March 25-July 15 | June 15-December 5 |
| Turnip | DS | February-April; September-December | February-May; November-January |

# 10. Greenhouse Production

Many growers have an interest in increasing productivity as well as having a seasonal product such as tomato, sweet pepper, cucumber, or lettuce year-round. To do this in the mid-Atlantic U.S., a temperature-controlled greenhouse structure is needed. Greenhouse production requires a much greater level of and often entirely different strategies of management compared to field production. Greenhouse production generally requires different varieties, nutrient sources, plant training, and pest management than field production. Hydroponic systems are commonly used.

The extensive differences between greenhouse and field production preclude the inclusion of these techniques in this guide. There are many complete guides for the production of vegetables in greenhouses that have been developed and distributed through the cooperative extension service in various states. Links to some guides are provided below. This list is not all-inclusive and does not endorse these guides exclusively.
*http://edis.ifas.ufl.edu/topic_book_florida_greenhouse_vegetable_production_handbook*
*https://ag.umass.edu/sites/agcenter/files/pdf-doc-ppt/p1828.pdf* (for tomatoes)
*http://ceac.arizona.edu/intro-hydroponics-cea.*

# 11. Wildlife Damage Prevention

Farms provide food and shelter for a variety of wildlife species. Although many wildlife species do not cause damage to agricultural crops, some can inflict serious economic losses on growers. What often makes effective resolution more difficult is that surrounding private lands and suburban neighborhoods provide refuge for wildlife that may be causing damage on farms and to which a grower has no access.

A wildlife damage management plan that proactively prevents or reduces conflict is recommended. As a part of your plan, you should delineate areas of your property where zero tolerance for damage exists, while other areas most likely can tolerate some damage. In most instances, wildlife of damage represents another cost of doing business; it's the severely damaging episodes must be avoided. The plan also should specify what management techniques you want to utilize and when they would be employed. Wildlife damage management practices can be divided into 3 major categories: husbandry methods, non-lethal techniques, and lethal techniques. This also is the order in which application should be implemented; lethal techniques are methods of last resort. Growers should recognize that many approaches will have varying levels of effectiveness and acceptable risk. Generally, an integrated wildlife damage management approach that employs several damage abatement techniques proactively over time will be more effective than a reactive strategy that relies on only a single approach.

A wide variety of damage management options exists, but not all may be suitable for use in all cases. Some options are more effective than others; some are temporary and intended for short-term, localized use, whereas others are more suited to permanent, long-term needs. Each situation where conflict between wildlife and people is occurring is likely to be unique, so management options usually need to be tailored to a specific site.

Capital and implementation costs associated with each management option also vary. Before deciding on a management technique, estimate the direct and indirect annual losses you actually experience from wildlife damage. A direct cost would be the yield lost by consumption of the crop. An indirect cost would be the amount of time you spend per year, trying to reduce or eliminate damage. Calculating an estimated total annual cost, in terms of actual economic loss due to wildlife, will help you decide which strategies are the most cost-effective. In some instances, it may be more practical to simply tolerate damage than to attempt to manage it. To determine the need for control, to select the most appropriate control technique, and to evaluate the techniques' effectiveness, it's always best to conduct pre- and post-treatment surveys.

Prior to employing any damage abatement practice, you must assure that you have correctly identified the species doing the damage. Do not assume that because you see an animal on your farm that it is causing damage. Wildlife populations are regarded a public resource and many of the animals that may cause damage to your farm are protected by state and federal laws. In addition, many damage management practices (*e.g.*, trapping, shooting, pesticide applications) are species specific and based on established regulation or code. If you mistakenly assign blame for damage to the wrong wildlife species, in addition to employing a technique that may not be effective, you also may find you are using an illegal approach. Therefore, before implementing any management practices, check with your county extension agent, local conservation police officer, or your district wildlife biologist to review depredation permit requirements and/or legal issues related to "take" or use.

**Bears**

The damage caused by black bears to field crops often is characterized by localized, circular patches where nearly all stems or plants have been trampled, pulled down, or broken. In corn fields, bears usually will consume all the corn on a cob before moving on to another. Scat and footprints typically are present in the area of feeding activity. There are no guaranteed bear management strategies that offer complete protection against crop damage, but several strategies used in combination may offer some relief.

**Cultural practices and habitat modification** can help to deter bears from entering fields. Restricting access to potential food resources, such as storing feed in bear-resistant containers, disposing of animal carcasses, and removing organic wastes, will lessen the overall attractiveness of the property to bears. Containing livestock in pens away from wooded areas may reduce negative interactions, particularly during calving/lambing season. Because bears generally avoid open areas away from protective cover, maintaining a mowed buffer approximately 50 yards wide around crop fields, particularly where fields are adjacent to the woods, may reduce bear activity. Alternating or strip planting row crops may help reduce protective cover afforded to bears.

**Fencing** is very effective in reducing bear damage; however, fencing can be expensive and may not be cost-effective for all farmers. Electric fencing is the most effective design and thus is recommended in most instances. To be most effective, fences should utilize high voltage ~6,000 volts), low-impedance (short-pulsed) systems. When first installed, bears should be lured to the fence with an attractant (*e.g.*, peanut butter, sardines) so they learn to associate the fence with a negative consequence. Fences should be baited at approximately 3 ft along the entire perimeter to encourage shock delivery to the muzzle.

**Sensory deterrents** have been used to deter black bears from crop fields. Pyrotechnics, horns, bright lights, propane cannons, and other devices provide both visual and auditory stimulation. The success of these techniques is highly variable. Bears usually become habituated to consistent or repetitive disturbance, and sensory deterrents should be switched and relocated often. Where bears have become tolerant of human activity, sensory deterrents often will not be effective. Human-conditioned bears can be dangerous, and caution is advised.

**Shooting** problematic black bears should be viewed as a last resort management practice, but may be necessary as means to reduce persistent crop damage caused by a single returning individual or family group. Special kill permits are required to "take" bears, so farmers need to work closely with their state wildlife agency. Farmers having persistent damage should develop relationships with local bear hunters or chase clubs to increase the level of pursuit activities on or adjacent to the farm as a means of reducing future losses. **This practice is not permitted in some jurisdictions. Consult your local Wildlife Management Authority.**

**Birds**

Blackbirds refer to a group of 10 species, including common grackle (*Quiscalus quiscula*) and brown-headed cowbird (*Molothrus ater*). Bird damage most often consists of holes and/or surface blemishes from the pecking of fruits, bulbs, or stems. Proper identification of the bird species is relatively easy since it is common to see blackbirds in and around farming operations. European starlings (Sturnus vulgaris) and common pigeons (Columba livia) also are common to farms, where they inhabit the rafters of barns, warehouses, and other structures. Birds inside packinghouses represent a serious source of fecal contamination, which may violate USDA food standard guidelines. Fecal contamination of fruits and vegetables in the field can occur if fields are located near a bird roost where large numbers of birds congregate. Blackbirds are considered migratory species and thus are granted **protection** under the federal Migratory Bird Treaty Act. Therefore, it is imperative to check with the state Fish and Wildlife authority before implementing any management to ensure compliance with state and federal wildlife laws.

**Cultural practices and habitat modification** may provide some reduction of crop damage. Because the most severe instances of blackbird damage commonly occur within 5 miles of roosts, planting highly attractive crops outside of this radius is recommended. Blackbirds generally do not prefer soybeans, hay, wheat, or potatoes. By planting crops that are more attractive to blackbirds farther from known roost sites, damage from birds to these higher value crops may be reduced. Planting multiple crops at the same time in other nearby fields may to reduce damage overall as the abundance of resources simply overwhelms the birds' needs. Modifying or relocating roost areas may reduce the number of birds in the area. For example, eliminating stands of bamboo or thinning dense conifer stands have been shown to reduce crop damage by dispersing blackbirds away from crop fields. Removal of about of 1/3 of a tree's crown or a 1/3 of a stand of trees has been successful in reducing or dispersing birds from a roost. Keep in mind, however, that you are also modifying habitat used by other non-destructive bird species. Providing hunting perches for raptors may reduce blackbird numbers as a result of the threat of predation.

**Exclusion** typically is practical only on small acreages or for high-value crops. Lightweight netting has been used successfully to prevent bird damage either by draping it over individual plants or constructing a frame stretching netting over an entire block of plants. To prevent birds from entering packinghouses, netting or some other type of barrier, should be placed over openings larger than 1/2 inch. In doorways where frequent pedestrian, vehicle, or machinery traffic occurs, hang heavy plastic or rubber strips, or install self-closing doors to prevent birds from accessing the building.

**Repellents** can be used to mitigate bird damage. Methyl anthranilate, the primary ingredient of artificial grape flavoring, is registered by EPA for use as a bird repellent. However, methyl anthranilate remains viable for only approximately 3 days, so it loses maximum efficacy quickly when exposed to UV radiation and weathering. Sucrose solutions may be applied to fruits to deter birds, but the efficacy of this method is not well documented and actually may attract other pests, such as Japanese beetles.

**Scare tactics** have been shown to be effective for relatively short-term protection of vegetable crops. Blackbirds are intelligent animals and quickly will habituate to repetitive or predictable patterns and disturbances. Frightening methods must be changed and/or relocated often to maintain the desired effect. Frightening devices include both visual and auditory deterrents. Pyrotechnics (*e.g.*, propane cannons and shotguns), mylar balloons and tape, raptor-shaped kites, scarecrows, flashing lights, water sprayers, and tape-recorded bird-distress calls or predator attack calls all represent examples of harassing techniques, but success of these devices varies substantially. In general, scare tactics should be activated early to mid-morning and mid- to late afternoon, when birds are most active. For maximum effectiveness, it is best to use two or more devices in combination with each other, vary the times and places they are employed, and be persistent.

Chemical frightening agents mixed into bait piles may be applicable in specific situations. Birds that ingest the treated bait fly in an erratic fashion, produce distress calls, and usually die. This unusual behavior triggers an alarm response the remaining birds in the flock, causing them to vacate the area. Dead birds should be collected and disposed of properly. However, use and application of such chemical agents is restricted only to certified applicators (usually representatives of USDA APHIS-WS). Check with your local county extension agent about the possibility of employing chemical frightening agents on your farm.

**Miscellaneous notes:**. Some states allow growers to shoot crows that are in the act of damaging crops, but this may not be universal in all states. Also, European starlings are considered to be a non-native species and thus do not have protection under migratory bird laws. Therefore, farmers are allowed to shoot starlings without need for any permit or further authorization, but it is recommended that farmers alert their municipality and/or neighbors to avoid negative consequences from the public.

## Deer

Deer damage may occur in the form of feeding, antler rubs, and/or trampling of crops. Deer browsing (feeding) damage can be recognized by a torn, jagged appearance on vegetation or a ragged break on woody material. Most browsing damage occurs from ground level and up to 6 ft above. Residual damage may occur from the trampling or matting down of vegetation as deer travel through crop fields or bed down to rest. Antler rub damage, which occurs as males shed the velvet from their antlers each autumn, can be identified as scarred saplings, broken limbs, bruised bark, and/or exposed wood. Rubs usually are located on the trunks of trees up to 3 ft above ground level.

An effective deer management strategy should incorporate several alternatives, considering the full suite of available husbandry, non-lethal, and, where warranted, lethal options. Recognize that each method carries with it both benefits and drawbacks; therefore, an accurate assessment of management needs and likely outcomes is critical.

**Habitat modification** is a form of husbandry that involves changing the landscape to make an area less attractive to deer. White-tailed deer are creatures of edges; they prefer habitats where two or more vegetation types or age classes meet. Habitat modification usually involves eliminating vegetation, planting non-palatable ("deer-resistant") species, or creating cover or foraging areas to attract deer away from managed areas. This strategy has been used effectively to reduce incidences of deer-vehicle collisions and also browsing on residential vegetation and commercial landscaping.

**Harassment or scare tactics** are intended to persuade deer to leave an area where they are not desired. Examples of scare techniques include dogs, auditory deterrents, such as propane cannons and sonic devices, and visual deterrents, such as bright lights. Although audio and visual deterrents are used more often on farms, dogs contained within invisible fencing have been used with some success on farms, depending on the number and aggressiveness of dogs and size of area needing protection. Dogs tied to chains or ropes are not effective because deer can detect that the dog's movement is restricted. Hazing campaigns generally are better suited for areas where damage from deer is minor or where other strategies may be prohibited (*e.g.*, hunting).

**Fencing** can be an effective management tool for eliminating or reducing deer damage and, in some cases, may be the preferred damage abatement option. When attempting to protect large areas, permanent high-tensile wire (HTW) fences are recommended. These fences consist of a series of electrified smooth wires spaced about 8 inches apart and extend about 8-10 ft in height. HTW fences are durable and long-lived, but do require periodic maintenance and monitoring to assure maximum cost-effectiveness. Temporary HTW electric fencing or fences that use polytape strands are other alternatives, usually best suited to for smaller acreages. When using any form of electrified fencing, the unit should be charged at all times to prevent deer from becoming habituated to it and gaining confidence by testing it during down times. Electric fences that have been baited with an attractant (for example peanut butter) demonstrate noticeable enhanced success over non-baited fences, as deer are more likely to develop an immediate association between the fence and its negative consequence when drawn in by baiting. The addition of cloth strips, flagging, and reflectors certainly increase visibility, but have displayed only marginal improvement in efficacy over fences lacking such visual cues. Although other fencing alternatives exist, such as double-barrier fencing (2 rows of fence placed approximately 4 ft apart), heavy plastic fencing, and strands of monofilament line decorated with flagging tape streamers, none provide the level of protection or cost-effectiveness of a well-designed and properly installed and maintained electric HTW fence. It is important to note that no type of HTW fence will eliminate all penetration by deer. If complete and absolute protection from deer is desired, the only fence design that can guarantee that outcome is a 10 foot tall (minimum) woven wire fence. However, in most situations, producers typically cannot justify the costs of procurement and installation of such a fencing system.

**Repellents** produce tastes, odors, or a combination of taste and odor that animals find offensive and thus are encourage deer to avoid the area being protected. There are 2 types of repellents: contact repellents and area repellents. Contact repellents are applied directly to vegetation or objects by spraying, shakable powders, or using a brush and repel by taste and/or odor. Area repellents are applied in the general vicinity of the protected object and repel primarily by odor. Repellents are can be expensive, based on initial cost of materials, but more so by the need for frequent reapplication. Rain can wash repellent off of protected vegetation, even if a “sticker” is used. The attractiveness of the food resource to deer, the density of deer in the area, and the availability of other natural foods in the area all influence effectiveness. Many repellents are labeled for use only on dormant vegetation or on non-consumable products, so growers must be sure to follow the manufacturer’s instructions. Repellents used during the growing season must be applied as new plant growth emerges to assure for maximum effectiveness. Regardless of the type of repellent used, all repellents are intended to reduce, rather than eliminate, deer damage; repellents should be used in conjunction with other damage abatement techniques to maximize overall success.

**Reproductive abatement:** Although there is great interest in and much research being conducted on the use of Contraceptives (chemicals given to female deer to disrupt reproductive behaviors), only specially trained wildlife professionals are permitted to administer this treatment (typically through use of a dart gun). To date, no effective reduction in population numbers, and thus a concurrent reduction in damage, has be achieved using contraceptives in free-roaming populations of deer. Success has been realized only in isolated contained populations where access to nearly all members of the population can be attained (*e.g.*, on islands, in confined city parks, etc.). This is a labor-intensive and costly strategy, and because individuals consistently move into and out of a population, is extremely difficult to treat a sufficient number of individuals or to know which individuals already may have been treated. Research to improve fertility control methods is ongoing.

**Trap and transfer** involves trapping deer in a specific area and physically moving them to another location. There are several techniques for trapping deer, including box traps, Clover traps, netted cage traps, drive nets, drop nets, rocket nets, corral traps, net guns, and immobilization drugs delivered through a dart. This strategy is labor-intensive, costly, and impractical at large scales due to poor survival of translocated individuals, a lack of suitable relocation sites, and the risk of spreading disease. Most states now ban the translocation of deer. **This practice is not permitted in some jurisdictions (*e.g.*, Virginia). Consult your local Wildlife Management Authority.**

**Trap and euthanasia** involves trapping deer and euthanizing the animal according to methods approved by the American Veterinary Medical Association. Deer are baited to a trap site and captured using box traps, Clover traps, drop nets, or rocket nets. Once captured, deer may be chemically immobilized prior to euthanasia. Approved methods for inducing death are barbiturate injections delivered intravenously or into the abdominal cavity, inhalant anesthetics, or potassium chloride in conjunction with general anesthesia. Use of a penetrating captive bolt gun is also approved if the animal is restrained to allow for accuracy. Captive bolt gun euthanasia is considered controversial because deer euthanized in this way can experience trauma if the process does not occur quickly. This method also is labor intensive and more expensive than other management strategies. Chemically or captive bolt gun euthanized deer cannot be consumed by humans. **This practice is not permitted in some jurisdictions (*e.g.*, Virginia). Consult your local Wildlife Management Authority.**

**The Community-Based Deer Management Program** addresses the need for deer population reduction in environments where traditional management methods are not an option. Under this program the state Fish and Wildlife authority cooperates with municipal, county, and federal agencies to provide technical assistance in developing alternative deer management options. Some options include sharpshooting, noise-suppressed firearms, and controlled hunting. State authorities have issued permits for special deer management areas where alternative control methods may be employed. Alternative control methods may only be employed after a series of municipal and state approvals are granted. **This practice is not permitted in some jurisdictions (*e.g.*, Virginia). Consult your local Wildlife Management Authority.**

**Regulated hunting** involves the use of hunters to harvest deer in accordance with defined seasons, bag limits, and population objectives. Hunting legally takes place during any of the various deer hunting seasons (archery, muzzleloaders, shotguns, and general firearms) established by the state Fish and Wildlife authority. Regulated hunting is the most cost-effective and efficient method to manage deer populations and is the only means to manipulate deer numbers statewide. See your state Fish and Wildlife authority for details on these permits.

**Permits to Shoot**, commonly referred to as a “Depredation Permit” or “Kill Permit” are issued by the state Fish and Wildlife authority to owners or lessees of land who are experiencing crop damage. Localized or conditional hunting permits are highly variable among jurisdictions, **consult your local authority**. These permits allow growers a mechanism to manage damage situations during times of the year when the regulated hunting season is closed and "take" normally would not be allowed. Depredation permits also may help regulate local deer populations, particularly in areas that receive only limited hunting pressure (*i.e.*, farms surrounded by residential properties). For more information or to apply for a depredation permit, contact your state Fish and Wildlife authority.

**Controlled hunts** combine conventional deer hunting methods with more stringent controls and restrictions on hunter activities. Participants in controlled hunts are chosen by various methods, ranging from random lotteries of licensed hunters to rigorous hunter-selection processes designed to determine hunting proficiency and disposition as means to reduce conflicts with the public or other hunters. Specific restrictions and controls applied to hunting activities will depend upon the needs and concerns of landowners, elected officials, and other stakeholders, but they usually involve measures similar to hunting regulations during normal deer hunting seasons.

Because deer populations range over multiple parcels or farms, management of deer numbers cannot be implemented effectively on single properties. Research clearly indicates that greater success in attaining population objectives can be achieved by developing and implementing a comprehensive **Community-Based Deer Management Program**, especially in environments where traditional management methods are not an option. Under such a program, the state Fish and Wildlife agency works with municipal, county, and federal agencies to develop alternative deer management options tailored to that specific community. Some options include sharpshooting, noise-suppressed firearms, and controlled hunting. State authorities have issued permits for special deer management areas where alternative control methods may be employed. Alternative control methods may only be employed after a series of municipal and state approvals are granted.

## Groundhogs

The most obvious signs of groundhog presence, aside from actually seeing the animal, are the entrances to a groundhog burrow system. Groundhog burrow systems are characterized by a large mound of excavated earth at the main entrance. The diameter of the main entrance may measure 10-12 inches. There are usually 2 or more additional entrances to a burrow system, and the secondary entrances usually will be well hidden. Groundhogs prefer leafy vegetable crops, but will utilize any crop throughout the growing season Seasonal or cyclic reproductive patterns may influence population numbers and the extent of damage.

**Habitat modification** is not a feasible strategy for minimizing groundhog damage.

**Exclusion** with fencing can be an effective short- or long-term strategy, depending on the type of fence and the size of the area to be protected. An electric wire placed 3-4" above the ground can deter groundhogs from entering a protected area. However, a determined groundhog eventually will dig under the wire and gain access to the area.

Woven mesh or chicken wire fencing provides a more permanent solution. Mesh openings should be ≤ 2.5 inches, and the fence should extend at least 3 ft from the ground. The top 15 inches of the fence should extend backward at a 45o angle to prevent individuals from climbing over the top. To prevent groundhogs from digging under the fence, the bottom edge of the fence should be buried at least 10 inches beneath the ground, with an additional 6-8" section bent outward at the bottom of the trench. Groundhogs are excellent climbers, so fence posts should be placed on the inside of the fence and greater deterrence has been achieved where the fence material is not drawn taut or rigid, but instead left somewhat loose.

**Fumigants** are effective in reducing groundhogs. Gas cartridges (sodium nitrate) currently are registered for this purpose. Ignited gas cartridges are placed in the burrow system after all but the primary entrance are sealed. As the cartridge burns, thick fumes are emitted and fill the burrow system. Burrows can be treated with gas anytime of the year, but this method is most effective in the spring before the young emerge. Gas cartridges are a GUP and can be purchased at most farm supply stores. A note of caution when using gas cartridges – because the gas cartridge must be ignited for proper use, a fire hazard does exist. Therefore, gas cartridges should not be used in burrows located under wooden sheds, buildings, or near combustible materials. Newly resident animals may recolonize empty burrow systems, so continued vigilance in recommended.

Aluminum phosphide tablets, placed deep inside the main burrow entrance, are another type of fumigant that can provide effective groundhog control. The tablets react with the moisture in the soil, creating hydrogen phosphide gas. Soil moisture and tightly sealed burrow entrances are important for the fumigant to be used effectively. The tablets are approved for outdoor use on non-cropland and orchards. Aluminum phosphide should not be used within 15 ft of any occupied building or in areas where gas could escape into areas occupied by animals or humans. Aluminum phosphide is a RUP and can be applied only by a certified pesticide applicator.

**Trapping** is effective in removing particularly problematic individuals. However, new groundhogs from the surrounding area quickly will reoccupy the territory. Steel leghold traps are illegal in some states, so check with your state wildlife agency to determine what is legal. However, a medium-sized live trap baited with a variety of baits (*e.g.*, lettuce, apples or plum tomatoes) can effectively trap groundhogs. Traps should be placed at main entrances or along major travel corridors and checked at least once every 24 hours. Once captured, the groundhog may be killed humanely or released off-site. If the groundhog is released, some states regulate where and how the live animal is handled. No releases are allowed on federal, state, county, or municipal land. **This practice is not permitted in some jurisdictions (*e.g.*, Virginia). Consult your local Wildlife Management Authority.**

**Shooting** groundhogs that are damaging crops or farmland is approved at any time of the year. Although groundhogs are considered a game species in some states (it is a "nuisance species" in VA), farmers do not need a valid hunting license to shoot nuisance groundhogs. Growers should verify with the state wildlife agency which weapons that are legal for this purpose in your state.

**Rabbits**

Rabbits can damage vegetation by clipping branches, stems, and buds. Damage may become especially pronounced during the heavy snow cover on overwintering vegetables or in the spring when plants are emerging from the ground. Vegetation that has been clipped by rabbits is characterized by a cleanly snipped, 45-degree angle cut where the damage has occurred. Rabbit tracks and their pelleted scat are easily recognizable.

Growers should adopt **cultural practices** and conduct **habitat modification** to maintain well-groomed plots and eliminate brush piles, heavy vegetation, and other cover in and adjacent to crop production sites that serve as nesting sites. However, removal of cover may be detrimental to other desirable wildlife species that also depend on brush piles for protection or shelter. Habitat modification techniques that enhance the success of rabbit predators (*i.e.*, fox, coyote, and raptors) will help to regulate rabbit numbers. Planting alternative crops in adjacent tracts has been suggested as a means to deter them from high-value crops, but this approach typically serves to attract or support higher numbers of rabbits.

**Exclusion** of rabbits through use of fencing can be effective. A 2-foot high fence consisting of 1-inch or smaller mesh and constructed of any metal (rabbits will gnaw through plastic) will eliminate most rabbit damage. To prevent rabbits from accessing snow-covered fields, consider increasing the height of the fence. The bottom of the fence should be buried 12 inches in the ground and bent outward away from the crops at a 90-degree angle. Larger areas can be protected with double-strand electric fencing.

Rabbit guards made of metal wire with ¼- to ¾-inch mesh may be effective in protecting individual high value specimens. Hardware cloth can also be used. Rabbit guards should be placed 1-2 inches away from the plant. Do not allow debris to accumulate inside these screen guards as this creates an ideal environment for borer infestation and may attract voles. All guards should be anchored at ground level. A good way to do this is with several shovel-fulls of pea-sized gravel, placed inside and outside the guard. The gravel will also prevent mice from injuring plants.

**Miscellaneous methods:** Harassment techniques, such as dogs and water-driven scarecrows, provide only short-term protection. Contact (*e.g.*, thiram-based) and area (*e.g.*, naphthalene) repellents have also been used for rabbit control with variable effectiveness; however, most rabbit repellents are not approved for use on foods grown for human consumption, so check the active ingredients of any product before use. Rabbits are classified as a game species and, as such, can usually be hunted during open rabbit seasons. Finally, trapping rabbits using either homemade or commercial live-traps may be a viable option if damage is not too extensive. Consult the state Wildlife agency prior to implementing any hunting or trapping program to assure compliance with existing regulations.

**Voles**

It is important to determine which species of vole occurs in your crop production sites. Vole species most commonly associated with depredation issues in the Mid-Atlantic region are the **meadow vole** (*Microtus pennsylvanicus*) and the **woodland vole** (*Microtus pinetorum*). Meadow voles, also called meadow mice, are about 5½ to 7½ inches long, with fur that ranges from gray to yellow-brown with black-tipped hairs; they also display a bi-colored tail. Woodland voles are about 4-6 inches long, have red-brown fur, and a tail about the same length as the hind foot. Vole populations are cyclic, where cycle peaks last approximately 1 year before the population abruptly crashes. It is during these peak times where the potential for significant crop damage is greatest.

Because voles remain active year-round, the damage they cause to crops can occur at any time, depending upon the crop. In vegetable crops, damage usually occurs in spring, as young plants are emerging. Voles are generalist herbivores, so they feed on roots, shoots, tubers, leaves, and seeds of many different plants. Meadow voles spend much more time above ground than do woodland voles, but both species inflict serious damage by feeding on the subsurface root systems of plants. Aboveground damage frequently consists of their gnawing on woody perennial plants, sprouts, and suckers that emerge from the base of such plants. Meadow voles construct surface runways (approx. 1 ½ to 2 inches wide) under or within the accumulated organic matter and duff layer that exists in fields; these runs often terminate at a 1” diameter wide hole that drops into an underground burrow network. In contrast, pine voles remain underground and inflict damage in the form of root girdling, which often goes unnoticed until severe damage already has occurred and the plant is in rapid decline. Both species are known for constructing burrows that follow trickle irrigation lines or areas where the soil has been loosened by mechanical planters.

**Cultural practices and habitat modification measures** are helpful in deterring vole populations. Voles avoid areas with few food resources and little protective cover. Control of ground vegetation with herbicides, mowers, or disking is effective, although voles will travel under snow cover in these areas. Herbicides are the preferred method to eliminate sod. Cultural practices that reduce the amount of organic litter around plants are essential. All areas should be kept clear of debris, stored objects (such as bags, boxes, pruned branches) because these items provide protection to voles and can hinder mowing and proper bait placement. Plastic or synthetic weed barriers will encourage the establishment of vole populations, so use of these materials should be avoided. A final close mowing of the row middles, after harvest, should be utilized annually to further reduce habitat and cover for rodents and to enhance the effectiveness of natural predators (such as hawks and owls).

**Exclusion methods** are feasible only at small scales and to protect high-value crops. Hardware cloth or woven wire fences (≤ ¼ inch) can be installed to a height of 1 ft above ground and buried to completely contain the rooting system of the plant. There are some newer products composed of sharp-edged rock or pumice granules that can be used to line the planting hole and will act much like a barrier against digging. This requires significant hand installation, so an analysis of cost-effectiveness is necessary before considering such methods.

**Repellents** that contain predator urine (coyote and fox) have demonstrated limited effectiveness in reducing vole numbers, primarily through the effects of stress on production rates. However, repellents are expensive and offer only short-term relief from damage. Repellents that contain thiram and capsaicin are not approved for use on plants grown for human consumption.

**Trapping** may be useful only where vole damage is localized (<1 acre). Place snap traps perpendicular to the runway with triggers in the runway at a frequency of 2 to 3 traps per runway. All traps should be covered by a weighted box or pail to prevent non-target captures. Multiple-catch mouse traps also have been used to trap voles. Because the trap holds multiple individuals, fewer traps are necessary. In addition, non-target animals can be released unharmed. Bait multiple-catch trap entrance points with seed. If a trap is unsuccessful for 2 consecutive nights, move the trap to another location.

**Toxicants** are used to control large vole populations and most are classified as Restricted Use Pesticides (RUP); these products can be applied only by a pesticide applicator who possesses both a general applicator certification and the advanced certification for vertebrate application (Category 7D). The only General Use Pesticide (GUP) approved for use in vole control is warfarin (alone or in combination with imidacloprid). Individual voles must ingest the bait 3 times to sustain a lethal dose. Therefore, bait stations must be continually maintained to ensure success.

Zinc phosphide is a single-dose RUP available as a concentrate or in pelleted or grain bait applications. Because of its foul taste, voles may avoid bait stations. Pre-baiting stations with untreated food for 2 to 3 days prior to applying the pesticide may increase success. Anticoagulants may also be effective in controlling vole damage. However, anticoagulant baits are slow acting and may take up to 15 days to be successful. Furthermore, most anticoagulants require more than one feeding for maximum effectiveness.

To avoid injury to non-target species, the use of bait stations is recommended and may be required in some states. Broadcasting bait across the area, or placing bait in piles or on bare soils, is not allowed. Shingles and tires used as bait stations are acceptable under state Pesticide Laws. However, the bait may not stay dry for long and quickly becomes ineffective when wet. In-furrow placement of zinc phosphide pellets is approved for corn and soybeans under a no-tillage management system. Hand placement of baits directly in runways and burrow openings within the tree drip line is essential for woodland vole control because of their subterranean behavior

To ensure the legality of a particular toxicant in your state, information can be obtained by calling your Pesticide Control Program. As with all use of toxicant products, follow the product’s labeling guidelines.

# 12. Pollination

Seed and fruit production in many vegetable crops is dependent on pollen transfer within or between flowers. In most cases, pollen transfer is accomplished by insects such as bees or flies, and it is often beneficial to release pollinating insects into the crop during the flowering stage to achieve desirable fruit set and mature quality. Some crops like cucurbits require multiple pollination events for normal fruit development. The size and shape of a mature fruit is usually related to the number of seeds, and each seed is the result of a pollination event. Generally as the number of bee visits increases there will be an increase in fruit set, number of seeds per fruit, fruit weight, and improved fruit shape. In strawberries, sufficient pollination also results in fruits with a longer shelf life and better color. Delay in pollination affects the timing of fruit set, and lack of adequate pollination usually results in small or misshapen fruit in addition to low yields. Even some crops that are capable of self-pollination (e.g., eggplant, lima beans, okra, peppers) often benefit from pollen transfer by insects.

**Integrated Crop Pollination**

Bees are the most important group of insects for crop pollination. Today's approach integrates managed and wild bee species. More information is available in the webinar "What is Integrated Crop Pollination" at:
*https://www.youtube.com/watch?v=yMP5dTDRi6g&index=10&list=UUN0Z_G59MEi7IW4e1IfvkgA*,
and the site of The Integrated Crop Pollination Project at *http://icpbees.org/tools-for-growers/*.
An example for pumpkins and squashes is available at:
*http://icpbees.org/wp-content/uploads/2014/05/Integrated-Crop-Pollination-for-Cucurbita-crops.pdf*.
For pumpkins, the webinar "Ensuring Pumpkin Pollination is available at:
*https://www.youtube.com/watch?time_continue=26&v=liI63L7oBQQ* and additional webinars are available at: *http://icpbees.org/home/videos/#Webinars*.
Compilations of valuable resources are available from the PennState College of Agricultural Sciences Center for Pollinator Research (*http://ento.psu.edu/pollinators* and *http://ento.psu.edu/pollinators/information-for-growers*), and in the Best Management Practices for Pollination in Ontario Crops at: *http://www.pollinator.ca/bestpractices/*.
All states are developing **pollinator protection plans**. The plan for Pennsylvania is available at: *http://ento.psu.edu/pollinators/research/the-pennsylvania-pollinator-protection-plan-p4*

European honey bees and commercial bumble bees are most used for managed pollination services because they can be moved. Populations of wild bees can also be important for vegetable pollination. Wild bees include bumble bees (*Bombus* species), squash bees (*Peponapis pruinosa*), orchard bees (*Osmia* species), and many species of solitary bees most of which nest in soil. Surveys of wild bees reveals over 500 species in the mid-Atlantic U.S., but not all will necessarily be visiting any given crop. The community of managed or wild bees visiting a crop varies among crops, and can be influenced by other flowering plants competing for these same bees.

Activity of managed or wild bees on crop flowers at the correct time will greatly enhance pollination. Individual cucurbit and strawberry flowers are usually open and attractive to bees for a day or less. The opening of the flower, release of pollen, and commencement of nectar secretion normally precede bee activity, and the timing is coordinated with receptivity of the stigma. Pumpkin, squash, and watermelon flowers normally open around daybreak and close by noon, whereas cucumber, strawberry, and muskmelon flowers generally remain open the entire day. Pollination usually takes place on the day the flowers open due to the short periods of pollen viability and stigmatic receptivity.

Activity and behavior varies with the species of pollinator. Bumble bees are active over a wide range of weather conditions and can tolerate foraging in cooler temperatures. Honey bee activity is determined to a great extent by weather and conditions outside the hive. Honey bees rarely leave the hive when the outside temperature is below 55°F (13°C). Flights seldom intensify until the temperature reaches 70°F (21°C). Wind speed in excess of 15 mph seriously impedes bee activity. Cool, cloudy weather and threatening storms greatly reduce honey bee flights. Squash bees are active soon after sunrise in July and August. Most of the feeding of female squash bees is completed by midmorning (9 or 10 AM) after which they return to their nests in the soil. Male squash bees will continue to feed on flowers for a longer time frame, often overnight.

Populations of wild bee species vary in their abundance from year to year. Regular pesticide applications may reduce the abundance and diversity of these pollinators, and some agricultural practices such as tillage may destroy wild bees that nest in the soil.

**Commercially Available Honey Bees**

For crops readily visited by honey bees, the most reliable way to ensure pollination is to own or rent strong colonies of European honey bees from a reliable beekeeper. European honey bees (*Apis mellifera*) are the primary managed pollinators because colonies with large populations can be easily moved to the field each year. With the arrival of parasitic honey bee mites (mainly *Varroa destructor*) along with likely impacts of pathogens, insecticides, and fungicides, the numbers of European honey bee colonies has significantly decreased in the last 20 years. Abundant colonies of feral honey bees (wild colonies nesting in trees or other cavities) are now uncommon to rare in most areas, and beekeepers are losing large numbers of colonies to mites, disease, and other stress factors. As a result, fewer beekeepers are providing honey bee colonies for pollination services, and some colonies may be of marginal quality for pollination. The Mid-Atlantic Apiculture Research and Extension Consortium is a regional group focused on addressing the crisis facing the beekeeping industry (*https://agdev.anr.udel.edu/maarec/about/contact-2/)*. Additional relevant websites are the Bee Informed Partnership (*https://beeinformed.org/*) and the Center for Pollinator Research (*http://ento.psu.edu/pollinators*).

A brief introduction to best management practices for honeybees can be found at *http://ento.psu.edu/pollinators/publications/p4-best-practices-for-beekeepers*. Best practices include: (1) Locating colonies in areas with sufficient flower forage and protected from exposure to sunlight (an east or southeast hive entrance encourages bee flights); (2) Elevating the colony to have the front entrance free of grass and weeds; (3) Allowing a clean water supply within a quarter mile of the hive.

The number of colonies per acre for adequate pollination varies with location, attractiveness of the crop, density of flowers, and length of blooming period, colony strength, and competitive plants in the area. In vine crops and strawberries, recommendations are 1 to 2 colonies per acre, with more hives required for higher density plantings.

**To ensure adequate quality and numbers of honey bee colonies, growers should:**

- **Contact beekeepers early**. Colonies may be in short supply. If you do not have a past relationship, make initial contact with the beekeeper the previous fall. Beekeepers usually assess the survival and strength of their colonies from mid-February to mid-March. **Requests for hive relocation should be given 48 hours or more in advance.**
- **Have a written and signed contract between the grower and the beekeeper.** This will ensure that enough pollinators are provided and that beekeepers are protected from pest control practices that may injure bees. The contract should specify the number and strength of colonies, rental fee, time of delivery, and distribution of bees in the field. A sample contract is at *http://edis.ifas.ufl.edu/aa169*.
- **Obtain an adequate number of colonies**. This varies among crops, location, attractiveness of the crop, density of the flowers, length of the blooming period, colony strength, and competitive plants in the area. A rule of thumb is to start with one colony per acre and make adjustments from there. Areas well populated with wild bees will not need as many rented honey bee hives.
- **Obtain bees at the appropriate time**. For melons, cucumbers, squash and strawberries, honey bees should be moved in when the crop is flowering adequately to attract bees. Competing food sources from other flowers in the field, such as dandelions, should be eliminated by mowing, cultivation, or herbicides.
- **Locate colonies for maximum effect**. Place colonies in groups of 4 to 8 in favorable locations throughout the farm or field to provide an even distribution of the bees. In large fields, pollination is effective if groups of 10 to 20 hives are distributed in sunny, wind-protected spots. Bales of straw or packing boxes stacked behind colonies offer wind protection.
- **Rent honey bee colonies that are healthy and contain a large enough population to do the job**. Packaged bees (bees purchased through the mail) and small hives are inferior to strong, overwintered colonies. Two weak colonies are not equal to one strong colony. However, in some areas colony loss has been so high that it may not be realistic to exclusively rely on overwintered colonies for pollination services. More information is available at: *https://agdev.anr.udel.edu/maarec/about/contact-2/*.
- **Consider the use of bee attractants**. Sugar-based attractant sprays are generally ineffective. Bees collect the sugar off the leaves, usually without visiting flowers. Although this brings more bees into the field, supplemented pollination does not necessarily occur, and the sugar may serve as a medium for sooty molds. Other attractants containing bee derived communication pheromones, such as geraniol, have proven more successful, but further testing is needed. One of the most promising attractants, "Fruit Boost", contains honey bee queen mandibular pheromone. U.S. distributors of "Fruit Boost" are in the Pacific Northwest. For more information, contact Phero Tech, Inc., 7572 Progress Way, RR 5, Delta, British Columbia, Canada V4G 1E9; phone: 604-940-9944; fax: 604-940-9433.

**Honeybee colony size and strength can be assessed in several ways:**
**1. Inspect hives:** This method is most time-consuming, but also most accurate. Colonies used for springtime pollination should have at least: a laying queen, 1½ or 2 stories (hive bodies or boxes) and 4 to 6 frames of brood, and enough adult bees to cover 6 to 8 frames. These are minimum requirements. Stronger colonies with larger populations make superior pollination units and may command a higher price. As these stronger colonies are opened, bees will "boil out" or cover the tops of the frames. When smoked, however, the bees move down onto the frames and may not cover the frame tops. In this case, the frames themselves should be covered with bees. Note that there will be some variability in the quality of the colonies you rent. As a general rule, a group of colonies where 10% fall below the minimum standard is acceptable if also 10% are above the minimum standard. Also, for a variety of reasons, some colonies may become queenless for a time; however, if these colonies meet all the other minimum requirements they still will be effective pollination units.

You can request hives to be inspected. In Pennsylvania, The PA Department of Agriculture Apiary Inspection Service runs a hive evaluation program for colonies used for pollination. Requests may be made by either the grower or the beekeeper and should be arranged through the state apiarist at the PDA Bureau of Plant Industry, 2301 North Cameron Street, Harrisburg, PA 17110; phone 717-772-5225. Requests should be made as early as possible to facilitate scheduling. The beekeeper will be informed if an evaluation is requested by the grower. Colonies are inspected to determine the colony size (number of supers), the presence of a laying queen, the number of frames of brood and adult bees, and the presence of disease and parasites. At least 10% of the colonies in an apiary, or a minimum of 5 colonies, are selected at random for inspection. Inspected colonies are identified by sticker. If selected colonies are banded or stapled, these are not refastened by the inspector. A copy of the evaluation report is given to both the grower and the beekeeper.
**2. Assess traffic at hive entrance:** This method is less time-consuming but also less accurate. On a calm, warm (70-80˚F, 21-27°C) day between 11 AM and 3 PM, bee traffic at hive entrances should be heavy. During a one-minute observation period, strong colonies should have 50-100 or more bees arriving and leaving the hive. Bees also should be seen arriving with pollen pellets on their back legs. In weak colonies, fewer than 40 bees will be seen arriving and leaving per minute. Colonies that are being used for summer pollination should have heavier traffic at the hive entrance.

Another crude way to assess colony strength is to observe entrances when temperatures are cool (55-60˚F, 13-16°C). In strong colonies, flights will be observed at these cool temperatures, but in weaker colonies bees rarely fly when temperatures are below 60°F. Honeybees very rarely fly when the temperature is below 55°F.
**3. Assess bee density on the crop:** This method allows you to assess the contribution of feral or other honeybee colonies in the area in addition to rented bees. If you are using rented colonies, however, this method tells you little about the quality of the bees. We suggest that if you use this technique and find that the number of bees on the crop is small, you then use options (1) or (2) to assess colony strength before renting additional bees.

**Additional information**
The following publications are available from the Mid-Atlantic Apiculture Research and Extension Consortium:
- Beekeeping Basics
- Beekeeping Topics: Sources of Bees for Pollination in Pennsylvania, Bees and Insecticides, Pollination Contracts, Basic Biology and Management of the Japanese Hornfaced Bee

Other sources of information for bee guides in your area are:
- State of NJ Department of Agriculture at: *http://www.state.nj.us/agriculture/divisions/pi/*
- The Virginia Fruit Web site at: http://www.virginiafruit.ento.vt.edu/VAFS-bees.html
- NCAT - ATTRA Sustainable Agriculture at: *https://attra.ncat.org/attra-pub/summaries/summary.php?pub=76*
- Farm Management for Native Bees, A Guide for Delaware at: *http://dda.delaware.gov/plantind/forms/publications/FarmManagementforNativeBees-GuideforDelaware.pdf*

**Commercially Available Bumble Bees**
Common Eastern bumble bee (*Bombus impatiens*) colonies may be purchased commercially to use as pollinators in vegetables and small fruits. The behavior, physiology and morphology of bumble bees make them ideal pollinators because of the speed at which they transfer pollen, the efficiency with which they gather pollen within various crops, and their ability to fly in adverse weather for longer periods of time. Bumble bees can also "buzz" pollinate, vibrating their wing muscles at a frequency that dislodges pollen from the flower, a technique not seen in

honey bees. Due to their robust body size bumble bees begin foraging earlier and end later in the day and at lower temperatures. Bumble bees are effective in greenhouse and high tunnel settings to pollinate tomatoes and strawberries. They also have been successfully used for field pollination in blueberries and watermelon. However, in pumpkins, efforts to increase pollination by adding commercial bumble bee colonies is not always successful, perhaps due to the presence of adequate wild bee (wild bumble bee or squash bee) populations.

Place bumble bee colonies in the field after crops have begun to bloom. Bees that have found unintended forage in the beginning of the season are likely to continue to forage on this unintended source, especially if it is more favorable than the intended crop.

Follow instructions provided by the supplier. Give the allotted time before opening up the colonies for the first time. Although bumble bees will need to excavate from natural enclosures in order to begin foraging, colonies should be given at least 30 minutes to settle after being handled during shipment and placement. Check each colony 2-3 hours later to ensure that the bees have successfully released and exited the nest. On occasion, bees are not released successfully and will need to be cut out.

Growers are urged to reduce each bumble bee colony entrance to one open hole at least two hours before each pesticide application. This will allow bumble bees to return to the hive and be kept in the colony to decrease exposure to pesticides. Bumble bees accumulate pesticides very easily within the wax and their bodies.

Place bumble bee colonies under shade to increase their productivity and longevity. Units placed in natural shade (along forest/field edges) or fitted with a shade structure last longer and are significantly more productive than those in full sunlight, especially during the warm summer months. Bumble bees constantly and actively strive to keep their colony temperature at around 86°F (30°C). Colonies exposed to direct sunlight use more energy for colony cooling.

Bumble bee colonies should be placed as far from honey bee hives as possible, especially when crops are not in bloom. When forage is low, colonies of pollinators should be more than 1 mile apart. Honey bees are very resourceful and a bumble bee colony is a great source of pollen and nectar. If surrounding forage is low or not agreeable to honey bees, bumble bees will be susceptible to honey bee pollen theft resulting in weakened honey and bumble bee colonies.

Bumble bees may be transferred to another field for additional pollination services throughout a season. Before moving, close the plastic opening tab to the one-hole open position. Allow forager bees at least two hours to return to the colony. The bumble bee colony may then be transferred to another site.

Follow the supplier’s recommendations for number of hives to use in a particular crop. Commercial bumble bee hives live for of 6 to12 weeks and must be replaced each year.

Dispose of bumble bee colonies in a timely and humane fashion. There is a risk of commercial bees breeding with native populations. Commercial bumble bees are mass reared, and therefore have less genetic diversity than the wild bees. The genetic integrity of wild bees is important because it allows for adaptation to a wide variety of environmental conditions and various pathogens that they may encounter. Disposal of commercial colonies may also minimize potential transmission of pathogens.

**Wild Bees**

Many wild bees, including squash bees (*Peponapis pruinosa*), multiple bumble bee species (*Bombus* sp., predominantly *Bombus impatiens*), orchard bees (*Osmia* sp.) and an assortment of other solitary bees (sweat bees, mining bees) are excellent crop pollinators. In the mid-Atlantic regions, wild pollinators have provided sufficient pollination for small, diversified farms located in complex landscapes that include wood lots and unmanaged (fallow) lands in close proximity. The landscape can strongly influence bee populations through the availability of nesting substrates (open soil, fallen logs, abandoned rodent burrows). In diversified farmscapes with a history of growing cucurbits, bumble bees and/or squash bees have provided sufficient pollination to pumpkins regardless of whether managed commercial bees were present. Landscapes utilizing conservation tillage tend to have higher populations of squash bees, presumably due to less disruption habitat.

Availability of additional food resources in nearby wild lands or a diverse (flowering) cropping system can help support wild bee populations throughout the growing season. The USDA National Resources Conservation Service is building efforts to supplement farms with perennial plantings (pollinator strips) or cover cropping schemes designed to provide timely floral resources.

Wild bumble bees live in colonies founded by a queen. The workers, which are daughters of the queen, do the foraging, brood-rearing and defend the nest. New queen bumble bees (called gynes) emerge from their natal nest in late summer or autumn. Each gyne will mate, forage, and then hibernate through the winter in a small insulated cavity. In the spring the gyne will emerge and search for a larger cavity to establish her nest in such as an old rodent nest or beneath clumps of bunchgrass. Colonies will increase in numbers over the spring and summer, reaching a peak of 250-450 individuals (in *Bombus impatiens*) before producing new gynes and males. These new reproductives will disperse and start the cycle over, while their natal colony dies out, leaving the gynes as the only carry-overs to the next year.

Most native bees do not live in groups like honey and bumble bees. Each female solitary bee establishes her own nest which may be located in the ground, an old beetle burrow in wood, or in a pithy stem (elderberry or brambles). Each female gathers pollen and nectar and feeds nest cells, making a pollen ball and laying a single egg in each cell. She repeats this process many times over the duration of her life, and will die before her offspring mature. The offspring overwinter in the cell within the nest, emerging the following spring or summer. Female solitary bees are reliable pollinators, visiting many flowers in their lifetime.

Snags or brush piles, along with undisturbed tall grassy areas, provide nesting sites for tunnel-nesting bees and bumble bees. Hedgerows, shelterbelts, and windbreaks containing flowering trees and shrubs can provide nesting habitat for bees as well as food. Deep soil tillage can block or harm ground-nesting bees.

Bees can vary greatly in their foraging range depending on body size and resource availability. Large species like bumble bees can fly long distances, but probably forage within 1 to 3 miles from the colony. Most species stay closer to their nest, no farther than about 0.5 mile. When resources are plentiful, bees are more likely to forage over shorter distances. It may be advantageous to manage farmscapes with these pollinators in mind, reserving bee habitat to benefit the crops and surrounding landscape.

**Information for managing wild bees, along with the biology of relevant species can be downloaded at:**

- Farm Management for Native Bees, A Guide for Delaware at: *http://dda.delaware.gov/plantind/forms/publications/FarmManagementforNativeBees-GuideforDelaware.pdf*
- Using integrated crop pollination for pumpkins and squash: *http://icpbees.org/wp-content/uploads/2014/05/Integrated-Crop-Pollination-for-Cucurbita-crops.pdf.*
- Squash Bees: *https://www.fs.fed.us/wildflowers/pollinators/pollinator-of-the-month/squash_bees.shtml,* and *https://content.ces.ncsu.edu/squash-bees-in-the-home-garden*

**Collections of resources are compiled at:**

- The Integrated Crop Pollination Project, Resources for Growers: *http://icpbees.org/tools-for-growers/*
- The Center for Pollinator Research: http://ento.psu.edu/pollinators/information-for-growers

There is ongoing research to determine whether reliance on wild bees will be adequate for pollination of large acreages grown for commercial production. The Xerces Society provides guidelines for developing landscapes and farmscapes that encourage conservation of communities of pollinators at:
*http://www.xerces.org/pollinator-conservation/*.
Alternative managed pollinators are described in “Managing Alternative Pollinators: A Handbook for Beekeepers, Growers, and Conservationists” (Mader *et al*., 2010, see “Resources” on Xerces Society website).

**Recommendations Related to Pesticides and Bees**

All bees are vulnerable to many chemicals used to control insects, pathogens and weeds. If insecticides are applied, select those that give effective control but pose the least danger to bees (see Table 4, starting on page 16, in *http://bspm.agsci.colostate.edu/files/2014/02/PNW-591-4-Avoiding-Bee-Poisoning.pdf,* Tables D-6 and Insect Control tables in chapter F in this guide, or Tables D1-D3 in the Mader handbook listed above). **Apply pesticides at dusk when the bees are not actively foraging and avoid spraying crops adjacent to foraging bees.** Give the beekeeper a 48-hour notice so that precautions can be taken to protect the hives.

**READ THE LABEL AND FOLLOW THE LABEL DIRECTIONS**

- Know the pesticides you are using and their toxicity to bees.
- Systemic seed treatments may result in residues in nectar and pollen. However, residues tend to be much lower from seed treatments compared to foliar treatments.
- Never use an insecticide on a flowering crop or on flowering weeds if bees are present.
- Flowering time varies among varieties. Bees pollinating one variety or crop may be at risk while another post-bloom crop or variety is being treated. Also, bees may be visiting flowering weeds in and around crops. Be aware of these situations and avoid the pesticide application if there is risk of drift onto blooming crops and

weeds if bees are present. If a spray must be applied, use the least toxic material and apply late in the day or at night when bees are not foraging

- Avoid pre-bloom pesticides just before bees are brought onto a crop. If one is needed pre-bloom, select a material with lower bee toxicity and apply only when bees are not foraging, preferably late evening.
- Do not apply pesticides post bloom until after managed colonies are removed.
- Honey bees need water for temperature regulation and brood production. Provide a clean water supply near the hives. Keep wheel ruts and areas around the sprayer fill point drained to eliminate a possible insecticide-laden water source.
- Many fungicides are known to interact antagonistically with insecticides, which can lead to higher toxicity to bees. Avoid fungicide application on flowering crops when bees are present.
- Give beekeepers 48-hours' notice to allow for the movement of bees onto or off the crop.

Online resources about pesticides and bees are at *http://bspm.agsci.colostate.edu/files/2014/02/PNW-591-4-Avoiding-Bee-Poisoning.pdf,* and *https://pesticidestewardship.org/pollinator-protection/*. Information about toxicity of organic pesticides to bees are at:
*http://www.xerces.org/wp-content/uploads/2009/12/xerces-organic-approved-pesticides-factsheet.pdf*

All growers should become familiar with EPA's new pollinator protection labeling guidelines and new bee advisory box which can be found at: *https://www.epa.gov/pollinator-protection/new-labeling-neonicotinoid-pesticides*.

## 13. Food Safety Concerns

In recent years, the importance of fruits and vegetables in the diet has received a considerable amount of attention. Fresh or processed products supply vitamins, fiber, and phytochemicals that are known to decrease the risk of several chronic diseases, including heart disease and cancer. Consumers are purchasing more fresh produce than ever before, and between 1970 and 2008, per capita consumption of fresh fruits increased 19%, while per capita consumption of fresh vegetables increased 67%.

However, reports of foodborne illness attributed to consumption of these products have also increased. Unlike processed foods, fresh fruits and vegetables are not heat-treated to eliminate potentially harmful microorganisms. Larger and more centralized farming and improved storage methods have resulted in the distribution of produce over vast geographic areas. Raw fruits and vegetables are also handled more frequently in the distribution chain. Cases of foodborne illness that once were limited to localized areas can now be spread over many states or countries. In addition, new minimal processing technologies have brought to the marketplace, for example fruits and vegetables that have been washed, peeled, and cut into convenient ready-to-eat products. Since these products are subject to more handling and typically are not heat-processed to eliminate harmful bacteria, they are at a greater risk for becoming contaminated and subsequently leading to foodborne illness. The vast majority of fresh fruits and vegetables are grown, harvested, and packed under safe and sanitary conditions. However, several highly publicized cases of foodborne illness have been associated with consumption of lettuce, salad mixes, green onions, tomatoes, sprouts, cantaloupe, cabbage, cucumbers, herbs and carrots. Implicated in most of these outbreaks have been the human pathogens: *Salmonella enterica*, *Escherichia coli* O157:H7, *Listeria monocytogenes*, and *Shigella* bacteria; *Cryptosporidium* and *Cyclospora* parasites; and Hepatitis A and Norwalk viruses.

In response to increasing concerns about the safety of fresh produce grown in the United States, the Food and Drug Administration (FDA) published "The Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables" in 1998. This guide is intended to assist growers, packers, and shippers of unprocessed or minimally processed fresh fruits and vegetables by increasing awareness of potential food safety hazards and providing suggestions for practices to minimize those hazards. Many Internet resources on food safety are also available that feature updated information from this guide and other sources.

In 2002, the United States Department of Agriculture (USDA) developed an audit/certification program known as "Good Agricultural Practices" (GAPs) to verify conformance to the 1998 guide. This is a voluntary program, although an increasing number of distribution networks are mandating GAPs certification from each participating grower. More recently, in 2011, the Food Safety Modernization Act (FSMA) was signed into law. FSMA (*http://www.fda.gov/FSMA/*) establishes mandatory practices growers must take to prevent microbial contamination of fresh produce. There are seven sections to FSMA with the Produce Safety Rule applying to many growers. The final Produce Safety rule (under FSMA) was released November, 2015, with the first compliance date being January, 2018 with complete compliance required by 2022. Whether a produce operation needs to comply with FSMA and when depends on whether it produces fresh fruits and vegetables and sales volume. In the current food safety climate, increased record-keeping and adherence to strict procedures of human hygiene are inevitable. All three resources (the 1998 guide, GAPs and FSMA) identify potential hazards and discuss possible control methods in different aspects of pre-harvest, harvest and post-harvest production, including: 1. Water, 2. Manure and Municipal Biosolids, 3. Worker Health and Hygiene, 4. Field Sanitation, 5. Packing Facility Sanitation, 6. Transportation, and 7. Product Trace-back. Each section is summarized below.

**1. Water**: Water is used for irrigation, pesticide application, cooling, transporting, washing, and processing. Water also has the potential to be a source of microbial contamination. Growers and packers should be aware of the source and quality of water that contacts fresh produce and consider practices that will protect water quality. Growers should periodically test irrigation water for the quantity of fecal indicator organisms such as generic E. coli (often represented by colony forming unit (CFU) or most probably number (MPN) of generic E. coli per 100 ml water). Groundwater should be tested at least once per year and surface water three times per year (additionally testing may be required under the FSMA Produce Safety Rule if water is directly applied to the harvestable portion of the crop). If irrigation water exceeds the agricultural water standards, water treatment with effective disinfectants would be necessary before continuing to use the water source. Application of SaniDate 5.0 or 12 and calcium hypochlorite tablets (Accutab) have been shown to be effective on the decontamination of bacterial foodborne pathogens. These products are approved by the Organic Materials Review Institute (OMRI) for use in irrigation water. Check the label to make sure the product can be used for this purpose; **the label is the law!** Growers often irrigate field crops using water obtained from rivers, lakes, ponds, or irrigation ditches. However, surface water can become contaminated by upstream animal operations, sewage discharge, or runoff from fields. Drip, trickle, underground, or low volume spray irrigation techniques are ways to minimize irrigation water contact with harvestable portions of the crop. Groundwater is less likely to become contaminated, although wells should be maintained in good working condition including proper backflow devices, and be constructed and protected so that surface water or runoff from manure storage areas cannot enter the system.

During post-harvest operations, only potable (microbially safe) water should be used. Water in dump tanks and flume systems should be changed regularly to prevent the buildup of organic materials. Contact surfaces should be cleaned and sanitized to help prevent cross-contamination. Sanitizers, such as chlorine and peroxyacetic acid may be added to water, but should be routinely monitored and recorded to ensure they are maintained at appropriate levels (e.g., water should be monitored for proper chlorine efficacy; 100 to 150 ppm of free chlorine, and a pH in the range of 6.5 to 7.5).

**2. Manure and Municipal Bio-solids**: Manure may be contaminated with human pathogens and should be properly treated and stored before field application. Store manure and compost away from produce fields and packinghouses to protect the produce crop from seepage and runoff. Physical barriers such as ditches, mounds, grass/sod waterways, diversion berms, and vegetative buffer areas may also help to prevent runoff. Current recommendations are to maximize the time between application of manure to production areas and harvest. For non-composted or raw manure, the recommendation is to wait at least 120 days (4 months) between manure application and harvest and at a minimum two weeks before planting. Growers should be aware that the FSMA Produce Safety Rule regulations have not yet been finalized. The Food and Drug Administration allows the use of the National Organic Standards for manure application until the final regulations are written. The National Organic Standards are 1. Incorporated into the soil a minimum of 120 days prior to harvest when the edible portion of the crop has soil contact; OR 2. Incorporated into the soil a minimum of 90 days prior to harvest of all other food crops. Recommendations, guidance, regulations may change; growers are encouraged to consult relevant online resources or county extension offices about up to date manure recommendations and regulations.

Domestic animals (including livestock and pets) may be a source of contamination and should be excluded from fields during the growing and harvesting season. Growers who use animals (such as horses) during production are advised to do a risk assessment of their operation and have a written plan in place to address possible sources of contamination. Wild animals, although more difficult to control, should be discouraged from entering fields; especially where crops are destined for fresh markets. Wildlife prevention may include noise makers, decoys, hunting, fencing or netting. However, the FDA does not authorize farms to take action(s) that would violate the Endangered Species Act or other federal, state, or local animal protection requirements (check with county extension on animal protection requirements).

Although municipal bio-solids (sewage sludge) are approved for certain agricultural uses, they are not recommended for application to soils used for vegetable production. This is due to the potential for human health issues. See “Sewage Sludge” in chapter B 4. Nutrient Management.

**3. Worker Health and Hygiene**: Human pathogens can be transferred to produce by workers who harvest or pack fresh produce. Growers should provide sanitary facilities that are accessible, clean, and well equipped (bathrooms or portable toilets with an adequate supply of toilet paper; handwashing stations with basin, microbially safe water, soap, disposable paper towels or other appropriate hand drying devices, and a waste container). All employees (field workers to office administration) should be trained in good hygiene practices, such as to toilet use and proper handwashing. Any worker who shows signs of an illness including diarrhea, coughing, fever, sneezing, sores, or infected wounds should not be allowed to handle produce.

**4. Field Sanitation**: Fresh produce can become contaminated through contact with soils, pests, equipment, and chemicals, such as fertilizers and pesticides. Growers should clean and or sanitize harvest equipment including knives, pruners, machines, containers, bins, etc. prior to use. Additionally, all equipment should be regularly serviced and inspected for general maintenance.

**5. Packing Facility Sanitation**: In packing facilities, pallets, containers or bins should be cleaned and sanitized before use and discarded if damaged or in poor condition. Equipment, packing and storage areas should be kept clean; empty or unused pallets, bins, or containers should be kept in a covered location to prevent contamination. Sanitizers, such as chlorine or peroxyacetic acid, may be added to water to prevent cross-contamination of produce during washing or transporting in dump tanks and flumes. If using a sanitizer, monitor the concentration on a regular schedule. It is recommended that the water be changed when it becomes excessively soiled or saturated with organic material. Food contact surfaces should be cleaned and sanitized at the end of each day. A pest control program must be established to prevent or limit rodents, birds, and insects from entering the packing and storage facilities/areas.

**6. Transportation**: Fresh produce can become contaminated during loading, unloading, and shipping. Inspect transportation vehicles for cleanliness, pests, odors, and obvious dirt or debris before loading. Make sure that fresh produce is not shipped in trucks that have previously been used to transport animals, fish, chemicals, or waste. Refrigeration units in trucks should be turned on before loading to ensure that proper temperatures are maintained during loading and transport.

**7. Trace-back**: Traceability is defined as a procedure which tracks where a food product came from (for example farm, field, row, date harvested) to where a food product is going (market, distribution center, consumer). Usually adequate trace-back procedures require a grower to track one step backwards and forwards. Growers should be able to trace each lot with the date of harvest, farm identification, and who handled the produce from grower to receiver. The ability to trace the distribution history of food items from grower to consumer will not prevent a foodborne outbreak or recall from occurring; however, traceability procedures may limit the public health and economic impacts of an outbreak or recall.

**Additional information to help vegetable growers adopt Good Agricultural Practices on the farm and in the packing house can be obtained from extension offices or the governmental agriculture authority in your state.**

# B. Soil and Nutrient Management

## 1. Soils

The best soils for growing vegetables have well drained, deep mineral topsoil with a relatively high percentage of organic matter (> 2%). Soil pH has been modulated through cycles of cultivation with lime and gypsum as needed and fertility levels (N-P-K) have been augmented as needed. Sandy loam or loamy sand soil textures are generally best suited for growing early market crops, since they are more accessible to machinery and workers during periods of high moisture. Loam and silt loam soils are generally better suited for growing crops for later fresh market use or for processing. Deep, well-drained muck soils are ideally suited for growing leafy vegetables, bulb, and root crops. The better suited the crop is to your soil, the greater chance of producing a successful crop. If you plant crops that require well-drained soils on poorly drained soils, you are doomed to failure regardless of your growing skills.

Typical BMPs (Best Management Practices) include a good soil management program, proper liming and fertilization, good tillage practices, crop rotation, annual supplements of organic matter, and adequate irrigation. Using winter cover crops and periodically resting the land with the use of summer cover crops between vegetable plantings are essential to prevent the deterioration of soil structure and to retain topsoil. Note: BMPs are similar to the Good Agricultural Practices (GAPs) described in chapter A, and share many elements. BMPs are aimed at consistently high crop yields and quality, whereas GAPs are focused on avoidance of food safety deterrents.

### Soil Tests

The most economical means of determining the lime and fertilizer needs of your soil is to have it tested. You can generally obtain soil sample kits or containers and instructions through your local Extension Office.

If you do not know the present fertility level of the soil in a field, your application rates of lime and fertilizer materials are likely to be inaccurate. For most efficient production, application rates of lime and fertilizer materials should consider the existing soil fertility level, past cropping and soil management practices, and the crop to be grown. Taking this approach also minimizes the potential for soil damage and water pollution. Knowing soil nutrient contents makes it less likely fertilizers and organic nutrients sources are applied when they are not needed, saving the cost of unneeded materials.

Lime and fertilizer recommendations from a soil testing laboratory are based on the soil test results, the crop to be grown, past cropping, liming, and fertilization practices; information you supply with the soil sample questionnaire when submitting the sample. For this reason, it is very important that you supply accurate information about the history and future use of the field along with the soil sample.

If you have a special problem related to soil drainage, tillage, or past history, inform your Extension Agent/Educator when you pick up the soil sampling kit or container, so he/she can advise you if any special tests are needed. The Agent/Educator will also be aware of the cost of the various soil testing services performed by the soil testing laboratory.

## 2. Liming Soils

Most soils in the mid-Atlantic region are naturally acidic or become acidic under crop production systems and rainfall. If soils become too acidic (generally pH less than 6.0), crop performance is hindered by many factors, including reduced availability of plant nutrients. A regular liming program is required to neutralize soil acidity and to supply crops with calcium and magnesium. The first step in a liming program is knowing the optimum or target value of the crop to be grown. Many crops will grow over a wide range of soil pH, but most vegetable crops perform best when soils are in the pH 6.0 to 7.0 range. Plan rotations such that all crops grown on a given field have similar pH and nutrient requirements. The target pH values and the low pH limits suitable for vegetable crop production are listed in Table B-1.

Soil pH alone cannot be used to determine the amount of liming material needed to correct soil pH. Information on soil texture and fertility is also required. Soil test results provide all of the data needed to determine the lime requirement and the type of lime to use when using soil-water pH. Alternatively, many state and private labs now use buffer solutions to extract active and reserve acidity for pH determination. Buffer solutions reduce interference that commonly occurs when substantial amounts of soluble salts are in the soil solution. When using buffer pH, calibrated charts along with the buffer pH can solely be used for lime requirement determination.

**Table B-1. Target Soil pH Values for Vegetable Crop Production**

| Crop | Target pH | Target lime when pH falls below | Crop | Target pH | Target lime when pH falls below |
|---|---|---|---|---|---|
| Asparagus | 6.8 | 6.2 | Okra | 6.5 | 6.0 |
| Beans - lima, snap | 6.2 | 6.0 | Onions - green, bulb, scallions | 6.5 | 6.0 |
| Beets | 6.5 | 6.2 | Parsley | 6.5 | 6.0 |
| Broccoli | 6.5 | 6.2 | Parsnips | 6.5 | 6.0 |
| Brussels sprouts | 6.5 | 6.2 | Peas | 6.5 | 6.0 |
| Cabbage | 6.5 | 6.2 | Peppers | 6.5 | 6.0 |
| Carrot | 6.0 | 5.5 | Potatoes, sweet | 6.2 | 5.5 |
| Cauliflower | 6.5 | 6.2 | Potatoes - white, scab susceptible | 5.2 | 5.0 |
| Collards | 6.5 | 6.2 | Potatoes - white, scab resistant | 6.2 | 5.5 |
| Cantaloupes | 6.5 | 6.0 | Pumpkins | 6.5 | 6.0 |
| Celery | 6.5 | 6.0 | Radish | 6.5 | 6.2 |
| Cucumber | 6.5 | 6.0 | Rhubarb | 6.5 | 5.5 |
| Eggplant | 6.5 | 6.0 | Rutabaga | 6.5 | 6.2 |
| Endive - escarole | 6.5 | 6.0 | Spinach | 6.5 | 6.0 |
| Horseradish | 6.5 | 5.5 | Squash - winter, summer | 6.5 | 6.0 |
| Kale | 6.5 | 6.2 | Sweet corn | 6.5 | 6.0 |
| Kohlrabi | 6.5 | 6.2 | Strawberries | 6.2 | 5.8 |
| Leeks | 6.5 | 6.0 | Tomatoes | 6.5 | 6.0 |
| Lettuce - leaf, iceberg | 6.5 | 6.0 | Turnips | 6.5 | 6.0 |
| Mixed vegetables | 6.5 | 6.0 | Watermelon | 6.2 | 5.5 |
| Muskmelons | 6.5 | 6.0 | | | |

## Lime Requirement

The lime requirement of a soil depends on total acidity that must be neutralized to raise pH to the desired level. It is important to understand that a water-soil pH measurement only indicates the concentration of active acidity in soil solution. Total acidity represents the active acidity in solution plus the amount of exchangeable acid cations bound to clay and organic matter (reserve acidity). For the purpose of lime recommendations using soil-water pH, total acidity is estimated from soil texture plus soil pH or it is measured directly by titration (which is referred to as buffer pH or lime requirement index). Buffer pH or lime requirement index measurements that appear on soil test reports are used to determine lime requirement and should not be confused with soil-water pH. The interpretation of buffer pH is specific to the buffer method employed by the laboratory and the properties of the soils in the region.

Lime requirement is also commonly determined by soil pH measurement and soil texture classification. Soil texture (e.g., loamy sand) may be considered a fixed soil property because it is not readily changed. Portable pH meters or colorimetric paper strip kits (less expensive but also less precise) may be helpful for planning your liming program. Once soil texture and pH are known, the lime requirement can be determined by referring to the appropriate table for the crop to be grown. Consult Table B-2 for lime requirements for crops with a target soil pH of 6.3 to 6.5 (the majority of crops), for crops with a target soil pH not exceeding 6.2 (e.g., snap beans grown on sandy Coastal Plain soils), and crops with a target soil pH of 5.2 (e.g., scab susceptible potatoes). Note: On soils with high organic content (> 6%) many crops with a desired soil pH of 6.5 can tolerate a lower soil pH (typically pH 5.6) than on mineral soils.

Typical soil test results will include pH and relative availability of Magnesium (Mg) and Calcium (Ca). While most vegetable crops grow best in soils that are slightly acid (pH 6.0-7.0), some crops (e.g., sweet potato and some white potato varieties) are best grown at soil pH 5.2. Soil test reports will usually report Mg and Ca levels as “above optimum” or “exceeds crop needs”, “optimum”, and “below optimum” or “deficient”, and may further specify “low/high” and “very low/very high”. These qualifications indicate relative need to remediate the soil by adding or withholding supplements of the indicated nutrient. Note: Excessively high pH increases the possibility of manganese (Mn) deficiency in sensitive crops.

## Calcium Carbonate Equivalent

Calcium carbonate is a popular form of liming material. Soil test recommendations for liming should be given in pounds of calcium carbonate equivalent per acre (lb CCE/A). Pure calcium carbonate ($CaCO_3$) has a CCE of 100% and is the standard against which all liming materials are measured. Since the CCE of liming materials may vary from 40 to 179%, the amount of liming material needed to supply a given quantity of CCE will vary considerably.

*Continued on page 4*

**Table B-2. Pounds of Calcium Carbonate Equivalent (CCE) Recommended per Acre**

**For Crops with a Target Soil pH of 6.5**

| | **Soil Texture and Fertility** | | | | |
|---|---|---|---|---|---|
| **Initial Soil pH** | **Loamy Sand** | **Sandy Loam** | **Loam** | **Silt Loam** | **Clay Loam** |
| 4.1-4.4 | 4,500 | 5,400 | 9,800 | 11,600 | 23,300 |
| 4.5-4.8 | 3,600 | 4,500 | 8,100 | 9,800 | 18,800 |
| 4.9-5.2 | 2,700 | 3,600 | 6,300 | 8,100 | 15,200 |
| 5.3-5.6 | 1,800 | 2,700 | 4,500 | 6,300 | 12,500 |
| 5.7-6.0 | 900 | 1,800 | 3,600 | 4,500 | 8,100 |
| 6.1-6.4 | 500 | 900 | 1,800 | 3,600 | 5,400 |
| Above 6.5 | 0 | 0 | 0 | 0 | 2,700 |

**For Crops with a Target Soil pH of 6.2**

| | **Soil Texture and Fertility** | | | | |
|---|---|---|---|---|---|
| **Initial Soil pH** | **Loamy Sandy** | **Sandy Loam** | **Loam** | **Silt Loam** | **Clay Loam** |
| 4.1-4.4 | 4,000 | 4,500 | 8,000 | 8,900 | 20,600 |
| 4.5-4.8 | 3,100 | 3,600 | 6,300 | 7,100 | 16,100 |
| 4.9-5.2 | 2,200 | 2,700 | 4,500 | 5,400 | 12,500 |
| 5.3-5.6 | 1,300 | 1,800 | 2,700 | 3,600 | 9,800 |
| 5.7-6.0 | 500 | 900 | 1,200 | 1,800 | 5,400 |
| Above 6.5 | 0 | 0 | 0 | 0 | 2,700 |

**For Potato Varieties with a Target Soil pH of 5.2**

| | **Soil Texture and Fertility** | | | |
|---|---|---|---|---|
| **Initial Soil pH** | **Loamy Sandy** | **Sandy Loam** | **Loam** | **Silt Loam** |
| 4.5 | 630 | 990 | 1,350 | 1,790 |
| 4.6 | 540 | 810 | 1,160 | 1,520 |
| 4.7 | 450 | 630 | 940 | 1,250 |
| 4.8 | 360 | 540 | 760 | 990 |
| 4.9 | 270 | 450 | 540 | 760 |
| 5.0 | 180 | 270 | 400 | 490 |
| 5.1 | 90 | 100 | 180 | 270 |
| 5.2 | 0 | 0 | 0 | 0 |

**Table B-3. Conversion of Recommended Calcium Carbonate Equivalent to Recommended Limestone**

| **CCE (lb/A) Recommended by Soil Test** | **Percent Calcium Carbonate Equivalent (% CCE) of Liming Material** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **70** | **75** | **80** | **85** | **90** | **95** | **100** | **105** |
| | **Actual Limestone Recommendation (lb/A)[1,2]** | | | | | | | |
| **1,000** | 1,400 | 1,300 | 1,200 | 1,200 | 1,100 | 1,100 | 1,000 | 1,000 |
| **2,000** | 2,900 | 2,700 | 2,500 | 2,400 | 2,200 | 2,100 | 2,000 | 1,900 |
| **3,000** | 4,300 | 4,000 | 3,700 | 3,500 | 3,300 | 3,200 | 3,000 | 2,900 |
| **4,000** | 5,700 | 5,300 | 5,000 | 4,700 | 4,400 | 4,200 | 4,000 | 3,800 |
| **5,000** | 7,100 | 6,700 | 6,200 | 5,900 | 5,600 | 5,300 | 5,000 | 4,800 |
| **6,000** | 8,600 | 8,000 | 7,500 | 7,100 | 6,700 | 6,300 | 6,000 | 5,700 |
| **7,000** | 10,000 | 9,300 | 8,700 | 8,200 | 7,800 | 7,400 | 7,000 | 6,700 |
| **8,000** | 11,400 | 10,700 | 10,000 | 9,400 | 8,900 | 8,400 | 8,000 | 7,600 |
| **9,000** | 12,000 | 12,000 | 11,200 | 10,600 | 10,000 | 9,500 | 9,000 | 8,600 |
| **10,000** | 14,300 | 13,300 | 12,500 | 11,800 | 11,100 | 10,500 | 10,000 | 9,500 |
| **11,000** | 15,700 | 14,700 | 13,700 | 12,900 | 12,200 | 11,600 | 11,000 | 10,500 |
| **12,000** | 17,100 | 16,000 | 15,000 | 14,100 | 13,300 | 12,600 | 12,000 | 11,400 |
| **13,000** | 18,600 | 17,300 | 16,200 | 15,300 | 14,400 | 13,200 | 13,000 | 12,400 |
| **14,000** | 20,000 | 18,700 | 17,500 | 16,500 | 15,600 | 14,700 | 14,000 | 13,300 |

[1]The amounts of CCE recommended in the table are for increasing the pH of an **8-inch soil layer** to the desired pH value. Multiply the numbers in the table by 1.25 to adjust a 10-inch plow layer to the desired pH. [2]**It is not advisable to apply more than the following lb/A of CCE as a topdressing:** loamy sand 2,000, sandy loam 3,000, loam 4,000, and silt loam 5,000. If fields are to be plowed and the CCE recommendation exceeds 3,000 lb/A, plow under half the needed amount and apply the other half after plowing and then disk in as deeply as possible.

### *Calcium Carbonate Equivalent - continued*
By law, the CCE of a liming material must be stated on the product label. To determine the application rate of liming material in CCE, refer to Table B-3 or use the following calculation:
**Actual amount of liming material required =** Soil test CCE recommendation **/** % CCE of liming material x 100
**Example:** The soil test recommends applying 2,000 lb CCE/A and the liming material purchased has 80% CCE.
Actual amount of liming material required per acre = 2,000/80 x 100 = 2,500 lb/A

Table B-3 may be used instead of the formula to convert soil test recommendations for lb CCE/A to lb of the actual liming materials to be applied. Find your soil test limestone recommendation in the left-hand column, then read across the table on the line until you come to the column headed by the percent CCE nearest to that of your liming material. Application rates may be rounded off to the nearest 500 lb/A practical for spreading equipment. Although liming recommendations should now be given in lb CCE/A, recommendations that are given as total oxides can be converted to CCE by multiplying by 1.79. **Example**: If the recommendation calls for 2,000 lb/A of total oxides, the recommendation for lb CCE/A is: 2,000 x 1.79 = 3,580 lb CCE/A.

## Selection of Liming Material
Liming materials neutralize soil acidity, supply calcium (Ca) and supply or increase available magnesium (Mg). Selection of the appropriate liming material based on its Ca and Mg concentrations is a key to furnishing crops and soils with sufficient amounts of these nutrients. The goal of a liming program is to establish the desired soil pH and to maintain the soil fertility levels for Mg and Ca in the *optimum* range.

Fine-sized liming materials are recommended when rapid neutralization of soil acidity is desired. Medium and coarse-sized liming materials are best suited for maintenance of soil pH once the desired soil pH range has been attained through the use of fine-sized liming material. When soil pH is low, soil test levels of Ca and Mg may be *below optimum* or *deficient*. It is important to choose a liming material that contains a significant concentration of Mg; these liming materials are commonly referred to as dolomitic type or dolomite. If the soil Mg level is *below optimum-very low* or *-low*, use a liming material that has a minimum concentration of 9% Mg. If the soil Mg level is *below optimum-medium*, use a dolomitic liming material that has 3.6 to 9% Mg. If the soil Mg level is *optimum* or *above optimum* or *exceeds* crop needs, use a calcitic or calcite liming material that has less than 3.6% Mg.

Occasionally soils test *below optimum* or *deficient* in Mg or Ca, but do not need lime for pH adjustment. For soils needing Mg, apply Epsom salt (9.9% Mg) or sulfate of potash magnesia (21.8% Mg). If soil pH is appropriate for the crop, but the soil test Mg level is *below optimum-very low*, apply 30 lb/A of Mg from a Mg fertilizer. If Mg is *below optimum-low*, apply 15 lb/A of Mg. If soil pH is satisfactory for the crop, but the Ca level is *below optimum-very low*, apply 350 lb/A of Ca (=1500 lb/A of gypsum). If the pH is satisfactory, but Ca is *below optimum-low*, apply 175 lb/A of Ca (=750 lb/A of gypsum).

## Timing of Application
Lime is slow to react in soil. The desired increase in soil pH may require several months. Thus, it is important to plan ahead and apply lime several months in advance of planting. Lime can be applied at any time of the year. Plan ahead and apply lime well in advance of planting crops that are sensitive to soil acidity. Fall applications have the advantage of allowing the lime to react in the soil prior to the start of the next growing season.

Careful attention to liming prior to planting perennial crops such as asparagus is important. Once the crop is established, it is virtually impossible to correct a soil pH problem using surface applications of lime. Lime should be applied at least six months to a year in advance of planting to ensure that the target pH has been achieved.

Soils naturally become more acidic over time. The frequency of prescribed lime application varies with soil characteristics, cropping system, and fertilizer practice. Heavy use of ammonium and urea N fertilizers accelerates soil acidification. Soil pH testing should be performed every1 to 3 years. Relime soils before pH drops below the desired range to avoid development of excess acidity.

## Lime Placement
Lime applications are most effective at neutralizing acidity when they are spread uniformly and thoroughly mixed with the soil by plowing, disking, and harrowing. When applying large amounts of lime, it is best to use split applications. Apply half the lime and plow it under. Next, apply the other half to the plowed surface and disk it into the soil as deeply as possible up to 24 inches.

Whenever conventional tillage is not practiced (e.g., perennial crops, conservation tillage systems), surface applications are recommended but the rate of pH change is much slower than for conventionally tilled soils. Monitor soil pH change and the need for lime to avoid higher lime requirements. Surface lime application rates should not exceed 3,000 lb CCE/A .

For crops using plastic or organic mulches, lime should be applied and incorporated prior to bedding rows. It is ineffective and not recommended to apply lime after plastic mulch has been laid.

### Special Considerations

**Potato scab** is caused by the soil-inhabiting fungus *Streptomyces scabies*. The disease is suppressed in acid soils (pH <5.2), so increase of soil pH with lime favors development of scab. When lime is needed, it is best to apply the lime after potato harvest and before the other crops grown in rotation. The optimum soil pH for growing scab susceptible potato varieties is about 5.0 to 5.2. Scab resistant potato varieties may be grown at pH 5.5 to 6.2.

Cabbage, broccoli, and leafy greens are subject to infection by the **clubroot fungus** *Plasmodiophora brassicae*. If clubroot is known to be present, cole crops should be grown at pH 6.5 to 7.0. The disease is also suppressed at pH 7.2 to 7.4 but crop production and/or quality may be decreased at the higher pH range.

**Spinach** requires an initial pH of 6.5 to 6.7 for good growth and leaf quality. Soil Ca levels should be medium or optimum and in balance with Mg. Plan ahead and adjust pH, Ca, and Mg the season before planting spinach.

### Lime and Fertilizer

Lime and fertilizer work together to produce high yields and better crops. Lime is not a substitute for fertilizer, and fertilizer is not a substitute for lime. The proper use of the two together makes for profitable vegetable crop production. The rate and frequency of their use depends on the crop to be grown, type of soil, soil acidity, and past use of fertilizer materials. The availability of nutrients is adversely affected by pH less than 5.0 or greater than 8.0.

## 3. Plant Nutrients

Many factors influence the nutrient requirements for optimum yield and quality of a given vegetable crop. The original source of soil particles, textural classification, cation exchange capacity, organic matter content, and drainage are important soil properties that influence the rates of nutrients applied to vegetables. In addition, rainfall amounts and distribution, irrigation types and management, and soil and air temperatures during the growing season can alter the retention, availability, and uptake of nutrients. Varieties of the same crop species often differ significantly in their nutrient requirements. Test soils to determine the kinds and amounts of pre-plant fertilizer nutrients required for optimum production. During the growing season, sap and tissue testing should be used when they have been shown to be effective to adjust nutrient applications to current growing conditions and the nutrient status of the crop.

**Pennsylvania growers will receive soil test results directly from the Agricultural Analytical Services Laboratory, College of Agriculture, The Pennsylvania State University; *http://agsci.psu.edu/aasl*. In years when soil tests are not taken, growers in Pennsylvania should use Tables B-4, as described below. Growers in Delaware, Maryland, New Jersey, Virginia and West Virginia should use Table B-4, as described below.**

**See important notes and discussion in the Plant Nutrient Recommendations section below to adjust nutrient rates and timing based on soil type, cation exchange capacity, cropping and manure history, and soil temperatures.**

### Soil Fertility Test Interpretation

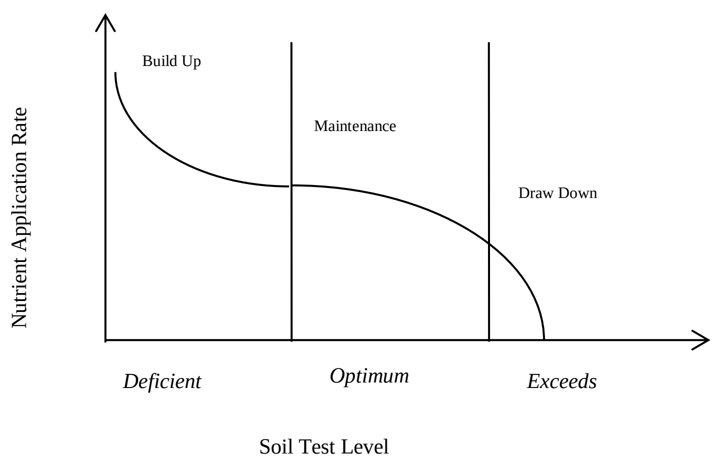
A soil fertility test evaluates the nutrient-supplying power of a soil. The results of the test are used to predict if, or how much fertilizer is required for optimum plant growth. Soil fertility categories include: *below optimum* or *deficient*, *optimum*, and *above optimum* or *exceeds crop needs*. *Below optimum* is divided into subcategories: *very low*, *low*, and *medium*. These soil fertility categories gauge the probability of a beneficial response to the addition of a given nutrient (assuming that other factors such as temperature, moisture and disease are not limiting growth). The critical factor is the soil test level below which a crop response to a nutrient application may be expected, and the level above which no crop response is expected. Crop yields may decrease at very high soil nutrient levels.

## Soil Test Categories

The basic soil test categories for management of soil Calcium (Ca), Magnesium (Mg), Phosphorus (P) and Potassium (K) are: "**below optimum**" or "**deficient**", "**optimum**", and "**above optimum**" or "**exceeds crop needs**". For limestone recommendations, these categories indicate the concentrations of Ca and Mg most suitable for use as a liming material. **Soil test categories, along with crop nutrient requirements, are the basis for nutrient recommendations**. For example, when the soil test category for K is *below optimum-low* or *deficient* the recommendation will indicate how much K to apply. The amount of K recommended however, depends on the crop.

Various crops accumulate different amounts of nutrients. Generally, crops that produce large yields of harvestable material will remove large amounts of nutrients from the soil and will have a higher nutrient recommendation. If the soil fertility category is *below optimum* or *deficient*, the nutrient recommendation for a particular crop is designed to achieve its full crop yield potential and to build the soil fertility level into the *optimum* range over time. If the soil fertility level is already in the *optimum* range, the nutrient recommendation is designed to replace the amount of nutrient removed by the crop to maintain optimum soil fertility. In general, no nutrient application is recommended if the soil test category is *above optimum* or *exceeds crop needs*. This allows "draw-down" of the nutrient level to the *optimum* range. However, certain crops (e.g., potatoes and tomatoes) still benefit from low fertilizer applications of root stimulating nutrients (e.g., phosphorus) that should be applied as a "starter" fertilizer. These concepts are illustrated in Figure B-1.

**Figure B-1. Nutrient Application Rates Vary in Relation to Soil Test Category**




## Soil Test Method and Interpretation

A common misconception is that a soil fertility test is a direct measurement of the total nutrient content of a soil that is available to the plant. Soil test values have historically been expressed in units of pounds per acre (lb/A), but they have no meaning in terms of actual quantity of nutrients available to crop plants. A soil test only provides an index of soil nutrient availability that is correlated with plant response. This correlation is determined by soil test calibration research and is the foundation for soil test interpretation.

Many different types of soil test extraction methods are in use, but only a few are appropriate for our local soils. The Mehlich-1 and Mehlich-3 soil tests are most appropriate for soil types found in the mid-Atlantic region. Soil test results and interpretations are specific for the soils of a region and for the particular soil test method employed. The soil test values for the Mehlich-1 and Mehlich-3 categories (Table B-4) were established based on research conducted on soils in the mid-Atlantic region. The categories were developed from crop yields that were observed during nutrient response studies conducted over a range of soil test levels.

Reading and understanding the soil report from any particular laboratory depends on knowing what soil test method is being used and what units are used to express the soil nutrient levels. If the soil test report does not state the method used, call the laboratory to find out. This information is needed before interpreting the soil test results.

**Table B-4. Soil Test Categories for Nutrients Extracted by Mehlich 3 and 1**

| Soil Test Category | Phosphorus (P) | Potassium (K) | Magnesium (Mg) | Calcium (Ca)[1] |
|---|---|---|---|---|
| | **Mehlich 3 Soil Test Value (lb/A)[2,3]** | | | |
| Deficient (very low) | 0-24 | 0-40 | 0-45 | 0-615 |
| Deficient (low) | 25-45 | 41-81 | 46-83 | 616-1007 |
| Deficient (medium) | 46-71 | 82-145 | 84-143 | 1008-1400 |
| Optimum (high) | 72-137 | 146-277 | 144-295 | 1401-1790 |
| Exceeds Crop Needs (very high) | 138+ | 278+ | 296+ | 1791+ |
| | **Mehlich 1 Soil Test Value (lb/A)[2]** | | | |
| Below Optimum (very low) | 0-3 | 0-15 | 0-24 | 0-240 |
| Below Optimum (low) | 4-11 | 16-75 | 25-72 | 241-720 |
| Below Optimum (medium) | 12-35 | 76-175 | 73-144 | 721-1440 |
| Optimum (high) | 36-110 | 176-310 | 145-216 | 1441-2160 |
| Above Optimum (very high) | 111+ | 311 | 217+ | 2161+ |

[1] Calcium values are for sandy loam soils. Multiply the calcium values in the table above by 0.625 to use for loamy sand soils; by 1.25 for loam soils; by 1.5 for silt loam soils, and by 1.75 for clay loam soils.
[2] Values are reported in elemental forms.
[3] Soil tests that are based on Bray-1 extractable P and neutral, 1N ammonium acetate extractable, K, Ca, and Mg are very similar to the Mehlich-3 extractable concentrations of these nutrients.

## Plant Nutrient Recommendations

**To obtain the highest yields with the least negative environmental impacts, ALWAYS base plant nutrition decisions on a current soil test and current recommendations. Fertilizer is expensive and soil tests are relatively cheap and the only indicator of true nutrient needs**. Refer to Table B-4 to interpret the relative levels of P and K in the soil based on the soil test report from the laboratory. When a current soil test is available, use recommendations for the specific commodity listed in Recommended Nutrients Based on Soil Tests tables in chapter F.

**The following adjustments to the nutrient recommendations in chapter F are recommended based on soil type and cation exchange capacity.**

1. For most vegetables grown on light-textured soils, apply the total recommended $P_2O_5$ and $K_2O$ together with 25 to 50% of the recommended N before planting. The remaining N can be side-dressed or applied with drip irrigation using a fertilizer containing N only. Sidedressing or topdressing potash ($K_2O$) is recommended only on extremely light sandy soils with very low cation exchange capacities.
2. It may be desirable to build up the P and K levels in very low-fertility loam and silt loam soils more rapidly than provided by these recommendations. In such instances, add an additional 40 to 50 lb/A of $P_2O_5$ and $K_2O$, respectively, to the recommendations listed in the table for soils testing low in P and K. Apply the additional amounts in broadcast and plow down or broadcast and disk-in application.

Plant nutrient recommendations listed in tables in chapter F (Recommended Nutrients Based on Soil Tests tables) are expressed in terms of nitrogen (N), phosphate ($P_2O_5$), and potash ($K_2O$), rather than in specific grades and amounts of fertilizer.

When soil test results are available, the phosphate ($P_2O_5$) and potash ($K_2O$) needs for each cropping situation can be determined by selecting the appropriate values under the relative soil test levels for phosphorus and potassium: low, medium, optimum, or very high.

The cropping and manuring history of the field must be known before a fertilization program can be planned. This history is very important in planning a N fertilization program. Certain crop residues and animal manures release nutrients into the soil over a long period of time as they are degraded.

Plant nutrient recommendations listed in the Recommended Nutrients Based on Soil Tests tables in chapter F were developed for fields where no manure is being applied and where no legume crop residue is being incorporated prior to the planting of a new crop. If manure and/or legume crops are being used, the plant nutrient recommendations in the specific commodity should be reduced by the amounts of nitrogen (N), phosphate ($P_2O_5$), and potash ($K_2O$) being contributed from these sources, see Table B-10.

When warm season crops, such as sweet corn, tomatoes, peppers, eggplants, and vine crops are seeded or transplanted and soil temperatures are below 65°F (18°C), 20 lb/A of $P_2O_5$ may be applied to replace phosphorus removed by the crop when soil test levels for phosphorus are *above optimum* or *exceeds crop needs*.

Once the final fertilizer nutrient needs are determined, it will be necessary to determine the grade and rate of fertilizer needed to fulfill these requirements. For example, if the plant nutrient requirements that need to be added as a commercial fertilizer are 50 lb of N, 100 lb of $P_2O_5$, and 150 lb of $K_2O$, you would need a fertilizer with a 1:2:3 ratio, e.g., a 5-10-15, 6-12-18, or 7-14-21. Once you have selected the grade of fertilizer, the amount needed to fulfill the plant nutrient requirement can be determined by dividing the amount of the nutrient needed per acre by the respective percentage of N, $P_2O_5$, or $K_2O$ in the fertilizer, and multiplying the answer by 100. For example, if you choose a 5-10-15 fertilizer grade to supply the 50 lb of N, 100 lb of $P_2O_5$, and 150 lb of $K_2O$ needed, you can calculate the amount of 5-10-15 fertilizer needed as follows: Divide the amount of N needed per acre (50 lb) by the percentage of N in the 5-10-15 fertilizer (5%), and multiply the answer by 100; the answer is 1,000 lb.

This same system can be used for converting any plant nutrient recommendations into grades and amounts of fertilizer needed. When you use this system, it is possible for you to select your fertilizer needs based on the most economical fertilizer grades available to you. In cases where the preferred grade is not available, it is also possible to change from one fertilizer grade to another, providing the plant nutrient ratio is the same. This flexibility may be necessary because of a shortage of some fertilizer materials.

# 4. Nutrient Management

Plants remove substances from the soil and air to enable them to grow and reproduce. The specific substances they remove are termed nutrients. Certain nutrients (**macronutrients**) are generally required in larger quantities. Nutrients needed in smaller quantities (**micronutrients**) are often as important as macronutrients for achieving desired results. Most commercial fertilizers contain the macronutrients N, P, and K, expressed as a weighted percentage (N-$P_2O_5$-$K_2O$). Micronutrients may be supplied along with macronutrients.

### Nitrogen Management

Nitrogen (N) is one of the most difficult nutrients to manage in vegetable production systems. N is readily leached or can be tied-up by soil microbes, can be lost to the atmosphere if not quickly incorporated, and is lost under water-saturated soil conditions. Due to the numerous N loss pathways, N is not routinely tested by state soil testing laboratories for making crop recommendations. Instead, N recommendations are based on years of fertilizer trials and yield potential. N application timings, application methods, and sources are also commonly tested in state fertilizer trials and have resulted in recommendations for splitting N fertilizer for increased fertilizer use efficiency.

Heavy rainfall, higher than normal yield, and following non-legume cover crops are just a few examples of situations where N fertilizer may be tied-up, lost from the production system, or another application of N is warranted. Tissue testing is the best option when deciding if and how much more N is needed to meet expected yields. Soil testing laboratories can provide N concentrations of plant materials with quick turnaround times to aid in N application decisions.

### Phosphorus Management

In general, crops are very likely to respond to phosphorus (P) fertilization if dictated necessary by soil tests. Soil test P levels of *deficient* or *below optimum-very low*, *low*, or *medium* indicate a strong response to P fertilizer. Crops in soils testing *optimum* may or may not respond to further additions, but P may be applied to maintain the fertility level in the *optimum* range (P fertilizer applied at crop removal rates). Crops in soils with levels in the *exceeds crop needs* or *above optimum-very high* categories may also respond to P fertilizer if conditions are favorable for high yields or plants have slow growing and/or shallow root systems. Tomato and potato are classic examples of crops benefiting from P fertilizer additions on very high soil test P concentrations.

It is often recommended that a band of P fertilizer be placed near the seed/transplant as a starter fertilizer regardless of the P fertility level. Banded P is especially helpful at low soil test P levels, however, overall field rates should not be decreased. When the soil test level is *deficient* or *below optimum*, P should generally be applied as a combination of broadcast and banded methods. Even at P soil test levels that are *very high-above optimum* or *exceeds crop needs*, a small amount of banded P may benefit crop establishment. Many test results describe soils as *above optimum* or *exceeds crop needs* due to previous fertilizer and manure applications. When applied in excess of crop removal, P accumulates in the soil. P is strongly adsorbed to soil particles and very little is subject to loss via leaching. In high concentrations, soil P will also interact with ionic micronutrients, such as zinc, to alter availability of P to the plant. If the soil test report indicates that P levels are *above optimum* or *exceeds crop needs,* crop and site-specific factors will determine if P fertilizer should still be applied, but the general recommendation under those circumstances is that soils should receive very little or no P fertilizer.

### Potassium Management

Crops are very likely to respond to K fertilizer when the soil test indicates that K is *deficient or below optimum-very low* or *low*. A soil testing *below optimum-medium* in K may or may not respond to K fertilizer. Soils testing *optimum*, *above optimum* or *exceeds crop needs* are unlikely to respond to K fertilizer, but it may be recommended to apply K to maintain the soil fertility level in the *optimum* range.

In general, most of K fertilizer should be broadcast. When the fertility level is *below optimum* or *deficient*, it may be advantageous to apply a portion of the total K application as a band. There is generally no benefit to applying banded K when soil fertility levels are *optimum* or *above optimum* or *exceeds crop needs*. In loamy sand and sand textured soils, split applications of K may be beneficial and may be applied using side-dress applications or applied through trickle irrigation.

Crops remove larger amounts of K than P from the soil during a growing season. In addition, sandy soils have low reserves of K, and K is susceptible to leaching. Therefore, frequent applications of K are needed to maintain K at an optimum fertility level.

### Secondary and Micronutrient Management

Calcium (Ca), magnesium (Mg), and sulfur (S) are included in the secondary element group. Ca may be deficient in soils that were not properly limed, where excessive amounts of potash fertilizer were used, and/or where crops are subjected to drought stress. Of these 3 elements, Mg is the most likely to be deficient in soils. Dolomitic or high-Mg limestone should be used for liming soils that are low in Mg. On low-Mg soils where lime is not needed, Mg should be applied in fertilizer. Magnesium may be applied as a foliar spray to supply Mg to crops in emergency situations. Contact your county Extension Agent/Educator for recommendations regarding scenarios that do not conform to these common soil nutrient ranges.

Sulfur is an important plant nutrient, especially for the onion family and cole crops. S may become deficient on light, sandy soils. S deficiencies may develop as more air pollution controls are installed and with the continued use of high-analysis fertilizers with low S content. S concentrations greater than 5 ppm are associated with increased pungency in sweet Spanish onions, and low soil S will result in reduced pungency. S can be supplied by application of S-containing fertilizers, e.g., Gypsum (Calcium Sulfate) or Epsom Salt (Magnesium Sulfate), see Table B-5.

### Micronutrients

**Boron (B) is the most widely deficient micronutrient in vegetable crop soils.** Deficiencies of this element are most likely to occur in the following crops: asparagus, most bulb and root crops, cole crops, and tomatoes. See Table B-7 for B recommendations for various crops based on soil or plant tissue test results. Use of excessive amounts of B can be very toxic to plant growth. **DO NOT** exceed recommendations listed in Table B-7 and in the Recommended Nutrients Based on Soil Tests tables for specific commodities in chapter F (note: in chapter F, Boron recommendations may be listed in a footnote under the Recommended Nutrients Based on Soil Test table).

**Manganese (Mn)** deficiency often occurs in plants growing on soils that have been over-limed with a pH above 7.0. A broadcast application of 20 to 30 lb/A or a band application of 4 to 8 lb/A of Mn will usually correct the deficiency. When Mn is applied as manganese sulfate, foliar application of 0.5 to 1 lb/A of Mn in 20 gal of water/A in one to three applications usually will help relieve the deficiency. Use a sulfate or chelate of Mn. Do not apply lime or poultry manure to such soils until the pH has dropped below 6.5, and be careful not to over-lime again.

**Molybdenum (Mb)** deficiency in cauliflower (whiptail) may develop when this crop is grown on soils that are more acid than pH 5.5. Liming acid soils to a pH of 6.0 to 6.5 will usually prevent the development of Mb deficiencies in vegetable crops.

Deficiencies of other micronutrients in vegetable crops in the mid-Atlantic region are rare; and when present, are usually caused by over-liming or other substandard soil management practices. Contact your county Extension Agent/Educator for advice if you suspect a deficiency of zinc, iron, copper, or chlorine in your crops. Sources of fertilizers for the essential plant nutrients may be found in Tables B-5 and 6.

### Table B-5. Composition of Principal Macronutrient Fertilizer Materials

| Material | N Nitrogen (%) | $P_2O_5$ Phosphorus (%) | $K_2O$ Potassium (%) | Mg Magnesium (%) | Ca Calcium (%) | S Sulfur (%) | $CaCO_3$ Equivalent (lb/ton) |
|---|---|---|---|---|---|---|---|
| Ammonia, Anhydrous | 82 | | | | | | -2960 |
| Ammonium Nitrate | 33 to 34 | | | | | | -1180 |
| Ammonium Phosphate Sulfate | 13 to16 | 20 to 39 | | | | 13 | -1520 to -2260 |
| Ammonium Polyphosphate (APP) | 10 to 11 | 34 to 37 | | | | | +1000 to 1800 |
| Ammonium Sulfate (Granular) | 21 | | | | | 24 | -2200 |
| Ammonium Sulfate (Liquid) | 8 | | | | | 9 | |
| Ammonium Sulfate Nitrate | 26 | | | | | 15 | -1700 |
| Ammonium Thiosulfate | 12 | | | | | 26 | -2000 |
| Calcium Nitrate | 15 | | | | 19 | | +400 |
| Calcium Sulfate (Gypsum) | | | | | 23 | 17 | |
| Diammonium Phosphate (DAP) | 18 | 46 | | | | | -1400 |
| Limestone, Calcite | | | | | 32 | | +1700 to 2000 |
| Limestone, Dolomite | | | | 11 | 22 | | +1900 to 2160 |
| Magnesium Oxide (Magnesia) | | | | 55 | | | |
| Magnesium Sulfate (Epsom Salt) | | | | 10 | 2.2 | 14 | |
| Monoammonium Phosphate (MAP) | 11 | 52 | | | | | -1160 |
| Nitric Phosphates | 14 to 22 | 10 to 22 | | | 8 to 10 | 0 to 4 | -300 to -500 |
| Phosphoric Acid | | 52 to 54 | | | | | -2200 |
| Potassium Chloride (Muriate) | | | 60 to 63 | | | | |
| Potassium Magnesium Sulfate | | | 22 | 11 | | 22 | |
| Potassium Nitrate | 13 | | 44 | | | | -460 |
| Potassium Sulfate | | | 50 to 53 | | | 18 | |
| Potassium Thiosulfate | | | 25 | | | 17 | |
| Rock Phosphate | | 30 to 36 | | | 33 | | +200 |
| Sodium Nitrate | 16 | | | | | | +580 |
| Sulfur Elemental | | | | | | 32 to 100 | |
| Superphosphate, Concentrated (Triple) | | 44 to 53 | | | 14 | | -3200 |
| Superphosphate, Normal | | 16 to 22 | | | 20 | 12 | |
| Urea | 45 to 46 | | | | | | -1680 |
| Urea Formaldehydes | 35 to 40 | | | | | | -1360 |
| Urea-Ammonium Nitrate Solutions | 21 to 49 | | | | | | -750 to -1760 |

### Table B-6. Chemical Sources of Secondary and Micronutrients

| Boron Sources Material | Chemical Formula | % B |
|---|---|---|
| Borax | $Na_2B_4O_7 \cdot 10H_2O$ | 11 |
| Boric acid | $H_3BO_3$ | 17 |
| Fert. borate-46 | $Na_2B_4O_7 \cdot 5H_2O$ | 14 |
| Fert. Borate-65 | $Na_2B_4O_7$ | 20 |
| Sodium pentaborate | $Na_2B_{10}O_{16} \cdot 10H_2O$ | 18 |
| Solubor | $Na_2B_{10}O_{16} \cdot 10H_2O$ + $Na_2B_4O_7 \cdot 5H_2O$ | 20 |

| Copper Sources Material | Chemical Formula | % Cu |
|---|---|---|
| Copper ammonium phosphate | $Cu(NH_4)PO_4 \cdot H_2O$ | 32 |
| Copper chelates | $Na_2CuEDTA$<br>NaCuHEDTA | 13<br>9 |
| Copper sulfate | $CuSO_4 \cdot 5H_2O$ | 25 |

| Calcium Sources Material | Chemical Formula | % Ca |
|---|---|---|
| Calcitic lime | $CaCO_3$ | 31.7 |
| Calcium nitrate | $Ca(NO_3)_2$ | 19.4 |
| Dolomitic lime | $CaCO_3$+$MgCO_3$ | 21.5 |
| Gypsum | $CaSO_4 \cdot 2H_20$ | 22.5 |
| Hydrated lime | $Ca(OH)_2$ | 46.1 |
| Superphosphate, normal | $Ca(H_2PO_4)_2$ | 20.4 |
| Superphosphate, triple | $Ca(H_2PO_4)_2$ | 13.6 |

| Iron Sources Material | Chemical Formula | % Fe |
|---|---|---|
| Ferrous ammonium phosphate | $Fe(NH_4)PO_4 \cdot H_2O$ | 29 |
| Ferrous sulfate | $FeSO_4 \cdot 7H_2O$ | 19 |
| Iron ammonium polyphosphate | $Fe(NH_4)HP_2O_7$ | 22 |
| Iron chelates | NaFeEDTA | 5 to 14 |
| | NaFeDTPA | 10 |
| | NaFeEDDHA | 6 |

*Table continued on next page*

*Table B-6. Chemical Sources of Secondary and Micronutrients - continued*

| Magnesium Sources Material | Chemical Formula | % Mg |
|---|---|---|
| Dolomitic lime | $MgCO_3$+$CaCO_3$ | 11.4 |
| Epsom salt | $MgSO_4$•$7H_2O$ | 9.6 |
| Magnesia | MgO | 55.0 |
| Potassium-Mg sulfate | $K_2SO_4$•$2MgSO_4$ | 11.2 |

| Sulfur Sources Material | Chemical Formula | % S |
|---|---|---|
| Ammonium sulfate | $(NH_4)_2SO_4$ | 24 |
| Ammonium thiosulfate | $(NH_4)_2S_2O_3$ | 26 |
| Gypsum | $CaSO_4$•$2H_2O$ | 16.8 |
| Potassium-Mg-sulfate | $K_2SO_4$•$2MgSO_4$ | 22.0 |
| Potassium thiosulfate | $K_2S_2O_3$ | 17 |
| Sulfur, elemental | S | 32 to 100 |

| Manganese Sources Material | Chemical Formula | % Mn |
|---|---|---|
| Manganese chelate | MnEDTA | 12 |
| Manganese oxide | MnO | 41 to 68 |
| Manganese sulfate | $MnSO_4$•$4H_2O$ | 26 to 28 |

| Zinc Sources Material | Chemical Formula | % Zn |
|---|---|---|
| Zinc carbonate | $ZnCO_3$ | 52 |
| Zinc chelates | $Na_2ZnEDTA$<br>NaZnHEDTA | 14<br>9 |
| Zinc oxide | ZnO | 78 |
| Zinc sulfate | $ZnSO_4$•$H_2O$ | 35 |

| Molybdenum Sources Material | Chemical Formula | % Mo |
|---|---|---|
| Ammonium molybdate | $(NH_4)6Mo_7O_{24}$•$2H_2O$ | 54 |
| Molybdenum trioxide | $MoO_3$ | 66 |
| Sodium molybdate | $Na_2MoO_4$•$2H_2O$ | 39 |

## Table B-7. Boron Recommendations Based on Soil Tests for Vegetable Crops

| Interpretation of Boron Soil Tests | | | Crops that often need additional Boron[1] | Boron (B) Recommendations (lb/A)[2] |
|---|---|---|---|---|
| **Parts per Million** | **Pounds per Acre** | **Relative Level** | | |
| **0.0-0.35** | **0.0-0.70** | **Low** | Beets, broccoli, Brussels sprouts, cabbage, cauliflower, celery, rutabaga, and turnips | **3** |
| | | | Asparagus, carrots, eggplant, horseradish, leeks, muskmelons, okra, onions, parsnips, radishes, squash, strawberries, sweet corn, tomatoes, and white potatoes | **2** |
| | | | Peppers and sweet potatoes | **1** |
| **0.36-0.70** | **0.71-1.40** | **Medium** | Beets, broccoli, Brussels sprouts, cabbage, cauliflower, celery, rutabaga, and turnips | **1.5** |
| | | | Asparagus, carrots, eggplant, horseradish, leeks, muskmelons, okra, onions, parsnips, radishes, squash, strawberries, sweet corn, tomatoes, and white potatoes | **1** |
| **>0.70** | **>1.40** | **High** | All crops | **0** |

[1]If boron deficiency is suspected in vegetable crops not listed above, a soil and/or plant tissue test should be made and used as a basis for treatment recommendations. [2]Approximate conversion factors to convert elemental boron (B) to different boron sources:
Boron (B) x 9 = borax (11.36% B); boron (B) x 7=fertilizer borate granular (14.3% B); boron (B) x 6.7 = fertilizer borate 48 (14.91% B); boron (B) x 5 = fertilizer borate 65 (20.2% B) or Solubor (20.5% B); boron (B) x 4.7 = fertilizer borate 68 (21.1% B).

**Note**. The most practical way to apply boron as a soil application is as an additive in mixed fertilizer bought specifically for the crop or field where it is needed. Do not use fertilizer containing more than 0.5 lb B per ton of fertilizer for crops not listed above, unless specifically recommended. To avoid possible boron toxicity damage to crops, apply boron in broadcast fertilizer rather than in bands or as a side-dressing. Boron may be broadcast pre-plant as a soluble spray alone or with other compatible soluble chemicals.

## Plant Tissue Testing

Plant tissue testing is an important tool in assessing vegetable nutrient status during the growing season. The following methods are commonly used: 1. Testing leaf tissue, 2. Testing whole petioles, and 3. Testing petiole sap.

**1. Collecting leaf tissue for analysis:**

- Sample the most recently matured leaf from the growing tip; the sample should not contain any root or stem. For sweet corn or onions, the leaf is removed just above the attachment point to the stalk or bulb. For compound leaves (e.g., carrots, peas, tomatoes) the whole leaf includes the main petiole, all the leaflets and their petioles. For heading vegetables, it is most practical to take the outermost whole wrapper leaf. When sampling particularly young plants, the whole above-ground portion of the plant may be sampled.
- A proper leaf sample should consist of about 25 to 100 individual leaves. The same leaf (i.e., physiological age and position) should be collected from each sampled plant.
- Avoid sampling plants damaged by pests, diseases, or chemicals.
- Sample across the field, from different rows, and avoid problem areas (e.g., low spots, ridges, washed out areas).
- Sample when the plants are actively growing (typically between 9 a.m. and 4 p.m.). Do not collect samples from water stressed plants.
- Send samples to a laboratory in a paper bag; **do not use plastic bags** (your samples may spoil in plastic).

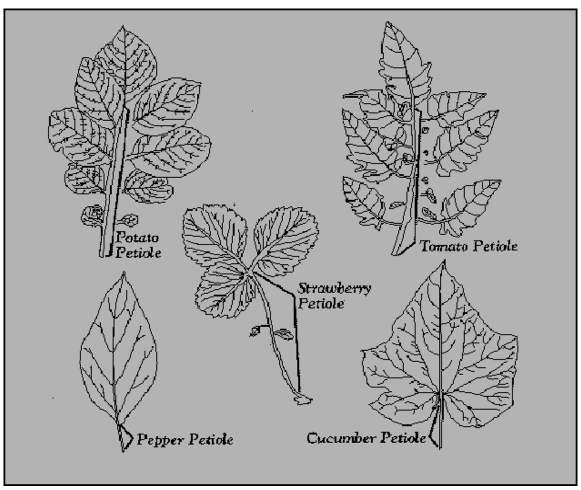
**2. Collecting whole petiole samples for analysis:**

- Sample the most recently matured leaf. Throw away the leaflets. (see Fig. B-2). Sample from 30 to 50 plants.
- Sample across the field, from different rows, and avoid problem areas (e.g., low spots, ridges, washed out areas).
- Sample between 10 a.m. and 2 p.m. Do not collect samples from water stressed plants.
- Send samples to a laboratory in a paper bag; **do not use plastic bags** (your samples may spoil in plastic)

**3. Collecting petiole sap samples for analysis:**

- Sample petioles from most recently matured leaves. Discard the leaflets (see Fig. B-2). Sample 30 to 50 plants.
- Sample across the field, from different rows, and avoid problem areas (e.g., low spots, ridges, washed out areas).
- Sample between 10 a.m. and 2 p.m. Do not collect samples from water stressed plants.
- After collection, squeeze collected petioles with a garlic press to extract sap. Use a handheld nitrate meter, (available widely from nutrient management supply companies) to read the sap nitrate concentration. Make sure you record the correct units as either $NO_3^{-1}$ or $NO_3^{-1}$-N. Petiole sap sufficiency ranges are found in Table B-9.

**Figure B-2 Petiole Delineation for Several Plant Species.**




## Interpreting Tissue Tests

Tissue tests will be reported as *adequate or sufficient* in a range; *low or deficient* below that range; *high or excessive* above that range; and *toxic* (if applicable) if in excess. Test interpretation for most vegetable crops can be found at this University of Florida website *http://edis.ifas.ufl.edu/ep081*. Test interpretations for selected crops can also be found in chapter F. **Petiole sap** sufficiency ranges can be found in Table B-9. The concentrations in the sufficiency range are measured in plants that have adequate amounts of nutrients available. Plants with nutrient concentrations in the high range are indicative of over-fertilization. Excessive values for micronutrients may result in phytotoxicity.

## Correcting Deficiencies

Recommendations for correcting nutrient deficiencies are presented in the previous sections and in table B-8.

**Table B-8. Recommendations for Correction of Vegetable Crop Nutrient Deficiencies**

| Nutrient | Fertilizer | Method | Application Rate (Nutrient) lb/A |
|---|---|---|---|
| **Nitrogen (N)** | Urea-ammonium nitrate solutions | T,S,D[1] | 30 to 40 |
| | Calcium nitrate | T,S,D | 30 to 40 |
| **Phosphorus ($P_2O_5$)** | Ammonium phosphates | T,S,D | 20 |
| | Triple superphosphate | T,S | 20 |
| | Phosphoric acid | S,D | 20 |
| **Potassium ($K_2O$)** | Potassium chloride | T,S,D | 30 |
| | Potassium nitrate | T,S,D | 30 |
| **Calcium (Ca)** | Calcium nitrate | T,S,D | 30 |
| | Calcium chloride | D | 30 |
| **Magnesium (Mg)** | Magnesium sulfate | T,S,D | 20 |
| | Potassium magnesium sulfate | T,S | 20 |
| **Sulfur (S)** | Ammonium Sulfate | T,S,D | 20 |
| | Gypsum | T,S,D | 20 |
| **Boron (B)** | Borax, Solubor[2] | D,F[1] | 0.1 to 0.2 |
| **Copper (Cu)** | Copper sulfate | D,F | 0.1 to 0.2 |
| **Iron (Fe)** | Ferrous sulfate, chelated iron | D,F | 0.2 to 0.5 |
| **Manganese (Mn)** | Manganous sulfate, chelated manganese | D,F | 0.5 to 1.0 |
| **Molybdenum (Mo)** | Sodium molybdate | D,F | 0.01 to 0.05 |
| **Zinc (Zn)** | Zinc sulfate, chelated zinc | D,F | 0.1 to 0.2 |

[1]T=topdress, S=sidedress, D=drip irrigation, F=foliar.
[2]Mention of a trade name does not imply a recommendation compared to similar materials.

**Table B-9. Sufficiency Ranges for Fresh Petiole Sap Concentrations in Vegetable Crops**

| Crop | Stage of Growth | Concentration (ppm) | | Crop | Stage of Growth | Concentration (ppm) | |
|---|---|---|---|---|---|---|---|
| | | K | $NO_3$-N | | | K | $NO_3$-N |
| **Cucumber** | First blossom | N/A | 800-1000 | **Potato** | Plants 8 in. tall | 4500-5000 | 1200-1400 |
| | Fruit (3 in.) | N/A | 600-800 | | First open flowers | 4500-5000 | 1000-1400 |
| | First harvest | N/A | 400-600 | | 50% flowers open | 4000-4500 | 1000-1200 |
| **Broccoli** | Six-leaf stage | N/A | 800-1000 | | 100% flowers open | 3500-4000 | 900-1200 |
| | Just prior to harvest | N/A | 500-800 | | Tops falling over | 2500-3000 | 600-900 |
| | At first harvest | N/A | 300-500 | **Squash** | First blossom | N/A | 900-1000 |
| **Eggplant** | First fruit (2 in. long) | 4500-5000 | 1200-1600 | | First harvest | N/A | 800-900 |
| | First harvest | 4000-5000 | 1000-1200 | **Tomato (Field)** | First buds | 3500-4000 | 1000-1200 |
| | Mid harvest | 3500-4000 | 600-800 | | First open flowers | 3500-4000 | 600-800 |
| **Muskmelon (Cantaloupe)** | First blossom | 4000-5000 | 1000-1200 | | Fruit (1 in. diameter) | 3000-3500 | 400-600 |
| | Fruit (2 in.) | 3500-4000 | 800-1000 | | Fruit (2 in. diameter) | 3000-3500 | 400-600 |
| | First harvest | 3000-3500 | 700-800 | | First harvest | 2500-3000 | 300-400 |
| **Pepper** | First flower buds | 3200-3500 | 1400-1600 | | Second harvest | 2000-2500 | 200-400 |
| | First open flowers | 3000-3200 | 1400-1600 | **Watermelon** | Vines (6 in. long) | 4000-5000 | 1200-1500 |
| | Fruit half-grown | 3000-3200 | 1200-1400 | | Fruit (2 in. long) | 4000-5000 | 1000-1200 |
| | First harvest | 2400-3000 | 800-1000 | | Fruit (half mature) | 3500-4000 | 800-1000 |
| | Second harvest | 2000-2400 | 500-800 | | At first harvest | 3000-3500 | 600-800 |

## Sustainable Nutrient Management

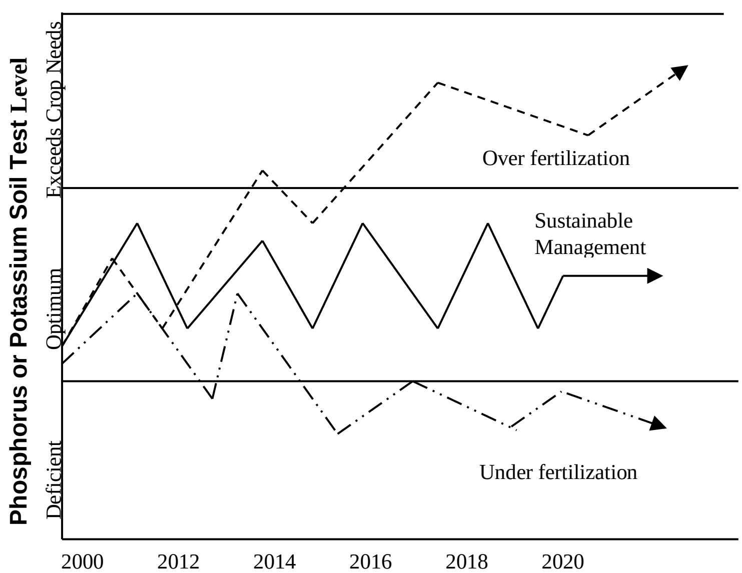
A major objective of nutrient management is to bring the soil fertility level into the *optimum* range and to sustain that fertility level during crop growth. Once soil fertility has reached the *optimum* level, the nutrient application rate should be only large enough to maintain the *optimum* level. This can be accomplished by applying nutrients at a rate that closely matches the rate of nutrient removal in the harvested crop. The rate may need to be slightly higher to account for other losses such as leaching.

Keeping records of soil test results enables you to track changes over time and to adjust recommendations as needed to maintain soil fertility in the optimum range. Meaningful records require a consistent approach to soil testing in terms of sample collection, sampling depth, and laboratory submission. Soil test levels can vary somewhat from sample to sample and having records helps to spot unusual soil test values that should be rechecked.

Although soil fertility levels naturally fluctuate from year to year due to crop rotation and manure application, the average levels of nutrients over time should remain in the optimum range, as shown in Figure B-3. If soil fertility levels are observed to fall in the *below optimum* or *deficient* category, under-fertilization is indicated. The nutrient recommendation should be adjusted so that the application rate is sufficient to meet the needs of the current crop, and to gradually rebuild the nutrient supply to the optimum level. If soil fertility levels are observed to climb into the *above optimum* or *exceeds crop needs* category, good crop yields may be obtained without adding the nutrient. Yield and quality are likely to be reduced by reapplying a nutrient already present in very high amounts. Over time, nutrient removal by crops should allow the soil fertility level to fall back into the optimum range (Figs. B-1 and 3).

Very high soil nutrient levels can be as detrimental to crop performance as low or deficient levels. High soil nutrient levels may not only result in an economic loss but they may also cause problems to animals or the environment. Very high soil P levels (above about 370 lb/A $P_2O_5$ or 160 lb/A P) may lead to deficiencies of other nutrients, especially of iron and zinc. High K levels (above about 205 lb/A $K_2O$ or 170 lb/A K) can induce magnesium or calcium deficiency through competition for plant uptake and vice versa. Use best management practices to avoid increasing soil nutrient levels that are already high.

**Figure B-3. Changes in Soil Test Levels over Time under Different Nutrient Management Scenarios.**




## Sewage Sludge

Sewage sludge, or biosolids, is a by-product of the purification of waste water. This type of material has significant organic matter content and contains micro- and macronutrients essential for plant growth. Sewage sludge can also contain contaminants such as heavy metals, organic contaminants, and human pathogens. Before it can be used for land application, sewage sludge must undergo additional treatment to stabilize and disinfest it. After appropriate treatment, federal and some state regulations allow the use of sewage sludge on vegetables. However, due to our lack of knowledge of biosolids and perishable food commodities **Cooperative Extension does not recommend the application of sewage sludge/biosolids to soils used for vegetable production.**

If the grower elects to use biosolids despite this warning, the material should not be applied to steeply sloping land, soils with bedrock near the surface, highly leachable soils, soils having a pH less than 6.0, soils with high water tables, or fields near surface water. When considering the land application of biosolids, carefully review the regulations and consult with the United States Department of Agriculture (USDA) and the Natural Resources Conservation Service (NRCS).

### Foliar Fertilization

Plants usually obtain nutrients from the soil through roots, but plants can also absorb a limited amount of some nutrients through aerial organs such as leaves. Properly managed soils are usually able to supply the essential mineral nutrients the crop will need during its development. If one or more soil-supplied nutrients become deficient or unavailable during the development of the crop, foliar nutrient applications may be beneficial. Care should be taken to use approved tank mixes if nutrients are combined with fungicides, insecticides, herbicides, or any other additive. Chelated nutrient sources are often optimal for tank mixes, but make sure to **read the label and conduct a jar test**. Generally, it is difficult to supply ample macro- and secondary nutrients through foliar fertilization, and application of this strategy should be focused on micronutrients only. If a nutrient deficiency occurs, efforts should be made to correct this deficiency via soil fertilization prior to the next growing season.

## 5. Soil Improvement and Organic Nutrient Sources

### Cover Crops

Cover cropping is an important practice for sustainable vegetable production; some reasons to consider cover crops:
**Return organic matter to the soil**: Vegetable rotations are tillage intensive and organic matter is oxidized at a high rate. Cover crops help maintain soil organic matter levels; a critical component of soil health and productivity.
**Provide winter cover**: By having a cover crop - including roots - growing on a field in the winter you recycle plant nutrients (especially N), reduce N leaching losses, reduce erosion by wind and water, and reduce surface compaction and the effects of heavy rainfall on bare soils. Cover crops also compete with winter annual weeds and can help reduce weed pressure in the spring.
**Reduce certain diseases and other pests**: Cover crops help maintain soil organic matter levels. Cover crop residues can help increase the diversity of soil organisms and reduce soil borne disease pressure. Some cover crops may also release compounds that help suppress certain soil borne pests, e.g., nematodes.
**Provide nitrogen for the following crop**: Leguminous cover crops, such as hairy vetch or crimson clover, can provide significant amounts of nitrogen, especially for late spring planted vegetables.
**Improve soil physical properties**: Cover crops help maintain or improve soil physical properties and reduce compaction. Roots of cover crops and incorporated cover crop residue will help improve drainage, water holding capacity, aeration, and tilth.

### Small Grains and Ryegrasses

Seeding spring oats at 60 to 100 lb/A during August or early September provides a good cover crop that will winter-kill in the colder areas but may overwinter in warmer areas. Rye, triticale, barley, or winter wheat can be seeded at 80 to 110 lb/A after early September. These crops can also provide strips for wind protection during the early part of the next growing season. Spring oats also works as a spring planted cover. Annual and perennial ryegrass or a mixture of the two seeded at 15-20 lb/A by early September are also good cover crops.

### Legumes

Legumes such as hairy vetch, crimson clover, field peas, subterranean clover, and other clovers are excellent cover crops and can provide significant amounts of N for vegetable crops that follow. Good examples are hairy vetch drilled at 25-60 lb/A, crimson clover at a rate of 15-30 lb/A, or field peas such as Austrian Winter planted at 50-70 lb/A. Subterranean clover is an option for the southern part of the region. Hairy vetch works very well in no-till vegetable systems where it is allowed to go up to flowering or early fruiting and then is killed by herbicides or with a roller-crimper. It is a common system for planting pumpkins in the region but also works well for late plantings of other vine crops, tomatoes and peppers. Hairy vetch, crimson clover, field peas and subterranean clover can provide from 80 to well over 100 lb/A of N equivalent. See table B-10 for estimated N credits from legumes. Remember to inoculate the seeds of these crops with the proper Rhizobia inoculants. All of these legume species should be planted as early as possible, from the last week in August through the end of September to get adequate fall growth. Legume cover crops should be planted a minimum of 4 weeks before a killing frost.

Red clover planted late winter or early spring can be used ahead of early summer vegetables. Summer legume cover crops can be used for soil improvement and provide N prior to planting fall vegetable crops. These include sun hemp, cowpeas, soybeans, annual lespedeza, and a number of medic (alfalfa) species.

## Summer Annual Grasses

Summer grass cover crops such as sudangrass, forage sorghum or sorghum x sudangrass crosses, seeded at 20 to 40 lb/A, are good green manure crops. Several millet species including forage-type pearl millet, teff, German or foxtail millet, and Japanese millet are also good cover crops. They can be planted as early as field corn is planted and as late as August 15 in MD and VA, and July 25 to August 1 in cooler areas of NJ and PA. These crops should be clipped, mowed, or disked to prevent seed development that could lead to weed problems. Summer cover crops can be disked and planted in wheat or rye in September or allowed to winter-kill and tilled in the spring.

## *Brassica* Species

There has been increased interest in the use of certain *Brassica* species, including both fully hardy overwintering species and species that will winter-kill but that can be planted in the spring ahead of crop production. They provide significant amounts of organic matter, recycle N, can reduce compaction (larger rooted types), and offer the potential for biofumigation (mustards and rapeseed). Plant by September 15 or in March-April. The following *Brassica* types are available:

**Rapeseed and Canola -** overwinter and are good biofumigants.

**Forage, Oilseed, and Daikon Radish -** very good for reducing compaction in soils; forage radish winter kills, oilseed radish is hardier.

**Mustards** (brown and yellow mustards as well as garden mustard) - offer good biofumigant potential; half hardy.

**Turnips** (forage and garden types) - good biomass production; half hardy.

**Kale** (forage and garden types) **-** winter hardy; good biomass production.

**Hybrid Forage Brassicas** (such as ‘Typhon’) - these are hybrid crosses of two or more species that will produce excellent fall growth and some will overwinter. Rapeseed has been used as a winter cover (when planted by early September) and has shown some promise as a biofumigant, reducing certain nematode levels in the soil. Several mustard species also have biofumigation potential. To take advantage of biofumigation properties (rapeseed and several mustards) plant in late summer or spring. Allow plants to develop until just before going to seed. Decomposing leaves release the fumigant-like chemicals. Mow using a flail mower and plow down the residue immediately. Never mow down more area than can be plowed under within two hours. Mowing injures the plants and initiates a process releasing biofumigant chemicals into the soil. Failure to incorporate mowed plant material into the soil quickly, allows much of these available toxicants to escape by volatilization.

Several mustard species can be used for fall cover but not all species/varieties will winter over into the spring. A succession rotation of an August planting of biofumigant mustards that are tilled under in October followed by small grain can significantly reduce diseases for spring planted vegetables that follow. **Make sure to mow and disk rapeseed and mustard in advance of seed maturation, since they can become serious noxious weeds.**

## Other Cover Crops/Special Considerations

A number of other cover crops may be useful. Buckwheat is a quick summer cover crop noted for its ability to smother out weeds. Marigold species have been used as nematode controls.

Many soils that are not very productive due to poor physical properties can be restored and made to produce good crops through the use of a good rotation program. This practice also helps to counteract the buildup of many diseases and insects that attack vegetable crops. Small grains, sudangrass, sorghum x sudangrass, timothy, orchardgrass, ryegrass and other grass hay species are good soil-resting crops. Consult your state field crop or agronomy recommendations for details on seeding rates and management practices.

Intensive cropping, working the soil when it was too wet, and excessive traffic from using heavy-tillage equipment has severely damaged many soils. These practices cause the soils to become very hard and compact, resulting in poor seed germination, loss of transplants, and shallow root formation. Also, such soils crust easily and compact severely, making them very difficult to irrigate properly. This results in poor plant stands, poor crop growth, low yields, and loss of income. Subsoil tilling in the row may help improve aeration and drainage of soils damaged by several years of excessive traffic from heavy equipment.

Alfalfa can aid in breaking up deep soil compaction. It is useful as a soil-resting crop and in crop rotations. However, it should not be used in rotation with other legumes such as: soybeans; peas; and snap, dry, and lima beans; and especially where soil-borne diseases have been a problem. Forage radish and oilseed radish are also very well suited to improving compacted soils.

Proper management of living cover crops can reduce nutrient loss during the winter and early spring. Living cover crops should be disked or plowed to return nutrients to the soil and before they seriously deplete soil moisture.

## Manure and Compost

Manures can be used in vegetable production but must be applied with sufficient time ahead of harvest to minimize the risk from pathogens that cause foodborne illness (e.g., *E. coli* 0157:H7, Listeria, Salmonella). See Table B-10 for estimated available nutrient content for different manure types by animal. Manure testing is recommended for developing nutrient management plans as the organic source of N in the manure will be available slowly. Current guidelines are to apply uncomposted animal manures at least 90 days prior to harvest for crops whose edible portions do not come in contact with the soil and at least 120 days prior to harvest for crops whose edible portions do come in contact with the soil. This is required under the US Department of Agriculture's National Organic Program for organic producers. Currently, days to harvest after manure application in fresh produce is under review by the Food and Drug Administration for upcoming produce regulations under the Food Safety Modernization Act (FSMA).

An alternative to direct application of manure is to compost the manure. Properly composted manure can be applied to produce at any time before harvest.

Application and incorporation of compost to soils will increase soil organic matter and certain soil nutrient levels. Compost ingredients can include animal manures, scrap table foods, food wastes, leaves, grass, wood products or other waste materials. Compost composition, nutrient analysis, and quality should be considered when used in vegetable production. Ingredients which make up specific compost may be alkaline (for example, lime is often added), resulting in a high pH of 7.5 to 8.5. Composts that have been made from manures may have high salt levels. Therefore, application rates of compost must be determined by considering nutrient content, salt levels, crop use, and pH before field applications are made. Composts are generally applied from 1 to 6 ton/A. Higher application rates may be deleterious. A compost analysis is essential to determine safe application rates.

A good extension web reference on the making and use of compost for vegetable production is *http://aggie-horticulture.tamu.edu/vegetable/guides/composts-vegetable-fruit-production/*. For more information on nutrients in organic production see: *Using Organic Nutrient Sources* at: *http://hightunnels.org/wp-content/uploads/uj256.pdf.*

**Table B-10. Plant Nutrient Value Credits to Be Allowed for Manure Applications and Crop Residues**

| Manure Applications | Pounds per Ton | | | | Crop Residues | Pounds per Acre | | |
|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | | | N | $P_2O_5$ | $K_2O$ |
| Cattle manure | 5-10[1] | 3 | 3 | | Alfalfa sod | 50-100[2] | 0 | 0 |
| Horse manure | 6-12[1] | 3 | 6 | | Birdsfoot trefoil | 40 | 0 | 0 |
| Liquid poultry manure (5-15% solids) | 7-15[1] | 5-10 | 5-10 | | Crimson clover sod | 50 | 0 | 0 |
| | | | | | Hairy vetch | 50-100[2] | 0 | 0 |
| Pig manure | 5-10[1] | 2 | 2 | | Ladino clover sod | 60 | 0 | 0 |
| Poultry manure | 25-50[1] | 40-80 | 30-60 | | Lespedeza | 20 | 0 | 0 |
| | | | | | Red clover sod | 40 | 0 | 0 |
| | | | | | Soybeans - grain harvest residue | 15 | 0 | 0 |
| | | | | | Soybeans - tops and roots | 40 | 0 | 0 |

[1] Lower values for fall- and winter-applied manure and higher values for spring applied manure. Use these data only if manure being used has not been analyzed. [2]75% stand = 100-0-0, 50% stand = 75-0-0, and 25% stand = 50-0-0

## Herbicide Carryover in Compost

It is important to know the source and composition of any soil amendment or compost that is used on or around vegetable crops. Compost that contains hay, straw, grass clippings, and cow or horse manure may potentially be a carrier of herbicide residue. Several herbicides commonly used in pasture and turf production may be present in straw or hay and can pass through the digestive system of animals and remain in manure. These herbicides are toxic in very low concentrations to many vegetable crops. Symptoms are often similar to growth regulating herbicides and include twisted or cupped leaves, misshapen fruit, reduced yields, or plant death. Additional information can be found at: *http://www.ces.ncsu.edu/fletcher/programs/ncorganic/special-pubs/herbicide_carryover.pdf*.

## Organic Production

Nutrient sources used for certified organic production must be included in the National List of Allowed and Prohibited Substances, which can be found at: *https://www.ams.usda.gov/about-ams/programs-offices/national-organic-program*. The Organic Materials Review Institute (OMRI; see *http://www.omri.org*) reviews products submitted by companies against the National Organic Standard (NOS) and can help identify which products are allowed in organic production. Certifying agencies also review products for compliance with the NOS. Before using any product, it is best to check with your certifying agency to make sure the product is allowed and thereby avoid compromising your organic certification. See Table B-11 for a list of various products useable on organic farms.

**Table B-11. Status for Organic Production, Mineral Nutrient Value, and Relative Availability of Various Materials** Check with your certifying agency before using any of the listed materials, as the status for organic production may have changed.

| Material[a] | Status for Organic Production[b] | Percent Nutrients[c] | | | Relative Availability |
|---|---|---|---|---|---|
| | | N | $P_2O_5$ | $K_2O$ | |
| Animal Tankage (dry) | Allowed | 7 | 10 | 0.5 | Medium |
| Bone Meal (raw) | Allowed | 2 to 6 | 15 to 27 | 0 | Slow |
| Bone Meal (steamed) | Allowed | 0.7 to 4.0 | 18 to 34 | 0 | Slow Medium |
| Cocoa Shell Meal | Allowed | 2.5 | 1.0 | 2.5 | Slow |
| Compost (not fortified) | Allowed[d] | 1.5 to 3.5 | 0.5 to 1.0 | 1.0 to 2.0 | Slow |
| Cottonseed Meal (dry) | Allowed[e] | 6 | 2.5 | 1.7 | Slow Medium |
| Dried Blood (dry) | Allowed | 12 | 1.5 | 0.57 | Medium Rapid |
| Fish Emulsion | Allowed | 5 | 2 | 2 | Rapid |
| Fish Meal (dry) | Allowed | 14 | 4 | 0 | Slow |
| Fish Scrap (dry) | Allowed | 3.5 to 12 | 1 to 12 | 0.08 to 1.6 | Slow |
| Garbage Tankage (dry) | Allowed | 2.7 | 3 | 1 | Very Slow |
| Grain Straw | Allowed | 0.6 | 0.2 | 1.1 | Very Slow |
| Guano (Bat) | Restricted[f] | 5.7 | 8.6 | 2 | Medium |
| Kelp[g] | Allowed | 0.9 | 0.5 | 4 to 13 | Slow |
| Manure[h] (fresh) - Cattle | Restricted[i] | 0.25 | 0.15 | 0.25 | Medium |
| Manure[h] (fresh) - Horse | Restricted[i] | 0.3 | 0.15 | 0.5 | Medium |
| Manure[h] (fresh) - Sheep | Restricted[i] | 0.6 | 0.33 | 0.75 | Medium |
| Manure[h] (fresh) - Swine | Restricted[i] | 0.3 | 0.3 | 0.3 | Medium |
| Manure[h] (fresh) - Poultry (75%) | Restricted[i] | 1.5 | 1 | 0.5 | Medium Rapid |
| Manure[h] (fresh) - Poultry (50%) | Restricted[i] | 2 | 2 | 1.0 | Medium Rapid |
| Manure[h] (fresh) - Poultry (30%) | Restricted[i] | 3 | 2.5 | 1.5 | Medium Rapid |
| Manure[h] (fresh) - Poultry (15%) | Restricted[i] | 6 | 4 | 3 | Medium Rapid |
| Marl | Allowed | 0 | 2 | 4.5 | Very Slow |
| Mushroom Compost[j] | Allowed[k] | 0.4 to 0.7 | 5.7 to 6.2 | 0.5 to 1.5 | Slow |
| Peanut Hulls | Allowed | 1.5 | 0.12 | 0.78 | Slow |
| Peat and Muck | Allowed[l] | 1.5 to 3.0 | 0.25 to 0.5 | 0.5 to 1.0 | Very Slow |
| Pomaces[m] - Apple (fresh) | Allowed | 0.17 to 0.3 | 0.4 to 0.7 | 0.2 to 0.6 | Slow |
| Pomaces[m] - Apple (dry) | Allowed | 0.7 to 0.9 | 1.2 to 2.1 | 0.6 to 1.8 | Slow |
| Pomaces[m] - Castor | Allowed | 5.0 | 1.0 | 1.0 | Slow |
| Pomaces[m] - Winery | Allowed | 1.5 | 1.5 | 0.80 | Slow |
| Sawdust | Allowed[n] | 4 | 2 | 4 | Very Slow |
| Soybean Meal (dry) | Allowed | 6.7 | 1.6 | 2.3 | Slow Medium |
| Tobacco Stems (dry) | Allowed | 2 | 0.7 | 6.0 | Slow |
| Wood Ashes[o] | Allowed[p] | 0 | 1 to 2 | 3 to 7 | Rapid |

[a] Some materials may not be obtainable because of restricted sources.
[b] Must be produced in accordance with the National Organic Standard to be allowed. Organic status was determined through listing with the Organic Materials Review Institute (OMRI; *https://www.omri.org/*). Brand used may affect allowability; check with your certifier before using any product to avoid compromising your certification.
[c] The percentage of plant nutrients is highly variable, mean percentages are listed.
[d] Must be produced in accordance with the National Organic Standards to be used in organic production.
[e] Brand used must not be derived from genetically modified cotton or contain prohibited substances.
[f] Allowed guano is decomposed and dried deposits from wild bats or birds. Must meet requirements for using raw manure.
[g] Contains common salt, sodium carbonates, sodium and potassium sulfates.
[h] Plant nutrients are available during year of application. Nutrient content varies with the amount of straw and method of storage.
[i] Uncomposted or raw animal manure must be used on fields with crops not to be consumed by humans or incorporated into the soil a minimum of 90 days before harvesting a product to be consumed by humans provided that the edible portion of the crop does not contact the soil or integrated into the soil a minimum of 120 days before harvesting a product to be consumed by humans that does come into contact with the soil. Using sewage sludge is prohibited in certified organic production.
[j] Use only after composting in compliance with the National Organic Standard. Fresh mushroom compost is usually too high in soluble salts.
[k] Must meet compost requirements.
[l] Not allowed if contains synthetic wetting agents.
[m] Plant nutrients are highly variable, depending on the efficiency and the processing techniques at the processing plant.
[n] Allowed only if wood is untreated and unpainted.
[o] Potash content depends upon tree species burned. Wood ashes are alkaline, contain about 32% CaO.
[p] Only from untreated and unpainted wood. Wood stove ash - only if not contaminated with colored paper, plastics, or other synthetic sources.

# C. Irrigation Management

## 1. Basic Principles

Moisture management throughout the growing season is a critical factor for production of high quality vegetables. Even relatively short periods of inadequate soil moisture can adversely affect crops. Supplemental irrigation is beneficial in most years, since rainfall in the mid-Atlantic region is rarely uniformly distributed, even in years with above-average precipitation.

Moisture stress has varying effects on plants depending on developmental stage and type of stress. Moisture deficiencies occurring early in the crop cycle may delay maturity and reduce yields and quality. Shortages later in the season often decrease quality, as well as yields, or even result in irreversible crop damage. Over-irrigation, especially late in the season, can reduce quality and postharvest life of the crop. Table C-1 shows the periods of crop growth when an adequate supply of water is critical for high quality vegetable production.

Applying the proper amount of water at the correct time and location is critical for achieving the optimum benefits from irrigation. The crop water requirement, termed evapotranspiration or ET, is equal to the quantity of water lost from the plant (transpiration) plus that evaporated from the soil surface. Knowledge of ET is the most important factor for effective irrigation management. Many factors must be considered when estimating ET. The most important factor is the amount of solar radiation, which provides the energy to evaporate moisture from the soil and the plant. Other important factors are air temperature, wind speed, and humidity level. Different crops also have different rates of transpiration.

Instruments that measure soil moisture content are commonly used to measure changes in soil moisture and adjust irrigation schedules (see “Scheduling Irrigation with Tensiometers and Resistance Meters” in the Drip (Trickle) Irrigation section below).

**Table C-1. Most Critical Periods of Water Needs by Crops**

| Crop | Most Critical Period | Crop | Most Critical Period |
|---|---|---|---|
| Asparagus | Brush (period following fern mowing) | Onions: dry | Bulb enlargement |
| Beans: lima | Pollination and pod development | Peas | Seed enlargement and flowering |
| Beans: snap | Pod enlargement | Peppers | Flowering and fruit development |
| Broccoli | Head development | Potatoes: white | Tuber set and tuber enlargement |
| Cabbage | Head development | Potatoes: sweet | Root enlargement |
| Carrots | Root enlargement | Radishes | Root enlargement |
| Cauliflower | Head development | Strawberries | Establishment, runner development, fruit enlargement |
| Corn | Silking and tasseling, ear development | | |
| Cucumbers | Flowering and fruit development | Squash: summer | Bud development and flowering |
| Eggplants | Flowering and fruit development | Tomatoes | Early flowering, fruit set, and enlargement |
| Lettuce | Head development | Turnips | Root enlargement |
| Melons | Flowering and fruit development | | |

**Plant factors that affect the crop water requirement are crop species and variety, canopy size and shape; leaf size, shape, wax coating and orientation; plant population density; rooting depth; and stage of growth and development of the crop**. The plant canopy size and shape influences transpiration, light absorption, reflection, and the rate that water evaporates from the soil. Crops that feature a canopy with more surface area for transpiration (mature corn, potatoes, snap beans) use more water than crops which do not have an extensive canopy (immature plants, recently transplanted crops). Leaf architecture affects the transpiration rate from individual leaves. Rooting depths vary with crop species and may be affected by soil compaction or hard pans. Rooting depth determines the volume of soil from which the crop can draw water and is important when determining to what depth the soil must be wetted by irrigation. For most vegetables, effective rooting depth is approximately 12 inches.

Plant growth stage influences susceptibility to moisture stress. Irrigation is critical when establishing newly seeded or transplanted crops. During seedling or transplant growth, especially the first 1 to 2 weeks, the root system is not yet established in surrounding soil. Irrigation after transplanting can significantly increase plant survival, especially when soil moisture is marginal and ET is high. Irrigation can also increase the uniformity of emergence and final stand of seeded crops. For seeded crops, reduce the rate of application and the total volume of water per application to avoid crusting (cohesion of soil particles at the surface). If crusting is present, continue to apply low rates and volume of irrigation water while seedlings are emerging. This reduces the force necessary for seeding emergence. Water use by vegetable crops increases up to full canopy and then will decrease thereafter. For warm season crops, peak water use can be as much as 0.30 inches per day in mid-summer.

**Cultural practices also influence ET**. Cultivation, mulching, weed growth, and method of irrigation are factors to consider. Cultivation generally increases soil evaporation but if crop roots are pruned or damaged by the cultivator, water uptake and transpiration may be reduced. Shallow cultivation may help eliminate soil crusts and improve water infiltration from rainfall or irrigation. Weeds compete with the crop for water and increase the volume lost through transpiration. Sprinkler irrigation wets the entire crop area and results in greater evaporation loss than trickle irrigation that wets only the area in the region of the plant root system.

**Soil factors must also be considered.** Soils with high levels of silt, clay, and organic matter have greater available water-holding capacities than do sandy soils or soils that are compacted (Table C-2). Available water refers to the amount of water that a plant is able to withdraw from the soil. Soils with high available water-holding capacities require less frequent irrigation than soils with low available water-holding capacities. A greater volume of water must be applied per application on silty soils.

Another soil factor that influences irrigation practices is the soil infiltration rate. Water should not be applied to soils at a rate greater than the rate at which soils can absorb water. Excessive irrigation may lead to erosion from runoff and promote disease development. Table C-3 lists the typical infiltration rates of several soils.

**Table C-2.**
**Available Water Holding Capacity Based on Soil Texture**

| Soil Texture | Available Water Holding Capacity (inch of water/ inch depth of soil) |
|---|---|
| Coarse sand/compacted sands | 0.02 - 0.06 |
| Fine sand | 0.04 - 0.09 |
| Loamy sand | 0.06 - 0.12 |
| Sandy loam | 0.11 - 0.15 |
| Fine sandy loam/compacted loams | 0.14 - 0.18 |
| Loam and silt loam | 0.17 - 0.23 |
| Clay loam and silty clay loam | 0.14 - 0.21 |
| Silty clay and clay | 0.13 – 0.18 |

**Table C-3.**
**Soil Infiltration Rates Based on Soil Texture**

| Soil Texture | Soil Infiltration Rate (inch/hour) |
|---|---|
| Coarse sand | 0.75 - 1.00 |
| Fine sand | 0.50 - 0.75 |
| Fine sandy loam | 0.35 - 0.50 |
| Silt loam | 0.25 - 0.40 |
| Clay loam | 0.10 - 0.30 |

**There is no simple method to accurately schedule irrigations since all the above factors interact to determine actual ET. In the absence of reliable methods to estimate ET, the following should be kept in mind when deciding when and how much to irrigate:**

1. Soils vary greatly in water-holding capacity and infiltration rate. Silt and clay soils and soils high in organic matter can hold much more water than sandy soils low in organic matter.
2. Water loss from plants and the soil surface is much greater on clear, hot, windy days than on cool, overcast, humid days. During periods of hot, dry weather, when the crop is at full canopy, ET rates may reach 0.3 inch/day or higher. The evaporation component of ET can be estimated by the use of a standard evaporation pan.
3. Research shows that irrigating to maintain soil moisture levels in a narrow range, just slightly below field capacity (60 to 80% available soil moisture), results in better crop performance than if the range is broader. Soil moisture monitoring is therefore a more accurate way to determine irrigation needs.
4. Plastic mulches reduce evaporation from the soil but also reduce the amount of water that can reach the root zone from rain. Thus, much of the natural precipitation should be discounted when scheduling irrigations for crops grown under plastic mulch.
5. In general, apply 0.25-0.75 inches of water per irrigation. This will ensure that water reaches active areas of the root zone. The exception is during early crop growth and establishment when lower rates may be appropriate.
6. If irrigation water has a high salt content (for example wells in coastal aquifers or tidal streams), excess water should be applied per irrigation to leach any salts before they are concentrated by evaporation.
7. Total weekly water needs for vegetable crops will increase up to full canopy and decrease thereafter. Irrigation rates should be adjusted accordingly. Critical crop stages such as fruiting or tuber bulking should also be considered in determining weekly irrigation rates.

## 2. Drip (Trickle) Irrigation

Drip (or trickle) irrigation is used on a wide range of vegetable crops. Drip (or trickle) irrigation is a method of slowly applying small amounts of water directly to the plant root zone. Water is applied frequently, often daily or several times a week, to maintain favorable soil moisture conditions. The primary advantage of drip irrigation systems is that water use is more efficient than with sprinkler or surface irrigation systems. In many cases, one-half or less of the water applied with sprinkler or surface systems is required with drip systems because there is no evaporation loss from the soil surface. In addition, substances applied through the drip irrigation system, such as pesticides and fertilizers, are conserved along with water.

Drip irrigation systems have several other advantages over sprinkler and surface irrigation systems. Low flow rates and operating pressures are typical for drip systems. These characteristics lead to lower energy and equipment costs. Once in place, drip systems require little labor to operate, can be automatically controlled, and can be managed to apply precisely the amount of water needed by the crop, which also reduces operating costs. With most drip systems, disease and insect damage is reduced because leaves are not moistened by irrigation water. In addition, the areas between rows remain dry, which reduces weed growth and water use, as well as pests and pathogens in these areas of the field. Another advantage is that field management operations can continue during irrigation.

There are also potential problems with drip irrigation systems. Most drip irrigation systems require a higher level of management than other irrigation systems. Moisture dispersal throughout the soil is limited, and usually a smaller soil water reserve is available to plants. Under these conditions, the potential to stress plants is greater than with other types of irrigation systems. Drip systems must be carefully managed to avoid localized moisture stress.

The equipment used in drip systems also presents potential problems and drawbacks. Drip irrigation equipment can be damaged by insects, rodents, and laborers. Pressure regulation and filtration require equipment not commonly found on sprinkler or surface systems. The drip system, including pump, headers, filters, and connections must be checked and ready to operate before planting. Failure to have the system operational could result in costly delays, poor plant survival or irregular stands, and reduced yield. Drip systems cannot be used for frost control. Calculating the length of time required to apply a specific depth of water with a trickle irrigation system is more difficult than with sprinkler systems. Drip systems add additional cost for processing vegetables, are not adapted to drilled crops such as peas and, therefore, may not be economical for these crops.

Drip irrigation is especially effective when used with plastic film or organic mulches. Unlike sprinkler systems, trickle systems apply water to only a small portion (mulched) of the total crop acreage. Usually, a fair assumption to make is that the mulched width approximates the extent of the plant root zone and should be used to calculate system run times for most vegetables. Table C-4 shows the length of time required to apply one inch of water with a drip irrigation system, based on the drip tube flow rate and the mulched width. The use of this table requires that the drip system be operated at the pressure recommended by the manufacturer.

**Table C-4. Hours Required to Apply 1 Inch of Water for Fine-Textured or Heavy Soils**

| Drip Tube Flow Rate | | Mulched Width/Bed Width (ft) | | | | |
|---|---|---|---|---|---|---|
| **gph/100 ft** | **gpm/100 ft** | **2.0** | **2.5** | **3.0** | **3.5** | **4.0** |
| 8 | 0.13 | 15.5 | 19.5 | 23.5 | 27.0 | 31.0 |
| 10 | 0.17 | 12.5 | 16.5 | 18.5 | 22.0 | 25.0 |
| 12 | 0.20 | 10.5 | 13.0 | 15.5 | 18.0 | 21.0 |
| 16 | 0.27 | 8.0 | 10.0 | 11.5 | 13.5 | 15.5 |
| 18 | 0.30 | 7.0 | 8.5 | 10.5 | 12.0 | 14.0 |
| 20 | 0.33 | 6.0 | 8.0 | 9.5 | 11.0 | 12.5 |
| 24 | 0.40 | 5.0 | 6.5 | 8.0 | 9.0 | 10.5 |
| 27 | 0.45 | 4.5 | 6.0 | 7.0 | 8.0 | 9.5 |
| 30 | 0.50 | 4.0 | 5.0 | 6.0 | 7.0 | 8.5 |
| 36 | 0.60 | 3.5 | 4.5 | 5.0 | 6.0 | 7.0 |
| 40 | 0.67 | 3.0 | 4.0 | 4.5 | 5.5 | 6.0 |
| 42 | 0.70 | 3.0 | 4.0 | 4.5 | 5.0 | 6.0 |
| 48 | 0.80 | 2.5 | 3.0 | 4.0 | 4.5 | 5.0 |
| 50 | 0.83 | 2.5 | 3.0 | 4.0 | 4.5 | 5.0 |
| 54 | 0.90 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 |
| 60 | 1.00 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |

On coarse-textured sandy soils, a larger water volume is required than on finer-textured soils. Table C-5 summarizes the length of time required to apply 1-inch of water with a drip irrigation system based on the drip tape flow rate and the crop row spacing. The use of this table requires that the drip system be operated at the pressure recommended by the manufacturer. Because water is not absorbed as much by coarse-textured than by fine-textured soils, it moves below the plant root zone, carrying nutrients and pesticides beyond the reach of the roots. Table C-6 presents the maximum recommended irrigation period for drip irrigation systems. The irrigation periods listed are based on the assumption that 50% of the available water in the root zone is depleted (see next section on the use of soil moisture monitoring equipment for determining when this occurs). Soil texture directly influences the water-holding capacity of soils and, therefore, the depth reached by irrigation water.

**Table C-5. Hours Required to Apply 1 Inch Water for Course-textured or Light Soils**

| Trickle Tube Flow Rate | | Row Spacing (ft) | | | | |
|---|---|---|---|---|---|---|
| **gph/100 ft** | **gpm/100 ft** | **4** | **5** | **6** | **8** | **10** |
| 13.2 | 0.22 | 19 | 24 | 28.5 | 38.0 | 47.5 |
| 20.4 | 0.34 | 12.5 | 15.5 | 18.5 | 24.5 | 31.0 |
| 27.0 | 0.45 | 9.5 | 11.5 | 14.0 | 18.5 | 23.5 |
| 40.2 | 0.67 | 6.5 | 8.0 | 9.5 | 12.5 | 15.5 |
| 80.4 | 1.34 | 3.5 | 4.0 | 5.0 | 6.5 | 8.0 |

**Table C-6. Maximum Number of Minutes per Application for Drip Irrigated Vegetables**
Based on 10-inch deep root zone and irrigation at 25% soil moisture depletion. Use this table in combination with Table C-4 or C-5. Consult Table C-2 for available water holding capacity based on soil texture.

| Available Water Holding Capacity (inch of water/inch depth of soil) | Tubing Flow Rate (gpm/100 ft). | | | | |
|---|---|---|---|---|---|
| | **0.2** | **0.3** | **0.4** | **0.5** | **0.6** |
| 0.02 | 20 | 14 | 10 | 8 | 7 |
| 0.04 | 41 | 27 | 20 | 16 | 14 |
| 0.06 | 61 | 41 | 31 | 25 | 20 |
| 0.08 | 82 | 54 | 41 | 33 | 27 |
| 0.10 | 102 | 68 | 51 | 41 | 34 |
| 0.12 | 122 | 82 | 61 | 49 | 41 |
| 0.14 | 143 | 95 | 71 | 57 | 48 |
| 0.16 | 163 | 109 | 82 | 65 | 54 |
| 0.18 | 183 | 122 | 92 | 73 | 61 |
| 0.20 | 204 | 136 | 102 | 82 | 68 |
| 0.22 | 224 | 150 | 112 | 90 | 75 |

## Scheduling Irrigation with Tensiometers and Resistance Meters

Irrigation scheduling is a management practice used to determine how often to irrigate and how much water to apply with each irrigation. Irrigation duration was discussed in the previous section, and should be based on soil available water-holding capacity, soil moisture depletion level, and drip tube flow rate.

### Tensiometers

Tensiometers are excellent tools for determining irrigation frequency because they measure water available in the crop root zone. Tensiometers are glass tubes with a porous tip submerged in the soil, and pressure gauge at the other end. If handled properly, they can remain in service for many years. Tensiometers directly measure soil tension. This is also often referred to as “soil suction” or “vacuum”. Soil tension is a measure of how tightly water is held in the soil, and is measured in pressure units of centibars (cb) or kilopascals (kPa). These are different units of measurement of the same condition: soil vacuum. To convert cb to PSI, multiply by 0.15; to convert PSI to cb, multiply by 6.67.

Soil tension increases as moisture in the soil is depleted. This force also draws water out of the tensiometer through its porous tip, creating a vacuum inside the tensiometer. This negative pressure, or tension, is registered on the tensiometer vacuum gauge. The soil tension measured with tensiometers is an indirect indication of soil moisture content and can be used as an indicator of irrigation need.

Table C-7 contains guidelines for using soil tension data to schedule irrigation events. Field capacity is the moisture content at which a soil is holding the maximum amount of water it can against the force of gravity. This moisture content is reached 24 to 72 h after a saturating rain or irrigation. Field capacity corresponds to soil tension levels ranging from 5 to 10 cb in coarse-textured soils and as high as 40 cb in fine-textured soils.

**Table C-7. Irrigation Guidelines for Tensiometers**

| Soil Texture | Soil Tension (cb) | Soil Moisture Status and Irrigation Requirement |
|---|---|---|
| Sand, Loamy Sand | 5 – 10 | Soil at field capacity; no irrigation required |
| Sandy Loam, Loam, Silt Loam | 10 – 20 | |
| Clay Loam, Clay | 20 – 40 | |
| Sand, Loamy Sand | 20 – 40 | 50% of available water depleted; irrigation required |
| Sandy Loam, Loam, Silt Loam | 40 – 60 | |
| Clay Loam, Clay | 50 – 100 | |

The soil tension range corresponding to the time when irrigation should begin is also influenced by **soil texture**. In coarse-textured soils, irrigation should begin at soil tensions of 20 to 40 cb. In extremely coarse-textured soils, irrigation may be necessary at even lower tensions (see Table C-7). Conversely, medium- and fine-textured soils do not need to be irrigated until soil tensions reach higher values, as shown in Table C-7. For all soil types, irrigate when a maximum of 50% of available water has been depleted. Lower depletion allowances may be used depending upon specific crop and management needs.

The utility of tensiometers in fine-textured soils is limited due to the range of detection. When soil dries beyond the 80 cb tension level, the column of water in the tensiometer "breaks," allowing air to enter the device. After breaking tension, the device ceases to operate correctly until it is serviced. Thus, tensiometers are most practical in sandy or coarse-textured soils where normal soil tension levels are well below the point of breaking tension.

Ideally, four tensiometers per management zone should be used to account for variability in soil texture and other factors within the field. Install at least one tensiometer in the area that will likely require water sooner than other areas of the field (e.g., sandier soils, higher elevations). The remaining tensiometers should be placed to inscribe a triangle within the area to be irrigated, but inside field edges. Irrigation decisions are based on the average of all the readings.

Tensiometer placement influences measured soil tension levels. Tensiometers should be placed where plant roots are actively growing. It is appropriate to monitor soil tension 6-12 inches below the soil surface and within 6-12 inches from the plant base. If using drip irrigation, place the tensiometer axis close to the drip tape or hose and the sensor (tip) buried 6-12 inches below the soil surface. This will insure that readings reflect moisture in the root zone and decrease when irrigation occurs. Placement near the drip tape is even more important when growing in coarse-textured soils and on raised, mulched beds. In these situations, the bed shoulders often remain very dry and placing tensiometers there will not give an accurate measure of soil tension in the active crop root zone.

Tensiometers can also be used in other ways. Placing tensiometers at various soil depths at the same location is useful for determining whether or not an irrigation or rainfall has reached a certain depth. Placing tensiometers at various depths is also useful for determining the depth from which plants draw the most water.

## Resistance Meters

Electrical resistance meters determine soil water by measuring the electrical resistance between two wire grids embedded in a porous matrix such as gypsum, ceramics, glass fibers, or nylon cloth. To measure soil moisture, sensors are buried in the crop root zone in the soil. The electrical resistance of sensors varies with water content, which in turn is dependent upon the water content of the soil in contact with them. As the soil dries, the sensor loses water and the electrical resistance increases. Therefore, resistance changes within the sensor as measured by the meter can be interpreted in terms of soil water content. New generation “matrix” sensors are more accurate and consistent than are older “gypsum” sensors. The sensors, which have embedded stainless steel electrodes are installed at desired locations and depths in the soil during the growing season. Insulated wires from each sensor are brought above the soil surface where they can be plugged into a portable meter for reading.

Resistance sensors are generally calibrated in terms of soil water tension so that readings are applicable across soil textures. Sensors should be calibrated for each soil type. The way different commercial sensors respond to changes in soil water tension varies considerably and manufacturers provides calibration curves for their equipment. When sensor readings are expressed as soil water tension, the irrigation chart C-7 can be used as a guide.

Prepare resistance matrix sensors according to manufacturer’s recommendations before installation. This normally requires soaking in water. Soaking removes air from the sensors and insures accurate meter readings.

Using a soil probe or auger, bore a hole in the row slightly larger than the sensor. Make a separate hole for each sensor to desired depth. Crumble up at least 3 inches of soil removed from the hole and put it back into the hole. Pour about ½ cup of water into the hole to form a slurry of mud at the bottom. Push the sensor firmly to the bottom of the hole, forcing the slurry to envelop the sensor. A good way to do this is to use a section of ½-inch electrical conduit or pipe; slip the conduit over the lead wire and against the top of the sensor. Back fill the holes with soil 3 or 4 inches at a time, tamping firmly as the hole is filled. Drive a stake midway between the filled holes and tie the wire leads to the stake. Be sure to mark the wires in some manner so that you can identify which one is for the shallow sensor and which one is for the deeper sensor. Install and locate resistance sensors and meters in a similar manner as for tensiometers to give accurate information of soil water depletion.

## Maintaining Drip Irrigation Systems

Water is carried through plastic tubing and distributed along the tubing through orifices or devices called emitters. The emitters dissipate the pressure from the system by forcing the water exiting from an emitter through orifices, tortuous flow paths, pressure reducing flow paths, or long low paths, thus allowing a limited flow of water to be discharged. The pressure-reducing flow path also allows the emitter diameter to remain relatively large, allowing particles that could clog an emitter to be discharged.

Insect damage to thin-walled polyethylene drip tubing or “tape” is a major problem. Ants, wireworms, earwigs, mole crickets, field crickets, grubs and other insects typically damage drip tape by chewing holes through the side walls. This damage destroys the integrity of the tape, resulting in small to massive leaks that may result in poor moisture distribution and soil erosion.

Other types of drip tape damage may be mistaken for insects. For example, rats, mice, gophers and birds can chew, gnaw or peck holes in thin walled polyethylene tapes. Damaged tape should be inspected under magnification to provide clues to the source prior to taking action to remediate the responsible agent.

Although modern emitter design reduces the potential for trapping small particles, emitter clogging remains the most serious problem with trickle irrigation systems. Clogging can be attributed to physical, chemical, or biological contaminants. Filtration and occasional water treatment may both be necessary to keep trickle systems from clogging.

Bacteria can grow inside trickle irrigation tubes and form a slime that can clog emitters. Algae present in surface waters can also clog emitters. Bacteria and algae can be effectively controlled by chlorination of the trickle system. Periodic treatment **before** clogging develops can keep the system functioning efficiently. The frequency of treatment depends on the quality of the water source. Generally, two or three treatments per season is adequate.

Irrigation water containing high concentrations of iron (greater than 1 ppm) can also result in clogging problems due to types of bacteria that "feed" on dissolved (ferrous) iron. The bacteria secrete a slime called ochre that may combine with other solid particles in the trickle tubing and plug emitters. The precipitated (ferric) form of iron, known commonly as rust, can also physically clog emitters. Treating water containing iron with chlorine will oxidize the dissolved iron, causing the element to precipitate so that it can be filtered and removed from the system. **Chlorine treatment should take place upstream of filters** in order to remove the precipitated iron and microorganisms from the system. Take care when adding chlorine to trickle irrigation systems, however, since concentration at or above 30 ppm can be toxic to growing plants.

Chlorine is available in either gas, liquid, or solid forms. Chlorine gas is extremely dangerous and not recommended for agricultural purposes. Solid chlorine is available as granules or tablets containing 65 to 70 percent calcium hypochlorite. Liquid chlorine is available in many forms, including laundry bleach and postharvest wash materials. Liquid forms typically contain between 5 and 15 percent sodium hypochlorite. **Use chlorine only if the product is labeled for use in irrigation systems**.

Because chlorination is most effective at pH 6.5 to 7.5, some commercial chlorination equipment also injects buffers to maintain optimum pH for effective kill of microorganisms. This type of equipment is expensive but more effective than simply injecting sodium hypochlorite solution. The rate of chlorine injection required is dependent on the number of microorganisms, the amount of iron in the water source, and the method of treatment being used.

For managing dissolved iron and microbes in the water source, one of the following basic strategies is suggested as a starting point:

***For iron treatment:***

- Inject liquid sodium hypochlorite continuously at a rate of 1 ppm for each 1 ppm of iron in irrigation water. In most cases, 3 to 5 ppm is sufficient.

***For bacteria and algae treatment:***

- Inject liquid sodium hypochlorite continuously at a rate of 5 to 10 ppm where the biological load is high.
- Inject 10 to 20 ppm during the last 30 minutes of each irrigation cycle.
- Inject 50 ppm during the last 30 minutes of irrigation cycles one to two times each month. Super chlorinate (inject at a rate of 200 to 500 ppm) once per month for the length of time required to fill the entire system with this solution and shut down the system. After 24 hours, open the laterals and flush the lines.

Chlorine can be injected using many types of fertilizer/pesticide injectors, including positive displacement injection pumps. These types of pumps are powered by gasoline or electric motors and include piston, diaphragm, gear or lobe, and roller (or peristaltic) types.

The injection rate for positive displacement injection pumps can be calculated from the following equation:

**Injection rate of chlorine solution in gallons per hour =**
[(0.006) x (desired chlorine concentration in ppm) x (irrigation gal per minute)] **/** % chlorine in bleach or concentrate

As an example, assume household bleach (5.25% sodium hypochlorite) is being used as a chlorine solution, that a treatment level of 5 ppm of chlorine is desired, and that the trickle system has a 200 gal per minute flow rate.

Injection rate of chlorine solution in gallons per hour =
[(0.006) x (5 ppm) x (200 gal/minute)] / 5.25% = 1.14 gal chorine per hour

Proportional injectors are also commonly used to inject chlorine. Proportional injectors are powered by the water pressure of the irrigation system and inject materials at a rate which is proportional to the irrigation system flow rate or system pressure. Injection rates are often adjustable and are usually specified as ratios, percentages, or ppm. Table C-7 lists equivalent values of these injection rate units.

For proportional injectors, the following equation can be used to calculate the required chlorine solution injection rate:

**Injection rate of chlorine solution in ppm concentrate=**
[(100) x (desired chlorine concentration in ppm)] / % chlorine in bleach or concentrate

As an example, assume postharvest wash material (12.5% sodium hypochlorite) is being used as a chlorine solution and that a treatment level of 10 ppm of chlorine is desired.
Injection rate of chlorine solution in ppm concentrate = [(100) x (10 ppm)] / 12.5% = 80 ppm

It is important to note that both liquid and solid forms of chlorine will cause water pH to rise. This is critical because chlorine (sodium hypochlorite) is most effective in water at pH 6.5-7.5. If water pH is above 7.5, it must be reduced to 6.5-7.5 for chlorine injection to be effective as a disinfectant.

**Table C-8. Equivalent Injection Proportions**

| Ratio | ppm | Percent |
|---|---|---|
| 1:10,000 | 100 | 0.01 |
| 1:5,000 | 200 | 0.02 |
| 1:2,000 | 500 | 0.05 |
| 1:1,000 | 1,000 | 0.1 |
| 1:500 | 2,000 | 0.2 |
| 1:200 | 5,000 | 0.5 |
| 1:100 | 10,000 | 1 |
| 1:50 | 20,000 | 2 |
| 1:20 | 50,000 | 5 |
| 1:10 | 100,000 | 10 |

**Important Notes**

1. **Approved backflow control valves and interlocks must be used in the injection system to prevent contamination of the water source. This is an absolute requirement if a public water source is used.**
2. **Chlorine concentrations above 30 ppm may cause phytotoxicity.**

# 3. Fertigation

Crops that are drip irrigated are usually fertilized during the growing phase through the irrigation system, termed fertigation. Before considering a fertilization program for mulched-drip irrigated crops, have the soil pH checked. If a liming material is needed to increase the soil pH, the material should be applied and incorporated into the soil as far ahead of mulching as practical. For most vegetables, adjust the soil pH to around 6.5 (see Table B-1).

When using drip irrigation in combination with mulch, apply the recommended amount of preplant fertilizer and incorporate 5-6 inches into the soil before laying the mulch. If equipment is available, apply the preplant fertilizer only to the soil area that will be covered by the mulch. This is more efficient than a broadcast application to the entire field.

The most efficient method of fertilizing an established mulched row crop is through a drip irrigation system that is usually installed during the mulching operation (see below). Due to the very small holes or orifices in the drip tubing, a completely soluble fertilizer or liquid solution must be used through the irrigation system. While in the past a 1-1-1 (N-$P_2O_5$-$K_2O$) ratio of completely soluble fertilizer, such as a 20-20-20 has been used successfully, in most cases, lower P concentrations are now recommended (for example 2-1-2 or 4-1-4 ratio). Solutions often are used without $P_2O_5$ (1-0-1 ratio) and this is specifically recommended where there is a high likelihood of P precipitating out of irrigation water and clogging drip emitters (hard irrigation water supplies). Including the essential micronutrients with the completely soluble N-$P_2O_5$-$K_2O$ fertilizer has resulted in positive yield responses. Including boron with the completely soluble N-$P_2O_5$-$K_2O$ fertilizer on sandy loam soils testing low to low-medium in boron is highly recommended for medium and high boron demand vegetable crops.

Nutrients to be applied to plants through the drip irrigation system are first completely dissolved in water to produce a concentrate. This concentrate is usually introduced into the irrigation system following filtration using an injector that is available from irrigation suppliers. Care should be taken when applying P through drip irrigation. If water sources contain high levels of calcium, calcium phosphate may precipitate which can clog drip emitters.

**<u>Fertigation Rates for Drip Irrigated Plasticulture Crops</u>**

All rates of soluble fertilizers applied through the drip irrigation system are based on crop recommendations (see individual vegetable crops in Section F). Suggested fertigation programs for common drip irrigated crops are given in Section F for the standard linear bed feet contained in an acre of that crop. This is called the Linear Bed Foot (LBF) system for fertilizer application. Rates are adjusted if crops are planted in row widths different from the standard, (more or less linear bed feet per acre). All fertigation recommendations are expressed in lb/A. Use of LBF as a fertilizer rate assures that an appropriate rate of fertilizer will be applied, regardless of the total number LBF in the cropped area. Use of lb/A to express the fertilizer rate requires an adjustment based upon actual cropped area. The goal is to provide a specific concentration of nutrients to plant roots; or a specific amount of fertilizer within a certain volume of soil. This approach assumes that most plant roots are confined within the volume of soil comprising the bed under plastic mulch. Fertigation can occur with each irrigation event, weekly, or prior to important crop growth stages.

**Calculating the fertilizer requirements for a fertigated acre based on 6 foot bed centers**

**a. Example for a soluble dry fertilizer to be dissolved and distributed through drip fertigation.**

If 40 pounds of N, 40 pounds of P ($P_2O_5$), and 40 pounds of potash ($K_2O$) per 7,260 linear bed feet (standard acre) per application are recommended, select a dry, completely soluble fertilizer with a 1-1-1 ratio, such as a 20-20-20. To determine the amount of 20-20-20 needed per acre, divide the percent N, $P_2O_5$, or $K_2O$ contained in the fertilizer into the quantity of the respective plant nutrient needed per acre and multiply the answer by 100:
[40 lbs. nitrogen needed / 20% N in fertilizer] x 100 = 200 lbs.20-20-20 per acre

**b. Example for a liquid fertilizer distributed through drip.**

Assume the same 40 lb N-$P_2O_5$-$K_2O$ and a 6-6-6 liquid is used.
If one gal of this fertilizer weighs 10 lb, 67 gal of 6-6-6 liquid fertilizer per acre per application is required.
1 gal (10 lb) of 6-6-6 contains:
10 lb x .06 (6% N) = 0.6 lb N in each gal
40 lbs. N per acre needed / 0.6 lb. N per gal 6-6-6 = 67 gal of 6-6-6 needed per acre

# 4. Subsurface Drip Irrigation Systems

Sub-surface drip irrigation, most commonly known as SDI, is the practice of using drip tape buried at depth for multi-year irrigation applications. SDI systems offer precise efficient delivery of water, deliver nutrition or crop protection, and achieve uniform plant production. These systems are easily automated, and can significantly decrease labor requirements. It is essential that SDI system operators be provided with adequate education to ensure they develop the necessary management skills. Water quality is a critical component of the success of an SDI system. Maintaining adequate water quality will maximize both system performance and longevity.

SDI is best addressed in two separate categories: Short-term SDI and Long-term SDI: Short-term SDI (ST SDI) is defined by a life expectancy ranging from 3 to 10 years. However system life alone does not define Short-term SDI. These systems are typically used on mid-valued vegetable crops (for example: processed crops). ST SDI systems are commonly designed to deliver peak ET water demand to crops giving the grower greater control in meeting the crop's water needs. Typically, drip tape is installed between 3 inches and 10 inches in depth, along each crop row on the raised bed. The headers of the drip tape can be supplied with water via surface hose or permanently buried PVC pipe; the other end of the drip lateral is typically left exposed for flushing. ST SDI offers many of the advantages of surface drip irrigation without the annual expense of drip tape replacement.

Long-term SDI (LT SDI) is characterized by a life expectancy of 10 years or greater. These systems are primarily designed for commodity crops (for example: corn, cotton). The LT SDI systems are designed to efficiently deliver water to large expanses of acreage. Due to limited water availability and high crop water demand, Long-term SDI systems are not typically designed to replenish peak volume needs, but rather used to manage soil moisture profile during periods of peak water demand. Drip tape is installed from 12 inches to 18 inches in depth depending primarily on soil characteristics. Drip tape is typically centered between rows of the crop along the raised bed. The drip tape is attached on each end to permanently buried PVC pipe; with one pipe serving as the water supply and the other pipe providing the flushing function. LT SDI offers many of the advantages of surface drip irrigation, however water is applied in a manner to best economize the application while fulfilling the needs of crops.

# 5. Chemigation

Chemigation is the application of any pesticide through any irrigation system and includes furrow, border, overhead and drip irrigation systems. Posting of areas to be chemigated is required when (1) any treated area is within 300 ft of sensitive areas such as residential, labor housing, businesses, hospitals, or any public zones such as schools, parks and playgrounds, or (2) when the chemigated area is open to the public such as golf courses or retail greenhouses.

Prior to chemigation, first start irrigation with water to wet the root zone, then introduce the pesticide uniformly over the crop being irrigated. After chemigation, flush the irrigation system with fresh water. Do not overwater during the flush phase to retain the pesticide in the root zone. The label must allow the use of chemigation before any pesticide can be applied in the irrigation system. **Consult the label for all rates and restrictions before use**.

## Chemigation Systems Connected to Public Water Systems

These systems must contain a functional, reduced-pressure zone, backflow preventer or the functional equivalent in the water supply line upstream from the point of pesticide introduction. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent flow of fluid back toward the injection pump.

- The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the system is either automatically or manually shut down.
- A functional interlocking control, to automatically shut off the pesticide injection pump when the water pump motor stops is also required, or in any situation where the water pressure decreases to the point where pesticide distribution is adversely affected.

Chemigation systems must use a metering pump, such as a positive displacement pump capable of being fitted with a system interlock.

## Chemigation with Drip and Overhead Irrigation Systems

A safe and effective chemigation system must include the following components: a functional check valve, vacuum relief valve and low pressure drain on the irrigation pipeline to prevent water source contamination from backflow. The pesticide pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back to the injection pump.

- The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the system is either automatically or manually shut down.
- Further, the system must contain a functional interlocking control to automatically shut off the pesticide injection pump when the water pump motor stops.
- Finally, the water pump must include a functional pressure switch which will stop the water pump when the water pressure decreases to the point where pesticide distribution is adversely affected.

**Table C-9. Using Insecticides with Labels for Chemigation**
**Note: Read and understand all chemigation instructions on the label before use on any crop!**

| **Drip/trickle Systems** | |
|---|---|
| azadirachtin (Aza-Direct or OLF) | imidacloprid (Admire PRO or OLF) |
| chlorantraniliprole (Coragen) | malathion (Malathion 8 Aquamul) |
| clothianidin (Belay) | oxamyl (Vydate) |
| dimethoate (Dimate) | rosemary oil + peppermint oil (Ecotec) |
| diazinon (Diazinon) | thiamethoxam (Platinum) |
| dinotefuran (Venom) | thiamethoxam + chlorantraniliprole (Durivo) |
| **Overhead and Sprinkler Systems** | |
| acetamiprid (Assail) | indoxacarb (Avaunt) |
| azadirachtin (Aza-Direct or OLF) | lambda-cyhalothrin (Warrior II) |
| *bacillus thuringiemsis* (DiPel, XenTari) | lambda-cyhalothrin + chlorantraniliprole (**potato only**) (Voliam Xpress ) |
| beta-cyfluthrin (Baythroid XL) | lambda-cyhalothrin + thiamethoxam (Endigo ZC) |
| bifenthrin (Capture or OLF) | malathion (Malathion 8 Aquamul) |
| bifenthrin + imidacloprid (Brigadier) | methomyl (**green/bulb onions, potatoes only**) (Lannate LV) |
| carbaryl (Sevin or OLF) | methyl parathion (Penncap-M) |
| chlorantraniliprole (Coragen) | novaluron (**potatoes only**) (Rimon) |
| chlorpyrifos (Lorsban) | permethrin (Pounce or OLF) |
| chlorpyrifos + gamma-cyhalothrin (Cobalt) | propargite (**sweet corn, potatoes only**) (Comite) |
| clothianidin (Belay) | pymetrozine (**potato only**) (Fulfill) |
| cryolite (Kryocide) | pyrethrins (PyGanic) |
| cyfluthrin (Renounce, Tombstone or OLF) | spinetoram (Radiant) |
| deltamethrin (Battalion) | spinosad (Entrust, SpinTor) |
| diazinon (Diazinon) | spinosad + gamma-cyhalothrin (**corn only**) (Consero) |
| dimethoate (Dimate or OLF) | spiromesifen (Oberon) |
| dinotefuran (Venom) | spirotetramat (Movento) |
| esfenvalerate (Asana) | thiamethoxam (Platinum, **potato only**) (Actara) |
| flonicamid (Beleaf) | thiamethoxam + chlorantraniliprole (**potato only**) (Voliam Flexi) |
| gamma-cyhalothrin (Proaxis) | thiodicarb (Larvin) |
| imidacloprid (Admire PRO or OLF) | zeta-cypermethrin (Mustang Maxx) |
| imidacloprid + beta-cyfluthrin (Leverage 2.7) | zeta-cypermethrin + bifentrin (Hero) |

# D. Pesticide Safety

## 1. General Information

**Laws and Regulations**
Be sure to check current state and federal laws and regulations regarding the proper use, storage, and disposal of pesticides before applying these chemicals. For restricted-use pesticides, an applicator is required to be certified or work under the direct supervision of a certified individual. **For information on the requirements for certification of pesticide applicators, contact your state pesticide regulatory agency or Cooperative Extension agent.**

**Certification Pesticide Applicators**
The Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (FIFRA) required each state to set up a program to certify users of pesticides. This certification is designed to show that users of pesticides know how to use pesticides safely in order that they do not endanger the user, his co-workers or the environment. Certified users of pesticides are classified as either private applicators or commercial applicators. The certification process is somewhat different for each group. **The definitions of private and commercial applicators are as follows**:

***Private Applicator***. Any person who uses, or supervises the use of, pesticides for the purpose of raising some type of agricultural commodity. The application can be done on land owned or rented by the applicator or the applicator's employer. However, any applications done on a "for-hire" basis are considered commercial applications. Examples of private applicators are dairy farmers, vegetable or fruit growers, greenhouse growers, and ranchers that apply pesticides only within their own confines. Private applicators who purchase and apply restricted-use pesticides must be certified and registered. In New Jersey, private applicators must be certified and licensed to apply any pesticide, including organic and general use pesticides.

***Commercial Applicator***. Any person who uses, or supervises the use of, pesticides on a "for-hire" basis; any person who applies pesticides for nonagricultural purposes; any person who applies pesticides as a part of his job with any governmental agency. Examples of commercial applicators are: exterminators; landscapers; tree services; crop dusters; weed control firms; and owners of apartments, motels, nursing homes, restaurants, etc., who do their own pest control work. Commercial applicators must be certified and licensed to use **any** pesticide in New Jersey, including organic and general use pesticides.

***Commercial Pesticide Operator Licensing (New Jersey)***. Anyone applying pesticides under direct supervision of a commercial licensed pesticide applicator must be licensed as a pesticide operator unless the certified applicator is always physically present when the uncertified individual is handling pesticides.

## 2. Handling Pesticides

## 2.1 Introduction

Before opening a pesticide container, applicators should **read the label carefully**, and accurately follow all directions and precautions specified by the label. Using a pesticide for any other uses or in any other manner than what is on the label information is against the law. Determine in advance the proper safety equipment, protective clothing and measuring equipment you will need for the pesticide task that you will be performing. The protective equipment necessary may include socks, shoes, long pants, long-sleeve shirt, and a hat. Additional safety equipment may also be required by the label. Consult the Precautionary Statements of pesticide label for the minimum Personal Protection Equipment (PPE) required by law. See the protective equipment paragraphs later in this section for more detail. Your physician should be advised of the types of pesticides you use in your work and if you will be using a respirator. Before the start of the spray season, each applicator should have a blood cholinesterase level determined. Every 4 to 6 weeks during the spray season, the level of blood cholinesterase should be reevaluated.

When applying pesticides, be sure to have a supply of clean water and liquid detergent available for drenching and washing in case of an accident. A single drop in the eye of certain pesticides is extremely hazardous. If the label requires goggles for eye protection, the handler must have immediate access to an eyewash container with a minimum of one pint per person at all times. Be prepared to wash a contaminated eye with clean water for as long as 15 minutes. Only an experienced applicator wearing the protective clothing and safety equipment prescribed by the manufacturer should handle highly toxic pesticides, such as concentrated organophosphates or carbamates.

## 2.2 Applying Pesticides

Before using a pesticide, read and obey all labeling instructions. Always have the label readily available when applying a pesticide.

- Do **not** handle or apply pesticides if you have a headache or do not feel well. **Never** smoke, eat or drink (or use cell phones!) while handling pesticides. **Avoid** inhaling pesticide sprays, dusts, and vapors. If the pesticide is dangerous to your respiratory system, the label will tell you to wear a respirator and specify which type (see Respiratory Protection Devices for Pesticides in this Section).
- Thoroughly wash exposed areas of yourself before eating, drinking, using tobacco products, using the bathroom, or using your cell phone. Wash your gloves with soap and water before you take them off. Then wash your hands and face.
- If hands, skin, or other body parts become contaminated or exposed, wash the area immediately with clean water and a liquid detergent. If clothing becomes contaminated, remove it immediately. If you splash a concentrate of a pesticide labeled with a "Danger "or "Warning" signal word, take your contaminated clothing off immediately and dispose of it; do not wash these items!
- After each spraying or dusting, bathe and change your clothing; always begin the day with clean clothing. Wash contaminated clothing separately and run an extra rinse cycle afterwards.
- Always have someone with you or close by if you are using highly toxic pesticides (those with the signal word **DANGER** plus skull and crossbones).

**Apply the Correct Dosage**

- To avoid excessive residues on crops for feed and food
- To achieve optimum pest control and minimum danger to non-targeted organisms
- To avoid chemical damage to the crops
- To obtain the most economical control of pests.

Use pesticides for only those crops specified on the label, and use only those that have state and federal registration. Avoid drift to non-targeted areas. Dusts drift more than sprays; air blast sprays drift more than boom sprays. When cleaning or filling application equipment, **do not** contaminate streams, ponds, or other water supplies. Always keep a record of all pesticides used (dates, locations, quantities).

## 2.3 Pesticide Transport

When pesticides are transported in a service vehicle to an application site outside the farm boundaries, the transport vehicle must be clearly marked as a pest control service vehicle in most states and for Category 7 operators in Delaware. Containers must be well secured to prevent breakage or spillage. If pesticide containers are glass, pad and secure them to prevent breakage. When containers are larger than 5 gallons, tightly brace them to a structural part of the vehicle to prevent accidental spills. Carry a supply of absorbent material to soak up or contain any liquid spills. Keep a shovel and/or broom and pan in the transport vehicle to help quickly contain any spills. Carry a working fire extinguisher (10 - B: C dry chemical, or carbon dioxide) on board as well. While under transport, pesticides must be stored in a separate compartment from the driver such as the bed of a pick-up truck or a van equipped with a partition. All pesticide containers and equipment must be secured to the vehicle so as to prevent removal by unauthorized person(s) when the vehicle is unattended. The door or hatch of any service vehicle tank containing a pesticide must be equipped with a cover that will prevent spillage when the vehicle is moving. The above requirements do not apply if the pesticide is being transported within the application equipment tank. **For additional information on pesticide transport, contact your state pesticide regulatory agency or Cooperative Extension Pesticide Safety Education Program.**

## 2.4 Pesticide Storage

Pesticides should always be stored in their original containers and kept tightly closed. Always read the label. Special storage recommendations or restrictions will be included. Write the purchase or delivery date of the product on the label with indelible ink. Products may lose their effectiveness over several years. Check for expiration dates in case they are included on the label. **For the protection of others, and especially in case of fire, the storage area should be posted as *Pesticide Storage* and kept securely locked.**

Herbicides, especially hormone-like weed killers such as 2,4-D, should **not** be stored with other pesticides - primarily insecticides and fungicides - to prevent the accidental substitution of the herbicide for these chemicals.

Store pesticides in a cool, dry, well-ventilated area that is not accessible to children and others who do not know and understand their safe and proper use.

Any restricted use pesticide or empty containers contaminated with their residues **must** be stored in a secure, locked enclosure while unattended. That enclosure must bear a warning that pesticides are stored there. If any pesticide must be stored in other than its original container (for example if the original container is leaking), that container must be labeled with the name and concentration of the active ingredient and the signal word and warning statements for the pesticide. Keep an inventory of all pesticides held in storage and locate the inventory list in an accessible place away from the storage site, so it may be referred to in case of an emergency at the storage site.

Keep your local fire department informed of the location of all pesticide storage locations. Fighting a fire that includes smoke from burning pesticides can be extremely hazardous. A fire with smoke from burning pesticides may also endanger the people of the immediate area or community. The people of an area or community may have to be evacuated if the smoke from a pesticide fire drifts in their direction. In **New Jersey**, applicators are required to send an inventory with the exact location of pesticides in storage to their local fire department by May 1st each year. For templates, see Rutgers Pesticide Safety Education Program's website at:
*http://pestmanagement.rutgers.edu/pat/record-forms/*

Pesticides may deteriorate due to storage conditions. Table D-1 provides general signs of deterioration.

**Table D-1. Deterioration of Pesticides**

| Formulation | General Signs of Deterioration |
|---|---|
| EC | Evidence of separation of components, such as sludge or sediment.<br>Milky appearance does not occur when water is added. |
| Oils | Milky appearance does not occur when water is added. |
| WP, SP, WDG | Excessive lumping; powder does not suspend in water. |
| D, G, WDG | Excessive lumping or caking. |

## Winter Storage of Pesticides

Plan pesticide purchases so that supplies are used by the end of the growing season. When pesticides are stored for the winter, keep them at temperatures above freezing, under dry conditions, and away from direct sunlight. After freezing, place pesticides in warm storage, 50-80°F (10-27°C), and shake or roll container every few hours to mix product or eliminate layering. If layering persists or if all crystals do not completely dissolve, do not use product. If in doubt, call the manufacturer for guidance. Table D-2 provides winter storage recommendations. Additional information can be obtained from manufacturers' websites.

**Table D-2. Winter Storage of Chemicals[1]**

| Chemical | Heated storage required | Heated storage not required | Quality questionable after freezing | Usable after freezing if put in warm storage | Usable after freezing if put in warm storage and shaken | Quality damaged by high temperatures |
|---|---|---|---|---|---|---|
| acephate | | | | | | x |
| Alanap-L | | | | | x | |
| Atrazine 4L | | x | | x | | |
| *Bacillus thuringiensis* | | x | | | | x |
| Banvel | | x | | x | | |
| Basagran | x | | | | x | |
| Benlate | | x | | | | |
| captan WP | | x | | | | |
| chlorothalonil | | | | | x | |
| Cythion 5E | | | | | x | x |
| Dacthal WP | | x | | | | |
| diazinon | | x | | x | | |
| dimethoate | x | | x | | | |
| Dual Magnum | | x | | x | | |
| Eptam 7E | | | x | | x | |
| Fusilade DX | | x | | x | | |

*Table continued on next page*

*Table D-2. Winter Storage of Chemicals - continued*

| Chemical | Heated storage required | Heated storage not required | Quality questionable after freezing | Usable after freezing if put in warm storage | Usable after freezing if put in warm storage and shaken | Quality damaged by high temperatures |
|---|---|---|---|---|---|---|
| Goal 2XL | x | | | | | |
| Gramoxone | x | | | | x | |
| Imidan WP | | x | | | | |
| Lannate | x | | | | x | |
| Lexone 4L | x | | x | | | |
| Lorox 4L | x | | x | | | |
| Lorsban | | x | | | x | |
| malathion EC | | x | | | x | x |
| Micro-Tech | x | | | | x | |
| Monitor 4E | | x | | x | | |
| Partner | x | | | | x | |
| Poast 1.5EC | x | | | | x | |
| Pounce | | x | | | x | |
| Prefar 4E | x | | x | | | |
| Prowl EC | x | | x | | | |
| Pursuit | x | | | x | | |
| Roundup Ultra Max | x | | x | | | |
| Sencor 4F | | x | | | x | |
| Sevin | | x | | | x | |
| Solicam 80DF | | x | | | | |
| Surflan AS | | x | | | x | |
| Treflan EC | x | | x | | | |
| 2,4-D amine | x | | x | | | |
| Vydate L | x | | | | | |

[1]Adapted from "Vegetable Newsletter," by Chris Doll, Illinois County Extension agent; the Cornbelt Chemical Company, McCook, Nebraska; and the "American Cemetery" magazine.

## 2.5 Disposal of Pesticides

**Pesticides should not be disposed of in sanitary landfills or by incineration, unless disposal sites and equipment are especially designed and licensed for this purpose by your state.** The best method to dispose of a pesticide is to use it in accordance with current label requirements.

The **triple rinse-and-drain** procedure or the **pressure-rinse** procedure is the recommended method to prepare pesticide containers for safe disposal (see below). This method can save you money as well as protect the environment. Crush or puncture the container for disposal in a sanitary landfill or deposit in landfills that accept industrial waste, or deliver the intact container to a drum reconditioner or recycling plant. Check with the landfill operator prior to taking empty containers for disposal. For additional information on the disposal of pesticides themselves or unrinsed containers or rinsate, call the state agency responsible for hazardous wastes.

**Organic Phosphate Pesticides**: The handling and disposal of waste organic phosphates is a specialized job. Many organophosphorous compounds break down by hydrolysis; most of these chemicals decompose much faster in alkaline situations than in acids or neutral solutions.

**Carbamate Pesticides**: Usually these chemicals decompose rapidly in soil; many break down much faster in an alkaline situation. An example of such carbamate chemicals is carbaryl.

## 2.6 Disposal of Containers

**Triple Rinse-and-Drain Method**: To empty a pesticide container for disposal, drain the container into the spray tank by holding container in a vertical position for 30 seconds. Add a solvent, capable of removing the pesticide, to the pesticide container, so that it is approximately one-fourth full. Agitate the container thoroughly, and then drain the liquid (rinsate) into the spray tank by holding in a vertical position for 30 seconds. Repeat two more times.

**Pressure Rinse Method**: An optional method to rinse small pesticide containers is to use a special rinsing device on the end of a standard water hose. The rinsing device has a sharp probe to puncture the container and several orifices to provide multiple spray jets of water. After the container has been drained into the sprayer tank (container is upside down), jab the pointed pressure rinser through the bottom of the inverted container. Rinse for at least 30 seconds. The spray jets of water rinse the inside of the container and the pesticide residue is washed down into the sprayer tank for proper use. Thirty seconds of rinse time is equivalent to triple rinsing. An added benefit is the container is rendered unusable. In Pennsylvania, this permits the containers to be disposed of as solid waste (not hazardous waste) in an ordinary landfill.

# 3. Soil Fumigants

EPA requires safety measures for use of the soil fumigants chloropicrin, dazomet, metam sodium/potassium, and methyl bromide. Each manufacturer is required to develop and implement training programs for applicators in charge of soil fumigation so these applicators are better prepared to effectively manage fumigant operations. Training must be completed every 3 years. Currently EPA-approved soil fumigant training for certified applicators may be found at: *https://www.epa.gov/soil-fumigants/soil-fumigant-training-certified-applicators*.

Soil fumigant labels require users to prepare a site-specific fumigation management plan (FMP) before the application begins. EPA has developed fumigant management plan templates that fulfill the elements required by the labels; see *https://www.epa.gov/soil-fumigants/fumigant-management-plan-templates-phase-2-files-listed-chemical*. Alternately, users may develop their own fumigant management plan or use one developed through an outside vendor to meet the label requirements rather than using these templates.

Some states currently require pesticide applicator certification categories for soil fumigation. These states may develop separate manuals, or they may use a national manual/certification study guide, the "National Soil Fumigation Manual". A low-resolution copy can be viewed/downloaded at: *http://www.ctaginfo.org/*. Additionally, some states will be requiring applicators to notify their state's licensing agency prior to use of these fumigants.

**New Jersey**: Currently, New Jersey does not have a separate license requirement for use of soil fumigants. Private applicators do not have to have an additional license to apply soil fumigants in New Jersey. However, private applicators are still required to read and follow all elements of the soil fumigant label, just like any other pesticide. In New Jersey there is no requirement for notification of soil fumigant use to the NJDEP. Rutgers has a limited stock of the national Soil Fumigation Manual (cited above) available to NJ applicators to use as a reference.

Please contact your state's applicator certification agency or your state Extension pesticide safety education program for state-specific regulations. You may contact either for further assistance.

# 4. Farm Worker Safety

## 4.1 Regulations

In April of 1994, the U.S. Environmental Protection Agency (EPA) implemented new regulations on worker safety, which are impacting agriculture throughout the U.S. These regulations, called the Federal Worker Protection Standard – CFR Title 40, Part 170 (WPS), provide specific safety requirements for both pesticide handlers and general agricultural workers. Farm workers must be informed about the pesticides with which they may come in contact. The following is a brief overview of some of these regulations.

1. Farm workers who enter treated fields within 30 days of an application of a pesticide must be trained as specified under the Worker Protection Standard (WPS) requirements.
2. No worker can enter a treated field before the end of the label specified restricted-entry interval (REI) unless properly protected. All WPS-labeled pesticide products are required to have a prescribed REI. These range from 4 to 48 hours or longer. Check your pesticide's label for the reentry time in effect. Some pesticides have one REI, such as 12 hours, for all crops and uses. Other products have different REIs depending on the crop or method of application. When two (or more) pesticides are applied at the same time, and have different REIs, you must follow the longer interval.
3. Employers must provide pesticide handlers protective equipment necessary may include socks, shoes, long pants, long-sleeve shirt, and a hat. Additional safety equipment may also be required by the label.
4. Farm workers must be verbally informed, in their native language, of all REIs if treated fields are not posted with the prescribed WPS warning sign during the reentry period. If workers are not verbally notified or the label requires it, treated fields must be posted with the prescribed WPS warning sign during the reentry period.
5. For all pesticides, workers must be warned by posting a bulletin board at a point(s) where workers might assemble. *(continued on next page)*

**This bulletin board should have a listing of the following information:**

a. Location and name of crop treated,
b. Brand name and common chemical of pesticide applied,
c. Date of application, and
d. Date of safe reentry into treated area.

*For example in New Jersey*. The bulletin board should also include a map of the farm which designates the different areas of the farm which might be treated. The required information must also be listed using column headings as defined by New Jersey Department of Environmental Protection, and must be in the native language of workers, in addition to English, if they do not read English. This information must be posted either before workers enter treated fields or prior to workers entering fields at the beginning of the next workday, whichever occurs first. Once posted, this information must remain posted for 30 days following the date for safe reentry.

6. Every farm must post the WPS safety poster in a central area at the farm where farm workers are able to view it.
7. Agricultural employers must also provide a decontamination site that includes water, soap, and single use towels for all farm workers who enter treated areas of the farm.

**These requirements are being implemented in different ways in each state. For additional information on these and other state farm worker regulations, contact your state pesticide regulatory agency or local Cooperative Extension office.**

**The US Environmental Protection Agency (EPA) revised its 1992 Agricultural Worker Protection Standard (WPS) on November 2, 2015. Compliance requirements for agricultural employers and handler employers are effective on January 2, 2017; and later on January 1, 2018. EPA's changes to the WPS are listed below, followed by information on compliance assistance resources for agricultural employers.**

**In the revised rule, EPA specifically summarizes the changes to the WPS as:**

- Requiring pesticide safety training at one-year intervals and amending the existing pesticide safety training content.
- Requiring recordkeeping for pesticide safety training.
- Eliminating the “grace period” that allowed workers to enter a treated area to perform WPS tasks before receiving full pesticide safety training.
- Establishing a minimum age of 18 for handlers and for workers who enter an area under a restricted entry interval (REI).
- Establishing requirements for specific training and notification for workers who enter an area under an REI.
- Restricting persons' entry into certain areas surrounding application equipment during an application.
- Clarifying requirements for supplies for routine washing and emergency decontamination.
- Requiring employers to post warning signs around treated areas when the product applied has an REI greater than 48 hours and allowing the employer to choose to post the treated area or give oral notification when the product applied has an REI of 48 hours or less (unless the labeling requires both types of notification).
- Requiring employers to maintain and make available copies of the Safety Data Sheets (SDSs) for products used on the establishment.
- Requiring employers to provide application information and SDSs to designated representatives making the request on behalf of workers or handlers.
- Adding elements to the requirement to maintain application-specific information.
- Adopting by cross reference certain OSHA requirements for employers to provide training, fit testing and medical evaluations to handlers using products that require use of respirators.
- Requiring employers to provide supplies for emergency eye flush at all pesticide mixing and loading sites when handlers use products that require eye protection.
- Maintaining the immediate family exemption and ensuring it includes an exemption from the new minimum age requirements for handlers and early-entry workers.
- Expanding the definition of “immediate family” to allow more family-owned operations to qualify for the exemptions to the WPS requirements.
- Revising definitions to improve clarity and to refine terms.

**Compliance Assistance**

EPA is providing resources to agricultural employers and handler employers to assist with compliance with the Revised WPS in conjunction with the Pesticide Educational Resources Collaborative (PERC). Key resources already developed and posted at the PERC website (*http://pesticideresources.org/*) are:

- "Quick Reference Guide to the Worker Protection Standard (WPS) as Revised in 2015"; see *http://pesticideresources.org/wps/hosted/quickrefguide.pdf*. This one-page double-sided chart outlines requirements with direct hyperlinks to the text of the regulation for each item being cited in the chart.
- "How to Comply With the 2015 Revised Worker Protection Standard For Agricultural Pesticides"; see *http://pesticideresources.org/wps/htc/index.html*". The purpose of this online guide is to help users of agricultural pesticides comply with the requirements of the revised federal Worker Protection Standard.

PERC will use email distribution lists to keep interested parties informed about new publications. PERC has developed lists for several target groups, including "Agricultural Employers and Handler Employers" to distribute notices relevant to agricultural employers and commercial pesticide handler employers, as defined by the WPS. See *http://pesticideresources.org//lists.html* to enroll in the email list(s) of your choice.

Please refer to your State pesticide regulatory agency for state-specific regulations and policy on the Revised WPS. **In cases where state rules are more stringent than federal, the state rules will take primacy.**

Contact your local Extension offices and state Extension Pesticide Safety Education Program (PSEP) for further assistance. Some state PSEP Programs, such as Rutgers New Jersey PSEP, will be providing WPS outreach to agricultural producers at conferences, meetings, its Farm Safety webpages (which can be accessed at *http://pestmanagement.rutgers.edu/*), and the Plant and Pest Advisory blog.

# 4.2 Protecting Yourself from Pesticides

**Personal Protective Equipment (PPE)**

Wearing PPE can greatly reduce the potential for dermal, eye, oral, and inhalation exposure; and thereby significantly reduce the chances of pesticide poisoning or injury. PPE includes such items as coveralls or protective suits, aprons, gloves, footwear, headgear, eyewear, and respirators. When selected correctly, these all reduce the risk of dermal exposure; but they do not eliminate it. All PPE should either be disposable, or easy to clean and sturdy enough for repeated use.

**Coveralls**

If the pesticide label only lists 'coveralls', it is allowable to wear a coverall made of any fabric, including wovens (like cotton or twill); as well as disposable non-wovens. These do not have to be chemical resistant.

**Chemical Resistant PPE**

Generally speaking, labels will specify PPE that is "chemical resistant" for protecting the body from moderately toxic (signal word 'Warning') or highly toxic (label signal word 'Danger') pesticides. However, that may not always be the case for specific products; always follow the label.

It is important that all pesticide handlers understand the limitations of PPE. Different types of PPE are not equally resistant to all pesticides and under all conditions. Chemical resistance of a given protective suit, for instance, can vary between different pesticides. Some materials restrict pesticide entry for a long time, while others allow the pesticide to pass through quickly.

There are several criteria for chemical resistance: penetration, degradation, and permeation. Penetration occurs when the chemical leaks through seams, pinholes, and other imperfections in the material. Degradation is a reduction in one or more physical properties of PPE due to contact with a chemical; it essentially starts to break down. Permeation is the process by which a chemical moves through protective material on a molecular level; measured as a volume per area overtime. Breakthrough is what occurs when there is complete passage of a pesticide to the inside of PPE, measured in elapsed time. Once this occurs, your skin is directly exposed to the pesticide.

In some instances, degradation of protective fabric is easy for applicators to recognize. PPE may swell, discolor, shrink, soften, become brittle, or change texture. Be alert for these signs and replace compromised clothing immediately to minimize your exposure to pesticides.

Permeation of a pesticide into a material may begin as soon as it gets on its surface. Once a pesticide is absorbed onto the surface of a garment, it is difficult to detect or decontaminate. In these cases, the pesticide continues to move into and through the PPE. How fast a given pesticide moves through different PPE materials (its permeation rate) can vary widely. Things that can affect the extent of permeation are contact time, concentration, temperature and physical state of the contaminant.

Pesticide breakthrough of PPE can occur without any noticeable signs. If a material is not chemical resistant to a pesticide, complete passage through it can occur very quickly, in just minutes.

Pesticide residues that remain on PPE are likely to continue to permeate through the material once contaminated.

If using "reusable" PPE, pay close attention and be ready to change them whenever the inside surface is contaminated or there are signs of pesticide permeation. Even if you do not see any signs of wear, replace reusable chemical-resistant items regularly - the ability of a chemical-resistant material to resist the pesticide decreases each time an item is worn.

Be sure to clean all reusable PPE items between uses, even if worn for only a brief period of exposure. If you wear that PPE again, pesticide may already be on the inside of the material next to your skin. In addition, PPE worn several times between launderings may build up pesticide residues. The residues can reach a level that can harm you, even if you are handling pesticides that are not highly toxic.

Disposable PPE is a preferred option to reusable PPE. They are low-cost, and their use minimizes clean-up and spread of contamination.

**Selecting chemical resistant PPE**

Always follow the pesticide label directions for what is required for you to use under the law. For pesticide handlers, the precautionary statement on the pesticide label indicates if chemical-resistant PPE is required. For workers performing "early entry" tasks, the Agricultural Use Requirements box on the label indicates PPE requirements.

For gloves, labels will often specify materials that are chemical resistant for that product. Older pesticide labels may add another statement that you can consult an EPA chemical resistance category chart for more options. In these cases, the glove type that provides highest protection is listed. Use only those listed.

In some cases, a pesticide label may say "wear chemical-resistant PPE" without specifying the material that protects you. This is more typically the case for suits, aprons, boots, and headgear. In these circumstances, you should consult the PPE manufacturer or their literature (often available online). They can recommend the best garments/gloves to wear with the pesticide that you will be using. Consult the pesticide manufacturer to find out what PPE they recommend to be chemical resistant. You can also contact your state Cooperative Extension pesticide safety office for assistance.

**Gloves**

The area of the body receiving most exposure from pesticides is hands and forearms. Research has shown that workers mixing pesticides received 85 percent of the total exposure to the hands and 13 percent to their forearms. The same study showed that wearing chemical-resistant gloves reduced exposure by 99 percent *(Source: The Farm Family Exposure Study, John Acquavella)*.

Wear the type of chemical-resistant glove specified by the product labeling. Select glove materials according to the label, or by chemical resistance charts, or manufacturer directions. Make sure not to use gloves made of any kind of absorbent material, leather, cloth, cloth-lined, or flocked, unless specified by the label. All of these materials can absorb pesticides, and hold them against your skin. Cotton gloves may be prescribed on the label in very specific uses such as protection for certain fumigants including aluminum phosphide. Always use label-prescribed gloves.

Gloves, non-woven (including coated non-woven) coveralls and hoods, such as Tyvek®, usually are designed to be disposed of after use. Most are intended to be worn for only one work day. For example, you might use disposable gloves, shoe covers, and an apron while pouring pesticide into a hopper or tank, cleaning or adjusting a nozzle, or making minor equipment adjustments. Place disposable PPE in a separate plastic bag or container prior to disposal.

**Footwear**

Pesticide handlers often get pesticides on their feet. Sturdy shoes and socks may be sufficient to protect your feet during many handling activities. However, some product labels require that you wear waterproof or chemical-resistant footwear.

If the product labeling specifies "chemical-resistant footwear", you can wear any chemical-resistant shoes; boots; or shoe coverings worn over shoes or boots. Leather or canvas footwear is not chemical resistant; they absorb pesticides and cannot be decontaminated. Do not wear leather boots in these cases.

**Eye Protection**

Eyes readily absorb pesticides. When a label simply says to "wear protective eyewear", you may use any of the following: goggles; face shield; safety glasses with shields at front, brow and temple; or a full-face respirator. Select goggles made of impact-resistant material such as polycarbonate. Goggles that have covered air baffles reduce lens fogging while keeping liquids out. Under the agricultural Worker Protection Standard, if the label requires goggles for eye protection, then the handler must have immediate access to **eyewash container** at all times. Regulations require a minimum of a pint per person.

## 4.3 Respiratory Protective Devices for Pesticides

You may be subject to exposure to toxic gases, vapors, and/or particulates when using pesticides. Although your respiratory (breathing) system tolerates a limited exposure, some chemicals can impair or destroy portions of the system. For many pesticides, the respiratory system is the quickest and most direct route into the circulatory system, allowing rapid transport throughout the body. Thus, it is important to follow the pesticide label and employ directions for control of exposure, especially when respiratory protection is specified.

A respirator is a safety device covering at least the mouth and nose that protects the wearer from contaminated air. Respiratory protection varies in design, use, and protective capacity. There are two major **classes** of respirators:

1. Air-purifying respirators that remove contaminants from the air.
2. Atmosphere-supplying respirators that provide clean, breathable air from an uncontaminated source.

Air-purifying respirators may be powered or non-powered. A powered air-purifying respirator uses a blower to pass contaminated air through purifying elements. Non-powered air-purifying respirators may be designed for single use or with replaceable filters, canisters, or cartridges. Air-purifying respirators **DO NOT** supply oxygen and should never be used when oxygen may be limited (<19.5 percent oxygen by volume) or when an environment is immediately dangerous to life or health (IDLH).

Purifying elements for air-purifying respirators contain a filter, sorbent, or catalyst (or a combination of these items) to remove specific contaminants from the air passing through the container. When pesticides are used, particulates may be present as solids and/or liquids. When this is the case, a particulate respirator (or filter) is prescribed for use. Pesticide products may be present as gases or vapors. When this is the case, a contaminant-specific chemical cartridge or canister is prescribed. Be sure that the respirator assembly (with component purifying element) is approved for protection against the pesticide you intend to use (see "Selection of Respirator Type" below). Respirators approved only for use against particulates must not be used for gases and vapors.

Air-supplying respirators include supplied-air respirators and self-contained breathing apparatus. These respirators should be used when oxygen is limited. However, the only type of atmosphere-supplying respirators that may be used in an IDLH environment is a **pressure-demand**, self-contained breathing apparatus. The breathing air supply for these respirators should meet or exceed the specification for Grade D breathing air as described in the most current Compressed Gas Association Specification G-7.1.
See: *https://www.osha.gov/publications/OSHA3079.pdf*.

**Certification of Respirators**

Standards, testing, and certification assure the commercial availability of safe, personal protective devices. The National Institute for Occupational Safety and Health (NIOSH) certifies respirators for the contaminant or situation of exposure. **When purchasing a new respirator, the certification numbers per respirator type, are as follows:**

TC-13F-XXXX: self-contained breathing apparatus
TC-14G-XXXX: gas masks with canisters
TC-19C-XXXX: supplied air respirators
TC-21C-XXXX: **powered** particulate respirators **only** (with HE filter only)
TC-23C-XXXX: chemical cartridge respirators
TC-84A-XXXX: **non-powered** particulate respirators (with N, P, and R series filters)

**There are nine classes of particulate filters based upon filter efficiency and oil degradation resistance.**
**The nine new classes and prescribed use of each are as follows:**

N95: Not oil-resistant; moderate filtering efficiency
R95: Oil-resistant; moderate filtering efficiency
P95: Oil-proof; moderate filtering efficiency

*(List continued on next page)*

N99: Not oil-resistant; high filtering efficiency
R99: Oil-resistant; high filtering efficiency
P99: Oil-proof; high filtering efficiency
N100: Not oil-resistant; highest filtering efficiency (99.97%)
R100: Oil-resistant; highest filtering efficiency (99.97%)
P100: Oil-proof; highest filtering efficiency (99.97%)

Although there are three distinct efficiency levels for filters, most manufacturers are marketing only the 95% to 99.97% efficiency filters as listed above. If you previously used a high efficiency particulate air filter (HEPA), a filtering unit with 99.97% filtering efficiency would be comparable. The appropriate N-, R-, or P-series for the filter will still need to be chosen. If the pesticide label specifies N-, R-, or P-series filtering elements, do not use the N-series when oil is present. The class of the filter will be clearly marked on the filter, filter package, or respirator box. In the case of chemical cartridges that include these filter elements, similar markings will be present.

**Selection of Respirator Type**

Manufacturers now provide recommendations for appropriate respiratory protection on the pesticide label. These label recommendations are product and task specific. For example, manufacturers may specify organic vapor cartridges or canisters in formulations where the solvent carrier for the pesticide active ingredient is petroleum based. **It is extremely important** to read and follow the product label for respirator requirements since pesticides may have different formulations and use directions.

EPA provides pesticide manufacturers' specific **pesticide label statements for respiratory protection** for five categories of pesticide formulation and application activity.

**Service Life of Filters**

The service life of all filters is limited and all soiled filters should be replaced whenever they are damaged or cause noticeably increased breathing resistance.

The effective service life of a chemical cartridge respirator depends on the conditions of use. Conditions include the type and concentration of contaminant(s), user's breathing rate, and humidity. Cartridges should remain sealed until ready to use. Make sure to use cartridges within the manufacturer's prescribed cartridge shelf life.

Chemical cartridge respirators, when selected appropriately, are essentially 100 percent efficient until the gas or vapor "breaks through." The service life for chemical cartridges can be identified by: warning properties (smell, taste, irrigation); chemical specific end-of-service-life-indicators (ESLI); and predetermined conservative change-out schedules. Reliance on warning properties is problematic due to a wide variation in odor threshold in the general population. The availability of ESLI is limited. Consult pesticide and respirator manufacturers, as well as NIOSH, OSHA, and EPA guidance when establishing a cartridge change-out schedule. Cartridges should be changed immediately whenever breakthrough is detected in the mask. Always dispose of chemical cartridges at the end of a workday. Never reuse a chemical cartridge.

**Use and Care of Respirators**

The most commonly used facepiece configurations for pesticide use are either half-masks or full-face masks. Half-face masks are typically available as single-use or with cartridges that are replaceable with each use. Full-face masks provide eye protection and a better seal; most full-face masks are sized small, medium, and large affording enhanced fit to the face. Full-facepieces, half-masks, quarter-masks, and different brands of the same type respirator have different fit characteristics. A qualitative or quantitative fit test of a given mask type on a user's face must be performed in order to select the best fitting respirator. Kits for qualitative testing are commercially available.

Prior to using a respirator, read and understand the manufacturer's instructions that are supplied with the respirator and its component parts. All respirators must be inspected for wear and deterioration of their components before and after each use. Special attention should be given to rubber or plastic parts that can deteriorate. Replacement component parts are available from most manufacturers.

Wearers should perform both positive and negative seal checks every time respirator masks are put on. This will ensure that the respirator is properly sealed on the face and that all inhalation and exhalation ports are functioning properly. Facial hair (*i.e.*, beards and mustaches) prevents the formation of a good seal and may negate any benefit gained by wearing a respirator.

- To perform a positive pressure seal check, cover the exhalation port with the palm of your hand and exhale into the mask. You will feel air escaping at any gaps in your seal. Readjust the mask until there is no leakage.

- To perform a negative pressure seal check, cover or seal off the surface or hose where air is inspired and suck in. A properly sealed mask should collapse on your face with no signs of leakage in the facepiece or hoses. Readjust the mask until there is no leakage.

After using the respirator, remove and properly dispose of any expendable components such as filters, cartridges, or canisters. Wash the facepiece in a cleaning/sanitizing solution as recommended by the respirator manufacturer. Take care to clean under and around gaskets and valves allowing components to air dry. Store cleaned respirators, as well as replacement purifying elements, in a clean dry place that is not exposed to sunlight or extreme temperatures. Do not store any protective equipment, including respirators, with or near chemicals such as pesticides.

**Call your state's Extension office to refer you to the pesticide safety education coordinator if you have any questions about pesticide safety equipment.**

## 4.4 Pesticide Poisoning

**If you have any of the following symptoms during or shortly after using pesticides: headache, blurred vision, pinpoint pupils, weakness, nausea, cramps, diarrhea, and discomfort in the chest, call a physician and the Poison Control Center (1-800-222-1222 for all states) or agency in your state.** Anyone with a pesticide exposure poisoning emergency can call the toll-free telephone number for help. Personnel at the Center will give you first-aid information and direct you to local treatment centers if necessary. **For immediate medical attention call 911. Prompt action and treatment may save a life.**

<u>In Case of an Accident</u>

- **Remove the person from exposure.**
- **Get away from the treated or contaminated area immediately.**
- **Remove contaminated clothing.**
- **Wash with soap and clean water.**
- **Call a physician and the Poison Control Center (1-800-222-1222) or agency in your state.**
- **Be prepared to give the active ingredient name (common generic name) to the responding center/agency.**

POISON Help®
1-800-222-1222

# 5. Protect the Environment

## 5.1 General Guidelines

- Always read the pesticide label and check for environmental concerns and restrictions.
- Do not burn pesticides. The smoke from burning pesticides is toxic and can pollute air.
- Do not dump pesticides in sewage disposal or storm sewers, because this will contaminate water.
- Avoid using excess quantities of pesticides. Calibrate your sprayer to make sure of the output.

*General Guidelines continued on next page*

***General Guidelines to Protect the Environment - continued***

- Adjust equipment to keep spray on target. Chemicals off-target pollute and can do harm to fish, wildlife, honeybees, and other desirable organisms.
- Keep pesticides out of ponds, streams, and water supplies, except those intended for such use. A small amount of drift can be hazardous to food crops and to wildlife. Empty and clean sprayers away from water areas.
- Protect bees and other beneficial insects by choosing the proper chemical and time of day for application.
- See additional precautions in section "Protecting Our Groundwater."

**Minimize Spray Drift**

- Avoid spraying when there is strong wind.
- Use large orifice nozzles at relatively low pressure.
- Use nozzles that do not produce small droplets.
- Adjust boom height as low as practical.
- Do not spray at high travel speeds.
- Spray when soil is coolest and relative humidity is highest.
- Use nonvolatile pesticides.
- Use drift control additives when permitted by the pesticide label.

## 5.2 Notification of Beekeepers

To avoid conflicts and possible lawsuits, it is advisable to always provide notification of insecticide applications to beekeepers within three miles from your site. In New Jersey, this is mandatory, as follows: Beekeepers registered with the New Jersey Department of Environmental Protection (DEP) must be notified before certain pesticides are applied. Growers using pesticides on vine crops (June through August), strawberries (April 15 to May 15), or sweet corn (during flowering stage), or in fields where flowering weeds are present that have information on the label indicating the pesticide is toxic to bees must notify beekeepers within three miles of the target site at least 24 hours prior to application. Notification must include approximate date and time of application; location, brand name, and active ingredient of the pesticide to be used; and the name and registration number of the certified pesticide applicator(s). Notification can be made by phone, regular or certified mail as long as it is received 24 hours before the application. A list of registered beekeepers can be obtained by writing to:
New Jersey Department of Environmental Protection Pesticide Control Program,
PO Box 420, Trenton, NJ 08625-0420
For more detailed information and regulations, consult the Pesticide Control Program (*http://www.nj.gov/dep/enforcement/pcp/bpo.htm*) or the Rutgers Cooperative Extension Pesticide Safety Education Program *(http://pestmanagement.rutgers.edu/rutgers-pesticide-safety-education-program/)*.

## 5.3 Protecting Your Groundwater

Groundwater is the water contained below our soils. This water is used by 90% of the rural population in the United States as their sole source of drinking water. Contamination of our water supply by pesticides and other pollutants is becoming a serious problem. One source of contamination is agricultural practices. **Protection of our groundwater by the agricultural community is essential.**

Groundwater collects under our soils in aquifers that are comprised of layers of sand, gravel or fractured bedrock which, by their nature, hold water. This water comes from rainfall, snowfall, etc., that moves down through the soil layers to the aquifer. The depth of the aquifer below the surface depends on many factors. Where it is shallow, we see lakes, ponds and wetlands.

**Factors That Affect Movement of Water and Contaminants**

The depth of aquifers, in conjunction with soil types, influences how much surface water reaches the aquifer. Their depth also affects how quickly water and contaminants reach an aquifer. Thus, shallow water tables tend to be more vulnerable to contamination than deeper ones.

This tendency, however, depends on the soil type. Soils with high clay or organic matter content may hold water longer and retard its movement to the aquifer. Conversely, sandy soils allow water to move downward at a fast rate. High levels of clay and/or organic content in soils also provide a large surface area for binding contaminants that can slow their movement into groundwater. Soil texture also influences downward water movement. Finer textured soils have fewer spaces between particles than coarser ones, thus decreasing movement of water and contaminants.

**Chemistry Plays a Role**

The characteristics of an individual pesticide affect its ability to reach groundwater. The most important characteristics are solubility in water, adsorption to soils, and persistence in the environment.

Pesticides that are highly soluble in water have a higher potential for contaminating groundwater than those which are less soluble. The water solubility of a chemical indicates how much chemical will dissolve in water and is measured in parts per million (ppm). Those chemicals with a water solubility greater than 30 ppm may create problems.

A chemical's ability to adhere to soil particles plays an important role. Chemicals with a high affinity for soil adsorption are less likely to reach the aquifer. Adsorption is also affected by the amount of organic matter in the soil. Soils with high organic matter content are less vulnerable than those with low organic matter content.

Finally, how persistent a chemical is in the environment may affect its ability to reach groundwater. Those which persist for a long time may be more likely to cause contamination than materials which breakdown quickly. Persistence is measured by the time it takes half of a given pesticide to degrade (half-life). Chemicals with an overall estimated half-life longer than 3 weeks pose a threat to groundwater.

**How to Prevent Contamination of Your Ground Water**

1. Examine the chemical properties of the pesticides that you use. If you are using materials which persist for long periods of time, are very water soluble, or are not tightly held by the soil, then you may be contaminating your groundwater. You may wish to select another material that has a shorter persistence, lower water solubility or higher potential for soil adsorption. The following table will assist you with these decisions.

**Table D-3. $K_d$, $K_{oc}$, Water Solubility and Persistence Values for Selected Pesticides**

| Pesticide | Adsorption to Soil $K_d$[1] | Adsorption to Organic Matter $K_{oc}$[1] | Water Solubility (ppm)[2] | Half Life (days)[3] |
|---|---|---|---|---|
| alachlor | 4.35 | 190 | 242 | 14 |
| atrazine | 127.00 | 160 | 33 | 60 |
| Dacthal | -- | 5,000 | 0 | 30 |
| disulfoton | 32.30 | 2,000 | 25 | 4 |
| fenamiphos | 4.41 | 171 | 700 | 20 |
| methomyl | 0.03 | 28 | 57,900 | 8 |
| metribuzin | 0.11 | 41 | 1,200 | 30 |
| oxamyl | 0.16 | 1 | 280,000 | 7 |
| S-metolachlor | -- | 200 | 530 | 20 |
| terbacil | 0.78 | 41 | 710 | 90 |

[1]A lower $K_d$ or $K_{oc}$ number indicates a greater chance for groundwater contamination. [2]A higher water solubility indicates a greater chance for groundwater contamination. [3]A longer half-life indicates a greater chance for groundwater contamination.

2. Determine your local soil and geologic circumstances. If you are in an area with a shallow water table or your soil is low in organic matter or sandy in nature, you have a greater risk of contaminating your groundwater. In these cases, choose a pesticide that has a low water solubility and is not persistent (has a short half-life).
3. Evaluate your management practices. They may be the most important factor in determining your risk of contaminating your groundwater. If you use the same materials year after year, or many times a season, you can increase the potential for contamination due to the amount of pesticide in your soil. The timing of pesticide applications has an effect on groundwater contamination. If you make applications during periods of high rainfall or heavy irrigation, it is more likely that contamination may occur. Also, the water table in the spring may be higher than at other times. Early season applications, therefore, may pose a greater chance for groundwater contamination. Finally, the method of application may have an effect on ground water contamination. Direct injection, incorporation, and chemigation all increase the chance of contamination. If you use these techniques, be sure to follow the procedures listed on the material's label.
4. The location of your wells can be important. If your sprayer loading area or pesticide storage building is too close to your well, the risk of contamination may be greater. Wells used for drinking water or other purposes should be at least 50 feet away from pesticide storage buildings and loading areas. In the event of an accident,

this distance should prevent contamination. This minimum distance should also be followed for field irrigation wells. If they are too close to application areas, contamination might occur.

5. Check the condition of any wells in the vicinity of sprayer loading areas, pesticide storage areas or field applications. If they have cracked casings you are inviting trouble. Cracks in a well casing provide a direct point of entry for pesticide-contaminated water in the soil around the well.
6. Incorporate an anti-backflow device in any system used for chemigation or to fill your sprayer with water. In the event of a pump shutoff or other failure, if any back-flow into the water system occurs, these devices will prevent pesticides from entering your well. In many states these devices are now required for sprayers by laws.
7. Care and maintenance of your equipment is also an important consideration. If your equipment does not function properly, you may be applying more than is needed and increasing the chance of groundwater contamination. Prior to the season, inspect all of the working parts of your sprayer or chemigation system. Check the pump to see if it is working properly. For both sprayers and chemigation systems, check the water lines for clogs and leaks. For sprayers, check the nozzles for wear and clogs. Clogged, leaking or worn lines and nozzles can cause pesticides to be delivered excessively or in unwanted areas. Be sure to calibrate your equipment. Uncalibrated equipment can cause over delivery as well. You should calibrate your equipment at the beginning of the season, periodically during the remainder of the season and any time you make changes or adjustment to the equipment.
8. Apply materials only when needed. The use of extraneous pesticides can increase the threat of contamination. Check your irrigation practices as well. Don't irrigate immediately after a pesticide application, unless required by a pesticide's label. The increased water content in the soil might speed up the movement of a pesticide into ground water. **Remember, you must protect your groundwater.**

## 5.4 Pesticide Spills

Keep a supply of an absorbent agent on hand to scatter over liquid spills in the area that you store pesticides. Sawdust or janitorial sweeping compound works well in absorbing the liquids in a cleanup. Use a respirator and chemical resistant gloves to clean up spills. Barrier laminate gloves have a broad range of chemical resistance are a good choice to keep in a spill kit. Rubber gloves might break down depending on the pesticide. Let it soak a couple of hours to absorb the spilled pesticide from the floor. This procedure is also recommended for cleaning truck beds that are contaminated.

Specific information concerning pesticide cleanup can be obtained by calling the manufacturer directly or consulting the products' MSDS. **The phone numbers for emergencies are listed on every product label**. Information can also be obtained by calling CHEMTREC at 1-800-424-9300, or visiting *http://www.chemtrec.com/*. Report pesticide spills to the proper state agency.

**Reporting of Pesticide Spills**

**For Delaware, Maryland, Pennsylvania, Virginia, and West Virginia,** pesticide spills may be reported to the US EPA Region 3 Office (1-800-438-2474).

**For New Jersey**, any registered pesticide applicator, or any registered pesticide applicator business, shall immediately inform the DEP of any reportable pesticide spill (1 pound active ingredient or 1 gallon of liquid) occurring under such person's direct supervision and/or direct observation and shall provide the following information:

1. Name of the pesticide applicator
2. Name of the applicator business, if any
3. Name of the property owner or operator
4. Location of the incident
5. Name and EPA registration number of the pesticide
6. Estimated amount of pesticide involved
7. Corrective action taken

**The report shall be made to the DEP hotline immediately by telephone. Call the Pesticide Control Program at 1 800-WARN-DEP (1-877-927-6337)**.

**Submit a written follow-up within 10 days to the Pesticide Control Program, PO Box 420, Trenton, NJ 08625.** (*See: http://www.nj.gov/dep/enforcement/docs/sdreport-rev5-12-14.pdf*)

# 6. Toxicity of Chemicals

The danger in handling pesticides does not depend exclusively on toxicity values. Hazard is a function of both toxicity and the amount and type of exposure. Some chemicals are very hazardous from dermal (skin) as well as oral (ingestion) exposure. Although inhalation values are not given, this type of exposure is similar to ingestion. A compound may be highly toxic but present little hazard to the applicator if the precautions are followed carefully.

Acute toxicity values are expressed as oral $LD_{50}$ in terms of milligrams of the substance per kilogram (mg/kg) of test animal body weight required to kill 50 percent of the population. The acute dermal $LD_{50}$ is also expressed in mg/kg. These acute values are for a single exposure and not for repeated exposures such as may occur in the field. Rats are used to obtain the oral $LD_{50}$ and the test animals used to obtain the dermal values are usually rabbits.

**Table D-4. Acute Categories of Toxicity[1]**

| Categories | Signal Word | $LD_{50}$ Value (mg/kg) | |
|---|---|---|---|
| | | **Oral** | **Dermal** |
| I | Danger-Poison | 0-50 | 0-200 |
| II | Warning | 50-500 | 200-2,000 |
| III | Caution | 500-5,000 | 2,000-5,000 |
| IV | Caution[2] | > 5,000 | > 5,000 |

[1]EPA accepted categories. For examples of each category, see Table D-6 (Toxicity of Chemicals).
[2]No signal word required based on acute toxicity; however, products in this category usually display "Caution."

**Read the labels and become familiar with the symptoms of pesticide poisoning. For help in a pesticide emergency, call the Poison Control Center 1-800-222-1222 (for all states).**

<u>**Toxicity and $LD_{50}$ Calculations**</u>

**Weight Conversions:**

1 ounce (oz) = 28 grams (gr)
1 pound (lb) = 454 grams (gr) = 0.45 kg
1 gram (gr) = 1,000 milligrams (mg)
1,000 mg = 0.035 oz
1 mg = 0.000035 oz

**Conversions of Body Weight in Pounds (lb) to Body Weight in Kilograms (kg):**

All the following calculations use a body weight of 100 pounds.
To calculate $LD_{50}$, first convert body weight in pounds to body weight in kilograms by multiplying weight in pounds by 0.454: 100 lb x 0.454 = 45.4 kg

Additional examples:

| | | | | | | |
|---|---|---|---|---|---|---|
| Body weight in lb: | 25 | 50 | 75 | 100 | 150 | 200 |
| Body weight in kg: | 11.4 | 22.7 | 34.1 | 45.4 | 68.1 | 90.8 |

Next, multiply given $LD_{50}$ by body weight in kg (**Note**: $LD_{50}$ numbers are given by the manufacturer).
For example: $LD_{50}$ of **11 mg/kg** x 45.4 kg = 499.4 mg

Next, to convert milligrams (mg) to ounces (oz), multiply mg by 0.000035.
For example: 499.4 mg x 0.000035 = 0.017 oz

**Table D-5.**
**$LD_{50}$ Figures Converted to Ounces for Three Commonly Used Products in Agriculture**

| | LD50 | Body Weight in Pounds | | | | |
|---|---|---|---|---|---|---|
| | | **30** | **60** | **100** | **150** | **200** |
| | | **Ounces** | | | | |
| **Insecticide** methomyl | 17 | 0.008 | 0.016 | 0.026 | 0.039 | 0.053 |
| **Herbicide** Micro-Tech/Partner | 1,800 | 0.9 | 1.7 | 2.8 | 4.3 | 5.7 |
| **Fungicide** chlorothalonil | 10,000 | 4.9 | 9.5 | 15.7 | 23.8 | 31.5 |

**Pesticide Formulations**

Commercial pesticides may be developed in many different formulations. Some are emulsifiable concentrates, flowables, wettable powders, dusts, and granules. After each pesticide recommendation in this publication, one of these formulations is presumed; however, unless stated to the contrary, equivalent rates of another formulation or concentration of that pesticide can be used.

In most cases, sprays rather than dusts are preferred for the control pests of vegetables. This is because sprays have produced better control and have resulted in less drift than dry particulates.

Table D-6 lists type class; use category; acute mammalian toxicity; reentry times; and toxicity to birds, fish, and bees for the pesticides recommended for use in this manual.

## Table D-6. Acute Toxicity of Chemicals

**Note:** The Occupational Safety and Health Administration (OSHA) requires growers to keep on file Safety Data Sheets (SDS) for certain chemicals used during normal spray programs (Safety Data Sheets replaced Material Safety Data Sheets). **SDS sheets should be obtained from either your local pesticide dealer or directly from the chemical manufacturer.** Some labels carry technical assistance phone numbers that you can call for further information. Call this number to request a SDS sheet from the manufacturer.

-- = Data not available, * = Material covered under the Superfund Amendments and Reauthorization Act of 1986 (SARA) for storage notification.

| Name[1] | Type[2] Class | Use[3] Category | LD$_{50}$ Values Mg/Kg[4] | | REI[5] (h) | Toxicity[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Oral | Dermal | | Bird | Fish | Bee |
| abamectin, Agri-Mek, ABBA, Epi-Mek, Temprano, Minecto Pro | I-FB | R | 300 | >1,800 | 12 | N | M | H |
| ABBA, abamectin | I-FB | R | 300 | >1,800 | 12 | N | M | H |
| Abound, azoxystrobin, | F | G | >2,000 | >5,000 | 4 | -- | H | N |
| Accent Q, nicosulfuron | H | G | >5,000 | >5,000 | 4 | N | N | N |
| acephate, Orthene | I-OP | G | tech 980 | >10,250 | 24 | M | N | H |
| acetamiprid, Assail, Tristar | I | G | 1,064 | >2,000 | 12 | N | N | M |
| acetochlor, Degree, Harness, Surpass | H | G | tech 4,124 | tech >2,000 | 12 | -- | H | -- |
| acetoctradin + dimethomorph, Zampro | F | G | >500 - >2,000 | >5,000 | 12 | --- | --- | --- |
| acibenzolar-S-methyl, Actigard, Blockade | B,F | G | -- | -- | 12 | N | M | N |
| Acramite, bifenazate | A | G | >5,000 | >5,000 | 12 | N | H | M |
| Actara, thiamethoxam | I-NN | G | >5,000 | >2,000 | 12 | N | N | H |
| Actigard, acibenzolar-S-methyl | B,F | G | -- | -- | 12 | N | M | H |
| Acuron, bicyclopyrone + mesotrione + s-metolachlor + atrazine | H | R-13 | 1,750 | >5,000 | 24 | -- | -- | -- |
| Admire Pro, imidacloprid | I-NN | G | tech 450 | >5,000 | 12 | M | M | H |
| Agree, *Bacillus thuringiensis aizawai +kurstaki* | I-BT | G | see footnote 7 | | 4 | N | N | N |
| Agri-Fos, phosphite salts, | F | G | | | 4 | -- | M | N |
| Agri-Mek, abamectin | I-FB | R | 300 | >1,800 | 12 | -- | M | H |
| Agri-Strep, streptomycin | B | G | 9,000 | -- | 12 | -- | -- | -- |
| Agri Tin, triphenyltin hydroxide | F | R | 160 | 500 | 48 | -- | H | -- |
| Aim, carfentrazone | H | G | 5,143 | >5,000 | 12 | N | M | N |
| alachlor, Micro-Tech | H | R-12 | 1,800 | -- | 12 | N | N | N |
| Alcide, sodium chlorite | F | G | -- | -- | 12 | N | N | N |
| Aliette, fosetyl Al | F | G | tech 5,000 | >2,000 | 12,24 | N | N | N |
| Allegiance, metalaxyl | F | G | >2,900 | >2,000 | 24 | N | N | N |
| Altacor, chlorantraniliprole | I | G | >5,000 | >5,000 | 4 | -- | -- | -- |
| Anthem Maxx, pyroxasulfone + fluthiacet | H | G | >5,000 | >5,000 | 12 | -- | M | -- |
| Apron, mefenoxam, metalaxyl | F | G | tech 669 | >3,100 | 12 | N | N | N |
| Aprovia Top, difenocozale + benzovindiflpyr | F | G | 1,750 | >5,000 | 12 | N | M | N |
| Armezon, topramezone | H | G | >2,000 | >2,000 | 12 | N | N | N |
| Asana XL, esfenvalerate | I-PY | R-12 | 458 | >2,000 | 12 | N | H | H |
| Assail, acetamiprid | I | G | 1,064 | >2,000 | 12 | N | N | M |
| Assure II, quizalofop | H | G | 1,210 | -- | 12 | N | N | N |
| Atrazine, atrazine | H | R-13 | tech 1,780 | 7,500 | 12 | S | S | N |

*Table continued on next page*

***Table D-6. Acute Toxicity of Chemicals - continued***

| Name[1] | Type[2] Class | Use[3] Category | $LD_{50}$ Values Mg/Kg[4] | | REI[5] (h) | Toxicity[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Oral | Dermal | | Bird | Fish | Bee |
| Avaunt, indoxacarb | I-CA | G | 268 | -- | 12 | M | M | H |
| azadirachtin, Aza-Direct, Azatin, Ecozin, Neemix | IGR | G | >5,000 | >2,000 | 12 | -- | H | N |
| Aza-Direct, azadirachtin | I | G | >5,000 | >2,000 | 4 | -- | H | N |
| Azatin, azadirachtin | IGR | G | >5,000 | >2,000 | 12 | -- | H | N |
| azoxystrobin, Abound, Dynasty, Quadris | F | G | >2,000 | >5,000 | 4 | -- | H | N |
| azoxystrobin, benzovindiflupyr, Elatus | F | G | 1,049 | >2,000 | 12 | -- | M | -- |
| azoxystrobin + chlorothalonil, Quadris opti | F | G | >2,000 | >5,000 | 4 | N | H | N |
| azoxystrobin + difenoconazole, Quadris Top | F | G | >2,000 | >2,000 | 12 | -- | -- | -- |
| azoxystrobin + propiconazole, Quilt | F | G | 1,750 | >5,000 | 12 | N | H | N |
| Aztec, cyfluthrin + tebupirimphos | I | -- | -- | -- | 12 | -- | H | N |
| *Bacillus pumilus* GB34, Yield Shield | F-BT | G | | NA | NA | NA | NA | NA |
| *Bacillus subtilis* GB03, Kodiak | F-BT | G | | NA | 4 | NA | NA | NA |
| *Bacillus thuringiensis*, Biobit | I-BT | G | see footnote 7 | | 4 | N | N | N |
| Banvel, dicamba | H | G | 2,629 | >2,000 | 12,24 | -- | -- | N |
| Basagran, bentazon | H | G | 2,063 | >6,050 | 12 | S | N | N |
| Basicop, fixed copper[9] | F | G | 472 | -- | 24 | -- | H | N |
| Battalion, deltamethrin | I | R | 445 | >2,000 | 12 | -- | H | H |
| Baythroid XL, beta-cyfluthrin | I | R | 647 | >2,000 | 12 | -- | H | H |
| Beleaf, flonicamid | I | G | >2,000 | >2,000 | 12 | -- | N | L |
| bensulide, Prefar | H | G | tech 271-1,470 | -- | 12 | -- | H | H |
| bentazon, Basagran | H | G | 2,063 | >6,050 | 12 | S | N | N |
| benzovindiflupyr, azoxystrobin, Elatus | F | G | 1,049 | >2,000 | 12 | -- | M | -- |
| benzovindiflupyr + difenocozale, Aprovia Top | F | G | 1,750 | >5,000 | 12 | N | M | N |
| Besiege, lambda-cyhalothrin + chlorantraniliprole | I | R-12 | 98.11 | >5,000 | 24 | -- | H | H |
| beta-cyfluthrin, Baythroid XL | I | R | 647 | >2,000 | 12 | -- | H | H |
| beta-cyfluthrin + imidacloprid, Leverage 360 | I | R | >1,044 | >2,000 | 12 | L | H | H |
| bicyclopyrone + mesotrione + s-metolachlor + atrazine, Acuron | H | R-13 | 1,750 | >5,000 | 24 | -- | -- | -- |
| bifenthrin, Bifenture, Brigade, Capture LFR Fanfare, Sniper, Tundra | I-PY | R | 262 | >2,000 | 24 | M | H | H |
| bifenthrin + imidacloprid, Brigadier | I | R | 175 | >5,000 | 12 | -- | H | H |
| Bifenthrin + zeta cypermethrin, Hero | I-PY | R-10,11 | 550 | -- | 24 | S | H | H |
| Bifenture, bifenthrin | I-PY | R | 262 | >2,000 | 24 | M | H | H |
| bifenazate, Acramite, Floramite | A | G | >5,000 | >5,000 | 12 | N | H | M |
| Biobit, *Bacillus thuringiensis kurstaki* | I-BT | G | see footnote 7 | | 4 | N | N | N |
| Blackhawk, spinosad | I-ML | G | >5,000 | >2,000 | 4 | H | -- | -- |
| Blockade, acibenzolar-S-methyl | B,F | G | -- | -- | 12 | N | M | N |
| Blocker, PCNB | F | G | >5,050 | >2,020 | 12 | -- | H | -- |
| boscalid, Endura | F | G | >2,000 | >2,000 | 12 | -- | -- | -- |
| Botran, dicloran | F | G | tech >5,000 | -- | 12 | S | M | N |
| Bravo, chlorothalonil | F | G | >10,000 | >10,000 | 12 | -- | H | N |
| *Bravo 720, chlorothalonil | F | G | >10,000 | >10,000 | 12 | -- | H | N |
| Bravo Ultrex, chlorothalonil | F | G | >10,000 | >10,000 | 12 | -- | H | N |
| Brigade, bifenthrin | I-PY | R | 262 | >2,000 | 24 | M | H | H |
| Brigadier, bifenthrin + imidacloprid | I | R | 175 | >5,000 | 12 | -- | H | H |
| bromoxynil, Maestro | H | G | tech 260 | >2,000 | 12 | H | H | H |
| buprofezin, Courier, Talus | IGR | G | >5,000 | >2,000 | 12 | -- | -- | -- |
| Cabrio, pyraclostrobin | F | G | >500 | >4,000 | 12 | -- | H | N |
| Callisto, mesotrione | H | G | >5,000 | >5,000 | 12 | N | N | N |
| Cannonball, fludioxonil | F | G | >5,000 | >2,000 | 12 | L | H | L |
| Caparol, promethryn | H | G | >5,000 | >5,000 | 24 | L | H | -- |
| Captan 400, captan | F | G | 9,000 | -- | 96 | S | H | N |
| *captan, Captan 400 | F | G | 9,000 | -- | 96 | S | H | N |

*Table continued on next page*

*Table D-6. Acute Toxicity of Chemicals - continued*

| Name[1] | Type[2] Class | Use[3] Category | $LD_{50}$ Values Mg/Kg[4] Oral | Dermal | REI[5] (h) | Toxicity[6] Bird | Fish | Bee |
|---|---|---|---|---|---|---|---|---|
| Captevate, fenhexamid + captan | F | G | >2,000 | >5,000 | 24 | N | H | N |
| *carbaryl, Sevin | I-CA | G | 500 | 850 | 12 | S | N | H |
| carfentrazone, Aim | H | G | 5,143 | >5,000 | 12 | -- | M | N |
| carfentrazone + sulfentrazone, Spartan Charge | H | G | 5,000 | >5,050 | 12 | N | M | N |
| Champ, fixed copper[9] | F | G | 1,000 | -- | 48 | -- | H | N |
| Champion, fixed copper[9] | F | G | 2,000 | -- | 48 | -- | H | N |
| Chateau, flumioxazin | H | G | >5,000 | >2,000 | 12 | N | N | N |
| chemopodium ambrosioides, Requiem | I,A | G | >5,000 | >5,000 | 4 | -- | -- | -- |
| chlorantraniliprole, Altacor, Coragen, | I | G | >5,000 | >5,000 | 4 | -- | -- | -- |
| chlorantraniliprole + lambda cyhalothrin, Besiege, Voliam Xpress | I | R-12 | 98 | >5,000 | 24 | -- | H | H |
| chlorantraniliprole, thiamethoxam, Durivo, Voliam Flexi | I-NN | G | >5,000 | >5,000 | 12 | -- | -- | H |
| chlorfonapyr, Pylon | A | G | 560 | -- | 12 | -- | H | H |
| chlorine, Clorox (bleach) | F | G | -- | -- | 12 | N | N | N |
| chloroneb | F | G | >5,000 | >5,000 | 12 | N | -- | -- |
| chloropicrin | F,N | R-3,10 | 250 | -- | 72 | -- | H | N |
| *chlorothalonil, Bravo, Bravo 720, Bravo Ultrex, Echo, Equus, Ridomil Gold Bravo | F | G | >10,000 | >10,000 | 12 | -- | H | L |
| chlorothalonil, oxathiapiprolin, Orondis Opti | F | G | >5,000 | >2,000 | 12 | -- | -- | -- |
| chlorothalonil + zoxamide, Zing! | F | G | 1,750 - 5,000 | >5,000 | 12 | M | N | N |
| *chlorpyrifos, Lorsban | I-OP | R | 92-276 | 2,000 | 12,24 | M | H | H |
| chlorpyrifos + lambda-cyhalothrin Cobalt Advanced | I | R | >50 | >3,000 | 24 | M | M | H |
| Clarity, dicamba | H | G | 2,629 | >2,000 | 12,24 | -- | -- | N |
| clethodim, Select, Select Max | H | G | 3,610 | >5,000 | 24 | L | M | L |
| clomazone, Command | H | G | 1,369 | >2,000 | 12 | -- | -- | -- |
| clopyralid, Spur, Stinger | H | G | >5,000 | >2,000 | 12 | -- | N | N |
| Clorox (bleach), chlorine | F | G | -- | -- | 12 | N | N | N |
| Closer, sulfoxaflor | I | G | >5,000 | >5,000 | 12 | N | M | H |
| clothianidin, Poncho, Belay | I-NN | G | >5,000 | >2,000 | -- | N | M | H |
| Cobalt Advanced, chlorpyrifos + lambda-cyhalothrin | I | R | >50 | >3,000 | 24 | M | M | H |
| Command, clomazone | H | G | tech 2,077 | >2,000 | 12 | -- | N | N |
| Concur, imidacloprid | I-NN | G | tech 450 | >5,000 | 12 | M | M | H |
| Confirm, tebufenozide | I | G | >5,000 | >5,000 | 4 | L | H | M |
| Coniothyrium minitans, Contans | F | G | -- | -- | 4 | -- | N | N |
| Conserve, spinosad | I-ML | G | >5,000 | >2,000 | 4 | H | -- | -- |
| Contans, Coniothyrium minitans | F | G | -- | -- | 4 | -- | N | N |
| Copper-Count-N, fixed copper[9] | F | G | -- | -- | 12 | -- | H | N |
| copper, fixed[9] | F | G | -- | -- | 24 | -- | H | N |
| copper hydroxide, Ridomil Gold Copper, ManKocide | F | G | tech 669 | >3,100 | 48 | -- | H | N |
| Coragen, chlorantraniliprole | I | G | >5,000 | >5,000 | 4 | -- | -- | -- |
| Counter, terbufos | I-OP | R-1,2 | tech 4.5 | 1.1 | 48 | -- | H | N |
| Courier, buprofezin | IGR | G | >5,000 | >2,000 | 12 | -- | -- | -- |
| Cruiser, thiamethoxam | I-NN | G | 5523 | >2,000 | 12 | N | N | H |
| Crymax, *Bacillus thuringiensis kurstaki* | I-BT | G | see footnote 7 | | 4 | N | N | N |
| cryolite, Kryocide, Prokil | I-IO | G | >5,000 | -- | 12 | N | N | N |
| Cuprofix Disperss, fixed copper | F | G | >2,000 | >4,000 | 24 | -- | H | N |
| Curbit, ethalfluralin | H | G | >10,000 | >10,000 | 12 | -- | H | N |
| Curzate, cymoxanil | F | G | 433 | >5,000 | 12 | N | H | N |
| Cutlass, *Bacillus thuringiensis kurstaki* | I-BT | G | see footnote 7 | | 4 | N | N | N |
| cyantraniliprole, Exirel, Pro Verimark, Minento Pro | I | G | >5,000 | >5,000 | 12 | -- | -- | H |
| cyazofamid, Ranman | F | G | >5,000 | >2,000 | 12 | L | L | L |

*Table continued on next page*

*Table D-6. Acute Toxicity of Chemicals - continued*

| Name[1] | Type[2] Class | Use[3] Category | LD50 Values Mg/Kg[4] | | REI[5] (h) | Toxicity[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Oral | Dermal | | Bird | Fish | Bee |
| *cycloate, Ro-Neet | H | G | 3,160-4,640 | -- | 12 | -- | M | N |
| cyflufenamid, Torino | F | G | >2,000 | >2,000 | 4 | -- | M | -- |
| cyfluthrin, Tombstone | I-PY | R | 500 | >5,000 | 12 | M | H | H |
| cymoxanil, Curzate, | F | G | 433 | >5,000 | 12 | N | H | N |
| cypermethrin, Ammo | I-PY | R | 250 | 2,000 | 12 | N | H | H |
| cyprodinil + fludioxonil, Switch | F | G | >5,000 | >2,000 | 12 | -- | H | N |
| cyromazine, Trigard | IGR | R,G | 3,387 | >3,100 | 12 | S | H | H |
| *Dacthal, DCPA | H | G | >10,000 | >2,000 | 24 | S | -- | N |
| Danitol, fenproparthrin | I-PY | R | 66 | >2,000 | 24 | H | H | H |
| DCP, dichloropropene | N | R(NJ),G | 300 | 333 | 72 | -- | -- | -- |
| *DCPA, Dacthal | H | G | >10,000 | >2,000 | 24 | S | -- | N |
| Deadline, metaldehyde | I-OT | G | 630 | -- | 12,24 | H | N | N |
| Degree, acetochlor | H | R-13 | >5,000 | >5,000 | 12 | -- | -- | -- |
| deltamethrin, Battalion | I | R | 445 | >2,000 | 12 | -- | H | H |
| Devrinol, napropamide | H | G | >4,640 | -- | 12 | -- | N | N |
| diazinon | I-OP | R-11 | tech 300-400 | 3,600 | 12,24 | H | H | H |
| dicamba, Banvel, Clarity | H | G | 2,629 | >2,000 | 12,24 | -- | -- | N |
| dichloropropene + chloropicrin, Telone II, Telone C-35 | F,N | R-3,10 | 127 | 423 | 72 | H | N | -- |
| dicloran, Botran | F | G | tech >5,000 | -- | 12 | S | M | N |
| dicofol, Kelthane, Kelthane MF | A | G | 820-960 | 1,000 -1,230 | 12 | M | H | N |
| difenoconazole+cyprodinil, Inspire Super | F | G | 5,000 | >5,000 | 12 | -- | H | -- |
| difenocozale + benzovindiflpyr Aprovia Top | F | G | 1,750 | >5,000 | 12 | N | M | N |
| *Dimate, dimethoate | I-OP | R(NJ),G | Tech 235 | >400 | 48 | H | H | H |
| dimethenamid, Outlook | H | G | 849 | >2000 | 12 | -- | -- | -- |
| *dimethoate, Dimate | I-OP | R(NJ),G | tech 235 | >400 | 48 | H | H | H |
| dimethomorph, Forum | F | G | 3,900 | >2,000 | 24 | -- | H | N |
| dimethomorph + acetoctradin, Zampro | F | G | >500 - >2,000 | >5,000 | 12 | --- | --- | --- |
| Dimetric, metribuzin | H | G | tech 2,000 | 20,000 | 12 | -- | N | N |
| dinotefuran, Safari, Venom, Scorpion | I | G | >5,000 | >5,000 | 12 | -- | -- | H |
| Dipel, *Bacillus thuringiensis kurstaki* | I-BT | G | see footnote 7 | | 4 | N | N | N |
| diquat, Reglone | H | G | 886 | >5,050 | 24 | -- | -- | -- |
| Discipline, bifentrin | I-PY | R | 262 | >2,000 | 24 | M | H | H |
| Distance, pyriproxyfen | IGR | G | >5,000 | >2,000 | 12 | -- | H | N |
| Dithane, mancozeb | F | G | 11,200 | 15,000 | 24 | -- | H | N |
| diuron, Karmex | H | G | tech >5,000 | >5,000 | 12 | -- | -- | N |
| dodine, Syllit | F | G | 1,000 | >6,000 | 48 | -- | H | H |
| Dual Magnum, S-metolachlor | H | G | tech 2,780 | >10,000 | 12 | S | M | N |
| Durivo, chlorantraniliprole + thiamethoxam, | I-NN | G | >5,000 | >5,000 | 12 | -- | -- | H |
| Dynasty, azoxystrobin | F | G | >2,000 | >5,000 | 4 | -- | H | N |
| EBDC, Potato Seed Treater | F | G | 4,500 | >5,000 | 24 | N | H | N |
| Echo, chlorothalonil | F | G | >10,000 | >10,000 | 12 | -- | H | N |
| Ecozin, azadirachtin | IGR | G | >5,000 | >2,000 | 12 | -- | H | N |
| Elatus, azoxystrobin, benzovindiflupyr | F | G | 1,049 | >2,000 | 12 | -- | M | -- |
| Elevate, fenhexamid | F | G | >5,000 | >5,000 | 4 | L | M | N |
| emamectin, Proclaim | I-FB | R | 1,516 | >2,000 | 48 | N | H | H |
| Endura, boscalid | F | G | >2,000 | >2,000 | 12 | -- | -- | -- |
| Entrust, spinosad | I-ML | G | >5,000 | >2,000 | 4 | H | -- | M |
| Epi-Mek, abamectin | I-FB | R | 300 | >1,800 | 12 | N | M | H |
| Eptam, EPTC | H | G | tech 1,630 | -- | 12 | -- | H | H |
| EPTC, Eptam | H | G | tech 1,630 | -- | 12 | -- | H | H |
| Equus, chlorothalonil | F | G | >10,000 | >10,000 | 12 | -- | H | -- |
| esfenvalerate, Asana XL | I-PY | R-12 | 458 | >2,000 | 12 | -- | H | H |
| ethalfluralin, Curbit | H | G | >10,000 | >10,000 | 12 | -- | H | N |

*Table continued on next page*

***Table D-6. Acute Toxicity of Chemicals - continued***

| Name[1] | Type[2] Class | Use[3] Category | $LD_{50}$ Values Mg/Kg[4] | | REI[5] (h) | Toxicity[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Oral | Dermal | | Bird | Fish | Bee |
| ethephon, Ethrel | PGR | G | 4,229 | -- | 48 | -- | -- | N |
| ethoprop, Mocap | N | R-2 | 6.2 | 2.4 | 48 | H | H | H |
| Ethrel, ethephon | PGR | G | 4,229 | -- | 48 | -- | -- | N |
| etoxazole, Zeal | A | G | >5,000 | >5,000 | 12 | N | H | N |
| Evolve, thiophanate methyl + mancozeb + cymoxanil | F | G | >5,000 | >2,000 | 24 | N | H | N |
| Exirel, cyantraniliprole, | I | G | >5,000 | >5,000 | 12 | -- | -- | H |
| famoxodone + cymoxanil, Tanos | F | G | 960 | >2,000 | 12 | -- | H | -- |
| Fanfare, bifenthrin | I-PY | R | 262 | >2,000 | 24 | M | H | H |
| fenamidone, Reason | F | G | >5,000 | >5,000 | 12 | -- | -- | -- |
| fenamiphos, Nemacur | N | R-2 | tech 3 | 200 | 48 | H | H | N |
| fenbutatin-oxide, Vendex | A | R | 2,631 | >2,000 | 48 | M | M | N |
| fenhexamid, Elevate | F | G | >5,000 | >5,000 | 4 | L | M | N |
| fenhexamid + captan, Captevate | F | G | >2,000 | >5,000 | 24 | N | H | N |
| fenproparthrin, Danitol | I-PY | R | 66 | >2,000 | 24 | H | -- | H |
| fenpyroximate, Portal | I,A | G | 810 | | 12 | -- | H | N |
| fipronil, Regent | I | R | 275 | 841 | 0 | M | H | M |
| fixed copper[9], Cuprofix Disperss | F | G | -- | -- | 12,24, 48 | -- | H | N |
| Flint, trifloxystrobin | F | G | >5,000 | >2,000 | 12 | M | H | N |
| flonicamid, Beleaf | I | G | >2,000 | >2,000 | 12 | -- | N | L |
| Floramite, bifenazate | A | G | >5,000 | >5,000 | 12 | N | H | N |
| Flouronil, mefenoxam + chlorothalonil | F | G | see footnote 10 | -- | 48 | -- | -- | -- |
| fluthiacet, Cadet | H | G | 2,537 | 2,020 | 12 | -- | M | -- |
| Flutriafol, Topguard | F | G | >2,000 | >2,000 | 12 | -- | -- | -- |
| *fluazifop, Fusilade DX | H | G | 3,328 | -- | 12 | -- | M | N |
| fluazinam, Omega | F | G | >5,000 | >2,000 | 48 | -- | H | N |
| fludioxonil, Cannonball, Maxim, Scholar | F | G | >5,000 | >2,000 | 12 | L | H | L |
| fludioxonil + mancozeb, Maxim MZ | F | G | >5,000 | >5,000 | 24 | N | H | N |
| fluensulfone, Nimitz | N | G | >2,000 | >2,000 | -- | M | N | N |
| flumioxazin, Chateau, Valor | H | G | >5,000 | >2,000 | 12 | N | N | N |
| fluopicolide, Presidio | F | G | >2,000 | >4,000 | 12 | L | H | L |
| fluopyram, Velum Prime | F | G | >2,000 | >2,000 | 12 | -- | -- | -- |
| fluopyram, pyrimethanil, Luna Tranquility | F | G | >2,000 | >2,000 | 12 | -- | -- | -- |
| fluopyram, tebuconazole, Luna Sensation | F | G | ≤5,000 | >2,000 | 12 | -- | M | -- |
| fluroxypyr, Starane Ultra | H | G | >5,000 | >5,000 | 24 | -- | M | -- |
| flutolanil + mancozeb, MonCoat MZ | F | G | >5,000 | >5,000 | 24 | M | M | N |
| flutolanil, Moncut | F | G | >5,000 | >5,000 | 12 | N | H | N |
| fluxapyroxad, Priaxor | F | G | >500->2,000 | >5,000 | 12 | N | N | N |
| fluxapyroxad + pyraclostrobin, Merivon | F | G | >50 - >300 | >5,000 | 12 | N | M | N |
| Folicur, tebuconazole | F | G | 3,743 | 2,011 | 12 | H | H | N |
| fomesafen, Reflex | H | G | 6,950 | >1,000 | 24 | N | N | N |
| Fontelis, penthiopyrad | F | G | >5,000 | >5,000 | 12 | H | L | L |
| Force, tefluthrin | I-PY | R | 1,213 | >2,000 | 0 | N | H | N |
| Formula 40, 2,4-D (acid) | H | R(NJ),G | 375 | -- | 48 | M | N | H |
| Forum, dimethomorph | F | G | 3,900 | >2,000 | 24 | -- | H | N |
| fosetyl Al, Aliette | F | G | 5,000 | >2,000 | 12,24 | N | N | N |
| Fulfill, pymetrozine | I-OT | G | >5,000 | >2,000 | 12 | N | N | N |
| Fusarex, TCNB | GR | G | -- | -- | -- | -- | -- | -- |
| *Fusilade DX, fluazifop | H | G | 2,712 | >2,420 | 12 | -- | M | N |
| gamma-cyhalothrin, Cobalt, Consero, Proaxis, | I-PY | R-12 | >2,500 | >5,000 | 24 | N | H | H |
| Gaucho, imidacloprid | I-NN | G | tech 450 | >5,000 | 12 | M | M | H |
| Gavel, zoxamide + mancozeb | F | G | -- | -- | 48 | -- | M | -- |
| Gem, trifloxystrobin | F | G | 5,050 | >2,000 | 12 | -- | H | N |
| gibberellic acid, GibGro, ProGibb | PGR | G | 1,000-25,000 | -- | 4 | -- | N | N |

*Table continued on next page*

*Table D-6. Acute Toxicity of Chemicals - continued*

| Name[1] | Type[2] Class | Use[3] Category | LD$_{50}$ Values Mg/Kg[4] | | REI[5] (h) | Toxicity[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Oral | Dermal | | Bird | Fish | Bee |
| GibGro, gibberellic acid | PGR | G | 1,000-25,000 | -- | 4 | -- | N | N |
| Glory, metribuzin | H | G | tech 2,000 | 20,000 | 12 | -- | N | N |
| glufosinate, Liberty 280 | H | G | >300-<2,000 | 1,400 | 12 | -- | -- | -- |
| glyphosate, Roundup | H | G | >5,000 | >5,000 | 24 | N | N | N |
| Goal, oxyfluorfen | H | G | tech >5,000 | >10,000 | 24 | -- | H | N |
| GoalTender, oxyfluorfen | H | G | tech >5,000 | >10,000 | 24 | -- | H | N |
| Gramoxone, paraquat | H | R-1,8 | 150 | -- | 12,48 | M | N | N |
| Guthion, azinphos-methyl | I-OP | R-1,2,3, 8,10,12 | tech 10 | 200 | 48 | M | H | H |
| halosulfuron, Permit, Sandea | H | G | 1,287 | >5,000 | 12 | -- | N | N |
| Harness, acetochlor | H | G | 1,849 | >5,000 | 12 | -- | H | -- |
| harpin protein, Messenger | F | G | >5,000 | >6,000 | 4 | -- | N | N |
| Headline, pyraclostrobin | F | G | >500 | >4,000 | 12 | -- | H | N |
| Hero, zeta cypermethrin+bifenthrin | I-PY | R-10,11 | 550 | -- | 24 | S | H | H |
| hexythiazox, Savey | A | G | >5,000 | >5,000 | 12 | -- | H | N |
| imazamox, Raptor | H | G | >5,000 | >4,000 | 4 | N | N | N |
| imazethapyr, Pursuit | H | G | >5,000 | >2,000 | 12,24 | -- | N | N |
| Imidan, phosmet | I-OP | R(NJ),G | tech 147-316 | >4,640 | 24 | S | H | H |
| imidacloprid, Admire, Admire Pro, Concur, Gaucho, Lattitude, Marathon | I-NN | G | tech 450 | >5,000 | 12 | M | M | H |
| imidacloprid, beta-cyfluthrin, Leverage 360 | I | R | >1,044 | >2,000 | 12 | L | H | H |
| Impact, topramezone | H | G | >2,000 | >2,000 | 12 | N | N | N |
| Incite, piperonyl butoxide | I-OT | G | >7,500 | -- | 12 | N | N | N |
| indoxacarb, Avaunt | I | G | 268 | -- | 12 | M | M | H |
| Inspire Super, difenoconazole + cyprodinil | F | G | 5,000 | >5,000 | 12 | -- | H | -- |
| iron phosphate, Sluggo | M | G | >5,000 | >5,000 | 0 | -- | -- | -- |
| insecticidal soap, M-Pede | I-SO | G | 16,900 | -- | 12 | N | N | N |
| Intrepid, methoxyfenozide | I | G | >5,000 | >2,000 | 4 | -- | N | N |
| *iprodione, Rovral | F | G | >4,400 | >2,000 | 12 | -- | S | N |
| Javelin, *Bacillus thuringiensis kurstaki* | I-BT | G | see footnote 7 | | 4 | N | N | N |
| K-Pam, metam potassium | F | G | 630 | >1,000 | 48 | H | H | N |
| Karmex, diuron | H | G | tech >5,000 | >5,000 | 12 | N | N | N |
| Kelthane, Kelthane MF, dicofol | A | G | 570-595 | >5,000 | 12 | M | H | N |
| Kerb, pronamide | H | R-5 | tech 8,350 | >3,160 | 12 | -- | N | N |
| Ketch, *Bacillus thuringiensis aizawai* | I-BT | G | see footnote 7 | | 4 | N | N | N |
| Knack, pyriproxyfen | IGR | G | >5,000 | >2,000 | 12 | -- | H | N |
| Kocide, fixed copper[9] | F | G | 1,000 | -- | 12,48 | M | H | N |
| Kodiak, *Bacillus subtilis* GB03 | F-BT | G | | NA | NA | NA | NA | NA |
| Kontos, spirotetramat | I | G | >2000 | >4000 | 24 | N | N | L |
| Kryocide, cryolite | I-IO | G | >5,000 | -- | 12 | N | N | N |
| Lambda cyhalothrin, Lambda-Cy, Lambda T, Silencer, Warrior II | I-PY | R | tech 79 | 632 | 24 | M | H | H |
| lambda-cyhalothrin, chlorpyrifos, Cobalt Advanced, | I | R | >50 | >3,000 | 24 | M | M | H |
| Lambda-Cy, lambda cyhalothrin | I-PY | R | tech 79 | 632 | 24 | M | H | H |
| lambda-cyhalothrin+chlorantraniliprole, Besiege, Voliam Xpress | I | R-12 | 98.11 | >5,000 | 24 | -- | H | H |
| Lambda T, lambda cyhalothrin | I-PY | R | tech 79 | 632 | 24 | M | H | H |
| Lannate, methomyl | I-CA | R-8,10 | 17 | 5,880 | 48 | H | H | H |
| Lattitude, imidacloprid | I-NN | G | tech 450 | >5,000 | 12 | M | M | H |
| Laudis, tembotrione | H | G | 1,750 | >5,000 | 12 | -- | -- | -- |
| Leverage 360, imidacloprid + beta-cyfluthrin, | I | R | >1,044 | >2,000 | 12 | L | H | H |
| Lexar, mesotrione + s-metolachlor + atrazine | H | R-13 | 4,144 | >5,000 | 24 | -- | -- | -- |
| Liberty 280, glufosinate | H | G | >300-<2000 | 1,400 | 12 | -- | -- | -- |
| lindane | I-CH | R-5 | 88-125 | 1,000 | 12,24 | M | M | N |

*Table continued on next page*

***Table D-6. Acute Toxicity of Chemicals - continued***

| Name[1] | Type[2] Class | Use[3] Category | $LD_{50}$ Values Mg/Kg[4] | | REI[5] (h) | Toxicity[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Oral | Dermal | | Bird | Fish | Bee |
| Linex, linuron | H | G | tech 4,000 | -- | 24 | -- | S | N |
| linuron, Linex, Lorox | H | G | tech 4,000 | -- | 24 | -- | S | N |
| Lorox, linuron | H | G | tech 4,000 | -- | 24 | -- | S | N |
| *Lorsban, chlorpyrifos | I-OP | R | 92-276 | 2,000 | 12,24 | M | H | H |
| Lumax, mesotrione + s-metolachlor + atrazine | H | R-13 | 3,129 | >5,000 | 24 | -- | -- | -- |
| Luna Experience, tebuconazole | F | G | ≤5,000 | >2,000 | 12 | -- | M | -- |
| Luna Sensation, fluopyram, tebuconazole | F | G | ≤5,000 | >2,000 | 12 | -- | M | -- |
| Luna Tranquility, fluopyram, pyrimethanil | F | G | >2,000 | >2,000 | 12 | -- | -- | -- |
| Maestro, bromoxynil | H | G | tech 260 | >2,000 | 12 | H | H | H |
| malathion | I-OP | G | tech 5,500 | >2,000 | 12 | M | H | H |
| *mancozeb, Acrobat MZ, Curzate, Dithane, Manex II, Manex, ManKocide, Penncozeb, Ridomil Gold MZ | F | G | 11,200 | 15,000 | 24 | -- | H | N |
| mancozeb + copper hydroxide, ManKocide | F | G | see footnote 10 | | | N | H | N |
| mandipropamid, Revus | F | G | >5,000 | >5,000 | 12 | | H | |
| mandipropamid + difenoconazole, Revus Top | F | G | 2,958 | >5,000 | 12 | L | H | M |
| mandipropamid, oxathiapiprolin, Orondis Ultra | F | G | >5,000 | >5,000 | 4 | -- | -- | -- |
| maneb, Manex | F | G | tech 7,990 | >5,000 | 24 | -- | H | N |
| Manex, maneb | F | G | tech 7,990 | >5,000 | 24 | -- | H | N |
| Manex II, mancozeb | F | G | 11,200 | >15,000 | 24 | -- | H | N |
| ManKocide, mancozeb + copper hydroxide | F | G | see footnote 10 | | 48 | | | |
| Marathon, imidacloprid | I-NN | G | Tech 450 | >5,000 | 12 | M | M | H |
| Matrix, rimsulfuron | H | G | >5,000 | >2,000 | 4 | N | L | L |
| Maxim, fludioxonil | F | G | >5,000 | >2,000 | 12 | L | H | L |
| Maxim MZ, fludioxonil + mancozeb | F | G | >5,000 | >5,000 | 24 | N | H | N |
| *MC-2, MC-33, methyl bromide | F,H,N | R-8 | see footnote 8 | | 48 | -- | -- | N |
| mefenoxam, Apron, Ridomil Gold, Orondis Gold, Ultra Flourish | F | G | -- | -- | -- | -- | H | N |
| mefenoxam + azoxystrobin, Uniform | F | G | 1,459 | >5,000 | 0 | -- | -- | -- |
| mefenoxam + chlorothalonil, Ridomil Gold Bravo, Flouronil | F | G | see footnote 10 | | | | | |
| mefenoxam + copper hydroxide, Ridomil Gold Copper | F | G | see footnote 10 | | | | | |
| mefenoxam + mancozeb, Ridomil Gold MZ | F | G | >5,000 | >2,000 | 48 | N | H | N |
| mefenoxam + PCNB, Ridomil Gold PCNB | F | G | >5,050 | >2,020 | 48 | N | H | N |
| Mertect, thiabendazole | F | G | >5,000 | >5,050 | 12 | N | H | N |
| mesotrione, Callisto | H | G | >5,000 | >5,000 | 12 | N | N | N |
| mesotrione + s-metolachlor, Zemax | H | G | >5,000 | >5,050 | 24 | -- | -- | -- |
| mesotrione + s-metolachlor + atrazine, Lexar | H | R-13 | 4,144 | >5,000 | 24 | -- | -- | -- |
| mesotrione + s-metolachlor + atrazine, Lumax | H | R-13 | 3,129 | >5,000 | 24 | -- | -- | -- |
| Messenger, harpin protein | F | G | >5,000 | >6,000 | 4 | -- | N | N |
| Merivon, fluxapyroxad + pyraclostrobin | F | G | >50 - >300 | >5,000 | 12 | N | M | N |
| metalaxyl, Allegiance, Apron, MetaStar | F | G | tech 669 | >3,100 | 12 | N | N | N |
| metaldehyde, Deadline | I-OT | | 630 | -- | | H | N | N |
| metam potassium, K-Pam | F | G | 630 | >1,000 | 48 | H | H | N |
| metam-sodium, Vapam HL | N | G | 1,891 | >3,074 | 48 | -- | H | N |
| MetaStar, metalaxyl | F | G | tech 669 | >3,100 | 12 | N | N | N |
| *Metasystox-R, oxydementon methyl | I-OP | R | tech 50 | 150 | 48 | -- | H | H |
| metconazole, Quash | F | G | 1,750 | >5,000 | 12 | -- | -- | -- |
| methomyl, Lannate | I-CA | R-8,10 | 17 | 5,880 | 48 | H | H | H |
| methoxyfenozide, Intrepid | I | G | >5,000 | >2,000 | 4 | -- | N | N |
| *methyl bromide, MC-2, MC-33, Terr-O-Gas 67 | F,H,N | R-8 | see footnote 8 | | 48 | -- | -- | N |
| methyl iodide, Midas | F, H, I | -- | -- | -- | -- | -- | -- | -- |
| metiram, Polyram | F | G | >5,000 | >2,000 | 24 | N | H | N |
| metrafenone, Vivando | F | G | >5,000 | >5,000 | 12 | -- | M | -- |

*Table continued on next page*

*Table D-6. Acute Toxicity of Chemicals - continued*

| Name[1] | Type[2] Class | Use[3] Category | LD$_{50}$ Values Mg/Kg[4] | | REI[5] (h) | Toxicity[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Oral | Dermal | | Bird | Fish | Bee |
| metribuzin, Glory, TriCor, Dimetric | H | G | tech 1,100-2,300 | >20,000 | 12 | -- | M | N |
| Mettle, tetraconazole | F | G | >4,090 | >2,000 | 12 | -- | L | -- |
| Micro-Tech, alachlor | H | R-12 | 930-1,350 | -- | 12 | S | M | N |
| Midas, methyl iodide | F, H, I | -- | -- | -- | -- | -- | -- | -- |
| Minecto Pro, cyantraniliprole + abamectin | I | R-10,12 | 451.1 | >2,000 | 12 | -- | H | H |
| Mocap, ethoprop | N | R-2 | 61.5 | 2.4 | 48 | H | H | H |
| MonCoat MZ, flutolanil+mancozeb | F | G | >5,000 | >5,000 | 24 | M | M | N |
| Moncut, flutolanil | F | G | >5,000 | >5,000 | 12 | N | H | N |
| Movento, spirotetramat | I | G | >2000 | >4000 | 24 | N | N | L |
| M-Pede, insecticidal soap | I-SO | G | 16,900 | -- | 12 | N | N | N |
| Mustang Maxx, zeta-cypermethrin | I-PY | R-10,11 | 310 | >5,000 | 12 | -- | H | H |
| MCPB, Thistrol | H | G | 5,000 | >5,000 | 24 | -- | -- | -- |
| myclobutanil, Nova, Rally | F | G | 1,600 | >5,000 | 24 | -- | N | N |
| napropamide, Devrinol | H | G | >4,640 | -- | 12 | -- | N | N |
| Neemix, azadirachtin | IGR | G | >5,000 | >2,000 | 12 | -- | H | N |
| Nemacur, fenamiphos | N | R-2 | tech 3 | 200 | 48 | H | H | N |
| neem oil, Trilogy | F,A,I | G | >5 g | -- | 4 | -- | H | H |
| nicosulfuron, Accent Q | H | G | >5,000 | >5,000 | 4 | N | N | N |
| Nimitz, fluensulfone | N | G | >2,000 | >2,000 | -- | M | N | N |
| norflurazon, Solicam | H | G | >8,000 | >20,000 | 12 | N | M | N |
| Nova, myclobutanil | F | G | 1,600 | >5,000 | 24 | -- | N | N |
| Novodor, *Bacillus thuringiensis tenebrionis* | I-BT | G | see footnote 7 | | 4 | N | N | N |
| novaluron, Rimon | I-IGR | G | 3,914 | >2,000 | 12 | N | H | H |
| Noxfire, rotenone | I-BO | G | 132-1,500 | -- | 12,24, 48 | S | H | N |
| NPV, Spod-X | I | G | -- | -- | 4 | -- | -- | -- |
| NutriPhyte, phosphite salts | F | G | | | 4 | -- | M | N |
| Oberon, spiromesifen | IGR | G | >2,000 | >4,000 | 12 | -- | H | -- |
| Omega, fluazinam | F | G | >5,000 | >2,000 | 48 | -- | H | N |
| Orondis Gold, mefenoxam | F | G | 550 | >2,000 | 48 | -- | -- | -- |
| Orondis Opti, chlorothalonil, oxathiapiprolin | F | G | >5,000 | >2,000 | 12 | -- | -- | -- |
| Orondis Ultra, oxathiapiprolin, mandipropamid | F | G | >5,000 | >5,000 | 4 | -- | -- | -- |
| Orthene, acephate | I-OP | G | tech 980 | >10,250 | 24 | M | N | H |
| Outlook, dimethenamid | H | G | 849 | >2000 | 12 | -- | -- | -- |
| oxamyl, Vydate L | I,N-CA | R | 37 | 2,960 | 48 | H | H | H |
| oxathiapiprolin, mandipropamid, Orondis Ultra | F | G | >5,000 | >5,000 | 4 | -- | -- | -- |
| oxyfluorfen, Goal, GoalTender | H | G | tech >5,000 | >10,000 | 24 | -- | H | N |
| parafinic oil | A | G | 22 g | -- | 4 | -- | -- | -- |
| paraquat, Gramoxone | H | R-1,8 | 150 | -- | 12,48 | M | N | N |
| PBO (piperonyl butoxide) | I-OT | G | >7,500 | -- | 12 | N | N | N |
| PCNB, Terraclor, Blocker | F | G | tech 1,700-5,000 | 2,000 -4,000 | 12,24 | S | H | H |
| pendimethalin, Prowl, Prowl H2O | H | G | 1,250 | >5,000 | 12,24 | -- | M | N |
| Penncozeb, mancozeb | F | G | 11,200 | >15,000 | 24 | -- | H | N |
| penthiopyrad, Fontelis | F | G | >5,000 | >5,000 | 12 | H | L | L |
| permethrin, Perm-Up | I-PY | R-12 | tech >4,000 | >4,000 | 24 | N | H | H |
| Permit, halosulfuron | H | G | 1,287 | >5,000 | 12 | -- | N | N |
| Perm-Up, permethrin | I-PY | R-12 | tech >4,000 | >4,000 | 24 | N | H | H |
| *phenmedipham, Spin-Aid | H | G | >8,000 | >4,000 | 24 | -- | M | N |
| *phorate, Thimet | I-OP | R-2,10,11 | tech 2-4 | 20-30 | 48 | H | H | H |
| phosmet, Imidan | I-OP | R(NJ),G | tech 147-316 | >4,640 | 24 | S | H | H |
| phosphite salts, Phostrol, ProPhyt, Agri-Fos, NutriPhyte, Rampart | F | G | >5,000 | >5,000 | 4 | N | H | N |
| Phostrol, phosphite salts | F | G | >5,000 | >5,000 | 4 | N | H | N |

*Table continued on next page*

***Table D-6. Acute Toxicity of Chemicals - continued***

| Name[1] | Type[2] Class | Use[3] Category | LD$_{50}$ Values Mg/Kg[4] | | REI[5] (h) | Toxicity[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Oral | Dermal | | Bird | Fish | Bee |
| Platinum, thiamethoxam | I-NN | G | >5,000 | >2,000 | 12 | -- | M | L |
| Poast, sethoxydim | H | G | 3,200-3,500 | >5,000 | 12,24 | S | M | S |
| Polyram, metiram | F | G | >5,000 | >2,000 | 24 | N | H | N |
| Poncho, clothianidin | I-NN | G | >5,000 | >2,000 | -- | N | M | H |
| Portal, fenpyroximate | I,A | G | 810 | | 12 | -- | H | N |
| Potato Seed Treater, EBDC | F | G | 4,500 | >5,000 | 24 | N | H | N |
| Prefar, bensulide | H | G | tech 271-1,470 | -- | 12 | -- | H | H |
| Presidio, fluopicolide | F | G | >2,000 | >4,000 | 12 | L | H | L |
| Previcur Flex, propamocarb hydrochloride | F | G | 2,900 | >3,000 | 12 | -- | N | N |
| Priaxor, fluxapyroxad | F | G | >500->2,000 | >5,000 | 12 | N | H | N |
| Pristine, pyraclostrobin + boscalid | F | G | >2,000 | >2,000 | 12 | -- | H | -- |
| Proaxis, gamma-cyhalothrin | I-PY | R-12 | >2,500 | >5,000 | 24 | N | H | H |
| Proclaim, emamectin | I-FB | R | 1,516 | >2,000 | 48 | N | H | H |
| Procure, triflumizole | F | G | 2,230 | >2,000 | 12 | -- | H | N |
| ProGibb, gibberellic acid | PGR | G | 1,000-25,000 | -- | 4 | -- | N | N |
| Pro-Gro, thiram + carboxin | F | G | >2,000 | >2,000 | -- | N | H | N |
| Prokil, cryolite | I-IO | G | >5,000 | -- | 12 | N | N | N |
| Proline, prothioconazole | F | G | 2,000-5,000 | >5,000 | 12 | -- | -- | -- |
| Prolong, *Bacillus thuringiensis kurstaki* | I-BT | G | see footnote 7 | | 4 | N | N | N |
| pronamide, Kerb | H | R-5 | tech 8,350 | 5,620 | 12 | -- | N | N |
| propamocarb hydrochloride, Previcur Flex | F | G | 2,900 | >3,000 | 12 | -- | N | N |
| promethryn, Caparol | H | G | >5,000 | >5,000 | 24 | L | H | -- |
| ProPhyt, phosphite salts | F | G | >5,000 | >5,000 | 4 | N | H | N |
| *propiconazole, Tilt | F | G | 1,517 | >4,000 | 24 | -- | H | N |
| prothioconazole, Proline | F | G | 2,000-5,000 | >5,000 | 12 | -- | -- | -- |
| ProVerimark, cyantraniliprole | I | G | >5,000 | >5,000 | 12 | -- | -- | H |
| Prowl, Prowl H2O, pendimethalin | H | G | 3,956 | 2,200 | 12,24 | -- | M | N |
| Pursuit, imazethapyr | H | G | >5,000 | >2,000 | 12,24 | -- | N | N |
| PyGanic EC 5.0 II, pyrethrins | I | G | >2,000 | >2,000 | 12 | -- | M | M |
| Pylon, chlorphanapyr | A | G | 560 | -- | 12 | -- | H | H |
| pymetrozine, Fulfill | I-OT | G | >5,000 | >2,000 | 12 | N | N | N |
| pyraclostrobin, Cabrio, Headline | F | G | >500 | >4,000 | 12 | -- | H | N |
| pyraclostrobin + boscalid, Pristine | F | G | >2,000 | >2,000 | 12 | -- | H | -- |
| pyraclostrobin + fluxapyroxad, Merivon | F | G | >50 - >300 | >5,000 | 12 | N | M | N |
| Pyrellin, pyrethrins, rotenone | I | G | 1,620 | -- | 12 | -- | H | -- |
| pyrethrins, PyGanic EC 5.0 II | I | G | >2,000 | >2,000 | 12 | -- | M | M |
| pyrethrum | I-BO | G | 1,500 | >1,800 | 12 | N | H | M |
| pyrimethanil, Scala | F | G | 4,505 | >5,000 | 12 | -- | M | -- |
| pyrimethanil, fluopyram, Luna Tranquility | F | G | >2,000 | >2,000 | 12 | -- | -- | -- |
| pyriproxyfen, Distance, Knack | IGR | G | >5,000 | >2,000 | 12 | -- | H | N |
| pyroxasulfone, Zidua | H | G | >2,000 | >2,000 | 12 | -- | H | -- |
| pyroxasulfone + fluthiacet, Anthem Maxx | H | G | >5,000 | >5,000 | 12 | -- | M | -- |
| Quadris, azoxystrobin | F | G | >2,000 | >5,000 | 4 | -- | H | N |
| Quadris Opti, azoxystrobin + chlorothalonil | F | G | 1,750 | >5,000 | 12 | N | H | N |
| Quadris Top, azoxystrobin + difenoconazole | F | G | >2,000 | >2,000 | 12 | -- | -- | -- |
| Quash, metconazole | F | G | 1,750 | >5,000 | 12 | -- | -- | -- |
| Quilt, azoxystrobin + propiconazole | F | G | 1,750 | >5,000 | 12 | N | H | N |
| Quintec, quinoxyfen | F | G | >2,000 | >2,000 | 12 | N | H | -- |
| quinoxfen, Quintec | F | G | >2,000 | >2,000 | 12 | N | H | -- |
| quizalofop, Assure II, Targa | H | G | 1,210 | -- | 12 | N | N | N |
| Radiant, spinetoram | I | G | >5,000 | >5,000 | 4 | N | H | H |
| Rally, myclobutanil | F | G | 1,600 | >5,000 | 24 | -- | N | N |
| Ranman, cyazofamid | F | G | >5,000 | >2,000 | 12 | L | L | L |
| Rampart, phosphite salts | F | G | -- | -- | 4 | N | H | N |
| Raptor, imazamox | H | G | >5,000 | >4,000 | 4 | N | N | N |

*Table continued on next page*

***Table D-6. Acute Toxicity of Chemicals - continued***

| Name[1] | Type[2] Class | Use[3] Category | $LD_{50}$ Values Mg/Kg[4] | | REI[5] (h) | Toxicity[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Oral | Dermal | | Bird | Fish | Bee |
| Raven, *Bacillus thuringiensis tenebrionis* | I-BT | G | see footnote 7 | | 4 | N | N | N |
| Reason, fenamidone | F | G | >5,000 | >5,000 | 12 | -- | -- | -- |
| Reflex, fomesafen | H | G | 6,950 | >1,000 | 24 | N | N | N |
| Regent, fipronil | I | R | 275 | 841 | 0 | M | H | M |
| Requiem, chemopodium ambrosioides | I,A | G | >5,000 | >5,000 | 4 | -- | -- | -- |
| Reglone, diquat | H | G | 886 | >5,050 | 24 | -- | -- | -- |
| Revus, mandipropamid | F | G | >5,000 | >5,000 | 12 | -- | H | -- |
| Revus Top, mandipropamid + difenoconazole | F | G | 2,958 | >5,000 | 12 | L | H | M |
| Ridomil Gold, mefenoxam | F | G | 1,172 | 2,020 | 48 | N | N | N |
| Ridomil Gold Bravo, mefenoxam + chlorothalonil | F | G | see footnote 10 | | 12 | | | |
| Ridomil Gold Copper, mefenoxam + copper hydroxide | F | G | see footnote 10 | | 48 | | | |
| Ridomil Gold MZ, mefenoxam + mancozeb | F | G | >5,000 | >2,000 | 48 | N | H | N |
| Ridomil Gold PCNB, mefenoxam + PCNB | F | G | >5,050 | >2,020 | 48 | N | H | N |
| Rimon, novaluron | I-IGR | G | 3,914 | >2,000 | 12 | N | H | H |
| *Ro-Neet, cycloate | H | G | tech 2,000-4,100 | -- | 12 | -- | M | N |
| Rotacide, rotenone | I-BO | G | 132-1,500 | -- | 24 | S | H | N |
| *rotenone, Rotenox, Rotacide, Noxfire | I-BO | G | 132-1,500 | -- | 12,24, 48 | S | H | N |
| Rotenox, rotenone | I-BO | G | 132-1,500 | -- | 48 | S | H | N |
| Roundup, glyphosate | H | G | >5,000 | >5,000 | 24 | N | N | N |
| *Rovral, iprodione | F | G | >4,400 | >2,000 | 12 | -- | S | N |
| Safari, dinotefuran | I | G | >5,000 | >5,000 | 12 | -- | -- | H |
| saflufenacil, Sharpen | H | G | >2,000 | >5,000 | 12 | -- | -- | -- |
| Sandea, halosulfuron | H | G | 1,287 | >5,000 | 12 | -- | N | N |
| Savey, hexythiazox | A | G | >5,000 | >5,000 | 12 | -- | H | N |
| Scala, pyrimethanil | F | G | 4,505 | >5,000 | 12 | -- | M | -- |
| Scholar, fludioxonil | F | G | >5,000 | >5,050 | post harvest | L | H | -- |
| Select, Select Max, clethodim | H | G | 3,610 | >5,000 | 24 | L | M | L |
| sethoxydim, Poast | H | G | 2,676-3,125 | >5,000 | 12,24 | S | M | S |
| Sevin, carbaryl | I-CA | G | tech 283 | >2,000 | 12 | S | N | H |
| Sharpen, saflufenacil | H | G | >2,000 | >5,000 | 12 | -- | -- | -- |
| Silencer, lambda cyhalothrin | I-PY | R | tech 79 | 632 | 24 | M | H | H |
| *Sinbar, terbacil | H | G | 5,000-7,500 | -- | 12 | -- | N | N |
| Sluggo, iron phosphate | M | G | >5,000 | >5,000 | 0 | -- | -- | -- |
| S-metolachlor, Dual Magnum | H | G | tech 2,780 | 10,000 | 12 | S | M | N |
| Sniper, bifenthrin | I-PY | R | 262 | >2,000 | 24 | M | H | H |
| sodium chlorite, Alcide | F | G | -- | -- | 12 | N | N | N |
| SoilGard, streptomycetes | F | G | -- | -- | 12 | N | N | N |
| Solicam, norflurazon | H | G | >8,000 | >20,000 | 12 | N | M | N |
| Spartan Charge, sulfentrazone + carfentrazone | H | G | 5,000 | >5,050 | 12 | N | M | N |
| *Spin-Aid, phenmedipham | H | G | >8,000 | >4,000 | 24 | -- | M | N |
| spinetoram, Radiant | I | G | >5,000 | >5,000 | 4 | N | H | H |
| spinosad, Blackhawk, Consero, Conserve, Entrust, | I-ML | G | >5,000 | >2,000 | 4 | H | -- | M |
| spiromesifen, Oberon | IGR | G | >2000 | >4,000 | 12 | -- | H | -- |
| spirotetramat, Kontos, Movento | I | G | >2000 | >4000 | 24 | N | N | L |
| Stinger, clopyralid | H | G | >5,000 | >2,000 | 12 | -- | N | N |
| Spod-X, NPV | I | G | -- | -- | 4 | -- | -- | -- |
| Spur, clopyralid | H | G | >5,000 | >2,000 | 12 | -- | N | N |
| Stratego, trifloxystrobin + propiconazole | F | G | 4,800 | >5050 | 12 | L | H | -- |
| Starane Ultra, fluroxypyr | H | G | >5,000 | >5,000 | 24 | -- | M | -- |

*Table continued on next page*

***Table D-6. Acute Toxicity of Chemicals - continued***

| **Name**[1] | **Type**[2] **Class** | **Use**[3] **Category** | **$LD_{50}$ Values Mg/Kg**[4] | | **REI**[5] **(h)** | **Toxicity**[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Oral** | **Dermal** | | **Bird** | **Fish** | **Bee** |
| Strategy, ethalfluralin + clomazone | H | G | >5,050 | >5,050 | 24 | -- | H | N |
| streptomycetes, SoilGard | F | G | -- | -- | 12 | N | N | N |
| streptomycin, Agri-Mycin-17, Agri-Strep | B | G | 9,000 | -- | 12 | -- | -- | -- |
| sulfentrazone, Spartan, Zeus | H | G | 1,750 | >5,000 | 12 | L | L | -- |
| sulfentrazone + carfentrazone, Spartan Charge | H | G | 5,000 | >5,050 | 12 | N | M | N |
| sulfoxaflor, Closer, Transform | I | G,R | >5,000 | >5,000 | 24 | S | H | H |
| sulfur | A,F, I-IO | G | >5,000 | >5,000 | 12,24, 48 | N | N | N |
| Super Cu, fixed copper[9] | F | G | -- | -- | 12 | -- | H | N |
| Super Tin, triphenyltin hydroxide | F | R | 160 | 500 | 48 | -- | H | -- |
| Surpass, acetochlor | H | G | 1,415 | >2,240 | 12 | -- | H | -- |
| Switch, cyprodinil + fludioxonil | F | G | >5,000 | >2,000 | 12 | -- | H | N |
| Syllit, dodine | F | G | 1,000 | >6,000 | 48 | -- | H | H |
| TCNB, Fusarex | GR | G | -- | -- | -- | -- | -- | -- |
| Talus, buprofenzin | IGR | G | >5,000 | >2,000 | 12 | -- | -- | -- |
| Tanos, famoxodone + cymoxanil | F | G | 960 | >2,000 | 12 | -- | H | -- |
| Targa, quizalofop | H | G | 1,210 | -- | 12 | N | N | N |
| tebuconazole, Folicur, Luna Experience, Tebuzol | F | G | 3,743 | 2,011 | 12 | H | H | N |
| tebuconazole, fluopyram, Luna Sensation | F | G | ≤5,000 | >2,000 | 12 | -- | M | -- |
| tebufenozide, Confirm | I | G | >5,000 | >5,000 | 4 | L | H | M |
| Tebuzol, tebuconazole | F | G | 3,743 | 2,011 | 12 | H | H | N |
| Tedion, tetradifon | A | G | >10,000 | >10,000 | 12 | -- | -- | -- |
| tefluthrin, Force | I-PY | R | 1,213 | >2,000 | 0 | N | H | N |
| Telone II, dichloropropene + chloropicrin | F,N | R-3,10 | 127 | 423 | 72 | H | N | -- |
| Telone C-35, dichloropropene + chloropicrin | F,N | R-3,10 | 127 | 423 | 72 | H | N | -- |
| tembotrione, Laudis | H | G | 1,750 | >5,000 | 12 | -- | -- | -- |
| Temprano, abamectin | I-FB | R | 300 | >1,800 | 12 | N | M | H |
| Tenn-Cop, fixed copper[9] | F | G | -- | -- | 24 | -- | H | N |
| *terbacil, Sinbar | H | G | 5,000-7,500 | -- | 12 | -- | N | N |
| terbufos, Counter | I-OP | R-1,2 | tech 4.5 | 1.1 | 48 | -- | H | N |
| Terraclor, PCNB | F | G | tech 1,700-5,000 | 2,000-4,000 | 12,24 | S | H | N |
| *Terr-O-Gas 67, methyl bromide | F,H,N | R-8 | see footnote 8 | | 48 | -- | -- | N |
| tetraconazole, Mettle | F | G | >4,090 | >2,000 | 12 | -- | L | -- |
| tetradifon, Tedion | A | G | >10,000 | >10,000 | 12 | -- | -- | -- |
| *thiabendazole, Mertect | F | G | >5,000 | >5,050 | 12 | N | H | N |
| thiamethoxam, Actara, Cruiser, Durivo Endigo, Platinum, Voliam flexi | I-NN | G | >5,000 | >2,000 | 12 | N | N | L |
| *Thimet, phorate | I-OP | R-2,10,11 | tech 2-4 | 20-30 | 48 | H | H | H |
| thiophanate-methyl, Topsin M | F | G | 7,500 | -- | 12 | -- | S | N |
| thiophanate-methyl + mancozeb, Tops MZ | F | G | >5,050 | >2,020 | 24 | N | H | N |
| thiophanate methyl + mancozeb + cmoxanil, Evolve | F | G | >5,000 | >2,000 | 24 | N | H | N |
| thiram, Thylate, 42-S Thiram | F | G | tech 1,000 | >5,000 | 12 | S | H | N |
| thiram + carboxin, Pro-Gro | F | G | >2,000 | >2,000 | | N | H | N |
| Thylate, thiram | F | G | tech 1,000 | >5,000 | 12 | S | H | N |
| Thistrol, MCPB | H | G | 5,000 | >5,000 | 24 | -- | -- | -- |
| *Tilt, propiconazole | F | G | 1,517 | >4,000 | 24 | -- | H | N |
| tolfenpyrad, Torac | I | G | 102 | >2,000 | 12 | -- | H | H |
| Tombstone, cyfluthrin | I-PY | R | 500 | >5,000 | 12 | M | H | H |
| topramezone, Armezon, Impact | H | G | >2,000 | >2,000 | 12 | N | N | N |
| Tops MZ, thiophanate-methyl + mancozeb | F | G | >5,050 | >2,020 | 24 | N | H | N |
| Topsin M, thiophanate-methyl | F | G | 7,500 | -- | 12 | -- | S | N |
| Torac, tolfenpyrad | I | G | 102 | >2,000 | 12 | -- | H | H |
| Transform, sulfoxaflor | I | R | >5,000 | >5,000 | 24 | S | H | H |

*Table continued on next page*

*Table D-6. Acute Toxicity of Chemicals - continued*

| Name[1] | Type[2] Class | Use[3] Category | LD$_{50}$ Values Mg/Kg[4] | | REI[5] (h) | Toxicity[6] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Oral | Dermal | | Bird | Fish | Bee |
| Topguard, flutriafol | F | G | >2,000 | >2,000 | 12 | -- | -- | -- |
| Torino, cyflufenamid | F | G | >2,000 | >2,000 | 4 | -- | M | -- |
| Treflan, trifluralin | H | G | >10,000 | -- | 12,24 | N | M | N |
| Tri-Basic Copper Sulfate, fixed copper[9] | F | G | 472 | -- | 24 | -- | H | N |
| TriCor, metribuzin | H | G | tech 2,000 | 20,000 | 12 | -- | N | N |
| trifloxystrobin, Gem, Flint | F | G | >5,000 | >2,000 | 12 | -- | H | N |
| trifloxystrobin + metalaxyl, Trilex AL | F | G | >5,000 | >5,000 | 24 | N | H | N |
| trifloxystrobin + propiconazole, Stratego | F | G | 4,800 | >5,050 | 12 | L | H | -- |
| triflumizole, Procure | F | G | 2,230 | >2,000 | 12 | -- | H | N |
| trifluralin, Treflan | H | G | >10,000 | -- | 12,24 | N | M | N |
| Trigard, cyromazine | IGR | R,G | 3,387 | 3,100 | 12 | S | H | H |
| Trilex AL, trifloxystrobin + metalaxyl | F | G | >5,000 | >5,000 | 24 | N | H | N |
| Trilogy, neem oil | F,A,I | G | >5 g | -- | 4 | -- | H | H |
| triphenyltin hydroxide, Super Tin, Agri Tin | F | R | 160 | 500 | 48 | -- | H | -- |
| Tristar, acetamiprid | I | G | 1,064 | >2,000 | 12 | N | N | M |
| Tundra, bifenthrin | I-PY | R | 262 | >2,000 | 24 | M | H | H |
| Ultra Flourish, mefenoxam | F | G | -- | -- | -- | -- | H | N |
| Uniform, mefenoxam + azoxystrobin | F | G | 1,459 | >5,000 | 0 | -- | -- | -- |
| Valor, flumioxazin | H | G | >5,000 | >2,000 | 12 | N | N | N |
| Vapam HL, metam-sodium | N | G | 1,891 | >3,074 | 48 | -- | H | N |
| Velum Prime, fluopyram | F | G | >2,000 | >2,000 | 12 | -- | -- | -- |
| Vendex, fenbutatin-oxide | A | R | 2,631 | >2,000 | 48 | M | M | N |
| Venom, dinotefuran | I | G | >5,000 | >5,000 | 12 | -- | -- | H |
| Vivando, metrafenone | F | G | >5,000 | >5,000 | 12 | -- | M | -- |
| Voliam Flexi, chlorantraniliprole, thiamethoxam | I-NN | G | >5,000 | >5,000 | 12 | -- | -- | H |
| Voliam Xpress, lambda-cyhalothrin + chlorantraniliprole | I | R-12 | 98.11 | >5,000 | 24 | -- | H | H |
| Vydate L, oxamyl | I,N-CA | R | 37 | 2,960 | 48 | H | H | H |
| Warrior, lambda cyhalothrin | I-PY | R | tech 79 | 632 | 24 | M | H | H |
| XenTari, *Bacillus thuringiensis aizawai* | I-BT | G | see footnote 7 | | 4 | N | N | N |
| Yield Shield, *Bacillus pumilus* GB34 | F-BT | G | | | NA | NA | NA | NA |
| Zampro, acetoctradin + dimethomorph | F | G | >500->2,000 | >5,000 | 12 | --- | --- | --- |
| Zeal, etoxazole | A | G | >5,000 | >5,000 | 12 | N | H | N |
| Zemax, mesotrione + s-metolachlor | H | G | >5,000 | >5,050 | 24 | -- | -- | -- |
| zeta cypermethrin, Mustang Maxx | I-PY | R-10,11 | 310 | >5,000 | 24 | S | H | H |
| zeta cypermethrin + bifenthrin, Hero | I-PY | R-10,11 | 550 | -- | 24 | S | H | H |
| Zeus, sulfentrazone | H | G | 1,750 | >5,000 | 12 | L | L | -- |
| Zidua, pyroxasulfone | H | G | >2,000 | >2,000 | 12 | -- | H | -- |
| Zing!, zoxamide + chlorothalonil | F | G | 1,750 - 5,000 | >5,000 | 12 | M | N | N |
| zoxamide, Gavel | F | G | -- | -- | 48 | -- | H | H |
| zoxamide + chlorothalonil, Zing! | F | G | 1,750 - 5,000 | >5,000 | 12 | M | N | N |
| 2,4-D (acid) | H | R(NJ),G | 375 | -- | 12,24 | M | N | H |
| 42-S Thiram, thiram | F | G | tech 1,000 | >5,000 | 12 | S | H | N |

## Table D-6: Explanation of Footnotes:

1. **Names**: Trade names begin with capital letters; common names with lower case letters.
2. **Type class**:
   A = acaricide; B = bactericide; F = fungicide; H = herbicide; IGR = insect growth regulator; I = insecticide (followed by the following: BO = botanical, BT = bacterial, CA = carbamate, CH = chlorinated hydrocarbon, EI = insect growth regulator [ecdysone inhibitor], FB = fermentation by-product, IO = inorganic, ML = macrocyclic lactone, NN = neonicotinoid, OP = organic phosphate, OT = other, PY = pyrethroid, SO = soap); N = nematicide; and PGR = plant growth regulator.

*Explanation of Footnotes continued on next page*

***Table D-6 Explanation of Footnotes - continued***

3. **Use category**: **R** = restricted use and **G** = general use. Chemicals designated as general or restricted use as determined by state or federal agencies. Restricted use may not apply to all formulations or all uses of a formulation. Check the label to be sure. The designation (NJ) refers to a compound that is classified as restricted use in New Jersey. The number(s) after the R designation refer to the following reasons for being classified as a federal restricted use product:
    1. acute oral toxicity
    2. acute dermal toxicity
    3. acute inhalation toxicity
    4. corrosive to eyes
    5. potential to cause tumors
    6. potential to cause genetic mutations
    7. potential to cause adverse reproductive effects
    8. accident history
    9. exposure hazard to workers
    10. potential effects on wildlife
    11. potential effects on birds
    12. potential effects on fish and/or other aquatic species
    13. potential for groundwater contamination
    14. lack of data
4. **LD50** = milligrams of substance per kilogram of body weight of the test animal. > = higher than the figure listed. Formulations: LD50 values given are for formulated material as you would purchase it; for example, 50WP, 4E, etc., unless otherwise noted. Source: 2001 Farm Chemicals Handbook; information is listed as supplied by manufacturer.
5. **REI**=Restricted Entry Interval (hours): The EPA Worker Protection Standard now requires minimum 12-hour REI for all Category III (CAUTION) pesticides, 24-hour minimum REI for all Category II (WARNING) pesticides, and 48-hour minimum REI for all Category I (DANGER) pesticides. In New Jersey, the NJDEP Pesticide Control Program has designated 48-hour REI's for some pesticides which EPA has assigned 12- or 24-hour REI's. Chemicals with multiple designations are based on product and/or formulation differences.
6. **N**=nontoxic; **L**=minimum impact on bees; **M**=moderately toxic; can be used if dosage, timing and method of application are correct but should **NOT** be applied directly to crop if bees are present; **H**=highly toxic, severe losses expected.
7. Toxicity of *Bacillus thuringiensis* is listed as harmless to humans, animals, and useful insects. Note that some formulations of BT may require safety equipment; follow the label. *Bacillus thuringiensis* materials are marketed as several different subspecies such as *aizawai*, *kurstaki*, and *tenebrionis*. Different *Bacillus thuringiensis* subspecies may have different insect control properties. **Check labels for pest insects controlled before use.**
8. Acute vapor toxicity, 200 ppm, extremely hazardous by vapor inhalation. Liquid can cause eye and skin burns.
9. Fixed coppers are listed under several commercially available trade names. Examples are: Basicop, Champ, Champion, Copper-Count-N,Cuprofix Disperss, Kocide, Super Cu, Tenn-Cop, Top Cop with Sulfur, Top Cop Tri-Basic, and Tri-Basic Copper Sulfate.
10. **For toxicity information on fungicide combinations**, see toxicity of each component listed by the common chemical name in this table.

# E. Pest Management

## 1. How to Improve Pest Management

## 1.1 Recommendations for More Effective Pest Control

Failure to control a weed, insect, or disease is often blamed on the pesticide when frequently the cause is one of the following: 1. Delaying applications until pests become too large or too numerous, 2. Making applications with insufficient gallonage or with clogged or poorly arranged nozzles, and 3. Selecting the wrong pesticide.
**For more effective pest control check the following recommendations:**

### 1. Field Inspection

Keep abreast of the pest situation and buildup in your fields. Frequent examinations (at least twice per week) help determine the proper timing of the next application. Do not apply controls simply because your neighbor does.

### 2. Integrated Pest Management (IPM)

Guidelines and information about current pest activity in vegetables are published in weekly IPM newsletters and reports. These publications provide accurate information for the timing of pesticide applications and suggestions for more effective control. To receive these newsletters and reports, contact your state Extension IPM specialist or Extension agent, or subscribe online at: *http://plant-pest-advisory.rutgers.edu/*.

**Pest control programs use biological, physical, cultural, and chemical methods in an integrated approach**. Field scouts collect pest population data. **Use this up-to-date information to decide whether pesticide applications or other management actions are needed**. Action thresholds for insects are generally expressed as a count of a given life stage or as a damage level based on a recommended sampling procedure. They are intended to reflect the population size that will cause economic damage and warrants the cost of treatment. Thresholds are listed for a number crops and pests in chapter F. **Control decisions are also based on the following: a)** economic action threshold level - when the cost of control equals or exceeds potential crop losses attributed to real or potential damage, **b)** field history, **c)** growth stage and vigor of crop, **d)** life stage of the pest, **e)** parasite and predator populations, **f)** pest populations, **g)** resistance to chemicals, **h)** time of the year, **i)** variety, and **j)** weather conditions

To employ an IPM program successfully, basic practices need to be followed. Whether participating in an IPM program, hiring a private consultant, or performing the work yourself, the grower should: **a)** examine fields frequently to determine pest populations and buildup, **b)** apply a control measure only when the economic action threshold level has been reached, and **c)** choose a pesticide that is least harmful to parasites and predators.

### 3. Resistance Management

Resistance to pesticides develops because pest organisms change genetically and intensive pesticide use kills the susceptible individuals in a population, leaving only resistant ones to reproduce. Consult the Weed, Insect and Disease Control sections in this chapter for more information on how to reduce the risk of developing resistance.

### 4. Pest Control: Insect and Weed Population Sampling Techniques and Disease Monitoring

**Insect Population Sampling Techniques:**

**a) Shake cloth (ground cloth):** Use a standard 3x3 ft shake cloth to assess insect populations. Randomly choose a site without disturbing the plants and carefully unroll the cloth between two rows. Bend the plants over the cloth one row at a time and beat the plants vigorously. Plants are pushed back to their original position and gently shaken to dislodge insects held on stems, leaves, and branches. Count only insects that have landed on the cloth. The number of sampling sites per field will vary with the crop. **b) Sweep net:** Use a standard 15 inch diameter sweep net to assess insect populations. While walking along one row, swing the net from side to side with a pendulum-like motion. The net should be rotated 180 degrees after each sweep and swung through the foliage in the opposite direction. Each pass of the net is counted as one sweep. The number of sweeps per field will vary with the crop. **c)Visual observation:** Examine plants or plant parts (leaves, stems, flowers) for direct counts of insect stages (eggs, larvae, adults), or for the presence of expected injuries. Counts can be taken on individual plants or a prescribed length of row depending on the crop. Quick moving insects are usually counted before less mobile insects.

**Weed Population Sampling Techniques:**

**a) Weed identification:** This first step is too frequently skipped. Perennial weeds and certain serious annual weeds should be controlled before they can spread. Common annual weeds need only be controlled if they represent a threat to yield, quality, or harvestability. **b) Growth stage determination:** The ability of weeds to compete with the crop is related to weed and crop size. Weed control by herbicides or mechanical methods is also dependent on weed size. Weed control decisions must be carried out before the crop is affected and before the weed is too large to be controlled easily. **c) Weed population:** Weed competition for light, water, nutrients, and space is dependent on population and is usually expressed as weeds per feet of row or weeds per square meter. Control measures are needed when the weed population exceeds the maximum tolerable population of that species.

**Disease Monitoring:**

**a) Determining the crop growth stage:** Disease control is primarily obtained by applying protective fungicides on a regular schedule. For many diseases, fungicide application must begin at a certain growth stage and be repeated every 7 to 10 days and according to label instructions. If environmental conditions are favorable for disease development, delaying a spray program will result in a lack of control if the disease has progressed too far. **b) Observing symptoms on plants:** For diseases that do not spread rapidly, fields should be scouted regularly. When the first disease symptoms are noticed, a fungicide should be applied and repeated every 7 to 10 days and according to label instructions. **c) Daily collection of weather conditions in the field:** Predictive systems are available for a few diseases. Temperature, rainfall, relative humidity, and duration of leaf wetness are monitored, and the timing of fungicide application is determined by applying a mathematical model.

## 5. Weather Conditions

Consider weather conditions before applying a pesticide. Spray only when wind velocity is less than 10 mph. Dust only when it is perfectly calm. Do not spray plants that are showing signs of moisture stress. Certain pesticides, including biological insecticides and some herbicides, are less ineffective in cool weather. Others do not perform well or may cause crop injury when hot or humid conditions occur. If possible, make applications when good weather conditions prevail.

Rainfall or overhead irrigation can wash pesticide deposits from foliage. Wait at least 48 hours after insecticide or systemic fungicide application and allow contact fungicides to dry on the leaf surface before irrigating. More frequent fungicide applications may be needed during and after periods of heavy rainfall. Provide a minimum rain/irrigation-free period of 1 to 4 hours after most postemergence herbicide applications.

Refer to individual product labels for all application precautions or restrictions.

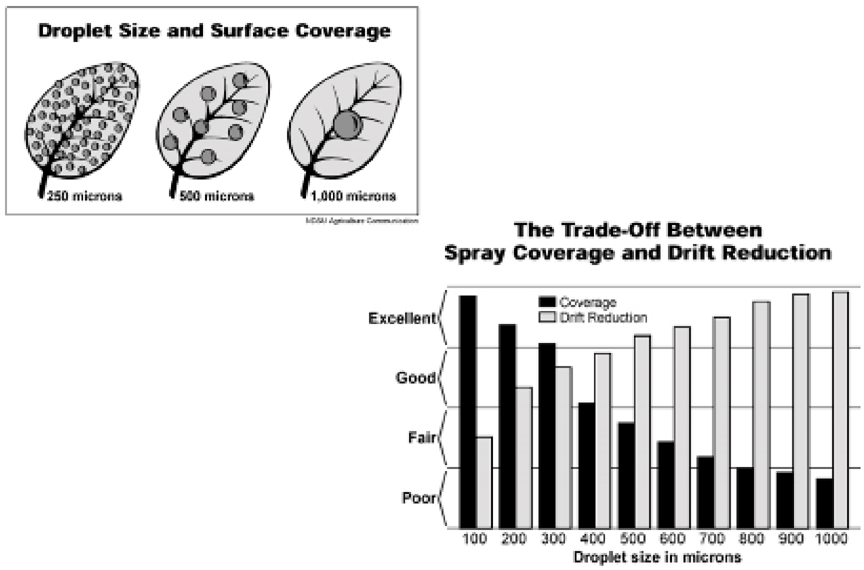
## 6. Pesticide Coverage of Plants

Non-systemic pesticides require more thorough spray droplet coverage than systemic pesticides which move through the plant's vascular system. A number of insects (e.g., aphids, mites) and diseases also require thorough spray coverage to obtain adequate control. Better pesticide performance can be accomplished by using adequate spray pressure and appropriately designed nozzles and nozzle arrangements with directed sprays to the surface as well as the underside of leaves.

High gallonage, air assisted sprayers and smaller droplets enhance spray coverage of many fungicides and insecticides (Fig. E-1). The volume of water required for adequate spray coverage increases as plants grow and leaf surface area increases; a minimum of 60 gal/A is recommended on vegetable crops for effective pest control with smaller droplets. As a rule of thumb: spray volumes in excess of 100 gal/A would be considered high-volume applications and spray pressures above 60 psi up to 400 psi would be considered high-pressure applications. **Refer to pesticide labels for specific application instructions. Note that pesticide drift increases with smaller spray droplets** (Fig. E-1). More information is available *at: http://sustainable-farming.rutgers.edu/companion-handouts-for-the-backpack-sprayer-videos/.*

**Use one sprayer for herbicides and a different sprayer for fungicides and insecticides**. Herbicide sprays should be applied at 15-25 gal/A of spray solution using low pressure (30-45 psi), and a nozzle designed to deliver the appropriate size droplet. Never apply herbicides with a high-pressure sprayer suitable for insecticide or fungicide application because excessive **drift** can result in damage to crops and non-target plants in adjacent areas. On crops that are difficult to wet (e.g., asparagus, cole crops, onions, peppers, and spinach), disease control can be improved with the addition of a spray adjuvant. However, **do not add oil concentrates, surfactants, spreader-stickers, or any other additive unless specified on the label, or the risk of crop injury may be increased.**

**Fig. E-1. Droplet size and surface coverage, and trade-off between spray coverage and drift reduction (North Dakota State University).**




## 7. Pesticide Selection

Know the pests to be controlled and choose the recommended pesticide and rate of application (**check the label**). If in doubt, consult your Extension agent. The herbicide choice should be based on weed species or cropping systems; see Table E-2 for a listing of herbicide effectiveness on common weeds in vegetables.

For insects that are extremely difficult to control or for whom resistance is a risk, it is important to alternate labeled insecticides with different modes of action (MoA). In this guide, recommended insecticides are listed with their Insecticide Resistance Action Committee (IRAC) group number. Insecticides are placed in IRAC groups based on common MoA and alternating between insecticides in different IRAC groups is a way of insuring that different MoA are used on a specific pest. Be alert for a possible aphid or mite buildup following the application of certain insecticides such as synthetic pyrethroids (IRAC 3A). For more assistance, contact your Extension agent.

**Caution:** Proper application of systemic insecticides is extremely important. Sprays should be directed according to the instructions on the label (which, in general, indicate away from the seed) or crop injury may occur.

**Be sure to properly identify disease(s)**. Many fungicides control only certain diseases and provide no control of others.

## 8. Pesticide Compatibility

**To determine if two pesticides are compatible, use the following "jar test" before tank-mixing pesticides or pesticides and fluid fertilizers**:

**a.** Add 1 pt of water or fertilizer solution to a clean qt jar, add pesticides in the same proportion as used in the field.

**b.** To a second clean qt jar, add 1 pt of water or fertilizer solution, and add ½ tsp of an adjuvant (such as Compex, Sponto 168D, Uni-Mix, or Unite) to keep the mixture emulsified. After that, add the pesticides to the water-adjuvant or fertilizer solution-adjuvant mixture in the same proportion as used in the field.

**c.** Close both jars tightly and mix thoroughly by inverting 10 times. Inspect the mixtures immediately and after standing for 30 minutes: If a uniform mix cannot be made, the mixture should not be used. If the mix in either jar remains uniform for 30 minutes, the combination can be used. If the mixture with adjuvant stays mixed and the mixture without adjuvant does not, use the adjuvant in the spray tank. If either mixture separates but readily remixes, constant agitation is required. If nondispersible oil, sludge, or clumps of solids form, do not use the mixture. **Note**. **For compatibility testing, the pesticide can be added directly or premixed in water first. In actual tank-mixing for field application, unless label directions specify otherwise, add pesticides to the water in the tank in this order**: **1)** add, wettable granules or powders; **2)** then add flowables, emulsifiable concentrates, water solubles, and companion surfactants. If tank-mixed adjuvants are used, these should be added first to the fluid carrier in the tank. Thoroughly mix each product before adding the next product.

## 9. Calibration of Application Equipment

Periodic calibrations of sprayers, dusters, and granule distributors are necessary to ensure accurate delivery rates of pesticides per acre. Calibrations are made by measuring the total gal/A of water applied in the case of sprayers, and the total lb/A of dust or granules in the case of dust and granule distributors. The application of too little spray or dust per acre results in inadequate distribution of toxicant over plant surfaces, usually poor control, and the need for additional applications. Application of too much spray or dust per acre is hazardous for the applicator, is frequently injurious to plants (phytotoxic), and could lead to excessive residues if applied close to harvest.

## 10. Selection of Sprayer Nozzle Tips

The selection of proper sprayer tips for use with various pesticides is very important. Flat fan-spray tips are designed for preemergence and postemergence application of herbicides. These nozzles produce a tapered-edge spray pattern that overlaps for uniform coverage when properly mounted on a boom. Standard flat fan-spray tips are designed to operate at low pressures (30-60 psi) to produce small- to medium-sized droplets that do not have excessive drift. Some flat fan tips (SP) are designed to operate at even lower pressures (15-40 psi) and are generally used for preemergence herbicide applications. Flat fan nozzle tips are available in brass, plastic, ceramic, stainless steel, and hardened stainless steel. Brass nozzles are inexpensive and are satisfactory for spraying liquid pesticide formulations. Brass nozzles are least durable, and hardened stainless steel nozzles are most durable and are recommended for wettable powder formulations which are more abrasive than liquid formulations. When using any wettable powder, it is essential to calibrate the sprayer frequently because, as a nozzle wears, the volume of spray material delivered through the nozzle increases.

Flood-type nozzle tips are used for various solutions (e.g., complete fertilizer, liquid N) and sometimes for spraying herbicides onto the soil surface prior to incorporation. They are less suited for spraying postemergence herbicides or for applying fungicides or insecticides to plant foliage. Coverage is often less uniform and complete when flood-type nozzles are used, compared with the coverage obtained with other types of nozzles. Results with postemergence herbicides applied with flood-type nozzles may be satisfactory if certain steps are taken to improve target coverage. Space flood-type nozzles a maximum of 20” apart, rather than the standard 40”. This will result in an overlapping spray pattern. Spray at the maximum pressure recommended for the nozzle. These techniques will improve target coverage with flood-type nozzles and result in satisfactory weed control in most cases.

Full and hollow-cone nozzles deliver circular spray patterns and are used for application of insecticides or fungicides to crops where thorough coverage of the leaf surfaces is extremely important and where spray drift will not cause a problem (see step 6). They are used when higher water volumes and spray pressures are recommended. With cone nozzles, the disk size and the number of holes in the whirl plate affect the output rate. Various combinations of disks and whirl plates can be used to achieve the desired spray coverage.

## 11. Pesticides and pH

Unsatisfactory results of pesticide applications may be caused by poor application, a bad batch of chemical, pest resistance, and weather conditions. Another possible reason may be the incorrect pH of the mixing water. **Check the pH of the water with a pH meter or ask your Extension agent to test a sample.**

Some materials carry a label cautioning the user against mixing the pesticide with alkaline materials, because the pesticide (in particular organophosphate insecticides) undergoes a chemical reaction known as "alkaline hydrolysis" when mixed with alkaline water (i.e., water with a pH greater than 7). The more alkaline the water, the faster the breakdown rate. In addition to lime sulfur, several other materials provide alkaline conditions, e.g., caustic soda, caustic potash, soda ash, magnesia or dolomitic limestone, and liquid ammonia. **Water sources in agricultural areas can vary in pH from below 3 to greater than 10.**

Many manufacturers provide information on the rate at which their products hydrolyze or break down in water solutions. This rate is expressed as "**half-life**," which is the time it takes for 50% hydrolysis or breakdown to occur. Examples of pesticides that are sensitive to hydrolysis in alkaline water solutions include Counter, malathion, dimethoate, Imidan, Lannate, Sevin, and Thimet.

**Correction of the alkaline pH**: Nutrient buffer sprays are one method; some brand names include: Buffer-X (Kalo Lab), LI-700 Buffer (Hopkins), Mix-Aid (Agway), Nutrient Buffer Sprays (Ortho), Sorba Spray (Leffingwell), Spray-Aide (Miller), and Unite (Hopkins). **Note**: Sprays containing fixed copper fungicides (e.g., Bordeaux mixture, copper oxide, basic copper sulfate, copper hydroxide) should **not** be acidified.

# 1.2 Calibrating Field Sprayers

**Width of Boom** The width of boom must be expressed in feet. The boom coverage is equal to the number of nozzles multiplied by the space between two nozzles.

**Ground Speed** Careful control of ground speed is very important for accurate spray application. Select a gear and throttle setting to maintain constant speed. A speed of 2-3 miles per hour (mph) is desirable. From a "running start," mark off the beginning and end of a 30-second run. The distance traveled (in feet) in this 30-second period divided by 44 will equal the speed in mph. Measure ground speed under field conditions.

**Table E-1. Ground Speed Conversion**

| Tractor speed (mph) | Distance (feet) traveled per minute | Travel time per 500 feet (minutes and seconds) | | Tractor speed (mph) | Distance (feet) traveled per minute | Travel time per 500 feet (minutes and seconds) |
|---|---|---|---|---|---|---|
| 1.0 | 88 | 5 min. and 41 sec | | 4.5 | 396 | 1 min and 16 sec |
| 1.5 | 132 | 3 min and 47 sec | | 5.0 | 440 | 1 min and 8 sec |
| 2.0 | 176 | 2 min and 50 sec | | 6.0 | 528 | 56 seconds |
| 2.5 | 220 | 2 min and 16 sec | | 7.0 | 616 | 49 seconds |
| 3.0 | 264 | 1 min and 53 sec | | 8.0 | 704 | 43 seconds |
| 3.5 | 308 | 1 min and 37 sec | | 9.0 | 792 | 38 seconds |
| 4.0 | 352 | 1 min and 25 sec | | 10.0 | 880 | 34 seconds |

**Calculating Gallons per Minute** Run the sprayer at a certain pressure, and catch the discharge from each nozzle for a known length of time. Collect all the discharge and measure the total volume. Divide this volume by the time in minutes to determine discharge in gallons per minute (GPM). Catching the discharge from each nozzle checks the performance of the individual nozzle. When it is not convenient to catch the discharge from each nozzle, a trough may be used to catch the total discharge. Formula For Calculating Sprayer Gallons Per Acre (GPA):

GPA= 5940 x GPM [per nozzle] / MPH x Width [nozzle spacing in inches]

## Before Calibrating

1. Thoroughly clean all nozzles, screens, etc., to ensure proper operation.
2. Check to be sure that all nozzles are the same, are made by one manufacturer, and have the same part number.
3. Check the spray patterns of all nozzles for uniformity. Check the volume of delivery by placing similar containers under each nozzle. All containers should fill at the same rate. Replace nozzles that do not have uniform patterns or do not fill containers at the same rate.
4. Select an operating speed. Note the tachometer reading or mark the throttle setting. When spraying, be sure to use the same speed as used for calibrating.
5. Select an operating pressure. Adjust pressure to desired psi while pump is operating at normal speed and water is actually flowing through the nozzles. This pressure should be the same during calibration and field spraying.

## Calibration (Jar Method)

Either a special calibration jar or a homemade one can be used. If you buy one, carefully follow the manufacturer's instructions. Take accurate speed and pressure readings and jar measurements; check several times. Keep in mind that you are collecting less than a quart of liquid to measure an application rate of several gallons per acre for many acres. Any 1-quart or larger container, such as a jar or measuring cup, if calibrated in fluid ounces, can easily be used in the following manner:

1. Measure a course on the same type of surface (e.g., sod, plowed) and same type of terrain (e.g., hilly, level) as that to be sprayed, according to nozzle spacing as follows:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Nozzle spacing (in)** | 16 | 20 | 24 | 28 | 32 | 36 | 40 |
| **Course length (ft)** | 255 | 204 | 170 | 146 | 127 | 113 | 102 |

2. Time the seconds it takes the sprayer to cover the measured distance at the desired speed. Average several runs.
3. With the sprayer standing still, operate at selected pressure and pump speed. Catch the water from several nozzles for the number of seconds measured in step 2.
4. Determine the average output per nozzle in fluid ounces. The ounces per nozzle equal the gallons per acre applied by one nozzle per spacing.

**Calibration (Boom or Airblast Sprayer)**

1. Fill sprayer with water.
2. Spray a measured area (width of area covered x distance traveled) at constant speed and pressure selected from manufacturer's information.
3. Measure amount of water necessary to refill tank (gallons used).
4. Multiply gallons used by 43,560 square feet (sq ft) per acre (A), and divide by the number of square feet in area sprayed. This gives gallons per acre (gal/A).
5. Add correct amount of spray material to tank to give the recommended rate per acre.

**Example**
**Assume**: 10 gal of water used to spray an area 660 ft long and 20 ft wide,
Tank size-100 gal, Spray material-2 lb formulated product/A

**Calculation**: (Gal used x 43,560 sq ft/A) / (area sprayed)
= (10 gal x 43,560 sq ft/A) / (660 ft x 20 ft)
= (435,600 gal x sq ft)/A / 1,320 sq ft
= 33 gal/A (all other units cancel out)
Tank capacity 100 gal / 33 gal/A = 3.03 A/tank

# 1.3 Calibrating Granular Applicators

Sales of granular fertilizer, herbicides and insecticides for application through granular application equipment have been on the increase. Much of the available equipment was not designed for precision application of granular materials; therefore, extra care must be taken to get the results desired. How well the material is applied is no accident. It will take a conscientious operator, effort, knowledge of equipment, and calibration.

The first step to good application is to be sure the equipment is prepared for operation. Be sure all controls are free and work properly. Check and lubricate moving parts as necessary, remove corrosion, and tighten loose nuts and bolts. Application rates of granular application equipment are affected by several factors: gate openings or settings, ground speed of the applicator, shape and size of granular material, and evenness of the soil surface.

**Calibration for Broadcast Applicators (Gravity-Drop or Spinner Applicators)**

**1.** From the label, determine the application rate.
**2.** From the operators' manual, set dial or feed gate to apply desired rate.
**3.** On a level surface, fill hopper to a given level and mark this level.
**4.** Measure test area-length of run will depend on size of equipment. It need not be one long run but can be multiple runs at shorter distances.
**5.** Apply material to measured area, operating at the speed applicator will travel during application.
**6.** Weigh amount of material required to refill hopper to the marked level.
**7.** Determine application rate:

**Area covered (A)** = number of runs x length of run (ft) x width of application (ft) **/** 43,560 sq ft/A

**Application rate (lb/A)** = amount applied (lbs to refill hopper) **/** area covered (A)

**Note**. Width of application is width of the spreader for drop or gravity spreaders. For spinner applicators, it is the working width (distance between runs). Check operator’s manual for recommendations, generally one-half to three-fourths of overall width spread.

**Example**:
**Assume**: Rate: 50 lb/A. Test run: 200 ft. Number of runs: 4. Application width: 12 ft. Lbs to refill hopper: 11.5 lb.

**Area covered**: (4 runs x 200 ft x 12 ft) / 43,560 sq ft/A = 9,600 runs x sq ft / 43,560 sq ft/A = 0.22 A

**Application rate**: 11.5 lb / 0.22 A = 52.27 lb/A

**8.** If application rate is not correct, adjust feed gate opening and recheck.

### Calibration for Band Applicators

1. From the label, determine application rate.
2. From the operator's manual, determine applicator setting and adjust accordingly.
3. Fill hopper half full.
4. Operate applicator until all units are feeding.
5. Stop applicator; remove feed tubes at hopper.
6. Attach paper or plastic bag over hopper openings.
7. Operate applicator over measured distance at the speed equipment will be operated.
8. Weigh and record amount delivered from each hopper.
   (Be sure all hoppers and all tubes deliver the same amount.)
9. Calculate application rate:
   Area covered in bands (A) = Number of bands x length of run (ft) x band width (ft) / 43,560 sq ft
10. If not correct, readjust and recheck.

### Calibration for Changing from Broadcast to Band Application

[Band width (ft) / row spacing (ft)] x broadcast rate (lb/A) = Amount needed (lb/A)

## 1.4. Pesticide Drift and Misapplication

Serious problems can occur when an unintended pesticide drifts onto your plants, or is directly applied due to misapplication or sprayer contamination. Misapplied herbicides, in particular, can result in significant injury to a vegetable crop for which the herbicide is not labeled. For all pesticides that are misapplied or that drift onto unintended crops, you must make a decision on whether the crop can be sold. To legally sell the produce, there has to be an established tolerance for the particular pesticide(s). Even though a pesticide is not sold for the particular crop, a tolerance may exist. A tolerance is an acceptable level of pesticide allowed based on EPA regulations. If the concentration of the pesticide in your vegetable is above the established tolerance or if there is no tolerance, you have a tainted crop that is illegal to sell. Pesticide residue levels can only be determined by laboratory analysis, contact you state department of agriculture or state extension specialists for an appropriate laboratory. To check for tolerances, go to: *https://www.epa.gov/pesticide-tolerances.*

Tolerances are not the only factor that should be considered in deciding whether or not to sell or consume produce. The U.S. EPA tolerance levels are the best scientific information available, but if your customers have heard of the drift problem, even if residues are below tolerances, selling affected produce may damage your farm's reputation.

**Samples for residue analysis must be collected correctly and in a timely manner for it to be useful in the decision-making process**. If the harvested part is present, collect that tissue. If fruit are not present, collect samples of recently formed leaves and shoot tips; translocated pesticides will concentrate in those tissues. Ask that fruit samples be collected later to help you in deciding whether or not to sell or consume the fruit. Make sure that samples are collected from the crop plants showing injury and as close as possible to the site of pesticide application.

What will pesticide residue concentrations tell you? Sometimes they may not tell you much. The critical question is: "Are the pesticides absent from the parts you wish to harvest and eat, or are the pesticide concentrations within the tolerances set by the EPA?" But undetectable residues may be due to poor sampling procedure, so care must be taken to ensure the samples were taken from the correct part of the plant, in a timely fashion, and handled properly. Be conservative in how you interpret the residue information.

The scientific literature suggests that acute poisoning effects in humans caused by pesticide residues in vegetables due to drift are very unlikely. Questions about the possible chronic effects (including cancer) from multiple exposures from repeated incidents of pesticide drift along with many other routes of exposure remain the subject of research.

Herbicide drift or herbicides misapplied to a vegetable crop for which the herbicide is not labeled can result in significant visible injury. But, misapplication of any pesticide has the same issues.

# 1.5 Soil Fumigation

In fields that are infested with soilborne plant pathogens, plant parasitic nematodes, or significant weed populations, soil fumigation can help reduce pest populations. Soil fumigants must be applied properly and an aeration period between fumigant application and planting of the crop is necessary to prevent plant injury. **Labels should be read carefully before deciding whether to use a soil fumigant.**

Nearly all soil fumigants have been re-registered since 2009 resulting in substantial label changes (see also section D.3. Soil Fumigants). **Labels now include mandatory stipulations on fumigant application including soil tillage, soil temperature, and soil moisture. Labels have specific requirements for plant-back periods that must be adhered to for crop safety. There are also new personal protective equipment mandates as well as site monitoring and management requirements**. Consult your Extension professional for advice regarding your specific needs and assistance with label interpretation. More information on Nematode Control can be found in the following section.

**One of the following multipurpose soil fumigants should be used to provide weed, disease, and/or nematode control. Rates are broadcast rates in product/acre:**

- allyl isothiocyanate + chloropicrin (Dominus 67:33), 20 gal/A
- allyl isothiocyanate (Dominus), 10-40 gal/A
- chloropicrin, 25-34 gal/A
- dichloropropene + chloropicrin (Pic-Clor 60) (if available), 20-30 gal/A
- dichloropropene + chloropicrin (Pic-Clor 80), 17-34 gal/A
- dichloropropene + chloropicrin (Telone C-17), 11-17 gal/A
- dichloropropene + chloropicrin (Telone C-35), 13-20.5 gal/A
- dimethyl disulfide + chloropicrin (Paladin) (if available), 50-60 gal/A
- metam-potassium (K-PAM HL), 30-60 gal/A
- metam-sodium (Vapam HL), 37.5-75 gal/A

**For nematode control only:**

- dichloropropene (Telone II), 9-12 gal/A

**To determine if it is safe to plant into fumigated soil, collect a soil sample from the treated field** (do not go below the treated depth). Place the sample in a glass jar with a screw top lid. Firmly press numerous seeds of a small seeded vegetable crop (e.g., lettuce or radish) on top of the soil and tighten the lid securely. Repeat the process in another jar with non-fumigated soil to serve as a check. Observe the jars within 1-2 days. If seeds have germinated, it is safe to plant in the field. If seeds have not germinated in the fumigated sample and have germinated in the non-treated sample, then the field is not safe to plant. Rework the field and repeat the process in a few days.

# 1.6 Nematode Control

Some 100 species of plant-feeding nematodes can seriously damage various crops. Before starting any nematode management procedure, determine what nematodes are present in the soil to find out if action is warranted. If nematode damage is suspected, both soils and roots should be examined to determine if and to what extent nematodes may be involved. Follow the procedures below for proper collection and handling of samples to enable an accurate diagnosis at a Nematode Diagnostic Laboratory.

## Soil and Root Samples for Nematode Detection

### 1. Collecting and Handling

Only a single, composite sample should be collected in each field. If the field is larger than 2 acres, divide the field into 2 acre blocks and collect a composite sample from each block. Label each bag accordingly. This will provide a more accurate assessment of the nematode population and enable more targeted management.

Collect soil and roots from the edges of the affected area(s) in the field. Take a mixture of roots and soil from at least 10 scattered sites, or preferably, under 10 scattered plants in the affected area. Do not take samples from areas where plants are dead. Dig up plants with a shovel and take a small handful of soil and roots from each, or use a soil sampling tube (3/4-inch diameter). Combine the individual samples in a bucket to make a composite sample of at least one quart of soil. Mix the soil in the bucket, then place one pint of the mixed soil in a plastic freezer bag and seal it to prevent drying of the soil. Protect bagged samples from high temperatures and freezing which can kill the nematodes.

Take soil samples while the crop is still growing so that areas that are suspected of being affected by nematodes can be identified and sampled, because these areas may be missed in random sampling. In general, samples can be collected from June through November. However, to plan your cropping sequence, it is best to take these survey samples after harvest in the fall *before* any fall tillage and *before* cold weather arrives. This timing is recommended (and especially important for growers who need to monitor root knot nematode populations) because nematode populations are generally highest in the fall. The chance of detecting damaging levels of plant pathogenic nematodes is greatest at that time. The *worst* time to sample to detect root knot nematodes is in late spring just before planting.

Survey samples should be taken at a depth of 8-10 inches, and several inches from the base of the plants, between plants in the row. Do not take samples if the soil is wet. The moisture level should be less than field capacity and there should not be any free water in the plastic bag after adding the sample. Use a soil sampling tube and take 20 to 25 cores per sample in a random pattern in the field. Mix soil cores in a plastic bucket and immediately place a pint of soil in a plastic bag or a nematode soil sample kit purchased from a Nematode Diagnostic Laboratory.

### 2. Submitting Samples to a Nematode Diagnostic Laboratory

Samples should be sent to the laboratory as soon as possible after collection. If there is any delay, refrigerate samples until shipment. Provide some insulation around the sample(s) during shipment, such as several layers of newspaper, a padded envelope or Styrofoam peanuts. Mark the samples: “For Nematode Analysis” and include the following information **with each sample** (check with the laboratory to see if any additional information is required):

1. Name and address of the grower and of the person submitting the sample
2. Date collected
3. Name of the present crop, the crop to be planted, and history of the affected area
4. Plant and field symptoms

Attach the paper with this information to the **outside** of the bag of soil. Forward the samples to your Extension agent, or directly to the diagnostic laboratory. There is usually a fee for nematode analyses.

## Nematode Management Strategies

Plant-parasitic nematodes are difficult to control after they have become established. The best strategy is to use preventive measures, including nematicides, soil fumigants, and/or cultural practices.

### 1. Chemical Management of Nematodes

#### Fumigants

Soil fumigation can effectively control plant-feeding nematodes. See Soil Fumigation above for specific fumigants, rates, and application techniques.

#### Nonfumigant nematicides

Several nonfumigant nematicides are currently available for selected vegetable commodities. These nematicides are listed in the sections dealing with the vegetables on which they are labeled. Some nonfumigant nematicides are not labeled in all states within the mid-Atlantic region, so consult the label carefully before applying a chemical. These nematicides do not volatilize in the soil as do fumigants. Consequently, these chemicals are effective over a wider range of soil temperature and moisture than are fumigants.

**Chemicals registered for use on selected vegetables include:**
**Contact nematicides: Counter (20CR), Mocap (10G and 6EC), Nimitz (4EC), Velum Prime.**
**Both contact and systemic nematicide: Vydate L.**
**Consult the label before applying any of these chemicals.**

**Factors Affecting the Efficacy of Nematicides** As with any pesticide, the two factors that determine efficacy are **concentration** and **exposure time**. If toxic nematicide concentrations do not come in contact with nematodes for a sufficient period of time, nematode control will be poor. Many factors can reduce the concentration of nematicide available in the soil and/or effectively shorten the time that nematodes are exposed. Good site preparation is extremely important. The soil should be thoroughly tilled several weeks before application to break up clods and encourage decomposition of plant residues. Nematicides can adsorb to organic matter and thus reduce the amount of compound free in the soil. Soil clods can interfere with nematicide distribution and reduce efficacy.

Fumigant nematicides such as Telone or Vapam volatilize and move through the soil as a gas. The movement of a fumigant through the soil is strongly affected by factors such as temperature, moisture, and soil texture. Fumigants tend to move upwards through the soil and will dissipate quickly unless the surface is sealed after treatment. Follow the label to ensure that you are applying the correct dose for your conditions.

Most nonfumigant nematicides such as Vydate are organophosphate or carbamate pesticides, which are potent cholinesterase inhibitors. Nimitz and Velum Prime are in different chemical classes than those mentioned above and kill nematodes via unknown modes of action. All of these compounds are extremely water-soluble, and their redistribution in the soil depends on water movement. Excessive rain or irrigation creates a risk of diluting the nematicide below the level needed to be effective. However, too little water may prevent the nematicide from being distributed effectively in the root zone. Nimitz has an additional concern of being phytotoxic to plants under cold stress; under those conditions, plants grow much slower than those not treated with Nimitz. During warmer periods of the growing season, Nimitz application results in little phytotoxicity to crops.

Organophosphate and carbamate nematicides act relatively slowly. Although high concentrations are lethal, the lower concentrations in soil generally kill by behavior modification. The affected nematodes typically are unable to move, find a host, feed, or find a mate. Eventually they die. If exposure to the nematicide is too short or at a too low concentration, however, these behavioral modifications can be reversed and the treatment is not effective. Both Nimitz and Velum Prime kill nematodes within the recommended dose ranges.

## 2. Nonchemical Management of Nematodes

### Prevention of spread

Plant-feeding nematodes move only short distances under their own power, i.e., a few inches to a few feet. Nematodes are commonly spread by the movement of infested soil and/or infected plants by human activity. Sanitation and good cultural practices are the best preventive measures against nematodes. Obtain nematode-free transplants from reputable sources. Wash soil from machinery and tools before using them at another location. Nematodes may also be spread by wind, water, soil erosion, and animals.

### Crop rotation

Rotation of crops is an effective and widely used cultural practice to reduce nematode populations in the soil. To be most effective, crops that are poor hosts or nonhosts of the target nematodes should be included in the rotation sequence.

### Cover crops

Some plants commonly used as cover crops are naturally suppressive to certain nematode species, but no single crop is effective against all nematodes. The cover crop plant may be a nonhost and, therefore, the nematodes starve, their population being reduced as with fallow. Nematodes invade the roots of certain other cover crop plants, but they fail to reproduce. Yet, other “antagonistic” plant species exude chemicals from their roots that are toxic to nematodes, such as marigold and asparagus.

### Green manures and soil amendments

In general, the incorporation of large amounts of organic matter into the soil reduces populations of plant-feeding nematodes. The decomposition products of some plants kill nematodes. These include butyric acid released during the decomposition of ryegrass and timothy, and isothiocyanates released during the decomposition of rapeseed and other plants in the genus Brassica. Maximum benefit of these “natural” nematicides is obtained when the plant material is incorporated into the soil as green manure. It is important to consult with a diagnostic lab or extension agent to make sure the treatment is appropriate for the nematode being controlled, as green manure treatments are not equally effective against all plant- parasitic nematodes. For example, rapeseed is effective against dagger nematodes but not lesion nematodes. Also keep in mind that varieties of the same green manure crop can differ in the amount of toxic chemical components in their cell walls and therefore differ in the amount of toxic byproducts released during decomposition.

For dagger nematode control, two years of rapeseed green manure is desirable, but it may be possible to realize the same benefit by growing two crops of rapeseed within one year. The following timetable is suggested for producing two rotations of rapeseed within one year:

- Prepare seedbed and plant rapeseed by late April or early May (plant only recommended winter rapeseed varieties).
- Turn under green rapeseed by early September. Prepare seedbed and plant second crop by mid-September.
- The second crop should be turned under in late spring after soil temperatures reach 45°F or higher.
- Ideal conditions for incorporating the cover crop are similar to those required for obtaining the maximum benefit from fumigation (i.e., the soil should be above 45°F and moist).
- Alternatively, planting dates may be reversed so that the first planting is in the fall followed by a second crop planted in the spring. This would end the rotation cycle in fall of the following year.

Some rapeseed varieties are more effective at suppressing nematode populations than others, and some varieties will not over-winter (i.e., spring types) or they bloom too early in summer to be useful. The winter varieties 'Dwarf Essex' and 'Humus' work well for both spring and fall planting dates. If planted in the spring, these varieties grow vigorously to crowd out weeds and do not go to seed.

**Tips**:

- Rapeseed requires a firm, smooth seedbed that is free of weeds, heavy residue, and large clods.
- Seed may be drilled or broadcast. Seed at a depth of 3/8 inch and avoid planting too deep! If seed is broadcast, a cultipacker may be used to cover seed.
- A seeding rate of 7–8 lb/A works well.
- Rapeseed is sensitive to broadleaf herbicide carryover.
- Fall-planted rapeseed should have 8–10 true leaves and a 5-6-inch tap root with a 3/8-inch diameter root neck before the ground freezes.
- Sulfur is necessary for rapeseed to produce nematicidal compounds. Some soils may be deficient in sulfur. A soil test for sulfur may be beneficial.

Keep in mind that some biofumigant crops like rapeseed and sorghum-sudangrass are hosts for nematodes and it is not until incorporated into the soil as green manure that they will suppress nematode populations.

**Plant nutrition and general care of the plant**

The harmful effects of nematodes on plants can be reduced by providing plants with adequate nutrition, moisture, and protection from stress.

**Fallow.** Fallow is the practice of keeping land free of vegetation for weeks or months by frequent tilling or applying herbicides. In the absence of a host, nematodes gradually die out; however, eggs of some nematodes may survive for years in the soil. Because fallow may be destructive to soil and the land is out of production during that time, extended periods of fallow are not recommended.

**Integrated management practices.** Each of the practices mentioned above reduces the soil population of plant-feeding nematodes to varying degrees. Each practice has limitations and the degree of nematode control achieved depends on environmental factors, as well as the particular nematode and crop being considered.

Maximum benefit is realized when several of these practices are employed in an integrated crop management program. Because the host range of different nematode varies, the selection of cover crops, rotation crops, and green manures will be determined by the kinds of nematodes present. No single practice is a "cure-all" for all nematode problems.

# 2. Weed Control

Effective weed control requires a program that emphasizes prevention and combines crop rotation with mechanical and chemical control methods.

## 2.1 Postharvest Perennial Weed Control

Weed seed populations in the soil should be kept to a minimum by preventing weeds from producing seed in and around vegetable fields. Destroy all weeds immediately after a crop is harvested. Consider control measures after harvest, but before the first frost, for the following weeds:

1. To suppress or control bitter nightshade, Canada thistle, field bindweed, hemp dogbane, horsenettle, or pokeweed, use a tank-mix of 1 qt Banvel plus 1 qt 2,4-D amine. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness (Note. Delay seeding of winter cover crop 3 wks for each pint per acre of Banvel used). See herbicide labels for optimum treatment time for each weed.
2. To suppress brambles, horseradish (volunteer), horsenettle, milkweed, poison ivy, or sow thistle, tank-mix 1.5 lb acid equivalent glyphosate, using one of many labeled glyphosate products, plus 1 pt Banvel (see note above). Use 1 to 2 qt surfactant per 100 gal of spray mixture. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness. See herbicide labels for optimum treatment time for each weed.
3. To control johnsongrass or quackgrass, apply 0.75 to 1.1 lb acid equivalent glyphosate, using one of many labeled glyphosate products. Delay tillage until 4 to7 days after application. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness.
4. To control bermudagrass, apply the maximum labeled rate of Poast, Fusilade, or clethodim (Select, Select Max) in late spring after the weed has begun to grow. Work toward planning your crops and crop rotation to be able to treat monthly with one of the above listed products through late summer without conflicting with the Preharvest Interval (PHI) of the crop(s) being grown.
5. To control yellow nutsedge foliage and suppress nutlet formation, spray with a labeled glyphosate product after flowers (seedheads) appear, but before foliage dies. Use 2.25 lb acid equivalent glyphosate. Expect only partial control of yellow nutsedge the first year after initiating the program. Plant a crop the following spring with registered herbicides recommended for yellow nutsedge control (see Table E-2). Effective yellow nutsedge control can be achieved by repeating the application for several consecutive years.

## 2.2 Herbicide Effectiveness on Common Weeds in Vegetables

**Table E-2 Herbicide Effectiveness on Common Weeds in Vegetables**

**NOTE:**
Herbicide performance depends on herbicide selection, herbicide rate, weed pressure, weather, soil type, and other factors.

The ratings in the following table indicate **ONLY relative effectiveness** in tests conducted by the University of Delaware, University of Maryland, University of Pennsylvania, Rutgers, The State University of New Jersey, and Virginia Polytechnic Institute and State University.
**Actual performance may be better or worse than indicated in this table.**

**The Weed Science Society of America (WSSA) group number** indicates the chemical structure and site of action of the herbicide.

**See also 2.4: Herbicide Site of Action: Reducing the Risk of Herbicide Resistance in this chapter.**

# Table E-2. Herbicide Effectiveness on Common Weeds in Vegetables

**See Note about Table E-2 on the preceding page.** Abbreviations: G=good, F=fair, P=poor, N=no control, -=insufficient data.

| Herbicide | WSSA Site of Action Number | Barnyardgrass | Crabgrass, Large | Fall Panicum | Foxtail sp. | Goosegrass | Johnsongrass (Seedlings) | Yellow Nutsedge | Carpetweed | Cocklebur, Common | Galinsoga, Hairy | Jimsonweed | Lambsquarters, Common | Morningglory sp. | Shepherdspurse | Pigweed sp. | Purslane, Common | Ragweed, Common | Smartweed, Pennsylvania | Nightshade, Eastern Black | Velvetleaf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Soil-Applied Herbicides (pre-plant incorporated or preemergence)** | | | | | | | | | | | | | | | | | | | | | |
| **Acetochlor products** | **15** | G | F/G | G | G | G | G | F | F | N | - | N | P/F | N | - | F/G | - | P | P | G | P |
| **Atrazine** | **5** | F | P/F | P | F | - | P | P/F | G | F/G | G | G | G | G | G | G | G | G | G | G | F |
| **Callisto** | **27** | N | F | N | P | N | N | P | - | P/F | G | F | G | F | G | F/G | - | P | - | P | - |
| **Caparol** | **5** | F | P/F | P | F | P/F | - | N | G | P | G | P/F | G | P | F | F/G | G | F | F | F | P |
| **Chateau** | **14** | P | P | P | P | P | P | P | G | F | G | - | G | F | G | G | G | F | G | G | - |
| **Command** | **13** | G | G | G | G | G | G | N | N | N/F | F | G | G | P | F | N/P | G | P/F | G | - | G |
| **Curbit** | **3** | F | G | G | - | G | - | N | G | N | N | N | P/F | P | - | F | F/G | N | P | P | P |
| **Dacthal** | **3** | F/G | G | F/G | G | F/G | - | N | P | N | N | P | G | N | P | F/G | G | N | N | N | N |
| **Devrinol** | **15** | G | G | G | G | G | G | N/P | G | N | F/P | N | F/G | N | - | F/G | G | P/F | P | N | N |
| **Dual Magnum** | **15** | G | G | G | G | G | G | F/G[1] | F | N | G | N | P | N | - | G | F/G | N | P | G | P |
| **Eptam** | **8** | G | G | G | G | G | G | G | G | P | N | P | F | F | - | G | G | P | P | F/G | F/G |
| **Goal/GoalTender** | **14** | P | P | P | P | P | P | P[2] | G[2] | - | G[2] | - | F | - | G | G | G | F | G[2] | G[2] | F[2] |
| **Karmex** | **7** | G | F/G | G | G | F/G | N | N | G | - | G | G | G | G | G | G | G | G | G | G | G |
| **Kerb** | **15** | G | G | G | G | G | - | N | G | N | P | N | G | - | - | G | G | P | - | - | P |
| **Lorox/Linex** | **7** | F | P/F | P | F | P/F | - | N | G | P | G | P/F | G | P | F | G | G | F | G | G | P |
| **Matrix** | **2** | G | F | F | G | - | - | F | - | - | F | - | F | P/F | - | G | G | F | F | P/F | P |
| **Metribuzin** | **5** | F | F | F | F | F | - | N | G | F | G | F/G | G | F/P | - | F/G | F | G | G | P | G |
| **Micro-Tech** | **15** | G | F/G | G | G | G | G | F | G | N | G | P | P/F | N | G | G | G | N | P | G | P |
| **Outlook** | **15** | G | G | G | G | G | P | P/F | - | N | G | N | P | N | - | F/G | G | N | P | F | N |
| **Prefar** | **8** | G | G | G | G | F/G | G | N | N | N | N | N | F/G | N | P/F | F | F | N | N | N | N |
| **Prowl/Prowl H2O** | **3** | G | G | G | G | - | G | N | G | N | N | N | F/G | P | N | F/G | F/G | N | F | P | G |
| **Pursuit** | **2** | P/F | P/F | P/F | P/F | - | N | G | F | - | F | G | F | F | G | G | P | G | F | G | G |
| **Reflex[3]** | **14** | P | P | P | P | P | P | N | G | N | G | F/G | P | P | G | E | E | G | P | G | P |
| **Ro-Neet** | **8** | G | G | G | G | G | - | N/P | G | N | N | N | F | - | G | G | G | N | - | - | F |
| **Sandea** | **2** | N | N | N | N | N | N | F | P | G | G | G | F | F | - | G | F | G | F | N | G |
| **Sinbar** | **5** | F | F | - | F | F | - | P | G | - | G | G | G | G | G | P | G | G | G | G | G |
| **Solicam** | **12** | G | G | G | G | - | F | F | - | - | - | F | F | P | - | G | G | G | - | - | F |
| **Spartan Charge** | **14+14** | P | P | P | P | P | P | P | - | - | - | - | P | P | - | F/G | - | N | P | - | - |
| **Strategy[4]** | **3+13** | G | G | G | G | G | G | N | G | N/F | F | G | G | P | F | F | G | F | G | P | G |
| **Treflan** | **3** | G | G | G | G | G | G | N | G | N | N | N | F/G | P/F | N | F | G | N | P/F | P | N |
| **Zeus** | **14** | P | P/F | P | P | P/F | P | P/F | G | P | - | G | F/G | F/G | F/G | - | G | G | P/F | F | F/G |
| **Zidua** | **15** | G | G | G | G | G | P | P | - | N | P | P | F | N | - | G | G | P | P | F/G | P |

*Table continued on next page*

***Table E-2. Herbicide Effectiveness on Common Weeds in Vegetables - continued***

| Herbicide | WSSA Site of Action Number | Barnyardgrass | Crabgrass, Large | Fall Panicum | Foxtail sp. | Goosegrass | Johnsongrass (Seedlings) | Yellow Nutsedge | Carpetweed | Cocklebur, Common | Galinsoga, Hairy | Jimsonweed | Lambsquarters, Common | Morningglory sp. | Shepherdspurse | Pigweed sp. | Purslane, Common | Ragweed, Common | Smartweed, Pennsylvania | Nightshade, Eastern Black | Velvetleaf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Postemergence** | | | | | | | | | | | | | | | | | | | | | |
| **2,4-D** | **4** | N | N | N | N | N | N | P | G | F/G | P | F | F/G | G | G | G | G | G | F | G | G |
| **Accent Q** | **2** | G | P/F | G | G | P | G | P | - | P | - | F | P | F | G | G | P/F | P | F/G | N | P |
| **Aim/Cadet** | **14** | N | N | N | N | N | N | N | G | P | - | P | G | F | - | G | - | F | - | G | G |
| **Assure II /Targa** | **1** | G | G | G | G | G | G | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| **Atrazine** | **5** | F | F | F | F | F | - | G | - | F | G | G | G | G | G | G | G | G | G | G | F/G |
| **Banvel/Clarity** | **4** | N | N | N | N | N | N | P | G | G | G | G | G | G | G | G | G | G | G | G | G |
| **Basagran** | **6** | N | N | N | N | N | N | F | N | G | F | G | F | P | - | F | F/G | G | G | P | G |
| **Callisto** | **27** | N | F | P | P | P | P | F | - | F/G | G | G | G | F | F/G | G | - | P | - | F/G | G |
| **Caparol** | **5** | F | P/F | P | F | P/F | - | N | G | P | G | P/F | G | P | F | F/G | G | F | G | G | P |
| **Fusilade DX** | **1** | G | F/G | G | G | G | G | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| **glyphosate products** | **9** | G | G | G | G | G | G | F | G | G | G | G | G | F | G | G | G | F | G | G | G |
| **Goal Tender** | **14** | P | P | P | P | P | P | P | G | P | G | F | G | F | G | G | G | F | G | G | F |
| **Gramoxone[5]** | **22** | F/G | F/G | F/G | G | F/G | - | G | G | G | G | G | F/G | F/G | - | G | F/G | G | P | - | - |
| **Impact/Armezon** | **27** | G | G | F/G | G | F | F | - | - | F/G | - | G | G | F | - | G | - | G | G | G | G |
| **Laudis** | **27** | G | F/G | P | G | F | G | - | - | F/G | - | G | G | F | - | G | - | F | - | - | - |
| **Lorox** | **7** | P | P | P | P | P | P | P | G | P/F | F/G | P/F | G | - | G | G | G | G | G | P/F | G |
| **Maestro/Buctril** | **6** | P | P | P | P | P | P | P | G | G | G | G | G | G | G | G | F | F | G | G | F |
| **Matrix** | **2** | G | P/F | F/G | G | P | - | F | - | F/G | - | F | F | F | G | G | F/G | P | P/F | P | F |
| **Metribuzin** | **5** | P | P | P | P | P | - | P | G | - | G | G | G | P | G | G | G | G | F | P | P/F |
| **Poast** | **1** | G | G | G | G | G | G | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| **Pursuit** | **2** | F/G | F/G | F/G | F/G | P | F/G | - | G | F | G | F | G | F | P/F | G | G | P/F | - | - | G |
| **Raptor** | **2** | P | P | P | P | P | P | P | - | F/G | G | - | F | F | G | G | P/F | P/F | G | G | G |
| **Reflex[3]** | **14** | P | P | P | P | P | P | P | G | F | G | G | P | F/G | G | G | - | F | P | F | P |
| **Sandea** | **2** | N | N | N | N | N | N | G | P | G | G | G | N | F | - | G | P | G | F | N | G |
| **Select** | **1** | G | G | G | G | P | G | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| **Sinbar** | **5** | F | F | - | F | F | - | P | G | G | G | G | G | G | G | P | G | G | G | G | G |
| **Spin-Aid** | **5** | P | P | P | P | P | P | P | - | P | G | G | F | G | G | P/F | G | F/G | - | - | N |
| **Starane Ultra** | **4** | N | N | N | N | N | N | N | N | G | - | - | F/G | - | F | G | G | - | F | G | G |
| **Stinger/Spur** | **4** | N | N | N | N | N | N | N | N | G | G | P | P | N | N | N | N | G | P | P | P |

[1]Control improved with a pre-plant incorporated treatment,
[2]Control of this species based on preemergence application; control from pre-plant incorporated treatment slightly reduced.
[3]Reflex ratings based on 1.25 pt/A. Lower rates will result in reduced levels of weed control.
[4]Strategy is a repackaged mixture of Command and Curbit.
[5]Gramoxone: nonselective herbicide that needs to be applied with shielded application equipment to prevent spray from contacting the crop.

# 2.3 Crop Rotation Planting Restrictions

## Table E-3.
## Crop Rotation Planting Restrictions: Months After Herbicide Application Until Planting New Crop

**NOTE**:
The table on the following pages summarizes the crop rotation restrictions after certain herbicide applications have been made, i.e., the waiting time until a new crop can be planted in monts after herbicide application. **For example**, if Devrinol was applied to tomatoes, planting sweet corn must be delayed for 12 months after the Devrinol application. **Consult the label** for a different time interval if two or more herbicides were applied in the same season. The label may also mention additional restrictions due to rainfall, soil, pH, geographical region, variety, or application rate. **This table is not a substitute for the label!**

### Explanation of Table Footnotes:

[1] Read the label for additional restrictions due to application rate, geographical region, rainfall, soil pH, tillage, variety, or supplemental labeling.

[2] 18 months with a soil pH > 6.5. At rates greater than 2.1 oz/A, a rotation interval of 30 months and a successful field bioassay are required.

[3] Rotation interval for pea and snap bean is extended to 18 months if Armezon PRO is applied at greater than 25 fl oz/A.

[5] Following application of Banvel/Clarity and a minimum of 1 inch of rainfall or overhead irrigation, a waiting interval of 30 days per pint restriction for soybean, and 20 days per pint restriction for small grains. If less than 1 inch or rainfall or irrigation is received after application and Status is applied at greater than 5 oz/A, the rotation interval is 4 months.

[6] If Basis rate is 0.33 to 0.5 oz/A or Basis Blend rate is 1.25 oz/A, alfalfa, sorghum, pea = 18 months; soybean, snap bean = 10 months; STS soybean = 1 month; spring oat = 9 months; if Basis rate is greater than 0.5 oz/A or Basis Blend rate is 2.5 oz/A, STS soybean = 4 months; if Basis rate is 0.33 oz/A or Basis Blend rate is 0.825, soybean = 0.5 month.

[7] 8 months if 0.38 oz/A Beacon is applied.

[8] NR for IMI (IR/IT) or Clearfield (CL) varieties.

[9] Transplanted.

[10] Use safener with seed.

[11] For winter wheat, at rates up to 2 oz/A, the rotation interval is 7 days for no-till or minimum-till wheat and 30 days for conventional-till wheat. At least 1 inch of rainfall/irrigation must occur between application and field corn, grain sorghum, or wheat planting, or crop injury may occur. For alfalfa and potato, the rotation interval is 5 months if the soil is tilled prior to planting or 10 months if no tillage is performed prior to planting. At lower rates of Valor/Rowel/Chateau, rotation interval for many crops are reduced. Chateau may be applied to potato following hilling at a rate of 1.5 oz/A. Consult labels for more specific information.

[13] Corn hybrids that are classified as IMI-corn or as tolerant (IT) or resistant (IR) may be planted in the spring of the year following regardless of rainfall or time interval from chemical treatment to corn planting.

[14] Rotation interval varies by tillage type and use rate. Consult the label for specific rotation intervals.

[15] Rotation interval is shorter for STS soybean.

[17] If Hornet WDG rate is < 4 oz/A, snap beans, peas, and some varieties of sweet corn = 10.5 months.

[18] If no more than 2 lb ai applied the previous year.

[19] Regardless of tillage, be sure to plant corn at least 1.5 inches deep and completely cover with soil.

[21] The rotation interval for the sweet corn varieties ‘Merit’, ‘Carnival’, and ‘Sweet Success’ is 15 months.

[23] Rotation intervals based on soil pH less than 7.0. In Pennsylvania, rotation interval for lima bean, muskmelon, onion, pepper, squash, and potato is 30 months. Consult seed corn agronomist regarding inbred sensitivity to Valor XLT/Rowel FX prior to planting inbred seed corn lines.

[24] If applied after June 1, rotating to crops other than corn (all types) may result in crop injury.

[25] For Bolt or non-Bolt soybean and minimum- or no-till field corn, if Afforia is used on coarse textured soils, such as sands and loamy sands, or on high-pH soils (>7.9), extend time to planting by 7 additional days. For minimum- or no-till wheat in the states of DE, MD, NJ, or VA, Afforia may be applied at a minimum 7 days before planting. Do not use on Durum wheat and do not irrigate between emergence and spike. Wheat must be planted at least 1 inch deep. Do not graze until wheat has reached 5 inches in height. For conventional-till field corn, grain sorghum, and wheat, at least 1 inch of rainfall/irrigation must occur between application and planting or crop injury may occur. For alfalfa, cabbage, cucumber, lima bean, muskmelon, onion, pepper, pumpkin, spring oat, squash, sweet corn, tomato, watermelon, and potato, the rotation interval is 4 months if the soil is tilled prior to planting. If no tillage is performed prior to planting these crops, the rotation interval is extended to 8 months.

[26] Rotation interval for grain sorghum, or winter barley at 5.7 oz/A or greater rates, the rotation interval is extended to 18 months. For winter wheat, at 5.7 oz/A or greater rates, the rotation interval is extended to 6 months.

[27] Seed corn inbred lines vary in sensitivity to herbicides; therefore, users should seek advice from seed corn agronomist regarding inbred sensitivity to Canopy Blend prior to planting inbred seed corn.

[28] For onion, the rotation interval for irrigated and nonirrigated is 8 and 18 months, respectively.

[29] For corn, if the original corn crop is lost, do not make a second application. Injury may occur to soybean planted the year following application on soils having a calcareous subsurface layer if products containing atrazine were used at rates greater than 0.75 lb/ai atrazine per acre in tank mixtures and/or sequentially with Resicore. If Resicore is applied after June 1, rotating to crops other than corn or grain sorghum the next spring may result in crop injury.

[30] NR for Clearfield corn (field and seed). For wheat, planting non-Clearfield cultivars in areas receiving less than 10 inches of precipitation from time of application up until wheat planting may result in wheat injury. Injury potential increases if less than normal precipitation occurs in the 2 months just after Varisto application. For barley, the rotation interval at pH > 6.2 and > 18 inches of rainfall/irrigation, pH < 6.2 and < 18 inches of rainfall/irrigation and with moldboard plowing, and pH < 6.2 and < 18 inches rainfall/irrigation and without moldboard plowing is 9, 9, and 18 months, respectively. For potato, the rotation interval at pH > 6.2 and > 18 inches of rainfall/irrigation and pH < 6.2 and < 18 inches of rainfall/irrigation is 9 and 18 months, respectively.

[31] Rotation information is unknown for this product. Please contact manufacturer for recommendations.

[32] In Delaware and Virginia, a Special Local Needs Label 24(c), has approved a 3 month plant back restriction for soybeans after an application to winter wheat.

[33] Rotation is 12 months for New Jersey and Pennsylvania, except southeastern Pennsylvania.

[34] NR for Enlist varieties.

**Table E-3. Crop Rotation Planting Restrictions: Months After Herbicide Application Until Planting New Crop**
**See Note about Table E-3 and explanation of footnotes on page 99. This table is not a substitute for the label!** Abbreviations: AH=after harvest, B=Bioassay of soil recommended before planting, NR=no restrictions, NY=next year, SY=second year following application.

| Herbicide Trade Name \ Crop | Alfalfa | Barley, winter | Bean, lima | Bean, snap | Cabbage | Corn, field | Corn, sweet | Cucumber | Musk-melon | Onion | Peas | Pepper | Potato | Pumpkin | Rye, winter | Sorghum, grain | Soybean | Squash | Tomato | Watermelon | Wheat, winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2,4-D[1] | 3 | 1 | 3 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 1 | 1 | 0.25–1[1] | 3 | 3 | 3 | 1 |
| Accent/Accent Q | 10 | 4 | 10 | 10 | 10[2] | NR | 10 | 10[2] | 10[2] | 10[2] | 10 | 10[2] | 10[2] | 10[2] | 4 | 10 | 0.5 | 10[2] | 10[2] | 10[2] | 4 |
| Acuron | 18 | 4 | 18 | 18 | 18 | NR | NR | 18 | 18 | 18 | 18 | 18 | 10 | 18 | 4 | 10 | 10 | 18 | 18 | 18 | 4 |
| Acuron Flexi[24] | 10 | 4 | 18 | 19 | 18 | NR | NR | 18 | 18 | 18 | 18 | 18 | 10 | 18 | 4 | 10 | 10 | 18 | 18 | 18 | 4 |
| Afforia (2.5 oz/A) | 4[25] | 3 | 4[25] | 3 | 4[25] | 0.5[25] | 3 | 4[25] | 4[25] | 4[25] | 3 | 4[25] | 4[25] | 4[25] | 3 | 1 | NR[25] | 4[25] | 4[25] | 4[25] | 1[25] |
| Aim | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | 12 | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Anthem | 10 | 11 | 18 | 11 | 18 | NR | NR | 18 | 18 | 18 | 11 | 18 | 4 | 18 | 11 | 6 | NR | 18 | 18 | 18 | 4 |
| Anthem ATZ | SY | NY | 18 | SY | 18 | NR | NR | SY | 18 | 18 | SY | SY | SY | SY | NY | SY | NY | 18 | SY | 18 | NY |
| Anthem Maxx (4.875 oz/A) | 10 | 11[26] | 18 | 18 | 18 | NR | NR | 18 | 18 | 18 | 11 | 18 | 4 | 18 | 11[26] | 11[26] | NR | 18 | 18 | 18 | 4[26] |
| Armezon (0.75 oz/A) | 9 | 3 | 18 | 9 | 18 | NR | NR | 18 | 18 | 18 | 9 | 18 | 9 | 18 | 3 | 9 | 9 | 18 | 18 | 18 | 3 |
| Armezon PRO (16-20 fl oz/A) | 9 | 4 | 18 | 9[3] | 18 | NR | NR | 18 | 18 | 18 | 9[3] | 18 | 9 | 18 | 4 | 9 | 9 | 18 | 18 | 18 | 4 |
| Assure II | 4 | 4 | 4 | NR | 4 | 4 | 4 | 4 | 4 | 4 | NR | 4 | 4 | 4 | 4 | 4 | NR | 4 | 4 | 4 | 4 |
| Authority Elite/BroadAxe | 12 | 4.5 | 12B | 12B | 2[9] | 10 | 18 | 12B | 12B | 12B | 12B | 12B | 4 | 12B | 4.5 | 10 | NR | 12B | 4 | 12B | 4.5 |
| Authority First/Sonic | 12 | 12 | 12 | 12 | 30B | 10-18 | 10-18 | 30B | 30B | 30B | 9 | 30B | 18 | 30B | 12 | 12 | NR | 30B | 30B | 30B | 4 |
| Authority MTZ | 12 | 4 | 18 | 18 | 18 | 10 | 18 | 18 | 18 | 18 | 18 | 18 | 12 | 18 | 4 | 12 | NR | 18 | NR[9] | 18 | 4 |
| Authority XL | 18 | 4 | 36 | 36 | 18 | 10 | 18 | 18 | 36 | 36 | 36 | 36 | 36 | 18 | 4 | 10 | NR | 36 | 18[9] | 18 | 4 |
| Autumn | 18B | 9 | 18B | 18B | 18B | 1 | 9[1] | 18 | 18B | 18B | 18B | 18B | 18B | 18B | 18B | 18B | 2 | 18B | 18B | 18B | 3[1] |
| Axial XL | 3 | NR | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | NR |
| Axiom | 12 | 12 | 12 | 12 | 12 | NR | 12 | 12 | 12 | 18 | 12 | 12 | 1 | 12 | 12 | 12 | NR | NY | 12 | 12 | 0.33–4 |
| Balance Flexx/Pro | 10 | 6 | 18 | 18 | 18 | NR | 6 | 18 | 18 | 18 | 18 | 18 | 6 | 18 | 4 | 6 | 6 | 18 | 18 | 18 | 4 |
| Banvel | AH | 1[5] | AH | AH | AH | NR | AH | AH | AH | AH | AH | AH | AH | AH | 1[5] | NR | 1[5] | AH | AH | AH | 1[5] |

*Table continued on next page*

*Table E-3. Crop Rotation Planting Restrictions: Months After Herbicide Application Until Planting New Crop - continued*

| Crop<br>Herbicide Trade Name | Alfalfa | Barley, winter | Bean, lima | Bean, snap | Cabbage | Corn, field | Corn, sweet | Cucumber | Musk-melon | Onion | Peas | Pepper | Potato | Pumpkin | Rye, winter | Sorghum, grain | Soybean | Squash | Tomato | Watermelon | Wheat, winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basagran | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Basis[6] | 10 | 3 | 18 | 10 | 18 | NR | 10 | 10 | 18 | 18 | 10 | 18 | NR | 18 | 3 | 10[6] | 0.5[6] | 18 | 1 | 18 | 3 |
| Basis Blend[6.] | 10[1] | 3 | 18 | 10 | 18 | NR | 10 | 10 | 18 | 18 | 1.5 | 18 | 1 | 18 | 3 | 10[6] | 0.5[6] | 18 | 1 | 18 | 3 |
| Beacon | 8 | 3 | 18 | 18[7] | 18 | 0.5[8] | 8 | 18 | 18 | 18 | 8 | 18 | 18[7] | 18 | 3 | 8 | 8 | 18 | 18 | 18 | 3 |
| Beyond | 3 | 9 | NR | NR | 9 | 8.5[8] | 8.5 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 4 | 9 | NR | 9 | 9 | 9 | 3[8] |
| Bicep products/Cinch ATZ | SY | NY | SY | SY | SY | NR | NY | SY | SY | SY | SY | SY | SY | SY | NY | NR[10] | NY | SY | SY | SY | NY |
| Boundary | 4.5 | 4.5 | 12 | 12 | 12 | 4 | 8 | 12 | 12 | 18 | 8 | 12 | 18 | 12 | 12 | 12 | NR | 12 | 12 | 12 | 4.5 |
| Breakfree | NY | NY | NY | NI | NI | NR | NR | NI | NI | NI | NI | NI | NY | NI | NY | NY | NY | NI | NI | NI | 4 |
| Buctril/Maestro | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Bullet | NY | NY | NY | SY | SY | NR | NY | SY | SY | SY | SY | SY | SY | SY | NY | NR[10] | NY | SY | SY | SY | NY |
| Cadet | AH | AH | AH | AH | AH | NR | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | NR | AH | AH | AH | AH |
| Callisto | 10 | 4 | 18 | 18 | 18 | NR | NR | 18 | 18 | 18 | 18 | 18 | 10 | 18 | 4 | NR | 10 | 18 | 18 | 18 | 4 |
| Callisto Xtra | NY | NY | 18 | 18 | 18 | NR | NR | 18 | 18 | 18 | 18 | 18 | NY | 18 | 18 | NR | NY | 18 | 18 | 18 | NY |
| Canopy[1] | 10 | 4 | 30 | 12 | 18 | 10 | 18 | 18 | 30 | 30 | 12 | 30 | 30 | 18 | 4 | 12 | NR | 30 | 10[9] | 18 | 4 |
| Canopy Blend | 10 | 4 | 30 | 18 | 18 | 10[27] | 18 | 18 | 30 | 30 | 12 | 30 | 30 | 18 | 4 | 18 | NR | 30 | 10[9] | 18 | 4 |
| Canopy EX[1] | 10 | 4 | 12 | 12 | 18 | 10 | 18 | 18 | 30 | 18 | 12 | 18 | 30 | 18 | 4 | 10 | NR | 30 | 10[9] | 18 | 4 |
| Caparol | 12 | 12 | 12 | 12 | 5 | 5 | 5 | 12 | 12 | 8 | 5 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Capreno | 10[1] | 10 | 18 | 18 | 18 | NR | 10 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 10 | 10 | 18 | 18 | 18 | 4 |
| Celebrity Plus[1] | 10 | 4 | 10 | 10 | 10 | 0.25 | 10 | 10[1] | 10 | 10 | 10 | 10[1] | 10[1] | 10[1] | 4 | 10 | 4 | 10 | 10[1] | 10 | 4 |
| Chaparral | SYB | NY | SYB | SYB | SYB | NY | SYB | SYB | SYB | SYB | SYB | SYB | SYB | SYB | NY | NY | SYB | SYB | SYB | SYB | NY |
| Chateau (up to 3 oz/A)[11] | 5[11] | 4 | 12B | 4 | 12 | 0.5-1 | 4 | 12 | 12B | 12B | 4 | 12B | 5[11] | 12B | 4 | 1 | NR | 12B | 12B | 12B | 2 |
| Cimarron Max/metsulfuron[1] | 12[1] | 10 | NYB | NYB | NYB | NYB | NYB | NYB | NYB | NYB | NYB | NYB | NYB | NYB | NYB | NYB | NYB | NYB | NYB | NYB | 1 |
| Cimarron Plus | 4 | 10 | B | B | B | 12 | B | B | B | B | B | B | B | B | 4 | B | 12 | B | B | B | 1 |

*Table continued on next page*

***Table E-3. Crop Rotation Planting Restrictions: Months After Herbicide Application Until Planting New Crop - continued***

| Herbicide Trade Name \ Crop | Alfalfa | Barley, winter | Bean, lima | Bean, snap | Cabbage | Corn, field | Corn, sweet | Cucumber | Musk-melon | Onion | Peas | Pepper | Potato | Pumpkin | Rye, winter | Sorghum, grain | Soybean | Squash | Tomato | Watermelon | Wheat, winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clarity | 4 | 0.5–1.5[5] | 4 | 4 | 4 | NR | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 0.5–1.5[5] | NR | 0.5–1[5] | 4 | 4 | 4 | 0.5–1.5[5] |
| Classic[1] | 10 | 4 | 30 | 12 | 18 | 9 | 18 | 18 | 30 | 30 | 12 | 30 | 30 | 18 | 4 | 12 | NR | 30 | 10[9] | 18 | 4 |
| Cobra | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Command | 12 | 12 | 12 | 9 | 9 | 9 | 9 | 9 | 9 | 12 | NR | NR | 9 | NR | 12 | 9 | NR | NR[1] | 9[9] | 9 | 12 |
| Corvus | 17 | 9 | 17 | 17 | 17 | NR | 9 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 4 | 17 | 9 | 17 | 17 | 17 | 4 |
| Crossbow[31] | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI |
| Curbit | | | NR | | | | | | NR | | | | | | | | NR | | | NR | |
| Curtail | 10.5 | 1 | 18 | 18 | 10.5 | 1 | 10.5 | 18 | 18 | 10.5 | 18 | 18 | 18 | 18 | 1 | 10.5 | 10.5 | 18 | 18 | 18 | 1 |
| Dacthal | 8 | 8 | 8 | 8 | NR | 8 | 8 | AH | 8 | NR | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | AH | AH | 8 |
| Degree Xtra | SY | SY | SY | SY | SY | NR | NY | SY | SY | SY | SY | SY | SY | SY | SY | NR[10] | NY | SY | SY | SY | AH |
| Devrinol | 12 | 6 | 12 | 12 | NR | 12 | 12 | 12 | 12 | 12 | 12 | NR | 12 | 12 | 6 | 12 | 12 | 12 | NR | 12 | 6 |
| DiFlexx | 4 | 2 | 4 | 4 | 4 | NR | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 4 | 4 | 4 | 2 |
| DiFlexx Duo | 10 | 4 | 18B | 10 | 18B | NR | 4 | 18 | 18 | 18[28] | 10 | 18B | 10 | 18 | 4 | 10 | 8 | 18B | 10 | 18 | 4 |
| Distinct | 1 | 1 | 4 | 4 | 4 | 0.25 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 1 | 1 | 1 | 4 | 4 | 1 |
| Dual products/Cinch | 4 | 4.5 | NR | NR | 2[1] | NR | NR | 12 | 12 | 12 | NR | 2[1] | 2[1] | 2[1] | 4.5 | NR[10] | NR | 12 | 2[1] | 12 | 4.5 |
| Enlist Duo | NI | NI | NI | NI | NI | 0.23-0.5[34] | 0.23-0.5 | NI | NI | NI | NI | NI | NI | NI | NI | NI | 1[34] | NI | NI | NI | NI |
| Envive | 10 | 4 | 12 | 12 | 18 | 10 | 18 | 18 | 30 | 30 | 12 | 30 | 30 | 18 | 4 | 12 | NR | 30 | 12[9] | 18 | 4 |
| Eptam | NR | AH | AH | NR | AH | AH | AH | AH | AH | AH | AH | AH | NR | AH | AH | AH | AH | AH | AH | AH | AH |
| Evik | 11 | 3 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 11 | 3 | 11 | 11 | 11 | 11 | 11 | 3 |
| Expert | SY | NY | SY | SY | SY | NR | NY | SY | SY | SY | SY | SY | SY | SY | NY | NR[10] | NY | SY | SY | SY | NY |
| Extreme | 4 | 4 | NR | 2 | 40B | 8.5[13] | 18 | 40B | 40B | 40B | 4 | 40B | 26 | 40B | 4 | 18 | NR | 40B | 40B | 40B | 3 |
| Facet L | 24B | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 24B | 10 | 24B | 10 | 10 | NR | 10 | 10 | 24B | 10 | NR |
| Fierce[14] | 10 | 11–12[14] | 18 | 11 | 18 | 1[14] | 18 | 18 | 18 | 18 | 11[14] | 18 | 4 | 18 | 11–12[14] | 18 | NR | 18 | 18 | 18 | 1–2[14] |

*Table continued on next page*

*Table E-3. Crop Rotation Planting Restrictions: Months After Herbicide Application Until Planting New Crop - continued*

| Herbicide Trade Name \ Crop | Alfalfa | Barley, winter | Bean, lima | Bean, snap | Cabbage | Corn, field | Corn, sweet | Cucumber | Musk-melon | Onion | Peas | Pepper | Potato | Pumpkin | Rye, winter | Sorghum, grain | Soybean | Squash | Tomato | Watermelon | Wheat, winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fierce XLT[1] | 18 | 18 | 18 | 18 | 18 | 10 | 18 | 18 | 18 | 18[1] | 18 | 30 | 18[1] | 18 | 18 | 18 | NR | 18 | 18[9] | 18 | 4 |
| Finesse Cereal and Fallow (0.4 oz/A) | B | 10[1] | B | B | B | 18 | B | B | B | B | B | B | 10 | B | NR | 18 | 18[15] | B | B | B | NR |
| FirstRate | 9 | 12 | 9 | 9 | 30B | 9 | 18 | 18 | 30B | 30B | 9 | 18 | 18 | 18 | 18 | 9 | NR | 30B | 18 | 30B | 4 |
| Flexstar/Flexstar GT | 18 | 4 | 4 | NR | 18 | 10 | 10 | 12 | 12 | 18 | 4 | 10[9] | NR | 10 | 4 | 18 | NR | 12 | 10[9] | 10 | 4 |
| FulTime/Keystone/Breakfree ATZ | 15 | 15 | SY | SY | SY | NR | SY | SY | SY | SY | SY | SY | 15 | SY | 15 | NY | NY | SY | SY | SY | 15 |
| Fusilade/Fusion | NR | 2 | NR | NR | NR | 2 | 2 | NR | NR | NR | NR | NR | NR | NR | 2 | 2 | NR | NR | NR | NR | 2 |
| Galigan | 2 | 10 | 2 | 2 | NR[9] | 10 | 10 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 10 | 10 | NR | 2 | 2 | 2 | 10 |
| Glyphosate | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Goal/GoalTender | 2 | 10 | 2 | 2 | 2 (NR[10]) | 10 | 10 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 10 | 10 | NR | 2 | 2 | 2 | 10 |
| Gramoxone/paraquat | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| GrazonNext HL | 24B | 12 | 24B | 24B | 24B | 12 | 12 | 24B | 24B | 24B | 24B | 24B | 24B | 24B | 12 | 24B | 24B | 24B | 24B | 24B | 12 |
| Grazon P+D | B | 2 | B | B | B | B | B | B | B | B | B | B | B | B | 2 | 8 | B | B | B | B | 2 |
| Guardsman Max | SY | SY | SY | SY | SY | NR | NY | SY | SY | SY | SY | SY | SY | SY | SY | NR[10] | NY | SY | SY | SY | SY |
| Halex GT | 10 | 4.5 | 18 | 10[1] | 18 | NR | NR | 18 | 18 | 18 | 10[1] | 18 | 10 | 18 | 4.5 | NR[10] | 10 | 18 | 18 | 18 | 4.5 |
| Harmony Extra SG | 1.5 | NR | 1.5 | 1.5 | 1.5 | 0.75 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 0.75 | 0.5 | 1.5 | 1.5 | 1.5 | NR |
| Harmony SG | 1.5 | NR | 1.5 | 1.5 | 1.5 | NR | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | NR | NR | 1.5 | 1.5 | 1.5 | NR |
| Harness | 9 | NY | SY | SY | SY | NR | NR | SY | SY | SY | NY | SY | NY | SY | NY | NR[10] | NY | SY | SY | SY | 4 |
| Harness Xtra | SY | SY | SY | SY | SY | NR | NR | SY | SY | SY | SY | SY | SY | SY | SY | NY | NY | SY | SY | SY | NY |
| Hornet/Stanza | 10.5[1] | 4 | 10.5[1] | 18[17] | 26 | NR | 18[17] | 26B | 26 | 26 | 18[17] | 26B | 18 | 26B | 4 | 12 | 10.5 | 26 | 26B | 26B | 4 |
| Huskie | 4[1] | 0.25 | 1B | 9 | 1B | 4 | 1B | 1B | 1B | 9[1] | 9 | 1B | 9 | 1B | 1 | 0.25 | 4 | 1B | 1B | 1B | 0.25 |
| Impact/Armezon (0.75 oz/A) | 9 | 3 | 18 | 9 | 18 | NR | NR | 18 | 18 | 18 | 9 | 18 | 9 | 18 | 3 | 9 | 9 | 18 | 18 | 18 | 3 |
| Instigate | 10 | 4 | 18 | 18 | 18 | NR | 10 | 18 | 18 | 18 | 18[1] | 18 | 10 | 18 | 4 | 10 | 10 | 18 | 18 | 18 | 4 |
| Karmex | 24 | 24 | 24 | 24 | 24 | 6 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | NY | 24 | 24 | 24 | 24 | 12 |

*Table continued on next page*

***Table E-3. Crop Rotation Planting Restrictions: Months After Herbicide Application Until Planting New Crop - continued***

| Herbicide Trade Name \ Crop | Alfalfa | Barley, winter | Bean, lima | Bean, snap | Cabbage | Corn, field | Corn, sweet | Cucumber | Musk-melon | Onion | Peas | Pepper | Potato | Pumpkin | Rye, winter | Sorghum, grain | Soybean | Squash | Tomato | Watermelon | Wheat, winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kerb | NR | 12 | 3-4 | 3-4 | 3-6 | 5 | 5 | 3-6 | 3-6 | 3-6 | 3-4 | 3-6 | 3 | 3-6 | 12 | 5 | 3-4 | 3-6 | 3-6 | 3-6 | 12 |
| Keystone NXT | SY | 15 | SY | 18 | 18 | NR | NR | 18 | 18 | 18 | SY | 18 | SY | 18 | 15 | NY | NY | 18 | 18 | 18 | 15 |
| Laudis | 10 | 4 | 18 | 10 | 18 | NR | NR | 18 | 18 | 8[1] | 10 | 18 | 10 | 18 | 4 | 10 | 8 | 18 | 10 | 18 | 4 |
| Leadoff (1.5 oz/A) | 10 | 3 | 10 | 18 | 18 | NR | 10 | 10 | 18 | 18 | 10 | 18 | 1 | 18 | 3 | 10 | 1[1] | 18 | 1 | 18 | 3 |
| Lexar/Lexar EZ | 18 | NY | 18 | 18 | 18 | NR | NR | 18 | 18 | 18 | 18 | 18 | 18 | 18 | NY | NR[10] | NY | 18 | 18 | 6 | NY |
| Liberty/Interline/Rely 280 | 6 | 2.3 | 6 | 6 | 2.3 | NR | NR | 6 | 6 | 2.3 | 6 | 6 | 2.3 | 6 | 2.3 | 6 | NR | 6 | 6 | 18 | 2.3 |
| Lightning | 9.5 | 9.5 | 40 | 9.5 | 40B | 8.5[8] | 18 | 40B | 40 | 40 | 9.5 | 40B | 26 | 40B | 4 | 18 | 9 | 40 | 40B | 40B | 4 |
| Lorox/Linex | 4 | 4 | 4 | 4 | 4 | NR | 4 | 4 | 4 | 4 | 4 | 4[9] | NR | 4 | 4 | 4 | NR | 4 | 4 | 4 | 4 |
| Lumax/Lumax EZ | 18 | 4.5 | 18 | 18 | 18 | NR | NR | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 4.5 | NR[10] | NY | 18 | 18 | 18 | 4.5 |
| Marksman | SY | 10 | SY | SY | SY | NR | NR | SY | SY | SY | SY | SY | SY | SY | 10 | NR | NY | SY | SY | SY | 10 |
| Marvel | 18 | 4 | 18 | NR | 18 | 10 | 10 | 18 | 18 | 18 | 10 | 4 | NR | 18 | 4 | 18 | NR | 18 | 4[9] | 18 | 4 |
| Matrix | 4 | 12 | 10 | 10 | 12 | NR | 10 | 10 | 18 | 10 | 8 | 12 | NR | 12 | 12 | 18 | 4 | 18 | NR | 12 | 4 |
| Maverick | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3–12[15] | 3B | 3B | 3B | 3 |
| Metribuzin | 4 | 4[1] | 18 | 12 | 18 | 4 | 4 | 12 | 18 | 18 | 8 | 12 | 12 | 12 | 12 | 12 | NR | 18 | 4 | 18 | 4[1] |
| Micro-Tech/Intrro | AH | AH | NR[1] | NY | NI | NR | NR | NY | NI | NI | NY | NY | NY | NY | AH | NR[10] | NR | NI | NY | NI | AH |
| Milestone | 24B | 12 | 24B | 24B | 12B | 12 | 24B | 24B | 24B | 24B | 24B | 24B | 24B | 24B | 12 | 24B | 24B | 24B | 24B | 24B | 12 |
| NorthStar | 8 | 3 | 18 | 8 | 18 | 0.5[8] | 8 | 18 | 18 | 18 | 8 | 18 | 8 | 18 | 3 | 8 | 8 | 18 | 18 | 18 | 3 |
| Optill[1] | 4 | 9.5 | 40B | 4 | 40B | 8.5 | 18 | 18 | 40B | 40B | 4 | 18 | 26 | 40B | 4 | 18 | 0–1 | 40B | 18 | 40B | 4 |
| Option | 2 | 2 | 2 | 2 | 2 | 0.25 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0.5 | 2 | 2 | 2 | 2 |
| Osprey | 10 | 1 | 10 | 10 | 10 | 3 | 10 | 10 | 10 | 10 | 3 | 10 | 10 | 10 | 10 | 3 | 3 | 10 | 10 | 10 | 0.25 |
| Outlook | 6 | 4 | 9 | 9 | 9 | NR | NR | 9 | 9 | 9 | 4 | 9 | 9 | 9 | 4 | NR[10] | NR | 9 | 9 | 9 | 4 |
| Outrider | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | 3B | NR |
| Overdrive | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

*Table continued on next page*

*Table E-3. Crop Rotation Planting Restrictions: Months After Herbicide Application Until Planting New Crop - continued*

| Herbicide Trade Name \ Crop | Alfalfa | Barley, winter | Bean, lima | Bean, snap | Cabbage | Corn, field | Corn, sweet | Cucumber | Musk-melon | Onion | Peas | Pepper | Potato | Pumpkin | Rye, winter | Sorghum, grain | Soybean | Squash | Tomato | Watermelon | Wheat, winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PastureGard | 1 | 4 | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | NI | 4 |
| Peak (0.25 oz/A)[1] | 22 | NR | 22 | 10 | 22 | 1 | 10 | 22 | 22 | 22 | 10 | 22 | 22 | 22 | NR | 1 | 10 | 22 | 22 | 22 | NR |
| Permit | 9 | 2 | 9 | 9[1] | 15 | 1[8] | 3 | 9 | 9 | 18 | 9 | 10 | 9 | 9 | 2 | 2 | 9 | 9 | 8[1] | 9 | 2 |
| Permit Plus | 9 | 2 | 9 | 2 | 15 | 1 | 3 | 2 | 9 | 18 | 9 | 10 | 9 | 9 | 2 | 2 | 9[15] | 9 | 2[9] | 9 | 2 |
| Poast | NR | AH | NR | NR | NR | AH | NR | NR | NR | NR | NR | NR | NR | NR | AH | AH | NR | NR | NR | NR | AH |
| PowerFlex HL | 9 | 9 | 12 | 12 | 12 | 9 | 9 | 12 | 12 | 12 | 9 | 12 | 9 | 12 | 12 | 9 | 5[1] | 12 | 12 | 12 | 1 |
| Prefar | 4 | 4 | 4 | 4 | NR | 4 | 4 | NR | NR | NR | 4 | NR | 4 | NR | 4 | 4 | 4 | NR | NR | NR | 4 |
| Prefix | 18 | 4.5 | 4 | NR | 18 | 10 | 10 | 12 | 18 | 18 | 4 | 10[9] | 1 | 10 | 4.5 | 18 | NR | 12 | 10[9] | 10 | 4.5 |
| Prequel[1] | 10 | 4 | 18 | 10 | 18 | NR | 10 | 18 | 18 | 18 | 18 | 18 | 6 | 18 | 4 | 10 | 10 | 18 | 18 | 18 | 4 |
| Princep | SY | NY | SY | SY | SY | NR | NY | SY | SY | SY | SY | SY | SY | SY | NY | NY | NY[18] | SY | SY | SY | NY |
| Prowl H2O | 6[1] | 4 | NR | NY | NY | NR[19] | NY | NY | NY | NY | NY | NY | NY | NY | NY | 10-18[1] | NR | NY | NY | NY | 4 |
| Pulsar | 9 | 0.75 | 12 | 12 | 12 | NR | 4 | 12 | 12 | 12 | 9 | 12 | 9 | 12 | 0.75 | 4 | 9 | 12 | 12 | 12 | 0.75 |
| Pursuit[1] | 4 | 4[1] | NR | 2 | 18 | 8.5[8] | 18 | 18 | 40 | 18 | NR | 18[9] | 18 | 40B | 4 | 18 | NR | 40B | 18[9] | 18 | 4 |
| Python/Accolade | 4 | 4 | 4 | 4[1] | 18 | NR | 18 | 26B | 26B | 26B | 4 | 26B | 12 | 26B | 4 | 12 | NR | 26B | 26B | 26B | 4 |
| Raptor | 3 | 9[1] | NR | NR | 9 | 8.5 | 8.5 | 9 | 9 | 9 | NR | 9 | 9[1] | 9 | 4 | 9 | NR | 9 | 9 | 9 | 3 |
| Realm Q | 10 | 4 | 18 | 10[1] | 18 | NR | 10 | 18 | 18 | 18 | 10[1] | 18 | 10 | 18 | 4 | 10 | 10 | 18 | 18 | 18 | 4 |
| Reflex | 18 | 4 | 4 | NR | 18 | 10 | 10 | 12 | 12 | 18 | 4 | 10[9] | NR | 10 | 4 | 18 | NR | 12 | 10[9] | 10 | 4 |
| Remedy Ultra | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Resicore | 10.5[29] | 10.5[29] | 18 | 18 | 18 | NR[29] | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 10.5[29] | 10.5[29] | 10.5[29] | 18 | 18 | 18 | 4 |
| Resolve (1 oz/A) | 10 | 18 | 18 | 10 | 18 | NR | 10 | 10 | 18 | 18 | 10 | 18 | NR | 18 | 18 | 10 | 10 | 18 | 1 | 18 | 4 |
| Resolve Q (1.25 oz/A) | 10 | 3 | 18 | 10 | 18 | NR | 10 | 10 | 18 | 18 | 10 | 18 | 1.5 | 18 | 3 | 10 | 2[1] | 18 | 1.5 | 18 | 3 |
| Resource | 1 | 1 | 1 | 1 | 1 | NR | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | NR | 1 | 1 | 1 | 1 |
| Revulin Q[1] | 10 | 4 | 18 | 18 | 18 | NR | 10[21] | 18 | 18 | 18 | 18 | 18 | 10[1] | 18 | 4 | 10 | 10 | 18 | 18 | 18 | 4 |

*Table continued on next page*

***Table E-3. Crop Rotation Planting Restrictions: Months After Herbicide Application Until Planting New Crop - continued***

| Herbicide Trade Name \ Crop | Alfalfa | Barley, winter | Bean, lima | Bean, snap | Cabbage | Corn, field | Corn, sweet | Cucumber | Musk-melon | Onion | Peas | Pepper | Potato | Pumpkin | Rye, winter | Sorghum, grain | Soybean | Squash | Tomato | Watermelon | Wheat, winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ro-Neet | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH |
| Sandea | 9 | 2 | NR | 2 | 15 | 1 | 3 | 2 | 9 | 18 | 9 | 10 | 9 | 9 | 2 | 2 | 5[1] | 9 | 2 | 9 | 2 |
| Scepter[13] | 18 | 11 | 18 | 11 | 18 | 9.5[13] | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 11 | NR | 18 | 18 | 18 | 3 |
| Select/Select Max | NR | 1 | NR | NR | NR | 1 | 1 | NR | NR | NR | NR | NR | NR | NR | 1 | 1 | NR | NR | NR | NR | 1 |
| Sentrallas | 4 | NR | 4 | 4 | 4 | NR | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | NR | 4 | 4 | 4 | 4 | NR |
| Sharpen (1 oz/A)[1] | 4 | NR | 9 | 4 | 9 | NR | 0.5 | 4 | 9 | 9 | NR | 4 | 4 | 4 | NR | NR | 0–1 | 9 | 4 | 9 | NR |
| Sierra[1] | 24B | 9 | 9 | 24B | 24B | 11 | 24B | 24B | 24B | 24B | 24B | 24B | 9 | 24B | 24B | 24B | 6–9 | 24B | 24B | 24B | NR |
| Sinbar | 12 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | NR | 24 |
| Solicam | 16 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 1.5–16 | 24 | 24 | 24 | 24 |
| Solstice | 10 | 4 | 18 | 18 | 18 | NR | NR | 18 | 18 | 18 | 18 | 18 | 10 | 18 | 4 | AH | 10 | 18 | 18 | 19 | 4 |
| Sonalan | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | AH | NR | AH | AH | AH | AH |
| Spartan | 12 | 4 | NR | 12B | NR | 10 | 18 | 12B | 12B | 12B | 12B | 12B | 12B | 12B | 4 | 10[1] | NR | 12B | NR[9] | 12B | 4 |
| Spartan Advance | 12 | 4 | NR | 12B | NR[9] | 4 | 12 | 12B | 12B | 12B | 12B | 12B | 4 | 12B | 4 | 10[1] | NR | 12B | 12B | 12B | 4 |
| Spartan Charge | 12 | 4 | 4 | 12B | NR[9] | 4 | 12 | 12B | 12B | 12B | 12B | 12B | 4 | 12B | 4 | 10–18 | NR | 12B | NR[9] | 12B | 4 |
| Spin-Aid | NR | 4 | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | 4 | NR | NR | NR | NR | NR | 4 |
| Spirit | 18 | 3 | 18 | 10 | 10 | 1[8] | 8 | 18 | 18 | 18 | 10 | 18 | 10 | 18 | 3 | 10 | 10 | 18 | 10 | 18 | 3 |
| Spur | 10.5 | NR | 18 | 18 | NR | NR | NR | 18 | 18 | 10.5 | 18 | 18 | 18 | 18 | NR | 10.5 | 10.5-18 | 18 | 10.5B | 10.5B | NR |
| Starane Ultra | 4 | NR | 4 | 4 | 4 | NR | NR | 4 | 4 | 4 | 4 | 4 | 4 | 4 | NR | NR | 4[32] | 4 | 4 | 4 | NR |
| Status | 1[5] | 1[5] | 4 | 4 | 4 | 0.25 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1[5] | 1[5] | 1[5] | 4 | 4 | 4 | 1[5] |
| Steadfast/Steadfast Q | 10[1] | 4 | 18 | 10 | 18 | NR | 10[1] | 10 | 18 | 18 | 10 | 10 | 10[1] | 10 | 4 | 10 | 0.5 | 18 | 10 | 18 | 4 |
| Stinger | 10.5 | NR | 18 | 18 | NR | NR | 10.5 | 18 | 18 | 10.5 | 18B | 18 | 18B | 18 | NR | 10.5 | 10.5[1] | 18 | 18 | 18 | NR |
| Storm | 3.3 | 1.5 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 1.5 | 3.3 | NR | 3.3 | 3.3 | 3.3 | 1.5 |
| Stout | 10 | 4 | 18 | 10 | 18 | NR | 10[21] | 18 | 18 | 18 | 10 | 18 | 10[1] | 18 | 4 | 10 | 0.5 | 18 | 18 | 18 | 4 |

*Table continued on next page*

*Table E-3. Crop Rotation Planting Restrictions: Months After Herbicide Application Until Planting New Crop - continued*

| Herbicide Trade Name \ Crop | Alfalfa | Barley, winter | Bean, lima | Bean, snap | Cabbage | Corn, field | Corn, sweet | Cucumber | Musk-melon | Onion | Peas | Pepper | Potato | Pumpkin | Rye, winter | Sorghum, grain | Soybean | Squash | Tomato | Watermelon | Wheat, winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SureStart/TripleFLEX | NY[1] | NY | NY | 26B | 26B | NR | 18[1] | 26B | 26B | 26B | NY | 26B | 18 | 26B | NY | 12 | NY[1] | 26B | 26B | 26B | 4 |
| Surpass NXT | 9 | NY | NY | NY | 18 | NR | NR | 18 | 18 | 18 | NY | 18 | NY | 18 | NY | NR[10] | NY | 18 | NY | 18 | 4 |
| Surveil | 10 | 30B | 30B | 9 | 30B | 9 | 18 | 30B | 30B | 30B | 9 | 30B | 18 | 30B | 30B | 9 | NR | 30B | 30B | 30B | 3 |
| Synchrony XP[1] | 12 | 3 | 9 | 9 | 18 | 9 | 18 | 18 | 30 | 30 | 9 | 30 | 8 | 18 | 3 | 9 | NR | 30 | 9[9] | 18 | 3 |
| Targa | 4 | NR | NR | NR | 4 | 4 | 4 | 4 | 4 | 4 | NR | 4 | 4 | 4 | 4 | 4 | NR | 4 | 4 | 4 | NR |
| Treflan | NR | NR | NR | NR | NR | NR | 12 | NR | 5 | NR | NR | NR[9] | NR | 5 | NR | NR | NR | 5 | NR | 5 | NR |
| Trivence | 10 | 4 | 30 | 30 | 18 | 10 | 18 | 18 | 30 | 30 | 12 | 30 | 30 | 18 | 30 | 18 | NR | 30 | 12[9] | 18 | 4 |
| Ultra Blazer | 3.3 | 1.5 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 1.5 | 3.3 | NR | 3.3 | 3.3 | 3.3 | 1.5 |
| Valor/Rowel (up to 3 oz/A) | 5[11] | 4 | 12B | 4 | 12B | 0.5-1[1] | 4 | 12B | 12B | 12B | 4 | 12B | 5[11] | 12B | 4 | 1 | NR | 12 | 12B | 12B | 2 |
| Valor XLT/Rowel FX | 12 | 4 | 18[23] | 12 | 18 | 10[23] | 18 | 18 | 18[23] | 18[23] | 12 | 18 | 18[23] | 18 | 4 | 10 | NR | 18[23] | 12[9] | 18 | 4 |
| Varisto | 3 | 9[30] | NR | NR | 9 | 8.5[30] | 8.5 | 9 | 9 | 9 | NR | 9 | 9[30] | 9 | 4 | 9 | NR | 9 | 9 | 9 | 3[30] |
| Verdict | NY | 4 | NY | NY | NY | NR | NR | NY | NY | NY | NY | NY | NY | NY | 4 | NR | 1-4[1] | NY | NY | NY | 4 |
| Vida | 1 | 1 day | 1day | 1 day | 1 day | NR | 1 | 1 day | 1 day | 1 day | 1 day | 1 day | NR | 1 day | 1 day | 1 day | NR | 1 day | 1 day | 1 day | NR |
| Warrant | 9 | NY | NI | NY | NI | NR | NY | NI | NI | NI | NY | SY | NY | SY | NY | NR[10] | NR | NI | NI | NI | 4 |
| Warrant Ultra | 18 | 4 | NI | NY | NI | 10 | 10[33] | 18 | NI | NI | 10 | 18 | 18 | 18 | 4 | 18 | NR | NI | 18 | NI | 4 |
| Xtendimax[1] | 4 | 1 | 4 | 4 | 4 | NR | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 0.5[1] | 1 | 4 | 4 | 4 | 1 |
| Yukon | 9 | 2 | NI | 2 | 15 | 1 | 3 | 9 | 9 | 18 | 9 | 10 | 9 | 9 | 2 | 2 | 9[1] | 9 | 2[9] | 9 | 2 |
| Zemax | 18 | 4.5 | 18 | 18 | 18 | NR | NR | 18 | 18 | 18 | 18 | 18 | NY | 18 | 4.5 | NR[10] | NY | 18 | 18 | 18 | 4.5 |
| Zeus XC | 12 | 4 | NR | 12B | NR[9] | 10 | 18 | 12B | 12B | 12B | 12B | 12B | 12B | 12B | 4 | 10[1] | NR | 12B | NR[9] | 12B | 4 |
| Zidua (3 or 5 fl oz/A)[1] | 10 | 11 | 11 | 11 | 18 | NR | NR | 18 | 18 | 18 | 11 | 18 | 4 | 18 | 11 | 10 | NR | 18 | 18 | 18 | 4 |

# 2.4 Prepackaged Herbicide Mixtures

**Table E-4. Prepackaged Herbicide Mixtures Available for Various Vegetable Crops and the Components of the Mixtures**

| Trade Name | Components (ai/gal or lb) | WSSA Site of Action Number | If You Apply (per acre) | You Have Applied (ai per acre) | Equivalent to a Tank Mixture of These Products (per acre) |
|---|---|---|---|---|---|
| **Acuron 3.44SC** | 2.14 lb s-metolachlor | 15 | 2.5 qt | 1.34 lb s-metolachlor | 1.4 pt Dual II Magnum 7.64E |
| | 0.24 lb mesotrione | 27 | | 0.15 lb mesotrione | 4.8 fl oz Callisto 4SC |
| | 0.06 lb bicyclopyrone | 27 | | 0.038 lb bicyclopyrone | 0.038 lb bicyclopyrone |
| | 1 lb atrazine | 5 | | 0.625 lb atrazine | 0.625 qt Atrazine 4L |
| **Acuron Flexi 3.26SC** | 2.86 lb s-metolachlor | 15 | 2 qt | 1.43 lb s-metolachlor | 1.5 pt Dual II Magnum 7.64E |
| | 0.32 lb mesotrione | 27 | | 0.16 lb mesotrione | 5.12 fl oz Callisto 4SC |
| | 0.08 lb bicyclopyrone | 27 | | 0.04 lb bicyclopyrone | 0.04 lb bicyclopyrone |
| **Armezon PRO 5.35 EC** | 0.1 lb topramezone | 27 | 24 fl oz | 0.017 lb topramezone | 0.76 fl oz Armezon |
| | 5.25 lb dimethenamid | 15 | | 0.84 lb dimethenamid | 18 fl oz Outlook |
| **Bicep II Magnum 5.5L** | 2.4 lb s-metolachlor | 15 | 2.1 qt | 1.26 lb s-metolachlor | 1.33 pt Dual II Magnum 7.64E |
| | 3.1 lb atrazine | 5 | | 1.63 lb atrazine | 1.63 qt Atrazine 4L |
| **Bullet 4ME** | 2.5 lb alachlor | 15 | 3 qt | 1.875 lb alachlor | 1.9 qt Intrro 4L |
| | 1.5 lb atrazine | 5 | | 1.125 lb atrazine | 1.13 qt Atrazine 4L |
| **Degree Xtra 4.04ME** | 2.7 lb acetochlor | 15 | 3 qt | 2.03 lb acetochlor | 4.3 pt Degree 3.8ME |
| | 1.34 lb atrazine | 5 | | 1 lb atrazine | 1 qt Atrazine 4L |
| **Guardsman Max 5L** | 1.7 lb dimethenamid | 15 | 3.5 pt | 0.74 lb dimethenamid | 15.9 fl oz Outlook 6E |
| | 3.3 lb atrazine | 5 | | 1.44 lb atrazine | 1.44 qt Atrazine 4L |
| **Harness Xtra 5.6L** | 0.74 lb dimethenamid | 15 | 2.5 qt | 1.94 lb acetochlor | 2.21 pt Harness 7E |
| | 1.44 lb atrazine | 5 | | 1.56 lb atrazine | 1.56 qt Atrazine 4L |
| **Keystone NXT 5.6SE** | 3.1 lb acetochlor | 15 | 2.5 qt | 1.94 lb acetochlor | 2.22 pt Surpass NXT 7E |
| | 2.5 lb atrazine | 5 | | 1.57 lb atrazine | 3.15 pt Atrazine 4L |
| **Lexar EZ 3.7SC** | 1.74 lb s-metolachlor | 15 | 3 qt | 1.3 lb s-metolachlor | 1.36 pt Dual II Magnum 7.64E |
| | 0.224 lb mesotrione | 27 | | 0.168 lb mesotrione | 5.36 oz Callisto 4SC |
| | 1.74 lb atrazine | 5 | | 1.3 lb atrazine | 1.3 qt Atrazine 4L |
| **Lumax EZ 3.6SC** | 2.49 lb s-metolachlor | 15 | 2.7 qt | 1.67 lb s-metolachlor | 1.75 pt Dual II Magnum 7.64E |
| | 0.249 lb mesotrione | 27 | | 0.168 lb mesotrione | 5.36 oz Callisto 4SC |
| | 0.935 lb atrazine | 5 | | 0.625 lb atrazine | 0.625 qt Atrazine 4L |
| **Revulin Q 51.2WDG** | 0.144 lb nicosulfuron | 2 | 4 oz | 0.036 lb nicosulfuron | 1.1 oz Accent Q WG |
| | 0.368 lb mesotrione | 27 | | 0.094 lb mesotrione | 3 fl oz Callisto 4SC |
| **Solstice 4SC** | 0.216 lb fluthiacet | 15 | 3 fl oz | 0.0051 lb fluthiacet | 0.7 fl oz Cadet 0.91EC |
| | 3.784 lb mesotrione | 27 | | 0.089 lb mesotrione | 2.85 fl oz Callisto 4SC |
| **Spartan Charge 3.5EC** | 3.15 lb sulfentrazone | 14 | 3.5 fl oz | 0.09 lb sulfentrazone | 2.8 fl oz Zeus 4L |
| | 0.35 lb carfentrazone | 14 | | 0.01 lb carfentrazone | 0.6 fl oz Aim 2EC |
| **Strategy 2.1SC** | 1.6 lb ethalfluralin | 3 | 3 pt | 0.61 lb ethalfluralin | 26 fl oz Curbit 3EC |
| | 0.5 lb clomazone | 13 | | 0.19 lb clomazone | 8 fl oz Command 3ME |
| **Varisto 4.187SL** | 4 lb bentazon | 6 | 21 fl oz | 0.65 lb bentazon | 21 fl oz Basagran 4L |
| | 0.187 imazamox | 2 | | 0.03 lb imzamox | 4 fl oz Raptor 1L |
| **Verdict 5.57EC** | 5 lb dimethenamid | 15 | 13 fl oz | 0.5 lb dimethenamid | 11 fl oz Outlook 6EC |
| | 0.57 lb saflufenacil | 14 | | 0.058 lb saflufenacil | 2.6 fl oz Sharpen 2.85L |
| **Zemax 3.67SC** | 3.34 lb s-metolachlor | 15 | 2 qt | 1.67 lb s-metolachlor | 1.75 pt Dual II Magnum 7.64E |
| | 0.33 lb mesotrione | 27 | | 0.165 lb mesotrione | 5.36 fl oz Callisto 4SC |

# 2.5 Herbicide Site of Action: Reducing the Risk of Herbicide Resistance

**Reducing the risk for developing herbicide-resistant weed populations requires incorporating a number of guidelines in managing your fields. These guidelines include:**

- Spray only when necessary
- Use alternative methods of control whenever possible such as mechanical cultivation or using cover crops, delayed planting (row crops), mowing (forage crops), and using weed-free crop seeds
- Rotate crops and their accompanying herbicides' site of action (WSSA Group Number, see note below)
- Limit the number of applications of herbicide(s) with the same site of action in a given growing season
- Use mixtures or sequential herbicide treatments with different sites of action that will control the weeds of concern
- Scout fields after herbicide application to detect weed escapes or shifts
- Clean equipment before leaving fields infested with or suspected to have resistant weeds

### Note: WSSA Group Number

A classification of herbicides based on mode and site of actions, was developed to better understand and plan for resistance management. Rotating herbicides with differing sites of action is important for minimizing the risk of developing herbicide-resistant weeds. The system was developed by the Weed Science Society of America (WSSA) (See: E. James Retzinger and Carol Mallory-Smith. 1997. Classification of Herbicides by Site of Action for Weed Resistance Management Strategies. Weed Technology volume 11, pages 384 to 393).

### Table E-5. Important Herbicide Groups for Commercial Vegetables

In the table below, important herbicide groups for vegetable crops grown in the Mid-Atlantic region are listed with their sites of action. Note that more than one herbicide family may have the same site of action.

| Trade Name | Active Ingredient | WSSA Group | Herbicide Class | Site of Action |
|---|---|---|---|---|
| **2,4-D** | 2-4-D | 4 | Plant growth regulators | IAA-like |
| **Accent Q** | nicosulfuron | 2 | Amino acid biosynthesis | ALS-enzyme |
| **Aim** | carfentrazone | 14 | Cell membrane disrupters | PPO (protoporphyr-ingogen oxidase) |
| **Armezon** | topramezone | 27 | Pigment inhibitors | HPPD (hydroxy-phenyl-pyruvate-dioxygenase) |
| **Assure II** | quizalofop | 1 | Fatty acid (Lipid) biosynthesis inhibitors | ACCase |
| **Atrazine** | atrazine | 5 | Photosynthesis inhibitors (mobile 1) | Photosystem II |
| **Banvel** | dicamba | 4 | Plant growth regulators | IAA-like |
| **Basagran** | bentazon | 6 | Photosynthesis inhibitors (non-mobile) | Photosystem II |
| **Breakfree** | acetochlor | 15 | Seedling growth inhibitors (Shoot) | Unknown |
| **Cadet** | fluthiacet | 14 | Cell membrane disrupters | PPO (protoporphyr-ingogen oxidase) |
| **Callisto** | mesotrione | 27 | Pigment inhibitors | HPPD (hydroxy-phenyl-pyruvate-dioxygenase) |
| **Caparol** | prometryn | 5 | Photosynthesis inhibitors (mobile 1) | Photosystem II |
| **Chateau** | flumioxazin | 14 | Cell membrane disrupters | PPO (protoporphyr-ingogen oxidase) |
| **Clarity** | dicamba | 4 | Plant growth regulators | IAA-like |
| **Command** | clomazone | 13 | Pigment inhibitors | Diterpenes (carotenoid biosynthesis) |
| **Curbit** | ethalfluralin | 3 | Seedling growth inhibitors (Root) | Microtubule inhibitors |
| **Dacthal** | DCPA | 3 | Seedling growth inhibitors (Root) | Unknown |
| **Degree** | acetochlor | 15 | Seedling growth inhibitors (Shoot) | Unknown |
| **Devrinol** | napropamide | 15 | Seedling growth inhibitors (Shoot) | Unknown |
| **Dimetric** | metribuzin | 5 | Photosynthesis inhibitors (mobile 1) | Photosystem II |
| **Dual Magnum** | s-metolachlor | 15 | Seedling growth inhibitors (Shoot) | Unknown |
| **Eptam** | EPTC | 8 | Seedling growth inhibitors (Shoot) | Lipid synthesis inhibitors |
| **Formula 40** | 2-4-D | 4 | Plant growth regulators | IAA-like |
| **Fusilade** | fluazifop | 1 | Fatty acid (Lipid) biosynthesis inhibitors | ACCase |
| **Glory** | metribuzin | 5 | Photosynthesis inhibitors (mobile 1) | Photosystem II |

*Table continued on next page.*

*Table E-5. Important Herbicide Groups for Commercial Vegetables - continued*

| Trade Name | Active Ingredient | WSSA Group | Herbicide Class | Site of Action |
|---|---|---|---|---|
| **Glyphosate** | glyphosate | 9 | Amino acid biosynthesis | EPSP-enzyme |
| **Goal** | oxyfluorfen | 14 | Cell membrane disrupters | PPO (protoporphyr-ingogen oxidase) |
| **Goal Tender** | oxyfluorfen | 14 | Cell membrane disrupters | PPO (protoporphyr-ingogen oxidase) |
| **Gramoxone** | paraquat | 22 | Cell membrane disrupters | Photosystem I |
| **Harness** | acetochlor | 15 | Seedling growth inhibitors (Shoot) | Unknown |
| **Impact** | topramezone | 27 | Pigment inhibitors | HPPD (hydroxy-phenyl-pyruvate-dioxygenase) |
| **Intrro** | alachlor | 15 | Seedling growth inhibitors (Shoot) | Unknown |
| **Karmex** | diuron | 7 | Photosynthesis inhibitors (mobile 2) | Photosystem II |
| **Kerb** | pronamide | 15 | Seedling growth inhibitors (Shoot) | Unknown |
| **Laudis** | tembotrione | 27 | Pigment inhibitors | HPPD (hydroxy-phenyl-pyruvate-dioxygenase) |
| **Liberty** | glufosinate | 10 | Phosphorylated amino acid (N metabolism disrupter) | Glutamine synthetase |
| **Linex** | linuron | 7 | Photosynthesis inhibitors (mobile 2) | Photosystem II |
| **Lorox** | linuron | 7 | Photosynthesis inhibitors (mobile 2) | Photosystem II |
| **Maestro** | bromoxynil | 6 | Photosynthesis inhibitors (non-mobile) | Photosystem II |
| **Matrix** | rimsulfuron | 2 | Amino acid biosynthesis | ALS-enzyme |
| **Metribuzin** | metribuzin | 5 | Photosynthesis inhibitors (mobile 1) | Photosystem II |
| **Outlook** | dimethenamid | 15 | Seedling growth inhibitors (Shoot) | Unknown |
| **Permit** | halosulfuron | 2 | Amino acid biosynthesis | ALS-enzyme |
| **Poast** | sethoxydim | 1 | Fatty acid (Lipid) biosynthesis inhibitors | ACCase |
| **Prefar** | bensulide | 8 | Seedling growth inhibitors (Shoot) | Lipid synthesis inhibitors |
| **Prowl** | pendimethalin | 3 | Seedling growth inhibitors (Root) | Microtubule inhibitors |
| **Prowl H2O** | pendimethalin | 3 | Seedling growth inhibitors (Root) | Microtubule inhibitors |
| **Pursuit** | imazethapyr | 2 | Amino acid biosynthesis | ALS-enzyme |
| **Raptor** | imazamox | 2 | Amino acid biosynthesis | ALS-enzyme |
| **Reflex** | fomesafen | 14 | Cell membrane disrupters | PPO (protoporphyr-ingogen oxidase) |
| **Rely** | glufosinate | 10 | Phosphorylated amino acid (N metabolism disrupter) | Glutamine synthetase |
| **Ro-Neet** | cycloate | 8 | Seedling growth inhibitors (Shoot) | Lipid synthesis inhibitors |
| **Roundup** | glyphosate | 9 | Amino acid biosynthesis | EPSP-enzyme |
| **Sandea** | halosulfuron | 2 | Amino acid biosynthesis | ALS-enzyme |
| **Select** | clethodim | 1 | Fatty acid (Lipid) biosynthesis inhibitors | ACCase |
| **Sinbar** | terbacil | 5 | Photosynthesis inhibitors (mobile 1) | Photosystem II |
| **Solicam** | norflurazon | 12 | Pigment inhibitors | PDS (carotenoid biosynthesis) |
| **Spin-Aid** | phenmedipham | 5 | Photosynthesis inhibitors (mobile 1) | Photosystem II |
| **Spur** | clopyralid | 4 | Plant growth regulators | IAA-like |
| **Starane Ultra** | fluroxypyr | 4 | Plant growth regulators | IAA-like |
| **Stinger** | clopyralid | 4 | Plant growth regulators | IAA-like |
| **Surpass** | acetochlor | 15 | Seedling growth inhibitors (Shoot) | Unknown |
| **Targa** | quizalofop | 1 | Fatty acid (Lipid) biosynthesis inhibitors | ACCase |
| **Thistrol** | MCPB | 4 | Plant growth regulators | IAA-like |
| **Treflan** | trifluralin | 3 | Seedling growth inhibitors (Root) | Microtubule inhibitors |
| **TriCor** | metribuzin | 5 | Photosynthesis inhibitors (mobile 1) | Photosystem II |
| **Valor** | flumioxazin | 14 | Cell membrane disrupters | PPO (protoporphyr-ingogen oxidase) |
| **Weedar 64** | 2-4-D | 4 | Plant growth regulators | IAA-like |
| **Zeus** | sulfentrazone | 14 | Cell membrane disrupters | PPO (protoporphyr-ingogen oxidase) |
| **Zidua** | pyroxasulfone | 15 | Seedling shoot inhibitor | Mitosis inhibitor |

# 3. Insect Control

## 3.1 Soil Pests - Detection and Control

### Cutworms

A number of cutworm species can damage vegetables. Cutworm larvae (caterpillars) chew leaves, sever stalks and stems, and also may chew tubers, roots, spears or fruit, rendering them unmarketable. Most cutworm larvae are night feeders and hide during the day, e.g., under sod clumps, stones, or decaying vegetation. During periods of drought, low-lying areas in fields are more subject to cutworm damage than other areas, presumably because of more desirable conditions.

For cutworm adults (moths), Weedy or minimum-tillage fields are especially attractive overwintering and egg-laying sites for cutworm adults. Cutworm adults can also lay eggs on transplants in greenhouses that are lighted at night, as the moths are attracted to light. Eggs and larvae may be transferred with transplants to the field.

**Control**. Where cutworms are suspected, a broadcast spray of a pyrethroid insecticide on no-till crop residue or broadcast incorporation of an insecticide treatment into the soil may be necessary just before planting (see individual crops for labeled insecticides). For organic producers, Seduce bait (OMRI listed) is labeled for cutworm control. **Always consult the label for rates and restrictions.**

Even if a broadcast treatment is used, fields should be scouted for cutworm damage within a week of planting or plant emergence. If cutworms are actively cutting plants, a post planting contact treatment may be necessary. The following procedures may help improve control when a contact insecticide treatment is used:

1. Direct sprays at the base of the plants where cutworms are actively feeding.
2. Increase the amount of water used to at least 30 gal/A, especially in dry weather.
3. Spray between midnight and 5 a.m. when cutworms are most active.
4. Cultivate after insecticide application to improve contact with cutworms, especially in dry weather.

### Garden Centipedes (Symphylans)

Garden centipedes are arthropods that are related to insects. They feed on germinating seed and fibrous roots of many crop and noncrop plants, including practically all vegetable species, and on decaying plant material. They are often associated with moist, fine textured heavier soils and typically establish in spots or field edges. Crops planted into those areas are often damaged, because the symphylans are continuously grazing on the fibrous roots. Spinach acts as very good host for this pest. Rotation does not appear to be an effective control.

**Detection**. The first symptom is an area or patch of poorly developing plants, similar to other root problems. Check the soil in these areas so that treatment can be made before planting the next crop, as there is no practical postplanting control. A common practice is to flag off the spot and treat that area with soil insecticides in the following fall or spring. Soil solarization has not been an effective control. Symphylans can probably be transported in soil on field equipment. Dig up the soil and look for small, slender (smaller than 0.25 inch) white centipede-like animals that move quickly and try to avoid light. Another sampling method is to drop soil into a bucket of water. Symphylans will float to the top. Symphylans have beaded antennae and 12 pairs of legs on 14 body segments. Do not confuse symphylans with true centipedes (that eat other arthropods and are considered beneficial). Centipedes are not white and have large mandibles. Note: Dry or cold (under 45°F/7°C) soil will reveal few, if any, symphylans.

**When to treat**. For spring soil samples, control is generally warranted if there are more than 2 symphylans per shovelful on average. For September or October soil samples, on average 4 or 5 per shovelful warrants treatment before the next crop. Insecticides are generally applied before spring planting, and fumigant treatments are usually made in the fall. Effectiveness of soil-applied insecticides decreases if soil temperatures are below 55°F (13°C).

### Grubs

Grubs are the larvae of various beetles and can be soil pests in most vegetable crops. Serious problems have occurred in potatoes, sweet potatoes, beans, corn, spinach, and strawberries. Grubs feed on the roots and underground parts of the plant from one to several inches below the soil surface. The plants may yellow and wilt, which causes a patchy growth in fields where plants are dead or dying. If injured plants are pulled up, the roots will show feeding damage, and usually the curve-bodied grub can be found in the soil. Adult beetles lay eggs in the soil during June and July. As the soil cools in the fall, grubs move deeper into the soil and return to the surface the following spring. Depending on the insect, grubs may take 1-3 years to become adults and may cause problems year after year.

**Control**. Grub damage is usually associated with grassy or weedy fields. Clean fields may help prevent serious grub damage. Problems may occur in crops planted to fields that were previously sod.

## Maggots

Several species of maggots attack either the seed or roots of vegetables during the growing season. The adult of the maggot (a fly) fluctuates in abundance in different areas in different years. Since it is impossible to determine when and where maggots will attack and since nothing can be done once the injury is noted, preventive controls are good insurance before planting if you have previously had maggot problems.

**Seed Maggots:** A seed attacked by seed maggots usually fails to sprout or, if it does, it is weak or sickly. Newly transplanted plants are also susceptible to maggots that tunnel up through the stem causing the plant to wilt. Injury is most severe in wet, cold springs and on land rich in organic matter.

**Control**. Control may be achieved using commercially applied seed treatments containing either chlorpyrifos (Lorsban 50W), clothianidin (Poncho 600), imidacloprid (Gaucho 600), or thiamethoxam (Cruiser 5FS, or Farmore DI-400). The level of control will depend on soil type, soil moisture, crop, weather conditions, and other factors. Refer to each specific crop section of this manual for listing of labeled seed treatments. **Do NOT use treated seed for food or feed**

**Root Maggots:** Plant roots become riddled with maggot tunnels, and underground fleshy parts soon become rotten. Above ground, plants appear off-color, wilt, and seldom reach full growth. Transplant water treatments, in-furrow treatments, preplant broadcast, and postplant treatments may be recommended depending on the crop. Refer to insecticide labels for labeled materials.

## Nematodes

Nematodes are not insects; see section 1.6. in this chapter for more information.

## Slugs

Slugs are not insects, but are closely related to snails. All slugs require damp or humid surroundings for development and will avoid the drying effects of sun and wind. During the day, slugs seek shelter under protective debris. This is why weed control is a useful deterrent to any slug problem.

**Control**. Metaldehyde (e.g., Deadline M-Ps Mini-Pellets) is an effective slug-control chemical, and numerous commercial preparations are available at farm supply centers. Sluggo or similar products such as Iron Fist (iron phosphate - OMRI listed) are also labeled for slug control on a number of crops.

**Read the label for crops and use rates, as not all products are labeled for all crops!**

## Wireworms

Wireworms injure vegetable crops by killing seeds or seedlings and tunneling and scarring tubers, roots, bulbs and low-growing vegetable fruit in contact with soil. Fields may be infested with wireworms but severe crop injury may occur only occasionally. Nearly all crops are susceptible.

**Detection**. Injury to young plants or tubers frequently is sufficient evidence to warrant future control measures. Since there is no effective post-planting rescue treatment, the following methods are useful to detect the presence of wireworms before planting:

**Method 1:** A technique using baits has been developed for evaluating wireworm potential before planting. The bait stations should be established 2-3 weeks before the anticipated planting date. Fields where small grain or grasses have been grown the preceding 2 or 3 years are the best candidates for bait stations. Since wireworm infestations are often localized within a field, it will be necessary to place the bait stations randomly throughout the field. One bait station per acre is desirable. Place 2 bait stations at the highest elevation in a field, 2 on a slope, and 2 in the lowest area. Follow this procedure for baiting:

1. Mix 1 cup of untreated wheat or rolled oats and 1 cup of untreated shelled corn at each station
2. Bury the bait about 2” deep (if buried too deeply the grain will rot). Cover the ground over each bait station with an 18” square of black plastic. The plastic collects solar heat and speeds germination of the corn and wheat, enticing overwintering wireworms to respond.
3. Mark each station with a flag or stake.
4. Dig up the bait stations after 10-14 days and count the number of wireworms. For best results wait until the germinating grain has emerged before digging. Look for slender, reddish-brown insects that are ¼-1” long.

**Method 2:** Be sure the soil temperature at the 6-inch depth ranges between 45-85°F (7-29°C) and that soil moisture is equivalent to that desired for planting.

1. Collect soil samples from 20 scattered sites per acre. Each sample should be about 12” deep and 6” in diameter. Sample sites should be near plant crowns.
2. Sift soil and count wireworms.

**Control**. If you find an average of 1 wireworm per bait station (Method 1) or if you find 5 or more wireworms in 20 soil samples (Method 2), a labeled soil insecticide should be used. Wireworm infestations tend to concentrate in some locations. Hence several wireworms may be found in one bait station and none in others. It may be possible to limit treatment to areas of the field with the largest concentration. **See individual crops for labeled insecticides.**

**When to apply**. Insecticides can be applied either in the spring or fall when the soil temperature at the 6-inch depth is at least 50°F (10°C) and soil moisture is equivalent to that desired for planting. Frequently, the insecticide is applied immediately before planting. Consider fall treatment if an early spring planting is planned.

## 3.2. Insecticide Mode of Action: Reducing the Risk of Insecticide Resistance

Resistance develops because intensive pesticide use kills the susceptible individuals in a population, leaving only resistant ones to reproduce. Adopting the practices outlined below will help reduce the development of pest resistance.

a. Crop rotation to a nonhost crop reduces the need for pesticide treatment and, thus, reduces the ratio of resistant to susceptible individuals in the breeding population.

b. Spot treatment is an important practice. Early season insects are often concentrated in areas near their overwintering sites. Spot treating these areas, rather than the entire field, will reduce the resistance problem at a reduced cost.

c. Younger insect larvae are more susceptible and less likely to develop resistance, than are older crop pests. Control efforts should be concentrated on the early stages of development.

d. Do not overspray. Attempts to destroy every pest in the field by multiple applications or by using rates higher than labeled rates often eliminate the susceptible but not the resistant pests. **The way pesticides are used affects the development of resistance.** Insecticides within a specific chemical group usually share a common target site within the pest, and thus share a common Mode of Action (MoA). Resistance often develops based on a genetic modification of this target site. When this happens, the compound usually loses its pesticidal activity. Because all insecticides within the chemical grouping share a common MoA, there is a high risk that this resistance will automatically confer cross-resistance to all the compounds in that group. The MoA classification provides a guide to the selection of insecticides for an insecticide resistance management strategy. The MoA classification was developed and is endorsed by the Insecticide Resistance Action Committee (IRAC) to insure growers can effectively alternate insecticides with different modes of action. More information can be found at: *http://www.irac-online.org/documents/moa-classification/?ext=pdf*. In Table E-6 below, insecticides are listed with their MoA classification (IRAC Group).

## 3.3 Insect Pest and Mite Control for Greenhouse Production

**Adequate ventilation is critical for greenhouse pesticide use. Follow the re-entry intervals (REI) listed on the labels for worker safety. Always read and fully understand the label before applying any pesticide.**

Applications of insecticides in **high tunnels** may be considered equivalent to a greenhouse, depending on the state’s definition of “high tunnel”. Check with your state’s pesticide regulatory agency for an interpretation concerning use of pesticides in high tunnels.

Yellow and blue sticky traps are very effective in catching winged aphids, leafminers, thrips, whiteflies, fungus gnats and shore flies. Traps can be hung vertically just above the plant canopy as well as the growing medium surface or near doors and side vents, or other areas where insects may enter or exit the greenhouse. It is suggested that at least 1 trap be used per 1,000 sq ft.

## Table E-6. Insecticides and Miticides Labeled for Use on Greenhouse Vegetables

Pesticides are listed in alphabetical order by Active Ingredient. The IRAC number refers to the Mode of Action, see section 3.2. Insecticide Mode of Action: Reducing the Risk of Insecticide Resistance.

| **IRAC Group** | **Active Ingredient** Product Name(s) | **Target Pests** | **Labeled Crops** | **PHI (d)** | **REI (h)** | **Comments** |
|---|---|---|---|---|---|---|
| 20B | **acequinocyl** Kanemite 15SC, Shuttle O | Two spotted spider mites | Fruiting vegetables, **except** cucurbits | 1 | 12 | Use at least 100 gal water/A 2 applications per year No surfactant or adjuvant use |
| 4A | **acetamiprid** TriStar 30SG | Aphids, leafhoppers, mealybugs, caterpillars, plant bugs, whiteflies, fungus gnat larvae, thrips, beetles, leafminers | Leafy vegetables, fruiting vegetables, cole crops, cucurbits, onions and bulb vegetables | 7 | 12 | **For vegetables grown as transplants only.** Treat small area to test for phytotoxicity first. |
| 18b | **azadirachtin** Azatin XL, Azatrol EC, Neemix, Ornazin, Azahar, Aza-Direct | Immature stages of whiteflies, aphids and other listed insects; fungus gnat larvae (as soil drench) | Most vegetables including fruiting vegetables and cucurbits, herbs, spices and others | 0 | 4 or 12 | Botanical insect growth regulator (some products OMRI listed). Can be applied via chemigation. Spray water pH should be between 5.5 and 6.5. REI 12 for Neemix and Ornazin |
| 11 | ***Bacillus thuringiensis*** var ***aizawai*** XenTari, Agree | Armyworms, beet armyworm, cabbage looper, tomato fruitworm | Most vegetables including fruiting vegetables and cucurbits, herbs, spices and others | 0 | 4 | Lepidopteran larvae only - most effective against early instars. |
| 11 | ***Bacillus thuringiensis*** var ***israelensis*** Gnatrol | Fungus gnats (larvae only) | All vegetables | 0 | 4 | Drench. Repeat applications may be needed. |
| 11A | ***Bacillus thuringiensis*** var ***kurstaki*** Dipel, Javelin, Deliver, Biobit | Armyworms, beet armyworm, cabbage looper, tomato fruitworm, | Most vegetables including fruiting vegetables and cucurbits, herbs, spices and others | 0 | 4 | Lepidopteran larvae only - most effective against early instars. |
| n/a | ***Beauveria bassiana*** strain GHA Mycotrol O (OMRI listed) BotaniGard ES, BotaniGard WP | Aphids, thrips, whiteflies, certain other pests | All vegetables, herbs, spices and others | 0 | 4 | Slow acting, fungus infects insects. Repeat applications at 5-10 day intervals may be needed. Note storage and other restrictions. **Do not use BotaniGard ES on tomatoes**. |
| 25 | **bifenazate** Floramite SC | Spider mites, clover mites | Tomatoes | 3 | 12 | No more than 2 applications per crop per season for tomatoes that are greater than 1” in diameter at maturity. Maintain spray water pH 5.5-6.5. **Do not use an adjuvant**. |
| 16 | **buprofezin** Talus 40SC | Leafhoppers, mealybugs, whiteflies | Tomatoes | 1 | 12 | Insect growth regulator for immature stages only. Maximum 2 applications per season at least 5 d apart. Will reduce egg viability. |
| 13 | **chlorfenapyr** Pylon | Caterpillars, spider mites (*Tetranychus* spp.), broad mites, western flower and melon thrips | Tomato, tomatillo, ground cherry, peppers, eggplant, pepinos | 0 | 12 | **Do not** use on tomato varieties with mature fruit less than 1 inch in diameter. No more than 3 applications per crop. |
| 28 | **cyantraniliprole** Exirel | Thrips, Whitefly | Tomato, eggplant, peppers | 1 | 12 | For whitefly add effective adjuvant. Only suppresses thrips |

*Table continued on next page*

***Table E-6. Insecticides and Miticides Labeled for Use on Greenhouse Vegetables - continued***

| **IRAC Group** | **Active Ingredient** Product Name(s) | **Target Pests** | **Labeled Crops** | **PHI (d)** | **REI (h)** | **Comments** |
|---|---|---|---|---|---|---|
| 17 | **cyromazine** Citation | Leafminers, fungus gnats, shore flies | Only for vegetable transplant production grown for consumers | 7 | 12 | Do not apply within 7 d of shipping to market. No more than 6 applications per crop |
| 4A | **dinotefuran** Safari 20 SG | Aphids, leafminers, mealybugs, whiteflies | Cucurbits, fruiting vegetables, head and stem brassicas, leafy vegetables | 1 or 7 | 12 | One application/crop. For vegetable transplants only. May be applied via a chemigation system. PHI 7 for leafy vegetables., PHI 1 for all other. |
| 10B | **etoxazole** TetraSan 5WDG | Spider Mites | Tomatoes only | 1 | 12 | Do not make more than 2 applications per season. Do not use with an adjuvant. |
| 21A | **fenpyroximate** Akari | Two spotted spider mites (suppresses whiteflies) | Cucumbers | 7 | 12 | One application per growing season. Do not use adjuvants. |
| 9C | **flonicamid** Beleaf 50 SG | aphids, plant bugs, GH whitefly | Cucumbers | 0 | 12 | Allow a minimum of 7 d between applications. Whitefly suppression only |
| 10A | **hexythiazox** Onager miticide 1EC | Two spotted spider mites, European red mites | Tomatoes | 1 | 12 | Do not make more than 1 application per year |
| 4A | **imidacloprid** Marathon | Aphids, fungus gnat larvae, leafhoppers, whiteflies, others | Cole crops, collards, kale, kohlrabi, lettuce, mustard greens, pepper, tomato, eggplant. | - | 12 | **Use on vegetable plants intended for resale only**. May be applied via a chemigation system. |
| 4A | **imidacloprid** Admire PRO | Aphids, whiteflies | Tomato and cucumber only in production greenhouses. | 0 | 12 | **Only** for plants growing in field soil, potting media or mixes. Do not apply to plants growing hydroponically or in rock wool, perlite or other soil-less mix. May be applied as drench or chemigation system. Label notes possible repellent effect on bumblebees and some beneficials (*Orius* sp.) |
| n/a | **iron phosphate** Sluggo-AG, Escar-Go | Slugs and snails | All vegetables | 0 | 0 | OMRI listed. Bait; scatter around plants or perimeter of plantings. |
| 1B | **malathion** Gowan Malathion 8F | Japanese beetles, thrips, onion maggots | Succulent beans, cucumbers, eggplant, lettuce, green and bulb onions, sweet corn, tomatoes (crops vary depending on label) | 1 to 7 | 12 | See label for specific crops. May be applied through a chemigation system. |
| n/a | **paraffinic oils** Sunspray Ultra-fine SuffOil-X | Aphids, two spotted spider mites, leafminers, thrips, whitefly | Tomato, pepper, lettuce, cucurbits, radish, squash, herbs, spices | 1 | 4 | Do not exceed 4 applications a growing season. Allow 2 w between applications. |
| n/a | **potassium salts of fatty acids** insecticidal soap M-Pede | Aphids; leafminer; spider, broad and russet mites; thrips; whiteflies; plant bugs; leafhopper; powdery mildew (cucumber only) | Many vegetables (see label for specifics), herbs, spices | 0 | 12 | Works well on whiteflies, mites and aphids if coverage is good but has no residual control. Note label cautions about application frequency, water quality and tank mixing. OMRI listed |

*Table continued on next page*

***Table E-6. Insecticides and Miticides Labeled for Use on Greenhouse Vegetables - continued***

| **IRAC Group** | **Active Ingredient** Product Name(s) | **Target Pests** | **Labeled Crops** | **PHI (d)** | **REI (h)** | **Comments** |
|---|---|---|---|---|---|---|
| 3a | **pyrethrins** Pyrenone Crop Spray, Pyronyl Crop Spray, PyGanic, Pyrethrum PT | All | All vegetables, herbs, spices | 0 | 12 | Pyrenone and Pyronyl include PBO synergist; PyGanic is OMRI listed. |
| 21 | **pyridaben** Sanmite | Two spotted spider mite, whiteflies, leafhoppers, European red mite, some aphid species, broad mite | Tomatoes (PHI 2) and Cucumbers (PHI 1) | 1 or 2 | 12 | Only 2 applications per crop per year. Allow 30 days between sequential applications. |
| 7c | **pyriproxyfen** Distance | Whiteflies, aphids, fungus gnats, shoreflies | Fruiting vegetables (except non-bell peppers) | 1 | 12 | Insect growth regulator. **Do not** use on tomato varieties with mature fruit less than 1 inch in diameter. Spray, sprench or drench. |
| n/a | **rosemary oil + peppermint oil** Ecotec | Aphids, beetles, mites, thrips, plant bugs, others | Many vegetables, herbs, spices | 0 | 0 | OMRI listed. Can be applied in drip for soil pests. |
| 23 | **spirotetramat** Kontos | Aphids, leafhoppers, mealybugs, psyllids, spider mites, spittlebugs, whiteflies | Vegetable transplants only (see label for list) | - | 24 | Apply as drench or via an irrigation system to plants in containers. Not for use in vegetable production. |
| 4a | **thiamethoxam** Flagship 25WG | Whiteflies, leafhoppers, Colorado potato beetle, stinkbugs | Fruiting vegetables and cucurbits | - | 12 | **ONLY** use for vegetable transplants intended for resale |

# 4. Disease Control

## 4.1 Fungicide Mode of Action: Reducing the Risk of Fungicide Resistance

Pathogens may develop resistance to fungicides because of genetic mutations in the organism, through natural selection, or by the intensive use of high-risk fungicides. High-risk fungicides kill only susceptible individuals within a given population, while resistant individuals continue to reproduce and cause more disease. Use the practices outlined below to help reduce the chances for fungicide resistance development.

**a.** Long and proper crop rotations with non-host crops will help break disease cycles and decrease the need or overuse of specific fungicides. This is especially important for controlling soil-borne pathogens.

**b.** Do not overspray. Attempts to kill every pest in the field by multiple applications or by using higher than labeled rates often eliminate the susceptible, but not the resistant pathogen population. Do not use lower than labeled rates which allow low to moderately resistant populations to survive.

**c.** Fungicides are organized according to Fungicide Resistance Action Codes (FRAC codes), based on chemical structure (see Table E-7) and Mode of Action (MoA). Fungicides within a given FRAC code control fungi in a similar manner and share the same risk for fungicide resistance development. Table E-8 lists commonly used fungicides and their FRAC codes. Always rotate fungicides with different FRAC codes.

**d.** Some fungicides are referred to as high- or at-risk fungicides because of their very specific MoA's and high risk for resistance development, for example, the QoI's (FRAC code 11) or DMI's (FRAC code 3). Fungicides in high- or at-risk groups (**in bold in Table E-8**) should be rotated and/or tank-mixed with broad spectrum, protectant fungicides to delay or reduce the development of resistant strains of fungi. High- or at-risk fungicides have seasonal application restrictions which should be followed precisely.

**e.** Do not use high- or at-risk fungicides as a rescue treatment for disease control. High-risk fungicides should be used according to the label in a full season disease control program or not at all. Applying high- or at-risk fungicides only after a disease is present in a field increases the chances for the development of resistant populations of plant pathogenic fungi. If you feel control with a high-risk fungicide is no longer effective, stop using it and switch to other Modes of Action (i.e., fungicides in other FRAC groups).

**Table E-7. FRAC Codes and Corresponding Chemical Groups for Commonly-Used Fungicides**

| FRAC Code | Chemical Group | | FRAC Code | Chemical Group |
|---|---|---|---|---|
| **P1** | Salicylic Acid Pathway | | **13** | quinolines |
| **M1** | inorganic copper | | **14** | aromatic hydrocarbons |
| **M2** | inorganic sulfur | | **17** | hydroxylanilide |
| **M3** | dithiocarbamate | | **21** | quinone outside inhibitor (QiI) |
| **M4** | phthalimide | | **22** | benzamides (toluamides) |
| **M5** | chloronitrile | | **27** | cyanoacetamideoximes |
| **1** | benzimidazole | | **28** | carbamates |
| **2** | dicarboximide | | **29** | dinitroanilines |
| **3** | triazole | | **30** | organotin compounds |
| **4** | phenylamide | | **33** | phosphonates |
| **7** | carboxamide | | **40** | carboxylic acid amides |
| **9** | pyridinamine | | **43** | benzamides (acylpicolides) |
| **11** | quinone inside inhibitor (QoI) | | **45** | triazolo-pyrimidylamine |
| **12** | phenylpyrroles | | | |

## 4.2. Fungicides Registered for Vegetables

**<u>Note about Table E-8</u>:**

**The following table lists commonly used fungicides.**

- **The table is not necessarily all inclusive; crop sections in chapter F may include additional recommendations.**
- **Crop sections in chapter F should be consulted to ensure efficacy on specific pests.**
- **Guidelines for preventing fungicide resistance development can be found in the paragraph "Fungicide Mode of Action: Reducing the Risk of Fungicide Resistance" (see 4.1. above).**

## Table E-8. Commonly Used Fungicides Registered for Vegetables

**See note about Table E-8 on page 117**. X=fungicide is registered for the crop. The number next to X=PHI (days to harvest); if no number is present PHI=0 days. XGH=labeled for greenhouse use (see also Table E-10. Selected Fungicides and Bactericides Labeled for Greenhouse Use).

| **Fungicides** | **Actigard** (acibenzolar-S-methyl) | **Aliette** (fosetyl A1) | **Aproach** (picoxystrobin) | **Aprova Top** (difenoconazole+benzovindiflupyr) | **azoxystrobin** | **Botran** (dichloran) | **Cabrio** (pyraclostrobin) | **Cabrio Plus** (pyraclostrobin+metiram) | **Cannonball** (fludioxonil) | **Chlorothalonil**[a] | **Curzate** (cymoxanil) | **Elatus** (azoxystrobin+benzovindiflupyr) | **Endura** (boscalid) | **Fixed copper**[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FRAC Code(s)** / **Crop** | **21** | **33** | **11** | **3+ 7** | **11** | **14** | **11** | **11+ M3** | **12** | **M5** | **27** | **11+ 7** | **7** | **M1** |
| Asparagus | | X110 | | | X100 | | | | | X190 | | | | |
| Beans, snap | | | X14 | X14 | X | X2 | | | X7 | X7 | | | X7 | X |
| Beans, lima | | | X14 | X14 | X | | | | X7 | X14 | | | X7 | X |
| Beets | | | | | X | | X | | | | | | | X |
| Broccoli | X7 | X3 | | | X | | X | | | X7 | | | X | X |
| Carrots | | | | | X | | X | | | X | | | X | X |
| Celery | | X3 | | | X | X7 | X | | X | X7 | | | X | X |
| Chinese cabbage | X7 | X3 | | | X | | X | | | X7 | | | X | X |
| Cole crops | X7 | X3 | | | X | | X | | | X7 | | | X14 | X |
| Cucumbers | X | X | | X | X1 | XGH | X | | | X | X3 | | X | X |
| Eggplants | | | | X | X | | X | | | X3 | | | X | X |
| Garlic | X7 | | | | X | | X7 | | X7 | X7 | | | X7 | X |
| Greens, mustard | X7 | X3 | | | X | | X | | | | | | X14 | X |
| Greens, turnip | X7 | | | | X | | | | | | | | | X |
| Horseradish | | | | | X | | X | | | X14 | | | X | |
| Leeks | | | | | X | X14 | X7 | | X7 | X14 | | | X7 | X |
| Lettuce | X7 | X3 | | | X | X14 | X | | X | | X3 | | X14 | X |
| Muskmelons | X | X | | X | X1 | | X | | X14 | X | X3 | | X | X |
| Okra | | | | X | X | | | | | X3 | | | | X |
| Onions, dry | X7 | X7 | | | X | X14 | X7 | | X7 | X14 | | | X7 | X |
| Onions, green | | X7 | | | X | X14 | X7 | | X7 | X14 | | | X7 | X |
| Parsley | | X | | | X | | X | | X | | | | X14 | X |
| Parsnips | | | | | X | | X | | | X10 | | | | |
| Peas | | | | X14 | X | | | | | | | | X21 | X |
| Peppers | X14 | | | X | X | | X | | | X3 | | | X | X |
| Potatoes | | | | | X14 | | | X14 | | X7 | X14 | X14 | X10 | X |
| Pumpkin/winter squash | X | X | | X | X1 | | X | | | X | X3 | | X | X |
| Radish | | | | | X | | X | | | | | | | |
| Spinach | X7 | X3 | | | X | | X | | X | | X1 | | | X |
| Squash, summer | X | X | | X | X1 | | X | | | X | X3 | | X | X |
| Strawberries | X | X | | | X | | X | | | | | | | X |
| Sweet corn | | | X7 | | X7 | | | | | X14 | | X7 | | X |
| Sweet potatoes | | | | X14 | X | Xb | | | | | | | X10 | |
| Tomatoes | X14 | X14 | | X | X | XGH | X | | | X | X3 | | X | X |
| Watermelon | X | X | | X | X1 | | X | | X14 | X | X3 | | X | X |

Superscripts: a=seed treatment or soil use only, b=Ultra Flourish is not labeled on these crops, c=Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury, d=Only in DE, PA, MD, and VA, e=See label for PHI.

*Table continued on next page.*

## Table E-8. Commonly Used Fungicides Registered for Vegetables - continued

**See note about Table E-8 on page 117**. X=fungicide is registered for the crop. The number next to X=PHI (days to harvest); if no number is present PHI=0 days. XGH=labeled for greenhouse use (see also Table E-10 Selected Fungicides and Bactericides Labeled for Greenhouse Use).

| **Fungicides** | **Fontelis** (penthiopyrad) | **Forum** (dimethomorph) | **Gavel** (zoxamide+mancozeb) | **Gem** (trifloxystrobin) | **Headline** (pyraclostrobin) | **Headline AMP** (pyraclostrobin+metconazole) | **Inspire Super** (difenoconazole+cyprodonil) | **iprodione** | **Luna Experience** (fluopyram+tebuconazole) | **Luna Privilege** (fluopyram) | **Luna Sensation** (fluopyram+trifloxystrobin) | **mancozeb** | **Merivon** (fluxapyroxad+pyraclostrobin) | **metalaxyl** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FRAC Code(s)** / **Crop** | **7** | **40** | **22+** M3 | **11** | **11** | **11+ 3** | **3+ 9** | **2** | **7+ 3** | **7** | **7+ 11** | M3 | **7+ 11** | **4** |
| Asparagus | | | | | | | | | | | | X180 | | X |
| Beans, snap | X | | | | X7 | | | X[e] | | | | | | X |
| Beans, lima | X | X7 | | | X7 | | | X[e] | | X14 | | | | X |
| Beets | X | | | X7 | | | | | | | | | X7 | X |
| Broccoli | X | X7 | | | | | X7 | X | | | | | | X |
| Carrots | X | | | X7 | | | | X | | | | | X7 | X |
| Celery | X3 | X7 | | X7 | | | | | | | | | X1 | X |
| Chinese cabbage | X | X7 | | | | | X7 | | | | | | | X |
| Cole crops | X | X7 | | | | | X7 | | | | | | | X |
| Cucumbers | X1 | X5 | X5 | | | | X7 | | | | | X5 | X | X |
| Eggplants | X | X5 | | X3 | | | X | | | | | | | X |
| Garlic | X3 | X5 | X7 | | | | X7 | X | | | | X7 | X7 | X |
| Greens, mustard | X | X7 | | | | | X7 | | | | | | | |
| Greens, turnip | X | X7 | | | | | X7 | | | | | | | |
| Horseradish | X | | | X7 | | | | | | | | | X7 | X |
| Leeks | X3 | X5 | | | | | X7 | | | | | | X7 | X |
| Lettuce | X3 | X7 | | | | | | X14 | | | | | X1 | X |
| Muskmelons | X1 | X5 | X5 | | | | X7 | | | | | X5 | X | X |
| Okra | X | | | | | | | | | | | | | |
| Onions, dry | X3 | X5 | X7 | | | | X7 | X7 | | | | X7 | X7 | X |
| Onions, green | X3 | X5 | X7 | | | | X14 | | | | | | X7 | X |
| Parsley | X3 | X7 | | | | | | | | | | | X1 | X |
| Parsnips | | | | X7 | | | | | | | | | X7 | X |
| Peas | X | | | | X7 | | | | | | | | | X |
| Peppers | X | X5 | | X3 | | | X | | | | | | | X |
| Potatoes | | X5 | X14[d] | X7 | X3 | | | X14 | | X7 | | X14[d] | | X |
| Pumpkin/winter squash | X1 | X5 | X5 | | | | X7 | | | | | | X | X |
| Radish | X | | | | | | | | | | | | X7 | X |
| Spinach | X3 | X7 | | | | | | | | | | | X1 | X |
| Squash, summer | X1 | X5 | X5 | | | | X7 | | | | | X5 | X | X |
| Strawberries | X | | | | | | | X[e] | | X1 | | | X | |
| Sweet corn | | | | | X7 | X7 | | | | | | X7 | | |
| Sweet potatoes | | | | | X3 | | | | | | | | | X |
| Tomatoes | X | X5 | X5 | X3 | | | X | | | | | X5 | | X |
| Watermelon | X1 | X5 | X5 | | | | X7 | | X7 | X | X | X5 | X | X |

Superscripts: a=seed treatment or soil use only, b=Ultra Flourish is not labeled on these crops, c=Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury, d=Only in DE, PA, MD, and VA, e=See label for PHI.

*Table continued on next page.*

## Table E-8. Commonly Used Fungicides Registered for Vegetables - continued

**See note about Table E-8 on page 117**. X=fungicide is registered for the crop. The number next to X=PHI (days to harvest); if no number is present PHI=0 days. XGH=labeled for greenhouse use (see also Table E-10 Selected Fungicides and Bactericides Labeled for Greenhouse Use).

| **Fungicides** | **Moncut** (flutolanil) | **Omega** (fluazinam) | **phosphonates**[a] | **Presidio** (fluopicolide) | **Previcur Flex** (propamocarb) | **Priaxor** (fluxapyroxad+pyraclostrobin) | **Pristine** (pyraclostrobin+boscalid) | **Procure** (triflumizole) | **Proline** (prothioconazole) | **propiconazole** | **Quadris Opti** (azoxystrobin+chlorothalonil) | **Quadris Top** (difenoconazole+azoxystrobin) | **Quash** (metconazole) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FRAC Code(s)** / **Crop** | **7** | **29** | **33** | **43** | **28** | **7+ 11** | **11+ 7** | **3** | **3** | **3** | **11+** M5 | **3+ 11** | **3** |
| Asparagus | | | | | | | | | | | | | |
| Beans, snap | | X14 | X | | | X7 | | | | X7 | | | |
| Beans, lima | | X30 | X | | | X7 | | | | X7 | X14 | | |
| Beets | | | | X7 | | | | | | X14 | | | |
| Broccoli | X | X50 | X | X2 | | X3 | | X1 | | | | X1 | |
| Carrots | | X7 | | X7 | | | X | | | X14 | X | X7 | |
| Celery | | | X | X2 | | | X | | | X14 | X7 | | |
| Chinese cabbage | | X20 | X | X2 | | X3 | | X1 | | | | X1 | |
| Cole crops | X | X20 | X | X2 | | X3 | | X1 | | | | X1 | |
| Cucumbers | | | X | X2 | X2 | | X | X | X7 | | X1 | X1 | |
| Eggplants | | X30 | X | X2 | | X | | | | | | X | |
| Garlic | | X7 | X | | | | X7 | | | X14 | X7 | X7 | |
| Greens, mustard | X | X20 | X | X2 | | X3 | | X1 | | | | X1 | |
| Greens, turnip | X | X20 | X | | | X3 | | X1 | | | | X1 | |
| Horseradish | | | | X7 | | | | | | | | | |
| Leeks | | | X | | | | X7 | | | X14 | X14 | X7 | |
| Lettuce | | X30 | X | X2 | X2 | | | X | | | | | |
| Muskmelons | | X30 | X | X2 | X2 | | X | X | X7 | | X1 | X1 | |
| Okra | | X30 | | | | | | | | | | | |
| Onions, dry | | X7 | X | | | | X7 | | | X14 | X7 | X7 | |
| Onions, green | | | X | | | | X7 | | | X14 | X14 | X7 | |
| Parsley | | | X | X2 | | | | X | | X14 | | | |
| Parsnips | | | | X7 | | | | | | | | | |
| Peas | | | X | | | X7 | | | X7 | | | | |
| Peppers | | X30 | X | X2 | X5 | X | | | | | | X | |
| Potatoes | X | X14 | X | | X14 | X7 | | | | | X14 | X14 | X1 |
| Pumpkin/winter squash | | | X | X2 | X2 | | X | X | X7 | | X1 | X1 | |
| Radish | | | | X7 | | | | | | | | | |
| Spinach | | | X | X2 | | | | | | | | | |
| Squash, summer | | | X | X2 | X2 | | X | X | X7 | | X1 | X1 | |
| Strawberries | | | | | | | X | X1 | | X | | X | |
| Sweet corn | | | | | | X7 | | | | X14 | | | |
| Sweet potatoes | | | | X7 | | | | | | | | X14 | X1 |
| Tomatoes | | | X | X2 | X5 | X | | | | | X | X | |
| Watermelon | | X30 | X | X2 | X2 | | X | X | X7 | | X1 | X1 | |

Superscripts: a=seed treatment or soil use only, b=Ultra Flourish is not labeled on these crops, c=Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury, d=Only in DE, PA, MD, and VA, e=See label for PHI.

*Table continued on next page.*

## Table E-8. Commonly Used Fungicides Registered for Vegetables - continued

**See note about Table E-8 on page 117**. X=fungicide is registered for the crop. The number next to X=PHI (days to harvest); if no number is present PHI=0 days. XGH=labeled for greenhouse use (see also Table E-10 Selected Fungicides and Bactericides Labeled for Greenhouse Use).

| **Fungicides** | **Quilt** (propiconazole+azoxystrobin) | **Quilt Xcel** (propiconazole+azoxystrobin) | **Quintec** (quinoxyfen) | **Rally** (myclobutanil) | **Ranman** (cyazofamid) | **Reason** (fenamidone) | **Revus** (mandipropamid) | **Revus Top** (mandipropamid+difenoconazole) | **Ridomil Gold**, **UltraFlourish** (mefenoxam) | **Ridomil Gold Bravo** (mefenoxam+chlorothalonil) | **Ridomil Gold Copper** (mefenoxam+copper) | **Ridomil Gold MZ** (mefenoxam+mancozeb) | **Ridomil Gold PC** (mefenoxam+PCNB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FRAC Code(s)** / **Crop** | **3+ 11** | **3+ 11** | **13** | **3** | **21** | **11** | **40** | **3+ 40** | **4** | **4+** M5 | **4+** M1 | **4+** M3 | **4+ 14** |
| Asparagus | | | | X180 | | | | | X | | | | |
| Beans, snap | X7 | X7 | | X | X | X3 | X1 | | X[b] | | X7 | | X |
| Beans, lima | X7 | X7 | | | X | X3 | | | X[b] | | X3 | | X |
| Beets | | | | | | X14 | | | X | | | | |
| Broccoli | | | | | X | X2 | X1 | | X[b] | X7 | | | |
| Carrots | X14 | X14 | | | X14 | X14 | | | X[b] | X7 | X7 | | |
| Celery | X14 | X14 | | | | X2 | X1 | | X | | | | |
| Chinese cabbage | | | | | X | X2 | X1 | | X[b] | X7 | | | |
| Cole crops | | | | | X | X2 | X1 | | X | X7 | | | |
| Cucumbers | | | | X | X | X14 | X | | X | X | X5 | X5 | |
| Eggplants | | | X3 | X | X | X14 | X | | X | | | | |
| Garlic | X14 | X14 | | | | X7 | X7 | | X[a] | X7 | X10 | X7 | |
| Greens, mustard | | | | | X | X2 | X1 | | X[b] | | | | |
| Greens, turnip | | | | | X | X2 | X1 | | X[b] | | | | |
| Horseradish | | | | | | X14 | | | X[a] | | | | |
| Leeks | X | X | | | | X7 | X7 | | X | X14 | X10 | X7 | |
| Lettuce | | | X1 | X3 | X | X2 | X1 | | X[a] | | | | |
| Muskmelons | | | X3 | X | X | X14 | X | | X | X | X5 | X5 | |
| Okra | | | | X | X | X14 | X | | | | | | |
| Onions, dry | X14 | X14 | | | | X7 | X7 | | X | X7 | X10 | X7 | |
| Onions, green | X | X | | | | X7 | X7 | | X | X14 | X7 | | |
| Parsley | | | | | X | X2 | X1 | | X | | | | |
| Parsnips | | | | | | X14 | | | X | | | | |
| Peas | | | | | | | | | X[b] | | | | |
| Peppers | | | X3 | X | X | X14 | X | | X | | X7 | | |
| Potatoes | | | | | X7 | X14 | | X14 | X | X14 | X14 | X14 | |
| Pumpkin/winter squash | | | X3 | X | X | X14 | X | | X | X | X5 | | |
| Radish | | | | | | X14 | | | X | | X7 | | |
| Spinach | | | | | X | X2 | X1 | | X | | X3 | | |
| Squash, summer | | | | X | X | X14 | X | | X | X | X5 | X5 | |
| Strawberries | | X | X1 | X | | | | | X | | | | |
| Sweet corn | X14 | X14 | | | | | | | | | | | |
| Sweet potatoes | | | | | X7 | X14 | | | X | | | | |
| Tomatoes | | | X3 | X | X | X14 | | X1 | X | X5 | X14 | X5 | |
| Watermelon | | | X3 | X | X | X14 | X | | X | X | X5 | X5 | |

Superscripts: a=seed treatment or soil use only, b=Ultra Flourish is not labeled on these crops, c=Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury, d=Only in DE, PA, MD, and VA, e=See label for PHI.

*Table continued on next page.*

## Table E-8. Commonly Used Fungicides Registered for Vegetables - continued

**See note about Table E-8 on page 117**. X=fungicide is registered for the crop. The number next to X=PHI (days to harvest); if no number is present PHI=0 days. XGH=labeled for greenhouse use (see also Table E-10 Selected Fungicides and Bactericides Labeled for Greenhouse Use).

| | **Scala** (pyrimethanil) | **Stratego** (propiconazole+trifloxystrobin) | **Sulfur** [c,e] | **Switch** (cyprodinil+fludioxonil) | **Tanos** (famoxadone+cymoxanil) | **tebuconazole** | **Terraclor** (PCNB) | **thiophanate-methyl** | **Torino** (cyflufenamid) | **Uniform** (mefenoxam+azoxystrobin) | **Vivando** (metrafenone) | **Zampro** (ametoctradin+dimethomorph) | **Zing!** (zoxamide+chlorothalonil) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FRAC CODE(S)** | **9** | **3+ 11** | M2 | **9+ 12** | **11+ 27** | **3** | **14** | **1** | **U6** | **4+ 11** | **U8** | **45+ 40** | **22+** M5 |
| Asparagus | | | X | | | X180 | | | | | | | |
| Beans, snap | | | X | X7 | | X14 | X14 | X14 | | X | | | |
| Beans, lima | | | X | X7 | | X14 | X14 | X14 | | X | | | |
| Beets | | | X | X7 | | X7 | | | | X | | | |
| Broccoli | | | X | X7 | | X7 | X | | | | | X | |
| Carrots | | | X | X7 | | | | | | | | | |
| Celery | | | X | X | | | | X7 | | X | | X | |
| Chinese cabbage | | | | X7 | | X7 | X | | | X | | X | |
| Cole crops | | | X | X7 | | X7 | X | | | X | | X | |
| Cucumbers | | | X | X1 | X3 | X7 | | X1 | X | X | X | X | X |
| Eggplants | | | X | X | | X7 | | | | | X | X4 | |
| Garlic | X7 | | X | X7 | X3 | X7 | X | Xa | | X | | X | X7 |
| Greens, mustard | | | X | X7 | | X7 | | | | X | | X | |
| Greens, turnip | | | X | X7 | | X7 | | | | | | | |
| Horseradish | | | X | X7 | | | | | | | | | |
| Leeks | X7 | | | X7 | X3 | X7 | | | | X | | X | |
| Lettuce | | | X | X | X1 | | | | | X | | X | |
| Muskmelons | | | X | X1 | X3 | X7 | | X1 | X | X | X | X | X |
| Okra | | | X | X | | X3 | | | | | X | | |
| Onions, dry | X7 | | X | X7 | X3 | X7 | | Xa | | X | | X | X7 |
| Onions, green | X7 | | X | X7 | X3 | X7 | | Xa | | X | | X | |
| Parsley | | | | X7 | X1 | | | | | X | | X | |
| Parsnips | | | X | X7 | | | | | | | | | |
| Peas | | | X | | | | | | | X | | | |
| Peppers | | | X | X | X3 | X7 | X | | | | X | X4 | |
| Potatoes | X7 | | X | X7 | X | | | X21 | | | | X4 | X7 |
| Pumpkin/winter squash | | | X | X1 | X3 | X7 | | X1 | X | X | X | X | X |
| Radish | | | X | X7 | | | | | | X | | | |
| Spinach | | | X | X | X1 | | | | | X | | X | |
| Squash, summer | | | X | X1 | X3 | X7 | | X1 | X | X | X | X | X |
| Strawberries | X1 | | X | X | | | | X1 | X | | | | |
| Sweet corn | | X14 | | | | X7 | | | | | | | |
| Sweet potatoes | X7 | | X | X7 | | | X | | | X | | | |
| Tomatoes | X1 | | X | X | X3 | X7 | X | | | | X | X4 | X5 |
| Watermelon | | | | X1 | X3 | X7 | | X1 | X | X | X | X | X |

Superscripts: a=seed treatment or soil use only, b=Ultra Flourish is not labeled on these crops, c=Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury, d=Only in DE, PA, MD, and VA, e=See label for PHI.

# 4.3 Disease Control in Seeds, Plant Growing Mix and Plant Beds

## Seed Treatment

Seed treatment is essential to control seed-born diseases in many transplanted crops. Failure to treat seed properly could lead to diseases in the plant bed that will reduce plant stands, or that are carried into the field at transplanting. Crop failure could result. Seed treatment is especially important for asparagus, broccoli, Brussels sprouts, cabbage, cauliflower, collards, eggplant, kale, kohlrabi, peppers, radish and tomato.

Heat treatment of seeds is a non-chemical alternative to conventional chlorine treatments with the additional benefit of killing pathogens that may be found within the seed coat (e.g., bacterial canker organism of tomatoes). Seed heat-treatment follows a strict time and temperature protocol, and is best done with thermostatically controlled water baths. Two baths are required: one for pre-heating and a second for the effective pathogen killing temperature. The initial pre-heat treatment is 10 minutes at 100ºF (38ºC). The effective temperature treatment and time in the second bath differ between crops; protocols for several important crops are listed in Table E-9.

Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process and dried on screen or paper. Seeds may be re-dusted with fungicide if desired. Pelleted seed is not recommended for heat treatment. Heat treat only seed that will be used during the current season. See crop sections for specific seed treatment recommendations.

**Table E-9. Effective Seed Treatment Temperature Protocols (2nd Bath) For Pathogen Eradication**

| Crop | Water Temperature | | Minutes |
|---|---|---|---|
| | °F | °C | |
| Brussels sprouts, eggplant, spinach, cabbage, tomato | 122 | 50 | 25 |
| Broccoli, cauliflower, carrot, collard, kale, kohlrabi, rutabaga, turnip | 122 | 50 | 20 |
| Mustard, cress, radish | 122 | 50 | 15 |
| Pepper | 125 | 51 | 30 |
| Lettuce, celery, celeriac | 118 | 48 | 30 |

## Disease Control in Plant Growing Mix

For the best control of all soil-borne diseases, use the plant-growing mix described in Table R-4 or R-5. If this is not possible, use soil steaming or fumigation as described below.

## Disease Control in Plant Beds

**Preplant: Soil steaming** is the only practice that ensures complete sterilization of soil. A temperature of 180°F (82°C) must be maintained throughout the entire mass of soil for a period of 30 minutes. **Soil fumigation** is also used to control disease. The following materials are suitable for small lots of soil:

- chloropicrin and metam-sodium (Vapam HL), see label for rates and instructions.

For larger areas, such as plantbeds or seedbeds, the following materials are suitable (see label for rates and instructions):

- chloropicrin
- metam-sodium (Busan, Nemasol, Vapam HL)
- Potassium N-methyldithiocarbamate (K-Pam HL)

Consulte Fumigation section in this chapter (section 1.5) for additional recommendations.

**Note: The use of soil fumigants has become severely limited because of new restrictions. Check with your local county agricultural agent.**

**Pre-and postseeding treatments in transplant and greenhouse production:** See crop sections for seed treatment options and Table E-10. below for a list of selected fungicides for use in greenhouse production.

**Nematode Control** - see section 1.6 in this chapter.

# 4.4 Disease Control for Greenhouse Production

**Table E-10. Selected Fungicides and Bactericides Labeled for Greenhouse Use**

**Note:** Some states define pesticide applications in high tunnels as greenhouse applications, others define them as field applications. Check with your extension educator or state department of agriculture for correct application.

**If any information in this table is inconsistent with the label, follow the label.**

| Fungicide | Target Diseases | Labeled Crops | Comments |
|---|---|---|---|
| **Azadirachtin + Neem oil** (DeBug Tres, Debug Turbo, Agro Logisitic Systems, Inc.) REI =4 h. | Nematodes. *Sclerotinia sclerotiorum* and *S. rolfsii* diseases | Cucurbits, fruiting vegetables and others (see label) | OMRI listed |
| **Azoxystrobin** (Heritage, Syngenta Crop Protection, LLC) REI=4 h. | Rhizoctonia, leaf spots and others | Brassica, cucurbit, fruiting vegetables and others | Vegetable and herb plants grown for transplanting |
| **Azoxystrobin + benzovindiflupyr** (Mural, Syngenta Crop Protection LLC) REI=12 h. | Powdery mildew, leaf mold and others. | Tomatoes | Vegetable plants for re-sale to consumers |
| ***Bacillus pumilus*** (Sonata; Bayer CropScience LP) REI=4 h. | Early blight, late blight, downy mildew, powdery mildew | Many vegetables including Brassicas, cucurbits, bulb, fruiting, and leafy vegetables and root and tuber crops | |
| ***Bacillus subtillus*** (Cease, BioWorks). REI= 4 h. | Suppression of soilborne and foliar diseases including damping off, root rot and early blight | Many vegetables including fruiting and leafy vegetables, cucurbits, cole crops and herbs | May be used in hydroponic and soilless production systems. Most effective used preventatively. |
| **Basic Copper Sulfate** (Cuprofix Ultra 40 Disperss; United Phosphorus, Inc.) REI=48 h. | Many diseases including angular leaf spot, downy mildew. *Alternaria* blight, *Anthracnose*, bacterial blight, etc. | Vegetables including cucumbers, eggplant, peppers, tomatoes, etc. | Crops grown in the greenhouse may be more sensitive to copper injury so the user should determine plant sensitivity. |
| **Coniothyrium minitans** (Contans, Sipcam Agro) REI=4 h. | *Sclerotinia sclerotiorum*, *Sclerotinia minor* | Many vegetables including leafy vegetables, brassicas, legumes, fruiting vegetables and bulb vegetables | OMRI listed. Contains a beneficial fungus. Do not allow to stand overnight following mixture. Acts as a preventative. |
| **Copper Hydroxide** (Kocide 2000, DuPont) REI=24/48 h. | Leaf spots, anthracnose and bacterial spots and others | See labels for specific crops | See labels for specific usage instructions. Phytotoxicity may occur. |
| **Cuprous Oxide** (Nordox, Monterey AgResources) REI=24 h. | Bacterial spot and speck, *Alternaria* leaf spot, anthracnose, early and late blight, etc. | Eggplant, pepper and tomato | See label for specific usage instructions. |
| **Cyazofamid** (Ranman, FMC Corporation) REI=12 h. | *Pythium* damping off Basil downy mildew | Tomato greenhouse transplant production and basil | Drench transplant tray with fungicide at planting or up until one week before transplant. See label for additional details. |
| **Dazomet (soil fumigant)** (Basamid G, Amvac) For entry restrictions, see label | Pre-plant control of soilborne diseases | Soil treatment only | **Restricted Use Pesticide** – see label for precautionary statements, restrictions, and directions for use. |
| **Dicloran** (Botran, Gowan Company) REI=12 h. | Pink rot, gray mold, *Sclerotinia* and *Sclerotium* rots, leaf blight and neck rot | Many vegetables including celery, lettuce, onions, garlic and shallots. | May cause leaf bronzing on lettuce. Use adequate volume of water. |
| **Fenhexamid** (Decree, Arysta LifeScience) REI=4 h. | *Botrytis* | Tomatoes, cucumber, pepper and lettuce | Protectant fungicide with some plant back restrictions. See label for details. |

*Table continued on next page*

*Table E-10. Selected Fungicides and Bactericides Labeled for Greenhouse Use - continued*

| Fungicide | Target Diseases | Labeled Crops | Comments |
|---|---|---|---|
| **Horticultural Oil** (Ultra-Pure Oil, Whitmire Micro-Gen) REI=4 h. | Powdery mildew | Cucurbits, melons, squash, tomatoes, oriental vegetables and others | Application should be made when disease is first noticed. See label for information on plant safety. Use lower label rates in the greenhouse. |
| **Hydrogen Dioxide** (Oxidate, BioSafe Systems LLC) REI=1 h. | *Anthracnose*, downy mildew, powdery mildew, *Pythium* root rot | Many vegetables including cole crops, cucurbit, leafy vegetables, peppers and tomatoes | Strong oxidizing agent. Contact, oxidizing sanitizer. (Active ingredient: hydrogen peroxide). |
| **Kaolin** (Surround WP, Nova Source Tessenderlo Group) REI=4 h. | Powdery Mildew | Cucurbit and other vegetables | Product forms a white clay film on leaves and fruit. Reduces sunburn and heat stress. |
| **Mancozeb** (Dithane M-45, DF, Dow AgroSciences LLC) REI=24 h. | Leaf spot diseases, seed treatment for damping off, seed rots and seedling blights | Tomatoes and others | Broad-spectrum protectant fungicide. |
| **Mandipropamid** (Micora, Syngenta) REI=4 h. | Downy mildews, blue mold, and late blight, and suppression of *Phytophthora* blight | Some vegetables and basil grown for transplant and retail sale to customres | Registered for closed greenhouses with permanent flooring on transplants for re-sale to consumers. |
| **Pentachloro-nitrobenzene PCNB** (Terraclor 400, Amvac) REI=12 h. | Root and stem rot, damping off (*Rhizoctonia solani*, *Pellicularia filamentosa*) | Vegetable bedding plants. Limited to container-grown beans, broccoli, Brussels sprouts, cabbage, cauliflower, peppers and tomatoes. | Apply as a soil drench in nursery and greenhouse to seedlings grown in containers prior to transplanting. See label for additional information. |
| **Penthiopyrad** (Fontelis, DuPont) REI=12 h. | Many diseases, including gummy stem blight, *Sclerotinia* stem rot, leaf spots, powdery mildew and *Anthracnose* | Tomatoes, peppers and edible peel cucurbits | See label for specific usage instructions. |
| **Phosphorous acids – mono and di-potassium salts** (Fungi-Phite, Verdesian Life Sciences U.S., LLC; Rampart, Loveland Products) REI= 4 h. | Root rots, damping off downy mildew, suppression of bacterial diseases (see label) | Cucurbit, fruiting vegetable and leafy vegetable crops | See label for pre-plant seedling tray application instructions. |
| **Potassium Bicarbonate** (Milstop, BioWorks, Inc.) REI=4 h. | Powdery mildew and others | Many vegetables including cabbage, cucumber, eggplant, broccoli, cauliflower, lettuce, peppers, tomatoes and squash | Works by contact. Potassium bicarbonate disrupts the potassium ion balance in the fungus cell, causing the cell walls to collapse. |
| **Potassium Salts of Fatty Acids** (M-Pede, Gowan) REI=12 h. | Powdery Mildew | Cucurbits, fruiting, leafy, root and tuber vegetables and others | Contact fungicide. See label for details. |
| **Propamocarb Hydrochloride** (Previcur Flex, Bayer Crop Science) REI=12 h. | *Pythium* root rot and damping off | Tomatoes, leaf lettuce, cucurbits and peppers | See label for specific usage instructions. |
| **Pyraclastrobin plus Boscalid** (Pageant Intrinsic, BASF Corp) REI=12 h. | *Botrytis* grey mold | Tomatoes and tomato transplants | Pageant Intrinsic is also labeled for greenhouse use on transplants grown for the home consumer market |
| **Pyrimethanil** (Scala, Bayer Crop Science) REI=12 h. | Early blight and gray mold, Botrytis | Tomatoes and greenhouse grown cucumber | Use in well-ventilated houses only and ventilate two hours after application. |

*Table continued on next page*

*Table E-10. Selected Fungicides and Bactericides Labeled for Greenhouse Use - continued*

| Fungicide | Target Diseases | Labeled Crops | Comments |
|---|---|---|---|
| **Reynoutria sachalinensis** (Regalia, Marrone Bio Innovations) REI=4 h. | Many diseases including powdery mildew | Cucurbits, bulb vegetables, Fruiting vegetables and others | OMRI listed. |
| **Streptomyces lydicus** (Actinovate,Novozymes BioAg, Inc.) REI=1 h. | Damping off and root rot, pathogens *Pythium*, *Rhizoctonia*, *Phytophthora*, *Verticillium*; and foliar diseases including downy and powdery mildew and *Alternaria* and *Botrytis*. | Greenhouse Vegetables and herbs and others. | May be applied to soil or foliage through mist systems or sprayer. |
| **Streptomycin Sulfate** (Agri-mycin 17, Nufarm Americas, Inc.) REI=12 h. | Bacterial spot, bacterial speck | Tomatoes and peppers grown for transplant | Repeated applications can result in resistant bacteria. Do not apply through any irrigation system. |
| **Sulfur** (Microthiol Disperss, United Phosphorus, Inc.) REI=24 h. | Powdery mildew | Crucifers, cucurbits, peppers and tomatoes | Crops grown in greenhouses may be more sensitive to sulfur injury, so the lowest label rate should be tried initially. Do not use within two weeks of an oil spray treatment. |
| **Trichoderma harzianum** (PlantShield, Rootshield, Bioworks, Inc.) REI=4 h. | *Pythium*, *Rhizoctonia*, and *Fusarium*. When applied as a foliar spray, suppresses *Botrytis* and powdery mildew. | Greenhouse vegetables | Contains a beneficial fungus. Avoid applications of fungicides at least one week before or after application. Acts as a preventative. Will not cure diseased plants. |
| **Trichoderma virens GL-21** (formerly known as Gliocladium virens) (SoilGard 12G, Certis USA LLC) REI=0 h. | Damping off and root rot, pathogens *Pythium* and *Rhizoctonia* | Food crop plants in greenhouse | Acts as a preventative and will protect noninfected plants. Will not cure already diseased plants. Allow treated soil to incubate for one day prior to planting for best results. Do not use other soil fungicides at time of incorporation |

# F. Commodity Recommendations

## Pesticide Use Disclaimer

**THE LABEL IS THE LAW**
**Before using a pesticide, check the label for up to date rates and restrictions.**

**Labels can be downloaded from:** *http://www.cdms.net/*, *http://www.greenbook.net/* or *http://www.agrian.com/labelcenter/results.cfm*

**Guide to the Recommended Pesticide Tables in the Following Crop Chapters:**

**1.** Pesticides are listed by **group or code number based on chemical structure and mode of action**, as classified by the Weed Science Society of America (WSSA) for herbicides, the Insecticide Resistance Action Committee (IRAC) for insecticides, and the Fungicide Resistance Action Committee (FRAC) for fungicides.
**If the number is in bold font, the product may have resistance concerns.**

**2.** For **restricted use pesticides**, the restricted active ingredients are labeled with a *. See the Pesticide Safety chapter for more information.

**3. In addition to the pesticides listed below, other formulations or brands with the same active ingredient(s) may be available. ALWAYS CHECK THE LABEL:**
**a) to ensure a pesticide is labeled for the same use,**
**b) to ensure the pesticide is labeled for the desired crop, and**
**c) for additional restrictions.**

**4.** All pesticide recommendations are made for spraying a **broadcast area of 1 acre** (43,560 square feet). **Adjust the rate for banded applications** (for more information, see the Pest Management chapter, Calibrating Granular Applicators section).

**5.** Check the label for the maximum amount of pesticide per application and the maximum number of applications per year.

**6.** **Bee Toxicity Rating (Bee TR)**: N=nontoxic; L=minimum impact on bees; M=moderately toxic, can be used if dosage, timing and method of application are correct, but should NOT be applied directly to crop if bees are present; H=highly toxic, severe losses expected, -- = data not available.

# Asparagus

## Recommended Varieties[1]

| | | |
|---|---|---|
| Greenix* (NJ-1021) (RR,FT) | Jersey Knight* (RR,FT) | Purple Passion |
| Greenox* (NJ-1122) (RR,FT) | Jersey Supreme* (RR,FT) | Sequoia * (NJ-1113) (RR,FT) |
| Jersey Giant* (RR,FT) | Millennium* | Spartacus* (NJ-978) (RR,FT) |

[1]Varieties are listed alphabetically. *Indicates hybrid variety. RR = rust resistant; FT = Fusarium tolerant.

## Recommended Nutrients Based on Soil Tests

Before using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Asparagus[1] | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| **Growing Crowns** | 50 | 200 | 100 | 50 | 0[2] | 200 | 100 | 50 | 0[2] | Total nutrient recommended |
| | 50 | 200 | 100 | 50 | 0[2] | 200 | 100 | 50 | 0[2] | Broadcast and disk-in |
| **New Plantings** Crowns and Transplants | 75-100 | 200 | 100 | 50 | 0[2] | 200 | 100 | 50 | 0[2] | Total nutrient recommended |
| | 50 | 200 | 100 | 50 | 0[2] | 200 | 100 | 50 | 0[2] | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 4 weeks after planting |
| **Cutting Beds to Maintain** | 75-100 | 200 | 150 | 100 | 0[2] | 300 | 225 | 150 | 0[2] | Total nutrient recommended |
| | 50 | 200 | 150 | 100 | 0[2] | 150 | 100 | 75 | 0[2] | Apply before cutting season |
| | 25-50 | 0 | 0 | 0 | 0 | 150 | 125 | 75 | 0 | Sidedress 4 weeks after cutting |

[1]Apply 1-2 lb/A of boron (B) every 3 yr on most soils; see also Table B-7 in the Soil and Nutrient Management chapter.
[2]In VA, crop replacement values of 50 lb/A of $P_2O_5$ and 75 lb/A of $K_2O$ are recommended on soils testing Very High.

## Purity of Seed Lots

The varieties listed in the table above are all male hybrids. Male asparagus hybrid varieties are preferred over standard hybrids and open-pollinated populations because male plants are more vigorous and productive. However, some seed lots may contain a significant percentage of female plants. Check with your seed supplier to determine the anticipated proportion of female and/or off-type plants in the lots you procure.

## Seed Treatment

Check if seed has been treated; see also Disease Control below.

## Growing Crowns and Transplants

Crowns can be purchased or grown from seed. Sow seed 1½ inches deep at a rate of 6-8 lb/A (10-12 seeds per ft) in rows 24-30 inches apart in mid-April in warmer, southern areas to mid-May in cooler areas. Crowns must be grown in an area where asparagus has never been grown.

Grow asparagus transplants in 72-100 cell trays containing artificial growing media formulated for pepper transplants. Grow seedlings for 8-10 weeks in the greenhouse, then harden-off in a protected outdoor area for 2 weeks before transplanting. **Timely irrigation, cultivation and application of herbicides are essential for successful use of seedling transplants**. Contact your County Extension Agent for specific herbicide suggestions.

## Planting and Spacing

Plant crowns and transplants April 1 to May 20 when soil conditions are favorable. Early plantings produce more vegetative growth and more vigorous crowns than late plantings. Space 1-year-old crowns and transplants 12 inches apart in rows 4½-5 ft apart. Make furrows 6-8 inches deep, plant crowns 5-7 inches deep. Cover crowns with 1-2 inches of soil. Cultivate and move soil to seedlings carefully to avoid covering foliage with soil. Gradually fill trenches during the growing season and form a 2-inch ridge over the plants after the fern turns brown in the fall.

## Harvest and Postharvest Considerations

Do not harvest asparagus the year of planting. Harvest for 2 weeks the 2nd year after planting and increase to 6-8 weeks as the planting matures. Stop harvesting by June 15 if fern vigor was good the previous fall. Stop sooner if spear thickness drops. Prolonged cutting increases stress on the plant and can increase root and crown rot. If foliage diseases were severe or fern vigor was low the previous fall, stop harvesting 10 days sooner than normal. Leave soil on young beds unridged for the first 2-3 weeks of harvest. On old beds, and in fields where freezing of early emerged spears occurs frequently, begin ridging at the start of the harvest season. In areas where freeze damage to spears occurs frequently, mulch the beds with straw after herbicide application to delay spear emergence. Remove spears from field promptly after cutting to maintain freshness and a low fiber content. After harvesting, spears should be washed, cooled, trimmed to a uniform length, graded by diameter and bunched. Spears can be stored for up to 3 weeks at 36°F (2°C) and 95% relative humidity.

## Mother Stalk Harvest System for Season Extension

Like many other crop species, asparagus possesses a feedback system for spear/shoot initiation from the underground crown. If few mature shoots (“fern”) exist, the crown perceives reduced phytohormone levels and releases additional spears/shoots for elongation. When a threshold number of mature shoots is reached, no more spears/shoots will elongate thereafter from the crown. It is possible to use this system for spear harvest season extension by limiting the number of mature shoots, known as the “mother stalk harvesting system” (MSHS).

MSHS begins by allowing a fixed number of spears to continue to grow into mature shoots, usually 3 to 4. After these shoots are established, all spears that subsequently emerge from the crown are harvested. Research has shown that spears will appear more or less continuously for several months, as long as the mature shoots remain healthy. The dynamics of yield are not consistent, however. Following the expected flush of spears in April-June, the rate of new spear emergence drops off during the warmer summer period, then increases again in the fall as air and soil temperatures drop into a more favorable range. Yields during the summer period can be extremely low, although spear quality remains acceptable. Spears harvested after the fern canopy is present often appear lighter in color, since chlorophyll deposition is associated with light levels. Summer yields are often insufficient to justify the cost of harvesting, but harvesting must continue since new mature shoots will suppress later spear emergence.

Successful MSHS usually requires more intensive management than conventional harvesting. Spear yields and quality are promoted by regular irrigation and fertilization, and pest and disease management as needed. Staking of the mature foliage prevents crop damage during violent weather events, and renders it easier to harvest young spears. The hope is that favorable market conditions will help to infringe the costs of additional management needs.

There are many variations on specific steps taken in MSHS. For example, research has shown that a period of conventional harvest at the beginning of the season (first 2-3 weeks) followed by the imposition of MSHS has a beneficial impact on cumulative season yield. Although data on the long-term effects of MSHS on crown viability are lacking, it is recommended that a minimum of 2 years of conventional harvest separate a season of MSHS on any given asparagus production block.

It is recommended that MSHS is practiced on a small scale by growers participating in direct marketing.

## Brush Removal

For very small plantings remove and properly discard brush if possible. Mow or disk brush in February or March. Avoid damage to spear buds by shallow disking. Burn brush during the winter to destroy fungi that cause diseases, such as rust and purple spot. Obtain a burn permit in areas where required.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the “Herbicide Effectiveness on Common Weeds in Vegetables” Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

<table>
<tr><td colspan="7">1.A. Seedbeds, Seeded Fields and Newly Planted Crowns: Preplant or Preemergence</td></tr>
<tr><th>Group</th><th>Product Name</th><th>Product Rate</th><th>Active Ingredient<br>(*=Restricted Use)</th><th>Active Ingredient Rate</th><th>PHI<br>(d)</th><th>REI<br>(h)</th></tr>
<tr><td>3</td><td>Prowl H2O 3.8CS</td><td>2.4 to 8.2 pt/A</td><td>pendimethalin</td><td>1.14 to 3.90 lb/A</td><td>14</td><td>24</td></tr>
<tr><td colspan="7">-Apply only to newly planted crown asparagus. Assure crowns are fully covered with 2 to 4 inches of soil.<br>-DO NOT apply to newly seeded asparagus. DO NOT apply more than 2.4 pt/A to sandy soils.<br>-DO NOT apply postemergence over the top of emerged spears or severe injury may occur.<br>-Maximum for Prowl H2O application: 8.2 pt/A per season.</td></tr>
<tr><td>7</td><td>Lorox 50DF</td><td>2 to 4 lb/A</td><td>linuron</td><td>1 to 2 lb/A</td><td>1</td><td>24</td></tr>
<tr><td colspan="7">-Use lower rate on coarse-textured (sandy) soils low in organic matter, and higher rate on fine-textured (silt and clay) soils.<br>-Make a single application of 2 to 4 lb/A after planting seed ½ inch deep in coarse soil and 1 inch deep in fine soils.<br>-During planting operation, spray activated charcoal as a 1 inch band on soil surface directly over seed row at rate of 300 lb/A.<br>-Preemergence weed control will be reduced in soils with high organic matter (greater than 5% and peat or muck).<br>-DO NOT use FLOWABLE (liquid) formulation, or crop injury may occur.<br>-DO NOT use surfactant or fertilizer solution in spray mixture.<br>-Maximum Lorox 50DF application: 4 lb/A per season.</td></tr>
<tr><td>9</td><td>Roundup PowerMax 4.5L<br>“Generic” glyphosate 3L</td><td>16 to 32 fl oz/A<br>24 to 48 fl oz/A</td><td>glyphosate</td><td>0.75 to 1.10 lb acid equivalent/A</td><td>5</td><td>4</td></tr>
<tr><td colspan="7">-Apply before seeding or at least 7 days prior to the emergence of the first asparagus spears.<br>-Some glyphosate formulations may require an adjuvant, refer to label.<br>-Tank-mix with appropriate herbicides for residual weed control.<br>-Glyphosate controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label. Repeat applications are allowed, with maximum application of 5.3 qt/A per year.</td></tr>
<tr><td>22</td><td>Gramoxone SL 2.0</td><td>2.4 to 4 pt/A</td><td>paraquat*</td><td>0.6 to 1.0 lb/A</td><td>6</td><td>24</td></tr>
<tr><td colspan="7">-Apply before seeding or before spear emergence. Always include an adjuvant (nonionic surfactant or crop oil concentrate).<br>-Tank mix with appropriate herbicides for residual weed control. Paraquat may not control established grasses.<br>-Spray coverage is essential for optimum control. Rainfastness 30 minutes. A maximum of 3 applications per year are allowed.</td></tr>
<tr><td colspan="7">1.B. Seedbeds, Seeded Fields and Newly Planted Crowns: Postemergence</td></tr>
<tr><th>Group</th><th>Product Name</th><th>Product Rate</th><th>Active Ingredient<br>(*=Restricted Use)</th><th>Active Ingredient Rate</th><th>PHI<br>(d)</th><th>REI<br>(h)</th></tr>
<tr><td rowspan="3">1</td><td>Select 2EC<br>Select Max 0.97EC</td><td>6 to 8 fl oz/A<br>9 to 16 fl oz/A</td><td>clethodim</td><td>0.07 to 0.12 lb/A</td><td>1</td><td>24</td></tr>
<tr><td>Poast 1.5EC</td><td>1 to 2.5 pt/A</td><td>sethoxydim</td><td>0.2 to 0.5 lb/A</td><td>1</td><td>12</td></tr>
<tr><td>Fusilade DX 2EC</td><td>8 to 12 fl oz/A</td><td>fluazifop</td><td>0.125 to 0.188 lb/A</td><td>1</td><td>12</td></tr>
<tr><td colspan="7">-Select 2EC: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution).<br>-Select Max: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution).<br>-Poast: Apply with COC at 1.0% v/v. Fusilade DX: Apply with COC at 1.0% v/v or NIS at 0.25% v/v.<br>-The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.<br>-If repeat applications are necessary, allow 14 days between applications.<br>-Do not tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-Rainfastness 1 hr.<br>-Do not apply more than 8 fl oz of Select 2EC in a single application and do not exceed 2 pt/A for the season;<br>do not apply more than 16 fl oz of Select Max in a single application and do not exceed 4 pt/A for the season.<br>-Do not apply more than 2.5 pt/A Poast in single application and do not exceed 5 pt/A for the season.<br>-Do not apply more than 24 fl oz/A of Fusilade DX in a single application and do not exceed 3 pt/A per season.</td></tr>
</table>

## 2. Cutting Bed

Use a combination of grass and broadleaf weed herbicides to control a wide spectrum of weeds. Identify the weeds in your field. Split the herbicide application. Spray part of your grass herbicide before harvest and the remainder after harvest, or switch to another grass herbicide after harvest. Rotate the use of metribuzin with Karmex or Sinbar to avoid repeated use of chemically related products. Choose metribuzin or Sinbar when weeds have emerged, unless another effective postemergence herbicide is used.

<table>
<tr><th colspan="7">2.A. Cutting Bed: Before Spear Emergence and/or After Harvest Season</th></tr>
<tr><th>Group</th><th>Product Name</th><th>Product Rate</th><th>Active Ingredient (*=Restricted Use)</th><th>Active Ingredient Rate</th><th>PHI (d)</th><th>REI (h)</th></tr>
<tr><td>3</td><td>Prowl H2O 3.8CS</td><td>2.4 to 8.2 pt/A</td><td>pendimethalin</td><td>1.14 to 3.90 lb/A</td><td>14</td><td>24</td></tr>
<tr><td colspan="7">-Apply only to newly planted crown asparagus. Assure crowns are fully covered with 2 to 4 inches of soil.<br>-DO NOT apply to newly seeded asparagus.<br>-DO NOT apply more than 2.4 pt/A to sandy soils.<br>-DO NOT apply postemergence over the top of emerged spears or severe injury may occur.<br>-Maximum for Prowl H2O: 8.2 pt/A per season.</td></tr>
<tr><td>3</td><td>Treflan 4EC</td><td>1.0 to 4 pt/A</td><td>trifluralin</td><td>0.5 to 2 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Apply only to established asparagus as a single or split application. See label for rates and instructions concerning split applications before and after harvest.<br>-Make applications to dormant asparagus in winter or early spring after mature ferns have been removed or post-harvest immediately after harvest in late spring or early summer just before ferns are allowed to develop.<br>-DO NOT apply after new spears begin to emerge.<br>-Maximum for Treflan: No more than 2 pt/A on coarse soils, 3 pt/A on medium soils, or 4 pt/A on fine soils per calendar year.</td></tr>
<tr><td>5</td><td>Metribuzin 75DF<br>Glory 4L<br>TriCor 4F</td><td>1.33 to 2.67 lb/A<br>2.1 to 4.2 pt/A<br>2 to 4 pt/A</td><td>metribuzin</td><td>1 to 2 lb/A</td><td>14</td><td>12</td></tr>
<tr><td colspan="7">-Apply before spears emerge or after harvest.<br>-Metribuzin primarily controls broadleaf weeds. Tank-mix with Devrinol or other residual grass herbicide to control annual grasses.<br>-Use Sinbar or Karmex after harvest when metribuzin is used in the early spring.<br>-For split applications preemergence followed by post-harvest use 0.5 to 1 lb ai/A preemergence followed by 1 to 1.5 lb ai/A post-harvest.<br>-For post-harvest applications, apply after last harvest of season but prior to emergence.<br>-Rainfastness is 6 hrs.<br>-Maximum for Metribuzin 75DF: 2.67 lb/A per season. Maximum for Glory 4L: 67.4 fl oz/A per season.<br>-Maximum for TriCor 4F: 64 fl oz/A per season.</td></tr>
<tr><td>5</td><td>Sinbar 80WDG</td><td>1.5 to 2.5 lb/A</td><td>terbacil</td><td>1.2 to 2 lb/A</td><td>5</td><td>12</td></tr>
<tr><td colspan="7">-Apply prior to spear emergence; application may be made immediately after clean cutting.<br>-Use lower rate on coarse-textured (sandy) soils low in organic matter, and higher rate on fine-textured (silt and clay) soils.<br>-Apply before weeds emerge or to small weeds (1/2 to 2 inches tall).<br>-DO NOT use on areas where subsoil or roots are exposed or on plants that are diseased or lacking in vigor, as crop injury may occur.<br>-DO NOT use on soils containing less than 1% organic matter.<br>-Not recommended for use at time of planting.<br>-Treated areas may be planted to asparagus 1 year after application. Do not replant any other crop within 2 years of last application.<br>-Maximum for Sinbar: 1.5 lb/A per application.</td></tr>
<tr><td>7</td><td>Karmex 80DF</td><td>1 to 4 lb/A</td><td>diuron</td><td>0.8 to 3.2 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-DO NOT apply to young plants during the first growing season (except as noted below), nor to newly seeded asparagus, nor on plants with exposed roots as severe injury may result.<br>-Apply prior to spear emergence or after harvest when the soil is disked and free of weeds.<br>-Preemergence weed control will be reduced on soils with greater than 5% organic matter.<br>-On light soils and other soils low in clay or organic matter, apply 1 to 2 lb/A. On soils high in clay or organic matter, use 2 to 4 lb/A.<br>-Maximum for Karmex: 6 lb/A per season, do not exceed 3 lb/A per application, no more than 2 applications.</td></tr>
<tr><td>7</td><td>Lorox 50DF</td><td>2 to 4 lb/A</td><td>linuron</td><td>1 to 2 lb/A</td><td>1</td><td>24</td></tr>
<tr><td colspan="7">-Apply prior to spear emergence, after harvest, or directed postemergence in the fern stage.<br>-Use lower rate on coarse-textured (sandy) soils low in organic matter, and higher rate on fine-textured (silt and clay) soils.<br>-Preemergence weed control will be reduced in soils with high organic matter (greater than 5% and peat or muck).<br>-Preemergence: make a single application of 2 to 4 lb/A.<br>-Postemergence: make 1 to 3 applications of 1 to 2 lb/A before weeds exceed 4 inches in height. Apply before cutting season or immediately after cutting.<br>-Directed Postemergence (Fern Stage): make a single application of 4 lb/A as a directed spray.<br>-DO NOT use FLOWABLE (liquid) formulation, or crop injury may occur.<br>-DO NOT use surfactant or fertilizer solution in spray mixture.<br>-Maximum for Lorox: 4 lb/A per season.</td></tr>
<tr><td>12</td><td>Solicam 80DF</td><td>2.5 to 5 lb/A</td><td>norflurazon</td><td>2 to 4 lb/A</td><td>14</td><td>12</td></tr>
<tr><td colspan="7">-Apply to asparagus that has been established for at least one growing season.<br>-Apply at the end of the cutting season immediately after the field is cultivated to level the ridges.<br>-Use 2.5 lb/A on sands and loamy sands, 3.75 lb/A on sandy loams, and 3.75 to 5 lb/A on medium and fine textured soils.<br>-Soil should be settled, firm, relatively free of weeds and debris, and free of depressions around asparagus at time of application.<br>-If no rainfall occurs within 4 weeks after application, the product must be incorporated by flood or sprinkler irrigation.<br>-DO NOT plant sensitive crops (see label) for 2 years after application.<br>-Maximum for Solicam: 5 lb/A per season.</td></tr>
</table>

*2.A. Cutting Bed: Before Spear Emergence and/or After Harvest Season continued on next page*

*2.A. Cutting Bed: Before Spear Emergence and/or After Harvest Season - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 13 | Command 3ME | 2.6 pt/A | **clomazone** | 1.0 lb/A | 14 | 12 |
| -**A supplemental label has been approved for the use of Command 3ME on asparagus.**<br>-Apply prior to spear and weed emergence. If spears have emerged, make an application after a clean harvest. Cover exposed plants with soil prior to application. Maximum for Command: 1.0 lb ai/A per application; 1.0 lb ai/A per year; No more than 1 application per year. | | | | | | |
| 15 | Devrinol 2-XT | 2 gal/A | **napropamide** | 4 lb/A | -- | 24 |
| -Apply to asparagus that has been established for at least one growing season. Apply before weeds emerge immediately after ridging in the spring. Split the application if ridges are leveled after harvest. Make the second application immediately after leveling the ridge following the harvest season. Incorporation may improve weed control if rainfall does not occur within 24 hrs of application.<br>-Devrinol primarily controls annual grasses. Tank-mix with metribuzin or other broadleaf residual herbicide for broadleaf weed control.<br>-Maximum for Devrinol 2-XT: 2 gal/A per season. | | | | | | |
| 15 | Dual Magnum 7.62E | 1.33 to 2 pt/A | ***s*-metolachlor** | 1.26 to 1.9 lb/A | 16 | 24 |
| -**Special Local-Needs Label 24(c) has been approved for NJ and DE only.**<br>-The use of Dual Magnum 7.62E is legal ONLY if a waiver of liability has been completed (see *http://www.farmassist.com/*).<br>-Apply to dormant established asparagus beds in the spring, prior to spear emergence. Use lower rates on coarse-textured soils and higher rates on fine-textured soils. Primarily controls annual grasses, certain broadleaf weeds, and nutsedge. **DOES NOT** control emerged weeds. Maximum for Dual Magnum: 2 pt/A per season, no more than 1 application. | | | | | | |
| 22 | Gramoxone SL 2.0 | 2.4 to 4 pt/A | **paraquat*** | 0.6 to 1.0 lb/A | 6 | 24 |
| -Apply prior to spear emergence or immediately after the last cutting. Emerged spears sprayed after last harvest will be killed but new growth from the crown will not be affected. Always include an adjuvant (nonionic surfactant or crop oil concentrate).<br>-Tank mix with appropriate herbicides for residual weed control. Paraquat may not control established grasses.<br>-Spray coverage is essential for optimum control. Rainfastness 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |
| **27** | Callisto 4SC | 3.0 to 7.7 fl oz/A | **mesotrione** | 0.094 to 0.24 lb/A | -- | 12 |
| -Apply in the spring after fern mowing, disking or other tillage operations but prior to spear emergence, as a post-harvest application (after final harvest), or both.<br>-Use the 3.0 fl oz/A rate for postemergence control of emerged weeds or the 6.6 to 7.7 fl oz/A rate for preemergence control.<br>-Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils.<br>-Use crop oil concentrate at 1 gal/100 gal spray solution or nonionic surfactant at 1 qt/100 gal spray solution if target weeds are emerged. A spray grade UAN at 2.5 gal/100 gal spray solution or AMS at 8.5 lb/100 gal spray solution may be added for improved burndown of emerged weeds. For post-harvest applications, the use of an adjuvant will increase the risk of crop injury.<br>-Till field or tank-mix with paraquat to eliminate emerged spears when Callisto is applied after harvest, or crop injury may be observed as bleaching or bleached streaks in the stems and ferns when treated spears grow.<br>-Callisto controls horseweed and common lambsquarters, but is weak on annual grasses. Tank-mix with a residual annual grass herbicide to control grasses.<br>-Post-harvest applications must be made in a way that minimizes contact with any standing asparagus spears or ferns.<br>-Rainfastness is 1 hr. Maximum for Callisto: 7.7 fl oz/A per season, no more than 2 applications per year. | | | | | | |

## 2.B. Cutting Bed: Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9 to 16 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 1 | 24 |
| | Poast 1.5EC | 1 to 2.5 pt/A | **sethoxydim** | 0.2 to 0.5 lb/A | 1 | 12 |
| | Fusilade DX 2EC | 8 to 12 fl oz/A | **fluazifop** | 0.125 to 0.188 lb/A | 1 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with crop oil concentrate at 1.0% v/v (1.0 gal/100 gal of spray solution).<br>**Fusilade DX:** Apply with crop oil concentrate (COC) at 1.0% v/v (1.0 gal/100 gal spray solution) or nonionic surfactant at 0.25% v/v (1 qt/100 gal spray solution). **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.<br>-Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or if the weather is hot or dry. If repeat applications are necessary, allow 14 d between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 32 fl oz for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 64 fl oz for the season.<br>-**Do not** apply more than 2.5 pt/A Poast in single application and **do not** exceed 5 pt/A for the season.<br>-**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 48 fl oz/A per season. | | | | | | |

*2.B. Cutting Bed: Postemergence continued on next page*

*2.B. Cutting Bed: Postemergence - continued*

<table>
<tr><td>2</td><td>Sandea 75DF</td><td>0.50 to 1.50 oz/A</td><td>halosulfuron</td><td>0.024 to 0.07 lb/A</td><td>1</td><td>12</td></tr>
<tr><td colspan="7">-Weed control is maximized with the addition of nonionic surfactant at 0.25% v/v (1.0 qt/100 gal of spray solution), however, the addition of surfactants and grass herbicides may enhance crop response.<br>-Postemergence/Post transplant: Apply to asparagus before or during the harvesting season.<br>-Post-harvest: Nonionic surfactant should be used post-harvest. Sandea can be applied post-harvest during the fern stage.<br>-Split application for enhanced control of nutsedge: Under heavy nutsedge pressure, split applications are recommended. Apply 0.75 to 1 oz/A Sandea during the cutting/harvesting season when the first flush of nutsedge is 3 to 5 leaf, followed by a second application of 0.75 to 1 oz/A at least 21 to 30 days later up to lay-by to control later flushes of nutsedge.<br>-Sandea may cause temporary stunting or twisting of fern on certain varieties when applied during spear emergence. Contact with ferns may cause temporary yellowing. Crop injury will be minimized and weed control maximized when applications are made with drop nozzles as a directed spray below the ferns to allow for more complete coverage of target weeds.<br>-Precaution: For first year transplants, apply no sooner than 6 weeks after fern emergence.<br>-Provides control of yellow nutsedge and certain annual broadleaf weeds. Control of weeds taller than 3 inches may not be adequate.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. Do not use Group 2 herbicides repeatedly in the same field. Do not apply Sandea to crops treated with a soil-applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Rainfastness is 4 hrs. Do not apply more than 2 applications, or more than 2 oz of product per 12 month period.</td></tr>
<tr><td>4</td><td>Banvel 480 4SC<br>Clarity 4SC</td><td>8 to 16 fl oz/A<br>8 to 16 fl oz/A</td><td>dicamba</td><td>0.25 to 0.5 lb/A</td><td>24</td><td>24</td></tr>
<tr><td colspan="7">-May be applied immediately after cutting asparagus but at least 24 hrs before next cutting.<br>-Controls or suppresses many annual and perennial broadleaf weeds.<br>-Multiple applications can be made per growing season.<br>-If spray contacts emerged spears, crooking (twisting) of some spears may result. If crooking occurs, discard affected spears.<br>-Warning: Dicamba spray or vapor drift may injure sensitive crops growing adjacent to treated fields. Do not apply to fields adjacent to sensitive horticultural, fruit, or vegetable crops. Do not apply on days when the temperature is expected to exceed 85 degrees Fahrenheit. Spray residue is difficult to completely remove from sprayers used to apply dicamba. Do not apply dicamba with sprayers which will be used to apply pesticides to sensitive crops.<br>-Rainfastness is 4 hrs.<br>-Maximum for Banvel: 16 fl oz/A per season. Maximum for Clarity: 16 fl oz/A per season.</td></tr>
<tr><td>4</td><td>Spur 3A</td><td>0.5 to 0.67 pt/A</td><td>clopyralid</td><td>0.188 to 0.25 lb/A</td><td>2</td><td>12</td></tr>
<tr><td colspan="7">-Other clopyralid formulations may not labeled (read the label).<br>-Applications may be made before or during the asparagus cutting season, or after harvest is complete but prior to fern growth.<br>-Apply Spur to control or suppress sensitive annual and perennial broadleaf weeds, including Canada thistle, goldenrod, mugwort, and wild aster species. Apply when majority of weeds' basal leaves have emerged, but before the flower stalk begins to grow. Use the higher rate for more effective control of perennial weeds.<br>-Some crooking or twisting of treated spears may occur. Discard crooked or twisted spears. DO NOT apply if some crooking of emerged spears is not acceptable. Clear-cutting spears just before applying Spur may reduce occurrence of crooking.<br>-Post-harvest layby applications should be made as soon as possible after cutting. Malformed ferns may result from application when spears are longer than 3 inches or with open seed heads.<br>-Spur carryover may affect subsequent crops; observe all plantback restrictions list on label.<br>-Rainfastness is 6 hrs. Maximum application for Spur: 0.67 pt/A per growing season.</td></tr>
<tr><td>4</td><td>Weedar 64 3.8L and various other generics</td><td>3.0 to 4.0 pt/A</td><td>2,4-D (* in NJ)</td><td>1.43 to 1.9 lb acid equivalent/A</td><td>30</td><td>48</td></tr>
<tr><td colspan="7">-Apply in the spring on actively growing weeds. Use drop nozzles to avoid contact with ferns if applied post-harvest. If asparagus spears are present, treat immediately after cutting. Spears contacted by the spray may be malformed and off-flavored. If spears are malformed by spray, cut immediately and discard.<br>-Warning: 2,4-D spray or vapor drift may injure sensitive crops growing adjacent to treated fields. Do not apply to fields adjacent to sensitive horticultural, fruit, or vegetable crops. Do not apply on days when the temperature is expected to exceed 85°F. Spray residue is difficult to completely remove from sprayers used to apply 2,4-D. Do not apply 2,4-D with sprayers which will be used to apply pesticides to sensitive crops.<br>-Minimum of 30 days between applications. Rainfastness is 6 to 8 hrs.<br>-Maximum for Weedar 64 3.8L: 2 applications per crop cycle, 4 pt/A per application, or a combined total of 4.0 lb ai/A 2,4-D per year.</td></tr>
<tr><td>7</td><td>Lorox 50DF</td><td>2 to 4 lb/A</td><td>linuron</td><td>1 to 2 lb/A</td><td>1</td><td>24</td></tr>
<tr><td colspan="7">-Apply prior to spear emergence, after harvest, or directed postemergence in the fern stage.<br>-Use lower rate on coarse-textured (sandy) soils low in organic matter, and higher rate on fine-textured (silt and clay) soils. Preemergence weed control will be reduced in soils with high organic matter (greater than 5% and peat or muck).<br>-Preemergence: make a single application of 2 to 4 lb/A. Postemergence: make 1 to 3 applications of 1 to 2 lb/A before weeds exceed 4 inches in height. Apply before cutting season or immediately after cutting.<br>-Directed Postemergence (Fern Stage): make a single application of 4 lb/A as a directed spray.<br>-DO NOT use FLOWABLE (liquid) formulation, or crop injury may occur.<br>-DO NOT use surfactant or fertilizer solution in spray mixture. Maximum for Lorox: 4 lb/A per season.</td></tr>
</table>

| **3. Other Labeled Herbicides** These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns. | | |
|---|---|---|
| **Group** | **Product Name** | **Active Ingredient (*=Restricted Use)** |
| **14** | Aim | **carfentrazone** |
| **14** | Chateau | **flumioxazin** |
| **14** | Zeus | **sulfentrazone** |
| 22 | Reglone Desiccant | **diquat** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

### Asparagus Aphids

Watch for tiny (1/16 inch long), bluish green aphids building up on brush. Protection may be important in newly seeded plantings and young cutting beds.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Malathion 57EC | 1.5 to 2.0 pt/A | malathion | 1 | 12 | H |
| 9 | Fulfill 50WDG | 2.75 oz/A | pymetrozine - **apply to ferns after harvest** | 170 | 12 | L |

### Asparagus Beetles

Apply one of the insecticides in the table below when needed during cutting season and late summer. Prevent large numbers of beetles from overwintering and laying eggs on spears in spring by spraying ferns in early fall. Daily harvest will minimize exposure to these pests and reduce damage.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 fl oz/A | methomyl* | 1 | 48 | H |
| 1A | Sevin XLR Plus | 1.0 qt/A | carbaryl | 1 | 12 | H |
| 1B | Malathion 57EC | 1.5 to 2.0 pt/A | malathion | 1 | 12 | H |
| 3A | Perm-Up 3.2EC | 2.0 to 4.0 fl oz/A | permethrin* | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 6.0 fl oz/A | spinosad -**post-harvest protection of ferns only** | 60 | 4 | M |
| 5 | Radiant SC | 4.0 to 8.0 fl oz/A | spinetoram - **post-harvest protection of ferns only** | 60 | 4 | H |

### Asparagus Fern Caterpillars (Beet Armyworms)

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 fl oz/A | methomyl* | 1 | 48 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 1 | 4 | L |

### Cutworms

**Note**. Early spears are the most heavily damaged because they are first to appear and grow slowest. Dig up to ½ inch deep around crowns and use bait if you find 1 cutworm larva or 1 severely damaged spear per 20 plants.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 fl oz/A | methomyl* | 1 | 48 | H |
| 1A | Sevin XLR Plus | 1.0 qt/A | carbaryl | 1 | 12 | H |
| 3A | Perm-Up 3.2EC | 2.0 to 4.0 fl oz/A | permethrin* | 1 | 12 | H |
| 5 | Seduce (OMRI) | 20 to 40 lb/A | spinosad - **post-harvest protection of ferns only** | 60 | 4 | M |

## Japanese Beetles

| Apply to foliage after the cutting season: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Perm-Up 3.2EC | 4.0 fl oz/A | permethrin* | 1 | 12 | H |

## Thrips

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 fl oz/A | methomyl* | 1 | 48 | H |
| 1B | Malathion 57EC | 1.5 to 2.0 pt/A | malathion | 1 | 12 | H |

# Disease Control

**THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.**
**Recommended Fungicides**

## Seed Treatment, For NJ Only.

Dip seed in a solution containing 1.0 pt/gal of Clorox in water for 1-2 minutes with constant agitation. Use 1.0 gal of this diluted Clorox solution per 2 lb of seed. Prepare a fresh solution for each batch of seed. Wash seed for 5 minutes in running water and dry thoroughly at room temperature.

## Asparagus Rust

For long term management of rust, plant resistant varieties; see the Recommended Varieties table above. Control is especially important in 1- or 2-year-old beds, even with the use of resistant varieties. Scout fields, particularly non-cutting beds, for disease beginning in late June. Traditionally sprays begin in mid-August. Rotate between the fungicides in the table below at the first sign of disease or when conditions favor disease development. Use high rates under severe pressure from rust.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Rotate or tank mix one of the following protectant fungicides** | | | | | | |
| M3 | mancozeb 75DF | 2.0 lb/A | mancozeb | 120 | 24 | N |
| M5 | chlorothalonil 6F | 2.0 to 4.0 pt/A | chorothalonil | 0 | 12 | L |
| **With one of the following FRAC code 3 fungicides[1]** | | | | | | |
| 3 | Rally 40WSP | 5.0 oz/A plus adjuvent | myclobutanil | 180 | 24 | N |
| 3 | Folicur 3.6F | 4.0 to 6.0 fl oz/A | tebuconazole | 180 | 12 | N |

[1]Rally and Folicur should not be used consecutively; overuse of FRAC code 3 fungicides could lead to fungicide resistance development.

## Fusarium Root Rot

The pathogen is ubiquitous in soils and may be present in fields where no asparagus has been grown. Plant varieties with tolerance to Fusarium root rot; see the Recommended Varieties table above. Stress caused by heavy insect feeding damage, herbicide injury, overharvesting, low soil pH, or low fertility may predispose crowns to Fusarium infection. For crown production, always plant treated seed and select a site where asparagus has never been grown before. For production fields, always plant disease-free crowns, transplants, or seed and select well-drained sites. If this is not possible, select fields that have not been in asparagus production for at least 8 years.

## Leaf Blights

Excessive rainfall during the summer months may lead to fungal leaf blights caused by *Alternaria* and *Cercospora* spp. Heavy infections may lead to premature defoliation and poor plant vigor later in the season and the following spring. The most noticeable signs of early leaf blight will be sporadic ‘hot spots’ of brown, dying ferns. Fields should be scouted regularly, especially during periods of prolonged wet weather. Additional fungicide applications may be necessary beyond those for Purple spot and Rust control. Fungicides used to control Purple Spot and Rust, such as chlorothalonil, Folicur, or mancozeb will be useful for leaf blight control. Apply and rotate the following fungicides on a 7-14 day schedule as long as weather conditions are favorable for disease development.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| M3 | mancozeb 75DF | 2.0 lb/A | mancozeb | 120 | 24 | N |
| M5 | chlorothalonil 6F | 2.0 to 4.0 pt/A | chlorothalonil | 0 | 12 | L |
| 3 | Folicur 3.6F | 4.0 to 6.0 fl oz/A | tebuconazole | 180 | 12 | N |

## Phytophthora Crown and Spear Rot

In fields with poor drainage or low areas, apply one of the following fungicides according to the label.
**Cutting fields**: Apply 30-60 days before the first harvest and make a second application prior to first cutting.
**Do not** apply Ridomil Gold, Ultra Flourish, or MetaStar one day prior to harvest or illegal residues may result.
**New plantings**: Apply after planting seedlings or after covering crowns.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 4 | Ridomil Gold 4SL | 1.0 pt/A | mefenoxam | AP | 48 | N |
| 4 | Ultra Flourish 2E | 2.0 pt/A | mefenoxam | AP | 48 | N |
| 4 | MetaStar 2E | 2 qt/A | metalaxyl | AP | 48 | -- |

## Purple Spot

Remove, mow, or burn brush (*i.e.*, dead ferns) after frost or during winter months to destroy the overwintering sources of the fungi (see Brush Removal above). Fungicide applications are not practical during the production season, because new spears emerge daily. Once fern stalks are full size, scout on a weekly basis and rotate the fungicides listed below every 2 to 4 weeks as long as conditions favor disease development or until frost.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| M5 | chlorothalonil 6F | 2.0 to 4.0 pt/A | chlorothalonil | 0 | 12 | L |
| 11 | azoxystrobin 2.08F | 6.2 to 15.5 fl oz/A | azoxystrobin | 100 | 4 | N |

# Beans (Snap and Lima)

## Recommended Snap Beans (Bush) Varieties[1]

| Snap Beans (Bush) | Variety | Color[2] | Length (inch) | Sieve Size[3] | Use[4] | Days | Reported Disease Resistance[5] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BCMV | BCTV | Cl | Ua | Psp | Xap | Pss |
| **Green Round Podded Types** | Achiever | DG | 5.5 | 3-4 | F | 53 | R | | | | | | |
| | Advantage | DG | 6.5 | 4 | F | 54 | R | | R | | | | |
| | Ambition | DG | 5.5 | 4 | F | 54 | R | | | | | | |
| | Ambra | MG | 6.0 | 4 | F | 52 | R | R | | | | | |
| | Barron | DG | 5.5 | 3-4 | F, P | 54 | R | R | | | R | I | R |
| | Boone | MDG | 5.5 | 3-4 | F, P | 59 | R | R | | R | I | | R |
| | Bowie | MDG | 5.5 | 3-4 | F, P | 56 | R | R | | | | | |
| | Bronco | DG | 5.3 | 3-4 | F | 53 | R | | | | | | |
| | Caprice | MDG | 5.5 | 3-4 | F, P | 56 | R | | R | | R | R | I |
| | Colter | MDG | 5.5 | 4 | F, | 53 | R | R | | R | | | |
| | Crockett | DG | 5.25 | 2-3 | F, P | 58 | R | R | | R | R | R | R |
| | Envy | MDG | 5.5 | 4-5 | P | 56 | R | | | | | | |
| | Hickok | MDG | 5.5 | 3-4 | F | 54 | R | R | | R | | | |
| | HM 5101 | MDG | 5.5 | 3-4 | P | 55 | R | I | | | | | I |
| | Inspiration | DG | 5.8 | 3-4 | F | 56 | R | I | | | | | |
| | Jade II | DG | 6.5 | 4 | F | 60 | R | | | I | | | |
| | Lewis | MDG | 5.5 | 3-4 | F, P | 53 | R | R | | R | R | | I |
| | Maxibel | MG | 7.0 | 2.3 | F | 60 | | | | | | | |
| | Momentum | DG | 5.8 | 3-4 | F | 56 | R | | | | | | |
| | Nickel | MG | 4.25 | 2-3 | F | 53 | | | | | I | | |
| | Pike | MDG | 5.25 | 3 | F | 55 | R | R | | | I | I | I |
| | Prevail | DG | 5.5 | 3-4 | F | 54 | R | I | | | | | |
| | Provider | MG | 5.5 | 4-5 | F | 55 | | | | | | | |
| | Secretariat | DG | 5.8 | 4 | F | 53 | R | | | | | | |
| | Slendrette | MDG | 5.0 | 3-4 | P | 55 | R | R | | | | | |
| | Strike | MG | 5.5 | 3-4 | F | 55 | R | | | | | | |
| | SV1137GF | MG | 5.5 | 3-4 | F | 53 | R | | R | | | | |
| | Tema | DG | 5.5 | 3 | F | 53 | R | | | | | | |
| | Valentino | DG | 5.75 | 3 | F | 53 | R | | | R | | | |
| | Wyatt | DG | 5.75 | 3-4 | P | 54 | R | R | | | R | R | R |
| **Green Flat Podded Types** | Furano | MG | 5.5 | | F, P | 54 | R | | | | | | |
| | Greencrop | MG | 6.5 | | F | 55 | | | | | | | |
| | Navaho | MDG | 5.5-6 | | P | 55 | | | R | | | | |
| | Roma II | MG | 5.5 | | F, P | 58 | R | | | | | | |
| | Velero | MDG | 6.25 | | P | 56 | R | R | | | | | |
| **Yellow (Wax) Round Podded Types** | Carson | Y | 5.5 | 4-5 | F, P | 56 | R | | R | | | | R |
| | Eureka | Y | 5.5 | 4-5 | F | 56 | R | | | | | | R |
| | Gold Mine | Y | 5.3 | 4-5 | P | 56 | R | | | | R | | |
| | Gold Rush | MY | 6.0 | 4 | F | 55 | R | | | | | | |
| | Rocdor | Y | 6.0 | 4 | F | 53 | R | | R | | R | | |
| | SV1003GF | MY | 5.2 | 3-4 | f | 56 | R | | | | | | I |

[1]Varieties are listed alphabetically. [2]G=Green, Y=Yellow, M=Medium and D=Dark.
[3]Bean diameter category for majority of beans at harvest, 2=14.5/64 to 18.5/64 inch, 3=18.5/64 to 21.0/64 inch, 4=21.0/64 to 24.0/64 inch, 5=24.0/64 to 27.0/64 inch.
[4]F=fresh, P=processing Not all processing beans that perform well in the region are listed; consult with your processor for variety recommendations.
[5]Disease resistance reported from source seed companies. R=resistant; I=intermediate/partial resistance; BCMV=Bean Common Mosaic Virus; BCTV=Beet Curly Top Virus; Ua=rust caused by *Uromyces appendiculatus*; Cl=anthracnose caused by *Colletotrichum lindemuthianum*; Psp=halo blight caused by *Pseudomonas savastanoi pv.phaseolicola*; Xap=common blight caused by *Xanthomonas axonopodis pv. phaseoli*; Pss=bacterial brown spot caused by *Pseudomonas syringae pv; syringae*.

## Recommended Lima Beans Varieties[1]

| Type | Variety | Comments and Downy Mildew Resistance[1] |
|---|---|---|
| **Lima Beans, Fordhook Types[2]** | Concentrated Fordhook | 94 days, no resistance to current races of downy mildew, variable yields |
| | Fordhook 242 | 77 days, no resistance to current races of downy mildew |
| **Lima Beans, Baby Types[2]** | C-elite Select | 84 days, resistant to downy mildew race E |
| | Cypress | 77 days, cold soil tolerance, resistant to downy mildew race E |
| | Dixie Butter Pea | 75 days, no resistance to current races of downy mildew |
| | Jackson Wonder | 85 days, no resistance to current races of downy mildew, speckled type |
| | Maestro | 77 days, resistant to downy mildew race E |
| | Maffei-15 | 80 days, resistant to downy mildew race F |
| | Meadow | 77 days, resistant to downy mildew race E |
| | 184-85 | 86 days, resistant to downy mildew race E |
| **Lima Beans, Pole Types** | Big 6 | No resistance to downy mildew |
| | Big Mama | |
| | Dr. Martin | |
| | King of the Garden | |
| | Locally Selected Heirlooms | |

[1]Varieties are listed alphabetically. Consult the University of DE Extension at: *http://extension.udel.edu/ag/vegetable-fruit-resources/vegetable-small-fruits-program/variety-trial-results/* for variety trial results. [1]Based on results from University of DE tests. [2]Use varieties recommended by processors.

## Variety Selection and Seed Treatment

Marketability, adaptability to the area, disease resistance and consistency in production should be considered when selecting snap bean types and varieties. Snap beans varieties can be bush types (can be harvested mechanically), or pole types (usually hand harvested). Pole types yield better in long season areas. Use seeds treated with fungicides to prevent diseases; see the Disease Control section below. Rough handling of seed greatly reduces germination.

## Poor Pod Set and Split Set

High temperature during bloom (> 90°F, > 32°C) can result in diminished pollen production and poor set or a "split set". Varieties differ in susceptibility to split set; choose only heat resistant varieties for summer flowering plantings. Consult with your seed supplier for information on heat tolerant varieties for your area.

## Recommended Nutrients Based on Soil Tests

Before using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Beans | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| **Snap Beans** Single Crop | 40-80 | 80 | 60 | 40 | 0[1] | 80 | 60 | 40 | 0[1] | Total nutrient recommended |
| | 20-40 | 80 | 60 | 40 | 0[1] | 80 | 60 | 40 | 0[1] | Broadcast and disk-in |
| | 20-40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 4 weeks after planting |
| **Snap Beans** After Peas | 20-40 | 80 | 60 | 40 | 0[1] | 80 | 60 | 40 | 0[1] | Total nutrient recommended |
| | 0-20 | 80 | 60 | 40 | 0[1] | 80 | 60 | 40 | 0[1] | Broadcast and disk-in |
| | 0-20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 4 weeks after planting |
| **Lima Beans** Single Crop | 60-90 | 100 | 60 | 20 | 0[1] | 140 | 100 | 60 | 0[1] | Total nutrient recommended |
| | 30-40 | 100 | 60 | 20 | 0[1] | 140 | 100 | 60 | 0[1] | Broadcast and disk-in |
| | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Band place with planter |
| | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 3-5 weeks after emergence |
| **Lima Beans** After Peas | 30-40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Total nutrient recommended |
| | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Band place with planter |
| | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 3-5 weeks after emergence |

Apply 1-2 lb/A of boron (B) every 3 yr on most soils; see also Table B-7 in the Soil and Nutrient Management chapter. **Do not** place B in starter fertilizers due to sensitivity problems. [1]In VA, crop replacement values of 20 lb/A of $P_2O_5$ and 40 lb/A of $K_2O$ are recommended on soils testing Very High.

## Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical snap bean tissue test values for most recently matured leaves up to first bloom: N 3-4%, P 0.3-0.5%, K 2.0-3.0%, Ca 0.8-1.5%, Mg 0.25-0.45% and S 0.2-0.4%. For additional nutrients and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *http://edis.ifas.ufl.edu/ep081*.

## Site selection, soil and fertilization

Well-drained friable sandy loams to clay loams are well suited for legumes. Avoid compacted soils that can flood. Slightly acid soils (pH 6-6.5) are preferred. If lime is needed, apply it several months before planting. All P and K can be applied before planting. Beans respond to N applications, especially bush types.

## Planting and Harvesting Dates

**Note**: In PA and normally cooler areas, delay the start of planting by 10 days and stop planting 14 days sooner than indicated below. In the southern part of the region, plantings that will result in pod set at temperatures above 90°F (commonly mid July-early August) are at risk of blossom drop, split set, high cull percentage, and reduced yield.

| Variety | Planting Dates | Harvesting Dates |
|---|---|---|
| Market Snap | April 10 - August 10 | June 20 - October 20 |
| Processing Snap | April 20 - August 10 | July 1 - October 20 |
| Fordhook Lima | May 15 - July 10 (June 20 - July 10 in the southern part of the region) | August 1 - October 20 |
| Baby Lima | May 15 - July 20 | August 1 - October 30 |
| Pole Lima | May 15 - June 15 | July 15 - October 30 |

## Spacing

**Snap Beans**. Rows 30-36 inches apart, 6-10 plants/ft. Plant 50-75 lb/A of seed depending on seed size (lower rate for lighter seeds). Narrow rows increase yields but render late-season tillage difficult. Plant in rows 18-24 inches apart with 5-7 plants/ft. Plant 75-120 lb/A of seed, depending on seed size. Calibrate planter according to seed size. Sow 1-1½ inches deep in light sandy soil; shallower in heavier soil.

**Lima Beans, Fordhook Type**. Rows 30-36 inches apart, 2 plants/ft. Plant 85 lb/A of seed, 1½ inches deep.

**Lima Beans, Baby Types.** Rows 30-36 inches apart, 3-4 plants/ft. Plant 50 lb/A of seed, 1½ inches deep (deeper if soil is dry). For irrigated fields: Rows 18-30 inches apart, 4-5 inches between plants; plant 96 lb/A of seed at close spacing and 78 lb/A at wider spacing.

**Lima Beans, Pole Types.** Large seeded pole lima beans are often started in a cold frame or greenhouse which results in higher germination percentages and earlier crops. Plant 1 seed per cell at a depth of 1 inch in containers or plug flats with cells that are at least 1.5 inches in diameter and 2 inches deep. Use a sterile commercial greenhouse medium. Bottom heat will stimulate growth and help produce transplants quicker. Transplant to the field once plants have the first true leaves. Do not allow transplants to become completely root bound. Do not disturb roots during the transplanting process or stunting may occur. Pole lima beans are very vigorous and should not be planted too close together or excessive vine growth may reduce yields. Space plants at a distance of 3-6 ft in the row (less vigorous types closer, more vigorous types further apart) with a minimum of 5 ft between rows.

## Irrigation

Snap and lima beans are grown under irrigated and dryland conditions. Bean crops respond to irrigation and highest yields are obtained when soil moisture is maintained at 50% of field capacity or higher, from the 2 trifoliate leaf stage through pod sizing. Water use during flowering and pod sizing can be over 0.25 inches/day and water deficit during this period will have the greatest negative impact on yield and pod quality. However, a balance must be struck between maintaining adequate moisture for pod growth and minimizing wetness in the canopy which promotes white mold in all beans and downy mildew and pod blight in lima beans.

## Trellising Pole Lima Beans

Sturdy wooden or metal posts should be spaced every 15-20 ft in the row. Additional smaller spacer stakes may be needed in between posts. At least 5 ft, preferably 6 ft, of the posts or stakes should be above ground. Tightly stretch a 10-12 gauge wire and nail it to the tops of the stakes. Stretch a smaller wire or twine and nail it to the posts halfway up above the ground. Then tie the twine in a crisscross fashion to the top wire and to the bottom wire (or twine) on which the beans will climb. An individual stake or line should be placed at each plant for initial climbing to the trellis. Bean supports should be put up before the bean plants begin producing "runners" and falling over. A ground wire may also be used and then twine is woven in a V fashion over the top wire and under the bottom wire. An alternative system would use 6 ft plastic netting attached to the posts and a top and bottom wire. Trellises have to be sturdy enough to support the heavy lima bean vines.

## No-Till / Conservation Tillage

Snap and lima beans have been successfully grown in no-till and conservation tillage systems, though lima bean yields are often lower and residues can make harvest more difficult. In no-till systems, bean seeds are usually drilled into the stubble/plant residue of a small grain crop. Consider bean variety, date of planting, soil fertility practices, insect control, planting equipment, mulch, residue at harvest, and weed species in the field. See "Conservation Tillage Crop Production" in the General Recommendations chapter for more information on this production method. **See "Conventional Tillage" for preemergence and postemergence weed control recommendations.**

## Harvest and Post Harvest Considerations

**Processing snap beans** are usually harvested when 50% of the beans are sieve size 4 or smaller, but this percentage will depend on processor needs and variety. Yield of processing snap beans ranges from 4 to 6 ton/A. Processing should occur soon after harvest and transport times should be minimized. Washing and precooling shelled beans is recommended for distance transport.

**Fresh market snap beans** are either hand harvested multiple times at the desired size or machine harvested when the highest percentage of marketable beans can be obtained. Yield of fresh market snap beans ranges from 150 to 250 bushel/A. Beans for fresh market shipping should meat US No. 1 standards or higher.

**Baby lima beans** for mechanical picking are harvested when the highest percentage of full pods can be obtained and when plants have approximately 10% dry pods. Hand-picked lima beans are picked at the full green seed stage.

**Fordhook lima beans** are harvested when the highest percentage of full pods can be obtained but before any pods have dried.

### Grading and Packing

A grading line will typically have offloading and conveying belts, a gravity separator to remove soil, rocks, and heavy field trash, an air blast trash remover for leaves, stems, and other light field trash, a rotating drum tumbler to remove pin beans and immature pods through slots, a broken bean eliminator, vibrating tables where good pods are further segregated from field trash, a sizer for processing beans, vibrating washers where pods are rinsed with water to remove soil particles and to remove some of the field heat, grading tables where pods are manually inspected to remove overmature, blemished, decayed, or other defective pods, and for fresh market beans, a box filler. Beans are moved by vibration into wire bound crates or waxed cartons, which are weighed and unloaded onto a box closing machine after which boxes go to a cold storage area. In smaller operations, many of these tasks will be done by hand at a sorting table. Field packing is practical mainly for direct market and local sales. Beans may also be harvested directly by consumers or local wholesalers as U-pick.

### Cooling and Storage

Fresh market snap beans are highly perishable and should be cooled rapidly after harvest, preferably to 40-43°F (4-6°C). Vacuum or forced-air cooling can be effective, but the preferred method is hydrocooling as the cold water cools beans rapidly and the free moisture helps prevent wilting or shriveling. Use chlorinated water with a 55-70 ppm free chlorine concentration and pH of 6.5-7 (neutral) for washing and hydrocooling.

Beans should be stored at 39-45°F (4-7°C) and 95% relative humidity. Under these conditions, beans will maintain quality for 7-10 days. Temperatures of 38°F (3°C) and lower may cause significant chilling injury. Beans lose moisture rapidly if not properly protected by packaging or by a relative humidity of 95% or above. When the relative humidity approaches saturation, as in consumer packages, temperatures above 45°F (7°C) must be avoided to prevent serious decay within a few days. Beans should not be stored or shipped with ethylene generating fruits and vegetables.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**1. Non-selective or Burndown**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **9** | Roundup PowerMax 4.5L<br>"Generic" glyphosate 3L | 16 to 32 fl oz/A<br>24 to 48 fl oz/A | **glyphosate** | 0.75 to 1.13 lb acid equivalent/A | -- | 24 |
| -**Snap beans and lima beans only**. Apply preplant or preemergence.<br>-Some glyphosate formulations may require an adjuvant, refer to label. Tank-mix with appropriate herbicides for residual weed control.<br>-Glyphosate controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label.<br>-Repeat applications are allowed, with maximum application of 5.3 qt/A per year. | | | | | | |
| | | | | | | |
| 22 | Gramoxone SL 2.0 | 2.4 to 4.0 pt/A | **paraquat*** | 0.6 to 1.0 lb/A | -- | 12 |
| -**Snap beans and lima beans only**. Apply preplant or preemergence. Always include an adjuvant (nonionic surfactant or crop oil concentrate). Tank-mix with appropriate herbicides for residual weed control.<br>-Paraquat may not control established grasses.Spray coverage is essential for optimum control.<br>-Rainfastness 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |

**2. Soil-Applied (Preplant Incorporated or Preemergence)**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **2** | Pursuit 2L | 1.5 to 2.0 fl oz/A | **imazethapyr** | 0.024 to 0.031 lb/A | 30 | 4 |
| -**Lima beans only.**<br>-Apply as preplant incorporated or to the soil surface, but shallow, thorough incorporation improves consistency of performance when dry weather follows application. Primarily controls broadleaf weeds. Combine with another herbicide to control annual grasses.<br>-Pursuit residues persist in the soil after harvest and may affect following crops. Follow label instructions.<br>-Pursuit is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.<br>-Maximum Pursuit application at planting: 2 fl oz/A. Maximum number of application per year: 1. | | | | | | |
| **2** | Sandea 75DF | 0.5 to 1.0 oz/A | **halosulfuron** | 0.024 to 0.047 lb/A | 30 | 12 |
| -**Snap beans and lima beans.** Apply after seeding but before cracking.<br>-Controls or suppresses yellow nutsedge and many annual broadleaf weeds. Results have been most consistent when the application was followed by rainfall or irrigation.<br>-Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine -textured (silt and clay) soils.<br>-Heavy rainfalls before crop emergence can resulted in crop stunting.<br>-**Do not** apply Sandea to crops treated with a soil-applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Sandea is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.<br>-Maximum Sandea application per season: 1 oz/A. | | | | | | |
| 3 | Prowl H2O 3.8CS | 1.0 pt/A | **pendimethalin** | 0.48 lb/A | -- | 24 |
| -**Snap beans and lima beans.**<br>-Labeld only for preplant incorporated appliecaiton; apply before planting and incorporate thoroughly within the top 2-3 inches of soil.<br>-Primarily controls annual grasses and certain broadleaf weeds.<br>-**Do not** use when soils are cold and/or wet soil conditions are anticipated during emergence, or crop injury may result.<br>-**Do not** apply more than once per cropping season. **Not recommended in NJ.** | | | | | | |
| 3 | Treflan 4E | 1.0 to 1.5 pt/A | **trifluralin** | 0.5 to 0.75 lb/A | -- | 12 |
| -**Snap beans and lima beans.** Labeld for preplant incorporation only; incorporate into 2-3 inches of soil within 8 hr after application.<br>-Primarily controls annual grasses and a few broadleaf weeds (weak on ragweed). Poor incorporation can reduce overall weed control.<br>-Treflan may be applied up to 4 weeks prior to planting.<br>-**Do not** use or reduce the rate used when cold, wet soil conditions are expected, or crop injury may result.<br>-Maximum application not addressed on label. | | | | | | |

*2. Soil-Applied (Preplant Incorporated or Preemergence) continued on next page*

*2. Soil-Applied (Preplant Incorporated or Preemergence) - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 8 | Eptam 7E | 3.0 to 3.5 pt/A | **EPTC** | 2.5 to 3.0 lb/A | -- | 12 |
| -**Snap beans only.** Preplant incorporated applications only; incorporate by disking twice into 3-4 inches of soil immediately after application. Useful for nutsedge control, annual grasses, and some broadleaf weeds.Combining Eptam with Dual Magnum may improve weed control but may increase the risk of crop injury when weather conditions are adverse. | | | | | | |
| 13 | Command 3ME | 4.0 to 8.0 fl oz/A | **clomazone** | 0.094 to 0.188 lb/A | 45 | 12 |
| -**Snap beans only.** Apply to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Command will not control yellow nutsedge or pigweed species.<br>-Use the lower rate on coarse -textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter.<br>-Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence; beans recover from minor early injury without affecting yield or earliness.<br>-**WARNINGS**: **1**. Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. **2.** Command residues may limit subsequent cropping options, see the label or consult your local Extension office.<br>-Maximum number of applications per season: 1. | | | | | | |
| **14** | Reflex 2SL | 1.0 to 1.5 pt/A | **fomesafen** | 0.25 to 0.375 lb/A | 30 | 24 |
| -**Snap beans only.** Controls several common broadleaf weeds. Tank-mix for control of annual grasses.<br>-Maximum of 1.25-1.5 pt/A may be applied either pre or post in one year (see Regional Use Map on herbicide label for details).<br>-**Do not** apply more than once in a 2-year period (alternate year applications). Rotational restrictions for most vegetables is 18 months. | | | | | | |
| **14+14** | Spartan Charge 3.5EC | 3 to 3.75 fl oz/A | **sulfentrazone + carfentrazone** | 0.082 to 0.103 lb/A | -- | 24 |
| -**Lima beans only.**<br>-**A Special Local -Needs Label 24(c) has been approved for the use of Spartan Charge for lima beans in DE only** for ALS-resistant pigweed (Group 2 herbicides).<br>-Combine with another herbicide to control annual grasses. Apply no later than 3 days after seeding, but **do not** apply after cracking. Expect some temporary crop injury after emergence. **Do not** use Spartan Charge if temporary crop injury is not acceptable. | | | | | | |
| 15 | Dual Magnum 7.62E | 0.66 to 2.0 pt/A | **s-metolachlor** | 0.63 to 1.91 lb/A | -- | 24 |
| -**Snap beans and lima beans.**<br>-Preplant incorporated or preemerngence; incorporated applications should be worked into the soil 2-3 inches deep by disking twice with blades set 4-6 inches deep. Primarily controls annual grasses and nutsedge; nutsedge control is improved with preplant incorporation. Dual will not control emerged weeds. A postemergence herbicide, may be required for adequate broadleaf weed control.<br>-**Do not** apply more than 2 pt/A during any one crop year.<br>-A modified fertility program may be necessary, especially for N (such as early sidedressing).<br>-**Do not** use on black turtle soup beans. | | | | | | |

## 3. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate (lb ai or ae/A) | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9.0 to 16.0 fl oz/A | **clethodim** | 0.07 to 0.125 lb/A | 21 | 12 |
| **1** | Assure II/Targa 0.88EC | 6.0 to 12.0 fl oz/A | **quizalofop-P-ethyl** | 0.04 to 0.08 lb/A | 15 | 12 |
| **1** | Poast 1.5EC | 1.0 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 15 | 12 |
| -**Select Max and Poast can be applied to snap beans and lima beans; apply Assure II/Targa to snap beans only.**<br>-**Select 2EC, Poast, and Assure II/Targa**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant at 0.25% v/v (1 qt/100 gal of spray solution).<br>-**The use of COC may increase the risk of crop injury under hot or humid conditions.** To reduce this risk, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Addition of nitrogen is not recommended.<br>-Controls many annual and certain perennial grasses. Poast is preferred for goosegrass control.For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions.<br>-Does not control yellow nutsedge, wild onion/garlic, or broadleaf weeds.<br>-**Do not** tank-mix with or apply within 3 to 7 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season.<br>-**Do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 2.5 pt/A Poast in single application and **do not** exceed 5 pt/A for the season.<br>-Maximum Assure II/Targa application per season is 14 fl oz/A. | | | | | | |

*3. Postemergence continued on next page*

*3. Postemergence - continued*

<table>
<tr><td>2</td><td>Raptor 1L</td><td>4.0 fl oz/A</td><td>imazamox</td><td>0.031 lb/A</td><td>--</td><td>4</td></tr>
<tr><td colspan="7">-Snap beans and lima beans.<br>-Apply to control annual broadleaf weeds when the crop has 1-2 fully expanded trifoliate leaves but before bloom stage of bean growth<br>-Add nonionic surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray).<br>-Add 0.5 to 1.0 pt/A of bentazon (Basagran) to reduce the expression of injury symptoms or use Varisto 4.18L which is a prepackaged mixture of Raptor plus Basagran; 21 fl oz of Varisto = 4 fl oz of Raptor and 21 fl oz of Basagran 4L<br>-Strictly observe all plantback restrictions.<br>-Raptor is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.<br>-Rainfastness is 1 hr. Do not apply more than 4 fl oz/A per year and more than one application per growing season.</td></tr>
<tr><td>2</td><td>Sandea 75DF</td><td>0.50 to 0.66 oz/A</td><td>halosulfuron</td><td>0.024 to 0.031 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Snap beans and lima beans.<br>-Apply plus nonionic surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray solution) to control yellow nutsedge and certain annual broadleaf weeds.<br>-Use only the lower rate when treating snap beans.<br>-Applications should be sprayed when the crop has 2-3 trifoliate leaves and annual weeds are less than 2 inches tall. (Treatments applied when beans are younger increases the risk of temporary stunting, and applications after the 3 trifoliate leaf stage increases the risk of a split set.) Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity.<br>-Sandea provides both residual and postemergence control of susceptible weed species.<br>-Sandea is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.<br>-Do not apply Sandea to crops treated with a soil-applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Rainfastness is 4 hrs. Maximum Sandea application per season: 1 oz/A.</td></tr>
<tr><td>6</td><td>Basagran 4L</td><td>1.0 to 2.0 pt/A</td><td>bentazon</td><td>0.5 to 1.0 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Snap beans and lima beans.<br>-Apply when beans have fully expanded first trifoliate leaves. Use lower rate to control common cocklebur, mustards, and jimsonweed and the higher rate to control yellow nutsedge, common lambsquarters, common ragweed, and Canada thistle (2 applications may be needed to control nutsedge and thistle).<br>-Temporary, pronounced crop injury may be observed that can result in delayed maturity.<br>-The use of oil concentrate may increase the risk and severity of crop injury. To reduce the risk of crop injury, omit additives or switch to a nonionic surfactant when weeds are small and soil moisture is adequate. Do not spray when temperatures are over 90°F (32°C).<br>-Rainfastness is 8 hrs.</td></tr>
<tr><td>14</td><td>Reflex 2SL</td><td>0.50 to 0.75 pt/A</td><td>fomesafen</td><td>0.125 to 0.188 lb/A</td><td>30</td><td>24</td></tr>
<tr><td colspan="7">-Snap beans only.<br>-Apply when snap beans have 1-2 fully expanded trifoliate leaves.<br>-The recommended rate is lower than the labeled rate to reduce the risk of crop injury. Use the lower recommended rate when weeds are small or when plentiful soil moisture, high humidity, and warm cloudy weather cause “soft” growing conditions.<br>-Add nonionic surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray). Tank-mix with bentazon to improve the control of common lambsquarters, smartweed, velvetleaf, cocklebur, galinsoga, and yellow nutsedge.<br>-Lima beans and most other vegetables are sensitive to fomesafen.<br>-Reflex provides both residual and postemergence control of susceptible weed species.<br>-Be sure to consider rotational crops when deciding to apply fomesafen.<br>-Rainfastness is 1 hr.<br>-Maximum Reflex application: 1.25 to 1.5 pt/A IN ALTERNATE YEARS.<br>-Maximum fomesafen application: 0.313 to 0.375 lb/A IN ALTERNATE YEARS.</td></tr>
</table>

<table>
<tr><th colspan="7">4. Postharvest</th></tr>
<tr><th>Group</th><th>Product Name</th><th>Product Rate</th><th>Active Ingredient (*=Restricted Use)</th><th>Active Ingredient Rate</th><th>PHI (d)</th><th>REI (h)</th></tr>
<tr><td>22</td><td>Gramoxone SL 2.0</td><td>2.4 pt/A</td><td>paraquat*</td><td>0.6 lb/A</td><td>--</td><td>24</td></tr>
<tr><td colspan="7">-A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.<br>-Apply after the last harvest. Always include an adjuvant. Spray coverage is essential for optimum effectiveness.<br>-See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed.</td></tr>
</table>

# Insect Control

**THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.**
**Recommended Insecticides**

## Soil Pests

### Seed Maggots

Seed maggots are mostly a problem in soils high in organic matter, under moist conditions, and when cool springs delay seed germination. For the best control, plant seeds commercially treated with one of the following: chlorpyrifos* (Lorsban) or thiamethoxam (Cruiser 5FS) **- commercially applied seed treatment only.**

## Above-ground Pests

### Aphids

Treat only if aphids are well distributed throughout the field (50% or more of terminals with 5 or more aphids), when weather favors population increase, and if beneficial species are lacking.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 1-3[1] | 48 | H |
| 1B | Dimethoate 400 4EC | 0.5 to 1.0 pt/A | dimethoate* | 0 | 48 | H |
| 4A | Admire PRO | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire PRO | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 7 | 12 | M |
| 4C | Transform WG | 0.75 to 1.0 oz/A | sulfoxaflor | 7 | 12 | H |
| 4D | Sivanto 200SL | 7.0 to 10.5 fl oz/A | flupyradifurone | 7 | 4 | M |
| 23 | Movento 2SC | 4 to 5 fl oz/A | spirotetramat | 1 | 24 | L |

[1]Days to harvest depends on rate, CONSULT LABEL.

### Bean Leaf Beetles and Mexican Bean Beetles

Bean leaf beetle adults, which are similar in size to spotted cucumber beetles, and Mexican bean beetle adults (copper-colored ladybeetles with black spots), and larvae (yellow with spines) chew holes in leaves, but also may cause direct injury to pods. Early control measures are recommended to reduce yield loss from defoliation, and reduce population levels later in the season. Begin spraying at 20% defoliation or 1 beetle per plant.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) and Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Sevin XLR Plus | 0.5 to 1.0 qt/A | carbaryl - **snap beans only** | 3 | 12 | H |
| 1B | Dimethoate 400 4EC | 0.5 to 1.0 pt/A | dimethoate* | 0 | 48 | H |
| 3A | Asana XL | 2.9 to 5.8 fl oz/A | esfenvalerate* - **snap beans only** | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Lambda-Cy, Lambda-T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.72 to 4.00 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A + 28 | Besiege | 6.0 to 10.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 7 | 12 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 7 | 12 | M |

### Cutworms - See also the Pest Management chapter, Insect Management section.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) and Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3 pt/A | methomyl* | 1-3[1] | 48 | H |
| 1A | Sevin XLR Plus | 1.00 to 1.50 qt/A | carbaryl - **snap beans only** | 3 | 12 | H |
| 1B | Diazinon AG500[2] | 2.0 to 4.0 qt/A[2] | diazinon* | see label | 72 | H |

*Cutwoms continued on next page*

*Cutwoms - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* - **snap beans only** | 3 | 12 | H |
| 3A | Warrior II | 0.96 to 1.60 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Lambda-Cy. LambdaT | 1.92 to 3.20 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 1.28 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A + 28 | Besiege | 5.0 to 8.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 7 | 12 | H |
| 5 | Blackhawk 36WG | 2.2 to 3.3 oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant SC | 4.0 to 8.0 fl oz/A | spinetoram | 3 | 4 | H |
| 18 | Intrepid 2F | 4.0 to16.0 fl oz/A | methoxyfenozide | 7 | 4 | L |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 1 | 4 | L |

[1]Days to harvest depends on rate, CONSULT LABEL. [2]Broadcast just before planting and immediately incorporate into the soil.

## Leafminers

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Dimethoate 400 4EC | 0.5 to 1.0 pt/A | dimethoate* | see label | 48 | H |
| 5 | Blackhawk 36WG | 2.5 to 3.3 oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant SC | 5.0 to 8.0 fl oz/A | spinetoram | 3 | 4 | H |
| 17 | Trigard 75WP | 2.66 oz/A | cyromazine | 7 | 12 | L |

## Mites

Spot-treat areas along edges of fields when white stippling along veins on the underside of leaves is first noticed. Broadspectrum insectides (Group 1B, 3) will provide initial knockdown, but continued use may result in outbreaks.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Dimethoate 400 4EC | 0.5 to 1.0 pt/A | dimethoate* | see label | 48 | H |
| 3A | Bifenture 2EC, Sniper | 5.12 to 6.40 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 20B | Kanemite 15SC | 31.0 fl oz/A | acequinocyl | 7 | 12 | L |
| 20D | Acramite 4SC | 16.0 to 24.0 fl oz/A | bifenazate | 3 | 12 | L |
| 21A | Portal XLO | 2.0 pt/A | fenpyroximate*- **snap beans only** | 1 | 12 | L |

## Potato Leafhoppers (PLH)

PLH can cause hopperburn on leaves, which can reduce photosynthesis and yield. Seeds treated commercially with thiamethoxam (Cruiser 5ST) are protected from PLH for about 3 weeks post planting. Sweep netting can help determine if pest densities warrant control. Treat if the number of adults plus nymphs exceeds 100 per 20 sweeps.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin XLR Plus | 1.0 qt/A | carbaryl - **snap beans only** | 3 | 12 | H |
| 1A | Lannate LV | 0.75 to 3.0 pt/A | methomyl* | 1-3[1] | 48 | H |
| 1B | Dimethoate 400 4EC | 0.5 to 1.0 pt/A | dimethoate* | see label | 48 | H |
| 3A | Bifenture 2EC, Sniper | 1.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* - **snap beans only** | 3 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.72 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A+4A | Brigadier | 3.8 to 5.5 fl oz/A | bifenthrin* + imidacloprid | 3 | 12 | H |
| 4A | Admire Pro | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.2 fl oz/A | imidacloprid - **folia**r | 7 | 12 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 7 | 12 | M |
| 4C | Transform WG | 1.5 to 2.75 oz/A | sulfoxaflor | 7 | 12 | H |
| 4D | Sivanto 200SL | 7.0 to 10.5 fl oz/A | flupyradifurone | 7 | 4 | M |

## Stink Bugs

Sweep netting can be useful to detect stink bugs. Treatment is recommended if stink bug adults and nymphs exceed 7 per 50 sweeps during pod development.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| **3A** | Bifenture 2EC, Sniper | 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| **3A** | Warrior II | 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| **3A** | Lambda-Cy. LambdaT | 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| **3A** | Mustang Maxx | 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| **3A** | Hero EC | 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |

## Tarnished Plant Bugs

Treat only if the number of adults and/or nymphs exceeds 15 per 50 sweeps from the pin pod stage until harvest.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3 pt/A | methomyl* | 1-3[1] | 48 | H |
| 1B | Dimethoate 400 4EC | 0.5 to 1.0 pt/A | dimethoate* | 7 | 48 | H |
| 3 | Bifenture 2EC, Sniper | 5.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3 | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3 | Lambda-Cy. LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3 | Mustang Maxx | 2.72 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3 | Hero EC | 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 4C | Transform WG | 1.5 to 2.25 oz/A | sulfoxaflor | 7 | 12 | H |

[1]Days to harvest depends on rate, CONSULT LABEL

## Thrips

Treatments should be applied if thrips are present from cotyledon stage to when the first true leaves are established and/or when first blossoms form.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3 pt/A | methomyl* | 1-3[1] | 48 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Lambda-Cy. LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.72 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Hero EC | 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A + 4A | Brigadier | 3.8 to 5.5 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 4A | Assail 30SG | 4.5 to 5.3 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Admire Pro | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 5 | Radiant SC | 5.0 to 8.0 fl oz/A | spinetoram | 3 | 4 | H |
| 5 | Blackhawk 36WG | 2.5 to 3.3 oz/A | spinosad | 3 | 4 | M |

[1]Days to harvest depends on rate. CONSULT LABEL

## Whiteflies

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 4A | Admire PRO | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire PRO | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Assail 30SG | 4.0 to 5.3 oz/A | acetamiprid | 7 | 12 | M |
| 4C | Transform WG | 2.0 to 2.75 oz/A | sulfoxaflor | 7 | 12 | H |
| 4D | Sivanto 200SL | 10.5 to 14.0 fl oz/A | flupyradifurone | 7 | 4 | M |

### "Worm" Pests, Including: Corn Earworms (CEW), Beet Armyworms (BAW), European Corn Borers (ECB), Cutworms, Yellow-Striped Armyworms, and Loopers

There are several species of lepidopteran "worm" pests that can attack beans. These pests feed on leaves and also attack pods. An action threshold of 30 larvae per 3 ft of row or about 20% defoliation is often used pre-pod. Once bean pods form, control measures are often needed weekly to protect the crop from direct damage or infestation of the pods. In processing snap beans, treat every 5-7 days if CEW catches in local blacklight traps average 20 or more per night and most corn in the area is mature. For lima beans, treat when CEW populations exceed 1 per 6 ft of row. **The listed insecticides will control any of the above "worm" pest species except BAW and soybean looper, which have developed resistance to certain classes of insecticides particularly pyrethroids (group 3).**

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3 pt/A | methomyl* | 1-3[1] | 48 | H |
| **3A** | Bifenture 2EC, Sniper[2] | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| **3A** | Asana XL[2] | 5.8 to 9.6 fl oz/A | esfenvalerate* - **snap beans only** | 3 | 12 | H |
| **3A** | Warrior II[2] | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| **3A** | Lambda-Cy. LambdaT[2] | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| **3A** | Mustang Maxx[2] | 3.2 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| **3A** | Hero EC[2] | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A + 28 | Besiege | l6.0 to 10.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 7 | 12 | H |
| 5 | Blackhawk 36WG | 2.2 to 3.3 oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant SC | 4.0 to 8.0 fl oz/A | spinetoram | 3 | 4 | H |
| 18 | Intrepid 2F | 4.0 to16.0 fl oz/A | methoxyfenozide | 7 | 4 | L |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 1 | 4 | L |

[1]Days to harvest depends on rate, CONSULT LABEL. [2]Not recommended for BAW or soybean looper due to resistance issues.

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Fungicides

**Nematodes -** See also the Soil Fumigation and Nematodes sections in the Pest Management chapter. Use fumigants listed in the Pest Management chapter or Mocap 15G at 13-20 lb/A (0.9 to 1.4 lb/1000 linear feet of row) in a 12 in. band over the row. Do not use as an in-furrow treatment.

Taking soil samples in the fall for soybean cyst nematode (SCN) and root knot nematode determinations from fields to be planted the following season is highly recommended. Growers who rotate snap beans with soybeans should be alert for problems caused by SCN in infested fields. Snap beans are susceptible, where baby lima beans are resistant to SCN. Snap beans and lima beans are very susceptible to root knot nematode.

### Seed Treatment

Use treated seed and avoid rough handling of seed as it greatly reduces germination.

| **IMPORTANT: Do not use treated seed for food or feed!** | | | | | | |
|---|---|---|---|---|---|---|
| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| **For Rhizoctonia and Fusarium Control:** | | | | | | |
| 12 | Maxim 4FS | 0.08 to 0.16 fl oz/100 lb seed | fludioxonil | AP | 12 | N |
| **For Rhizoctonia Control:** | | | | | | |
| 11 | Dynasty | 0.15 to 0.76 fl oz/100 lb seed | azoxystrobin | AP | 4 | N |
| **For Pythium/Phytophthora Control:** | | | | | | |
| 4 | Apron XL | 0.16 to 0.64 fl oz/100 lb seed | mefenoxam | AP | 48 | N |

## Damping Off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

Damping off and root rots are caused by a complex of soilborne fungi including *Rhizoctonia*, *Pythium*, *Phytophthora*, and *Fusarium* spp. In the mid-Atlantic region, the primary cause of root rot in bean are *Pythium* spp., which often cause extensive damage during periods of warm, wet, humid weather in July and August. On snap beans, *Pythium* spp. can also cause extensive pod rot.

Rotate beans with non-legume crops. Avoid fields with low lying areas, poorly drained soils, and minimize soil compaction. Plow under previous crop residue rather than disking. Select varieties that set pods high in the plant and use a close row spacing to help avoid pod contact with the soil surface.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following at-planting (see label for application methods and restrictions):** | | | | | | |
| **Pythium root rot** | | | | | | |
| 4 | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | AP | 48 | N |
| **Pythium and Rhizoctonia root rot** | | | | | | |
| 4 + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence. | mefenoxam + azoxystrobin | AP | 0 | N |
| **Rhizoctonia root rot** | | | | | | |
| 7 | Fontelis 1.67SC | 1.2 to 1.6 fl oz/1000 ft row | penthiopyrad | AP | 12 | N |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | AP | 4 | N |

## <u>Bacterial and Fungal Diseases</u>

## Anthracnose (*Colletotrichum*) and Web Blight (*Rhizoctonia*)

Use western-grown seed and rotate to allow 2 years between bean plantings.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations on a 7-14 day schedule and rotate between different fungicides:** | | | | | | |
| 3 + 11 | Quilt Xcel 2.2 SE | 10.5 to 14.0 fl. oz/A | propiconazole + azoxystrobin | 7 | 12 | N |
| 11 | azoxystrobin 2.08F | 6.2 to 15.5 oz/A | azoxystrobin | 14 | 4 | N |
| 11 | Headline 2.1EC | 6.0 to 9.0 fl oz/A | pyraclostrobin | 21 | 12 | N |
| 7 + 11 | Priaxor 4.17SC | 4.0 to 8.0 fl oz/A | fluxapyroxad + pyraclostrobin | 14 | 12 | N |

## Bacterial Blight

Use western-grown, certified seed. Apply copper as a preventative prior to the onset of disease and on a weekly basis as long as conditions favor disease development to help mitigate the spread of the pathogen. Avoid harvesting during wet conditions.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **When incidence is low, apply the following on a 7-10 day schedule:** | | | | | | |
| M1 | copper (OMRI)[1] | at labeled rates | copper | 0 | 48 | N |

[1]There are a number of copper based products with OMRI labels. See labels for specifics. Copper applications for bacterial disease control may help suppress some fungal pathogens in organic production systems.

## Bacterial Brown Spot

Use certified pathogen free seed. Bacterial brown spot occurs primarily on lima beans and is more troublesome in irrigated fields and during wet seasons. Apply copper as a preventative prior to the onset of disease and on a weekly basis as long as conditions favor disease development to help mitigate the spread of the pathogen. Avoid harvesting during wet conditions.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **When incidence is low, apply the following on a 7-10 day schedule:** | | | | | | |
| M1 | copper (OMRI) | at labeled rates | copper | 0 | 48 | N |

[1] There are a number of copper based products with OMRI labels. See labels for specifics. Copper applications for bacterial disease control may help suppress some fungal pathogens in organic production systems.

## Common Bean Rust (*Uromyces appendiculatus*) of Snap Bean

Rust is often a problem during late summer and early fall. Plant resistant varieties whenever possible. For susceptible varieties, start fungicide applications when the disease first appears.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations on a 7-14 day schedule and rotate between fungicides with different modes of action:** | | | | | | |
| M5 | chlorothalonil | 2.0 to 4.0 pt/A | chlorothalonil | 14 | 12 | N |
| 3A | Rally 40WSP | 4.0 to 5.0 oz/A | myclobutanil | 0 | 24 | N |
| 3A | tebuconazole | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3A + 11 | Quilt Xcel 2.2SE | 10.5 to 14.0 fl oz/A | propiconazole + azoxystrobin | 7 | 12 | N |
| 7 | Fontelis 1.67SC | 14.0 to 30.0 fl oz/A | penthiopyrad | 21 | 12 | N |
| 11 | Headline 2.1EC | 6.0 to 9.0 fl oz/A | pyraclostrobin | 21 | 12 | N |
| 11 | azoxystrobin | 6.2 to 15.5 fl oz/A | azoxystrobin | 14 | 4 | N |

## Lima Bean Downy Mildew (*Phytophthora phaseoli*)

Races B, D, E, and F of the pathogen have been found in the mid-Atlantic area over the past 15 years. **Race F has been the only race detected in Delaware since 2006.** Plant resistant varieties when possible (see varieties table above). Avoid excessive irrigation and poorly drained soils.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **When weather conditions are favorable for disease development, apply and rotate between the following fungicides with different modes of action:** | | | | | | |
| 4 + M1 | Ridomil Gold Copper 65WP | 2.0 lb/A | mefenoxam + copper | 3 | 48 | N |
| 11 | Headline 2.1EC | 6.0 t0 9.0 fl oz/A | pyraclostrobin | 21 | 12 | N |
| 21 | Ranman 400SC | 2.75 fl oz /A | cyazofamid | 0 | 12 | N |
| 29 | Omega 500F | 0.5-0.85 pt/A | fluazinam | 30 | 12 | N |
| 40 | Forum 4.18SC (seed only) | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |
| **If lima bean downy mildew is observed in the field, apply one of the following:** | | | | | | |
| 4 + M1 | Ridomil Gold Copper 65WP | 2.0 lb/A | mefenoxam + copper | 3 | 48 | N |
| 33 | Phosphite | 4.0-6.0 pt/A | phosphite salts | 0 | 4 | N |

## Lima Bean Pod Blight (*Phytophthora capsici*)

*P. capsici* has a very broad host range and can survive in the soil for several years. Avoid heavy irrigation and irrigating at night, especially after pod set. Avoid planting on poorly drained or compacted soils.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **When weather conditions are favorable for disease development, apply and rotate between the following fungicides with different modes of action:** | | | | | | |
| 4 + M1 | Ridomil Gold Copper 65WP | 2.0 lb/A | mefenoxam + copper | 3 | 48 | N |
| 7 | Endura 70W | 8.0 to 11.0 oz/A | boscalid | 7 | 12 | N |
| 21 | Ranman 400SC | 2.75 fl oz/A | cyazofamid | 0 | 12 | N |
| 29 | Omega 500F[1,2] | 8.0 fl oz/A | fluazinam | 30 | 12 | N |
| 33 | phosphite | 4.0 to 6.0 pt/A | phosphite | 0 | 4 | N |
| 40 | Forum 4.18SC | 6.0 fl. oz/A | dimethomorph | 0 | 12 | N |

[1]Applied for downy mildew management may also control *P. capsici*. [2]Not labeled for aerial applications.

## Pythium blight (Cottony leak)

Cottony leak can be a serious problem during prolonged periods of hot, humid, wet weather. Select varieties with good plant architecture that keep the pods off the soil surface. Pods in contact with the soil surface are more prone to infection. Using a narrower row spacing may help keep plants more erect and pods from coming into contact with the soil. Select fields with good drainage and avoid planting in low-lying areas. Avoid overhead watering.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations at disease onset and rotate between different modes of action:** | | | | | | |
| 4 + M1 | Ridomil Gold Copper 65WP | 2.5-5.0 lb/A | mefenoxam + copper | 3 | 48 | N |
| 21 | Ranman 400SC | 2.75 fl oz/A | cyazofamid | 0 | 12 | N |
| 33 | Phosphite | 4.0 to 6.0 pt/A | phosphite | 0 | 4 | N |

## Southern Blight *(Sclerotium rolfsii)*

Southern blight can be a serious disease of snap and lima beans in the southernmost areas of the region. The pathogen may survive in the soil for many years so avoid planting in fields with a known history of the pathogen. Disease development is favored by high temperatures and wet weather conditions. Rotations will not eliminate the pathogen, but rotations with corn, sorghum, small grains or grasses may help reduce disease severity. Avoid overhead irrigation. Apply the following in a preventative manner, especially in fields with a history of the disease.

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 11 | azoxystrobin 2.08F | 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |

## White Mold (*Sclerotinia*) and Gray Mold (*Botrytis*)

White mold is caused by *Sclerotinia* which has a broad host range and can persist in the soil for over 5 yr. Avoid poorly drained soils and excessive overhead irrigation, especially preceding and during flowering. Rotation to non-hosts (such as corn or small grains) for at least 3 yr may help reduce disease levels but will not completely eliminate the pathogen. Always harvest infested fields **after** non-infested fields to help minimize potential spread.

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **Preplant: For white mold only.** Apply 3-4 months prior to disease onset to allow the active agent to reduce levels of sclerotia in the soil. Incorporate 1-2 in. deep but **do not plow before seeding** to avoid spreading of untreated sclerotia from lower to upper soil layers. | | | | | | |
| Bio. | Contans WG (OMRI) | 2.0 to 4.0 lb/A | *Coniothyrium miticans* | -- | -- | N |
| **Post seeding:** Close spacing of snap beans may increase the potential for white mold. **Fungicide sprays are needed *only* when the soil has been wet for 6-10 days before or during bloom.** This causes sclerotia to germinate and eject spores.<br>For snap beans, a fungicide should be applied at 10-20% bloom. <u>A second spray should be made 7-10 days after the first spray if the soil remains wet and blossoms are still present.</u> Check labels for details on fungicide timing.<br>For lima beans, later fungicide applications have been beneficial if favorable environmental conditions persist.<br>**Apply one of the following:** | | | | | | |
| 1 | thiophante-methyl | 30.0 to 40.0 fl oz/A | thiophanate-methyl | 14 | 24 | N |
| 7 | Endura 70W | 8.0 to 11.0 oz/A | boscalid | 7 | 12 | N |
| 7 | Fontelis 1.67SC | 16.0 to 30.0 fl oz/A | penthiopyrad | 0 | 12 | N |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 7 | 12 | N |
| 29 | Omega 500F | 8.0 fl oz /A | fluazinam | 30 | 12 | N |

# Beets (Garden)

Beets are frost tolerant and produce the best commercial quality when grown during cool temperatures (50-65°F, 10-18°C). Lighter color and wider zoning occur during rapid growth in warm temperatures. Beets will form seed stalks if exposed to temperatures below 50°F (10°C) for 2 or 3 weeks after several true leaves have formed. Beets have a high boron requirement - see Plant Nutrient Recommendations below.

## Recommended Varieties[1]

| Market | Hybrid | Days | Color | Shape | Use |
|---|---|---|---|---|---|
| Boro | Yes | 51 | Red | Globe | Roots, tops, bunching, baby beets |
| Chioggia Guardsmark | No | 60 | Purple and White Zones | Globe | Roots |
| Cylindra | No | 54 | Red | Cylindrical | Roots, bunching |
| Eagle | Yes | 50 | Red | Globe | Roots, bunching |
| Early Wonder | No | 52 | Red | Globe | Greens, bunching |
| Greentop Bunching | No | 58 | Red | Round | Greens, bunching |
| Kestrel | Yes | 53 | Red | Globe | Roots, Bunching |
| Merlin | Yes | 55 | Red | Globe | Roots |
| Pacemaker III | Yes | 53 | Red | Globe | Roots, bunching |
| Red Ace | Yes | 53 | Red | Globe | Roots, bunching |
| Red Cloud | Yes | 53 | Red | Round | Roots, bunching |
| Ruby Queen | No | 55 | Red | Round | Roots, bunching |
| Solo | Yes | 50 | Red | Globe | Roots, bunching (mono-germ) |
| Touchstone Gold | No | 60 | Gold | Round | Roots, bunching |
| Zeppo | Yes | 50 | Red | Round | Roots, bunching |

[1]Listed alphabetically

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Beets[1] | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 75-100 | 150 | 100 | 50 | 0 | 150 | 100 | 50 | 0 | Total nutrient recommended |
| | 50 | 150 | 100 | 50 | 0 | 150 | 100 | 50 | 0 | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 4-6 weeks after planting |

[1]Apply 1.5-3 lb/A of boron (B); see also Table B-7 in the Soil and Nutrient Management chapter.

**Boron Deficiency and Black Spot** Boron (B) deficiency can cause black spots inside roots and large black dry rots on root surfaces. B deficiency is most likely to occur in alkaline soils high in calcium and is exacerbated by dry conditions. Apply B at planting according to soil test results.

**Seed Treatment** Use treated seed to prevent disease, see Disease Control below for more information.

**Seeding and Spacing** Seed from early April to mid-August. Optimum germination temperatures range from 50-85°F (10-29°C). Sow seed ½ inch deep at the rate of 15-18 seeds/ft of row. Space rows 15-20 inches apart; thin plants to 3 inches apart. For fall seeding, rows should be spaced 4-6 inches apart.

## Harvest and Post Harvest Considerations

Market beets are harvested when they reach a size of 1.5-3 inches in diameter. Beet tops for greens may be cut and handled similar to spinach or chard. For bunching beets, roots are undercut and carefully pulled by the tops. For larger acreages, beets for roots may be topped and machine dug using a modified potato digger.

Store beets at 32°F (0°C) and 98-100% relative humidity. Like other root crops, beets are well adapted to storage. Topped beets stored at 32°F can keep 4-6 months. Cold storage or cool-cellar storage are both suitable, provided the humidity is kept sufficiently high to prevent dehydration. Before storage, beets should be topped and sorted to remove the ones with disease symptoms or mechanical injuries. Beets should not be stored in large bulk. They should be stored in well-ventilated containers such as ventilated bin boxes or slatted crates to help dissipate respiratory heat. Increased carbon dioxide concentrations (5-10%) in beet storage increases fungal spoilage.

Bunched beets and beet greens are much more perishable than topped beets, but they can be stored at 32°F for 10-14 days. A relative humidity of at least 95% is desirable to prevent wilting. Air circulation should be adequate to remove respiration heat but not so rapid that it speeds up transpiration and wilting. Satisfactory precooling is accomplished by vacuum cooling or hydrocooling. Crushed ice helps keep the bunched beets cold, especially if refrigeration is not available. Bunched beets are commonly shipped with package and top ice to maintain freshness.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the “Herbicide Effectiveness on Common Weeds in Vegetables” Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

### 1. Soil-Applied (Preplant Incorporated)

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 8 | Ro-Neet 6E | 1.67 to 2 qt/A | **cycloate** | 2.5 to 3 lb/A | -- | 48 |

- Preplant incorporated only; incorporate into 3 to 4 inches of soil immediately after application. Plant any time after treatment. Use on mineral soils **ONLY**. Use lower rate on sandy soils and higher rate on heavier soils.
- **Do not** apply over 150 lb N/A when applying this herbicide in conjunction with a fluid fertilizer.

### 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A,<br>12 to 16 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 30 | 24 |
| **1** | Poast 1.5EC | 1 to 2.5 pt/A | **sethoxydim** | 0.2 to 0.5 lb/A | 60 | 12 |

- **Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v.
- **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.
- Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
- Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.
- Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or if the weather is hot or dry. If repeat applications are necessary, allow 14 d between applications.
- **Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.
- **Do not** apply more than 2.5 pt/A Poast in single application and **do not** exceed 5 pt/A for the season.

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **5** | Spin-Aid 1.3EC | 1.5 to 3 pt/A | **phenmedipham*** | 0.244 to 0.488 lb/A | 60 | 12 |

- **For use in DE, MD, NJ, and VA only. See label for application restrictions, mixing instructions, and weather restriction to prevent crop injury or herbicide failure.** Multiple applications may be applied to ground to control early germinating weeds. Apply 1.5 pt/A after the 2-leaf stage. Increase rate up to 2.3 pt/A after the 4-leaf stage. Increase rate up to 3 pt/A after the 6-leaf stage. Repeat application may be made 5 to 7 days later, or when another flush of weeds germinates. A maximum of 3 applications is allowed.
- Spin-Aid is effective on brassica species including wild mustard, shepherdspurse, and London rocket. Other weeds controlled include common chickweed, common lambsquarters, groundcherry, purslane, common ragweed, and annual sowthistle
- **Do not** apply this product through any type of irrigation system. **Do not** spray when conditions for drift are favorable or while dew is present. Leave a 16 ft buffer from the treated area when the wind direction is toward sensitive plants
- Spin-Aid may cause injury if the crop is under stress as the result of rapid climate changes from cool, overcast days to hot (>75°F), bright days; windy conditions; drought; use of preplant herbicides, preemergence herbicides, or other chemicals; insect or disease injury; or close cultivation. Rainfastness is 6 hrs.

| 3. Postharvest | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| 22 | Gramoxone SL 2.0 | 2.25 to 3.5 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant. Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

| 4. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns. | | |
|---|---|---|
| **Group** | **Product Name** | **Active Ingredient (*=Restricted Use)** |
| **2** | UpBeet | **triflusulfuron** |

# Insect Control

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## Recommended Insecticides

### Aphids

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Bifenture 2EC, Sniper | 5.12 to 6.40 fl oz/A | bifenthrin* | 1 | 12 | H |
| 4A | Admire PRO | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire PRO | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.70 to 4.01 oz/A | thiamethoxam - **soil** | see label | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 7 | 12 | H |
| 4C | Transform SG | 0.75 to 1.5 oz.A | sulfoxaflor | 7 | 12 | M |
| 4D | Sivanto 200S | 7.0 to 10.50 fl oz/A | flupyradifurone - **foliar** | 7 | 4 | M |

### Beet Armyworms and Webworms

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 5 | Blackhawk 36WG | 2.25 to 3.5 oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant SC | 6.0 to 8.0 fl oz/A | spinetoram | 7 | 4 | H |
| 11A | Dipel, others (OMRI) | 1.0 to 2.0 lb/A | *Bacillus thuringiensis kurstaki* | 1 | 4 | N |
| 18 | Intrepid 2F | 8.0 to 16.0 fl oz/A | methoxyfenozide | 1 | 4 | L |
| 22 | Avaunt 30WDG | 3.5 to 6.0 oz/A | indoxacarb | 7 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 1 | 4 | L |

### Flea Beetles

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin XLR Plus | 0.5 to 1.0 qt/A | carbaryl | 7 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 5.12 to 6.40 fl oz/A | bifenthrin* | 1 | 12 | H |
| 3A | Hero EC | 2.6 to 6.1 fl oz/A | zeta-cypermethrin* + bifenthrin* | 1 | 12 | H |
| 3A | Mustang Maxx | 1.76 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 4A | Admire PRO | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire PRO | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.70 to 4.01 oz/A | thiamethoxam - **soil** | see label | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 7 | 12 | H |

### Leafminers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 5 | Blackhawk 36WG | 2.25 to 3.5 oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant SC | 6.0 to 8.0 fl oz/A | spinetoram | 7 | 4 | H |

# Disease Control

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See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

**Seed Treatment** Use seed treated with Apron XL (0.085 to 0.64 fl oz/100 lb) or Allegiance FL (0.75 fl oz/100 lb) for *Pythium* damping-off protection *plus* Maxim 4FS (0.08 to 0.16 fl oz/100 lb) for *Rhizoctonia* and *Fusarium* protection. Seed treatments are not a substitute for high quality seed.

### Damping-Off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following preplant incorporated or as a soil-surface spray after planting:** | | | | | | |
| 4 | Ridomil Gold 4SL | 1.0 to 2.0 pt/A | mefenoxam | 0 | 48 | N |
| 4 | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | 0 | 48 | N |
| 4 | MetaStar 2E (see label) | 4.0 to 8.0 pt/A | metalaxyl | 14 | 48 | N |
| **Apply the following as an in-furrow spray only for *Pythium* and *Rhizoctonia* control:** | | | | | | |
| 4 + 11 | Uniform 3.66SE[1] | 0.34 fl oz/1000 ft row | mefenoxam + azoxystrobin | AP | 0 | -- |

### Leaf Spots (*Cercospora* and *Alternaria*) and other foliar diseases

Allow 2-3 years between beet plantings. Thoroughly disc under crop residues as pathogens can overwinter on residues. Warm, wet weather and rainfall favor leaf spot development. Scout plantings regularly, especially if wet weather persists. Apply one of the fungicides listed below preventatively and/or when weather conditions are favorable for disease development. Repeat every 7-10 d. **Do not** make more than 2 sequential applications of Cabrio, or 1 application of a FRAC code 11 fungicide, before alternating to a non-FRAC code 11 fungicide. **Tank mix fungicides with fixed copper** to help reduce ial fungicide resistance development.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| M1 | Copper (OMRI)[1] | at labeled rates | copper | 0 | 48 | N |
| **Rotate one of the following FRAC code 11 fungicides plus a fixed copper at labeled rates:** | | | | | | |
| 11 | azoxystrobin 2.08F[2,5] | 6.0 to 15.5 fl oz/A[2,5] | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 8.0 to 12.0 oz/A | pyraclostrobin | 0 | 12 | N |
| 11 | Gem 500SC | 1.9 to 2.9 fl oz/A | trifloxystrobin | 7 | 12 | N |
| 11 | Reason 500SC | 8.2 fl oz/A[3] | fenamidone | 14 | 12 | -- |
| **With one of the following:** | | | | | | |
| 3 | tebuconazole | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3 | Tilt 3.6EC[4] | 3.0 to 4.0 fl oz/A[4] | propiconazole | 14 | 12 | N |
| 7 | Fontelis 1.67SC | 16.0 to 30.0 fl oz/A | penthiopyrad | 0 | 12 | L |

[1]There are a number of copper based products with OMRI labels; see labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems. [2]9.0 to 15.5 fl oz/A for Cercospora leaf spot; [3]Alternaria leaf spot suppression only; [4]Cercospora leaf spot only; [5]Poor control with azoxystrobin (FRAC code 11) has been reported in southern NJ.

### Pocket Rot, Wirestem, Stem Canker, and Crown Rot (*Rhizoctonia solani*)

Pocket rot and other diseases caused by *Rhizoctonia* are most prevalent in cool, wet soils and especially in plantings showing poor plant vigor. Rotate between fields each year and scout on a regular basis. Applications of azoxystrobin will also help manage foliar diseases of beet such as *Cercospora* and *Alternaria* leaf spots, and powdery mildew.

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 11 | azoxystrobin 2.08F[1] | 0.40 to 0.80 fl oz/1000 ft row, banded or in-furrow | azoxystrobin | 0 | 4 | N |
| 4+11 | Uniform 3.66SE [1,2] | 0.34 fl oz/1000 ft row | mefenoxam+azoxystrobin | AP | 0 | -- |

[1]See label for specific details. [2]Also for *Pythium* damping-off

# Carrots

## Recommended Varieties[1]

| | | | |
|---|---|---|---|
| **Processing: Dicing** | Danvers 126<br>Danvers Half Long<br>Royal Chantenay*<br>Red Cored Chantenay | **Fresh Market** | Bolero*<br>Cellobunch*<br>Enterprise*<br>Envy* (early)<br>Goldfinger* (early)<br>Maverick (early)*<br>Nantindo* (early)<br>Sugarsnax 54*<br>Tendersnax*<br>Tendersweet |
| **Processing: "Coins"** | Bolero (early)*<br>Scarlet Nantes<br>SV2384DL*<br>YaYa* | | |

[1]Listed alphabetically. *Indicates hybrid variety

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| **Carrots[1]** | | **Soil Phosphorus Level** | | | | **Soil Potassium Level** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Low** | **Med** | **High (Opt)** | **Very High** | **Low** | **Med** | **High (Opt)** | **Very High** | |
| | **N (lb/A)** | **$P_2O_5$ (lb/A)** | | | | **$K_2O$ (lb/A)** | | | | **Nutrient Timing and Method** |
| | 50-80 | 150 | 100 | 50 | 0 | 150 | 100 | 50 | 0 | Total nutrient recommended |
| | 50 | 150 | 100 | 50 | 0 | 150 | 100 | 50 | 0 | Broadcast and disk-in |
| | 25-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress if needed |

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter.

**Seed Treatment** See Disease Control below. Seed treatments are not a substitute for high-quality seed.

## Seeding Dates

For early harvest (late June to September), sow March 20 to April 30. For late harvest, sow May 1 to July 5 (May 1 to June 15 in PA and northern NJ). Practice crop rotation and plant after a small grain crop for highest yields.

## Seeding Rate and Spacing

**Processing**: Rows 18-36 inches apart. "Coins": sow at a density of 16 plants/ft. Dicing: sow 6 plants/ft (8 if soil is fine-textured). Dicers: 1-2 lb/A using 2-inch scatter shoe. Depth of seeding should be no greater than ¼ inch.
**Fresh market and Cut and Peel**: Rows 18-36 inches apart; sow for 6-8 plants/ft or 2-4 lb/A using 4-inch scatter shoe. Depth of seeding should be no greater than ¼ inch.
**Processing and Fresh**: Sowing with a precision vacuum seeder produces more uniform carrots. In a row, each vacuum plate meters seed to three separate lines. Lines are generally 1.5-2 inches apart and seeds are dropped about 1.5-2 inches apart within the line, resulting in 4-6 seeds/ft of seed-line for dicers and 6-8 plants/ft for slicers or fresh market. If triple line sets are used, increase the distance between seeds in the center row.

**Cultivation** Hill with 2 inches of soil to cover shoulders to minimize greening.

## Harvest and Post Harvest Considerations

Early fresh market carrots are harvested from July to September. Late market carrots are harvested from September into early winter. Fresh market carrots should be over 5 inches long and 0.75-1.5 inches in diameter. Carrots harvested and handled in hot weather are more prone to rapid decay, and care should be exercised in handling to prevent wilting. Fresh market carrots in small plantings are harvested by loosening the soil around the plants with a garden fork and then pulling carrots gently out of the ground by the tops. For larger acreages carrots with intact tops are harvested with a belt pick-up harvester that lifts carrots by their foliage. Belt pick up, coulter pick up, or modified potato harvester types are used for processing carrots.

Carrots are processed immediately after harvest. Most are scalped (tops removed) just before digging. A reduction in yield of about 15-20% occurs when carrots are field scalped. Scalped carrots, and those with inadequate, or frozen tops are harvested with a coulter pick-up or a modified potato harvester. Carrots with intact tops are harvested with a belt pick-up harvester that lifts carrots by their foliage then cuts off the tops.

Fresh market carrots are washed, sorted, and packed into 48 1-lb plastic bags, or 24 2-lb plastic bags per carton, or loose in 50-lb mesh or plastic sacks. Store carrots at 32°F (0°C) and 98-100% relative humidity. Carrots for processing may be given a pre-storage dip treatment in a 0.1% solution of sodium o-phenylphenate (SOPP) to reduce storage decay. The solution is not rinsed off after treatment. Careful handling during and after harvest to avoid bruising, cutting and breakage, will help ensure successful storage.

Mature topped carrots can be stored 7-9 months at 32-34°F (0- 1°C) and 98-100% relative humidity. Prompt cooling to 40°F (4°C) or below is essential for extended storage. Humidity should be kept high to prevent wilting. Carrots stored at 98-100% relative humidity develop less decay, lose less moisture, and remain crisper than those stored at 90-95% relative humidity. A temperature of 32-34°F is essential to minimize decay and sprouting.

Pre-storage washing of carrots may be desirable if they are harvested under wet conditions. Many potential decay-causing organisms are removed by washing and air circulation is improved. Air circulation between crates or pallet boxes with carrots is desirable to remove respiratory heat, maintain uniform temperatures, and help prevent condensation. An air velocity of about 14-20 ft/min is adequate at low storage temperatures.

Bitterness in carrots, which may develop in storage, is due to ethylene exposure. This gas is given off by apples, pears, and certain other fruits and vegetables and from decaying tissues. Bitterness can be prevented by storing carrots away from such products. Also, ethylene and development of bitterness can be minimized by low-temperature. Surface browning or oxidative discoloration often develops in carrots stored for extended periods.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

| **1. Soil-Applied (Preplant Incorporated or Preemergence)** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| 3 | Treflan 4EC | 1 to 2 pt/A | **trifluralin** | 0.50 to 1.0 lb/A | -- | 12 |
| -Labeled for preplant incorporated only; incorporate into 2-3 inches of soil within 8 hr after application. Primarily controls annual grasses with a few broadleaf weeds. **Do not** use (or reduce the rate) when cold, wet soil conditions are expected, or crop injury may result.<br>-Poor incorporation can reduce overall weed control. Maximum application not addressed on label. | | | | | | |
| **5** | Caparol 4L | 2 to 4 pt/A | **prometryn** | 1 to 2 lb/A | 30 | 12 |
| -Apply after seeding, but before crop emergence. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. Follow with overhead irrigation if rainfall does not occur.<br>-Primarily controls annual broadleaf weeds. Annual grasses may only be suppressed. | | | | | | |
| 7 | Lorox 50DF | 1 to 3 lb/A | **linuron** | 0.5 to 1.5 lb/A | 14 | 24 |
| -**Labeled for use in DE, MD, NJ, and VA ONLY!** Apply after seeding, but before crop emergence. Determine carrot variety tolerance to Lorox prior to use. Sow seed at least ½ inch deep. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. Follow with overhead irrigation if rainfall does not occur.<br>-Primarily controls annual broadleaf weeds. Annual grasses may only be suppressed.<br>-**Do not** exceed a total of 2 lb/A of active ingredient linuron per season. | | | | | | |
| 15 | Dual Magnum 7.62E | 1.33 to 2 pt/A | ***s*-metolachlor** | 1.26 to 1.9 lb/A | 64 | 24 |
| -**A Special Local-Needs 24(c) label has been approved for the use of Dual Magnum 7.62E to control weeds in carrots in NJ**. The use of Dual Magnum is legal ONLY if a waiver of liability has been completed (see *http://www.farmassist.com/*).<br>-**Do not** incorporate. Use ONLY on high organic matter (>20%) muck soils. Primarily controls annual grasses, certain broadleaf weeds, and nutsedge. Dual will not control emerged weeds. **Do not** apply more than 2 pt/A during any one crop year.<br>-Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. | | | | | | |

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2 EC<br>Select Max 0.97EC | 6.0-8.0 fl oz/A<br>9.0 to 16.0 fl oz/A | **clethodim** | 0.07 to 0.12 | 30 | 24 |
| **1** | Poast 1.5EC | 1.0 to 2.5 pt/A | **sethoxydim** | 0.2 to 0.5 lb/A | 30 | 12 |
| **1** | Fusilade DX 2EC | 8 to 12 fl oz/A | **fluazifop** | 0.125 to 0.188 lb/A | 45 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution).<br>-**Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution).<br>-**Poast**: Apply with COC at 1.0% v/v.<br>-**Fusilade DX:** Apply with COC at 1.0% v/v or NIS at 0.25% v/v.<br>-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions. If repeat applications are necessary, allow 14 days between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 2.5 pt/A Poast in single application and **do not** exceed 5 pt/A for the season.<br>-**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 3 pt/A per season. | | | | | | |
| **5** | Caparol 4L | 2 to 4 pt/A | **prometryn** | 1.0 to 2.0 lb/A | 30 | 12 |
| -Apply 4L after the crop has 3 true leaves, through the 6 true leaf stage of growth.<br>-Add nonionic surfactant to be 0.5% of the spray solution (2 qt/100 gal) or oil concentrate to be 1% of the spray solution (1 gal/100 gal).<br>-Primarily controls many seedling annual broadleaf weeds less than 2 inches tall. Annual grasses may only be suppressed.<br>-Follow with overhead irrigation if rainfall does not occur.<br>-Use lower rate when the crop and weeds are small, or when cloudy, humid growing conditions prevail and the higher rate when the crop and weeds are more mature and hot dry growing conditions prevail.<br>-One preemergence treatment of up to 4 pt/A plus two postemergence treatments of 2 pt/A may be applied, but **do not** exceed 8 pt/A per crop cycle. | | | | | | |
| **5** | Glory 75DF, TriCor 75DF | 0.33 lb/A | **metribuzin** | 0.25 lb/A | 60 | 12 |
| -Apply after carrots have formed 5 to 6 true leaves, but before weeds are 1 inch in height or diameter.<br>-Controls many broadleaf weeds, including tropic croton, spotted spurge, and horseweed.<br>-**Do not** use to control triazine-resistant weeds.<br>-**Do not** apply to carrots grown for seed.<br>-**Do not** apply within 3 days after periods of cool, wet, cloudy weather.<br>-**Do not** tank-mix with any other pesticide or apply within 3 days, or excessive crop injury may result.<br>-If needed a second application may be made after an interval of at least 3 weeks. **Do not** apply more than 0.67 lb/A per season<br>-Following application of metribuzin chlorosis (yellowing) and burning of the leaf tissue may occur.<br>-Varietal differences exist in carrot tolerance to metribuzin. Use caution when treating new varieties.<br>-Rainfastness is 6 hrs. | | | | | | |
| 7 | Lorox 50DF | 1.5 to 3 lb/A | **linuron** | 0.75 to 1.5 lb/A | 14 | 24 |
| -Apply when carrots are approximately 36 inches tall. Avoid postemergence applications when daily temperatures are 90°F (32°C) or above or during a period of cloudy weather or just after rain or irrigation.<br>-Linuron is effective on most weeds including ragweed.<br>-**Do not** plant treated area to crops not on the label within a 4-month period after treatment. | | | | | | |

## 3. Postharvest

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | 0 | 24 |
| -**A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.**<br>-Apply after the last harvest. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

### Aphids

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Malathion 57 EC | 1.5 to 2.0 pt/A | malathion | 7 | 24 | H |
| 4A | Actara | 1.5 to 3.0 oz/A | thiamethoxam | 7 | 12 | H |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** (in furrow spray) | 21 | 12 | H |
| 4A | Admire Pro | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 9C | Beleaf 50 G | 2.0 to 2.8 oz/A | flonicamid | 3 | 12 | L |

### Carrot Weevils

Begin treatment when weevils become active usually when the soil surface reaches 60°F (16°C).

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate L | 2 to 4 pt/A | oxamyl* | 14 | 48 | H |
| 3A | Asana XL | 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A | Baythroid XL | 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Tombstone | 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A + 4A | Leverage 360 | 2.4 to 2.8 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |

### Cutworms

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 0.75 to 1.5 pt/A | methomyl* | 1 | 48 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Tombstone | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |

### Leafhoppers

Begin spraying when true leaves first appear. Repeat every 14 days or as needed. Leafhoppers transmit aster yellows. Seedling protection from leafhoppers is important.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 1 | 48 | H |
| 1B | Malathion 57 EC | 2.0 pt/A | malathion | 7 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Tombstone | 1.6 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A + 4A | Leverage 360 | 2.4 to 2.8 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 4A | Actara | 1.5 to 3.0 oz/A | thiamethoxam | 7 | 12 | H |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 7 | 12 | H |
| 4A | Admire Pro | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |

# Disease Control

**THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.**
**Recommended Fungicides**

## Nematodes

Avoid seeding in fields with a known history of nematode problems. Nematode control is essential for successful production. See fumigants listed in the Pest Management chapter (Soil Fumigation and Nematodes sections).

## Seed Treatment

Use seed treated with Maxim 4FS (0.08 to 0.16 fl oz/100 lb seed) for *Rhizoctonia* and *Fusarium* control or Apron XL (0.32 to 0.64 fl oz/100 lb seed) or Allegiance FL (0.75 fl oz/100 lb seed) for *Pythium* damping-off protection. Seed treatments are not a substitute for high-quality seed.

## Damping-Off caused by *Phytophthora* and *Pythium*

Use seed treatments as instructed above.

| **Apply one of the following preplant incorporated or as a soil-surface spray after seeding.<br>Note: If seed treatment contained mefenoxam (Apron) or metalaxyl (Allegiance) do not use soil application.** | | | | | | |
|---|---|---|---|---|---|---|
| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 4 | Ridomil Gold 4SL | 0.5 to 1.3 pt/A | mefenoxam | AP | 48 | N |
| 4 | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | AP | 48 | N |

## <u>Bacterial and Fungal Diseases</u>

## Aster Yellows

Use insecticides to control leafhoppers. Control weed populations (including carrot volunteers) on the periphery of fields early in the season to prevent transmission by leafhoppers from the weeds into the crop. The severity of aster yellows and damage to the crop will depend on the age of the crop. The earlier the infection occurs, the more severe and widespread the symptoms may become later in the season. See leafhopper management under Insect Control above.

## Bacterial Blight (*Xanthomonas*)

Initiate a fixed copper-based program as soon as symptoms are observed. Copper content and active ingredient(s) vary between copper-based products. See label for specific rates and use. Avoid working in fields when the foliage is wet to reduce spread of the disease. Some coppers are OMRI-approved and may be helpful in suppressing bacterial blight and some fungal leaf blights in organic production systems.

## Leaf Blights (*Alternaria* and *Cercospora*)

Begin fungicide applications when disease threatens or start preventative fungicide programs in early July and continue every 7 to 10 days as long as conditions favor disease development. For processing crops or situations where the crop is not being marketed with its foliage, a 25% disease incidence threshold may be used to time the first fungicide application. Scout carrot fields by variety. While walking across the field in a ‘V’ or ‘W’ shaped transect for each variety, evaluate disease incidence on 5 leaves from 5 adjacent plants in a minimum of 10 locations. A leaf is infected if one or more fungal leaf blight lesions are observed. Apply the first fungicide spray when 12 of the 50 leaves (~25%) scouted show symptoms. Subsequent sprays should be applied based on the label recommended spray interval or on increased disease severity. Under severe defoliation, add urea (10.0 lb/A) to encourage new leaf growth.

*Leaf Blight continued on next page*

*Leaf Blight - continued*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Tank mix one of the following fungicides *with* chlorothalonil 6F 1.5 to 2.0 pt/A and rotate between different FRAC codes[1]:** | | | | | | |
| 7 | Fontelis 1.67SC | 16.0 to 30.0 fl oz/A | penthiopyrad | 0 | 12 | L |
| 7 + 11 | Merivon 2.09SC | 4.0 to 5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 7 + 11 | Pristine 38WG | 8.0 to 10.5 oz/A | boscalid + pyraclostrobin | 0 | 12 | -- |
| 11 | azoxystrobin 2.08F | 9.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 8.0 to 12.0 oz/A | pyracclostrobin | 0 | 12 | N |
| **For Alternaria leaf blight only, tank mix one of the following fungicides *with* chlorothalonil 6F 1.5 to 2.0 pt/A and rotate between different FRAC codes[1]:** | | | | | | |
| 2 | iprodione 50WP[2] | 1.0 to 2.0 pt/A[2] | iprodione | 0 | 24 | N |
| 7 | Endura 70W | 4.5 oz /A | boscalid | 0 | 12 | -- |
| 7 | Fontelis 1.67SC | 16.0 to 30.0 fl oz/A | penthiopyrad | 0 | 12 | L |
| 7 + 11 | Merivon 2.09SC | 4.0 to 5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 7 | 12 | N |

[1]Chlorothalonil applied alone will not provide adequate control of *Cercospora*, *Alternaria*, or Powdery mildew.
[2]Check label for rotational restrictions.

## Powdery Mildew

Initiate a fungicide program to protect foliage if symptoms are observed early in the season. Do not make more than one sequential application of Cabrio or Pristine before alternating to chlorothalonil alone. Disease development mid- to late-season rarely results in reduced yield. Under severe defoliation, add urea (10.0 lb/A) to encourage new leaf growth.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Tank mix one of the following fungicides with chlorothalonil 6F 1.5 to 2.0 pt/A and rotate:** | | | | | | |
| 7 | Fontelis 1.67SC | 16.0 to 30.0 fl oz/A | penthiopyrad | 0 | 12 | L |
| 11 | Cabrio 20EG | 8.0 to 12.0 oz/A | pyraclostrobin | 0 | 12 | N |
| **Or rotate one of the following fungicides with chlorothalonil 6F 1.5 to 2.0 pt/A:** | | | | | | |
| 7 + 11 | Merivon 2.09SC | 4.0-5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 7 + 11 | Pristine 38WG | 8.0 to 10.5 oz/A | boscalid + pyraclostrobin | 0 | 12 | -- |

## Southern blight (*Sclerotium rolfsii*)

Southern blight can cause significant losses. Once established, southern blight will persist in infested soils for many years. Rotate away from known infested fields. Apply a fungicide every 7-14 days and rotate between the following fungicides with different modes of action when symptoms appear:

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 3 + 11 | Quadris Top 1.67SC | 14.0 fl oz/A | difenoconazole + azoxystrobin | 7 | 12 | -- |
| 7 | Fontelis 1.67SC | 16.0 to 30.0 fl oz A | penthiopyrad | 0 | 12 | L |
| 11 | azoxystrobin 2.08F | 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 29 | Omega 500F | 1.0 pt/A | fluazinam | 7 | 12 | N |

## Storage rots caused by *Botrytis* and White mold (*Sclerotinia sclerotiorum*)

Remove roots from field, separate and discard all damaged roots before placing them in storage at 32°F (0°C) and 90-95% relative humidity immediately after digging.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Prior to harvest apply:** | | | | | | |
| 7 | Fontelis 1.67SC | 16.0 to 30.0 fl oz/A | penthiopyrad | 0 | 12 | L |
| **Or, as carrots are placed into storage, dip into:** | | | | | | |
| 1 | Mertect 340F | 41.0 fl oz/100 gal water for 5-10 seconds | thiabendazole | NA | NA | N |

# Celery

## Recommended Varieties
The varieties Merengo (hybrid), Tango (hybrid), and PennCrisp (PA only) are recommended for PA and other areas where climate conditions are favorable for celery production. Varieties are listed by maturity (earliest listed first).

## Recommended Nutrients Based on Soil Tests
In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| **Celery**[1] | | **Soil Phosphorus Level** | | | | **Soil Potassium Level** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Low** | **Med** | **High (Opt)** | **Very High** | **Low** | **Med** | **High (Opt)** | **Very High** | |
| | **N (lb/A)** | **$P_2O_5$ (lb/A)** | | | | **$K_2O$ (lb/A)** | | | | **Nutrient Timing and Method** |
| | 150-175 | 250 | 150 | 100 | 0 | 250 | 150 | 100 | 0 | Total nutrient recommended |
| | 50-75 | 250 | 150 | 100 | 0 | 250 | 150 | 100 | 0 | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 2-3 weeks after planting |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 6-8 weeks after planting |

[1]Apply 1.5-3 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter. Check **Brown Check** under Celery Disorders below.

## Seed Treatment
Freshly harvested seed may exhibit dormancy leading to poor germination. Seeds should either be stored below 40°F (4°C) for 6 months or longer, or treated with phytohormones. For seed treatments, see Disease Control below.

## Transplant Production
Transplants grown locally in greenhouses or imported from Florida are commonly used. Sow seed 10-12 weeks before field planting. About 35,000 plants can be produced from 2½ oz seed. Maintain the greenhouse at 70-75°F (21-24°C) until emergence, and after that at 65-70°F (18-21°C) for steady growth. Maintain night temperatures above 55°F (13°C) to avoid the production of "seeders". Plants for an early crop should be set in the field when there is no more risk of frost or a cold period. If plants become too tall or spindly before field setting, they can be clipped back to a height of 5-6 inches. Plants can be hardened by withholding water 7-10 days before field planting. Never harden celery plants by lowering temperatures.

## Planting and Field Spacing
Celery is a cool-season crop that grows most rapidly, and develops the best yield and quality at moderately cool temperatures (55-75°F, 13-24°C), good soil moisture, and relatively high humidity. Satisfactory crops can be produced on fertile, medium-textured mineral soils with irrigation. The usual planting period is May 1 to June 30. Field Spacing: Rows: 16-32 inches apart. Plants: 8 inches apart in row. Set 30,000-45,000 plants/A.

Celery will withstand light freezes, but both young and old plants are damaged by moderate freezes. After exposure to temperatures below 55°F (13°C) for a number of days, celery (a biennial) initiates seed stalks (bolts). Under satisfactory growing conditions, celery reaches usable size 85-100 days from transplanting. High plant populations can promote blanching. For non self-blanching cultivars, blanching can be accomplished by trenching or other mechanical means. Special blanching practices can improve color and eating quality.

Since celery is expensive to grow, experience in both production and marketing is desirable before large-scale operations are attempted.

## Harvest and Postharvest Considerations
Harvest when stalks are of sufficient size but before any pithiness has developed in the petioles. Harvested celery should be cooled quickly to temperatures below 45°F (7°C) by hydrocooling, vacuum-cooling, icing, or other means of refrigeration. Stalks can be held 5-7 weeks if storage is near 32°F (0°C) with 98% relative humidity.

## Celery Disorders

**Blackheart**: Internal leaves develop a brown discoloration which eventually becomes deep black. The cause is similar to tip-burn of lettuce or blossom-end rot of tomato. The development of blackheart is promoted by environmental conditions that favor rapid growth, such as heavy rain or irrigation before drought, or high nitrogen, potassium, and sodium levels. Water stress may result in a calcium deficiency disorder causing cell death. The risk of blackheart is reduced by avoiding wide fluctuations in moisture and nutrients and ensuring steady plant growth. Drip irrigation, which provides more even moisture levels can help reduce the risk. Drench applications of soluble calcium can lessen or prevent the development of blackheart.

**Brown Check**: A physiological disorder called "brown check," is characterized by russeting and cracking on the inner side of the petiole. Brown check may be caused by high levels of soil potassium and/or high potassium fertilization rates, although boron nutrition may also be involved.

# Weed Control

### THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

### Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

| **1. Soil-Applied (Preplant Incorporated or Preemergence)** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| 5 | Caparol 4L | 2.4 to 3.3 pt/A | **prometryn** | 1.2 to 1.6 lb/A | -- | 12 |
| -Apply after seeding, but before crop emergence. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils; **DO NOT** use on sand or loamy sand soils, or crop injury may occur. Follow with overhead irrigation if rainfall does not occur. Primarily controls annual broadleaf weeds; annual grasses may only be suppressed.<br>-Only 1 application per crop per year, **DO NOT** used both at planting and postemergence applications. | | | | | | |
| 8 | Prefar 4E | 5.0 to 6.0 qt/A | **bensulide** | 5.0 to 6.0 lb/A | -- | -- |
| -Labeled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum).<br>-**24(c) label for NJ only** allows applications up to 9 qt/A.<br>-Irrigate within 36 hrs of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 hrs, weed control maybe reduced. Provides control/suppression of some annual grass weeds and pigweeds, purslane, and lambsquarters.<br>-**Do not** apply more than 6 lb ai/A per season. | | | | | | |
| **2. Postemergence** | | | | | | |
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| **1** | Select 2EC<br>SelectMax 0.97EC | 6 to 8 fl oz/A<br>9 to 16 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 30 | 24 |
| | Poast 1.5EC | 1.0 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 30 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **Fusilade DX:** Apply with COC at 1.0% v/v or NIS at 0.25% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Select will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions. If repeat applications are necessary, allow 14 days between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 3 pt/A for the season. | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | Caparol 4L | 1.6 to 2.0 pt/A | **prometryn** | 0.8 to 1.0 lb/A | 40 | 12 |

-Postemergence application can be made after the crop has 3 to 5 true leaves.
-Primarily controls many seedling annual broadleaf weeds less than 2 inches tall. Annual grasses may only be suppressed. Use lower rate when the crop and weeds are small, or when cloudy, humid growing conditions prevail and the higher rate when the crop and weeds are larger or hot dry growing conditions prevail.
-**DO NOT** use on sand or loamy sand soils, or crop injury may occur. **DO NOT** tank-mix Caparol with any other pesticide.
-**DO NOT** use spray additives such as nonionic surfactant or oil concentrate.
-**DO NOT** apply within 2 weeks of any herbicidal oil such as "carrot oil" or Stoddard Solvent.
-Only 1 application per crop per year, **DO NOT** used both at planting and postemergence applications.

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | Lorox 50DF | 1.5 to 3.0 lb/A | **linuron** | 0.75 to 1.5 lb/A | 45 | 24 |

-**For use on celery grown on muck soils only.** Make a single application after celery transplants are established, but before celery is 8 inches tall Lorox will provide broadleaf weed control when applied to small weeds; will not control grass weeds.
-**DO NOT** exceed 40 psi or apply when temperatures exceed 85°F. **DO NOT** add surfactants, oil concentrate, or liquid fertilizer.
-Use only the Lorox 50DF formulation of linuron. Only 1 application per season is allowed.

### 3. Postharvest

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone 2SL | 2.4 pt/A | **paraquat*** | 0.6 lb/A | -- | 24 |

-**A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant. Spray coverage is essential for optimum effectiveness.See the label for additional information and warnings. Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed.

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

## Aphids

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Acephate 97 UP | 0.5 to 1 lb/A | acephate | 21 | 24 | H |
| 1B | Malathion 57 EC | 1.5 pt/A | malathion | 7 | 24 | H |
| 4A | Actara | 1.5 to 3.0 oz/A | thiamethoxam | 7 | 12 | H |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 45 | 12 | H |
| 4A | Assail 30 SG | 2 to 4 fl oz/A | acetamiprid | 7 | 12 | M |
| 4A | Belay | 9 to 12 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay | 3 to 4 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4C | Closer SC | 1.5 to 2 fl oz/A | sulfoxaflor | 3 | 12 | H |
| 9B | Fulfill | 2.75 oz/A | pymetrozine | 7 | 12 | N |
| 23 | Movento | 4 to 5 fl oz/A | spirotetromat | 7 | 24 | L |
| 28 + 6 | Minecto Pro | 10 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Beet Armyworms (BAW), Fall Armyworms (FAW)

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 7 | 48 | H |
| 1B | Acephate 97 UP | 1 lb/A | acephate | 21 | 24 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5 SG | 2.4 to 4.8 fl oz/A | emamectin benzoate* | 7 | 12 | H |
| 22A | Avaunt | 3.5 fl oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen | 3.5 to 7.5 fl oz/A | chlorantraniliprole | 1 | 4 | L |
| 28 | Exirel | 7 to 13.5 fl oz/A | cyantraniliprole | 1 | 12 | H |
| 28 | Verimark | 5 to 10 fl oz/A | cyantraniliprole | NA | 4 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cabbage Loopers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 3 pt/A | methomyl* | 7 | 48 | H |
| 1B | Acephate 97 UP | 1 lb/A | acephate | 21 | 24 | H |
| 3A | Perm-Up | 2 to 8 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5 SG | 3.2 to 4.8 fl oz/A | emamectin benzoate* | 7 | 12 | H |
| 11A | Dipel (OMRI) | 1 to 2 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 22A | Avaunt | 3.5 fl oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen | 3.5 to 7.5 fl oz/A | chlorantraniliprole | 1 | 4 | L |
| 28 | Exirel | 10 to 17 fl oz/A | cyantraniliprole | 1 | 12 | H |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole | NA | 4 | H |

## Cutworms

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 pt/A | methomyl* | 7 | 48 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Perm-Up | 4 to 8 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |

## Leafhoppers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 7 | 48 | H |
| 1B | Sevin XLR | 0.5 to 1 qt/A | carbaryl | 14 | 12 | H |
| 3A | Baythroid XL | 2.4 to 3.2 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Tombstone | 2.4 to 3.2 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 4A | Actara | 1.5 to 3.0 oz/A | thiamethoxam | 7 | 12 | H |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 45 | 12 | H |
| 4A | Belay | 9 to 12 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay | 3 to 4 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Scorpion 35 SL | 9 to 10.5 fl oz/A | dinetofuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35 SL | 2 to 5.25 fl oz/A | dinetofuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70 SG | 5 to 7.5 fl oz/A | dinetofuran - **soil** | 21 | 12 | H |
| 4A | Venom 70 SG | 1 to 3 fl oz/A | dinetofuran - **foliar** | 7 | 12 | H |
| 16 | Courier 3.6 SC | 9 to 13.6 fl oz/A | buprofezin* | 7 | 12 | L |

## Leafminers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 4A | Scorpion 35 SL | 9 to 10.5 fl oz/A | dinetofuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35 SL | 2 to 5.25 fl oz/A | dinetofuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70 SG | 5 to 7.5 fl oz/A | dinetofuran - **soil** | 21 | 12 | H |
| 4A | Venom 70 SG | 1 to 3 fl oz/A | dinetofuran - **foliar** | 7 | 12 | H |
| 5 | Entrust SC (OMRI) | 6.0 to 10.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 oz/A | spinetoram | 1 | 4 | H |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 17 | Trigard | 2.66 oz/A | cyromazine | 7 | 12 | H |
| 28 | Coragen | 5.0 to 7.5 | chlorantraniliprole | 1 | 4 | L |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole | 1 | 12 | H |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole | NA | 4 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Mites

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Tarnished Plant Bugs (*Lygus*)

Look for bugs on leaves shortly after transplanting and when nearby alfalfa or grain is cut.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Sevin XLR | 1 to 2 qt/A | carbaryl | 14 | 12 | H |
| 3A | Baythroid XL | 2.4 to 3.2 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Tombstone | 2.4 to 3.2 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 9C | Beleaf 50 SG | 2.0 to 2.8 fl oz/A | flonicamid | 0 | 12 | L |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Fungicides

## Seed Treatment

Use seed that is at least 2 years old. Soak new seed in hot water at 118°F (48°C) for 30 minutes. Use seed treated with Maxim 4F (0.08 to 0.16 fl oz/100 lb) for *Rhizoctonia* and *Fusarium* management and Apron XL (0.085 to 0.64 fl oz/100 lb seed) for *Pythium* damping-off protection.

## Damping-Off caused by *Phytophthora*, *Pythium* and *Rhizoctonia*

Damping-off is favored by excessive soil moisture. Avoid over-saturation of seedbeds and do not transplant unhealthy plants in the field.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following in a 7-inch band:** | | | | | | |
| **Phytophthora and Pythium root rot** | | | | | | |
| 4 | Ridomil Gold 4SL | 1.0 to 2.0 pt/A | mefenoxam | 0 | 48 | N |
| 4 | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | 7 | 48 | N |
| **Pythium and Rhizoctonia root rot** | | | | | | |
| 4 + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row in-furrow, see label | mefenoxam + azoxystrobin | AP | 0 | -- |

## Celery Leaf Curl/Anthracnose (*Colletotrichum*)

This relatively new disease is characterized by curled, cupped and twisted leaves, and dark, brownish necrotic lesions near the base of the petioles. It is suspected to be seedborne; planting high quality seed is recommended. Consider hot water seed treatment.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **For resistance management, alternate one of the following protectant fungicides:** | | | | | | |
| M1 | Copper (OMRI)[1] | at labeled rates | copper | 0 | see label | N |
| M5 | chlorothalonil 6F | 2.0 pt/A | chlorothalonil | 7 | 12 | L |
| **With *one* of the following FRAC code 11 fungicides:** | | | | | | |
| 11 | azoxystrobin 2.08F | 9.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 12.0 to 16.0 oz/A | pyraclostrobin | 0 | 12 | N |

[1]There are a number of copper based products with OMRI labels; see labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.

## Crater and Petiole Rot or Basal Stalk Rot (*Rhizoctonia*)

Rotate out of celery for at least 3 years to ensure crop residue is thoroughly decomposed. Avoid planting transplants too deep and in poorly drained soils. Where problems occur regularly apply fungicides.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply in a 7-in band in-furrow or shortly after emergence directed at the stem:** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | 0 | 4 | N |

## Fusarium Yellows

Do not obtain plants from areas of known infestation. There are no means of chemical management. Avoid seeding or transplanting into infested soil or use resistant varieties.

## Leaf Blights (*Cercospora* and *Septoria*)

Use certified, pathogen-free seed or treat seed with hot water or fungicide seed treatments. Practice careful sanitation in transplant production. Use 3 or 4 year crop rotation.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Alternate one of the following FRAC code 11 fungicides:** | | | | | | |
| 7 + 11 | Merivon 2.09SC | 4.0 to 11.0 fl oz/A | fluxapyroxad + pyraclostrobin | 1 | 12 | N |
| 11 + M5 | Quadris Opti 5.5SC | 2.4 to 3.7 pt/A | azoxystrobin + chlorothalonil | 7 | 12 | N |
| 11 | azoxystrobin 2.08F | 9.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 12.0 to 16.0 oz/A | pyraclostrobin | 0 | 12 | N |
| **With one of the following fungicides:** | | | | | | |
| M1 | Copper (OMRI)[1] | at labeled rates | copper | 0 | see label | N |
| M5 | chlorothalonil 6F | 2.0 pt/A | chlorothalonil | 7 | 12 | L |
| 3 | propiconazole 3.6C | 4.0 fl oz/A | propiconazole | 14 | 12 | N |
| 7 | Fontelis 1.67C | 14.0 to 24.0 fl oz/A | penthiopyrad | 3 | 12 | L |

[1] There are a number of copper based products with OMRI labels; see labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.

## Pink Rot (*Sclerotinia sclerotiorum*)

Under moist conditions, white to pinkish cottony growth develops on the petioles and around the base of the plant. This is followed by a pink, watery, soft rot that causes a rapid collapse and death of the plant. Few products are available for managing pink rot. Avoid planting in shaded or poorly drained areas and areas with a history of pink rot. Rotate fields for at least 2 or 3 years. Maximize air movement through the plant canopy.

Apply Contans 3 to 4 months prior to the onset of disease to allow the mycoparasite to reduce soil inoculum (sclerotia) levels. Following application, incorporate 1-2 inches deep; however, to avoid the chance of infesting the upper soil layer with untreated sclerotia from the lower soil layer, **do not plow** between treatment and planting.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply 3 to 4 months prior to the onset of disease (see instructions above and on the label):** | | | | | | |
| Bio. | Contans 5.3WG (OMRI) | 2.0 to 4.0 lb/A | *Coniothyrium minitans* | 0 | 4 | N |
| **Rotate between the following fungicides as long as weather conditions are favorable for disease development:** | | | | | | |
| M5 | chlorothalonil 6F[1] | 3.0 pt/A[1] | chlorothalonil | 7 | 12 | L |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxanil | 0 | 12 | N |
| 12 | Cannonball 50WP | 7.0 oz/A | fludioxanil | 0 | 12 | L |

[1]Shortly after plants emerge and repeat on a 7-day schedule (suppression only).

# Cole Crops: Broccoli, Brussels Sprouts, Cabbage, Cauliflower, Collards, Kale and Kohlrabi

## Recommended Varieties (listed alphabetically)

| | Variety | Hybrid | Days[1] | Black Rot[2] | Downy Mildew[2] | Hollow Stem[2] | Cold[2] | Heat[2] |
|---|---|---|---|---|---|---|---|---|
| **Broccoli** | Arcadia | Yes | 63 | X | X | | X | X |
| | Bay Meadows | Yes | 60 | | | | X | X |
| | BC1691 | Yes | 83 | | | | | X |
| | BC1764 | Yes | 62 | | | | | |
| | Belstar | Yes | 66 | | X | | X | |
| | Burney | Yes | 60 | | | | | X |
| | DeCicco | No | 48 | | | | X | |
| | Diplomat | Yes | 68 | | X | X | X | X |
| | Durapak 16 | Yes | 80 | | | | | |
| | Eastern Crown | Yes | 80 | | | | | |
| | Emerald Crown | Yes | 63 | | | | X | |
| | Emerald Jewel | Yes | 85 | | | | | |
| | Emerald Pride | Yes | 74 | | X | | | |
| | Eureka | Yes | 76 | X | X | | X | |
| | Everest | Yes | 61 | | X | | X | |
| | Fiesta | Yes | 60 | | | | X | |
| | Green Magic | Yes | 60 | | | | | X |
| | Green Gold | Yes | 80 | | | | | X |
| | Gypsy | Yes | 60 | | X | | X | |
| | Imperial | Yes | 72 | | | | | X |
| | Ironman | Yes | 78 | | | X | | |
| | Lieutenant | Yes | 80 | | | X | | |
| | Luna | Yes | 78 | | | | | |
| | Marathon | Yes | 70 | | | | X | |
| | Millennium | Yes | 74 | | | | | X |
| | Patron | Yes | 63 | | X | | | |
| | Tradition | Yes | 63 | | | | | |
| | Windsor | Yes | 68 | | X | | X | X |

[1]Days from transplant to first harvest. [2]X denotes some degree of resistance or tolerance to disease or environmental condition.

| | Variety | Hybrid | Days |
|---|---|---|---|
| **Brussels Sprouts** | Dimitri | Yes | 105 |
| | Jade Cross E | Yes | 85 |
| | Churchill | Yes | 90 |
| | Nelson | Yes | 90 |
| | Franklin | Yes | 100 |
| | Hestia | Yes | 93 |

| **Cabbage** | **Variety** | **Hybrid** | **Days** | **Pounds** | **Use[2]** | **Pest or Abiotic Stress Reaction[1]** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **Yellows** | **Black rot** | **Tip burn** | **Thrips** | **Split Head** |
| **Green Cabbage** *(continued on next page)* | Bajonet | Yes | 80 | 3-5 | F | H | | | | |
| | Benelli | Yes | 78 | 4-10 | F-P | H | M | M | M | H |
| | Blue Dynasty | Yes | 75 | 4 | F | H | H | | | H |
| | Blue Lagoon | Yes | 68 | 3-5 | F | H | M | | | |
| | Blue Thunder | Yes | 80 | 4-5 | F | H | M | | | H |
| | Blue Vantage | Yes | 72 | 4 | F | H | L | H | H | |
| | Bobcat | Yes | 76 | 4-6 | F | H | | H | H | H |
| | Bravo | Yes | 85 | 4-10 | F, P | H | H | | | |
| | Bronco | Yes | 78 | 3-5 | F | H | | M | M | |
| | Bruno | Yes | 81 | 4 | F | H | H | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Green Cabbage** *(continued)* | Caraflex (pointed) | Yes | 68 | 2-3 | F | H | | | H | |
| | Cecile | Yes | 80 | 6 | P | H | | H | | |
| | Charmant | Yes | 65 | 2.5-3 | F | H | H | | L | H |
| | Cheers | Yes | 75 | 5 | F | H | H | | H | |
| | Early Thunder | Yes | 72 | 3-4 | F | H | M | M | H | |
| | Emblem | Yes | 85 | 3-5 | F | H | H | H | | H |
| | Excalibur | Yes | 78 | 5-7 | P | H | H | | | |
| | Grand Vantage | Yes | 79 | 5-6 | F | H | | | | |
| | Megaton | Yes | 85 | 10-20 | P | H | | H | | |
| | Padoc | Yes | 70 | 5-8 | P | H | | H | | |
| | Platinum Dynasty | Yes | 70 | 4-10 | F, P | H | H | H | | H |
| | Primo Vantage | Yes | 73 | 4-4.5 | F | H | | | | |
| | Quick Start | Yes | 64 | 3-4 | F | H | | H | M | |
| | Ramada | Yes | 83 | 3-6 | F | H | H | | | |
| | Royal Vantage | Yes | 79 | 3-5 | F | H | H | H | H | |
| | Solid Blue 780 | Yes | 79 | 3-4 | F | H | M | H | H | |
| | Superstar | Yes | 85 | 3-4 | F | H | H | H | M | |
| | Supreme Vantage | Yes | 67 | 4-5 | F, P | H | | | | |
| | Thunderhead | Yes | 74 | 3-5 | F | H | H | H | H | |
| | Vantage Point | Yes | 85 | 5-6 | F | H | H | H | H | |
| | Viceroy | Yes | 90 | 4-8 | F, P | H | I | H | H | |
| **Green Savoy Cabbage** | Alcosa | Yes | 62 | 2-4 | F | H | | H | | |
| | Clarissa | Yes | 78 | 2-3 | F | H | | H | | |
| | Melissa | Yes | 80 | 2-4 | F | H | | H | | |
| | Miletta | Yes | 88 | 3-4 | F | | | H | | |
| | Savoy Ace | Yes | 78 | 3-4 | F | M | | | | |
| | Savoy Blue | Yes | 85 | 3-5 | F | | | | | |
| | Savoy King | Yes | 80 | 4 | F | | | H | | |
| **Red Cabbage** | Azurro | Yes | 78 | 3-4 | F | | | H | H | |
| | Cairo | Yes | 85 | 3-6 | F | M | | H | H | H |
| | Red Dynasty | Yes | 75 | 5-12 | F, P | | | H | | H |
| | Red Jewel | Yes | 75 | 3-5 | F | | | H | | |
| | Ruby Perfection | Yes | 80 | 3-4 | F | M | M | M | H | |
| | Rio Grande Red | Yes | 83 | 4-5 | F | | | M | | |
| | Super Red 80 | Yes | 80 | 2-5 | F | | M | H | | H |
| **Red Savoy Cabbage** | Deadon | Yes | 105 | 3-5 | F | | | | | |

[1]M=Moderate or intermediate and H=high level of resistance or tolerance. [2]F=Fresh market, P=Processing (slaw, kraut).

| | Variety | Shape/Color | Hybrid | Days to maturity |
|---|---|---|---|---|
| **Chinese Cabbage** | Blues | Napa (barrel) | Yes | 57 |
| | China Gold | Napa (barrel) | Yes | 65 |
| | China Express | Napa (barrel) | Yes | 62 |
| | Emiko | Napa (barrel) | Yes | 55 |
| | Optiko | Napa (barrel) | Yes | 60 |
| | Rubicon | Napa (barrel) | Yes | 52 |
| | Spring Crisp | Napa (barrel) | Yes | 75 |
| | Yuki | Napa (barrel) | Yes | 67 |
| | Jazz | Napa (barrel) | Yes | 63 |
| | Greenwich | Narrow | Yes | 69 |
| | Green Rocket | Narrow | Yes | 70 |
| | Jade Pagoda | Narrow | Yes | 68 |
| **Pak Choi** | Black Summer | Green petiole | Yes | 45 |
| | Mei Quing Choi | Green petiole | Yes | 40 |
| | Joi Choi | White petiole | Yes | 50 |
| | Win-Win Choi | White petiole | Yes | 52 |

| | Variety | Hybrid | Color | Days | Self Wrapping |
|---|---|---|---|---|---|
| **Cauliflower** | Absolute | Yes | White | 70 | Yes |
| | Accent | Yes | White | 75 | Partial |
| | Amazing | Yes | White | 75 | Yes |
| | Apex | Yes | White | 70 | Yes |
| | Artica | Yes | White | 80 | Yes |
| | Aquarius | Yes | White | 70 | Yes |
| | Attribute | Yes | White | 67 | Yes |
| | Bishop | Yes | White | 65 | Partial |
| | Candid Charm | Yes | White | 68 | Partial |
| | Casper | Yes | White | 75 | Yes |
| | Cheddar | Yes | Orange | 80 | No |
| | Fremont | Yes | White | 62 | Yes |
| | Freedom | Yes | White | 67 | Yes |
| | Graffiti | Yes | Purple | 75 | No |
| | Majestic | Yes | White | 50 | No |
| | Minuteman | Yes | White | 53 | No |
| | Snow Crown | Yes | White | 55 | No |
| | Steady (trial) | Yes | White | 65 | Partial |
| | Symphony | Yes | White | 71 | Partial |
| | Synergy | Yes | White | 75 | Yes |
| | Vitaverde | Yes | Green | 71 | No |
| | Whistler | Yes | White | 78 | No |
| | White Sails | Yes | White | 68 | Yes |
| | 26-701 RZ | Yes | Green | 75 | No |

| | Variety | Hybrid | Color | Comments |
|---|---|---|---|---|
| **Collards** | Bulldog | Yes | Dark Green | Lightly waved leaves |
| | Bluemax | Yes | Blue Green | Lightly savoyed leaves |
| | Hi-Crop | Yes | Deep Green | Semi-savoyed leaves |
| | Top Bunch | Yes | Blue Green | Lighly savoyed leaves |
| | Flash | Yes | Deep Green | Flat to lightly waved leaves |
| | Vates | No | Deep Green | Flat to lightly waved leaves |
| | Tiger | Yes | Deep Blue Green | Flat to lightly waved leaves |
| | Champion | No | Deep Green | Flat to lightly waved leaves |
| **Kale** | Dwarf Blue Curled (Vates) | No | Blue Green | Curled leaf |
| | Dwarf Siberian | No | Green | Light to medium curl, overwinters |
| | Red Russian | No | Blue Green-Red | Flat toothed leaf green with red midrib |
| | Winterbor | Yes | Dark Green | Curled leaf |
| | Blue Knight | Yes | Blue Green | Curled leaf |
| | Blue Armor | Yes | Blue Green | Very curled leaf |
| | Blue Ridge | Yes | Blue Green | Very curled leaf |
| | Redbor | Yes | Deep Red | Curled leaf |
| | Lacinato | No | Blue Green | Puckered strap-like lance leaf |
| | Black Magic | No | Dark Blue Green | Broader leaved lance leaf type |
| | Reflex | Yes | Deep Green | Very tight curled leaf |
| | Starbor | Yes | Blue Green | Curled leaf |
| **Kohlrabi** | Azure Star | Yes | Deep Blue-Purple | |
| | Grand Duke | Yes | Light Green | |
| | Kolibri | Yes | Deep Purple | |
| | Konan | Yes | Light Green | |
| | Quickstar | Yes | Light Green | |
| | Winner | Yes | Light Green | |

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Cole Crops | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| **Broccoli** | 150-200 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Total nutrient recommended |
| | 50-100 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Broadcast and disk-in |
| | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 2-3 weeks after planting |
| | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 4-6 weeks after planting |
| | | | | | | | | | | |
| **Brussels Sprouts, Cabbage, Cauliflower** | 100-150 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Total nutrient recommended |
| | 50-75 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 2-3 weeks after planting |
| | | | | | | | | | | |
| **Kale, Collards** | 100-200 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Total nutrient recommended |
| | 50-100 | 200 | 100 | 50 | 0[1] | 200 | 100 | 50 | 0[1] | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress after each cutting or stripping |
| | | | | | | | | | | |
| **Kohlrabi** | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Total nutrient recommended |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress if needed according to weather |

For broccoli, apply 1.5-3 lb/A of boron (B). For Brussels sprouts, cabbage and cauliflower, apply 1.5-3 lb/A of B and 0.2 lb molybdenum (Mo) applied as 0.5 lb/A sodium molybdate with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter. Include 25-40 lb/A of sulfur in the fertilizer program for cole crops. [1]In VA, crop replacement values of 25 lb/A of $P_2O_5$ and 25 lb/A of $K_2O$ are recommended on soils testing Very High.

## Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical cabbabe tissue test values for most recently matured leaves 8 weeks after transplanting: N 3-6%, P 0.3-0.6 %, K 2.0-4.0 %, Ca 1.5-2.0%, Mg 0.25-0.6% and S 0.3%. For additional nutrients, other cole crops and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *http://edis.ifas.ufl.edu/ep081*

## Seed Treatment

Check with your seed company if seed is hot water-treated for blackrot; see also Disease Control below.

## Planting and Spacing

All cole crops may be direct seeded or transplanted.

**Direct Seeding** Precision seeders are recommended. Sow 15-20 days before the normal transplant date for the same maturity date.

**Transplant Production and Handling for All Cole Crops** Sow in 72-128 cell plug trays or in transplant production beds at 10 seeds/ft of row in rows 12-18 inches apart. Early transplant production will require heated greenhouse facilities or frames. Transplants for summer plantings may be produced in field beds. Transplants are ready in 4-6 weeks. Bare root transplants should be planted soon after lifting. Storage of pulled, field-grown cabbage transplants should not exceed 9 days at 32°F (0°C) or 5 days at 66°F (19°C) prior to planting in the field.

**Broccoli - Fall Production**

**Direct field seeding:** Rows 30-36 inches apart; seed: ½-1 lb/A so that plants are 12-18 inches apart in row. Make successive plantings June 20 to July 20 (June 20 to July 5 in PA and northern NJ).

**Transplants:** Successive plantings between July 15 and August 20, depending on location. Set transplants 12-18 inches apart in rows 36 inches apart (14,520 plants/A).

**High population planting for bunched broccoli:** 2-4 rows per bed, rows 18-20 inches apart, plants 9-10 inches in row (27,000-32,000 plants/A). Seed June 25 to July 10; transplant July 20 to August 15, depending on location.

**For fall plasticulture double cropping**, remove previous crop debris and set broccoli transplants 12-21 inches apart in double rows 10-12 inches apart. For larger heads allow greater in-row spacing. Set plants in late July through mid-August, depending on variety maturity and location.

**Broccoli - Spring Production** Spring production of broccoli is successful in cooler areas of the region but is limited by heat in southern areas. Use heat tolerant varieties. For spring production transplant April 1-April 20.

**Brussels Sprouts** Brussels sprouts are a long season crop grown for fall production. Transplant rows 3 ft apart; plants 15 inches apart in row. Start planting transplants June 20. Start field seeding June 1.

**Cabbage** Cabbage is planted from March through early August depending on location, variety, and intended harvest date. Early varieties require 85-90 days from seeding to harvest, and main-season crops require 110-115 days. Crops grown from transplants are 14-21 days earlier. Transplants are set in rows 2-3 ft apart and 9-15 inches apart in the row for early plantings and 9-18 inches apart for late plantings, depending on variety, fertility, and market use.

**Cauliflower** Transplants are set in rows 3-4 ft apart, and plants are set 18-24 inches apart in the row. Make successive plantings in the field between July 15 and August 20, depending on location. **Note**. In PA and other cool areas, early maturing cultivars can be grown in the spring. Transplant to the field in early April. Spring production in the southern part of the region is not recommended.

**Collards** Direct seeded: Seed at the rate of 2 lb/A. Transplanting: Transplants are set in rows 16-36 inches apart and 6-12 inches apart in the row. Use wider between-row and in-row spacing for multiple hand harvests by stripping leaves. Collards for spring and early summer harvest can be transplanted or seeded starting April 1 in VA and warmer, southern areas and April 20 in PA and normally cooler areas. Collards can be seeded starting in mid-July through late August for fall harvest. Collards for processing are planted in 4-6 row beds, 12-16 inches between rows at a rate of 10-16 seeds/ft of row.

**Kale** Direct Seeding: Sow seed at 3-4 lb/A in rows spaced 16-36 inches apart. Thin to 4-5 inches apart in the row. Transplanting: Transplants are set in rows 16-36 inches apart and 6-12 inches apart in the row. Use wider between-row and in-row spacing for multiple hand harvests by stripping leaves. Kale for spring and early summer harvest can be transplanted or seeded starting April 1 in VA and warmer, southern areas and April 20 in PA and normally cooler areas. Kale can be seeded or transplanted starting in mid-July through late August for fall harvest. Kale for processing is planted in 4-6 row beds, 12-16 inches between rows at a rate of 10-16 seeds per foot of row.

**Kohlrabi** Transplants may be used for a spring crop. Plant in the field at the same time as broccoli or cabbage. Fall crops can be established by direct-seeding between June 25 and July 15. Seed open-pollinated varieties at the rate of 2-3 lb/A and thin to 6-8 inches between plants in the row. Precision-seed hybrid varieties. Set transplants July 20 to August 15. Space rows 18-24 inches apart.

## No-Till / Conservation Tillage

Cabbage and broccoli have been successfully grown by transplanting into rolled or herbicide killed cover crops using a no-till transplanter.

## Irrigation and Water Use

All cole crops benefit from irrigation to achieve the highest yields and quality. Cole crops require a seasonal total of 10-15 inches of water. Amounts will depend on planting date, seasonal variation, variety, and number of times the field is harvested. For spring crops highest demand is near harvest. For fall crops highest demand is mid-season Consistent soil moisture level is especially critical to achieve maximum quality in cauliflower. Any moisture stress, especially when plants reach the 6-7 leaf stage may cause cauliflower to button or form heads prematurely.

## Common Physiological Disorders

### Black Petiole in Cabbage

Black petiole or black midrib is an internal disorder of cabbage that has been observed in recent years. As heads approach maturity, the under side of the internal leaf petioles or midribs turn dark gray or black at or near the point where the midrib attaches to the main stem. It is believed that this disorder is associated with a potassium (K) - phosphorus (P) imbalance. Proper nutrient management and choice of cultivar will help minimize this condition.

**Blanching and Off-Colors in Cauliflower**
Heads exposed to sunlight may develop a yellow and/or red to purple pigment. Certain varieties such as Snow Crown are more predisposed to purple off-colors, especially in hot weather. Self-blanching varieties have been developed to reduce problems with curd yellowing. For open headed varieties, the usual method to exclude light is to tie the outer leaves when the curd is 8 cm in diameter. Leaves may also be broken over the curd to prevent yellowing. In hot weather, blanching may take 3-4 days, but in cool weather, 8-12 or more days may be required. Cauliflower fields scheduled to mature in cool weather (September and October) that are well supplied with water and planted with "self-blanching" cultivars do not require tying. Newer orange cauliflower and green broccoflower varieties are less susceptible to off-colors but can still turn purple under warm conditions.

**Bolting/Buttoning Due to Low Temperatures in Broccoli, Cabbage, Cauliflower, Collards and Kale**
Bolting in cabbage, collards and kale, and "buttoning" in cauliflower can occur if early-planted crops are subjected to low temperatures (between 35-50°F/2-10°C for 10 or more continuous days). Temperature-induced bolting responses depend on variety.

**Boron Deficiencies**
Cole crops have a high boron requirement. Boron deficiency results in cracked and corky stems, petioles and midribs for most cole crops. For broccoli, cabbage and cauliflower, stems can be hollow and sometimes discolored. Cauliflower curds become brown and leaves may roll and curl, while cabbage heads may be small and yellow.

**Brown Floret (Bead) and Yellowing Floret in Broccoli**
**Brown Floret** is thought to be caused by plant nutritional imbalances but also may be due to insect feeding damage (*e.g*., harlequin bugs). Areas of florets do not develop properly, die and lead to brown discolored areas.
**Yellowing florets** may be due to over-maturity at harvest, high storage temperatures and/or exposure to ethylene. Any development of yellow beads ends commercial marketability. Bead yellowing due to senescence should not be confused with the yellow to light-green color of areas of florets not exposed to light during growth, sometimes called "marginal yellowing". Proper postharvest handling and packaging will help minimize this problem.

**Curd Bracts in Cauliflower**
Development of curd bracts or small green leaves between the segments of the curd in cauliflower is caused by high temperature or drought. Heat-resistant cultivars and proper water management can help minimize this condition.

**Edema on Cole Crop Leaves**
Edema is water blistering on cole crop leaves. The most common cause of edema is the presence of abundant, warm soil water and a cool, moist atmosphere. Proper water management can help to minimize this condition.

**Hollow Stem in Broccoli and Cauliflower Not Caused by Boron Deficiency**
This condition starts with gaps that develop in stem tissues. These gaps gradually enlarge to create a hollow stem. Ordinarily, there is no discoloration of the surface of these openings at harvest but both discoloration and tissue breakdown may develop soon after harvest. Some cultivars of hybrid cauliflower and broccoli may have openings from the stem into the head. Hollow stem increases with wider plant spacing and as the rate of nitrogen increases. The incidence of hollow stem can be greatly reduced by increasing the density of the plant population.

**Lack of Heads in Broccoli and Cauliflower**
During periods of extremely warm weather, *i.e.*, days over 86°F (30°C) and nights over 77°F ( 25°C), broccoli and cauliflower can remain vegetative due to inadequate cold exposure. This can cause a problem in scheduling the maturation and marketing dates for these crops.

**Premature Heading (Buttoning) in Broccoli and Cauliflower**
Losses are usually most severe when transplants have gone past the juvenile stage before setting in the field. Stress factors such as low soil nitrogen, low soil moisture, disease, insects, or micronutrient deficiencies can also cause this problem. Some cultivars, particularly early ones, are more susceptible to buttoning than others.

**Ricing and Fuzziness in Cauliflower**
"Riciness" and "fuzziness" in heads is caused by high temperatures, exposure to direct sun, rapid growth after the head is formed, high humidity, or high nitrogen. When "ricing" occurs, flower buds develop, elongate and separate, making the curd unmarketable. Proper cultivar and nutrient management can help minimize this condition.

**Splitting in Cabbage**
Cabbage splitting mainly occurs in early cabbage when moisture stress is followed by heavy rain. Rapid growth associated with rain, high temperatures and high fertility can cause splitting. Proper irrigation and deep cultivation may help prevent splitting. There are significant differences between cultivars in their susceptibility to this problem.

**Tipburn in Cauliflower, Cabbage, and Brussels Sprouts**
Tipburn is a breakdown of plant tissue inside the head of cabbage, individual sprouts in Brussels sprouts, and on the inner wrapper leaves of cauliflower. It is associated with an inadequate supply of calcium in the affected leaves, causing a collapse of the tissue and death of the cells. Calcium deficiency may occur where the soil calcium is low or where there is an imbalance of nutrients in the soil along with certain weather conditions (high humidity, low soil moisture, high potash and high nitrogen aggravate calcium availability). Secondary rots caused by bacteria can follow the onset of tipburn and heads of cauliflower can be severely affected. Some cabbage and cauliflower cultivars are relatively free of tipburn problems. This problem can cause severe economic losses.

## Harvest and Post Harvest Considerations

**Broccoli** should be harvested when heads have reached maximum diameter and flower buds (beads) are still tight. Bunched broccoli heads are tied together in groups of 3-4 with a rubber band. Broccoli should be hydrocooled or packed in ice immediately after harvest and stored at 32°F (0°C) and relative humidity of 95-100% to maintain salable condition. Under these conditions broccoli should keep satisfactorily 10-14 days. For processing, broccoli has the potential to be machine harvested but due to uniformity differences at harvest, hand harvest produces the highest yields and best quality.

**Cabbage** is harvested when heads are tight and have reached the desired size for the variety and spacing. The head is harvested by bending it to one side and cutting the base with a knife. Harvesting knives should be sharpened frequently. The stalk should be cut flat and as close to the head as possible, yet long enough to retain 2-4 wrapper leaves. Extra leaves act as cushions during handling and may be desired in certain markets. Yellowed, damaged, or diseased wrapper leaves should be removed. Heads with insect damage and other defects should be discarded. It is important that unharvested immature heads are undamaged because fields will be harvested multiple times. Harvested cabbage can be placed in bags, boxes, wagons, or pallet bins, depending on the harvesting method. Holding cabbage too long past harvest maturity will result in head splitting. Store harvested cabbage at 32°F (0°C) and a relative humidity of 98-100%. For processing, cabbage has the potential to be machine harvested but due to uniformity differences at harvest, hand harvest produces the highest yields and the best quality.

**Cauliflower** is harvested while the heads are pure white and before the curds become loose and ricey. Most varieties are self-blanching. For those that are not, blanching is achieved by tying outer leaves over the heads when heads are 3 to 4 inches in diameter. Blanching takes about 1 week in hot weather and 2 weeks in cooler weather. Store harvested cauliflower at 32°F (0°C) and a relative humidity of at least 95%. Avoid bruising heads in harvest, handling and packing.

**Kale and Collards** are harvested by cutting off entire plants near ground level. Whole plants are then bunched, or lower leaves may be stripped from plants and packed individually. For processing, kale and collards are machine cut 4-6 inches from the ground when full tonnage has been achieved but before petioles have elongated. Multiple harvests are possible. Because of their perishability, kale and collards should be held as close to 32°F (0°C) as possible. At this temperature, they can be held for 10-14 days. Relative humidity of at least 95% is desirable to prevent wilting. Air circulation should be adequate to remove heat of respiration, but excessive air circulation will speed transpiration and wilting. Satisfactory precooling is accomplished by vacuum cooling or hydrocooling. These leafy greens are commonly shipped with package and top ice to maintain freshness. Kale packed in polyethylene-lined crates and protected by crushed ice keeps in excellent condition for 3 weeks at 32°F (0°C).

**Kohlrabi** is harvested when stems are full sized but before they begin to split.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

<table>
<tr><th colspan="7">1.a. Soil-Applied (Preplant Incorporated or Preemergence)</th></tr>
<tr><th>Group</th><th>Product Name</th><th>Product Rate</th><th>Active Ingredient<br>(*=Restricted Use)</th><th>Active Ingredient Rate</th><th>PHI<br>(d)</th><th>REI<br>(h)</th></tr>
<tr><td>3</td><td>Dacthal 6F<br>Dacthal W-75</td><td>6.0 to 14.0 pt/A<br>6.0 to 14.0 lb/A</td><td>DCPA</td><td>4.5 to 10.5 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Labeled for broccoli, Brussels sprouts, cabbage, cauliflower, collards, kale, and kohlrabi.<br>-Apply after seeding to a clean, weed-free soil. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse -textured soils low in organic matter, and when the application are followed by rainfall or irrigation. Maximum application not addressed on label.</td></tr>
<tr><td>3</td><td>Treflan 4E</td><td>Seeded: 1.0 to 1.5 pt/A<br>Transplanted: 1.0 to 2.0 pt/A</td><td>trifluralin</td><td>Seeded: 0.50 to 0.75 lb/A<br>Transplanted: 0.5 to 1.0 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Labeled for broccoli, Brussels sprouts, cabbage, cauliflower, collards, and kale only. Labeled seeded-crop as well as transplants.<br>-Apply only as preplant incorporated and incorporate into 2-3 inches of soil within 8 hr after application.<br>-Primarily controls annual grasses and a few broadleaf weeds.<br>-Do not use (or reduce the rate) used when cold, wet soil conditions are expected, or crop injury may result.<br>-Poor incorporation can reduce overall weed control. Maximum application not addressed on label.</td></tr>
<tr><td>8</td><td>Prefar 4E</td><td>5.0 to 6.0 qt/A</td><td>bensulide</td><td>5.0 to 6.0 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Labeled for broccoli, Brussels sprouts, cabbage, cauliflower, collards, kale, and kohlrabi.<br>-24(c) label for NJ only allows applications up to 9 qt/A. Labeled for seeded-crop as well as transplants. Labeled for preplant incorporated or preemergence applications; do not incorporate more than 2 inches deep (1 inch is optimum). If applied preemergence, irrigate within 36 hrs of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 hrs, weed control maybe reduced.<br>-Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters.<br>-Do not apply more than 6 lb ai/A per season.</td></tr>
<tr><td>14</td><td>Goal 2XL or Galigan 2E<br>GoalTender 4FL</td><td>1.0 to 2.0 pt/A<br>0.5 to 1.0 pt/A</td><td>oxyfluorfen</td><td>0.25 to 0.5 lb/A</td><td>--</td><td>24</td></tr>
<tr><td colspan="7">-Labeled for broccoli, cabbage, and cauliflower only.<br>-Labeled for transplanting only. Apply before transplanting and transplant through the herbicide on the soil surface<br>-Use lower rates on coarse-textured soils low in organic matter. Cold, wet conditions in early spring may increase the risk of temporary crop injury which could delay maturity. Use of transplants less than 5 weeks old or use of succulent transplants grown in containers less than 1 inch square may increase severity of crop injury.<br>-Goal control broadleaf weeds including common lambsquarters, common purslane, common ragweed, pigweed sp., and galinsoga.<br>-Treflan or Dual Magnum may increase the potential for crop injury, especially when conditions are cold and wet, and it is not recommended for use prior to Goal application.<br>-Delay cultivation after Goal application, when possible, to reduce deactivation of the Goal by incorporation.<br>-Do not apply more than 1 pt/A per season of GoalTender or more than 2 pt/A of Goal 2XL.</td></tr>
<tr><td>15</td><td>Devrinol 2-XT</td><td>2.0 qt/A</td><td>napropamide</td><td>1.0 lb/A</td><td>--</td><td>24</td></tr>
<tr><td colspan="7">-Labeled for broccoli, Brussels sprouts, cabbage, cauliflower, collards, and kale only. Recommended in PA ONLY!<br>-Labeled for seeded-crop as well as transplants<br>-Apply preplant incorporated or preemergencs; if incorporated do no incorporate than seeding depth; if surface applied then irrigate within 72 hrs with sufficient water to we the soil to a depth of 4 to 8 inches. Primarily controls annual grasses and certain broadleaf weeds.<br>-Tank-mix with minimum recommended rate of Treflan 4EC to improve the spectrum of broadleaf weeds controlled.<br>-Use only on fine-textured soils such as silt or clay loams with more than 2% organic matter. Crop injury has occurred when used on coarse-textured soils low in organic matter.<br>-Do not exceed 2 qt/A per crop cycle.</td></tr>
<tr><td>15</td><td>Dual Magnum 7.62E</td><td>0.5 to 1.33 pt/A</td><td>s-metolachlor</td><td>0.48 to 1.27 lb/A</td><td>60</td><td>24</td></tr>
<tr><td colspan="7">-Labeled for transplanted cabbage in PA only!<br>-A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E and the use of this product is legal ONLY if a waiver of liability has been completed (see http://www.farmassist.com/).<br>-Apply before transplanting. Do not mechanically incorporate Dual Magnum prior to transplanting.<br>-Risk of injury is less with post-transplanted applications than pre-transplant applications. Chinese cabbage varieties are more sensitive to Dual injury.<br>-Make only 1 application per crop and do not apply more than 1.3 pt/A.</td></tr>
</table>

## 1.b. Post-Transplant Application / Preemergence Control

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 3 | Dacthal 6F<br>Dacthal W-75 | 6.0 to 14.0 pt/A<br>6.0 to 14 lb/A | **DCPA** | 4.5 to 10.5 lb/A | -- | 12 |
| -**Labeled for broccoli, Brussels sprouts, cabbage, cauliflower, collards, kale, and kohlrabi.**<br>-Apply after seeding or transplanting to a clean, weed-free soil. Labeled for over the top application of transplants without injury (will not control emerged weeds). Primarily controls annual grasses and a few broadleaf weeds, including common purslane.<br>-Results have been most consistent when used in fields with coarse -textured soils low in organic matter, and when the application are followed by rainfall or irrigation. Maximum application not addressed on label. | | | | | | |
| 15 | Dual Magnum 7.62E | 0.5 to 1.33 pt/A | **s-metolachlor** | 0.48 to 1.27 lb/A | 60 | 24 |
| -**Labeled for transplanted cabbage or emerged cabbage ONLY in NJ and PA! Transplanted broccoli, cabbage, cauliflower, collard, and kale in VA.**<br>-**A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E and the use of this product is legal ONLY if a waiver of liability has been completed** (see *http://www.farmassist.com/*).<br>-Apply directly over the top of transplants within 48 hrs of transplanting.<br>-**Do not** mechanically incorporate prior to transplanting.<br>-May be applied over the top of direct-seeded cabbage after cabbage has developed 3 to 4 leaves. **Do not** apply to direct-seeded cabbage prior to the 3 to 4-leaf growth stage or the risk of crop injury may be increased.<br>-Use of an adjuvant or another registered herbicide will increase the risk of injury from postemergence applications<br>-Risk of injury is less with post-transplanted applications than pre-transplant applications.<br>-Chinese cabbage varieties are more sensitive to Dual injury.<br>-Dual Magnum will **not** control emerged weeds. Emerged weeds should be controlled by cultivation, hoeing, or postemergence herbicides prior to Dual Magnum application.<br>-Make only 1 application per crop and **do not** apply more than 1.3 pt/A | | | | | | |

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6.0 to 8.0 fl oz/A<br>12.0 to 16.0 fl oz/A | **clethodim** | 0.094 to 0.125 lb/A | 30/14 | 24 |
| | Poast 1.5EC | 1.0 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 30 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v<br>-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.<br>-Controls many annual and certain perennial grasses, including annual bluegrass, but Select will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.<br>-If repeat applications are necessary, allow 14 days between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-Pre-harvest interval of Select and Select Max for broccoli, Brussel sprouts, cabbage, cauliflower, and kohlrabi is 30 days; PHI for collards and kale is 14 days.<br>-Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season.<br>-**Do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 3 pt/A for the season. | | | | | | |
| 4 | Stinger 3A | 4.0 to 8.0 fl oz/A | **clopyralid** | 0.047 to 0.188 lb/A | 30 | 12 |
| -Spray additives are not needed or required by the label, and are not recommended.<br>-Stinger controls composite and legume weeds including galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum).<br>-Stinger is very effective on small seedling annual and emerging perennial weeds less than 2-4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2.0 to 4.0 fl oz/A to control annual weeds less than 2 inches tall. Increase the rate to 4.0 to 8.0 fl oz/A to control larger annual weeds. Apply the maximum rate of 8.0 fl oz/A to suppress or control perennial weeds.<br>-Observe follow crop restrictions or injury may occur from herbicide carryover.<br>-Rainfastness is 6 hrs. Maximum Stinger application per year is 2, but not to excel a total of 8 fl oz/A per season.. | | | | | | |

*2. Postemergence continued on next page*

*2. Postemergence - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 14 | GoalTender 4F | 4.0 to 6.0 fl oz/A | **oxyfluorfen** | 0.125 to 0.188 lb/A | 35 | 24 |

-**Labeled for use on broccoli, cabbage and cauliflower in DE, NJ, PA ONLY! A Special Local Needs 24(c) label for broccoli, cabbage, and cauliflower has been approved for the use of GoalTender postemergence in DE, NJ, and PA.**
-Apply after direct-seeded crops reach a minimum of 4 true leaves; for transplanted crops apply after a minimum of 2 weeks after transplanting. Expect some temporary crop injury (speckling and/or crinkling of foliage) after treatment.
-**Do not** tank-mix with any other pesticide or use any spray additive, or severe crop injury may result.
-**Do not** use any oxyfluorfen formulation other than GoalTender 4F, or severe crop injury may result.
-GoalTender will provide residual control, but **do not** cultivate after application, or the herbicide will be deactivated. Weeds controlled or suppressed include common groundsel, common lambsquarers, pigweeds, purslane, shepherdspurse, and annual sowthistle when applied to weeds with 1 to 4 true leaves.
-Rainfastness is not specified. Maximum GoalTender per application is 8 fl oz/A; a pre-transplant application followed by a post-transplant application can be made but the combined amount may not exceed 16 fl oz/A per season.

**3. Postharvest**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56-0.75 lb/A | -- | 24 |

-**A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant.
-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.
-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed.

**4. Other Labeled Herbicides** These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| 3 | Prowl H2O / Prowl | **pendimethalin** (broccoli, Brussel sprouts, cabbage, cauliflower, collards, kale, kohlrabi) |
| 13 | Command | **clomazone** (cabbage) |
| **14** | Zeus | **sulfentrazone** (cabbage) |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Insecticides

## <u>Soil Pests</u>
### Cabbage Maggots

Cabbage maggots overwinter as pupae. Overwintered adults (flies) emerge when yellow-rocket (mustard) first blooms, then begin laying eggs on roots or soil near roots. All cole crops are affected. Eggs hatch within 3-7 days. As maggots feed on roots, plants begin to wilt. Ultimately, infested plants become severely stunted, or die outright. This pest has 3-4 generations per growing season, although the first generation is often the most economically damaging. The last larval generation is in October, particularly in warmer years. Treatments for cabbage maggot must be done preventively, as once damage is evident, loss of plants is unavoidable. Barriers, such as row covers, may be useful in excluding flies from smaller plantings. Prompt and complete destruction of crop residue is helpful. Chemical treatments should be applied pre-plant, or at planting, depending on the product used.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) and Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Diazinon AG500 | 2.0 to 3.0 qt/A pre-plant broadcast **OR** 4.0 to 8.0 fl oz/ 50 gal transplant water | diazinon* - **not labeled for cabbage maggot control on collards and kale** | AP | 96 | H |
| 1B | Lorsban Advanced | See specific rates on label based on method of application and crop. Preplant, at-plant, and post-plant applications are recommended. | chlorpyrifos* **- soil** (REI on cauliflower 72 h) | 30 | 24/ 72 | H |
| 3A | Capture LFR | 3.4 to 6.8 fl oz/A | bifenthrin* **- soil** | AP | 12 | H |
| 28 | Verimark | 10.0 to 13.5 fl oz/A | cyantraniliprole **- soil** | AP | 4 | H |

**Cutworms -** See also the Pest Management chapter, Insect Management section.

Cutworms are moth larvae (caterpillars) that live in the soil and feed on plant roots and stems. Cutworms chew through plant stems at or near the soil line, causing young plants to topple over. Larvae are typically active at night, and spend most of this stage belowground. Cutworms are favored by less disturbed soils and debris covered soil surfaces. Thus, conventional tillage and incorporation of crop debris into the soil helps reduce populations. There are several species of cutworm in New Jersey that are capable of causing injury to young plants. In general, there are two generations per season. If cutworm damage is anticipated, it is best to treat preventively with insecticide.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | See label for rates and current registration status. | methomyl* - **not labeled for kohlrabi** | see label | see label | H |
| 1B | Lorsban Advanced | Check specific rates on the label | chlorpyrifos* - **soil** (REI on cauliflower 72 hours) | 30 | 24/ 72 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* - **not labeled for collards and kale** | 0 | 12 | H |
| 3A | Bifenture 2EC (or Sniper) | 2.1 to 6.4 fl oz/A | bifenthrin* **- soil** | 7 | 12 | H |
| 3A + **4A** | Leverage 360 | 3.0 fl oz/A | beta-cyfluthrin + imidacloprid | 7 | 12 | H |
| 3A + 28 | Besiege | 5.0 to 8.0 fl oz/A | lambda-cyhalothrin+chlorantraniliprole* **- not labeled for collards and kale** | 3 | 24 | H |

## Aboveground Pests

### Aphids

Aphids can occasionally become a problem, particularly as a contaminant in Brussels sprouts, cabbage and some types of kale. To prevent flare-ups, avoid overuse of pyrethroid (Group 3) insecticides for caterpillar control. If growing transplants for field use, control aphid populations in the greenhouse to avoid transplanting infested crops.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Orthene 97 | 0.5 to 1.0 lb/A | acephate - **only labeled for Brussels sprouts and cauliflower** | 14 | 24 | H |
| 3A + **4A** | Brigadier | 3.8 to 6.1 fl oz/A | imidacloprid + bifenthrin* | 7 | 12 | H |
| 3A + **4A** | Endigo ZC | 4.0 to 4.5 oz/A | thiamethoxam + lambda-cyhalothrin* - **not labeled for collards and kale** | 1 | 24 | H |
| 3A + **4A** | Leverage 360 | 3.0 fl oz/A | thiamethoxam + beta-cyfluthrin* | 7 | 12 | H |
| **4A** | Actara | 1.5 to 3.0 fl oz/A | thiamethoxam (PHI on collards, kale, kohlrabi 7 d) | 0/7 | 12 | H |
| **4A** | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid **- soil** | 21 | 12 | H |
| **4A** | Admire Pro | 1.3 fl oz/A | imidcloprid - **foliar** | 7 | 12 | H |
| **4A** | Assail 30SG | 2.0 to 4.0 oz/A | acetamiprid | 7 | 12 | M |
| **4A** + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantrinilaprole **- soil** | 30 | 12 | H |
| **4A** + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantrinilaprole **- foliar** (PHI on collards and kale 7 days) | 3/7 | 12 | H |
| **4C** | Closer SC | 1.5 to 2.0 fl oz/A | sulfoxaflor | 3 | 12 | H |
| **4D** | Sivanto 200SL | 7.0 to 12.0 fl oz/A | flupyradifurone | 1 | 4 | M |
| 9B | Fulfill 50W | 2.75 oz/A | pymetrozine | 7 | 12 | N |
| 9C | Beleaf 50SG | 2.0 to 2.8 oz/A | flonicamid | 0 | 12 | L |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 1 | 24 | L |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole **- soil** | AP | 4 | H |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole **- foliar** | 1 | 12 | H |
| N/A | Requiem (OMRI) | 2.0 to 4.0 qt/A | *Chenopodium* extract | 0 | 4 | L |

### Caterpillar "Worm" Pests Including: Cabbage Loopers (CL), Diamondback Moths (DBM), Imported Cabbageworms (ICW), Cross-striped Cabbageworms, Cabbage Webworms, and Armyworms

Cole crops may require multiple treatments per season. **Not all materials are labeled for all crops, insects or application methods; be sure to read the label. Due to resistance development, pyrethroid insecticides (Group 3A) are not recommended for control of DBM or beet armyworm (BAW)**. Other insecticides may no longer be effective in certain areas due to DBM resistance; consult your county Extension office for most effective insecticides in your area. Rotation of insecticides with different modes of action is recommended to reduce the development of resistance.

**Threshold**: For fresh-market cabbage, Brussels sprouts, broccoli and cauliflower, treat when 20% or more of the plants are infested with any species during seedling stage, then 30% infestation from early vegetative to cupping stage. From early head to harvest in cabbage and Brussels sprouts use a 5% threshold. For broccoli and cauliflower, use 15% at curd initiation/cupping, then 5% from curd development to harvest. Spray coverage under the leaves is essential for effective control particularly with *Bacillus thuringiensis* and contact materials. With boom-type rigs, apply spray with at least 3 nozzles per row - one directed downward and one directed toward each side. Evaluate effectiveness to consider need for further treatment.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | See label for rates and registration status. | methomyl*<br>- **not labeled for kohlrabi** | see label | see label | H |
| 1B | Orthene 97S | 1.0 lb/A | acephate<br>- **only labeled for Brussels sprouts and cauliflower** | 14 | 24 | H |
| 3A | Baythroid XL | 1.6 to 3.2 fl oz/A | beta-cyfluthrin* - **not labeled for collards and kale**<br>**- not recommended for DBM, BAW** | 0 | 12 | H |
| 3A | Bifenture 2EC (or Sniper) | 2.1 to 6.4 fl oz/A | bifenthrin*<br>- **not recommended for DBM, BAW** | 7 | 12 | H |
| 3A | Warrior II | 0.96 to 1.60 fl oz/A | lambda-cyhalothrin*<br>- **not labeled for collards and kale**<br>- **not recommended for DBM, BAW** | 1 | 24 | H |
| 3A+**4A** | Brigadier | 3.8 to 6.1 fl oz/A | bifenthrin + imadacloporid*<br>- **not recommended for DBM, BAW** | 7 | 12 | H |
| 3A+**4A** | Endigo ZC | 4.0 to 4.5 oz/A | thiamethoxam + lambda-cyhalothrin*<br>- **not labeled for collards and kale**<br>- **not recommended for DBM, BAW** | 1 | 24 | H |
| 3A+**4A** | Leverage 360 | 3.0 fl oz/A | thiamethoxam + beta-cyfluthrin*<br>- **not recommended for DBM, BAW** | 7 | 12 | H |
| 3A+28 | Besiege | 5.0 to 8.0 fl oz/A | lambda-cyhalothrin + chlorantraniliprole*<br>- **not labeled for collards and kale** | 3 | 24 | H |
| **4A**+ 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantrinilaprole **- soil** | 30 | 12 | H |
| **4A** +28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantrinilaprole **- foliar**<br>(PHI for collards and kale 7 d) | 3/7 | 12 | H |
| 5 | Entrust (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5 SG | 3.2 to 4.8 oz/A | emamectin benzoate* (PHI on collards and kale 14 d) | 7/14 | 12 | H |
| 11A | Dipel (OMRI) | 1.0 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 15 | Rimon 0.83 EC | 6.0 to 12.0 fl oz/A | novaluron* - **not labeled for collards and kale** | 7 | 12 | N |
| 18 | Confirm 2F | 6.0 to 8.0 oz/A | tebufenozide | 7 | 4 | M |
| 18 | Intrepid 2F | 4.0 to 8.0 fl oz/A | methoxyfenozide | 1 | 4 | N |
| 22A | Avaunt 30 WDG | 2.5 to 3.5 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67 SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 3 | 4 | L |
| 28 | Verimark | 5.0 to 10.0 fl oz/A | cyantraniliprole **- soil** | AP | 4 | H |
| 28 | Exirel | 7.0 to 13.5 fl oz/A | cyantraniliprole **- foliar** | 1 | 12 | H |

## Flea Beetles

Treat if the population reaches 1 beetle per transplant or 5 beetles per 10 plants during cotyledon stage. Crop rotation, management of wild hosts (wild mustard, rocket etc.) and prompt destruction of crop residue are helpful in population suppression. Sequential plantings of host crops can result in population build-up.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin XLR Plus | 0.5 to 1.0 qt/A | carbaryl (PHI on collards and kale 14 d)<br>- **not labeled for Chinese cabbage** | 3/14 | 12 | H |

*Flea Beetles continued on next page*

*Flea Beetles - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A | Baythroid XL | 2.4 to 3.2 fl oz/A | beta-cyfluthrin*<br>- **not labeled for collards and kale** | 0 | 12 | H |
| 3A | Bifenture 2EC (or Sniper) | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin*<br>- **not labeled for collards and kale** | 1 | 24 | H |
| 3A + **4A** | Brigadier | 3.8 to 6.1 fl oz/A | bifenthrin + imadacloporid* | 7 | 12 | H |
| 3A + **4A** | Endigo ZC | 4.0 to 4.5 oz/A | thiamethoxam + lambda-cyhalothrin*<br>- **not labeled for collards and kale** | 1 | 24 | H |
| 3A + **4A** | Leverage 360 | 3.0 fl oz/A | thiamethoxam + beta-cyfluthrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin + chlorantraniliprole*<br>- **not labeled for collards and kale** | 3 | 24 | H |
| **4A** | Actara 25 WDG | 1.5 to 3.0 oz/A | thiamethoxam<br>(PHI on collards, kale and kohlrabi 7 d) | 0/7 | 12 | H |
| **4A** | Admire Pro | 1.3 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| **4A** | Venom 70 SG | 5.0 to 6.0 fl oz/A | dinotefuran - **soil**<br>- **not labeled for collards and kale** | 21 | 12 | H |
| **4A** + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantrinilaprole - **soil** | 30 | 12 | H |
| **4A** + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantrinilaprole - **foliar**<br>(PHI on collards and kale 7 d) | 3/7 | 12 | H |
| 28 | Verimark | 5.0 to 10.0 fl oz/A | cyantraniliprole - **soil** | AP | 4 | H |

## Harlequin Bugs

These orange, black and white stinkbugs can be quite destructive, particularly on leafy cole crops like collards. Egg masses consist of numerous white and black barrel-shaped eggs in neat rows. Nymphs remain clustered near the eggs until molting. Infestations, can be quite heavy. Feeding results in pale blotches with scalloped edges on foliage.

**Apply one of the following formulations:**

| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 1A | Sevin XLR Plus | 0.5 to 1.0 qt/A | Carbaryl (PHI on collards and kale 14 d)<br>- **not labeled for Chinese cabbage** | 3/14 | 12 | H |
| 3A | Baythroid XL | 2.4 to 3.2 fl oz/A | beta-cyfluthrin*<br>- **not labeled for collards and kale** | 0 | 12 | H |
| 3A | Bifenture 2EC (or Sniper) | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin*<br>- **not labeled for collards and kale** | 1 | 24 | H |
| 3A + **4A** | Endigo ZC | 4.0 to 4.5 oz/A | thiamethoxam + lambda-cyhalothrin*<br>- **not labeled for collards and kale** | 1 | 24 | H |
| 3A + **4A** | Leverage 360 | 3.0 fl oz/A | thiamethoxam + beta-cyfluthrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin + chlorantraniliprole*<br>- **not labeled for collards and kale** | 3 | 24 | H |
| **4A** | Admire Pro | 1.3 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| **4A** | Belay 2.13 SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | AP | 12 | H |
| **4A** | Venom 70 SG | 1.0 to 4.0 fl oz/A | dinotefuran - **foliar**<br>- **not labeled for collards and kale** | 1 | 12 | H |

## Thrips

The small size of thrips, their habit of feeding near growing points, and the waxy nature of cole crop foliage can result in poor control with contact insecticides. The addition of a wetting agent may improve efficacy.

**Apply one of the following formulations:**

| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin*<br>- **not labeled for collards and kale** | 0 | 12 | H |
| 3A | Bifenture EC | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A + **4A** | Brigadier | 3.8 to 6.1 fl oz/A | imidacloprid + bifenthrin* | 7 | 12 | H |
| 3A + **4A** | Endigo ZC | 4.0 to 4.5 oz/A | thiamethoxam + lambda-cyhalothrin*<br>- **not labeled for collards and kale**<br>Tank mix with Actara for thrips control. | 1 | 24 | H |

*Thrips continued on next page*

*Thrips - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A + **4A** | Leverage 360 | 3.0 fl oz/A | thiamethoxam + beta-cyfluthrin* | 7 | 12 | H |
| **4A** | Actara | 1.5 to 3.0 fl oz/A | thiamethoxam (PHI on collards, kale, kohlrabi 7 d) | 0/7 | 12 | H |
| **4A** | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid **- soil** | 21 | 12 | H |
| **4A** | Assail 30SG | 4.0 oz/A | acetamiprid | 7 | 12 | M |
| **4A** | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin **- soil** | AP | 12 | H |
| **4A** | Venom | 5.0 to 6.0 oz/A | dinotefuran **- soil**<br>**- not labeled for collards and kale** | 21 | 12 | H |
| **4A** + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantrinilaprole **- soil** | 30 | 12 | H |
| **4A** + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantrinilaprole **- foliar**<br>(PHI on collards and kale 7 d) | 3/7 | 12 | H |
| **4C** | Closer SC | 5.75 fl oz/A | sulfoxaflor (suppression only) | 3 | 12 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 10.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 1 | 24 | L |
| 28 | Verimark | 10.0 to 13.5 fl oz/A | cyantraniliprole **- soil** | AP | 4 | H |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole **- foliar** | 1 | 12 | H |

[1] **Resistance concerns with western flower thrips only**

## Whiteflies

Due to insecticide resistance issues with several species, rotation among insecticide groups is essential for control and management of resistance in local populations. Thorough coverage, use of wetting agents, and initiation of treatment at low population levels will all improve control.

**Apply one of the following formulations:**

| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 3A + **4A** | Brigadie**r** | 6.1 fl oz/A | imidacloprid + bifenthrin* | 7 | 12 | H |
| 3A + **4A** | Endigo ZC | 4.5 oz/A | thiamethoxam + lambda-cyhalothrin*<br>**- not labeled for collards and kale**<br>Tank mix with Actara for whitefly control. | 1 | 24 | H |
| 3A + **4A** | Leverage 360 | 3.0 fl oz/A | thiamethoxam + beta-cyfluthrin* | 7 | 12 | H |
| **4A** | Actara | 1.5 to 3.0 fl oz/A | thiamethoxam (PHI on collards, kale, kohlrabi 7 d) | 0/7 | 12 | H |
| **4A** | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid **- soil** | 21 | 12 | H |
| **4A** | Admire Pro | 1.3 fl oz/A | imidcloprid **- foliar** | 7 | 12 | H |
| **4A** | Assail 30SG | 2.5 to 4.0 fl oz/A | acetamiprid | 7 | 12 | M |
| **4A** | Venom | 5.0 to 7.5 oz/A | dinotefuran **- soil; not labeled for collards and kale** | 21 | 12 | H |
| **4A** | Venom | #1 - 1.0 to 4.0 oz/A<br>#2 - 2.0 to 3.0 oz/A | dinotefuran **- foliar; rate #1 - head and stem cole crops; rate #2 - leafy cole crops** | 1 | 12 | H |
| **4A** + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantrinilaprole **- soil** | 30 | 12 | H |
| **4A** + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantrinilaprole **- foliar**<br>(PHI on collards and kale 7 d) | 3/7 | 12 | H |
| **4C** | Closer SC | 4.25 to 5.75 fl oz/A | sulfoxaflor | 3 | 12 | H |
| **4D** | Sivanto 200SL | 10.5 to 14.0 fl oz/A | flupyradifurone | 1 | 4 | M |
| 7C | Knack | 8.0 to 10.0 fl oz/A | pyriproxifen | 7 | 12 | N |
| 9B | Fulfill 50W | 2.75 oz/A | pymetrozine | 7 | 12 | N |
| 15 | Rimon 0.83 EC | 12.0 fl oz/A | novaluron*- **not labeled for collards and kale** | 7 | 12 | N |
| 16 | Courier SC | 9.0 to 13.6 fl oz/A | buprofezin | 1 | 12 | L |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 1 | 24 | L |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole **- soil** | AP | 4 | H |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole **- foliar** | 1 | 12 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Pesticides

**Nematodes** - See the Soil Fumigation and Nematodes sections in the Pest Management chapter

## Seed Treatment

Purchase hot water treated seed, or request hot water seed treatment by the seed company. If you are unsure whether your seeds have been treated, consult a qualified seed testing service.

Hot water seed treatment is a non-chemical alternative to conventional chlorine treatment which only kills pathogens on the surface of the seed. Heat-treatment done correctly kills pathogens inside the seed as well. If done incorrectly, it may not eradicate pathogens and may reduce germination and vigor. For cole crops, it is especially important to follow treatment protocols as seeds can split.

Seed heat treatment follows a strict time and temperature protocol and is best done with thermostatically controlled water baths. Two baths are required: one for pre-heating, and a second for the effective (pathogen killing) temperature. For cole crops, the initial pre-heating is at 100°F (38°C) for 10 minutes. The effective temperature is 122°F (50°C). Soaking at the effective temperature should be done for 20 minutes for broccoli, cauliflower, collards, kale, and Chinese cabbage, and 25 minutes for Brussels sprouts and cabbage. Immediately after removal from the bath, seeds should be rinsed with cool water to stop the heating process. After that, seeds should be dried on a screen or paper. Pelleted seeds are not recommended for heat treatment. **Only treat seed that will be used immediately.**

As an alternative to hot water seed treatment, use 1 part Alcide (sodium chlorite), 1 part lactic acid, and 18 parts water as a seed soak. Treat seed 1-2 minutes and rinse for 5 minutes in running water at room temperature.

Following hot water or chlorine treatment, dust the dried seed with Captan 50WP or Thiram 480DP at 1 level tsp/lb of seed (3 oz/100 lb).

## Damping-off caused by *Pythium*, *Phytophthora*, and *Rhizoctonia*

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| **After seeding, apply one of the folowing in a band up to 7 inches wide. See labels for rates based on row spacing.** | | | | | | |
| **Phytophthora and Pythium root rot** | | | | | | |
| 4 | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | AP | 48 | N |
| **Phytophthora, Pythium, and Rhizoctonia root rot** | | | | | | |
| 4 + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence. | mefenoxam + azoxystrobin | AP | 0 | N |
| **Rhizoctonia root rot** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | AP | 4 | N |

## <u>Bacterial and Fungal Diseases</u>

## Bacterial Head Rot

Bacterial head rot can be a problem on broccoli. The only effective control strategy is to plant tolerant varieties. Tolerant varieties to bacterial head rot have dome-shaped, tight heads with very small beads.

## Black Rot

Black rot caused by a bacterium, *Xanthomonas campestris*, and can cause serious losses. Symptoms of black rot include large, V-shaped chlorotic lesions that develop on the margins of leaves and its development is favored by warm, wet weather. The pathogen can be seed borne, thus purchase certified seed or use hot water seed treatment.

For black rot control, rotate at least 2 years between plantings. Fixed copper sprays (1.0 lb active ingredient/A) will reduce spread of black rot if treatments are started as soon as the disease is present. Some coppers are OMRI-approved and may help suppress these diseases in organic production systems. Copper applied at high rates may cause phytotoxicity for some cabbage cultivars in the form of flecking on the wrapper leaves.

## Blackleg

Blackleg (Phoma Stem Canker) is caused by the fungus, *Phoma lingan*, and can survive in the soil for up to 3 years and on related weed hosts. On seedlings, pale gray lesions develop near the soil line causing the seedling to die off. On infected stems, elongated light brown sunken lesions with purple margins develop. Spores are spread rapidly via rainfall and overhead irrigation. Blackleg can be seed borne, thus purchase certified seed or use hot water seed treatment. For blackleg control, rotate fields to allow 4 years between plantings and control related weeds.

*Blackleg continued*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following at the first sign of disease and continue every 7-10 days. Rotate between fungicides with different modes of action as long as conditions favor disease development.** | | | | | | |
| M1 | Copper (OMRI)[1] | See labeled rates | copper | 0 | 48 | N |
| 3 | tebuconazole | 3.0 to 4.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3 + 9 | Inspire Super 2.82SC | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodinil | 7 | 12 | -- |
| 3 + 11 | Quadris Top 2.72SC | 12.0 to 14.0 fl oz/A | difenoconazole + azoxystrobin | 1 | 12 | -- |
| 7 + 11 | Priaxor 4.17SC | 6.0 to 8.2 fl oz/A | fluxapyroxad + pyraclostrobin | 3 | 12 | N |
| 11 | Cabrio 20EG[2] | 12.0 to 16.0 oz/A | pyraclostrobin | 0/3[2] | 12 | N |

[1]Some coppers are OMRI-approved and may help suppress some fungal diseases in organic production systems. Copper applied at high rates may cause phytotoxicity for some cabbage cultivars in the form of flecking on the wrapper leaves.[2]For Cabrio, PHI=0 d for broccoli, Brussels sprouts, cabbage, tight-heading varieties of Chinese cabbage, cauliflower and kohlrabi; PHI=3 d for Collards and Kale.

**For blackleg control in <u>broccoli only</u>**: use iprodione 4L at 2.0 lb/A immediately after thinning as a directed spray to the base of the plant and adjacent soil surface. A second application may be made up to the day of harvest.

## Clubroot

Use of irrigation water containing clubroot spores is the principal way the disease is spread to other fields. If clubroot occurs, clean and disinfest all equipment. Adjust soil pH with hydrated lime to as close to 7.0 as possible. Improve the drainage in the field and grow the crop on raised beds.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Use Terraclor 75WP in one of the following ways. Do not use the Terraclor 2EC formulation.** | | | | | | |
| 14 | Terraclor 75WP | **Option 1:** Use 30.0 lb/A or 37.0 oz/1000 ft of row. Apply in a 12-15 inch band and incorporate 4-6 inches deep before planting<br>**Option 2:** Use 40.0 lb/A, broadcast and incorporate 4-6 inches deep before planting,<br>**Option 3:** Use 2.0 lb/100 gal of solution and 0.5 pt/plant as a transplant solution. | PNCB | AP | 12 | N |
| **In addition, Ranman 3.33SC can be used in the following ways, see label for additional instructions.** | | | | | | |
| 21 | Ranman 3.33SC | **Option 1:** 12.9 to 25.75 fl oz/A use as a transplant soil drench<br>**Option 2:** 20.0 fl oz/A use incorporated into the soil | cyazofamid | 0 | 0 | L |

## Downy Mildew

Downy mildew can cause serious losses if left uncontrolled. Symptoms include light green, chlorotic spots on the upper leaf surface. During periods of high humidity, grayish white spores may develop on the underside of leaves. High humidity, fog, drizzling rains, and heavy dew favor disease development. Optimum conditions for disease development are night temperatures of 46-61°F for 4 or more successive nights, and day temperature ~75°F or lower. Control related weeds and avoid overhead irrigation. Initiate fungicide applications prior to the onset of disease symptoms and continue as long as weather conditions favor disease development. Rotate and/or tank mix chlorothalonil 6F with one of the following fungicides. Rotate between fungicides with different modes of action.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| M5 | chlorothalonil 6F (not labeled for Collards, Kale, and Kohlrabi) | 1.5 pt/A | chorothalonil | 7 | 12 | N |
| 11 | azoxystrobin 2.08F | 6.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 12.0 to 16.0 oz/A | pyraclostrobin | 0/3[2] | 12 | N |
| 21 | Ranman 3.33SC | 2.75 fl oz/A | cyazofamid | 0 | 0 | L |
| 33 | Phosphite | 1.0 to 3.0 qt/A | phosphite | 0 | 4 | N |
| 33 | Aliette 80WDG | 3.0 to 5.0 lb/A (every 14 d) | fosetyl-Al | | | N |
| 40 | Revus 2.08SC | 8.0 fl oz/A | mandipropamid | 1 | 4 | -- |
| 40 + 45 | Zampro 4.38SC | 14.0 fl oz/A | dimethomorph + ametoctradin | 0 | 12 | -- |
| 43 | Presidio 4SC | 3.0 to 4.0 fl oz/A | fluopicolide | 2 | 12 | L |
| **Actigard is a plant defense activator. Begin applications 7-10 d after thinning and reapply every 7 d for a total of 4 applications per season.** | | | | | | |
| P1 | Actigard 50WG | 1.0 oz/A | acibenzolar-S-methyl | 7 | 12 | N |

## Leaf Spots (Caused by *Alternaria* and *Pseudocercosporella*)

Leaf spots can cause serious losses if left uncontrolled. Leaf spots caused by *Alternaria* and *Pseudocercosporella* are favored by long extended periods of cool, wet weather and favored by rain, heavy dews, and overhead irrigation. Symptoms of *Alternaria* spp. include yellow, dark-brown to black circular leaf spots with target like, concentric rings. *Pseudocercospora capsallae*, also known as White leaf spot, causes tannish-white, irregular or roundish spots develop on infected leaves, especially near leaf tips and edges, spots later become ash-gray to white with a brownish margin and sometimes have a yellowish halo. Initiate fungicide applications prior to the onset of disease symptoms and continue as long as weather conditions favor disease development. Rotate and/or tank mix chlorothalonil 6F at 1.5 pt/A with one of the following fungicides.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Tank mix one of the following with chlorothalonil at the first sign of disease and continue every 7-10 days. Rotate between fungicides with different modes of action as long as conditions favor disease development.** | | | | | | |
| M1 | Copper (OMRI)[1] | See labeled rates | copper | 0 | 48 | n |
| 3 + 9 | Inspire Super 2.82SC | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodinil | 7 | 12 | -- |
| 3 + 11 | Quadris Top 2.72SC | 12.0 to 14.0 fl oz/A | difenoconazole + azoxystrobin | 1 | 12 | -- |
| 4 + M5 | Ridomil Gold Bravo 76.5WP | 1.5 lb/A (14-day schedule) | mefenoxam + chlorothalonil - **not labeled for Collards, Kale and Kohlrabi** | 7 | 48 | N |
| 7 | Endura 70WG[2] | 6.0 to 9.0 oz/A | boscalid | 0/14[1] | 12 | -- |
| 7 | Fontelis 1.67SC | 14.0 to 30.0 fl oz/A | penthiopyrad | 0 | 12 | L |
| 7 + 11 | Priaxor 4.17SC | 6.0 to 8.2 fl oz/A | fluxapyroxad | 3 | 12 | N |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 7 | 12 | N |
| 11 | azoxystrobin 2.08F | 6.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG[3] | 12.0 to 16.0 oz/A | pyraclostrobin | 0/3[2] | 12 | N |

[1]There are a number of copper based products with OMRI labels. See labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems. [2]See Endura label for specific recommendations. [3]For Cabrio, PHI=0 d for broccoli, Brussels sprouts, cabbage, tight-heading varieties of Chinese cabbage, cauliflower and kohlrabi; PHI=3 d for Collards and Kale.

## White Mold

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| Apply Contans 5.3WG 3-4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate 1-2 inches deep but do not plow before seeding cole crops to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer. See label for specifics. | | | | | | |
| Bio. | Contans 5.3WG (OMRI) | 2.0 to 4.0 lb/A | *Coniothyrium minitans* | -- | -- | NA |
| **Alternatively, during seasons when soils remain wet for an extended period of time apply one of the following preventatively:** | | | | | | |
| 7 | Endura 70WG | 6.0 to 9.0 oz/A | boscalid | 0/14[1] | 12 | -- |
| 7 | Fontelis 1.67SC | 16.0 to 30.0 fl oz/A | penthiopyrad | 0 | 12 | L |

[1]See Endura label for specific recommendations.

## Yellows (*Fusarium*) 

Use resistant varieties when possible and practice long crop rotations.

# Cucumbers

For earlier cucumber production and higher, more concentrated yields, use gynoecious varieties. A gynoecious plant produces a high percentage of female flowers and fruit. To produce pollen, 1 to 15% of pollinator must be planted and seed companies add this seed to the gynoecious variety. Both pickling and slicing gynoecious varieties are available. Parthenocarpic cucumbers that produce fruit without pollination are also available for protected culture and field production.

## Recommended Varieties[1]

| | Variety | Days | F1[2] | Type[3] | Use[4] | Reported Disease Resistance[5] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Scab (Ccu) | PM (Px) | AN (Co) | DM[5] (Pcu) | ALS (Psl) | Cmv | Wmv | Zmv | Prsv |
| **Standard Slicing Varieties** | Bristol | 54 | Yes | Gyn | F | X | X | X | | X | X | X | X | X |
| | Dasher II | 58 | Yes | Gyn | F | X | X | X | | X | X | | | |
| | Dominator | 55 | Yes | Gyn | F | X | X | X | | X | X | | | |
| | General Lee | 66 | Yes | Gyn | F | X | X | | | | X | | | |
| | Indy | 59 | Yes | Gyn | F | X | X | X | | X | X | X | X | X |
| | Intimidator | 53 | Yes | Gyn | F | X | X | X | | X | X | | | |
| | Mongoose | 55 | Yes | Gyn | F | X | X | X | | X | X | X | X | X |
| | Python | 55 | Yes | Gyn | F | X | X | X | | X | X | | | |
| | Speedway | 56 | Yes | Gyn | F | X | X | X | | X | X | | | |
| | Stonewall | 53 | Yes | Gyn | F | X | X | X | | X | X | | | |
| | SV3462CS | 56 | Yes | Gyn | F | X | X | X | X | X | | | X | |
| | SV4719CS | 56 | Yes | Gyn | F | X | X | X | X | X | | | X | |
| | Talladega | 61 | Yes | Gyn | F | X | X | X | | X | X | X | | |
| | Thunder | 58 | Yes | Gyn | F | X | X | X | | X | X | | X | |
| **Slicers Long Types** | Suyo Long | 61 | No | Mon | F | | X | | | | | | | |
| | Tasty Green | 52 | Yes | Mon | F | | X | | | | | | | |
| **Pickels** | Bowie | 51 | Yes | Parth | MP | X | X | | | | | | | |
| | Calypso | 51 | Yes | Gyn | HF | X | X | X | | X | X | | | |
| | Citadel | 52 | Yes | Gyn | HMP | X | X | X | X | X | X | | | |
| | Eureka | 57 | Yes | Mon | HF | X | X | X | | X | X | X | | X |
| | Expedition | 50 | Yes | Gyn | MP | X | X | X | | X | X | | | |
| | Fanci Pak | 53 | Yes | Gyn | HF | X | X | X | | X | X | | | |
| | Feisty | 57 | Yes | Gyn | MP | X | X | X | | X | X | | | |
| | Jackson Supr. | 52 | Yes | Gyn | HMFP | X | X | X | | X | X | | | |
| | Lafayette | 52 | Yes | Gyn | MP | X | X | X | | X | X | | | |
| | Logan | 51 | Yes | Gyn | MP | X | X | X | | X | X | | | |
| | Max Pack | 57 | Yes | Mon | FH | X | X | X | | X | X | X | X | X |
| | NQ5007 | 50 | Yes | Parth | MP | X | X | X | | X | X | | | |
| | NQ5543 | 49 | Yes | Parth | MP | X | X | X | | X | X | | | |
| | Peacemaker | 52 | Yes | Gyn | MHP | X | X | X | X | X | X | | | |
| | Puccini | 50 | Yes | Parth | HMFP | X | X | X | | X | X | | | |
| | SV7140CN | 50 | Yes | Gyn | MP | X | X | X | | X | X | | | |
| | Vlaspik | 51 | Yes | Gyn | MP | X | X | X | | X | X | | | |
| **Protected Culture / High Tunnels** | Corinto | 48 | Yes | Parth | F | X | | | | | X | | | |
| | Cucapa | 48 | Yes | Parth | F | | X | | | | X | | | |
| | Lisboa | 60 | Yes | Parth | F | X | | | | | | | | |
| | Picolino | 45 | Yes | Parth | F | | X | | | | X | | | |
| | Rocky | 46 | Yes | Parth | F | X | X | | | | | | | |
| | Socrates | 52 | Yes | Parth | F | X | X | | | | | | | |

[1]Varieties are listed alphabetically. [2]Hybrid. [3]Gyn=Gynoecious or mostly female flowers; 5-15% of a monoecious pollinizer variety added; Mon=Monoecious type with female and male flowers; Parth=Parthenocarpic type that sets fruit without pollination. [4]F=Fresh Market, P=Processing (pickling), H=Hand harvest multiple times, M=Machine harvest once. [5]X=high or intermediate level of resistance to Scab, PM=Powdery Mildew, AN=Anthracnose, DM=Downy Mildew, ALS=Angular Leaf Spot, Cmv=Cucumber mosaic virus, Wmv=Watermelon Mosaic Virus, Zmv=Zucchini yellows mosaic virus, Prsv=Papaya ring spot virus. [5]Only varieties with some resistance to the current strain of downy mildew are noted with an X.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Cucumbers[1] | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 80-150 | 150 | 100 | 50 | 0[2] | 200 | 150 | 100 | 0[2] | Total nutrient recommended |
| | 25-50 | 125 | 75 | 25 | 0[2] | 175 | 125 | 75 | 0[2] | Broadcast and disk-in |
| | 25 | 25 | 25 | 25 | 0 | 25 | 25 | 25 | 0 | Band place with planter |
| | 25-75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress when vines begin to run |

[1]For plasticulture, fertilization rates are based on a standard row spacing of 6 ft.
[2]In VA, crop replacement values of 25 lb/A of $P_2O_5$ and 50 lb/A of $K_2O$ are recommended on soils testing Very High.

## Fertigation Schedule Examples

This table provides examples of fertigation schedules based on two common scenarios - sandy coastal plain soils and heavier upland soils. It should be modified according to specific soil tests and base fertility.

| **Fertigation recommendations for 125 lb N and 125 lb $K_2O$[1,2]** For soils with organic matter content less than 2% or coarse texture and low to medium or deficient K | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Nitrogen** | | | **Potash** | | |
| **Preplant (lb/A)[3]** | | | **25** | | | **50** | | |
| | | | **N** | **N** | **N** | **$K_2O$** | **$K_2O$** | **$K_2O$** |
| **Stage and Description** | Weeks | Days | lb/day | lb/week | lb/stage | lb/day | lb/week | lb/stage |
| **1 Early vegetative** | 1 | 1-7 | 0.5 | 3.5 | 3.5 | 0.4 | 2.8 | 2.8 |
| **2 Late vegetative** | 2-3 | 8-14 | 0.9 | 6.3 | 12.6 | 0.7 | 4.9 | 9.8 |
| **3 Fruiting and harvest** | 4-7 | 15-42 | 1.4 | 9.8 | 39.2 | 0.9 | 6.3 | 25.2 |
| **4 Later harvest[4]** | 8-10 | 43-70 | 0.9 | 6.3 | 18.9 | 0.6 | 4.2 | 12.6 |
| **Fertigation recommendations for 75 lb N and 50 lb K20[1,2]** For soils with organic matter content greater than 2% or fine texture and high or optimum K | | | | | | | | |
| | | | **Nitrogen** | | | **Potash** | | |
| **Preplant (lb/A)[3]** | | | **50** | | | **50** | | |
| | | | **N** | **N** | **N** | **$K_2O$** | **$K_2O$** | **$K_2O$** |
| **Stage and Description** | Weeks | Days | lb/day | lb/week | lb/stage | lb/day | lb/week | lb/stage |
| **1 Early vegetative** | 1 | 1-7 | 1 | 7 | 7 | 1 | 7 | 7 |
| **2 Late vegetative** | 2-3 | 8-14 | 1.5 | 10.5 | 21 | 1.6 | 11.2 | 22.4 |
| **3 Fruiting and harvest** | 4-7 | 15-42 | 2.2 | 15.4 | 61.6 | 2.2 | 15.4 | 61.6 |
| **4 Later harvest[4]** | 8-10 | 43-70 | 1.7 | 11.9 | 35.7 | 1.6 | 11.2 | 33.6 |

**[1]**Rates are based on 7,260 linear bed ft/A (6 ft bed spacing). If beds are closer or wider, fertilizer rates should be adjusted proportionally. Drive rows should not be used in acreage calculations (see the Fertigation section in the Irrigation Management chapter). **[2]**Base overall application rate on soil test recommendations. **[3]**Applied under plastic mulch to effective bed area using modified broadcast method. **[4]**For extended harvest after 10 weeks continue fertigation at this rate.

## Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season, to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities.

Critical cucumber tissue test values for most recently matured leaves up to first bloom: N 3.5-6 %, P 0.3-0.6 %, K 1.6-3.0 %, Ca 2-4 %, Mg 0.5-0.7% and S 0.3-0.8%. For additional nutrients and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *http://edis.ifas.ufl.edu/ep081*

**Seed Treatment** Seed should be treated; check with your seed company and see Disease Control below.

## Planting Dates
Start seeding for transplanting in mid-April in warmer, southern areas and May 10 in PA and other cool areas. Successive plantings can be made through early August. Container-grown plug plants are planted through the plastic when daily mean temperatures have reached 60°F (16°C). Planting dates vary from April 20 in southern regions to June 20 in northern areas. Early plantings should be protected from winds with hot caps, tents, row covers or rye windbreaks.

## Spacing
**Slicers**: Space rows 3-4 ft apart with plants 9-12 inches apart. Seeding rate: 1.5 lb/A.
**Machine Harvest Pickles**: Research and field data have shown that 55,000-65,000 plants/A is the optimum population for yield and quality. To accommodate a harvester with an 84-inch head, 3 rows 26-28 inches apart should be planted on each bed with plants 4-5 inches apart in the row. If the harvester has a 90-inch head, space rows 30 inches apart and space plants 3-4 inches apart in the row. For machine harvest of pickles, high plant populations concentrate pickle maturity. Parthenocarpic pickles are being trialed in the region. These are planted to achieve 22,000 to 28,000 plants/A.
**Hand Harvest Pickles**: Space rows 3-4 ft apart with plants 6-8 inches apart. Seeding rate: 1.5-2 lb/A.

## Mulching and Fumigation
Plastic mulch laid on moist soil before field planting conserves moisture, and increases soil temperature and early and total yield. Various widths of plastic are available; choose one that works with your production system and equipment. Fumigation will be necessary when there is a history of soil-borne diseases in the field; several fumigants can be used on cucumber depending on what the predominant pests are (see the Soil Fumigation section in the Pest Management chapter). Fumigation also aids in the control of weeds. Fumigant and mulch should be applied to well-prepared planting beds; check the fumigant label for the plant-back period that must be adhered to for crop safety. Plastic should be laid immediately over the fumigated soil. Fumigation alone may not provide satisfactory weed control under plastic. Black plastic can be used without a herbicide to provide control of most weeds.

Fertilizer must be applied during bed preparation. At least 50% of the N should be in the nitrate ($NO_3^-$) form. Drip (trickle) irrigation is recommended for plastic mulch systems and tape is laid at the same time as mulch. Foil and highly reflective mulches can be used to repel aphids that transmit viruses in fall-planted (after July 1) cucurbits. Direct seeding through the mulch is recommended for maximum virus protection; transplants should not be used with foil mulches. Also, an herbicide is not necessary.

Cucumbers also have been successfully grown in no-till systems on cover crop mulch.

## Irrigation
Cucumbers require irrigation for best yield and quality. During flowering and fruiting water use can be over 0.25 inches/day and water deficit during this period will have the greatest negative impact on yield and fruit quality. A balance must be struck, however, between maintaining adequate moisture for fruiting while minimizing wetness in the canopy and on the soil surface which promotes fruit rots and downy mildew.

## Trellising
Fresh market slicer cucumbers and pickles may be produced on trellises which may result in 2-3 times greater average yield than in non-trellised fields. Trellising is the preferred system in high tunnels. Trellising incurs a higher cost than growing cucumbers on the ground, but it has the following benefits:
1. Improved fruit quality, particularly with respect to color and shape (no yellow “ground spot”).
2. More effective control of many diseases and insects.
3. Less damage to vines resulting in a longer harvest season.
4. More consistent and thorough harvesting resulting in fewer jumbos and culls.
5. Easier harvesting than ground grown cucumbers.

Erect the trellis so that it is 6 ft high with a top (No. 8) and bottom (No. 12) wire and plastic twine or netting tied between the two wires at each plant. Posts or poles should be no more than 15 ft apart and the top wire should be very taut. An additional brace between posts may be required when the fruit load becomes heavy. In high tunnels, wires are stretched at the height desired and plastic twine is used to train plants. Training the main stem is required until it reaches and extends over the top wire. Pruning lateral runners near the base of the plant will result in higher yields. The first 4-6 lateral runners that appear should be removed. Other runners above this point should be allowed to run. Single stem systems are often used in high tunnels.

## Pollination

Honeybees, squash bees, bumblebees and other wild bees are important for proper cucumber pollination and fruit set. In high tunnels bumblebees are particularly effective. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See the section on Pollination in the General Production Recommendations chapter. Bee Toxicity ratings are available in the insecticide tables below.

## Parthenocarpic Cucumbers

Parthenocarpic cucumbers do not require pollination to set fruit. They will be nearly seedless or have unformed seeds. They should be isolated from seeded cucumber types to increase productivity and maintain the seedless nature. Parthenocarpic types should be considered when bee activity is limited such as in high tunnels, under row covers, or in very early plantings.

## Season Extension

**Low Tunnel Cucumber Production** Cucumbers for early production may be successfully grown in high tunnels, in low tunnels with perforated clear plastic row covers, or using floating row covers. Use plastic mulch and trickle irrigation as discussed above. The following field system - similar to that used for early sweet corn - is also successful: A modified bedshaper is used to form a ridge on each side of the plant row, leaving a suitable area for planting. A 36-inch wide piece of embossed clear plastic is then used to cover the plant row, leaving a 5-6 inch high space between the planted row and the plastic cover. It is estimated that temperatures may be increased 10-20°F depending on time of planting and sunlight availability and intensity.

**High Tunnel Cucumber Production** Cucumbers are a potentially profitable crop for spring and fall production within a high tunnel. Cucumbers mature in approximately half the length of time required for tomato ripening. Cucumbers are also amenable to vertical trellising which increases production and quality. High tunnel cucumber varieties are often parthenocarpic (requiring no pollenizers) although gynoecious varieties can also be used (with pollenizers). Cucumbers can be established by direct seeding or transplanting. Space plants 12-18 inches apart in-row on 42-48 inch bed centers. High tunnel varieties can remain unpruned, though pruning can reduce pest infestation and improve marketable yield. If pruning is done, the lower laterals (suckers) should be pruned on the bottom 2 ft leaving 1 or 2 stems per plant to trellis. More information on relative planting and harvesting dates is available under "High Tunnels" in the General Production Recommendations chapter.

**Greenhouse Production** Varieties are usually parthenocarpic varieties bred specifically for the lower light conditions of fall, winter, and early spring. European "English" or "Dutch" types and Asian types are available. Hydroponic nutrient solution systems are commonly used and cucumbers are trellised with single or double stems trained onto twine; see also Greenhouse Production in the General Production Recommendations chapter.

## Harvest and Storage

Cucumbers should be harvested when they have reached full size for the variety but while seeds are still soft. For slicers and manually harvested pickles, multiple harvests at 2-3 day intervals will be necessary. Machine-harvested pickles are harvested once when less than 5% have become oversized, as this produces the highest bushel yields. Size requirements of processors will also dictate schedules for machine and hand harvesting pickles.

Cucumbers can be held for 10-14 days at 50-55°F (10-13°C) with a relative humidity of 90-95%. At 50°F and above, cucumbers ripen rapidly, with the green color changing to yellow, starting after about 10 days. The color change is accelerated if cucumbers are stored in the same room as apples, tomatoes, or other ethylene-producing crops. Cucumbers for fresh market are usually waxed to reduce moisture loss. Cucumbers are subject to chilling injury if held below 50°F for longer than about 2 days.

# Weed Control

**THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.**

**Recommended Herbicides**

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.
**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

## Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by blocking light from germinated seeds. Herbicides control weeds under the mulch and around the planting hole. Irrigation tubing on the soil surface may cause weed problems by leaching herbicide away at the emitters, especially when clear plastic is used. Bury tubing several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds. **Do not** apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. Apply herbicide(s) in a band as wide as the mulch after the bed is formed, as a part of the same operation.
2. Lay the plastic mulch and trickle irrigation tubing. Irrigate to activate the herbicide if necessary. **Condensation that forms on the underside of the mulch will activate the herbicide**. Delay punching the planting holes until seeding or transplanting.

## Weed Control For Soil Strips Between Rows Of Plastic Mulch

Follow the instructions below or crop injury and/or poor weed control may result.

1. Spray preemergence herbicide(s) in bands onto the soil and the shoulders of the plastic mulch before planting and weed germination. **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **Do not broadcast spray over the plastic mulch unless specifically stated on the label!**
2. Incorporate preemergence herbicide into the soil with 0.5 to 0.75 inch of rainfall or overhead irrigation within 48 hr of application.

## Weed Control For Seeding Into Soil Without Plastic Mulch

Use the following instructions or crop injury and/or poor weed control may result:

1. Complete soil tillage, apply preplant herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 mph.
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

**Labeled Applications Sites for Cucumbers**

| | | Plastic mulch production | | | | | | Bare-ground production | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil-Applied | | Postemergence | | | | | | |
| **Herbicides** | WSSA group number | Under Plastic | Row Middles | Over Plastic | Row Middles | Post-Harvest | | Soil-applied | POST | Post-harvest |
| Sandea | 2 | YES | YES | YES | YES | | | YES | YES | |
| Treflan | 3 | | YES | | | | | | | |
| Curbit | 3 | | YES | | | | | YES | | |
| Prefar | 8 | YES | YES | | | | | YES | | |
| Command | 13 | | YES | | | | | YES | | |
| Strategy | 3+13 | | YES | | | | | YES | | |
| Select | 1 | | | YES | YES | | | | YES | |
| SelectMax | 1 | | | YES | YES | | | | YES | |
| Poast | 1 | | | YES | YES | | | | YES | |
| Gramoxone | 22 | | | | YES | YES | | | | YES |

## 1. Soil-Applied

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **2** | Sandea 75DF | 0.5 to 1 oz/A | **halosulfuron** | 0.023 to 0.047 lb/A | 14 | 12 |
| -**Plasticulture**: can be applied in a band under the plastic, immediately before laying the mulch; delay seeding or transplanting for 7 days after application. Row row middles: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v or include a non-selective herbicide.<br>-**Bareground**: apply broadcast after seeding but before crop emergence or no sooner than 7 days before transplanting.<br>-Suppresses or controls yellow nutsedge and certain broadleaf weeds.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field. **Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season. | | | | | | |
| 3 | Curbit 3EC | 1 to 3 pt/A | **ethalfluralin** | 0.38 to 1.13 lb/A | -- | 24 |
| -**Plasticulture** row middles only: apply as a banded spray after crop emergence or transplanting. **Do not** soil incorporate.<br>-**Bareground**: apply broadcast after direct-seeding but prior to crop emergence; **do not** use on transplanted cucumbers.<br>-Controls annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp.<br>-Use lower rate for coarse-textured soils or soils with low organic matter.<br>-Where overhead irrigation is available, activate Curbit with 0.5 inch of irrigation within 2 days after application; if no irrigation or rainfall occurs within 5 days of application, activity of Curbit can be reduced.<br>-Available as a pre-mix herbicide Strategy. Strategy at 3 pt/A= Curbit at 26 fl oz (0.6 lb ai) and Command at 8 fl oz (0.188 lb ai)<br>-Maximum applications per season: not specified | | | | | | |
| 3 | Treflan 4EC | 1 to 2 pt/A | **trifluralin** | 0.5 to 1 lb/A | 30 | 12 |
| -**Plasticulture** row middles only: apply as a directed spray after emergence when plants have reached the 3 to 4 true leaf stage of growth.<br>-**Not labeled for bareground production**.<br>-Primarily controls annual grasses with a few broadleaf weeds. **Do not** use (or reduce the rate) when cold, wet soil conditions are expected, or crop injury may result. Maximum applications per season: not specified. | | | | | | |
| 3 + 13 | Strategy 2.1SC | 1.5 to 6 pt/A | **ethalfluralin *plus* clomazone** | 0.39 to 1.58 lb/A | 45 | 24 |
| -**Plasticulture**: row middles application. **Bareground**: apply broadcast just before planting or after planting but before crop emergence.<br>-Strategy is a prepackage mixture of Curbit 3EC and Command 3ME. Refer to individual products for comments.<br>-**Do not** apply prior to planting crop. **Do not** soil incorporate. Maximum applications per season: not specified. | | | | | | |
| 8 | Prefar 4E | 5 to 6 qt/A | **bensulide** | 5 to 6 lb/A | -- | 12 |
| -**Plasticulture**: under plastic: apply in a band under the plastic, immediately before laying the mulch. Plasticulture: row middles application is labeled.<br>-**Bareground**: apply preemergence or preplant incorporated. Preemergence applications should be followed by irrigation within 36 hrs (apply enough water to wet the soil at leat 2 to 4 inches deep). Preplant incorporated applications should be incorporated 1 to 2 inches deep (deeper than 2 inches will result in reduced weed control).<br>-Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters.<br>-Maximum applications per season: not specified. | | | | | | |
| 13 | Command 3ME | 4 to 8 fl oz/A | **clomazone** | 0.094 to 0.19 lb/A | 45 | 12 |
| -**Plasticulture**: row middles application only.<br>-**Bareground**: apply broadcast just before planting or after planting but before crop emergence.<br>-Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops.<br>-Controls annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Carpetweed, morningglory sp., pigweed sp., and yellow nutsedge will not be controlled. Higher rates will improve control (or expand number of species controlled) such as common cocklebur, common ragweed, or jimsonweed (refer to label for specific weeds and rates).<br>-**WARNING**: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application (refer to label for restrictions).<br>-Available as a pre-mix herbicide Strategy: Strategy at 3 pt/A= Command at 8 fl oz (0.188 lb ai) and Curbit at 26 fl oz (0.6 lb ai)<br>-Maximum number of Command applications per year: 1. | | | | | | |

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>12 to 16 fl oz/A | **clethodim** | 0.094 to 0.13 lb/A | 14 | 24 |
| | Poast 1.5EC | 1 to 1.5 pt/A | **sethoxydim** | 0.19 to 0.28 lb/A | 3 | 12 |

*2. Postemergence (Select, Poast) continued on next page*
*2. Postemergence (Select, Poast) continued on next page*

-Postemergence as broadcast spray with both plasticulture and bareground
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions. If repeat applications are necessary, allow 14 days between applications.
-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.
-Rainfastness is 1 hr. **Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 64 fl oz/A for the season.
-**Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 3 pt/A for the season.

| | | | | | | |
|---|---|---|---|---|---|---|
| **2** | Sandea 75DF | 0.5 to 1 oz/A | **halosulfuron** | 0.023 to 0.047 lb/A | 14 | 12 |

-**Plasticulture**: broadcast (over the top) or directed to row middles; broadcast for bareground.
-**Bareground**: apply Sandea after the crop has at least 3 to 5 true leaves but before first female flowers appear and no sooner than 14 days after transplanting. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v.
-Suppresses or controls yellow nutsedge and certain broadleaf; control of weeds taller than 3 inches may not be adequate. Sandea will not control common lambsquarters or eastern black nightshade if applied postemergence; for row middle application, tankmix with a non-selective herbicide to increase spectrum of control.
-Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.
-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field.
-**Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.
-Rainfastness is 4 hrs. Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season

| | | | | | | |
|---|---|---|---|---|---|---|
| 22 | Gramoxone 2SL | 1.95 pt/A | **paraquat*** | 0.49 lb/A | 14 | 24 |

-**A Supplemental Label has been approved for the use of Gramoxone 2SL for postemergence weed control in DE, MD, NJ, PA, and VA.** Row middles as a shielded application.Apply as a directed spray in a minimum of 20 gal spray mix/A to control emerged weeds between the rows after crop establishment. Include a nonionic surfactant at 0.25% v/v.
-Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings.
-Rainfastness is 30 minutes. A maximum of 3 applications per year are allowed.

### 3. Postharvest

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |

-**For postharvest desiccation of vegetable vines. A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 for postharvest desiccation of the crop in DE, NJ and VA.**
-Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.
-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.
-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed.

### 4. Other Labeled Herbicides
These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| **9** | Roundup (various) | **glyphosate** |
| **14** | Aim EC | **carfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

## Seed Treatments for Seedcorn Maggot

See also the Pest Management chapter, Insect Management section. Control may be achieved by using commercially applied seed treatments containing chlorpyrifos (Lorsban 50W) or thiamethoxam (Farmore DI-400). **Note**: The use of neonicotinoid insecticides (Group 4A) at planting may help reduce seedcorn maggot populations.

## Aphids **Note**: Aphids transmit multiple viruses.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV (melon aphid) | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 4A | Admire PRO | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Assail 30G | 2.5 to 4.0 oz/A | acetamidprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil/drip** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 9B | Fulfill 50WP | 2.75 oz/A | pymetrozine | 0 | 12 | L |
| 9C | Beleaf 50SG | 2.0 to 2.8 oz/A | flonicamid | 0 | 12 | L |
| 28 + 6 | Minecto Pro | 10 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cabbage Loopers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A | Baythroid XL | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Danitol 2.4EC | 10.67 to 16.0 fl oz/A | fenpropathrin* | 7 | 24 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, Lambda T CS | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant EC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 11A | Dipel (OMRI) | 0.5 to 2.0 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 2.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **soil/drip/foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 7.5 to 10 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cucumber Beetles

Cucumber beetles can transmit bacterial wilt; however, losses from this disease vary greatly between fields and varieties. Pickling cucumbers grown in high-density rows for once-over harvesting can compensate for at least 10% stand losses. On farms with a history of bacterial wilt and where susceptible varieties are used, insecticides should be used to control adult beetles before they feed extensively on the cotyledons and first true leaves. If foliar insecticides are used, begin spraying shortly after plant emergence and repeat applications weekly if new beetles continue to invade fields. Treatments may be required until vines begin to run (usually about 3 weeks after plant emergence). Seeds pretreated with a neonicotinoid seed treatment such as Farmore DI-400 should provide up to 14 days of control of cucumber beetle, otherwise, apply one of the following formulations:

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Sevin XLR Plus | 1.0 qt/A | carbaryl | 3 | 12 | H |
| 3A | Baythroid XL | 2.4 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Danitol 2.4EC | 10.67 to 16.0 fl oz/A | fenpropathrin* | 7 | 24 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone | 2.4 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zetacypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Admire PRO | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |

## Cutworms - See also the Pest Management chapter, Insect Management section.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 1.28 to 4.00 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |

## Leafminers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate 2L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |

*Leafminers continued on next page*

*Leafminers - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A + 28 | Voliam Xpress | 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 6.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant 1SC | 6.0 to 10.0 fl oz/A | spinetroram | 1 | 4 | H |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 17 | Trigard 75WSP | 2.66 oz/A | cyromazine | 0 | 12 | L |
| 28 | Coragen 1.67SC | 5.0 to 7.5 fl oz/A | chlorantraniprole - **soil/drip/foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Melonworms (MW), Pickleworms (PW)

**When using foliar materials, make 1 treatment prior to fruit set, and then treat weekly. Check the label for additional instructions when using soil or drip applications.Apply one of the following formulations:**

| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Sevin XLR Plus | 0.5 to 1.0 qt/A | carbaryl | 3 | 12 | M |
| 3A | Baythroid XL | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL (pickleworm) | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 2.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 2.0 to 3.5 fl oz/A MW<br>3.0 to 7.5 fl oz/A PW | chlorantraniliprole - **drip/foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Mites

Mite infestations generally begin around field margins and grassy areas. **Do not mow or maintain field margins and grassy areas after midsummer since this forces mites into the crop**. Local infestations can be spot-treated. Begin treatment when 10-15% of the crown leaves are infested early in the season, or when 50% of the terminal leaves are infested later in the season. **Note**: Continuous use of carbaryl or a pyrethroid may result in mite outbreaks.

**Apply one of the following formulations:**

| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 10B | Zeal Miticide | 2.0 to 3.0 oz/A | etoxazole | 7 | 12 | L |

*Mites continued on next page*

*Mites - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 20D | Acramite 50WS | 0.75 to 1.00 lb/A | bifenazate | 3 | 12 | M |
| 21A | Portal | 2.0 pt/A | fenpyroximate | 1 | 12 | L |
| 23 | Oberon 2SC | 7.0 to 8.5 fl oz/A | spiromesifen | 7 | 12 | M |
| 28 + 6 | Minecto Pro | 5.5-10 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Thrips

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil/drip** | 30 | 12 | H |
| 5 | Entrust SC (OMRI) | 6.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetroram | 1 | 4 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Pesticides

## Nematode Control

See also the Pest Management Chapter (Soil Fumigation and Nematodes sections), or apply one of the following:

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 1A | Vydate L | 0.5 to 1.0 gal/A Incorporate into top 2-4 inches of soil, ***OR*** 2.0 to 4.0 pt/A apply 2 w after planting and repeat 2-3 w later. | oxamyl* | 1 | 48 | H |
| 7 | Velum Prime | 6.5 to 6.84 fl oz/A | fluopyram | 0 | 12 | -- |
| -- | Nimitz 4EC | 3.5 to 5.0 pt/A Incorporate or drip-apply 7 d before planting | fluensulfone | n/a | 12 | N |

**Seed Treatment** Check if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 480DP (4.5 fl oz/100 lb seed) and an approved commercially available insecticide.

## Damping-Off caused by *Pythium*, *Phytophthora*, and *Rhizoctonia*

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **Apply one of the following at-planting (see label for application methods and restrictions):** | | | | | | |
| **Phytophthora and Pythium root rot** | | | | | | |
| **4** | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | 5 | 48 | N |
| **4** | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | 5 | 48 | N |
| **4** | MetaStar 2E | 4.0 to 8.0 pt/A | metalaxyl | AP | 48 | N |
| **Phytophthora, Pythium, and Rhizoctonia root rot** | | | | | | |
| **4** + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row. Avoid direct seed .contact, which may cause delayed emergence. | mefenoxam + azoxystrobin | AP | 0 | N |
| **Rhizoctonia root rot** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | AP | 4 | N |
| **Pythium root rot only** | | | | | | |
| 28 | Previcur Flex 6F | 1.2 pt/A in transplant water, drip irrigation, or direct spray at base of plant and soil | Propamocarb HCL | 2 | 12 | N |

## Bacterial and Fungal Diseases

### Angular Leaf Spot

At first sign of disease, apply the labeled rates of fixed copper plus mancozeb. Some coppers are OMRI-approved and can be used in organic production systems to help suppress Angular leaf spot and other fungal diseases. Repeat every 7 days. To minimize the spread of disease, avoid working in field while foliage is wet.

### Anthracnose

Resistant varieties should be used when possible (see table Recommended Varieties). Begin fungicide applications when vines begin to run, or earlier if symptoms are detected. Alternate chlorothalonil or mancozeb with other effective fungicides every 7 days. Fungicides with a high risk for resistance development such as FRAC code 11 fungicides that do not come in a mix with another fungicide active ingredient that is effective on anthracnose, should be tank-mixed with a protectant fungicide. Use at least the minimum labeled rate of each fungicide in the tank-mix. **Do not** apply FRAC code 11 fungicides more than 4 times total per season. **Do not** apply FRAC code 11 fungicides if resistance exists in the area; use fungicides with a different FRAC code instead.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Under LIGHT or MODERATE disease pressure ALTERNATE:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |
| **WITH a TANK MIX the following fungicide PLUS mancozeb 75DG 2.0 to 3.0 lb/A OR chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| 1 | thiophanate-methyl 70WP | 0.5 lb/A | thiophanate-methyl | 1 | 12 | N |
| **Under HIGH disease pressure, TANK-MIX one of the following fungicides WITH chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| 3 + 11 | Quadris Top 2.7F | 12.0 to 14.0 fl oz/A | difenoconazole + azoxystrobin | 0 | 12 | -- |
| 7 + 11 | Merivon 500SC | 5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 0 | 12 | N |
| 7 + 11 | Pristine 38WG | 18.5 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |
| 11 | azoxystrobin 2.08F | 11.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 12.0 to 16.0 fl oz/A | pyraclostrobin | 0 | 12 | N |
| **AND ROTATE with a TANK-MIX of the following fungicide PLUS mancozeb 75DG 2.0 to 3.0 lb/A OR chlorothalonil 6F 2.0 to 3.0 pt/A every 7 days** | | | | | | |
| 1 | thiophanate-methyl 70WP | 0.5 lb/A | thiophanate-methyl | 1 | 12 | N |

### Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See preceding “Cucumber Beetle” section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage all season; additional foliar insecticide applications may be necessary.

### Belly Rot (*Rhizoctonia*)

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply at the 1 to 3 leaf stage. Make a 2nd application 10-14 d later or just prior to vine tip–over (whichever occurs first):** | | | | | | |
| 11 | azoxystrobin 2.08F | 11.0 to 15.5 fl oz/A | azoxystrobin | 1 | 4 | N |

### Cottony Leak (*Pythium*) - See also Damping off

At planting, apply mefenoxam (Ridomil Gold 4SL, Ultra Flourish 2E) or metalaxyl (MetaStar 2E).

### Downy Mildew

The pathogen does not overwinter, but introduction to the region can occur early in the year. Newly developed cultivars with resistance or tolerance should be planted where available (see table Recommended Varieties). Even when using resistant cultivars, a good fungicide program is important. However, fungicide efficacy may vary, as strains of the pathogen may vary between seasons.

Scout fields beginning at plant emergence. Begin sprays when vines run or earlier if disease occurrence is predicted for the region (check the Cucurbit Downy Mildew Forecasting website at *http://cdm.ipmpipe.org*). Once the disease has become established in an area, new plantings should receive an application of Ranman, or Previcur Flex at the 1-3 leaf stage. **Preventative applications are much more effective than applications made after disease is detected. In addition, spray programs that include fungicides with several different modes of action**

**(FRAC codes) are more effective than programs with few modes of action.** For example, alternate Ranman (Code 21) *PLUS* Gavel (Codes M3 + 22), with Orondis Ultra (Codes U15 + 40) *PLUS* chlorothalonil (Code M5). Follow all fungicide label precautions in order to reduce the chance of resistance development.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **The following are the most effective products. Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced IF the label allows. ALWAYS tank mix these products with a protectant fungicide (listed below):** | | | | | | |
| U15+40 | Orondis Ultra | 5.5 to 8.0 fl oz/A | oxathiapiprolin + mandipropamid | 0 | 4 | -- |
| 21 | Ranman 400SC | 2.10 to 2.75 fl oz/A (**do not** apply with copper; see label) | cyazofamid | 0 | 12 | L |
| 28 | Previcur Flex 6F | 1.2 pt/A | propamocarb | 2 | 12 | N |
| 43 | Presidio 4SC | 4.0 fl oz/A (caution: pathogen is now less sensitive to Presidio) | fluopicolide | 2 | 12 | L |
| M5 + 22 | Zing! 4.9SC | 36.0 fl oz/A | chlorothalonil + zoxamide | 0 | 12 | N |
| M5 + 27 | Ariston 42SC | 3.0 pt/A | chlorothalonil +cymoxanil | 3 | 12 | -- |
| 11 + 27 | Tanos 50DF | 8.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 27 | Curzate 60DF | 3.2 oz/A | cymoxanil | 3 | 12 | N |
| 40 | Forum 4.17SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | acetoctradin + dimethomorph | 0 | 12 | -- |
| ***TANK-MIX WITH* protectant fungicides:** | | | | | | |
| M3 | mancozeb 75DG | 3.0 lb/A | mancozeb | 5 | 24 | N |
| M3 + 22 | Gavel 75DF | 1.5 to 2.0 lb/A | mancozeb + zoxamide | 5 | 48 | -- |
| M5 | chlorothalonil 6F | 1.5 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |

## Gummy Stem Blight

Gummy stem blight occurs primarily in the late summer. Fungicides with a high-risk for resistance development such as Pristine (FRAC code 11) should be tank-mixed with a protectant fungicide to reduce the chances for resistance development. Use at least the minimum labeled rate for each fungicide in the tank mix. **Do not** apply FRAC code 11 fungicides more than 4 times total per season. Apply fungicides from a different FRAC code if resistance to FRAC code 11 fungicides exists in the area. Begin sprays when vines begin to run.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| ***ALTERNATE* one of the following formulations:** | | | | | | |
| M3 | mancozeb 75DG | 2.0 to 3.0 lb/A | mancozeb | 5 | 24 | N |
| M5 | chlorothalonil 6F | 2.0 pt/A | chlorothalonil | 0 | 12 | L |
| **WITH A TANK-MIX containing either chlorothalonil or mancozeb PLUS one of the following fungicides:** | | | | | | |
| 3 | Proline 480SC | 5.7 fl oz/A | prothioconazole | 7 | 12 | L |
| 3 | tebuconazole 3.6 F | 8.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3 + 9 | Inspire Super 2.8F | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodinil | 0 | 12 | -- |
| 3 + 7 | Luna Experience 3.34SC | 10.0 to 17.0 fl oz/A | fluopyram + tebuconazole | 7 | 12 | -- |
| 7 | Fontelis 1.67SC | 12.0 to 16.0 fl oz/A | penthiopyrad | 1 | 12 | L |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 1 | 12 | N |
| 3 + **11** | Aprovia Top 1.62EC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflupyr | 0 | 12 | N |
| 3 + **11** | TopGuard EQ | 5.0 to 8.0 fl oz/A | azoxystrobin + flutriafol | 1 | 12 | -- |
| 7 + **11** | Merivon 500SC | 5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 7 + **11** | Pristine 38WG | 12.5 to 18.5 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |
| **11** | azoxystrobin 2.08F[1] | 11.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| **11** | Cabrio 20EG[1] | 12.0 to 16.0 oz/A | pyraclostrobin | 0 | 12 | N |

[1]azoxystrobin 2.08F and Cabrio 20EG are not recommended in MD, DE and VA due to resistance development.

## Phytophthora Crown and Fruit Rot

Different strategies should be used to minimize the occurrence of this disease. Rotate away from susceptible crops (such as cucurbits, peppers, lima and snap beans, eggplants, and tomatoes) for as long as possible, improve field drainage, and apply preplant fumigants. When conditions favor disease development apply fungicides following excellent resistance management practices. Fungicides provide suppression only.

*Phytophthora Crown and Fruit Rot continued on next page*

*Phytophthora Crown and Fruit Rot - continued*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following fungicides. Rotate fungicides with different FRAC codes and tank mix with a fixed copper (exception: do not tank mix Ranman 400SC with copper).** | | | | | | |
| U15 +40 | Orondis Ultra | 5.5 to 8.0 fl oz/A | oxathiapiprolin + mandipropamid | 0 | 4 | -- |
| 40 | Revus 2.08F | 8.0 fl oz/A | mandipropamid | 0 | 4 | -- |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | acetoctradin + dimethomorph | 0 | 12 | -- |
| 43 | Presidio 4SC[1] | 3.0 to 4.0 fl oz/A | fluopicolide | 2 | 12 | L |
| M3 + 22 | Gavel 75DF | 1.5 to 2.0 lb/A | mancozeb + zoxamide | 5 | 48 | -- |
| 11 + 27 | Tanos 50DF | 8.0 to 10.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 21 | Ranman 400SC | 2.75 fl oz/A (plus a non-ionic or organosilicon surfactant; see label for additional precautions) | cyazofamid | 0 | 12 | L |
| 40 | Forum 4.17SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |

[1]Presidio may also be applied through the drip irrigation (see supplemental label). Soil drench followed by drip application has given good results in some trials on crown rot caused by *Phytophthora capsici*.

## Powdery Mildew

Excellent resistance is available (see table Recommended Varieties). The fungus that causes cucurbit powdery mildew has developed resistance to high-risk fungicides. In the Eastern US, resistance to strobilurin (FRAC code 11), DMI (FRAC code 3), and SDHI (FRAC code 7) fungicides has been reported. Proper fungicide resistance management should be followed to help delay the development of resistance and minimize control failures.

Powdery mildew generally occurs from mid-July until the end of the season. Observe plants for the presence of powdery mildew. If one lesion is found on the underside of 45 old leaves/A, begin the following fungicide program:

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **TANK MIX one of these products with a protectant such as chlorothalonil 6F at 2.0 to 3.0 pt/A:** | | | | | | |
| U6 | Torino 0.85SC | 3.4 fl oz/A | cyflufenamid | 0 | 4 | -- |
| U8 | Vivando 2.5SC | 15.4 fl oz/A | metafenone | 0 | 12 | -- |
| 3 + 7 | Luna Experience 3.34SC | 10.0 to 17.0 fl oz/A | tebuconazole + fluopyram | 7 | 12 | -- |
| **AND ALTERNATE with a TANK MIX of one of the following and a protectant such as chlorothalonil 6F at 2.0 to 3.0 pt/A** | | | | | | |
| 3 | Proline 480SC | 5.7 fl oz/A | prothioconazole | 7 | 12 | -- |
| 3 | Procure 480SC | 4.0 to 8.0 fl oz/A | triflumizole | 0 | 12 | N |
| 3 | Rally 40WSP | 5.0 oz/A *PLUS* | myclobutanil | 0 | 24 | N |
| 3 | tebuconazole 3.6F | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3 + 9 | Inspire Super 2.8F | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodinil | 0 | 12 | -- |
| 3 + **11** | Aprovia Top 1.62EC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflupyr | 0 | 12 | N |
| 3 + **11** | TopGuard EQ | 5.0 to 8.0 fl oz/A | azoxystrobin + flutriafol | 1 | 12 | -- |
| 7 | Fontelis 1.67SC | 12.0 to 16.0 fl oz/A | penthiopyrad | 1 | 12 | L |
| 7 + **11** | Pristine 38WG | 12.5 to 18.5 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |

## Scab

Scab typically occurs during cool periods. Excellent resistance is available in some varieties and they should be used when possible.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following as true leaves form and repeat every 5-7 days:** | | | | | | |
| M3 | mancozeb 75DG | 2.0 to 3.0 lb/A | mancozeb | 5 | 24 | N |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |

## Viruses

The most prevalent virus in the mid-Atlantic region is WMV2, followed by PRSV, ZYMV and CMV. Use varieties with multiple virus resistance when possible (see table Recommended Varieties). Plant fields far away from existing cucurbit plantings to help reduce aphid transmission of viruses into new fields.

# Eggplant

## Recommended Varieties[1,2]

| | Variety | Days[3] | F1[4] | Color | Calyx Color | Shape | Type | TMV[5] |
|---|---|---|---|---|---|---|---|---|
| **Standard Market Type** | Clara | 65 | Yes | White | Green | Teardrop | | |
| | Epic | 64 | Yes | Purple/black | Green | Oval | | X |
| | Nadia | 70 | Yes | Black | Green | Oval Long | | X |
| | Night Shadow | 68-75 | Yes | Black | Green | Teardrop | | |
| | Santana | 80 | Yes | Black/Purple | Green | Elongated Oval | | |
| | White Lightning | 75 | Yes | White | Green | Teardrop | | |
| | White Star | 55 | Yes | White | Green | Teardrop | | |
| **Specialty Types** | Barbarella | 65 | Yes | Purple | Purple | Round | Sicilian | |
| | Calliope | 64 | Yes | Purple variegated | Green | Oval | Asian | |
| | Fairy Tale | 65 | Yes | Purple variegated | Green | Mini Slender | Japanese | |
| | Gretel | 55 | Yes | White | Green | Mini Slender | Japanese | |
| | Hansel | 55 | Yes | Purple | Green | Mini Slender | Japanese | |
| | Kermit | 60 | Yes | Green and White | Green | Mini Round | Thai | |
| | Machiaw | 65 | Yes | Violet | Green | Slender Long | Asian | |
| | Megal | 60 | Yes | Purple/Black | Green | Elongated Oval | Italian | X |
| | Millionaire | 55 | Yes | Black | Purple | Slender | Japanese | |
| | Nubia | 68 | Yes | Purple Variegated | Green | Oval Elongated | Italian | |
| | Orient Charm | 65 | Yes | Violet | Green | Slender Long | Asian | |
| | Orient Express | 58 | Yes | Purple | Purple | Slender Long | Asian | |
| | Palermo | 70 | Yes | Purple | Purple | Round | Sicilian | |
| | Purple Fingers | 65 | No | Purple | Green | Mini Slender | Italian | |
| | Purple Shine | 70 | Yes | Purple | Purple | Slender Long | Chinese | |
| | Sabelle | 65 | Yes | Purple | Purple | Oval/Round | Sicilian | |
| | Shoya Long | 55-60 | Yes | Purple | Purple | Slender Long | Japanese | |
| | Shooting Stars | 57 | No | Purple variegated | Green | Elongated Oval | | |

[1]Varieties are listed alphabetically. [2]Variety y attributes based on Seed Company information.
[3]Days from transplanting till harvest. [4]Hybrid (yes/no).
[5]TMV=Tobacco Mosaic Virus. Only those varieties with some resistance or tolerance to TMV are noted with an X.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| **Eggplant[1]** | | **Soil Phosphorus Level** | | | | **Soil Potassium Level** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Low** | **Med** | **High (Opt)** | **Very High** | **Low** | **Med** | **High (Opt)** | **Very High** | |
| | **N (lb/A)** | **$P_2O_5$ (lb/A)** | | | | **$K_2O$ (lb/A)** | | | | **Nutrient Timing and Method** |
| | 125-150[2] | 250 | 150 | 100 | 0 | 250 | 150 | 100 | 0 | Total nutrient recommended |
| | 50-100 | 250 | 150 | 100 | 0 | 250 | 150 | 100 | 0 | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 3-4 weeks after planting |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 6-8 weeks after planting |

[1]For plasticulture, fertilization rates are based on a standard row spacing of 6 ft. Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter.
[2]If crop is to be mulched with plastic but not drip/trickle fertilized, broadcast 225 lb/A N with recommended $P_2O_5$ and $K_2O$ and disk-in or incorporate prior to laying mulch.

## Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities.

*Plant Tissue Testing - continued*

| Critical Eggplant Tissue Test Values For Most Recently Matured Leaves | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Timing** | **Value** | **N** | **P** | **K** | **Ca** | **Mg** | **S** | **Fe** | **Mn** | **Zn** | **B** | **Cu** | **Mo** |
| | | **%** | **%** | **%** | **%** | **%** | **%** | **ppm** | **ppm** | **ppm** | **ppm** | **ppm** | **ppm** |
| **Early Fruit Set** | **Deficient** | <4.2 | 0.3 | 3.5 | 0.8 | 0.25 | 0.4 | <50 | 50 | 20 | 20 | 5 | 0.5 |
| | **Adequate range** | 4.2 | 0.3 | 3.5 | 0.8 | 0.25 | 0.4 | 50 | 50 | 20 | 20 | 5 | 0.5 |
| | | 6 | 0.6 | 5 | 1.5 | 0.6 | 0.6 | 100 | 100 | 40 | 40 | 10 | 0.8 |
| | **High** | >6.0 | 0.6 | 5 | 1.5 | 0.6 | 0.6 | >100 | 100 | 40 | 40 | 10 | 0.8 |
| | **Toxic (>)** | - | - | - | - | - | - | - | - | - | - | - | - |

**Seed Treatment** Use hot water seed treatment - see Seed Treatment in the Pest Management chapter.

## Transplant Production and Transplanting Dates

Sow seed in the greenhouse 8-10 weeks before field planting. Three to four ounces of seed are necessary to produce plants for 1 acre. Optimum temperatures for germination and growth are 70-75°F (21-24°C). Seedlings should be transplanted to 2-inch or larger pots any time after the first true leaves appear, or seed can be sown directly into the pots and thinned to a single plant per pot.

Harden plants for a few days at 60-65°F (16-18°C) and set in field after danger of frost when average daily temperatures have reached 65-70°F (18-21°C). Usual transplanting period is May 15 to June 5. Eggplant is a warm-season crop that grows best at temperatures between 70-85°F (21-29°C). Temperatures below 65°F (18°C) result in poor growth and fruit set.

**Spacing** Rows: 4-5 feet apart; plants: 2-3 feet apart in the row. Space plants 18-30 inches apart in PA.

## Drip/Trickle Fertilization

Before mulching, adjust soil pH to around 6.5 and then apply enough farm-grade fertilizer to supply 60 lb/A of N, $P_2O_5$ and $K_2O$. Thoroughly incorporate fertilizer into the soil. If soil tests medium or less in soil K, apply a fertilizer with a ratio of 1-1-2 or 1-1-3 carrying 60 lb/A of N. After mulching and installing the drip irrigation system, apply completely soluble fertilizers to supply 40 lb/A (10-20 lb/A in PA) of N, $P_2O_5$ and $K_2O$ during each application. On soils testing low and low to medium in B and that have not received any preplant B fertilizer, include 0.25 lb/A of actual B in each soluble fertilizer application. The first soluble fertilizer application should be applied through the trickle irrigation system within 1 week after field transplanting. The same rate of soluble fertilizer should be applied about every 3 weeks during the growing season for a total of 6-7 applications.

## Mulching and Fumigation

The use of black plastic mulch can increase eggplant yield and promote earliness. Various widths of plastic are available depending on production system and available equipment. At least 50% of the N should be in nitrate form ($NO_3^{-1}$) when planting in fumigated soil under plastic mulch. For more details, see the Weed Control section below.

## Staking

High intensity eggplant production can benefit from staking, but the heavy fruit load results in a high cost for staking materials. Use a staking system similar to that described for tomatoes. Pruning is not required for eggplant, but removing the two lowest branches helps with plastic removal at seasons end if the plants are mowed off.

## Harvest and Post Harvest Considerations

Fruit should be harvested when the skin is still a glossy color and the seed and pulp are white. Soft fruit and dark seed indicate over maturity. Mature fruit must be harvested to ensure continued fruit set. Harvested fruit should be moved to a protected area as soon as possible. If left in direct sunlight the fruit will sunburn. Cool eggplants in a cold room, forced-air or forced-air and evaporative cooling. Fruit are sensitive to temperatures below 50°F (10°C) (see fruit disorders below), but can be stored for 1-2 weeks at 50-54°F (10-12°C) and 90-95% relative humidity.

## Fruit Disorders

**Liver Spot and Pitting**: 'Liver spot' and 'pitting' are late season physiological disorders that become apparent on the fruit surface post-harvest. Light-tan to coppery colored spots and scratching may appear after washing; scratching is most likely caused by rough handling or contact of fruit with the ground. Pitting (small slightly sunken brown pits) may also occur. Liver spot and/or pitting are thought to be the caused by a thinner waxy fruit cuticle as a result of cooler temperatures. Temperatures at or below 50°F (10°C) are often associated with both disorders.

**Internal Seed Cavity Browning**: Symptoms of internal seed cavity browning include the discoloration or browning of the fruit tissue directly surrounding the seed cavity. The discoloration can be caused by low temperatures and/or bruising and compression injury during harvest and postharvest handling.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**Labeled Applications Sites for Eggplant**

| | | Plastic mulch production | | | | | | Bare-ground production | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil-Applied | | Postemergence | | | | | | |
| **Herbicides** | WSSA group number | Under Plastic | Row Middles | Over Plastic | Row Middles | Post-Harvest | | Soil-applied | POST | Post-harvest |
| Sandea | 2 | | YES | | YES | | | directed* | | |
| Dacthal | 3 | | | | | | | | YES** | |
| Prowl H20 | 3 | | YES | | | | | YES | | |
| Devrinol | 15 | YES | YES | | | | | YES | | |
| Poast | 1 | | | YES | | | | | YES | |
| Select | 1 | | | YES | | | | | YES | |
| SelectMax | 1 | | | YES | | | | | YES | |
| Gramoxone | 22 | | | | YES | YES | | | | YES |

*Sandea is labeled for bareground only if the spray is directed to the row middles.

**Dacthal is labeled for over the top application, but will it will not control emerged weeds.

**1. Soil-Applied**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **2** | Sandea 75DF | 0.5 to 1.0 oz/A | **halosufluron** | 0.023 to 0.047 lb/A | 30 | 12 |
| -**Plasticulture**: row middles only; adjust equipment to keep the spray off the plastic.<br>-**Bareground**: apply between rows of direct-seeded or transplants; **DO NOT** apply as broadcast application; avoid contact of the herbicide with the planted crop<br>-Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field. **Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season. | | | | | | |
| 3 | Dacthal 6F<br>Dacthal W-75 | 8.0 to 14.0 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6.0 to 10.5 lb/A | -- | 12 |
| -Labeled for applications over the top of transplants without injury (will not control emerged weeds); transplants should be well-established and growing conditions favorable for good plant growth. Label recommends 4 to 6 weeks after transplanting or direct-seeded plants at 4 to 6 inches in height. Post-transplant applications can only be made with bare-ground production.<br>-Dacthal will not control emerged weeds; apply to weed-free soils. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse -textured soils low in organic matter, and when the application are followed by rainfall or irrigation. Maximum application not addressed on label. | | | | | | |

*1. Soil-Applied continued on next page*

*1. Soil-Applied - continued.*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | Prowl H2O 3.8CS | 1.0 to 3.0 pt/A | **pendimethalin** | 0.48 to 1.42 lb/A | 70 | 24 |
| -**Plasticulture**: recommended for row middles only. Labeled for under plastic, but no local data or experience with this application.<br>-**Bareground**: broadcast preplant or preplant incorporated before transplanting; not labeled for direct-seeded crop.<br>-Avoid root contact with Prowl-treated soil when placing transplants into furrow or hole or injury may occur.<br>-Prowl labeled for directed application to transplanted or established direct-seeded eggplant; avoid contact with leaves or stems.<br>-Prowl will not control emerged weeds, only provides residual control; row middle applications may be made with Gramoxone using shielded sprayers. Use the lower rate on coarse-textured or sandy soils. Activate with ½ inch of rainfall or sprinkler irrigation within 48 hr of application to control most annual grasses and certain broadleaf weeds.<br>-Maximum Prowl H2O application per season: 3 pt/A. | | | | | | |
| 15 | Devrinol 2-XT | 2 to 4 qt/A | **napropamide** | 1.0-2.0 lb/A | -- | 24 |
| -**Plasticulture**: labeled for under plastic mulch; apply in a band under the plastic, immediately before laying mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Plasticulture: row middles application is labeled.<br>-**Bareground**: apply as broadcast, preemergence treatment for transplanted eggplant.<br>-Annual grasses and certain annual broadleaf weeds will be suppressed or controlled. May reduce stand and yield of fall planted small grain crop. Moldboard plowing will reduce the risk of injury. Maximum Devrinol 2-XT application per season: 4 qt/A. | | | | | | |

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9 to 16 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 1 | 24 |
| | Poast 1.5EC | 1 to 2.5 pt/A | **sethoxydim** | 0.2 to 0.5 lb/A | 1 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Safe for broadcast (over the top) applications with both plasticulture and bareground production.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Select will not consistently control goosegrass. Control may be reduced if grasses are large or if the weather is hot or dry. If repeat applications are necessary, allow 14 d between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. Rainfastness is 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 1.5 pt/A Poast 1.5EC in single application and **do not** exceed 4.5 pt/A for the season. | | | | | | |
| 3 | Dacthal 6F<br>Dacthal W-75 | 8.0 to 14.0 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6.0 to 10.5 lb/A | -- | 12 |
| -Labeled for applications over the top of transplants. Dacthal will not control emerged weeds; apply to weed-free soils.<br>-**See comments under soil applied section** | | | | | | |
| 22 | Gramoxone 2SL | 2.4 pt/A | **paraquat*** | 0.6 lb/A | -- | 24 |
| -Gramoxone can be applied before or after transplanting to control emerged broadleaf weeds and grass seedlings.<br>-Include a nonionic surfactant at 0.25% v/v. **Do not** allow spray to contact crop foliage as injury may result. Use flaps that drag along the edge of plastic mulch and use low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift.<br>-See the label for additional information and warnings. Rainfastness is 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |

## 3. Postharvest

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone 2SL | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 until December 31, 2017, for postharvest desiccation of the crop in DE, NJ and VA.** Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

## 4. Other Labeled Herbicides

These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| **9** | Roundup (various) | **glyphosate** |
| **14** | Aim | **carfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

### Aphids

Green peach aphids (GPA) are the most common aphids on eggplant. Winged females can produce numerous live pale, yellow or pink-colored young (nymphs). Tremendous numbers can build up on the undersides of leaves often following pyrethroid insecticide applications. Aphids are sucking insects. They excrete a sugary, sticky substance ("honeydew") that can cause growth of black sooty mold fungus. Both honeydew and mold on fruit can hurt its marketability. Predators and parasitoids (braconid wasps) often can keep aphid populations below damaging levels. Broad spectrum insecticides, like pyrethroids, destroy these natural enemies. Use selective insecticides whenever possible. Sample plants for aphids as well as the presence of natural enemy species. Spray only when aphid densities appear to be increasing in the absence of predators.

| **Apply one of the following formulations (note: spray coverage to the underside of the leaf is important):** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV (GPA only) | 0.75 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 7 | 48 | H |
| 1B | Malathion 57EC | 1.5 pt/A | malathion | 3 | 12 | H |
| 3A + 4A | Brigadier | 3.80 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Leverage 360 | 3.8 to 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 4A | Actara 25WDG | 2.0 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Admire Pro | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.3 to 2.2 fl oz/A | imidacloprid - **foliar** | 0 | 12 | H |
| 4A | Assail 30SG | 2.0 to 4.0 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | chlothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | chlothianidin - **foliar** | 1 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67oz/A | thiamethoxam - **foliar** | 30 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 fl oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 4C | Closer SC | 1.5 to 2.0 fl oz/A | sulfoxaflor | 1 | 12 | H |
| 4D | Sivanto 200SL | 21.0 to 28.0 fl oz/A | flupyradifurone - **soil** | 45 | 4 | L |
| 4D | Sivanto Prime | 7.0 to 14.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | L |
| 9B | Fullfill 50WDG | 2.75 oz/A | pymetrozine | 0 | 12 | L |
| 9C | Beleaf 50SG | 2.0 to 2.8 oz/A | flonicamid | 0 | 12 | L |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 1 | 24 | L |
| 28 + 6 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |
| n/a | Requiem EC (OMRI) | 2.0 to 3.0 qt/A | *Chenopodium* extract (biopesticide) | 0 | 4 | L |

### Colorado Potato Beetles (CPB)

CPB has the ability to rapidly develop resistance to insecticides (see also "Insect Resistance and Control" in the Pest Management chapter, Insect Management section). The use of the egg parasitoid, *Edovum puttleri*, has been shown to control CPB effectively in eggplant, or apply one of the following insecticides.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 7 | 48 | H |
| 3A + 4A | Brigadier | 5.10 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Leverage 360 | 3.8 to 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 0 | 12 | H |
| 3A + 4A | Swagger | 10.2 to 19.7 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 4A | Admire Pro | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.3 to 2.2 fl oz/A | imidacloprid - **foliar** | 0 | 12 | H |
| 4A | Assail 30SG | 1.5 to 2.5 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 2.0 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |

*Colorado Potato Beetle continued on next page*

*Colorado Potato Beetle - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 7.5 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 fl oz/A | thiamethoxam + chlorantraniliprole | 1 | 12 | H |
| 4D | Sivanto 200SL | 10.5 to 14.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | L |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Agri-Mek 0.7SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 11 | Trident[1] (OMRI) | 3 to 6 qt/A | *Bacillus thuringiensis tenebrionis*[1] | 0 | 0 | L |
| 15 | Rimon 0.83EC | 9.0 to 12.0 fl oz/A | novaluron | 1 | 12 | L |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chorantraniliprole- **drip, foliar** | 1 | 4 | L |
| 28 | Exirel | 7.0 to 13.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 | Verimark | 5.0 to 10.0 fl oz/A | cyantraniliprole - **soil** | 1 | 4 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

[1]Small Larvae only, NOT effective against medium larvae and adults. Larval reduction may not be noticeable for 48-72 h. Apply when eggs begin to hatch and repeat at 5-7-day intervals. If rainfall occurs within 24 h post-treatment, reapplication may be necessary.

## Eggplant Lacebugs

Eggplant lacebug is a sporadic pest. It is a small sucking insect with lacey wings and conspicuous veins. Damage consists of stippling and yellowing/whitening of the leaves. Good insecticide coverage is essential.

**Apply the following formulation:** (**Note**: Infestations are reduced by the use of dinotefuran, emamectin benzoate, oxamyl, permethrin and lambda-cyhalothrin+chorantraniliprole).

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Malathion 57EC | 2.5 pt/A | malathion | 3 | 12 | H |

## Flea Beetles

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Leverage 360 | 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 3A + 4A | Swagger | 7.6 to 19.6 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 5 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A | Baythroid XL | 2.8 fl oz/A | beta-cyfluthrin* | 7 | 12 | H |
| 3A | Bifenture EC | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 7 | 12 | H |
| 3A | Lambda-cy, LambdaT | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Permethrin 3.2, Perm-up 3.2 | 4.0 to 8.0 fl oz/A | permethrin* | 3 | 12 | H |
| 3A | Proaxis | 2.56 to 3.84 fl oz/A | gamma-cyhalothrin* | 5 | 24 | H |
| 3A | Tombstone, Tombstone Helios | 2.8 fl oz/A | cyfluthrin* | 7 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 5 | 24 | H |
| 4A | Admire Pro | 7.0 to 10.5 fl oz/A | imidacloprid- **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 2.0 to 3.0 oz/A | thiamethoxam- **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 7.5 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran **- foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 fl oz/A | thiamethoxam +chlorantraniliprole - **foliar** | 1 | 12 | H |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole - **soil** | 1 | 4 | H |

## Leafminers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 7 | 48 | H |
| 3A + 4A | Brigadier (adults only) | 5.1 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Swagger (adults only) | 10.2 to 19.7 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A | Perm-up 3.2, Permethrin 3.2 | 4.0 to 8.0 fl oz/A | permetrhin* | 3 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 7.5 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 5 | Entrust SC (OMRI) | 6.0 to 10.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Agri-Mek 0.7SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 6 | Proclaim 5SG | 3.2 to 4.8 oz/A | emamectin benzoate | 7 | 12 | H |
| 16B | Rimon 0.83EC | 12 fl oz/A | novaluron | 1 | 12 | L |
| 28 | Verimark | 6.75 to 10.0 fl oz/A | cyantraniliprole - **soil** | 1 | 4 | H |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Mites

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 6 | Agri-Mek 0.7SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 10B | Zeal miticide | 2.0 to 3.0 oz/A | etoxazole | 7 | 12 | L |
| 12B | Vendex 50WP | 2.0 to 3.0 lb/A | fenbutatin-oxide* | 3 | 48 | H |
| 21A | Portal/Portal XLO | 2.0 pt / A | fenpyroximate | 1 | 12 | L |
| 23 | Oberon 2SC | 7.0 to 8.5 fl oz/A | spiromesifen | 1 | 12 | M |
| 25 | Acramite 50WS | 0.75 to 1.00 lb/A | bifenazate | 3 | 12 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Thrips

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 5 | 24 | H |
| 3A + 4A | Leverage 360 (foliage feeding thrips only) | 3.8 to 4.1 fl oz/A | imidacloprid + beta-cyfluthrin | 7 | 12 | H |
| 3A + 4A | Swagger | 7.6 to 19.7 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| **3A**[1] | Baythroid XL[1] | 2.1 to 2.8 fl oz/A | beta-cyfluthrin* | 7 | 12 | H |
| **3A**[1] | Hero EC[1] | 10.3 fl oz/A | zeta-cypermethrin*+bifenthrin* | 3 | 12 | H |
| **3A**[1] | Lambda-Cy, LambdaT[1] | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| **3A**[1] | Tombstone, Tombstone Helios[1] | 2.1 to 2.8 fl oz/A | cyfluthrin* | 7 | 12 | H |
| **3A**[1] | Warrior II[1] | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 4A | Admire Pro (foliage feeding thrips only) | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 fl oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Venom 70SG | 5.0 to 7.5 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 6.0 to 10.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |

[1]Resistance concerns with Western flower thrips only.

# Disease Control

**THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.**
**Recommended Pesticides**

## Nematodes

See the Soil Fumigation and Nematodes sections in the Pest Management chapter.

## Seed Treatment

Use hot water seed treatment - see Seed Treatment in the Pest Management chapter (section Disease Management).

## Damping-Off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following at-planting (see label for application methods and restrictions):** | | | | | | |
| **Phytophthora and Pythium root rot**[1] | | | | | | |
| **4** | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | 5 | 48 | N |
| **4** | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | 5 | 48 | N |
| **4** | MetaStar 2E | 4.0 to 8.0 pt/A | metalaxyl | AP | 48 | N |
| **Phytophthora, Pythium, and Rhizoctonia root rot** | | | | | | |
| **4** + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence. | mefenoxam + azoxystrobin | AP | 0 | N |
| **Rhizoctonia root rot**[2] | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | AP | 4 | N |

[1]Also see Phytophthora blight - root and crown rot below.
[2] Rhizoctonia can become a problem in transplants that have been in transplant trays for too long prior to transplanting, or in transplants shortly after planting where the root zone is allowed to become excessively dry. To help suppress Rhizoctonia root rot apply the following via drip at transplanting.

## Phytophthora Blight (*Phytophthora capsici*) - Root and Crown Rot

To minimize the occurrence of Phytophthora blight rotate fields away from susceptible crops (such as cucurbits, peppers, eggplants, and tomatoes) for as many years as possible. Avoid using mefenoxam if insensitivity is known to exist. Sensitivity to mefenoxam can return if it has not been used in recent years.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations via drip application at transplanting and 30 days later:** | | | | | | |
| 4 | Ridomil Gold 4SL | 1.0 pt/A | mefenoxam | 7 | 12 | N |
| 4 | Ultra Flourish 2E | 1.0 qt/A | mefenoxam | 7 | 12 | N |
| U15 + 4 | Orondis Gold 1.67SC[1] | 1.0 pt/A | oxathiapiprolin + mefenoxam | 0 | 4 | -- |
| **If conditions favor disease development, apply the following drip application 14 d after at-transplanting applications:** | | | | | | |
| 43 | Presidio 4SC | 3.0 to 4.0 fl oz/A | fluopicolide | 2 | 12 | L |

[1]If Orondis Gold is applied via drip application it cannot be applied as a foliar spray. See label for restrictions.

## Phytophthora Blight (*Phytophthora capsici*) - Fruit and Stem Rot

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **For suppression of the aerial stem and fruit rot phase of Phytophthora blight, apply and rotate the following with a fixed copper at labeled rates on a 7 to 10 day schedule or when environmental conditions are conducive for disease development:** | | | | | | |
| 21 | Ranman 400SC | 2.75 fl oz/A *PLUS* a non-ionic surfactant (**do not** apply Ranman with copper) | cyazofamid | 0 | 12 | L |
| 40 | Forum 4.18SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |
| 43 | Presidio 4SC | 3.0 to 4.0 fl oz/A | fluopicolide | 1 | 12 | L |
| U15 + 4 | Orondis Gold 1.67SC[1] | 1.0 pt/A[1] | oxathiapiprolin + mefenoxam | 0 | 4 | -- |

[1]If Orondis Gold is applied via a foliar application it cannot be applied via drip system. See label for restrictions.

## Fungal Fruit Rots

Scout regularly and begin preventative sprays when weather conditions favor disease development and repeat every 7-10 days. **Do not** apply FRAC code 11 fungicides more than 4 times in a single year. Tank mix FRAC code 11 fungicides with a protectant fungicide such as fixed copper or chlorothalonil to help reduce resistance development.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Tank mix chlorothalonil 1.5 pt 6F/A or fixed copper at labeled rates with one of the following FRAC code 11 fungicides:** | | | | | | |
| 11 | azoxystrobin 2.08F | 6.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 + 3 | Quadris Top 2.72SC | 8.0 to 14.0 fl oz/A | azoxystrobin + difenoconazole | 0 | 12 | -- |
| 11 + 7 | Priaxor | 4.0 to 8.0 fl oz/A | pyraclostrobin + fluxapyroxad | 7 | 12 | N |
| **And rotate with one of the following:** | | | | | | |
| M1 | copper (OMRI)[1] | Use labeled rate | copper | 0 | 24 | N |
| M5 | chlorothalonil 6F | 1.5 pt/A | chlorothalonil | 3 | 12 | L |

[1]There are a number of copper based products with OMRI labels. See labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.

## Fungal Leaf Spots

Scout on a regular basis and begin preventative sprays when weather conditions favor disease development, or when symptoms of disease first appear, and repeat every 7-10 days. **Do not** apply FRAC code 11 fungicides more than 4 times in a single year. Tank mix FRAC code 11 fungicides with a protectant fungicide such as copper or chlorothalonil to help reduce resistance development.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Tank mix chlorothalonil 6F 1.5 pt/A or fixed copper at labeled rates with one of the following FRAC code 11 fungicides:** | | | | | | |
| 11 | azoxystrobin 2.08F | 6.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 8.0 to 12.0 oz/A (leaf spots only) | pyraclostrobin | 0 | 12 | N |
| 11 | Fontelis 1.67SC | 10.0 to 24.0 fl oz/A | penthiopyrad | 7 | 12 | L |
| 11 | Quadris Top 2.72SC | 8.0 to 14.0 fl oz/A | azoxystrobin + difenoconazole | 0 | 12 | -- |
| **And rotate with one of the following:** | | | | | | |
| M1 | copper (OMRI)[1] | Use labeled rate | copper | 0 | 24 | N |
| M5 | chlorothalonil 6F | 1.5 pt/A | chlorothalonil | 3 | 12 | L |

[1] There are a number of copper based products with OMRI labels. See labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.

## Verticillium Wilt

Best control can be accomplished by using a 4 to 5 year rotation with crops other than tomato, potato, pepper, strawberry, or any of the brambles. Varieties which appear to maintain yield in infested fields include Classic, and Epic. Soil fumigation will provide some control by delaying symptom expression. Use metam-sodium (Vapam HL - see label for specifics and restrictions). Broadcast treatments are superior to row treatments. Refer to the "Soil Fumigation" section in the Pest Management chapter for details on application.

## <u>Viruses</u>

## Tomato Spotted Wilt Virus

Tomato Spotted Wilt Virus is spread by thrips from flowering ornamental plants to eggplant. Do not grow any ornamental bedding plants in the same greenhouse as eggplant transplants. Monitor and scout greenhouses for thrips and begin an insecticide control program once observed.

# Garlic

## Recommended Varieties

Obtain the best strains of Italian or German "Rocambole" garlic (late or pink-skinned type), Polish softneck types that will braid (no hard seed stalk), or elephant types from a reputable agriculture products vendor or a local grower who has had success with fall-planted garlic. A locally grown strain will be hardy and may overwinter better than many commercially available strains. Avoid Creole garlics (also called Early, Louisiana, White Mexican, etc.), since they are not very winter-hardy and do not keep well.

Bulbs of both Creole and Italian garlic have a white outer skin, but the Italian type has a pink skin around each clove. Elephant garlic (*Allium ampeloprasum*) is a type of leek that produces bulbils, is milder than regular garlic, and up to four times larger. However, Elephant garlic may not yield well when fall-planted in areas with severe cold or extensive freezing and thawing cycles, which cause heaving. The Italian and Elephant types take about 220 days to mature.

Many of the most productive Italian garlic strains will produce seed stalks prior to harvest. Snap these seed stalks just as they begin to coil for best yields. "Rocambole" types have coiled seed stalks that are perfectly normal and not the result of any poor cultural practice or herbicide contamination.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Garlic | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 125 | 150 | 150 | 150 | 0 | 150 | 150 | 150 | 0 | Total nutrient recommended |
| | 75 | 150 | 150 | 150 | 0 | 150 | 150 | 150 | 0 | Broadcast and disk-in |
| | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Topdress[1] when 6 inches tall (March 15) |
| | 25[1] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Topdress[2] 6 weeks after first split (May 1) |

[1]Apply all topdressing at mid-day when plants are dry to reduce the chance of burn.
[2]Use ammonium sulfate for the second topdressing to help with pungency.

## Planting

Garlic cloves should be planted between about September 15 and October 25 in central PA. They could be planted up to 10 days earlier in cool, short-season areas and up to 3 weeks later in warm, long-season areas. Growers should plant as late as possible to escape damage from the fall generation of the allium leafminer if present in the growing area (See Allium leafminer in Insect Control section.) Yield tends to increase with the size of the mother bulb. Do not use the following for planting: long, slender cloves in the center of the bulb, cloves weighing less than 1 gram, or bulbs with side growths and very poor skin covering of cloves.

Garlic must be exposed to temperatures between 32-50°F (0-10°C) for about 2 months prior to the long day-length periods that induce bulbing. Fall-planted garlic establishes an excellent root system and receives a natural cold treatment that produces the highest possible garlic yields. Spring-planted garlic (*e.g.*, Elephant type) may be fairly successful where it can be planted by early March.

## Spacing

Cloves should be planted 4 by 4 inches apart in triple rows or multiple beds 16-18 inches apart. Between-row spacing depends on equipment available. Clove tops should be covered with 1-1½ inches of soil. Cloves must not be so deep that the soil will interfere with the growth of the bulbs, nor so shallow that rain, heaving from alternate freezing and thawing, and birds may dislodge them. Cloves placed with the root end down give optimum results. Cloves dropped into furrows will be in various positions and may produce plants with crooked necks.

## Harvest and Post-Harvest Considerations

Fall-planted garlic is ready for harvesting about the second week in July when 40-60% of the leaves have yellowed (garlic generally has 6 leaves). When plants reach this stage pull a sample. There are only about 10-14 days for optimum harvest, when each clove is fully segmented and yet fully covered by a tight outer skin. Before the optimum harvest time, garlic is unsegmented like an onion. After the optimum time, cloves may have separated, the outer sheath split, and part of the naked cloves may be exposed.

Run a cutter bar under the bulbs to cut the extensive root system and partially lift the bulbs. Bulbs can be pulled and gathered into windrows. Tops are placed uppermost in the windrow to protect bulbs from the sun. Garlic is left in the field for a week or more to dry or cure thoroughly. Curing can also be accomplished in a well-ventilated shed or barn. Use this option when rain is forecasted. Bulbs must be thoroughly dried before being shipped or stored.

After curing, remove the outer loose portions of the sheath, and trim the roots close to the bulbs. Braid or bunch the tops together, or cut off the tops and bag the bulbs like dry onions. Discard diseased and damaged bulbs.

When properly cured, garlic keeps well under a wide range of temperatures. Temporary storage in open-mesh sacks in a dry, well-ventilated storage room at 60-90°F is acceptable. However, storage at 32-35°F and 65% relative humidity (the same conditions as required for onions) is best. Avoid prolonged storage near 40°F to prevent sprouting of cloves. and avoid a relative humidity above 70% to prevent sprouting and development of mold.

## Marketing

New growers should develop a local retail market (road-side stands, night markets, and gourmet restaurants), wholesale shipper, or processing market before planting. The demand for garlic is increasing due to recent reports about its health and medical benefits.

# Weed Control

### THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

### Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**1. Soil-Applied (Preplant Incorporated or Preemergence)**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 8 | Prefar 4E | 5.0 to 6.0 qt/A | **bensulide** | 5 to 6 lb/A | -- | -- |

-Labeled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum).
-If applied preemergence, irrigate within 36 hrs of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 hrs, weed control maybe reduced.
-Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters.
-**Do not** apply more than 6 lb ai/A per season.

**2. Postemergence**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9.0 to 16.0 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 45 | 24 |
| | Fusilade DX 2EC | 8 to 12 fl oz/A | **fluazifop** | 0.125 to 0.19 lb/A | 45 | 12 |
| | Poast 1.5EC | 1.0 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 30 | 12 |

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **Fusilade DX:** Apply with COC at 1.0% v/v or NIS at 0.25% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.

*2. Postemergence continued on next page*

*2. Postemergence (Select, Fusilade, Poast)- continued.*

| | | | | | | |
|---|---|---|---|---|---|---|
| -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Select will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions. If repeat applications are necessary, allow 14 days between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 applications per season; **do not** apply more than 32 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 1.5 pt/A in single application and maximum Poast application per season is 4.5 pt/A.<br>-**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 3 pt/A per season. | | | | | | |
| 6 | Maestro 2E / Moxy 2E | 1.5 to 2 pt/A | **bromoxynil** | 0.38 to 0.5 lb/A | 60/112***** | 24 |
| -Apply after garlic emergence but before 12 inches in height.<br>-Apply in a minimum of 20 gal/A. No surfactant or adjuvant is recommended due to risk of crop injury.<br>-Apply to small broadleaf weeds (up to 4-leaf stage, 2 inches in height or 1 inch diameter). Rainfastness 1 hr.<br>-**Do not** apply more than 2 pt/A during the season.<br>***Do not** harvest for 112 days after application on mineral soils or 60 days on muck soils grown in the northeastern US. | | | | | | |

**3. Postharvest**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

**4. Other Labeled Herbicides** These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| 3 | Prowl | **pendimethalin** |
| **14** | Chateau | **flumioxazin** |
| **14** | Goal or GoalTender | **oxyfluorfen** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

### Allium Leafminers

This new pest to the mid-Atlantic area is a grey-black fly with a distinctive yellow or orange patch on its head, yellow sides and "knees" (femur-tibia junction), and white halteres (knobs in place of 2nd pair of wings). Larvae are a typical whitish maggot. Leek (*A. porrum*) tends to be the most damaged Allium species. Adult females repeatedly puncture leaves with their ovipositors, resulting in a line of small white dots near the tips. Leaves can be wavy, curled and distorted. Larvae mine leaves, and move towards and into bulbs and leaf sheathes where they pupate. Covering plants in February, prior to the emergence of adults, and keeping plants covered during spring emergence can exclude the pest. Other suggested methods include avoiding the adult oviposition period by delaying planting, and covering fall plantings during the 2nd generation flight. Systemic and contact insecticides can be effective.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 3A | Mustang Maxx | 2.88 to 4.0 fl oz/A | zeta-cypermethrin* | 7 | 48 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 14 | 24 | H |
| 4A | Scorpion 35 SL | 8.75 to 10.5 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Scorpion 35 SL | 5.25 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |

*Allium Leafminers continued on next page*

*Allium Leafminers - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4A | Venom 70SG | 5.0 to 6.0 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Venom 70SG | 3.0 to 4.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 6.0 to 10.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 17 | Trigard 75 WSP | 2.66 oz/A | cyromazine | 0 | 12 | L |
| 28 + 6 | Minecto Pro | 7.0 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 30 | 12 | H |

## Beet Armyworms (BAW)

Beet armyworm comes into our area from the South usually in late July. Female moths lay egg masses on the underside of leaves that are covered in scales with a fuzzy appearance. Young larvae are greyish or dark green with distinct dark heads. Most larvae have a distinct black spot on the second abdominal segment. BAW damage is characterized by leaf skeletonization. One of the best scouting methods is to examine nearby pigweed or lambsquarters weeds, as BAW typically infests those plants first. BAW control can be challenging as they are resistant to certain insecticides, particularly pyrethroids.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 pt/A | methomyl* | 7 | 48 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 30 | 12 | H |

## Thrips

Thrips have mouth parts that pierce plant tissue and remove plant liquids resulting in whitish or chlorotic streaks or blotches. During hot, dry weather, the population of thrips increases following harvest of adjacent alfalfa or grain fields. Thrips could at that time pose the most serious insect problem on garlic.

**Apply one of the following formulations (note: The use of spinosad or methomyl* for beet armyworm control will suppress thrips populations):**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Malathion 57 EC | 1.5 to 2.0 pt/A | malathion | 3 | 24 | H |
| 3A | Mustang Maxx | 2.88 to 4.0 fl oz/A | zeta-cypermethrin* | 7 | 12 | H |
| 3A | Perm-UP 3.2 EC | 6.0 to 8.0 fl oz/A | permethrin* | 1 | 24 | H |
| 3A | Proaxis | 2.56 to 3.84 fl oz/A | gamma-cyhalothrin* | 14 | 24 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 14 | 24 | H |
| 4A | Assail 30 SG | 5.0 to 8.0 fl oz/A | acetamiprid | 7 | 12 | M |
| 4A | Scorpion 35 SL | 5.0 to 6.0 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35 SL | 3.0 to 4.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70 SG | 5.0 to 6.0 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70 SG | 8.75 to 10.5 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 3 | 24 | H |
| 23 | Movento (larvae) | 5.0 fl oz/A | spirotetramat | 3 | 24 | L |
| 28 + 6 | Minecto Pro | 7.0 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 30 | 12 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

## Nematodes

### Bloat Nematode (*Ditylenchus dipsaci*)

Infected garlic appears bloated and twisted, with swollen leaves and distorted and cracked bulbs. Secondary infection by *Fusarium* spp. is common. Currently there are no certification programs for garlic; make sure your supplier produces clean seed cloves. Avoid planting bulbs that are split, have damaged basal plates or are desiccated.

Plant garlic in a location that has not been cropped to garlic or another *Allium* crop for at least 4 years. Following harvest, planting biofumigant cover crops may help reduce nematode levels. Keep soils moist since the bloat nematode cannot survive long periods in high moisture. Implement good sanitation practices and avoid dumping culls and other infested debris in the field.

## Damping-Off caused by *Pythium* and *Rhizoctonia*

Use clean pathogen-free seed that has been treated with a fungicide.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following at planting to help manage damping-off pathogens:** | | | | | | |
| **For Pythium only:** | | | | | | |
| 4 | MetaStar 2EC | 2.0 to 4.0 pt/A | metalaxyl | AP | 48 | N |
| 4 | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | 7 | 12 | N |
| 4 | Ultra Flourish 2E | 1.0 to 2.0 pt/A | mefenoxam | AP | 48 | N |
| **For Rhizoctonia only:** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 row ft | azoxystrobin | 0 | 4 | N |
| **For Pythium and Rhizoctonia:** | | | | | | |
| 4 + 11 | Uniform 3.66 SE | 0.34 fl oz/1000 row ft in furrow, see label | mefenoxam + azoxystrobin | AP | 0 | -- |

# Bacterial and Fungal Diseases

## Botrytis Leaf Blight (*Blast*)

Scout fields regularly. Cool summer temperatures (55-75°F) and long periods of leaf wetness provide optimum environmental conditions for rapid leaf blighting. Older plants are more susceptible to blast infection than younger plants. Apply the following preventatively when weather conditions favor disease development and repeat at 7-10 day intervals. **Do not** make more than 2 consecutive applications of Endura or Pristine before switching to a fungicide with a different mode of action. Thoroughly disc or plow under plant debris after harvest.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Tank mix and/or alternate chlorothalonil 6F** | | | | | | |
| M5 | chlorothalonil 6F | 1.0 to 3.0 pt /A | chlorothalonil | 7 | 12 | L |
| **With one of the following:** | | | | | | |
| 3 + 9 | Inspire Super 2.82SC [1] | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodonil | 7 | 12 | -- |
| 3 + 11 | Quilt Xcel 2.2SE [2] | 17.5 to 26.0 fl oz/A | propiconazole + azoxystrobin | 14 | 12 | N |
| 7 | Endura 70WG [1] | 6.8 oz/A | boscalid | 7 | 12 | -- |
| 7 + 11 | Pristine | 14.5 to 18.5 oz/A | pyraclostrobin + boscalid | 7 | 12 | -- |
| 29 | Omega 500F [1,2] | 1.0 pt/A | fluazinam | 7 | 12 | N |

[1] Also manages purple blotch. [2] Also manages downy mildew.

## Downy Mildew (*Peronospora destructor*)

The pathogen can survive as oospores in the soil, or on bulbs, sets and seed. Downy mildew development is promoted by cool, moist conditions. Management begins with planting pathogen-free seed or sets and crop rotations of at least 3 years without related crops. Be sure to eliminate culls and volunteers from the field.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Tank mix chlorothalonil** | | | | | | |
| M5 | chlorothalonil 6F | 1.0 to 3.0 pt /A | chlorothalonil | 7 | 12 | L |
| **With one of the following fungicides and rotate between fungicides with different modes of action (FRAC codes):** | | | | | | |
| 3 + 11 | Quilt Xcel 2.2SE | 17.5 to 26.0 fl oz/A | propiconazole + azoxystrobin | 14 | 12 | N |
| 11 | azoxystrobin 2.08F | 9.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 12.0 oz/A | pyraclostrobin | 7 | 12 | N |
| 11 | Reason 500SC | 5.5 fl oz/A | fenamidone | 7 | 12 | -- |
| 29 | Omega 500F (also manages Botrytis leaf blight and purple blotch) | 1.0 pt/A | fluazinam | 7 | 12 | N |
| 40 | Forum 4.18SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | dimethomorph + ametoctradin | 0 | 12 | -- |

## Fusarium Basal Rot (*Fusarium* spp.)

The fungus infects and causes decay of the basal plate. During the growing season, leaves can turn yellow and then brown. This disease is favored by very warm soil temperatures so symptoms are most frequently observed in mid- to late summer. A 4 year crop rotation with non-hosts is the most effective management strategy.

## Purple Blotch (*Alternaria porri*)

Scout fields regularly. Purple blotch development increases with high humidity, rain and persistent dews with an optimum 71 to 85°F temperature range. Apply one of the following preventatively when weather conditions favor disease development and repeat at 7-10 day intervals. **Do not** apply Pristine, azoxystrobin (both FRAC code 11) or Endura (FRAC code 7) more than once before switching to a fungicide with a different mode of action (FRAC code). Thoroughly disc or plow under plant debris after harvest.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Tank mix** | | | | | | |
| M5 | chlorothalonil 6F | 1.0 to 3.0 pt /A | chlorothalonil | 7 | 12 | L |
| **With one of the following fungicides and rotate between fungicides with different modes of action:** | | | | | | |
| 3 | tebuconazole 3.6F | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3 + 9 | Inspire Super 2.82SC [1] | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodonil | 7 | 12 | -- |
| 3 + 11 | Quilt 1.66F | 14.0 to 27.5 fl oz/A | propiconazole + azoxystrobin | 14 | 12 | N |
| 3 + 11 | Quilt Xcel 2.2SE | 17.5 o 26.0 fl oz/A | propiconazole + azoxystrobin | 14 | 12 | N |
| 7 | Endura 70WG | 6.8 oz/A | boscalid | 7 | 12 | -- |
| 7 | Fontelis SC | 16.0 to 24.0 fl oz/A | penthiopyrad | 3 | 12 | L |
| 11 | azoxystrobin 2.08F | 9.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 8.0 to 12.0 oz/A | pyraclostrobin | 7 | 12 | N |
| 29 | Omega 500F [1,2] | 1.0 pt/A | fluazinam | 7 | 12 | N |

[1]Also labeled for Botrytis leaf blight. [2]Also labeled for downy mildew.

## White Rot (*Sclerotium cepivorum*)

Disease development is favored by cool, moist soil conditions. Infection occurs at soil temperatures ranging from 50-75°F, with the optimum at 60-65°F. The disease is greatly inhibited at soil temperatures above 78°F. Sclerotia can survive for over 20 yr, even in the absence of a host plant. Soil moisture conditions that are favorable for onion and garlic growth are also ideal for white rot development. Rotate between crops for as many years as possible.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **At planting, apply an in-furrow treatment of one of the following:** | | | | | | |
| 2 | iprodione (spray both the cloves and the covering soil used to fill furrow; maximum application: 1 per year) | 4.0 pt in 20 gal of water minimum based on a 38 to 40-inch row spacing | iprodione | AP | 24 | N |
| 3 | tebuconazole 3.6F (immediately after seeding; can also be applied via drip irrigation) | 20.5 oz/A in a 4-6 inch band over the top or in-furrow | tebuconazole | 7 | 12 | N |
| 12 | Cannonball 50 WP (prior to seed placement) | 0.5 oz/1000 ft row in-furrow | fludioxonil | 7 | 12 | L |
| **Two additional foliar applications of tebuconazole may be applied:** | | | | | | |
| 3 | tebuconazole 3.6F | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |
| **Note: In treated fields, do not grow crops other than garlic and leafy vegetables during the harvest year, and do not grow garlic, leafy vegetables, tomatoes, root crops, cereal grains, or soybeans during the following year.** | | | | | | |

# Greens (Mustard and Turnip)

## Recommended Varieties - Mustards and Turnips[1,2]

| Type | Variety | Use | Hybrid | Season[3] | Description |
|---|---|---|---|---|---|
| Mustard | Florida Broadleaf | Cooked | No | Fall | Green, flat leaf |
| | Garnet Giant | Salad | No | Fall | Red, flat leaf |
| | Green Wave | Cooked, Salad | No | Fall | Green, curled leaf |
| | Red Giant | Cooked, Salad | No | Fall | Red, crinkled leaf |
| | Red Splendor | Cooked, Salad | No | Spring/Fall | Red, serrated leaf |
| | Savannah | Cooked | Yes | Spring/Fall | Green, flat leaf |
| | Scarlet Frills | Salad | No | Spring/Fall | Red, ruffled leaf |
| | Southern Giant Curled | Cooked | No | Fall | Green, curled leaf |
| | Tendergreen | Cooked | No | Fall | Green, flat leaf |
| Asian Mustard | Carlton Komatsuna | Cooked, Salad | Yes | Spring/Fall | Green, flat leaf |
| | Green Mizuna | Cooked, Salad | No | Fall | Green, serrated leaf |
| | Miz America | Cooked, Salad | No | Fall | Red, toothed leaf |
| | Purple Mizuna | Cooked, Salad | No | Fall | Purple, serrated leaf |
| | Summerfest Komatsuna | Cooked, Salad | Yes | Spring/Fall | Green, flat leaf |
| | Tatsoi | Cooked, Salad | No | Fall | Green, semi savoy leaf |
| | Tatsoi Savoy | Cooked, Salad | No | Fall | Green, heavy savoy leaf |
| Turnip | Alamo | Cooked, Salad | Yes | Spring/Fall | Green, flat leaf |
| | All Top | Cooked | Yes | Fall | Green, flat leaf |
| | Seven Top | Cooked | No | Fall | Green, serrated leaf |
| | Southern Green | Cooked | Yes | Fall | Green flat leaf |
| | Topper | Cooked | Yes | Spring/Fall | Green, serrated leaf |
| | Top Star | Cooked | Yes | Spring/Fall | Green, serrated leaf |

[1]Listed alphabetically. [2]**For Kale and Collard Greens, see the Cole Crops section**. [3]Recommended growing season for full size harvest without bolting. Greens may be planted throughout the year for harvest in the baby stage.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Greens (Mustard, Turnip) | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 50-110 | 150 | 100 | 50 | 0 | 150 | 100 | 50 | 0 | Total nutrient recommended |
| | 50 | 150 | 100 | 50 | 0 | 150 | 100 | 50 | 0 | Broadcast and disk-in |
| | 25-60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Topdress after each cutting |

## Seeding

Seed in early- to mid-August for fall harvest. Mustards and turnip greens planted in the spring are susceptible to bolting if exposed to cold temperatures for prolonged periods of time, and only bolt-resistant varieties such as Savanna mustard and Alamo turnip should be grown. Later spring plantings (April) have a lower risk of bolting. For all plantings, sow 3-4 lb/A of seed in rows 12-24 inches apart. A wide variety of mustards are available for incorporating into salad mixes for microgreens or baby salad mixes. These are sown in beds or trays as a broadcast or in narrow rows. They can be seeded from late winter through late fall in high tunnels for successive harvests.

## Harvesting

Greens may be harvested by cutting off entire plants near ground level for a single harvest, or by cutting 2-6 inches above the ground to allow for regrowth. For processing, greens are machine cut 4-6 inches from the ground when full tonnage has been achieved but before petioles and midribs have become too large. Multiple harvests may be possible. Greens should be transported as quickly as possible to the processing plant.

Greens for baby salad mixes are cut at ground level for a single harvest, or 1-2 inches from the ground for multiple cuts. They should be held as close to 32°F as possible, because of their perishability. At this temperature, they can be held 10-14 days. Relative humidity of at least 95% is desirable to prevent wilting. Air circulation should be adequate to remove heat of respiration, but not too rapid as that will speed transpiration and wilting. Satisfactory precooling is accomplished by vacuum cooling or hydrocooling.

Greens are commonly shipped with package and top ice. Greens packed in polyethylene-lined crates and protected by crushed ice keep in excellent condition if kept near 32°F but deteriorate rapidly at higher temperatures.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**1. Soil-Applied (Preplant Incorporated or Preemergence)**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 3 | Dacthal 6F<br>Dacthal W-75 | 6.0 to 14.0 pt/A<br>6.0 to 14 lb/A | **DCPA** | 4.5 to 10.5 lb/A | -- | 12 |
| -**Labeled for turnip and mustard greens**. Labeled for preplant incorporated or preemergence; **do not** incorporate deeper than 2 inches.<br>-Labeled for applications over the top of transplants without injury (will not control emerged weeds).<br>-Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse -textured soils low in organic matter, and when the application are followed by rainfall or irrigation.<br>-Maximum application not addressed on label. | | | | | | |
| 3 | Treflan 4EC | 1.0 to 1.5 pt/A | **trifluralin** | 0.5 to 0.75 lb/A | -- | 12 |
| -**Labeled for turnip greens for processing and mustard greens**. Incorporate into 2-3 inches of soil within 8 hr after application.<br>-Primarily controls annual grasses and a few broadleaf weeds. Poor incorporation can reduce overall weed control.<br>-**Do not** use (or reduce the rate) used when cold, wet soil conditions are expected, or crop injury may result.<br>-Maximum application not addressed on label. | | | | | | |
| 8 | Prefar 4E | 5.0 to 6.0 qt/A | **bensulide** | 5.0 to 6.0 lb/A | -- | -- |
| -**Labeled for mustard greens.** 24© label for NJ only allows applications up to 9 qt/A.<br>-Labeled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum).<br>-If applied preemergence, irrigate irrigate within 36 hrs of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 hrs, weed control maybe reduced. Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. **Do not** apply more than 6 lb ai/A per season. | | | | | | |

**2. Postemergence**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9.0 to 16.0 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 14 | 24 |
| | Poast 1.5EC | 1.0 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 30 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Select will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.<br>-If repeat applications are necessary, allow 14 days between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. Rainfastness 1 hr. **Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season. **Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 3 pt/A for the season. | | | | | | |
| 4 | Stinger 3A / Spur 3A | 4.0 to 8.0 fl oz/A | **clopyralid** | 0.047 to 0.188 lb/A | 30/15 | 12 |
| -**Labeled for mustard greens and turnip greens.** Spray additives are not needed or required by the label, and are not recommended<br>-Stinger controls composite and legume weeds including galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). | | | | | | |

*2. Postemergence, Stinger continued on next page*

***2. Postemergence, Stinger- continued***

| |
|---|
| -Stinger is very effective on small seedling annual and emerging perennial weeds less than 2-4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2.0 to 4.0 fl oz/A to control annual weeds less than 2 inches tall. Increase the rate to 4.0 to 8.0 fl oz/A to control larger annual weeds. Apply the maximum rate of 8.0 fl oz/A to suppress or control perennial weeds.<br>-Observe follow crop restrictions or injury may occur from herbicide carryover.<br>-Rainfastness is 6 hrs. **Do not** harvest mustard greens within 30 days of harvest or turnip greens within 15 days of harvest.<br>-Maximum Stinger application per year: 8.0 fl oz/A; maximum number of applications: 1 for turnip greens, 2 for mustard greens. |

**3. Postharvest**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant. .Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

## Aphids

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) and Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Dimethoate 400 | 0.5 pt/A | dimethoate* | 14 | 48 | H |
| 1B | Malathion 57EC[1] | 1.0 to 1.6 pt/A[1] | malathion | 7 | 12 | H |
| 3A + 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 4A | Actara | 1.5 to 3.0 oz/A | thiamethoxam - **mustard greens only** | 7 | 12 | H |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.2 fl fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Assail 30SG | 2 to 5.3 fl oz/A | acetamiprid | 3 | 12 | H |
| 4A | Belay | 9 to 12 fl oz/A | clothianidin – **soil, mustard greens only** | 21 | 12 | H |
| 4A | Belay | 3 to 4 fl oz/A | clothianidin - **foliar, mustard greens only** | 7 | 12 | H |
| 4A | Platinum 75SG | 5.0 to 11.0 oz/A | thiamethoxam - **mustard greens only** | 30 | 12 | H |
| 4C | Closer SC | 1.5 to 2 fl oz/A | sulfoxaflor - **mustard and turnip greens** | 3/7 | 12 | H |
| 9B | Fulfill 50WDG | 2.75 oz/A | pymetrozine | 7 | 12 | N |
| 9C | Beleaf 50SG | 2.0 to 2.8 fl oz/A | flonicamid | 0 | 12 | L |

[1]Maximum of 3 applications per season at the 1.6 pt/A rate.

## Caterpillar "Worms" Pests Including: Beet Armyworms (BAW), Cabbage Loopers (CL), Diamondback Moths (DBM), and Imported Cabbageworms (ICW)

Due to resistance development, pyrethroid insecticides are not recommended for control of DBM or BAW. Other insecticides may no longer be effective in certain areas due to DBM resistance; consult your county Extension. Rotation of insecticides with different modes of action is recommended to reduce the development of resistance.

**Apply one of the following formulations (Not all materials are labeled for all crops, insects or application methods, check labels).**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) and Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 10 | 48 | H |
| **3A** | Baythroid XL (CL, ICW) | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| **3A** | Tombstone (CL, ICW) | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 5 | Entrust SC (OMRI) | 1.5 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5 SG | 2.4 to 4.8 fl oz/A | emamectin benzoate* | 14 | 12 | H |
| 11A | Dipel (OMRI) | 0.25 to 1 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 18A | Intrepid 2F | 4 to 8 fl oz/A early season;<br>8 to 10 oz/A late season | methoxyfenozide | 1 | 4 | N |

*Caterpillar "Worms" continued on next page*

*Caterpillar "Worms" - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 22A | Avaunt | 2.5 to 3.5 fl oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen | 3.5 to 7.5 fl oz/A | chlorantraniliprole<br>**- mustard and turnip greens** | 3/1 | 4 | L |
| 28 | Exirel | 7 to 13.5 fl oz/A;<br>10 to 17 fl oz A for CL | cyantraniliprole | 1 | 12 | H |
| 28 | Verimark | 5 to 10 fl oz/A | cyantraniliprole | NA | 4 | H |

## Flea Beetles

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) and Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Sevin XLR Plus | 0.5 to 1 qt/A | carbaryl | 14 | 12 | H |
| 3A | Baythroid XL | 2.4 to 3.2 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Tombstone | 2.4 to 3.2 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A + 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid+beta-cyfluthrin* | 7 | 12 | H |
| 4A | Actara | 1.5 to 3.0 oz/A | thiamethoxam - **mustard greens only** | 7 | 12 | H |
| 4A | Admire Pro | 1.3 fl oz/A | Imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Belay | 9 to 12 fl oz/A | clothianidin - **soil**, **mustard greens only** | 21 | 12 | H |
| 4A | Belay | 3 to 4 fl oz/A | clothianidin - **foliar, mustard greens only** | 7 | 12 | H |
| 4A | Platinum | 5.0 to 11.0 fl oz/A | thiamethoxam | 30 | 12 | H |

## Hawaiian Beet Webworms

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) and Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 5 | Radiant SC | 7.0 to 10.0 oz/A | spinetoram | 1 | 4 | H |
| 28 | Coragen | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **mustard greens only** | 3 | 1 | L |

## Leafhoppers

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) and Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Dimethoate 400 | 0.5 pt/A | dimethoate* | 14 | 48 | H |
| 1B | Sevin XLR Plus | 0.5 to 1 qt/A | carbaryl | 14 | 12 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Tombstone | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A + 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil, mustard greens only** | 21 | 12 | H |
| 4A | Admire Pro | 1.3 fl oz/A | imidacloprid - **foliar, mustard greens only** | 7 | 12 | H |
| 4A | Belay | 9 to 12 fl oz/A | clothianidin - **soil, mustard greens only** | 21 | 12 | H |
| 4A | Belay | 3 to 4 fl oz/A | clothianidin - **foliar, mustard greens only** | 7 | 12 | H |

## Leafminers

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) and Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Dimethoate 400 | 0.5 pt/A | dimethoate* | 14 | 48 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 10.0 fl oz/A | spinosad - **mustard and turnip greens only** | 1 | 4 | M |
| 17 | Trigard | 2.66 oz/A | cyromazine - **mustard and turnip greens only** | 7 | 12 | H |

## Thrips

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) and Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 3A + 4A | Leverage 360 (controls foliage feeding thrips only) | 3.0 fl oz/A | imidacloprid + beta-cyfluthrin | 7 | 12 | H |
| 4A | Actara | 3.0 to 5.5 oz/A | thiamethoxam | 7 | 12 | H |
| 4A | Platinum | 5.0 to 11.0 fl oz/A | thiamethoxam | 30 | 12 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 10.0 fl oz/A | spinosad - **mustard and turnip greens only** | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Fungicides

### Damping-Off caused by *Phytophthora, Pythium* and *Rhizoctonia*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following at seeding (see label for application methods and restrictions):** | | | | | | |
| **Pythium root rot** | | | | | | |
| 4 | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | AP | 48 | N |
| **Pythium and Rhizoctonia root rot** | | | | | | |
| 4 + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence. | mefenoxam + azoxystrobin | AP | 0 | N |
| **Rhizoctonia root rot** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | AP | 4 | N |

### Downy Mildew

The pathogen has a wide host range including broccoli, brussels sprouts, cauliflower, cabbage, kale, chinese cabbage, chinese broccoli, chinese mustard, radish, etc. and related weeds in the brassica family. Plant certified seed since the pathogen can be seed-borne. Use hot water seed treatment (See Cole Crops, Disease Control section). Avoid overhead watering in the morning when spores are released.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Scout regularly. Rotate the following fungicides with different modes of action during periods of high moisture and moderate temperatures and continue as long as weather conditions favor disease development:** | | | | | | |
| 11 | azoxystrobin 2.08F | 6.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 8.0 to 16.0 oz/A | pyraclostrobin | 0 | 12 | N |
| 21 | Ranman 3.33SC | 2.75 fl oz/A | cyazofamid | 0 | 12 | L |
| 33 | Aliette 80WDG (for mustard greens only) | 3.0 lb/A | fosetyl-Al | 3 | 12/24 | N |
| 40 | Forum 4.18SC/A *plus* fixed copper | 6.0 fl oz | dimethomorph | 0 | 12 | N |
| 40 | Revus 2.08SC | 8.0 fl oz/A | mandipropamid | 1 | 4 | -- |
| 40 + 45 | Zampro 4.38SC | 14.0 fl oz/A | ametoctradin + dimethomorph | 0 | 12 | -- |
| 43 | Presidio 4SC | 4.0 fl oz/A | fluopicolide | 2 | 12 | L |

### Leaf Spots caused by *Alternaria* or *Cercospora* spp.

The fungal pathogens that cause leaf spot overwinter in the soil. Rotate away from fields for as long as possible.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| M1 | Copper (OMRI)[1] | At labeled rates | copper | 0 | | N |
| **When conditions favor disease development, apply one of the following fungicides every 7 to 10 days for as long as conditions are favorable for disease development. Rotate between fungicides with different mode of actions:** | | | | | | |
| 3 | Folicur 3.6F | 3.0 to 4.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3 + 9 | Inspire Super 2.82SC | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodinil | 7 | 12 | -- |
| 3 + 11 | Quadris Top 2.72SC | 12.0 to 14.0 fl oz/A | difenoconazole + azoxystrobin | 1 | 12 | -- |
| 7 | Endura 70WG | 14.0 oz/A | boscalid | 0 | 12 | -- |
| 7 | Fontelis 1.67SC | 14.0 to 30.0 fl oz/A | penthiopyrad | 0 | 12 | L |
| 7 + 11 | Priaxor 4.17SC | 6.0 to 8.2 fl oz/A | fluxapyroxad + pyraclostrobin | 3 | 12 | N |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 7 | 12 | N |
| 11 | azoxystrobin 2.08F | 6.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 8.0 to 16.0 oz/A | pyraclostrobin | 0 | 12 | N |

[1]There are a number of copper based products with OMRI labels. See labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.

# Horseradish

Horseradish is a hardy perennial from the Mustard family that is grown for its fleshy white roots in annual production systems. Roots that are left in the ground for two or more growing seasons become stringy and woody. If roots are not harvested or killed, horseradish can become a weed.

There are three types of horseradish: "**Common**" types have broad crinkled leaves and high quality, large, smooth roots, but they are susceptible to virus and white rust. "**Bohemian**" types have medium-sized narrow smooth leaves and somewhat lower quality roots. They are susceptible to virus, but have some white rust tolerance. "B**ig Top Western**" types have smooth, large upright leaves and large good quality roots, however, the roots are rough or corky on the surface. "Big Top Western" types have resistance to virus and white rust. Use locally selected horseradish strains that are adapted to the area.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Horse-radish | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 150-200 | 200 | 150 | 100 | 0 | 200 | 150 | 100 | 0 | Total nutrient recommended |
| | 50 | 200 | 150 | 100 | 0 | 200 | 150 | 100 | 0 | Broadcast and disk-in |
| | 50-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 3-5 weeks after planting |
| | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 4-6 weeks after planting if needed |

Apply 1.0 to 2.0 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter.

## Planting and Spacing

Sets are selected roots from the previous crop. They should be 10-1-2 inches long and ¼-5/8 inch in diameter. Do not allow roots to dry out before planting. To ensure proper orientation at planting, make a square cut at the end of the roots nearest the main root. Make a slanting cut at the other end and plant the slanting cut end downward.

Plant in late April to early May. Place sets at an angle in a furrow so the top will be 1 inch deep and the bottom 2 inches deep. Alternatively, use a dribble to make a slanted planting hole, or leave several inches above the soil surface and cover sets by forming ridges in the row. Sets should point in the same direction that the cultivator will go, *e.g.*, for two-row cultivator, two rows in one direction and the next two rows in the opposite direction. Space rows 34-36 inches apart with 18 inches between sets in the row.

## Harvesting and Storage

Dig roots as needed. In an annual system, the set will become the main root which is the largest and most valuable for market. For maximum growth, harvest once tops have died due to frost. Alternatively, tops can be cut off as close to the soil surface as possible. Then wait several days before harvesting. Roots overwinter, but winter soil conditions may prevent harvesting. Store horseradish in the dark with temperatures between 32-40°F (0-4°C) and 98% relative humidity. Roots exposed to light become green. Roots can be stored for 8-9 months. If storage and temperature conditions cannot be met, consider harvesting the following spring by digging the roots as soon as new growth starts to appear. Select the top performing lateral roots for the next crop.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

## 1. Preemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 3 | Dacthal 6F<br>Dacthal W-75 | 8.0 to 14.0 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6.0 to 10.5 lb/A | 25 | 12 |
| -Labeled for preemergence; incorporation is not recommended.<br>-Labeled for applications over the top of transplants without injury (will not control emerged weeds).<br>-Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse-textured soils low in organic matter and when the application are followed by rainfall or irrigation.<br>-Maximum application not addressed on label. | | | | | | |
| 14 | Goal 2XL<br>GoalTender 4F | 2.0 pt/A<br>1 pt/A | **oxyfluorfen** | 0.5 lb/A | -- | 48 |
| -Apply immediately after planting but before emergence of new leaves.<br>-Emerged leaves that receive direct herbicide application will be injured.<br>-It may be desirable to cultivate immediately prior to application to remove germinated weeds. Delay cultivation after Goal application, when possible, to reduce deactivation of Goal by incorporation.<br>-**Do not** use Goal herbicide on horseradish plantings which are weak or under stress due to temperature, disease, fertilizer, nematodes, insects, pesticides, drought, or excessive moisture.<br>-**Do not** apply more than 2 pt/A of Goal 2XL per crop or no more than 1 pt/A per crop of GoalTender. | | | | | | |
| 15 | Dual Magnum 7.62E<br>generic metolachlor 8EC | 1.0 to 1.3 pt/A<br>1.0 to 2.0 pt/A | **s-metolachlor**<br>**metolachlor** | 0.95 to 1.27 lb/A<br>0.95 to 1.91 lb/A | -- | 24 |
| -Apply after planting, but before crop emergence; Dual will not control emerged weeds. Primarily controls annual grasses, certain broadleaf weeds, and nutsedge. **Do not** make more than one application per crop; **do not** apply more than 1.33 pt/A per crop. | | | | | | |

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9.0 to 16.0 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 30 | 24 |
| | Poast 1.5EC | 1.0 to 2.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 60 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Select will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.<br>-If repeat applications are necessary, allow 14 days between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season;<br>-**Do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 2.5 pt/A Poast in single application and **do not** exceed 5 pt/A for the season. | | | | | | |

## 3. Postharvest

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant. Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

## 4. Other Labeled Herbicides

These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| 7 | Lorox | **linuron** |
| **14** | Zeus | **sulfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

### Aphids

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 pt/A | methomyl* | 65 | 48 | H |
| 1B | Malathion 57 EC | 1.0 to 2.0 pt/A | malathion | 7 | 24 | H |
| **4A** | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam | 7 | 12 | H |
| **4A** | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| **4A** | Admire Pro | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| **4D** | Sivanto 200 SL | 7.0 to 10.0 fl oz/A | flupyradifurone | 7 | 4 | M |
| 9C | Beleaf 50 SG | 2.0 to 2.8 oz/A | flonicamid | 3 | 12 | L |

### Cutworms - See also the Pest Management chapter, Insect Management section.

Cutworms are moth larvae (caterpillars) that feed on roots and stems. They chew on stems at or near the soil line, causing young plants to topple over. Larvae are typically active at night, and spend most of this stage belowground. Cutworms are favored by less disturbed soils and debris covered soil surfaces. Conventional tillage and soil incorporation of crop debris helps reduce populations. Several species in NJ are capable of causing injury to young plants. There are usually 2 generations per season. If cutworm damage is anticipated, it is best to treat preventively.

| Apply the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Sniper | 5.1 to 6.4 fl oz/A | bifenthrin* | 21 | 12 | H |

### Flea Beetles (FB), Harlequin Bugs

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin SLR Plus | 1.0 qt/A | carbaryl | 7 | 12 | H |
| 3A | Sniper | 6.4 fl oz/A | bifenthrin* | 21 | 12 | H |
| **4A** | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam | 7 | 12 | H |
| **4A** | Admire Pro | 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| **4A** | Admire Pro | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 5 | Blackhawk (FB only) | 1.7 to 3.3 oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant SC (FB only) | 5.0 to 6.0 fl oz/A | spinetoram | 3 | 4 | H |

### Imported Cabbageworm (and Other Caterpillars)

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Malathion 57 EC | 1.0 to 2.0 pt/A | malathion | 7 | 24 | H |
| 3A | Sniper | 5.12 to 6.4 fl oz/A | bifenthrin* | 21 | 12 | H |
| 5 | Blackhawk | 3.3 oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant | 6 fl oz/A | spinetoram | 3 | 4 | H |
| 5 | Entrust (OMRI) | 1.0 to 2.0 fl oz/A | spinosad | 3 | 4 | M |
| 11A | Javelin (OMRI) | 0.12 to 1.5 lb/A | *Bacillus thuringiensis* | 0 | 4 | L |
| 28 | Coragen | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 1 | 4 | L |

## Leafhoppers

Note: Some species of leafhopper can transmit horseradish brittleroot disease.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin SLR Plus | 0.5 to 1.0 qt/A | carbaryl | 7 | 12 | H |
| **4A** | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam | 7 | 12 | H |
| **4A** | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| **4A** | Admire Pro | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| **4D** | Sivanto 200 SL | 7.0 to 10.0 fl oz/A | flupyradifurone | 7 | 4 | M |

## Thrips

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 pt/A | methomyl* | 65 | 48 | H |
| **4A** | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 5 | Entrust (OMRI) | 1.0 to 2.0 oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant SC | 6.0 to 8.0 fl oz/A | spinetoram | 3 | 4 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Pesticides

## Damping-Off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **Apply one of the following at planting (see label for application methods and restrictions):** | | | | | | |
| **Phytophthora and Pythium root rot** | | | | | | |
| **4** | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | 5 | 48 | N |
| **4** | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | 5 | 48 | N |
| **4** | MetaStar 2E | 4.0 to 8.0 pt/A | metalaxyl | AP | 48 | N |
| **Phytophthora, Pythium, and Rhizoctonia root rot** | | | | | | |
| **4** + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence. | mefenoxam + azoxystrobin | AP | 0 | N |
| **Rhizoctonia root rot** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | AP | 4 | N |

## Bacterial Leaf Spot

Rotate away from cruciferous crops for at least 2 years if the field has a known history of disease. Avoid excessive irrigation and maintain proper drainage. Avoid cultivation or other activity when foliage is wet to minimize spread.

**Leaf Spots caused by *Alternaria* and *Cercospora* spp.** Use resistant varieties where available. A 3-year rotation to non-cruciferous crops may be required if the field has a history of disease.

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **When conditions favor disease development, apply one of the following on a 7-14 d schedule and rotate between fungicides with different FRAC codes as long as weather conditions favor disease development:** | | | | | | |
| 7 | Endura 70WG | 4.5 fl oz/A (Alternaria only) | boscalid | 0 | 12 | N |
| 7 | Fontelis 1.67SC | 16.0 to 30.0 fl oz/A | penthiopyrad | 0 | 12 | N |
| 11 | azoxystrobin 2.08F | 6.2 to 15.5 fl oz/A | azoxystrobin | 0 | 12 | N |
| 11 | Cabrio 20EG | 8.0 to 16.0 oz/A | pyraclostrobin | 0 | 12 | N |

**Ramularia Stem and Leaf Spot** In fields with a known history of Ramularia stem and leaf spot apply the following preventatively or when conditions favor disease development.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| M5 | chlorothalonil 6F | 3.0 pt/A | chlorothalonil | 14 | 12 | L |

**Verticillium wilt** Rotate away from fields with a known history of Verticillium wilt.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply through irrigation system 0.6-1.0 inches of water in the fall (once):** | | | | | | |
| -- | Vapam HL | 50.0 gal/A | metam sodium | 0 | 48 | -- |

## White Rust

Use certified, disease-free seed. A rotation to non-cruciferous crops may be required if the field has a history of disease. Manage weeds and volunteer hosts which may act as reservoirs for the pathogen. Plant “Big Top Western” types which have virus and white rust resistance.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **When conditions favor disease development, apply one of the following on a 7-14 day schedule:** | | | | | | |
| 11 | azoxystrobin 2.08F | 6.2 to 15.5 fl oz/A | azoxystrobin | 0 | 12 | N |
| 11 | Cabrio 20EG | 8.0 to 16.0 oz/A | pyaclostrobin | 0 | 12 | N |

# Leeks

## Recommended Varieties[1]

| | | |
|---|---|---|
| Belton* (summer/fall)[2] | Matejho RZ (summer/fall) | Rally* (summer) |
| Lancelot (fall/overwinter) | Megaton* (summer/fall) | Runner* (summer) |
| Lexton (overwinter) | Pandora (summer/fall) | Tadorna (fall/overwinter) |

[1]Varieties listed in alphabetical order; [2]Harvest period in parentheses; *Indicates F1 hybrid varieties.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Leeks[1] | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 100-125 | 200 | 150 | 100 | 0 | 200 | 150 | 100 | 0 | Total nutrient recommended |
| | 50-75 | 200 | 150 | 100 | 0 | 200 | 150 | 100 | 0 | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 3-4 weeks after planting if needed |

[1]Apply 3-4 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter.

## Seeding and Transplanting

For early spring plantings, southern transplants are used. For summer plantings, sow in seedbeds from early March to mid-May. About 2 lb of seed are required to provide enough plants to set an acre. Plant seed 1/3 to ½ inch deep 12-16 weeks before field setting. Transplants can be produced in 200-288 deep cell trays. Plants will be ready to set in early August. Spring leeks should be seeded approximately the third week of December and the fall crop approximately the first week of June.

## Field Spacing

Rows 20-30 in. apart; plants 4-6 in. apart in the row. Set plants in trenches 3-4 in. deep using celery-type planter.

## Culture

Leeks grow slowly for the first 2 or 3 months. To develop a long white stem, start to gradually fill in trenches and then hill soil around stems to 3 or 4 inches.

## Harvest and Post Harvest Considerations

Spring-transplanted leeks are ready for harvest in July. August-planted leeks are ready for harvest by November or can be overwintered. Half-mature leeks of the hardy varieties will stand winter freezing with some protection such as salt hay or straw if planted in very cold areas. In mild winter areas no protection is required and leeks will be ready for harvesting early in the spring. Undercut the leeks with a bar on a tractor or for smaller plantings dig with a spading fork.

After digging, leeks can be left in the field to dry for a short period. Leeks are bunched with 3-4 leeks per bunch. If soil sticks to the leeks, power wash the bunches before packing. If necessary, leeks can be cooled by icing in the box, hydrocooling or vacuum cooling with a water spray. Store leeks at 32-36°F and 95-100% relative humidity. Typical storage time is 7-21 days, but up to 2 months is possible.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

### 1. Soil-Applied (Preemergence)

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 3 | Dacthal 6F<br>Dacthal W-75 | 8.0 to 14.0 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6.0 to 10.5 lb/A | -- | 12 |
| -Labeled for both bulb onions and green onions. Apply at time of seeding or immediately after planting sets.<br>-Labeled for applications directly over transplants without crop damage.<br>-A second application may be needed for longer season seed onions; but will not control emerged weeds.<br>-Primarily controls annual grasses and a few broadleaf weeds, including common purslane.<br>-Results have been most consistent when used in fields with coarse -textured soils low in organic matter, and when the application are followed by rainfall or irrigation. Maximum application not addressed on label. | | | | | | |
| 3 | Prowl H2O 3.8CS | 2 pt/A | **pendimethalin** | 0.5 lb/A | 30 | 24 |
| -Apply at time of seeding or postemergence; **do not** mechanically incorporate. **Do not** apply preemergence to onions planted on mineral soils with less than 3% organic matter or injury may occur. Onion seed must be fully covered by soil, injury may occur if seed is exposed. Prowl H2O can be applied directly over emerged plants with 2 to 3 true leaves without crop damage.<br>-If sequential applications are made, allow 30 days between applications<br>-Primarily controls annual grasses and certain broadleaf weeds.<br>-**Do not** apply more than 2 pt/A per application; and **do not** apply more than 4 pt/A per season. | | | | | | |

### 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Poast 1.5EC | 1.0 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 30 | 12 |
| -Apply with crop oil concentrate at 1.0% v/v (1.0 gal/100 gal of spray solution). **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur.<br>-Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled.<br>-Repeated applications may be needed to control certain perennial grasses.<br>-**Do not** tank-mix with or apply within 1 week before or any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result.<br>-Rainfastness 1 hr. **Do not** apply more than 1.5 pt/A in single application and maximum Poast application per season is 4.5 pt/A. | | | | | | |
| 15 | Dual Magnum | 0.67 to 1.33 pt/A | **s-metolachlor** | 0.64 to 1.27 lb/A | 21 | 24 |
| -**A special Local-Needs 24© Label has been approved for the use of Dual Magnum in leeks in NJ.**<br>-The use of Dual Magnum is legal ONLY if a waiver of liability has been completed (see *http://www.farmassist.com/*).<br>-Apply after leeks have reached the 2 true leaf stage of growth; Dual Magnum will not control weeds that have emerged at time of application.<br>-Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. **Do not** use on coarse textured soils with less than 1% organic matter.<br>-Follow with overhead irrigation if rainfall does not occur.<br>-Primarily controls annual grass and certain broadleaf weeds, including galinsoga preemergence.<br>-**Do not** apply more than once per crop season; and **do not** exceed 1.33 pt/A per crop season. | | | | | | |

### 3. Postharvest

| | | | | | | |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25-3 pt/A | **paraquat*** | 0.56-0.75 lb/A | -- | 24 |
| -**For post-harvest desiccation of vegetable vines. A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest desiccation of the crop in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. Rainfastness 30 minutes.<br>-A maximum of 2 applications for crop dessication are allowed. | | | | | | |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

### Allium Leafminers

This new pest to the mid-Atlantic area is a long grey-black fly with a distinctive yellow or orange patch on the top of its head, yellow sides and "knees" (femur-tibia junction), and white halteres (knobs as second pair of wings). The larvae are a typical whitish maggot. Leek (*A. porrum*) tends to be the most damaged Allium species. Females repeatedly puncture leaves with their ovipositor, resulting in a line of small white dots near the tip. Leaves can be wavy, curled and distorted. Larvae mine leaves, and move into bulbs and leaf sheathes where they pupate. Covering plants in February, prior to the emergence of adults, and keeping plants covered during spring emergence, can exclude the pest. Avoid the adult oviposition period by delaying planting, cover fall plantings during the 2nd generation flight and grow leeks as far as possible from chives. Systemic and contact insecticides can be effective.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 3A | Mustang Maxx | 2.88 to 4.0 fl oz/A | zeta-cypermethrin* | 7 | 12 | H |
| 4A | Scorpion 35SL | 8.75 to 10.5 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Scorpion 35SL | 5.25 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Venom 70SG | 3.0 to 4.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinatoram | 1 | 4 | H |
| 17 | Trigard WSP | 2.66 oz/A | cyromazine | 0 | 12 | L |
| 28 + 6 | Minecto Pro | 7.0 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 30 | 12 | H |

### Aphids

Aphids found on leeks and other related vegetables are usually dark red or black. They are attracted to the compounds in Allium species that give them their distinctive smell. They walk short distances between plants and spread over long distances via air currents. They can survive on volunteer plants or on bulbs in storage. Aphids suck the sap of leek plants which can cause them to collapse. Look for aphids on leaves in the early to mid-season.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Malathion 57EC | 1.5 to 2.0 pt/A | malathion | 3 | 24 | H |
| 3A | Mustang Maxx | 2.24 to 4.00 fl oz/A | zeta-cypermethrin* | 7 | 12 | H |
| 4A | Assail 30SG | 5.0 to 8.0 oz/A | acetamiprid | 7 | 12 | H |
| 28 + 6 | Minecto Pro | 10 fl oz/A | cyantraniliprole + abamectin* | 30 | 12 | H |

### Armyworms (AW), Cutworms (CW), Cabbage Loopers (CL)

These lepidopteran pests (caterpillars) come in various colors and shapes and can be found from the beginning till the end of the season. Cutworms are found very early in the season. They are immigrants from southern regions, or have passed the winter in the area as pupae. Lepidopteran pest infestations are sporadic; no reliable methods have been found for predicting their occurrence. Plants should be scouted from planting until harvest for foliar feeding.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 3A | Mustang Maxx | 2.24 to 4.00 fl oz/A | zeta-cypermethrin* | 7 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A (AW and CL) | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A (AW and CL) | spinetoram | 1 | 4 | H |
| 11A | Dipel (OMRI) | 0.5 to 2.0 lb/A (CW and CL);<br>1.0 to 2.0 lb/A (AW) | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 18 | Intrepid 2F | 4.0 to 8.0 fl oz/A (AW) | methoxyfenozide | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 7.0 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 30 | 12 | H |

## Onion Maggots

This pest is more important in onions, but it can also be a problem in leeks. Planting successive crops of any Allium species in the same field increases the likelihood of maggot damage. Adults resemble small, slender house flies. There are 3 generations each year, but the spring generation is generally most damaging. Flies live for 2-4 weeks and are capable of migrating about a mile in search of suitable hosts. Females oviposit on the soil near the plants or occasionally on the young leaves or plant necks. Maggot feeding causes wilting of foliage, after which it collapses. Larger leeks may survive, but have distorted growth.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Malathion 57EC | 1.5 to 2.0 pt/A (adults only) | malathion | 3 | 24 | H |
| 3A | Mustang Maxx | 2.24 to 4.00 fl oz/A (adults only) | zeta-cypermethrin* | 7 | 12 | H |

## Thrips

Thrips pierce plant tissue and remove liquids. Immature thrips often feed on young tissue between the leaf sheaths and the stem; adults feed on more mature tissue. Feeding injury results in whitish or chlorotic blotches. Extended feeding can reduce bulb size and increase leaf and bulb rots. Effective management relies on high pressure, high gallonage sprays for thorough coverage and penetration into the foliage.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Malathion 57EC | 1.5 to 2.0 pt/A | malathion | 3 | 24 | H |
| 3A | Mustang Maxx | 2.88 to 4.00 fl oz/A | zeta-cypermethrin* | 7 | 12 | H |
| 4A | Assail 30SG | 5.0 to 8.0 oz/A | acetamiprid | 7 | 12 | H |
| 4A | Scorpion 35SL | 8.75 to 10.5 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Scorpion 35SL | 5.25 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Venom 70SG | 3.0 to 4.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 28 + 6 | Minecto Pro | 7.0 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 30 | 12 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

## Damping-Off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **FOR SEEDED BEDS: (Note:** Apron XL LS and Maxim 4FS can be combined**).** | | | | | | |
| **For Pythium and Phytophthora control, use a seed treatment such as:** | | | | | | |
| 4 | Apron XL LS | 0.085 to 0.64 fl oz/100 lb seed | mefenoxam | NA | NA | NA |
| **For control of other root rots apply:** | | | | | | |
| 4 | Maxim 4FS | 0.08 to 0.16 fl oz/100 lb seed | fludioxonil | NA | NA | NA |
| **FOR TRANSPLANTED BEDS:** | | | | | | |
| **For Pythium root rot control apply one of the following as a banded spray:** | | | | | | |
| 4 | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | AP | 48 | N |
| 4 | MetaStar 2E AG | 2.0 to 4.0 pt/A | metalaxyl | AP | 48 | N |
| **For Rhizoctonia root rot control apply as in-furrow application:** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | 0 | 4 | N |
| **For Pythium and Rhizoctonia root rot control apply as banded spray application:** | | | | | | |
| 4 + 11 | Uniform 3.66SC | 0.34 fl oz/1000 ft row (see label) | mefenoxam + azoxystrobin | AP | 0 | N |

## Downy Mildew (*Peronospora destructor*)

Downy mildew on leeks is caused by the same pathogen as for onion and garlic. Its development is promoted by cool, moist conditions. Management begins with planting pathogen-free seed or sets and crop rotations of at least 3 years without related crops. Be sure to eliminate culls and volunteers from the field.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following preventatively prior to the onset of disease. Notes: 1) Do not apply chlorothalonil more than 3 times per season. 2) Forum 4.18SC must be tank mixed with another fungicide effective for downy mildew.** | | | | | | |
| M5 | chlorothalonil 6F | 1.5 to 3.0 pt/A | chlorothalonil | 14 | 12 | L |
| 40 | Forum 4.18SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |
| **Rotate one of the following FRAC code 7 or 11 fungicides every 7 d when conditions favor disease development or when symptoms are present in the field:** | | | | | | |
| 7 | Fontelis 1.67SC | 16.0 to 24.0 fl oz/A | penthiopyrad | 0 | 12 | L |
| 7 + 11 | Merivon 2.09SC | 8.0 to 11.0 fl oz/A (for suppression) | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 7 + 11 | Pristine 38WP | 18.5 oz/A (for suppression) | boscalid + pyraclostrobin | 7 | 12 | -- |
| 11 | azoxystrobin 2.08F | 9.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 12.0 oz/A | pyraclostrobin | 7 | 12 | N |
| **Rotate one of the above with the following every 7 d as long as weather conditions favor disease development:** | | | | | | |
| 3 | Folicur 480SC | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |

## Fusarium Basil Rot

Leaf tips of infected plants will turn yellow and curl and eventually entire leaves will become chlorotic, turn brown and decay. Infected roots will turn dark brown. The outermost layers of infected bulbs will have a watery, brown discoloration. White mycelium may be present. The pathogen can survive in the soil for many years. Rotate away from leeks, garlic or onions for 4-5 years minimum. Avoid excess fertility. Insect feeding damage can increase basil rot; control onion maggot and other insects that may feed on bulbs.

## Purple Blotch

Begin preventative applications in the fall as soon as transplants are set out especially in fields with a history of the disease. Rotate the following at 7-10 d intervals as long as night temperatures remain warm and there are extended periods of leaf wetness.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply the following preventatively prior to the onset of disease. Do not apply chlorothalonil more than 3 times per season.** | | | | | | |
| M5 | chlorothalonil 6F | 1.5 to 3.0 pt/A | chlorothalonil | 14 | 12 | L |
| **Tank mix or rotate the above with one of the following FRAC code 3, 7 or 11 fungicides when conditions favor disease development or when symptoms are present in the field. Rotate fungicides with different modes of action.** | | | | | | |
| 3 | Folicur 480SC | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3 + 9 | Inspire Super 2.82 SC | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodinil | 7 | 12 | -- |
| 7 | Endura 70WG | 6.8 oz/A | boscalid | 7 | 12 | -- |
| 7 | Fontelis 1.67SC | 16.0 to 24.0 fl oz/A | penthiopyrad | 0 | 12 | L |
| 7 + 11 | Pristine 38WP | 10.5 to 18.5 oz/A | boscalid + pyraclostrobin | 7 | 12 | -- |
| 11 | Cabrio 20EG | 8.0 to 12.0 oz/A | pyraclostrobin | 7 | 12 | N |
| 11 | azoxystrobin 2.08F | 6.0 to 12 fl oz/A | azoxystrobin | 4 | 0 | N |

## White Rot (*Sclerotium cepivorum*)

White Rot is severe only on overwintered leeks. Cool, moist soil conditions that are favorable for the growth of leek, garlic and onion are also ideal for white rot. Infection occurs at soil temperatures between 50-75°F (60-65°F optimum). The disease is greatly inhibited above 78°F. Sclerotia can survive for over 20 yr, even in the absence of a host plant. In treated fields, do not grow crops other than leek and leafy vegetables during the harvest year, and do not grow leeks, garlic, leafy vegetables, tomatoes, root crops, cereal grains or soybeans the following year.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply the following fungicide at 10-14 d intervals (for suppression only):** | | | | | | |
| 3 | Folicur 480SC | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |

# Lettuce, Endive and Escarole

## Recommended Varieties[1]

| Crop | Type | Variety | Color | Season[2] | | Disease Resistance[3] | | | Environment | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sp | LSF | DM | LMV | CR | Heat[4] | Tip[5] |
| **Lettuce** | Bibb | Buttercrunch | Green | X | | | | | | |
| | | Winter Density | Green | X | X | | | | | |
| | Boston | Nancy | Green | X | | | X | | | |
| | | Optima | Green | X | | X | X | | | X |
| | Butterhead | Adriana | Green | X | | X | X | | X | X |
| | | Forlina | Green | X | X | X | X | | X | |
| | | Harmony | Green | X | | X | X | | | X |
| | | Hungarina | Green | X | X | X | X | | X | |
| | | Rex[6] | Green | X | X | X | | | X | X |
| | | Skyphos | Red | X | | X | X | | | |
| | Crisp | Cherokee | Red | X | X | X | | | X | |
| | | Magenta | Red | X | X | X | X | | | |
| | | Muir | Green | X | X | X | X | | X | |
| | | Nevada | Green | X | X | | | | X | X |
| | | Sierra | Green | X | X | | | | X | |
| | Iceberg | Ithaca | Green | X | X | | | | | |
| | | Summer Time | Green | X | | | | | X | |
| | Leaf | Bergams Green | Green | X | X | | | X | X | X |
| | | Green Star | Green | X | X | X | | | X | X |
| | | New Red Fire | Red | X | X | | | | | |
| | | Red Express | Red | X | X | | | | | |
| | | Red Sails | Red | X | | | | | | |
| | | Royal Oakleaf | Green | X | | | | | | |
| | | Starfighter | Green | X | X | X | | | X | |
| | | Tropicana | Green | X | X | | | | X | X |
| | | Two Star | Green | X | X | | | | X | X |
| | | Waldmann's Green | Green | X | | | | | | |
| | Romaine | Coastal Star | Green | X | | | | X | | |
| | | Cuore | Green | X | | X | | | | |
| | | Dov | Green | X | X | | | | X | |
| | | Green Forest | Green | X | | | | X | | X |
| | | Helvius | Green | X | | X | X | X | | X |
| | | Ideal Cos | Green | X | X | | | | | X |
| | | Monte Carlo | Green | X | | X | | | | X |
| | | Pomegranate Crunch | Red | | X | | | | | |
| | | Rouge de Hiver | Red | X | | | | | | |
| **Endive** | Endive | Green Curled | Green | X | | | | | | |
| | | Keystone | Green | X | | | | | | X |
| | | Salad King | Green | X | | | | | | |
| **Escarole** | Escarole | Florida Deep Heart | Green | X | | | | | | |
| | | Full Heart | Green | X | | | | | | |

[1]Listed alphabetically. [2]Sp=Spring, LSF=Late Summer and Fall. [3]DM=Downy Mildew resistant, LMV=Lettuce Mosaic Virus resistant, CR=Corky Root resistant. [4]Heat and bolting tolerant. [5]Leaf tipburn resistant. [6]Rex Variety: for high tunnel or greenhouse use only.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

*Recommended Nutrients Based on Soil Tests - continuedI*

| | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | **N (lb/A)** | **$P_2O_5$ (lb/A)** | | | | **$K_2O$ (lb/A)** | | | | **Nutrient Timing and Method** |
| **Leaf Lettuce, Endive, or Escarole** | 100-125 | 200 | 150 | 100 | 0 | 200 | 150 | 100 | 0 | Total nutrient recommended |
| | 50-75 | 200 | 150 | 100 | 0 | 200 | 150 | 100 | 0 | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 3-5 weeks after planting |
| **Iceberg Lettuce** | 60-80 | 200 | 150 | 100 | 0 | 200 | 150 | 100 | 0 | Total nutrient recommended |
| | 25-50 | 200 | 150 | 100 | 0 | 200 | 150 | 100 | 0 | Broadcast and disk-in |
| | 25-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 3-5 weeks after planting |

## Lettuces for Salad Mixes - See also the “Specialty Vegetables” section.

Loose-, red- and oakleaf, romaine and other lettuces are commonly used in baby or small leaf stages in salad mixes.

## Growing Conditions

Lettuce, endive and escarole are cool-season crops. Properly hardened lettuce transplants can tolerate temperatures as low as 20-25°F (-7 to -4°C). Temperatures above 85°F (29°C) for several days will cause seedstalk formation and bolting in lettuce. Temperatures below 70°F (21°C) during the seedling stage promote premature seedstalk formation in endive and escarole.

**Seed Treatment** Treat seeds to prevent disease. See Disease Control below.

## Seeding and Transplanting

**Spring Crop**: The early endive and escarole crop is usually grown from transplants shipped into the region. Lettuce transplants are started in frames or greenhouses. Lettuce seed is sown in frames in November, in unheated greenhouses in December, and in heated greenhouses in January and February at the rate of 4-6 oz seed for 1 acre of plants. Plants are ready for field planting early March.

Direct-seeded lettuce is sown in prepared beds as early in the spring as the ground can be worked. Seeds require light to germinate so should be sown at shallow depth. Some of the seeds should actually be uncovered. Pelleted seed should be watered at night during high-temperature periods (soil temperatures above 80°F/27°C) until germination occurs. The spring lettuce crop can be field-seeded or transplanted through May. In the southern part of the region, planting after April results in seed stalk formation. Only leaf lettuce should be seeded as late as May. Successive plantings of endive can be made through the middle of August.

**Seed Priming**: Lettuce seeds enter physiological dormancy at temperatures above 85°F (29°C). This can make it difficult to establish a fall crop. Priming seeds in 1% potassium phosphate ($K_3PO_4$) for 20 hours at 75°F (24°C) prior to sowing will prevent thermodormancy. Many vendors offer primed lettuce seeds for fall production.

**Fall Lettuce Crop**: Seed in the field July 25 to August 10 in PA and other cool areas, and August 5-20 in warmer areas. When transplants are used, planting dates can be delayed 2-3 weeks.

## Spacing

**Lettuce**: Head and Romaine lettuce is planted in rows 2 ft apart with plants 12-15 inches apart in the row. Leaf and Boston type lettuce are planted 3-4 rows per bed with beds spaced 66-72 inches on centers; space plants 9-12 inches apart in the row. Lettuce for baby greens or salad mixes is direct seeded in close rows (3-6 inches apart) or broadcast across beds. Coated seed is recommended for precision seeding of heading types. Plant 1 coated seed every 2-3 inches, or 2 seeds spaced 1 inch apart every 12 inches. Direct-seeded plants should be thinned when 2 or 3 true leaves have formed. **Endive and Escarole**: Plant 3-4 rows per bed and space beds 66-72 inches on centers. Space plants 9-15 inches apart in the row.

**Irrigation** Lettuce requires frequent irrigation with total seasonal water requirements of 10-12 inches.

## Harvest and Post Harvest Considerations

Lettuce is extremely perishable and needs to be handled delicately and marketed rapidly. Head lettuce is harvested when the heads are of good size (about 2 lb), well formed and solid. Head lettuce is hand cut and trimmed (leave 3 undamaged wrapper leaves on each head), and placed in containers in the field. It is then vacuum cooled or hydrocooled. Specialty leaf lettuces and other greens for bag mixes are harvested by hand or mechanically. If the harvest is delayed or if the crop is over-mature, a strong bitter taste and toughness develop and the product becomes unmarketable. Leaf, butterhead and cos/romaine types are cut, trimmed and bundled before placing in cartons.

Lettuce should be precooled to 34°F (1°C) soon after harvest and stored at 32°F (0°C) and 98-100% relative humidity for retention of quality and shelf life. At 32°F, head lettuce can be held in good condition for 2-3 weeks. Leaf, cos/romaine, and butterhead lettuce have a shorter shelf life. Lettuce is easily damaged by freezing, so all parts of the storage room must be kept above the freezing point (31.7°F, -0.2°C).

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

| **1. Soil-Applied (Preplant, Preemergence, or After Transplanting)** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| 8 | Prefar 4E | 5 to 6 qt/A | **bensulide** | 5.0 to 6.0 lb/A | -- | 12 |
| -Labled for preplant or preemergence applications. 24© label for **NJ only** allows applications up to 9 qt/A. Use on mineral soils only.<br>-If applied preemergence, irrigate within 36 hr of application with ½ inch of water; if not incorporated with rainfall or within 36 hr, weed control may be reduced. Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. **Do not** apply more than 6 qt/A per season. | | | | | | |
| 15 | Kerb 50-W (WP)<br>Kerb 3.3SC | 2 to 4 lb/A,<br>2 to 5 pt/A | **pronamide*** | 1.0 to 2.0 lb/A | 55 | 24 |
| -**Kerb 50-W is labled for head lettuce, endive, and escarole**.<br>-**Kerb 3.3SC has a supplemental label for leaf lettuce; rates for leaf lettuce range from 1.25 to 5 pt/A Kerb SC**<br>-Applications can be made preplant, preemergence, or after lettuce has emergence.<br>-Kerb needs water after application for optimum performance; 0.5-1 inches of rainfall or 1-2 inches of irrigation is recommended.<br>-Primarily controls annual grasses and certain broadleaf weeds. Kerb will not control emerged weeds.<br>-The required dosage rate is dependent on soil texture, target weed size, and method of irrigation. Refer to label for specific instructions.<br>-**Do not** use more than 1.5 lb/A pronamide on val temp, grande verde, and prima verde crisp head lettuce; or on endive (escarole).<br>-**Do not** make more than 1 application of Kerb 50W per crop.<br>-Kerb SC application can be split so part of the maximum allowable rate can be applied initially and the balance up to 10 days later.<br>-**Do not** apply more than 4 lb/A Kerb 50W or 5 pt/A Kerb SC per crop.<br>-Crops that are not on the label should not be planted for 3 to 12 months, depending on herbicide rate used and crop. | | | | | | |

| **2. Postemergence** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| **1** | Select 2 EC,<br>Select Max 0.97EC | 6 to 8 fl oz<br>9 to 16 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 14 | 24 |
| **1** | Poast 1.5EC | 1 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.28 lb/A | 15/30 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. The use of COC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions. Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.<br>-If repeat applications are necessary, allow 14 d between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-Rainfastness 1 hr. **Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 3 pt/A for the season.<br>-**Poast 1.5 EC labeled for leaf and head-type lettuces** (PHI=15 d for leaf types, 30 d for head types). | | | | | | |

| **3. Postharvest** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| 22 | Gramoxone 2SL | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant. Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

| **4. Other Labeled Herbicides** These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns. | | |
|---|---|---|
| **Group** | **Product Name** | **Active Ingredient (*=Restricted Use)** |
| 3 | Treflan | **trifluralin** |
| **14** | Aim | **carfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

**Aphids** On fall crop, seedling protection from aphids is important. Spray if the aphid population reaches 1 aphid/seedling or > 4 aphids/plant beyond the seedling stage.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 fl oz/A | methomyl* (check the label for PHI) | 7/10 | 48 | H |
| 1B | Acephate 97UP | 0.5 to 1.0 lb/A | acephate - **only labeled for head lettuce** | 21 | 24 | H |
| 1B | Dimethoate 400 | 0.5 pt/A | dimethoate* - **not labeled for head lettuce** | 14 | 48 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin + thiamethoxam* - **only labeled for head and leaf lettuce** | 7 | 24 | H |
| 3A + 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 4A | Actara | 1.5 to 3.0 oz/A | thiamethoxam | 7 | 12 | H |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.3 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Assail 30SG | 2.0 to 4.0 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Belay | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam | 30 | 12 | H |
| 4C | Closer SC | 1.5 to 2 fl oz/A | sulfoxaflor | 3 | 12 | H |
| 9B | Fulfill 50WP | 2.75 oz/A | pymetrozine | 7 | 12 | N |
| 9C | Beleaf 50SG | 2.0 to 2.8 oz/A | flonicamid | 0 | 12 | L |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 3 | 24 | L |
| 28 + 6 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

### Beet Armyworms

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* (check the label for PHI) | 7/10 | 48 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5 SG | 2.4 to 4.8 fl oz/A | emamectin benzoate* | 7 | 12 | H |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 1 | 4 | N |
| 22A | Avaunt | 3.5 to 6 fl oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen | 3.5 to 7.5 fl oz/A | chlorantraniliprole | 1 | 4 | L |
| 28 | Exirel | 7 to 13.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 | Verimark | 5 to 10 fl oz/A | cyantraniliprole - **soil** | NA | 4 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cabbage Loopers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* (check the label for PHI) | 7/10 | 48 | H |
| 3A | Baythroid XL | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Bifenture EC | 2.1 to 6.4 fl oz/A | bifenthrin* - **head lettuce only** | 7 | 12 | H |
| 3A | Perm-Up 3.2 | 2 to 8 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 0.96 to 1.6 fl oz/A | lambda-cyhalothrin* - **head and leaf lettuce** | 1 | 24 | H |
| 6 | Proclaim 5 SG | 3.2 to 4.8 fl oz/A | emamectin benzoate* | 7 | 12 | H |
| 11A | Dipel (OMRI) | ½ to 1 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 18 | Intrepid 2F (early season) | 4 to 8 fl oz/A | methoxyfenozide | 1 | 4 | N |
| 18 | Intrepid 2F (late season) | 8 to 10 fl oz/A | methoxyfenozide | 1 | 4 | N |
| 22A | Avaunt | 2.5 to 3.5 fl oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen | 3.5 to 7.5 fl oz/A | chlorantraniliprole | 1 | 4 | L |
| 28 | Exirel | 10 to 17 fl oz/A | cyantraniliprole **- foliar** | 1 | 12 | H |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole **- soil** | n/a | 4 | H |
| 28 + 6 | Minecto Pro | 7.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Corn Earworms (CEW)

**Note**: Head lettuce seedlings in the 7-18 leaf stage are vulnerable to CEW attack in August and September. Control must be achieved before center leaves start to form a head (15-18 leaf stage). Apply Lannate every 2-5 days or permethrin every 5-10 days according to CEW moth populations and pest management alerts.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* (check the label for PHI) | 7/10 | 48 | H |
| 3A | Baythroid XL | 2.4 to 3.2 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Bifenture EC | 2.1 to 6.4 fl oz/A | bifenthrin* - **head lettuce only** | 7 | 12 | H |
| 3A | Perm-Up 3.2 | 4 to 8 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone | 2.4 to 3.2 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* - **head and leaf lettuce** | 1 | 24 | H |
| 5 | Radiant SC | 5.0 to 10.0 oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim | 2.4 to 4.8 fl oz/A | emamectin benzoate* | 7 | 12 | H |
| 28 | Coragen | 3.5 to 7.5 fl oz/A | chlorantraniliprole | 1 | 4 | L |
| 28 | Exirel | 7 to 13.5 fl oz/A | cyantraniliprole **- foliar** | 1 | 12 | H |
| 28 | Verimark | 5 to 10 fl oz/A | cyantraniliprole **- soil** | n/a | 4 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cutworms - See also the Pest Management chapter, Insect Management section.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 pt/A | methomyl* (check the label for PHI) | 7/10 | 48 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Bifenture EC | 2.1 to 6.4 fl oz/A | bifenthrin* - **head lettuce only** | 7 | 12 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cyhalothrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 | 4 to 8 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 0.96 to 1.6 fl oz/A | lambda-cyhalothrin* - **head and leaf lettuce** | 1 | 24 | H |
| 3A+ 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6 to 9 fl oz/A | lambda-cyhalothrin + chlorantraniliprole* | 1 | 24 | H |

## Leafhoppers

Control of leafhoppers will prevent spread of lettuce yellows. In the spring, spray when plants are ½ inch tall, and repeat as needed. In the fall, spray seedlings 4-5 times at 5-day intervals.

*Leafhoppers - continued*

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* (check the label for PHI) | 7/10 | 48 | H |
| 1B | Acephate 97 UP | 0.5 to 1 lb/A | acephate - **head lettuce only** | 21 | 24 | H |
| 1B | Dimethoate 400 | 0.5 pt/A | dimethoate* - **not labeled for head lettuce** | 14 | 48 | H |
| 3A | Baythroid XL | 2.4 to 3.2 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Perm-Up 3.2 | 2 to 8 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone | 2.4 to 3.2 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | zeta-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 4A | Actara | 1.5 to 3 fl oz/A | thiamethoxam | 7 | 12 | H |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.3 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Belay | 9 to 12 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay | 3 to 4 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum | 5 to 11 fl oz/A | thiamethoxam | 30 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinetofuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 5.25 fl oz/A | dinetofuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70SG | 5.0 to 7.5 fl oz/A | dinetofuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 3.0 fl oz/A | dinetofuran - **foliar** | 7 | 12 | H |
| 16 | Courier SC | 9 to 13.6 fl oz/A | buprofezin | 7 | 12 | L |

## Leafminers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Dimethoate 400 | 0.5 pt/A | dimethoate* - **not labeled for head lettuce** | 14 | 48 | H |
| 3A | Perm-Up 3.2 | 4 to 8 fl oz/A | permethrin* | 1 | 12 | H |
| 4A | Scorpion 35 SL | 9 to 10.5 fl oz/A | dinetofuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35 SL | 2 to 5.25 fl oz/A | dinetofuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70 SG | 1 to 3 fl oz/A | dinetofuran | 7 | 12 | H |
| 4A | Venom 70 SG | 5 to 7.5 fl oz/A | dinetofuran | 21 | 12 | H |
| 5 | Entrust SC (OMRI) | 6.0 to 10.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 oz/A | spinetoram | 1 | 4 | H |
| 6 | Agri-Mek | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 17 | Trigard | 2.66 oz/A | cyromazine | 7 | 12 | H |
| 28 | Coragen (larvae only) | 5.0 to 7.5 fl oz/A | chlorantraniliprole | 1 | 4 | L |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole | 1 | 12 | H |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole | NA | 4 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Tarnished Plant Bugs

Can cause serious damage to the fall crop; it is usually numerous where weeds abound.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Sevin XLR Plus | 1 to 2 qt/A | carbaryl | 14 | 12 | H |
| 3A | Baythroid XL | 2.4 to 3.2 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Bifenture EC | 5.12 to 6.4 fl oz/A | bifenthrin* - **head lettuce only** | 7 | 12 | H |
| 3A | Mustang Maxx | 3.2 to 4.0 fl oz/A | zeta-cyhalothrin* | 1 | 12 | H |
| 3A | Tombstone | 2.4 to 3.2 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* - **head and leaf lettuce** | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4 to 4.5 fl oz/A | lambda-cyhalothrin+thiamethoxam* - **head and leaf lettuce** | 7 | 24 | H |

## Thrips

Some species spread Tomato Spotted Wilt Virus. Scout for thrips and begin treatments when observed.
**Do not** produce vegetable transplants with bedding plants in the same greenhouse.

*Thrips - continued*

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 fl oz/A | methomyl* (check the label for PHI) | 7/10 | 48 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Hero EC (onion thrips only) | 10.3 fl oz/A | zeta-cypermethrin + bifenthrin* **- only labeled for head lettuce** | 7 | 12 | H |
| 3A | Mustang Maxx | 3.2 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A + 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 5 | Entrust SC (OMRI) | 6.0 to 10.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole | 1 | 12 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

**Seed Treatment** Dust seed with thiram 480DP at the rate of 1 level tsp/lb of seed (3.0 oz/100 lb).

### Damping-Off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

An application of mefenoxam or metalaxyl at planting will also help suppress White rust and Downy mildew development early in the season. Uniform applied at transplanting or seeding will also help suppress early-season Rhizoctonia root rot and Downy mildew.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following in a 7-inch band after seeding or transplanting:** | | | | | | |
| 4 | Ridomil Gold 4SL | 1.0 to 2.0 pt /A | mefenoxam | AP | 12 | N |
| 4 | Ultra Flourish 2E | 2.0 to 4.0 pt /A | mefenoxam | AP | 48 | N |
| 4 | MetaStar 2E AG | 4.0 to 8.0 pt/A | metalaxyl | AP | 48 | N |
| 4 + 11 | Uniform 3.66SE | 0.34 fl oz/1000 row | mefenoxam + azoxystrobin | AP | 0 | N |

## Bacterial and Fungal Diseases

### Bottom Rot caused by *Rhizoctonia*

A midsummer application of a soil fumigant will be beneficial for a fall crop (See Soil Fumigation section in the Pest Management chapter). For the spring and fall crops, all fields should receive one of the following fungicide applications one week after transplanting or thinning and at 10 and/or 20 days later if conditions warrant and/or cultivation has been done. Uniform (0.34 fl oz 3.66SE/1000 ft row) applied in-furrow at transplanting or seeding for root rot control will also help early-season suppression of downy mildew.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 2 | iprodione[1] | 1.5 to 2.0 lb 50WP/A | iprodione | 14 | 12 | N |
| 4 + 11 | Uniform | 0.34 fl oz 3.66SE/1000 ft row | mefenoxam + azoxystrobin | AP | 0 | -- |
| 7 | Endura | 8.0 to 11.0 oz 70W/A | boscalid[1] **- not labeled for Endive and Escarole** | 14 | 12 | -- |

[1]**Do not** cultivate directly after applying iprodione or Endura (see labels for details).

### Corky Root (*Rhizomonas suberifaciens*)

Development of this bacterial disease is favored by continual cropping in the same field. Cultural practices that reduce soil compaction, such as the use of a rye cover crop and high beds, should be considered. Limit irrigation between transplanting or thinning. Warm soil temperatures and high soil N levels may exacerbate disease.

### Downy Mildew (*Bremia lactucae*)

Ridomil Gold 4SL, Ultra Flourish 2E, or MetaStar 2E used for damping-off at seeding or transplanting will also help in the control of early-season downy mildew. Downy mildew can cause problems during extended periods of cool, wet weather. Fungicide applications should begin and continue as conditions favor disease development.

*Downy Mildew - continued*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Rotate one of the following fungicides:** | | | | | | |
| 7 + 11 | Merivon 2.09SC | 8.0 to 11.0 fl oz/A | fluxapyroxad + azoxystrobin | 1 | 12 | N |
| 11 | Reason 500SC | 5.5 to 8.2 fl oz/A | fenamidone - **not labeled for Endive and Escarole** | 2 | 12 | -- |
| 28 | Previcur Flex 6F | 1.33 pt/A | propamocarb HCL | 2 | 12 | N |
| **With one of the following FRAC code 40 fungicides every 7 d as long as weather conditions favor disease development.** | | | | | | |
| 40 | Revus 2.08SC | 8.0 fl oz/A | mandipropamid - **not labeled for Escarole** | 1 | 4 | N |
| 40 | Forum 4.18SV | 6.0 fl oz/A | dimethomorph - **not labeled for Escarole** | 0 | 12 | N |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | dimethomorph + ametoctradin | 0 | 12 | -- |

## Gray Mold (*Botrytis cinera*)

Gray old is most troublesome in transplant greenhouses where air movement is poor and relative humidity high. Avoid overcrowding plants and water early in the day to help reduce leaf wetness overnight. Vent structure as much as possible to reduce relative humidity. See Table E-10 for options for *Botrytis* control in the greenhouse. In the field, rotate between the following fungicides every 7 d as long as conditions are favorable for disease development.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 7 | Endura 70WG | 8.0 to 11.0 oz/A | boscalid - **not labeled for Endive and Escarole** | 14 | 12 | -- |
| 7 + 11 | Merivon 2.09SC | 8.0 to 11 fl oz/A | fluxapyroxad + pyraclostrobin | 1 | 12 | N |
| 12 | Cannonball 50WP | 7.0 oz/A | fludioxonil | 0 | 12 | L |
| 14 | Botran 75WP | 2.0 to 5.3 lb/A | dichloran | 14 | 12 | N |

## Leaf Spots caused *Septoria*, *Anthracnose*, and *Cercospora* spp.

In fields with a history of leaf spot diseases, and when conditions are favorable for disease development, alternate among the following fungicides every 7 d as long as weather conditions favor disease development.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 7 | Fontelis 1.67SC | 14.0 to 24.0 fl oz/A | penthiopyrad | 3 | 12 | L |
| 7 + 11 | Merivon 2.09SC | 4.0 to 11.0 fl oz/A | fluxapyroxad + pyrclostrobin | 14 | 12 | N |
| 11 | azoxystrobin 2.08F | 6.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |

## Lettuce Drop (*Sclerotinia sclerotiorum*)

The pathogen has a wide host range including allium, brassica, and solanaceous crops. Proper and adequate crop rotations are necessary since the pathogen can survive in soils for many years.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following as a directed spray at transplanting and/or thinning. See labels for restrictions. Rotate between the following fungicides if more than one application is needed.** | | | | | | |
| 2 | iprodione 50WP[1] | 1.5 to 2.0 lb/A | iprodione | 14 | 12 | N |
| 7 | Endura 70W | 8.0 to 11.0 oz/A | boscalid - **not labeled for Endive and Escarole** | 14 | 12 | -- |
| 12 | Cannonball 50WP | 7.0 oz/A | fludioxonil | 0 | 12 | L |
| **Other preplant option**: Apply Contans 5.3WG at 2.0 to 4.0 lb/A approximately 3-4 months prior to the anticipated onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1-2 inches but **do not** plow before seeding or transplanting lettuce to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer. | | | | | | |

[1]**Do not** cultivate directly after application (see labels for details).

## <u>Viruses</u>

**Big-Vein**: Big Vein is favored by cool temperatures (<60°F, 16°C) and high soil moisture conditions. Produce the crop on raised beds and avoid planting in fields with low-lying areas. Soil fumigation is helpful (See Pest Management chapter). **Lettuce Mosaic Virus**: Use virus-free or mosaic tested lettuce seed. **Tomato Spotted Wilt Virus (TSWV)**: TSWV is spread from flowering ornamental plants (flowers) to lettuce by thrips. Do not grow any ornamental bedding plants in the same greenhouse as lettuce transplants. Scout and monitor for greenhouse thrips regularly and begin an insecticide control program once observed. **Turnip Mosaic Virus**: Troublesome in late summer and early fall plantings. Control weed hosts around irrigation risers and in border areas. **Yellows**: Control leafhopper vectors with insecticides - see Insect Control section above.

# Muskmelons and Mixed Melons

## Recommended Varieties[1,2]

| Type | Flesh Color | Variety | Days[3] | Rind Description | Lb | PM[4] | FW[5] |
|---|---|---|---|---|---|---|---|
| **Muskmelon** | Orange | Accolade | 74 | Oval, medium netting, light sutures | 5 | 1,2 | 0,1,2 |
| | | Aphrodite | 80 | Light netting, light sutures | 7 | 1 | 0,1,2 |
| | | Astound | 75 | Oval, fine netting, light sutures | 5 | 1,2 | 0,1,2 |
| | | Athena | 79 | Oval, medium netting, light sutures | 6 | 1,2 | 0,1,2 |
| | | Atlantis | 74 | Oval, medium netting, light sutures | 7 | 1,2 | 0,1,2 |
| | | Avatar | 72 | Oval, medium netting | 8 | 1,2 | 0,1,2 |
| | | Caribbean Gold | 80 | Round, netted, no sutures | 3 | 2 | 0,1,2 |
| | | Goddess | 68 | Oval, medium netting, light sutures | 5 | 1,2 | 0,1,2 |
| | | Grand Slam | 85 | Oval, coarse netting, no sutures | 7 | 1,2 | 0,2 |
| | | Halona | 73 | Round, netted, heavy sutures | 4 | 1,2 | 0,1,2 |
| | | Minerva | 78 | Oval, coarse netting, light sutures | 8 | 1,2 | 0,1,2 |
| | | Orange Sherbert | 80 | Oval, medium netted, heavy sutures | 7 | 1 | 1,2 |
| | | Sarah’s Choice | 76 | Round, netted, no sutures | 3 | 1,2 | 0,1,2 |
| | | Strike | 85 | Oval, coarse netting, no sutures | 7 | 1,2 | 0,2 |
| | | Sugar Cube | 80 | Mini, round, netted, no sutures | 2 | 1,2 | 0,1,2 |
| **Canary** | White | Amy | 75 | Slight oval, yellow, no net | 3 | | |
| | | Camino Europa | 84 | Oval, yellow, wrinkled, no net | 5 | 1,2 | 0,1,2 |
| | | Camposol | 80 | Oval, yellow, wrinkled, no net | 6 | 1,2 | |
| **Galia** | Green | Arava | 77 | Slight oval, fine net, no sutures | 3 | 1,2 | |
| | | Courier | 85 | Slight oval, fine net, no sutures | 5 | 1,2 | 0,1,2 |
| | | Diplomat | 75 | Slight oval, fine net, no sutures | 5 | 1,2 | |
| | | Visa | 75 | Slight oval, fine net, no sutures | 4 | 1,2 | |
| **Honeydew** | Light green | Dewlightful | 90 | Round, white, smooth | 7 | 1,2 | |
| | | Earli-Dew | 80 | Round, white, smooth | 3 | | 2 |
| | | New Moon | 85 | Round, white, smooth | 5 | 1 | 0,2 |
| | | Summer Dew | 88 | Round, white, smooth | 5 | 1,2 | 0,2 |
| **Asian** | White | Sprite | 70 | Oval, smooth, white rind | 1 | | |
| **Christmas** | Light green | Lambkin | 70 | Oval, smooth, green/yellow rind | 3 | | |

[1]Listed alphabetically. [2]All varieties are hybrids. [3]Relative days to harvest. [4]PM=Powdery Mildew; resistance to PM races as reported from source seed companies. [5]FW=Fusarium Wilt; resistance to FW races as reported from source seed companies.

## Melon Descriptions

| | |
|---|---|
| **Ananas** | Middle Eastern Melons. Oval shaped with medium-fine netting over pale green to orange rind. Very sweet, aromatic white flesh or orange-pink flesh. Average weight 3-4 pounds. |
| **Canary** | Bright yellow rinds and an oblong shape. Inside, the pale, cream-colored flesh is juicy, and the flavor is very mild. |
| **Casaba** | Oval shape with a pointy end, wrinkled yellow skin, weighing 4-7 pounds. The pale, almost white flesh is extremely sweet. |
| **Charentais** | French melons identifiable by their smooth, gray, or gray-blue rinds with sutures and orange flesh and are small in size. |
| **Christmas** | Football shape and weighing upwards of 5 to 8 pounds. They have green mottled rinds and pale orange to light green flesh depending upon the variety. Sweet flesh. |
| **Crenshaw** | Casaba cross with a slightly more oblong shape, weighing at least 5 pounds. The slightly wrinkled green rind ripens to yellow. Inside, the flesh is pale peachy orange. It has a strong, spicy aroma. |
| **Crosses** | There are a number of crosses, e.g, muskmelon x Galia and Charentais x Muskmelon that produce excellent melons. |
| **Galia** | Israeli melons that have netted rinds similar to cantaloupes but paler in color. The sweet pale green to almost white flesh has the consistency of a honeydew with what has been described as a spicy-sweet or banana-like aroma. When ripe, they slip from the vine. |
| **Honeydew** | Smooth, white to greenish-white rinds (some may be yellow) and sweet flesh that may be green, white, or orange. Its texture is similar to a cantaloupe, but the flavor more subtle and sweet. |
| **Musk** | The familiar American cantaloupes with orange flesh and netted skin. This includes deep sutured round to oval “Superstar” types, Eastern “Athena” types that are oval with slight sutures, and Western shipping types without sutures. |
| **Oriental** | Small (weighing a little more than 1 pound), elongated yellow melons with white sutures, and sweet, pale peach to white flesh. Because the seeds are so small and the rind is so thin, the entire melon can be eaten. |
| **Other** | Specialty melons that do not fit into the other catagories are also available including those catagorized as “Gourmet”. |
| **Persian** | Bigger than cantaloupes, have a dark green rind with light brown netting. As it ripens, the rind turns to light green. Bright pink-orange flesh has a delicate flavor. Unlike most melons in the Reticulatus group, Persian melons do not slip from the vine when mature. |

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Musk-melons[1] | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 75-150 | 150 | 100 | 50 | 0[1] | 200 | 150 | 100 | 0[1] | Total nutrient recommended |
| | 25-50 | 150 | 100 | 50 | 0[1] | 200 | 150 | 100 | 0[1] | Broadcast and disk-in or follow fertigation schedule |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress when vines begin to run or follow fertigation schedule |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress prior to first harvest or follow fertigation schedule |

[1]For plasticulture, fertilization rates are based on a standard row spacing of 6 ft. Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter. [1]In VA, crop replacement values of 25 lb/A of $P_2O_5$ and 50 lb/A of $K_2O$ are recommended on soils testing Very High.

## Fertigation Schedule Examples

This table provides examples of fertigation schedules based on two common scenarios – sandy coastal plain soils and heavier upland soils. Modify according to specific soil tests and base fertility.

| **Fertigation recommendations for 100 lb N and 100 lb $K_2O$[1,2]** For soils with organic matter content less than 2% or coarse texture and low to medium or deficient K | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Nitrogen** | | | **Potash** | | |
| **Preplant (lb/A)[3]** | | | **50** | | | **100** | | |
| | | | **N** | **N** | **N** | **$K_2O$** | **$K_2O$** | **$K_2O$** |
| **Stage and Description** | Weeks | Days | lb/day | lb/week | lb/stage | lb/day | lb/week | lb/stage |
| **1 Early vegetative** | 1-4 | 1-28 | 0.9 | 6.3 | 25.2 | 0.9 | 6.3 | 25.2 |
| **2 Late vegetative** | 5-7 | 29-49 | 1.3 | 9.1 | 27.3 | 1.3 | 9.1 | 27.3 |
| **3 Flowering and fruiting** | 8-11 | 50-77 | 1.5 | 10.5 | 42 | 1.5 | 10.5 | 42 |
| **4 Harvest[4]** | 12-13 | 78-91 | 0.7 | 4.9 | 9.8 | 0.7 | 4.9 | 9.8 |
| **Fertigation recommendations for 60 lb N and 60 lb $K_20$[1,2]** For soils with organic matter content greater than 2% or fine texture and high or optimum K | | | | | | | | |
| | | | **Nitrogen** | | | **Potash** | | |
| **Preplant (lb/A)[3]** | | | **40** | | | **40** | | |
| | | | **N** | **N** | **N** | **$K_2O$** | **$K_2O$** | **$K_2O$** |
| **Stage and Description** | Weeks | Days | lb/day | lb/week | lb/stage | lb/day | lb/week | lb/stage |
| **1 Early vegetative** | 1-4 | 1-28 | 0.5 | 3.5 | 14 | 0.5 | 3.5 | 14 |
| **2 Late vegetative** | 5-7 | 29-49 | 0.8 | 5.6 | 16.8 | 0.8 | 5.6 | 16.8 |
| **3 Flowering and fruiting** | 8-11 | 50-77 | 0.9 | 6.3 | 25.2 | 0.9 | 6.3 | 25.2 |
| **4 Harvest[4]** | 12-13 | 78-91 | 0.4 | 2.8 | 5.6 | 0.4 | 2.8 | 5.6 |

[1]Rates are based on 7,260 linear bed ft/A (6-ft bed spacing). If beds are closer or wider, fertilizer rates should be adjusted proportionally. Drive rows should not be used in acreage calculations (see the Fertigation section in the Irrigation Management chapter). [2]Base overall application rate on soil test recommendations. [3]Applied under plastic mulch to effective bed area using modified broadcast method. [4]For extended harvest after 10 weeks continue fertigation at this rate.

## Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical muskmelon tissue test values for most recently matured leaves prior to fruit set: N 4-5 %, P 0.4-0.7 %, K 5.0-7.0 %, Ca 3-5%, Mg 0.35-0.45% and S 0.2%. For additional nutrients and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *http://edis.ifas.ufl.edu/ep081*

**Seed Treatment** Seed should be treated; check with your seed company and see Disease Control below.

## Plant Production, Planting and Spacing

Transplants should be grown in pots or cells with at least 2 x 2 inches per plant. Smaller pots or cells will restrict root growth and provide less protection to the newly set transplant. If the seed is of good quality with a high germination test, one seed per pot is sufficient. One ounce of muskmelon seed contains 950-1,250 seeds.

Transplant container-grown plants through plastic mulch when daily mean temperatures have reached 60°F (16°C). Temperatures below 45°F (7°C) can stunt plant growth. Planting dates vary from May 1 in southern regions to June 5 in northern areas. Early plantings should be protected from winds with hot caps, tents, row covers, or rye strips. The recommended spacing for muskmelons is 5-6 ft between rows and 2-3 ft between plants in the row.

## Drip/Trickle Fertilization

Before mulching, adjust soil pH to around 6.5, apply enough farm-grade fertilizer to supply 25-50% of N and $K_2O$ requirements and thoroughly incorporate into the soil. At least 50% of N should be in the nitrate ($NO_3^{-1}$) form. Apply all $P_2O_5$ pre-plant and incorporate into the soil. Apply the balance of N and $K_2O$ through the drip irrigation system throughout the season. The first fertigation application should be within a week after field transplanting or direct seeding.

**Manganese Toxicity** This disorder occurs in acid soils (pH < 5.8). Maintain soil pH at 6.5 to avoid toxicity.

## Mulching

Plastic mulch laid on moist soil before field plantings conserves moisture, increases soil temperature, and increases early and total yields. Various widths of plastic mulch are available; choose a width that works with your production system and available equipement. Fumigion aids in the control of weeds and soil-borne diseases. Several fumigants can be used on muskmelon depending on what the predominant pests are. Plastic and fumigant should be applied to well-prepared soil 30 days before field planting. Fumigation alone may not provide satisfactory weed control under plastic. Black plastic or paper can be used without an herbicide.

## Pollination

Honeybees, squash bees, bumblebees and other wild bees are important for pollination and fruit set. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See section on "Pollination" in the General Production Recommendations chapter and/or Tables below for relative toxicity of various pesticides for bees.

## Harvest and Post Harvest Considerations

Muskmelons should be harvested no sooner than at half-slip and preferably at full-slip for optimum fruit quality. Canary melons and Galia melons also slip, but Honeydews do not. Pick honeydew melons when the stem end becomes slightly springy and the skin takes on a creamy yellow appearance. Harvest daily in hot weather. Cooling to remove field heat is desired. Precooling can be done with cold water, cold air, or ice. Hydrocooling is the most efficient method, but room cooling and forced air cooling are also suitable for melons. After precooling, muskmelons should be stored at 36-41°F (2-5°C) and 95% relative humidity. A full-slip melon can be kept about 15 days at this temperature. Honeydews and other non-slip melons should not be stored below 40°F (4°C), as chilling injury will result. They will retain adequate quality for 2-3 weeks at 45-50°F (7-10°C).

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**Labeled Applications Sites for Muskmelon**

| | | Plastic mulch production | | | | | | Bare-ground production | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil-Applied | | Postemergence | | | | | | |
| **Herbicides** | WSSA group number | Under Plastic | Row Middles | Over Plastic | Row Middles | Post-Harvest | | Soil-applied | POST | Post-harvest |
| Sandea | 2 | YES | YES | YES | YES | | | YES | YES | |
| Curbit | 3 | | YES | | | | | YES | | |
| Prowl H2O | 3 | | YES | | | | | | | |
| Treflan | 3 | | YES | | | | | | | |
| Prefar | 8 | YES | YES | | | | | YES | | |
| Command | 13 | | YES | | | | | YES | | |
| Strategy | 3 + 13 | | YES | | | | | YES | | |
| Poast | 1 | | | YES | | | | | YES | |
| Select | 1 | | | YES | | | | | YES | |
| SelectMax | 1 | | | YES | | | | | YES | |
| Gramoxone | 22 | | | | YES | YES | | | | YES |

## 1. Soil-Applied

<table>
<tr><th>Group</th><th>Product Name</th><th>Product Rate</th><th>Active Ingredient (*=Restricted Use)</th><th>Active Ingredient Rate</th><th>PHI (d)</th><th>REI (h)</th></tr>
<tr><td>2</td><td>Sandea 75DF</td><td>0.5 to 1 oz/A</td><td>halosulfuron</td><td>0.023 to 0.047 lb/A</td><td>57</td><td>12</td></tr>
<tr><td colspan="7">-Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but NOT labeled on muskmelons.<br>-Plasticulture: can be applied in a band under the plastic, immediately before laying the mulch; delay seeding or transplanting for 7 days after application. Row middles: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v or include a non-selective herbicide.<br>-Bareground: apply broadcast after seeding but before crop emergence or no sooner than 7 days before transplanting.<br>-Suppresses or controls yellow nutsedge and certain broadleaf weeds.<br>-Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. Do not use Group 2 herbicides repeatedly in the same field.<br>-Do not apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Maximum number of Sandea applications per year is 2 and do not exceed 2 oz/A during the crop season.</td></tr>
<tr><td>3</td><td>Curbit 3EC</td><td>1 to 3 pt/A</td><td>ethalfluralin</td><td>0.38 to 1.13 lb/A</td><td>--</td><td>24</td></tr>
<tr><td colspan="7">-Plasticulture: row middles only: apply as a banded spray after crop emergence or after transplanting. Do not soil incorporate.<br>-Bareground: apply broadcast after direct-seeding but prior to crop emergence; do not use on transplanted melons.<br>-Controls annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp.<br>-Use lower rate for coarse-textured soils or soils with low organic matter.<br>-Where overhead irrigation is available, activate Curbit with 0.5 inch of irrigation within 2 days after application; if no irrigation or rainfall occurs within 5 days of application, activity of Curbit can be reduced.<br>-Available as a pre-mix herbicide Strategy. Strategy at 3 pt/A= Curbit at 26 fl oz (0.6 lb ai) and Command at 8 fl oz (0.188 lb ai)<br>-Maximum applications per season: not specified</td></tr>
<tr><td>3</td><td>Prowl H2O 3.8CS</td><td>2.1 pt/A</td><td>pendimethalin</td><td>1 lb/A</td><td>35</td><td>24</td></tr>
<tr><td colspan="7">-Plasticulture: row middles only: apply as a banded spray before seeded crop has emerged or before transplanting.<br>-Bareground: apply with shielded sprayer band between rows, leaving 6 inches of untreated area on both sides of the seeded or transplanted row. Apply before seeded crop emerges or before transplanting.<br>-Where overhead irrigation is available, activate Prowl with 0.5 inch of rainfall or sprinkler irrigation within 48 hr of application; if no irrigation or rainfall occurs within 5 days of application, activity of Prowl can be reduced<br>-A second application at the same rate may be applied to row middles as a banded spray postemergence a minimum of 21 days after the first application, but before the vines begin to run.<br>-Do not apply over the top of the crop, or severe injury may occur.<br>-Maximum number of Prowl H2O applications per season is 2 and do not exceed 4.2 pt/A during the crop season.</td></tr>
<tr><td>3</td><td>Treflan 4EC</td><td>1 to 2 pt/A</td><td>trifluralin</td><td>0.5 to 1 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Plasticulture: row middles only: apply as a directed spray after emergence when plants have reached the 3 to 4 true leaf stage of growth. Not labeled for bareground production. Primarily controls annual grasses with a few broadleaf weeds.<br>-Do not use (or reduce the rate) when cold, wet soil conditions are expected, or crop injury may result.<br>-Maximum applications per season: not specified.</td></tr>
</table>

*1. Soil-Applied continued on next page*

*1. Soil-Applied - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 + 13 | Strategy 2.1SC | 1.5 to 6 pt/A | **ethalfluralin *plus* clomazone** | 0.39 to 1.58 lb/A | 45 | 24 |

- **Plasticulture**: row middles application. **Bareground**: apply broadcast just before planting or after planting but before crop emergence.
- Strategy is a prepackage mixture of Curbit 3EC and Command 3ME.
- **Do not** apply prior to planting crop. **Do not** soil incorporate. Refer to individual products for comments.
- Maximum applications per season: not specified.

| | | | | | | |
|---|---|---|---|---|---|---|
| 8 | Prefar 4E | 5 to 6 qt/A | **bensulide** | 5 to 6 lb/A | -- | 12 |

- **Plasticulture** under plastic: apply in a band under the plastic, immediately before laying the mulch. Plasticulture: row middles application is labeled. **Bareground**: apply preemergence or preplant incorporated. Preemergence applications should be followed by irrigation within 36 hrs (apply enough water to wet the soil at leat 2 to 4 inches deep). Preplant incorporated applications should be incorporated 1 to 2 inches deep (deeper than 2 inches will result in reduced weed control).
- Prefar provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. Maximum applications per season: not specified.

| | | | | | | |
|---|---|---|---|---|---|---|
| 13 | Command 3ME | 6,4 to 10.7 fl oz/A | **clomazone** | 0.15 to 0.25 lb/A | -- | 12 |

- **Plasticulture**: row middles application only. **Bareground**: apply broadcast just before planting or after planting but before crop emergence. Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops.
- Controls annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Carpetweed, morningglory sp., pigweed sp., and yellow nutsedge will not be controlled. Higher rates will improve control (or expand number of species controlled) such as common cocklebur, common ragweed, or jimsonweed (refer to label for specific weeds and rates).
- **WARNING**: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application (refer to label for restrictions).
- Available as a pre-mix herbicide Strategy: Strategy at 3 pt/A= Command at 8 fl oz (0.188 lb ai) and Curbit at 26 fl oz (0.6 lb ai)
- Maximum number of Command applications per year: 1.

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>12 to 16 fl oz/A | **clethodim** | 0.094 to 0.13 lb/A | 14 | 24 |
| | Poast 1.5EC | 1 to 1.5 pt/A | **sethoxydim** | 0.19 to 0.28 lb/A | 14 | 12 |

- Postemergence as broadcast spray with both plasticulture and bareground
- **Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.
- Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.
- If repeat applications are necessary, allow 14 days between applications.
- **Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.
- Rainfastness is 1 hr.
- **Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 64 fl oz/A for the season.
- **Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 3 pt/A for the season.

| | | | | | | |
|---|---|---|---|---|---|---|
| **2** | Sandea 75DF | 0.5 to 0.66 oz/A | **halosulfuron** | 0.023 to 0.031 lb/A | 57 | 12 |

- **Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but NOT labeled on muskmelons.**
- **Plasticulture**: broadcast (over the top) or directed to row middles; broadcast for bareground.
- **Bareground**: apply Sandea after the crop has at least 3 to 5 true leaves but before first female flowers appear and no sooner than 14 days after transplanting. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v.
- Suppresses or controls yellow nutsedge and certain broadleaf; control of weeds taller than 3 inches may not be adequate. Sandea will not control common lambsquarters or eastern black nightshade if applied postemergence; for row middle application, tankmix with a non-selective herbicide to increase spectrum of control.
- Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field.
- **Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.
- Rainfastness is 4 hrs. Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season

*2. Postemergence continued on next page*

*2. Postemergence - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 1.95 pt/A | **paraquat *** | 0.49 lb/A | 14 | 24 |

-**A Supplemental Label has been approved for the use of Gramoxone 2SL for postemergence weed control in DE, MD, NJ, PA, and VA.** Row middles as a shielded application.
-Apply as a directed spray in a minimum of 20 gallons spray mix per acre to control emerged weeds between the rows after crop establishment. Include a nonionic surfactant at 0.25% v/v. Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings.
-Rainfastness is 30 minutes. A maximum of 3 applications per year are allowed.

### 3. Postharvest

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |

-**For postharvest desiccation of vegetable vines. A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest desiccation of the crop in DE, NJ and VA.**
-Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.
-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.
-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed.

### 4. Other Labeled Herbicides

These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| **2** | League | **imazosulfuron** |
| 3 | Dacthal | **DCPA** |
| **9** | Roundup (various) | **glyphosate** |
| **14** | Aim EC | **carfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

**Seedcorn Maggot** To prevent **seedcorn** maggot damage to transplants, a banded application of a soil-incorporated neonicotinoid (Group 4A) insecticide may be needed at planting. See also the Pest Management chapter (Insect Management section).

**Aphids** Note. Aphids transmit multiple viruses.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV (melon aphid) | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Vydate 2L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 1B | Dimethoate 400 | 0.5 to 1.0 pt/A | dimethoate* | 3 | 48 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 4A | Admire Pro 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid - **soil only** | 21 | 12 | H |
| 4A | Assail 30SG | 2.5 to 4.0 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil/drip** | 30 | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |

*Aphids continued on next page*

*Aphids - continued.*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 4D | Sivanto 200SL | 21.0 to 28.0fl oz/A | flupyradifurone | 21 | 4 | M |
| 9B | Fulfill 50WP | 2.75 oz/A | pymetrozine | 0 | 12 | L |
| 9C | Beleaf 50SG | 2.0 to 2.8 oz/A | flonicamid | 0 | 12 | L |
| 28 + 6 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Beet Armyworms

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6 .0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 5 | Entrust 2SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 3.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole - **soil/drip/foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cabbage Loopers

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A | Baythroid XL 1EC | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Danitol 2.4EC | 10.67 to 16.00 fl oz/A | fenpropathrin* | 7 | 24 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT CS | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 11A | Dipel (OMRI) | 0.5 to 2.0 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 2.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole - **soil/drip/foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cucumber Beetles

Cucumber beetles transmit bacterial wilt, and most varieties of muskmelons are highly susceptible to this disease. Adult beetles can also cause direct feeding injury to young plants. Insecticides should be used to control adults before they feed extensively on the cotyledons and first true leaves. If foliar insecticides are used, begin spraying shortly after plant emergence and repeat applications at weekly intervals if new beetles continue to invade fields. Treatments may be required until vines begin to run. Seeds pretreated with a neonicotinoid such as Farmore DI-400 should provide up to 14 days of control of cucumber beetle. Otherwise, apply one of the following formulations:

*Cucumber Beetles - continued*

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Sevin XLR Plus | 1.0 qt/A | carbaryl | 3 | 12 | H |
| 3A | Baythroid XL | 2.4 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Danitol 2.4EC | 10.67 to 16.0 fl oz/A | fenpropathrin* | 7 | 24 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | LambdaT | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone | 2.4 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zetacypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Admire PRO | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |

## Cutworms - See also the Pest Management chapter, Insect Management section.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV (variegated) | 1.5 pt/A | methomyl* | 3 | 48 | H |
| 1A | Lannate LV (granulate) | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 1.28 to 4.00 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |

## Leafhoppers High numbers cause leaf yellowing (chlorosis) known as hopper burn, and yield loss.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Dimethoate 400 | 1.0 pt/A | dimethoate* | 3 | 48 | H |
| 3A | Baythroid XL 1EC | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |

*Leafhoppers continued on next page*

*Leafhoppers - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT CS | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 28 | Voliam Xpress | 6 .0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Admire PRO 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid - **soil only** | 21 | 12 | H |
| 4A | Assail 30SG | 2.5 to 4.0 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil/drip only** | 30 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |

## Leafminers

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate 2L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 1B | Dimethoate 400 | 1.0 pt/A | dimethoate* | 3 | 48 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 28 | Voliam Xpress | 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil/drip** | 30 | 12 | H |
| 4A | Actara 25 WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70S G | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70S G | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 6.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 6.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 17 | Trigard 75WSP | 2.66 oz/A | cyromazine | 0 | 12 | L |
| 28 | Coragen 1.67SC | 5.0 to 7.5 fl oz/A | chlorantraniliprole - **soil/drip** | 1 | 4 | L |
| 28 | Coragen 1.67SC | 5.0 to 7.0 fl oz/A | chlorantraniliprole - **foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Mites

Infestations generally begin around field margins and grassy areas. **DO NOT** mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot treated. Begin treatment when 10-15% of the crown leaves are infested early in the season.

| **Apply one of the following formulations. Note: Continuous use of carbaryl or pyrethroids may result in mite outbreaks.** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 10B | Zeal Miticide1 | 2.0 to 3.0 oz/A | etoxazole | 7 | 12 | L |
| 20D | Acramite 50WS | 0.75 to 1.00 lb/A | bifenazate | 3 | 12 | M |

*Mites continued on next page*

*Mites - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 21A | Portal | 2.0 pt/A | fenpyroximate | 3 | 12 | L |
| 23 | Oberon 2SC | 7.0 to 8.5 fl oz/A | spiromesifen | 7 | 12 | M |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Pickleworms, Melonworms

**If foliar materials are used, make one treatment prior to fruit set, and then treat weekly.**
**If soil or drip applications are used, check the label for instructions.**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Sevin XLR | 0.5 to 1.0 qt/A | carbaryl | 3 | 12 | H |
| 3A | Baythroid XL 1EC | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL (pickleworm) | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT CS | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A+4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A+28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 0 | 12 | M |
| 4A+28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A+28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 2.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC (melonworm) | 2.0 to 3.5 fl oz/A | chlorantraniliprole - **drip/foliar** | 1 | 4 | L |
| 28 | Coragen 1.67SC (pickleworm) | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Rindworms

Damage to the rinds may result from a complex of insect pests including cucumber beetle, wireworms, and a number of “worm” species (*e.g.*, beet armyworm). Management of adult cucumber beetles early in the season may help reduce damage. See cucumber beetle section for labeled products.

**For Lepidopteran rindworms, use one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 3A | Baythroid XL 1EC | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT CS | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |

## Thrips

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate2L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 1B | Dimethoate 400 | 1.0 pt/A | dimethoate* | 3 | 48 | H |
| 3A | Lambda-Cy, LambdaT CS | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Admire PRO 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/ | thiamethoxam - **soil/drip** | 30 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 6.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 6.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |

## Whiteflies

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 4A | Admire PRO 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil/drip** | 30 | 12 | H |
| 4A | Actara 25WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole- **soil/drip** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 7C | Knack | 8.0 to 10.0 fl oz/A | pyriproxyfen | 7 | 12 | L |
| 9B | Fulfill 50WDG | 2.75 oz/A | pymetrozine | 0 | 12 | L |
| 9C | Beleaf 50SG | 2.8 oz/A | flonicamid | 0 | 12 | L |
| 21A | Portal XLO | 2.0 pt/A | fenpyroximate | 3 | 12 | L |
| 23 | Oberon 2SC | 7.0 to 8.5 fl oz/A | spiromesifen | 7 | 12 | M |
| 28 + 6 | Minecto Pro. Plus | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

## Nematode Control - See also the Pest Management Chapter.

Use fumigants listed under Soil Fumigation in the Pest Management Chapter, or one of the nematicides listed below.

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 1A | Vydate L | 0.5 to 1.0 gal/A Incorporate into top 2-4 inches of soil, ***OR*** 2.0 to 4.0 pt/A apply 2 w after planting and repeat 2-3 w later. | oxamyl* | 1 | 48 | H |
| 7 | Velum Prime | 6.5 to 6.84 fl oz/A | fluopyram | 0 | 12 | -- |
| -- | Nimitz 4EC | 3.5 to 5.0 pt/A Incorporate or drip-apply 7 d before planting. | fluensulfone | n/a | 12 | N |

**Seed Treatment** If seed has not been treated with a fungicide and insecticide, use a mixture of thiram 480DP (4.5 fl oz/100 lb) and an approved commercially available insecticide.

## Damping-Off caused by Phytophthora, Pythium, and Rhizoctonia

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following at-planting (see label for application timing, methods, and restrictions):** | | | | | | |
| **Phytophthora and Pythium root rot** | | | | | | |
| **4** | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | AP | 48 | N |
| **4** | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | AP | 48 | N |
| **4** | MetaStar 2EAG | 4.0 to 8.0 pt/A | metalaxyl | AP | 48 | N |
| **Phytophthora, Pythium, and Rhizoctonia root rot** | | | | | | |
| **4** + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence. | mefenoxam + azoxystrobin | AP | 0 | N |
| **Rhizoctonia root rot** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | AP | 4 | N |
| **Pythium root rot only** | | | | | | |
| 28 | Previcur Flex 6F | 1.2 pt/A in transplant water, drip irrigation, or direct spray at base of plant and soil | propamocarb HCL | 2 | 12 | N |

## Bacterial and Fungal Diseases

### Alternaria Leaf Blight

Rotate muskmelons with unrelated crops. Begin sprays when vines begin to run, or earlier if symptoms are detected.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Begin sprays when vines begin to run. ALTERNATE one of the following:** | | | | | | |
| M3 | mancozeb 75DF[1] | 2.0 to 3.0 lb/A[1] | mancozeb | 5 | 12,24 | N |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |
| **WITH A TANK MIX of one of the following fungicides PLUS chlorothalonil 6F 2.0 to 3.0 pt/A every 14 days. Materials with different modes of action (FRAC codes) should always be alternated.** | | | | | | |
| 7 + **11** | Pristine 38WG | 12.5 to 18.5 oz/A | boscalid + pyraclostrobin | 0 | 12 | -- |
| 3 + 9 | Inspire Super 2.8F | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodonil | 0 | 12 | -- |
| 3 + **11** | Quadris Top 2.7F | 12.0 to 14.0 fl oz/A | difenoconazole + azoxystrobin | 0 | 12 | -- |
| 7 + **11** | Luna Sensation 4.25SC[1] | 7.6 fl oz/A | fluopyram + trifloxystrobin | 0 | 12 | -- |
| 7 + 3 | Aprovia Top 1.63EC | 10.5 to 13.5 fl oz/A | benzovindiflupyr + difenoconazole | 0 | 12 | N |
| 7 + **11** | Merivon 500SC[1] | 4.0 to 5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 0 | 12 | N |
| 3 + **11** | TopGuard EQ | 5.0 to 8.0 fl oz/A | azoxystrobin + flutriafol | 1 | 12 | -- |
| **11** | azoxystrobin 2.08F | 11.0 to 15.5 fl oz/A (**do not** apply near apples, see label) | azoxystrobin | 0 | 12 | N |
| **11** | Cabrio 20EG | 12.0 to 16.0 oz/A | pyraclostrobin | 0 | 12 | N |
| **11** | Reason 500SC | 5.5 fl oz/A | fenamidone | 14 | 12 | -- |

**[1]The varieties 'Harvest Queen', 'Gold Star', 'Super Star', 'Sweet and Early', and 'Saticoy' are sensitive to mancozeb.**

### Angular Leaf Spot and Bacterial Leaf Spot

At first sign of disease, apply the labeled rates of fixed copper plus mancozeb. Some coppers are OMRI-approved and can be used in organic systems to help suppress Angular leaf spot and other fungal diseases. Repeat every 7 d. Avoid overhead irrigation when symptoms are present and working in field while foliage is wet.

### Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage all season; additional foliar insecticide applications may be necessary.

### Downy Mildew

Scout fields for disease incidence beginning in early summer. Begin sprays when vines run or if disease is predicted for the region (check the Cucurbit Downy Mildew Forecasting website at: *http://cdm.ipmpipe.org*). **Preventative**

**applications are much more effective than applications made after detection.** Materials with different modes of action (FRAC codes) should always be alternated. Tank mix with protectant if not included in the product.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **The following are the most effective products. Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced IF the label allows.** | | | | | | |
| U15+40 | Orondis Ultra | 5.5 to 8 fl oz/A | oxathiapiprolin + mandipropamid | 0 | 4 | -- |
| 21 | Ranman 400SC | 2.10 to 2.75 fl oz/A (**do not** apply with copper; see label for details) | cyazofamid | 0 | 12 | L |
| **Other materials for use in rotation as tank mix partners with a protectant:** | | | | | | |
| M3 + 22 | Gavel 75DF contains protectant | 1.5 to 2.0 lb/A | mancozeb + zoxamide (**note**: some cultivars are sensitive to mancozeb) | 5 | 48 | -- |
| M5 + 22 | Zing! 4.9SC contains protectant | 36 fl oz/A | chlorothalonil + zoxamide | 0 | 12 | N |
| M5 + 27 | Ariston 42SC contains protectant | 3.0 pt/A | chlorothalonil + cymoxanil | 3 | 12 | -- |
| 11 + 27 | Tanos 50WDG | 8.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 27 | Curzate 60DF | 3.2 oz/A | cymoxanil | 3 | 12 | N |
| 28 | Previcur Flex 6F | 1.2 pt/A | propamocarb | 3 | 12 | N |
| 40 | Forum 4.17SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | acetoctradin + dimethomorph | 0 | 12 | -- |
| 43 | Presidio 4SC | 4.0 fl oz/A | fluopicolide | 2 | 12 | L |

## Fusarium Wilt

Rotate to allow 5 years between muskmelon plantings in any given location. Use resistant cultivars when possible, see table Recommended Varieties.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Application of Proline through drip irrigation may reduce Fusarium wilt early season:** | | | | | | |
| 3 | Proline 480SC | 5.7 fl oz/A | prothioconazole | 7 | 12 | -- |

## Gummy Stem Blight

In the mid-Atlantic regions, fungicide that only contain FRAC code 11 components are not recommended. Pristine, which contains both FRAC code 11 and 7 components should always be tank-mixed with a protectant fungicide to reduce the possibility of resistance development. **When tank-mixing use at least the minimum labeled rate of each fungicide. Alternate fungicides with different modes of action. Do not apply FRAC code 11 fungicides more than 4 times total per season.** Begin sprays when vines begin to run.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Under LOW DISEASE PRESSURE, apply the following every 7 days:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |
| **Under HIGH DISEASE PRESSURE, ALTERNATE:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A[1] | chlorothalonil | 0 | 12 | L |
| **WITH A TANK-MIX containing a protectant fungicide (such as chlorothalonil) PLUS one of the following:** | | | | | | |
| 3 | Proline 480SC | 5.7 fl oz/A | prothioconazole | 7 | 12 | -- |
| 3 | tebuconazole 3.6 F[2] | 8.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3 + 9 | Inspire Super 2.8F | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodinil | 0 | 12 | -- |
| 3 + 11 | Aprovia Top 1.62EC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflupyr | 0 | 12 | N |
| 7 | Fontelis 1.67SC | 12.0 to 16.0 fl oz/A | penthiopyrad | 1 | 12 | L |
| 7 + 11 | Merivon 500SC | 5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 7 + 11 | Pristine 38WG | 12.5 to 18.5 oz/A | boscalid + pyraclostrobin | 0 | 12 | -- |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 fl oz/A | cyrpdinil + fludioxonil | 1 | 12 | N |

[1]Use low rate early in season. [2]Note: reduced sensitivity of the pathogen to tebuconazole has been found in the Southern U.S.

## Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Grow muskmelons on raised beds and drain fields adequately so that water will not accumulate around the base of the plants. Rotate away from susceptible crops (cucurbits, peppers, lima beans and beans, eggplants and tomatoes) for as long as possible. Apply preplant fumigants to suppress disease. Apply fungicides when conditions are favorable for disease development.

*Phytophthora Crown and Fruit Rot - continued*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following fungicides and tank mix with fixed copper at labeled rates when conditions favor disease development (for suppression only). Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development:** | | | | | | |
| M3 + 22 | Gavel 75DF | 1.5 to 2.0 lb/A | mancozeb + zoxamide (**note**: some cultivars are sensitive to mancozeb) | 5 | 48 | -- |
| 11 + 27 | Tanos 50DF | 8.0 to 10.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 21 | Ranman 400SC | 2.75 fl oz/A (**Do not** apply with copper, see label for additional precautions) | cyazofamid | 0 | 12 | L |
| 40+U15 | Orondis Ultra | 5.5 tp 8.0 fl oz/A | mandipropamid + oxathiapiprolin | 0 | 4 | -- |
| 40 | Forum 4.17SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |
| 40 | Revus 2.08F | 8.0 fl oz/A | mandipropamid | 0 | 4 | -- |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | acetoctradin + dimethomorph | 0 | 12 | -- |
| 43 | Presidio 4SC[1] | 4.0 fl oz/A | fluopicolide | 2 | 12 | L |

[1]Presidio may also be applied through the drip irrigation (see supplemental label). Soil drench followed by drip application has given good results in some trials on crown rot caused by *Phytophthora capsici*.

## Powdery Mildew

Excellent host resistance is available (see table Recommended Varieties). The fungus that causes cucurbit powdery mildew has developed resistance to high-risk fungicides. In the Eastern US, resistance to strobilurin (FRAC code 11), SDHI (FRAC code 7), and DMI (FRAC code 3) fungicides has been reported. Proper fungicide resistance management should be followed to help delay the development of resistance and minimize control failures. Materials with different FRAC codes should always be alternated. Powdery mildew generally occurs from mid-July until the end of the season. Scout fields for the presence of powdery mildew. If one lesion is found on the underside of 45 old leaves per acre, begin the following fungicide program:

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **TANK MIX one of these products with a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| U6 | Torino 0.85SC | 3.4 fl oz/A | cyflufenamid | 0 | 4 | -- |
| U8 | Vivando 2.5SC | 15.4 fl oz/A | metrafenone | 0 | 12 | -- |
| 13 | Quintec 2.08SC | 6.0 fl oz/A | quinoxyfen | 3 | 12 | -- |
| 3 + 7 | Luna Experience 3.34SC | 10.0 to 17.0 fl oz/A | fluopyram + tebuconazole | 7 | 12 | -- |
| 7 + **11** | Luna Sensation 4.25SC | 7.6 fl oz/A | fluopyram + trifloxystrobin | 0 | 12 | -- |
| **AND ALTERNATE with a TANK MIX of one of the following and a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| **3** | Proline 480SC | 5.7 fl oz/A | prothioconazole | 7 | 12 | -- |
| **3** | Procure 480SC | 4.0 to 8.0 fl oz/A | triflumizole | 0 | 12 | N |
| **3** | Rally 40WSP | 5.0 oz/A | myclobutanil | 0 | 24 | N |
| **3** | tebuconazole 3.6F | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 7 | Fontelis 1.67SC | 12.0 to 16.0 fl oz/A | penthiopyrad | 1 | 12 | L |
| 3 + **11** | Aprovia Top 1.62EC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflupyr | 0 | 12 | N |
| 3 | Rhyme 2.08F | 5.0 to 7.0 fl oz/A | flutriafol | 0 | 12 | -- |
| U8 | Vivando 2.5SC | 15.4 fl oz/A | metrafenone | 0 | 12 | -- |
| **7 + 11** | Pristine 38WG | 12.5 to 18.5 oz/A | boscalid + pyraclostrobin | 0 | 12 | -- |
| 3 + 9 | Inspire Super 2.8F | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodonil | 0 | 12 | -- |
| 13 | Quintec 2.08SC | 6.0 fl oz/A | quinoxyfen | 3 | 12 | -- |

**Scab** The fungus that causes Scab typically occurs during periods of cool, wet weather when temperatures are below normal. Rotate away from fields with a history of Scab for at least 2 years.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Begin sprays as true leaves form and repeat every 5-7 days:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |

**Viruses** The most prevalent virus in the mid-Atlantic region is **WMV2**, followed by **PRSV**, **ZYMV** and **CMV**. Plant fields as far away from existing cucurbit plantings as possible to help reduce the chances of aphid transmission of viruses from existing fields to new fields.

# Okra

Okra is a tropical annual with a wide range of adaptation. However, okra is very sensitive to frost and cold temperatures and should not be planted until soil has warmed in the spring.

## Recommended Varieties[1]

| | | | | |
|---|---|---|---|---|
| Annie Oakley II* | Cajun Delight* | Clemson Spineless 80 | Jambolaya* | Zarah* |

[1]Listed alphabetically, *Hybrid.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Okra | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 125-150[1] | 250 | 150 | 100 | 0 | 250 | 150 | 100 | 0 | Total nutrient recommended |
| | 50-100 | 250 | 150 | 100 | 0 | 250 | 150 | 100 | 0 | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 3-4 weeks after planting |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 6-8 weeks after planting |

Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter. [1]If crop is to be mulched with plastic but not drip/trickle fertilized, broadcast 225 lb/A of N with recommended P and K and disk-in prior to laying mulch. For drip/trickle fertilization, see the Fertigation section in the Irrigation Management chapter.

**Seed Treatment** See Disease Control for seed treatment to prevent disease.

## Seeding and Spacing

Field seeding is usually done between May 20 and June 1. Generally, only one planting is made. In northern areas of the region, sow seed in the greenhouse in cells in early May and transplant to the field through black plastic mulch on raised beds with drip irrigation in early to mid June. Okra also responds to row covers or high tunnels.

For dwarf varieties, space the rows 3-3½ ft apart. For medium and tall varieties, space the rows 4-4½ ft apart. Drill seeds ¼-½ inch deep, 3 or 4 per ft of row (5-7 lb/A). Thin the plants when they are 5 inches tall. Plants of dwarf varieties should be about 12-15 inches apart in the row; plants of tall varieties should be 18-24 inches apart.

## Harvest and Post Harvest Considerations

Okra pods usually reach harvesting maturity 4-6 days after the flowers open. At this stage, the pods are 3-3½ inches long, free of excessive fiber and tender. Pick pods at 2-day intervals by snapping off or clipping the pedicel. Gloves should be worn to avoid skin reactions to the fine spines on the fruit. Large and undesirable pods should be removed to keep the plant productive over a longer period. Harvested okra should be kept at 50-55°F (10-13°C) and 85-90% relative humidity. Below 50°F, okra pods are subject to chilling injury.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

## 1. Soil-Applied (Preplant Incorporated or Preemergence)

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 3 | Treflan 4EC | 1.0 to 2.0 pt/A | **trifluralin** | 0.5 to 0.75 lb/A | -- | 12 |
| -Incorporate into 2-3 inches of soil within 8 hr after application.<br>-Primarily controls annual grasses and a few broadleaf weeds.<br>-**Do not** use (or reduce the rate) used when cold, wet soil conditions are expected, or crop injury may result.<br>-Poor incorporation can reduce overall weed control.<br>-Maximum application not addressed on label. | | | | | | |
| **27** | Callisto 4SC | 6.0 fl oz/A | **mesotrione** | 0.188 lb/A | 28 | 12 |
| -Use as row-middle or hooded post-directed treatment, but not both.<br>-Apply as a band, leaving 1 foot of untreated soil over the seeded row (6” of untreated soil on each side of the row); **do not** apply over the row or severe injury will occur. If replanting, **do not** plant into treated soil.<br>-Callisto controls common lambsquarters, pigweeds, as well and many other small-seeded annual broadleaf weeds, but Callisto is weak on ragweed and morningglory species. Apply Treflan 4EC between the rows of mulch to control annual grasses.<br>-Crop injury may occur if an organophosphate or carbamate insecticide is applied within 7 days of Callisto.<br>-**Do not** apply more than 1 application of Callisto per crop; **do not** apply more than 6 fl oz per year as a banded application. | | | | | | |

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Poast 1.5EC | 1.0 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 14 | 12 |
| -Apply with crop oil concentrate at 1.0% v/v (1.0 gal/100 gal of spray solution). **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur.<br>-Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled.<br>-Repeated applications may be needed to control certain perennial grasses.<br>-**Do not** tank-mix with or apply within 1 week before or any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result.<br>-**Do not** apply more than 1.5 pt/A in single application and maximum Poast application per season is 5.5 pt/A. | | | | | | |
| 22 | Gramoxone SL 2.0 | 1.95 pt/A | **paraquat *** | 0.49 lb/A | 21 | 24 |
| -Row middles as a shielded application. Include a nonionic surfactant at 0.25% v/v.<br>-Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings.<br>-Rainfastness is 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |
| **27** | Callisto 4SC | 3.0 fl oz/A | **mesotrione** | 0.094 lb/A | 28 | 12 |
| -Use as row-middle or hooded post-directed treatment, but not both.<br>-Apply as a direct spray using a hooded sprayer. Okra must be at least 3 inches tall at time of application.<br>-Use a nonionic surfactant (0.25% v/v).<br>-Set spray equipment to minimize amount of Callisto that comes in contact with okra foliate or crop injury will occur.<br>-Callisto controls common lambsquarters, pigweeds, as well and many other small-seeded annual broadleaf weeds, but Callisto is weak on ragweed and morningglory species. Apply Treflan 4EC between the rows of mulch to control annual grasses.<br>-Crop injury may occur if an organophosphate or carbamate insecticide is applied within 7 days of Callisto.<br>-Rainfastness is 1 hr.<br>-**Do not** apply more than 1 application of Callisto per crop; **do not** apply more than 3 fl oz/A per year as a post-directed application. | | | | | | |

## 3. Postharvest

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Insecticides

### Aphids

Cotton/melon aphids and green peach aphid (GPA) are most common on okra. In the summer, GPA winged females can produce numerous pale yellow or pink colored live young (nymphs). GPA are larger than cotton/melon aphids. Cotton/melon aphids are yellow. Tremendous numbers of aphids can build up on the undersides of leaves often following pyrethroid insecticide applications. Aphids are sucking insects that excrete a sugary, sticky substance ("honeydew") that can coat fruit and cause growth of black sooty mold fungus. Both honeydew and mold can hurt marketability. Predators and parasitoids (braconid wasps) often can keep aphid populations below damaging levels. Broad spectrum insecticides, like pyrethroids, destroy these natural enemies. Preserve natural enemies by using selective insecticides whenever possible. Sample plants for aphids as well as the presence of natural enemy species. Spray only when aphid densities appear to be increasing in the absence of predators.

| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations (note: spray coverage to the underside of the leaf is important):** | | | | | | |
| 1B | Malathion 57EC | 1.5 pt/A | malathion | 1 | 12 | H |
| 3A + 4A | Brigadier | 3.8 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Swagger | 7.6 to 19.6 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 4A | Admire Pro | 7.0 to 14.0 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.3 to 2.2 fl oz/A | imidacloprid - **foliar** | 0 | 12 | H |
| 4A | Assail 30SG | 2.0 to 4.0 oz/A | acetamiprid | 7 | 12 | M |
| 4C | Closer SC | 1.5 to 2.0 fl oz/A | sulfoxaflor | 1 | 12 | H |
| 4D | Sivanto 200SL,Sivanto Prime | 21.0 to 28.0 fl oz/A | flupyradifurone - **soil** | 45 | 4 | L |
| 4D | Sivanto 200SL | 7.0 to 12.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | L |
| 4D | Sivanto Prime | 7.0 to 14.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | L |
| 4D | Sivanto Prime (GPA) | 10.5 to 14.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | L |
| 9C | Beleaf 50SG | 2.8 to 4.28 fl oz/A | flonicamid | 0 | 12 | L |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 1 | 24 | L |
| 28 | Verimark (melon aphid) | 6.75 to 10.0 fl. oz/A | cyantraniliprole - **soil/drip** | 1 | 4 | H |
| 28 | Verimark (GPA) | 10.0 to 13.5 fl oz/A | cyantraniliprole - **soil/drip** | 1 | 4 | H |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 + 6 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

### Corn Earworms (CEW)

CEW is a lepidopteran pest of okra that appears when moths emerge from drying field corn. Moths lay a single egg on a leaf. Larvae vary in color (yellow, brown, green or red) but display longitudinal light-colored stripes and black dots from which hair grow. CEW larvae can be distinguished from other larvae due to the presence of hair on their body. Larvae will attack fruit almost immediately following their emergence. Scouting for signs of their presence is necessary. Pheromone traps can also be used to determine periods of moth activity.

| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations:** | | | | | | |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Swagger | 10.2 to 19.6 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A | Bifenture 2EC | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Sniper, Sniper Helios | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 13.0 fl oz/A | zeta-cypermethrin* + bifenthrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 11A | Dipel (OMRI) | 0.5 to 1.0 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 16B | Rimon 0.83EC | 9.0 to 12.0 fl oz/A | novaluron | 1 | 12 | L |

*Corn Earworms continued on next page*

*Corn Earworms - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 22 | Avaunt 30WDG | 3.5 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole - **soil**,/**drip, foliar** | 1 | 4 | L |
| 28 | Verimark | 5.0 to 10.0 fl oz/A | cyantraniliprole - **soil/drip** | 1 | 4 | H |
| 28 | Exirel | 7.0 to 13.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Japanese beetles

Adult Japanese beetles emerge in June and can cause substantial feeding damage on okra leaves. They skeletonize leaves leaving a lace-like appearance.

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations:** | | | | | | |
| 1B | Malathion 57EC | 1.5 pt/A | malathion | 1 | 12 | H |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Swagger | 10.2 to 19.6 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A | Bifenture 2EC, Sniper, Sniper Helios | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |

## Stink Bugs

Multiple species may damage fruit including brown and green stink bugs, and the invasive brown marmorated stink bug (BMSB). Stink bugs have a characteristic shield shape, a triangle on their thorax, are approximately 0.5 inch long and can emit a foul odor when disturbed. BMSB can be distinguished from the native brown stink bug by the white stripes on the antennae. BMSB nymphs have characteristic black and white striped legs and a dark colored or dark and white body, depending on the instar or stage of development. Stink bug eggs are in masses, barrel shaped and cream to greenish colored. Both nymphs and adults remove fluid from the fruit tissue, leaving a conspicuous white “halo” or discoloration on the surface. BMSB feeding injury can be significantly more severe than that of other species. Growers should scout for their presence on plants, and initiate weekly spays if observed.

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations:** | | | | | | |
| 1A | Sevin XLR Plus, Sevin 4F | 1.0 to 1.5 qt/A | carbaryl | 3 | 12 | H |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Swagger | 7.6 to 19.6 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A | Bifenture 2EC, Sniper, Sniper Helios | 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |

## Whiteflies

Whiteflies can be found on the underside of leaves where they aggregate in numbers. When disturbed, the white, tiny moth-like adults will fly off but quickly return to the plant. Nymphs and adults feed by removing fluids from plant material, creating stippling, yellowing and distortion of the leaves. Whiteflies also secrete honeydew, leaving a conspicuous sticky, shiny appearance to the plant during times of heavy infestation.

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations:** | | | | | | |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Swagger | 10.2 to 19.6 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 4A | Admire Pro | 7.0 to 14.0 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.3 to 2.2 fl oz/A | imidacloprid - **foliar** | 0 | 12 | H |
| 4C | Closer SC | 4.25 to 4.5 fl oz/A | sulfoxaflor | 1 | 12 | H |
| 4D | Sivanto 200SL, Sivanto Prime | 21.0 to 28.0 fl oz/A | flypyradifurone - **soil** | 45 | 4 | L |
| 4D | Sivanto 200SL, Sivanto Prime | 10.5 to 14.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | L |
| 7C | Knack | 8.0 to 10.0 fl oz/A | pyriproxyfen | 1 | 12 | L |
| 16 | Courier SC | 9.0 to 13. 6 fl oz/A | buprofezin | 1 | 12 | L |
| 21A | Portal or Portal XLO | 2.0 pt/A | fenpyroximate | 1 | 12 | L |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 1 | 24 | L |
| 28 + 6 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Fungicides

### Nematode Control
Okra roots are very susceptible to the damage caused by root knot and sting nematodes. See also the Soil Fumigation and Nematodes sections in the Pest Management chapter. Use the fumigants listed in the Pest Management chapter or the nematocide in the table below. Consult the label.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Incorporate or drip-apply 7 days before planting:** | | | | | | |
| -- | Nimitz 4EC | 3.5 to 5.0 pt/A | fluensulfone | n/a | 12 | N |

### Seed Treatment
Use thiram 480DP at 3.0 to 4.0 oz/100 lb of seed (2/3 tsp/lb) *plus* Apron XL LS (0.32 to 0.64 fl oz/100 lb of seed) for improved germination and stand.

### Damping-Off caused by *Rhizoctonia*
For control of seedling root rot and basal stem rot apply the following fungicide:

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 row ft | azoxystrobin | 0 | 4 | N |

## Fungal Diseases
### Fruit Rot (*Choanephora*)
Choanephora is a soil-borne fungal disease which attacks senescent blossoms and fruit. There are no fungicides labeled for Choanephora control. Improving air circulation is the only effective means of reducing the chances for Choanephora development. In extreme cases, growers may remove the lower juvenile leaves to improve air circulation.

### Fusarium and Verticillium Wilts
Rotate with non-solanaceous crops and avoid planting in fields with a history of either disease. If rotation is not option, soil fumigation will help reduce soil population of causal agents.

### Cercospora leaf spot and Powdery mildew

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Rotate the following every 7 d as long as weather conditions favor disease development:** | | | | | | |
| M1 | Copper (OMRI)[1] | at labeled rates | copper | 0 | 48 | N |
| M5 | chlorothalonil 6F[2] | 1.5 pt/A | chlorothalonil | 7 | 12 | N |
| 3 | Folicur 3.6F[3] | 4.0 to 6.0 fl oz/A | tebuconazole | 4 | 12 | N |
| 11 | azoxystrobin 2.08F[4] | 6.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |

[1]There are a number of copper based products with OMRI labels. See labels for specifics. Copper applications for bacterial disease control may help suppress some fungal pathogens in organic production systems.[2] Cercospora and Powdery mildew;[3] Cercospora only; [4] Powdery mildew only

# Onions

## Recommended Bulbing Onion Varieties[1]

| Type | Variety | Hybrid | Days[2] | Description[3] | Color | Storage | Method[4] | Size[5] |
|---|---|---|---|---|---|---|---|---|
| **Long Day** (direct seeded or transplanted in early spring) | Braddock | Yes | 107 | Storage LD N | Yellow | Long | DS, TP | L |
| | Bradley | Yes | 118 | Storage LD Sp | Yellow | Long | DS, TP | L |
| | Delgado | Yes | 118 | Storage LD Sp | Yellow | Long | DS, TP | M-L |
| | Dulce Reina | Yes | 120 | Sweet Spanish | Yellow | Medium | TP | L |
| | Ebenezer | No | 120 | Storage LD | Yellow | Long | Sets | M-L |
| | Fortress | Yes | 110 | Storage LD N | Yellow | Long | DS, TP | M |
| | Mesquite | Yes | 120 | Sp | Yellow | Medium | DS, TP | VL |
| | Montero | Yes | 110 | Sweet Spanish | Yellow | Medium | DS, TP | L |
| | Prince | Yes | 105 | Storage LD N | Yellow | Long | DS, TP | L |
| | Red Sky | Yes | 110 | Storage LD Sp | Red | Long | DS, TP | M-L |
| | Red Wing | Yes | 118 | Storage LD | Red | Long | DS, TP | L |
| | Safrane | Yes | 106 | Storage LD N | Yellow | Long | DS, TP | M |
| | Scout | Yes | 118 | Sweet Spanish | Yellow | Medium | TP | VL |
| | Sedona | Yes | 120 | Storage LD Sp | Yellow | Long | DS, TP | L |
| | Southport Red Globe | No | 120 | Storage LD | Red | Long | DS, TP | L |
| | SV4058NV | Yes | 115 | Sp | White | Medium | TP | L |
| | Talon | Yes | 110 | Storage LD Sp | Yellow | Long | DS, TP | L |
| | Tequila | Yes | 120 | Sp | Yellow | Medium | DS, TP | VL |
| | Vision | Yes | 125 | Storage LD Sp | Yellow | Long | DS, TP | L |
| **Intermediate Day** (normally early spring transplanted) | Candy | Yes | 95 | Sweet Spanish | Yellow | Very Short | TP | VL |
| | Cimarron | Yes | 99 | Sweet Spanish | Yellow | Medium | TP | L |
| | Exacta | Yes | 94 | Sweet Spanish | Yellow | Very Short | TP | L |
| | Expression | Yes | 98 | Sweet Spanish | Yellow | Short | TP | L |
| | Great Western | Yes | 110 | Sweet Spanish | Yellow | Medium | TP | L |
| | Mt. Whitney | Yes | 104 | Sweet Spanish | White | Medium | TP | L |
| | Spanish Medallion | Yes | 110 | Sweet Spanish | Yellow | Medium | TP | VL |
| | Super Star | Yes | 100 | Sweet Spanish | White | Short | TP | L |
| **Overwinter** (direct seeded in later summer) | Bridger | Yes | n/a | Storage | Yellow | Long | DS | L |
| | Hi-keeper | Yes | n/a | Storage | Yellow | Long | DS | M-L |
| | Toughball | Yes | n/a | Storage | Yellow | Long | DS | M |
| | T-420 | Yes | n/a | Storage | Yellow | Long | DS | M-L |

[1]Listed alphabetically. [2]Days to maturity; n/a=not available. [3]Storage=long keeping types; LD=Long Day; Sp=Spanish type; N=Northern type; Sweet Spanish=short keeping softer scale sweet types. [4]DS=Direct Seeded, TP=Transplanted. [5]M=Medium, L=Large, VL=Very Large.

## Recommended Green or Bunching Onions (Scallions) Varieties[1]

| Variety | Production Method |
|---|---|
| Evergreen Long White Bunching | Overwinter |
| Feast | Summer |
| Green Banner | Fall, Overwinter, Spring, Summer |
| Ishikura Improved | Summer |
| Kincho | Summer |
| Parade | Summer |
| Southport White Globe | Overwinter |
| Tokyo Long White Bunching | Summer |
| White Gem | Summer-Fall |
| White Sweet Spanish | Spring-summer |

[1]Listed alphabetically.

### Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

*Recommended Nutrients Based on Soil Tests - continued*

| **Onions**[1] | | **Soil Phosphorus Level** | | | | **Soil Potassium Level** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Low** | **Med** | **High (Opt)** | **Very High** | **Low** | **Med** | **High (Opt)** | **Very High** | |
| | **N (lb/A)** | **$P_2O_5$ (lb/A)** | | | | **$K_2O$ (lb/A)** | | | | **Nutrient Timing and Method** |
| **Bulb Onions** | 75-100 | 200 | 100 | 50 | 0[2] | 200 | 100 | 50 | 0[2] | Total nutrient recommended |
| | 50-75 | 200 | 100 | 50 | 0[2] | 200 | 100 | 50 | 0[2] | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 4-5 weeks after planting |
| **Green Onions** | 150-200 | 200 | 100 | 50 | 0[2] | 200 | 100 | 50 | 0[2] | Total nutrient recommended |
| | 50-75 | 200 | 100 | 50 | 0[2] | 200 | 100 | 50 | 0[2] | Broadcast and disk-in |
| | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 4-5 weeks after planting |
| | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 3-4 weeks before harvest |

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter.
[2]In VA, crop replacement values of 25 lb/A of $P_2O_5$ and 25 lb/A of $K_2O$ are recommended on soils testing Very High.

**Seed Treatment** Buy commercial fungicide treated seed, if available. See Disease Control below.

## Planting and Seeding Dates

For dry bulb onions, sets or seeds can be planted as soon as soil conditions are favorable in the spring; transplants can be planted March 20 to April 1. For bunching onions, seeds can be planted as soon as soil conditions are favorable in the spring; successive plantings can be made through the summer. For PA growers, the Simply Sweet Onion™ branding program is an option. Visit *https://www.pvga.org/services/pennsylvanias-simply-sweet-onion/* and/or contact the PA Vegetable Growers Association for more information (717-694-3596 or *pvga@pvga.org*).

## Transplant Production

Produce onion transplants in cell trays. For sweet Spanish transplants, the recommended maximum cell size is 338 cells per tray. Grow transplants 10-12 weeks and maintain a plant height of 4 inches by trimming the plants with a sharp clean blade.

## Spacing

For dry bulb onions, space rows 24 inches apart. Space 8-9 sets per ft (24 bushels/A). For large Spanish onions, space sets 4-5 inches apart and seeds ½-2 inches in row (2 lb/A using split shoe). For bunching onions, space rows 12-16 inches apart; space seed ½-1½ inches apart (7-10 lb/A). Plant seed ½-¾ inch deep except on muck soils. On muck soils plant seed ½-1 inch deep. Place sets 1-1½ inches deep.

## Plasticulture

For sweet Spanish onion, plasticulture has resulted in consistent high quality, large-sized bulb onions. Raised beds (6-8 inches high) are generally placed on 72-78 inch centers (66 inch centers if equipment is adjustable and soil friable). Transplant on 6 x 6 inch spacing with 4 rows across a 28-30 inch wide raised bed. Two drip irrigation lines are placed in the bed between each of the outer 2 rows of transplants to maintain adequate soil moisture for sizing onion bulbs and producing a sweet taste.

Broadcast 2/3 of the recommended N prior to making raised beds and laying plastic and 1/3 through the drip irrigation system. Apply P and K as well as any magnesium or calcium based on soil test results prior to making the beds with plastic mulch and drip tape. If top growth appears chlorotic (yellow) or stunted, a tissue test analysis is recommended in order to make corrective measures before onions initiate bulb enlargement. Avoid using sulfur containing fertilizers. While some sulfate is required for optimum plant growth, soil sulfur levels should be less than 20 ppm; since high soil sulfur increases the pungency of onion bulbs by increasing pyruvic acid levels.

Onions are shallow-rooted, and unless moisture supply is constant, they bulb early and produce small bulbs. To minimize leaching of nitrogen from the root zone, light, frequent irrigations should be used when onions are small (3 to 5 applications of 1.5-2 inches of water/week are recommended). Soil type does not affect the total amount of water needed, but does dictate the frequency of application. Lighter soils need more frequent applications, but less water applied per application. Irrigation should thoroughly wet the soil to a depth of 18 inches. Stop watering after bulbs have reached full size, and tops have begun to fall.

**Cultivation** For bunching onions, hill 1-2 inches to ensure white bases.

## Harvest and Postharvest Considerations

**Bulb Onions**: Start harvesting when at least 50% of tops have fallen. Tops of some Sweet Spanish cultivars may not fall at maturity and bulbs have to be checked for desired size before harvesting. Pull bulbs by hand or undercut them without damaging their base. In plasticulture, pull bulbs through existing holes in the plastic. Under dry conditions, lay bulbs on the soil or mulch surface for 3 days. If rain is predicted, cut the tops (leaving 1.5 inch necks; shorter necks increase the risk of disease) and place bulbs in potato burlap bags or bulk bins. Place burlap bags in a greenhouse or high tunnel for 5-7 days; cover burlap with sheets of row cover material to reduce/eliminate sunburn. Place bulk bins in a room with high air flow and controlled heat source (maximum drying temperature 90°F or 32°C). Keep in dryer at moderate heat for at least 48 hours. Check randomly selected onions for dryness of the neck surface paper. For storage of sweet onion (up to 2 months), maintain cool temperatures (38-45°F, 3-7°C), low relative humidity (75-85%) and active air movement.

For storage-type onions, bulbs are undercut, and after an appropriate time, lifted and windrowed for field curing. Rod-weeder diggers and knife undercutters are commonly used. Tops may be left on to prevent sunscald, or removed by hand or machine in the windrowing operation. With good air movement and proper placement, onions store best with tops on. However, this may complicate removal from storage and cause extra handling at packing.

Onions should be adequately cured in the field, in open sheds, or by forced air. In the field or in open sheds, this may require 2-4 weeks, depending on the weather. The best skin color develops between 75-90°F (24-32°C) and 60-75% relative humidity. The most common curing method is forced ventilation in storage. Heated air (75-85°F, 24-29°C) is blown through onions at a rate of 2 cubic feet per minute (CFM). Onions are considered cured when the neck is tight and the outer scales are dry and brittle. This condition is reached after a 3-5% weight loss. If not adequately cured, stored onions are likely to decay.

Onions that are marketed in late spring are often stored refrigerated. Onions should be placed in cold storage immediately after curing. At 32°F (0°C) and with sufficient air circulation, onions that were cured well will stay dormant and reasonably free from decay for 6-8 months.

**Green Onions and Scallions**: Harvest should begin when the base is ¼-½ inch in diameter. Semi-bulbing types will be slightly enlarged (up to 1 inch) at the base. Hand pull and bunch with 6-9 onions, or ¼ lb, held together with rubber bands. Pulling is usually done without undercutting and bunching is usually done in the field. Field boxes are moved to packing areas within 2-3 hours after harvesting. It is recommended that bunched green onions are run through a washer/cooler machine with wash water temperatures of 33-35°F (1-2°C). Green tops are usually trimmed to 12 inches. Harvested onions may be bunched in the packing shed. Chilled wash water removes field and ambient heat and then the onions are immediately packed in waxed boxes. Hold green onions at 32°F and 95-100% relative humidity. Green onions are normally marketed promptly, but can be stored 3-4 weeks at 32°F if moisture loss is prevented. Crushed ice or packaging in perforated polyethylene film aids in preventing moisture loss.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the “Herbicide Effectiveness on Common Weeds in Vegetables” Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**1.a. Soil-Applied (Preplant Incorporated or Preemergence)**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 3 | Dacthal 6F<br>Dacthal W-75 | 8.0 to 14.0 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6.0 to 10.5 lb/A | -- | 12 |
| -**Labeled for both bulb onions and green onions**. Apply at time of seeding or immediately after planting sets. Labeled for applications directly over transplants without crop damage. A second application may be needed for longer season seed onions; but will not control emerged weeds. Primarily controls annual grasses and a few broadleaf weeds, including common purslane.<br>-Results have been most consistent when used in fields with coarse-textured soils low in organic matter, and when the application are followed by rainfall or irrigation. Maximum application not addressed on label. | | | | | | |

*1.a. Soil-Applied (Preplant Incorporated or Preemergence) continued on next page*

*1.a. Soil-Applied (Preplant Incorporated or Preemergence) - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | Prowl H2O 3.8CS | 2 pt/A | **pendimethalin** | 0.5 lb/A | 30 | 24 |
| -**Labeled for green onions**. Apply at time of seeding or postemergence. Do no apply preemergence to onions planted on mineral soils with less than 3% organic matter or injury may occur. Onion seed must be fully covered by soil, injury may occur if seed is exposed. Prowl H2O can be applied directly over emerged plants with 2 to 3 true leaves without crop damage.<br>-If sequential applications are made, allow 30 days between applications<br>-Prowl will not control emerged weeds, only provides residual control; controls most annual grasses and certain broadleaf weeds.<br>-**Do not** apply more than 2 pt/A per application; and **do not** apply more than 4 pt/A per season. | | | | | | |
| 3 | Prowl 3.8EC<br>Prowl H2O 3.8CS | 4.8 pt/A<br>4.0 pt/A | **pendimethalin** | 1.9 lb/A | 45 | 24 |
| -**Labeled for bulb onions grown on muck soils only.** Apply from preemergence through 9 true leaf stage; crop safety is greater if application is delayed to loop stage. If irrigating, **do not** apply more than 0.5 inches of water until loop stage<br>-Prow willl not control emerged weeds, only provides residual control; controls most annual grasses and certain broadleaf weeds.<br>-**Do not** apply more than 14.4 pt/A per season of Prowl 3.8EC or Prowl H2O at 12.6 pt/A per season. | | | | | | |
| 8 | Prefar 4E | 5.0 to 6.0 qt/A | **bensulide** | 5 to 6 lb/A | -- | -- |
| -**Labeled for bulb onions only.**<br>-Labeled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum).<br>-If applied preemergence, irrigate within 36 hrs of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 hrs, weed control maybe reduced. Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. **Do not** apply more than 6 lbs ai/A per season. | | | | | | |

## 1.b. Post-Transplant Application / Preemergence Control

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 3 | Prowl 3.3EC<br>Prowl H2O 3.8CS | 1.8 to 3.6 pt/A<br>1.5 to 3.2 pt/A | **pendimethalin** | 0.7 to 1.5 lb/A | 45 | 24 |
| -**Labeled for bulb onions.** Apply directly over emerged onions with 2 to 9 true leaves. If sequential applications are made, allow 30 days between applications. Prowl will not control emerged weeds, only provides residual control; controls most annual grasses and certain broadleaf weeds. **Do not** apply more than 3.6 pt/A per season of Prowl 3.8EC, or more than 3.2 pt/A per season of Prowl H2O. | | | | | | |
| 15 | Dual Magnum 7.62E | 0.67 to 1.33 pt/A | **s-metolachlor** | 0.0.64 to 1.27 lb/A | 21/60 | 24 |
| -**A Special Local-Needs Label 24© has been approved for the use of Dual Magnum 7.62E to control weeds in dry bulb onions in NJ and PA and in green onions in NJ. The use of this product is legal ONLY if a waiver of liability has been completed** (see *http://www.farmassist.com/*).<br>-Apply at the 2 true leaf stage; a second application if soil organic matter is greater than 5%. The 2nd application can not be less than 21 days apart. Dual Magnum will **not** control emerged weeds. Emerged weeds should be controlled by cultivation, hoeing, or postemergence herbicides prior to Dual Magnum application.<br>-For bulb onions: **do not** make more than 2 applications per crop and **do not** apply more than 1.3 pt/A in a single application or mre than 2.6 pt per crop; for green onions **do not** apply more than once and **do not** apply more than 1.33 pt/A.<br>-**Do not** harvest bulb onions within 60 days of application or green onions within 21 days of application. | | | | | | |
| 15 | Outlook 6EC | 10 to 21 fl oz | **dimethenamid** | 0.47 to 0.98 lb/A | 30 | 12 |
| -**Labeled for bulb onions**. Apply after onions have reached the 2 true-leaf stage. A second application may be needed for longer season seed onions; but will not control emerged weeds. If split applications are made allow at least 14 days between applications.<br>-Outlooks provides control of many grass species and a few small-seeded broadleaf weeds.<br>-Do no apply more than 21 fl oz/A in a single growing season. | | | | | | |

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9.0 to 16.0 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 45 | 24 |
| | Fusilade DX 2EC | 8 to 12 fl oz/A | **fluazifop** | 0.125 to 0.19 lb/A | 45 | 12 |
| | Poast 1.5EC | 1.0 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 30 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **Fusilade DX:** Apply with COC at 1.0% v/v or NIS at 0.25% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Select will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions. | | | | | | |

*2. Postemergence (Select, Fusilade, Poast) continued on next page*

*2. Postemergence (Select, Fusilade, Poast) - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| -If repeat applications are necessary, allow 14 days between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 applications for the season; **do not** apply more than 32 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 4.5 pt/A for the season.<br>-**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 3 pt/A per season. | | | | | | |
| 6 | Maestro 2E / Moxy 2E | 1.5 to 2 pt/A | **bromoxynil** | 0.38 to 0.5 lb/A | 60, 112***** | 24 |
| -Apply to onions with 2 to 5 true leaves. Apply in a minimum of 50 gals/A. Leaf surface should be dry at time of application.<br>-No surfactant or adjuvant is recommended due to risk of crop injury.<br>-Apply to small broadleaf weeds (up to 4-leaf stage, 2 inches in height or 1 inch diameter).<br>-Rainfastness is 1 hr. **Do not** apply more than 2 pt/A during the season.<br>*****Do not harvest for 112 days after application on mineral soils or 60 days on muck soils grown in the northeastern US. | | | | | | |
| **14** | Goal 2XL | 2 to 4 fl oz/A (NJ)<br>Up to 8 fl oz (all other states) | **oxyfluorfen** | 0.03 to 0.125 lb/A | 45 | 48 |
| | GoalTender 4F | 1.0 to 2.0 fl oz/A (NJ)<br>up to 4 fl oz/A (all other states) | | | | |
| -Apply when onions have a **minimum of 3 true leaves (do not count the flag leaf)**<br>-Multiple treatments of 4 fl oz can be made up to a maximum of 1 pt/A per season.<br>-Goal may cause injury to onion foliage; the injury will appear as necrotic spots on leaves and/or twisted leaves. Heed the following precautions to avoid or minimize injury: Use flat fan nozzles, 20-40 psi and 20-40 gal/A of water. **Do not** tank-mix with any other pesticide. **Do not** use surfactant, oil concentrates, or any other additive. **Do not** apply during extended periods of cool, wet, cloudy weather. Control is best if weeks are in the 2 to 4 leaf stage and actively growing. Rainfastness is not specified.<br>-Maximum Goal 2XL application per season 32 fl oz/A. Maximum Goal Tender 4F application per season16.0 fl oz/A. | | | | | | |

**3. Postharvest**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant. Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Insecticides

## Soil Pests

**Onion Maggots** Rotation is extremely important to reduce damage. First-brood adult flies appear in early to mid-May, 2nd brood in July, and 3rd brood in August-September. Flies migrate up to half a mile. Foliar insecticide applications are not likely to control maggot flies as flies spend most of their time outside onion fields. If a spray is applied, apply directly over the row. Soak soil around base of seedlings. Fall maggots are most important, because they may end up in stored onions and cause rot. Avoid mechanical injury to bulbs in the field or during harvesting. Crushed onions or culls attract onion maggot flies. Eliminate (bury) culls. Onion seed treated commercially with cyromazine (Trigard ST) is available (pelleted).

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Preplanting or in-furrow broadcast just before planting, mix into top 3-4 inches of soil:** | | | | | | |
| 1B | Diazinon AG 500 | 2.0 to 4.0 qt/A | diazinon* | 60 | 72 | H |
| **Postplanting Soil Drench:** | | | | | | |
| 1B | Lorsban Advanced | 1.0 qt/A | chlorpyrifos* - **dry bulb only** | 60 | 24 | H |
| **Postplanting Spray Treatment:** | | | | | | |
| 1B | Malathion 57EC | 2.5 pt/A | malathion | 3 | 12 | H |
| 3A | Mustang Maxx | 2.24 to 4.00 fl oz/A | zeta-cypermethrin* | 7 | 24 | H |
| 3A | Perm UP 3.2EC[1] | 4.0 to 12.0 fl oz/A | permethrin* (also has a repellend effect) | 1 | 12 | H |
| 3A | Proaxis | 1.92 to 3.20 fl oz/A | gamma-cyhalothrin* - **bulb only** | 14 | 24 | H |

## Aboveground Pests

### Allium Leafminers

This new pest to the mid-Atlantic area is a long grey-black fly with a distinctive yellow or orange patch on the top of its head, yellow sides and "knees" (femur-tibia junction), and white halteres (knobs as second pair of wings). The larvae are a typical whitish maggot. Leek (*A. porrum*) tends to be the most damaged Allium species. Females repeatedly puncture leaves with their ovipositor, resulting in a line of small white dots near the tip. Leaves can be wavy, curled and distorted. Larvae mine leaves, and move into bulbs and leaf sheathes where they pupate. Covering plants in February, prior to the emergence of adults, and keeping plants covered during spring emergence, can exclude the pest. Avoid the adult oviposition period by delaying planting, cover fall plantings during the 2nd generation flight and grow onions as far as possible from chives. Systemic and contact insecticides can be effective.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Mustang Maxx | 2.88 to 4.0 fl oz/A | zeta-cypermethrin* | 7 | 12 | H |
| 3A | Warrior | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 14 | 24 | H |
| 4A | Scorpion 35SL | 8.75 to 10.5 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Scorpion 35SL | 5.25 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Venom 70SG | 3.0 to 4.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 17 | Trigard WSP | 2.66 oz/A | cyromazine | 0 | 12 | L |
| 28 + 6 | Minecto Pro | 7.0 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 30 | 12 | H |

### Cutworms - See also the Pest Management chapter, Insect Management section.

Infestations often occur early in the spring and damaging infestations are usually limited to the earliest plantings. Infestations are intermittent and there are no useful methods to predict when and if the pest might occur. Black cutworm moths are attracted to fields containing winter and perennial weeds such as chickweed, purslane, shepherd's purse and yellow rocket. Moths also are attracted to cereals used as a winter cover crop. Larvae feed just below the soil surface, eventually pulling the above ground portion into the feeding cell. One possible management option includes reducing winter and perennial weeds that serve as oviposition sites.

| **Apply one of the following formulations, Sprays should be directed at the bases of plants.** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate | 1.5 to 3.0 fl oz/A | methomyl* | 7 | 48 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 7 | 12 | H |
| 3A | Proaxis | 1.92 to 3.2 fl oz/A | gamma-cyhalothrin* | 14 | 24 | H |
| 3A | Warrior II | 0.96 to 1.6 fl oz/A | lambda-cyhalothrin* | 14 | 24 | H |

### Leafminers *(Liriomyza)*

Adult flies are black and yellow. The female punctures the leaf to feed on plant sap and to lay eggs. Eggs hatch within 2-4 days and the yellow larvae tunnel within the leaf tissue producing the characteristic "mines" in the leaf. Larvae pupate in the soil or in the leaf axils on plants. Many generations occur each year. Damage caused by leafminers can result in dried out, dead foliage and loss of yield or quality.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 4A | Scorpion 35 SL | 8.75 to 10.5 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Scorpion 35 SL | 5.25 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70 SG | 5.0 to 6.0 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Venom 70 SG | 3.0 to 4.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 17 | Trigard 75 WSP | 2.66 oz/A | cyromazine | 60 | 12 | L |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole - **use with adjuvant** | 1 | 12 | H |
| 28 + 6 | Minecto Pro | 7.0 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 30 | 12 | H |

## Thrips

Onion thrips populations frequently increase following adjacent alfalfa or cereal harvest, as adults overwinter in these fields. Thrips pierce plant tissue and remove plant liquids. Immature thrips usually feed on young tissue between the leaf sheaths and stem; adults feed on more mature tissue. Feeding damage on leaves looks like whitish or chlorotic streaks. If feeding is severe, particularly under dry conditions, the tips of leaves become brown. Prolonged feeding reduces bulb size and increases the incidence of leaf and bulb rots. There are 3-5 overlapping generations per season. Effective management relies primarily on foliar insecticide sprays based on some treatment threshold, usually from 2-4 immatures/leaf. High spray pressures and high gallonages are necessary to ensure good contact between the pest and chemical. **Note**: Use of spinosad for leafminer control will suppress thrips population.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 3.0 pt/A | methomyl* | 7 | 48 | H |
| 3A | Lambda T | 2.56 to 3.2 fl oz/A | lambda-cyhalothrin* | 14 | 24 | H |
| 3A | Mustang Maxx | 2.88 to 4.0 fl oz/A | zeta-cypermethrin* | 7 | 12 | H |
| 3A | Perm-UP 3.2 EC | 6.0 to 12.0 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Warrior | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 14 | 24 | H |
| 4A | Assail 30SG | 5.0 to 8.0 fl oz/A | acetamiprid | 7 | 12 | M |
| 4A | Scorpion 35SL | 8.75 to 10.5 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Scorpion 35SL | 5.25 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70 SG | 5.0 to 6.0 fl oz/A | dinotefuran - **soil** | 1 | 12 | H |
| 4A | Venom 70 SG | 3.0 to 4.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Agri-Mek SC | 1.75 to 3.5 fl oz/A | abamectin* | 30 | 12 | H |
| 23 | Movento | 5.0 fl oz/A | spirotetramat | 3 | 24 | L |

# Disease Control

### THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

### Recommended Fungicides

**Seed Treatment** Check with your seed company if fungicide treated seed is available. Multiple fungicides are often needed to manage the diversity of soilborne fungi that cause decay.

## Damping-off caused by *Pythium* and *Rhizoctonia*

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **Pythium Root Rot** | | | | | | |
| 4 | Ridomil Gold 4SL[1] | 0.5 to 1.0 pt/A | mefenoxam | 7 | 48 | N |
| 4 | Ultra Flourish 2E[1] | 1.0 to 2.0 pt/A | mefenoxam | AP | 48 | N |
| **Pythium and/or Rhizoctonia Root Rot** | | | | | | |
| 4 + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft of row in-furrow (see label), or apply 4.5 fl oz/A to the bed during shaping for transplanted onions | mefenoxam + azoxystrobin | AP | 0 | -- |

[1]Applied as a broadcast or banded immediately after seeding the field

## Bacterial Diseases

### Soft rot, Slippery Skin, Sour Skin and Center Rot

Plant pathogen-free seed and transplants. Rotate to a non-host for 2 or more years and eliminate volunteer onions and weeds. Avoid overhead irrigation especially with water that may be contaminated with pathogen(s). Minimize injury to maturing or harvested bulbs and consider harvesting early under high disease pressure. Dry mature bulbs as soon as possible after harvest. For sweet onions grown on plastic mulch, consider transplanting into silver reflective or black biogradable plastic mulch to reduce the soil temperatures associated with increased losses due to center rot. When conditions are favorable for bacterial diseases, typically warm and wet, initiate a preventative program consisting of fixed copper tank mixed with mancozeb. There are a number of copper-based products that are OMRI-approved for use in organic production systems which will help suppress damage caused by bacterial diseases.

## Fungal Diseases

### Black Mold (*Aspergillus niger*)

This fungus is common in the soil and crop residue and affects a large number of vegetables. Manage by promptly and adequately drying bulbs after harvest. Heated air favors disease development. Storing bulbs at low temperature and humidity will help manage black mold.

### Botrytis Leaf Blight (*Botrytis squamosa*)

The pathogen overwinters in cull piles, on onion debris in the soil, and as sclerotia where related crops were recently grown. Botrytis leaf blight is promoted by moist, cool to mild conditions. Eliminate inoculum sources and rotate 2 or 3 years between onion-related crops. Fungicides can be delayed until there is an average of 1 lesion on 10 leaves.

| **Apply and alternate between one of the following. Always alternate between fungicides from different FRAC codes to reduce chances for fungicide resistance development.** | | | | | | |
|---|---|---|---|---|---|---|
| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| M5 | chlorothalonil 6F | 1.0 to 3.0 pt/A | chlorothalonil | 7 | 12 | L |
| 2 | iprodione 4F | 1.5 pt/A | iprodione | 7 | 24 | N |
| 3 + 9 | Inspire Super 2.82SC | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodonil | 7 | 12 | -- |
| 3 + 11 | Quilt Xcel 2.2SE | 14.0 to 21.0 fl oz/A | propiconazole + azoxystrobin | 14 | 12 | N |
| 7 | Endura 70WG | 6.8 oz/A | boscalid | 7 | 12 | -- |
| 7 | Fontelis 1.67SC | 16.0 to 24.0 fl oz/A | penthiopyrad | 3 | 12 | L |
| 7 + 11 | Merivon 2.09SC | 8.0 to 11.0 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 9 | Scala SC | 9.0 oz/A | pyrimethanil | 7 | 12 | -- |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 7 | 12 | N |
| 11 | azoxystrobin 2.08F | 9.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 + 7 | Pristine 38WG | 14.5 to 18.5 oz/A | pyraclostrobin + boscalid | 7 | 12 | -- |
| 11 + M5 | Quadris Opti 5.5SC | 1.6 to 3.2 pt/A | azoxystrobin + chlorothalonil | 7 | 12 | N |
| 29 | Omega 500F | 1.0 pt/A | fluazinam | 7 | 48 | N |

### Botrytis Neck Rot (*Botrytis alli*)

Infection is favored by cool, wet conditions and poor drying and curing, and often develops on injured bulbs in storage. Minimize N late in the season to promote drying of the necks at harvest. Windrow plants to ensure dry tops before topping operation. Apply and alternate between the following. Always alternate fungicides from different FRAC codes to reduce chances for fungicide resistance development.

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 2 | iprodione 4F[1] | 1.5 pt/A | iprodione | 7 | 24 | N |
| 7 | Endura 70WG | 6.8 oz/A | boscalid | 7 | 12 | -- |
| 7 + 11 | Merivon 2.09SC | 8.0 to 11.0 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 9 | Scala SC | 9.0 oz/A | pyrimethanil | 7 | 12 | -- |
| 29 | Omega 500F | 1.0 pt/A | fluazinam | 7 | 48 | N |

[1]Apply at 14-day intervals (for dry bulb onions only)

### Downy Mildew (*Peronospora destuctor*)

The pathogen can survive as oospores in the soil, or on bulbs, sets and seed. Downy mildew development is promoted by cool, moist conditions. Management begins with planting pathogen-free seed or sets and crop rotations of at least 3 years without related crops. Be sure to eliminate culls and volunteers from the field. Apply one of the following fungicides accordingly and rotate between different FRAC codes.

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| M3 | mancozeb 75DF | 3.0 lb/A | mancozeb | 7 | 24 | N |

*Downy Mildew continued on next page*

*Downy Mildew - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| M5 | chlorothalonil 6F | 1.0 to 3.0 pt/A | chlorothalonil | 7 | 12 | L |
| 3 + 11 | Quilt Xcel 2.2SE | 14.0 to 21.0 fl oz/A | propiconazole + azoxystrobin | 14 | 12 | N |
| 11 | Cabrio 20 EG | 12.0 oz/A | pyraclostrobin | 7 | 12 | N |
| 11 | Reason 500SC | 5.5 fl oz/A | fenamidone | 7 | 12 | -- |
| 11 + M5 | Quadris Opti 5.5SC | 1.6 to 3.2 pt/A | azoxystrobin + chlorothalonil | 7 | 12 | N |
| 29 | Omega 500F | 1.0 pt/A | fluazinam | 7 | 48 | N |
| 45 + 40 | Zampro 525SC | 14.0 fl oz /A | ametoctradin + dimethomorph | 0 | 12 | -- |

## Purple Blotch (*Alternaria porri*) and Stemphylium Leaf Blight

The pathogen overwinters in plant residue from onion-related plants. Purple blotch and Stemphylium development are favored by warm, moist conditions. Grow onions in well-drained soil and rotate with non-related crops. Sweet Spanish types are especially susceptible to purple blotch. Several of the most effective fungicides are listed below.

**Apply and alternate between one of the following. Rotate fungicides in different FRAC codes to slow the development of fungicide resistance. Applications may be needed every 7 days for proper management.**

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| M5 | chlorothalonil 6F (for purple blotch only) | 1.0 to 3.0 pt/A | chlorothalonil | 7 | 12 | L |
| 2 | iprodione 4F[1] | 1.5 pt/A | iprodione | 7 | 24 | N |
| 3 + 9 | Inspire Super 2.82SC | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodonil | 7 | 12 | -- |
| 3 + 11 | Quilt 1.66F | 14.0 to 27.5 fl oz/A | propiconazole + azoxystrobin | 14 | 12 | N |
| 3+ 11 | Quilt Xcel 2.2SE | 14.0 to 21.0 fl oz/A | propiconazole + azoxystrobin | 14 | 12 | N |
| 7 | Endura 70WG | 6.8 oz/A | boscalid | 7 | 12 | -- |
| 7 | Fontelis 1.67SC | 16.0 to 24.0 fl oz/A | penthiopyrad | 3 | 12 | L |
| 7 + 9 | Luna Tranquility SC | 16.0 to 27.0 fl oz/A | fluopyram + pyrimethanil | 7 | 12 | -- |
| 9 | Scala SC | 9.0 oz/A | pyrimethanil | 7 | 12 | -- |
| 9 + 12 | Switch 62.5WG[2] | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 7 | 12 | N |
| 11 | azoxystrobin 2.08F | 9.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20 EG | 12.0 oz/A | pyraclostrobin | 7 | 12 | N |
| 11 | Reason 500SC | 5.5 fl oz/A | fenamidone | 7 | 12 | -- |
| 11 + M5 | Quadris Opti 5.5SC | 1.6 to 3.2 pt/A | azoxystrobin + chlorothalonil | 7 | 12 | N |
| 11 + 7 | Pristine 38WG (apply at 14 day intervals) | 10.5 to 18.5 oz/A | pyraclostrobin + boscalid | 7 | 12 | -- |
| 29 | Omega 500F | 1.0 pt/A | fluazinam | 7 | 48 | N |

[1]Apply at high rate and at 14-day intervals (for dry bulb onions only). [2] For Stemphyllium leaf blight only.

## White Rot (*Sclerotium cepivorum*)

White rot is most limiting in cool, moist soils and most severe on overwintered onions. The sclerotia can be long lived (over 20 years) in the soil in the absence of an Allium host. White rot development is very dependent on soil temperatures with optimum temperatures of 60-65°F (16-18°C).

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply in a 4- to 6-inch band over or into the furrow at planting or may also be applied by chemigation:** | | | | | | |
| 3 | tebuconazole 3.6F | 20.5 oz/A | tebuconazole | 7 | 12 | N |
| **Two additional foliar applications may be applied (dry bulb onion only):** | | | | | | |
| 3 | tebuconazole 3.6F | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |

# Parsley

## Recommended Varieties[1,2]

| Flat Leaf | Curly Leaf | | |
|---|---|---|---|
| Giant of Italy | Banquet (Overwintering) | Forest Green (Semi-curled) | Moss Curled II |
| Italian Flat Leaf | Champion Moss | Krausa | Titan |
| Italian Plain Leaf | Darki | Lisette | |

[1]Listed alphabetically, [2]All varieties are open pollinated.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Parsley | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 150-175 | 200 | 150 | 100 | 0 | 200 | 150 | 100 | 0 | Total nutrient recommended |
| | 50-75 | 200 | 150 | 100 | 0 | 200 | 150 | 100 | 0 | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress after first cutting |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress after each additional cutting |

## Seeding and Spacing

Seed is sown 1/3 inch deep in a well-prepared seedbed as early as ground can be worked in late February/early March through mid-May for late spring/summer harvest. Later plantings can be sown beginning in mid-July for fall harvest and through mid-August for overwintered production. Spacing between rows is 12-18 inches. Parsley seeds are drilled at a rate of 20-40 lb/A, with plants spaced 1-2 inches apart in each row. Seed is slow to germinate. If seeds are more than 1 year old, test the germination and increase the sowing rate to compensate for reduced germination.

Overwintered and the earliest spring and later fall plantings benefit from the use of floating row covers and/or low or high tunnels for protection from freezing. Floating row covers can create conditions favorable for bacterial leaf spot infections to start and spread. Removing row covers on warm or windy days to allow excess moisture to evaporate will help reduce incidence of bacterial leaf diseases.

## Harvest and Post-Harvest Considerations

Parsley can be harvested by cutting a few leaves at a time from each plant, or entire plants may be cut or dug with roots attached and bunched for sale. If cut above the crown, plants will regrow for a second cutting. Parsley leaves are used most commonly for fresh market, but for dried herb markets, the characteristic flavor and green color can be retained if the leaves are dehydrated. Store fresh parsley at 32°F (0°C) and 95-100% relative humidity. Parsley can keep up to 2-2.5 months at 32°F, but high humidity is essential to prevent desiccation. Do not store with other crops that produce ethylene as parsley is very sensitive to ethylene. Packaging in perforated polyethylene bags and using top ice are beneficial for longer storage periods. Controlled atmosphere of approximately 10% oxygen and 11% carbon dioxide at moderate temperatures (41-50°F/5-10°C) can help retain green color and salability.

# Weed Control

### THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

### Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

## 1. Soil-Applied (Preplant Incorporated or Preemergence)

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **5** | Caparol 4L | 1 pt/A | **prometryn** | 0.5 lb/A | 30 | 12 |
| -Apply after seeding, but before crop emergence. Follow with overhead irrigation if rainfall does not occur. Primarily controls annual broadleaf weeds. Annual grasses may only be suppressed. Additional postemergence and postharvest treatments may be applied.<br>-**Do not** use on sand or loamy sand soils, or crop injury may occur.<br>-**Do not** tank-mix Caparol with any other pesticide.<br>-**Do not** apply more than 1 pt/A in a single application and maximum Caparol 4L application per season is 3 pt/A. | | | | | | |
| 7 | Lorox 50DF | 1 to 3 lb/A | **linuron** | 0.5 to 1.5 lb/A | 30 | 24/96 |
| -Apply immediately after seeding. Follow with irrigation if rainfall does not occur. Primarily controls broadleaf weeds. Annual grasses may only be suppressed.<br>-**Do not** apply more than 1.5 lb/A linuron per season. **Do not** apply to parsley through any type of irrigation system<br>-The restricted-entry interval is extended from 24 to 96 hrs (4 days) after hand-set irrigation activity. | | | | | | |
| 8 | Prefar 4E | 5 to 6 qt/A | **bensulide** | 5 to 6 lb/A | -- | 12 |
| -Labeled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum).<br>-24© label for NJ only allows applications up to 9 qt/A. Use on mineral soils only.<br>-If applied preemergence, irrigate within 36 hr of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 hr, weed control maybe reduced.<br>-Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters.<br>-**Do not** apply more than 6 lb ai/A per season. | | | | | | |

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2 EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9 to 16 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 14 | 24 |
| **1** | Poast 1.5EC | 1 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.28 lb/A | 15 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v.<br>-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.<br>-Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.<br>-If repeat applications are necessary, allow 14 days between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 3 pt/A for the season. | | | | | | |
| 5 | Caparol 4L | 1 pt/A | **prometryn** | 0.5 lb/A | 30 | 12 |
| -Apply after the crop has developed 3 true leaves. Primarily controls seedling annual broadleaf weeds less than 2 inches tall. Annual grasses may only be suppressed. An additional treatment can be applied to regrowth after the first harvest.<br>-**Do not** use on sand or loamy sand soils, or crop injury may occur. **Do not** apply if parsley is under stress.<br>-**Do not** tank-mix Caparol with any other pesticide.<br>-**Do not** use spray additives such as nonionic surfactant or oil concentrate.<br>-**Do not** apply more than 1.0 pt/A in a single application and maximum Caparol 4L application per season is 3 pt/A. | | | | | | |

## 3. Postharvest

| | | | | | | |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

## 4. Other Labeled Herbicides

These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| **14** | Aim | **carfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

### Aphids

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Malathion 57EC | 1.0 to 2.0 pt/A | malathion (2 applications per season, only) | 7 | 24 | H |
| 3A + 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 4A | Actara | 1.5 to 3.0 oz/A | thiamethoxam | 7 | 12 | H |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.3 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Belay | 9 to 12 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay | 3 to4 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum | 5 to 11 fl oz/A | thiamethoxam | 30 | 12 | H |
| 4C | Closer SC | 1.5 to 2 fl oz/A | sulfoxaflor | 3 | 12 | H |
| 9B | Fulfill | 2.75 oz/A | pymetrozine | 7 | 12 | N |
| 9C | Beleaf 50SG | 2.0 to 2.8 fl oz/A | flonicamid | 0 | 12 | L |
| 23 | Movento | 4 to 5 fl oz/A | spirotetramet | 3 | 24 | L |
| n/a | Ecozin Plus (OMRI) | 15 to 30 fl oz/A | azadirachtin | 0 | 4 | N |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

### Armyworms

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Mustang-Max | 3.2 to 4.0 fl oz/A | zeta-cypermethrin* **- not for beet armyworm** | 1 | 12 | H |
| 3A | Tombstone | 2.4 to 3.2 fl oz/A | cyfluthrin* **- not for beet armyworm** | 0 | 12 | H |
| 3A + 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid+beta-cyfluthrin* **- not for beet armyworm** | 7 | 12 | H |
| 5 | Entrust SC (OMRI) | 6.0 to 10.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5SG | 2.4 to 4.8 fl oz/A | emamectin benzoate* | 7 | 12 | H |
| 18 | Intrepid 2F (early season) | 4 to 8 fl oz/A | methoxyfenozide | 1 | 4 | N |
| 18 | Intrepid 2F (late season) | 8 to 10 fl oz/A | methoxyfenozide | 1 | 4 | N |
| 28 | Exirel | 7 to 13.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 | Verimark | 5 to 10 fl oz/A | cyantraniliprole - **soil** | NA | 4 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole+abamectin | 7 | 12 | H |

### Carrot Weevils

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Malathion 57EC | 1.0 to 2.0 pt/A | malathion | 7 | 24 | H |

### Flea Beetles, Leafhoppers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Sevin XLR Plus | 0.5 to 1 qt/A | carbaryl | 14 | 12 | H |
| 3A | Baythroid XL | 2.4 to 3.2 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 | 2 to 8 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone | 2.4 to 3.2 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A + 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |

*Flea Beetles, Leafhoppers continued on next page:*

*Flea Beetles, Leafhoppers - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4A | Actara | 1.5 to 3.0 oz/A | thiamethoxam | 7 | 12 | H |
| 4A | Admire Pro | 1.3 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Belay | 9 to 12 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay | 3 to 4 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 5 to 11 fl oz/A | thiamethoxam | 30 | 12 | H |
| 4A | Scorpion 35SL | 9 to 10.5 fl oz/A | dinetofuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2 to 5.2 fl oz/A | dinetofuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70SG | 5 to 7.5 fl oz/A | dinetofuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1 to 3 fl oz/A | dinetofuran - **foliar** | 1 | 12 | H |
| 4C | Closer SC | 1.5 to 2 fl oz/A | sulfoxaflor | 3 | 12 | H |

## Tarnished Plant Bugs

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Sevin XLR Plus | 1 to 2 qt/A | carbaryl | 14 | 12 | H |
| 3A | Baythroid XL | 2.4 to 3.2 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Mustang Maxx | 3.2 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Tombstone | 2.4 to 3.2 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A + 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 9C | Beleaf 50SG | 2.0 to 2.8 fl oz/A | flonicamid | 0 | 12 | L |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Fungicides

### Nematode Control

Nematode control is essential for satisfactory parsley production; see the Nematodes and Soil Fumigation sections in the Pest Management chapter. Before planting, soil should be fumigated with metam-sodium (Busan or Vapam HL) according to directions in the Soil Fumigation section in the Pest Management chapter.

## Seed Treatment

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **For Pythium and Phytophthora Control:** | | | | | | |
| 4 | Apron XL LS[1] | 0.085 to 0.64 fl oz/100 lb seed | mefenoxam | NA | NA | N |
| **For Control of Other Root Rots:** | | | | | | |
| 12 | Maxim 4FS[1] | 0.08 to 0.16 fl oz/100 lb seed | fludioxonil | NA | NA | N |

[1]Apron XL LS and Maxim 4FS can be combined.

## Damping-off caused *Pythium* and *Rhizoctonia*

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **For Pythium root rot control, apply as banded spray:** | | | | | | |
| 4 | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | NA | 48 | N |
| 4 | MetaStar 2E AG | 2.0 to 4.0 pt/A | metalaxyl | NA | 48 | N |
| **For Rhizoctonia root rot control, apply as in-furrow application:** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/A | | NA | 4 | N |
| **For Pythium and Rhizoctonia root rot control apply as banded spray:** | | | | | | |
| 11 + 4 | Uniform 3.66SC | 0.34 fl oz/1000 ft row | azoxystrobin + mefenoxam | NA | 0 | N |

## Bacterial Leaf Blight and Septoria Leaf Spot

To help reduce disease pressure from bacterial and fungal diseases, rotate with non-related crops for at least 2 years. Space successive plantings in the same year as far apart as possible. Heavy winds and rain may damage leaves and predispose leaves to bacterial infections.

**Bacterial leaf blight:** Prevention is key. Avoid working in the fields while the foliage is wet to help reduce spread. Scout fields on a regular basis for early symptoms, apply fixed copper at labeled rates with regular maintenance applications for leaf spot diseases and repeat every 7 days. Some copper-based products are OMRI-approved and can be used in organic production systems for the suppression of bacterial and some fungal diseases.

**Septoria leaf spot:** The disease causes serious problems in fields where parsley has been grown extensively. Grow parsley in fields without a history of the disease. Plant blocks as far apart as possible. **Early detection and prevention are key**. Scout daily, and apply fungicides preventatively before first leaf spots appear. Early season infections (*i.e.*, prior to first cutting) will severely reduce subsequent harvests.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Rotate the following every 7 days prior to the onset of the disease:** | | | | | | |
| 7 | Fontelis 1.67SC[1] | 14.0 to 24.0 fl oz/A | penthiopyrad | 3 | 12 | L |
| 7 + 11 | Merivon 2.09SC[1] | 4.0 to 11.0 fl oz/A | fluxapyroxad + azoxystrobin | 1 | 12 | N |
| **with a FRAC code 11 fungicide where resistance is not present:**[2] | | | | | | |
| 11 | azoxystrobin 2.08F[1] | 6.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20WG[1] | 12.0 to 16.0 oz/A | pyraclostrobin | 0 | 12 | N |

(*) See labels for specific crop use.

[1] Tank-mixing the above with a fixed copper may also help suppress bacterial infections.

[2] Poor control has been noted in areas of southern NJ where FRAC code 11 fungicides have been used extensively to control Septoria leaf spot.

# Parsnips

| Recommended Varieties | Albion (hybrid) | Harris Model | Javelin (hybrid) |
|---|---|---|---|

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Parsnips | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 50-75 | 150 | 100 | 50 | 0 | 150 | 100 | 50 | 0 | Total nutrient recommended |
| | 25-50 | 150 | 100 | 50 | 0 | 150 | 100 | 50 | 0 | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 4-5 weeks after planting |

Apply 1-2 lb/A of boron (B) with broadcast fertilizer; s See also Table B-7 in the Soil and Nutrient Management chapter.

## Seeding and Spacing

Seeds germinate slowly. Never use seed that is more than 1 yr old. In March and April, seed 3-5 lb/A at a depth of ¼-3/8 inch in rows 18-30 inches apart. Adjust seeder to give 8-10 plants/ft of row. Thin seedlings to 2-4 inches in the row.

## Harvest and Postharvest Considerations

Parsnips may be dug, topped, and stored at 32°F (0°C). Storage relative humidity must be kept high (90-95%) to prevent wilting; ventilated plastic crate liners help to prevent moisture loss. Parsnips can be stored for up to 6 months. Good market quality is the result of starch changing to sugar which occurs after 2-3 weeks in storage below 35°F (2°C); leaving parsnips in the ground over winter or freezing them is not necessary. If parsnips are left in the ground over winter, remove them before growth starts in the spring.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**1. Soil-Applied (Preemergence)**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 7 | Lorox 50DF<br>Linex 4L | 1.5 to 3 lb/A<br>1.5 to 3 pt/A | **linuron** | 0.75 to 1.5 lb/A | -- | 24 |
| -Apply right after seeding, but before crop emergence. Plant seed at least 0.5 inch deep. | | | | | | |

**2. Postemergence**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz<br>9 to 16 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 30 | 24 |
| **1** | Poast 1.5EC | 1.0 to 2.5 pt/A | **sethoxydim** | 0.2 to 0.5 lb/A | 14 | 12 |

*2. Postemergence (Select, Select Max, Poast) continued on next page*

*2. Postemergence (Select, Select Max, Poast) - continued*

| |
|---|
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions. If repeat applications are necessary, allow 14 days between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 2.5 pt/A Poast in single application and **do not** exceed 2.5 pt/A for the season. |

**3. Postharvest**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant. Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

**4. Other Labeled Herbicides** These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| **14** | Aim | **carfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

### Aphids

Aphids are small soft bodied insects, usually green or yellow colored. They are found on the underside of leaves and/or on stems. If aphid infestation is heavy it may cause: yellowing or distorted leaves, necrotic spots on leaves and stunted shoots. Aphids secrete a sticky, sugary substance called honeydew which encourages the growth of sooty mold. Plants generally tolerate low to medium levels of infestations.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Malathion 57EC | 1.0 to 2.0 pt/A | malathion | 7 | 24 | H |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.7 to 4.0 oz/A | thiamethoxam - **soil** | 7 | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 fl oz/A | thiamethoxam - **foliar** | 7 | 12 | H |
| 4C | Closer 2SC | 1.5 to 2.0 fl oz/A | sulfoxaflor | 7 | 12 | H |
| 4D | Sivanto 200SL | 7.0 to 10.5 fl oz/A | flupyradifurone | 7 | 4 | L |
| 9C | Beleaf 50SG | 2.0 to 2.8 fl oz/A | flonicamid | 3 | 12 | L |
| n/a | Ecozin Plus (OMRI) | 15.0 to 30.0 oz/A | azadirachtin | 0 | 4 | N |

### Leafhoppers

Leafhoppers suck sap and plant juices, causing small white spots (stippling) on the upper leaf surface, usually beginning near the midrib. Stippled areas can coalesce into larger whitish blotches on mature leaves. Prolonged feeding causes a drying and yellowing (or browning) of leaf margins, and possibly the whole leaf. Some leafhopper species cause curling or stunting of terminal leaves.

Some leafhoppers species can transmit aster yellows, which cause a yellowing of leaves while the veins remain green. Aster yellows also slows down growth and leaves may be smaller and narrower. The spread of aster yellows is worse in a cool, wet summer. Row covers can be used to eliminate leafhoppers. Control weeds such as plantain and dandelion that may harbor the disease. In our area leafhoppers only occasionally require treatment.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin Plus XLR | 0.5 to 1.0 qt/A | carbaryl | 7 | 12 | H |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.2 to 4.0 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.7 to 4.0 oz/A | thiamethoxam - **soil** | 7 | 12 | H |
| 4A | Actara 25 WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 7 | 12 | H |
| 4C | Closer 2SC | 2.75 to 5.75 fl oz/A | sulfoxaflor | 7 | 12 | H |

## Whiteflies

While whiteflies are not very common pests on parsnips they can occasionally build their populations up and need treatment. Whiteflies use their piercing, sucking mouthparts to suck sap from phloem tissues in plant stems and leaves. Large populations can cause leaves to turn yellow and die. Whiteflies excrete honeydew, so leaves may be sticky or covered with black sooty mold that grows on the honeydew.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 4A | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.7 to 4.0 oz/A | thiamethoxam - **soil** | 7 | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 7 | 12 | H |
| 4D | Sivanto 200SL | 10.5 to 14.0 fl oz/A | flupyradifurone | 7 | 4 | L |
| 4C | Closer 2SC | 4.25 to 5.75 fl oz/A | sulfoxaflor | 7 | 12 | H |
| 9C | Beleaf 50SG | 2.8 fl oz/A | flonicamid | 3 | 12 | L |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

## Damping-Off caused by *Phytophthora* and *Pythium*

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **Apply the following preplant incorporated or as a soil-surface spray after planting:** | | | | | | |
| 4 | Ridomil Gold 4SL | 1.0 to 2.0 pt/A | mefenoxam | 0 | 48 | N |
| 4 | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | AP | 48 | N |

## Leaf Spots (*Alternaria* and *Cercospora*), Rhizoctonia Stem Canker, and Powdery Mildew

Rotate fields to allow at least 2 yr between parsnip plantings. Always plant in well-drained soils with a pH of 7.0. Ridge soil over shoulders to prevent pathogen infection. Begin sprays at the first sign of disease and repeat no more than 3 times at 10-day intervals. **Do not** make more than one consecutive application of a FRAC code 11 fungicide.

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **Rotate, or tank-mix the following** | | | | | | |
| M5 | chlorothalonil 6F | 1.5 to 2.0 pt/A | chlorothalonil | 10 | 12 | L |
| **WITH ONE of the following FRAC code 11 fungicides:** | | | | | | |
| 7 + 11 | Merivon 2.09SC | 4.4 to 5.5 fl oz/A (use highest rate for Cercospora leaf spot) | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 11 | azoxystrobin 2.08F | 9.0 to 15.5 fl oz/A | azoxystrobin | 0 | 12 | N |
| 11 | Cabrio 20EG | 8.0 to 12.0 oz/A | pyraclostrobin | 0 | 12 | N |
| 11 | Gem 500SC | 1.9 to 2.9 oz/A | trifloxystrobin | 7 | 12 | N |

# Peas (Succulent)

## Recommended Varieties[1]

| | Season | Variety | Heat Units | Leaf Type | Reported Disease Reaction[2] |
|---|---|---|---|---|---|
| **Processing Peas** | **First Early** | Jumpstart | 1110 | normal | F1 |
| | | Strike | 1140 | normal | F1 |
| | **Early** | Icepack | 1170 | afila | F1 |
| | | June | 1160 | normal | F1 |
| | **Midseason** | Dakota | 1190 | normal | F1, PM |
| | | Marias | 1290 | normal | F1 |
| | | SV0935QF | 1390 | afila | F1, F2, PM, DM |
| | **Late** | Ashton | 1480 | normal | F1, DM(I) |
| | | Bolero | 1480 | normal | F1 |
| | | Grundy | 1595 | normal | F1 |
| | | Hacienda | 1520 | afila | F1, F2, PM |
| | | Hudson | 1540 | normal | F1, F2, PM |
| | | PLS 595 | 1550 | normal | F1, PM(I) |
| | | Quad | 1600 | normal | F1, PM |
| | | SV7688QF | 1520 | afila | F1, F2, PM |

Consult the University of Delaware Extension website at *http://extension.udel.edu/ag/vegetable-fruit-resources/vegetable-small-fruits-program/variety-trial-results/* for results from recent processing peas variety trials. [1]Use varieties recommended by processors. [2]From source companies. F1=Resistant to Fusarium wilt race 1, F2=Resistant to Fusarium wilt race 2, DM= resistance to downy mildew; PM=Resistant to powdery mildew, (I) indicates intermediate resistance or tolerance.

| | Use | Variety | Days | Height (Inch)[1] | Reported Disease Reaction[2] |
|---|---|---|---|---|---|
| **Fresh Market Peas** | **Shelled** | Bolero | 68 | 30 | F1 |
| | | Green Arrow | 70 | 30 | PM |
| | | Jumpstart | 56 | 22 | F1 |
| | | Knight | 61 | 19 | F, PM |
| | | Lincoln | 67 | 30 | F |
| | | Mr. Big | 60 | 30 | F1, PM |
| | | Progress #9 | 62 | 16 | |
| | | Strike | 49 | 24 | F |
| | **Snow** | Dwarf Gray Sugar | 74 | 28 | |
| | | Oregon Sugar Pod #2 | 60 | 28 | F1, PM |
| | **Snap** | Sugar Ann | 55 | 26 | |
| | | Sugar Sprint | 55 | 26 | PM |
| | | Super Sugar Snap | 58 | 60 | F1, PM |

[1]Peas that are taller than 24 inches may require trellising. [2]From source seed companies: F=general Fusarium wilt resistant, F1=Resistant to Fusarium wilt race 1, PM=powdery mildew resistant.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| **Peas** | | **Soil Phosphorus Level** | | | | **Soil Potassium Level** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Low** | **Med** | **High (Opt)** | **Very High** | **Low** | **Med** | **High (Opt)** | **Very High** | |
| | **N (lb/A)** | **$P_2O_5$ (lb/A)** | | | | **$K_2O$ (lb/A)** | | | | **Nutrient Timing and Method** |
| | 40-80 | 120 | 80 | 40 | 0[1] | 120 | 80 | 40 | 0[1] | Total nutrient recommended |
| | 40-80 | 120 | 80 | 40 | 0[1] | 120 | 80 | 40 | 0[1] | Broadcast and disk -in |

[1]In VA, crop replacement values of 20 lb/A of $P_2O_5$ and 20 lb/A of $K_2O$ are recommended on soils testing Very High.

## Seed Treatment

Use seed already treated with an approved seed treatment, or treat seed with a slurry or dust that contains an approved commercial fungicide -insecticide mixture. See the Disease Control section for more information.

## Seeding and Spacing

Peas thrive in cool weather and can tolerate light frost. Planting for processing is based on the heat -unit theory?. Plant peas between February 25 and April 30 when soil conditions are favorable. For processing peas, drill 250-275 lb/A of seed in rows 6-8 inches apart. For fresh market peas, seed 80-120 lb/A (25 seeds per ft in a band) in 30-36 inch rows. Sow at a depth of no more than 1 inch unless soil is dry. Use press wheel drill or seeder to fix seeds into soil. There is the potential for mid to late summer plantings for fall harvest where local markets exist. Fall plantings usually yield less than spring plantings.

## Harvest and Post Harvest Considerations

Processing peas are mature from May 20 through July 5. Pick shelling types while they are firm, but still succulent. Harvest snow peas before seed swelling becomes too pronounced. Crisp fleshy snap types should be picked when they are round and firm, but still succulent. Peas in pod, shelled peas, and edible pod peas lose part of their sugar content, on which much of their flavor depends, unless they are cooled to near 32°F (0°C) immediately after harvest and maintained at 32°F and 90-95% relative humidity. Forced air cooling is preferred since it does not result in surface moisture formation, and minimizes the risk of decay. After precooling, the peas should be packed with crushed ice (top ice) to maintain freshness and turgidity. Top ice provides the desired high humidity to prevent wilting. Temperatures should not exceed 34°F (1°C) when any moisture is present on the surface of the peas or rapid decay and deterioration will occur. Edible pod peas, peas in pod, and shelled peas are only salable for 1-2 weeks even at 32°F unless packed in crushed ice. With top ice, the storage period may be extended a week.

## Pea Shoots

Peas, preferably snap and snow pea varieties, may also be grown for shoots for local markets. Follow the instructions for planting and spacing described above. When plants are 8-12 inches tall, clip off the growing points plus one pair of leaves to encourage branching. These clippings can be used as a first harvest. Keep clipping the top 2-6 inches of each plant after regrowth, every 3-4 weeks. Harvested shoots should include the top pair of small leaves, delicate tendrils and a few larger leaves and blossoms or immature buds. Select undamaged, fresh, crisp and bright green shoots. Harvest a planting until shoots begin to taste bitter. Pea shoots for fall harvest are planted mid to late summer and harvested until a hard freeze. Shoots may also be grown in high tunnels throughout the fall, winter, and early spring. Pea shoots have a short storage life and should be marketed within 2 days after harvest. Rapidly precool shoots to 32°F, and store at 32-34°F (0-1°C) and 98-100% relative humidity. Freezing will damage leaf tissues, so maintain storage temperatures above 28°F (-2°C)

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

| **1. Non-Selective or Burndown** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate/A** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate (lb ai or ae/A)** | **PHI (d)** | **REI (h)** |
| **9** | Roundup PowerMax 4.5L<br>"Generic" glyphosate 3L | 16 to 32 fl oz/A<br>24 to 48 fl oz/A | **glyphosate** | 0.75 to 1.13 lb acid equivalent/A | -- | 4 |
| -Apply preplant or preemergence. Some glyphosate formulations may require an adjuvant, refer to label.<br>-Tank-mix with appropriate herbicides for residual weed control. Glyphosate controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label. Repeat applications are allowed, with maximum application of 5.3 qt/A per year. | | | | | | |
| 22 | Gramoxone SL 2.0 | 2.4 to 4.0 pt/A | **paraquat*** | 0.6 to 1.0 lb/A | -- | 24 |
| -Apply preplant or preemergence. Always include an adjuvant (nonionic surfactant or crop oil concentrate). Tank-mix with appropriate herbicides for residual weed control. Paraquat may not control established grasses. Spray coverage is essential for optimum control.<br>-Rainfastness 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |

## 2. Soil-Applied (Preplant Incorporated or Preemergence)

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **2** | Pursuit 2L | 1.5 to 2.0 fl oz/A | **imazethapyr** | 0.024 to 0.032 lb/A | -- | 4 |
| -Shallow, thorough incorporation improves consistency of performance when dry weather follows application.<br>-Primarily controls broadleaf weeds. Use in combination with another herbicide to control annual grasses. In DE, MD, and VA **do not** apply more than 2 fl oz/A to sand or loamy sand soils; other states in the region can use up to 3 fl oz/A. Pursuit residues persist in the soil after harvest and may affect following crops (check the label). Maximum number of applications per year: 1. | | | | | | |
| 13 | Command 3ME | 1.3 pt/A | **clomazone** | 0.5 lb/A | -- | 12 |
| -Apply to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled.<br>-Some temporary injury, seen as a partial whitening of leaf and/or stem of the crop, may be observed after seedling emergence. Complete recovery from early injury will occur without affecting yield or delaying maturity.<br>-**WARNING**: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions.<br>-Herbicide residues may limit subsequent cropping options when Command is used for weed control in peas. See planting restrictions on the label or consult your local Cooperative Extension office. Maximum number of applications per season: 1. | | | | | | |
| 15 | Dual Magnum 7.62E | 0.5 to 1.0 pt/A | **s-metolachlor** | 0.48 to 0.96 lb/A | 60 | 24 |
| -Primarily controls annual grasses, suppresses yellow nutsedge, and suppresses or controls certain annual broadleaf weeds including pigweed and nightshade species. Common lambsquarters and common ragweed will NOT be controlled.<br>-Recommended rates may be lower than the labeled rate to reduce the risk of crop injury. The use of less than 1 pt/A of Dual Magnum may reduce the duration or level of control of some weeds.<br>-Cold wet weather after application increases the risk of crop injury, which may delay maturity. Use the minimum recommended rate, or choose another herbicide when cold wet weather is anticipated.<br>-Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.<br>-Maximum number of applications per season: 1. | | | | | | |

## 3. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9.0 to 16.0 fl oz/A | **clethodim** | 0.07 to 0.125 lb/A | 14 | 12 |
| **1** | Assure II/Targa 0.88EC | 6.0 to 12.0 fl oz/A | **quizalofop-P-ethyl** | 0.04 to 0.08 lb/A | 15 | 12 |
| **1** | Poast 1.5EC | 1.0 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 15 | 12 |
| -**Select 2EC, Poast, and Assure II/Targa**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant at 0.25% v/v (1 qt/100 gal of spray solution). **The use of COC may increase the risk of crop injury under hot or humid conditions.** To reduce this risk, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Addition of nitrogen is not recommended.<br>-Controls many annual and certain perennial grasses. Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. Does not control yellow nutsedge, wild onion/garlic, or broadleaf weeds.<br>-**Do not** tank-mix with or apply within 3 to 7 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 2.5 pt/A Poast in single application and **do not** exceed 5 pt/A for the season.<br>-Maximum Assure II/Targa 0.88EC application per season is 14 fl oz/A. Rainfastness 1 hr. | | | | | | |
| **2** | Pursuit 2L | 1.5 to 3 fl oz/A | **imazethapyr** | 0.024 to 0.048 lb/A | -- | 4 |
| -Apply early postemergence to control annual broadleaf weeds and some grasses when the crop is at least 3-inches tall (after 1-true leaf stage) but before 5 nodes before flowering. Add nonionic surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray).<br>-Pursuit can delay maturity if growing conditions are less than favorable at time of application.<br>-Rainfastness is 1 hr. **Do not** apply more than 1 application per growing season. | | | | | | |
| **2** | Raptor 1L | 3 fl oz/A | **imazamox** | 0.023 lb/A | -- | 4 |
| -Apply to control annual broadleaf weeds and some grasses when the crop is at least 3-inches tall but before 5 nodes before flowering.<br>-Add nonionic surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray); **do not** use nitrogen fertilizer in spray solution.<br>-In DE and MD, Basagran must always be added to the spray mixture to reduce crop injury; mix 6 to 16 fl oz/A of bentazon (Basagran) to reduce the expression of injury symptoms or use **Varisto 4.18L** which is a prepackaged mixture of Raptor plus Basagran; 21 fl oz of Varisto = 4 fl oz of Raptor and 21 fl oz of Basagran 4L<br>-The use of trifluralin (e.g., Treflan) before Raptor application may increase the possibility and severity of crop injury.<br>-Use Raptor only if good agronomic practices have been used to establish and maintain the crop.<br>-Rainfastness is 1 hr. **Do not** apply more than 3 fl oz/A per year and more than 1 application per growing season. | | | | | | |

*3. Postemergence continued on next page*

*3. Postemergence - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | Thistrol 2L | 2 to 6 pt/A | **MCPB** | 0.5 to 1.5 lb/A | -- | 24 |
| -Apply postemergence to control certain annual broadleaf weeds (e.g., lambsquarters, pigweed, smartweed, morningglory) and Canada thistle when the crop is from shoot emergence to 3-leaf nodes before flowering. Typical application is from 6 to 12 nodes.<br>-Tank-mix with Basagran to broaden weed control spectrum. See label for additional guidelines.<br>-**Do not** spray peas under moisture stress and when air temperatures exceed 90F. Temporary twisting may occur on some pea varieties. | | | | | | |
| 6 | Basagran 4L | 1.5 to 2 pt/A | **bentazon** | 0.75 to 1 lb/A | 30 | 12 |
| -Apply after peas have more than 3 pairs of leaves. **Do not** add oil concentrate. Ground application in a minimum of 20 gal/A is preferred. For broadleaf weed control only. See label for weed size for effective control. Rainfastness is 8 hrs. | | | | | | |

**4. Postharvest**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone 2SL | 2.4 pt/A | **paraquat*** | 0.6 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

**5. Other Labeled Herbicides** These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| **5** | Lorox | **linuron** |
| 3 | Prowl / Prowl H2O | **pendimethalin** |
| **14** | Sharpen | **saflufenacil** |
| 3 | Treflan | **trifluralin** |

# Insect Control

## THE LABEL IS THE LAW- See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

## Soil Pests

### Seed Maggots

Commercially applied seed treatments only: chlorpyrifos* (Lorsban 50W) or thiamethoxam (Cruiser 5FS).

## Above-ground Pests

### Armyworms and Other "Worm" or Caterpillar Pests

Armyworms often feed in groups on leaves and also attack pods. An action threshold of 30 larvae per 3 ft of row or about 20% defoliation is often used pre-pod. The insecticides listed below will control any of the above "worm" pest species with exception of beet armyworm and soybean looper, which have developed resistance to certain classes of insecticides particularly pyrethroids **(Group 3 in bold-face type)**.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3 pt/A | methomyl* | see label | 48 | H |
| **3A** | Asana XL | 5.8 to 9.6 fl oz/A | **esfenvalerate*** | 3 | 12 | H |
| **3A** | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | **bifenthrin*** | 3 | 12 | H |
| **3A** | Hero EC | 4.0 to 10.3 fl oz/A | **zeta-cypermethrin* + bifenthrin*** | 3 | 12 | H |
| **3A** | LambdaCy, LambdaT | 2.56 to 3.84 fl oz/A | **lambda-cyhalothrin*** | 7 | 12 | H |
| **3A** | Mustang Maxx | 3.2 to 4.0 fl oz/A | **zeta-cypermethrin*** | 1 | 12 | H |
| **3A** | Warrior II | 1.28 to 1.92 fl oz/A | **lambda-cyhalothrin*** | 7 | 12 | H |
| **3A** + 28 | Besiege | l6.0 to 10.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 7 | 12 | H |
| 5 | Blackhawk 36WG | 2.2 to 3.3 oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant SC | 4.0 to 8.0 fl oz/A | spinetoram | 3 | 4 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 1 | 4 | L |

**Cutworms -** See also the Pest Management chapter, Insect Management section.

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations:** | | | | | | |
| 1A | Lannate LV | 1.5 to 3 pt/A | methomyl* | see label | 48 | H |
| 1A | Sevin XLR Plus | 1.00 to 1.50 qt/A | carbaryl | 3 | 12 | H |
| 1B | Diazinon AG500[2] | 2.0 to 4.0 qt/A | diazinon* - **pre-plant broadcast and immediately incorporate into the soil** | see label | 72 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy. LambdaT | 1.92 to 3.20 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 1.28 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Warrior II | 0.96 to 1.60 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 5.0 to 8.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 7 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 1 | 4 | L |

**Pea Aphids** Treat when there are 5-10 aphids per plant or 50 or more aphids per sweep in a 15-inch sweep net.

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations:** | | | | | | |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | see label | 48 | H |
| 1B | Dimethoate 400 4EC | 0.5 pt/A | dimethoate* | 0 | 48 | H |
| 3A | Asana XL | 2.9 to 5.8 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 4A | Admire PRO | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire PRO | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 7 | 12 | M |
| 4D | Sivanto 200SL | 7.0 to 10.5 fl oz/A | flupyradifurone | 7 | 4 | M |

# Disease Control

## THE LABEL IS THE LAW- See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

**Seed Treatment** Use seed already treated with an approved seed treatment, or treat seed with a slurry or dust that contains an approved commercial fungicide-insecticide mixture. For disease control, use seed treated with:

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **For Rhizoctonia and Fusarium Control:** | | | | | | |
| 12 | Maxim 4FS | 0.08 to 0.16 fl oz/100 lb seed | fludioxonil | -- | 12 | L |
| **For Pythium Control:** | | | | | | |
| 4 | Apron XL | 0.16 to 0.64 fl oz/100 lb seed | mefenoxam | -- | 48 | N |
| 4 | Allegiance FL | 0.75 fl oz/100 lb seed | metalaxyl | -- | 24 | N |

### Damping-Off caused *Pythium* and *Rhizoctonia*

Rotate and allow 4-5 years between plantings. Do not double crop with another legume of any type.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following according to the label:** | | | | | | |
| **Pythium root rot only:** | | | | | | |
| 4 | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | -- | 48 | N |
| 4 | Ultra Flourish 4E | 1.0 to 2.0 pt/A | mefenoxam | AP | 48 | N |
| 4 | MetaStar 2E AG | 2.0 to 4.0 pt/A | metalaxyl | -- | 48 | N |
| **For Pythium and/or Rhizoctonia root rots:** | | | | | | |
| 4 + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft of row in-furrow, see label | mefenoxam + azoxystrobin | AP | 0 | -- |
| **Rhizoctonia root rot only:** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 row ft | azoxystrobin | 0 | 4 | N |

# Bacterial and Fungal Diseases

## Ascochyta Blight

Ascochyta blight is favored by long periods of leaf wetness and heavy growth of vines that creates a moist environment under the pea vine canopy. Plant fungicide treated seed. Deeply incorporate crop debris immediately after harvest before the fungus can be dispersed by wind or rain. Scout on a regular basis because pathogen can develop and spread rapidly. In fields with a history of Ascochyta blight apply one of the following fungicides preventatively, and rotate between fungicides every 7 d as long as conditions favor disease development.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 7 | Endura 70W | 8.0 to 11.0 oz/A | boscalid | 7 | 12 | -- |
| 7 + 11 | Priaxor 4.17SC (also effective for powdery mildew) | 4.0 to 8.0 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 11 | azoxystrobin 2.08F | 6.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Headline 2.1EC | 6.0 to 9.0 fl oz/A | pyraclostrobin | 7 | 12 | N |

## Bacterial Blight

The pathogen can be seedborne so source high quality seed. Avoid walking or moving equipment through fields when vines are wet, as this will spread the disease.

## Downy Mildew (*Peronospora viciae*)

Control strategies include planting recommended resistant varieties, crop rotations of 3 years or more, and effective seed treatments (*e.g.*, Allegiance FL or Apron XL) prior to seeding. Avoid planting in fields that had peas the previous year because the pathogen can overwinter on old debris. Downy mildew development is favored by prolonged cool, wet weather conditions.

## Fusarium Wilt

Use resistant varieties if available. Plant as early as possible to minimize crop growth when soil temperatures are ideal for Fusarium wilt development (68 to 72°F).

## Powdery Mildew

Powdery mildew is favored by warm, dry days and cool nights that lead to dew formation. Disease severity is usually highest in late summer. Fall plantings are most susceptible. If available plant resistant or less susceptible cultivars. At first appearance of the disease, apply one of the following and rotate between different fungicides as long as conditions favor disease development.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| M2 | Sulfur (OMRI)[1] | 3.0 to 10.0 lb/A | sulfur | -- | 24 | N |
| 7 | Endura 70W | 8.0 to 11.0 oz/A | boscalid | 7 | 12 | -- |
| 7 + 11 | Priaxor 4.17SC[2] | 4.0 to 8.0 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |

[1] Some sulfur based products are OMRI-approved for use in organic production systems. [2] Also effective for Ascochyta blight

## White Mold

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Preplant. Apply 3-4 months prior to planting to reduce levels of sclerotia inoculum in the soil. Incorporate to a depth of 1-2 inches. Do not plow before seeding peas to avoid moving untreated sclerotia from lower to upper soil layers:** | | | | | | |
| Bio. | Contans 5.3WG (OMRI) | 2.0 to 4.0 lb/A | *Coniothyrium minitans* | 0 | 4 | N |
| **At the beginning of flowering or prior to onset of disease apply:** | | | | | | |
| 7 | Endura 70W[1] | 8.0 to 11.0 oz/A | boscalid | 7 | 12 | -- |
| 7 + 11 | Priaxor 4.17SC | 6.0 to 8.0 fl oz/A (suppression only) | fluxapyroxad + pyraclostrobin | 7 | 12 | N |

[1] Apply at 7 to 10 d interval, maximum 2 applications per growing season.

# Viruses

Use resistant varieties when possible and manage aphid populations.

# Peppers

## Recommended Varieties[1]

| | Variety (all hybrids) | Color[2] | Disease Resistance[3] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | BLSR | CMV | PVY | PHY | TEV | TM | TMV | TSWV |
| **Bell Type** | Archimedes | G/R | 0-3, 7, 8 | | | T | | R | | |
| | Aristotle | G/R | 1-3 | | | T | | R | | |
| | Declaration | G/R | 1-3, 5 | | | T | | | | T |
| | Delerio | G/O | | | | | | | R | R |
| | Early Sunsation | G/Y | 1-3 | | | | | | | |
| | Intruder | G/R | 1-3 | | | T | R | | R | |
| | Karisma | G/R | 1-3 | T | R | | | | R | |
| | Mecate | G/Y | 1-3 | | | | | | R | |
| | Mercer | G/R | 0-3, 7, 8 | | | T | | | R | |
| | Paladin | G/R | | | | R/T | | R | | |
| | Playmaker | G/R | 0-10 | | | T | | R | | |
| | Red Knight | G/R | 1-3 | | R | | | | | |
| | Revolution | G/R | 1-3, 5 | T | | T | | | | |
| | Turnpike | G/R | 0-5, 7-9 | | | T | | | | |
| | 1819 | G/R | 1-5 | | | T | | | | |
| **Cherry Type** | Fireball | G/R | | | | | | | | |
| | Grandi | G/R | | | | | | | | |
| | Super Sweet Cherry | G/R | | | | | | | T | |
| **Sweet Frying Type** | Aruba | LG | | | | T | | | | |
| | Biscayne | LY | | | | | | | | |
| | Carmen | G/R | | | | | | | | |
| | Cheyenne (Cayenne) | G/R | | | | | | | | |
| | Key West | LG/R | 1-3 | | | | | | | |
| | Red Crest | G/R | | | | | | | | |
| | Yellow Crest | G/Y | | | | | | | | |
| **Hot Types** | Campeon (Jalapeno) | G/R | 0-3, 7, 8 | | R | | | | | |
| | Compadre (Jalapeno) | G/R | | | | | | | | |
| | El Jefe (Jalapeno) | G/R | 0-3, 7, 8 | | R | | T | | | |
| | Grande (Jalapeno) (processing) | G/R | | | R | | R | | | |
| | Mesilla (Cayenne) | G/R | | | R | | R | | R | |
| | Nainari (Cayenne) | G/R | | | | | | | | |
| | New Park (Jalapeno) | G/R | 1-3 | | | | | | | |
| | Numex Joe E. Parker (Anaheim) | G/R | | | | | | | | |
| | Pace 105 (non-hot) | G/R | | | | | | | | |
| | P115 (non-hot) | G/R | 1-3 | | | | | | | |
| | Rayo (Jalapeno) (processing) | G/R | 1-3 | | | | | | | |
| | SV8066HJ (non-hot) | G/R | | | | | | | | |
| **Banana and Hungarian Types for Fresh or Processing** | Boris | Y/R | | | | | | | | R |
| | Bounty | Y/R | | | | | | | | |
| | Budapest (hot) | Y/R | | | | | | | | |
| | Doblon | Y/R | | | | | | | R | R |
| | Ethem | Y/R | | | | | | | | |
| | Goldrush | Y/R | 2 | | | | | | | |
| | Inferno (hot) | Y/R | | | | | | | | |
| | Pagaent | Y/R | 1-3 | | | | | | | |
| | Sopron | Y/R | 1-3 | | | | | | | |
| | Sweet Savannah | Y/R | | | | | | | | |
| | Sweet Sunset | Y/R | 1-3 | | | | | | | |

[1]Listed alphabetically. [2]G/O=Green to Orange, G/R=Green to Red, G/Y=Green to Yellow, LG=Light Green, LG/R=Light Green to Red, LY=Light Yellow, Y/R Yellow to Red. [3]Information provided by seed companies; T=tolerant and R=resistant. BLSR=Bacterial Leaf Spot Resistance (races listed), CMV=Cucumber Mosaic Virus, PHY=*Phytophthora capsici*, PVY=Potato Virus Y, TEV=Tobacco Etch Virus, TM=Tobamovirus, TMV=Tobacco Mosaic Virus, TSWV=Tomato Spotted Wilt Virus.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Peppers | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | **N (lb/A)** | **$P_2O_5$ (lb/A)** | | | | **$K_2O$ (lb/A)** | | | | **Nutrient Timing and Method** |
| | 100-180[1] | 200 | 150 | 100 | 0[2] | 200 | 150 | 100 | 0[2] | Total nutrient recommended |
| | 50 | 200 | 150 | 100 | 0[2] | 200 | 150 | 100 | 0[2] | Broadcast and disk-in or follow fertigation schedule |
| | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress after first fruit set or follow fertigation schedule |
| | 25-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress later in season if needed or follow fertigation schedule |

Apply 1 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter. [1]If crop is mulched with plastic but not drip/trickle fertilized, broadcast 150 lb/A of N with P and K fertilizer. [2]In VA, crop replacement values of 50 lb/A of $P_2O_5$ and 50 lb/A of $K_2O$ are recommended on soils testing Very High.

## Fertigation Schedule Examples

This table provides examples of fertigation schedules based on two common scenarios – sandy coastal plain soils and heavier upland soils. Modify according to specific soil tests and base fertility.

| **Fertigation recommendations for 75 lb N and 125 lb $K_2O$[1,2]** For soils with organic matter content less than 2% or coarse texture and low to medium or deficient K | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Nitrogen** | | | **Potash** | | |
| **Preplant (lb/A)[3]** | | | **50** | | | **100** | | |
| | | | **N** | **N** | **N** | **$K_2O$** | **$K_2O$** | **$K_2O$** |
| **Stage and Description** | Weeks | Days | lb/day | lb/week | lb/stage | lb/day | lb/week | lb/stage |
| **1 Early vegetative** | 1-2 | 1-14 | 0.5 | 3.5 | 7 | 0.5 | 3.5 | 7 |
| **2 Late vegetative** | 3-4 | 15-28 | 0.7 | 4.9 | 9.8 | 0.7 | 4.9 | 9.8 |
| **3 Early Flowering** | 5-6 | 29-42 | 1.0 | 7 | 14 | 1 | 7 | 14 |
| **4 Fruit Development** | 7-8 | 43-56 | 1.5 | 10.5 | 21 | 1.5 | 10.5 | 21 |
| **5 Harvest Period[4]** | 9-14 | 56-98 | 1.8 | 12.6 | 75.6 | 1.8 | 12.6 | 75.6 |
| **Fertigation recommendations for 75 lb N and 75 lb K20[1,2]** For soils with organic matter content greater than 2% or fine texture and high or optimum K | | | | | | | | |
| | | | **Nitrogen** | | | **Potash** | | |
| **Preplant (lb/A)[3]** | | | **50** | | | **50** | | |
| | | | **N** | **N** | **N** | **$K_2O$** | **$K_2O$** | **$K_2O$** |
| **Stage and Description** | Weeks | Days | lb/day | lb/week | lb/stage | lb/day | lb/week | lb/stage |
| **1 Early vegetative** | 1-2 | 1-14 | 0.25 | 1.75 | 3.5 | 0.25 | 1.75 | 3.5 |
| **2 Late vegetative** | 3-4 | 15-28 | 0.35 | 2.45 | 4.9 | 0.35 | 2.45 | 4.9 |
| **3 Early Flowering** | 5-6 | 29-42 | 0.5 | 3.5 | 7 | 0.5 | 3.5 | 7 |
| **4 Fruit Development** | 7-8 | 43-56 | 0.75 | 5.25 | 10.5 | 0.75 | 5.25 | 10.5 |
| **5 Harvest Period[4]** | 9-14 | 56-98 | 1.25 | 7.7 | 46.2 | 1.1 | 7.7 | 46.2 |

[1]Based on 7,260 linear bed ft/A (6 ft bed spacing). If beds have a different width, adjust fertilizer rates Drive rows should not be used in acreage calculations (see the Fertigation section in the Irrigation Management chapter). [2]Base overall application rate on soil tests. [3]Applied under plastic mulch to effective bed area using modified broadcast method. [4]For extended harvest after 10 w continue fertigation at this rate.

## Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities.

| **Critical Pepper Tissue Test Values For Most Recently Matured Leaves** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Timing** | **Value** | **N** | **P** | **K** | **Ca** | **Mg** | **S** | **Fe** | **Mn** | **Zn** | **B** | **Cu** |
| | | **%** | **%** | **%** | **%** | **%** | **%** | **ppm** | **ppm** | **ppm** | **ppm** | **ppm** |
| **Prior to Bloom** | **Deficient** | <4.0 | 0.3 | 5 | 0.9 | 0.35 | 0.3 | <30 | 30 | 25 | 20 | 5 |
| | **Adequate range** | 4 | 0.3 | 5 | 0.9 | 0.35 | 0.3 | 30 | 30 | 25 | 20 | 5 |
| | | 5 | 0.5 | 6 | 1.5 | 0.6 | 0.6 | 150 | 100 | 80 | 50 | 10 |
| | **High** | >5.0 | 0.5 | 6 | 1.5 | 0.6 | 0.6 | >150 | 100 | 80 | 50 | 10 |
| | **Toxic (>)** | - | - | - | - | - | - | - | - | - | 350 | - |

*Plant Tissue Testing continued on next page*

*Plant Tissue Testing - continued*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **First Flower** | **Deficient** | <3.0 | 0.3 | 2.5 | 0.9 | 0.3 | 0.3 | <30 | 30 | 25 | 20 | 5 |
| | **Adequate range** | 3 | 0.3 | 2.5 | 0.9 | 0.3 | 0.3 | 30 | 30 | 25 | 20 | 5 |
| | | 5 | 0.5 | 5 | 1.5 | 0.5 | 0.6 | 150 | 100 | 80 | 50 | 10 |
| | **High** | >5.0 | 0.5 | 5 | 1.5 | 0.5 | 0.6 | >150 | 100 | 80 | 50 | 10 |
| | **Toxic (>)** | - | - | - | - | - | - | - | 1000 | - | 350 | - |
| **Early Fruit Set** | **Deficient** | <2.9 | 0.3 | 2.5 | 1 | 0.3 | 0.3 | <30 | 30 | 25 | 20 | 5 |
| | **Adequate range** | 2.9 | 0.3 | 2.5 | 1 | 0.3 | 0.3 | 30 | 30 | 25 | 20 | 5 |
| | | 4 | 0.4 | 4 | 1.5 | 0.4 | 0.4 | 150 | 100 | 80 | 50 | 10 |
| | **High** | >4.0 | 0.4 | 4 | 1.5 | 0.4 | 0.4 | >150 | 100 | 80 | 50 | 10 |
| | **Toxic (>)** | - | - | - | - | - | - | - | - | - | 350 | - |

## Seed Treatment

Check with your seed company if seed is hot water-treated. Purchase hot water treated seed if possible or request hot water seed treatment - see also Disease Control below.

## Transplant Production

Sow seed in the greenhouse 6-8 weeks before field planting. Seven ounces of seed are necessary to produce 10,000 plants per acre. Optimum temperature for germination is 85°F (29°C). Seed in 72-200 cell trays, depending on desired earliness and greenhouse space. Larger cell sizes are easier to maintain and result in better transplants, but are more expensive to produce.

## Planting and Spacing

Pepper is a warm-season crop that grows best at temperatures between 70-75°F (21-24°C). Peppers are sensitive to temperature extremes. Poor fruit set and blossom drop can be expected when night temperatures drop below 60°F (16°C) or day temperatures rise above 85°F (29°C). Transplant into the field May 1-30 for summer harvest. In VA and warm areas, transplant July 25 to August 1 for fall harvest. Space rows 4-5 feet apart. Set plants 12-18 inches apart in single or double rows. Select fields with good drainage. Plant on raised, beds to aid in disease management. To minimize sunscald when growing peppers on sandy soils and on plastic mulch without drip irrigation, plant varieties that have excellent fruit cover from foliage.

## Drip/Trickle Fertilization

Before mulching, adjust soil pH to approximately 6.5 and then apply enough fertilizer to supply 25-50% of total crop N and $K_2O$ requirements and thoroughly incorporate into the soil. Apply all $P_2O_5$ pre-plant and incorporate into the soil. Apply the balance of N and $K_2O$ through the drip irrigation system throughout the season. On soils testing low and low to medium in boron, also include 0.25 lb/A of actual boron in each soluble fertilizer application.

The first soluble fertilizer application should be applied through the trickle irrigation system within 1 week after field transplanting peppers. The same rate of soluble fertilizer should be applied about every 3 weeks during the growing season for a total of 6 applications through the trickle irrigation system. The soluble fertilizer may be delivered in 12 equally timed applications provided the soluble nutrients are applied at half the above suggested rates per application so that the total seasonal rates of N, $P_2O_5$, and $K_2O$ and B are the same. The number of fertilizer applications can be reduced for late plantings and in areas where the growing season is short. These rates were developed on sandy loam soils with a cation exchange capacity (CEC) of 3-5. If your soil has a lower CEC, you may wish to increase the total seasonal soluble fertilizer nutrient rates by at least one-third. On very coarse, very low CEC soils, it may be profitable to increase the total seasonal soluble fertilizer nutrient rates two-thirds over the first suggestion. On the heavier textured soils with higher CEC, you may wish to decrease the total seasonal soluble fertilizer nutrients by one-half. Review the tables above for suggested application rates and timing.

## Mulching

The use of black plastic mulch with drip irrigation and double rows can greatly increase yields and percentage of large fruit. Use opaque, white plastic when planting in the summer for fall harvest. Plant double rows 12-15 inches apart with plants staggered 12-18 inches apart in each of the double rows. Use 5-ft wide plastic for double rows and 4-ft wide plastic for single row peppers. Do not use plastic mulch without trickle irrigation on coarse or sandy soils.

## Staking

Staking peppers helps protect fruit from sunburn by holding the plants in an upright position. Use 2-2½ ft long by 1¼ x 1½-inch Honduran pine stakes (half-length tomato stakes). Drive stakes 6-8 inches into the soil every 4-5 ft in the plant row. Tie plants with polyethylene string that is used for staked tomatoes. Tie the first string 7-9 inches above the soil when plants are 10-12 inches tall or at first fruit set. For single row peppers, run the string on one side of the row, looping and tightening string around each stake for about 100 ft. Then run the string back on the opposite side of the plant row using the same procedure. Allow 3-4-ft untied breaks every 100 ft to make harvesting easier. For double rows of peppers, use one row of stakes in each row of peppers. Tie each row separately as described above for single row peppers.

A second tie should be made at 6-8 inches above the first string and before peppers enlarge and fall over the first string. Use the same procedure described above. An alternate method for applying the second string in single and double rows is to run a single string in the center of the plant canopy of each row, allowing the branches to grow up through the string and be caught and supported by the string.

Consider the cost of staking versus reduction in losses and increases in quality and price received. The higher price offered for red peppers increases the potential for profit when staking for the red compared to the green market.

## Physiological Disorders

**Blossom End Rot:** This physiological disorder is caused by reduced Calcium (Ca) uptake and movement into fruit at low soil moisture. To control blossom end rot, maintain proper soil Ca, nutrient balance, and uniform, favorable soil moisture. This is especially important when cropping in raised beds for Phytophthora control, because soil in raised beds will dry more quickly than in flat bed culture.

**Skin separation or "silvering" of bell pepper fruit:** Skin separation or "silvering" in bell pepper fruit reduces aesthetic fruit quality. Research in NJ has shown that phytophthora-tolerant bell pepper cultivars (such as 'Paladin' and 'Aristotle') are more prone to the development of "silvering" than phytophthora-susceptible varieties such as 'Alliance' or 'Camelot'.

**Sunscald:** To reduce sunscald, select varieties with good foliage cover. Maintain vigorous vegetative growth by following the recommended fertilizer (especially N) program and timely irrigation. Harvest carefully to avoid damaging stems, branches and foliage

## Harvest and Post Harvest Considerations

Harvest green fruit once they have reached full size and the walls are firm. Harvest every 714 days to achieve maximum yields. Harvest red, yellow, or orange peppers after they turn color. Colored pepper production requires 24 weeks of additional growing time. Increased attention to insects and diseases is required to produce mature, colored fruit. Harvest hot peppers after they reach full size and the walls are firm for green fruit and after they have turned color for colored fruit.

Peppers are picked by hand using a upward snap and pull motion with part of the stem (peduncle) and fruit cap (calyx) adhering to the fruit; branches of the plant are usually brittle and can break easily if pulled too hard. Hot peppers generally detach from the plant much more easily than sweet peppers and plants are less brittle.

Keep harvested peppers out of direct sunlight to avoid water loss, sunscald, and heat damage. Peppers can be brushed or washed after harvest. If peppers are washed in a dump tank, wash water temperature should be up to 10°F warmer than the peppers. Cold water creates a partial vacuum that draws some water (and potentially bacteria) into the fruit, leading to premature breakdown. Chlorinated water or another labeled surface disinfectant should be used in the wash water. Peppers can be cooled with room cooling, forced air cooling, forced air with evaporative cooling, or vacuum cooling.

Optimal conditions for storing peppers are 45-50°F (7-10°C) with relative humidity of 85-90%. Chilling injury occurs at temperatures below 45°F, and damage may occur even below 50°F depending on variety and other factors. Bell peppers may be stored 2-3 weeks if handled properly. Dried hot peppers are stored at 32-38°F (0-3°C).

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**Labeled Applications Sites for Peppers**

| | | **Plastic mulch production** | | | | | | **Bare-ground production** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil-Applied | | Postemergence | | | | | | |
| **Herbicides** | WSSA group number | Under Plastic | Row Middles | Over Plastic | Row Middles | Post-Harvest | | Soil-applied | POST | Post-harvest |
| Sandea | 2 | | YES | | YES | | | | | |
| Prowl H2O | 3 | | YES | | | | | YES | | |
| Treflan | 3 | | | | | | | YES | | |
| Prefar | 8 | | | | | | | YES | | |
| Command | 13 | YES | YES | | | | | | | |
| Reflex | 14 | YES | YES | | YES | | | | | |
| Dual | 15 | YES | YES | | | | | | | |
| Devrinol | 15 | YES | YES | | | | | | | |
| Select | 1 | | | YES | | | | | YES | |
| SelectMax | 1 | | | YES | | | | | YES | |
| Poast | 1 | | | YES | | | | | YES | |
| Gramoxone | 22 | | | | YES | YES | | | | YES |

**1. Soil-Applied**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **2** | Sandea 75DF | 0.5 to 1.0 oz/A | **halosufluron** | 0.023 to 0.047 lb/A | 30 | 12 |
| -**Plasticulture**: row middles only; apply as shield application after crop has been planted.<br>-Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field. **Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season. | | | | | | |
| 3 | Prowl H2O 3.8CS | 1.0 to 3.0 pt/A | **pendimethalin** | 0.48 to 1.42 lb/A | 70 | 24 |
| -**Plasticulture**: recommended for row middles only. Labeled for under plastic, but no local data or experience with this application.<br>-**Bareground**: broadcast preplant or preplant incorporated before transplanting; not labeled for direct-seeded crop.<br>-Avoid root contact with Prowl-treated soil when placing transplants into furrow or hole or injury may occur.<br>-Prowl labeled for directed application to transplanted or established direct-seeded peppers; avoid contact with leaves or stems.<br>-Prowl will not control emerged weeds, only provides residual control; row middle applications may be made with Gramoxone using shielded sprayers.<br>-Use the lower rate on coarse-textured or sandy soils. Activate with ½ inch of rainfall or sprinkler irrigation within 48 hr of application to control most annual grasses and certain broadleaf weeds. Maximum Prowl H2O application per season: 3 pt/A. | | | | | | |
| 3 | Treflan 4E | 1 to 2 pt/A | **trifluralin** | 0.5 to 1.0 lb/A | -- | 12 |
| -**Labeled for transplanted peppers only**; not labeled for seeded peppers<br>-Apply preplant incorporated. Incorporate 23 inches of the soil within 8 hr of application<br>-Slight stunting may occur if weather is cool and damp at time of transplanting. Maximum application per season: not specified. | | | | | | |
| 8 | Prefar 4E | 5.0 to 6.0 qt/A | **bensulide** | 5 to 6 lb/A | -- | 12 |
| -**Bareground only**: labled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum). If applied preemergence, irrigate irrigate within 36 hrs of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 hrs, weed control maybe reduced.<br>-Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters.<br>-**Do not** apply more than 6 lbs ai/A per season. | | | | | | |

*1. Soil-Applied continued on next page*

*1. Soil-Applied - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 13 | Command 3ME | 0.66 to 1.33 pt/A | **clomazone** | 0.25 to 0.50 lb/A | -- | 12 |
| -**Plasticulture**: under plastic: apply in a band under the plastic, immediately before laying the mulch. Plasticulture: row middles application is labeled.<br>-**Bareground**: apply preemergence for seeded peppers **or** before transplanting (**do not** apply over emerged plants).<br>-Use the lower rate on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops. Use higher rates on fine-textured soils or soils with high organic matter, or to improve control of certain weeds, including common cocklebur (refer to label for specific weeds and rates).<br>-Broad-spectrum herbicide that will control annual grasses and many broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge; combine with Devrinol or Dual Magnum (transplants only) to improve the control.<br>-**WARNING**: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions.<br>-Maximum number of applications per season: 1. | | | | | | |
| **14** | Reflex 2SL | 16 to 20 fl oz/A NJ<br>16 to 24 fl oz/A VA | **fomesafen** | 0.25 to 0.375 lb/A | 60 | 24 |
| -**Special Local-Needs Label 24© has been approved for NJ and VA only until Dec. 31, 2020.**<br>-The use of Reflex 2SL is legal ONLY if a waiver of liability has been completed (see *http://www.farmassist.com/*).<br>-**Plasticulture**: under plastic is labeled; apply in a band under the plastic, immediately before laying the mulch; use on transplants only (not for seeded peppers). Crops may be transplanted immediately following application. Row middles application is labeled.<br>-**Bareground**: apply as broadcast, preemergence treatment on transplants only (not for seeded peppers). **Do not** incorporate.<br>-NJ label includes Bell, Chile, Cooking, and Sweet peppers; VA label does not specify pepper type.<br>-To avoid injury, transplants must have a minimum of 5 true leaves when planted in soil treated with Reflex.<br>-Reflex provides both residual and postemergence control of susceptible weeds. Effective postemergence control requires an adjuvant.<br>-Varieties may vary in their response to Reflex; treat small acreages first to determine crop tolerance.<br>-Consider rotational crops when applying fomesafen. If crop is replanted **do not** re-apply. Rotational restrictions depend on whether fomesafen was applied bareground, or under or over plastic mulch, see 24© label for specifics.<br>-Maximum Reflex application: NJ 20 fl oz/A; VA 24 fl oz/A IN ALTERNATE YEARS.<br>-Maximum fomesafen application: NJ 0.313 lb/A, VA 0.375 lb/A IN ALTERNATE YEARS. | | | | | | |
| 15 | Devrinol 2-XT | 2 to 4 qt/A | **napropamide** | 1.0-2.0 lb/A | -- | 24 |
| -**Plasticulture**: under plastic is labeled for seeded or transplanted peppers; apply in a band under the plastic, immediately before laying mulch. Use lower rate on coarse textured or sandy soil. Condensation that forms on the underside of the mulch will activate the herbicide. Plasticulture: row middles application is labeled.<br>-**Bareground**: apply as broadcast, preemergence treatment for seeded and transplanted peppers.<br>-Annual grasses and certain annual broadleaf weeds will be suppressed or controlled.<br>-May reduce stand and yield of fall planted small grain crop. Moldboard plowing will reduce the risk of injury.<br>-Maximum Devrinol 2-XT application per season: 4 qt/A. | | | | | | |
| 15 | Dual Magnum 7.62EC | 0.67 to 1.0 pt/A | **s-metolachlor** | 0.63 to 0.95 lb/A | 60 | 24 |
| -**Special Local-Needs Label 24© has been approved for NJ and VA until Deember 31, 2021.**<br>-Labeled for use in transplanted bell and non-bell peppers (except tabasco peppers). The use of Dual Magnum is legal ONLY if a waiver of liability has been completed (see *http://www.farmassist.com/*).<br>-**Plasticulture**: under plastic is labeled for seeded or transplanted peppers; apply in a band under the plastic, immediately before laying mulch. Use lower rate on coarse textured or sandy soil. Condensation that forms on the underside of the mulch will activate the herbicide. Plasticulture: row middles application is labeled.<br>-**Bareground**: apply as broadcast, preemergence treatment for transplanted bell and non-bell peppers, do no use on seeded peppers; **do not** incorporate.<br>-Maximum number of applications per season: 1. | | | | | | |

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9 to 16 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 1 | 24 |
| | Poast 1.5EC | 1 to 2.5 pt/A | **sethoxydim** | 0.2 to 0.5 lb/A | 1 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v<br>-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Safe for broadcast (over the top) applications with both plasticulture and bareground production.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Select will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions. If repeat applications are necessary, allow 14 days between applications. | | | | | | |

*2. Postemergence (Select, Poast) continued on next page*

*2. Postemergence (Select, Poast) - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| -**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season. **Do not** apply more than 1.5 pt/A Poast 1.5EC in single application and **do not** exceed 4.5 pt/A for the season. Rainfastness is 1 hr. | | | | | | |
| 22 | Gramoxone 2SL | 2.4 pt/A | **paraquat** | 0.6 lb/A | -- | 24 |
| -Gramoxone can be applied before or after transplanting to control emerged broadleaf weeds and grass seedlings.<br>-Include a nonionic surfactant at 0.25% v/v. **Do not** allow spray to contact crop foliage as injury may result. Use flaps that drag along the edge of plastic mulch and use low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift.<br>-See the label for additional information and warnings. Rainfastness is 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |

**3. Postharvest**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone 2SL | 2.25 to 3 pt/A | **paraquat** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 until December 31, 2017, for postharvest desiccation of the crop in DE, NJ and VA.** Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

## Aphids

Green peach aphid is the most common aphid on peppers. Females can produce numerous pale yellow or pink-colored young (nymphs); large numbers can build up on the undersides of leaves, often following pyrethroid insecticide applications. Aphids are sucking insects that excrete a sugary, sticky substance (honeydew) that coats fruit and causes growth of black sooty mold fungus. Both honeydew and mold can hurt marketability. Natural predators and parasitoids (braconid wasps) can keep aphid populations below damaging levels, but broadspectrum insecticides, like pyrethroids, destroy natural enemies. Use selective insecticides whenever possible. Begin sampling plants in July for the presence of aphids and natural enemies. Spray only when aphid densities appear to be increasing in the absence of predators. Treat if aphids exceed 5 per leaf. When plants are small, silver reflective plastic mulch can significantly reduce the number of aphids landing on the crop.

**Apply one of the following formulations:**
**Note: Spray coverage to the underside of the leaf is important; add a spreader-sticker to foliar sprays.**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* - **foliar** | 7 | 48 | H |
| 1B | Dimethoate 4EC | 0.5 to 0.66 pt/A | dimethoate* | 0 | 48 | H |
| 1B | Orthene 97 | 0.5 to 1.0 lb/A (bell) | acephate | 7 | 24 | H |
| 1B | Orthene 97 | 0.5 lb/A (non-bell) | acephate | 7 | 24 | H |
| 3A + 4A | Leverage 360 | 3.8 to 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 0 | 12 | H |
| 4A | Admire Pro | 7.0 to 14.0 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.3 to 2.2 fl oz/A | imidacloprid - **foliar** | 0 | 12 | H |
| 4A | Assail 30SG | 2.0 to 4.0 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 2.0 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4D | Sivanto 200SL | 21 to 28 oz/A | flupyradifurone - **soil** | 45 | 4 | L |
| 4D | Sivanto 200S | 7.0 to 12.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | L |
| 4H | Closer SC | 1.5 to 2.0 fl oz/A | sulfoxaflor | 1 | 12 | H |
| 4H | GrandevoOG (OMRI) | 2 to 3 lb/A | *Chromobacterium subtsugae* - **biopesticide** | 0 | 4 | M |
| 9B | Fulfill 50WDG | 2.75 oz/A | pymetrozine | 0 | 12 | L |

*Aphids continued on next page*

*Aphids - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 9C | Beleaf 50SG | 2.0 to 2.8 oz/A | flonicamid | 0 | 12 | L |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 1 | 24 | L |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole | 1 | 12 | H |
| 28 + 6 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |
| n/a | Requiem (biopesticide) | 2.0 to 3.0 qt/A | *Chenopodium* extract - **biopesticide** | 0 | 4 | L |

## Beet Armyworms (BAW)

BAW do not overwinter in our region, moths migrate from the South beginning late July. Females lay egg masses covered in scales, usually resulting in a fuzzy or cottony appearance, on the underside of leaves. Larvae lack hairs or spines; Young larvae are greyish or dark green with distinct dark heads. Subsequent instars acquire darker green dorsal coloring or stripes with a lighter colored (white or yellow) lateral stripe dividing the dorsal and abdominal from yellow to green. Most larvae have a distinct black spot on the second abdominal segment. BAW damage is characterized by leaf skeletonization ("window pane effect"), where they remove green leaf tissue and leave a white, clear or translucent area. Examine nearby pigweed or lambsquarters weeds, as BAW typically infest those plants first. BAW control can be challenging as they are resistant to certain insecticides, particularly pyrethroids.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin + chlorantraniliprole* | 5 | 24 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5SG | 2.4 to 4.8 oz/A | emamectin benzoate | 7 | 12 | H |
| 18 | Intrepid 2F | 4.0 to 16.0 fl oz/A | methoxyfenozide | 1 | 4 | L |
| 22 | Avaunt 30WDG | 3.5 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **soil**, **foliar** | 1 | 4 | L |
| 28 | Exirel | 7.0 to 13.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 | Verimark | 5.0 to 10.0 fl oz /A | cyantraniliprole - **soil/drip** | 1 | 4 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cabbage Loopers (CL)

CL can often be found on pepper crops in late July or early August. This caterpillar has a light green color with narrow white stripes along its sides and back, 3 pairs of prolegs, and lengths up to 1.5-2". It characteristically loops when crawling. CL damage on peppers is not significant and is primarily observed as feeding holes on foliage. The fruit is rarely attacked. Concerns may arise from the potential of sun scalding of the fruit and reduced plant vigor due to excessive foliage feeding. Besides population mortality due to general predators and viruses, CL can be parasitized by small wasps such as *Trichogramma.*

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1B | Orthene 97 | 0.5 to 1.0 lb/A (bell) | acephate | 7 | 24 | H |
| 1B | Orthene 97 | 0.5 lb/A (non-bell) | acephate | 7 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A | Baythroid XL | 2.1 to 2.8 fl oz/A | beta-cyfluthrin* | 7 | 12 | H |
| 3A + 4A | Leverage 360 | 3.8 to 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 5.0 to 8.0 fl oz/A | lambda-cyhalothrin + chlorantraniliprole* | 5 | 24 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 13.0 fl oz/A | zeta-cypermethrin* + bifenthrin* | 7 | 12 | H |
| 3A | Lambda-cy, Lambda-T | 1.92 to 3.20 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 3.2 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Tombstone | 2.1 to 2.8 fl oz/A | cyfluthrin* | 7 | 12 | H |
| 3A | Warrior II | 0.96 to 1.60 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |

*Cabbage Loopers continued on next page*

*Cabbage Loopers - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin + thiamethoxam* | 5 | 24 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5SG | 2.4 to 4.8 oz/A | emamectin benzoate | 7 | 12 | H |
| 11A | Dipel (OMRI) | 1.0 to 2.0 lb/A | *Bacillus thuringiensis kurstaki* | 4 | 0 | N |
| 18 | Confirm 2F | 6.0 to 16.0 fl oz/A | tebufenozide | 7 | 12 | L |
| 18 | Intrepid 2F | 4.0 to 16.0 fl oz/A | methoxyfenozide | 1 | 4 | L |
| 22 | Avaunt 30WDG | 2.5 to 3.5 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **soil**, **foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 7.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Corn Earworms (CEW) also Called Tomato Fruitworms, Hornworms

CEW is a lepidopteran pest that appears when moths emerge from drying field corn. Moths lay one egg on leaves near green fruit. Larvae vary in color (yellow, brown, green or red) but display longitudinal light-colored stripes and black dots with hair. CEW larvae can be distinguished from other larvae by the presence of hair on their body. Larvae will attack fruit almost immediately upon emergence, feeding near the stem and leaving small holes in the fruit. Their feeding will lead to introduction of pathogens and rot as with other lepidopteran pests. Scouting for signs of their presence is necessary. Pheromone traps can also be used to determine periods of moth activity.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin+chlorantraniliprole* | 5 | 24 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 13.0 fl oz/A | zeta-cypermethrin* + bifenthrin* | 7 | 12 | H |
| 3A | Lambda-cy, Lambda-T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 3.2 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-up 3.2, .Permethrin 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 3 | 12 | H |
| 3A | Tombstone | 1.6 to 2.8 fl oz/A | cyfluthrin* | 7 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin + thiamethoxam* | 5 | 24 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam+chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam+chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5SG | 2.4 to 4.8 oz/A | emamectin benzoate | 7 | 12 | H |
| 16B | Rimon 0.83EC | 9.0 to 12.0 fl oz/A | novaluron | 1 | 12 | L |
| 18 | Confirm 2F | 6.0 to 16.0 fl oz/A | tebufenozide | 7 | 12 | L |
| 22 | Avaunt 30WDG | 3.5 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **soil**, **foliar** | 1 | 4 | L |
| 28 | Verimark | 5.0 to 10.0 fl oz/A | cyantraniliprole - **soil** | 1 | 4 | H |
| 28 | Exirel | 7.0 to 13.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cutworms - See also the Pest Management chapter, Insect Management section.

Cutworms are not a major pest of peppers but are occasionally encountered in July and August. They can feed on the lower smaller leaves but typically create the most damage by feeding near the soil, often clipping small transplants off. Cutworms feed at night and hide in the top layer of the soil near the plant roots during the day.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Pre-Planting** | | | | | | |
| 3A | Capture LFR | 3.4 to 6.8 fl oz/A | bifenthrin* | n/a | 12 | H |

*Cutworms continued on next page*

*Cutworms - continued*

| **Post-Planting** | | | | | | |
|---|---|---|---|---|---|---|
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 13.0 fl oz/A | zeta-cypermethrin + bifenthrin* | 7 | 12 | H |
| 3A | Lambda-cy, Lambda-T | 1.92 to 3.20 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Warrior II | 0.96 to 1.60 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A + 28 | Voliam Xpress | 5.0 to 8.0 fl oz/A | lambda-cyhalothrin + chlorantraniliprole | 5 | 24 | H |

## European Corn Borers (ECB)

Population levels of ECB have declined in most areas due to area-wide suppression from Bt field corn usage. Local pheromone or blacklight traps are effective for monitoring populations. Consult your Extension Agent or IPM alerts for information about trap catches. ECB moth flights in July and August most often cause problems. Moths lay flat egg masses on the undersides of leaves. Larvae often bore into fruit under the calyx. The damage is often inconspicuous unless the calyx is slightly lifted to reveal the boring hole and sawdustlike frass.

| **Begin treatments when fruit are present and ECB moths are being caught. Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1B | Orthene 97 | 0.5 to 1.0 lb/A (bell) | acephate | 7 | 24 | H |
| 1B | Orthene 97 | 0.5 lb/A (non-bell) | acephate | 7 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin + imidacloprid* | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 5.0 to 8.0 fl oz/A | lambda-cyhalothrin + chlorantraniliprole* | 5 | 24 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 13.0 fl oz/A | zeta-cypermethrin + bifenthrin* | 7 | 12 | H |
| 3A | Lambda-cy, Lambda-T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-up 3.2EC | 8.0 fl oz/A | permethrin* | 3 | 12 | H |
| 3A | Tombstone | 1.6 to 2.8 fl oz/A | cyfluthrin* | 7 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 16B | Rimon 0.83EC | 9.0 to 12.0 fl oz/A | novaluron | 1 | 12 | L |
| 18 | Confirm 2F | 6.0 to 16.0 fl oz/A | tebufenozide | 7 | 4 | L |
| 18 | Intrepid 2F | 4.0 to 16.0 fl oz/A | methoxyfenozide | 1 | 4 | L |
| 22 | Avaunt 30WDG | 3.5 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **soil**, **foliar** | 1 | 4 | L |
| 28 | Verimark | 10.0 fl oz/A | cyantraniliprole - **soil** | 1 | 4 | H |
| 28 | Exirel | 7.0 to 13.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Fall Armyworms (FAW)

Moths do not overwinter in the northeast, but migrate from the south in the summer. Green or yellow bucket traps baited with pheromone lures are helpful for alerting growers to heavy moth activity. Larvae feed on foliage, but also bore into fruit. Pest densities vary from year to year. FAW are best controlled when larvae are small.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin + imidacloprid* | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin + chlorantraniliprole* | 5 | 24 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 13.0 fl oz/A | zeta-cypermethrin + bifenthrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |

*Fall Armyworms continued on next page*

*Fall Armyworms - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5SG | 2.4 to 4.8 oz/A | emamectin benzoate | 7 | 12 | H |
| 11A | Dipel (OMRI) | 1.0 to 2.0 lb/A | *Bacillus thuringiensis kurstaki* | 4 | 0 | N |
| 18 | Intrepid 2F | 4.0 to 16.0 fl oz/A | methoxyfenozide | 1 | 4 | L |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **soil**, **foliar** | 1 | 4 | L |
| 28 | Verimark | 5.0 to 10.0 fl oz /A | cyantraniliprole - **soil** | 1 | 4 | H |
| 28 | Exirel | 7.0 to 13.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Flea Beetles

Tobacco and eggplant flea beetle damage consists of foliage feeding resembling tiny shotgun holes, primarily on young transplants. Control of flea beetles is suggested before plants reach 25% defoliation.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Leverage 360 | 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin + chlorantraniliprole* | 5 | 24 | H |
| 3A | Baythroid XL | 2.8 fl oz/A | beta-cyfluthrin* | 7 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin + bifenthrin* | 7 | 12 | H |
| 3A | Lambda-cy, Lambda-T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-up 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 3 | 12 | H |
| 3A | Tombstone | 1.6 to 2.8 fl oz/A | cyfluthrin* | 7 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 4A | Admire Pro | 7 to 14 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 2.0 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 28 | Verimark | 6.75 to 13.5 fl oz /A | cyantraniliprole - **soil** | 1 | 4 | H |

## Leafminers

Leafminers exhibit several generations per year but they are considered minor pests of peppers. Adult flies penetrate the leaf surface to deposit a single egg. Larvae emerge and form galleries or tunnels during their feeding process. These tunnels can be observed as white, serpentine mines on the leaves. Excessive damage on small transplants can lead to leaf drop and plant death.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* - **foliar** | 7 | 48 | H |
| 3A+28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin+chlorantraniliprole* | 5 | 24 | H |
| 3A | Perm-up 3.2, Permethrin 3.2 | 4.0 to 8.0 fl oz/A | permethrin* | 3 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |

*Leaminers continued on next page*

*Leafminers - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | Entrust SC (OMRI) | 6.0 to 10.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Agri-Mek 0.7SC | 1.75 to 3.5 fl oz/A | abamectin | 7 | 12 | H |
| 6 | Proclaim 5SG | 3.2 to 4.8 oz/A | emamectin benzoate | 7 | 12 | H |
| 17 | Trigard 75WSP | 2.66 oz/A | cyromazine | 0 | 12 | L |
| 28 | Coragen 1.67SC | 5.0 to 7.5 fl oz/A | chlorantraniliprole - **soil**, **foliar** | 1 | 4 | L |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole - **soil** | AP | 4 | H |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Mites

Two-spotted spider mites (TSSM) are the most common mites found on peppers, although broad mites are also a sporadic pest. TSSM are tiny (1/60-1/80 inch), yellowish in color with 2 dark spots on each side of their body. Their damage is most often the first indicator of their presence on pepper plants. They feed by removing fluids from plant tissue leading to lighter colored or white areas described as stippling. Extensive feeding can lead to reduced photosynthesis, reduced vigor, and potential death of plants. TSSM most often occur on the undersides of leaves. They reproduce very quickly, and once a heavy population is reached, webbing can be observed on plants. Mites are flared by hot, dry conditions, particularly in July and August, and by the use of broad-spectrum insecticides like organophosphates, carbamates or pyrethroids killing predators, or by frequent applications of fungicides.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 6 | Agri-Mek 0.7SC | 1.75 to 3.5 fl oz/A | abamectin | 7 | 12 | H |
| 10B | Zeal Miticide | 2.0 to 3.0 oz/A | etoxazole | 7 | 12 | L |
| 21A | Portal / Portal XLO | 2.0 pt/A | fenpyroximate | 1 | 12 | L |
| 23 | Oberon 2S | 7.0 to 8.5 fl oz/A | spiromesifen | 1 | 12 | M |
| 25 | Acramite 50WS | 0.75 to 1.0 lb/A | bifenazate | 3 | 12 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Pepper Maggots (PM)

Horsenettle and ground cherries are primary hosts of the pepper maggot. Adult flies are active all summer and deposit eggs in the tissue of young pepper fruit by piercing it with their ovipositor. PM strongly prefer cherry peppers and other round fruit. Maggots feed on the developing seeds and internal tissue of the fruit then exit the fruit leaving a large hole which is highly susceptible to pathogens and rot. Sanitation and rotation is important as adult flies are attracted to rotting fruit. Yellow sticky traps baited with a 30% liquid ammonia and installed in trees surrounding fields can indicate the presence of adult flies. Planting cherry peppers can alert growers of PM's presence. Sprays should be initiated one week following detection of the first flies; 2-3 sprays may be necessary.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Dimethoate 400 | 0.50 to 0.66 pt/A | dimethoate* | 0 | 48 | H |
| 1B | Malathion 57EC | 2.5 fl oz/A | malathion | 3 | 12 | H |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin + imidacloprid* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin + bifenthrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 7 | 12 | H |

**Note:** Use of acephate in bell peppers will reduce pepper maggot infestations.

## Pepper Weevils (PW)

Adults are small beetles with a long snout. PW do not overwinter in our area, but is a sporadic pest occasionally imported on transplants or fruit from the South. PW require a constant pepper host throughout the year and can therefore not survive north of South Carolina. **The materials listed here are effective for adult weevil control but are ineffective in controlling the larvae.**

*Pepper Weevils continued on next page*

*Pepper Weevils - continued*

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* - **foliar** | 7 | 48 | H |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin + imidacloprid* | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin + chlorantraniliprole* | 5 | 24 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 13.0 fl oz/A | zeta-cypermethrin + bifenthrin* | 7 | 12 | H |
| 3A | Lambda-cy, Lambda-T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-up, Permethrin 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 3 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 4A | Actara 25WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar only** | 0 | 12 | H |
| 4A | Admire Pro | 2.2 fl oz/A | imidacloprid - **foliar only** | 0 | 12 | H |
| 4A | Assail 30SG | 2.5 to 4.0 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 1 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 16B | Rimon 0.83EC | 9.0 to 12.0 fl oz/A | novaluron | 1 | 12 | L |

## Stink Bugs

Brown, green, and the invasive brown marmorated stink bugs (BMSB) may attack pepper fruit. Stink bugs have a characteristic shield shape, a triangle on their thorax, are approximately 0.5 inch long and can emit a foul odor when disturbed. BMSB have white stripes on their antennae; nymphs have a dark colored or dark and white body, depending on the instar or stage of development, and have characteristic black and white striped legs. Stink bug eggs are in masses, barrel shaped and cream to greenish colored. Both nymphs and adults feed on fruit, and leave a conspicuous white “halo” or discoloration on the surface. Feeding injury from BMSB can be significantly more severe than that from other species. Growers should scout for stink bugs, and initiate weekly sprays if observed.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3 | Danitol 2.4EC | 10.67 fl oz/A | fenpropathrin* | 3 | 24 | H |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Leverage 360 | 3.8 to 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin + chlorantraniliprole* | 5 | 24 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 7 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 13.0 fl oz/A | zeta-cypermethrin + bifenthrin* | 7 | 12 | H |
| 3A | Lambda-cy, Lambda-T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 3.2 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Tombstone | 1.6 to 2.8 fl oz/A | cyfluthrin* | 7 | 12 | H |
| 3A | Warrior II | 1.28 to1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin + thiamethoxam* | 5 | 24 | H |
| 4A | Actara 25WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 1 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |

## Thrips

Several species can be present; tobacco, flower, and Western flower thrips are the most common. Thrips fly in from surrounding crops or weeds and feed on the foliage, flowers and fruit. Larvae and adults cause damage by removing fluids from tissues. Adults can also damage fruit by leaving oviposition marks forming a small indent. Resulting damage from feeding leaves silvery or gray areas on fruit. Leaf distortion can also occur. More importantly, several species of thrips are vectors of Tomato Spotted Wilt Virus (TSWV), an important and untreatable disease (once acquired) of tomato, tobacco, and pepper crops. Thrips control is critical for reducing TSWV. Scout for thrips and begin treatments when observed. Do not produce transplants with bedding plants in the same greenhouse.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* - **foliar** | 7 | 48 | H |
| 3A + 4A | Leverage 360 | 3.8 to 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 0 | 12 | H |
| **3A**[1] | Baythroid XL | 2.1 to 2.8 fl oz/A | beta-cyfluthrin* | 7 | 12 | H |
| **3A**[1] | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| **3A**[1] | Tombstone | 2.1 to 2.8 fl oz/A | cyfluthrin* | 7 | 12 | H |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin + thiamethoxam* | 5 | 24 | H |
| 4A | Admire Pro | 7.0 to 14.0 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Assail 30SG | 4.0 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 2.0 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 7.5 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 9B | Fulfill 50WDG | 2.75 oz/A | pymetrozine | 0 | 12 | L |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 1 | 24 | L |

[1] **Resistance concerns with western flower thrips only**

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Fungicides

## Nematodes

See the Pest Management chapter (Soil Fumigation and Nematodes sections) for listed fumigants or use nematicides listed below. Consult the label.

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 1A | Vydate L | see label | oxamyl* | 7 | 48 | H |
| -- | Nimitz 4EC | 3.5 to 5.0 pt/A | fluensulfone | n/a | 12 | N |

## Seed Treatment: Reducing Bacterial Leaf Spot

Purchase hot water treated seed if possible or request hot water seed treatment. Heat treatment of seeds is a nonchemical alternative to conventional chlorine treatments that only kill pathogens on the surface of the seed coat. Heat treatment has the additional benefit of killing pathogens within the seed coat and is particularly useful for crops that are prone to seed-borne bacterial infections such as pepper and tomato. Seed heat treatment follows a strict time and temperature protocol and is best done with thermostatically controlled water baths. Two baths are required: one for pre-heating, and a second for the effective (pathogen killing) temperature. For pepper seed, the initial pre-heating is at 100°F (38°C) for 10 minutes, followed by the effective temperature of 125°F (52°C) for 30 minutes. Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process. After that, seeds should be dried on a screen or paper. Pelleted seed is not recommended for heat treatment. Only use heat treatment on seed that will be used during the current production season. Following heat or chlorine treatment, dust the dried seed with Captan 50WP or Thiram 480DP at 1 level tsp/lb of seed (3.0 oz/100 lb). Both for Bacterial leaf spot and Phytophthora, it is important to use resistant varieties on farms or fields with a history of the disease.

### Damping-off caused by *Pythium* and *Rhizoctonia*

Use new planting mix. Soilless mixes containing microorganisms that help suppress damping-off fungi should be considered. Transplants that have been in flats for extended periods of time and/or are slow to establish after setting are prone to Rhizoctonia root rot while wet soils favor Pythium root rot.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Pythium Root Rot** | | | | | | |
| 40 | Previcur Flex 4F[1] | 1.2 pt/A | mandipropamid | 5 | 12 | N |
| **Rhizoctonia Root Rot** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 row feet | azoxystrobin | 0 | 4 | N |

[1]Can be applied via drip or mixed in transplant water with Admire Pro when setting transplants for Pythium control.

## Bacterial and Fungal Diseases

### Anthracnose Fruit Rot

Anthracnose 'hot spots' typically develop in fields with prior history of the disease, especially un fields where peppers or tomatoes have been grown extensively. Heavy winds and rain help spread spores. Excessive fertilization may create dense canopies, which create microclimates conducive for fruit infection and reduced fungicide control. Scout regularly as fruit begin to develop. Use adequate water when spraying to insure good penetration into canopy. Apply preventative applications starting at bloom, especially in fields with a history of the disease. Removing infected fruit from heavily infested areas has been shown to reduce inoculum levels and reduce spread of the disease if done early.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Beginning at flowering, on a 7 day schedule, apply a tank mix containing chlorothalonil at 1.5 pt/A OR Manzate at 1.6 lb/A** | | | | | | |
| M3 | manzate 75DG | 1.6 to 3.2 lb/A | mancozeb | 7 | 24 | H |
| M5 | chlorothalonil 6F | 1.5 pt/A | chlorothalonil | 3 | 12 | H |
| **WITH ONE of the following fungicide products:** | | | | | | |
| 3 + 7 | Aprovia Top 1.67SC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflpyr | 0 | 12 | N |
| 11 + 3 | Quadris Top 2.72SC | 8.0 to 14.0 fl oz/A | azoxystrobin + difenoconazole | 0 | 12 | N |
| 11 | Cabrio 20EG | 8.0 to 12.0 oz/A | pyraclostrobin | 0 | 12 | N |
| 11 | Priaxor 4.17SC | 4.0 to 8.0 fl oz/A | fluxapyroxad | 7 | 12 | N |
| 11 | Quadris 2.08F | 6.2 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| **NOTE: DO NOT make more than 2 consecutive applications of any FRAC code 11 fungicide** | | | | | | |

### Bacterial Leaf Spot (BLS)

The best method for limiting loss due to BLS is to plant resistant cultivars. Races 1 to 6 and possibly 10 have been identified in areas of the region. A number of new bell pepper cultivars have resistance to races 1 to 5, 7, 8 and 9 of the pathogen (see table Recommended Varieties). In fields with a history of BLS, only plant cultivars that are resistant. When producing transplants, be sure to use seed treated with hot water (described above) or Clorox. Purchase heat-treated seed or disease-free transplants. Prior to transplanting, apply Agri-Mycin 17 (Code 25, streptomycin) sprays when first true leaves appear and continue every 45 days until transplanting (1.0 lb/100 gal, 1.25 tsp/gal, REI 12 h). Streptomycin cannot be used after transplanting.

Loss from BLS may be reduced by maintaining a high level of fertility, which will stimulate additional leaf formation and help replace leaves lost due to BLS. However, sufficient restraint with fertilizing must be used to ensure that plants do not become overly vegetative, or fruit set may be severely reduced. Where disease is present or anticipated, do not work in fields when plant surfaces are wet. Disk field as soon as possible after the growing season is finished. This will hasten breakdown of the crop debris that is harboring the bacteria and minimize overwintering of the bacteria in the field.

*(Bacterial Leaf Spot continued on next page)*

**Field sprays to help reduce spread: If growing susceptible varieties or varieties showing symptoms of the disease, apply a fixed copper + mancozeb at labeled rates.** If necessary, begin preventative fungicide applications shortly after transplanting and repeat every 7-10 days, especially if symptoms of BLS are present during transplant production and/or on transplants. A Section 2ee for the use of Quintec for the suppression of bacterial leaf spot in pepper has been granted for DE, MD, NJ, PA, and VA (not in WV). Consult label before use.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Tank mix the following beginning shortly after transplanting and repeat every 7 days:** | | | | | | |
| M1 | copper (OMRI)[1,2] | 1.0 lb ai/A | copper | 0 | see label | N |
| M3 | mancozeb 75DG | 1.5 lb/A | mancozeb | 5 | 12/24 | N |
| **The following is a plant defense activator and preventative applications should begin prior to the onset of symptoms.** | | | | | | |
| P1 | Actigard 50WG | 0.33 to 0.75 oz/A (see label) | acibenzolar-S-methyl | 14 | 12 | N |

[1]Copper based OMRI approved products for suppression of BLS are available; see labels for rates. [2]Copper can be tank mixed with mancozeb to help reduce Anthracnose fruit rot.

## Bacterial Soft Rot in Harvested Fruit

During periods of humid weather, the stem ends of harvested peppers may turn brown due to bacterial soft rot. If necessary, pack peppers without washing to minimize soft rot. If peppers must be washed, maintain 25 ppm of chlorine in the water (1 tbs Clorox/8 gal water). Avoid washing peppers with water more than 10°F (6°C) cooler than the fruit temperature to prevent movement of bacteria into the stem end of the fruit.

## Phytophthora Blight

Plant loss can be severe in all pepper types. Phytophthora blight typically develops in low-lying areas after rain and can spread quickly. Planting on a ridge or raised, dome-shaped bed will help provide better soil drainage. Use a minimum 3-year crop rotation with crops other than peppers, cucurbits, lima and snap beans, eggplants, or tomatoes. In fields with low-lying or wet areas, plant only Phytophthora-tolerant cultivars such as ‘Paladin’, ‘Aristotle’, or ‘Turnpike’. In heavily infested fields with a known history of Phytophthora blight, plant only resistant/tolerant cultivars to help reduce plant losses. **If mefenoxam-insensitivity is known to exist in a farm or field, plant only tolerant cultivars. Do not apply mefenoxam or metalaxyl in fields where insensitivity is known to exist.**

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **For control of the CROWN ROT phase of Phytophthora blight, apply one of the following at transplanting and 30 days later.** | | | | | | |
| **4** | MetaStar 2E | 4.0 to 8.0 pt/A[1] | metalaxyl | 7 | 12 | N |
| **4** | Ridomil Gold 4SL | 1.0 pt/A[1] | mefenoxam | -- | -- | N |
| **4** | Ultra Flourish 2E | 1.0 qt/A[1] | mefenoxam | -- | -- | N |
| 21 | Ranman 400SC | 2.75 fl oz/A[2,3] | cyazofamid | 0 | 12 | L |
| 43 | Presidio 4SC | 3.0 to 4.0 fl oz/A[3] | fluopicolide | 2 | 12 | L |
| U15 + **4** | Orondis Gold 200 | See labels[1,2,4] | oxathiapiprolin + mefenoxam | 0 | 4 | N |
| **For prevention of the AERIAL STEM AND FRUIT ROT phase of Phytophthora blight, tank mix one of the following with fixed copper and alternate with Ridomil Gold Copper 65WP at 2.5 lb/A (PHI 7 d, REI 48 h).** | | | | | | |
| 21 | Ranman 400SC | 2.75 fl oz/A | cyazofamid | 0 | 12 | L |
| 40 | Forum 4.18SC | 6.0 fl oz/A | dimethomorph | 4 | 12 | N |
| 40 | Revus 2.08SC | 8.0 fl oz/A | mandipropamid | 1 | 12 | -- |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | dimethomorph + ametoctradin | 4 | 12 | -- |
| 43 | Presidio 4SC | 3.0 to 4.0 fl oz/A | fluopicolide | 2 | 12 | L |
| U15 + **4** | Orondis Gold 200 | See labels[4] | oxathiapiprolin + mefenoxam | 0 | 4 | -- |

[1]Apply at transplanting and 30 d later. [2]May also be applied via transplant water (see label for restrictions). [3]Apply Presidio or Ranman via drip between mefenoxam/metalaxyl applications.[4]If applying as drip(s), **do not** apply as foliar application, see label for restrictions.

## Southern Blight (*Sclerotium rolfsii)*

High soil moisture and temperature favor disease development. Long crop rotations with corn and small grains help reduce disease incidence. Additionally, use the following in the transplant water. Consult label before use.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **In Transplant Water** | | | | | | |
| 11 | azoxystrobin 2.08F | 15.5 fl oz/A as a directed spray | azoxystrobin | n/a | 4 | N |
| 14 | Terraclor 75WP | 3.0 lb/100 gal of water, apply 0.5 pt/plant | Pentachloronitrobenzene (PCNB) | n/a | 12 | -- |

## Verticillium Wilt

This soil-borne fungus can infect many crops including eggplant, tomato, pepper, potato, and strawberries and can survive in the soil for many years. A long, proper crop rotation is necessary to reduce losses. DO NOT grow tomato, potato, strawberries, or eggplant in rotation or consecutively in the same field and never plant other solanaceous crops, such as eggplants or tomatoes, between pepper plantings.

## Viruses

Early season cooler than normal temperatures often result in virus-like mosaic and distortion symptoms in actively growing young plants. In past instances, entire fields or blocks looked symptomatic. Earlyseason transplants will grow out of problem over time.

**Aphid-transmitted viruses**: **Alfalfa Mosaic Virus, Cucumber Mosaic Virus, Potato Virus X, Potato Virus Y, and Tobacco Etch Virus.** Cucumber Mosaic Virus has caused problems in peppers in the midAtlantic region the past few growing seasons. Infected fruit may develop small, irregular brown spots that run parallel on fruit. Young leaves may develop mosaic symptoms. The identification of pepper viruses with laboratory tests can be difficult. Importantly, these viruses of pepper cannot adequately be controlled with insecticide applications, but symptom expression can be delayed through their use. Since aphids transmit the virus, growers may wish to use yellow trap pans containing water to determine when mass flights of aphids occur. Repeated applications of a contact aphicide at those times are most beneficial.

**Thrips-transmitted viruses: Tomato Spotted Wilt Virus (TSWV) and Impatiens Necrotic Spot Virus (INSV).** Resistant varieties should be used, especially in VA. TSWV can be severe on peppers during both greenhouse transplant and field production of the crop. INSV causes similar symptoms as TSWV, however, the virus is not as severe and does not limit production to the same extent. Both viruses are transmitted by a number of thrips species (*e.g.*, Western flower thrips) during the entire thrips life cycle. DO NOT GROW ornamental bedding plants in the same greenhouse as pepper transplants, as thrips are known to transmit the virus from infected ornamental plants. Monitor greenhouses and scout fields regularly for thrips. When thrips are observed in the field, treat with an insecticide and rogue out any plant showing TSWV symptoms.

**Mechanically transmitted viruses: Tobacco mosaic virus (TMV).** Use resistant varieties.

# Potatoes

## Recommended Varieties

| Maturity Group | Varieties[1,2] | Table Stock[3] | Chipping[3] | Yield[3] | Spacing (in.) |
|---|---|---|---|---|---|
| **Early** | Andover | +++ | +++ | + | 9-10 |
| | Dark Red Norland D | ++ | No | + | 8-10 |
| | Envol | +++ | No | ++ | 8-10 |
| | Michigan Purple (purple skin) | ++ | No | ++ | 8-10 |
| | Superior (SR, VS) | +++ | + | ++ | 8-12 |
| | Vivaldi (yellow flesh) | +++ | No | ++ | 8-10 |
| **Midseason** | Atlantic[4] | No | +++ | +++ | 7- 9 |
| | Chieftain (red skin) | ++ | No | ++ | 7- 9 |
| | Dakota Crisp | ++ | +++ | +++ | 8-10 |
| | Eva | ++ | ++ | ++ | 8-10 |
| | Harley Blackwell | ++ | +++ | ++ | 9-12 |
| | King Harry (for organic production) | ++ | -- | ++ | 8-10 |
| | Kueka Gold (pale yellow flesh) | ++ | + | +++ | 9-10 |
| | NorDonna (red skin) | ++ | No | ++ | 9-12 |
| | Norkotah Russet | ++ | No | + | 9-12 |
| | Peter Wilcox (purple skin/yellow flesh) | ++ | No | ++ | 8-10 |
| | Purple Majesty (purple skin/purple flesh) | ++ | ++ | ++ | 9-12 |
| | Reba[5] | +++ | ++ | ++ | 7- 9 |
| | Yukon Gold[5] (yellow flesh) | +++ | No | ++ | 8-10 |
| **Late** | Gold Rush | +++ | No | ++ | 8-10 |
| | Katahdin (LR) | ++ | No | +++ | 8-10 |
| | Kennebec (VS, LBT) (not for eastern VA) | ++ | No | +++ | 7-10 |
| | Lehigh (yellow flesh) | +++ | ++ | +++ | 8-10 |
| | Marcy | ++ | +++ | +++ | 7- 9 |
| | Snowden (for chips only) | No | +++ | ++ | 8-10 |

[1]Listed alphabetically within maturity group.
[2]Letters in parentheses indicate disease resistance: LR=leaf roll resistant, LBT=Leaf Blight Tolerant, SR=Scab Resistant, VS=Verticillium Wilt Susceptible.
[3]+=fair, ++= good, +++= excellent.
[4]Tubers are extremely susceptible to internal necrosis and hollow heart.
[5]Tubers are susceptible to hollow heart during cool growing seasons. Apply one-third of the N at planting and sidedress the remainder when plants are 4-6 inches tall to help reduce hollow heart.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| White Potatoes | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 150-180[1] | 200 | 150 | 100 | 0[2] | 300 | 200 | 100 | 0[2] | Total nutrient recommended |
| | 50 | 200 | 150 | 100 | 0[2] | 300 | 200 | 100 | 0[2] | Broadcast and disk-in |
| | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 4-5 weeks after planting |
| | 0-30[1] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Adjust rate based on petiole nitrate testing at flowering |

Apply 1 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter. [1]For high yielding crop systems (>250 cwt/A), an extra split N application at flowering may be useful. Consult "Nitrogen Management for White Potato Production" at: *http://pubs.ext.vt.edu/438/438-012/438-012.html*. [2]In VA, crop replacement values of 50 lb/A of $P_2O_5$ and 50 lb/A of $K_2O$ are recommended on soils testing Very High.

## Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities.

| Critical Potato Tissue Test Values For Most Recently Matured Leaves | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Timing** | **Value** | **N** | **P** | **K** | **Ca** | **Mg** | **S** | **Fe** | **Mn** | **Zn** | **B** | **Cu** | **Mo** |
| | | **%** | **%** | **%** | **%** | **%** | **%** | **ppm** | **ppm** | **ppm** | **ppm** | **ppm** | **ppm** |
| **Row Closure** | **Deficient** | <3.0 | 0.2 | 3.5 | 0.6 | 0.3 | 0.3 | <40 | 30 | 30 | 20 | 5 | 0.1 |
| | **Adequate range** | 3 | 0.2 | 3.5 | 0.6 | 0.3 | 0.3 | 40 | 30 | 30 | 20 | 5 | 0.1 |
| | | 6 | 0.8 | 6 | 2 | 0.6 | 0.5 | 150 | 60 | 60 | 60 | 10 | 0.2 |
| | **High** | >6.0 | 0.8 | 6 | 2 | 0.6 | 0.5 | >150 | 60 | 60 | 30 | 10 | - |
| | **Toxic (>)** | - | - | - | - | - | - | - | - | - | - | - | - |
| **First Blossom** | **Deficient** | <3.0 | 0.2 | 3 | 0.6 | 0.25 | 0.2 | <40 | 30 | 30 | 20 | 5 | 0.1 |
| | **Adequate range** | 3 | 0.2 | 3 | 0.6 | 0.25 | 0.2 | 40 | 30 | 30 | 20 | 5 | 0.1 |
| | | 4 | 0.5 | 5 | 2 | 0.6 | 0.5 | 150 | 100 | 60 | 30 | 10 | 0.2 |
| | **High** | >4.0 | 0.5 | 5 | 2 | 0.6 | 0.5 | >150 | 100 | 60 | 30 | 10 | - |
| | **Toxic (>)** | - | - | - | - | - | - | - | - | - | - | - | - |
| **Tubers Half Size** | **Deficient** | <2.0 | 0.2 | 2.5 | 0.6 | 0.25 | 0.2 | <40 | 20 | 30 | 20 | 5 | 0.1 |
| | **Adequate range** | 2 | 0.2 | 2.5 | 0.6 | 0.25 | 0.2 | 40 | 20 | 30 | 20 | 5 | 0.1 |
| | | 4 | 0.4 | 4 | 2 | 0.6 | 0.5 | 150 | 100 | 60 | 30 | 10 | 0.2 |
| | **High** | >4.0 | 0.4 | 4 | 2 | 0.6 | 0.5 | >150 | 100 | 60 | 30 | 10 | - |
| | **Toxic (>)** | <3.0 | 0.2 | 3.5 | 0.6 | 0.3 | 0.3 | - | - | - | - | - | - |

## Variety Selection

Consider market preferences, variety adaptation to local conditions and specific field problems. Use certified, disease-free “seed” (tuber or piece used for planting) of good quality from reputable source to maximize yield and quality. Depending on variety, production area and market, crop takes 90 to 160 days to mature and harvest.

## Site Selection, Soil and Fertilization

The best soils are well-drained, deep, well aerated, sandy and sandy loam soils high in organic matter (especially muck soils). Avoid heavy soils and soils that adhere to tubers. Use crop rotation to decrease the incidence of soil-borne diseases. Avoid fields that have had potatoes in the past 2 years, and those with high nematode populations. Test the soil for nematodes and fertility. Optimum soil pH is 5.5 to 6.5. All P and K can be applied before planting. Split the recommended N (See table: Recommended Nutrients Based on Soil Tests above).

## Seed-Piece Treatment

Use certified seed. See Disease Control below.

## Planting and Spacing

The recommended planting dates are March 10 to April 5 in MD and VA, March 20 to April 15 in DE, March 20 to April 25 in NJ, and March 25 to June 5 in PA. Space seed 7 to 12 inches apart in 34 or 36-inch rows. Use close spacing for large, cut seed pieces and wider spacing for whole (B-size) seed. Use close spacing for potatoes that are to be marketed in 5 and 10-pound consumer packs, and for ‘Katahdin’ and ‘Kennebec’, which tend to produce few oversized tubers.

## Harvest and Storage Considerations

Monitor environmental conditions prior to harvest to determine potential incidence of a disorder associated with adverse conditions (see Common Physiological Disorders below). Consider the susceptibility-tolerance to these disorders when selecting varieties. Preharvest conditioning in potato is critical to set the skin and facilitate harvest. In early harvests, vine killing can hasten or improve skin set on relatively immature potatoes, thus reducing tuber damage during harvest, grading, packing and shipping. Tubers stop growing after vine killing and proper skin set improves shelf life, promotes retention of potato quality during transport, and improves eye appeal. Chemical vine killing is the most common method (see Vine Killing below), but mechanical vine killing (mowing) is also used. Vines of potatoes going into storage should be completely dead at least 14-21 days before harvest. Use potato chain diggers or other means of bulk-harvest with appropriate design to reduce bruises. After harvest, healing of cuts and bruises is most rapid at 50-60°F (10-16°C) tuber temperature and 90-95% relative humidity without water condensation. This temperature should be maintained 2-3 weeks at the beginning of the storage period. The temperature should then be lowered to 40°F (4°C) for table stock or seed potatoes. Potatoes for processing are stored at 45-50°F (7-10°C), but if a rot-producing agent such as field frost, late blight, or soft rot is present, the curing period should be eliminated, air flow increased, and the temperature lowered to 45°F (7°C) as soon as possible. Monitor the storage daily and, if the rot continues, sell the crop immediately.

## Common Physiological Disorders

Disorders that are associated with adverse environmental conditions or cultural practices are listed below.

| **Disorder** | **Primary Cause** | **Occurrence** | **Market Effect** |
|---|---|---|---|
| Blackheart | low oxygen, wet soil | bulking, storage | quality, poor processing |
| Brown center and hollow heart | rapid growth after stress | early to mid-bulking | quality, poor processing |
| Chaining | hot soil | mid-bulking | yield (size) |
| Chilling, Freezing | low temperature | harvest, storage | quality, yield prone to rots |
| Deformation | growth stops and go | bulking | quality |
| Greening | light | bulking, storage | quality |
| Growth crack | wet/dry soil | bulking | quality |
| Heat necrosis | heat, acid soil (low Ca) | harvest | quality, yield, poor processing |
| Heat and hair sprouting | hot soil | late bulking, early storage | quality, yield, poor processing |
| Internal sprouting | piling, sprout inhibition | storage | quality, poor seed |
| Jelly End, Glassy End | fast vine death, low moisture | harvest | poor processing |
| Swollen lenticel | wet soil | bulking, harvest | storage rots |
| Vascular discoloration | fast vine death, low moisture | harvest | poor processing |

## Air Pollution

Symptoms appear as tiny spots of brown tissue on the upper surface of leaves and a bronzing of the lower surfaces. Some varieties (*e.g.*, Snowden) are particularly sensitive.

## Vine Killing

Vine desiccation facilitates harvesting by reducing potato and weed foliage. Decisions as to when to apply vine desiccants are based on market, demand for a given size and the need for high quality, non-skinned tubers.

| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
|---|---|---|---|---|---|---|
| 10 | Rely 280 2.34L | 21 fl oz/A | **glufosinate** | 0.38 lb/A | 9 | 12 |
| -Apply at the beginning of natural vine senescence in a single application; cover vines thoroughly.<br>-**Do not** apply to potatoes grown for seed. **Do not** plant treated areas with wheat, barley and other small grains until 30 or more days after application. Refer to label for rotational restrictions. Presence of heavy or dense vines may require an application of another desiccation product (i.e. Reglone). Rainfastness is 4 hrs. **Do not** apply more than 1 application per harvest. | | | | | | |
| 22 | Reglone 2SL | 1 to 2 pt/A | **diquat** | 0.25 to 0.5 lb/A | 7 | 24 |
| -Add a non-ionic surfactant 0.5% v/v (2 qt/100 gal). Ground application in a minimum of 20 gal/A of water.<br>-**Do not** apply to drought stressed potatoes. If a second application is necessary, allow at least 5 days between applications.<br>-Rainfastness is 30 minutes. Maximum application of Reglone per season is 4 pt/A | | | | | | |

**Other Labeled Products** These products are labeled but limited local data is available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| **Group** | **Product Name** | **Active Ingredient (*=Restricted Use)** |
|---|---|---|
| **14** | Aim | **carfentrazone** |
| **14** | Vida | **pyraflufen** |
| 22 | Generic paraquat | **paraquat*** |

## Sprout Inhibitors

| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
|---|---|---|---|---|---|---|
| -- | Sprout Nip 3EC | Apply ast 1% emulsion | **chlorpropham** | 0.01 lbs ai/1100 lbs potatoes | -- | -- |
| -Refer to label for respirator and other PPE requirements. **Do not** use on seed potatoes.<br>-Use to treat potatoes after storage and washing; use only after bruises and cuts have healed (normally a minimum of 2 weeks)<br>-Use at 1% emulsion by diluting 1 gallon of Sprout Nip 3EC to 35 gallons of water.<br>-Apply at rate of 1 qt of 1% emulsion per 20 bags of potatoes (100 lbs/bag)<br>-Spray uniformly across rollers moving the potatoes. | | | | | | |

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

| **1. Non-Selective or Burndown** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| **9** | Roundup PowerMax 4.5L<br>"Generic" glyphosate 3L | 16 to 32 fl oz/A<br>24 to 48 fl oz/A | **glyphosate** | 0.75 to 1.10 lb acid equivalent/A | -- | 4 |
| -Apply prior to planting. Some glyphosate formulations may require an adjuvant, refer to label.<br>-Glyphosate controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label. Repeat applications are allowed, with maximum application of 5.3 qts per acre per year. | | | | | | |
| 22 | Gramoxone SL 2.0 | 1 to 2 pt/A | **paraquat*** | 0.25 to 0.5 lb/A | -- | 24 |
| -Apply up to ground cracking, before potato has emerged. Always include an adjuvant (nonionic surfactant or crop oil concentrate).<br>-Tank mix with appropriate herbicides for residual weed control. Paraquat may not control established grasses. Spray coverage is essential for optimum control. Rainfastness 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |

| **2. Soil-Applied (Preemergence/Drag-Off)** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| **2** | Matrix 25DF | 1.0 to 1.5 oz/A | **rimsulfuron** | 0.0156 to 0.023 lb/A | 60 | 4 |
| -Apply immediately after hilling or drag-off.<br>-Apply with nonionic surfactant at 0.25% v/v (1.0 qt/100 gal of spray solution) if weeds are emerged at time of application.<br>-Controls many weeds including foxtail species, pigweed species, wild mustard, and wild radish. Suppresses common lambsquarters, common ragweed, jimsonweed, morningglory species, and yellow nutsedge. Tank mix with other residual products to improve spectrum of weed control. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur.<br>-Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled.<br>-Repeated applications may be needed to control certain perennial grasses.<br>-Temporary chlorosis may occur to potatoes under stress from drought, cold temperatures, high temperatures, or extreme temperature variations.<br>-**Do not** tank-mix with or apply within 1 week before or after any pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. Matrix is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field. Maximum for Matrix: 2.5 oz/A per year. | | | | | | |
| 3 | Prowl H2O 3.8CS | 1.5 to 3.0 pt/A | **pendimethalin** | 0.71 to 1.43 lb/A | -- | 24 |
| -Apply preemergence after planting, but before potatoes and weeds emerge, or after drag-off.<br>-Activity of Prowl H2O is improved by incorporation. Apply preemergence incorporated after planting but before potatoes and weeds emerge. Where drag-off is practiced, apply and incorporate before, at, or after drag-off, but before potatoes and weeds emerge.<br>-Ensure incorporation equipment does not damage seed pieces or elongating sprouts.<br>-Prowl H2O controls certain broadleaf weeds and annual grasses. Does not control yellow nutsedge.<br>-Use lower rates on coarse-textured soils with < 3% organic matter and higher rates on medium- and fine-textured soil with > 3% organic matter. Tank mix with appropriate postemergence herbicides if weeds are emerged at time of application. Tank-mix with other residual herbicides such as Lorox or Metribuzin to improve broadleaf control.<br>-Application to 'White Rose' variety during or followed by cool and/or wet conditions may result in crop injury.<br>-A maximum of 1 application per season is allowed. | | | | | | |
| 5 | Metribuzin 75DF | 0.5 to 0.66 lb/A | **metribuzin** | 0.38 to 0.5 lb/A | 60 | 12 |
| -Apply just prior to emergence or after drag-off. Metribuzin primarily controls broadleaf weeds and is weak on grasses.<br>-Tank mix with Dual Magnum or Prowl H2O, or use in addition to Eptam for preemergence annual grass control.<br>-A pre-mix of Dual Magnum and Metribuzin is sold under the trade name Boundary.<br>-Metribuzin has some postemergence activity. To get consistent control, apply Metribuzin before weeds are 1 inch tall.<br>-Tank mix with appropriate postemergence herbicides if weeds are emerged at time of application.<br>-Preemergence application to 'Atlantic' and 'Norland' or to any early maturing, smooth, white- or red-skinned potato varieties, may cause crop injury, especially under adverse weather conditions and when higher labeled rates are used.<br>-'Atlantic', 'Bellchip', 'Centennial', 'Chipbell', and 'Shepody' are sensitive to Metribuzin and may be injured by preemergence applications under adverse weather conditions on coars soils, under high soil pH, with higher rates, and with mechanical incorporation.<br>-Maximum for Metribuzin 75DF: May be applied once preemergence and once postemergence. **Do not** exceed 1.33 lb/A per season. | | | | | | |

*2. Soil-Applied (Preemergence/Drag-Off) continued on next page*

*2. Soil-Applied (Preemergence/Drag-Off) - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | Lorox 50DF<br>Linex 4L | 0.8 to 2.0 lb/A<br>0.75 to 2 pt/A | **linuron** | 0.4 to 1.0 lb/A | -- | 24 |
| -Apply just prior to emergence or after drag-off.<br>-Primarily controls broadleaf weeds and is weak on grasses. Tank mix with Dual Magnum for preemergence annual grass control.<br>-Use lower rates on coarse-textured soil low in organic matter and higher rates on medium- or fine-textured soils with greater organic matter. Linuron has some postemergence activity. To get consistent control, apply just before or when weed seedlings emerge. If weeds are emerged add a nonionic surfactant at 0.5% v/v (2 qt/100 gal spray solution).<br>-Maximum for Lorox: 3 lb/A per year. Maximum for Linex: 3 pt/A per year. | | | | | | |
| 8 | Eptam 7E | 3.4 to 5.1 pt/A | **EPTC** | 3.0 to 4.5 lb/A | 30 | 12 |
| -Apply at one of the following timings: 1) just before planting and disking. For plantings before April 1, Eptam may reduce early vigor and yields slightly; 2) just after drag-off and incorporate with 1 or 2 cultivations by a spike-tooth harrow or similar piece of equipment; and 3) just before first or second cultivation.<br>-Eptam controls annual grasses, yellow nutsedge, and a few broadleaf weeds. Tank mix with Lorox or Metribuzin to improve broadleaf weed control. Maximum for Eptam: 14 pt/A per season. | | | | | | |
| **14** | Chateau 51WDG | 1.5 oz/A | **flumioxazin** | 0.048 lb/A | -- | 12 |
| -**A Supplemental Label has been approved for the use of Chateau on potato in DE, MD, NJ and VA.**<br>-Apply preemergence after hilling or drag-off. Chateau primarily controls broadleaf weeds and is weak on grasses.<br>-Tank mix with Dual Magnum, Prowl H2O, or use in addition to Eptam for preemergence annual grass control.<br>-A minimum of 2 inches of soil must cover potato shoots at time of application; less than 2 inches of soil may result in crop injury.<br>-Maximum Chateau: 1.5 oz/A per single application; 1.5 oz/A per growing season. | | | | | | |
| **14** | Reflex 2SL | 0.75 to 1.0 pt/A | **fomesafen** | 0.188 to 0.25 lb/A | 70 | 24 |
| -Apply after planting but before potato emergence.<br>-**DO NOT** preplant incorporate nor apply to emerged potatoes or severe injury will occur.<br>-Reflex primarily controls broadleaf weeds and is weak on grasses.<br>-Tank mix with Dual Magnum, Prowl H2O, or use in addition to Eptam for preemergence annual grass control.<br>-Reflex has postemergence activity. To get consistent control, apply before weeds reach 4 inches.<br>-Potato varieties vary in response to Reflex. Determine crop tolerance before using.<br>-Maximum for Reflex 2SL: 1 pt/A per season on potatoes. Maximum fomesafen for all crops: NJ and most of PA 0.313 lb/A in alternate years; DE, MD, VA, and parts of PA 0.375 lb/A in alternate years. | | | | | | |
| 15 | Dual Magnum 7.62E | 1.0 to 2.0 pt/A | ***s*-metolachlor** | 0.96 to 1.91 lb/A | 60 | 24 |
| -Apply preplant incorporated, postplant incorporated up to drag-off, preemergence, delayed preemergence, or after drag-off prior to emergence of potatoes and weeds. If incorporate, use appropriate equipment to evenly distribute the herbicide into the top 2 to 3 inches of soil. Ensure incorporation equipment does not damage seed pieces or elongating sprouts.<br>-Dual Magnum controls most annual grasses (except Texas panicum), small seeded broadleaf weeds, and suppresses yellow nutsedge.<br>-Tank mix with Lorox or Metribuzin for additional broadleaf weed control.<br>-A pre-mix of Dual Magnum and Metribuzin is sold under the trade name Boundary.<br>-If cool, wet soil conditions occur after application, *s*-metolachlor may delay maturity and/or reduce yield of 'Superior' and other early maturing potato varieties. **DO NOT** use on muck or peat soils. **DO NOT** apply both a preemergence and an incorporated treatment.<br>-Maximum for Dual Magnum: 3.6 pt/A per crop season. | | | | | | |

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9 to 16 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 30 | 24 |
| 1 | Poast 1.5EC | 1.0 to 2.5 pt/A | **sethoxydim** | 0.2 to 0.47 lb/A | 30 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v.<br>-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.<br>-Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.<br>-If repeat applications are necessary, allow 14 days between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 2.5 pt/A Poast in single application and **do not** exceed 5 pt/A for the season. | | | | | | |

*2. Postemergence continued on next page*

*2. Postemergence - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| **2** | Matrix 25DF | 1.0 to 1.5 oz/A | **rimsulfuron** | 0.0156 to 0.023 lb/A | 60 | 4 |
| -Apply early postemergence; typically weeds at 1 inch tall or less; crop stage is not defined on label.<br>-Apply with nonionic surfactant at 0.25% v/v (1.0 qt/100 gal of spray solution).<br>-Controls many small weeds including foxtail species, pigweed species, wild mustard, and wild radish. Suppresses common lambsquarters, common ragweed, jimsonweed, morningglory species, and yellow nutsedge.<br>-Temporary chlorosis may occur to potatoes under stress from drought, cold temperatures, high temperatures, or extreme temperature variations.<br>-Matrix provides both residual and postemergence control of susceptible weed species. Matrix is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field.<br>-Rainfastness is 4 hrs. Maximum for Matrix: 2.5 oz/A per year. | | | | | | |
| 5 | Metribuzin 75DF | 0.33 to 0.66 lb/A | **metribuzin** | 0.25 to 0.50 lb/A | 60 | 12 |
| -Apply just prior to emergence or after drag-off. Metribuzin primarily controls broadleaf weeds and is weak on grasses.<br>-Tank mix with Dual Magnum or Prowl H2O, or use in addition to Eptam for preemergence annual grass control.<br>-Metribuzin has some postemergence activity. To get consistent control, apply Metribuzin before weeds are 1 inch tall.<br>-Tank mix with appropriate postemergence herbicides if weeds are emerged at time of application.<br>-Postemergence application can used only on russet or white-skinned varieties that are not early maturing.<br>**DO NOT** use on red-skinned or early maturing, smooth, white-skinned varieties.<br>-Potato varieties vary in sensitivity to Metribuzin. Determine tolerance on a trial basis before using on field scale. ‘Atlantic’, ‘Bellchip’, ‘Centennial’, ‘Chipbell’, and ‘Shepody’ are sensitive to Metribuzin. Avoid postemergence applications to these varieties.<br>-Apply only if there have been at least three successive sunny days prior to application. May cause some chlorosis or minor necrosis.<br>-Maximum for Metribuzin: 0.66 lb/A postemergence. May be applied once preemergence and once postemergence.<br>-**Do not** exceed 1.33 lb/A per season. Rainfastness is 6 hrs. | | | | | | |

### 3. Postharvest

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24© label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant. Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

### 4. Other Labeled Herbicides

These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| 3 | Treflan | **trifluralin** |
| 15 | Outlook | **dimethenamid** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

## <u>Soil Pests</u>

**Wireworms** See also the Pest Management chapter (Insect Management section).

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations:** | | | | | | |
| **Preplant Application: Broadcast and incorporate just before planting.** | | | | | | |
| 1B | Mocap EC | 2/3 to 1.0 gal/A | ethoprop* | n/a | 48 | H |
| 3A | Bifenture EC, Sniper, Sniper Helios | 19.2 fl oz/A | bifenthrin* | n/a | 12 | H |
| 3A | Capture LFR, Sniper LFR | 12.75 to 25.5 fl oz/A | bifenthrin* | n/a | 12 | H |
| **Planting Application** | | | | | | |
| 1B | Mocap EC | 2/3 to 1.0 gal/A | ethoprop* | AP | 48 | H |
| 1B | Thimet 20G | 8.5 to 11.3 oz/1000 ft at planting and post-emergence light or sandy soils; 13.0 to 17.3 oz/1000 ft at planting only heavy or clay soils | phorate* | 90 | 48 | H |

*Wireworms continued on next page*

*Wireworms Planting Application - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 2B | Regent 4SC | 2.9 to 3.2 fl oz/A (see label for rate based on row spacing) | fipronil | 90 | 0 | H |
| 3A+4A | Brigadier | 16.0 to 25.6 fl oz/A | bifenthrin*+imidacloprid | 21 | 12 | H |
| 3A+4A | Swagger | 32.0 to 51.2 fl oz/A | bifenthrin*+imidacloprid | 21 | 12 | H |
| 3A | Bifenture EC, Sniper, Sniper Helios | 19.2 fl oz/A | bifenthrin* | 21 | 12 | H |
| 3A | Capture LFR, Sniper LFR | 12.75 to 25.5 fl oz/A | bifenthrin* | 21 | 12 | H |
| **Lay-by Application** | | | | | | |
| 3A | Bifenture EC, Sniper, Sniper Helios | 3.2 to 9.6 fl oz/A | bifenthrin* | 21 | 12 | H |
| 3A | Capture LFR, Sniper LFR | 12.75 to 25.5 fl oz/A | bifenthrin* | 21 | 12 | H |

# Above-ground Pests

## Aphids

Insecticide treatments are recommended when aphid counts exceed 2 per leaf prior to bloom, 4 per leaf during bloom, and 10 per leaf within 2 weeks of vine kill.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 6 | 48 | H |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 7 | 48 | H |
| 1B | Dimethoate 400 / 4EC | 0.5 to 1.0 pt/A | dimethoate* | 0 | 48 | H |
| 3A + 4A | Brigadier | 16.0 to 25.6 fl oz/A | bifenthrin* + imidacloprid - **soil** | 21 | 12 | H |
| 3A + 4A | Brigadier | 3.8 to 6.14 fl oz/A | bifenthrin* + imidacloprid - **foliar** | 21 | 12 | H |
| 3A + 4A | Leverage 360 | 2.8 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 3A + 4A | Swagger | 32.0 to 51.2 fl oz/A | bifenthrin* + imidacloprid - **soil** | 21 | 12 | H |
| 3A + 4A | Swagger | 7.6 to 12.28 fl oz/A | bifenthrin* + imidacloprid - **foliar** | 21 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 21 | 12 | H |
| 4A | Admire Pro | 5.7 to 8.7 fl oz/A | imidacloprid - **soil** | AP | 12 | H |
| 4A | Admire Pro | 1.3 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Assail 30SG | 2.5 to 4.0 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Belay | 9.0 to 12.0 fl oz/A | chlothianidin - **soil** | AP | 12 | H |
| 4A | Belay | 2.0 to 3.0 fl oz/A | chlothianidin - **foliar** | 14 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 2.67 oz/A | thiamethoxam - **soil** | AP | 12 | H |
| 4A | Actara 25WDG | 3.0 oz/A | thiamethoxam - **foliar** | 14 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 14 | 12 | H |
| 4D | Sivanto 200SL | 7.0 to 10.5 fl oz/A | flupyradifurone - **foliar** | 7 | 4 | L |
| 4D | Sivanto Prime | 7.0 to 14.0 fl oz/A | flupyradifurone - **foliar** | 7 | 4 | L |
| 4H | Transform WG | 0.75 to 1.5 oz/A | sulfoxaflor | 7 | 24 | H |
| 9B | Fulfill 50WDG | 2.75 to 5.5 oz/A | pymetrozine | 14 | 12 | L |
| 9C | Beleaf 50SG | 2.0 to 2.8 oz/A | flonicamid | 7 | 12 | L |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 7 | 24 | L |
| 28 + 3 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 14 | 12 | H |
| n/a | Requiem 25EC | 2.0 to 3.0 qt/A | *Chenopodium* extract (biopesticide) | 0 | 4 | L |

## Colorado Potato Beetles (CPB) - Pesticide Resistance Management

Do not rely exclusively on the neonicotinoid class of insecticides (Class 4: Actara, Assail, Cruiser, Gaucho, imidacloprid, Leverage 360, Platinum, Scorpion, or Venom) for CPB control. It is important to use all available effective pest management strategies, including crop rotation, pest scouting, treatment thresholds, and alternative (different class) insecticides, such as abamectin* (Agri-Mek), Avaunt plus PBO, Blackhawk, Coragen, Entrust, Radiant, Rimon, Verimark, Voliam Xpress, or Vydate.

For rotated fields adjacent to CBP overwintering sites or to previous year’s potato fields, most of the colonizing adults can be killed by treating only a strip of rows along the field edge where the invasion front is expected. Fields should still be monitored for beetles and other insect pests throughout the season.

**DO NOT use foliar applications of any neonicotinoid insecticide (clothianidin, imidacloprid, thiamethoxam, dinotefuron, acetamiprid) in fields previously treated with seed-treatment or at-planting neonicotinoids.**

*Colorado Potato Beetles - continued*

| Apply one of the following formulations. Preplant or planting application. | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A + 4A | Brigadier | 16.0 to 25.6 fl oz/A | bifenthrin* + imidacloprid - **soil** | 21 | 12 | H |
| 3A + 4A | Swagger | 32.0 to 51.2 fl oz/A | bifenthrin* + imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 5.7 to 8.7 fl oz/A | imidacloprid - **soil** | AP | 12 | H |
| 4A | Belay | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | AP | 12 | H |
| 4A | Imidacloprid 2F | 13.0 to 20.0 fl oz/A | imidacloprid - **soil** | AP | 12 | H |
| 4A | Platinum 75SG | 1.66 to 2.67 oz/A | thiamethoxam - **soil** | AP | 12 | H |
| 4A | Scorpion 35SL | 11.5 to 13.25 fl oz/A | dinotefuran - **soil** | AP | 12 | H |
| 4A | Venom 70SG | 11.5 to 13.25 fl oz/A | dinotefuran - **soil** | AP | 12 | H |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole - **soil** | AP | 4 | H |

## Colorado Potato Beetles - Postemergence Application

Rotation to non-solanaceous crops (crops other than potato, tomato, eggplant, and pepper) is extremely important in reducing CPB problems. Avoid applying late-season sprays to prevent the buildup of insecticide-resistant beetles.

Beginning at plant emergence, sample fields weekly for CPB to determine the need to spray. Select at least 10 sites per field along a V- or W-shaped path throughout the field. At each site, select 1 stem from each of 5 adjacent plants and count and record all adults, large larvae (larger than half-grown), and small larvae (smaller than half-grown). If more than 50 adults or 75 large larvae or 200 small larvae are counted per 50 stems, treatment is recommended. Yield loss as a result of CPB feeding depends on the age of the potato plant. 'Superior' variety (short season) cannot compensate for early season defoliation by overwintered beetles, but during the last 30 days of the season, 'Superior' can withstand up to 50% defoliation without yield loss.

**Note: Several of these insecticides may no longer be effective in certain areas due to CPB resistance. Check with your county Extension agent for most effective control.**

| Apply one of the following formulations. Postemergence application. | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate L | 1.0 to 4.0 pt/A | oxamyl* | 7 | 48 | H |
| 1B | Imidan 70W | 1 1/3 lb/A | phosmet | 7 | 120 | H |
| 3A+4A | Brigadier | 4.8 to 6.14 fl oz/A | bifenthrin* + imidacloprid | 21 | 12 | H |
| 3A+4A | Leverage 360 | 2.8 fl oz/A | imidacloprid + bifenthrin* | 7 | 12 | H |
| 3A+4A | Swagger | 9.6 to 12.28 fl oz/A | bifenthrin* + imidacloprid | 21 | 12 | H |
| 3A+28 | Besiege | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 14 | 24 | H |
| 3A+4A | Endigo ZC | 3.5 to 4.0 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 14 | 24 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 fl oz/A | thiamethoxam | 14 | 12 | H |
| 4A | Admire Pro | 1.3 fl oz/A | imidacloprid | 7 | 12 | H |
| 4A | Assail 30SG | 1.5 to 4.0 oz/A | acetamiprid | 7 | 12 | H |
| 4A | Belay | 2.0 to 3.0 fl oz/A | chlothianidin | 14 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 2.75 fl oz/A | dinotefuran | 7 | 12 | H |
| 4A | Venom 70SG | 1.0 to 1.5 oz/A | dinotefuran | 7 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 oz/A | thiamethoxam + chlorantraniliprole | 14 | 12 | H |
| 4D | Sivanto 200SL, Sivanto Prime | 10.5 to 14.0 fl oz/A | flupyradifurone | 7 | 4 | L |
| 5 | Blackhawk | 1.7 to 3.3 fl oz/A | spinosad | 7 | 4 | M |
| 5 | Radiant SC | 4.5 to 8.0 fl oz/A | spinetoram | 7 | 4 | H |
| 6 | Agri-Mek 0.7SC | 1.75 to 3.5 fl oz/A | abamectin* | 14 | 48 | H |
| 11 | Trident (OMRI) | 3.0 t 6.0 qt/A | *Bacillus thuringiensis tenebrionis* | 0 | 0 | L |
| 15 | Rimon 0.83EC | 6.0 to 12.0 fl oz/A | novaluron | 14 | 12 | H |
| 17 | Trigard | 2.66 oz/A | cyromazine | 7 | 12 | L |
| 22 | Avaunt 30WDG | 3.5 to 6.0 oz/A | Indoxacarb **- addition of the synergist piperonyl butoxide (PBO) is needed** | 7 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole | 14 | 4 | L |
| 28 | Exirel | 5.0 to 13.5 fl oz/A | cyantraniliprole | 7 | 12 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 14 | 12 | H |
| n/a | Azatin O, AzaDirect, Ecozin, Neemis (OMRI) | Refer to individual labels for rates | azadirachtin (biopesticide) | 0 | 4 | N |

## Cutworms - See also the Pest Management chapter, Insect Management section.

Present during July and August. Especially troublesome to tubers where soil cracking occurs. Variegated cutworms feed on lower leaves and petioles, and protective sprays should be applied if numbers exceed 6 worms per plant or foliar loss is more than 10%. Black cutworms are largely underground feeders, but will occasionally feed on leaves.

| Apply one of the following formulations. Note: No materials are effective if larvae do not feed above ground (foliar and systemic insecticides are ineffective). Several spray applications may be required for control. | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 pt/A | methomyl* | 6 | 48 | H |
| 1A | Sevin XLR plus | 1.0 to 2.0 qt/A | carbaryl | 7 | 12 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A+4A | Leverage 360 | 2.8 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 3A+28 | Besiege | 5.0 to 8.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole | 14 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A | Hero EC | 2.6 to 6.1 fl oz/A | zeta-cypermethrin* + bifenthrin* | 21 | 12 | H |
| 3A | Lambdy-cy, LambdaT | 1.92 to 3.2 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A | Mustang Maxx | 1.28 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-up 3.2EC, Permethrin 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 14 | 12 | H |
| 3A | Tombstone, Tombstone Helios | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 0.96 to 1.6 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A+4A | Endigo ZC | 3.5 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 14 | 24 | H |

## European Corn Borers (ECB)

Proper timing of ECB sprays is critical. Apply first spray when 10% of the stems have entry holes in fresh market varieties or 25% in processing varieties. Make 2 to 3 applications on a 5-10-day schedule. Consult your county Extension agent and/or area pest management newsletter.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A+4A | Brigadier | 4.8 to 6.14 fl oz/A | bifenthrin* + imidacloprid | 21 | 12 | H |
| 3A+4A | Swagger | 9.6 to 12.28 fl oz/A | bifenthrin* + imidacloprid | 21 | 12 | H |
| 3A+28 | Besiege | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole | 14 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 21 | 12 | H |
| 3A | Lambda-cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A | Mustang Maxx | 1.76 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-up 3.2EC, Permethrin 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 14 | 12 | H |
| 3A | Tombstone, Tombstone Helios | 1.6 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A+4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 14 | 24 | H |
| 4A+28 | Voliam Flexi | 4.0 oz/A | thiamethoxam + chlorantraniliprole | 14 | 12 | H |
| 5 | Blackhawk | 1.7 to 3.3 fl oz/A | spinosad | 7 | 4 | M |
| 5 | Radiant SC | 6.0 to 8.0 fl oz/A | spinetoram | 7 | 4 | H |
| 15 | Rimon 0.83EC | 6.0 to 12.0 fl oz/A | novaluron | 14 | 12 | L |
| 22 | Avaunt 30WDG | 3.5 to 6.0 oz/A | indoxacarb | 7 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole | 14 | 4 | L |
| 28 | Verimark | 10.0 to 13.5 fl oz/A | cyantraniliprole - **soil** | AP | 4 | H |
| 28 | Exirel | 7.0 to 12.5 fl oz/A | cyantraniliprole - **foliar** | 7 | 12 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 14 | 12 | H |

## Flea Beetles

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 pt/A | methomyl* | 6 | 48 | H |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 7 | 48 | H |

*Flea Beetles continued on next page*

*Flea Beetles - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1B | Imidan 70W | 1 1/3 lb / A | phosmet | 7 | 120 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A+4A | Brigadier | 16.0 to 25.6 fl oz/A | bifenthrin* + imidacloprid - **soil** | 21 | 12 | H |
| 3A+4A | Brigadier | 4.8 to 16.4 fl oz/A | bifenthrin* + imidacloprid - **foliar** | 21 | 12 | H |
| 3A+4A | Leverage 360 | 2.8 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 3A+4A | Swagger | 32.0 to 51.2 fl oz/A | bifenthrin* + imidacloprid - **soil** | 21 | 12 | H |
| 3A+4A | Swagger | 9.6 to 12.28 fl oz/A | bifenthrin* + imidacloprid - **foliar** | 21 | 12 | H |
| 3A+28 | Besiege | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole | 14 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A | Bifenture 2EC, Sniper, Sniper Helios | 2.1 to 6.4 fl oz/A | bifenthrin* | 21 | 12 | H |
| 3A | Hero EC | 2.6 to 6.1 fl oz/A | zeta–cypermethrin* + bifenthrin* | 21 | 12 | H |
| 3A | Lambda-cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A | Mustang Maxx | 1.76 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-up 3.2EC, Permethrin 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 14 | 12 | H |
| 3A | Tombstone, Tombstone Helios | 1.6 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A+4A | Endigo ZC | 3.5 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 14 | 24 | H |
| 4A | Admire Pro | 5.7 to 8.7 fl oz/A | imidacloprid - **soil** | AP | 12 | H |
| 4A | Admire Pro | 1.3 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Assail 30SG | 1.5 to 2.5 oz/A | acetamiprid | 7 | 12 | H |
| 4A | Belay | 9.0 to 12.0 fl oz/A | chlothianidin - **soil** | AP | 12 | H |
| 4A | Belay | 2.0 to 3.0 fl oz/A | chlothianidin - **foliar** | 14 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 2.67 oz/A | thiamethoxam - **soil** | AP | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 14 | 12 | H |
| 4A | Scorpion 35SL | 11.5 to 13.25 fl oz/A | dinotefuran - **soil** | AP | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 2.75 fl oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70SG | 6.5 to 7.5 oz/A | dinotefuran - **soil** | AP | 12 | H |
| 4A | Venom 70SG | 1.0 to 1.5 oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A+28 | Voliam Flexi | 4.0 oz/A | thiamethoxam + chlorantraniliprole | 14 | 12 | H |

## Potato Leafhoppers

Monitor fields for the buildup of leafhoppers from early June until early August. Treatment is suggested if leafhopper counts exceed 1 adult per sweep or 1 nymph per 10 leaves.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 6 | 48 | H |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 7 | 48 | H |
| 1B | Dimethoate 400/4EC | 0.5 to 1.0 pt/A | dimethoate* | 0 | 48 | H |
| 1B | Imidan 70W | 1 1/3 lb/A | phosmet | 7 | 120 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A+4A | Brigadier | 16.0 to 25.6 fl oz/A | bifenthrin* + imidacloprid **- soil** | 21 | 12 | H |
| 3A+4A | Brigadier | 3.8 to 6.14 fl oz/A | bifenthrin* + imidacloprid - **foliar** | 21 | 12 | H |
| 3A+4A | Leverage 360 | 2.8 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 3A+4A | Swagger | 32.0 to 51.2 fl oz/A | bifenthrin* + imidacloprid - **soil** | 21 | 12 | H |
| 3A+4A | Swagger | 7.6 to 12.28 fl oz/A | bifenthrin* + imidacloprid - **foliar** | 21 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta–cypermethrin* + bifenthrin* | 21 | 12 | H |
| 3A | Lambda-cy, LambdaT | 1.92 to 3.2 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A | Mustang Maxx | 3.2 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-up 3.2EC, Permethrin 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 14 | 12 | H |
| 3A | Tombstone, Tombstone Helios | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 0.96 to 1.6 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A + 4A | Endigo ZC | 3.5 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 7 | 24 | H |
| 4A | Admire Pro | 5.7 to 8.7 fl oz/A | imidacloprid - **soil** | AP | 12 | H |
| 4A | Admire Pro | 1.3 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Assail 30SG | 1.5 to 4.0 oz/A | acetamiprid | 7 | 12 | H |

*Potato Leafhoppers continued on next page*

*Potato Leafhoppers - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4A | Belay | 9.0 to 12.0 fl oz/A | chlothianidin- **soil** | AP | 12 | H |
| 4A | Belay | 2.0 to 3.0 fl oz/A | chlothianidin - **foliar** | 14 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 2.67 oz/A | thiamethoxam - **soil** | AP | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 14 | 12 | H |
| 4A | Scorpion 35SL | 11.5 to 13.25 fl oz/A | dinotefuran - **soil** | AP | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 2.75 fl oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70SG | 6.5 to 7.5 oz/A | dinotefuran - **soil** | AP | 12 | H |
| 4A | Venom 70SG | 1.0 to 1.5 oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A + 28 | Voliam Flexi | 4 oz/A | thiamethoxam + chlorantraniliprole | 14 | 12 | H |
| 4C | Transform WG | 1.5 to 2.25 fl oz/A | sulfoxaflor | 7 | 12 | H |
| 4D | Sivanto 200SL | 7.0 to 10.5 fl oz/A | flupyradifurone | 7 | 4 | L |
| 4D | Sivanto Prime | 7.0 to 14.0 fl oz/A | flupyradifurone | 7 | 4 | L |
| 21A | Portal XLO | 2.0 pt/A | fenpyroximate | 7 | 12 | L |

## Potato Tuberworms

Treat when foliage injury is first noted; 4 to 5 applications at 7 to 14 day intervals may be needed. Tuberworms are primarily a problem on the fall crop. Because moths are actively flying at dusk, sprays are most effective when applied early evening.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 6 | 48 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A+4A | Brigadier | 4.8 to 6.14 fl oz/A | bifenthrin* + imidacloprid - **foliar** | 21 | 12 | H |
| 3A+4A | Leverage 360 | 2.8 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 3A+4A | Swagger | 9.6 to 12.28 fl oz/A | bifenthrin* + imidacloprid - **foliar** | 21 | 12 | H |
| 3A+28 | Besiege | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole | 14 | 24 | H |
| 3A | Asana XL | 2.9 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A | Lambda-cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A | Perm-up 3.2EC, Permethrin 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 14 | 12 | H |
| 3A | Tombstone, Tombstone Helios | 1.6 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A+4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 7 | 24 | H |
| 15 | Rimon 0.83EC | 6.0 to 12.0 fl oz/A | novaluron | 14 | 12 | L |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 14 | 12 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Fungicides

## Nematodes

See the Nematodes and Soil Fumigations sections in the Pest Management chapter (including "Nonchemical Management of Nematodes" - certain mustard green cover crops planted in the fall and incorporated prior to planting may offer nematode suppression). Use fumigants listed in the Soil Fumigation section in the Pest Management chapter, or one of the following:

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 1A | Vydate L* | 1.0 to 2.0 gal/A in at least 20 gal/A preplant in-furrow treatment. See label. | oxamyl* | AP | 48 | H |
| 1B | Mocap 6F* | 4.4 fl oz/1000 ft row in 12 inch band over the row at planting. See label. | ethoprop | AP | 48 | H |

## Seed-Piece Treatment

Use certified seed. Keep seed at 65-70°F (18-21°C) for 2-3 weeks before planting to encourage rapid emergence. Plant seed pieces immediately after cutting or store under conditions suitable for rapid healing of the cut surfaces (60-70°F, 16-21°C plus high humidity). Dust seed pieces with fungicides immediately after cutting. Some fungicide seed-piece treatments are formulated with fir or alder bark. Bark formulations have been effective treatments.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| **For *Fusarium* spp.:** | | | | | | |
| M3 | mancozeb 8D[1] | 1.0 lb/cwt | mancozeb | -- | -- | N |
| M3 | Polyram 7D | 1.0 lb/cwt | metiram | -- | -- | N |
| M4 | Captan 7.5D | 1.0 lb/cwt | captan | -- | -- | N |
| **For *Fusarium* spp. and *Rhizoctonia* spp.:** | | | | | | |
| 1+M3+27 | Evolve | 0.75 lb/cwt | thiophanate methyl + mancozeb + cymoxanil | -- | -- | N |
| 1 | Tops 2.5D | 1.0 lb/cwt | thiophanate methyl | -- | -- | N |
| 1 + M3 | Tops MZ 8.5D[1] | 0.75 to 1.0 lb/cwt | thiophanate methyl + mancozeb | -- | -- | N |
| 7 + M3 | MonCoat MZ 7.5D[1] | 0.75 to 1.0 lb/cwt | flutolanil + mancozeb | -- | -- | N |
| 12 | Maxim 0.5D | 0.5 lb/cwt | fludioxonil | -- | -- | N |
| 12 + M3 | Maxim MZ[1] | 0.5 lb/cwt | fludioxonil + mancozeb | -- | -- | N |

[1]Seed-piece fungicides that contain EBDC fungicides or cymoxanil also provide protection against seedborne late blight infections.

## <u>Bacterial and Fungal Diseases</u>

## Bacterial Soft Rot

Prevent wounding and make certain tubers are dry before packing. Free chlorine wash maintained at 25 ppm chlorine or use of a fresh chlorine rinse maintained at 50 ppm chlorine may help reduce soft rot.

## Common Scab

Potato scab is caused by a soil-inhabiting fungus (*Streptomyces scabies*). The disease is suppressed in acid soils and the optimum soil pH for growing scab susceptible varieties is about 5.0-5.2. Scab resistant varieties may be grown at pH 5.5 to 6.2. If lime is needed, apply after potato harvest and before subsequent crops grown in rotation.

Plant scab-free seed potatoes. Use resistant varieties and rotate with small grains, corn, or alfalfa. Avoid rotations using red clover. Maintain adequate soil moisture during and after tuber set. Avoid heavy application of manures.

## *Dickeya diathicola* and *Pectobacterium* spp.

In 2015, *Dickeya dianthicola* was introduced to the Mid-Atlantic region. *Dickeya* is transmitted via infested seed pieces and is thought to have limited survival in our soils. Rotations that contain corn followed by brassicas should be avoided prior to potato planting. Growers should purchase certified seed that has been properly inspected and determined free of *Dickeya*. Fields where *Dickeya* has been confirmed should be avoided for the upcoming year. Growers are reminded to practice sound sanitation practices when handling seed pieces (particularly those not tested for *Dickeya*) to prevent contamination of other potato lots.

## Early Blight

Begin preventative sprays and continue every 7-10 d according to a disease forecasting system where available. If late blight is a threat, then begin sprays when plants are 8 inches tall.

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **Rotate and TANK-MIX one of the following protectant fungicides:** | | | | | | |
| M3 | mancozeb 75DG | 1.5 to 2.0 lb/A | mancozeb | 0 | 12 | N |
| M3 | Polyram 80DF | 2.0 lb/A | metiram | 14 | 24 | N |
| M5 | chlorothalonil 6F | 1.0 to 1.5 pt/A | chlorothalonil | 0 | 12 | N |
| M5 + 22 | Zing! 4.9SC | 32.0 to 34.0 fl oz/A | chlorothalonil + zoxamide | 7 | 12 | N |
| 30 | Super Tin 4L | 3.0 to 6.0 fl oz/A | triphenyltin hydroxide | 7 | 48 | -- |

***WITH one of the following pre-mix fungicides*** - ***table continued on next page***

*Early Blight - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| **WITH one of the following pre-mix fungicides:** | | | | | | |
| M5 + 11 | Quadris Opti 5.5 SC | 1.6 pt/A | chlorothalonil + azoxystrobin | 14 | 12 | N |
| 3 + 11 | Quadris Top 2.72SC | 8.0 to 14.0 fl oz/A | tebuconazole + azoxystrobin | 0 | 12 | -- |
| 3 + 40 | Revus Top 4.16 SC | 5.5 to 7.0 fl oz/A | difenoconazole + mandipropamid | 1 | 12 | M |
| 7 + 9 | Luna Tranquility 4.16SC | 8.0 to 11.2 fl oz/A | fluopyram + pyrimethanil | 7 | 12 | -- |
| 7 + 11 | Priaxor 4.17SC | 4.0 to 8.0 fl oz/A | boscalid + pyraclostrobin | 7 | 12 | N |
| 11 + 27 | Tanos 50W | 6.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| **OR tank mix a protectant fungicide with one of the following single-active ingredient fungicides:** | | | | | | |
| 3 | Quash 50WDG | 2.5 to 4.0 oz/A | metconazole | 1 | 12 | -- |
| 7 | Endura 70WG | 2.5 to 4.5 oz/A | boscalid | 0 | 12 | -- |
| 11 | azoxystrobin 2.08F | 6.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Gem 25WDG | 6.0 to 8.0 oz/A | trifloxystrobin | 7 | 12 | N |
| 11 | Headline 2.1F | 6.0 to 9.0 fl oz/A | pyraclostrobin | 3 | 12 | N |
| 11 | Reason 500SC | 5.5 to 8.2 fl oz/A | fenamidone | 14 | 12 | -- |

## Late Blight

Begin fungicide applications when plants are 6 inches tall and repeat every 7 d or apply fungicides according to a disease forecasting system such as BLITECAST or WISDOM. Monitor for progress of the disease by following local Extension reports or visiting the following website (*http://www.usablight.org/*). When a field contains new late blight infections and harvest is near, vines should be destroyed immediately to help prevent tuber infection.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **One of the following protective fungicides should be applied early in the season PRIOR to occurrence of any disease in the region:** | | | | | | |
| M3 | mancozeb 75DG[1] | 1.5 to 2.0 lb/A[1] | mancozeb | 0 | 12 | N |
| M3 | Polyram 80DF[1] | 2.0 lb/A[1] | metiram | 14 | 24 | N |
| M3 + 22 | Gavel 75DF | 1.5 to2.0 lb/A | mancozeb + zoxamide | 5 | 48 | N |
| M5 | chlorothalonil 6F | 1.0 to 1.5 pt/A | chlorothalonil | 0 | 12 | N |
| M5 + 22 | Zing! 4.9SC | 34.0 gl oz/A | chlorothalonil + zoxamide | 7 | 12 | N |
| **Once late blight is detected in your area, rotate and tank mix one of the following fungicides with a protectant fungicide listed above. Apply on a 7 day schedule as long as conditions are favorable for disease development.** | | | | | | |
| 3 + 40 | Revus Top 4.16SC | 5.5 to 7.0 fl oz/A | difenoconazole + mandipropamid | 1 | 12 | M |
| 11 + 27 | Tanos 50W | 6.0 to 8.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 21 | Ranman 400SC | 1.40 to 2.75 fl oz/A | cyazofamid | 0 | 12 | L |
| 27 | Curzate 60DF | 3.33 oz/A | cymoxanil | 3 | 12 | N |
| 28 | Previcur Flex 6F | 1.2 pt/A | propamocarb HCL | 5 | 12 | N |
| 29 | Omega 500F | 5.5 fl oz/A | fluazinam | 14 | 48 | N |
| 30 | Super Tin 4L* | 3.0 to 6.0 fl oz/A | triphenyltin hydroxide | 7 | 48 | -- |
| 40 | Forum 4.18SC | 4.0 to 6.0 fl oz/A | dimethomorph | 4 | 12 | N |
| 43 | Presidio 4SC | 4.0 fl. oz/A | fluopicolide | 2 | 12 | L |
| U15+M5 | Orondis Opti | 1.75 to 2.5 pt/A | oxathiapiprolin + chlorothalonil | 7 | 12 | -- |

[1]**DO NOT** apply more than a combined total of 15.0 lb/A of mancozeb 75DG or Polyram 80DF per crop

## Leak (*Pythium*) and Pink Rot (*Phytophthora*)

Leak usually enters the tubers through bruises occurring in conjunction with the harvesting of immature tubers during hot weather. Pink rot generally occurs in poorly drained areas. Rotate field out of potatoes for at least 2 yr.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following fungicides in a 6-8 inch band directly over the seed-piece prior to row closure:** | | | | | | |
| 4A + 4 | Platinum Ridomil Gold 1.6E | 2.2 fl oz/1000 ft row | thiamethoxam + mefenoxam | AP | 48 | N |
| 4 | Ridomil Gold 4SL | 0.42 fl oz/1000 ft row | mefenoxam | AP | 48 | N |
| 4 | Ultra Flourish 2E | 0.84 fl oz/1000 ft row | mefenoxam | AP | 48 | N |
| 21 | Ranman (Section 2ee) | 0.42 fl oz/1000 ft row (see label) | cyazofamid | AP | 12 | N |
| **As an alternative, apply one of the following fungicides with as much water as possible for ground applications and a minimum of 5 gal/A for aerial applications. Apply at flowering and 14 d later. If the field has a history of pink rot or leak a third application might be warranted 14 d after that. Be sure to get some coverage of the soil surrounding plants for root uptake to occur.** | | | | | | |
| 4 + M1 | Ridomil Gold Copper 65WP | 2.0 lb/A | mefenoxam + copper | 14 | 48 | N |
| 4 + M3 | Ridomil Gold MZ 68WP | 2.5 lb/A | mefenoxam + mancozeb | 14 | 48 | N |
| 4 + M5 | Ridomil Gold Bravo 76WP | 2.0 lb/A | mefenoxam + chlorothalonil | 14 | 48 | N |

## Rhizoctonia stem canker and black scurf

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations as an in-furrow spray at planting:** | | | | | | |
| 7 | Moncut 70DF | 0.79 to 1.18 oz/1000 ft row | flutolanil | AP | 12 | N |
| 7 + 11 | Elatus 45WG | 0.34 to 0.50 oz/1000 ft row | benzovindiflupyr + azoxystrobin | AP | 12 | N |
| 11 | azoxystrobin 2.08F | 0.4 to 0.6 fl oz/1000 ft row | azoxystrobin | AP | 4 | N |

## Verticillium Wilt

Select fields with a low incidence of wilt. Use resistant varieties where possible. Do not plant tomato, eggplant, or pepper in rotation with potato. The use of Sudangrass in rotation with potato may reduce nematode levels. The use of Mocap will reduce lesion nematode levels in the soil, resulting in less Verticillium wilt.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following through center pivot irrigation in the fall to fallow fields for suppression of Verticillium and lesion nematode:** | | | | | | |
| -- | K-Pam HL* | 30 to 60 gal/A | potassium methyldithiocarbamate | AP | 48 | N |
| -- | Vapam HL* | 37.5 to 70 gal/A | metam-sodium | AP | 48 | N |

## White Mold

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following immediately prior to row closing and repeat 28 d later with a different FRAC code:** | | | | | | |
| 1 | thiophanate-methyl 70WP | 1.0 to 1.5 lb/A | thiophanate methyl | 14 | 12 | N |
| 2 | iprodione 4L AG | 2.0 pt/A | iprodione | 14 | 24 | N |
| 7 | Endura 70WG | 5.5 to 10.0 oz/A | boscalid | 0 | 12 | -- |
| 29 | Omega 500F | 5.5 to 8.0 fl oz/A | fluazinam | 14 | 48 | N |

## Viruses

Numerous seed borne viruses can occur in potato including potato leafroll, potato virus S, potato virus M, and several strains of potato virus Y. There has been an increase in occurrence of the potato virus YN strain in the region. Control these seed borne viruses by obtaining virus-free certified or foundation seed.

# Pumpkins and Winter Squash

## Recommended Varieties[1]

| | | | |
|---|---|---|---|
| **Pumpkins, Less than 1 pound** | WeeeeeOne* (PMR) | **Pumpkins 10 to 20 pounds** | Magic Lantern* (PMT) |
| | Munchkin | | Bus Stop* |
| | Wee-B-Little* | | Magician* (PMR, ZYMVR) |
| | Baby Boo | **Pumpkins More than 20 pounds** | Cronos* (PMT) |
| **Pumpkins 1 to 3 pounds** | Baby Pam | | Howden Biggie |
| | Baby Bear* | | Gladiator* (PMT) |
| | Touch of Autumn* (PMT) | | Aladdin* (PMT) |
| | Rockafellow* (PMT) | | Gold Medal* |
| **Pumpkins 2 to 6 pounds** | Prankster* (PMT) | | Rhea* (PMT) |
| | Cannonball* (hard shell) | | Solid Gold* |
| | Iron Man* (FR, PR, PMT) (hard shell) | | Captain Jack* |
| | Field Trip*(PMT) | **Pumpkins More than 50 pounds** | Atlantic Giant |
| | Orange Smoothie* (hard shell) | | Prizewinner |
| | Hybrid Pam* | **Pumpkins, Ornamental** | Knucklehead* |
| | Fall Splendor Plus*(PMT) | | Goosebumps II* |
| | Mystic Plus* (PMT) (5-6 lbs, plant at closer spacing to reduce size) | **Pumpkins, Processing** | Neck Pumpkin Types |
| | Small Sugar (BRT) | | |
| | Kakai (edible seeds) | | |

| | | | |
|---|---|---|---|
| **Winter Squash Acorn Type** | Table Ace* | **Winter Squash Buttercup Type** | Sunshine*(orange) |
| | Taybelle* (semi bush, PMT) | | Buttercup |
| | Table Gold | | Sweet Mama* |
| | Table Queen | | Bonbon* |
| | Table Star* (PMT) | **Winter Squash Hubbard Type** | Hubbard Types |
| | Autumn Delight* (PMT) | | Boston Marrow Types |
| **Winter Squash Butternut Type** | Butterboy* (restricted vine) | **Spaghetti Squash** | Primavera* |
| | Early Butternut* | | Tivoli* |
| | Metro* (restricted vine, PMR) | | Vegetable Spaghetti |
| | Quantum* | | |
| | Waltham Butternut | **Processing Squash** | Atlas* and Other Butternut Types |

[1]Varieties are listed by maturity within each type, earliest first. *Hybrid varieties. Disease resistance: BRT=Black rot tolerant, FR=*Fusarium* wilt resistant, PMR=Powdery mildew resistant, PMT=Powdery mildew tolerant, PR=*Phytophthora* resistant, ZYMVR=Zucchini yellow mosaic virus resistant.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Pumpkins and Winter Squash[1] | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 50-100 | 150 | 100 | 50 | 0[2] | 200 | 150 | 100 | 0[2] | Total nutrient recommended |
| | 25-50 | 150 | 100 | 50 | 0[2] | 200 | 150 | 100 | 0[2] | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress when vines start to run |

[1]For crops grown on plastic mulch, fertilization rates are based on a standard row spacing of 6 ft.
[2]In VA, crop replacement values of 25 lb/acre of $P_2O_5$ and 50 lb/acre of $K_2O$ are recommended on soils testing Very High.

**Seed Treatment** Check if seed has been treated with an insecticide and fungicide. See Disease Control below.

## Planting and Spacing

Seed or transplant in the field between June 15 and July 5 in cooler areas, and between June 15 and July 15 in warmer, southern areas. Base plant spacing on vine habit and average fruit size of the variety. **Note**. Fruit size may be decreased at closer spacings.

**Small vine/bush with fruit less than 8 lbs**: Rows 5-6 ft apart with 2 ft between plants in the row.
**Large/medium vine with fruit 8-15 lbs**: Rows 6-7.5 ft apart with 3-4 ft between plants in the row.
**Large vine with fruit 12 to 25 lbs**: Rows 7.5-9 ft apart with 4 ft between plants in the row.
**Large vine with fruit over 30 lbs**: Rows 10-12 ft apart with 5-6 ft between plants in the row.

## Conservation Tillage (No-Till) Pumpkins

Seed or transplanted no-till pumpkins planted into small grain cover crop or stubble, hairy vetch, or fallow ground has produced commercially acceptable yields. A cover crop on the soil surface will reduce dirty pumpkins at harvest, provide some weed suppression, and minimize fruit rot by creating a barrier between pumpkins and the soil. Since cultivation is not an option in a no-till planting system and few post-emergence herbicides are available to control escaped weeds, choose fields carefully for no-till production. The performance of residual preemergence herbicides depends on rainfall or overhead irrigation for activation. Moisture for activation is more critical in no-till fields consisting of a trash or straw layer. Postemergence, control grasses with Poast or Select, and use Sandea to control yellow nutsedge and certain annual broadleaf weeds. Sandea is an ALS inhibitor (Group 2), and is at high risk for weed resistance development. ALS resistant weed biotypes have been identified for common ragweed, common cocklebur, Palmer amaranth, and other pigweed species in the mid-Atlantic region. Sandea will NOT control certain pigweed species, common lambsquarters, annual morningglory, Eastern black nightshade, or any ALS resistant weed. Suggested cultural procedures are outlined below. **Not recommended in NJ due to the high risk of weed resistance development and the lack of postemergence control options for certain pigweed species, common lambsquarters, annual morningglory, Eastern black nightshade, or any ALS resistant weed.**

## Cover Crop Establishment and Weed Management

**Small grain stubble provides an ideal crop-mulch for pumpkins**. Make sure the combine distributes straw uniformly. No other manipulation of the residue is required before planting pumpkins. An alternative crop-mulch is hairy vetch; seed in the fall 3-4 weeks before the average frost date at the rate of 20-25 lb/A with a grain drill or broadcast spreader. On sloping ground, mix a winter-killed variety of spring oats (0.5 bushel/A) with the vetch to decrease the time required for ground cover to reduce soil erosion. Adjust soil pH before vetch is seeded as tillage will not be performed before pumpkin planting. Application of P and K before seeding vetch is optional, depending on soil test results.

**Soil moisture prior to planting is a critical factor for successful establishment of pumpkins.** The living, hairy vetch cover crop may remove soil moisture and prevent pumpkin germination and growth. If irrigation is not available, kill the vetch 10-14 days prior to planting in order for rainfall to provide adequate soil moisture for seeding or transplanting. If rainfall is excessive, hairy vetch may remove water to facilitate timely planting. Irrigation will eliminate the concerns about soil moisture for pumpkin seeding and germination.

## Termination Of The Cover Crop

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **9** | Roundup PowerMax 4.5L<br>“Generic” glyphosate 3L | 16 to 32 fl oz/A<br>24 to 48 fl oz/A | **glyphosate** | 0.75 to 1.13 lb acid equivalent/A | -- | 4 |
| -Allow at least 3 days between application and planting. Some glyphosate formulations may require an adjuvant, refer to label.<br>-Glyphosate is not very effective for control of hairy vetch.Glyphosate is preferred for the control of grasses.<br>-Glyphosate-resistant horseweed is widespread in the region. To prevent herbicide resistance, avoid repeated annual applications of glyphosate. Repeat applications are allowed, with maximum application of 5.3 qt/A per year. | | | | | | |
| 22 | **Gramoxone 2SL** | 2.4 to 4 pt/A | **paraquat *** | 0.6 to 1 lb/A | -- | 24 |
| -Apply 10-14 days before planting, followed by a second application after seeding but before pumpkin seedlings emerge or before transplanting. Always include an adjuvant (nonionic surfactant or crop oil concentrate).<br>-Tank-mix with appropriate herbicides for residual weed control; see Weed Control For Seeding Into Soil Without Plastic Mulch.<br>-Paraquat may not control established grasses. Spray coverage is essential for optimum control.<br>-See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |

## Pumpkin Planting

See the herbicide recommendations for pumpkins for further discussion. Use "no-till" corn planters equipped with coulters to cut through straw or cover crop stems killed by contact herbicides. Planters with finger pickup or air/vacuum units function well for seeding pumpkins. Plate planters may damage seed and should be evaluated carefully before use. Cole plate planters are satisfactory. A disk coulter on the seeding unit is essential to cut through the vetch or straw stems. Mount a 3-inch wide waffle coulter ahead of pot-transplanters to provide for effective penetration of the cover crop and plant placement.

## Fertility

Hairy vetch will normally supply all the N requirements for pumpkins. However, if N deficiency symptoms appear before fruit production, topdress with 20-30 lb N/A. P and K amendments can be applied (based on soil tests) to the soil surface before planting cover crop or before planting pumpkins. When planting pumpkins into non-legume cover crops for grain stubble, apply the recommended P, K, lime, and other nutrients based on soil tests before planting. N rate recommendations may need to be increased based on fertilizer source, fertilizer application method, crop residue amount, and amount of time in a conservation tillage (no-till) production system. See Conservation Tillage Crop Production in the General Production Recommendations chapter.

## Pollination

Honeybees, squash bees, bumblebees and other wild bees are important for proper set and pollination. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See Pollination section in the General Production Recommendations chapter and/or the pesticide tables below for relative toxicity to bees.

## Harvesting and Post Harvest Considerations

Disease-free fruit following a regular fungicide program during crop production will minimize postharvest fruit rots. Harvest when fruits are mature and prior to frost. Use care in handling fruit to prevent wounds. **Wounding can negate benefits from a season-long fungicide program.** Cure fruit after harvest at temperatures between 80 and 85°F (27-29°C) with a relative humidity of 75-80% for approximately 10 days. Temperatures below 50°F (10°C) cause chilling injury.

The hard-shelled squashes, such as Butternut, Delicious, Spaghetti, and the Hubbard strains, can be stored at 55°F (13°C) and 50-70% relative humidity. Acorn squash will store for 5-8 weeks; pumpkins for 2-3 months and other hard-shelled squashes will store for 3 months except hubbard that may hold for 5-6 months. Remove squash from the field before they have chilling injury and do not allow fruits to be exposed to extended periods below 50°F (10°C). Handle fruits carefully to eliminate bruising or damage and remove stems from squash like butternuts that can damage adjacent fruit. Store winter squash in a cool, dry, well-ventilated area. The longer keeping winter squash types can be kept in saleable condition through late winter into spring (3-6 months). Research has not documented any benefit to post-harvest fruit fungicide dips.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

## Labeled Applications Sites for Pumpkins

| | | Plastic mulch production | | | | | | Bare-ground production | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil-Applied | | Postemergence | | | | | | |
| **Herbicides** | WSSA group number | Under Plastic | Row Middles | Over Plastic | Row Middles | Post-Harvest | | Soil-applied | POST | Post-harvest |
| Sandea | 2 | | YES | | YES | | | YES | YES | |
| Curbit | 3 | | YES | | | | | YES | | |
| Prefar | 8 | YES | YES | | | | | YES | | |
| Command | 13 | | YES | | | | | YES | | |
| Strategy | | | YES | | | | | YES | | |
| Reflex | 14 | | YES | | YES | | | YES | | |
| Dual | 15 | | YES | | | | | YES* | | |
| Select | 1 | | | YES | | | | | YES | |
| Select Max | 1 | | | YES | | | | | YES | |
| Poast | 1 | | | YES | | | | | YES | |
| Gramoxone | 22 | | | | YES | YES | | | | YES |

*Dual and Reflex are labeled for bareground only if the spray is directed to the row middles.

## 1. Soil-Applied

| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
|---|---|---|---|---|---|---|
| **2** | Sandea 75DF | 0.5 to 1 oz/A | **halosulfuron** | 0.023 to 0.047 lb/A | 30 | 12 |
| -**Plasticulture** row middles application only: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v or include a non-selective herbicide.<br>-**Bareground**: apply broadcast after seeding but before crop emergence or no sooner than 7 days before transplanting.<br>-Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field.<br>-**Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season. | | | | | | |
| 3 | Curbit 3EC | 1 to 3 pt/A | **ethalfluralin** | 0.38 to 1.13 lb/A | -- | 24 |
| -**Plasticulture**: row middles only: apply as a banded spray after crop emergence or transplanting. **Do not** soil incorporate.<br>-**Bareground**: apply broadcast after direct-seeding but prior to crop emergence; **do not** use on transplanted pumpkins.<br>-Controls annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp.<br>-Use lower rate for coarse-textured soils or soils with low organic matter.<br>-Where overhead irrigation is available, activate Curbit with 0.5 inch of irrigation within 2 days after application; if no irrigation or rainfall occurs within 5 days of application, activity of Curbit can be reduced.<br>-Available as a pre-mix herbicide Strategy. Strategy at 3 pt/A= Curbit at 26 fl oz (0.6 lb ai) and Command at 8 fl oz (0.188 lb ai)<br>-Maximum applications per season: not specified | | | | | | |
| 3 + 13 | Strategy 2.1SC | 1.5 to 6 pt/A | **ethalfluralin *plus* clomazone** | 0.39 to 1.58 lb/A | 45 | 24 |
| -**Plasticulture**: row middles application only.<br>-**Bareground**: apply broadcast just before planting or after planting but before crop emergence.<br>-Strategy is a prepackage mixture of Curbit 3EC and Command 3ME. Refer to individual products for comments.<br>-**Do not** apply prior to planting crop. **Do not** soil incorporate.<br>-Maximum applications per season: not specified. | | | | | | |
| 8 | Prefar 4E | 5 to 6 qt/A | **bensulide** | 5 to 6 lb/A | -- | 12 |
| -**Plasticulture**: under plastic: apply in a band under the plastic, immediately before laying the mulch. Plasticulture: row middles application is labeled.<br>-**Bareground**: apply preemergence or preplant incorporated. Preemergence applications should be followed by irrigation within 36 hrs (apply enough water to wet the soil at leat 2 to 4 inches deep). Preplant incorporated applications should be incorporated 1 to 2 inches deep (deeper than 2 inches will result in reduced weed control).<br>-Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters.<br>-Maximum applications per season: not specified. | | | | | | |

*1. Soil-Applied continued on next page*

*1. Soil-Applied - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 13 | Command 3ME | 0.67 to 2 pt/A | **clomazone** | 0.0.25 to 0.75 lb/A | 45 | 12 |

- **Labeled for winter squash and processing pumpkins; not labeled for jack-o-lantern pumpkins.**
- **Plasticulture**: row middles application only. **Bareground**: apply broadcast just before planting but before crop emergence, or just before transplantings. Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops.
- Controls annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Carpetweed, morningglory sp., pigweed sp., and yellow nutsedge will not be controlled. Higher rates will improve control (or expand number of species controlled) such as common cocklebur, common ragweed, or jimsonweed (refer to label for specific weeds and rates).
- **WARNING**: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application (refer to label for restrictions).
- Available as a pre-mix herbicide Strategy: Strategy at 3 pt/A= Command at 8 fl oz (0.188 lb ai) and Curbit at 26 fl oz (0.6 lb ai)
- Maximum number of Command applications per year: 1.

| | | | | | | |
|---|---|---|---|---|---|---|
| **14** | Reflex 2SL | Rates vary, refer to the specific label | **fomesafen** | 0.13 to 0.38 lb/A | 32 | 24 |

- **For pumpkins ONLY. A Special Local-Needs Label 24© has been approved for the use of Reflex 2SL to control weeds in pumpkins in DE, MD and VA. The use of this product is legal ONLY if a waiver of liability has been completed (see *http://www.farmassist.com/*).**
- Rates differ by states, soil types, and planting method. Rates as low as 10 fl oz/A caused injury on coarse-textured soils.
- **Plasticulture**: row middles application only.
- **Bareground**: apply broadcast within 24 hrs after direct-seeding and follow with 0.2 to 0.5 inches of overhead irrigation at least 36 hr before pumpkin begin to crack through the soil. For transplants, apply Reflex and then irrigate with 0.2 to 0.5 inches of water and then transplant. **Do not** prepare transplant holes until after Reflex application and irrigation.
- Foliar application of Reflex will severely damage or kill pumpkin. The potential of crop injury is greater on lighter textured soils combined with intensive irrigation programs or high amounts of rainfall, therefore, adjust rates accordingly.
- Reflex provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. **Pumpkin varieties may vary in their response to Reflex**. Treat small acreages first to determine tolerance, especially when applying to a new variety.
- Reflex rates lower than 16 fl oz/A should be used with other herbicides and/or other methods of weed control.
- Consider rotational crops when applying fomesafen. If crop is replanted, **do not** re-apply Reflex. Refer to 24(c) label for specifics on rotational restrictions.
- Maximum for Reflex application in DE, MD, and VA: 24 fl oz/A **IN ALTERNATE YEARS.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 15 | Dual Magnum 7.62E | 1 to 1.33 pt/A | **s-metolachlor** | 0.95 to 1.27 lb/A | 30 | 24 |

- **For pumpkins ONLY. Plasticulture**: row middles application only. **Bareground**: apply as an inter-row or inter-hill spray, leaving 1 ft of untreated area over the row. **Do not** use as an over the top application. **Do not** soil incorporate.
- Suppresses or controls annual grasses, yellow nutsedge, and certain annual broadleaf weeds including nightshade species.
- Dual Magnum will not control emerged weeds. Cultivate and/or hoe or tank-mix with Gramoxone 2SL to control emerged weeds before treatment.
- Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter. Maximum applications per season: not specified.

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>12 to 16 fl oz/A | **clethodim** | 0.094 to 0.13 lb/A | 14 | 24 |
| | Poast 1.5EC | 1 to 1.5 pt/A | **sethoxydim** | 0.19 to 0.28 lb/A | 3 | 12 |

- **Postemergence as broadcast spray with both plasticulture and bareground**
- **Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.
- Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.
- If repeat applications are necessary, allow 14 days between applications.
- **Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. Rainfastness is 1 hr.
- **Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 64 fl oz/A for the season.
- **Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 3 pt/A for the season.

*2. Postemergence continued on next page*

*2. Postemergence - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| **2** | Sandea 75DF | 0.5 to 1 oz/A | **halosulfuron** | 0.023 to 0.047 lb/A | 30 | 12 |
| -**Plasticulture**: row middles application only.<br>-**Bareground**: broadcast for bareground. Apply Sandea after the crop has at least 3 to 5 true leaves but before first female flowers appear and no sooner than 14 days after transplanting. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v.<br>-Suppresses or controls yellow nutsedge and certain broadleaf; control of weeds taller than 3 inches may not be adequate. Sandea will not control common lambsquarters or eastern black nightshade if applied postemergence; for row middle application, tankmix with a non-selective herbicide to increase spectrum of control.<br>-Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field. **Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Rainfastness is 4 hrs.<br>-Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season | | | | | | |
| 22 | Gramoxone 2SL | 1.95 pt/A | **paraquat*** | 0.49 lb/A | 14 | 24 |
| -**A Supplemental Label has been approved for the use of Gramoxone 2SL for postemergence weed control in DE, MD, NJ, PA, and VA.**<br>-Row middles as a shielded application. Apply as a directed spray in a minimum of 20 gal spray mix/A to control emerged weeds between the rows after crop establishment. Include a nonionic surfactant at 0.25% v/v.<br>-Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings.<br>-Rainfastness is 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |

**3. Postharvest**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone 2SL | 2.25 to 3 pt/A | **paraquat** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 until December 31, 2017, for postharvest desiccation of the crop in DE, NJ and VA.** Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

**4. Other Labeled Herbicides** These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| **9** | Roundup (various) | **glyphosate** |
| **14** | Aim EC | **carfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Insecticides

### Seed Corn Maggots

The use of neonicotinoid insecticides (Group 4A) at planting may help reduce seed corn maggot populations. See also the Pest Management chapter (Insect Mangement section).

### Aphids

Aphids transmit mosaic virus.

**Apply one of the following formulations:**
**Note: Thorough spray coverage beneath leaves is important. Treat seedlings every 5-7 days, or as needed.**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |

*Aphids continued on next page*

*Aphids - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4A | Admire PRO 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Assail 30G | 2.5 to 4.0 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam+chlorantraniliprole -**soil/drip** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam+chlorantraniliprole - **foliar** | 1 | 12 | H |
| 4D | Sivanto 200SL | 7.0 to 12.0 fl oz/A | flupyradifurone | 1 | 12 | M |
| 9B | Fulfill 50WDG | 2.75 oz/A | pymetrozine | 0 | 12 | L |
| 9C | Beleaf 50SG | 2.0 to 2.8 oz/A | flonicamid | 0 | 12 | L |
| 28 + 6 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cabbage Loopers

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 3A | Baythroid XL 1EC | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Danitol 2.4EC | 10.67 to 16.0 fl oz/A | fenpropathrin* | 7 | 24 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 11A | Dipel (OMRI) | 0.5 to 2.0 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 2.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole - **soil/drip/foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 7.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cucumber Beetles

Young plants need to be protected from cucumber beetle feeding as the beetles commonly carry bacterial wilt bacteria on their mandibles. Cucumber beetles also cause direct damage to pumpkin and winter squash rinds. Fall treatments with foliar insecticides may also reduce the incidence of black rot. Seeds pretreated with a neonicotinoid seed treatment such as Farmore DI400 should provide up to 14 days of control of cucumber beetle. Otherwise, apply one of the following formulations:

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Sevin XLR Plus | 1.0 qt/A | carbaryl | 3 | 12 | H |
| 3A | Baythroid XL 1EC | 2.4 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Danitol | 10.67 to 16.00 fl oz/A | fenpropathrin* | 7 | 24 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |

*Cucumber Beetles continued on next page*

*Cucumber Beetles - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A | Tombstone 2EC | 2.4 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Admire PRO 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Venom 70SG | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.o to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |

## Cutworms - See alse the Pest Management chapter, Insect Management section.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 3A | Baythroid XL 1EC | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 1.28 to 4.00 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 6.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |

## Leafminers

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 6.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant 1SC | 6.0 to 10.0 fl oz/A | spinetroram | 1 | 4 | H |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 17 | Trigard 75WSP | 2.66 oz/A | cyromazine | 0 | 12 | L |
| 28 | Coragen 1.67SC | 5.0 to 7.5 fl oz/A | chlorantraniprole - **soil/drip/foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10. 0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Pickleworms and Melonworms

When using foliar materials make one treatment prior to fruit set, and then treat weekly. For soil or drip applications check the label for instructions on treatment frequency.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Sevin XLR Plus | 0.5 to 1.0 qt/A | carbaryl | 3 | 12 | M |
| 3A | Baythroid XL | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL (pickleworm) | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 2.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC (melonworm) | 2.0 to 3.5 fl oz/A | chlorantraniliprole - **drip/foliar** | 1 | 4 | L |
| 28 | Coragen 1.67SC (pickleworm) | 3.0 to 7.5 fl oz/A | chlorantraniliprole - **drip/foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Mites

Mite infestations generally begin around field margins and grassy areas. **DO NOT** mow or maintain these areas after midsummer to prevent mites from moving into the crop. Localized infestations can be spot-treated. Begin treatment when 10-15% of the crown leaves are infested early in the season.

| Apply one of the following formulations:<br>Note: Continuous use of carbaryl or pyrethroids may result in mite outbreaks. Addition of crop oils or organosilicon spray additives will increase miticide effectiveness. | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 10B | Zeal Miticide | 2.0 to 3.0 oz/A | etoxazole | 7 | 12 | L |
| 20D | Acramite 50WS | 0.75 to 1.00 lb/A | bifenazate | 3 | 12 | M |
| 23 | Oberon 2SC | 7.0 to 8.5 fl oz/A | spiromesifen | 7 | 12 | M |
| 28 + 6 | Minecto Pro | 5.5 to 10. 0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Rindworms

Damage to the rinds may result from a complex of insect pests including cucumber beetle, wireworms, and a number of “worm” species, (beet armyworm, etc). Management of adult cucumber beetles early in the season may help reduce damage. See cucumber beetle section for labeled products.

| For Lepidopteran rindworms, apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Baythroid XL 1EC | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |

*Rindworms continued on next page*

*Rindworms - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |

## Squash Bugs

Begin treatments if more than one egg mass per plant is present. Sprays should target nymphal stages.

| **Apply one of the following formulations: Note: Under-leaf spray coverage is essential.** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin XLR Plus | 1.0 qt/A | carbaryl | 3 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethin + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Assail 30SG | 5.3 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4D | Sivanto 200SL | 10.5 to 14.0 fl oz/A | flupyradifurone | 1 | 12 | -- |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |

## Squash Vine Borers

When vines begin to run, apply to bases of plants 4 times at 7-day intervals. Pheromone traps for squash vine borer are commercially available. These traps can be used to indicate when moth activity begins. Note: Use of spinosad or spinetoram for Cabbage Looper control will reduce squash vine borer populations.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Assail 30SG | 5.3 oz/A | acetamiprid | 0 | 12 | M |

## Thrips

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A+ 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Admire PRO 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.o to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 6.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 6.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |

## Whiteflies

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 4A | Admire PRO 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 9 .0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.o to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 4D | Sivanto 200SL | 7.0 to 10.5 fl oz/A | flupyradifurone | 1 | 12 | M |
| 7C | Knack | 8.0 to 10.0 fl oz/A | pyriproxyfen | 7 | 12 | L |
| 9B | Fulfill 50WDG | 2.75 oz/A | pymetrozine | 0 | 12 | L |
| 9C | Beleaf 50SG | 2.8 oz/A | flonicamid | 0 | 12 | L |
| 23 | Oberon 2SC | 7.0 to 8.5 fl oz/A | spiromesifen | 7 | 12 | M |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

**Nematodes -** See also the Soil Fumigation and Nematodes sections in the Pest Management chapter. Use fumigants listed in the Pest Management chapter, or nematicides listed below. Consult the label.

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 1A | Vydate L | 0.5 to 1.0 gal/A incorporate into top 2-4 inches of soil, *OR* 2.0 to 4.0 pt/A apply 2 w after planting and repeat 2-3 w later. | oxamyl* | 1 | 48 | H |
| 7 | Velum Prime | 6.5 to 6.84 fl oz/A | fluopyram | 0 | 12 | -- |
| -- | Nimitz 4EC | 3.5 to 5.0 pt/A Incorporate or drip-apply 7 d before planting | fluensulfone | n/a | 12 | N |

## Seed Treatment

Check with your seed company if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 480DP (4.5 fl oz/100 lb seed) and an approved commercially available insecticide.

## Damping-Off caused by Phytophthora, Pythium, and Rhizoctonia

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following at-planting (see label for application timing, methods, and restrictions):** | | | | | | |
| **Phytophthora and Pythium root rot** | | | | | | |
| **4** | Ridomil Gold 4SL[1] | 0.5 to 1.0 pt/A | mefenoxam | AP | 48 | N |
| **4** | Ultra Flourish 2E[1] | 2.0 to 4.0 pt/A | mefenoxam | AP | 48 | N |
| **4** | MetaStar 2EAG[1] | 4.0 to 8.0 pt/A | metalaxyl | AP | 48 | N |
| **Phytophthora, Pythium, and Rhizoctonia root rot** | | | | | | |
| **4** + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence. | mefenoxam + azoxystrobin | AP | 0 | N |
| **Rhizoctonia root rot** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | AP | 4 | N |
| **Pythium root rot only** | | | | | | |
| 28 | Previcur Flex 6F | 1.2 pt/A in transplant water, drip irrigation, or direct spray at base of plant and soil | Propamocarb HCL | 2 | 12 | N |

[1]To determine the amount of Ridomil Gold, Ultra Flourish, or MetaStar needed per acre, use the following calibration formula for changing from broadcast to band application: [Band width (ft) / row spacing (ft)] x broadcast rate (lb/A) = Amount needed lb/A. [2]Applied at planting.

# Bacterial and Fungal Diseases

## Angular Leaf Spot/Bacterial Leaf Spot

Both diseases can produce foliar symptoms that are often overlooked. Early detection is important, since control of the foliar phase can reduce infections in developing fruit. Infected fruit will become unmarketable. Both diseases are seedborne and can survive on infested debris for at least one year or until the debris decomposes. Rotate away from fields with a history of bacterial problems. Incorporate the following into a standard disease management program when leaf spot is first detected, and repeat every 7 to 10 days: fixed copper at labeled rates plus mancozeb.

**Anthracnose** - see Gummy Stem Blight (Black Rot) and Anthracnose below.

## Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See "Cucumber Beetles" in the Cucumber Insect Control section for specific recommendations. Insecticide applications made at planting may not prevent beetle damage season-long; additional foliar insecticide applications may be necessary.

## Choanophora fruit rot

This disease occurs during warm wet weather and develops predominantly on flowers or fruit near the ground. Management is difficult because disease development is rapid and weather dependent. Fungicide sprays are not effective because flowers, which open daily, must be protected immediately. Practices that reduce soil moisture or reduce flower-soil contact, such as raised beds and plastic mulch, may be beneficial.

## Downy Mildew

Scout fields for disease incidence on a regular basis. Begin targeted sprays when downy mildew is predicted for the region. For current status of the disease, check the Cucurbit Downy Mildew forecasting website at *http:cdm.ipmpipe.org/*. Preventative applications are much more effective than applications made after disease is detected. Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.

*Downy Mildew continued on next page*

*Downy Mildew - continued*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Sprays should be applied on a 7-d schedule when disease is forecast or present in the region. Under severe disease conditions and conducive weather, spray interval may be reduced IF the label allows. TANK-MIX one of these products WITH a protectant fungicide such as chlorothalonil 6F or Gavel 75DF:** | | | | | | |
| U15+40 | Orondis Ultra | 5.5 to 8.0 fl oz/A | oxathiapiprolin + mandipropamid | 0 | 4 | -- |
| 21 | Ranman 400SC | 2.10 to 2.75 fl oz/A (plus a non-ionic or organosilicon surfactant; **do not** apply with copper; see label) | cyazofamid | 0 | 12 | L |
| **Other materials for use in rotations as tank mix partners with a protectant:** | | | | | | |
| 43 | Presidio 4SC | 3.0 to 4.0 fl oz/A | fluopicolide | 1 | 12 | L |
| 28 | Previcur Flex 6F | 1.2 pt/A | propamocarb | 2 | 12 | N |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | acetoctradin + dimethomorph | 0 | 12 | -- |
| M3 + 22 | Gavel 75DF contains protectant | 1.5 to 2.0 lb/A | zoxamide + mancozeb | 5 | 48 | -- |
| M5 + 22 | Zing! 4.9SC contains protectant | 36 fl oz/A | chlorothalonil + zoxamide | 0 | 12 | N |
| M5 + 27 | Ariston 42SC contains protectant | 3.0 pt/A | chlorothalonil + cymoxanil | 3 | 12 | -- |
| 11 + 27 | Tanos 50DF | 8.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 27 | Curzate 60DF | 3.2 oz/A | cymoxanil | 3 | 12 | N |
| 40 | Forum 4.17SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |

## Fusarium Fruit Rot

This disease is especially destructive in fields where pumpkins are grown every year. Once the pathogen is established in a field, loss can be significant. Fruit rot is caused by several Fusarium spp., and fungicide applications are not effective. Hard rind cultivars are less susceptible to Fusarium fruit rot than other cultivars. Production of pumpkin on a no-till cover crop mulch layer such as winter rye plus hairy vetch has been shown to help reduce disease incidence. Greater disease reductions will occur when the mulch layer is thicker.

## Gummy Stem Blight (Black Rot) and Anthracnose

Rotate crops to allow at least 2 years between cucurbit plantings. Pumpkin cv. 'Small Sugar' appears to be the least affected by Black Rot.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Fungicides with a high-risk for resistance development, such as FRAC code 11 fungicides (Cabrio, Pristine and Quadris), should be tank-mixed with a protectant fungicide. Use at least the minimum labeled rate of each fungicide in the tank-mix. Do not apply FRAC code 11 fungicides more than 4 times total per season. If resistance to FRAC code 11 fungicides exists in the area, use fungicides from a different FRAC code. Begin the following fungicide program when fruit start to form: ALTERNATE:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A (use low rate early in season) | chlorothalonil | 0 | 12 | L |
| **WITH one of the following:** | | | | | | |
| 3 | tebuconazole 3.6 F | 8.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3 | Proline 480SC | 5.7 fl oz/A | prothioconazole | 7 | 12 | -- |
| 3 + 9 | Inspire Super 2.8F | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodinil | 0 | 12 | -- |
| 3 + 7 | Luna Experience 3.34SC | 10.0 to 17.0 fl oz/A | fluopyram + tebuconazole | 7 | 12 | -- |
| 7 | Fontelis 1.67SC | 12.0 to 16.0 fl oz/A | penthiopyrad | 1 | 12 | L |
| 9 + 12 | Switch 62.5 WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 1 | 12 | N |
| 3 + 11 | Aprovia Top 1.62EC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflupyr | 0 | 12 | N |
| 7 + 11 | Merivon 500SC | 5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 7 + 11 | Pristine 38WG | 12.5 to 18.5 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |
| **Maintain fungicide schedule until harvest (see "Harvesting and Postharvest Considerations" section). Fungicide application for Black Rot control will help maintain "handles" on the fruit. Harvest carefully because wounding can negate benefits from a season-long fungicide program.** | | | | | | |

## Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Rotate away from susceptible crops (such as peppers, eggplants, tomatoes, lima and snap beans, and other cucurbits) for as long as possible. Preplant fumigants will also suppress disease. Fields should be adequately drained to ensure that water does not accumulate around the base of the plant. Once the canopy closes, subsoil between the rows to allow for faster drainage following rainfall. Materials with different modes of action (i.e. FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations pre-plant for early season control:** | | | | | | |
| 4 | MetaStar 2E | 4.0 to 8.0 pt/A | metalaxyl | AP[2] | 48 | N |
| 4 | Ridomil Gold 4SL | 4.0 to 8.0 pt/A | mefenoxam | 5 | 48 | N |
| 4 | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | 5 | 48 | N |
| 4 + 11 | Uniform 3.66SE | 0.34 fl oz/100 ft row | mefenoxam + azoxystrobin | AP[2] | 0 | -- |
| 28 | Previcur Flex 6F | 1.2 pt/A in transplant water, drip irrigation, or spray directed to the base of the plants and soil. | propamocarb | 2 | 12 | N |
| **Apply one of the following fungicides and tank mix with fixed copper at labeled rates when conditions favor disease development (for suppression only):** | | | | | | |
| U15 + 40 | Orondis Ultra | 5.5 to 8.0 fl oz/A | oxathiapiprolin + mandipropamid | 0 | 4 | -- |
| 21 | Ranman 400SC | 2.75 fl oz/A (plus a non-ionic or organosilicon surfactant; **do not apply** with copper, see label) | cyazofamid | 0 | 12 | L |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | acetoctradin + dimethomorph | 0 | 12 | -- |
| 40 | Revus 2.08F | 8.0 fl oz/A | mandipropamid | 0 | 4 | -- |
| 11 + 27 | Tanos 50DF | 8.0 to 10.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 40 | Forum 4.17SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |
| 43 | Presidio 4SC | 4.0 fl oz/A | fluopicolide | 2 | 12 | L |

## Plectosporium Blight (Microdochium blight)

Research has shown that no-till pumpkin production may reduce disease. Rotate with crops other than cucurbits. It is important to achieve maximum foliage coverage with each fungicide application. Scout fields regularly.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Once symptoms appear on petioles or as fruit begins to form, apply one of the following and repeat every 7-10 days:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |
| 3 + 11 | Quadris Top 2.7F | 12.0 to 14.0 fl oz/A | difenoconazole + azoxystrobin | 0 | 12 | -- |
| **A spray schedule that alternates Cabrio or Flint with chlorothalonil will also provide control.** | | | | | | |

## Powdery Mildew

Some varieties have resistance or tolerance to powdery mildew and should be used if possible (see table Recommended Varieties above). The fungus that causes cucurbit powdery mildew has developed resistance to high-risk fungicides. In the Eastern US, resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides has been reported. Proper fungicide resistance management should be followed to help delay the development of resistance and minimize control failures.

Powdery mildew generally occurs from mid-July until the end of the season. Development on tolerant varieties will vary from year to year. Planting tolerant varieties will help delay the development of powdery mildew and improve the performance of fungicides. If powdery mildew has become well established in the mid- to late part of the season, only apply protectant fungicides such as chlorothalonil or sulfur. Make first application when powdery mildew is observed in the area or is detected by scouting (one lesion on the underside of 45 old leaves per acre).

*Powdery Mildew continued on next page*

*Powdery Mildew - continued*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **TANK MIX one of these products with a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| U6 | Torino 0.85SC | 3.4 fl oz/A | cyflufenamid | 0 | 4 | -- |
| U8 | Vivando 2.5SC | 15.4 fl oz/A | metrafenone | 0 | 12 | -- |
| 3 + 7 | Luna Experience 3.34SC | 10.0 to 17.0 fl oz/A | fluopyram + tebuconazole | 7 | 12 | -- |
| 13 | Quintec 2.08SC | 6.0 fl oz/A | quinoxyfen | 3 | 12 | -- |
| **AND ALTERNATE with fungicides from different FRAC codes with a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| 3 | tebuconazole 3.6F | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3 | Procure 480SC | 4.0 to 8.0 fl oz/A | triflumizole | 0 | 12 | N |
| 3 | Proline 480 SC | 5.7 fl oz/A | prothioconazole | 7 | 12 | -- |
| 3 | Rally 40WSP | 5.0 oz/A | myclobutanil | 0 | 24 | N |
| 3 + 9 | Inspire Super 2.8F | 16.0 fl oz/A | difenoconazole + cyprodinil | 0 | 12 | -- |
| 3 + 11 | Aprovia Top 1.62EC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflupyr | 0 | 12 | N |
| 7 | Fontelis 1.67SC | 12.0 to 16.0 fl oz/A | penthiopyrad | 1 | 12 | L |
| 7 + 11 | Pristine 38WG | 12.5 to 18.5 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |
| **OR WITH (Note: Sulfur may injure plants**, especially at high temperatures. Certain varieties can be more sensitive. Consult the label for precautions). | | | | | | |
| M2 | Micronized Wettable Sulfur 80W | 4.0 lb/A | sulfur | -- | 24 | N |

## Scab

Select scab-resistant varieties. The fungus that causes scab typically occurs during periods of cool, wet weather when temperatures are below normal. Rotate away from fields with a history of scab for at least 2 years.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Begin sprays as true leaves form and repeat every 5 to 7 days:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |

## Viruses (WMV2, PRSV, ZYMV, and CMV)

The most prevalent virus in the mid-Atlantic region is WMV2, followed by PRSV, ZYMV, and CMV. An easy method for mitigating potential losses are to plant varieties with resistance packages to multiple viruses whenever possible. Plant fields as far away from existing cucurbit plantings as possible to help reduce aphid transmission of viruses.

# Radishes, Rutabagas and Turnips

**Radishes** are a quick-growing, cool-season crop, that develops its best quality (small tops and well-shaped roots) when grown at 50-65°F (10-18°C) in medium to short day lengths. Crop must be grown rapidly (23-28 days) with adequate soil moisture. When growth is checked, the radish becomes hot, tough, and pithy. Long days (15 hours) and warm temperatures induce seed-stalk formation.

**Rutabagas** and **Turnips** are cool-season crops that develop their best root growth at 40-60°F (4-16°C). They can be grown in spring or fall. Rutabagas require 90 days to mature so spring crops must be planted as early in the season as possible. Early maturing turnip varieties can be harvested in 40 days, but late maturing varieties in 75 days. As biennial plants, both rutabagas and turnips with be induced to flower after exposure to cool temperatures in spring planted crops or if fall crops are left to regrow over winter. Seed stalk formation will stop root development rendering them unsalable.

## Recommended Varieties[1]

| | | |
|---|---|---|
| **Radish (Red Globe; White Interior)** | Rover[2] | Cherry Belle |
| | Cherriette[2] | Pink Beauty (organic) |
| | Crunchy Royale[2] | Champion |
| | Diego[2] | Crimson Giant (large globe) |
| | Red Satin[2] | |
| **Daikon/Specialty Radish** | Watermelon (white flesh, red interior, globe) | |
| | Shumkyo Semi Long (red flesh, white interior, elongated) | |
| | White icicle (white flesh, white interior, elongated) | |
| | Eastern Egg (multi-color) | |
| | Minowase (Daikon) | |
| | Mihashige (Daikon) | |
| | China Rose (red flesh, white interior, elongated) | |
| | Chinese Winter (Daikon) | |
| | Black Spanish Round(dark flesh, white interior, large globe) | |
| | April Cross* (Daikon) | |
| **Rutabaga** | Helenor | Laurentian |
| **Turnip White** | Tokyo Cross[2] | Shogoin |
| | White Lady[2] | Just Right[2] |
| | Hakeuri[2] | White Ball[2] |
| **Turnip Purple** | Purple Prince[2] | Royal Crown[2] |
| | Purple Top White Globe (MR[3]) | |

[1]Varieties listed earliest to latest according to vendors: Radish 18-45 days; Daikon/Specialty Radish 24-80 days; Rutabaga 90-100 days; Turnip 35-75 days. [2]F1 hybrid variety. [3]MR = mosaic resistant (vendor information).

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| | | **Soil Phosphorus Level** | | | | **Soil Potassium Level** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Low** | **Med** | **High (Opt)** | **Very High** | **Low** | **Med** | **High (Opt)** | **Very High** | |
| | **N (lb/A)** | **$P_2O_5$ (lb/A)** | | | | **$K_2O$ (lb/A)** | | | | **Nutrient Timing and Method** |
| **Radishes Rutabagas and Turnips[1]** | 50 | 150 | 100 | 50 | 0 | 150 | 100 | 50 | 0 | Total nutrient recommended |
| | 50 | 150 | 100 | 50 | 0 | 150 | 100 | 50 | 0 | Broadcast and disk-in |

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter.

## Seed Treatment - See also Disease Control below

Purchase hot water treated seed or request hot water seed treatment, if possible (check with your seed company).

## Spacing and Seeding

**Radishes**: Seed as early in the spring as soil can be worked, then at 8-10 day intervals through September. Seed 10-15 lb/A in rows 8-15 inches apart with 12-15 plants/ft in the row.

**Rutabagas**: Seed in early spring for the early summer crop and at least 90 days before the fall early freeze date. Seed 1½-2 lb/A, ¼ inch deep, in rows 30-36 inches apart. Thin plants to 4-8 inches apart in the row when plants are 2-3 inches tall.

**Turnips**: Seed as early in the spring as soil can be worked or at least 70 days before the fall early freeze date. Seed 1-2 lb/A, ⅛-¼ inch deep, in rows 14-18 inches apart. Plants should be 2-3 inches apart in the row. Seed can also be broadcast at the rate of 2.5 lb/A.

## Harvesting and Post-Harvest Considerations

**Radishes**: Bunched with tops or wrapped/bagged without tops are the two ways radishes are sold. In this region, bunching radishes is most common. Plants are pulled and gathered with rubber bands or twist ties. Shelf life is 10-14 days. Store at 32°F (0°C) and 95-100% relative humidity.

**Rutabagas**: Pull and trim tops in the field. Bruised, damaged, or diseased rutabagas will not store well. Wash rutabagas in clean water, spray-rinse with clean water, then dry as rapidly as possible before waxing or shipping. Rutabagas can be stored 2-4 months at 32°F (0°C) and 90-95% relative humidity.

**Turnips**: The crop is dug mechanically and either bunched or topped. Turnips can be stored over winter at 32-35°F (0-2°C) and at 90-95% relative humidity.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**1. Soil-Applied (Preplant Incorporated or Preemergence)**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 3 | Dacthal 6F<br>Dacthal W-75 | 6 to 14 pt/A<br>6 to 14 lb/A | **DCPA** | 4.5 to 10.5 lb/A | 25 | 12 |

-**For radishes and turnips only**. Apply preplant incorporated or preemergence in turnips;, **do not** incorporate deeper than 2 inches
-**Do not** apply preplant incorporated for radishes.
-Primarily controls annual grasses and a few broadleaf weeds, including common purslane.
-Results have been most consistent when used in fields with coarse-textured soils low in organic matter, and when the application are followed by rainfall or irrigation. Maximum application not addressed on label.

**2. Postemergence**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9 to 16 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 15/<br>30 | 24 |
| **1** | Poast 1.5EC | 1 to 2.5 pt/A | **sethoxydim** | 0.2 to 0.5 lb/A | 14 | 12 |

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.
-If repeat applications are necessary, allow 14 days between applications.

*2. Postemergence (Select, Poast) continued on next page*

*2. Postemergence (Select, Poast) - continued*

-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. Rainfastness 1 hr.
-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 1 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.
-**Do not** apply more than 2.5 pt/A Poast in single application and **do not** exceed 2.5 pt/A for the season.
-**Do not** harvest radish within 15 days of application and rutabagas and turnips within 30 days of application.

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | Stinger 3A | 2 to 8 fl oz/A | **clopyralid** | 0.047 to 0.188 lb/A | 15/30 | 12 |

-**Turnip roots and tops ONLY!** Other clopyralid formulations may not be labeled (read the label).
-Apply in a single application to control certain annual and perennial broadleaf weeds.
-Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum).
-Stinger is very effective on small seedling annual and emerging perennial weeds less than 2-4 inches tall, but is less effective and takes longer to work when weeds are larger.
-Use 2 to 4 fl oz/A to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fl oz/A to control larger annual weeds. Apply the maximum rate of 8 fl oz/A to suppress or control perennial weeds.
-Spray additives are not needed or required by the label, and are not recommended.
-PHI is 15 d for turnip tops and 30 d for turnip roots. Observe follow-crop restrictions, or injury may occur from herbicide carryover.
-Rainfastness is 6 hrs.

**3. Postharvest**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |

-**A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant.
-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.
-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed.

**4. Other Labeled Herbicides** These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| 3 | Treflan | **trifluralin** |
| **14** | Aim | **carfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Insecticides

## Soil Pests
### Cabbage Maggots

Cabbage maggots overwinter as pupae. Overwintered adults (flies) emerge when yellow-rocket (mustard) first blooms, then begin laying eggs on roots or soil near roots. All brassica crops are affected. Eggs hatch within 3-7 days. Young plants may become severely stunted or die. Larvae or tunnels in harvest bulbs may be evident from later infestations. This pest has 3-4 generations per growing season, although the first generation is often the most economically damaging. The last larval generation is in October, particularly in warmer years. Treatments for cabbage maggot must be done preventively, as once damage is evident, loss of plants is unavoidable. Barriers, such as row covers, may be useful in excluding flies from smaller plantings. Prompt and complete destruction of crop residue is helpful. Chemical treatments should be applied pre-plant, or at planting, depending on the product used.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) and Crop Restrictions | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Lorsban Advanced | Rates vary between crops and application methods, see the label. | chlorpyrifos*- **soil only (if used pre-plant, do not apply at planting or post-planting)** | 30 | 24 | H |
| 1B | Diazinon AG500 | 2.0 to 4.0 qt/A | diazinon* - **Rutabaga only; preplant broadcast, incorporate immediately to 4” depth** | AP | 96 | H |

**Cutworms**- See also the Pest Management chapter, Insect Management section.

Cutworms are moth larvae (caterpillars) that feed on roots and stems. Cutworms chew through stems at or near the soil line, causing young plants to topple over. Cutworms may also feed on the subterranean portion of bulb crops like radish, turnips and rutabagas. Larvae are typically active at night, and spend most of this stage belowground. Cutworms are favored by less disturbed soils and debris covered soil surfaces. Conventional tillage and crop debris incorporation helps reduce populations. Several species in NJ are capable of injuring young plants. There are usually two generations per season. If cutworm damage is anticipated, it is best to treat preventively with insecticide.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin XLR Plus | 1.0 to 2.0 qt/A | carbaryl **- PHI turnip 14 days** | 7/14 | 12 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Tombstone | 1.6 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A + 4A | Leverage 360 | 2.4 to 2.8 fl oz/A | beta-cyfluthrin + imidacloprid* - **radish only** | 7 | 12 | H |

## Above-ground Pests

**Aphids** To prevent flare-ups, avoid overuse of synthetic pyrethroid (3A) insecticides for control of other pests.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Malathion 57EC | 1.0 to 1.6 pt/A (radish and rutabaga); 1.0 to 2.0 pt/A (turnip) | malathion (PHI turnip is 1 day) | 7/1 | 12 | H |
| 3A + **4A** | Leverage 360 | 2.4 to 2.8 fl oz/A (radish) 3.0 fl oz/A (turnip) | imidacloprid + beta-cyfluthrin* *Radish and Turnip only* | 7 | 12 | H |
| **4A** | Actara 25 WDG | 1.5 to 3.0 fl oz/A | thiamethoxam - **foliar** | 7 | 12 | H |
| **4A** | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| **4A** | Admire Pro | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| **4A** | Platinum 75 SG | 1.70 to 2.17 oz/A (radish) 1.70 to 4.01 oz/A (rutabaga and turnip) | thiamethoxam - **soil** | AP | 12 | H |
| **4C** | Closer SC | 1.5 to 2.0 fl oz/A | sulfoxaflor | 7 | 12 | H |
| **4D** | Sivanto 200SL | 7.0 to 10.5 fl oz/A | flupyradifurone | 7 | 4 | M |
| 28 | Verimark | 6.57 to 13.5 fl oz/A | cyantraniliprole - **soil, turnip only** | AP | 4 | H |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole - **foliar, turnip only** | 1 | 12 | H |

### Caterpillar "Worm" Pests Including Cabbage Loopers, Diamondback Moths, Imported Cabbageworms, Cross-striped Cabbageworms, Cabbage Webworms, and Armyworms

Due to resistance development, pyrethroid insecticides are not recommended for control of Diamondback Moth or Beet Armyworm. Other insecticides may no longer be effective in certain areas due to Diamondback Moth resistance; consult your Extension Office. Rotation of insecticides with different modes of action is recommended to reduce the development of resistance. Under-leaf spray coverage is essential for effective control particularly with *Bacillus thuringiensis* and contact materials. With boom-type rigs, apply spray with at least 3 nozzles per row, one directed downward and one directed toward each side. Evaluate effectiveness when considering further treatment.

| **Apply one of the following formulations: Note: not all materials are labeled for all crops, insects or application methods, check the label for directions!** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* - **turnip: imported cabbageworm and beet armyworm only; radish: beet armyworm only; not labeled for rutabaga** | 7 | 12 | H |
| 5 | Entrust (OMRI) | 1.7 to 3.3 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant SC | 6.0 to 8.0 fl oz/A | spinetoram | 3 | 4 | H |
| 11A | Dipel (OMRI) | 0.5 to 2.0 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 18 | Intrepid | 8.0 to 10.0 fl oz/A | methoxyfenozide | 1 | 4 | N |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 1 | 4 | L |
| 28 | Verimark | 5.0 to 10.0 fl oz/A | cyantraniliprole - **soil, turnip only** | AP | 4 | H |
| 28 | Exirel | 7.0 to 13.5 fl oz/A | cyantraniliprole - **foliar, turnip only** | 1 | 12 | H |

## Flea Beetles

Crop rotation, management of wild hosts (wild mustard, rocket etc.) and prompt destruction of crop residue are helpful in population suppression. Sequential plantings of host crops can result in population build-up.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin XLR Plus | 0.5 to 1.0 qt/A | carbaryl (turnip PHI 14 days) | 7/14 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* - **radish and turnip only** | 7 | 12 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Tombstone | 1.6 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A + **4A** | Leverage 360 | 2.4 to 2.8 fl oz/A (radish) 3.0 fl oz/A (turnip) | thiamethoxam + beta-cyfluthrin* - **radish and turnip only** | 7 | 12 | H |
| **4A** | Admire Pro | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| **4A** | Admire Pro | 1.2 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| **4A** | Platinum 75SG | 1.7 to 2.17 oz/A | thimamethoxam - **soil** | 21 | 12 | H |
| **4A** | Actara 25 WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 7 | 12 | H |
| 5 | Entrust (OMRI) | 1.0 to 2.0 fl oz/A | spinosad | 3 | 4 | M |

## Leafminers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use) and Crop Restrictions** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Dimethoate 400 | 0.5 pt/A | dimethoate* - **turnip only** | 14 | 48 | H |
| 5 | Entrust (OMRI) | 1.0 to 2.0 oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant SC | 6.0 to 8.0 fl oz/A | spinetoram | 3 | 4 | H |
| 28 | Verimark | 6.57 to 13.5 fl oz/A | cyantraniliprole - **soil, turnip only** | AP | 4 | H |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole - **foliar, turnip only** | 1 | 12 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Fungicides

## Seed Treatment Options

Heat treatment is a non-chemical alternative to conventional chlorine treatments that only kill pathogens on the surface of the seed coat. Heat treatment has the additional benefit of killing pathogens within the seed coat and is particularly useful for crops that are prone to seed-borne bacterial infections. Seed heat treatment follows a strict time and temperature protocol and is best done with thermostatically controlled water baths. Two baths are required; one for pre-heating, and a second for the effective (pathogen killing) temperature. The initial pre-heating is at 100ºF (37ºC) for 10 minutes. In the second bath, soak radish seed at 122°F (50°C) for 15 minutes. Immediately after removal from the second bath, rinse seeds with cool water. Dry seeds on a screen or paper. Pelleted seed is not recommended for heat treatment. Only treat seed that will be used during the current production season.

An alternative to hot water seed treatment is to use 1 part Alcide (sodium chlorite), 1 part lactic acid, and 18 parts water as a seed soak. Treat seed for 1-2 minutes with constant agitation and rinse for 5 minutes in running water. Following either treatment above, dust dried seed with Captan 50WP or Thiram 480DP at 1 level tsp/lb of seed (3 oz/100 lb).

## Seed Treatment Prior to Seeding

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **For Pythium and Phytophthora root rot control use a seed treatment such as:** | | | | | | |
| 4 | Apron XL LS | 0.085 to 0.64 fl oz/100 lb seed | mefenoxam | -- | -- | -- |
| **For control of other root rots apply:** | | | | | | |
| 12 | Maxim 4FS | 0.08 to 0.16 fl oz/100 lb seed | fludioxinil | -- | -- | -- |
| **Note: Apron XL LS and Maxim 4FS can be combined.** | | | | | | |

## Damping-off caused by *Pythium* and *Rhizoctonia*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **For Pythium root rot control apply as banded spray:** | | | | | | |
| 4 | MetaStar 2E[1] | 2.0 to 4.0 pt/A | metalaxyl | AP | 48 | -- |
| 4 | Ridomil Gold 4SL[1] | 0.5 to 1.0 pt/A | mefenoxam | AP | 48 | N |
| 43 | Presidio 4SC[1] | 3.0 to 4.0 fl oz/A | fluopicolide | AP | 48 | -- |
| **For Rhizoctonia root rot control apply as in-furrow application:** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/A (see label) | azoxystrobin | 0 | 4 | L |
| **For Pythium and Rhizoctonia root rot control apply as banded spray:** | | | | | | |
| 4 + 11 | Uniform 3.66SC[1] | 0.34 fl oz/1000 ft. row[2] | mefenoxam + azoxystrobin | AP | 0 | -- |

[1]Applications at seeding will also help control Downy mildew. [2] See label for restrictions

## Bacterial and Fungal Diseases

**Alternaria, Blackleg and Black Rot** Can survive on infested debris and seed. Purchase certified or treated seed. Use hot water seed treatment to help reduce seed-borne infections (see above). Thoroughly disc or plow under plant debris after harvest. Eliminate cruciferous weeds which can act as hosts and rotate with non-cruciferous crops.

**Clubroot** Radishes are susceptible, whereas turnips are resistant. Use of irrigation water containing fungus spores is the principal way of spreading the pathogen. If clubroot occurs, clean and disinfest any equipment to be used in other fields. Adjust soil pH with hydrated lime to as close to 7.0 as possible. Improve drainage and use raised beds.

### Downy Mildew

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply the following when weather conditions favor disease development and/or disease is first noticed:[1,2]** | | | | | | |
| M1 | Copper (OMRI)[1] | check the label | copper | 0 | 48 | N |
| 21 | Ranman 400SC | 2.75 fl oz/A (turnip greens only) | cyazofamid | 0 | 12 | L |

[1]Some copper based products are OMRI-approved for organic production and may help suppress some fungal pathogens in these crops.
[2]Uniform, Presidio, mefenoxam, or metalaxyl applications for root rot control at seeding will also help control downy mildew.

### Leaf Spots (caused by *Cercospora* or *Alternaria)* and Powdery Mildew

Long periods of wet weather and driving rains which promote soil splashing are conducive for development. Thoroughly disc or plow under plant debris after harvest. Eliminate cruciferous weeds which can act as hosts and rotate with non-cruciferous crops.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply the following preventatively and/or when conditions favor development:** | | | | | | |
| 7 + 11 | Merivon 2.09SC | 4.0 to 5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 0 | 12 | N |
| **Rotate with one of the following FRAC code 11 fungicides:** | | | | | | |
| 11 | azoxystrobin 2.08SC | 6.0 to 15.5 oz/A plus fixed copper at labeled rates | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20WG | 8.0 to 12.0 oz/A plus fixed copper at labeled rates | pyraclostrobin | 0 | 12 | N |

**Scab** Scab is more severe under dry soil conditions, high soil pH, and low level of Mg. Heavy irrigation in the first two weeks after emergence and the application of S to reduce soil pH will assist in disease control.

### White Rust

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **When weather conditions favor disease development or at the first sign of disease in field, apply:** | | | | | | |
| 4 + M1 | Ridomil Gold Copper 65WP[1] | 2.0 lb/A every 7 days (not for use in rutabagas and turnip) | mefenoxam + copper | 7 | 48 | N |
| **Alternate with one of the following FRAC code 11 fungicides:** | | | | | | |
| 11 | azoxystrobin 2.08SC | 6.0 to 15.5 oz/A | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20WG | 8.0 to 16.0 oz/A | pyraclostrobin | 0 | 12 | N |

[1]Ridomil Gold Copper applications will also help control downy mildew (see labels for restrictions).

# Specialty Vegetables

## Niche Marketing

The term ‘specialty vegetables’ refers to a broad range of crops that sold in niche markets. They are sometimes called ‘exotic’ as they represent a class of vegetables unlike standard tomatoes, peppers, beans, peas and sweet corn, etc.; ‘alternative’ because they represent new enterprises that traditional vegetable growers might try; or ‘designer veggies’ that allow the consumer to be creative with their presentation. Recently, the term 'ultra-niche crops' was created to describe very high value specialty crops that provide opportunities to help beginner/small farmers get established. Most fresh-market specialty vegetables and herbs fit this description.

Specialty vegetables can be described by the **new or unusual in the manner they are grown** (organic, hydroponic); by the **color, shape or flavor** of the varieties grown (red and oakleaf lettuces, pear tomatoes, heirloom varieties, or unusual greens like radicchio); by their **size** (baby, miniature, micro); or by their **ethnic origins and demand** (Asian crucifers and cucurbits, Hispanic peppers, African greens and eggplants).

## Specialty Vegetable Markets

Developing a marketing plan for specialty vegetables is essential. Important points to consider include:

- Before planting, know where you will be selling your crop;
- Understand all the quality, grading and packaging requirements, and costs for various market outlets (similar ethnic groups may want different varieties/types of the same crop, use the same/similar names for different types of crops, or different names for the same crop);
- Determine that consumers will want it when you can produce it;
- Assess the costs of production, especially the time and labor required. Maynard and Hochmuch (In: Knott's Handbook for Vegetable Growers, 5th ed., 2006,. John Wiley and Sons, Inc., NY).describe conducting on-farm trials to help determine varieties and production systems. Small plantings can help work out problems that can be resolved easily. Accurate records of small plantings can be used to estimate costs and returns for full-scale plantings;
- Increase production as demand grows, but aware of competitors entering the market (prospective buyers, state and federal crop reporting agencies, and local Extension workers can be good sources of information);
- Project the impact that various levels of competitive supply will have on price to determine if returns will pay for any required capital costs over a specified period of time; and
- Understand that a specialty crop enterprise may not be limited to a single vegetable, but may include a group of complimentary crops that fill a market niche. Several different crops may be a required in order to gain a foothold in the market.

A successful specialty/ethnic produce business requires knowledge and experience. It is advisable to start small and build the business gradually. Understanding marketing for specialty crops is the first step toward making profitable production decisions. The following sections describe production practices for specialty vegetables grouped by the general market outlets for the specific crops directing the producer’s attention to that critical part of the decision process.

### Organic and Hydroponic Production

Organic and hydroponic production which, in and of themselves, create niche-market specialty crops are not the focus of this guide, but most, if not all of the crops described, can be grown using ‘organic’ practices, *i.e.*, those approved under the USDA National Organic Program. Where appropriate, organic practices and pest control options are provided under each crop throughout this guide (see also Organic Production in the General Production Recommendations chapter). Using ‘hydroponic’ techniques to grow crops in a nutrient solution, usually within a controlled environment such as a greenhouse, is also suitable for many vegetable crops where there is sufficient market demand to justify the capital investment for this type of system. Both of these production systems require selling to specific niche markets where demand provides the greatest return. **Note**: Under current USDA OP rules, 'hydroponic' production is a distinct *soilless* production system that cannot be marketed as 'organic' even if 'organic' fertilizers and pest control methods are employed in the production. 'Hydroponic' specialties should be marketed on their own unique qualities.

**Fresh-Cut Processing**

The rapid growth in demand for convenience foods has encompassed fresh vegetables with the advent of fresh-cut processing, *i.e.*, pre-packaged, ready-to-eat salads and washed, trimmed, pre-cut and ready-to-cook vegetables. The major ingredients used by the fresh-cut salad industry are mainstay vegetables like iceberg and Romaine lettuces, cabbage, carrots and spinach, complimented by a variety of additional crops that can provide color, texture and taste in both salad and stir-fry mixes. Salad and stir-fry mixes are commonly made up of chopped or shredded mature crops grown by standard practices, but are usually sold alongside mesclun which is a blend of baby greens (see Mesclun section below).

Advances in packaging and post-harvest technologies has allowed the fresh-cut processing industry to develop into its own specialty niche. The shelf-life of fresh vegetables, once cut, is inherently very short, especially leafy vegetables such as lettuces. Oxidative browning and decay follow rapidly. Development of breathable plastic films which create a miniature controlled atmosphere within the package reduces the levels of oxygen and ethylene while increasing the carbon dioxide levels. These conditions slow respiration, the chemical browning process, and reduce the growth of decay organisms. Sanitizing the produce before and during the processing/packaging greatly reduces the number of decay organisms entering the package (see Section A - Food Safety Concerns and Postharvest Handling). The combination of handling practices and packaging materials has increased the shelf-life of fresh-cut products, in some cases, from a few days to several weeks.

**Ethnic Vegetables**

Growth of communities of new immigrant populations throughout the MidAtlantic and Northeast have created opportunities for specialty produce farmers to cater to these ethnically diverse consumers. Major retailers are responding to these population shifts creating sales opportunities for both retail and wholesale growers.

It is critical to understand the ethnic community for which you will be growing in order to make the correct crop and variety selections, harvest at the correct stage, and package in appropriate containers. The worldcrops.org website is designed to help growers exploring ethnic crop markets understand the nuances of marketing to such diverse groups. For example, Hispanic cultures consume many types of peppers/chiles, but assuming every ethnic group wants one type of pepper would be a mistake.

Similarly, eggplant is very popular among Asian Indian people, but they prefer a small, egg size, pink 'brinjal' eggplant, while Chinese consumers look for long, slender fruit, and people in various Africans countries consume a white or pale green, medium size eggplant (a little smaller than the traditional Italian eggplant) that most call 'Bitter Ball'. West Africans also use a pea-sized, red eggplant for medicinal purposes, known as the 'Ghanan pea' in most countries. That unusual eggplant is called 'Kiteley' in Liberia, while 'Kitley' describes 'Bitter Ball' in Ghana.

**Table 1. Common Ethnic Vegetable Crops for Mid-Atlantic Growers**
(see *https://worldcrops.org/* for more information)

| Vegetable Types | Ethnic Community | Ethnic Crop Name |
|---|---|---|
| **Solanaceous** | | |
| Eggplant | Brazil | Gilo |
| | West Africa | Bitter Ball, Kiteley, Ghanan Pea |
| | India | Brinjal |
| | France | Aubergine |
| Pepper | Mexico | Habanero |
| | Dominican Republic | Aji Dulce |
| Husk Tomato | Mexico | Tomatillo |
| **Cruciferous** | China, Southeast Asia | Napa/Chinese Cabbages, Pak Choys, Mustards, Flowering Broccoli |
| **Other Greens** | West Africa | Jute |
| | India | Fenugreek (Methi) |
| | Mexico | Purslane (Verdolaga) |
| | Universal | Amaranth, Roselle, Malabar Spinach |

**"Designer Veggies"**

Coined to describe unusual produce used by creative chefs to decorate gourmet plates with more than a traditional garnish, "designer veggies" can be any crop grown for its size, shape, color, texture, or flavor. Types of "designer veggies" may include, but are not limited to, any/all of the crops described in the following sections. They are usually 'trendy' crops that help celebrity chefs stand out from the crowd, so one year's hot item may be a slow mover a year or two later, especially if a number of growers add more plantings. Radicchio can be considered one of the original "designer veggies". When it appeared in produce aisles in the mid-1980s there was nothing similar to its bright red leaves with contrasting white veins and strong bitter flavor. Today, while radicchio leaves are common ingredients in many salad mixes, recent studies show that it qualifies as a nutrient-dense 'super food'. Coupling nutritional qualities with its ability to stand up to cooking in a variety of ways and increasing attention by food marketers, radicchio may once again be propelled into "designer veggie" status.

Success in the "designer veggie" business requires working closely with chefs and gourmand customers, paying close attention to food and trade publications and TV, attending produce and gourmet food shows, and being able to grow and deliver small quantities of labor intensive produce.

## Baby, Miniature and Micro Vegetables

### Variety Selection

Though the publicity is perhaps not as great as during the late 1980's when they were faddish, demand continues for smaller vegetables among gourmet and specialty food outlets. Today, **micro-greens** may be the most popular type in highest demand. **Micro-greens** are seedling plants consumed at a stage (stem and cotyledon as 1 or 2 true leaves appear - smaller than transplant seedlings) between **sprouts** (roots and unopened cotyledons) and **baby** sizes (immature root vegetables or the first few true leaves of many greens). **Micro-greens** are cut above the soil line so no roots or seed coats typically found in sprouted crops are included. Many types of vegetables can be harvested at these immature stages and sold as **baby** or **micro-vegetables**. There are other cultivars of vegetables which mature smaller than standard types of the same vegetable. These are referred to as **miniatures** and are grown to full maturity. Most seed companies offering specialty vegetables also recommend certain varieties for immature harvest in addition to listing miniature varieties.

**Table 2. Baby and Miniature Vegetable Varieties and Harvest Stage**

| Vegetable Type | Harvest Stage[1] | Varieties for Baby Harvest | Miniature Varieties |
|---|---|---|---|
| **Beans** | IF | Aiguillon Cristal, Fine de Bagnols, Blue Lake | |
| **Beets** | IR | Burpee Golden, Boldet, Dwergina | Baby Beet Spinel, Crosby's Egyptian, Little Ball |
| **Carrots** | IR | Minicor, Round Paris Market, A&C Brand Nantes, Nantes, Scarlet Nantes S. T., Chantenay Red Core #5, Amsterdam A. B. K., Caramba | Carrot Sucrum, Baby Long Carrot, AMCA, Planet, Little Finger, Amstel |
| **Corn** | IF | Any sweet corn variety harvested within 3 days of silk emergence - supersweet varieties with tendencies to produce multiple ears/plant will increase yields | Golden Midget, Baby Asian Corn |
| **Greens** | G | Most greens, including mustards, cabbages (European and Oriental), chicories, etc. can be harvested at the 46" stage. A mixture of baby greens and lettuces can be sold as "Mesclun" salad mix. | |
| **Lettuce** | G | Green Oak Leaf, Red Oak Leaf, Merveille de Quatra Saisons, Sucrine, Lollo Rosso, Lollo Biondo, Red Grenobloise, Diana, Kagraner Sommer, Craquante D'Avignon, Red Salad Bowl | Tom Thumb, Baby Oak, Perella Red, Perella Green, Rougette de Midi, Morgana,Summer Baby Bibb, Little Gem Mini Romaine, Rubens Dwarf Romaine |
| **Peppers, Tomatoes, Eggplant** | IF | Fingerling eggplant | Miniature Baby Bell peppers, Cherry and Mini-Pear tomatoes |
| **Radish** | IR | Flamboyant, Flambo, Sezanne, Italian Oliva, French Breakfast | |
| **Squash** | IF | zucchini and yellow curved or straightneck, white and golden scallop, Jersey Golden Acorn, and Sweet Dumpling all can be harvested just before or after blossom drop. | |
| **Turnips** | IR | Milan Early Red Top, De Milan, Tokyo Cross, White Lady | Market Express |

[1]IF=immature fruit, IR=immature roots (usually ½1 inch diameter), G=greens (usually 4-6 inches and before head formation).

**<u>Culture</u>**

**<u>Micro-greens</u>** can be grown in protected culture for year-round, continuous harvesting. Typically, microgreens are planted in the containers in which they will be shipped and/or sold, leaving the 'harvesting' to the end user (chef or consumer). For wholesale customers, plastic transplant trays are lined with rock-wool/coir mats or a thin layer of soilless mix upon which the seeds are spread. Similarly, consumer packages such as clamshells or lidded trays can be used. Germination and 1 or 2 days of growth without light will cause the seedlings to stretch taller for easier harvest. This is followed by 2-3 days in full light which will allow the plant to produce chlorophyll and a dark green color. Un-cut micro-greens can then be delivered directly to chefs/consumers within a week to 10 days to harvest themselves.

**<u>Baby and miniature vegetables</u>** are planted and grown much the same as standard varieties. Plant spacing is one major exception because miniatures are physically smaller and baby leaf and root crops are often harvested at the stage a standard variety would be thinned. Higher plant densities are desirable to maximize production. Baby leaf and some root crops can be grown in a solid bed by broadcast seeding since they will be harvested before crowding becomes a factor, or they may be drilled in rows 4-6 inches apart and as many across a bed as will fit. Spacing of miniature varieties will depend on the final size of the dwarfed plant. On the other hand, vegetables grown for their fruit (seeds or pods) such as beans, corn and squash should be grown at standard plant spacing to maximize output per plant. Crowding can affect the production of fruit reducing yields even if those fruit are to be harvested at an immature stage.

Field fertility may be modified depending on the crop and harvest stage. Immature, baby vegetables are harvested before they begin drawing significant amounts of nutrients from the soil. Most will perform with little additional fertilizer beyond the reserves left from previous crops.

Baby and miniature vegetables production can be scheduled to provide continual year-round harvests by using high tunnels or greenhouses.

Harvesting baby and miniature fruiting vegetables is laborious and time-consuming as hand harvest is the only option. Conversely, specialty equipment manufacturers, especially in Europe, have developed efficient mechanical harvesters for baby greens. These tools may need to be used in conjunction with matched bed shapers and other implements, so careful analysis of the market and size of production is required to justify the added expense. Smaller scale manual and semi-mechanical harvest tools have been developed for smaller operations.

**<u>Postharvest Handling</u>**

Baby vegetables are immature crops at harvest-time and as such, both fruit and leafy crops tend to have higher respiration rates and are more tender than when they reach maturity. Proper postharvest handling procedures are critical to maximize shelf-life. Gentle handling and special packaging from harvest on are required to reduce bruising and dehydration. Rapid postharvest cooling removes field heat and extends shelf-life. This may be combined with triple washing to remove soil and field debris followed by spin-drying as a method of adding value.

Plastic-lined cardboard boxes, clear plastic food-service containers and inflated, resealable, plastic bags are some of the innovative packages tried in early tests. The industry has settled on 3-pound plastic-lined, or wax treated, cardboard boxes for the wholesale trade. Larger bulk boxes may be suitable to send these products to fresh-cut processors who eventually repackage their finished products in the consumer-oriented plastic bags or clamshell boxes. This packing system allows modified atmosphere treatment to reduce decay while providing support throughout the bulk package to reduce bruising/injury caused by the weight of the product itself. Micro-greens that are harvested at the farm are offered the most protection by use of clamshell boxes. Determine the appropriate package for the intended market.

## Mesclun (French)/Misticanza (Italian)

Mesclun usually refers to mixed young/baby salad greens and herbs. Ingredients in mesclun blends vary, consisting of many varieties of the crops listed in Table 3. Seed companies sometimes sell pre-mixed selections for mesclun production, but since different species emerge and grow at different rates, it is recommended to grow each separately and mix after harvest. This allows the grower to create unique blends, as well as timing production to allow harvest of similar stages of growth of each species.

**Table 3. Potherbs and Salad Greens** Leafy greens can be described simply as any plant grown for consumption of its fleshy leaves, petioles and/or stems, either raw (salad greens) or cooked (potherbs) (see also Greens section).

| | | |
|---|---|---|
| **Types of Greens** | **Lettuces** | Iceberg, Romaine, Crisphead/Batavia, Leaf, Bibb, Boston |
| | **Other Composites** | Endive and Frisee, Escarole, Radicchio, Dandelion |
| | **Mustards** | Arugula, Cress, Mustard, Turnip tops, Watercress |
| | **Cabbages** | Red, Green and Savoy, Chinese Napa |
| | **Spinach** | Usually Flat leaf varieties |
| | **Oriental Mustards** | Mibuna, Misuna, Mizuna, Pak Choy; Flowering Broccoli |
| | **Other Oriental Greens** | Tricolor Amaranth, Shungiku Chrysanthemum |
| | **Miscellaneous** | Beet tops and Chard, Belgian Endive, Mache/Corn Salad, Orach, Claytonia/Miner's Lettuce, Sorrel, Purslane, Pea tips, Nasturtium leaves |
| | **Herbs** | Parsley, Basils, Borage, Chervil, Chives, Fennel, Salad Burnet |
| | **Edible Flowers** | Nasturtium, Viola, Violets, Pansy |

# Pest Control

## Under Protected Culture

Specialty vegetable production can be extended in the field by the use of floating row covers and nearly year-round in most of the mid-Atlantic states using high-tunnels. Pests likely to be encountered in high density plantings growing in high humidity are slugs, white flies, and botrytis. Slugs can be trapped and there are parasites for controlling white flies. Maintaining constant air circulation and adequate ventilation to reduce humidity within the plant canopy will reduce the incidence of botrytis. If making multiple harvests, carefully remove all dropped cut leaves as botrytis and bacterial soft rot get started on injured tissue.

### Weed Control

Weed control may be the most difficult aspect of baby leafy green and herb production. Selecting fields with low levels of weed seeds and free of perennial species is important. Preventing weeds from producing seeds will help with control in subsequent seasons. Herbicides must be labeled for the specific greens and herbs grown; consult the weed control sections in this publication for herbicide recommendations for specific crops. Consult the herbicide label to determine if the time between herbicide use and harvest is equal to or exceeds the required preharvest interval (PHI).

Use cultural weed control methods such as stale seedbeds or plastic mulch when applicable. Mechanical weed control must be done in a planned, timely fashion. Most crops relying on mechanical weed control will require multiple cultivations which will be more difficult in high density plantings. Resort to hoeing and hand weeding when necessary.

### Insect Control

Careful crop monitoring is required to produce insect-free greens. Timing production and using physical insect barriers such as floating row covers can effectively control insects on many of the shortest season crops. Longer season crops usually require insecticides of some type to protect them from an array of root maggots, lepidopteran larvae, aphids, thrips, flea beetles, and more. Effective IPM scouting can identify pest population changes and alert the grower when a pest control application may be required. Given the diversity of crops within this group, there may be unexpected pests occurring on small plots of crop plants, making control even more difficult. Read pesticide labels carefully to ensure that a product is registered for use on a specific specialty crop. Many specialty vegetables fall under Crop Grouping labels. Consult the crop specific guidelines in this book for pest control recommendations.

### Disease Control

Scout plantings on a regular basis and adopt IPM practices that will help produce a disease-free crop. Use genetic resistance to help limit potential losses due to disease. Many specialty vegetables fall under Crop Grouping labels, therefore consult the fungicide label and crop guidelines in this book for disease control recommendations.

# Spinach

## Recommended Varieties[1]

| Fall (Summer Planted) | "Baby" Leaf Type |
|---|---|
| Avenger* (Smooth; DM races 1-7,9,11,13,15) | Carmel* (Semi-savoy; DM races 1-11, 13) |
| Carmel* (Semi-savoy; DM races 1-11, 13) | El Real* (Smooth; DM races 1-8,10-12) |
| Emu* (Slow bolting; DM races 1-10) | Imperial* (Asian; DM races 1-7, 9, 11, 13) |
| Interceptor* (DM races 1-7, 9, 11) | Marabu* (Smooth; DM races 1-10,15) |
| Kookaburra* (Savoy; DM races 1-13) | Molokai* (Smooth; DM races 1-13, 15) |
| Palco* (Savoy; DM races 1-5, 8, 9, 11) | Riverside* (Smooth; DM races 1-11) |
| Platypus* (Savoy; DM races 1-15) | Scarlet* (Red vein; DM races 1-3) |
| Python* (DM races 1-7, 9, 11) | |
| Rushmore* (Smooth, slow-bolting, DM races 1-5, 8, 9, 11, 12, 14) | |
| SV1714VC* (Smooth; DM races 1-13,15) | |
| **Summer (Spring Planted)** | |
| Carmel* (Semi-savoy; DM races 1-11, 13) | |
| Corvair* (DM races 1-11) | |
| Emporer* (Savoy; DM races 1-10) | |
| Kookaburra* (Savoy; DM races 1-13) | |
| Marabu* (Smooth; DM races 1-10,15) | |
| Olympia* (DM races 1-3) | |
| Platypus* (Savoy; DM races 1-15) | |
| SV1714VC* (Smooth; DM races 1-13,15) | |

[1]Listed alphabetically. *F1 hybrid variety. Disease resistance/tolerances (according to vendors) and specialty characters in parentheses: CMV=cucumber mosaic virus, DM=downy mildew. PM=powdery mildew, WRR=white rust resistant. Processors generally specify preferred varieties for contracted plantings.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Spinach | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| **Spring or Fall** | 100-230 | 200 | 150 | 100 | 0[1] | 200 | 150 | 100 | 0[1] | Total nutrient recommended |
| | 50-75 | 200 | 150 | 100 | 0[1] | 200 | 150 | 100 | 0[1] | Broadcast and disk-in |
| | 25-40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress or topdress |
| | 40-60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Topdress after each cutting |
| **Overwinter** | 100-190 | 200 | 150 | 100 | 0[1] | 200 | 150 | 100 | 0[1] | Total nutrient recommended |
| | 20-30 | 200 | 150 | 100 | 0[1] | 200 | 150 | 100 | 0[1] | Broadcast and disk-in at fall planting |
| | 50-80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Topdress in late February when crop begins to grow |
| | 30-40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Topdress in March |
| | 40-60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Topdress for second cutting |

[1]In VA, crop replacement values of 50 lb/A of $P_2O_5$ and 50 lb/acre of $K_2O$ are recommended on soils testing Very High.

**Seed Treatment** Use treated seed. See Disease Control below for more information.

## Seeding

**Dates:** *Spring*: March 12 to April 20 (harvest May 20 to June 7). *Fall*: August 10-31 (harvest September 25 to October 10). *Overwinter*: October 1-15 (harvest in the spring).
**Rates:** *Not clipped*: 10-14 lb/A. *Clipped*: 18-25 lb/A.
**Spacing:** *Processing*: rows on 12-inch centers. *Market:* rows on 12-inch centers. Planted on 6- and 8-row beds.

## Preharvest

FOR FALL HARVEST ONLY. Apply 6.0 to 8.0 g/A (active ingredient) gibberellic acid to improve harvesting efficiency of semi-upright varieties and to increase yield under cool growing conditions. For best response, apply when daytime temperatures are 40-70°F (4-21°C) and when early morning dew is present on the crop. Apply by ground equipment in 20-50 gal of water/A,12-18 days before each harvest. Wait until some regrowth has occurred before applying gibberellic acid to promote growth of a second or third cutting.

## Harvest and Post Harvest Considerations

For processing spinach, harvest plants before they are too large (or begin to bolt in spring plantings), usually when 16-17 inches tall. A second cut is made often in summer planted for fall harvest after suitable regrowth. The first cut is made 6-7 inches above the ground to eliminate as much stem, petiole and older leaves as possible for the whole leaf pack. Prior to the second cutting, small disks can be used to cut away yellow or old leaves and to remove some soil away from the crown to facilitate harvest. Depending on temperature and plant density, 3-4 weeks between the first and second cutting are needed to obtain adequate regrowth.

For fresh market spinach, plants should be dry prior to harvest to prevent petiole breakage. When harvesting by hand, cut leaves above the crown or soil line and bunch. Exclude yellow leaves and leaves that are dirty with soil. Bunched spinach must be handled very carefully to avoid breakage of plants or bunches during bunching, washing and packaging. Spinach for bag mixes are usually hand harvested, but mechanical harvesters for this purpose are now available. Walk-behind harvesters are also available for smaller acreage growers.

Store spinach at 32°F (0°C) and 95-100% relative humidity. Spinach is very perishable and can be stored for only 10-14 days. Crushed ice should be used for rapid cooling and for removing the heat of respiration. Top ice, hydro-cooling and vacuum cooling are other satisfactory cooling methods.

Most spinach for fresh market is prepackaged in perforated plastic bags to reduce moisture loss and physical injury. Controlled atmospheres with 10-40% carbon dioxide and 10% oxygen retard yellowing and extend shelf life. Special guidance for handling cut spinach, particularly for the bagged salad market, has been developed due to elevated food safety concerns. Check *http://www.caleafygreens.ca.gov/food-safety-practices* for more information.

# Weed Control

### THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

### Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**1. Soil-Applied**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 8 | Ro-Neet 6E | 4.0 pt/A | **cycloate** | 3.0 lb/A | -- | 48 |
| -Preplant incorporated treatments; apply before seeding and incorporate into soil 2-3 inches, and incorporation should occur within a few hours of application. Delay planting 7-10 days may help reduce potential injury.<br>-Ro-Neet provides residual control for a short period of time (about 3 weeks). Only 1 application is allowed per crop cycle | | | | | | |
| 15 | Dual Magnum 7.62E | 0.33 to 0.67 pt/A | **s-metolachlor** | 0.32 to 0.63 lb/A | 50 | 24 |
| -**A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in spinach in DE, NJ, PA and VA.** The use of Dual Magnum 7.62E is legal ONLY if a waiver of liability has been completed (see *http://www.farmassist.com/*).<br>-Apply as a preemergence treatment, **do not** incorporate.<br>-Primarily controls annual grasses and certain broadleaf weeds. Dual will not control emerged weeds.<br>-At the rates labeled for spinach, Dual will only provide a few weeks of residual control<br>-Apply to spinach accurately with a well calibrated sprayer. The margin of crop safety for Dual Magnum on spinach is narrow; rates higher than recommended for the soil type may result in crop injury.<br>-Only 1 application per same season is allowed. | | | | | | |

| **2. Postemergence** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9.0 to 16.0 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 14 | 24 |
| | Poast 1.5EC | 1.0 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 15 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Select will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 4 pt/A for the season.<br>-**Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 3.5 pt/A for the season. | | | | | | |
| 4 | Stinger 3A / Spur 3A | 1/6 to 0.33 pt/A | **clopyralid** | 0.06 to 0.12 lb/A | 21 | 12 |
| -Apply to spinach in the 2 to 5-leaf stage<br>-Stinger will control common cocklebur, groundsel, jimsonweed, prickly lettuce, pineappleweed, common ragweed, and legumes.<br>-Some leaf curling may occur; as well as noticeably more upright leaf development, but does not affect yield or maturity<br>-Use 2.0 to 4.0 fl oz/A to control annual weeds less than 2 inches tall; increase the rate to 4.0 to 8.0 fl oz/A to control larger annual weeds.<br>-Spray additives are not needed or required by the label, and are not recommended.<br>-Observe crop rotation restrictions or injury may occur from herbicide carryover.<br>-Rainfastness is 6 hrs. Maximum use rate is 0.5 pt/A per season. | | | | | | |
| 5 | Spin-Aid 1.3EC | 3 to 6 pt/A | **phenmedipham*** | 0.5 to 1 lb/A | 21 | 12 |
| -**Labeled for processing spinach only.**<br>-Apply to spinach at the 4-true leaf stage or larger; spinach plants less than 4 to 6 true leaf may be injured from Spin-Aid<br>-**Do not** apply if temperatures are over 75 F in order to reduce risk of crop injury. **Do not** spray if dew is present on leaves.<br>-For best results spray when weeds are at the 2 true leaf stage. The use of an 8002 flat fan nozzle or a comparable nozzle is suggested.<br>-Rainfastness is 6 hrs. Split applications of Spin-Aid is allowed, but total rate of Spin-Aid rate is 6 pt/A per season. | | | | | | |

| **3. Postharvest** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Insecticides

## Aphids

Green peach aphid is the most common aphid on spinach. Populations can remain on spinach throughout the winter and their presence can be a contamination concern for leafy crops. Females fly to plants and produce numerous pale yellow or pink-colored young (nymphs). Large numbers of aphids can build up on the undersides of leaves, often following pyrethroid insecticide applications. Aphids are sucking insects and excrete a sugary, sticky substance (honeydew). Preserve natural enemies by using selective insecticides whenever possible. Spray coverage to the underside of the leaf is important; add a spreader-sticker to foliar sprays.

*Aphids continued on next page*

*Aphids - continued*

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | see label | 48 | H |
| 4A | Admire PRO | 4.4 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire PRO | 1.3 fl oz/A | imidacloprid - **foliar** | 7 | 12 | H |
| 4A | Assail 30SG | 2.0 to 4.0 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 7 | 12 | H |
| 4C | Closer SC | 1.5 to 2.0 fl oz/A | sulfoxaflor | 3 | 12 | H |
| 4D | Sivanto 200SL | 10.5 to 12.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | M |
| 9B | Fulfill 50WDG | 2.75 oz/A | pymetrozine | 7 | 12 | N |
| 9C | Beleaf 50SG | 2.0 to 2.8 oz/A | flonicamid | 0 | 12 | L |
| 23 | Movento 2SC | 4.0 to 5.0 fl oz/A | spirotetramat | 3 | 24 | L |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole | 1 | 12 | H |

## Cutworms - See also the Pest Management chapter, Insect Management section.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Mustang Maxx | 2.24 to 4.00 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Tombstone | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |

## Leafminers Serpentine leafminers can cause direct damage to spinach leaves affecting marketability.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.00 to 5.25 fl.oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 3.0 oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 7 | 12 | H |
| 5 | Entrust SC (OMRI) | 6.0 to 10.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Agri-Mek 0.70 SC | 1.7 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 17 | Trigard 75WSP | 2.66 oz/A | cyromazine | 7 | 12 | L |
| 28 | Coragen 1.67SC | 5.0 to 7.5 fl oz/A | chlorantraniliprole - **soil, foliar** | 1 | 4 | L |

## Non-Lepidopteran Chewing Pests Including: Flea Beetles and Grasshoppers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin XLR Plus | 0.5 to 1.0 qt/A | carbaryl | 21 | 12 | H |
| 3A | Baythroid XL | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Mustang Maxx | 2.2 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Tombstone | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A + 4A | Leverage 360 | 3.0 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 4A | Admire PRO | 1.3 fl oz/A | imidacloprid - **foliar only** | 7 | 12 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.00 to 5.25 fl.oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70SG | 1.0 to 3.0 oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 7 | 12 | H |

## "Worm Pests" Including: Beet Armyworms (BAW), Cabbage Loopers (CL), and Webworm

Caterpillars can cause direct feeding damage spinach thus, there is low tolerance for their presence. **Note**: pyrethroid insecticides (Group 3A, in bold-face type) are not reccommended for control of BAW due to resistance issues.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3 pt/A | methomyl* | see label | 48 | H |
| **3A** | Baythroid XL (CL only) | 1.6 to 2.4 fl oz/A | **beta-cyfluthrin* - not recommended for BAW.** | 0 | 12 | H |
| **3A** | Tombstone (CL only) | 1.6 to 2.4 fl oz/A | **cyfluthrin* - not recommended for BAW.** | 0 | 12 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5SG | 3.2 to 4.8 oz/A | emamectin benzoate* | 7 | 12 | H |
| 11A | Dipel (OMRI) | 0.5 to 2.0 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 1 | 4 | L |
| 22 | Avaunt 30WDG | 3.5 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 1 | 4 | L |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole - **soil** | NA | 4 | H |
| 28 | Exirel | 10.0 to 17.0 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

### Seed Treatment

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **For Rhizoctonia and Fusarium Control:** | | | | | | |
| 12 | Maxim 4FS | 0.08 to 0.16 fl oz/100 lb seed | fludioxinil | n/a | n/a | n/a |
| **For Pythium Control:** | | | | | | |
| 4 | Apron XL LS | 0.16 to 0.64 fl oz/100 lb seed | mefenoxam | n/a | n/a | n/a |

### Damping-Off caused *Pythium* and *Rhizoctonia*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following preplant incorporated or as a soil surface spray after planting:** | | | | | | |
| **For Pythium root rot control** | | | | | | |
| 4 | Ridomil Gold 4SL | 1.0 to 2.0 pt/A | mefenoxam | 21 | 48 | N |
| 4 | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | 21 | 48 | N |
| 4 | MetaStar 2E | 4.0 to 8.0 pt/A | metalaxyl | 21 | 48 | N |
| **For Pythium and Rhizoctonia root rot control** | | | | | | |
| 4 + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row | mefenoxam + azoxystrobin | -- | 0 | N |
| **Application of mefenoxam or metalaxyl at planting will also help control early-season white rust infections in spinach.** | | | | | | |

### Downy Mildew (Blue Mold) and White Rust

**Use resistant varieties** (see Recommended Varieties Table). Rotate away from spinach for at least 2 years. Do not plant spring crop near overwintered fields. The use of mefenoxam or metalaxyl at planting for damping-off control will provide early season control. Fungicides containing copper may cause phytotoxicity.

**Shank application:** mefenoxan (0.25 pt/A Ridomil Gold 4SL or 0.5 pt/A Ultra Flourish 2E) or metalaxyl (1.0 pt/A MetaStar 2EAG) may be shanked in 21 days after planting or after first cutting. A second shanked application may be made 21 days later or after the second cutting.

**Foliage Application**: Beginning 2-3 weeks after emergence (or prior to symptom development), rotate one of the following fungicides on a 7 to 10-day schedule (do not apply if temperature is 90°F/32°C or above):

*Downy mildew continued on next page*

*Downy mildew - continued*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Beginning 2-3 weeks after emergence (or prior to symptom development), rotate the following fungicide on a 7 to 10-day schedule as long as weather conditions favor disease development:** | | | | | | |
| 4 + M1 | Ridomil Gold Copper 65WP | 2.5 lb/A | mefenoxam + copper | 21 | 48 | N |
| **With one of the following FRAC code 11 fungicides[1]:** | | | | | | |
| 11 | Reason 500SC | 5.5 to 8.2 fl oz/A | fenamidone | 2 | 12 | -- |
| 11 + 27 | Tanos 50W | 8.0 to 10.0 oz/A | famoxadone + cymoxanil | 1 | 12 | -- |
| **Or with one of the following fungicides:** | | | | | | |
| 21 | Ranman 400F | 2.75 fl oz/A | cyazofamid | 0 | 12 | L |
| 33 | Aliette 80WDG | 3.0 lb/A | fosetyl Al | 3 | 12 | N |
| 43 | Presidio 4SC | 4.0 fl oz/A | fluopicolide | 2 | 12 | L |

[1] FRAC code 11 fungicides such as Reason and Tanos should not be applied more than twice before switching to a fungicide with a different mode of action.

## Leaf Spots and Anthracnose

These diseases can be prevalent in overwintered spinach and during periods between second and third cuttings. Apply one of the following as soon as symptoms appear in the spring or shortly after cutting and repeat every 7 to 10 days as long as conditions favor disease development.

| **Recommended Fungicides** | | | | | | |
|---|---|---|---|---|---|---|
| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| **Alternate one of the following fungicides if more than one application is needed:** | | | | | | |
| 7 | Fontelis 1.67SC | 24.0 fl oz/A | penthiopyrad | 3 | 12 | L |
| 11 | Cabrio 20EG | 12.0 to 16.0 oz/A | pyraclostrobin | 0 | 12 | N |
| **Apply the following if only one application is needed:** | | | | | | |
| 7 + 11 | Merivon 2.09SC | 4.0 to 11.0 fl oz/A | fluxapyroxad + azoxystrobin | 1 | 12 | N |

## Cucumber Mosaic Virus

Use resistant varieties. See Recommended Varieties Table above.

# Strawberries

Note: "**The Mid-Atlantic Berry Guide for Commercial Growers**", a cooperative publication for PA, MD, NJ, DE, WV and VA, provides additional information.

## Annual Production System on Plastic Mulch ("Plasticulture")

This system is recommended for DE, MD, NJ, VA, southeastern PA, and for trial in other areas of PA.

### Recommended Varieties

| Early | Midseason | Late | Everbearer |
|---|---|---|---|
| Sweet Charlie[1] | Chandler | AC Valley Sunset | Albion[3] |
| AC Wendy | Camarosa[2] (shipping only) | | San Andreas[3] |
| | Flavorfest | | Seascape |

[1]Matures 7-10 days earlier than Chandler; recommended for trial in southern regions of MD. Plant only in areas with low risk of frost; may require overhead sprinkler for additional frost protection during bloom. [2]Must be fully red-ripe for flavor development. [3]Produces light yields throughout the spring summer and fall resulting in moderate total yields for the season.

### Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Annual System[1] Strawberry | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 90-120 | 100 | 70 | 40 | 0-30[2] | 165 | 115 | 65 | 0 | Total nutrient recommended |
| | 60-75 | 100 | 70 | 40 | 0-30[2] | 165 | 115 | 65 | 0 | Broadcast and disk-in |
| | 15-25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Inject through drip at first flowering in spring |
| | 15-25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Inject through drip at fruit enlargement, about 2 weeks after first flowering |

[1]For plasticulture, fertility rates are based on 5 ft row spacing. Apply 1-2 lb/A of boron with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter. [2]Replacement value of 30 lb/A of $P_2O_5$ is recommended in MD, DE and VA on Very High P soils.

### Background

The annual plasticulture system has the potential for a higher profit than the conventional matted-row system. Establishment costs are higher, but production is earlier (when crop value is highest) and berries are usually larger. Start with small acreage and increase acreage as knowledge and experience with the system is gained. This is an integrated system and all of the following components are important for maximizing production and efficiency.

### Site Selection

Plasticulture's highest yields are achieved at locations with a long growing season. Select fields with good surface and internal drainage, a southern exposure, and protection from westerly winds. If you are planning a Pick-Your-Own-Operation, take into account that customers prefer plasticulture over matted rows.

### Plant Bed Preparation, Fumigation and Fertilization

Use soil test results to determine specific nutritional needs. Apply 50-75 lb/A actual N, and $P_2O_5$ and $K_2O$ as indicated by soil test results. Apply 1-2 lb/A of boron unless soil test results indicate above-normal levels, and work into beds. Base additional P, K and B application rates on soil test results. It is particularly important to adjust the soil pH to the 6-6.5 range, see the "Liming Soils" section in the Soil and Nutrient Management chapter.

Prepare raised beds: 30-40 inches wide and 6-8 inches high on 5-5½-ft row centers. Beds should be center-crowned and firm. Depending on soil type, plant vigor, and plant tissue test results, inject an additional 30-40 lb/A of N through the drip system in the spring.

Fumigation is essential to control weeds because labeled residual herbicides cannot be used over the top of the plastic. For additional control of weeds that grow around plant holes, and for banded treatments between the mulched beds, see Weed Control below.

**Choose from the following options for bed preparation, fumigation and fertilization:**

**1.** Prepare soil, apply fertilizer, then apply fumigant. See the Soil Fumigation section in the Pest Management chapter for materials, rates and precautions. Wait 20 days to allow the fumigant to act and disperse. Then prepare raised beds as described above and apply 4.0 to 6.0 lb/A of Devrinol DF-XT to the surface of the bed and the area between beds. Lay drip irrigation and plastic mulch.

**2.** Apply fertilizer, prepare raised beds, and inject metam-sodium (Vapam HL) at 56.0 to 75.0 gal/A or 37.0 gal/mulched A. Immediately reshape beds (if necessary to form a firm, crowned bed) and apply 4.0 to 6.0 lb/A of Devrinol DF-XT to the surface of the bed and the area between beds, and lay drip irrigation and plastic mulch. Wait 20 days between fumigation and planting to allow the fumigant to act and to disperse.

**3.** Apply fertilizer and prepare raised beds as described above. Apply 4.0 to 6.0 lb/A of Devrinol DF-XT to the surface of the bed. Apply drip irrigation and plastic mulch. Inject metam-sodium (Vapam HL) through the drip system at 37 gal/mulched A. Wait 20 days between fumigation and planting to allow the fumigant to act and to disperse.

## Plants and Planting

Use transplant "plugs" propagated from actively growing runner tips. Plugs can be purchased or produced. To produce plugs from runner tips, use a well-drained artificial mix containing 50% peatmoss and 50% horticultural vermiculite or 50% pearlite. A poorly drained growing medium promotes root diseases. Consult your Extension office for a list of nurseries that supply plugs and runner tips and/or directions for propagating from tips.

Plugs can easily be planted mechanically with a waterwheel-type planter. Plant the crown of the transplant at soil level, as deep planting can promote decay and shallow planting can cause desiccation of the plant. Space plants 12 inches apart in each of the double rows in a staggered pattern. If using double rows, space rows 12-18 inches apart; this requires a 36- to 40-inch wide bed. The 18-inch between-row spacing has produced high yields. In southern NJ, DE, MD and VA, plant in late August to early September for highest first-year yields. In northern NJ and PA, plant in mid to late August. The latest recommended planting date is mid-September.

Alternatively, dormant plants may be planted directly in the field with a tool that allows the roots to be inserted into the soil without digging a hole. Planting time varies from mid-June to mid-July. The roots of dormant plants may also be trimmed to allow planting in 32-cell trays, followed by growing the plants in the trays until planting at the usual time for plug plants.

## Irrigation

At planting, overhead irrigation is essential to cool plants and plastic in warm weather and improve establishment. In the fall, irrigation may promote plant growth before row covers are applied. In the spring, overhead mist irrigation may be required for frost and freeze protection. Maintain adequate soil moisture via frequent drip irrigation in the growing season as this is effective in increasing fruit size without wetting the fruit and increasing rots.

## Row Covers

Floating row covers (FRC) are an essential part of plasticulture to reduce the desiccating effects of winter winds, for frost and freeze protection, and for early fruiting. Ultraviolet light resistant covers, 1-1.4 oz/sq yd and 60-70% light transmission have been effective. Apply FRC between October 15 and November 15, depending on location and planting date, for maximum fall growth and yields. FRC can be applied in early December for protection over the winter. Remove the FRC at the first signs of flower bud emergence. Leaving the covers on too long may reduce fruit size. Leave the covers at the edge of the field so plants can be quickly covered if there is a frost warning.

## Pest Control

Use an effective disease control program. If there is a known risk for Phytophthora crown rot caused by *Phytophthora cactorum* on the newly set transplants, apply Ridomil Gold 4SL 1.0 pt/A through the trickle irrigation system 10 days after transplanting. During late summer and fall, insecticides and miticides should be applied to prevent aphids and mites from reaching damaging levels in the spring. After plants are established and just before covering plants with the floating row in the fall, apply a fungicide to control leaf spots. After covers are removed in the spring, maintain a good pest control program. Bloom sprays are important for control of Botrytis gray mold. See the "Disease Control" and "Insect Control" sections below for materials and rates.

## Harvesting

The harvest season lasts about 3 weeks. For local markets, harvest when tips are red. The Chandler variety grown with the annual system ripens about 1 week earlier than standard varieties grown in matted rows.

## Renovation

Strawberries grown on plasticulture can be renovated in July and carried over for a second harvest year. For most varieties, mow tops with a rotary mower, leaving several leaves on the plant. For vigorous varieties and plantings that have thick foliage and numerous crowns (*e.g*., Sonata), mowing, followed by crown thinning using an asparagus knife to cut away part of the plant or "breaking out" half of the plant by hand may be the most effective technique. After renovation, maintain adequate soil moisture, and insect and disease control. In early September, apply 60 lb/mulched A of N, $P_2O_5$, and $K_2O$ via drip irrigation and follow the same cultural practices as for a new planting.

Berry size is usually smaller than in the first harvest season. With careful management, marketable yields of renovated beds can be equal to or greater than yields in the first harvest season. Renovation is especially useful if the planting will be harvested as a Pick-Your-Own.

# Matted Row Culture

## Recommended Varieties[1]

| Early | Midseason | Late |
|---|---|---|
| Earliglow (RSR) | Darselect | Jewel |
| | Allstar (VR, RSR) | |
| | Honeoye[2] | |

[1]Letters in parentheses: RSR=red stele resistant; VR=verticillium wilt resistant. [2]Becomes dark and soft under hot conditions.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Matted Row Strawberry | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| New Plantings[1] | 110-150[2] | 100 | 70 | 40 | | 165 | 115 | 65 | 0 | Total amount of nutrients recommended |
| | 30 | 100 | 70 | 40 | | 165 | 115 | 65 | 0 | Broadcast and disk-in deep |
| | 20-30 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | Sidedress 2 weeks after planting |
| | 20-30 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | Sidedress when first runners start |
| | 30-40 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | Topdress in mid-August |
| | 10-20[3] | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | Topdress in spring when plants begin to grow |
| Established Plantings | 30 | 100 | 70 | 40 | | 165 | 115 | 65 | 0 | Topdress at renovation |
| | 20-30 | 100 | 70 | 40 | | 165 | 115 | 65 | 0 | Topdress in Mid-August |
| | 20-30 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | Topdress in spring when plants begin to grow |

[1]For new plantings, apply 1-2 lb/A of boron (B) with broadcast fertilizer; see Table B-7 for more specific recommendations. [2]Rates are appropriate for lighter soils and should be reduced by about 25% for heavier soils in northern locations. [3]On heavier soils in northern locations, omit this application unless rainfall has been excessive.

## Plants and Spacing

Use certified dormant plants packed dry in polyliners. Plant virus-free plants as early in the spring as possible. Plant in rows approximately 4 ft apart with plants 18-30 inches apart in the row. Distance will depend on variety and soil type. The approximate number of plants needed at these spacings is between 4,400 and 7,300/A.

## Renovation

Strawberry plantings must be renovated annually (immediately after harvest) to thin the plants, retain vigor, and maintain berry size in subsequent years. Follow the steps below:

1. Apply 2,4-D herbicide for broadleaf weed control. Wait 7-8 days for weeds to absorb the herbicide.
2. Mow off the leaves as close to the ground as possible without damaging the crowns.
3. Narrow row widths to 12 inches using a cultivator or rototiller. Allow ½-1 inch of soil to cover the crown.
4. Apply topdressing with N, P and K (preferably based on soil test results, or as indicated in the Recommended Nutrients table above).
5. Apply preemergent herbicides and irrigate to incorporate fertilizer and herbicide.

## Pollination

Honeybees and wild bees are important for proper pollination and fruit set. Avoid applying insecticides to flowers or weeds in bloom, as pollinators may be adversely affected. If an insecticide must be applied during bloom, observe the precautions for use (see also the Pollination section in the General Production Recommendations chapter). Bee toxicity ratings for pesticides are available in the Pesticide Safety chapter and in the pesticide tables below.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

| **1.A. New Planting: Soil-Applied (Preplant Incorporated or Preemergence)** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| 3 | Dacthal 6F<br>Dacthal W-75 | 8 to 12 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6 to 9 lb/A | -- | 12 |
| -Apply preplant incorporated with shallow cultivation before transplanting, or apply any time after transplanting to weed-free soil.<br>-Primarily controls annual grasses and certain small-seeded broadleaf weeds. Maximum applications per season: not specified | | | | | | |
| **5** | Sinbar 80WDG | 2 to 3 oz/A | **terbacil** | 0.1 to 0.15 lb/A | 110 | 12 |
| -Apply after transplanting but before new runner plants start to root. If transplants are allowed to develop new foliage prior to application, the spray must be followed immediately by 0.5-1.0" of irrigation or rainfall to rinse the foliage, or unacceptable crop injury may result.<br>-Controls many annual broadleaf weeds, but may be weak on pigweed species.<br>-Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. **Do not** apply Sinbar to soils with less than 0.5% organic matter.<br>-**Do not** add surfactant, oil concentrate, or any other spray additive, or tank-mix with any other pesticide unless the mixture is approved on the Sinbar label.<br>-Data have shown that more consistent weed control and less crop injury occurs when 0.05 lb/A terbacil (1.0 oz/A Sinbar) is applied at 3 week intervals. Begin applications 3-6 weeks after transplanting, when the strawberries have 3 new full size trifoliate leaves, but before weeds exceed 1 inch in height. Maximum Sinbar application per season: 8.0 oz/A, unless otherwise directed on the label. | | | | | | |
| 15 | Devrinol 2-XT 2EC<br>Devrinol DF-XT 50DF | 2 to 4 qt/A<br>2 to 4 lb/A | **napropamide** | 1 to 2 lb/A | -- | 24 |
| -Labeled for preplant incorporated application with plastic mulch production; apply and uniformly incorporate to a depth of 2 inches.<br>-**Bareground** production: apply to weed-free soil immediately after transplanting. Activate with ½ inch sprinkler irrigation within 24hr after application. Irrigation moves the herbicide into the soil and prevents breakdown of napropamide by the sun.<br>-**Do not** apply from bloom through harvest. Primarily controls annual grasses and suppresses or controls certain annual broadleaf weeds.<br>-Maximum for Devrinol 2-XT 2EC: 8 qt/A per season. Maximum Devrinol DF-XT 50DF: 8 fl oz/A per season. | | | | | | |

## 1.B. New Planting: Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>12 to 16 fl oz/A | **clethodim** | 0.094 to 0.13 lb/A | 4 | 24 |
| | Poast 1.5EC | 1 to 2 pt/A | **sethoxydim** | 0.19 to 0.38 lb/A | 7 | 12 |
| -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v.<br>-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.<br>-Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.<br>-If repeat applications are necessary, allow 14 days between applications.<br>-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.<br>-Rainfastness 1 hr.<br>-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 64 fl oz/A for the season.<br>-**Do not** apply more than 2.5 pt/A Poast in single application and **do not** exceed 2.5 pt/A for the season. | | | | | | |
| **5** | Sinbar 80WDG | 2 to 6 oz/A | **terbacil** | 0.1 to 0.3 lb/A | 110 | 12 |
| -Apply in late summer or early fall to control winter annual broadleaf weeds. If the crop is not dormant at the time of application, the spray must be followed immediately by 0.5-1.0 inches of irrigation or rainfall to rinse the strawberry foliage, or unacceptable crop injury may result. Controls many annual broadleaf weeds, but may be weak on pigweed species.<br>-Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. **Do not** apply Sinbar to soils with less than 0.5% organic matter.<br>-**Do not** add surfactant, oil concentrate, or any other spray additive, or tank-mix with any other pesticide unless the mixture is approved on the Sinbar label.<br>-Maximum Sinbar application per season: 8.0 oz/A, unless otherwise directed on the label. | | | | | | |

## 1.C. New Planting: Late Fall Dormant

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>12 to 16 fl oz/A | **clethodim** | 0.094 to 0.13 lb/A | 4 | 24 |
| | Poast 1.5EC | 1 to 2 pt/A | **sethoxydim** | 0.19 to 0.38 lb/A | 7 | 12 |
| -See Select 2EC / Select Max 0.97EC / Poast 1.5EC in listing under “New Planting-Postemergence” | | | | | | |
| 3 | Dacthal 6F<br>Dacthal W-75 | 8 to 12 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6 to 9 lb/A | -- | 12 |
| -Apply to weed-free soil in the fall and repeat in early spring.<br>-Primarily controls annual grasses and certain small-seeded broadleaf weeds.<br>-Maximum applications per season: not specified | | | | | | |
| **5** | Sinbar 80WDG | 2 to 4 oz/A | **terbacil** | 0.1 to 0.2 lb/A | 110 | 12 |
| -Apply just prior to mulching in late fall to extend weed control through harvest the following spring.<br>-Controls many annual broadleaf weeds, but may be weak on pigweed species.<br>-Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. **Do not** apply Sinbar to soils with less than 0.5% organic matter.<br>-**Do not** add surfactant, oil concentrate, or any other spray additive, or tank-mix with any other pesticide unless the mixture is approved on the Sinbar label.<br>-Maximum Sinbar application per season: 8.0 oz/A, unless otherwise directed on the label. | | | | | | |
| 15 | Devrinol 2-XT 2EC<br>Devrinol DF-XT 50DF | 4 to 6 qt/A<br>4 to 6 lb/A | **napropamide** | 2 to 3 lb/A | -- | 24 |
| -Apply in late fall through early winter (not on frozen ground) or in early spring. Activate with ½ inch sprinkler irrigation within 24hr after application. Irrigation moves the herbicide into the soil and prevents breakdown of napropamide by the sun.<br>-Primarily controls annual grasses and suppresses or controls certain annual broadleaf weeds.<br>-Maximum for Devrinol 2-XT 2EC: 8 qt/A per season. Maximum Devrinol DF-XT 50DF: 8 fl oz/A per season. | | | | | | |

| 2.A. Bearing Year: Late Winter or Early Spring | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>12 to 16 fl oz/A | **clethodim** | 0.094 to 0.125 lb/A | 4 | 24 |
| | Poast 1.5EC | 1 to 2 pt/A | **sethoxydim** | 0.2 to 0.4 lb/A | 7 | 12 |
| -See Select 2EC / Select Max 0.97EC / Poast 1.5EC in listing under "New Planting - Postemergence" | | | | | | |
| 3 | Dacthal 6F<br>Dacthal W-75 | 8 to 12 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6 to 9 lb/A | -- | 12 |
| -Apply anytime to weed-free soil in the early spring. **Do not** apply after first bloom through harvest.<br>-Primarily controls annual grasses and certain small-seeded broadleaf weeds. Maximum applications per season: not specified | | | | | | |
| 4 | 2,4-D amine 4SL<br>Formula 40 or Weedar | 1 to 1.5 qt/A | **2,4-D** | 1 to 1.5 lb/A | -- | 48 |
| -Apply to established stands in late winter or early spring when the strawberries are dormant.<br>-**Do not** apply 2,4-D between mid-August and winter dormancy, as it may affect flower bud formation, resulting in distorted berries.<br>-**Do not** apply unless possible injury to the crop is acceptable. Controls many broadleaf weeds. Rainfastness is 6 to 8 hrs.<br>-Maximum number of Formula 40 4 SL applications per year is 1 and **do not** exceed 1.5 qt/A per application. | | | | | | |
| 4 | Stinger 3A | 2 to 10.5 fl oz/A | **clopyralid** | 0.047 to 0.25 lb/A | 30 | 12 |
| -**A Special Local-Needs Label 24(c) has been approved for the use of Stinger 3A to control broadleaf weeds in strawberries in NJ, MD, PA and VA. The legal use of this product may require a waiver of liability signed by the grower, and returned to Dow AgroSciences.** Apply in 1 or 2 applications. When 2 applications are used to control susceptible hard-to-kill perennial weeds, spray the first application at least 30 days before harvest and the second application at renovation, after harvest<br>-Controls weeds in the Composite and Legume families, including annuals (galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch) and perennials (Canada thistle, goldenrod species, aster species, and mugwort).<br>-Use 2 to 4 fl oz/A to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fl oz/A to control larger annual weeds. Apply the maximum rate of 10.5 fl oz/A (in 1 or split into 2 applications) to suppress or control perennial weeds.<br>-**Do not** tank-mix Stinger with other herbicides registered for use in strawberries. **Do not** use Stinger with surfactants.<br>-Stinger is a postemergence herbicide with residual soil activity. Observe crop restrictions or injury may occur from carryover.<br>-Rainfastness is 6 hrs. Maximum Stinger application per year: 10.5 fl oz/A. | | | | | | |
| **14** | Chateau 51WDG | 3 oz/A | **flumioxazin** | 0.096 lb/A | -- | 12 |
| -Apply to established stands of matted row strawberries in late winter or early spring when strawberries are dormant, or as a hooded or shielded spray between the rows of strawberries on plastic mulch before fruit set.<br>-Controls many annual broadleaf weeds, and suppresses or controls wild pansy.<br>-Tank-mix with 2,4-D to improve the spectrum of weeds controlled when treating dormant matted row strawberries, or tank-mix with Gramoxone when applying a hooded or shielded spray between the rows of strawberries grown on plastic mulch. Oil concentrate at 1% v/v or nonionic surfactant at 0.25% v/v may be added to improve the control of emerged weeds, but may also increase the risk of crop injury. Maximum for Chateau: 3 oz/A per application, 3 oz/A per season. | | | | | | |
| 15 | Devrinol 2-XT<br>Devrinol DF-XT 50DF | 4 to 6 qt/A<br>4 to 6 lb/A | **napropamide** | 2 to 3 lb/A | -- | 24 |
| -Apply in late fall through early winter (not on frozen ground) or in early spring. **Do not** apply from bloom through harvest Activate with ½ inch sprinkler irrigation within 24 hr after application. Irrigation moves the herbicide into the soil and prevents breakdown of napropamide by the sun. Primarily controls annual grasses and suppresses or controls certain annual broadleaf weeds; will not control emerged weeds. Maximum for Devrinol 2-XT 2EC: 8 qt/A per season. Maximum Devrinol DF-XT 50DF: 8 fl oz/A per season. | | | | | | |

| 2.B. Bearing Year: Renovation-Summer | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>12 to 16 fl oz/A | **clethodim** | 0.094 to 0.125 lb/A | 4 | 24 |
| | Poast 1.5EC | 1 to 2 pt/A | **sethoxydim** | 0.2 to 0.4 lb/A | 7 | 12 |
| -See Select 2EC / Select Max 0.97EC / Poast 1.5EC in listing under "New Planting - Postemergence" | | | | | | |
| 3 | Dacthal 6F<br>Dacthal W-75 | 8 to 12 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6 to 9 lb/A | -- | 12 |
| -Apply any time after harvest to weed-free soil. Primarily controls annual grasses and certain broadleaf weeds.<br>-Maximum applications per season: not specified | | | | | | |
| 4 | 2,4-D amin 4SL<br>Formula 40 or Weedar | 1 to 1.5 qt/A | **2,4-D** | 1.0 to 1.5 lb/A | -- | 48 |
| -**Do not** apply 2,4-D between mid-August and winter dormancy, as it may affect flower bud formation, resulting in distorted berries. **Do not** apply unless possible injury to the crop is acceptable. Controls many broadleaf weeds. Rainfastness is 6 to 8 hrs.<br>-Maximum number of Formula 40 4 SL applications per year is 1 and **do not** exceed 1.5 qt/A per application. | | | | | | |

*2.B. Bearing Year: Renovation-Summer continued on next page*

*2.B. Bearing Year: Renovation-Summer - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | Stinger 3A | 2 to 10.5 fl oz/A | **clopyralid** | 0.047 to 0.25 lb/A | 30 | 12 |
| -**A Special Local-Needs Label 24(c) has been approved for the use of Stinger 3A to control broadleaf weeds in strawberries in NJ, MD, PA and VA. The legal use of this product may require a waiver of Liability signed by the grower, and returned to Dow AgroSciences.**<br>-Apply in 1 or 2 applications. When 2 applications are used to control susceptible hard-to-kill perennial weeds, spray the first application at least 30 days before harvest and the second application at renovation, after harvest<br>-Controls weeds in the Composite and Legume families, including annuals (galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch) and perennials (Canada thistle, goldenrod species, aster species, and mugwort).<br>-Use 2 to 4 fl oz/A to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fl oz/A to control larger annual weeds. Apply the maximum rate of 10.5 fl oz/A (in 1 or split into 2 applications) to suppress or control perennial weeds.<br>-**Do not** tank-mix Stinger with other herbicides registered for use in strawberries.<br>-**Do not** use Stinger with surfactants.<br>-Stinger is a postemergence herbicide with residual soil activity. Observe crop restrictions or injury may occur from carryover.<br>-Rainfastness is 6 hrs. Maximum Stinger application per year: 10.5 fl oz/A. | | | | | | |
| 5 | Sinbar 80WDG | 4 to 8 oz/A | **terbacil** | 0.2 to 0.4 lb/A | 110 | 12 |
| -Apply at postharvest renovation after old leaves have been removed but before new growth begins.<br>-Controls many annual broadleaf weeds, but may be weak on pigweed species.<br>-Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. **Do not** apply Sinbar to soils with less than 0.5% organic matter.<br>-**Do not** add surfactant, oil concentrate, or any other spray additive, or tank-mix with any other pesticide unless the mixture is approved on the Sinbar label.<br>-Maximum Sinbar application per season: 8.0 oz/A, unless otherwise directed on the label. | | | | | | |
| 22 | Gramoxone 2SL | 2 pt/A | **paraquat** | 0.5 lb/A | 21 | 24 |
| -Apply as a directed shielded spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray solution). **Do not** allow spray or spray drift to contact the crop (use shields) or injury may result. **Do not** exceed a spray pressure of 30 psi. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 3 application per year are allowed. | | | | | | |

## 2.C. Established Planting: Late Fall Dormant

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>12 to 16 fl oz/A | **clethodim** | 0.094 to 0.125 lb/A | 4 | 24 |
| | Poast 1.5EC | 1 to 2 pt/A | **sethoxydim** | 0.2 to 0.4 lb/A | 7 | 12 |
| -See Select 2EC / Select Max 0.97EC / Poast 1.5EC in listing under “New Planting - Postemergence” | | | | | | |
| 3 | Dacthal 6F<br>Dacthal W-75 | 8 to 12 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6 to 9 lb/A | -- | 12 |
| -Apply to weed-free soil in the fall and repeat in early spring. **Do not** apply after first bloom through harvest.<br>-Primarily controls annual grasses and certain small-seeded broadleaf weeds. Maximum applications per season: not specified | | | | | | |
| **5** | Sinbar 80WDG | 4 to 8 oz/A | **terbacil** | 0.2 to 0.4 lb/A | 110 | 12 |
| -Apply just prior to mulching in late fall to extend weed control through harvest the following spring. Controls many annual broadleaf weeds, but may be weak on pigweed species. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. **Do not** apply Sinbar to soils with less than 0.5% organic matter.<br>-**Do not** add surfactant, oil concentrate, or any other spray additive, or tank-mix with any other pesticide unless the mixture is approved on the Sinbar label. Maximum Sinbar application per season: 8.0 oz/A, unless otherwise directed on the label. | | | | | | |
| 15 | Devrinol 2-XT<br>Devrinol DF-XT 50DF | 4 to 6 qt/A<br>4 to 6 lb/A | **napropamide** | 2 to 3 lb/A | -- | 24 |
| -Apply in late fall through early winter (not on frozen ground) or in early spring. **Do not** apply from bloom through harvest<br>-Activate with ½ inch sprinkler irrigation within 24 hr after application. Irrigation moves the herbicide into the soil and prevents breakdown of napropamide by the sun. Primarily controls annual grasses and suppresses or controls certain annual broadleaf weeds.<br>-Maximum for Devrinol 2-XT 2EC: 8 qt/A per season. Maximum Devrinol DF-XT 50DF: 8 fl oz/A per season. | | | | | | |

## 3. Other Labeled Herbicides

These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| 3 | Prowl H2O | **pendimethalin** |
| **9** | Roundup (various) | **glyphosate** |
| **14** | Ultra Blazer | **acifluorfen** |
| **14** | Goal (VA only) | **oxyfluorfen** |
| **14** | Aim | **carfentrazone** |
| **14** | Spartan | **sulfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Insecticides

**Aphids, Spittlebugs** Aphids can vector viruses into a planting, thus tolerance for this pest is low. Spittlebugs are primarily a nuisance for harvesters.

| Apply one of the following formulations 10 days after new growth begins: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Diazinon AG500 (aphids) | 1.0 pt/A | diazinon* | 5 | 36 | H |
| 1B | Malathion 57EC | 1.5 to 3.0 pt/A | malathion | 3 | 12 | H |
| 3A | Brigade WSB | 6.4 to 32 oz/A | bifenthrin* | 0 | 12 | H |
| 3A | Danitol2.4EC (spittlebugs) | 10.67 fl oz/A | fenpropathrin* | 2 | 24 | H |
| 4A | Actara 25WDG (aphids) | 1.5-3.0 oz/A | thiamethoxam - **foliar** | 3 | 12 | H |
| 4A | Admire Pro (aphids) | 10.5-14 fl oz/A | imidacloprid - **soil** | 14 | 12 | H |
| 4A | Admire Pro (aphids and spittlebugs) | 1.3 fl oz/A | imidacloprid - **foliar** | 5 | 12 | H |
| 4A | Assail 30SG | 1.9-4.0 oz/A | acetamiprid | 1 | 12 | M |
| 4A+28 | Voliam Flexi (aphids) | 2.0 to 4.0 oz/A | thiamethoxam+chlorantraniliprole-**foliar** | 3 | 12 | H |
| 9C | Beleaf 50SG (aphids) | 2.8 oz/A | flonicamid | 0 | 12 | L |
| n/a | Ecotec (OMRI) | 1.0 to 4.0 pt/A | rosemary oil + peppermint oil | 0 | 0 | -- |
| n/a | Ecozin Plus 1.2% ME (OMRI) | 15.0 to 30.0 fl oz/A | azadirachtin | see label | 4 | N |
| n/a | Trilogy (aphids) (OMRI) | 0.5 to 1.0% solution | neem extract | 0 | 4 | H |

**Leafrollers** Leafrollers are a sporadic pest in most of the region. Treatment is usually not required.

| The following formulations are available. Apply one spray 10 days after full bloom: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Diazinon AG500 | 1.0 pt/A | diazinon* | 5 | 36 | H |
| 3A | Brigade WSB | 6.4 to 32.0 oz/A | bifenthrin* | 0 | 12 | H |
| 3A | PyGanic EC 5.0 II | 4.5 to 18.0 fl oz/A | pyrethrins | 0 | 12 | M |
| 4A | Assail 30SG | 4.0 to 6.9 oz/A | acetamiprid | 1 | 12 | M |
| 5 | Entrust SC (OMRI) | 4.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| n/a | Ecozin Plus 1.2% ME (OMRI) | 15.0 to 30.0 oz/A | azadirachtin | see label | 4 | N |

### Potato Leafhoppers

Potato leafhoppers cause leaf yellowing and distortion. There are no effective cultural controls, though damage may be worse after neighboring fields or weedy patches are mowed as leafhoppers will move to strawberry plants.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Malathion 57EC | 1.5 to 3.0 pt/A | malathion | 3 | 12 | H |
| 3A | PyGanic EC 5.0 II | 4.5 to 18.0 fl oz/A | pyrethrins | 0 | 12 | M |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam | 3 | 12 | H |
| 4A | Assail 30SG | 1.9 to 4.0 oz/A | acetamiprid | 1 | 12 | M |
| 4A + 28 | Voliam Flexi | 2.0 to 4.0 oz/A | thiamethoxam + chlorantraniliprole | 3 | 12 | H |
| n/a | Ecozin Plus 1.2% ME (OMRI) | 15.0 to 30.0 oz/A | azadirachtin | see label | 4 | N |

### Root Weevils

Several species can damage strawberry plants; damage is often worst near wooded field edges. Watch for characteristic leaf notching as a sign of active adults. Larvae should be targeted starting in mid-summer.

| Apply one of the following formulations (note: foliar sprays target adults, soil applications target larvae): | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| n/a | Entomopathogenic nematodes[1] | see footnote | see footnote | -- | -- | -- |

*Root weevils continued on next page*

*Root weevils - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1B | Malathion 57EC | 1.5 to 3.0 pt/A | malathion | 3 | 12 | H |
| 3A | Brigade WSB | 8.0 to 32.0 oz/A | bifenthrin* | 0 | 12 | H |
| 4A | Platinum 75SG | 1.70 to 4.01 oz/A | thiamethoxam - **soil** | 75 | 12 | L |
| 4A | Actara 25WDG | 4.0 oz/A | thiamethoxam - **foliar** | 3 | 12 | H |

[1]Entomopathogenic nematodes (use *Heterorhabditis bacteriophora*). Apply 1-2 billion/A during evening or early morning when soil temperatures are at or above 60°F (16°C), then irrigate them into the soil.

## Sap Beetles

Sap beetles are attracted to ripe, decaying fruit and bore into berries. They are a nuisance, especially in Pick-Your-Own fields with rotting, over-ripe berries abound. Preventing the accumulation of decaying fruit on or between beds is one way of avoiding beetle buildup. Sprays may not reach adults which are protected under the berries. Sprays that target larvae should be applied when adults are first noticed.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Brigade WSB | 6.4 to 32.0 oz/A | bifenthrin* | 0 | 12 | H |
| 3A | Danitol 2.4 EC | 16.0 to 21.3 fl oz/A | fenpropathrin* | 2 | 24 | H |
| 4A | Assail 30SG | 4.0 to 6.9 oz/A | acetamiprid | 1 | 12 | M |
| 15 | Rimon 0.83EC (only affects larvae) | 12.0 fl oz/A | novaluron | 1 | 12 | H |
| n/a | Ecozin Plus 1.2% ME (OMRI) | 15.0 to 30.0 oz/A | azadirachtin | see label | 4 | N |

## Slugs

Slugs prefer a cool, wet, dark environment, and mulch, weeds, and other plant trash in beds during a wet spring provide the perfect setting. Mulch removal and adequate weed control help reduce the slug population.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| n/a | Sluggo (OMRI) | 20.0 to 44.0 lb/A | iron phosphate | 0 | 0 | -- |
| n/a | Deadline Bullets | see labels for rates | metaldehyde | --- | 12 | -- |

**Spittlebugs** See Aphids, Spittlebugs above.

## Spotted Wing Drosophila

Sporadically problematic on day-neutral strawberries during late summer and fall, but not earlier in the season.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Danitol 2.4 EC | 16.0 to 21.3 fl oz/A | fenpropathrin* | 2 | 24 | H |
| 5 | Radiant SC | 6-10 fl oz/A | spinetoram | 1 | 4 | H |
| 15 | Rimon 0.83EC | 12.0 fl oz/A | novaluron (affects larvae only) | 1 | 12 | H |
| n/a + 3A | Azera (OMRI) | 2.0 to 3.0 pt/A | azadirachtin + pyrethrins | see label | 12 | M |
| 3A | PyGanic EC 5.0 II (OMRI) | 4.5 to 18.0 fl oz/A | pyrethrins | 0 | 12 | M |
| 5 | Entrust SC (OMRI) | 4.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |

**Strawberry Rootworms** Use of broad-spectrum insecticides for other pests will aid in controlling rootworms.

## Strawberry Weevils (Strawberry Clippers)

| **Apply one of the following formulations after new growth starts and before fruit buds are visible. Repeat 10 days later:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin XLR | 1.0 to 2.0 qt/A | carbaryl | 7 | 12 | H |
| 1B | Lorsban Advanced | 1.0 qt/A | chlorpyrifos* - **prebloom only** | 21 | 24 | H |
| 3A | Brigade WSB | 6.4 to 32 oz/A | bifenthrin* | 0 | 12 | H |
| 3A | Danitol 2.4 EC | 16.0 to 21.3 fl oz/A | fenpropathrin | 2 | 24 | H |
| n/a | Ecozin Plus 1.2% ME (OMRI) | 15.0 to 30.0 oz/A | azadirachtin | see label | 4 | N |

## Tarnished Plant Bugs

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Brigade WSB | 6.4 to 32.0 oz/A | bifenthrin* | 0 | 12 | H |
| 3A | Danitol 2.4EC | 10.67 fl oz/A | fenpropathrin | 2 | 24 | H |
| 4A | Assail 30SG | 4.0 to 6.9 oz/A | acetamiprid | 1 | 12 | M |
| 9C | Beleaf 50SG | 2.8 oz/A | flonicamid | 0 | 12 | L |
| 1B | Malathion 57EC | 1.5-3.0 pt/a | malathion | 3 | 12 | H |
| 3A | PyGanic EC 5.0 II (OMRI) | 4.5 to 18.0 fl oz/A | pyrethrins | 0 | 12 | M |
| n/a | Ecozin Plus 1.2% ME (OMRI) | 15.0 to 30.0 oz/A | azadirachtin | see label | 4 | N |
| n/a | Ecotec (OMRI) | 1.0 to 4.0 pt/A | rosemary oil + peppermint oil | 0 | 0 | -- |

## Thrips

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 4A | Assail 30SG | 4.0 to 6.9 oz/A | acetamiprid | 1 | 12 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 3A | PyGanic EC 5.0 II (OMRI) | 4.5 to 18.0 fl oz/A | pyrethrins | 0 | 12 | M |
| 5 | Entrust SC (OMRI) | 4.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| n/a | Ecozin Plus 1.2% ME (OMRI) | 15.0 to 30.0 oz/A | azadirachtin | see label | 4 | N |
| n/a | Trilogy (OMRI) | 0.5 to 1.0% solution | neem extract | 0 | 4 | H |
| n/a | Ecotec (OMRI) | 1.0 to 4.0 pt/A | rosemary oil + peppermint oil | 0 | 0 | -- |

## Two-Spotted Spider Mites (TSSM)

For best results, control TSSM early in the spring before eggs are laid. Thorough underleaf spray coverage is necessary. For resistance management, alternate materials with different modes of action.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 6 | Agri-mek 0.15 EC | 16.0 fl oz/A | abamectin* | 3 | 12 | H |
| 20B | Kanemite 15SC | 21.0 to 31.0 fl oz/A | acequinocyl | 1 | 12 | L |
| 21A | Portal | 2.0 pt/A | fenpyroximate | 1 | 12 | N |
| 23 | Oberon 2SC | 12.0 to 16.0 fl oz/A | spiromesifen | 3 | 12 | M |
| 25 | Nealta | 13.7 fl oz/A | cyflumetofen | 1 | 12 | -- |
| 12B | Vendex 50WP | 1.5 to 2.0 lb/A | fenbutatin-oxide* | 1 | 48 | N |
| 20D | Acramite 50WS | 0.75 to 1.00 lb/A | bifenazate | 1 | 12 | M |
| 10B | Zeal Miticide[1] | 2.0 to 3.0 oz/A | etoxazole | 1 | 12 | N |
| 10A | Savey 50DF | 6.0 oz/A | hexythiazox | 3 | 12 | N |
| n/a | Trilogy (OMRI) | 0.5 to 2.0% solution | neem extract | 0 | 4 | H |
| n/a | Ecotec (OMRI) | 1.0 to 4.0 pt/A | rosemary oil + peppermint oil | 0 | 0 | -- |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

**Nematode Control** See the Soil Fumigation and Nematodes sections in the Pest Management chapter.

## Dip Treatments for Freshly Dug (Bare Root) Transplants

Use Abound or Switch for plants with a known Anthracnose crown rot problem. Dip entire plant 2-5 minutes, then plant as quickly as possible. Phosphite fungicides can be used to suppress Pythium or Phytophthora (check labels).

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 9 + 12 | Switch | 5.0 to 8.0 fl oz/100 gal water | cyprodinil + fludioxonyl | 0 | 12 | N |
| 11 | Abound | 5.0 to 8.0 fl oz/100 gal water | azoxystrobin | 0 | 4 | N |

## Bacterial and Fungal Diseases

### Angular Leaf Spot

This disease may cause caps to turn brown or black resulting in unmarketable fruit. Planting disease-free plants is critical. If symptoms appear on established plants, applying fixed copper products can help, but not if weather conditions are highly favorable to the disease. Discontinue fixed copper applications if plant injury occurs, usually after 4-5 sprays. Overhead irrigation/frost protection will make angular leaf spot worse.

### Anthracnose Crown Rot

This disease is caused by *Colletotrichum gloeosoporioides* as opposed to *C. acutatum* that causes mostly fruit rot. The response to fungicides differs between these species and a product may not be effective against both diseases.

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Do not apply Quadris Top more than twice before rotating with Captan or Switch on a 10-14 day schedule.** | | | | | | |
| M3 | Thiram 480DP | 4.4 lb/A | thiram | 3 | 24 | N |
| M4 | Captan 80WDG | 3.7 lb/A | captan | 0 | 24 | N |
| 3 + 11 | Quadris Top | 12 to14 fl oz/A | azoxystrobin + difenoconazole | 0 | 12 | -- |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 oz /A | cyprodinil + fludioxonil | 0 | 12 | N |

### Anthracnose Fruit Rot (*Colletotrichum acutatum*)

Begin sprays prior to disease development or no later than at 10% bloom and continue on a 7-10 day interval. Use the higher rates and shorter intervals when disease pressure is high.

Except for Captan and Thiram, do not apply the same fungicides more than 2 times in a row; switch to a fungicide in a different FRAC code. Maintain continuous coverage of Captan and/or a FRAC code 11 fungicide, by applying the following combinations:

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following PRIOR to disease development:** | | | | | | |
| M3 | Thiram 75WDG | 4.4 lb/A | thiram | 3 | 24 | N |
| M4 | Captan 80WDG | 3.7 lb/A | captan | 0 | 24 | N |
| **and tank-mix one of the above with one of the following FRAC code 11 fungicides AFTER onset of disease:** | | | | | | |
| 7 + 11 | Merivon | 5.5 to 8 fl oz | pyraclostrobin + fluxapyroxad | 0 | 12 | N |
| 7 + 11 | Pristine 38WG | 18.5 to 23.0 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |
| 11 | Cabrio 20EG | 12.0 to 14.0 oz/A | pyraclostrobin | 0 | 12 | N |
| **Rotate AND tank mix one of the following:** | | | | | | |
| M4 | Captan 80WDG | 3.7 lb/A | captan | 0 | 24 | N |
| M4 + 17 | Captevate 68WDG[1] | 3.5 to 5.25 lb/A | captan + fenhexamid | 0 | 24 | N |
| **With one of the following as long as weather conditions favor disease development or disease is present.** | | | | | | |
| 7 + 11 | Pristine 38WG | 18.5 to 23.0 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |
| 11 | Cabrio 20EG | 12.0 to 14.0 oz/A | pyraclostrobin | 0 | 12 | N |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 0 | 12 | N |
| 17 | Elevate 50WDG[1] | 1.1 to 1.5 lb /A | fenhexamid | 0 | 12 | N |

[1] Do not tank mix Captivate with Elevate

### Black Root Rot

This is a disease complex caused by cultural stresses coupled with many different fungi and by nematode feeding injury, and is the main reason for preplant fumigation of strawberry. The most prevalent fungi associated with the disease are *Rhizoctonia* and *Pythium*. Crop rotation of 4-5 years will reduce the incidence of black root rot. In fields with a high water table, the use of raised beds will provide some control. If rotation is not an option, preplant fumigation may be helpful. Fumigants are listed in the Soil Fumigation section in the Pest Management Chapter. Applying azoxystrobin may help suppress Rhizoctonia root rot. Also see Red stele and Phytophthora crown rot.

### Fungal Leaf Blight, Leaf Scorch and Leaf Spot

In the fall or early spring, leaf diseases are not usually problematic in strawberries, but prolonged warm, wet weather favors the disease in the late spring and summer. Incidence may be associated with plant source.

*Fungal Leaf Blight, Leaf Scorch and Leaf Spot continued on next page*

*Fungal Leaf Blight, Leaf Scorch and Leaf Spot - continued*

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **PRIOR TO THE ONSET OF DISEASE, TANK MIX one of the following fungicides:** | | | | | | |
| M1 | Topsin-M 70WP | 1.0 lb/A | thiophanate methyl | 1 | 24 | N |
| M4 | Captan 80WDG | 3.8 lb/A | captan | 0 | 24 | N |
| M4 | Captec 4L | 3.0 qt/A | captan | 0 | 24 | N |
| 2 | Rovral 4FL (prebloom only) | 1.5 to 2.0 pt/A | iprodione | 1 | 12 | N |
| **WITH one of the following fungicides (Do not apply FRAC code 11 fungicides (Cabrio or Pristine) more than twice in a row. Rotate to a product with a different mode of action to reduce the chance of fungicide resistance development):** | | | | | | |
| 3 | Rally 40WSP | 2.5 to 5.0 oz/A | myclobutanil | 0 | 24 | N |
| 7 + 11 | Pristine 38WG | 18.5 to 23.0 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |
| 11 | Cabrio 20EG | 12.0 to 14.0 oz/A | pyraclostrobin | 0 | 12 | N |

## Gray Mold (Botrytis Fruit Rot)

Start spraying at 5-10% bloom, because most fruit infections occur through the flower. Repeat every 7-10 days. Spray less frequently during prolonged dry periods, but spray every 5-7 days during very wet periods. For season-long control it is usually sufficient to spray once a week for 4 weeks. Tank-mix and rotate fungicides from different FRAC codes to reduce the chance of fungicide resistance development. **Note: If Pristine is included in the schedule for Anthracnose control, in most cases that may provide satisfactory Gray Mold control and separate application of specific products may not be necessary.**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Application #1, apply ONE of the following:** | | | | | | |
| M3 | Thiram 480DP | 4.4 lb/A | thiram | 3 | 24 | N |
| M4 | Captan 80WDG | 3.7 lb/A | captan | 0 | 24 | N |
| 11 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 0 | 12 | N |
| **Application #2, apply ONE of the following if resistance is NOT SUSPECTED on your farm:** | | | | | | |
| 7 | Fontelis 1.67SC (except Jewel, L'Amour and Clancy varieties)[1] | 16.0 to 24.0 oz/A | penthiopyrad | 0 | 12 | L |
| 17 | Elevate 50WDG[1] | 1.1 to 1.5 lb/A | fenhexamid | 0 | 12 | N |
| **If testing, observation, or frequent prior use of the above materials indicates high resistance risk, apply ONE of the following:** | | | | | | |
| M3 | Thiram 480DP | 4.4 lb/A | thiram | 3 | 24 | N |
| M4 | Captan 80WDG | 3.7 lb/A | captan | 0 | 24 | N |
| M4 + 17 | Captevate 68WDG | 3.5 to 5.25 lb/A | captan + fenhexamid | 0 | 24 | N |
| **Application #3: Same as Application #1** | | | | | | |
| **Application #4. For subsequent applications, ROTATE BETWEEN the following fungicides with different modes of action.** | | | | | | |
| 7 | Fontelis 1.67SC (except Jewel, L'Amour and Clancy varieties)[1] | 16.0 to 24.0 oz/A | penthiopyrad | 0 | 12 | L |
| 11 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 0 | 12 | N |
| 17 | Elevate 50WDG[1] | 1.1 to 1.5 lb /A | fenhexamid | 0 | 12 | N |

[1] If fungicide resistance is suspected do not apply.

## Powdery Mildew

Unless symptoms are severe, crop losses are rare in the fall and the disease may not reappear in the spring. Check both sides of leaves in the spring for disease pressure. Severe disease during spring may justify fungicide application on a 14-21 day interval. Do not apply FRAC code 11 fungicides (i.e., Cabrio or Pristine) more than twice in a row. Switch to another product to reduce the chance of fungicide resistance development.

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Rotate between the following fungicides with different modes of action (FRAC code):** | | | | | | |
| U6 | Torino 0.85SC | 3.4 oz/A | cyflufenamid | 0 | 4 | -- |
| 3 | Mettle 125ME | 3.0 to 5.0 fl oz/A | tetraconazole | 0 | 12 | -- |
| 3 | Procure 50WSP | 4.0 to 8.0 oz/A | triflumizole | 1 | 12 | N |
| 3 | Rally 40WSP | 2.5 to 5.0 oz/A | myclobutanil | 0 | 24 | N |
| 3 + 9 | Inspire Super 2.8F | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodinil | 0 | 12 | -- |
| 7 + 11 | Pristine 38WG | 18.5 to 23.0 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |
| 11 | Cabrio 20EG | 12.0 to 14.0 oz/A | pyraclostrobin | 0 | 12 | N |
| 13 | Quintec 2.08SC | 4.0 to 6.0 fl oz/A | quinoxyfen | 1 | 12 | -- |

## Red Stele and Phytophthora Crown Rot

Prevent spread of the red stele pathogen via cultivation equipment and/or surface runoff water. Selecting fields with well-drained soils and planting on high, raised beds will help reduce disease. Crop rotation may be of little value, as the red stele pathogen persists in soil for many years, and persistence of the crown rot pathogen is unknown. However, disease is very unlikely when clean plants are introduced to soil with no history of strawberry production. If red stele is present in the soil, consider using varieties that are resistant to several races such as 'Allstar', 'Earliglow', 'Guardian' or 'Latestar'. For crown rot, resistant cultivars are not available.

The following fungicides can be applied as preplant dips (See note for: "Dip Treatments for Freshly Dug (Bare Root) Transplants" above), foliar sprays, or by drip irrigation for additional control.

| **NEW PLANTINGS** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| **Foliar sprays of phosphite products should begin 14 to 21 days after planting and continue on a 30 to 60 day interval as long as favorable disease conditions occur. These products include:** | | | | | | |
| 33 | Aliette 80WDG | 2.5 to 5.0 lb/A | aluminium tris | 0.5 | 12 | N |
| 33 | Phosphite salts | 1.0 to 3.0 qt/A | phosphite | 0 | 4 | N |
| **Fungicides containing mefenoxam or metalaxyl can be applied as sprays or through drip irrigation.** | | | | | | |
| **4** | MetaStar 2E AG | 2.0 qt/*treated* A | metalaxyl | 0 | 48 | N |
| **4** | Ridomil Gold 4SL | 1.0 pt /*treated* A | mefenoxam | 0 | 48 | N |
| **4** | Ultra Flourish 2F | 2.0 pt/*treated* A | mefenoxam | 0 | 48 | N |

| **ESTABLISHED PLANTINGS** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| **Spring applications should begin when plants start active growth and before 1st bloom. Foliar sprays of phosphite products should be repeated every 30 to 60 days as long as weather conditions favor disease development. These products include:** | | | | | | |
| 33 | Aliette 80WDG | 2.5 to 5.0 lb/A | aluminum tris | 0.5 | 12 | N |
| 33 | Phosphite salts | 1.0 to 3.0 qt/A | phosphite | 0 | 4 | N |
| **Fungicides containing mefenoxam or metalaxyl can be applied as sprays or through drip irrigation. The first spring application should be made when plants start active growth before 1st bloom. A second spring application may be made at fruit set when Ridomil Gold is used, but not Meta Star or Ultra Flourish. All 3 products may be applied to perennial plantings in the fall after harvest has been completed. These fungicides include (apply one of the following):** | | | | | | |
| **4** | Ridomil Gold 4SL | 1.0 pt /*treated* A | mefenoxam | 0 | 48 | N |
| **4** | Ultra Flourish 2E | 2.0 pt /*treated* A | mefenoxam | 0 | 48 | N |
| **Calculate the correct fungicide rate for drip applications as for a banded spray, see the explanation under NEW PLANTINGS in the table above.** | | | | | | |

## <u>Virus Diseases</u>

Use certified, virus-free plants.

# Summer Squash

## Recommended Varieties[1]

| Type | Variety (all hybrids) | Reported Disease Resistance[2] CMV | WMV2 | ZYMV | PRSV | PM | Comments |
|---|---|---|---|---|---|---|---|
| **Scallop** | Flying Saucer | | | | | | Yellow and Green Fruit |
| | Garden Sun | | | | | | Yellow Fruit |
| | Peter Pan | | | | | | Light Green Fruit |
| | Starship | | | | | | Dark Green Fruit |
| | Sunburst | | | | | | Golden Yellow Fruit |
| | Sunny Delight | | | | | | Yellow Fruit |
| **Specialty** | Comela | | | | | | Middle Eastern Type, Light Green Fruit |
| | Eight Ball | | | | | | Round Green fruit |
| | Magda | | | | | | Middle Eastern Type, Light Green Fruit |
| | One Ball | | | | | | Golden Yellow Round Zucchini Type Fruit |
| **Yellow Straightneck** | Conqueror III | R | R | R | I | I | Green Stem |
| | Fortune | | | | | | Precocious Yellow[3] |
| | Goldprize | | I | I | | | Green Stem |
| | Lemondrop L | | | | | | Green Stem |
| | Liberator | I | I | I | | | Precocious Yellow |
| | Lioness | | I | I | | | Green Stem |
| | Multipik | | | | | | Precocious Yellow |
| | Patriot II | | I | I | | | Precocious Yellow |
| | Seneca Prolific | | | | | | Green Stem |
| | Superpik | | | | | | Precocious Yellow |
| | XPT 1832 III | I | I | I | | | Transgenic Resistance |
| **Yellow Crookneck** | Gentry | | | | | | Tolerant to High Temperatures |
| | Gold Star | I | | | | I | |
| | Prelude II | I | I | I | | I | Green Stem |
| | Superset | I | I | | | | Precocious Yellow |
| **Green Zucchini** | Cashflow | | | I | | | Medium Green Fruit |
| | Dividend | I | I | I | | | Medium Green Fruit |
| | Equinox | | I | I | | I | Dark Green Fruit |
| | Independence II | | R | I | | | Medium Green Fruit, Transgenic Resistance |
| | Judgement III | R | R | R | | | Medium Green Fruit, Transgenic Resistance |
| | Justice III | | R | | | | Medium Green Fruit, Transgenic Resistance |
| | Paycheck | I | I | I | | I | Medium Green Fruit |
| | Payload | I | I | I | | I | Medium Green Fruit |
| | Payroll | | I | I | | I | Medium Green Fruit |
| | Quirinal | | I | I | | I | Medium Green Fruit |
| | Respect | | I | I | I | I | Medium-Dark Green Fruit |
| | Reward | I | I | I | | I | Medium-Dark Green Fruit |
| | Senator | | | | | | Medium Green Fruit, Not for late season |
| | Spineless Beauty | | | | | | Medium Green fruit, Not for late season |
| | Spineless Perfection | | I | I | | I | Medium Green Fruit |
| | Tigress | | I | I | I | | Medium Green Fruit |
| | Zucchini Elite | | | | | | Medium Green Fruit, Not for late season |
| **Golden Zucchini** | Golden Dawn III | | | | | | |
| | Golden Delight | | I | I | | | |
| | Golden Glory | | I | I | | I | |
| | Golden Rod | I | I | | | | |
| | Gold Rush | | | | | | |

[1]Listed alphabetically; recommended for DE, MD, NJ, PA, VA and WV. Additional information is based on seed manufacturer and/or seed distributor claims; consult seed vendor for maturity/days to harvest. [2]CMV=Cucumber Mosaic Virus, WMV2=Watermelon Mosaic Virus 2, ZYMV=Zucchini Yellow Mosaic Virus, PRSV=Papaya Ring Spot Virus, PM=Powdery Mildew. I=Intermediate and R=High Resistance. Transgenic resistance of specific varieties can be found by consulting the seed manufacturer or distributor. [3]In yellow-fruited summer squash the precocious yellow gene confers tolerance to CMV and WMV2 as compared to the green stem counterpart. Varieties expressing the precocious yellowing gene will mask the greening of fruit caused by WMV and CMV, but will become bumpy and/or distorted when infected with either PRSV or ZYMV. **All 4 viruses may be detected at some level in squash fields in our region in any given year, therefore it is best to plant varieties with resistance to more than one virus, especially in later plantings when virus transmission by aphids increases. Virus resistance and PM resistance is recommended for fall/late planted varieties.**

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| Summer Squash[1] | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 75-100 | 150 | 100 | 50 | 0[2] | 200 | 150 | 100 | 0[2] | Total nutrient recommended |
| | 25-50 | 150 | 100 | 50 | 0[2] | 200 | 150 | 100 | 0[2] | Broadcast and disk-in |
| | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress and fertigate when vines start to run |
| | 25-30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Apply through irrigation system |

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer.; see also Table B-7 in the Soil and Nutrient Management chapter.
[2]In VA, crop replacement values of 25 lb/A of $P_2O_5$ and 50 lb/A of $K_2O$ are recommended on soils testing Very High.

**Seed Treatment** Check if seed has been treated with insecticide and fungicide; see also Disease Control below.

## Seeding, Transplanting, and Spacing

Seed April 15 through August 15 in warmer, southern regions and May 10 to August 1 in PA and other cool areas. Use 4-6 lb/A of seed, or 3,500-4,500 seed/A.

Container-grown plants are planted through the plastic when daily mean temperatures have reached 60°F (16°C). Planting dates vary from April 15 in southern regions to June 1 in northern areas. Early plantings should be protected from winds with hot caps, tents, or row covers. Space rows 5-6 ft apart with plants 2-3 ft apart in the row.

## Field Preparation

Plastic mulch and fumigant should be applied to well-prepared, moist soil 30 days before field planting. Plastic mulch conserves moisture, increases soil temperature, and increases early and total yields. Various widths of plastic are available to accommodate different production systems and equipment.

Fumigation will be necessary when there is a history of soil-borne diseases. The type of fumigant depends on the predominant pest. Several fumigants can be used on summer squash. Fumigation also aids in the control of weeds, though fumigation alone may not be sufficient for weed control under plastic mulch (black plastic or paper may be used without additional herbicides, however may not control yellow nutsedge). Foil mulches can be used to repel aphids that transmit mosaic virus in fall planted squash (after July 1). Direct seeding through the mulch is recommended for maximum virus protection. Transplants should not be used with foil or other repellent mulches.

Fertilizer must be applied during bed preparation. At least 50% of the N should be in the nitrate ($NO_3^{-1}$) form. Consider drip irrigation (more information in the "Irrigation Management chapter).

## Pollination

Honeybees, squash bees, bumblebees and other wild bees are important for pollination and fruit set. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until blooms are completed before application. See the section on "Pollination" in the General Production Recommendations chapter and/or pesticide tables below for toxicity to bees. Read the pesticide label for specific directions to protect pollinators.

## Harvest and Post-Harvest Considerations

Zucchini and summer squash are harvested after fruit reach the desired size but before they form hard seeds or rinds. Size is highly dependent on market demands. Crook-neck and straight-neck squash and zucchini should be 1.25-2 inches in diameter. Straight-neck squash and zucchini should be 7-8 inches long. Scallop squash should be 3-4 inches in diameter.

Summer squash and zucchini are delicate and prone to bruising and scratching. Handle with care when harvesting, grading and packing. Squash should be stored at 41-50°F (5-10°C) and 95% relative humidity. The typical shelf life is 7-14 days. Summer squash is highly sensitive to freezing injury and will show pitting on the skin if exposed to temperatures below 41°F (5°C). Do not store or transport with ethylene producing crops.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**Labeled Applications Sites for Summer Squash**

| | | **Plastic mulch production** | | | | | | **Bare-ground production** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil-Applied | | Postemergence | | | | | | |
| **Herbicides** | WSSA group number | Under Plastic | Row Middles | Over Plastic | Row Middles | Post-Harvest | | Soil-applied | POST | Post-harvest |
| Sandea | 2 | | YES | | YES | | | | | |
| Curbit | 3 | | YES | | | | | YES | | |
| Prefar | 8 | YES | YES | | | | | YES | | |
| Command | 13 | | YES | | | | | YES | | |
| Stragegy | 3 + 13 | | YES | | | | | YES | | |
| Reflex | 14 | YES | YES | | YES | | | YES | | |
| Select | 1 | | | YES | | | | | YES | |
| Select Max | 1 | | | YES | | | | | YES | |
| Poast | 1 | | | YES | | | | | YES | |
| Gramoxone | 22 | | | | YES | YES | | | | YES |

<table>
<tr><th colspan="7">1. Soil-Applied</th></tr>
<tr><th>Group</th><th>Product Name</th><th>Product Rate</th><th>Active Ingredient (*=Restricted Use)</th><th>Active Ingredient Rate</th><th>PHI (d)</th><th>REI (h)</th></tr>
<tr><td>2</td><td>Sandea 75DF</td><td>0.5 to 1 oz/A</td><td>halosulfuron</td><td>0.023 to 0.047 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Plasticulture: can be applied in a band under the plastic, immediately before laying the mulch; delay seeding or transplanting for 7 days after application. Row middles: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v or include a non-selective herbicide.<br>-Bareground: apply broadcast after seeding but before crop emergence or no sooner than 7 days before transplanting.<br>-Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. Do not use Group 2 herbicides repeatedly in the same field.<br>-Do not apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Maximum number of Sandea applications per year is 2 and do not exceed 2 oz/A during the crop season.</td></tr>
<tr><td>3</td><td>Curbit 3EC</td><td>1 to 3 pt/A</td><td>ethalfluralin</td><td>0.38 to 1.12 lb/A</td><td>--</td><td>24</td></tr>
<tr><td colspan="7">-Plasticulture: row middles only: apply as a banded spray after crop emergence or transplanting. Do not soil incorporate.<br>-Bareground: apply broadcast after direct-seeding but prior to crop emergence; do not use on transplanted crop.<br>-Controls annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp.<br>-Use lower rate for coarse-textured soils or soils with low organic matter.<br>-Where overhead irrigation is available, activate Curbit with 0.5 inch of irrigation within 2 days after application; if no irrigation or rainfall occurs within 5 days of application, activity of Curbit can be reduced.<br>-Available as a pre-mix herbicide Strategy. Strategy at 3 pt/A= Curbit at 26 fl oz (0.6 lb ai) and Command at 8 fl oz (0.188 lb ai)<br>-Maximum applications per season: not specified</td></tr>
<tr><td>8</td><td>Prefar 4E</td><td>5 to 6 qt/A</td><td>bensulide</td><td>5 to 6 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Plasticulture: under plastic: apply in a band under the plastic, immediately before laying the mulch. Plasticulture row middles: application is labeled.<br>-Bareground: apply preemergence or preplant incorporated. Preemergence applications should be followed by irrigation within 36 hrs (apply enough water to wet the soil at leat 2 to 4 inches deep). Preplant incorporated applications should be incorporated 1 to 2 inches deep (deeper than 2 inches will result in reduced weed control).<br>-Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters.<br>-Maximum applications per season: not specified.</td></tr>
</table>

*1. Soil-Applied continued on next page*

*1. Soil-Applied - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 13 | Command 3ME | 4 to 8 fl oz/A | **clomazone** | 0.094 to 0.19 lb/A | 45 | 12 |

-**Plasticulture**: row middles application only.
-**Bareground**: apply broadcast just before planting but before crop emergence, or just before transplantings.
-Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops.
-Controls annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Carpetweed, morningglory sp., pigweed sp., and yellow nutsedge will not be controlled. Higher rates will improve control (or expand number of species controlled) such as common cocklebur, common ragweed, or jimsonweed (refer to label for specific weeds and rates).
-**WARNING**: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application (refer to label for restrictions).
-Available as a pre-mix herbicide Strategy: Strategy at 3 pt/A= Command at 8 fl oz (0.188 lb ai) and Curbit at 26 fl oz (0.6 lb ai)
-Maximum number of Command applications per year: 1

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 + 13 | Strategy 2.1L | 1.5 to 4 pt/A | **ethalfluralin *plus* clomazone** | 0.39 to 1.05 lb/A | 45 | 24 |

-**Plasticulture**: row middles application only.
-**Bareground**: apply broadcast just before planting or after planting but before crop emergence.
-Strategy is a prepackage mixture of Curbit 3EC and Command 3ME.
-**Do not** apply prior to planting crop. **Do not** soil incorporate. **Refer to individual products for comments.**
-Maximum applications per season: not specified.

| | | | | | | |
|---|---|---|---|---|---|---|
| **14** | Reflex 2SL | 8 fl oz/A | **fomesafen** | 0.13 lb/A | 32 | 24 |

-**A Special Local-Needs Label 24(c) has been approved for the use of Reflex 2SL in DE and MD. The use of this product is legal ONLY if a waiver of liability has been completed (see *http://www.farmassist.com/*).**
-**Labeled for straight neck yellow, crooked neck yellow, and zucchini types only**!
-**Plasticulture** under plastic: apply in a band under the plastic, immediately before laying the mulch. Plasticulture: pre-transplant applications over the plastic mulch is labeled; row middles application is labeled.
-**Bareground**: apply broadcast within 24 hrs after direct-seeding and follow with 0.2 to 0.5 inches of overhead irrigation at least 36 hr before the crop begins to crack through the soil. For transplants, apply Reflex and then irrigate with 0.2 to 0.5 inches of water and then transplant. **Do not** prepare transplant holes until after Reflex application and irrigation.
-Foliar application of Reflex will severely damage or kill squash. The potential of crop injury is greater on lighter textured soils combined with intensive irrigation programs or high amounts of rainfall, therefore, adjust rates accordingly.
-Reflex provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. Summer squash varieties may vary in their response to Reflex; therefore, treat small acreages first to determine crop tolerance, especially when applying to a new variety.
-Reflex rates lower than 16 fl oz/A should be used with other herbicides and/or other methods of weed control.
-Consider rotational crops when applying fomesafen. If crop is replanted, **do not** re-apply Reflex. Refer to 24(c) label for specifics on rotational restrictions. Maximum for Reflex application in DE and MD: 24 fl oz/A **IN ALTERNATE YEARS.**

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>12 to 16 fl oz/A | **clethodim** | 0.094 to 0.13 lb/A | 14 | 24 |
| | Poast 1.5EC | 1 to 1.5 pt/A | **sethoxydim** | 0.19 to 0.28 lb/A | 3 | 12 |

-Postemergence as broadcast spray with both plasticulture and bareground
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v.
-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.
-Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.
-If repeat applications are necessary, allow 14 days between applications.
-**Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses.
-Rainfastness is 1 hr.
-**Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 64 fl oz/A for the season.
-**Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 3 pt/A for the season.

*2. Postemergence continued on next page*

*2. Postemergence - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| **2** | Sandea 75DF | 0.5 to 1 oz/A | **halosulfuron** | 0.023 to 0.047 lb/A | 30 | 12 |
| -**Plasticulture**: row middles application only.<br>-**Bareground**: broadcast for bareground. Apply Sandea after the crop has at least 3 to 5 true leaves but before first female flowers appear and no sooner than 14 days after transplanting. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v.<br>-Suppresses or controls yellow nutsedge and certain broadleaf; control of weeds taller than 3 inches may not be adequate. Sandea will not control common lambsquarters or eastern black nightshade if applied postemergence; for row middle application, tankmix with a non-selective herbicide to increase spectrum of control.<br>-Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field.<br>-**Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Rainfastness is 4 hrs. Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season | | | | | | |
| 22 | Gramoxone 2SL | 1.95 pt/A | **paraquat *** | 0.49 lb/A | 14 | 24 |
| -**A Supplemental Label has been approved for the use of Gramoxone 2SL for postemergence weed control in DE, MD, NJ, PA, and VA.** Row middles as a shielded application. Apply as a directed spray in a minimum of 20 gal spray mix/A to control emerged weeds between the rows after crop establishment. Include a nonionic surfactant at 0.25% v/v.<br>-Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings.<br>-Rainfastness is 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |

**3. Postharvest**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone 2SL | 2.25 to 3 pt/A | **paraquat** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 until December 31, 2017, for postharvest application to desiccate the crop in DE, NJ and VA.**<br>-Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

**4. Other Labeled Herbicides** These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| 3 | Treflan | **trifluralin** |
| **9** | Roundup (various) | **glyphosate** |
| **14** | Aim | **carfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

### Seed Corn Maggots

The use of neonicotinoid insecticides (Group 4A) at planting may help to reduce seed corn maggot populations. See also the Pest Management chapter, Insect Management section.

### Aphids

Aphids transmit multiple viruses. Cultivars resistant to multiple aphid-transmitted viruses are available.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* **- melon aphid only** | 3 | 48 | H |
| 1A | Vydate 2L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |

*Aphids continued on next page*

*Aphids - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4A | Admire Pro 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid - **soil only** | 21 | 12 | H |
| 4A | Assail 30SG | 2.0 to 4.0 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil/drip** | 30 | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 4D | Sivanto 200SL | 21.0 to 28.0fl oz/A | flupyradifurone | 21 | 4 | M |
| 9B | Fulfill 50WP | 2.75 oz/A | pymetrozine | 0 | 12 | L |
| 9C | Beleaf 50SG | 2.0 to 2.8 oz/A | flonicamid | 0 | 12 | L |
| 28 + 6 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cabbage Loopers

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A | Baythroid XL 1EC | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Danitol 2.4EC | 10.67 to 16.00 fl oz/A | fenpropathrin* | 7 | 24 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, Lambda T | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 11A | Dipel (OMRI) | 0.5 to 2.0 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 2.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole - **soil/drip/foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cucumber Beetles

Cucumber beetles can transmit bacterial wilt, though losses from this disease vary greatly between fields and varieties. Young plants need to be protected to manage bacterial wilt. Also, adult beetles can cause direct feeding injury to young plants. If adult beetles are abundant and there is a disease history, insecticides should be applied before beetles feed extensively on the cotyledons and first true leaves. If foliar insecticides are used, begin spraying shortly after plant emergence and repeat applications at weekly intervals if new beetles continue to invade fields.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Sevin XLR Plus | 1.0 qt/A | carbaryl | 3 | 12 | H |
| 3A | Baythroid XL | 2.4 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |

*Cucumber Beetles continued on next page*

*Cucumber Beetles - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Danitol 2.4EC | 10.67 to 16.0 fl oz/A | fenpropathrin* | 7 | 24 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | LambdaT | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone | 2.4 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zetacypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Admire PRO | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |

## Cutworms - See also the Pest Management chapter, Insect Management section.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV (variegated cutworm) | 1.5 pt/A | methomyl* | 3 | 48 | H |
| 1A | Lannate LV (granulate cutworm) | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin*+bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 1.28 to 4.00 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |

## Leafminers

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate 2L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil/drip** | 30 | 12 | H |
| 4A | Actara 25 WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |

*Leafminers continued on next page*

*Leafminers - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4A | Venom 70S G | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70S G | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 6.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 6.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 17 | Trigard 75WSP | 2.66 oz/A | cyromazine | 0 | 12 | L |
| 28 | Coragen 1.67SC | 5.0 to 7.5 fl oz/A | chlorantraniliprole - **soil/drip** | 1 | 4 | L |
| 28 | Coragen 1.67SC | 5.0 to 7.0 fl oz/A | chlorantraniliprole - **foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Mites

Mite infestations generally begin around field margins and grassy areas. CAUTION: DO NOT mow or maintain these areas after midsummer to prevent mites from moving into the crop. Localized infestations can be spot treated. Begin treatment when 10 to 15% of the crown leaves are infested early in the season.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 10B | Zeal Miticide1 | 2.0 to 3.0 oz/A | etoxazole | 7 | 12 | L |
| 20D | Acramite 50WS | 0.75 to 1.00 lb/A | bifenazate | 3 | 12 | M |
| 23 | Oberon 2SC | 7.0 to 8.5 fl oz/A | spiromesifen | 7 | 12 | M |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Pickleworms, Melonworms

| **Apply one of the following formulations. If foliar materials are used, make one treatment prior to fruit set, and then treat weekly. If soil or drip applications are used, check the label for instructions on application frequency.** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Sevin XLR | 0.5 to 1.0 qt/A | carbaryl | 3 | 12 | H |
| 3A | Baythroid XL 1EC | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL (pickleworm) | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 0 | 12 | M |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 2.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC (melonworm) | 2.0 to 3.5 fl oz/A | chlorantraniliprole - **drip/foliar** | 1 | 4 | L |
| 28 | Coragen 1.67SC (pickleworm) | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

**Rindworms (Cucumber Beetle Larvae)** Damage to the rinds may result from a complex of insect pests, including cucumber beetle, wireworms, and a number of "worm" species, (beet armyworm, etc). Management of adult cucumber beetles early in the season may help reduce damage. See "Cucumber Beetles" for labeled products.

| **For Lepidopteran rindworms, apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Baythroid XL 1EC | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |

## Squash Bugs

Treat if more than 1 egg mass per plant is present. Target nymphal stages. Under leaf spray coverage is essential.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin XLR Plus | 1.0 qt/A | carbaryl | 3 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda -Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethin + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Assail 30SG | 5.3 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4D | Sivanto 200SL | 10.5 to 14.0 fl oz/A | flupyradifurone | 21 | 4 | M |

## Squash Vine Borers

When vines begin to run, apply one of the following formulations to bases of plants 4 times at 7-day intervals. Pheromone traps for squash vine borer are commercially available. These traps can be used to indicate when moth activity begins. **Note**: Use of spinosad or spinetoram for looper control will reduce squash vine borer populations.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |

*Squash Vine Borers continued on next page*

*Squash Vine Borers - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz /A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Assail 30SG | 5.3 oz/A | acetamiprid | 0 | 12 | M |

## Thrips

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate2 L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Admire PRO 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/ | thiamethoxam - **soil/drip** | 30 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 6.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 6.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |

# Disease Control

**THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.**
**Recommended Fungicides**

**Nematodes** - See also Soil Fumigation and Nematodes sections in the Pest Management chapter. Use fumigants listed in the Pest Management chapter, or nematicides listed below. Consult the label.

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| 1A | Vydate L | 0.5 to 1.0 gal/A Incorporate into top 2-4 inches of soil, *OR* 2.0 to 4.0 pt/A apply 2 w after planting and repeat 2-3 w later. | oxamyl* | 1 | 48 | H |
| 7 | Velum Prime | 6.5 to 6.84 fl oz/A | fluopyram | 0 | 12 | |
| -- | Nimitz 4EC | 3.5 to 5.0 pt/A incorporate or drip-apply 7 d before planting | fluensulfone | n/a | 12 | N |

## Seed Treatment

Check with your seed company if seed has been treated with an insecticide and fungicide. For untreated seed, use a mixture of thiram (4.5 fl oz 480DP/100 lb) and an approved commercially available insecticide.

## Damping-Off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

| **Code** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
|---|---|---|---|---|---|---|
| **Apply one of the following at-planting (see label for application timing, methods, and restrictions):** | | | | | | |
| **Phytophthora and Pythium root rot** | | | | | | |
| **4** | Ridomil Gold 4SL[1] | 0.5 to 1.0 pt/A | mefenoxam | AP | 48 | N |
| **4** | Ultra Flourish 2E[1] | 2.0 to 4.0 pt/A | mefenoxam | AP | 48 | N |
| **4** | MetaStar 2EAG[1] | 4.0 to 8.0 pt/A | metalaxyl | AP | 48 | N |

*Damping-Off continued on next page*

*Damping-Off - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| **Phytophthora, Pythium, and Rhizoctonia root rot** | | | | | | |
| **4** + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence. | mefenoxam + azoxystrobin | AP | 0 | N |
| **Rhizoctonia root rot** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | AP | 4 | N |
| **Pythium root rot only** | | | | | | |
| 28 | Previcur Flex 6F | 1.2 pt/A in transplant water, drip irrigation, or direct spray at base of plant and soil | Propamocarb HCL | 2 | 12 | N |

[1]To determine the amount of Ridomil Gold, Ultra Flourish or MetaStar needed per acre, use the following calibration formula for changing from broadcast to band application: [Band width (ft) / row spacing (ft)] x broadcast rate (lb/A) = Amount needed lb/A. [2]Applied at planting.

# Bacterial and Fungal Diseases

## Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage season long, therefore, additional foliar insecticide applications may be necessary.

## Choanophora Fruit Rot

This disease occurs during warm wet weather and develops predominantly on flowers or fruit near the ground. Management is difficult because disease development is rapid, and weather dependent. Fungicide sprays are not effective because flowers, which open daily, must be protected immediately. Practices that reduce soil moisture or reduce soil contact, such as raised beds and plastic mulch, may be beneficial.

## Downy Mildew

Scout fields early in the growing season. Begin sprays when plants meet in the row or if disease occurrence is predicted for the region (check the Cucurbit Downy Mildew Forecasting website at *http://cdm.ipmpipe.org*). Preventative applications are much more effective than applications made after detection. **Materials with different FRAC codes should be alternated to reduce the chances for fungicide resistance development.**

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Sprays should be applied on a 7-day schedule when disease is forecast or present in the region. Under severe disease conditions spray interval may be reduced IF the label allows.** | | | | | | |
| **TANK-MIX one of the following products with a protectant such as chlorothalonil 1.5 to 2.0 pt 6F/A :** | | | | | | |
| U15+40 | Orondis Ultra | 5.5 to 8.0 fl oz/A | oxathiapiprolin+mandipropamid | 0 | 4 | -- |
| 21 | Ranman 400SC | 2.10 to 2.75 fl oz/A (plus a non-ionic or organosilicon surfactant; **do not** apply with copper; see label) | cyazofamid | 0 | 12 | L |
| **Other materials for use in rotation as tank mix partners with a protectant:** | | | | | | |
| 28 | Previcur Flex 6F | 1.2 pt/A | propamocarb | 2 | 12 | N |
| 43 | Presidio 4SC | 3.0 to 4.0 fl oz/A (**caution**: pathogen is now less sensitive to Presidio) | fluopicolide | 2 | 12 | L |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | acetoctradin + dimethomorph | 0 | 12 | -- |
| M3 + 22 | Gavel 75DF | 1.5 to 2.0 lb/A (includes protectant mancozeb) | mancozeb + zoxamide | 5 | 48 | -- |
| M5 + 22 | Zing! 4.9SC | 36 fl oz/A (includes protectant chlorothalonil) | chlorothalonil + zoxamide | 0 | 12 | N |
| M5 + 27 | Ariston 42SC | 3.0 pt/A (includes protectant chlorothalonil) | chlorothalonil + cymoxanil | 3 | 12 | -- |
| 11 + 27 | Tanos 50DF | 8.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 27 | Curzate 60DF | 3.2 oz/A | cymoxanil | 3 | 12 | N |
| 40 | Forum 4.17SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |

## Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Rotate away from susceptible crops (such as peppers, eggplants, tomatoes, lima and snap beans, and other cucurbits) for as long as possible. Preplant fumigants will also suppress disease. Fields should be adequately drained to ensure that water does not accumulate around the base of the plant. Once the canopy closes, subsoil between the rows to allow for faster drainage following rainfall. **Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.** **(***Continued on next page)*

*Phytophthora Crown and Fruit Rot - continued*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations pre-plant for early season control:** | | | | | | |
| 4 | MetaStar 2E | 4.0 to 8.0 pt/A | metalaxyl | AP | 48 | N |
| 4 | Ridomil Gold 4SL | 1.0 to 2.0 pt/A | mefenoxam | 5 | 48 | N |
| 4 | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | 5 | 48 | N |
| 4 + 11 | Uniform 3.66SE | 0.34 fl oz/100 ft row | mefenoxam + azoxystrobin | AP | 0 | -- |
| 28 | Previcur Flex 6F | 1.2 pt/A in transplant water, drip irrigation, or spray directed to the base of the plants and soil. | propamocarb | 2 | 12 | N |
| **When conditions favor disease development, apply one of the following WITH FIXED COPPER at labeled rates (for suppression only):** | | | | | | |
| U15+40 | Orondis Ultra | 5.5 to 8.0 fl oz/A | oxathiapiprolin + mandipropamid | 0 | 4 | -- |
| 40 | Revus 2.08F | 8.0 fl oz/A | mandipropamid | 0 | 4 | -- |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | acetoctradin + dimethomorph | 0 | 12 | -- |
| 43 | Presidio 4SC[1] | 4.0 fl oz/A[1] | fluopicolide | 2 | 12 | L |
| M3 + 22 | Gavel 75DF | 1.5 to 2.0 lb/A | zoxamide + mancozeb | 5 | 48 | -- |
| 11 + 27 | Tanos 50DF | 8.0 to 10.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 21 | Ranman 400SC | 2.75 fl oz/A (**Do not** apply with copper; see label) | cyazofamid | 0 | 12 | L |
| 40 | Forum 4.17SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |

[1]Presidio may also be applied through the drip irrigation (see label). Soil drench followed by drip application has given good results in some trials on crown rot caused by *Phytophthora capsici*.

## Plectosporium Blight (Microdochium blight)

A 3-year rotation with crops other than cucurbits is advised. It is important to achieve maximum foliage coverage with the fungicide application.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Once symptoms appear on petioles or after fruit form, apply one of the following and repeat every 7 to 10 d (a spray schedule that rotates Cabrio or Flint with chlorothalonil will also provide control):** | | | | | | |
| M3 | mancozeb 75DF | 2.0 to 3.0 lb/A | mancozeb | 5 | 24 | N |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |
| 3 + 11 | Quadris Top 2.7F | 12.0 to 14.0 fl oz/A | difenoconazole + azoxystrobin | 0 | 12 | -- |

## Powdery Mildew

Some varieties have intermediate resistance; they should be used if possible (see Recommended Varieties above). The fungus that causes cucurbit powdery mildew has developed resistance to high-risk fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern U.S. Proper fungicide management should be followed to help delay the development of resistance and minimize control failures. Powdery mildew generally occurs from mid-July until the end of the season. Once observed in the area or detected by scouting (1 lesion on the underside of 45 old leaves per acre), begin the following fungicide program:

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **TANK-MIX one of these products with a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| U8 | Vivando 2.5SC | 15.4 fl oz/A | metrafenone | 0 | 12 | -- |
| U6 | Torino 0.85SC | 3.4 fl oz/A | cyflufenamid | 0 | 4 | -- |
| 3 + 7 | Luna Experience 3.34SC | 6.0 to 17.0 fl oz/A | fluopyram + tebuconazole | 7 | 12 | -- |
| **AND ALTERNATE with a TANK-MIX of one of the following and a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| 3 | Procure 480SC | 4.0 to 8.0 fl oz/A | triflumizole | 0 | 12 | N |
| 3 | Proline 480SC | 5.7 fl oz/A | prothioconazole | 7 | 12 | -- |
| 3 | Rally 40WSP | 5.0 oz/A | myclobutanil | 0 | 24 | N |
| 3 | tebuconazole 3.6 F | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 3 + 11 | Aprovia Top 1.62EC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflupyr | 0 | 12 | N |
| **OR with one of the following:** | | | | | | |
| 3 + 9 | Inspire Super 2.8F | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodinil | 0 | 12 | -- |
| 7 | Fontelis 1.67SC | 12.0 to 16.0 fl oz/A | penthiopyrad | 1 | 12 | L |
| 7 + 11 | Pristine 38WG | 12.5 to 18.5 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |

## Scab

Select scab-resistant varieties. The fungus that causes scab typically occurs during periods of cool, wet weather when temperatures are below normal. Rotate away from fields with a history of scab for at least 2 years.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Begin sprays as true leaves form and repeat every 5 to 7 days:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |

## Viruses (WMV2, PRSV, ZYMV, and CMV)

The most prevalent virus in the mid-Atlantic region is WMV2, followed by PRSV, ZYMV, and CMV. Varieties with multiple resistance packages are available (see table Recommended Varieties). Varieties expressing the precocious yellowing gene such as “Multipik” will mask the greening of fruit caused by WMV2 and CMV but will become distorted when infected with either PRSV or ZYMV. All 4 viruses may be detected at some level in squash fields in the region in any given year, therefore plant varieties with resistance to more than one virus. The following control measures should also be used.

Plant fields as far apart as possible from existing cucurbit plantings to reduce the chances for aphid transmission. Using reflective mulch may help to prevent aphid transmission of viruses.

# Sweet Corn

## Recommended Varieties

**Fresh Market Sweet Corn**

| | Variety | Relative Maturity | Kernel Type[1] | Disease Resistance[2] | | | | | Bt Insect Resistance[3] |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Et | Pst | Ps | MDMV | Bm | |
| **Bicolor Varieties** | Temptation | 72 | Sugary Enhanced | | | | | | |
| | Temptation II (GMO) | 72 | Sugary Enhanced | | | | | | Performance |
| | Sweet Rhythm | 73 | Synergistic | I | I | | | | |
| | Awesome | 74 | Synergistic | | I | | | | |
| | BSS0977(GMO) | 78 | Supersweet | I | I | R | | | Attribute |
| | Xtra-Tender 278A | 78 | Augmented Shrunken | I | I | | | I | |
| | Montauk | 79 | Synergistic | I | I | | | | |
| | Obsession | 79 | Augmented Shruken | I | I | R | | | |
| | Obsession II (GMO) | 79 | Augmented Shruken | I | I | R | | | Performance |
| | Summer Sweet 7902R | 79 | Supersweet | R | I | R | | I | |
| | BC0805 (GMO) | 82 | Synergistic | | | I | | I | Attribute |
| | Providence | 82 | Synergistic | | | R | | I | |
| | Serendipity | 82 | Synergistic | | | | | I | |
| | Delectable | 84 | Sugary Enhanced | I | I | R | R | | |
| **White Varieties** | Mirai 421W | 71 | Mirai | I | I | I | | | |
| | Xtra-Tender 372 | 72 | Augmented Shruken | | I | | | I | |
| | Piscataway | 72 | Supersweet | | | | | | |
| | Sugar Pearl | 73 | Sugary Enhanced | I | I | I | | | |
| | Sweet Ice | 74 | Synergistic | | I | | | | |
| | Whiteout | 74 | Sugary Enhanced | I | I | | | | |
| | Edelweiss | 76 | Sugary Enhanced | | | | | | |
| | Eden | 76 | Augmented Shruken | | | | | | |
| | Placer | 76 | Supersweet | | | | I | | |
| | Xtra-Tender 378A | 78 | Augmented Shruken | | I | | | I | |
| | Munition | 78 | Supersweet | I | I | R | I | | |
| | Summer Sweet 8909MRW | 79 | Supersweet | I | | R | | I | |
| | SV1580SC | 80 | Supersweet | I | | R | | | |
| | Mattapoisett | 80 | Synergistic | I | I | I | | | |
| | WSS0987 (GMO) | 81 | Supersweet | I | | R | | | Attribute |
| | Avalon | 82 | Synergistic | I | I | | | I | |
| | Devotion | 82 | Augmented Shruken | | I | | | | |
| | Silver King | 82 | Sugary Enhanced | I | I | I | | I | |
| | Argent | 83 | Sugary Enhanced | I | R | I | | | |
| **Yellow Varieties** | Vision | 73 | Augmented Shruken | | I | | | I | |
| | GSS0966 (GMO) | 78 | Supersweet | I | I | R | | | Attribute |
| | Summer Sweet 7210R | 78 | Supersweet | R | R | R | | R | |
| | Incredible | 82 | Sugary Enhanced | | I | R | R | | |

**Processing Sweet Corn[4]**

| | Variety | Relative Maturity | Kernel Type[1] | Disease Resistance[2] | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Et | Pst | Ps | MDMV | Bm |
| **Yellow Varieties** | GSS 1453 | 84 | Supersweet | R | | R | | |
| | GSS 2259P | 84 | Supersweet | I | I | R | R | |
| | GH 6462 | 83 | Sugary Normal | I | I | R | I | I |
| | GH 9597 | 83 | Sugary Normal | I | R | R | R | |
| | Overland | 84 | Supersweet | R | R | R | | I |
| | Protégé | 77 | Supersweet | R | I | R | | R |
| | SS Jubilee Plus | 83 | Supersweet | | | R | | I |

*Footnotes on next page.*

*Footnotes Recommended Varieties:*
[1]See also: "Sweet Corn Genetics and Isolation Requirements" below.
[2]R=resistance; I=intermediate/partial resistance. Et=Northern corn leaf blight caused by *Exserohilum turcicum,* Pst=Stewart's wilt caused by *Pantoea stewartii*, Ps=Common rust caused by *Puccinia sorghi*, MDMV=Maize dwarf mosaic virus, Bm=Southern corn leaf blight caused by *Bipolaris maydis*.
[3]Insect resistance from *Bacillus thuringiensis* transgenes is available in some varieties. Attribute varieties have the Cry1Ab gene for corn earworm and European corn borer resistance. Performance Series varieties have the Cry1A.105 and Cry2AB genes for corn earworm, European corn borer and fall armyworm resistance, as well as the transgenes conferring glyphosate resistance.
[4]Processors requirements must be considered. Consult the DE Extension Vegetable and Small Fruits Program for variety trial results at: *http://extension.udel.edu/ag/vegetable-fruit-resources/vegetable-small-fruits-program/variety-trial-results/*.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Sweet Corn | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| Fresh Market | 125-175 | 160 | 120 | 80 | 0[1,2] | 160 | 120 | 80 | 0[1,2] | Total nutrient recommended |
| | 40-60[3] | 120 | 100 | 60 | 0[1] | 120 | 100 | 60 | 0[1] | Broadcast and disk-in |
| | 20 | 40 | 20 | 20 | 0[1,2] | 40 | 20 | 20 | 0[1,2] | Band-place with planter |
| | 50-100[3] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress when corn is 12 inches tall |
| Processing | 150-200 | 160 | 120 | 80 | 0[1,2] | 160 | 120 | 80 | 0[1,2] | Total nutrient recommended |
| | 55-80 | 120 | 100 | 60 | 0[1] | 120 | 100 | 60 | 0[1] | Broadcast and disk-in |
| | 20 | 40 | 20 | 20 | 0[1,2] | 40 | 20 | 20 | 0[1,2] | Band-place with planter |
| | 50-100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress 2 weeks after emergence |

Apply 1 to 2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter. [1]In VA, crop replacement values of 40 lb/A of $P_2O_5$ and 40 lb/A of $K_2O$ are recommended on soils testing Very High. [2]For early planting when soil temperatures are low, band 20 lb/A $P_2O_5$ and 20 lb/A $K_2O$ when soil tests are Very High to facilitate early growth. [3]On very sandy soils, reduce the amount of N applied via broadcast application and disked-in. Instead, split N applications to include an additional split when corn is 6 in. tall of 40 lb/A of N. So, N is applied with the broadcast fertilizer, at-planting in a band, when corn is 6 in. tall, and again when corn is 12 in. tall. In NJ, consult your Extension Agent for information on the approved pre-sidedress nitrate test.

## Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities.

| Critical Sweet Corn Tissue Test Values | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Timing | Value | N | P | K | Ca | Mg | S | Fe | Mn | Zn | B | Cu | Mo |
| | | % | % | % | % | % | % | ppm | ppm | ppm | ppm | ppm | ppm |
| Whole plants at the 6 inch stage | Deficient | <3.0 | 0.3 | 2.5 | 0.5 | 0.25 | 0.4 | <50 | 40 | 30 | 10 | 5 | 0.1 |
| | Adequate range | 3 | 0.3 | 2.5 | 0.5 | 0.25 | 0.4 | 50 | 40 | 30 | 10 | 5 | 0.1 |
| | | 4 | 0.5 | 4 | 0.8 | 0.5 | 0.6 | 100 | 100 | 40 | 30 | 10 | 0.2 |
| | High | >4.0 | 0.5 | 4 | 0.8 | 0.5 | 0.6 | >100 | 100 | 40 | 30 | 10 | 0.2 |
| | Toxic (>) | - | - | - | - | - | - | - | - | - | 100 | - | - |
| Leaves[1] at the 30 inch stage | Deficient | <2.5 | 0.2 | 2.5 | 0.5 | 0.2 | 0.2 | <40 | 40 | 25 | 10 | 4 | 0.1 |
| | Adequate range | 2.5 | 0.2 | 2.5 | 0.5 | 0.2 | 0.2 | 40 | 40 | 25 | 10 | 4 | 0.1 |
| | | 4 | 0.4 | 4 | 0.8 | 0.4 | 0.4 | 100 | 100 | 40 | 30 | 10 | 0.2 |
| | High | >4.0 | 0.4 | 4 | 0.8 | 0.4 | 0.4 | >100 | 100 | 40 | 30 | 10 | 0.2 |
| | Toxic (>) | - | - | - | - | - | - | - | - | - | 100 | - | - |
| Leaves[1] just prior to tassel | Deficient | <2.5 | 0.2 | 2 | 0.3 | 0.15 | 0.2 | <30 | 30 | 20 | 10 | 4 | 0.1 |
| | Adequate range | 2.5 | 0.2 | 2 | 0.3 | 0.15 | 0.2 | 30 | 30 | 20 | 10 | 4 | 0.1 |
| | | 4 | 0.4 | 3.5 | 0.6 | 0.4 | 0.4 | 100 | 100 | 40 | 20 | 10 | 0.2 |
| | High | >4.0 | 0.4 | 3.5 | 0.6 | 0.4 | 0.4 | >100 | 100 | 40 | 20 | 10 | 0.2 |
| | Toxic (>) | - | - | - | - | - | - | - | - | - | 100 | - | - |

[1]Most recently matured leaves

## Pre-sidedress Soil Nitrogen Test (PSNT)

The PSNT was developed to determine the need for sidedress nitrogen (N) on corn. The PSNT is effective for soils with loamy-texture and high organic matter or where manure has been applied. Sandy soils with low organic matter are already known to have low N availability. Contact your county Extension Agent for information on sampling and using the PSNT (**NJ and PA only**).

## Sweet Corn Genetics and Isolation Requirements

Tendernss of corn kernels is determined by the silk parent. However, kernel sweetness is determined by both tassel and silk parents. Therefore, pollen from varieties and types other than the one planted in the field may interfere with sweetness, and isolation through distance or different silking dates may be necessary. For example, all sweet corn must be isolated from field and popcorn varieties by at least 500 ft. Certain sweet corn varieties must be isolated from each other by at least 500 ft or a difference in silking date of at least 12 days. The table below may be used to determine which varieties must be isolated from each other during pollination.

| Variety Class | Genes Present | Variety Examples | Kernel Properties | Grow Apart from Class(es)[1] |
|---|---|---|---|---|
| Normal | *su* | Silver Queen,<br>Stowells Evergreen | 100% normal | Supersweet<br>Augmented Shrunken |
| Sugary Enhanced (heterozygous) | *su, se (1 copy)* | Silverado,<br>Argent | 75% normal<br>25% sugary enhanced | Supersweet<br>Augmented Shrunken |
| Sugary Enhanced (homozygous) | *su, se (2 copies)* | Table Sweet™ varieties,<br>Silver King, Sugar Snow II,<br>Imaculata, Brilliance | 100% sugary enhanced | Supersweet<br>Augmented Shrunken |
| Supersweet | $sh_2$ | Snow White,<br>Boreal, Millenium | 100% supersweet | Normal<br>Sugary Enhanced (all)<br>Synergistic (all) |
| Synergistic (Heterozygous se with $sh_2$) | *su, se (1 copy)*<br>$sh_2$ *(1 copy)* | Sweet Breed™ varieties | 56% normal<br>19% sugary enhanced<br>25% supersweet | Supersweet<br>Augmented Shrunken |
| Synergistic (Homozygous se with $sh_2$) | *su, se (2 copies)*<br>$sh_2$ *(1 copy)* | TripleSweet™ varieties,<br>Cinderella | 75% sugary enhanced<br>25% tender supersweet | Supersweet<br>Augmented Shrunken |
| Synergistic (Homozygous se with $bt_2$) | *su, se (2 copies)*<br>$bt_2$ *(1 copy)* | Misquamicut,<br>Avalon | 75% sugary enhanced<br>25% tender supersweet | Supersweet<br>Augmented Shrunken |
| Augmented Shrunken | *se (2 copies)*<br>$sh_2$ *(2 copies)* | Gourmet Sweet™ varieties,<br>Multisweet™ varieties,<br>Xtra-Tender™ varieties | 100% tender supersweet | Normal<br>Sugary Enhanced (all)<br>Synergistic (all) |
| Mirai™ | *su, se (2 copies)*<br>$sh_2$ *(2 copies)* | Mirai 002 | 100% tender supersweet | None necessary |

[1]To avoid starchy kernels, isolate by ≥ 500 ft or ≥ 12 days in silking.

## Seed Treatment

Request that seed be treated with fungicides, see Disease Control below. For seed corn maggot and wireworm control, see Insect Control below. Super sweet ($sh_2$) varieties are more difficult to establish than other types. Handle seed gently and use plateless planters to prevent seed damage. Soil temperature and soil moisture should be optimal to reduce seed decay and obtain good stands.

## Seeding and Spacing

Sow in rows 30-36 inches apart and at a depth of 1-1.5 inches. First sowing is as early as late March for warmer regions of the mid-Atlantic, and on sandy soils, and as late as early May in cooler regions. Fresh market growers often plant successively through July to ensure continuity of supply. Use varieties that are resistant to frost and chilling injury for early plantin**gs.**

**Fresh Market**: Small-eared early varieties are sown at an in-row spacing of 8-10 inches. Larger-eared mid- and late-season varieties are planted at an in-row spacing of 10-12 inches. This equates to planting densities ranging from 14,500-22,000/A.

**Processing**: The recommended planting density is usually 22,000-24,000/A, though some varieties may be planted at densities of up to 30,000/A. Consult the seed company for the target density that best maximizes crop yield and quality.

## Mulching

Using clear plastic mulch as a row cover can improve stands, conserve moisture, and produce earlier maturity. Corn is seeded in the usual manner except 10-20 days earlier in double rows 14 inches apart and on 5-6 ft centers. Apply herbicide and then cover with clear plastic. Using ridges between double rows or wire hoops to allow space for corn seedlings to grow vertically. Allow plastic to remain over plants for 30 days after emergence, then cut and remove plastic from the field. Plants can then be grown out in the usual manner. Before using this system, it is recommended that the soil is tested for nematodes. If present, control measures are necessary before the above procedure can be used. Clear plastic will allow weeds to germinate and grow quickly, and premergence herbicides should be used under the plastic. Otherwise weeds become too large to be effectively controlled with herbicides after the plastic is removed. Use a cold-tolerant variety to avoid uneven stand and uneven vigor. Sweet corn can also be grown by planting as seed or transplants through black plastic or IRT mulch in early plantings using plastic mulch planters.

## Harvest and Handling

**Fresh Market**: Harvesting sweet corn at the proper stage is critical for its sweetness and tenderness. In the field, sweet corn stays in prime condition for only 1-2 days. As the ear reaches prime condition the silks begin to dry down, the husk fills out with plump kernels, and the kernels exude a milky liquid when punctured with the thumbnail. Ear tips should be filled. Sweet corn approaches maturity 18-22 days after silking and should be picked daily, preferably early in the morning at low field heat. After prime harvest time, sugars in the kernel convert to starch and the hull becomes tough. Supersweet varieties maintain sweetness longer than other varieties and extra tender varieties maintain eating quality for a longer period.

Sweet corn may be harvested by hand or mechanically. Handpicking is done by grasping the ear near the base and sharply twisting it downward. Mechanical harvesters are more efficient; however, the entire crop is picked when primary ears are ready, and any secondary ears will not be marketable.

Corn is normally piled on a wagon in the field or is put in baskets or bins and then graded/packed at a nearby packing area. Sweet corn should be trimmed uniformly to eliminate flag leaves and long shanks. If left on the ear, they will cause packaging problems and induce further moisture loss. Objectionable kernel denting may occur from a moisture loss of 2% or less. Only first-quality sweet corn devoid of defects and of uniform maturity, color, shape, and size should be selected and packed. Any ears exhibiting signs of disease or mechanical or insect damage should be discarded along with any ears that lack adequate shuck coverage.

For optimum sweetness and tenderness, sweet corn should be cooled immediately after harvest and kept near 32°F (0°C). Hydrocooling is the most efficient and effective cooling method. Corn is immersed in ice cold water, which quickly removes all field heat. Hydrocooling is recommended for sweet corn that is shipped long distance. For smaller growers and short distance shippers, ice can be added to the crate (or burlap bags) during packing; 1 lb ice/5 lb corn is usually sufficient. Ice can also be blown on top of the crates when placed in a cooler or refrigerated truck. Sweet corn placed in cold storage before being pre-cooled will not retain freshness for nearly as long as hydrocooled or iced sweet corn.

Sweet corn for shipping is most commonly packaged in wire bound crates or perforated wax boxes. Pallet or bin boxes are sometimes used, however, corn packed in this manner will be hard to cool completely and ears will heat up in the center of the bin from respiration. Burlap bags may be used for local shipments.

**Processing Sweet Corn**: Harvest of standard sugary (su) and sugary-extender (se) varieties begins when kernels reach 70-75% moisture. Supersweet ($sh_2$) varieties have a much higher sugar content than su or se varieties and maintain their sugar content longer after harvest. They are usually harvested at 77-78% moisture. Harvest timing will be determined by the processing companies.

# Weed Control

### THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

### Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the “Herbicide Effectiveness on Common Weeds in Vegetables” Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

## 1. Non-Selective or Burndown

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate (lb ai or ae/A) | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **9** | Roundup PowerMax 4.5L<br>"Generic" glyphosate 3L | 16 to 32 fl oz/A<br>24 to 48 fl oz/A | **glyphosate** | 0.75 to 1.13 lb acid equivalent/A | -- | 4 |
| -Apply before or after seeding but before crop emergence. (Ensure planter slits are fully closed if applying after planting.)<br>-Tank-mix with other herbicides (see table below) for enhanced burndown and/or residual weed control.<br>-Glyphosate controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label. Glyphosate may be applied in clear liquid nitrogen fertilizers and clear liquid complete-analysis fertilizers, but it may be less effective on certain annual grasses and perennials. **Do not** use glyphosate with suspension-type liquid fertilizers.<br>-Repeat applications are allowed, with maximum application of 5.3 qt/A per year. | | | | | | |
| 22 | Gramoxone SL 2.0 | 2.4 to 4.0 pt/A | **paraquat*** | 0.6 to 1.0 lb/A | -- | 24 |
| -Apply before or after seeding but before crop emergence. (Ensure planter slits are fully closed if applying after planting.). Tank-mix with other herbicides (see table below) for enhanced burndown and/or residual weed control. Paraquat may not control established grasses.<br>-Apply in 20 to 60 gal/A for control of emerged annual weeds. Spray coverage is essential for optimum control.<br>-Add 16 to 32 oz non-ionic surfactant/100 gal of spray.<br>-Phosphate-containing liquid fertilizer solutions diminish paraquat activity if used as a carrier.<br>-Use appropriate precautions when handling paraquat to minimize exposure to the herbicide. **Do not** use flood jet tips larger than size 20 or spacing greater than 40 inches. Rainfastness 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |

## 2. Soil-Applied (Preplant Incorporated or Preemergence)

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate (lb ai or ae/A) | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 3 | Prowl 3.3E<br>Prowl H2O 3.8CS | 1.8 to 4 pt/A<br>2 to 4 pt/A | **pendimethalin** | 0.75 to 1.65 lb/A<br>0.95 to 1.9 lb/A | -- | 24 |
| -Control several common annual grasses and broadleaves but does not control yellow nutsedge and ragweed.<br>-Plant corn at least 1.5 inches deep to avoid Prowl injury; however most sweet corn seeds need to be seeded less than 1 inch for optimum emergence. **Do not** incorporate. Must be applied after planting up until corn reaches 30 inches tall.<br>-Preemergence applications can injure corn. Delaying application until spike stage helps maximize crop safety.<br>-Prowl H2O and Satellite HydroCap are water-based capsule suspension formulation that provides similar weed control as the older 3.3E product but causes less staining and odor. Other generic pendimethalin products are available. | | | | | | |
| **5** | Atrazine 4FL | 1.0 to 1.5 qt/A | **atrazine*** | 1.0 to 1.5 lb/A | -- | 12 |
| -Primarily controls broadleaf weeds and provides some suppression of annual grasses. Mostly used in combination with other herbicides especially acetamides. Some prepackaged mixture examples include Bicep II Magnum, Harness Xtra, Keystone NXT, and Guardsman Max. On highly erodible ground with less than 30% surface residue, no more than 1.6 qt may be applied prior to crop emergence.<br>**<u>Atrazine Use Restrictions</u>**<br>-**Preplant or Preemergence:** On highly erodible soils (as defined by the U.S. Natural Resources Conservation Service):<br>-Fields where **more** than 30% of the soil surface is covered with plant residue at planting, apply a maximum of 2 lb/A of active ingredient as a broadcast spray. Fields where **less** than 30% of the soil surface is covered with plant residue at planting, apply a maximum of 1.6 lb/A of active ingredient as a broadcast spray.<br>-Apply a maximum of 2 lb/A of active ingredient as a broadcast spray.<br>-**Postemergence:** If no atrazine was applied prior to crop emergence, use a maximum rate of 2 lb/A of active ingredient. If a soil-applied application was made in the same calendar year, the combined preplant or preemergence and postemergence applications may not exceed 2.5 lb/A of active ingredient.<br>**<u>Safety Precautions for Using Atrazine</u>**<br>-**Do not** mix, load, or apply within 50 ft of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes. **Do not** mix or load within 50 ft of intermittent streams, perennial streams, rivers, lakes, or reservoirs. **Do not** apply within 200 ft of lakes or reservoirs. **Do not** apply within 66 ft of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-ft buffers should be planted to a crop or seeded with grass on highly erodible land. | | | | | | |
| 15 | Dual II Magnum 7.64E<br>Cinch 7.64E | 1.0 to 2.0 pt/A | **s-metolachlor** | 0.96 to 1.91 lb/A | 30 | 24 |
| -Dual II Magnum/Cinch are similar in activity to Harness, Micro-Techs, Outlook, and Surpass NXT. Dual II Magnum/Cinch contains a crop-safening agent. Primarily controls annual grasses, controls or suppresses yellow nutsedge, and suppresses certain broadleaf weeds.<br>-Use preplant incorporated to improve yellow nutsedge control. Combine with atrazine to improve control of most broadleaf weeds.<br>-Also commonly sold as prepackaged mixture e with atrazine:<br>o Bicep II Magnum 5.5L at 2.1 qt/A = 1.3 pt Dual II Magnum 7.64E + 1.6 qt atrazine 4L<br>o Bicep Lite II Magnum 6L at 1.3 qt/A= 1.13 pt Dual II Magnum 7.64E + 0.9 qt atrazine 4L<br>o Cinch ATZ 5.5L at 2.1 qt/A = 1.3 pt Dual II Magnum 7.64E + 1.6 qt atrazine 4L<br>-Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop and may or may not include the safener for corn | | | | | | |

*2. Soil-Applied (Preplant Incorporated or Preemergence) continued on next page*

*2. Soil-Applied (Preplant Incorporated or Preemergence) - continued*

<table>
<tr><td>15</td><td>Harness 7E<br>Degree 3.8ME<br>Surpass NXT 7E<br>Breakfree NXT 7E</td><td>1.25 to 2.75 pt/A<br>2.25 to 5 pt/A<br>1.5 to 3 pt/A<br>1.5 to 3 pt/A</td><td>acetochlor</td><td>1 to 2.4 lb/A<br>1.07 to 2.38 lb/A<br>1.09 to 2.6 lb/A<br>1.09 to 2.6 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Acetochlor products can be applied preplant incorporated or preemergence but prior to weed emergence, and before corn height exceeds 11 inches. Control many annual grasses and yellow nutsedge as well as certain small seeded broadleaves. Check label for specific rate depending on soil type and organic matter. Also commonly sold as prepackaged mixture with atrazine:<br>o Harness Xtra 5.6L at 2.5 qt/A= 2.2 pt Harness 7E + 1.6 qt atrazine 4L<br>o Degree Xtra 4.04ME at 3 qt/A= 4.3 pt Degree 3.8ME + 1 qt atrazine 4L<br>o Keystone NXT 5.6SE at 2.5 qt/A= 2.2 pt Surpass NXT 7E + 3 pt atrazine 4L<br>o Breakfree NXT 5.6SE at 2.5 qt/A= 2.2 pt Surpass NXT 7E + 3 pt atrazine 4L<br>-Other products and formulations may be available.</td></tr>
<tr><td>15</td><td>Micro-Tech</td><td>1.5 to 3.0 qt/A</td><td>alachlor*</td><td>1.5 to 3.0 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Primarily controls annual grasses and certain broadleaf weeds, including pigweed, nightshade, and galinsoga, and suppresses yellow nutsedge when preplant incorporated. Combine with atrazine to improve control of other broadleaf weeds.<br>-Also available as a prepackaged mixture with atrazine:<br>o Bullet 4ME at 3 qt/A= 1.9 qt Micro-Tech + 1.13 qt atrazine 4L</td></tr>
<tr><td>15</td><td>Outlook 6E</td><td>10 to 21 fl oz/A</td><td>dimethenamid</td><td>0.47 to 0.98 lb/A</td><td>50</td><td>12</td></tr>
<tr><td colspan="7">-Outlook is similar in activity to Dual, Harness, and Micro-Tech. Primarily controls annual grasses, controls or suppresses yellow nutsedge, and suppresses certain broadleaf weeds. Local data has shown sweet corn injury with Outlook applied preemergence on coarse-textured soils. Outlook may be applied preemergence on up to 12-inch-tall corn prior to weed emergence.<br>-The medium soil texture rate is 16 fl oz/A for Outlook.<br>-For early preplant applications or fields with heavy surface plant residue, increase the Outlook rate by 1–2 fl oz/A.<br>-Lower use rates, 6–16 fl oz/A, may be used in situations where partial control or reduced length of residue control is required, such as early postemergence applications or preemergence applications followed by postemergence herbicides.<br>-Incorporation improves control of yellow nutsedge.<br>-Prepackaged mixture with atrazine: Guardsman Max 5L at 3.5 pt/A= 16 fl oz Outlook 6E + 1.4 qt atrazine 4L<br>-Prepackaged mixture with saflufenacil (Sharpen): Verdict 5.57EC at 10 fl oz = 8.5 fl oz Outlook 6E + 2 fl oz Sharpen 2.85L</td></tr>
<tr><td>15</td><td>Zidua 85WG<br>Anthem Maxx 4.3SE</td><td>1.5 to 4 oz/A<br>3 to 6 fl oz/A</td><td>pyroxasulfone<br>(± fluthiacet)</td><td>0.08 to 0.21 lb/A<br>0.1 to 0.2 lb/A</td><td>37</td><td>12</td></tr>
<tr><td colspan="7">-Zidua contains the single active ingredient pyroxasulfone. Anthem Maxx also contains fluthiacet (Cadet) however, it does not provide any residual weed control. Pyroxasulfone has annual grass activity similar to Dual, Harness, Outlook, Surpass, etc., but also provides good control of several annual broadleaves. These herbicides can be applied preplant (surface or incorporated) up to 45 d before planting or preemergence. Rates can be adjusted for soil type or 2-pass application programs. Corn must be planted at least 1 inch deep.<br>-These herbicides can be tank-mixed with atrazine or other corn herbicides to broaden weed control spectrum.</td></tr>
<tr><td>27</td><td>Callisto 4SC</td><td>6 fl oz/A</td><td>mesotrione</td><td>0.188 lb/A</td><td>45</td><td>12</td></tr>
<tr><td colspan="7">-Primarily controls common lambsquarters and many other annual broadleaf weeds, including triazine resistant biotypes, but Callisto is weak on ragweed and morninglory species.<br>-Typically combined with other herbicides to improve control of grasses and broaden broadleaf spectrum. (See comments under Lumax, Lexar, Zemax, and Acuron for more details about these prepackaged mixtures.)<br>-Cold weather that slows corn growth will also retard recovery from injury following preemergence treatments.<br>-Sweet corn varieties differ in sensitivity to mesotrione.<br>-Severe crop injury may occur if an organophosphate or carbamate insecticide is applied within 7 days of Callisto.<br>-See the sweet corn section of the Callisto label for additional use precautions.</td></tr>
<tr><td>27, 15, 5</td><td>Lexar EZ 3.7SC<br>Lumax EZ 3.67SC<br>Acuron 3.44SC<br>Acuron Flexi 3.26SC<br>Zemax 3.67SC</td><td>3 to 3.5 qt/A<br>2.7 to 3.25 qt/A<br>2.5 to 3 qt/A<br>2 to 2.25 qt/A<br>2 to 2.4 qt/A</td><td>mesotrione + s-metolachlor + atrazine (± bicyclopyrone)</td><td>2.78 to 3.24 lb/A<br>2.48 to 2.98 lb/A<br>2.15 to 2.58 lb/A<br>1.63 to 1.83 lb/A<br>1.8 to 2.2 lb/A</td><td>45</td><td>24</td></tr>
<tr><td colspan="7">-Lexar EZ and Lumax EZ are mixtures of s-metolachlor (Dual II Magnum), mesotrione (Callisto), and atrazine.<br>-Acuron contains the same active ingredients as Lumax/Lexar with the addition of another Group 27 herbicide, bicyclopyrone. In general, it controls a broader weed spectrum and is better on ragweed, cocklebur, and annual morningglory, and effective on many annual broadleaves and some grasses compared to Lumax/Lexar.<br>-The typical use rates in all tillage systems are 3 qt/A Lexar EZ, 2.7 qt/A Lumax EZ, and 2.5 qt/A Acuron. These products may be applied broadcast on up to 12-inch-tall corn, but prior to annual grass emergence. Do not apply more than 3.5 qt/A Lexar EZ, 3.25 qt/A Lumax EZ, or 3 qt/A Acuron per growing season.<br>-Sweet corn varieties differ in sensitivity to mesotrione.<br>-Do not apply Lexar, Lumax, or Acuron early POST if the corn was treated with Counter insecticide. Do not tank-mix Lexar, Lumax, or Acuron with organophosphate (OP) or carbamate insecticides and apply as a foliar POST application. Do not make a foliar POST application of any OP or carbamate insecticide within 7 days before or 7 days after a Lexar EZ, Lumax EZ, or Acuron application, or severe corn injury may occur. Corn, soybeans, small grains, and sorghum may be planted the spring following Lexar EZ, Lumax EZ, or Acuron application. Zemax is similar to Lumax EZ but contains no atrazine. The typical use rate is 2 qt/A.<br>-Do not apply any of these herbicides postemergence in sweet corn.</td></tr>
</table>

## 3.a. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate (lb ai or ae/A) | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **2** | Accent Q 54.5WG | 0.9 oz/A | **nicosulfuron** | 0.031 lb/A | -- | 4 |
| -Apply as a broadcast or with drop nozzles as a directed spray as an early postemergence rescue treatment to control emerged annual grasses. Treat sweet corn with a broadcast spray or with drop nozzles as a directed spray up to 18 inches tall or up to and including 6 leaf collars (V6). **Do not** treat sweet corn more than 18 inches tall to control many annual grasses and certain annual broadleaf weeds.<br>-Tank-mix with atrazine to increase the spectrum of weeds controlled.<br>-Add nonionic surfactant to be 0.25% of the spray solution (1 qt/100 gal of spray solution).<br>-**Accent Q is safe to apply to certain varieties, but injures or kills others**. Contact your DuPont Crop Protection Sales Representative for information on local sweet corn varieties that have been evaluated for tolerance to Accent Q.<br>-**Do not** use if organophosphate (OP) insecticides have been applied to the crop or tank-mix with bentazon (Basagran) or the risk of crop injury may increase. **Do not** tank-mix with 2,4-D otherwise grass control will be reduced.<br>-Accent Q is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.<br>-**Do not** make more than one application of Accent Q per year. The following prepackaged mixture also contains nicosulfuron:<br>o Revulin Q 51.2WG at 4 oz/A= 1.1 oz Accent Q 54.5WG + 3 fl oz Callisto 4SC<br>-Rainfastness is 4 hrs. | | | | | | |
| **2** | Sandea 75DF, Permit 75DF | 0.5 to 0.66 oz/A | **halosulfuron** | 0.023 to 0.031 lb/A | 30 | 12 |
| -Apply to control yellow nutsedge and broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and velvetleaf. Sandea/Permit applied postemergence will not control common lambsquarters or eastern black nightshade, and will only suppress morningglory species.<br>-Spray before corn reaches 8"in height, or use drop nozzles when corn is over 8" tall to avoid spraying the foliage and into the whorl.<br>-Always add nonionic surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray solution).<br>-**Corn varieties may vary in sensitivity to Sandea**. Use caution when treating new varieties. **Do not** apply to "Jubilee".<br>-**Do not** use if organophosphate (OP) insecticides have been applied to the crop, or the risk of crop injury may increase.<br>-Sandea is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.<br>-Rainfastness is 4 hrs. | | | | | | |
| 4 | 2,4-D amine 4L | 0.5 to 1.0 pt/A | **2,4-D amine** | 0.25 to 0.5 lb/A | 45 | 48 |
| -Apply after corn and weeds emerge. Use drop nozzles when corn is over 8" tall to avoid spraying the foliage or into the whorl.<br>-Warm, wet weather at application may increase the possibility of crop injury. Use the lower recommended rate under these conditions.<br>-Delay cultivation for 8-10 days after treatment to avoid damaging corn due to temporary brittleness sometimes caused by 2,4-D.<br>-**Sweet corn varieties differ in 2,4-D tolerance**. Super sweet varieties may be more sensitive than other varieties. Injury will be less when the minimum recommended rate is used. Use with caution on new varieties. At high rates, 2,4-D may cause temporary injury to corn.<br>-**Do not apply from tasseling to dough stage**. Ester formulations, although labeled, are more subject to volatilization and movement to sensitive crops and are not recommended. Rainfastness is 6 to 8 hrs. | | | | | | |
| 4 | Starane Ultra 2.8L | 0.4 pt/A | **fluroxypyr** | 0.14 lb/A | 31 | 12 |
| -Apply in 1 or 2 applications to control certain annual and perennial broadleaf weeds when sweet corn is less than V5 growth stage.<br>-Starane Ultra has a limited control spectrum but the label lists weeds such as chickweed, cocklebur, ragweed, purslane, bindweed, dogbane, morningglory, and velvetleaf. Starane can cause poor development of brace roots. Rainfastness is 1 hr.<br>-Maximum Starane Ultra application per year: 0.7 pt/A and no more than 2 applications per crop season. | | | | | | |
| 4 | Stinger 3A | 2.0 to 10.5 fl oz/A | **clopyralid** | 0.047 to 0.25 lb/A | 30 | 12 |
| -Apply in 1 or 2 applications to control certain annual and perennial broadleaf weeds when sweet corn is less than 18 inches tall.<br>-Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum).<br>-Stinger is very effective on small seedling annual and emerging perennial weeds less than 2-4 inches tall, but is less effective and takes longer to work when weeds are larger.<br>-Use 2.0 to 4.0 fl oz/A to control annual weeds less than 2 inches tall. Increase the rate to 4.0 to 8.0 fl oz/A to control larger annual weeds. Apply the maximum rate of 10.5 fl oz/A, in 1 or split into 2 applications to suppress or control perennial weeds.<br>-Spray additives are not needed or required by the label, and are not recommended.<br>-Observe follow-crop restrictions, or injury may occur from herbicide carryover.<br>-Rainfastness is 6 hrs. Maximum Stinger application per year: 10.5 fl oz/A. | | | | | | |
| **5** | Atrazine 4L | 1.0 to 2.0 qt/A | **atrazine*** | 1.0 to 2.0 lb/A | -- | 12 |
| -Primarily controls broadleaf weeds. Apply postemergence when weeds are less than 2 inches tall. Add oil concentrate to be 1% of the spray solution. **Do not** apply if corn is greater than 12" tall<br>-**Do not** exceed the maximum rate per acre per year listed on the label for your soil's erodibility class.<br>-**ATRAZINE RESTRICTIONS**: Refer to "Atrazine Use Restrictions" in the Soil-applied section above.<br>-When this and other atrazine treatments are used, **do not** double-crop during this season. Cover crops after corn are satisfactory providing the recommended rate of atrazine is not exceeded. Mold-board plowing before planting grain or vegetables the following spring will minimize the risk of atrazine residue injury. See label for specific crop rotation restrictions. Rainfastness is 1 to 2 hrs. | | | | | | |

***3.a. Postemergence continued on next page***

***3.a. Postemergence - continued***

<table>
<tr><td>6</td><td>Basagran 4L</td><td>1.5 to 2.0 pt/A</td><td>bentazon</td><td>0.75 to 1.0 lb/A</td><td>--</td><td>48</td></tr>
<tr><td colspan="7">-See label for susceptible broadleaf weeds; results are better when weeds are young. Basagran will provide partial control of yellow nutsedge. Grasses will NOT be controlled. Cultivation within 10-14 days will increase control. Rainfastness is 8 hrs.</td></tr>
<tr><td>14</td><td>Aim 2EC</td><td>0.5 fl oz/A</td><td>carfentrazone</td><td>0.008 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Apply before corn reaches 8 inches in height to control seedling broadleaf weeds including pigweed species, common lambsquarters, morningglory species, eastern black nightshade, and velvetleaf. Aim will not control ragweed species.<br>-Tank-mix with atrazine at reduced rates or another broadleaf weed herbicide to increase the spectrum of weeds controlled. Do not tankmix with Basagran due to concerns for crop safety. Always add nonionic surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray solution). Expect to see speckling on the crop foliage after application. Initially the injury may appear to be substantial, but it is not systemic and corn outgrows the injury rapidly.<br>-Variety sensitivity to Aim may vary. Use caution when treating new varieties.<br>-Weather conditions may affect the degree of injury observed. Injury may be more severe during periods of warm, cloudy weather with high humidity and plentiful soil moisture when corn growth is rapid and "soft."<br>-To reduce the risk of crop injury, use drop nozzles when corn is over 8 inches tall to avoid spraying the foliage and into the whorl.<br>-Rainfastness is 1 hr.</td></tr>
<tr><td>14</td><td>Cadet 0.91EC</td><td>0.6 to 0.9 fl oz/A</td><td>fluthiacet</td><td>0.004 to 0.006 lb/A</td><td>40</td><td>12</td></tr>
<tr><td colspan="7">-Apply before corn is 48 inches tall or prior to tasseling.<br>-While Cadet has a wide application window, it will only control weeds less than 2 inches tall, except velvetleaf which is very sensitive to Cadet. Cadet should not be tankmixed with Basagran due to concerns of crop safety. See comments for carfentrazone above.<br>-Also available as a prepackaged mixture with mesotrione:<br>o 3 fl oz Solstice 4SC = 0.7 fl oz Cadet 0.91E + 2.85 fl oz Callisto 4SC<br>-Rainfastness is 1 hr.</td></tr>
<tr><td>27</td><td>Callisto 4SC</td><td>3.0 fl oz/A</td><td>mesotrione</td><td>0.094</td><td>45</td><td>12</td></tr>
<tr><td colspan="7">-Primarily controls common lambsquarters and many other annual broadleaf weeds, including triazine resistant biotypes, but Callisto is weak on ragweed and morningglory species.<br>-Always add nonionic surfactant to be 0.25% of the spray solution (1 qt/100 gal of spray solution), but do not add oil concentrate, liquid fertilizer, or AMS, or tank-mix Callisto and bentazon (Basagran), or severe crop injury may be observed. Temporary minor injury, appearing as whitening of the new foliage, may occur. The crop will quickly outgrow minor injury with no effect on yield or earliness.<br>-Tank-mix with 0.25 to 1.0 lb ai/A of atrazine for improved control and to broaden the spectrum of weed control. Research results support the use of at least 0.5 lb ai/A of atrazine. Do not apply tank-mixes of Callisto and atrazine to corn greater than 12 inches tall.<br>-Sweet corn varieties differ in sensitivity to mesotrione. The majority of varieties may exhibit slight injury symptoms. Certain varieties are tolerant while others exhibit more noticeable injury. No variety was severely injured by the recommended rates applied with nonionic surfactant.<br>-Do not tank-mix Callisto with organophosphate or carbamate insecticides, or apply if the crop was treated with Counter or Lorsban, or severe crop injury may occur.<br>-See the sweet corn section of the Callisto label for additional use precautions.<br>-Prepackaged mixture that also contain mesotrione for postemergence use:<br>o Revulin Q 51.2WG at 4 oz/A = 1.1 oz Accent Q 54.5WG + 3 fl oz Callisto 4SC<br>o Solstice 4SC at 3 fl oz/A = 0.7 fl oz Cadet 0.91E + 2.85 fl oz Callisto 4SC<br>-Rainfastness is 1 hr.</td></tr>
<tr><td>27</td><td>Impact/Armezon 2.8SC</td><td>0.75 to 1.0 fl oz/A</td><td>topramezone</td><td>0.016 to 0.022 lb/A</td><td>45</td><td>12</td></tr>
<tr><td colspan="7">-Apply postemergence to control many annual broadleaf weeds, including common lambsquarters and triazine-resistant broadleaf weed biotypes, and annual grasses. Impact/Armezon will control/suppress crabgrass and most other annual grass species, but may not control certain grass species or grasses larger than the maximum recommended size when treated. Most broadleaf weeds should be treated before they are 6 inches tall and grass weeds should be treated before 2 inches in height. Use the higher recommended rate to suppress or control panicum species or in rescue applications where the target weeds have grown beyond the size indicated on the label.<br>-Add oil concentrate (COC) to be 1% of the spray solution (1 gal/100 gal of spray solution). In addition, the label requires N fertilizer (liquid or AMS).<br>-Tank-mix with 0.25 to 1.0 lb ai/A of atrazine for improved control and to broaden the spectrum of weed control. Research results support the use of at least 0.5 lb ai/A of atrazine. Do not apply tank-mixes of Impact/Armezon and atrazine to corn greater than 12 inches tall.<br>-Do not use postemergence if mesotrione (e.g., Callisto, Lumax, Lexar, Acuron) was used preemergence.<br>-Do not tank-mix with Callisto.<br>-Impact/Armezon has an 18 month replant restriction for most vegetables.<br>-Do not apply more than 1 fl oz/A during the growing season.<br>-Prepackaged mixture that also contains topramezone:<br>o Armezon PRO 5.35EC at 24 fl oz/A= 0.76 fl oz Armezon 2.85SC (or Impact) + 18 fl oz Outlook 6E<br>-Rainfastness is 1 hr.</td></tr>
<tr><td>27</td><td>Laudis</td><td>3.0 fl oz/A</td><td>tembotrione</td><td>0.082 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Apply postemergence to control many annual broadleaf weeds, including common lambsquarters and triazine-resistant broadleaf weed biotypes, and many annual grasses. Laudis will control/suppress most annual grass species, but may not control certain grass species or grasses larger than the maximum recommended size when treated. Fall panicum is not controlled. Most broadleaf weeds should be treated before they are 6 inches tall and grass weeds should be treated before 2 inches in height and before V7 sweet corn growth stage.</td></tr>
</table>

***3.a. Postemergence (Laudis, active ingredient tembotrione) continued on next page***

***3.a. Postemergence (Laudis, active ingredient tembotrione) - continued***

- Add methylated seed oil (MSO) or concentrate (COC) to be 1% of the spray solution (1.0 gal/100 gal of spray solution). In addition, the label requires the addition of N liquid fertilizer (1.5 qt/A) or AMS (1.5 lb/A).
- Tank mix with 0.25 to 1.0 lb ai/A of atrazine for improved control and to broaden the spectrum of weed control. Research supports the use of at least 0.5 lb ai/A of atrazine. **Do not** apply tank-mixes of Laudis and atrazine to corn greater than 12 inches tall.
- **Sweet corn varieties differ in sensitivity to tembotrione**.
- **Do not** use postemergence if mesotrione (e.g., Callisto, Lumax, Lexar, Acuron) was used preemergence. **Do not** tank-mix with Callisto.
- Laudis has up to an 18 month replant restriction for many vegetables.
- Rainfastness is 1 hr. **Do not** apply more than 1 application per growing season

**3.b. Postemergence for Herbicide Resistant Sweet Corn Varieties ONLY!**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Poast 1.5EC | 0.75 to 1.5 pt/A | **sethoxydim** | 0.15 to 0.3 lb/A | 30 | 12 |
| -**USE ONLY ON "POAST PROTECTED" SWEET CORN!** Other sweet corn varieties will be severely injured or killed.<br>-Apply with oil concentrate to be 1% of the spray solution (1.0 gal/100 gal of spray solution) postemergence to control annual grasses and certain perennial grasses. Yellow nutsedge, wild onion/garlic, or broadleaf weeds will not be controlled.<br>-Refer to Poast label for additional application guidelines.<br>-Rainfastness is 1 hr. Maximum Poast application per season: 3 pt/A. | | | | | | |
| **9** | Roundup PowerMax 4.5L (or other labeled generic formulation) | 16 to 44 fl oz/A | **glyphosate** | 0.75 to 1.5 lb acid equivalent/A | 30 | 4 |
| -**USE ONLY ON "ROUNDUP READY" SWEET CORN!** Other sweet corn varieties will be severely injured or killed.<br>-Apply before weeds exceed 2 inches in height or have 4 true leaves. Larger weeds can be killed but yield may be reduced before the weeds are killed. Treat 3-4 weeks after planting when growing conditions are favorable. Perennial weeds must be treated at the proper growth stage to obtain effective control (see label for application time and rate).<br>-Tank-mix glyphosate with Dual II Magnum for residual annual grass control and atrazine for residual annual broadleaf control.<br>-Rainfastness is 6 hrs.<br>-Observe all rate restrictions and Preharvest Intervals for all products. **Do not** apply more than 44 fl oz/A in a single application and before 48" tall corn and more than 4.1 qt/A total of all in-crop applications. | | | | | | |
| 10 | Liberty 280 2.34L | 22 fl oz/A | **glufosinate** | 0.4 lb/A | 50 | 4 |
| -**USE ONLY ON "LIBERTY LINK" (ATTRIBUTE OR ATTRIBUTE II) SWEET CORN!** Other sweet corn varieties will be severely injured or killed. Control many annual broadleaves and grasses. Apply before weeds exceed 3 inches tall and corn reaches V6 growth stage. Include AMS (ammonium sulfate) at 1.5-3 lb/A in the spray mixture.<br>-Use at least 15 gal/A spray volume and medium to coarse spray nozzles.<br>-Tank-mix with other labeled sweet corn herbicides to broaden control spectrum and for residual control.<br>-Rainfastness is 4 hrs. **Do not** apply more than 22 fl oz/A in a single application and 44 fl oz/A per year. | | | | | | |

**4. Other Labeled Herbicides** These products are labeled but limited local data is available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| **14** | Sharpen | **saflufenacil** |
| **14**,15 | Verdict | **saflufenacil + dimethenamid** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Insect pest management in sweet corn typically occurs in four separate phases:

**1)** preventive measures at the time of seed purchase such as selecting a transgenic *Bt* hybrid and/or pretreated a commercially-applied insecticide seed treatment; **2)** at-planting insecticide applications for soil pests; **3)** managing whorl stage corn for lepidopteran pests; and **4)** ear protection.

## 1) Preventive Control

### Bt Transgenic Sweet Corn

*Bacillus thuringiensis* (Bt) sweet corn hybrids are available that express single or pyramided insecticidal proteins for protection against lepidopteran "worm" pests. Attribute® hybrids (Syngenta Seeds) expressing the cry1Ab protein (YieldGard trait) have been available since 1998, and growers can purchase 80K or 25K seed units of white, yellow and bicolor SE and Sh2 hybrids for local, shipping, and processing markets. These hybrids now express the Liberty Link herbicide tolerance trait. Performance Series™ hybrids (Seminis Seeds) expressing two Bt proteins (cry1A.105 and cy2Ab2) are also available in 80K or 25k seed units. These pyramided traits provide additional protection, particularly for corn earworm and fall armyworm, and also are Roundup Ready. In addition, Attribute® II hybrids (Syngenta Seeds) with pyramided genes expressing YieldGard and Viptera traits (Vip3A protein) and stacked with the Liberty Link trait are now available. This Bt pyramided gene technology currently provides nearly 100% control of all lepidopteran pests of sweet corn.

All Bt sweet corn hybrids, regardless of whether single or pyramided traits, provide 100% protection against European corn borers, thus no insecticides are needed during the whorl or tasseling stages, or even during silking if this pest is the only concern. However, corn earworm and fall armyworm are more tolerant to the cry proteins, and sweet corn is also exposed to sap beetles, stink bugs, and silk feeding by corn rootworm adults which can reduce pollination. Because of this pest complex, insecticide sprays may be needed to ensure fresh market quality of Bt hybrids. Furthermore, control efficacy of the YieldGard trait against corn earworm has significantly declined in the Attribute hybrids, and there is recent evidence that the Performance Series hybrids are also showing reduced efficacy due to corn earworm resistance development to the cry proteins. Thus, fields planted in these Bt hybrids will need insecticide applications, depending on the insect pressure and level of resistance in the population. In addition, under moderate to high moth activity (early August-early September), many eggs are laid later in ear development after the expressed Bt protein has degraded in dead silk tissue. This loss of protein activity also is accelerated by hot, dry conditions, which cause rapid desiccation of the silk tissue. As a result, earworms and fall armyworms have a greater chance of surviving and invading the ear. Under high moth activity, up to 50% or more of the Attribute ears can become infested with larvae. In this situation, spray schedules of 3 or 4 applications starting 3-4 days after the first onset of silking and repeated 3-4 days apart may be required. The pyramided Bt hybrids (Performance Series™, Attribute® II) are more effective than the single protein Attribute hybrids and should require much fewer applications, depending on the ear quality requirements. For these hybrids under high corn earworm pressure, a single application of insecticide applied when 100% of the ears have silked (about 5-6 days after the first onset of silking) has been sufficient to ensure fresh market quality. This timing compared to an earlier silk application conserves beneficial insects that provide an important ecological service by feeding on eggs and small larvae during the fresh silking period.

**Insecticidal Seed Treatments**

| **Commercially-Applied Seed Treatments Only** | | |
|---|---|---|
| **Group** | **Product Name** | **Active Ingredient(s)** |
| 1B | Lorsban 50W | chlorpyrifos* - SCM only |
| 4A | Cruiser 5FS | thiamethoxam |
| 4A | Gaucho 600 | imidacloprid |
| 4A | Poncho 600 | clothianidin |
| 4A + 6 | Avicta Complete Corn | abamectin* + thiamethoxam |
| 4A + 11B | Poncho/Votivo | clothianidin + *Bacillus firmus* |
| 4A + 28 | Lumivia | thiamethoxam + chlorantraniliprole |

## 2) At-Planting Insecticide Applications for Soil Pests

### Seedcorn Maggots (SCM), Wireworms (WW), and White Grubs (WG)

These insects can attack germinating corn seeds and the early developing roots. Early season control can be achieved with either commercially-treated seed, or in-furrow insecticide treatments. Larger white grubs may not be completely controlled with most seed treatments. Rescue treatments applied post-planting are not effective.

| **At planting soil-applied treatment. Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Counter 20G–SmartBox® system | 4.5 to 6.0 oz/1000 row ft | terbufos* | see label | see label | H |
| 1B | Lorsban 15G | 8 oz/1000 row ft | chlorpyrifos* | 21 | 24 | H |
| 3A | Force 3G | 4.0 to 5.0 oz/1000 row ft | tefluthrin* | see label | see label | H |

### Corn Flea Beetles

Corn flea beetles transmit bacterial wilt disease (also known as Stewart's wilt) and are numerous after mild winters. If possible, use varieties resistant to bacterial wilt disease. Plants are most vulnerable to the disease in the seedling stage. Treat susceptible varieties at spike stage when > 5% of the plants are infested with beetles.

**Note: Commercially-applied neonicotinoid seed treatments (Cruiser, Gaucho, or Poncho) provide early-season protection from corn flea beetle injury.**

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin XLR Plus[1] | 1.0 to 2.0 qt/A[1] | carbaryl[1] | see label | see label | H |
| 1B | Lorsban Advanced | 1.0 to 2.0 pt/A | chlorpyrifos* | 21 | 24 | H |
| 1B + 3A | Cobalt Advanced | 11.0 to 26.0 fl oz/A | chlorpyrifos* + lambda-cyhalothrin* | 21 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.24 to 4.00 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-UP 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone 2EC | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 6.0 to 10.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole | 7 | 12 | H |
| 4A | Assail 30SG | 4.0 to 5.3 oz/A | acetamiprid | see label | 12 | M |

**[1]Use of carbaryl prohibited on hand harvested corn.**

### Corn Rootworm Larvae

Western corn rootworm can be a serious pest of corn planted continuously year after year in the same field. Eggs are laid in cornfields the previous summer and hatch the following spring. Rootworm larvae can only survive on corn. Larvae prune back and tunnel into roots. Crop rotation is the most effective control for corn rootworm. Avoid planting corn after corn, cucumbers, pumpkins, or squash; rotation distance of even 3 ft is effective. Soil insecticides applied at planting aim to protect the root zone for about 6-8 weeks after application. When allowed on the label, T-band tends to be more effective than in-furrow application.

**Cutworms -** See also the Pest Management chapter, Insect Management section.

Black cutworm is a sporadic pest that can be particularly problematic in no-till situations. Cutworms can clip corn seedlings killing entire plants as they craw down a row. Use of a soil-applied insecticide for other pests such as white grubs and rootworms will provide some control of cutworms.

| **For rescue treatment, apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Lorsban Advanced | 1.0 to 2.0 pt/A | chlorpyrifos* | 21 | 24 | H |
| 1B + 3A | Cobalt Advanced | 11.0 to 26.0 fl oz/A | chlorpyrifos* + lambda-cyhalothrin* | 21 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.24 to 4.00 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-UP 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone 2EC | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 6.0 to 10.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 7 | 12 | H |

**True Armyworms** Armyworms are a sporadic pest that chew jagged holes in the edges of leaves. They are primarily a concern of seedling to early-whorl stage corn. They are active at night.

| **For rescue treatment, apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV[1] | 0.75 to 1.5 pt/A[1] | methomyl*[1] | see label | 48 | H |
| 1B | Lorsban Advanced | 1.0 to 2.0 pt/A | chlorpyrifos* | 21 | 24 | H |
| 1B + 3A | Cobalt Advanced | 11.0 to 26.0 fl oz/A | chlorpyrifos* + lambda-cyhalothrin* | 21 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-UP 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 6.0 to 10.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole | 7 | 12 | H |
| 5 | Blackhawk 36WG | 1.67 to 3.3 oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 3.0 to 6.0 fl oz/A | spinetoram | 1 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 16.0 fl oz/A | methoxyfenozide | 3 | 4 | L |

**[1]Read new methomyl* label restrictions regarding use on seedling stage corn and before tassel push!**

## 3) Managing Whorl Stage Corn for Lepidopteran Pests

### Whorl/Tassel Infestation by European Corn Borer (ECB) and Fall Armyworm (FAW)

In general, insect larval feeding (ECB and FAW) during the whorl stage of development has a greater impact on early planted, short-season varieties. For ECB on early plantings, apply first spray when 15% of the plants show fresh feeding signs. Additional applications may be necessary if infestation remains above 15%. An early tassel treatment is usually more effective than a whorl treatment because larvae are more exposed to the chemicals.

For mid- and late-season plantings, the impact of infestation depends on the growth stage of the plants. Treat for FAW during the early whorl stage when more than 15% of the plants are infested. During mid- to late-whorl stages, treatment for both FAW and ECB may be necessary if more than 30% of the plants are infested. Treat fields in early tassel stage if more than 15% of the emerging tassels are infested with ECB, FAW, or young CEW larvae. Thorough spray coverage in whorls and on plants is essential; direct spray over the plants so that it penetrates leaf whorls. For foliar spray applications, 50-75 gal/A is necessary for effective control. Group 3 pyrethroids may not provide complete control of FAW.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV[1] | 0.75 to 1.5 pt/A[1] | methomyl*[1] | See label | 48 | H |
| 1B | Lorsban Advanced | 1.5 to 2.0 pt/A | chlorpyrifos* | 21 | 24 | H |
| 1B + 3A | Cobalt Advanced | 16.0 to 38.0 fl oz/A | chlorpyrifos* + lambda-cyhalothrin* | 21 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-UP 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 6.0 to 10.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 7 | 12 | H |
| 5 | Blackhawk 36WG | 1.67 to 3.3 oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 3.0 to 6.0 fl oz/A | spinetoram | 1 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 16.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22 | Avaunt 30WDG | 2.5 to 3.5 oz/A | indoxacarb - **through tassel push only** | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 1 | 4 | L |

**[1]Read new methomyl* label restrictions regarding use on seedling stage corn and before tassel push!**

## 4) Ear Protection

**Corn Earworms (CEW) and Other "Worm" Pests Including European Corn Borers (ECB), Fall Armyworms (FAW), and Western Bean Cutworms (WBC)**

CEW is the major pest attacking corn ears in the mid-Atlantic U.S. Moth activity increases after mid-July and continues into September. One female can deposit an egg on hundreds of ears. Direct sampling for CEW, FAW, and ECB during silking is not practical. Begin treatment when the ear shanks emerge or the very first silks appear. Silk sprays should continue on a schedule based on area blacklight or pheromone trap counts, geographical location, and time of year. Before mid-July, silk sprays may be required on a 3-6-d schedule. When CEW populations are heavy (> 10 moths per night), and/or later in the summer, it may be necessary to treat on a 2-3 day schedule.

Applications during the low populations can be terminated up to 5 d before last harvest. During heavy populations and high temperatures, treatments will need to be made according to the legal "days to harvest" of the chemical. For best control during heavy infestations, maximize the gallonage of water per acre, use a wetting agent, and make applications during the early morning if possible. If irrigation or rains wash off the spray within 24 hrs after an application, repeat treatment as soon as the foliage dries. For more precise timing of silk sprays, use blacklight and pheromone traps to determine the actual moth activity on your farm. Contact your county Extension agent or consult your state pest management newsletter for more information on these techniques.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.0 to 1.5 pt/A | methomyl* | See label | 48 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-UP 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 6.0 to 10.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole | 7 | 12 | H |
| 5 | Blackhawk 36WG | 2.2 to 3.3 oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 3.0 to 6.0 fl oz/A | spinetoram | 1 | 4 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole | 1 | 4 | L |

### Corn Leaf Aphids

Corn leaf aphids are contamination concerns for sweet corn as their densities can reach extremely high numbers on corn husks leading to sticky honey dew build up and concomitant sooty mold growth on the husks. This hurts the marketability. Aphid outbreaks are typically caused by frequent applications of pyrethroid insecticides, which **do not** control the aphids, but rather eliminate natural enemies that consume the aphids under normal conditions.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 0.75 to 1.5 pt/A | methomyl* | see label | 48 | H |
| 1B | Lorsban Advanced | 1.0 to 2.0 pt/A | chlorpyrifos* | 21 | 24 | H |
| 4A | Assail 30SG | 4.0 to 5.3 oz/A | acetamiprid | see label | 12 | M |

### Corn Rootworm Adults and Japanese Beetles - Silk clipping Beetles

High rates of silk feeding by corn rootworm beetles, Japanese beetles, and other silk-feeders can affect pollination and cause ear quality problems. **Note: Sweet corn varieties with the *Bacillus thuringiensis* genes will NOT control any of these insects.** For silk feeding insects, when more than 50% of ears have fresh silks cut back and the plants are still pollinating, an insecticide spray also is recommended.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 0.75 to 1.5 pt/A | methomyl* | see label | 48 | H |
| 1B | Lorsban Advanced | 1.0 to 2.0 pt/A | chlorpyrifos* | 21 | 24 | H |

*Corn Rootworm Adults and Japanese Beetles - Silk clipping Beetles continued on next page*

*Corn Rootworm Adults and Japanese Beetles - Silk clipping Beetles - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1B + 3A | Cobalt Advanced | 11.0 to 26.0 fl oz/A | chlorpyrifos* + lambda-cyhalothrin* | 21 | 24 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-UP 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 1 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 6.0 to 10.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 7 | 12 | H |
| 4A | Assail 30SG | 4.0 to 5.3 oz/A | acetamiprid | see label | 12 | M |

### Grasshoppers

Grasshoppers may be quite conspicuous on corn feeding on leaves, but they are seldom of economic concern because they often move into corn later in the season after other grasses and plants have dried down or been harvested. Unless they are seedlings, corn plants typically can tolerate their feeding injury. Grasshoppers also are more abundant on field edges giving the impression that their pest densities are higher than they actually are across the field. Most insecticides (Group 1A, 1B, 3, or 4A) applied for other insects will also control grasshoppers.

### Mites

Mites feed by removing fluids from plant tissue leading to lighter colored or white areas described as stippling. Extensive feeding may lead to reduced photosynthesis and reduced vigor plants.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Bifenture 2EC, Sniper | 6.40 fl oz/A | bifenthrin* | 1 | 12 | H |
| 3A | Hero EC | 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 23 | Oberon 2SC | 5.7 to 16.0 fl.oz/A | spiromesifen | 5 | 12 | M |

### Sap Beetles

Most sap beetle infestations follow behind "worm" infestations, which create entry holes for the beetles to reach kernels to deposit their eggs. Nevertheless, on farms with a known history of sap beetle problems, an insecticide application 5-6 days after the first onset of silking is the best timing for maximum protection against these pests, which are attracted to the ear zone to lay eggs as silk tissue degrades. Varieties with long, tight silk tubes can reduce sap beetle damage. Begin sampling at pollen shed and treat when 5% of the ears have adults and/or eggs. Most insecticides used for "worm" control at silking will control these beetles. **Note: Sweet corn varieties with the *Bacillus thuringiensis* genes will NOT control sap beetles.**

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 0.75 to 1.5 pt/A | methomyl* | see label | 48 | H |
| 1A | Sevin XLR Plus | 1.0 to 2.0 qt/A | carbaryl* | see label | see label | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 6.0 to 10.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole | 7 | 12 | H |
| 4A | Assail 30SG | 4.0 to 5.3 oz/A | acetamiprid | see label | 12 | M |

### Stink Bugs

Stink bugs including the invasive brown marmorated stink bug can feed on developing ears resulting in misshapen ears, unfilled kernels, collapsed kernels, and kernels that turn dark after corn is cooked. **Note: Sweet corn varieties with the *Bacillus thuringiensis* genes will NOT control any of these insects.** *(Continued on next page)*

*Stinkbugs - continued*

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations:** | | | | | | |
| 1B + 3A | Cobalt Advanced | 26.0 fl oz/A | chlorpyrifos* + lambda-cyhalothrin* | 21 | 24 | H |
| 3A | Baythroid XL | 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A | Tombstone 2EC | 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 10.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 7 | 12 | H |

# Disease Control

## Nematodes

Control is very important to the production of sweet corn. See also the Nematodes and Soil Fumigation sections in the Pest Management chapter. Use fumigants listed in the Pest Management chapter, or one of the following:

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1B | Counter 15G | see label for use directions (Not for use in WV) | terbufos* | AP | 48 | H |
| 1B | Mocap 15G | see label for use directions | ethoprop* | AP | 48 | H |

## Seed Treatment

Request that seed be treated with one or more of the following fungicides for seedling diseases and damping-off: Allegiance, Apron XL, Dynasty, or Maxim XL. Seed treatment with these fungicides is especially important for early seedings of Super Sweet (sh) varieties.

## Bacterial and Fungal Diseases

### Leaf Blights (Northern, Southern, and Anthracnose Leaf Blights), and Leaf Spots (Gray Leaf Spot, Northern Corn Leaf Spot)

These diseases originate in corn residue and progress up the plant with persistent rain or overhead irrigation. Avoid planting continuous corn and bury residue with tillage. For optimal control, begin sprays before symptoms appear. Regular scouting and protectant fungicides late in the season may be necessary.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following protectant fungicides:** | | | | | | |
| M3 | mancozeb 75DF | 1.5 lb/A | mancozeb | 7 | 24 | N |
| M5 | chlorothalonil 6F (7-day schedule, **do not** apply to corn to be processed) | 0.75 to 2.0 pt/A | chlorothalonil | 12 | 12 | N |
| **AND rotate on a 7-14 day schedule with one of the following (do not apply the same fungicide more than twice in a row; switch to fungicides with different FRAC codes):** | | | | | | |
| 3 | propiconazole 3.6EC | 2.0 to 4.0 fl oz/A | propiconazole | 12 | 12 | N |
| 3 + 3 | Prosaro 421SC | 6.5 fl. oz/A (5-14 day schedule) | tebuconazole + prothioconazole | 7 | 12 | N |
| 3+7+11 | Trivapro | 14.5 fl oz/A (10.5 fl oz/A Trivapro A and 4 fl oz/A Trivapro B) | propiconazole + soletanol + azoxystrobin | 7 | 12 | N |
| 3 + 11 | Headline AMP 1.68SC | 10.0 to 14.4 fl oz/A | pyraclostrobin + metaconazole | 20 | 12 | N |
| 3 + 11 | Quilt Xcel 2.2SC | 10.5 to 14 fl oz/A | propiconazole + azoxystrobin | 14 | 12 | N |
| 3 + 11 | Stratego 2.08 EC | 10.0 fl oz /A | propiconazole + trifloxystrobin | 14 | 12 | N |
| 3 + 11 | Stratego YLD 4.18EC | 4.0 to 5.0 fl oz/A (5-14 d. schedule) | prothioconazole + trifloxystrobin | 0 | 12 | N |
| 7 + 11 | Priaxor 4.17SC | 4.0 to 8.0 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 11 | Aproach 2.08 SC | 6.0 to 12.0 fl oz/A | picoxystrobin | 7 | 12 | N |
| 11 | azoxystrobin 2.08F | 9.2 to 15.5 fl oz/A | azoxystrobin | 7 | 4 | N |
| 11 | Headline 2.1EC | 9.0 to 12.0 fl oz/A | pyraclostrobin | 7 | 12 | N |

## Root and Stalk Rots

Root and stalk rots are caused by several species of fungi, including *Fusarium*, *Diplodia*, *Pythium* and *Macrophomina*. Some of these fungi enter through the roots and move up into the stalk, while others enter the stalk directly at the nodes. Insects can increase infection by enabling fungi to enter the plant in damaged areas. Use fungicide-treated seed and plant in well-drained areas. Do not exceed recommended plant densities. Keep soil fertility balanced based on soil tests. Manage insects throughout the growing season.

## Rust (Common and Southern)

Rust is caused by a pathogen that blows into our region from Southern areas. In most years chemical control measures are not necessary, but rust occasionally becomes troublesome on susceptible hybrids planted later in the growing season. Corn warrants spraying if infection occurs prior to the whorl stage, particularly if Southern rust is detected. Observe fields on a regular basis.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **If pustules are observed prior to the whorl stage, apply one of the following on a 7-14 day schedule (do not apply the same fungicide more than twice in a row; switch to fungicides with different FRAC codes):** | | | | | | |
| 3 + 3 | Prosaro 421 SC | 6.5 fl. oz/A (5-14 day schedule) | tebuconazole + prothioconazole | 7 | 12 | N |
| 3+7 +11 | Trivapro | 14.5 fl oz/A (10.5 fl oz/A Trivapro A and 4 fl oz/A Trivapro B) | propiconazole + soletanol + azoxystrobin | 7 | 12 | N |
| 3 + 11 | Headline AMP 1.68SC | 10.0 to 14.4 fl oz/A | pyraclostrobin + metaconazole | 20 | 12 | N |
| 3 + 11 | Quilt Xcel 2.2SC | 10.5 to 14 fl oz/A | propiconazole + azoxystrobin | 14 | 12 | N |
| 3 + 11 | Stratego 2.08 EC | 10.0 fl oz /A | propiconazole + trifloxystrobin | | | N |
| 3 + 11 | Stratego YLD 4.18 EC | 4.0 to 5.0 fl oz/A (5-14 day schedule) | prothioconazole + trifloxystrobin | 0 | 12 | N |
| 7 + 11 | Priaxor 4.17SC | 4.0 to 8.0 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |

## Smut

There is no true genetic resistance to smut in sweet corn. Later maturing, larger varieties tend to be more tolerant to smut than early, smaller varieties. Since damaged tissue is more prone to infection, control corn borers, stink bugs, and other problematic insect pests as the first tassel appears.

## Stewart’s Bacterial Wilt

Use varieties resistant to Stewart’s wilt listed in the sweet corn varieties table at the front of this section in areas with a history of bacterial wilt. More variety information relative to Stewart’s Bacterial Wilt is available at: *http://sweetcorn.illinois.edu/index.html*. Control of flea beetles is essential for effective disease management. Flea beetles transmit Stewart’s wilt and are prevalent after mild winters. Use insecticide-treated seed or a recommended insecticide at seedling emergence. Treat susceptible varieties at spike stage when 5% of the plants are infested. See Insect Control Section for flea beetle control recommendations.

## Viruses

## Maize Dwarf Mosaic Virus (MDMV)

MDMV is most likely to occur on corn planted after July 1. The virus is transmitted by aphids to sweet corn from infected weeds, especially Johnsongrass. Less frequently, the disease may be transmitted in/on seed. For control, manage weeds and aphids and plant resistant varieties for fall harvest.

# Sweet Potatoes

## Recommended Varieties[1]

| Orange Flesh | | White Flesh |
|---|---|---|
| Beauregard[2] "B-14" and "B-63" (FR) | Covington (FR, RKR) | Bonita (RKR) |
| Bellevue (FR, RKR) | Evangeline (FR, RKR) | O' Henry |
| Burgundy (FR, RKR) | Orleans (FR) | |

[1]Listed alphabetically; letters in parentheses indicate disease resistance: FR = *Fusarium* wilt resistant; RKR = root-knot nematode resistant.
[2] Mericlones B-14 and B-63 have compact and extended vines, respectively.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| Sweet Potatoes | | Soil Phosphorus Level | | | | Soil Potassium Level | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High (Opt) | Very High | Low | Med | High (Opt) | Very High | |
| | N (lb/A) | $P_2O_5$ (lb/A) | | | | $K_2O$ (lb/A) | | | | Nutrient Timing and Method |
| | 50-75 | 200 | 100 | 50 | 0[1] | 300 | 200 | 100 | 0[1] | Total nutrient recommended. |
| | 25 | 200 | 100 | 50 | 0[1] | 300 | 200 | 100 | 0[1] | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress when vines start to run. |

[1]In VA, crop replacement values of 25 lb/A of $P_2O_5$ and 50 lb/A of $K_2O$ are recommended on soils testing Very High.

## Variety Selection

Select variety according to market preferences, local adaptation and specific soil problems. Current varieties require 100 to 140 days to achieve maximum yield, depending on cultural practices, irrigation and environmental conditions. Use certified G1 or G2 (generations), virus tested, disease-free "seeds" (storage root used for transplant/slip production) or slips (sprouts or cuttings for field planting) to maximize yield and quality.

## Site selection, soil and fertilization

Well-drained sandy to sandy loam soils are best for sweet potato, either bedding or production. Avoid heavy soils and soils that will stand water for more than 24 hr. Avoid excessive amount of organic matter (fields just broken from pastures). Soils with high levels of organic matter may promote scurf. Use long rotations with grains and soybean to decrease the incidence of soil-borne diseases. Avoid fields with high nematode populations and those that had sweet potato in the past two years. Test the soil for nematodes and fertility. Optimum soil pH is 5.8-6.2. If lime is needed, apply it several months before planting. All P and K can be applied before planting. Apply half of the recommended N before planting (broadcast or band) and apply the rest at layby when vines start to run.

## Plant Production

Sweet potato is propagated vegetatively by sprouts or slips from storage roots ("seed"). Select good quality, certified G1 or G2 "seeds" that are uniform and free from insects and diseases. Before bedding, "seeds" should be pre-sprouted at 85°F (29°C) and 90% relative humidity for 3-4 weeks until the sprouts are 1-1½ inch long. Make sure "seeds" are well ventilated because the process requires oxygen. For bedding, avoid sites that had sweet potato in the past 3 years to reduce the risk of diseases. Fertilize with 4-5 lb/100 sqft bed area of 8-8-8 or its equivalent. Bed "seed" stock the first week of April and use black or clear plastic mulch to warm up the soil. Minimum soil temperature for sweet potato to grow is 60°F (16°C). Treat "seeds" with appropriate fungicides to reduce decay. Spread "seeds" (one layer) in beds 2-3 ft wide, cover with 2-3 inches of soil or sand and cover with plastic mulch. After 5-7 days, punch holes every 4 ft on each side of the bed to prevent accumulation of carbon dioxide. When clear plastic mulch is used, apply an herbicide (see the Weed Control section). Remove plastic mulch when sprouts begin to emerge and cover with floating row cover to promote growth and protect against cold temperatures. Remove row covers 5-7 days prior to planting to harden the slips. The warmer conditions in greenhouses and high tunnels (hoop houses) promote sprouting and growth for an early production of slips. For optimal growing conditions keep beds moist and temperature between 75-85°F (24-29°C); however, greenhouse or high tunnel slips are less sturdy than slips from field beds for field planting. One 50-lb bushel of “seed” roots produces 500 to 1,000 sprouts in 10-15 sq ft of bed area. For field planting, best slips are 10-12 inches long and they should be cut (not pulled) from the beds at 1 inch above the soil line to minimize transmission of pests and diseases.

### Field Planting

Sweet potato is cold sensitive and should be planted after all danger of frost is over and the soil temperature at 4 inch-deep is >65°F (>18°C). The optimum growth temperature is between 70-85°F (21-29°C), although plants can tolerate temperatures between 65-95°F (18-35°C). Plant slips in the field between May 5 and June 15 in warmer, southern areas and between May 20 and June 5 in cooler areas. Slips 12-inch long with 6-8 leaves and well initiated root system are best. Plant slips on moist ridged rows 8-10 inches high. Plant spacing is 12-18 inches along rows and 36-48 inches between rows. Water or starter fertilizer solution (1 oz/gal of 15-30-15 or equivalent) at 4-5 oz/slip applied at planting will benefit establishment. If irrigation is available, water field immediately after planting and then as needed.

### Harvest and Postharvest Considerations

Prior to harvest, scout the field to determine storage root size and appropriate proportion of desired market grade. Pre-harvest conditioning and appropriate harvest handling is critical to reduce bruising of the delicate skin. Striking roots with harvesting equipment or dropping them into containers injures the skin resulting in increased susceptibility to disease. Even if the injury heals, the scars render unappealing storage roots with no fresh market value. Kill vines mechanically (devining) with a flail mower of appropriate design 5 -7 d before harvest to improve skin set and facilitate harvest.

Various methods can be used to harvest sweet potato. Growers with small area may harvest by hand using a garden fork. Intermediate sized commercial growers can use a 1 or 2-row modified mold board or disc plow, or middle buster with a notched coulter adjusted just left of the main stems to turn the rows and expose the storage roots. Remove roots from the vines by hand and place them into smooth baskets. Use globes to keep bruises and abrasions to a minimum. Mechanical diggers patterned after a low flat-bed type potato digger or digger-windrower can facilitate harvest in larger areas. These are 1 or 2-row diggers that incorporate a short separating chain behind a wide blade to dig both soil and roots onto the chain. Soil falls through the chain as the storage roots move up with the chain and drop off to the ground in the back of the digger. Care must be taken to bring enough soil up with the chain to minimize bruises. Storage roots are then picked up by hand and placed in smooth sided baskets. With more advanced harvesters, the storage roots continue on the chain through a platform where they are picked up by hand and placed directly into bins. After the roots are harvested, they should be cured in the storage house at 85°F (29°C) and 85-90% relative humidity for 5-7 days. After curing, temperature should be lowered to 55°F (13°C), but relative humidity should be maintained at 85% for long term storage.

Sweet potato is marketed based on the U.S. Standards for Grades of Sweet Potatoes. U.S. No.1 (roots of 1¾ to 3½ inches in diameter and 3 to 9 inches long) is the preferred grade for fresh market and has the highest price. U.S. No.2 includes smaller root (canner) and larger roots (jumbo), and are accepted by the processing industry. Well-shaped small storage roots free of blemishes have been sold also as fingerling or nuggets in specialty markets.

## Weed Control

### THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

### Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the “Herbicide Effectiveness on Common Weeds in Vegetables” Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

## 1.a. Soil-Applied: Pretransplant

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 14 | Valor SX 51WDG | 2.5 oz/A | **flumioxazin** | 0.078 lb/A | -- | 12 |

-Apply 2 to 5 day pre-transplant after all tillage has been completed. Limit disturbance of treated soil with transplant equipment. Tillage or cultivation after applying Valor SX reduces or eliminates weed control. Valor SX controls many broadleaf weeds, but only suppresses annual grasses. Tank mix with Command pretransplant or follow with a residual grass product to improve control of annual grasses.
-**DO NOT** apply postemergence to sweet potatoes.
-**DO NOT** use on any variety other than 'Beauregard', unless user has tested Valor SX and found tolerance to be acceptable.
-**DO NOT** use on greenhouse grown transplants or transplants that have been harvested more than 2 days prior to transplanting.
-Valor SX can be difficult to clean out of spray tank and hoses. Follow tank cleaning recommendations on the label.
-Maximum for Valor SX 51WDG: 3 oz/A per growing season.

## 1.b. Soil-Applied: After Transplanting

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 3 | Dacthal 6F<br>Dacthal W-75 | 8.0 to 14.0 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6.0 to 10.5 lb/A | -- | 12 |

-Apply at transplanting or 10-14 days after transplanting. Labeled for applications directly over transplants without injury.
-If weeds are present, the crop should be weeded or cultivated prior to application. Dacthal controls annual grasses and certain broadleaf weeds. Maximum application not addressed on label.

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 13 | Command 3ME | 1.33 to 2.66 pt/A | **clomazone** | 0.5 to 1.0 lb/A | 95 | 12 |

-Apply after transplanting and prior to weed emergence. Use lower rates on coarse-textured soils low in organic matter and higher rates on fine-textured soils and soils with high organic matter. Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops.
-Controls annual grasses and many broadleaf weeds depending on use rate, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge.
-Some temporary crop injury (partial whitening of leaf or stem tissue) may occur. Complete recovery will occur from minor early injury without affecting yield or delaying maturity.
-**WARNING**: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application (refer to label for restrictions).
-Maximum number of applications per season is 1.

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 15 | Devrinol 2-XT | 2.0 to 4.0 qt/A | **napropamide** | 1.0 to 2.0 lb/A | -- | 24 |

-Apply immediately after transplanting and prior to weed emergence.
-Annual grasses and certain annual broadleaf weeds will be suppressed or controlled. Use lower rate on coarse textured or sandy soil.
-Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.
-Maximum for Devrinol 2-XT: No more than 4 qt/A per crop cycle.

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>9.0 to 16.0 fl oz/A | **clethodim** | 0.07 to 0.12 lb/A | 30 | 24 |
| | Poast 1.5EC | 1.0 to 1.5 pt/A | **sethoxydim** | 0.2 to 0.3 lb/A | 30 | 12 |
| | Fusilade DX 2EC | 8 to 12 fl oz/A | **fluazifop** | 0.125 to 0.188 lb/A | 14 | 12 |

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution).
-**Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution).
-**Poast**: Apply with COC at 1.0% v/v. **Fusilade DX:** Apply with COC at 1.0% v/v or NIS at 0.25% v/v.
-**The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions. If repeat applications are necessary, allow 14 days between applications. **Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. Rainfastness 1 hr.
-**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season.
-**Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 4.5 pt/A for the season.
-**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 3 pt/A per season.

| 3. Postharvest | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 for postharvest crop desiccation in DE, NJ and VA.** Apply after the last harvest. Always include an adjuvant. Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

| **4. Other Labeled Herbicides** These products are labeled but limited local data is available; and/or are labeled but not recommended in our region due to potential crop injury concerns. | | |
|---|---|---|
| **Group** | **Product Name** | **Active Ingredient (*=Restricted Use)** |
| **14** | Aim | **carfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

In the Mid-Atlantic U.S., the primary insect pest concerns for sweet potatoes are a complex of soil-inhabiting beetle larvae including white grubs, wireworms, flea beetles, and southern corn rootworms. In general, very little economic damage occurs to this crop from above-ground insect pests. Pest control mostly occurs at planting.

## Soil insects: Wireworms, Flea Beetle Larvae, White Grubs, and Rootworms

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1B | Mocap 6EC | 5.1 to 6.9 fl oz/ 1000 row ft | ethoprop* - **Pre-plant application in a 12-15-inch band on the row 2-3 w before planting.** | see label | 48/5 | H |
| 1B | Lorsban Advanced | 4.0 pt/A | chlorpyrifos* - **Pre-plant broadcast and incorporate.** | 125 | 24 | H |
| 3A | Bifenture 2EC, Sniper | 19.2 fl oz/A | bifenthrin* - **at-planting in-furrow** | see label | 12 | H |
| 3A | Bifenture 2EC, Sniper | 3.2 to 9.5 fl oz/A | bifenthrin* - **apply to soil prior to lay-by or first cultivation** | see label | 12 | H |
| 3A | Capture LFR | 12.75 to 25.5 fl oz/A | bifenthrin*- **at-planting in-furrow or to soil prior to lay-by or first cultivation** | see label | 12 | H |

## Cutworms - See also the Pest Management chapter, Insect Management section.

Various species can cause direct damage to sweet potatoes as well as sever plant stems.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 21 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 1.92 to 3.20 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A | Mustang Maxx | 1.28 to 4.00 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Tombstone 2EC | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 0.96 to 1.6 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A + 28 | Besiege | 5.0 to 8.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole | 14 | 24 | H |

## Cucumber Beetles, Flea Beetles, Click Beetles and Tortoise Beetle Adults

Well timed foliar applications during the summer months targeting beetle adults can help reduce the number of eggs deposited in fields, which may reduce the amount of larval damage to roots.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Sevin XLR Plus | 1.0 to 2.0 qt/A | carbaryl | 7 | 12 | H |
| 3A | Baythroid XL | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |

*Cucumber Beetles, Flea Beetles, Click Beetles and Tortoise Beetle Adults continued on next page*

*Cucumber Beetles, Flea Beetles, Click Beetles and Tortoise Beetle Adults - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A | Bifenture 2EC, Sniper | 2.1 to 6.4 fl oz/A | bifenthrin* | see label | 12 | H |
| 3A | Hero EC | 2.6 to 6.1 fl oz/A | zeta-cypermethrin* + bifenthrin* | 21 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A | Mustang Maxx | 1.28 to 4.00 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 7 | 24 | H |
| 3A + 4A | Brigadier | 5.1 to 7.7 fl oz/A | bifenthrin* + imidacloprid | 7 | 12 | H |
| 3A + 4A | Endigo ZC | 3.5 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 14 | 24 | H |
| 3A + 4A | Leverage 360 | 2.4 to 2.8 fl oz/A | imidacloprid + beta-cyfluthrin* | 7 | 12 | H |
| 3A + 28 | Besiege | 5.0 to 8.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 14 | 24 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam | 14 | 12 | H |
| 4A | Admire PRO | 1.2 fl oz/A | imidacloprid | 7 | 12 | H |
| 4A | Assail 30SG | 1.5 to 2.5 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Belay 2.13SC | 2.0 to 3.0 fl oz/A | clothianidin | 14 | 24 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

### Nematodes

See also the Nematodes and Soil Fumigation sections in the Pest Management chapter. Use fumigants listed under Soil Fumigation or listed below. Consult the label.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Vydate L | see label | oxamyl* | AP | 48 | H |
| 1B | Mocap 15G | see label (not for use in WV) | ethoprop* | AP | 48 | H |

### Damping Off caused by *Pythium* and *Rhizoctonia*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 4 | Ridomil Gold 4SL | 1.0 to 2.0 pt/A | mefenoxam | AP | 48 | N |
| 4 + 11 | Uniform 3.66SE | 0.34 fl oz/1,000 ft row | mefenoxam + azoxystrobin | AP | 12 | -- |
| 11 | Quadris 2.08F | 0.4 to 0.8 fl oz/1,000 ft row | azoxystrobin | AP | 4 | N |

### Bacterial and Fungal Diseases

### Black Rot and Scurf

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1 | Mertect 340-F - see label for application methods[1] | 107 fl oz/100 gal | thiabendazole | 0.5 | 12 | N |

**Fusarium Wilt** Use resistant varieties.

**Pox (Soil Rot)** Use resistant varieties. Maintain a pH between 4.8-5.2 to assist in control. Use crop rotation, clean seed, and lean beds. Fumigation prior to planting may also help.

**Surface Rot** Minimize injury during harvest. Cure as soon as possible under proper storage conditions. Use clean seed for bedding.

### Postharvest Soft Rot (*Rhizopus*)

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 12 | Scholar 1.9SC - see label for application methods | 16 to 32 fl oz/100 gal | fludioxonil | -- | 12 | -- |

# Tomatoes

## Recommended Varieties

| | Variety[1] | Type | Season | Culture | Use[2] | Disease Resistance[3] | Plant Habit[4] |
|---|---|---|---|---|---|---|---|
| Market | Applause | Globe, Red | Early | Field | DM, LW | V,F | D |
| | Primo Red | Globe, Red | Early | Field | DM, LW, S | V,F,Tomv | D |
| | Sunshine | Globe, Red | Early | Field | DM, LW, S | V,F,Gls | D |
| | Sunbrite | Globe, Red | Early | Field, High Tunnel | DM, LW, S | Asc, V,F,Gls | D |
| | Amelia | Globe, Red | Mid | Field | LW, S | V,F,Tswv | D |
| | BHN 1009 | Globe, Red | Mid | Field | LW, S | V,F | D |
| | BHN 589 | Globe, Red | Mid | Field, High Tunnel | DM, LW | V,F,Tomv | D |
| | BHN 961 | Globe, Red | Mid | Field | DM, LW, S | V,F,Tomv | D |
| | BHN 964 | Globe, Red | Mid | Field | DM, LW, S | V,F,Tomv,Eb | D |
| | Biltmore | Globe, Red | Mid | Field | DM, LW, | V,F,Asc,Gls | D |
| | Brandy Boy | Globe, Red | Mid | Field, High Tunnel | DM, LW | | I |
| | Charger | Globe, Red | Mid | Field, High Tunnel | DM, LW, S | V,F,Gls,Asc,Tylc | D |
| | Crista | Globe, Red | Mid | Field | DM, LW, S | V,F,Tswv | D |
| | Defiant | Globe, Red | Mid | Field | DM, LW | V,F,Lb | D |
| | Floralina | Globe, Red | Mid | Field | DM, LW | V,F,Asc,Gls | D |
| | Florida 47R | Globe, Red | Mid | Field | LW, S | V,F,Asc,Gls | D |
| | Mountain Glory | Globe, Red | Mid | Field | DM, LW, S | V,F,Gls,Tswv | D |
| | Mountain Spring | Globe, Red | Mid | Field | DM, LW | V,F | D |
| | Mt. Merit | Globe, Red | Mid | Field | DM, LW, S | V,F,N,Tswv, Lb, | D |
| | Red Deuce | Globe, Red | Mid | Field | DM, LW, S | V,F,Tomv,Gls,Asc | D |
| | Red Defender | Globe, Red | Mid | Field | DM, LW, S | V,F,N,Tswv | D |
| | Red Mountain | Globe, Red | Mid | Field, High Tunnel | DM, LW, S | V,F,Tswv | D |
| | Rocky Top | Globe, Red | Mid | Field, High Tunnel | DM, LW, S | V,F,Gls | D |
| | Scarlet Red | Globe, Red | Mid | Field, High Tunnel | DM, LW, S | V,F | D |
| | Red Morning | Globe, Red | Mid | Field | DM, LW, S | V,F, Tomv, Tswv | D |
| | Volante | Globe, Red | Mid | Field | DM. LW, S | V,F,Gls,Asc, Tswv | D |
| | BHN 871 | Globe, Yellow | Mid | Field, High Tunnel | DM, LW | V,F,Tomv | D |
| | Carolina Gold | Globe, Yellow | Mid | Field | DM, LW | V,F | D |
| | Lemon Boy | Globe, Yellow | Mid | Field, High Tunnel | DM, LW | V,F,N | I |
| | BHN 602 | Globe, Red | Mid, Late | Field | DM, LW, S | V,F,Tswv | D |
| | Florida 91 | Globe, Red | Mid, Late | Field | DM, LW, S | V,F,Asc,Gls | D |
| | Mt. Fresh Plus | Globe, Red | Mid, Late | Field | DM, LW, S | V,F,N | D |
| | Phoenix | Globe, Red | Mid, Late | Field | LW, S | V,F,Asc,Gls | D |
| | Red Bounty | Globe, Red | Mid, Late | Field, High Tunnel | DM, LW | V,F,N,Gls,Tswv | D |

[1]All varieties are hybrids. [2]DM=Direct Market, LW=Local Wholesale, S=Shipping. [3]Resistances or tolerances: Asc=Alternaria stem canker, Eb=Early blight, F=Fusarium wilt, Gls=Gray leaf spot, Lb=Late blight, N=Root-knot nematode, Tomv=Tomato mosaic virus, Tswv=Tomato spotted wilt virus, Tylc=Tomato Yellow Leaf Curl virus, V=Verticillium wilt. [4]D=Determinate, I=Indeterminate.

| | Variety | Maturity | Size | Shape | Color | Plant Habit |
|---|---|---|---|---|---|---|
| Heirloom | Mortgage Lifter | Late | Large | Beefsteak | Pink skin, Pink flesh | I |
| | Hawaiian Pineapple | Late | Large | Beefsteak | Orange bicolor | I |
| | Prudens Purple | Mid | Large | Globe | Deep pink skin and flesh | I, potato leaf |
| | Mister Stripy | Late | Large | Round | Bicolor red and yellow | I |
| | Brandywine Red | Late | Large | Beefsteak | Red skin, red flesh | I, potato leaf |
| | Box Car Willie | Late | Med-large | Globe | Red skin, red flesh | I |
| | Eva Purple Ball | Mid | Medium | Round | Deep pink skin and flesh | I |
| | Arkansas Traveler | Late | Medium | Round | Red skin, red flesh | I |
| | Costoluto Genovese | Late | Medium | Ribbed flat globe | Red skin and flesh | I |
| | Snow White | Late | Small | Round cherry | Yellow skin and flesh | I |
| | Yellow Pear | Late | Small | Small pear | Yellow skin and flesh | I |

*Recommended Varieties continued on next page*

*Recommended Varieties - continued*

| | Variety[1] | Type | Color | Disease Resistance[2] | Plant Habit[3] |
|---|---|---|---|---|---|
| **Plum, Cluster, Cherry and Grape** | Plum Crimson | Plum | Red | V,F | D |
| | Plum Dandy | Plum | Red | V,F | D |
| | Plum Regal | Plum | Red | V,F,Lb,Tswv, | D |
| | Picus | Plum | Red | V,F,Asc,Gls,Tswv | D |
| | Pony Express | Plum | Red | V,F,N,Tomv,Bs | D |
| | Mariana | Plum | Red | V,F,N,Asc | D |
| | Victoria Supreme | Plum | Red | V,F,N,Asc,Gls | D |
| | Health Kick | Plum | Red | V,F,Asc,Tswv,Bs | D |
| | Mt. Magic | Small cluster | Red | V,F,Lb | I |
| | BHN 762 | Cherry | Red | V,F | D |
| | Sun Sugar | Cherry | Orange | F, Tmv | I |
| | Mountain Bell | Cherry | Red | V,F | I |
| | Sweet Chelsea | Cherry | Red | V,F,N,Tomv | I |
| | Sun Gold | Cherry | Orange | F, Tomv | I |
| | Sweet Treats | Cherry | Pink | F,Tomv,Gls | I |
| | BHN 785 | Grape | Red | F | D |
| | Mini Charm | Grape | Red | V,F,Tomv | I |
| | Smarty | Grape | Red | V, F | I |
| | Jolly Girl | Grape | Red | V, F | D |
| | Cupid | Grape | Red | F, Asc | I |
| | Juliet | Large Grape | Red | | I |

[1]All varieties are hybrids. [2]Resistances or tolerances: Asc=Alternaria stem canker, Bs=Bacterial speck, Eb=Early blight, F=Fusarium wilt, Gls=Gray leaf spot, Lb=Late blight, N=Root-knot nematode, Tmv=Tobacco mosaic virus,.Tomv=Tomato mosaic virus, Tswv=Tomato spotted wilt virus, V=Verticillium wilt. [3]D=Determinate, I=Indeterminate.

| | Variety[1] | Season | Disease Resistance[3] |
|---|---|---|---|
| **Processing[2]** | TSH4 | Early | V,F,Bs |
| | H-3402 | Mid | V,F,N,Bs |
| | H-9704 | Mid | V,F,Asc |
| | H-9997 | Early | V,F,N,Asc,Bs |

[1]All varieties are hybrids. [2]Most plantings are contracted by processor; consult with processor to determine preferred varieties [3]Disease resistance or tolerance: Asc=Alternaria stem canker, Bs = Bacterial speck, F=Fusarium wilt, N=Root-knot nematode, V=Verticillium wilt.

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state’s soil test report recommendations and/or your farm’s nutrient management plan supersede recommendations found below.

| **Tomatoes[1]** | | **Soil Phosphorus Level** | | | | **Soil Potassium Level** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Low** | **Med** | **High (Opt)** | **Very High** | **Low** | **Med** | **High (Opt)** | **Very High** | |
| | **N (lb/A)** | **$P_2O_5$ (lb/A)** | | | | **$K_2O$ (lb/A)** | | | | **Nutrient Timing and Method** |
| **Bare-Ground Fresh Market** | 80-90 | 200 | 150 | 100 | 0[2] | 300 | 200 | 100 | 0[2] | Total nutrient recommended |
| | 40-45 | 200 | 150 | 100 | 0[2] | 300 | 200 | 100 | 0[2] | Broadcast and disk-in |
| | 40-45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress when first fruits are set |
| **Processing Machine Harvest** | 50-75 | 200 | 150 | 100 | 0[2] | 250 | 150 | 100 | 0[2] | Total nutrient recommended |
| | 25 | 200 | 150 | 100 | 0[2] | 250 | 150 | 100 | 0[2] | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress at first cultivation |
| **Polyethelene Mulched Fresh Market** | 150-210 | 200 | 150 | 100 | 0[2] | 300 | 200 | 100 | 0[2] | Total nutrient recommended |
| | 0 | 200 | 150 | 100 | 0[2] | 150 | 100 | 50 | 0 | Broadcast and disk-in |
| | 50-85 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Incorporate into the plant bed before laying polyethylene mulch |
| | 90-125 | 0 | 0 | 0 | 0 | 150 | 100 | 50 | 0[2] | Fertigate 0.5 to 2.5 lb/day. See chart and Drip/Trickle Fertilization section |

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7 in the Soil and Nutrient Management chapter.
[2]In VA, crop replacement values of 50 lb/A of $P_2O_5$ and 50 lb/A of $K_2O$ are recommended on soils testing Very High.

## Fertigation Schedule Examples for Fresh Market Tomatoes

This table provides examples of fertigation schedules based on two common scenarios – sandy coastal plain soils and heavier upland soils. Modify according to specific soil tests and base fertility.

| **Fertigation recommendations for 150 lb N and 150 lb $K_2O$**[1,2] For soils with organic matter content less than 2% or coarse texture and low to medium or deficient K | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Nitrogen** | | | **Potash** | | |
| **Preplant (lb/A)**[3] | | | **50** | | | **125** | | |
| | | | **N** | **N** | **N** | **$K_2O$** | **$K_2O$** | **$K_2O$** |
| **Stage and Description** | Weeks | Days | lb/day | lb/week | lb/stage | lb/day | lb/week | lb/stage |
| **1 Early vegetative** | 1-2 | 1-14 | 0.5 | 3.5 | 7 | 0.5 | 3.5 | 7 |
| **2 Late vegetative** | 3-4 | 15-28 | 0.7 | 4.9 | 9.8 | 0.7 | 4.9 | 9.8 |
| **3 Early flowering** | 5-6 | 29-42 | 1.0 | 7 | 14 | 1 | 7 | 14 |
| **4 Flowering and fruiting** | 7-8 | 43-56 | 1.5 | 10.5 | 21 | 1.5 | 10.5 | 21 |
| **5 Early harvest** | 9-11 | 57-77 | 2.2 | 15.4 | 46.2 | 2.2 | 15.4 | 46.2 |
| **6 Later harvest**[4] | 12-14 | 78-98 | 2.5 | 17.5 | 52.5 | 2.5 | 17.5 | 52.5 |
| **Fertigation recommendations for 75 lb N and 75 lb $K_20$**[1,2] For soils with organic matter content greater than 2% or fine texture and high or optimum K | | | | | | | | |
| | | | **Nitrogen** | | | **Potash** | | |
| **Preplant (lb/A)**[3] | | | **50** | | | **50** | | |
| | | | **N** | **N** | **N** | **$K_2O$** | **$K_2O$** | **$K_2O$** |
| **Stage and Description** | Weeks | Days | lb/day | lb/week | lb/stage | lb/day | lb/week | lb/stage |
| **1 Early vegetative** | 1-2 | 1-14 | 0.25 | 1.75 | 3.5 | 0.25 | 1.75 | 3.5 |
| **2 Late vegetative** | 3-4 | 15-28 | 0.35 | 2.45 | 4.9 | 0.35 | 2.45 | 4.9 |
| **3 Early flowering** | 5-6 | 29-42 | 0.5 | 3.5 | 7 | 0.5 | 3.5 | 7 |
| **4 Flowering and fruiting** | 7-8 | 43-56 | 0.75 | 5.25 | 10.5 | 0.75 | 5.25 | 10.5 |
| **5 Early harvest** | 9-11 | 57-77 | 1.1 | 7.7 | 23.1 | 1.1 | 7.7 | 23.1 |
| **6 Later harvest**[4] | 12-14 | 78-98 | 1.25 | 8.75 | 26.25 | 1.25 | 8.75 | 26.25 |

[1]Rates above are based on 7,260 linear bed ft/A (6 ft bed spacing). If beds are closer or wider, fertilizer rates should be adjusted proportionally. Drive rows should not be used in acreage calculations. See Fertigation in C-Irrigation Management for more information.
[2]Base overall application rate on soil test recommendations.
[3]Applied under plastic mulch to effective bed area using modified broadcast method. [4]For extended harvest after 10 weeks continue fertigation at this rate.

## Critical Tomato Tissue Test Values for Most Recently Matured Leaves

| **Timing** | **Value** | **N** | **P** | **K** | **Ca** | **Mg** | **S** | **Fe** | **Mn** | **Zn** | **B** | **Cu** | **Mo** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **%** | **%** | **%** | **%** | **%** | **%** | **ppm** | **ppm** | **ppm** | **ppm** | **ppm** | **ppm** |
| **Prior to Blossom** | **Deficient** | <3.0 | 0.3 | 3 | 1 | 0.3 | 0.3 | <40 | 30 | 25 | 20 | 5 | 0.3 |
| | **Adequate range** | 3 | 0.3 | 3 | 1 | 0.3 | 0.3 | 40 | 30 | 25 | 20 | 5 | 0.2 |
| | | 5 | 0.6 | 5 | 2 | 0.5 | 0.8 | 100 | 100 | 40 | 40 | 15 | 0.6 |
| | **High** | >5.0 | 0.6 | 5 | 2 | 0.5 | 0.8 | >100 | 100 | 40 | 40 | 15 | 0.6 |
| | **Toxic (>)** | - | - | - | - | - | - | - | - | - | - | - | - |
| **At First Flower** | **Deficient** | <2.8 | 0.2 | 2.5 | 1 | 0.3 | 0.3 | <40 | 30 | 25 | 20 | 5 | 0.2 |
| | **Adequate range** | 2.8 | 0.2 | 2.5 | 1 | 0.3 | 0.3 | 40 | 30 | 25 | 20 | 5 | 0.2 |
| | | 4 | 0.4 | 4 | 2 | 0.5 | 0.8 | 100 | 100 | 40 | 40 | 15 | 0.6 |
| | **High** | >4.0 | 0.4 | 4 | 2 | 0.5 | 0.8 | >100 | 100 | 40 | 40 | 15 | 0.2 |
| | **Toxic (>)** | - | - | - | - | - | - | - | 1500 | 300 | 250 | - | - |
| **At Early Fruit Set** | **Deficient** | <2.5 | 0.2 | 2.5 | 1 | 0.25 | 0.3 | <40 | 30 | 20 | 20 | 5 | 0.2 |
| | **Adequate range** | 2.5 | 0.2 | 2.5 | 1 | 0.25 | 0.3 | 40 | 30 | 20 | 20 | 5 | 0.2 |
| | | 4 | 0.4 | 4 | 2 | 0.5 | 0.6 | 100 | 100 | 40 | 40 | 10 | 0.6 |
| | **High** | >4.0 | 0.4 | 4 | 2 | 0.5 | 0.6 | >100 | 100 | 40 | 40 | 10 | 0.6 |
| | **Toxic (>)** | - | - | - | - | - | - | - | - | - | 250 | - | - |

## Plant Petiole Sap Testing

Plant petiole sap and tissue testing are valuable tools to assess crop nutrient status during the growing season, to aid with in-season fertility programs, or to evaluate potential deficiencies or toxicities.

| Tomato Developmental Stage | Fresh Petiole Sap Concentration (ppm) | |
|---|---|---|
| | $NO_3$-N | K |
| First buds | 1000-1200 | 3500-4000 |
| First open flowers | 600-800 | 3500-4000 |
| Fruits 1 inch diameter | 400-600 | 3000-3500 |
| Fruits 2 inch diameter | 400-600 | 3000-3500 |
| First harvest | 300-400 | 2500-3000 |
| Second harvest | 200-400 | 2000-2500 |

## Seed Treatment

Purchase hot water treated seed if possible or request hot water seed treatment. Hot water treatment is administered to eradicate bacterial pathogens. For more information see Disease Control below.

## Hardening Transplants

Hardening seedlings before field planting is recommended. However, hardening by exposure to cool temperatures 60-65°F (16-18°C) day and 50-60°F (10-16°C) night for one week or more causes catfacing. Instead, harden plants by withholding N and reducing water; allow plants to wilt slightly between light waterings.

## Drip/Trickle Fertilization

The start of any nutrient management program is an accurate soil test from a certified laboratory. Choose a nutrient program that meets your individual production system requirements based on soil and production history.

Before laying plastic mulch, adjust soil pH to 6.5 and apply enough farm-grade fertilizer to supply 50-85 lb/A of N, depending on soil and yield potential. Apply the balance of your needed $K_2O$ that you do not plan to apply via fertigation as a modified broadcast application that treats only the mulched area. Nitrogen fertilizer should be incorporated into the bed or split between incorporated and a surface band bed treatment immediately before laying plastic mulch.

After laying plastic mulch and installing the trickle irrigation system, apply completely soluble fertilizer through the drip system to supply additional N and potash throughout the season. Depending on soil texture and yield potential, N and K fertigation should be increased over the growing season as plants mature. Adjust rates as necessary based on soil and tissue tests (see tables above). For more information, see the Drip Irrigation section in the Irrigation Management chapter.

## Fresh Market

Yield and fruit size and quality of fresh market tomatoes are increased by the use of black plastic mulch in combination with trickle irrigation. Form raised, dome-shaped beds to aid in disease control. Lay 4 ft wide black plastic mulch tightly over the beds. For early summer harvest of market tomatoes, start transplanting April 10-20 in southern or normally warmer areas, and May 10-25 in cooler, northern areas.

**Ground Culture**: Space determinate vined varieties in rows 4-5 ft apart with plants 15-24 inches apart in the row. For indeterminate varieties, space rows 5-6 ft apart with plants 24-36 inches apart in the row.

**Stake Culture**: Staking tomatoes is a highly specialized production system. Staking improves fruit quality by keeping plants and fruit off the ground and allows for better spray coverage. Staked tomatoes are easier to harvest than non-staked tomatoes. The recommendations below are for the short-stake cultural system using determinate cultivars that grow 3-4 ft tall. Row widths of 5-6 ft with in-row spacings of 18-24 inches between plants are recommended.

***Pruning*** is practiced to establish a desired balance between vine growth and fruit growth. Little to no pruning results in a plant with a heavy load of smaller fruit. Moderate pruning results in fewer fruit that are larger and easier to harvest. Pruning can result in earlier maturity of the crown fruit and improve spray coverage and pest control. The pruning method is variety and fertility dependent. Less vigorous determinate cultivars generally require less pruning. Growers should experiment with several degrees of pruning on a small scale to determine pruning requirements for specific cultivars and cultural practices.

Removing all suckers up to the one immediately below the first flower cluster is adequate for most determinate cultivars. Removing the sucker immediately below the first flower cluster or pruning above the first flower cluster can result in severe leaf curling and stunting of the plant. Prune when the suckers are 2-4 inches long. A 2nd pruning may be required to remove suckers that are too small to be easily removed during the 1st pruning and to remove ground suckers that may develop. Pruning when suckers are too large requires more time and can damage the plants, delay maturity, and increase disease incidence. Do not prune plants when they are wet to avoid spread of bacterial diseases. Pruning should be done before the first stringing because the string can slow down the pruning process.

***Staking*** involves setting up a series of wooden stakes with twine woven around the stakes to train the plants to grow vertically off the ground. Stakes 4-4½-ft long by 1-inch square are driven approximately 12 inches into the soil between the plants.

Vigorous cultivars may require larger and longer stakes. A stake placed between every other plant is adequate to support most determinate varieties. Placing an additional stake at an angle and tied to the end stake of each section or row is needed to strengthen the trellis system. Stakes can be driven by hand with a homemade driving tool or with a commercially available, power-driven stake driving tool. Drive stakes to a consistent depth so that spray booms can be operated in the field without damaging the trellis system. Select "tomato twine" that is resistant to weathering and stretching and that binds well to the wooden stakes. Tomato twine is available in 3-4-lb boxes and approximately 30 lb/A are required. To make tying convenient, use a homemade stringing tool made from a length of metal conduit, PVC pipe, broom handle, or wooden dowel. With conduit or PVC pipe, the string is fed through the pipe. With a broom handle or wooden dowel, two small parallel holes, each approximately ½-1 inch from the end, must be drilled to feed the string through one hole along the length of the tool and through the other hole. The tool serves as an extension of the worker's arm (the length cut to the worker's preference) and helps to keep the string tight.

***Stringing*** consists of tying the twine to an end stake passing the string along one side of the plants, looping the twine around each stake until you reach the end of a row or section (100-ft sections with alleys may be helpful for harvesting). The same process is continued on the other side of the row. The string tension must be tight enough to hold the plants upright but harvest can be difficult and strings can scar fruit if they are too tight.

The first string should be strung 8-10 inches above the ground when plants are 12-15 inches tall and before they fall over. Run the next string 6-8 inches above the preceding string before plants start to fall over. Three to 4 stringings are required for most determinate varieties. Stringing should be done when the foliage is dry to prevent the spread of bacterial diseases.

## Processing Tomatoes

**Transplanting**: Processing tomatoes can be transplanted starting April 15-20 in warmer, southern areas to May 5-10 in PA and normally cooler areas. Successive plantings can be made through early June. Space transplants 9-12 inches apart in single rows 5 ft. apart or to accommodate machine harvesters. Small, determinate varieties may be grown in double rows. Space double rows 12 inches apart and space plants 12-18 inches apart in each of the double rows.

**Fruit Ripening**: Ethephon is a growth regulator labeled for use on processing tomatoes. Proper application increases earliness and yield and decreases sorting of green fruit in machine-harvested tomatoes. Rate and time of application are critical for successful use, see state fact sheets and check product label for details.

## Harvest and Post-Harvest Considerations

Depending on marketing requirement, tomatoes may be harvested at the **mature green stage** (when and after which the fruit cavity is filled by gel), **breaker stage** (just showing pink at the bottom of the fruit), **semi-ripe** (with different amounts of red pigmentation) or **fully ripe**. Fruit are very perishable and subject to surface and internal damage, and must be handled with care. If tomatoes are to be harvested at breaker, partially ripe, or vine-ripe stages, fields should be harvested often and thoroughly to hasten the ripening of later fruits and reduce the range of ripeness. Harvesting every day may be desirable during peak season. Remove all diseased, misshapen, and otherwise cull tomatoes from the vines as soon as they are discovered. Remove discarded tomatoes from the field to avoid the spread and buildup of diseases and insect pests. For standard slicing tomatoes, cherry tomatoes, and plum tomatoes, remove the stem during picking. Cluster tomatoes are harvested with the whole truss attached to fruits.

Tomatoes should be washed sufficiently to remove dust and foreign material, by hand or mechanically by spraying them with chlorinated water as they move over a set of soft brush rolls. The small amount of retained water may be removed by absorbent rollers alone or in combination with an overhead air-blast drier. The wash water should be several degrees warmer than the pulp temperature of the tomatoes to avoid drawing water and disease organisms into the fruit. The water should be chlorinated at the rate of 125 ppm. The chlorine level and pH (6 to 7) of the wash water should be checked at least hourly during the day with test papers or a meter. Tomatoes are then sized and separated by color and grade and carefully packed into 25 lb boxes.

## Size Classification of Tomatoes

| Size Designation | Minimum Diameter (inch) | Maximum Diameter (inch) |
|---|---|---|
| **Extra small** | 1-28/32 | 2-4/32 |
| **Small** | 2-4/32 | 2-9/32 |
| **Medium** | 2-9/32 | 2-17/32 |
| **Large** | 2-17/32 | 2-28/32 |
| **Extra large** | 2-28/32 | 3-15/32 |

## Color Classification of Tomatoes

Tomatoes may be graded into the following color classes (some classes may be combined).

| | |
|---|---|
| **Green** | The surface of the tomato is completely green. The shade of green may vary from light to dark. Mature green fruits are typically ripened at the terminal market or by the repacker with ethylene gas. |
| **Breakers** | There is a definite break in the color from green to tannish yellow with pink or red skin covering not more than 10% of the surface. |
| **Turning** | More than 10% but not more than 30% of the surface, shows a definite change in color from green to tannish yellow, pink, red, or a combination of those colors. |
| **Pink** | More than 30% but not more than 60% of the surface shows pinkish red or red color. |
| **Light Red** | More than 60% but not more than 90% shows pinkish red or red color. |
| **Red** | More than 90 % of the surface shows red color. |

## Shipping

For long distance shipping, mature green harvest is the common practice. For local wholesale, harvest is usually at the breaker stage. For direct market, harvest is at the ripe stage. Store mature-green tomatoes at 55-70°F (13-21°C); breakers, partially ripe, and ripe fruit at 50°F (10°C) and a relative humidity of 90-95%. Exposing tomatoes to temperatures below 50°F results in loss of color, shelf life, firmness and flavor.

## Tomato Disorders

**Blossom-End Rot (BER)** This physiological disorder is caused by inadequate movement of calcium into the fruit. BER occurs at low soil moisture and is more severe when plants have small, shallow root systems. Plastic mulch can restrict the movement of water to the root zone and increase BER. Hot, windy conditions increase water loss from the plant and increase the incidence of BER.

Be sure soil calcium is sufficient and in balance with other essential plant nutrients. Test the soil and apply lime and fertilizer according to recommendations, then lay plastic mulch when soil moisture is optimal for planting. Apply irrigation to wet the root zone and encourage deep root development.

**Blotchy Ripening, Graywall and Internal White Tissue** These problems are a complex of physiological disorders and pathological diseases. Blotchy Ripening and graywall often appear on shaded fruit growing in the interior of dense vegetative plants. Yellow-eye, a ring of yellow tissue surrounding the blossom scar, often occurs in fruit with blotchy ripening and internal white tissue.

*Blotchy ripening* is when areas of the fruit do not ripen or do so after the rest of the fruit is ripe. White or yellow blotches may appear on the surface of the fruit while the internal tissue is still hard. Usually this disorder occurs on the upper portion of the fruit and there is no internal browning of the fruit. This disorder is more often seen during cool, wet and cloudy conditions. It is worsened by too much or too little water. High N and/or low K will cause an increase in the disorder. Older varieties are often more susceptible to this disorder.

Research in California indicates that for proper fruit color development higher K levels than are necessary for yield alone are needed. Soils and plants with high K had lower levels of the disorder. Foliar applications of K were not totally effective in reducing the disorder. Work in Michigan suggests that soils high in organic matter (above 3.5%) helped to reduce the disorder in a tomato crop. In addition, soils with a pH of 6.4 had low incidence of yellow shoulder while tomatoes grown on soils with a pH above 6.7 had a high incidence.

Growers should have K tissue levels of at least 3% before fruit is one inch in diameter. In addition, the ratio of Magnesium (MG) to Calcium (Ca) is important and a ratio of Mg:Ca of 1:4 to 1:6 should be maintained in the crop.

*Graywall* appears as grayish and sometimes sunken areas on a fruit. Internally the vascular tissue is brown resulting from collapse of the tissue. This can occur on the outer part of the fruit as well as in the center. It is usually more of a problem with cool, short days and often occurs in a late tomato crop. Graywall usually develops in green fruit but can occur as fruit is ripening. Fruit do not ripen properly and will have a blotchy appearance making them unmarketable. Graywall occurs on any part of the fruit. High N may increase the incidence of graywall and adequate K may reduce the problem. The disorder may also be caused by stress on the plants resulting from drought, excessive heat, root problems, severe nutrient deficiencies, etc. and there are varietal differences in susceptibility. This disorder is not clearly understood. Note that internal browning can also be caused by tobacco mosaic virus (TMV).

*Internal white tissue* is a disorder where the fruit usually show no external symptoms. When a ripe, affected fruit is cut there will be white, hard areas found in the outer tissue and sometimes in the center of the fruit as well. High temperatures during ripening are believed to be the cause of this disorder. Maintaining adequate K in the soil may reduce but not eliminate it. Some varieties are more susceptible to this disorder, especially high colored varieties. This disorder can be severe enough to cause fruit to be unmarketable.

**Catfacing** Catfacing is where fruit are malformed and scarred, usually at the blossom end. It is caused by exposure of seedlings to 60-65°F (16-18°C) day temperatures and 50-60°F (10-16°C) night temperatures for 1 week, approximately 4 weeks before pollination. The first flower cluster is susceptible to low temperature-induced catfacing when seedlings have 4-5 true leaves. Fruit on later clusters will show catfacing if exposed to low temperatures in the field. Avoid hardening seedlings by exposure to low temperatures. Varieties differ in their susceptibility to the disorder.

**Cracking** Cracking is due to the rapid uptake of water, resulting in enlargement of cells and separation of the epidermis of the fruit. Water can be taken up through the roots or through the tissue around the stem scar. The type of cracking (concentric, radiating out from the stem, or diagonal or transverse cracks across the fruit) is determined primarily by fruit structure and variety. Different types of cracking may be present in a variety or an individual fruit.

The severity of cracking is determined by water availability, variety and maturity. As the fruit ripens, the bonding between cells progressively weakens, resulting in more severe cracking. High rainfall and irrigation, or frequent low to moderate rainfall, especially following a period of low soil moisture may increase cracking. To minimize cracking, select a crack-resistant variety, maintain a high calcium level in the soil and keep fruit growing at a uniform rate by maintaining uniform soil moisture levels. Maintain good fruit cover by proper fertilization and fungicide applications. Harvest fruit at the earliest stage of maturity that is acceptable by your market.

**Russeting** Russeting, or weather checking of the surface of the fruit is caused by the presence of water on the fruit surface for extended periods of time when there are frequent light rainfalls, mist, fog, and dew. Wide fluctuations in temperature of exposed fruit also contribute to this disorder. Russeting can cause fruit to be unmarketable. Maintain good fruit cover by proper fertilization and fungicide applications. Use varieties that feature a dense canopy and resistance to foliar diseases.

**Sunburn and Sunscald** Sunburn and sunscald result from exposure to direct sunlight. Mild sunburn appears as yellowish or yellow-red color of fruit on the side exposed to the sun. Severe symptoms appear as whitish, water-soaked, scalded, or blistered areas. Sunscald is more severe on fruit that developed in shaded conditions but was exposed to direct sunlight after defoliation or harvesting. Under dry conditions, the white areas can become dry and leathery. Secondary infection can produce a dark, dry rot. Under moist conditions, scalded areas can decay from secondary infections. To control sunburn and sunscald, select varieties with good fruit cover, supply sufficient water and nutrients to provide good vegetative growth and manage pests. Train workers to avoid turning vines during harvesting or to reposition vines to shade fruit.

**Yellow Shoulders** Yellowing may occur on the shoulders of fruit exposed to the sun, especially on varieties that have darker green shoulders when immature (those lacking the uniform ripening gene). The tissue beneath the yellow shoulder is usually corky and may vary from greenish white to pale yellow. Select varieties with the uniform ripening gene and provide good fruit cover as described above.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

**1.** Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" Table (E-2) in the Pest Management chapter.

**2.** Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**Labeled Applications Sites for Tomato**

| | | **Plastic mulch production** | | | | | | **Bare-ground production** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil-Applied | | Postemergence | | | | | | |
| **Herbicides** | WSSA group number | Under Plastic | Row Middles | Over Plastic | Row Middles | Post-Harvest | | Soil-applied | POST | Post-harvest |
| Sandea | 2 | YES* | YES | | YES | | | YES* | YES | |
| Dacthal | 3 | | | | | | | | YES*** | |
| Prowl H2O | 3 | | YES | | | | | YES | | |
| Treflan | 3 | | YES | | | | | YES** | | |
| Metribuzin | 5 | YES | YES | | YES | | | YES | YES | |
| Reflex | 14 | YES | YES | | YES | | | YES** | | |
| Devrinol | 15 | YES | YES | | | | | YES | | |
| Dual | 15 | YES | YES | | | | | YES | | |
| Select | 1 | | | YES | | | | | | |
| SelectMax | 1 | | | YES | | | | | | |
| Poast | 1 | | | YES | | | | | | |
| Matrix | 2 | | YES | | YES | | | | YES | |
| Gramoxone | 22 | | | | YES | YES | | | | YES |

*Delay transplanting for 7 days after application; not labeled for direct-seeding. **Transplants only.
***Dacthal is labeled for over the top application, but will it will not control emerged weeds.

**1. Soil-Applied**

| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
|---|---|---|---|---|---|---|
| **2** | Sandea 75DF | 0.5 to 1.0 oz/A | **halosufluron** | 0.023 to 0.047 lb/A | 30 | 12 |
| -**Plasticulture**: under plastic application is labeled delay transplanting 7 days after herbicide application. Apply in a band under the plastic, immediately before laying the mulch; use on transplants only (not for seeded tomatoes), avoid herbicide treated soil from moving into the holes during transplanting. Plasticulture: labeled for row middle application with directed/shield application.<br>-**Bareground**: for transplants only: apply preplant incorporated 7 days before transplanting; use on transplants only (not for seeded tomatoes), avoid herbicide treated soil from moving into the holes during transplanting.<br>-Bareground: for directed-seeded apply as directed/shielded application to row middles<br>-Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field.<br>-**Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season. | | | | | | |
| 3 | Dacthal 6F<br>Dacthal W-75 | 8.0 to 14.0 pt/A<br>6.0 to 14 lb/A | **DCPA** | 6.0 to 10.5 lb/A | -- | 12 |
| -Labeled for applications over the top of transplants without injury (will not control emerged weeds); transplants should be well-established and growing conditions favorable for good plant growth.<br>-Label recommends 4 to 6 weeks after transplanting or direct-seeded plants at 4 to 6 inches in height<br>-Post-transplant applications can only be made with bare-ground production.<br>-Dacthal will not control emerged weeds; apply to weed-free soils.<br>-Primarily controls annual grasses and a few broadleaf weeds, including common purslane.<br>-Results have been most consistent when used in fields with coarse -textured soils low in organic matter, and when the application are followed by rainfall or irrigation.<br>-Maximum application not addressed on label. | | | | | | |

*1. Soil-Applied continued on next page*

*1. Soil-Applied - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | Prowl H2O 3.8CS | 1.0 to 3.0 pt/A | **pendimethalin** | 0.48 to 1.42 lb/A | 70 | 24 |
| -**Plasticulture**: recommended for row middles only. Labeled for under plastic, but no local data or experience with this application.<br>-**Bareground**: broadcast preplant or preplant incorporated before transplanting; not labeled for direct-seeded crop.<br>-Avoid root contact with Prowl-treated soil when placing transplants into furrow or hole or injury may occur.<br>-Prowl labeled for directed application to transplanted or established direct-seeded peppers; avoid contact with leaves or stems.<br>-Prowl will not control emerged weeds, only provides residual control; row middle applications may be made with Gramoxone using shielded sprayers. Use the lower rate on coarse-textured or sandy soils. Activate with ½ inch of rainfall or sprinkler irrigation within 48 hr of application to control most annual grasses and certain broadleaf weeds.<br>-Maximum Prowl H2O application per season: 3 pt/A. | | | | | | |
| 3 | Treflan 4E | 1 to 2 pt/A | **trifluralin** | 0.5 to 1.0 lb/A | -- | 12 |
| -**Plasticulture**: labeled for row middles only.<br>-**Bareground**: broadcast preplant or preplant incorporated before transplanting; not labeled for direct-seeded crop. All applications need to be mechanically incorporating.<br>-Stunting may occur if weather is cool and damp at time of transplanting. Maximum application per season: not specified. | | | | | | |
| **5** | Metribuzin 75DF | 0.33 lb/A | **metribuzin** | 0.25 lb/A | 7 | 12 |
| -**Plasticulture**: under plastic application is labeled; apply in a band under the plastic, immediately before laying the mulch; use on transplants only (not for seeded tomatoes), roots of the transplants need to be placed below the zone of treated soil. There is no local data and limited experience with this use. Plasticulture: labeled for row middle application with directed/shield application.<br>-**Bareground**: broadcast preplant or preplant incorporated before transplanting; use on transplants only (not for seeded tomatoes), roots of the transplants need to be placed below the zone of treated soil.<br>-Metribuzin primarily controls broadleaf weeds and is weak on grasses; tankmix to improve grass control.<br>-Metribuzin has some postemergence activity. To get consistent control, apply Metribuzin before weeds are 1 inch tall.<br>-Rainfastness is 6 hrs. Maximum for Metribuzin 75DF: 1.33 lb/A per crop season. | | | | | | |
| **14** | Reflex 2SL | 16 to 20 fl oz/A NJ<br>16 to 24 fl oz/A VA | **fomesafen** | 0.25 to 0.375 lb/A | 70 | 24 |
| -**Special Local-Needs Label 24(c) has been approved for NJ and VA only until Dec. 31, 2020.**<br>-The use of Reflex 2SL is legal ONLY if a waiver of liability has been completed (see *http://www.farmassist.com/*).<br>-**Only labeled for transplanted tomatoes**; **do not** use on directed seeded crop. Ensure that Reflex treated soil is not moved into the transplant holes.<br>-**Plasticulture**: under plastic application is labeled; apply in a band under the plastic, immediately before laying the mulch; **do not** mechanically incorporate. Crops may be transplanted immediately following application.<br>-Plasticulture: labeled for application over the top of plastic before transplanting only if beds are shaped to allow herbicide to be readily washed off with irrigation or rainfall; and single rainfall or irrigation provides at least 0.5 inches of water before transplanting; and plastic does not have any holes until after Reflex has been washed off.<br>-Plasticulture: labeled row middles application prior to transplanting.<br>-**Bareground**: labeled for pre-transplant applied to soil surface, **do not** mechanically incorporate. Rainfall or irrigation between herbicide application and transplanting will likely reduce the risk of crop injury due to splashing.<br>-Reflex provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. Varieties may vary in their response to Reflex; treat small acreages first to determine crop tolerance.<br>-Consider rotational crops when applying fomesafen. If crop is replanted **do not** re-apply. Rotational restrictions depend on whether fomesafen was applied bareground, or under or over plastic mulch, see 24(c) label for specifics.<br>-Maximum Reflex application: NJ 20 fl oz/A; VA 24 fl oz/A IN ALTERNATE YEARS. | | | | | | |
| 15 | Devrinol 2-XT | 2 to 4 qt/A | **napropamide** | 1.0 to 2.0 lb/A | -- | 24 |
| -**Plasticulture**: under plastic is labeled for seeded or transplanted tomatoes; apply in a band under the plastic, immediately before laying mulch. Use lower rate on coarse textured or sandy soil. Condensation that forms on the underside of the mulch will activate the herbicide. Plasticulture: row middles application is labeled.<br>-**Bareground**: apply as broadcast, preemergence treatment for seeded and transplanted tomatoes.<br>-Annual grasses and certain annual broadleaf weeds will be suppressed or controlled. May reduce stand and yield of fall planted small grain crop. Moldboard plowing will reduce the risk of injury. Maximum Devrinol 2-XT application per season: 4 qt/A. | | | | | | |
| 15 | Dual Magnum 7.62E | 1.0 to 2.0 pt/A | **s-metolachlor** | 0.95 to 1.9 lb/A | 30 to 90 | 24 |
| -**Plasticulture**: under plastic is labeled transplanted tomatoes; apply in a band under the plastic, immediately before laying mulch. Use lower rate on coarse textured or sandy soil. Condensation that forms on the underside of the mulch will activate the herbicide. Plasticulture: row middles application is labeled.<br>-**Bareground**: apply for preplant incorporated or broadcast, preemergence treatment before transplanting tomatoes. Seeded tomatoes can be treated when at least 4 inches tall at time of application and spray is directed at the soil and minimal amounts of herbicide contact tomato plants. Avoid moving treated soil into transplant holes.<br>-Use lower rates on coarse-textured soils low in organic matter and higher rates on fine-textured soils with greater organic matter.<br>-Application to varieties with unknown tolerance to Dual Magnum may result in crop injury. Transplants weakened by any cause may be injured by Dual Magnum. Plant healthy transplants and avoid planting when wet, cool, or unfavorable growing conditions exist.<br>-Delaying transplanting for 7 days or more can reduce risk of injury.<br>-**DO NOT** apply within 30 days of harvest if 1.33 pt/A or less is used, or within 90 days of harvest if more than 1.33 pt/A is used except in VA, where a 60 day PHI must be observed when 1.67 pt or less Dual Magnum is used per year.<br>-**DO NOT** exceed 2 applications per growing season. | | | | | | |

<table>
<tr><th colspan="7">2. Postemergence</th></tr>
<tr><th>Group</th><th>Product Name</th><th>Product Rate</th><th>Active Ingredient<br>(*=Restricted Use)</th><th>Active Ingredient Rate</th><th>PHI<br>(d)</th><th>REI<br>(h)</th></tr>
<tr><td rowspan="2">1</td><td>Select 2EC<br>Select Max 0.97EC</td><td>6 to 8 fl oz/A<br>9 to 16 fl oz/A</td><td>clethodim</td><td>0.07 to 0.12 lb/A</td><td>20</td><td>24</td></tr>
<tr><td>Poast 1.5EC</td><td>1 to 2.5 pt/A</td><td>sethoxydim</td><td>0.2 to 0.5 lb/A</td><td>20</td><td>12</td></tr>
<tr><td colspan="7">-Select 2EC: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). Select Max: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). Poast: Apply with COC at 1.0% v/v<br>-The use of COC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.<br>-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.<br>-Safe for broadcast (over the top) applications with both plasticulture and bareground production.<br>-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.<br>-Controls many annual and certain perennial grasses, including annual bluegrass, but Select will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.<br>-If repeat applications are necessary, allow 14 days between applications.<br>-Do not tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. Rainfastness is 1 hr.<br>-Do not apply more than 8 fl oz of Select 2EC in a single application and do not exceed 2 pt/A for the season; do not apply more than 16 fl oz of Select Max in a single application and do not exceed 4 pt/A for the season.<br>-Do not apply more than 1.5 pt/A Poast 1.5EC in single application and do not exceed 4.5 pt/A for the season.</td></tr>
<tr><td>2</td><td>Matrix 25DF</td><td>1.0 to 2.0 oz/A</td><td>rimsulfuron</td><td>0.0156 to 0.0312 lb/A</td><td>45</td><td>4</td></tr>
<tr><td colspan="7">-Apply early postemergence but not before the crop has at least 2 full-sized true leaves (label allows applications as early as cotyledon stage of tomatoes; but no local data is available at that stage). Not recommended for over the top application with plasticulture.<br>-Apply with nonionic surfactant at 0.25% v/v (1.0 qt/100 gal of spray solution); use of an adjuvant may cause temporary chlorosis, but symptoms usually disappear within 5 to 15 days.<br>-Controls many weeds including foxtail species, pigweed species, wild mustard, and wild radish. Suppresses common lambsquarters, common ragweed, jimsonweed, morningglory species, and yellow nutsedge. Optimum performance is obtained when weeds are less than 1 inch in height and are actively growing. Tank mix with metribuzin to improve broadleaf weed control.<br>-Best results occur with 0.5 inches of rainfall or irrigation no sooner than 4 hours but not more than 5 days after application.<br>-Matrix provides both residual and postemergence control of susceptible weed species.<br>-Matrix is an ALS inhibiting herbicide and resistant weed populations are common in the region. Do not use Group 2 herbicides repeatedly in the same field. Rainfastness is 4 hrs. Maximum for Matrix: 4 oz/A per year.</td></tr>
<tr><td>2</td><td>Sandea 75DF</td><td>0.5 to 1.0 oz/A</td><td>halosulfuron</td><td>0.023 to 0.047 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Apply over the top, post directed, or with crop shields; not recommended for over the top application with plasticulture.<br>-Apply to tomato plants that are established, actively growing and a minimum of 14 days after transplanting or after the 4th leaf stage of seeded tomatoes. Applications during bloom can cause bloom drop under certain environmental conditions.<br>-Apply with nonionic surfactant at 0.25% v/v (1.0 qt/100 gal of spray solution).<br>-Provides control of yellow nutsedge and certain annual broadleaf weeds. Control of weeds taller than 3 inches may not be adequate.<br>-Sandea provides both residual and postemergence control of susceptible weed species.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. Do not use Group 2 herbicides repeatedly in the same field. DO NOT apply Sandea to crops treated with a soil-applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Rainfastness is 4 hrs.<br>-Do not apply more than 2 applications, or more than 2 oz of product, per crop cycle; do not exceed 2 oz/A per 12 month period.</td></tr>
<tr><td>3</td><td>Dacthal 6F<br>Dacthal W-75</td><td>8.0 to 14.0 pt/A<br>6.0 to 14 lb/A</td><td>DCPA</td><td>6.0 to 10.5 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Labeled for applications over the top of transplants.<br>-Dacthal will not control emerged weeds; apply to weed-free soils. See comments under soil applied section</td></tr>
<tr><td>5</td><td>Metribuzin 75DF</td><td>0.33 lb/A</td><td>metribuzin</td><td>0.25 lb/A</td><td>7</td><td>12</td></tr>
<tr><td colspan="7">-Apply over the top, post directed, or with crop shields; not recommended for over the top application with plasticulture.<br>-Apply postemergence to transplants with at least 5 true leaves and have recovered from transplant shock (new growth evident) or at least 2 weeks after transplanting. Transplant with fewer than 5 true leaves are at greater risk of herbicide injury.<br>-Do not use hot caps on tomatoes within 7 days before or after application.<br>-DO NOT apply within 3 days after periods of cool, wet, or cloudy weather or crop injury will occur.<br>-DO NOT apply within 24 hrs of applications of other pesticides.<br>-Allow at least 14 days between applications or severe crop injury may occur.<br>-Metribuzin primarily controls broadleaf weeds and is weak on grasses.<br>-Metribuzin has some postemergence activity. To get consistent control, apply Metribuzin before weeds are 1 inch tall.<br>-Tank mix with appropriate postemergence herbicides if weeds are emerged at time of application.<br>-Maximum for Metribuzin 75DF: 1.33 lb/A per crop season.</td></tr>
</table>

*2.Postemergence continued on next page*

*2. Postemergence - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 22 | Gramoxone 2SL | 2.4 pt/A | **paraquat** | 0.6 lb/A | 30 | 24 |
| -Gramoxone can be applied before or after transplanting to control emerged broadleaf weeds and grass seedlings.<br>-Include a nonionic surfactant at 0.25% v/v. **Do not** allow spray to contact crop foliage as injury may result. Use flaps that drag along the edge of plastic mulch and use low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift.<br>-See the label for additional information and warnings.<br>-Rainfastness is 30 minutes. A maximum of 3 applications per year are allowed. | | | | | | |

**3. Postharvest**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone 2SL | 2.25 to 3 pt/A | **paraquat** | 0.56 to 0.75 lb/A | -- | 24 |
| -**A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 for postharvest application to desiccate the crop in DE, NJ and VA.** Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.<br>-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.<br>-Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed. | | | | | | |

**4. Other Labeled Herbicides** These products are labeled but limited local data is available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| **2** | Envoke | **trifloxysulfuron** |
| **2** | League | **imazosulfuron** |
| **9** | Roundup (various) | **glyphosate** |
| **14** | Aim | **carfentrazone** |
| **14** | Spartan | **sulfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides Field Tomatoes (Fresh Market and Processing Tomatoes)

## Aphids - Green Peach (GPA) and Potato

**Apply one of the following formulations (thorough spray coverage between leaves is important):**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 7 | 48 | H |
| 3A + 4A | Brigadier | 5.10 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 1 | 12 | H |
| 3A + 4A | Leverage 360 | 3.8 to 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 0 | 12 | H |
| 3A + 4A | Swagger | 7.6 to 19.7 fl oz/A | bifenthrin* + imidacloprid | 1 | 12 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 5 | 24 | H |
| 4A | Admire Pro | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.3 to 2.2 fl oz/A | imidacloprid - **foliar** | 0 | 12 | H |
| 4A | Assail 30SG | 2.0 to 4.0 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 2.0 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam+chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam+chlorantraniliprole - **foliar** | 1 | 12 | H |
| 4C | Closer SC | 1.5 to 2.0 fl oz/A | sulfoxaflor | 1 | 12 | H |
| 4D | Sivanto 200SL, Sivanto Prime | 21.0 to 28.0 fl oz/A | flupyradifurone - **soil** | 45 | 4 | L |
| 4D | Sivanto 200SL | 7.0 to 12.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | L |
| 4D | Sivanto Prime | 10.5 to 14.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | L |
| 9B | Fulfill 50WDG | 2.75 oz/A | pymetrozine | 0 | 12 | L |
| 9C | Beleaf 50 SG | 2.0 to 4.28 oz/A | flonicamid | 0 | 12 | L |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 1 | 24 | L |
| 28 + 6 | Minecto Pro (GPA only) | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |
| n/a | Requiem EC | 2.0 to 3.0 qt/A | *Chenopodium* extract - **biopesticide** | 0 | 4 | L |

## Armyworms: True Armyworms (TAW), Fall Armyworms (FAW), Yellow-striped Armyworms (YSAW), Beet Armyworms (BAW)

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole -.**foliar** | 5 | 24 | H |
| 3A | Bifenture 2EC, Sniper (except BAW) | 2.1 to 5.2 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC (except BAW) | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 1 | 12 | H |
| 3A | Mustang Maxx | 3.2 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliiprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliiprole - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5SG | 2.4 to 4.8 oz/A | emamectin benzoate* | 7 | 12 | H |
| 15 | Rimon 0.83EC | 9.0 to 12.0 fl oz/A | novaluron | 1 | 12 | L |
| 18 | Confirm 2F | 6.0 to 8.0 fl oz/A (early season); 8.0 to 16.0 fl oz/A (late season) | tebufenozide | 7 | 4 | L |
| 18 | Intrepid 2F | 4.0 to 8.0 fl oz/A (early season), 8.0 to 16.0 fl oz/A (late season) | methoxyfenozide | 1 | 4 | L |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **soil, drip, foliar** | 1 | 4 | L |
| 28 | Verimark | 5.0 to 10.0 fl oz/A | cyantraniliprole - **soil** | 1 | 4 | H |
| 28 | Exirel | 7.0 to 13.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 + 3A | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Caterpillars: Tomato Fruitworms also called Corn Earworms (CEW), Hornworms (HW), European Corn Borers (ECB), Cabbage Loopers (CL)

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A | Danitol 2.4EC (except ECB) | 10.67 fl oz/A | fenpropathrin | 3 | 24 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 5 | 24 | H |
| 3A | Asana XL (except ECB) | 2.9 to 5.8 fl oz/A (HW only); 5.8 to 9.6 fl oz/A (CEW, CL) | esfenvalerate* | 1 | 12 | H |
| 3A | Bifenture 2EC, Sniper, Sniper Helios | 2.1 to 5.2 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 1 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Proaxis | 1.92 to 3.2 fl oz/A (HW, CL); 2.56 to 3.84 fl oz/A (ECB, CEW) | gamma-cyhalothrin* | 5 | 24 | H |
| 3A | Tombstone, Tombstone Helios | 1.6 to 2.8 fl oz/A (CEW, HW, ECB); 2.1 to 2.8 fl oz/A (CL) | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 5 | 24 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam+chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam+chlorantraniliiprole - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Proclaim 5SG | 2.4 to 4.8 oz/A | emamectin benzoate* | 7 | 12 | H |
| 11A | Dipel (OMRI) | 1.0 to 2.0 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |

*Caterpillars continued on next page*

*Caterpillars: Tomato Fruitworms also called Corn Earworms (CEW), Hornworms (HW), European Corn Borers (ECB), Cabbage Loopers (CL) - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 15 | Rimon 0.83EC | 9.0 to 12.0 fl oz/A | novaluron | 1 | 12 | L |
| 18 | Confirm 2F | 6.0 to 8.0 fl oz/A (early season); 8.0 to 16.0 fl oz/A (late season) | tebufenozide | 7 | 4 | L |
| 18 | Intrepid 2F | 4.0 to 8.0 fl oz/A (early season); 8.0 to 16.0 fl oz/A (late season) (ECB, HW, CL only) | methoxyfenozide | 1 | 4 | L |
| 22 | Avaunt 30WDG (except ECB) | 2.5 to 3.5 oz/A (HW, CL); 3.5 oz/A (CEW) | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **soil, drip, foliar** | 1 | 4 | L |
| 28 | Verimark | 5.0 to 10.0 fl oz/A (CEW, HW); 6.75 to 10.0 fl oz/A (CL) | cyantraniliprole - **soil** | 1 | 4 | H |
| 28 | Exirel | 7.0 to 13.5 fl oz/A (CEW, HW, ECB); 10.0 to 17.0 fl oz/A (CL) | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Colorado Potato Beetles (CPB)

Rotation to crops other than potato, tomato, and eggplant is extremely important in reducing CPB problems. Also, transplants placed into no-till fields, mulches or other crop residue will reduce or delay potato beetle infestations.

Look for CPB adults shortly after seedling emergence or transplanting. Early season populations tend to be concentrated in areas where tomatoes or potatoes were previously grown. For direct-seeded tomatoes during emergence, treat when CPB adults are reducing plant densities below recommended levels for maximum yields. Thoroughly scout tomato fields and spray only when necessary. Also spot treatment of "hot spots" only is recommended if infestation is localized. For established direct-seeded or transplant tomatoes, begin treatment if the population level exceeds 15 CPB adults per 10 plants throughout the field. If early treatment is not applied, wait for egg hatch and spray when larvae are young and exceed 20 CPB larvae and/or adults per 10 plants. Reassess after each treatment. Avoid the application of late-season sprays to prevent the buildup of insecticide-resistant beetles.

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate L | 2.0 to 4.0 pt/A | oxamyl* | 7 | 48 | H |
| 3A+4A | Brigadier | 3.8 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 1 | 12 | H |
| 3A+4A | Leverage 360 | 3.8 to 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 0 | 12 | H |
| 3A+4A | Swagger | 10.2 to 19.7 fl oz/A | bifenthrin* + imidacloprid | 1 | 12 | H |
| 3A+28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 5 | 24 | H |
| 3A+4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 5 | 24 | H |
| 4A | Admire Pro | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Admire Pro | 1.3 to 2.2 fl oz/A | imidacloprid - **foliar** | 0 | 12 | H |
| 4A | Assail 30SG | 1.5 to 2.5 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 2.0 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A+28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A+28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 4D | Sivanto Prime | 10.5 to 14.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | L |
| 5 | Entrust SC (OMRI) | 3.0 to 6.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Agri-Mek 0.7SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 11 | Trident (small larvae only; OMRI) | 3.0 to 6.0 qt/A | *Bacillus thuringiensis tenebrionis* | 0 | 0 | L |
| 15 | Rimon 0.83EC | 9.0 to 12.0 fl oz/A | novaluron | 1 | 12 | L |
| 28 | Coragen 1.67SC | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **soil, drip, foliar** | 1 | 4 | L |
| 28 | Verimark | 5.0 to 10.0 fl oz/A | cyantraniliprole - **soil, drip** | 1 | 12 | H |
| 28 | Exirel | 7.0 to 13.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cutworms - See also the Pest Management chapter, Insect Management section.

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations:** | | | | | | |
| **Preplanting Field Treatment. Just before seeding or transplanting, broadcast on the soil surface the following:** | | | | | | |
| 1B | Diazinon AG500 | 2.0 to 4.0 qt/A | diazinon* | n/a | 48 | H |
| 3A | Capture LFR | 3.4 to 6.8 fl oz/A | bifenthrin* | n/a | 12 | H |
| **Postplanting Treatment. If control is required after seedling emergence or after transplanting, treat soil thoroughly beneath plants with the following:** | | | | | | |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 5.0 to 8.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 5 | 24 | H |
| 3A | Bifenture 2EC, Sniper, Sniper Helios | 2.1 to 6.4 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 1 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 1.92 to 3.2 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Proaxis | 1.92 to 3.2 fl oz/A | gamma-cyhalothrin* | 5 | 24 | H |
| 3A | Warrior II | 0.96 to 1.6 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |

## Flea Beetles

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following formulations:** | | | | | | |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate | 7 | 12 | H |
| 3A | Baythroid XL | 2.8 fl oz/A | beta-cyfluthrin* | 7 | 12 | H |
| 3A + 4A | Brigadier | 3.8 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 1 | 12 | H |
| 3A + 4A | Leverage 360 | 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 0 | 12 | H |
| 3A + 4A | Swagger | 7.6 to 19.7 fl oz/A | bifenthrin* + imidacloprid | 1 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 5 | 24 | H |
| 3A | Bifenture EC, Sniper, Sniper Helios | 2.1 to 5.2 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 1 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Proaxis | 2.56 to 3.84 fl oz/A | gamma-cyhalothrin* | 5 | 24 | H |
| 3A | Tombstone, Tombstone Helios | 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 5 | 24 | H |
| 4A | Admire Pro | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 2.0 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil, drip** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole - **soil** | 1 | 4 | H |

## Leafminers

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Treat with one of the following formulations when first mines appear and repeat every 7 days or as needed.** | | | | | | |
| 1B | Dimethoate 4EC | 0.5 to 1.0 pt/A | dimethoate* | 7 | 48 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda*-cyhalothrin + chlorantraniliprole | 5 | 24 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |

*Leafminers continued on next page*

*Leafminers - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 6.0 to 10.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Agri-Mek 0.7SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 6 | Proclaim 5SG | 3.2 to 4.8 oz/A | emamectin benzoate* | 7 | 12 | H |
| 16B | Rimon 0.83EC | 12 fl oz/A | novaluron | 1 | 12 | L |
| 17 | Trigard 75WSP | 2.66 oz/A | cyromaxine | 0 | 12 | L |
| 28 | Coragen 1.67SC (larvae only) | 5.0 to 7.5 fl oz/A | chlorantraniliprole - **soil, drip, foliar** | 1 | 4 | L |
| 28 | Exirel | 13.5 to 20.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 4 | H |
| 28 | Verimark | 6.75 to 10.0 fl oz/A | cyantraniliprole - **drip or injection** | 1 | 4 | H |
| 28 | Verimark | 6.75 to 13.5 fl oz/A | cyantraniliprole - **soil (at-planting)** | 1 | 4 | H |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Mites

Mite infestations generally begin around field margins, grassy areas, and windbreaks. **DO NOT** mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot treated. The use of dimethoate for aphids and leafminers will reduce spider mite populations.

**Apply one of the following formulations:**
**Note: Thorough spray coverage beneath leaves is important.**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 6 | Agri-Mek 0.7SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 48 | H |
| 21A | Portal / Portal XLO | 2.0 pt/A | fenpyroximate | 1 | 12 | L |
| 23 | Oberon 2S | 7.0 to 8.5 fl oz/A | spiromesifen | 1 | 12 | M |
| 25 | Acramite 50WS | 0.75 to 1.0 lb/A | bifenazate | 3 | 12 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Pinworms

This pest is introduced on southern transplants. Begin sprays if leaf damage is observed. Late evening sprays may be most effective when moths are active.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 7 | 12 | H |
| 3A + 4A | Leverage 360 | 3.8 to 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 0 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 5 | 24 | H |
| 3A | Baythroid XL | 2.1 to 2.8 fl oz/A | beta-cyfluthrin* | 7 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 1 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A | Mustang Maxx | 2.24 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Proaxis | 2.56 to 3.84 fl oz/A | gamma-cyhalothrin* | 5 | 24 | H |
| 3A | Tombstone, Tombstone Helios | 2.1 to 2.8 fl oz/A | cyfluthrin* | 7 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | Warrior II | 5 | 24 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 5.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |
| 6 | Agri-Mek 0.7SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 48 | H |
| 6 | Proclaim 5SG | 2.4 to 4.8 oz/A | emamectin benzoate* | 7 | 12 | H |
| 16B | Rimon 0.83EC | 9.0 to 12.0 fl oz/A | novaluron | 1 | 12 | L |
| 22 | Avaunt 30WDG | 3.5 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC (larvae) | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **soil/drip/foliar** | 1 | 4 | L |

*Pinworms continued on next page*

*Pinworms - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 28 | Exirel | 7.0 to 13.5 fl oz/A | cyantraniliprole - **foliar** | 1 | 12 | H |
| 28 | Verimark | 5.0 to 10.0 fl oz/A | cyantraniliprole - **soil** | 1 | 4 | H |
| 228 + 6 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |
| n/a | NoMate TPW[1] | 200 to 400 spirals/A | mating disruption hormone | n/a | n/a | n/a |

[1]NoMate uses a disruption pheromone for preventing mating of emerging adults from young transplants. The pheromone is applied to a hard plastic matrix formed into a hanging "spiral" for dispersal into the air. Apply at first sign of pinworm larvae in leaves.

## Stink Bugs

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV (brown marmorated stink bug only) | 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A | Danitol 2.4EC | 10.67 fl oz/A | fenpropathrin* | 3 | 24 | H |
| 3A + 4A | Brigadier | 5.1 to 9.85 fl oz/A | bifenthrin* + imidacloprid | 1 | 12 | H |
| 3A + 4A | Leverage 360 | 4.1 fl oz/A | imidacloprid + beta-cyflutthrin* | 0 | 12 | H |
| 3A + 4A | Swagger | 7.6 to 19.7 fl oz/A | bifenthrin* + imidacloprid | 1 | 12 | H |
| 3A | Baythroid XL | 2.8 fl oz/A | beta-cyfluthrin* | 7 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 5.2 fl oz/A | bifenthrin* | 7 | 12 | H |
| 3A | Hero EC | 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 0 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 3.84 fl oz/A | lambda-cyhalothrin | 5 | 24 | H |
| 3A | Mustang Maxx | 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Proaxis | 3.84 fl oz/A | gamma-cyhalothrin* | 5 | 24 | H |
| 3A | Tombstone, Tombstone Helios | 2.8 fl oz/A | cyfluthrin* | 7 | 12 | H |
| 3A | Warrior II | 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A + 4A | Endigo ZC | 4.5 fl ozA | lambda-cyhlalothrin | 5 | 24 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 5 | 24 | H |
| 4A | Actara 25WDG | 5.5 oz /A | thiamethoxam | 0 | 12 | H |
| 4A | Scorpion 35SL | 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A+28 | Durivo | 10.0 to 13.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole -**soil** | 30 | 12 | H |
| 4A+28 | Voliam Flexi | 4.0 to 7.0 oz/A | lambda-cyhalothrin*+chlorantraniliprole -**foliar** | 1 | 12 | H |

## Thrips

Several species of thrips spread Tomato Spotted Wilt Virus. Scout for thrips and begin treatments when observed. Do not produce vegetable transplants with bedding plants in the same greenhouse.

**Apply one of the following formulations:**

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **3A** | **Baythroid XL[1]** | 1.6 to 2.8 fl oz/A | beta-cyfluthrin* | 7 | 12 | H |
| **3A** | **Lambda-cy, LambdaT[1]** | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| **3A** | **Proaxis[1]** | 2.56 to 3.84 fl oz/A | gamma-cyhalothrin* | 5 | 24 | H |
| **3A** | **Tombstone, Tombstone Helios[1]** | 2.1 to 2.8 fl oz/A | cyfluthrin* | 7 | 12 | H |
| **3A** | **Warrior II[1]** | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 5 | 24 | H |
| 3A + 4A | Endigo ZC[1] | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 5 | 24 | H |
| 3A + 4A | Leverage 360 (foliage feeding thrips only) | 3.8 to 4.1 fl oz/A | imidacloprid + beta-cyfluthrin* | 0 | 12 | H |
| 4A | Admire Pro (foliage feeding thrips only) | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Assail 30SG | 4.0 oz/A | acetamiprid | 7 | 12 | M |
| 4A | Platinum 75SG | 1.66 to 2.67 oz/A | thiamethoxam | 30 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |

*Thrips continued on next page*

*Thrips - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 5 | Entrust SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 1 | 4 | M |
| 5 | Radiant SC | 6.0 to 10.0 fl oz/A | spinetoram | 1 | 4 | H |

[1]Resistance concerns with Western flower thrips only

## Whiteflies

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 4A | Actara 25WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Admire Pro | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Assail 30SG | 2.5 to 4.0 oz/A | acetamiprid | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 4C | Closer SC | 4.25 to 4.5 fl oz/A | sulfoxaflor | 1 | 12 | H |
| 4D | Sivanto 200SL, Sivanto Prime | 21.0 to 28.0 fl oz/A | flupyradifurone - **soil** | 45 | 4 | L |
| 4D | Sivanto 200SL, Sivanto Prime | 10.5 to 14.0 fl oz/A | flupyradifurone - **foliar** | 1 | 4 | L |
| 7C | Knack | 8.0 to 10.0 fl oz/A | pyriproxyfen | 1 | 12 | L |
| 9B | Fulfill 50WDG | 2.75 oz/A | pymetrozine | 0 | 12 | L |
| 16 | Courier SC | 9.0 to 13.6 fl oz/A | buprofezin | 1 | 12 | L |
| 21A | Portal, Portal XLO | 2.0 pt /A | fenpyroximate | 1 | 12 | L |
| 23 | Movento | 4.0 to 5.0 fl oz/A | spirotetramat | 1 | 24 | L |
| 23 | Oberon 2SC | 7.0 to 8.5 fl oz/A | spiromesifen | 1 | 12 | M |
| 28 + 6 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |
| n/a | Requiem EC (biopesticide) | 2.0 to 3.0 qt/A | *Chenopodium* extract | 0 | 4 | L |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.
## Recommended Fungicides

**Nematodes** See the Soil Fumigation and Nematodes sections in the Pest Management chapter

### Seed Treatment

Purchase hot water treated seed or request hot water treatment. Heat treatment is a non-chemical alternative to conventional chlorine treatments that only kills pathogens on the surface of the seed coat. Heat treatment has the additional benefit of killing pathogens within the seed coat and is particularly useful for crops that are prone to seed-borne bacterial infections such as tomato and pepper. Seed heat treatment follows a strict time and temperature protocol and is best done with thermostatically controlled water baths. Two baths are required: one for pre-heating, and a second for the effective (pathogen killing) temperature. Seeds stay in the first bath at 100ºF (38ºC) for 10 minutes, and in the second bath at 122°F (50°C) for 25 minutes. Immediately after removal from the second bath, seeds should be thoroughly rinsed with cool water, and dried on a screen or paper.

Alternatively, soak seeds in a mixture of 1 part Alcide (sodium chlorite), 1 part lactic acid, and 18 parts water for 1-2 minutes under constant agitation, and rinse for 5 minutes in cool running water. Do not use pelleted seeds because moisture results in the loss of coating material. (

Only treat seed that will be used during the current production season. Following heat or chlorine treatment, dust dried seed with Captan 50WP or Thiram 480DP at 1 level tsp/lb seed (3.0 oz/100 lb).

## Damping-off and Root Rots

*Greenhouse*: Use seed treatment and plant in a disease-free mix.
*Field*: At planting apply one of the fungicides via drip or banded spray. Additional field applications may be made as needed, see label for specific instructions.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 4 | MetaStar 2E AG | 2.0-4.0 pt/A | metalaxyl | AP | 48 | N |
| 4 | Ridomil Gold 4SL[1] | 1.0-2.0 pt/A[1] | mefenoxam | AP | 48 | N |
| 4 | Ultra Flourish 2E[1] | 2.0-4.0 pt/A[1] | mefenoxam | AP | 48 | N |
| 33 | Aliette 80WDG | 2.5 to 5.0 lb/A | Fosetyl-Al | 14 | 12 | N |

[1]Apply in a 7-inch band at transplanting. Determine the amount of Ridomil Gold or Ultra Flourish per acre using the calibration formula for changing from broadcast to band application (see the section "Calibrating Granular Applicators" in the Pest Management chapter).

## Bacterial Diseases:

## Bacterial Canker

Use certified transplants. Rotate to allow 3 years between plantings. When producing transplants, use clorox or heat-treated seed and treat used flats with sodium hypochlorite (bleach) (see the section Transplant Growing in the General Production Recommendations chapter). Stakes from bacterial canker infested fields should be power washed, soaked in a 20% (1 part bleach plus 4 parts water) commercial bleach solution for at least 30 minutes, and power wash a second time prior to use. Avoid pruning and stringing when foliage is wet as this will promote the spread of the disease in infested fields. Applications of Actigard 50WG (0.33 oz/A increasing to 0.75 oz/A when plants are full size, see label) PLUS fixed copper (1.5 lb active/A) have been shown to reduce bacterial canker symptoms on fruit.

## Bacterial Speck and Bacterial Spot

When producing transplants, use clorox or heat-treated seed as described above under Seed Treatment. Apply streptomycin sprays (Agri-Mycin 17, Agri-Strep, 1.0 lb/100 gal, 1.25 tsp/gal) when the first true leaves appear and continue every 4-5 days until transplanting. Streptomycin cannot be used after transplanting. Limit handling of plants and keep greenhouse moisture levels low.

Rotate to allow 2 - -3 years between plantings. Use only certified transplants. Bacterial speck and/or spot occur more often on southern-produced transplants. Strains of copper resistant bacterial spot are common in some areas of the mid-Atlantic particularly on the Eastern Shore of VA. Use Actigard alone or in conjunction with copper-containing materials. Where disease is present or anticipated, do not work in fields when plant surfaces are wet.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Tank mix the following beginning shortly after transplanting and repeat every 7 days.** | | | | | | |
| M1 | copper (OMRI) | 1.0 lb ai/A | copper | 0 | see label | N |
| M3 | mancozeb 75DF | 1.5 lb/A | mancozeb | 5 | 12/24 | N |
| **And rotate with or apply the following:** | | | | | | |
| M1 + M3 | ManKocide 61WP | 2.5 to 5.0 lb/A | copper hydroxide + mancozeb | 5 | 48 | N |
| **The following is a plant defense activator and preventative applications should begin prior to the onset of symptoms.** | | | | | | |
| P1 | Actigard 50WG[1] | 0.33 to 0.75 oz/A (see label) | acibenzolar-S-methyl | 14 | 12 | N |

[1]Use in areas where copper resistance is known. See label for rates and times of use.

## Bacterial Wilt

Use certified transplants. Avoid growing tomatoes in fields where bacterial wilt has occurred. Crop rotation to non--host crops is the best measure to reduce levels of bacterial wilt. In particular, avoid planting where tomatoes or peppers were grown in the preceding year. Some resistant cultivars, such as BHN669, are available. Avoid irrigating with pond water when possible, especially for ponds that are adjacent to previously diseased fields as they may be contaminated with the causal agent.

## Fungal Diseases:

### Botrytis Fruit Rot (Gray Mold)

Gray mold is a problem during the fall in fields with dense foliage and poor drainage. For fall production, select fields with good drainage.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Shortly before harvest or when conditions are wet and cool, rotate the following as long as weather conditions favor disease development:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 2.75 pt/A also very good for late blight | chlorothalonil | 0 | 12 | N |
| 7 | Endura 70WG | 9.0 to 12.5 oz/A also very good for early blight | boscalid | 0 | 12 | -- |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodinil + fludioxonil | 0 | 12 | N |

### Buckeye Rot caused by *Phytophthora parasitica* and Fruit Rot caused by *Pythium* spp.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following as a soil surface application under the vines 48 weeks before harvest. Apply broadcast or banded (adjust amount). Irrigate after application.** | | | | | | |
| 4 | Ridomil Gold 4SL | 1.0 pt/A | mefenoxam | AP | 48 | N |
| 4 | Ultra Flourish 2E | 1.0 qt/A | mefenoxam | AP | 48 | N |
| **An alternative to soil application of mefenoxam: Apply one of the following as a foliar spray beginning when crown fruit are one-third their final size. repeat every 14 days up to a total of 3 times:** | | | | | | |
| 4 + M1 | Ridomil Gold Copper 65WP | 2.0 lb/A | mefenoxam + copper | 14 | 48 | -- |
| 4 + M5 | Flouronil 76WP | 2.0 lb/A | mefenoxam + chlorothalonil | 14 | 48 | -- |
| 4 + M5 | Ridomil Gold Bravo 76WP | 2.0 lb/A | mefenoxam + chlorothalonil | 14 | 48 | -- |
| **If weather and soil conditions continue to favor disease development apply one of the following between applications of the above listed fungicides:** | | | | | | |
| 11 + 27 | Tanos 50WG | 8.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 22 + M3 | Gavel 75DF | 1.5 to 2.0 lb/A | mancozeb + zoxamide | 5 | 48 | -- |

### Fusarium Wilt and Verticillium Wilt

Select varieties with resistance to Fusarium and Verticillium wilts. For Fusarium wilt, select cultivars that are resistant to Races 1, 2, and 3 as all are prevalent on in the Mid-Atlantic region. Soil fumigation and proper crop rotation are essential components of a successful management program.

### Late Blight

Use disease free transplants. If possible, produce your own transplants since transplants obtained from other regions may increase the risk of a late blight infestation. A strong scouting program, preventative fungicide applications when warranted, and microclimate management to reduce levels of free moisture on foliage are essential to help reduce the potential for disease development. Tomato cultivars with resistance to Late blight are available.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **When plants are 6 inches tall, apply one of the following protectant fungicides and repeat every 7 days.** | | | | | | |
| M3 | mancozeb 75DF | 3.0 lb/A | mancozeb | 5 | 12,24 | N |
| M3+22 | Gavel 75DF | 1.5 to 2.0 lb/A | mancozeb + zoxamide | 5 | 48 | -- |
| M5 | chlorothalonil 6F | 1.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | N |
| M5+22 | Zing! 4.9SC | 36.0 fl oz/A | chlorothalonil + zoxamide | 7 | 12 | N |
| **Protectant fungicides should only be applied preventatively. Monitor the movement of the disease at *http://www.usablight.org/* or via local online Extension resources. Once late blight is detected in your area, TANK MIX one of the following translaminar fungicides which can move into and through leaves WITH A PROTECTANT FUNGICIDE such as chlorothalonil, Gavel, or mancozeb. Products containing mefenoxam should not be used unless your extension professional or the aforementioned website are certain that current strains are sensitive. To achieve the best control rotate between one of the following options:** | | | | | | |
| 3 + 40 | Revus Top 4.16SC | 5.5 to 7.0 fl oz/A; also offers protection from leaf spots; **not** for use on small fruited varieties. | difenoconazole + mandipropamid | 1 | 12 | M |
| 11 | Reason 500SC | 5.5 to 8.2 fl oz/A | fenamidone | 14 | 12 | -- |
| 11+27 | Tanos 50WG | 8.0 oz/A; also offers protection from leaf spots | famoxadone + cymoxanil | 3 | 12 | -- |

*Late Blight continued on next page*

*Late Blight - continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 21 | Ranman 400SC | 2.10 to 2.75 fl oz/A | cyazofamid | 0 | 12 | L |
| 27 | Curzate 60DF | 3.2 to 5.0 oz/A | cymoxanil | 3 | 12 | N |
| 28 | Previcur Flex 6F | 1.5 pt/A | propamocarb HCL | 5 | 12 | N |
| 40 | Forum 4.18SC | 6.0 fl oz/A | dimethomorph | 4 | 12 | N |
| 43 | Presidio 4SC | 3.0 to 4.0 fl oz/A | fluopicolide | 2 | 12 | L |
| **GREENHOUSE USE: Consult fungicide labels to ensure greenhouse applications are permitted. The following materials permit greenhouse applications and can offer suppression. Apply one of the following:** | | | | | | |
| M5+33 | Catamaran 5.3F | 5.5 to 7.0 pt/A | chlorothalonil + phosphite | 0 | 12 | -- |
| 11 | Heritage 50WG | 1.6 to 2.0 oz/A | azoxystrobin | 0 | 4 | N |

## Leaf Mold

Leaf mold is caused by the fungus *Passalora fulva* (previously called *Fulvia fulva* or *Cladosporium fulvum*). Leaf mold may occur during periods of high moisture particularly within the canopy.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply or rotate between the following fungicides as long as conditions are favorable for disease development:** | | | | | | |
| M5 + 33 | Catamaran 5.3F | 4.5 to 7.0 pt/A | chlorothalonil + phosphite | 4 | 12 | -- |
| 3 + 40 | Revus Top 4.16SC | 5.5 to 7.0 fl oz/A | difenoconazole + mandipropamid | 1 | 12 | M |

Leaf mold is primarily damaging in greenhouse and high tunnel tomato settings with long periods of high relative humidity. Vent structures regularly to reduce humidity and leaf wetness. See Table E-10 for fungicides labeled for use in greenhouses.

## Leaf Spots caused by Early blight and Septoria leaf spot and Fruit Rots caused by Anthracnose and Early blight:

Follow a crop rotation with at least 2 years without tomatoes or potatoes. Use disease-free transplants and disease resistant varieties when possible. In high elevated areas, in fields not rotated away from tomatoes, or in late planted fields begin sprays shortly after transplanting. In all other areas, follow a regular (7-day) spray schedule.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Alternate or tank mix one of the following protectant fungicides:** | | | | | | |
| M3 | mancozeb 75DF | 3.0 lb/A (also for gray leaf spot and leaf mold) | mancozeb | 5 | 12/24 | N |
| M3 + 22 | Gavel 75DF | 1.5 to 2.0 lb/A | mancozeb + zoxamide | 5 | 48 | -- |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A (also for gray leaf spot, black mold and soil rot) | chlorothalonil | 0 | 12 | N |
| M5 + 22 | Zing! 4.9SC | 36.0 fl oz/A | chlorothalonil + zoxamide | 7 | 12 | N |
| **WITH one of the following fungicides (fungicides from different FRAC codes should be rotated to help reduce the chances for fungicide resistance development):** | | | | | | |
| 3 + 7 | Aprovia Top 1.62SC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflupyr | 0 | 12 | N |
| 3 + 9 | Inspire Super 2.82SC | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodonil | 0 | 12 | -- |
| 3 + 11 | Quadris Top 2.72SC | 8.0 fl oz/A | difenoconazole + azoxystrobin | 0 | 12 | -- |
| 3 + 40 | Revus Top 4.16SC | 5.5 to 7.0 fl oz/A | difenoconazole + mandipropamid | 1 | 12 | M |
| 7 | Endura 70W | 2.5 to 3.5 oz/A (also for *Botrytis* at 9.0 to 12.5 oz/A) | boscalid | 3 | 12 | -- |
| 7 | Fontelis 1.67SC | 16.0 to 24.0 fl oz/A | penthiopyrad | 0 | 12 | L |
| 7 + 11 | Priaxor 4.17SC | 4.0 to 8.0 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 11 | azoxystrobin 2.08SC | 5.0 to 6.2 fl oz/A (also for black mold and buckeye rot. **Do not** apply near apples, see label) | azoxystrobin | 0 | 4 | N |
| 11 | Cabrio 20EG | 8.0 to 12.0 oz/A | pyraclostrobin | 0 | 12 | N |
| 11 | Flint 50WDG | 4.0 oz/A (**Do not** apply near Concord grapes) | trifloxystrobin | 3 | 12 | N |
| 11 + 27 | Tanos 50W | 8.0 oz/A *PLUS* protectant fungicide (also for buckeye rot suppression and gray leaf spot). | famoxadone + cymoxanil | 12 | 3 | -- |

## Postharvest Rots

Avoid harvesting when the foliage is wet. To prevent rots in mature green tomatoes, avoid washing freshly harvested fruit in cold water. To prevent movement of bacteria into the stem end of the fruit, do not allow water temperatures in flumes and tanks of more than 10°F above fruit temperature. Use a minimum of 100 ppm free chlorine and keep pH between 6.5-7.0 in the flume. Store at 55°F (13°C) with relative humidity of 80%. For more information on postharvest tomato diseases, see *http://edis.ifas.ufl.edu/HS131*.

## Powdery Mildew

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **At first appearance of the disease, rotate between the following fungicides[1]:** | | | | | | |
| **FIELD, repeat every 7 to 14 days:** | | | | | | |
| 3 | Rally 40WSP | 2.5 to 4.0 oz/A | myclobutanil | 0 | 12 | **N** |
| 3 + 7 | Aprovia Top 1.62SC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflupyr | 0 | 12 | **N** |
| 3 + 9 | Inspire Super 2.82SC | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodonil | 0 | 12 | -- |
| 3 + 40 | Revus Top 4.16SC | 5.5 to 7.0 fl oz/A | difenoconazole + mandipropamid | 1 | 12 | M |
| 11 | Cabrio 20EG | 8.0 to 12.0 oz/A | pyraclostrobin | 0 | 12 | N |
| 13 | Quintec 2.08SC | 6.0 fl oz/A | quinoxyfen | 3 | 12 | -- |
| **GREENHOUSE[2], thoroughly cover upper and lower leaf surfaces and repeat every 7 days:** | | | | | | |
| -- | JMS Stylet Oil | 1.0 to 2.0 gal/100 gal | | | | -- |
| 9 | Scala 5SC | 7.0 fl oz/A | pyrimethanil | 1 | 12 | -- |

[1] Fungicides from different FRAC codes should be rotated to help reduce the chances for fungicide resistance development. [2] Powdery mildew can cause serious problems in greenhouse and high tunnel settings. See Table E-14 for additional fungicides labeled for use in greenhouses.

## Southern Blight (*Sclerotium rolfsii*)

Southern blight is most commonly seen in the southern part of the Mid-Atlantic region. High soil moisture and temperature favor disease, while long crop rotations with corn and small grains help reduce disease incidence. Weed control is important as *Sclerotium rolfsii* can infect a number of common weeds in the Mid-Atlantic region. Soil fumigation and staking will greatly reduce disease incidence. Applications of Blocker 4F in transplant water or as an in-furrow treatment may suppress the disease.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1 | Blocker 4F | See label | pentachloronitrobenzene (PCNB) | AP | **12** | -- |

## Timber Rot (*Sclerotinia sclerotiorum)*

Tomato timber rot, also known as sclerotinia stem rot, is a fungal disease caused by *Sclerotinia sclerotiorum*. Rotate away from fields where snap or lima beans, peas, peanuts, lettuce, or cucurbits were grown in the past. **--** Timber rot occurs during prolonged wet periods and cooler temperatures (<80°F).

## Viruses: Tomato Spotted Wilt Virus (TSWV)

TSWV can result in severely stunted plants. The virus is spread by thrips from ornamental flowering plants, field crops, and weeds to tomatoes. TSWV can be particularly devastating in southern and eastern parts of VA. Use resistant varieties when available. Do not grow any ornamental bedding plants in the same greenhouse as tomato transplants. Control weeds in and around greenhouses, high tunnels, or transplant areas. Monitor greenhouses and tomato fields for thrips and begin an insecticide control program once observed. Use of reflective mulch can help repel thrips. If tomato crops are near wheat or barley fields be aware of increased thrips pressure once these crops start to turn brown in the spring.

# Watermelons

## Recommended Varieties

| | Reported Disease Resistance[1] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fon[2] Gen | Fon 0 | Fon 1 | Fon 2 | Co[3] | Px[4] | Size (lb) | Shape | Flesh Color | Rind Description |
| **Seeded (also see seeded pollenizers)** | | | | | | | | | | |
| Crimson Sweet | R | | | | R | | 16-20 | globe | red | medium green with dark green stripes |
| Jamboree | | | I | | I | | 24-28 | oblong | red | dark green with broken light green stripes |
| Mardi Gras | I | | | | I | | 20-24 | oblong | red | dark green with broken light green stripes |
| Sangria | I | | | | I | | 20-24 | oblong | red | dark green with broken light green stripes |
| Starbrite | | | | | R | | 22-31 | oblong | red | medium green with dark green stripes |
| Top Gun | | | I | | I | | 21-24 | globe | red | medium green with dark green stripes |
| **Seedless Early** | | | | | | | | | | |
| Melody | | | | | | | 14-16 | globe | red | medium green with dark green stripes |
| Sweet Gem | | | | | | | 13-16 | globe | red | dark green |
| Sweet Eat'n | I | | | | I | | 15-20 | oval | red | light green with broad, medium green stripes |
| Secretariat | | | | | | | 16-20 | oval | red | light green with broad, medium green stripes |
| Amarillo | | | | | | | 13-15 | globe | yellow | light green with narrow dark green stripes |
| Vagabond | | | | | | | 14-17 | oval | red | medium green with dark green stripes |
| **Seedless Mid Season** | | | | | | | | | | |
| Bottle Rocket | | | I | | | | 18-21 | oblong | red | medium green with dark mottled stripes |
| Charismatic | | | | | | | 13-16 | globe | red | medium green with dark green stripes |
| Joy Ride | R | | | | | | 18-20 | oblong | red | medium green with dark green stripes |
| Road Trip | R | | | | R | | 16-18 | oblong | red | medium green with mottled green stripe |
| SS 7167 | | | | | | | 16-20 | oval | red | medium green with dark green stripes |
| Gypsy | | | | | I | | 13-17 | globe | red | medium green with dark green stripes |
| Fascination | | | I | | I | | 16-20 | oval | red | medium green with dark green stripes |
| Crisp N Sweet | | | | | | | 16-20 | oval | red | light green with broad, medium green stripes |
| Cut Above | I | | | | | | 15-17 | round oval | red | medium green with dark green stripes |
| Sugar Heart | | | | | | | 16-20 | oval | red | light green with broad, medium green stripes |
| Traveler | | | | | | | 15-20 | oval | red | medium green with dark green stripes |
| Unbridled | | | | | | | 13-16 | globe | red | medium green with dark green stripes |
| Kingman | | | | | | | 16-20 | oval | red | light green with broad, medium green stripes |
| SV0258WA | | | | | | | 15-20 | oval | red | light green with broad, medium green stripes |
| SV0241WA | | | I | | R | | 12-15 | oval | red | light green with medium green stripes |
| Warrior | | | | | | | 17-20 | oval | red | medium green with dark green stripes |
| Wayfarer | | | | | R | | 13-18 | globe | red | solid dark green to black |
| Butterball | | | I | | | | 12-18 | globe | yellow | light green with narrow dark green stripes |
| **Seedless Late** | | | | | | | | | | |
| Sugar Fresh | | | | | | | 15-18 | oval | red | light green with broad, medium green stripes |
| Traveler | | | | | R | | 12-17 | globe | red | medium green with dark green stripes |
| Troubadour | | | | | R | | 14-17 | oval | red | medium green with dark green stripes |
| SS 7197 | | | | | I | | 16-20 | oval | red | medium green with dark green stripes |
| Sweet Polly | | | | | | | 15-18 | oval | red | medium green with dark green stripes |
| Captivation | | | I | | I | | 14.17 | oval | red | medium green with dark green stripes |
| Maxima | | | | | | | 19-22 | globe | red | medium green with dark green stripes |
| Talca | | | | | | | 17-20 | oval | red | green with very dark green stripes |
| SugaRed | | | | | | | 16-18 | oval | red | light green with broad, medium green stripes |
| Exclamation | | | I | | I | | 17-21 | oval | red | medium green with dark green stripes |
| Crunchy Red | | | | | R | | 16-20 | oval | red | light green with broad, medium green stripes |
| Premont | | | I | | I | | 15-17 | oval to round | red | medium green with green stripes |

*Continued on next page*

*Recommended Varieties - continued*

| | Reported Disease Resistance[1] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Fon[2] Gen** | **Fon 0** | **Fon 1** | **Fon 2** | **Co[3]** | **Px[4]** | **Size (lb)** | **Shape** | **Flesh Color** | **Rind Description** |
| **Seedless Personal Melon** | | | | | | | | | | |
| Extazy | | | | | | | 4-7 | globe | red | medium green with dark green stripes |
| Ladybelle | | | | | | | 4-8 | globe | red | dark green with thin darker stripes |
| Solitaire | | | | | | | 3-5 | globe | red | medium green with dark green stripes |
| Vanessa | | | | | | | 5-7 | globe | red | dark green |
| **Edible Pollenizers** | | | | | | | | | | |
| Estrella | | | I | | I | | 20-24 | oblong | red | dark green with broken, light green stripes |
| Jade Star | | | | | | | 13-16 | globe | red | dark green |
| Mickeylee | R | | | | R | | 8-12 | globe | red | light green |
| Pata Negra | | | | | | | 12-15 | globe | red | dark green |
| Premium (micro seeded) | | | | | | | 5-7 | oval | red | light green with thin dark green strips |
| Sangria | | | I | | I | | 20-24 | oblong | red | dark green with broken light green stripes |
| SF 800 | | | I | | I | | 24-28 | oblong | red | dark green with broken light green stripes |
| Stargazer | | | | | I | | 24-26 | oblong | red | dark green with broken light green stripes |
| **Inedible Special Pollenizers** | | | | | | | | | | |
| Accomplice | | I | I | | R | | | | | |
| Ace Plus | | | I | | I | | | | | |
| Pollen Pro | I | | | | I | | | | | |
| Polimax | | | | | | | | | | |
| Sidekick | | | | | R | | | | | |
| SP 6 | | | I | I | I | I | | | | |
| Wild Card Plus | | | I | | I | | | | | |

[1]Reported disease resistance from source seed companies and University trials. R=Resistance; I=intermediate/partial resistance.
[2]Fon=Fusarium wilt caused by *Fusarium oxysporum f. sp. niveum* Race 1,2, or 3. Fon Gen=general resistance to Fon; [3]Co=Anthracnose caused by *Colletotrichum orbiculare*; [4]Px=Powery mildew caused by *Podosphaeria xanthii.*

## Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and the Soil and Nutrient Management chapter. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

| **Watermelons** | | **Soil Phosphorus Level** | | | | **Soil Potassium Level** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Low** | **Med** | **High (Opt)** | **Very High** | **Low** | **Med** | **High (Opt)** | **Very High** | |
| | **N (lb/A)** | **$P_2O_5$ (lb/A)** | | | | **$K_2O$ (lb/A)** | | | | **Nutrient Timing and Method** |
| **Non-Irrigated** | 80-100[1] | 150 | 100 | 50 | 0[2] | 200 | 150 | 100 | 0[2] | Total nutrient recommended |
| | 50 | 150 | 100 | 50 | 0[2] | 200 | 150 | 100 | 0[2] | Broadcast and disk-in |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress when vines start to run |
| **Irrigated** | 125-150[1] | 150 | 100 | 50 | 0[2] | 200 | 150 | 100 | 0[2] | Total nutrient recommended |
| | 25-50 | 150 | 100 | 50 | 0[2] | 200 | 150 | 100 | 0[2] | Broadcast and disk-in or follow fertigation schedule for K |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress when vines start to run or follow fertigation schedule |
| | 25-50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Sidedress after first harvest or follow fertigation schedule |

[1]For seedless watermelons, high rates of N may increase the risk of hollow heart.
[2]In VA, crop replacement values of 25 lb/A of $P_2O_5$ and 50 lb/A of $K_2O$ are recommended on soils testing Very High.

## Fertigation Schedule Examples

This table provides examples of fertigation schedules based on two common scenarios – sandy coastal plain soils and heavier upland soils. Modify according to specific soil tests and base fertility.

| **Fertigation recommendations for 125 lb N and 125 lb $K_2O$[1,2]**<br>For soils with organic matter content less than 2% or coarse texture and low to medium or deficient K | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Nitrogen** | | | **Potash** | | |
| **Preplant (lb/A)[3]** | | | **25** | | | **50** | | |
| | | | **N** | **N** | **N** | **$K_2O$** | **$K_2O$** | **$K_2O$** |
| **Stage and Description** | Weeks | Days | lb/day | lb/week | lb/stage | lb/day | lb/week | lb/stage |
| **1 Early vegetative** | 1-2 | 1-14 | 1 | 7 | 14 | 1 | 7 | 14 |
| **2 Late vegetative** | 3-4 | 15-28 | 1.5 | 10.5 | 21 | 1.5 | 10.5 | 21 |
| **3 Flowering and fruiting** | 5-8 | 29-56 | 2 | 14 | 56 | 2 | 14 | 56 |
| **4 Harvest** | 9-10 | 57-70 | 1.5 | 10.5 | 21 | 1.5 | 10.5 | 21 |
| **5 Repeat harvest[4]** | 11-12 | 71-84 | 1 | 7 | 14 | 1 | 7 | 14 |
| **Fertigation recommendations for 100 lb N and 50 lb $K_20$[1,2]**<br>For soils with organic matter content greater than 2% or fine texture and high or optimum K | | | | | | | | |
| | | | **Nitrogen** | | | **Potash** | | |
| **Preplant (lb/A)[3]** | | | **50** | | | **50** | | |
| | | | **N** | **N** | **N** | **$K_2O$** | **$K_2O$** | **$K_2O$** |
| **Stage and Description** | Weeks | Days | lb/day | lb/week | lb/stage | lb/day | lb/week | lb/stage |
| **1 Early vegetative** | 1-2 | 1-14 | 0.4 | 2.8 | 5.6 | 0.3 | 2.1 | 4.2 |
| **2 Late vegetative** | 3-4 | 15-28 | 0.9 | 6.3 | 12.6 | 0.6 | 4.2 | 8.4 |
| **3 Flowering and fruiting** | 5-8 | 29-56 | 1.4 | 9.8 | 39.2 | 0.9 | 6.3 | 25.2 |
| **4 Harvest** | 9-10 | 57-70 | 0.9 | 6.3 | 12.6 | 0.6 | 4.2 | 8.4 |
| **5 Repeat harvest[4]** | 11-12 | 71-84 | 0.4 | 2.8 | 5.6 | 0.3 | 2.1 | 4.2 |

[1]Rates are based on 6,222 linear bed ft/A (7 ft bed spacing). If beds are closer or wider, fertilizer rates should be adjusted proportionally. Drive rows should not be used in acreage calculations (see the Fertigation section in the Irrigation Management chapter).
[2]Base overall application rate on soil test recommendations.
[3]Applied under plastic mulch to effective bed area using modified broadcast method.
[4]For extended harvest after 12 weeks continue fertigation at this rate.

## Plant Tissue and Petiole Sap Testing

Plant tissue and petiole sap testing are useful tools for monitoring plant nutrient status, especially for N and K.
**Petiole sap**: Petiole sap can be tested with a portable meter. When vines are 6 inches long, petiole sap nitrate-N should be 1200-1500 ppm and K 4000-5000 ppm. When fruit are 2 inches long, nitrate-N should be 1000-1200 ppm and K 4000-5000 ppm. When fruit are half mature, nitrate-N should be 800-1000 ppm and K 3500-4000 ppp. At first harvest, nitrate-N should be 600-800 ppm and K 3000-3500 ppm.
**Tissue testing**: Take the most recent fully expanded leaves at early bloom and follow laboratory instructions. The table below lists nutrient concentrations in leaf tissue at various growth stages, ranging from adequate to toxic.

| **Timing** | **Value** | **N** | **P** | **K** | **Ca** | **Mg** | **S** | **Fe** | **Mn** | **Zn** | **B** | **Cu** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **%** | **%** | **%** | **%** | **%** | **%** | **ppm** | **ppm** | **ppm** | **ppm** | **ppm** |
| **When Vines Touch** | **Deficient** | <3.0 | 0.3 | 3 | 1 | 0.25 | 0.2 | <30 | 20 | 20 | 20 | 5 |
| | **Adequate range** | 3 | 0.3 | 3 | 1 | 0.25 | 0.2 | 30 | 20 | 20 | 20 | 5 |
| | | 4 | 0.5 | 4 | 2 | 0.5 | 0.4 | 100 | 100 | 40 | 40 | 10 |
| | **High** | >4.0 | 0.5 | 4 | 2 | 0.5 | 0.4 | >100 | 100 | 40 | 40 | 10 |
| | **Toxic (>)** | - | - | - | - | - | - | - | 800 | - | - | - |
| **At First Flower** | **Deficient** | <2.5 | 0.3 | 2.7 | 1 | 0.25 | 0.2 | <30 | 20 | 20 | 20 | 5 |
| | **Adequate range** | 2.5 | 0.3 | 2.7 | 1 | 0.25 | 0.2 | 30 | 20 | 20 | 20 | 5 |
| | | 3.5 | 0.5 | 3.5 | 2 | 0.5 | 0.4 | 100 | 100 | 40 | 40 | 10 |
| | **High** | >3.5 | 0.5 | 3.5 | 2 | 0.5 | 0.4 | >100 | 100 | 40 | 40 | 10 |
| | **Toxic (>)** | - | - | - | - | - | - | - | - | - | - | - |
| **At First Fruit** | **Deficient** | <2.0 | 0.3 | 2.3 | 1 | 0.25 | 0.2 | <30 | 20 | 20 | 20 | 5 |
| | **Adequate range** | 2 | 0.3 | 2.3 | 1 | 0.25 | 0.2 | 30 | 20 | 20 | 20 | 5 |
| | | 3 | 0.5 | 3.5 | 2 | 0.5 | 0.4 | 100 | 100 | 40 | 40 | 10 |
| | **High** | >3.0 | 0.5 | 3.5 | 2 | 0.5 | 0.4 | >100 | 100 | 40 | 40 | 10 |
| | **Toxic (>)** | - | - | - | - | - | - | - | - | - | - | - |

## Seed Treatment

Check if seed has been treated with an insecticide and fungicide. See Disease Control below.

## Plant Production

Transplants should be grown in plug trays with cells at least 1.5 inches in diameter and 2 inches deep. Smaller pots or cells will restrict root growth and provide less protection to the transplant. Plant 1 seed per cell. Triploid (seedless) watermelon seeds require a special regime to germinate well. The seed coat tends to adhere to the seedling as it emerges, at times slowing growth or reducing stand. Seeds are of lower vigor than standard diploid types.

**Seedless watermelon transplant production can be broken into 6 stages:**
**1) Seeding** Trays should be evenly filled with a general commercial greenhouse growing medium like Pro-Mix BX®, Fafard® #2, or Sunshine® #1 (these all have a starter fertilizer). Do not use fine seed starter or plug mix types. Do not compress the growing media. Trays should be watered to capacity and then allowed to drain excess water for 24 h in a heated area so that the media can warm up to 85°F (29°C). This temperature should be maintained during seeding. Make 1 inch deep planting holes and plant seeds with the "pointed" side up. Cover with a small amount of warm moist medium. Do not water after seeding.

**2) Initial Germination** During germination it is critcal that trays are kept at a uniform temperature of 85-90°F (29-32°C) and at high humidity. It may be necessary to move trays around after 24 h (trays on bottom shelves moved to top shelves and vice versa) to ensure even temperature exposure. During this 48 h phase, the root will emerge but the epicotyl ("crook") that will carry the leaves above the media surface should not be visible. If crooks are visible, trays may have been left in the germination area for too long. In that case, plants may "stretch" during emergence which results in poor transplant quality.

**3) Emergence** After initial germination, move plants immediately to the greenhouse. If another grower germinates your seeds, schedule pickup or delivery without delays. Greenhouses should be set at 72-75°F (22-24°C) during the day and 65°F (18°C) at night. Do not water until after crook emergence. Thereafter, water sparingly as needed to prevent media and emerging seedlings from drying out. Excess water and too high temperatures during the emergence phase will lead to stretch.

**4) Seed Leaf Stage to First True Leaf** Maintain greenhouse temperatures in the 72-75°F range during the day and at 65°F at night. Water moderately. Do not fertilize if you are using a medium with starter fertilizer. Plants should grow slowly for highest quality.

**5) First True Leaf to Second True Leaf** Maintain greenhouse temperatures in the 72-75°F range during the day and at 65°F at night. Once the first true leaf emerges, trays can be fertilized. Generally 2 fertilizations of 100 ppm N, one at first true leaf and one at second true leaf appearance will be sufficient. If a constant feed system is used, set for 50 ppm N for each watering once the first true leaf has emerged. Avoid using fertilizers with large amounts of ammonium as the N source as this can lead to stretch; use fertilizers with calcium nitrate and potassium nitrate instead. Avoid over-watering. These rates are for media that contain starter fertilizer, like the ones listed in the seeding section above. If a medium without starter fertilizer is used, use a different fertilizer program. Using fertilizers with calcium nitrate and potassium nitrate as N sources, apply 50 ppm N every 3 days from emergence to first true leaf, and 200 ppm N every other day from first true leaf to second true leaf.

**6) Hardening Off** It will take 4-6 weeks from sowing to finish transplants. Prior to transplanting into the field, harden off plants for one week. This is accomplished by lowering day temperatures (if greenhouses have side curtains, roll them up during days if temperatures are not too cool). Reduce watering and stop fertilization. If possible, place plants on wagons or move benches outside during the day and bring them in at night, but make sure the area is sheltered from high winds and avoid days where the temperature is below 60°F (16°C).

**Seeded pollenizers and standard seeded watermelon transplant production** do not need special germinating conditions and can be done directly in the greenhouse. Time the production so that plants are produced and hardened off at the same time as the seedless types. Grow plants slowly to avoid stretch. Follow the same recommendations as for seedless watermelons from seed leaf stage through hardening off, *i.e.*, stages 4 to 6 above.

## Planting and Spacing

**<u>Transplants</u>**: Transplant container-grown plants through plastic mulch when daily mean temperatures have reached 60°F (16°C). Planting dates vary from May 1 in southern areas to June 20 in northern areas. Early plantings should be protected from winds with hot caps, tents, row covers, or rye windbreak strips.

**<u>Direct-seeded</u>:** Seed April 20 to May 15 in VA and normally warmer areas, and May 15 to June 10 in PA and normally cooler areas. Seed 3-5 lb/A of seed.

**<u>Recommended Spacing</u>:** 6-8 ft between rows with 3-4 ft between plants in the row.

**<u>Seedless varieties</u>**: see the Pollination and Pollenizers section below for planting recommendations.

## Mulching

Watermelons are usually grown on black plastic mulch with drip irrigation (see also the Irrigation Management chapter). Weeds under the plastic are controlled by labeled herbicides (see Weed Control below) or by fumigation. Fumigation is also used to control soil borne diseases such as *Fusarium*. Fumigation is necessary when there is a history of soil-borne diseases in the field (recommendations can be found in the Soil Fumigation section in the Pest Management chapter).

Plastic and fumigant should be applied on well-prepared planting beds 30 days before field planting. Plastic should be 3-4 ft wide and laid on 6-8 ft centers immediately over the fumigated soil. The soil must be moist when laying the plastic. Infra-Red Transmitting (IRT) plastic has been used in cooler areas for additional soil heating. Fertilizer must be applied during bed preparation. At least 50% of the N should be in the nitrate form. Direct seeding through the mulch is possible for seeded watermelons but is not generally recommended for seedless varieties

## Pollination and Pollenizers

Watermelon fruit set and enlargement is dependent on growth regulators from the pollen grains and from embryos in developing seeds. Inadequate pollination results in triangular-shaped triploid watermelon fruit of inferior quality. Inadequate pollination may increase the incidence of hollowheart. Triploid watermelon flowers do not produce sufficient viable pollen to induce fruit set and development; pollen from a normal or a special diploid pollenizer variety must be present. Field should be **inter-planted** with triploid and pollenizer plants (the pollenizer variety and the seedless variety should **not** be planted in separate but adjacent blocks!). Three methods can be used: 1) Pollenizer plants may be dedicated to every 3$^{rd}$ row, 2) Plant a pollenizer every 3$^{rd}$ or 4$^{th}$ plant in-row with additional spacing for pollenizers, and 3) Plant the pollenizer between every 3$^{rd}$ and 4$^{th}$ plant in-row without changing plant spacing. Co-planted pollinizers are also available and widely used (pollenizer planted in the same cell as seedless in every 3$^{rd}$ or 4$^{th}$ cell). When the latter methods are chosen, the use of a special pollenizer is recommended, as standard diploid varieties planted in-row may decrease yields of closely associated triploid plants. Special pollenizer varieties (see Recommended Varieties table above) have been developed solely for pollen production and most do not produce marketable fruit. The use of special pollenizers planted in-row allows the field to be 100% seedless.

When using pollenizer plants arranged in dedicated rows, it is important to use a marketable pollenizer variety, because up to one-third of the melons produced in the field will be of this variety. The rind pattern and/or shape of the seeded pollenizer fruit should be easily distinguishable from that of the triploid fruit. Most special pollenizers are distinguishable from triploid fruit by size, however, if mini seedless watermelons are planted rind pattern must be used to distinguish pollenizer and seedless fruit. Selection of a pollenizer variety that will be harvested should also take into account the market demand, plant vigor, pollen production, disease resistance, and environmental conditions.

Pollen from the diploid pollenizer variety should be available when the female blossoms on the triploid plants are ready for pollination. The following recommendations pertain only to pollenizers planted in dedicated rows. Special pollenizer plants should be transplanted at the same times as triploid plants. As a general rule, direct field seeding of the pollenizer variety should be done on the same day the triploid seed is planted in the greenhouse. If transplants are used for pollenizers, they can be seeded a few days after triploid transplants are seeded.

Honeybees, squash bees, bumblebees and other wild bees are essential for proper watermelon pollination and fruit set. Honeybee or bumblebee colonies are commonly rented or purchased. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See the section on Pollination in the General Production Recommendations chapter. Bee Toxicity ratings are available in the insecticide tables below.

## Windbreaks

Use windbreaks as necessary. Small grain windbreaks are recommended and may be established between every bed, every 2-3 beds, or in drive row areas (every 6-8 beds). Use windbreaks between every row for the earliest plantings for additional protection. Rye is most commonly used, due to its height and rapid growth. Establish windbreaks in the fall, either as a solid planting, or in windbreak rows. Plant at high density to insure a good stand. In the spring, for solid plantings, till areas where plastic is to be laid before small grain starts to elongate. Windbreaks may be eliminated with herbicides or mowed out after the crop is well established.

## Vine Turning

Move vines in outer rows out of driveways so they are not damaged by vehicle traffic. This reduces disease incidence. Several trips over the field may be necessary.

## Irrigation

Watermelons can be grown under dryland conditions, however highest yields are obtained with irrigation. Irrigation is recommended for seedless watermelons. Schedule irrigation so that soil moisture does not drop below 50% of field capacity. At peak, during fruit set and full vine cover, watermelons will use up to 0.30 inches of water per day.

## Harvest and Post Harvest Considerations

Watermelons are hand harvested into bins, trucks, or buses for shed packing. Use every sixth or eighth row as a drive row for field access. Ripeness is indicated by a creamish to slight yellowing of the white background color of the part of the melon that rests on the ground. Drying of the stem tendril nearest the attachment point of the melon and green color tone of the rind are also indicators of ripeness but these vary with cultivar. Melons should be cut from the vine rather than pulled, twisted, or broken off. Rough handling will result in serious losses. Bulk bins with pallets, if used, can speed handling and minimize melon damage.

Harvested watermelons should be kept at 50-60°F (10-16°C) and a relative humidity of 90% during storage and shipping. Watermelons are not suitable for long storage. At low temperatures, they may develop various chilling injury symptoms and lose quality, and at high temperatures they are susceptible to decay.

Watermelons should be consumed within 2-3 weeks after harvest, primarily because of the gradual loss of crispness. High quality in watermelons is determined largely by high sugar content, deep red fresh color, and a pleasant crisp texture of the edible flesh. These factors are dependent on maturity, cultivar, and handling methods.

Commercial melons for distant markets are usually harvested when mature, but before full ripeness, to minimize handling damage and flesh breakdown. Watermelons are sensitive to high levels of ethylene gas during storage, and should not be stored or shipped with fruit that emit substantial amounts of ethylene.

Watermelons are marketed by weight and bin counts: “Large” is 32-35 melons/bin (more than 18 lb/melon), “medium” is 45 melons/bin (14-18 lb/melon) and “small” is 50-60 melons/bin (≤ 14 lb/melon). The wholesale grower is generally paid by the pound. “Personal” (very small) watermelons are maketed by box counts and weight. The trend in consumer preference has been increased demand for smaller sizes.

## Watermelon Disorders

**Hollow heart** is an internal crack in the flesh of the melon. Hollow heart is generally more severe in seedless varieties and in crown-set fruit. Inadequate pollen has been shown to be one causal factor. Cold weather during fruit set, poor fruit set and low fruit load, excess nutrients (especially N), and factors producing rapid growth have been reported to impact the severity of hollow heart.

**Internal rind necrosis** is indicated by the presence of a corky, red-brown layer of tissue on the inside of the rind of affected fruit without extending into the fruit flesh. The disease occurs sporadically and is thought to be caused by bacteria (*Erwinia*) that are naturally present on fruit. Drought stress has been implicated in this disorder.

**Irregular ripening** can be a problem in some years and varieties. Watermelons are classified as non-climacteric since they do not ripen significantly after harvest. However, research has shown that watermelon fruit produce a burst of ethylene at the white fruit stage and factors that reduce ethylene at this stage will slow ripening. Watermelon fruit development and ripening also depend on the accumulation of sugars. Loss of foliage or stem tissue due to diseases such as gummy stem blight or insect or mite feeding can reduce the amount of sugars available to the fruit. Different varieties, low K nutrition, or variability in vine health will lead to variability in fruit ripening.

**Misshapen fruits** Poor pollination due to low bee activity, may result in "bottlenecks", or constricted growth at the stem end of the fruit, especially in seeded/elongated watermelons. Research has shown that the distribution of a minimum of 1,000 pollen over the three lobes of the flower stigma are required to produce a uniformly shaped fruit. In seedless watermelons, poor pollination may lead to undesirable “triangular” fruit.

**Ozone Injury** Ozone is a common air pollutant. When present in high concentrations, ozone will cause chlorosis and upper surface bronzing and scorching in older leaves, which leads to defoliation. ‘Sugar Baby’ is one of the more sensitive varieties.

**Splitting** during handling occurs in fruit under excessive water pressure as a result of excess irrigation or rainfall.

**Sunscald** occurs when fruit are exposed to direct sunlight, especially on extremely hot days. Under these conditions, rind surfaces can reach temperatures exceeding 140ºF (60°C), killing cells and resulting in sunburn spots. Fruit with little or no foliar cover are at most risk. Sunscald or sunburn first appears as a gray or white area on the exposed upper surface of the fruit. Fruit with dark rinds are more susceptible to sunscald than those with light colored rinds. Sunscald severity is related directly to fertility regime and foliage cover. Proper fertility and soil management promotes adequate vine growth and coverage of fruit. Sunscald severity is also associated with diseases that reduce foliage cover, such as anthracnose, alternaria, gummy stem blight and downy mildew. Recommendations for managing these diseases may be found in the Disease Control section below.

**Water soaking** occurs where excess water accumulates at the bottom of the fruit resulting in a water soaked appearance of internal flesh. Water accumulates during cloudy weather when transpiration from vines is low. Water soaking sometimes appears in fruits where foliage has deteriorated since excess water cannot be transpired.

# Weed Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the “Herbicide Effectiveness on Common Weeds in Vegetables” Table (E-2) in the Pest Management chapter.
2. Minimize herbicide resistance development. Identify the herbicide site mode of action group and follow recommended good management practices. Include non-chemical weed control whenever possible.

**Labeled Applications Sites for Watermelon**

| | | **Plastic mulch production** | | | | | | **Bare-ground production** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil-Applied | | Postemergence | | | | | | |
| **Herbicides** | WSSA group number | Under Plastic | Row Middles | Over Plastic | Row Middles | Post-Harvest | | Soil-applied | POST | Post-harvest |
| Sandea | 2 | YES | YES | | YES | | | YES | | |
| Curbit | 3 | | YES | | | | | YES | | |
| Prowl H2O | 3 | | YES | | | | | | | |
| Treflan | 3 | | YES | | | | | | | |
| Sinbar | 5 | YES | YES | | | | | YES | | |
| Prefar | 8 | YES | YES | | | | | YES | | |
| Command | 13 | | YES | | | | | YES | | |
| Strategy | 3 + 13 | | YES | | | | | YES | | |
| Chateau | 14 | | YES | | | | | | | |
| Reflex | 14 | YES | YES | | YES | | | YES | | |
| Dual | 15 | | YES | | | | | | | |
| Poast | 1 | | | YES | | | | | YES | |
| Select | 1 | | | YES | | | | | YES | |
| SelectMax | 1 | | | YES | | | | | YES | |
| Gramoxone | 22 | | | | YES | YES | | | | YES |

| 1. Soil-Applied | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient (*=Restricted Use)** | **Active Ingredient Rate** | **PHI (d)** | **REI (h)** |
| **2** | Sandea 75DF | 0.5 to 1 oz/A | **halosulfuron** | 0.023 to 0.047 lb/A | 57 | 12 |
| -**Plasticulture**: can be applied in a band under the plastic, immediately before laying the mulch; delay seeding or transplanting for 7 days after application. Plasticulture row middles: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v or include a non-selective herbicide.<br>-**Bareground**: apply broadcast after seeding but before crop emergence or no sooner than 7 days before transplanting.<br>-Maximum rate for application in seeded or transplanted row is 0.75 oz/A and up to 1 oz/A for row middle application.<br>-Limit movement of treated soil into transplant hole during transplanting.<br>-Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.<br>-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field. **Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.<br>-Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season. | | | | | | |
| 3 | Curbit 3EC | 1 to 3 pt/A | **ethalfluralin** | 0.38 to 1.13 lb/A | -- | 24 |
| -**Plasticulture**, row middles only: apply as a banded spray after crop emergence or after transplanting. **Do not** soil incorporate.<br>-**Bareground**: apply broadcast after direct-seeding but prior to crop emergence; **do not** use on transplanted melons.<br>-Controls annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp.<br>-Use lower rate for coarse-textured soils or soils with low organic matter.<br>-Where overhead irrigation is available, activate Curbit with 0.5 inch of irrigation within 2 days after application; if no irrigation or rainfall occurs within 5 days of application, activity of Curbit can be reduced.<br>-Available as a pre-mix herbicide Strategy. Strategy at 3 pt/A= Curbit at 26 fl oz (0.6 lb ai) and Command at 8 fl oz (0.188 lb ai)<br>-Maximum applications per season: not specified | | | | | | |
| 3 | Prowl H2O 3.8CS | 2.1 pt/A | **pendimethalin** | 1 lb/A | 35 | 24 |
| -**Plasticulture**: row middles only: apply as a banded spray before seeded crop has emerged or before transplanting.<br>-**Bareground**: apply with shielded sprayer band between rows, leaving 6 inches of untreated area on both sides of the seeded or transplanted row. Apply before seeded crop emerges or before transplanting.<br>-Where overhead irrigation is available, activate Prowl with 0.5 inch of rainfall or sprinkler irrigation within 48 hr of application; if no irrigation or rainfall occurs within 5 days of application, activity of Prowl can be reduced<br>-A second application at the same rate may be applied to row middles as a banded spray postemergence a minimum of 21 days after the first application, but before the vines begin to run. **Do not** apply over the top of the crop, or severe injury may occur.<br>-Maximum number of Prowl H2O applications per season is 2 and **do not** exceed 4.2 pt/A during the crop season. | | | | | | |
| 3 | Treflan 4EC | 1 to 2 pt/A | **trifluralin** | 0.5 to 1 lb/A | 60 | 12 |
| -**Plasticulture**: row middles only: apply as a directed spray after emergence when plants have reached the 3 to 4 true leaf stage.<br>-**Not labeled for bareground production.** Primarily controls annual grasses with a few broadleaf weeds.<br>-**Do not** use (or reduce the rate) when cold, wet soil conditions are expected, or crop injury may result.<br>-Maximum applications per season: not specified. | | | | | | |
| 3 + 13 | Strategy 2.1SC | 1.5 to 6 pt/A | **ethalfluralin *plus* clomazone** | 0.39 to 1.58 lb/A | 45 | 24 |
| -**Plasticulture**: row middles application. **Bareground**: apply broadcast just before planting or after planting but before crop emergence.<br>-Strategy is a prepackage mixture of Curbit 3EC and Command 3ME. **Do not** apply prior to planting crop. **Do not** soil incorporate.<br>-**Refer to individual products for comments**.Maximum applications per season: not specified. | | | | | | |
| **5** | Sinbar 80WDG | 2 to 4 oz/A | **terbacil** | 0.1 to 0.2 lb/A | 70 | 12 |
| -**Plasticulture**: can be applied in a band under the plastic, immediately before laying the mulch. Sinbar can be broadcast over the plastic before transplanting or before holes are made in the plastic; but must be washed off with a minimum of 0.5 inches for rainfall or irrigation before transplanting. Plasticulture row middles: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged include a non-selective herbicide.<br>-**Bareground**: apply broadcast after seeding but before crop emergence.<br>-**Do not** apply over the top of the crop or allow spray to contact crop foliage, or injury may result.<br>-Controls many annual broadleaf weeds, but may be weak on pigweed species. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter.<br>-Maximum number of Sinbar applications per year is 2 and **do not** exceed 4 oz/A during the crop season | | | | | | |
| 8 | Prefar 4E | 5 to 6 qt/A | **bensulide** | 5 to 6 lb/A | -- | 12 |
| -**Plasticulture**: under plastic: apply in a band under the plastic, immediately before laying the mulch. Plasticulture: row middles application is labeled. **Bareground**: apply preemergence or preplant incorporated. Preemergence applications should be followed by irrigation within 36 hrs (apply enough water to wet the soil at leat 2 to 4 inches deep). Preplant incorporated applications should be incorporated 1 to 2 inches deep (deeper than 2 inches will result in reduced weed control).<br>-Prefar provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters.<br>-Maximum applications per season: not specified. | | | | | | |

*Soil Applied continued on next page*

*Soil Applied - continued.*

| | | | | | | |
|---|---|---|---|---|---|---|
| 13 | Command 3ME | 6,4 to 10.7 fl oz/A | **clomazone** | 0.15 to 0.25 lb/A | -- | 12 |

- **Plasticulture**: row middles application only.
- **Bareground**: apply broadcast just before planting or after planting but before crop emergence.
- Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops.
- Controls annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Carpetweed, morningglory sp., pigweed sp., and yellow nutsedge will not be controlled. Higher rates will improve control (or expand number of species controlled) such as common cocklebur, common ragweed, or jimsonweed (refer to label for specific weeds and rates).
- **WARNING**: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application (refer to label for restrictions).
- Available as a pre-mix herbicide Strategy: Strategy at 3 pt/A= Command at 8 fl oz (0.188 lb ai) and Curbit at 26 fl oz (0.6 lb ai)
- Maximum number of Command applications per year is 1.

| | | | | | | |
|---|---|---|---|---|---|---|
| **14** | Chateau 51WDG | up to 4 oz/A | **flumioxazin** | 0.13 lb/A | -- | 12 |

- **A Special Local-Needs Label 24(c) has been approved for the use of Chateau SW to control weeds in watermelon in DE only. This label is administered through the DE Fruit/Vegetable Association and requires a signed authorization and waiver of liability.**
- Plasticulture: apply to row middles only; with raised plastic-mulched beds that are at least 4 inches higher than the treated row middle and the mulched bed must be a minimum of a 24-inch bed width. Spray must remain between raised beds and contact no more than the bottom 1 inch of the side of the raised bed.
- **Do not** apply after crops are transplanted/seeded.
- **All applications must be made with shielded or hooded equipment**.
- For control of emerged weeds, a non-selective herbicide may be tank-mixed. Tank-mixtures with labeled residual grass herbicides are allowed.
- Maximum use of Chateau during any single application: 4 oz/A.

| | | | | | | |
|---|---|---|---|---|---|---|
| **14** | Reflex 2SL | 10 to 16 fl oz/A | **fomesafen** | 0.16 to 0.25 lb/A | 35 | 24 |

- **A Special Local-Needs Label 24(c) has been approved for the use of Reflex 2SL to control weeds in watermelon in DE, MD and VA. The use of this product is legal ONLY if a waiver of liability has been completed (see *http://www.farmassist.com/*).**
- **Rates vary by state and application method; refer to label to determine correct rates.**
- **Plasticulture**: can be applied in a band under the plastic at 10 to 12 fl oz, immediately before laying the mulch.
- Plasticulture: Reflex at 10 to 12 fl oz can be broadcast over the plastic before transplanting or before holes are made in the plastic; but must be washed off with a minimum of 0.5 inches for rainfall or irrigation before transplanting.
- Plasticulture row middles: before emergence of seeded crop or before transplanting; apply up to 12 fl oz in VA or up to 16 fl oz in DE and MD.
- Plasticulture row middles with shielded/hood sprayers after transplanting; apply 16 to 24 fl oz in DE and MD prior to vines "running" off the plastic. Severe crop injury can occur if spray comes in contact with crop foliage.
- **Bareground direct-seeded**: apply broadcast within 24 hrs after seeding followed by 0.2 to 0.5 inch of overhead irrigation at least 36 hrs before watermelon crack the soil surface
- **Bareground transplants**: apply as broadcast spray followed by irrigaton of 0.2 to 0.5 inches. Then prepare holes and transplant; avoid moving herbicide-treated soil into transplant holes.
- Reflex provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.
- **Watermelon varieties may vary in their response to Reflex**. Treat small acreages first to determine crop tolerance, especially when applying to a new variety.
- Consider rotational crops when applying fomesafen. Rotational restrictions are dependent on whether fomesafen was applied under the plastic, bare ground, or over plastic mulch, refer to 24(c) label for specifics.
- Consider rotational crops when applying fomesafen. If crop is replanted **do not** re-apply Reflex. Rotational restrictions are dependent on whether fomesafen was applied under the plastic, bare ground, or over plastic mulch, refer to 24(c) label for specifics.
- Maximum for Reflex application in DE, MD, and VA: 24 fl oz/A **IN ALTERNATE YEARS**

| | | | | | | |
|---|---|---|---|---|---|---|
| 15 | Dual Magnum 7.62E | 0.67 to 1.27 pt/A | **s-metolachlor** | 0.64 to 1.21 lb/A | 60 | 24 |

- **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds between the rows of plastic mulch in watermelon in DE. The use of this product is legal ONLY if a waiver of liability is completed (see *http://www.farmassist.com/*).**
- **Plasticulture**: row middle application only.
- **Do not** apply Dual Magnum to the plastic mulch, or allow the spray to contact watermelon foliage.
- **Do not** soil incorporate.
- Suppresses or controls annual grasses, yellow nutsedge, and certain annual broadleaf weeds including nightshade species.
- Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter.
- Maximum number of Dual Magnum applications per year is one and **do not** exceed 1.27 pt/A during the crop season.

## 2. Postemergence

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **1** | Select 2EC<br>Select Max 0.97EC | 6 to 8 fl oz/A<br>12 to 16 fl oz/A | **clethodim** | 0.094 to 0.13 lb/A | 14 | 24 |
| | Poast 1.5EC | 1 to 1.5 pt/A | **sethoxydim** | 0.19 to 0.28 lb/A | 14 | 12 |

- Postemergence as broadcast spray with both plasticulture and bareground
- **Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: Apply with COC at 1.0% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate.
- Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but will not consistently control goosegrass. Control may be reduced if grasses are large or under hot or dry weather conditions.
- If repeat applications are necessary, allow 14 days between applications.
- **Do not** tank-mix with or apply within 2 to 3 days of any other pesticide - unless labeled - as this may increase the risk of crop injury or reduce the control of grasses. Rainfastness is 1 hr.
- **Do not** apply more than 8 fl oz of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; **do not** apply more than 16 fl oz of Select Max in a single application and **do not** exceed 64 fl oz/A for the season.
- **Do not** apply more than 1.5 pt/A Poast in single application and **do not** exceed 3 pt/A for the season.

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| **14** | Reflex 2SL | 10 to 16 fl oz/A | **fomesafen** | 0.16 to 0.25 lb/A | 35 | 24 |

- **A Special Local-Needs Label 24(c) has been approved for the use of Reflex 2SL to control weeds in watermelon in DE, MD and VA. The use of this product is legal ONLY if a waiver of liability has been completed (see *http://www.farmassist.com/*).**
- **Rates vary by state and application method; refer to label to determine correct rates.**
- See soil applied section for application prior to planting or transplanting.
- **Plasticulture** row middles: before emergence of seeded crop or before transplanting; apply up to 12 fl oz in VA or up to 16 fl oz in DE and MD. Plasticulture row middles with shielded/hood sprayers after transplanting; apply 16 to 24 fl oz in DE and MD prior to vines "running" off the plastic. Severe crop injury can occur if spray comes in contact with crop foliage.
- Foliar application of Reflex will severely damage or kill watermelon.
- **Watermelon varieties may vary in their response to Reflex**.Treat small acreages first to determine crop tolerance, especially when applying to a new variety.
- Reflex provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. Consider rotational crops when applying fomesafen. Rotational restrictions are dependent on whether fomesafen was applied under the plastic, bare ground, or over plastic mulch, refer to 24(c) label for specifics.
- Consider rotational crops when applying fomesafen. If crop is replanted **do not** re-apply Reflex. Rotational restrictions are dependent on whether fomesafen was applied under the plastic, bare ground, or over plastic mulch, refer to 24(c) label for specifics.
- Maximum for Reflex application in DE, MD, and VA: 24 fl oz/A **IN ALTERNATE YEARS**

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 1.95 pt/A | **paraquat *** | 0.49 lb/A | 14 | 24 |

- **A Supplemental Label has been approved for the use of Gramoxone 2SL for postemergence weed control in DE, MD, NJ, PA, and VA. Row middles** as a shielded application. Apply as a directed spray in a minimum of 20 gal spray mix/A to control emerged weeds between the rows after crop establishment. Include a nonionic surfactant at 0.25% v/v. Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings. Rainfastness is 30 minutes. A maximum of 3 applications per year are allowed.

## 3. Postharvest

| Group | Product Name | Product Rate | Active Ingredient (*=Restricted Use) | Active Ingredient Rate | PHI (d) | REI (h) |
|---|---|---|---|---|---|---|
| 22 | Gramoxone SL 2.0 | 2.25 to 3 pt/A | **paraquat*** | 0.56 to 0.75 lb/A | -- | 24 |

- **For postharvest desiccation of vegetable vines. A Special Local-Needs 24(c) label has been approved for the use of Gramoxone SL 2.0 for postharvest desiccation of the crop in DE, NJ and VA.**
- Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.
- Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.
- Rainfastness 30 minutes. A maximum of 2 applications for crop dessication are allowed.

## 4. Other Labeled Herbicides

These products are labeled but limited local data is available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

| Group | Product Name | Active Ingredient (*=Restricted Use) |
|---|---|---|
| **2** | League | **imazosulfuron** |
| 3 | Dacthal | **DCPA** |
| **9** | Roundup (various) | **glyphosate** |
| **14** | Aim | **carfentrazone** |

# Insect Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Insecticides

### Seed Corn Maggots - See also the Pest Management chapter (Insect Management section).

Maggot problems can occur in the field and in transplant bedding trays in the greenhouse. An application of a soil-incorporated insecticide may be needed immediately before planting. The use of neonicotinoid insecticides (Group 4A) at planting may help to reduce seed corn maggot populations.

### Aphids **Note: Cultivars that are resistant to multiple aphid-transmitted viruses are available.**

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV (melon aphid only) | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Vydate 2L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 1B | Dimethoate 400 | 0.5 to 1.0 pt/A | dimethoate* | 3 | 48 | H |
| 3A+4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 4A | Admire Pro 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid - **soil only** | 21 | 12 | H |
| 4A | Assail 30SG | 2.5 to 4.0 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil/drip** | 30 | 12 | H |
| 4A | Actara 25WDG | 1.5 to 3.0 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A +28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A +28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 4D | Sivanto 200SL | 21.0 to 28.0fl oz/A | flupyradifurone | 21 | 4 | M |
| 9B | Fulfill 50WP | 2.75 oz/A | pymetrozine | 0 | 12 | L |
| 9C | Beleaf 50SG | 2.0 to 2.8 oz/A | flonicamid | 0 | 12 | L |
| 28 + 6 | Minecto Pro | 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

### Beet Armyworms

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6 .0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 5 | Entrust 2SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 3.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole - **soil/drip/foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

### Cabbage Loopers

| **Apply one of the following formulations:** | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A | Baythroid XL 1EC | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |

*Cabbage Loopers continued on next page.*

*Cabbage Loopers continued*

| | | | | | | |
|---|---|---|---|---|---|---|
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Danitol 2.4EC | 10.67 to 16.00 fl oz/A | fenpropathrin* | 7 | 24 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 11A | Dipel | 0.5 to 2.0 lb/A | *Bacillus thuringiensis kurstaki* | 0 | 4 | N |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 2.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC | 3.5 to 5.0 fl oz/A | chlorantraniliprole - **soil/drip/foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Cucumber Beetles

Watermelons are resistant to bacterial wilt; however, control may be needed to prevent feeding damage to seedlings. Seeds pretreated with a neonicotinoid seed treatment such Farmore DI-400 should provide up to 21 days of control of cucumber beetle..Otherwise, treat when an average of 2 beetles per plant is found.

| Group | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Sevin XLR Plus | 1.0 qt/A | carbaryl | 3 | 12 | H |
| 3A | Baythroid XL | 2.4 to 2.8 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Danitol 2.4EC | 10.67 to 16.0 fl oz/A | fenpropathrin* | 7 | 24 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | LambdaT | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone | 2.4 to 2.8 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zetacypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Admire PRO | 7.0 to 10.5 fl oz/A | imidacloprid - **soil** | 21 | 12 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 0 | 12 | M |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 3.0 to 4.0 fl oz/A | clothianidin - **foliar** | 7 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam - **soil** | 30 | 12 | H |
| 4A | Actara 25WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran - **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole - **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |

## Cutworms - See also the Pest Management chapter, Insect Management section.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV (variegated cutworm) | 1.5 pt/A | methomyl* | 3 | 48 | H |
| 1A | Lannate LV (granulate cutworm) | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 3A | Baythroid XL | 0.8 to 1.6 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 1.28 to 4.00 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone | 0.8 to 1.6 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin*+chlorantraniliprole | 1 | 24 | H |

## Leafminers

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate 2L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 1B | Dimethoate 400 | 1.0 pt/A | dimethoate* | 3 | 48 | H |
| 3A + 4A | Endigo ZC | 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin - **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/A | thiamethoxam- **soil/drip** | 30 | 12 | H |
| 4A | Actara 25 WDG | 3.0 to 5.5 oz/A | thiamethoxam - **foliar** | 0 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran- **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A | Venom 70S G | 5.0 to 6.0 oz/A | dinotefuran- **soil** | 21 | 12 | H |
| 4A | Venom 70S G | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 1 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole- **soil** | 30 | 12 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 6.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 6.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 17 | Trigard 75WSP | 2.66 oz/A | cyromazine | 0 | 12 | L |
| 28 | Coragen 1.67SC | 5.0 to 7.5 fl oz/A | chlorantraniliprole- **soil/drip** | 1 | 4 | L |
| 28 | Coragen 1.67SC | 5.0 to 7.0 fl oz/A | chlorantraniliprole - **foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

**Mites** Mite infestations generally begin around field margins and grassy areas. **DO NOT mow or maintain these areas after midsummer** since this forces mites into the crop. Localized infestations can be spot treated. Begin treatment when 10-15 % of the crown leaves are infested early in the season, or when 50% of the terminal leaves are infested later in the season. Note: Continuous use of Sevin, or the pyrethroids may result in mite outbreaks.

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A + 6 | Gladiator | 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 6 | Agri-Mek 0.7 SC | 1.75 to 3.5 fl oz/A | abamectin* | 7 | 12 | H |
| 10B | Zeal Miticide1 | 2.0 to 3.0 oz/A | etoxazole | 7 | 12 | L |
| 20D | Acramite 50WS | 0.75 to 1.00 lb/A | bifenazate | 3 | 12 | M |
| 21A | Portal | 2.0 pt/A | fenpyroximate | 3 | 12 | L |
| 23 | Oberon 2SC | 7.0 to 8.5 fl oz/A | spiromesifen | 7 | 12 | M |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Melonworms, Pickleworms

| If foliar materials are used, make one treatment prior to fruit set, and then treat weekly. If soil or drip applications are used, check the label for instructions on treatment frequency. | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Lannate LV | 1.5 to 3.0 pt/A | methomyl* | 3 | 48 | H |
| 1A | Sevin XLR | 0.5 to 1.0 qt/A | carbaryl | 3 | 12 | H |
| 3A | Baythroid XL 1EC | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL (pickleworm) | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2 EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Assail 30SG | 2.5 to 5.3 oz/A | acetamiprid | 0 | 12 | M |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam+chlorantraniliprole- **soil** | 30 | 12 | H |
| 4A + 28 | Voliam flexi | 4.0 to 7.0 oz/A | thiamethoxam+chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |
| 22A | Avaunt 30WDG | 2.5 to 6.0 oz/A | indoxacarb | 3 | 12 | H |
| 28 | Coragen 1.67SC (melonworm) | 2.0 to 3.5 fl oz/A | chlorantraniliprole - **drip/foliar** | 1 | 4 | L |
| 28 | Coragen 1.67SC (pickleworm) | 3.5 to 7.5 fl oz/A | chlorantraniliprole - **foliar** | 1 | 4 | L |
| 28 + 6 | Minecto Pro | 5.5 to 10.0 fl oz/A | cyantraniliprole + abamectin* | 7 | 12 | H |

## Rindworms

Damage to the rinds may result from a complex of insect pests including cucumber beetle, wireworms, and a number of "worm" species, (beet armyworm, etc). Management of adult cucumber beetles early in the season may help reduce damage. See cucumber beetle section for labeled products.

| For Lepidopteran rindworms, use one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 3A | Baythroid XL 1EC | 1.6 to 2.4 fl oz/A | beta-cyfluthrin* | 0 | 12 | H |
| 3A | Asana XL | 5.8 to 9.6 fl oz/A | esfenvalerate* | 3 | 12 | H |
| 3A | Bifenture 2EC, Sniper | 2.6 to 6.4 fl oz/A | bifenthrin* | 3 | 12 | H |
| 3A | Hero EC | 4.0 to 10.3 fl oz/A | zeta-cypermethrin* + bifenthrin* | 3 | 12 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Mustang Maxx | 2.8 to 4.0 fl oz/A | zeta-cypermethrin* | 1 | 12 | H |
| 3A | Perm-Up 3.2EC | 4.0 to 8.0 fl oz/A | permethrin* | 0 | 12 | H |
| 3A | Tombstone 2EC | 1.6 to 2.4 fl oz/A | cyfluthrin* | 0 | 12 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 6 | Gladiator | 14.0 to 19.0 fl oz/A | zeta-cypermethrin* + avermectin B1 | 7 | 12 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A + 28 | Voliam Flexi | 4.0 to 7.0 oz/A | thiamethoxam + chlorantraniliprole - **foliar** | 1 | 12 | H |
| 5 | Entrust 2SC | 4.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 5.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |
| 18 | Intrepid 2F | 4.0 to 10.0 fl oz/A | methoxyfenozide | 3 | 4 | L |

## Thrips

| Apply one of the following formulations: | | | | | | |
|---|---|---|---|---|---|---|
| **Group** | **Product Name** | **Product Rate** | **Active Ingredient(s) (*=Restricted Use)** | **PHI (d)** | **REI (h)** | **Bee TR** |
| 1A | Vydate2 L | 2.0 to 4.0 pt/A | oxamyl* | 1 | 48 | H |
| 3A | Lambda-Cy, LambdaT | 2.56 to 3.84 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A | Warrior II | 1.28 to 1.92 fl oz/A | lambda-cyhalothrin* | 1 | 24 | H |
| 3A + 4A | Endigo ZC | 4.0 to 4.5 fl oz/A | lambda-cyhalothrin* + thiamethoxam | 1 | 24 | H |
| 3A + 28 | Voliam Xpress | 6.0 to 9.0 fl oz/A | lambda-cyhalothrin* + chlorantraniliprole | 1 | 24 | H |
| 4A | Admire PRO 4.6SC | 7.0 to 10.5 fl oz/A | imidacloprid- **soil** | 21 | 12 | H |
| 4A | Belay 2.13SC | 9.0 to 12.0 fl oz/A | clothianidin- **soil** | 21 | 12 | H |
| 4A | Platinum 75SG | 1.66 to 3.67 oz/ | thiamethoxam- **soil/drip** | 30 | 12 | H |
| 4A | Scorpion 35SL | 9.0 to 10.5 fl oz/A | dinotefuran- **soil** | 21 | 12 | H |
| 4A | Scorpion 35SL | 2.0 to 7.0 fl oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A | Venom 70SG | 5.0 to 6.0 oz/A | dinotefuran- **soil** | 21 | 12 | H |
| 4A | Venom 70SG | 1.0 to 4.0 oz/A | dinotefuran - **foliar** | 7 | 12 | H |
| 4A + 28 | Durivo | 10.0 to 13.0 fl oz/A | thiamethoxam + chlorantraniliprole- **soil** | 30 | 12 | H |
| 5 | Entrust 2SC (OMRI) | 6.0 to 8.0 fl oz/A | spinosad | 3 | 4 | M |
| 5 | Radiant 1SC | 6.0 to 10.0 fl oz/A | spinetoram | 3 | 4 | H |

# Disease Control

## THE LABEL IS THE LAW - See the Pesticide Use Disclaimer on page F 1.

## Recommended Fungicides

**Nematodes -** See also the Nematodes and Soil Fumigation sections in the Pest Management chapter.
Use fumigants listed under Soil Fumigation in the Pest Management chapter, or apply one of the following:

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| 1A | Vydate L | 0.5 to 1.0 gal/A Incorporate into top 2-4 inches of soil, *OR* .2.0 to 4.0 pt/A apply 2 w after planting and repeat 2-3 w later. | oxamyl* | 1 | 48 | H |
| 7 | Velum Prime | 6.5 to 6.84 fl oz/A | fluopyram | 0 | 12 | -- |
| -- | Nimitz 4EC | 3.5 to 5.0 pt/A Incorporate or drip-apply 7 d before planting. | fluensulfone | n/a | 12 | N |

## Seed Treatment

Check with your seed company if seed has been treated with an insecticide and fungicide. For untreated seed, use a mixture of thiram (4.5 fl oz 480DP/100 lb) and an approved commercially available insecticide.

## Damping-off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following at-planting (see label for application timing, methods, and restrictions):** | | | | | | |
| **Phytophthora and Pythium root rot:** | | | | | | |
| **4** | Ridomil Gold 4SL | 0.5 to 1.0 pt/A | mefenoxam | AP | 48 | N |
| **4** | Ultra Flourish 2E | 2.0 to 4.0 pt/A | mefenoxam | AP | 48 | N |
| **4** | MetaStar 2EAG | 4.0 to 8.0 pt/A | metalaxyl | AP | 48 | N |
| **Phytophthora, Pythium, and Rhizoctonia root rot:** | | | | | | |
| **4** + 11 | Uniform 3.66SE | 0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence. | mefenoxam + azoxystrobin | AP | 0 | N |
| **Rhizoctonia root rot only:** | | | | | | |
| 11 | azoxystrobin 2.08F | 0.40 to 0.80 fl oz/1000 ft row | azoxystrobin | AP | 4 | N |
| **Pythium root rot only:** | | | | | | |
| 28 | Previcur Flex 6F | 1.2 pt/A in transplant water, drip irrigation, or direct spray at base of plant and soil | Propamocarb HCL | 2 | 12 | N |

## Bacterial and Fungal Diseases

### Alternaria Leaf Blight

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Begin sprays when vines begin to run. ALTERNATE one of the following:** | | | | | | |
| M3 | mancozeb 75DF | 2.0 to 3.0 lb/A | mancozeb | 5 | 12,24 | N |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A[1] | chlorothalonil | 0 | 12 | L |
| **WITH A TANK MIX of one of the following fungicides PLUS chlorothalonil 6F 2.0 to 3.0 pt/A every 14 days** | | | | | | |
| 3 + 9 | Inspire Super 2.8F | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodonil | 0 | 12 | -- |
| 3 + **11** | TopGuard EQ[2] | 5.0 to 8.0 fl oz/A | azoxystrobin + flutriafol | 1 | 12 | -- |
| 3 + **11** | Quadris Top 2.7F[2] | 12.0 to 14.0 fl oz/A | difenoconazole + azoxystrobin | 0 | 12 | -- |
| 7 + 3 | Aprovia Top | 10.5 to 13.5 fl oz/A | benzovindiflupyr + difenoconazole | 0 | 12 | N |
| 7 + **11** | Luna Sensation 4.25SC[2] | 7.6 fl oz/A | fluopyram + trifloxystrobin | 0 | 12 | -- |
| 7 + **11** | Pristine 38W[2] | 12.5 to 18.5 oz/A (no tank mix) | pyraclostrobin + boscalid | 0 | 12 | -- |
| 7 + **11** | Merivon[2] | 4 to 5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 0 | 12 | N |
| **11** | azoxystrobin 2.08F[2] | 11.0 to 15.5 fl oz/A[3] | azoxystrobin | 0 | 4 | N |
| **11** | Cabrio 20EG[2] | 12.0 to 16.0 oz/A | pyraclostrobin | 0 | 12 | N |
| **11** | Reason 500SC[2] | 5.5 fl oz/A | fenamidone | 14 | 12 | -- |

[1]Low rate early in the season. [2]**Do not** use if resistance to FRAC code 11 fungicides exists in the area. [3]**Do not apply near apples**, see label.

**Angular Leaf Spot** At first sign of disease, apply the labeled rates of fixed copper plus mancozeb. Repeat every 7 d. To minimize the spread of disease, avoid working in field while foliage is wet.

**Anthracnose** Excellent resistance is available in some varieties and those should be used when possible. Begin fungicide applications when vines run or earlier if symptoms are detected. **If resistance to FRAC code 11 (strobilurin) fungicides has been detected in the area, do not use Quadris, Quadris Top, Tanos or Cabrio.**

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Under LIGHT or MODERATE disease pressure, ALTERNATE:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A (low rate early in the season) | chlorothalonil | 0 | 12 | L |
| **WITH a TANK MIX the following fungicide PLUS mancozeb 80 DF 2.0 to 3.0 lb/A OR chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| 1 | thiophanate-methyl 70WP | 0.5 lb/A | thiophanate-methyl | 1 | 12 | N |
| **Under HIGH disease pressure, TANK-MIX one of the following fungicides WITH chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| 3 + **11** | Quadris Top 2.7F | 12.0 to 14.0 fl oz/A | difenoconazole + azoxystrobin | 0 | 12 | -- |
| 3 + **11** | TopGuard EQ | 10.0 to 14.0 fl oz/A | Azoxystrobin + flutriafol | 1 | 12 | -- |
| 7 + **11** | Merivon | 5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 0 | 12 | N |
| 7 + **11** | Pristine 38WG | 18.5 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |
| **11** | azoxystrobin 2.08F | 11.0 to 15.5 fl oz/A | azoxystrobin | 0 | 4 | N |
| **11** | Cabrio 20EG | 12.0 to 16.0 fl oz/A | pyraclostrobin | 0 | 12 | N |
| **AND ROTATE with a TANK MIX of the following fungicde PLUS mancozeb 75DF 2.0 to 3.0 lb/A OR chlorothalonil 6F 2.0 to 3.0 pt/A every 7 days:** | | | | | | |
| 1 | thiophanate-methyl 70WP | 0.5 lb/A | thiophanate-methyl | 1 | 12 | N |

### Bacterial Fruit Blotch (BFB)

Obtain seed or seedlings that were tested and found to have “no evidence” of the pathogen, which will reduce the risk of BFB development. Practice good sanitation during transplant production. Segregate different seed lots in the transplant house to reduce the chance of cross contamination. Scout seedlings daily, have suspect plants tested and destroy all diseased plants. Use only transplants from houses in which there were no seedling symptoms of BFB. If BFB is detected after transplanting, always work infested fields at the end of the day. Rotate to allow 2 yrs between watermelon plantings and control volunteers during those years.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following fungicide schedules beginning before the first flower is open and continuing until 3 weeks after flowering. Subsequent fruit sets must also be protected.** | | | | | | |
| M1 | copper, fixed | At labeled rates | copper, fixed | 0 | see label | N |
| P1 | Actigard 50WG (must apply 1 or 2 weeks prior to flowering to be effective) | 0.5 to 1.0 oz/A | acibenzolar-S-methyl | 0 | 12 | N |

## Downy Mildew

Scout fields for disease incidence regularly. Begin targeted sprays when disease occurrence is predicted for the region (check the Cucurbit Downy Mildew Forecasting website at *http://cdm.ipmpipe.org*). **Preventative applications are much more effective than applications made after detection. Materials with different Modes of Action (FRAC codes) should be alternated.** The following are the most effective products.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Sprays should be applied on a 7-day schedule when disease is forecast or present in the region. Under severe disease conditions and conducive weather, spray interval may be reduced IF the label allows. TANK-MIX one of these products WITH a protectant fungicide such as chlorothalonil 1.5 to 2.0 pt 6F/A:** | | | | | | |
| U15+40 | Orondis Ultra | 5.5 to 8 fl oz/A | oxathiapiprolin + mandipropamid | 0 | 4 | -- |
| 21 | Ranman 400SC (**Do not** apply with copper; see label for details) | 2.10 to 2.75 fl oz/A | cyazofamid | 0 | 12 | L |
| **Other materials for use in rotation as tank mix partners with a protectant:** | | | | | | |
| 43 | Presidio 4SC | 4.0 fl oz/A | fluopicolide | 2 | 12 | L |
| **28** | Previcur Flex 6F | 1.2 pt/A | propamocarb | 2 | 12 | N |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | acetoctradin + dimethomorph | 0 | 12 | -- |
| M3 + 22 | Gavel 75DF contains protectant | 1.5 to 2.0 lb/A | mancozeb + zoxamide | 5 | 48 | -- |
| M5 + 22 | Zing! 4.9SC contains protectant | 36.0 fl oz/A | chlorothalonil + zoxamide | 0 | 12 | N |
| M5 + 27 | Ariston 42SC contains protectant | 3.0 pt/A | chlorothalonil + cymoxanil | 3 | 12 | -- |
| 11 + 27 | Tanos 50DF | 8.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 27 | Curzate 60DF | 3.2 oz/A | cymoxanil | 3 | 12 | N |
| 40 | Forum 4.17SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |

## Fusarium Wilt

Use a rotation of at least 5 years and resistant varieties when possible. Several newly released *seedless* varieties have resistance to Fusarium wilt caused by race 1. However, their level of resistance is lower than that of resistant *seeded* varieties and race 2 also occurs in our region. Some *pollinizers* have good resistance to Fusarium wilt caused by race 1.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Application of Proline through drip irrigation or as a post-plant drench, may reduce Fusarium wilt early season:** | | | | | | |
| 3 | Proline 480 SC | 5.7 fl oz /A | prothioconazole | 7 | 12 | -- |

## Gummy Stem Blight

Fungicide solo products within the FRAC code 11 (Cabrio, Quadris and Flint) are not recommended in the mid-Atlantic region. Pristine or Luna Sensation, which contain both FRAC code 11 and 7 components should always be tank-mixed with a protectant fungicide to reduce the chances for resistance development (see Table E-8 in the Pest Management chapter. **When tank-mixing use at least the minimum labeled rate of each fungicide. Do not apply FRAC code 11 fungicides more than 4 times total per season.**

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Begin sprays when vines begin to run. Apply the following under LOW disease pressure:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A every 7 days | chlorothalonil | 0 | 12 | L |
| **Under HIGH disease pressure, ALTERNATE:** | | | | | | |
| M5 | chlorothalonil 6F | 2.0 to 3.0 pt/A | chlorothalonil | 0 | 12 | L |
| **WITH a TANK-MIX containing chlorothalonil or mancozeb PLUS one of the following fungicides:** | | | | | | |
| 3 | Proline 480SC | 5.7 fl oz/A | prothioconazole | 7 | 12 | -- |
| 3 | tebuconazole 3.6F[1] | 8.0 fl oz/A[1] | tebuconazole | 7 | 12 | N |
| 3 + 7 | Luna Experience 3.34SC | 10.0 to 17.0 fl oz/A | fluopyram + tebuconazole | 7 | 12 | -- |
| 3 + 9 | Inspire Super 2.8F | 16.0 to 20.0 fl oz/A | difenoconazole + cyprodonil | 0 | 12 | -- |
| 3 + **11** | Aprovia Top 1.62EC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflupyr | 0 | 12 | N |
| 7 | Fontelis 1.67SC | 12.0 to 16.0 fl oz/A | penthiopyrad | 1 | 12 | L |
| 7 + **11** | Merivon 500SC | 5.5 fl oz/A | fluxapyroxad + pyraclostrobin | 7 | 12 | N |
| 7 + **11** | Pristine 38WG | 12.5 to 18.5 oz/A | pyraclostrobin + boscalid | 0 | 12 | -- |
| 9 + 12 | Switch 62.5WG | 11.0 to 14.0 oz/A | cyprodonil + fludioxonil | 1 | 12 | N |

[1]Note: reduced sensitivity of the pathogen to tebuconazole 3.6 F has occurred in the Southern U.S.

## Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Grow muskmelons on raised beds and drain fields adequately so that water will not accumulate around the base of the plants. Rotate away from susceptible crops (cucurbits, peppers, lima beans and beans, eggplants and tomatoes) for as long as possible. Apply preplant fumigants to suppress disease. Watermelon should be grown on raised beds and fields should be adequately drained to ensure water does not accumulate around the base of the plants. When the vines begin to run, subsoil between rows to allow for faster drainage following rainfall.

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **Apply one of the following fungicides and tank mix with fixed copper at labeled rates when conditions favor disease development (for suppression only). Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development:** | | | | | | |
| U15+40 | Orondis Ultra | 5.5 tp 8.0 fl oz/A | oxathiapiprolin + mandipropamid | 0 | 4 | -- |
| 40 | Revus 2.08F | 8.0 fl oz/A | mandipropamid | 0 | 4 | -- |
| 40 + 45 | Zampro 525SC | 14.0 fl oz/A | acetoctradin + dimethomorph | 0 | 12 | -- |
| 43 | Presidio 4SC[1] | 4.0 fl oz/A | fluopicolide | 2 | 12 | L |
| M3 + 22 | Gavel 75DF | 1.5 to 2.0 lb/A | macozeb + zoxamide (**note**: some cultivars are sensitive to mancozeb) | 5 | 48 | -- |
| 11 + 27 | Tanos 50DF | 8.0 to 10.0 oz/A | famoxadone + cymoxanil | 3 | 12 | -- |
| 21 | Ranman 400SC | 2.75 fl oz/A (**Do not** apply with copper, see label for additional precautions) | cyazofamid | 0 | 12 | L |
| 40 | Forum 4.17SC | 6.0 fl oz/A | dimethomorph | 0 | 12 | N |

[1]Presidio may also be applied through the drip irrigation (see supplemental label). Soil drench followed by drip application has given good results in some trials on crown rot caused by *Phytophthora capsici*.

## Powdery mildew

Detection of powdery mildew is more difficult in watermelons than in other cucurbits because sporulation is sparse and masked by leaf color. Look for chlorotic spots on the upper surface of young, fully expanded leaves, and then inspect the corresponding lower surface with a hand lens to confirm presence of the fungus.

The fungus that causes cucurbit powdery mildew can develop resistance to high risk fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern U.S. Proper fungicide resistance management should be followed. **Materials with different modes of action (FRAC codes) should always be alternated.**

Powdery mildew generally occurs from mid-July until the end of the season. Observe fields for its presence. mildew. If 1 lesion is found on the underside of 45 old leaves per acre, begin the following fungicide program:

| Code | Product Name | Product Rate | Active Ingredient(s) (*=Restricted Use) | PHI (d) | REI (h) | Bee TR |
|---|---|---|---|---|---|---|
| **TANK MIX one of these products with a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| U6 | Torino 0.85SC | 3.4 fl oz/A | cyflufenamid | 0 | 4 | -- |
| U8 | Vivando 2.5SC | 15.4 fl oz/A | metrafenone | 0 | 12 | -- |
| 13 | Quintec 2.08SC | 6.0 fl oz/A | quinoxyfen | 3 | 12 | -- |
| 3 + 7 | Luna Experience 3.34SC | 10.0 to 17.0 fl oz/A | fluopyram + tebuconazole | 7 | 12 | -- |
| 7 + **11** | Luna Sensation 4.25SC | 7.6 fl oz/A | fluopyram + trifloxystrobin | 0 | 12 | -- |
| **AND ALTERNATE with a TANK MIX of one of the following and a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:** | | | | | | |
| 3 | Proline 480SC | 5.7 fl oz/A | prothioconazole | 7 | 12 | -- |
| 3 | Procure 480SC | 4.0 to 8.0 fl oz/A | triflumizole | 0 | 12 | N |
| 3 | Rally 40WSP | 5.0 oz/A | myclobutanil | 0 | 24 | N |
| 3 | tebuconazole 3.6F | 4.0 to 6.0 fl oz/A | tebuconazole | 7 | 12 | N |
| 7 | Fontelis 1.67 SC | 12.0 to 16.0 fl oz/A | penthiopyrad | 1 | 12 | L |
| 3 + **11** | Aprovia Top 1.62EC | 10.5 to 13.5 fl oz/A | difenoconazole + benzovindiflupyr | 0 | 12 | N |

## Viruses (WMV2, PRSV, ZYMV, and CMV)

The most prevalent virus in the mid-Atlantic region is WMV2 followed by PRSV, ZYMV, and CMV. Plant fields as far away from existing cucurbit plantings as possible to help reduce the chances of aphid transmission of viruses from existing fields to new fields.

# G. Resources and Records

## 1. Resources

## 1.1 Vegetable Seed Sizes

**Table G-1. Vegetable Seed Sizes**

Use this table to estimate your seed requirements. Varieties and seed lots can differ in seed size.
Check with your seed supplier and the label on the container for more precise information.

| Crop | Seeds/Unit Weight | | Crop | Seeds/Unit Weight |
|---|---|---|---|---|
| **Asparagus** | 13,000-20,000/lb | | **Mustard** | 15,000-17,000/oz |
| **Beans: baby lima** | 1,150-1,450/lb | | **Okra** | 450-550/oz |
| **Beans: fordhook** | 440-550/lb | | **Onions: bulb** | 105,000-144,000/lb |
| **Beans: snap** | 1,600-2,200/lb | | **Onions: bunching** | 180,000-200,000/lb |
| **Beets** | 24,000-26,000/lb | | **Parsnips** | 7,500-12,000/oz |
| **Broccoli** | 8,500-9,000/oz | | **Parsley** | 240,000-288,000/lb |
| **Brussels sprouts** | 8,500-9,000/oz | | **Peas** | 1,440-2,580/lb |
| **Cabbage** | 8,500-9,000/oz | | **Peppers** | 4,000-4,700/oz |
| **Carrots** | 300,000-400,000/lb | | **Pumpkins** | 1,900-3,200/lb |
| **Cauliflower** | 8,900-10,000/oz | | **Radishes** | 40,000-50,000/lb |
| **Celery** | 60,000-72,000/oz | | **Rutabaga** | 150,000-192,000/lb |
| **Collards** | 7,500-8,500/oz | | **Spinach** | 25,000-50,000/lb |
| **Cucumbers** | 15,000-16,000/lb | | **Squash: summer** | 3,500-4,800/lb |
| **Eggplants** | 6,000-6,500/oz | | **Squash: winter** | 1,600-4,000/lb |
| **Endive, Escarole** | 22,000-26,000/oz | | **Sweet corn: normal, sugary enhanced** | 1,800-2,500/lb |
| **Kale** | 7,500-8,900/oz | | **Sweet corn: Super sweet (Sh)** | 3,000-5,000/lb |
| **Leeks** | 170,000-180,000/lb | | **Tomatoes: fresh** | 10,000-11,400/oz |
| **Lettuce: head** | 20,000-25,000/oz | | **Tomatoes: processing** | 160,000-190,000/lb |
| **Lettuce: leaf** | 25,000-31,000/oz | | **Watermelons: small seed** | 8,000-10,400/lb |
| **Muskmelons** | 16,000-19,000/lb | | **Watermelons: large seed** | 3,200-4,800/lb |

## 1.2 Plant Spacings and Populations

**Table G-2: Plant Spacings and Populations**

This table lists population size of plants per acre at several between-row and in-row spacings.

| Between-Row Spacing (inch) ↓ | In-Row Spacing (inch) → | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2** | **4** | **6** | **8** | **10** | **12** | **14** | **16** | **18** | **24** | **30** | **36** | **48** |
| **7** | 448,046 | 224,023 | 149,349 | 112,011 | 89,609 | 74,674 | 64,006 | | | | | | |
| **12** | 261,360 | 130,680 | 87,120 | 65,340 | 52,272 | 43,560 | 37,337 | 32,670 | 29,040 | 21,780 | 17,424 | 14,520 | 10,890 |
| **18** | 174,240 | 87,120 | 58,080 | 43,560 | 34,848 | 29,040 | 24,891 | 21,780 | 19,360 | 14,520 | 11,616 | 9,680 | 7,260 |
| **21** | 149,349 | 74,674 | 49,783 | 37,337 | 29,870 | 24,891 | 21,336 | 18,669 | 16,594 | 12,446 | 9,957 | 8,297 | 6,223 |
| **24** | 130,680 | 65,340 | 43,560 | 32,670 | 26,136 | 21,780 | 18,669 | 16,335 | 14,520 | 10,890 | 8,712 | 7,260 | 5,445 |
| **30** | 104,544 | 52,272 | 34,848 | 26,136 | 20,909 | 17,424 | 14,935 | 13,068 | 11,616 | 8,712 | 6,970 | 5,808 | 4,356 |
| **36 (3 ft)** | 87,120 | 43,560 | 29,040 | 21,780 | 17,424 | 14,520 | 12,446 | 10,890 | 9,680 | 7,260 | 5,808 | 4,840 | 3,630 |
| **42 (3½ ft)** | 74,674 | 37,337 | 24,891 | 18,669 | 14,934 | 12,446 | 10,668 | 9,334 | 8,297 | 6,223 | 4,978 | 4,149 | 3,111 |
| **48 (4 ft)** | 65,340 | 32,670 | 21,780 | 16,335 | 13,068 | 10,890 | 9,334 | 8,167 | 7,260 | 5,445 | 4,356 | 3,630 | 2,722 |
| **60 (5 ft)** | | | 17,424 | 13,068 | 10,454 | 8,712 | 7,467 | 6,534 | 5,808 | 4,356 | 3,485 | 2,904 | 2,178 |
| **72 (6 ft)** | | | 14,520 | 10,890 | 8,712 | 7,260 | 6,223 | 5,445 | 4,840 | 3,630 | 2,904 | 2,420 | 1,815 |
| **84 (7 ft)** | | | 12,446 | 9,334 | 7,467 | 6,223 | 5,334 | 4,667 | 4,149 | 3,111 | 2,489 | 2,074 | 1,556 |
| **96 (8 ft)** | | | 10,890 | 8,167 | 6,534 | 5,445 | 4,667 | 4,084 | 3,630 | 2,722 | 2,178 | 1,815 | 1,361 |

## 1.3 Frequently Used Weights and Measures

**Table G-3: Frequently Used Weights and Measures**

Frequently Used Weights and Measures and Approximate Metric Equivalents

| Liquid | | | | Dry | | | |
|---|---|---|---|---|---|---|---|
| **Pint** | **Liters** | **Gallons** | **Liters** | **Ounces** | **Grams** | **Pounds** | **Kilograms** |
| 0.5 | 0.24 | 1 | 3.8 | 0.25 | 7.1 | 1 | 0.45 |
| 1.0 | 0.47 | 2 | 7.6 | 0.50 | 14.2 | 2 | 0.91 |
| 1.5 | 0.71 | 3 | 11.4 | 0.75 | 21.3 | 3 | 1.36 |
| 2.0 | 0.95 | 4 | 15.1 | 1.0 | 28.4 | 4 | 1.81 |
| 2.5 | 1.18 | 5 | 18.9 | 2.0 | 56.7 | 5 | 2.27 |
| 3.0 | 1.42 | 6 | 22.7 | 3.0 | 85.0 | 6 | 2.72 |
| 3.5 | 1.65 | 7 | 26.5 | 4.0 | 113.4 | 7 | 3.18 |
| 4.0 | 1.90 | 8 | 30.3 | 5.0 | 141.7 | 8 | 3.63 |
| 4.5 | 2.13 | 9 | 34.1 | 10.0 | 283.5 | 9 | 4.08 |
| 5.0 | 2.37 | 10 | 37.9 | 16.0 | 453.6 | 10 | 4.54 |

| Length | Area |
|---|---|
| 1 inch = 2.54 centimeters | 1 acre = 0.405 hectares |
| 1 foot = 30.48 centimeters | 1 square mile = 2.59 square kilometers |
| 1 yard = 0.914 meters | 1 square yard = 0.836 square meters |
| 1 mile = 1.61 kilometers | 1 square foot = 0.0929 square meters |
| | 1 square inch = 6.45 square centimeters |

## 1.4 Making a Plant-Growing Mix

Many pre-mixed growing media products suitable for conventional and organic production are available commercially. A good, lightweight, disease-free, plant-growing material can also be made from a mixture of peat and vermiculite. A formula for a very simple mix for conventional production is given in Table R-4, but a preferred formulation is shown in Table R-5. If plants are to be grown in a mix longer than 8 weeks, use the formula in Table R-5. Organic growing media differ from conventional media because all components used must be allowable under organic production standards. When mixing your own formulation it is important to verify with your certifier that the materials you are using will not compromise your certification. For more information on organic growing media including several formulations can be found in:

- Potting Media and Plant Propagation: *https://extension.psu.edu/potting-media-and-plant-propagation*
- Potting Mixes for Certified Organic Production: *https://attra.ncat.org/attra-pub/viewhtml.php?id=47*
- Organic Potting Mix Basics: *http://www.extension.org/pages/20982/organic-potting-mix-basics*

**Regardless of which formula is chosen, unless good mixing procedures are used, the results will be less than optimal**. For best mixing, use a horizontal-type paddle mixer that folds or blends the components, such as lime and fertilizer, evenly throughout the mix. With tilted or other types of mixers, the components tend to segregate or separate out, resulting in erratic performance of the mix.

### Good procedures to follow when preparing a mix are:

1. **Use a respirator to prevent inhalation of dust when mixing peat, vermiculite and additives.**
2. For small quantities of mix preparation (1 cubic yard or less) place 4 to 5 inches of vermiculite in the bottom of a 5-gallon pail. Add all the additives (lime, fertilizer, etc.) to the vermiculite in the pail and mix thoroughly.
3. Fluff the recommended amount of peat. Start mixer and begin blending the peat.
4. While blending, add water according to the dampness of the peat. You will need approximately 1 gallon of water per bushel of peat in the mix.
5. While blending, slowly pour the additives, which you have already mixed thoroughly with a small amount of vermiculite, into the mixer and blend for 3 to 5 minutes.
6. Add the recommended amount of vermiculite after the other ingredients and blend for 1 minute or less, depending on the consistency of the vermiculite. It should be mixed thoroughly without breaking down.
7. **Use the mix for growing your plants soon after mixing.** It is not a good practice to stockpile the mix in large piles for long periods of time.
8. **Read all labels of the ingredients used, and heed all warnings that may be marked on the labels or bags.**

**Table G-4. Simple Plant-Growing Mix**

This mix will only get the seedlings up. Supplemental fertilizing will be needed to grow plants to transplant size. About 3 weeks after seeding, begin liquid fertilizing the plants with a soluble fertilizer, such as a 20-20-20, at the rate of 2-3 tsp/gal water. This rate should be applied at least weekly. More frequent applications may be desirable. **Note:** Lettuce and cabbage transplants have been grown successfully on this mix diluted with an equal part of sand.

| **Materials** | **One Cubic Yard (=22 Bushels)** | **(2 Bushels)** |
|---|---|---|
| Shredded sphagnum peat moss | 11 bu | 1 bu (10 gal) |
| No. 2, 3, or 4 domestic or African vermiculite[1] or horticultural grade (dust-screened) | 11 bu | 1 bu (10 gal) |
| Pulverized limestone<br>- use *dolomitic* lime for mixes made with *domestic* vermiculite<br>***or***<br>- use *calcitic* lime mixes made with *African* vermiculite | <br>10 lb<br><br>***or***<br>6 lb | <br>1 lb (1¼ cups)<br><br>***or***<br>9 oz (3/4 cup) |
| **-** Superphosphate (20% $P_2O_5$)<br>***or***<br>**-** Triple superphosphate (46% $P_2O_5$) | 2½ lb<br>***or***<br>1¼ lb | 4 oz (½ cup)<br>***or***<br>2 oz (¼ cup) |
| Fertilizer (5-10-10) | 5 lb | 8 oz (1 cup) |

[1]Vermiculite should be approximately pea sized and relatively free of fines and dust. Final mix should have a pH of 6.0-6.5.

**Table G-5. Preferred Plant-Growing Mix**

**Note**: Osmocote is a slow-release fertilizer. Use a formula that will release nutrients over a period of 8-9 months. **Mixes should be made just prior to seeding.** Plants grown in mixes containing Osmocote must be carefully watered and the temperature must be carefully controlled prior to field planting. When using small cells, reduced Osmocote rates are suggested to control plant height.

| **Materials** | **One Cubic Yard (=22 Bushels)** | **(2 Bushels)** |
|---|---|---|
| Shredded sphagnum peat moss | 11 bu | 1 bu (10 gal) |
| No. 2, 3, or 4 domestic or African vermiculite[1] or horticultural grade (dust-screened) | 11 bu | 1 bu (10 gal) |
| Pulverized limestone<br>- use *dolomitic* lime for mixes made with *domestic* vermiculite<br>***or***<br>- use *calcitic* lime mixes made with *African* vermiculite | <br>10 lb<br><br>***or***<br>6 lb | <br>1 lb (1¼ cups)<br><br>***or***<br>9 oz (3/4 cup) |
| **-** Superphosphate (20% $P_2O_5$)<br>***or***<br>**-** Triple superphosphate (46% $P_2O_5$) | 2½ lb<br>***or***<br>1¼ lb | 4 oz (½ cup)<br>***or***<br>2 oz (¼ cup) |
| Sulfate or muriate of potash (50%-60% $K_2O$) | ½ lb | 1 oz (2 tbs) |
| Osmocote (18-6-12) | 4 lb (tomatoes)<br>8 lb (eggplants)<br>8 lb (peppers) | 6 oz (3/4 cup) (tomatoes)<br>12 oz (1½ cups) (eggplants)<br>12 oz (1½ cups) (peppers) |
| Micronutrient mix | Use according to manufacturer recommendations | |
| Wetting agent (such as Aqua-Gro granular) | 1½ pt | 1 oz (4 tbs) |

[1]Vermiculite should be approximately pea-sized and relatively free of fines and dust. Final mix should have a pH of 6.0-6.5.

# 2. Records

## 2.1 Pesticide Application Record

| PESTICIDE APPLICATION RECORD | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location of Application** | | | | **Pesticide Product Used** | | | **Mixture Recipe per Product Label** | | | **Date (M/D/Y) and Time (am/pm)** | | |
| Farm Name and Address; City or Township; and County of Application | Field Name | Acres Treated | Crop Treated | Brand Name of Pesticide | EPA Registration Number | Active Ingredient(s) | Amount of Pesticide Concentrate used before mixing | Total Diluent | Total Volume Applied | Date/Time Application Completed | Date/Time of Reentry | Applicator Full Name/ Pesticide License or Handler Number |
| | Sitio Aplicado | Acres Tratado | Cosech Tratado | Nombre del Pesticida | Numero de Registracion EPA | Ingrediente Acitvo | Aumente el pesticida concentrado usarlo antes mesclarlo | Candidad Usada | Total Volumen Aplicar | Fecha y Hora de la Aplicacion | Fecha y Hora de Reentrada | |
| | | | | | | | | | | | | |

# PESTICIDE APPLICATION RECORD

New Jersey regulations require growers (private applicators) to maintain records of **all applications** of pesticides (both general and restricted use) for 3 years. All records should be recorded in writing as soon as possible, but no later than 24 hours. These records must be made available to the New Jersey Department of Environmental Protection and medical personnel (for emergencies) upon request.

Below is an example using a one-page format for keeping your records. The most current version can be found on the Rutgers Pest Management Office website at *http://pestmanagement.rutgers.edu/pat/record-forms/*. You can use your own recordkeeping format as long as you include all of the information required by State regulations (NJAC 7:30-8.8 Records). If you don't include it as part of your application record, keep a separate list of handlers working under the private applicator's supervision.

The crop/field designation must be specific. *For example* - assign a number to each field, or the parts of a field planted to different crops, or the parts of a field planted to the same crop in a different growth stage. Then use this number on the application record for each application to that specific location. For all pesticides having a reentry time, enter the date and the hour that the application was completed.

| **Location of Application** | | | | **Pesticide Product Used** | | | **Mixture Recipe per Product Label** | | | **Date (M/D/Y) and Time (am/pm)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Farm Name and Address; City or Township; and County of Application | Field Name | Acres Treated | Crop Treated | Brand Name of Pesticide | EPA Registration Number | Active Ingredient(s) | Amount of Pesticide Concentrate used before mixing | Total Diluent | Total Volume Applied | Date/Time Application Completed | Date/Time of Reentry | Applicator Full Name/ Pesticide License or Handler Number |
| | Sitio Aplicado | Acres Tratado | Cosech Tratado | Nombre del Pesticida | Numero de Registracion EPA | Ingrediente Acitvo | Aumente el pesticida concentrado usarlo antes mesclarlo | Candidad Usada | Total Volumen Aplicar | Fecha y Hora de la Aplicacion | Fecha y Hora de Reentrada | |
| ***Example***:<br>XYZ Farm<br>1234 Farm Road;<br>Agriville; Cumberland County | G-11 | 8 | Tomatoes | Vydate L | 352-372 | Oxamyl | 12 qts. | 400 gal | 400 gal | 6/15/12<br>9:30 a.m. | 6/17/12<br>9:30 a.m. | John Smith<br>C080569 |

# 2.2. Pesticide Registration Numbers Record

**PESTICIDE REGISTRATION NUMBERS RECORD**
**Use the space below to list the pesticides that you use and their EPA registration numbers. These numbers are printed on the label.**

| Pesticide* | EPA Registration No.* | Active Ingredient* | Formulation |
|---|---|---|---|
| ***Example**:* Rally | 62719-410 | myclobutanil 40% | 40 WSP |

* In New Jersey, a form listing all pesticides stored on site must be sent each year to your local Fire Department with an explanatory cover letter. It must include a description or diagram of the exact location of the storage area. See ***http://pestmanagement.rutgers.edu/pat/record-forms/*** for template