VIRGINIA COTTON

PRODUCTION GUIDE

2012

Virginia Cooperative Extension

Virginia Tech
Invent the Future

VSU
VIRGINIA STATE

VIRGINIA COTTON

Tidewater Agricultural Research and Extension Center

PRODUCTION GUIDE 2012

Prepared / Edited by:

D. Ames Herbert, Extension Entomologist, Tidewater AREC

David Horton, Research Technician, Tidewater AREC

Patrick M. Phipps, Extension Plant Pathologist, Tidewater AREC

Gail White, Research Technician, Tidewater AREC

Henry Wilson, Extension Weed Scientist, Eastern Shore AREC

Mark S. Reiter, Extension Nutrient and Soils Management Specialist, Eastern Shore AREC

Produced by:

Office of Communications and Marketing,
College of Agriculture and Life Sciences, Virginia Tech

Laura Neff-Henderson, Communications Project Coordinator

Chris Cox, Graphic Designer

Funding for the 2012 Guide was provided by the Tidewater Agricultural Research and Extension Center.

Table of Contents

COTTON FERTILITY

Mark S. Reiter, Extension Nutrient and Soils Management Specialist, Eastern Shore AREC

Proper soil fertility management ensures sufficient nutrients for maximum cotton production. Obtaining and maintaining appropriate soil nutrient concentrations is imperative, as fertilizer inputs are the largest component of production budgets for Virginia cotton farmers. At the same time, excessive nutrient application wastes money, wastes natural resources, and can negatively impact yields and environmental quality.

Soil sampling and analysis is the most efficient, accurate and cost-effective way to determine necessary fertilizer and lime applications. Focus should be placed on the appropriate nutrient to achieve maximum benefit from your fertilizer dollar. For instance, out of all soils sent to the Virginia Tech Soil Testing Laboratory between 2007 and 2009 and coded for cotton, no soil tested low for phosphorus, 25% tested medium, and 75% tested high or very high. However, 82% of land being prepared for cotton production tested low to medium for potassium, 18% tested high and no soil sample tested very high. The largest yield increases are seen with fertilizers applied to low and medium testing soils. High testing soil recommendations are designed to replace nutrients removed in the cotton lint and seed. Soils testing very high will see little if any benefit to fertilizer additions and can be “mined”.

Soil samples should be collected in fall or early winter to allow time for laboratory analysis and nutrient management planning. Discussion on proper soil sampling methodology can be found in the Agronomy Handbook (Virginia Cooperative Extension (VCE) publication 424-100). For the most accurate fertilizer and liming recommendations, the crop history, lime history, yield goals, and soil texture should accompany the soil samples on the Soil Sample Information Sheet for Commercial Crop Production (VCE publication 452-124). Soil texture can be determined from soil survey maps available through the Natural Resources Conservation Service or by using the Web Soil Survey available at: *http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm*. Soil testing forms and publications are available at: *http://www.soiltest.vt.edu/*. As of this printing, routine soil sample analysis is free for commercial crop production at the Virginia Tech Soil Testing Laboratory.

Lime

Of the samples sent to the Virginia Tech Soil Testing Laboratory between 2007 and 2009, 30% of the samples may have significant pH associated problems with readings lower than 5.9 or higher than 7.0. Cotton grows best when the soil pH is within the range of 5.8 to 6.5 with a target pH of 6.2. Cotton is sensitive to soils with a low pH as dissolved compounds from acid soil conditions can lead to toxic concentrations of naturally occurring elements, such as aluminum. Several forms of lime are commercially available to increase pH. Dolomitic lime is an economical way of altering pH while also adding magnesium to the soil. In situations where soil

magnesium levels are high, calcitic lime may be an economically feasible liming material. Other materials may offer liming capabilities, but care should be taken to ensure that the material application rate is corrected for the “liming power” using the calcium carbonate equivalent (CCE). Correcting with the CCE will prevent under or over liming. A pH above 7.0 can cause problems with nutrient availability with elements such as phosphorus or manganese. For more information on liming materials and their common CCE values, consult VCE publication 452-510 entitled Sources of Lime for Acid Soils in Virginia.

Phosphorus

Soil phosphorus concentrations should be maintained in the medium to high range since phosphorus is important for seedling development. Most soil tests from the cotton production region of Virginia contain high to very high levels of phosphorus and deficiency symptoms are rarely seen. Sufficient phosphorus fertilizer may be applied in starter fertilizer or broadcast prior to planting to aid in seedling root establishment and early season growth. If phosphorus deficiency is seen, soil pH is a likely cause and should be scrutinized and corrected.

Potassium

Coastal Plain soils in Eastern Virginia typically test low to medium for potassium. We expect to see significant yield advantages to fertilizing soils with low to medium soil test levels. Sandy textured soils have a low cation exchange capacity (CEC), which is the soil’s ability to retain positively charged cations like potassium. Low CEC soils leach potassium over time making it difficult to build residual soil concentrations. Soils with “heavier” silt and/or clay textures have a higher CEC, resist potassium loss from leaching, and can “bank” more potassium for future use than sandier soils. Potassium applied via fertilizer is generally readily plant available as Virginia soils have low tendencies to fix potassium into unavailable forms.

Potassium leaching in sandy textured soils in wet years can cause significant yield loss. Some producers split potassium applications with a reduced application rate at-planting and the remaining potassium applied in a side-dress application. However, splitting potassium fertilizer should be evaluated closely as research from Georgia on similar soil series to Virginia indicated that splitting potassium applications can reduce yields in dry years. Therefore, when soil potassium concentrations are low it may be best to apply the full recommended rate at-planting. A soil test with recommendations based on your soil series is the best method for determining fertilizer recommendations. If significant leaching has occurred, research in North Carolina states that 25-30 lbs of potash per acre should be sufficient for replacing leached nutrients. If deficiency symptoms or significant leaching occurs, tissue tests are the best option to monitor plant potassium concentrations and quantify if further fertilizer applications are necessary. See the Agronomy Handbook (VCE publication 424-100) for plant tissue sampling instructions and corresponding sufficiency ranges.

Nitrogen

Rates – Nitrogen has more impact, whether negative or positive, on cotton yields than any other nutrient. Too much nitrogen causes excessive plant growth, slows fruiting, delays maturity, makes defoliation more difficult, and increases hard lock, disease, and insect problems. Too little nitrogen results in reduced plant growth and cause premature cutout, resulting in low yields. Nitrogen rates of 60-90 lbs per acre may be necessary for cotton grown on sandier textured soils that have higher leaching potential. On "heavier" soils with more silt or clay, a rate of 50 -60 lbs per acre may be sufficient. Lower rates may be sufficient for cotton grown on heavier land following peanuts. Peanut vines supply 30 to 60 lb/acre of residual nitrogen and soybeans may supply 1 lb nitrogen/acre per bushel. Petiole nitrate or leaf tissue analysis is the best tool for determination of cotton nitrogen needs throughout the growing season. See the Agronomy Handbook (VCE publication 424-100) for sampling instructions and plant nitrogen sufficiency ranges.

Timing – Cotton takes up very little nitrogen before square formation; therefore, proper timing is imperative for avoiding excessive nitrogen losses. Most nitrogen is not assimilated by the plant until after first bloom. At-planting, apply one-third of your planned nitrogen program (17-20 lb nitrogen) per acre. Increase this rate to 20-30 lb on sandy soils or when low residual soil nitrogen concentrations are expected. Apply the remaining nitrogen at first square formation (about 45 days after planting) as a side-dress application in mid- to late June.

Boron

Boron is an essential micronutrient critical for flowering, pollination, and boll development. Boron is required in small amounts and can be applied either to the soil or crop foliage. A suggested rate of soil-applied boron at-planting is 1 lb elemental boron per acre. Boron can leach out of the root zone with excessive rainfall. Therefore, yield may benefit from foliar applications on sandy textured soils. Foliar applications should be applied twice at a rate of 1/4 lb boron/acre. At least one boron application should be applied by first bloom with the second application two weeks later.

Sulfur

Reductions in air pollution and acid rain have reduced sulfur availability to Virginia crops. Therefore, there is an increasing need for sulfur fertilizer additions. When grown in rotation with peanuts, residual sulfur from gypsum (land plaster) applications is usually sufficient for cotton. For cotton following other crops in rotation, application rates of 20 lb elemental sulfur/acre may be necessary. Sulfur may be applied preplant or with side-dress nitrogen applications. Sulfur is mobile in the soil and is readily leached from sandy soils. Therefore, split sulfur applications may be beneficial. Leaching may also accumulate sufficient sulfur concentrations deeper in the soil profile as clay concentrations increase. Research has indicated that most cotton roots are in the top two feet of the soil profile, but significant quantities of roots may go three feet or deeper. Soil sulfur deposits deeper in the soil profile may be sufficient for optimal crop yields as roots penetrate this nutrient rich zone. Obtaining a deep soil profile core (2 feet) aids in determination of clay layers that can be sent to private soil testing laboratories for testing.

Starter Fertilizer

Primary benefits of starter fertilizer include faster growth following planting, earlier maturity and higher yields. Starter fertilizers predominantly consist of nitrogen and phosphorus but may contain other nutrients such as sulfur. Cotton response to starter fertilizer varies by year but positive crop responses are typically found on soils testing low to medium in phosphorus, are cool, and/or wetter than normal. Little response to starter fertilizer is noted in hot and dry years. The ratio of nitrogen and phosphorus varies since there are many different formulations of starter fertilizers. Use 12-20 lbs. of nitrogen per acre and follow soil sample recommendations for phosphorus application rates.

Conservation Tillage Fertility Considerations

Conservation tillage systems have increased in popularity as they increase soil organic matter, increase water infiltration, have positive impacts on soil structure, and reduce soil erosion. However, producers switching to long-term conservation tillage systems need to evaluate several components to ensure optimal cotton production.

Lime – Lime moves slowly through the soil profile and generally only neutralizes acid in the application zone for several years. Therefore, pH must be adjusted via lime incorporation prior to or with the last tillage operation. If the pH is adjusted properly prior to the onset of a continuous conservation tillage operation, research suggests that surface lime applications are sufficient to maintain soil pH over the long-term. Soil test liming recommendations based on a four inch soil sample should be followed following establishment of the permanent conservation tillage system.

Nitrogen Rate – Nitrogen needs may vary significantly from previous needs in the initial years of starting a continuous conservation tillage operation. Nitrogen fertilizer needs generally increase in the “start-up” phase as soil organic matter increases. More soil organic matter means more microbial activity that assimilates nitrogen fertilizer. After a new equilibrium is reached, nitrogen fertility requirements will likely decrease below pre-conservation tillage levels. In the initial years of conservation tillage conversion, nitrogen requirements may be 0 to 60% higher and vary based on environmental, soil, and residue conditions. For instance, cotton planted into high residue cereal cover crops requires more nitrogen than cotton following legume cover crops or a winter fallow. Careful consideration to nitrogen application rates should be considered and plants tested throughout the growing season to ensure adequate nitrogen availability as outlined in the Agronomy Handbook (VCE publication 424-100).

Nitrogen Source – Nitrogen source is generally a non-issue as nitrogen will be quickly converted to nitrate by soil microbes following application. However, ammonia volatilization can be a concern for urea containing fertilizers applied to conservation tillage systems, such as urea-ammonium nitrate that is commonly referred to as liquid nitrogen. To help reduce nitrogen losses, consideration should be given to surface or subsurface banding applications to reduce urea nitrogen contact with crop residue and the urease enzyme. Similarly, applications prior to rainfall or irrigation can incorporate nitrogen fertilizers and increase urea fertilizer nitrogen efficiency. For more information concerning urea containing fertilizers, consult VCE publication 2908-1404, Virginia No-Till Fact Sheet Series Number Five – Understanding Volatilization from Fertilizers.

TILLAGE PRACTICES

Mark S. Reiter, Extension Soils and Nutrient Management Specialist, Eastern Shore AREC

Picking the Correct Tillage System

It is imperative to first understand whether tillage will benefit your particular cropping system or not. Many farmers can produce optimal cotton yields with continuous no-tillage systems or using minimal tillage; both of which assist in reducing soil erosion and improving overall soil tilthe. This trend is clearly observed in Virginia as conservation tilled cotton production has increased from 14% in 1989 to 63%; which is significantly higher than the United States' conservation tillage average of 21%. However, research on Coastal Plain soils has demonstrated that significant yield increases (15 to 20% or more) will occur if soil tillage is necessary and tillage is performed to the proper depth.

Deep Tillage

No-tillage systems are important for improving soil tilthe, reducing tillage costs, and reducing erosion; however, encouraging healthy cotton roots is imperative for productive and healthy plants. Cotton roots penetrate the soil to a depth of 10 inches before the cotyledon leaves emerge; while most roots of a mature plant are found between 1 and 3 feet deep with a significant quantity of roots being found 4 feet deep or more. Therefore, root restricting hardpans can be detrimental to cotton yields and many soils contain hardpans that should be broken with proper deep tillage techniques. Producers should check their fields for hardpans using penetrometers or similar devices (i.e. soil probes, rods, etc.). If a hard pan exists, measure the hardpan depth so the proper tillage depth and implement can be used. Tilling when not necessary and tilling too deep wastes energy (horsepower and fuel) and may cause a tillage pan to form deeper in your soil profile. Likewise, tilling too shallow will not offer yield benefits if a hardpan exists and all of the resulting time and money spent are wasted.

Subsoiling is a deep tillage technique (10 to 18 inches) that aggressively breaks hardpans throughout the field. Many different implements are available to adequately deep till the soil. Care should be taken when running deep tillage rigs to ensure that soil moisture is not too high. Deep tilling wet soils can further increase compaction in the non-shank area, causes sidewall spearing in the shank trench, and will not adequately shatter the hardpan. Tillage on drier soils is more productive as the hardpan will shatter and introduce more pore space for air and water movement. Subsoiling is often conducted directly under the cotton row to assist with taproot penetration and is often in conjunction with a planter, strip tillage, or a bedding rig.

The major disadvantage of deep tillage includes cost, as significant horsepower is required to pull deep tillage rigs and labor is necessary to run equipment that is generally narrow in scope due to the significant horsepower required. However, research in North Carolina found that deep tillage benefits can be seen throughout

the cropping rotation for up to three years. In a North Carolina cotton-corn rotation on a loamy sand soil, researchers found that they maintained 50% of the deep tillage benefit in year two after using deep tillage and maintained 20% of the benefit in year three. Researchers also found that there was no difference in Fall deep tillage when compared to Spring deep tillage; thereby allowing farmers to spread out tillage expense and work load.

Strip Tillage

Strip-till cotton production tills an 8 to 12 inch wide area along the cotton row and has many benefits compared to both “full field conventional” and no-tillage in Virginia. Strip tillage can be shallow for working the seedbed surface or used in conjunction with deep tillage to break hardpans. Strip-till allows for fewer trips over the field compared to conventional tillage and allows for considerable residue to remain on the soil surface between rows while allowing for a clean soil surface within the cotton row. Residue between rows aids in cotton plant protection during windy springs as the residue reduces particulates in the air and reduces wind speed near the cotton seedling to reduce damage from sand blasting. Additionally, surface residue increases organic matter and reduces likelihood of erosion from rainfall events. Due to the lack of soil disturbance and increased organic matter, water holding capacity of the soil is increased along with other positive conservation tillage soil building characteristics.

Early season growth is important for optimal cotton production in Virginia and using strip tillage systems can assist with drying fields, removing organic thatch, and with aeration; which can all increase soil temperature. Ideally, soil temperatures should be above 65° at 10:00 AM before planting. Soil temperatures cooler than 60° can severely hamper germination and reduces early season vigor that is necessary for high yields. Therefore, strip tillage may be especially useful in the northern Cotton Belt areas such as Virginia as bare soil surfaces may be 2 to 4° warmer than soil covered with crop residues.

There are two predominant challenges with strip tilling. In heavier textured soils (soils with higher clay concentrations), it is difficult to obtain loose soil that is free from clods to establish a fine seedbed for proper seed to soil contact. Secondly, strip tillage does not provide a sufficient planting bed and may increase compaction issues when soils are wet.

Bedding

In the northern Cotton Belt, cotton is often planted during cool and wet Springs that can significantly reduce seedling vigor and plant populations. Utilizing raised beds is a tool for producers wishing to increase their soil temperature and reduce soil moisture. Raised beds can be used with conventional and conservation tillage systems although different management decisions are necessary depending on the specific tillage and cropping system. For conventional tillage systems, raised beds can be formed in Spring to assist with soil drying and warming prior to planting. For conservation tillage systems, raised beds can be formed in the Fall following peanuts, corn, or tobacco and followed by planting of a small grain cover

crop to reduce erosion pressures and to “bank” valuable fertilizer nutrients for the following cotton crop (especially nitrogen, potassium, and sulfur). For continuous cotton producers utilizing conservation tillage and wishing to plant on raised beds, a bent leg subsoiler can be used to provide deep tillage under the cotton row without destroying existing cotton beds and avoiding problems associated with previous crop cotton residue.

PLANTING

Joel Faircloth, Former Extension Cotton/Peanut Specialist, Tidewater AREC

Planting Date

The recommended planting dates for Virginia are from April 20 to May 25. Regardless of the planting date, soil moisture and soil temperature need to be suitable for rapid germination, and emergence. To obtain good germination, soil temperature should be 65˚F by 10 a.m., at a soil depth of 3 inches. Delay planting cotton whenever temperatures below 50˚F are expected. Whenever possible, planting should be done when a warming trend is expected for 5 to 7 days after planting. Cotton planted in early to mid May typically does very well in Virginia. Later-planted cotton grows much more aggressively than early-planted cotton (it will actually pass the early cotton) and needs higher rates of mepiquat-type growth regulators applied prior to bloom to prevent rank growth.

Planting Depth

Planting depth depends on the year and sometimes the day. Seed placement to a depth of 3/4 inch in the soil is optimum in a good, moist seedbed. In cool, wet springs, shallow planting allows for a stressed seedling to emerge with less effort. Shallow planting provides fast emergence as long as moisture is sufficient. Long hot, dry spells often prevent shallow planting, and deeper planting is preferred under these conditions. Seed germinates and emerges quickly when it is in the moisture. Planting seed 1 inch deep is often necessary in the light soils in order to find moisture. If rain is forecast prior to expected emergence, then deeper planting becomes risky. It would be better to plant shallow in extremely dry conditions and let the rain initiate germination rather than planting 1.5 inches or deeper. The hill-drop planting method is a way to allow greater “push” and reduce the risk associated with deeper planting.

Plant Population

Planting at a rate of 3.0 to 4.0 seed per foot of row in 36-inch rows and 2.5 to 3.5 seed per foot of row in 30-inch rows should provide optimum plant populations. Optimal yields are obtained with final stands of 1 to 2 plants per foot. It is not uncommon to have 50 percent emergence under stressful conditions but this is still acceptable. Hill drop planting rate recommendations are the same as conventional planting rates.

Replanting

Replanting may be necessary through mid-May if the stand or plant health is questionable. Provided plant stand is a minimum 1 plant per foot of row, replanting is typically not recommended. Variability in plant stand within a field may justify replanting certain areas. However, the time interval between plantings should not exceed 2.5 weeks to minimize in-season management challenges. However, producers often wish they had left the first stand which often recovers dramatically. Weak, gappy stands planted early often out-yield good stands planted in late May or early June.

PLANT GROWTH REGULATOR USE

Henry Wilson, Extension Weed Scientist, Eastern Shore AREC

The cotton plant has a natural mechanism (good boll set) to prevent excessive vegetative growth if nitrogen levels, soil moisture, temperature, insect, disease, and nematode controls, and plant populations are all well balanced. In many cases, these factors are not well balanced and growth regulators are needed to maintain proper plant size and to promote boll set and early maturity. Additionally, certain growthy, indeterminate varieties also require plant growth regulator applications to shift cotton from vegetative to reproductive growth. Applying growth regulators based only on stage of development (ex. pinhead square) is not recommended as plant vigor may vary across fields. Although plant growth regulator applications can be an important part of an overall cotton management program, they can result in reduced yields if applied while plants are undergoing stressful conditions. Before applying plant growth regulators, variety, soil type, fertility, irrigation potential, and field history must be taken into consideration.

Mepiquat chloride is the most commonly used cotton-plant growth regulator. It is used to control plant growth and is available under a number of trade names that include Pix, Mepex, Pix Plus, Pix Ultra, and others. Pentia is a new mepiquat product containing a boron molecule (mepiquat pentaborate). This addition of boron is not enough to serve as a replacement for boron fertilization; however, a reduced rain-free interval (1 hour) may make this product attractive in some situations. All mepiquat-containing products will be collectively referred to as Pix through the remainder of this section.

Based on similarities in growing conditions between North Carolina and Virginia, plant growth regulator application rules are likely very similar. Therefore, the early-bloom strategy developed and widely adopted in North Carolina should prove useful to Virginia producers as well. Using this strategy, 0.5 to 1 pt of Pix is applied to cotton 24 inches and taller where conditions favor a response at early bloom. Early bloom is defined as five to six white blooms per 25 ft of row. Conditions favoring a Pix response include: high nitrogen levels, growthy varieties, late-planted cotton, thick stands, excessive rainfall, fields with a history of rank growth, and fields where cotton is to be harvested first. The 0.5 to 1 pt rate of Pix should also be applied to cotton reaching an average of 28 inches prior to early bloom. These same rates can be applied to cotton past early bloom if growth is excessive. The longer the application is delayed, however, the less opportunity there is for Pix activity and thus less potential for reducing plant growth and achieving a desirable response. The early-bloom strategy should serve as a general guideline for making Pix application decisions and it can be modified to fit the needs of individual conditions. As previously mentioned, Pix should not be applied when cotton is undergoing stress conditions (especially moisture stress). Consult the label for additional precautions.

One difficulty in implementing the early-bloom strategy occurs when the amount of cotton that needs to be sprayed outweighs the amount that the producer can spray in a timely manner. Some producers may prefer to utilize the modified

early-bloom strategy on a portion of their acreage to help manage this situation. The modified early-bloom strategy involves the use of height-to-node ratios and measurement of the most recently expanded internode length. The most recently expanded internode is measured by counting down the plant from the highest mainstem leaf (> quarter size) to the fourth leaf. Examine the internode above and below the fourth leaf and measure the larger of the two. This is a good indicator of the plant vigor over that past week or so. Long internodes will range between 2.5 to 3 inches while short internodes will be below 2 inches. The charts below provide an aid in determining Pix application decisions using the modified early bloom strategy.

10 to 14 days after first square.

	Plant height		
	< 17 in	**17 – 20 in**	**>20 in**
Height to node ratio > 1.85 in	4 oz	6 oz	8 oz
*Internode > 2.5 in	4 oz	6 oz	8 oz

Do not apply if soil moisture is poor.
** most recently expanded internode (see measurement description above).*

Early bloom – use this chart if prior Pix has been applied.

	Plant height			
	< 24 in	**24 – 27 in**	**27 – 30 in**	**> 30 in**
*Internode > 2.5 in	6 oz	6 oz	9 oz	12 oz

Do not apply if soil moisture is poor.
Do not apply if nodes above the highest first position white bloom < 7.
** most recently expanded internode (see measurement description above).*

Early bloom – use this chart if no prior Pix has been applied.

	Plant height			
	< 24 in	**24 – 27 in**	**27 – 30 in**	**> 30 in**
*Internode > 2.5 in	8 oz	8 oz	12 oz	16 oz

Do not apply if soil moisture is poor.
Do not apply if nodes above the highest first position white bloom < 7.
** most recently expanded internode (see measurement description above).*

10 to 14 days after early bloom		
	Pix applied at early bloom	
	> 8 oz	**0 – 8 oz**
*Internode < 2.5 in	0 oz	0 oz
Internode 2.5 – 3.5 in	8 oz	12 oz
Internode > 3.5 in	12 oz	16 oz

Do not apply if soil moisture is poor.
Do not apply if nodes above the highest first position white bloom < 5.5.
** most recently expanded internode (see measurement description above).*

Cotton Variety Trials

Gail White, Research Technician, Tidewater AREC
David Horton, Research Technician, Tidewater AREC

2011 Variety Yield Results

The 2011 Official Cotton Variety Performance trial included 32 varieties at the Tidewater Agricultural Research and Extension Center in Suffolk. The varieties evaluated consisted of 20 transgenic varieties (16 Bollgard II, [15 Roundup Ready Flex, and Liberty Link], 4 Roundup Ready Flex), 2 conventional variety, and 10 experimental varieties.

The variety trial located at Tidewater was planted on April 26 and harvested October 18.

The Virginia Cotton Variety Performance County Strip trials are conducted annually to provide an unbiased comparison of commercially available varieties, utilizing uniform cultural practices within each location. Variety performance in these trials was evaluated using standard production practices for non-transgenic varieties. Trials in various locations in the production area make it possible to evaluate variety performance under the wide range of soil and climatic conditions existing in Virginia. The additional strip trials were conducted at six locations and data pooled and analyzed to evaluate six transgenic varieties.

Summary of Yield and Performance

In 2011, yields ranged from 900.4 to 522.2 pounds of lint per acre. Table 1 summarizes the performance of all the entries at TAREC. Table 2 presents the two-year average for all varieties and Table 3 presents the three year averages. Tables 4 and 5 present the specifics and results of the county strip trials.

Variety Selection

There are numerous factors to consider when selecting varieties including yield, maturity, herbicide and/ or insect tolerance traits, quality, and stability. Data from these variety trials are used to identify promising varieties based on performance. Despite the small region in southeastern Virginia where cotton is produced, performance may vary on individual farms due to soil type, environment, and other factors. Virginia producers should select varieties based on their performance at the location most representative of their farm. This should include examination of NCSU University Variety Trials conducted in nearby Lewiston, North Carolina. For more information on varieties and how they might perform under various conditions, please contact Virginia Cooperative Extension.

HVI Classing

Fiber property values were determined using the High Volume Instrumentation (HVI) classing system. Producers are encouraged to consider these fiber properties when selecting varieties for 2011. The HVI system includes measurements for fiber strength, micronaire, length, and uniformity. Fiber strength is expressed as grams per tex. A tex unit is equal to the weight in grams of 1000 meters of fiber. Therefore, the strength reported is the force in grams required to break a bundle of fibers one tex unit in size. Strength values 25.5 through 29.4 will not receive a premium or discount. Values below 25.5 will be discounted, and values above 29.4 will carry a premium on the loan chart. The fiber length is the average length of the longest one-half of the fibers (upper half means length or UHM) measured and is expressed in 100^{ths} of an inch. Discounts for length are determined on a sliding scale and dependent on color and leaf grade. The length uniformity is the ratio between the mean length and upper mean length (UHM) of fibers and is expressed as a percentage. Uniformity index is becoming increasingly important as we are increasing the percentage of cotton exported. Values below 79.5 are discounted while values above 82.5 receive a premium based on the loan chart. Micronaire is a measurement of the lint surface area and thus an indirect measure of fineness and maturity. Measurements above 4.9 or below 3.5 will result in a discount and measurements between 3.7 and 4.2 will result in a premium based on the USDA loan chart.

Table 1. Yield, fiber quality, and performance of ALL cotton varieties, 2011.

		Lint		Fiber Properties			
Seed Company	Variety	Yield lb/A	Lint %	Mic.	Len. (in.)	Str. (g/tex)	Uni. (%)
Dow Agro Sciences	PHY 499 WRF	900.4	43.0	5.1	1.15	32.6	82.9
Crop Production Services	DG 2570 B2RF	820.6	41.5	5.1	1.11	31.0	80.8
Dow Agro Services	PHY 565 WRF	768.8	40.9	4.6	1.15	32.9	82.4
Monsanto	DP 1219 B2RF	755.9	42.5	4.7	1.19	34.2	81.9
Monsanto	DP 1137 B2RF	755.5	43.8	5.0	1.09	29.0	81.3
Bayer CropScience	ST 5288 B2F	752.4	42.2	5.1	1.13	30.5	81.7
Crop Production Services	DG 2450 B2RF	745.3	40.6	4.8	1.18	30.6	82.3
Monsanto	DP 1133 B2RF	713.7	44.1	5.1	1.15	32.0	83.4
Monsanto	DP 1028 B2RF	706.1	45.2	5.3	1.13	28.7	83.3
Bayer CropScience	ST 5458 B2RF	697.7	41.7	4.9	1.12	30.8	80.8
Bayer CropScience	BX 1262 B2F	690.0	39.5	4.7	1.18	31.4	82.0
Americot	AM 1550 B2RF	684.8	42.2	5.1	1.12	29.3	81.2
Bayer CropScience	FM 1740 B2F	680.7	42.8	5.0	1.14	31.4	81.8
Americot	AM 1511 B2RF	674.7	44.4	5.1	1.11	29.8	80.2
Dow Agro Sciences	PHY 367 WRF	668.7	42.5	4.9	1.16	31.3	81.3
Bayer CropScience	BX 1261 B2F	665.8	40.1	4.8	1.17	30.7	81.2
Seed Source Genetics	SSG HQ 210 CT	662.7	38.5	4.7	1.08	30.6	81.2
Americot	AMX 003 B2RF	661.6	42.8	5.1	1.14	28.5	81.4
Monsanto	DP 1034 B2RF	653.1	43.6	4.9	1.16	29.9	82.2
Crop Production Services	CT 11212	647.8	43.0	5.1	1.11	28.9	82.1
Monsanto	DP 0920 B2RF	645.6	42.7	5.0	1.11	30.5	80.9
Monsanto	DP 0912 B2RF	640.4	38.2	5.2	1.11	31.2	81.2
Monsanto	DP 0924 B2RF	637.5	40.9	5.2	1.11	29.8	81.6
Bayer CropScience	ST 4288 B2F	637.2	39.5	5.3	1.14	30.7	82.2
Dow Agro Sciences	PHY 375 WRF	635.9	42.7	4.8	1.13	30.5	81.3
Monsanto	10R020B2R2	626.5	42.0	5.0	1.13	30.5	82.0
Seed Source Genetics	SSG HQ 110 CT	602.6	40.3	5.2	1.14	32.1	82.8
Bayer CropScience	ST 4145 LLB2	596.8	40.9	4.7	1.16	32.4	85.6
Bayer CropScience	BCSX 1150 B2F	585.2	39.2	5.0	1.21	33.0	82.7
Monsanto	DP 1212 B2RF	554.4	41.2	4.9	1.16	32.1	81.4
Bayer CropScience	BX 1254 LLB2	541.4	42.2	4.8	1.20	33.2	82.4
Bayer CropScience	BX 1252 LLB2	522.2	39.4	5.0	1.18	33.5	82.7
	Mean	672.9	41.7	5.0	1.14	31.1	81.8
	LSD	112.54	0.83	0.35	0.053	1.53	1.39

Table 2. Two-year average of yield, fiber quality, and performance of all cotton varieties.

				Fiber Properties			
Seed Company	Variety	Lint Yield lb/A	Lint %	Mic.	Len. (in.)	Str. (g/tex)	Uni. (%)
Dow Agro Sciences	PHY 499 WRF	1089.7	45.4	5.1	1.14	32.3	83.1
Crop Production Services	DG 2570 B2RF	969.8	43.2	4.9	1.12	30.7	82.1
Monsanto	DP 1028 B2RF	948.7	46.9	5.2	1.13	29.0	83.1
Monsanto	DP 1137 B2RF	941.2	45.7	5.0	1.11	29.1	82.4
Americot	AM 1550 B2RF	935.9	44.5	5.1	1.10	28.9	81.7
Dow Agro Sciences	PHY 565 WRF	918.7	42.5	4.7	1.15	32.6	82.7
Bayer CropScience	ST 5288 B2F	902.7	44.3	5.2	1.11	29.9	81.5
Monsanto	DP 1034 B2RF	902.6	45.5	4.9	1.15	30.3	82.8
Monsanto	DP 1133 B2RF	898.7	45.9	5.1	1.15	32.0	83.6
Bayer CropScience	FM 1740 B2F	897.2	44.7	4.9	1.13	30.3	82.4
Dow Agro Sciences	PHY 375 WRF	880.1	45.0	4.9	1.12	30.2	82.1
Seed Source Genetics	SSG HQ 210 CT	878.0	41.3	5.0	1.09	30.8	81.5
Dow Agro Sciences	PHY 367 WRF	868.1	44.3	5.0	1.13	30.6	81.5
Bayer CropScience	ST 5458 B2RF	846.0	43.5	5.0	1.13	31.1	81.6
Monsanto	DP 0912 B2RF	838.1	41.9	5.2	1.09	30.6	81.7
Crop Production Services	DG 2450 B2RF	835.8	43.0	4.7	1.16	29.5	82.3
Monsanto	DP 0924 B2RF	831.0	42.9	5.2	1.11	30.3	82.2
Monsanto	DP 0920 B2RF	798.5	45.5	5.2	1.11	29.7	81.7
Bayer CropScience	ST 4288 B2F	798.3	41.6	5.2	1.13	29.9	82.4
Seed Source Genetics	SSG HQ 110 CT	787.8	43.2	5.1	1.12	31.3	82.4
	Mean	888.3	44.0	5.0	1.12	30.4	82.2
	LSD	230.59	2.47	0.19	0.024	1.16	0.83

Table 3. Three-year average of yield, fiber quality, and performance of all cotton varieties.

				Fiber Properties			
Seed Company	Variety	Lint Yield lb/A	Lint %	Mic.	Len. (in.)	Str. (g/tex)	Uni. (%)
Monsanto	DP 1028 B2RF	1294.7	47.9	5.0	1.14	28.8	83.2
Crop Production Services	DG 2570 B2RF	1248.7	44.9	4.9	1.13	30.3	82.4
Dow Agro Sciences	PHY 375 WRF	1235.6	46.0	4.8	1.13	29.9	82.6
Monsanto	DP 0912 B2RF	1216.0	43.5	5.2	1.10	30.4	82.3
Americot	AM 1550 B2RF	1204.2	45.6	4.9	1.11	28.8	82.2
Bayer CropScience	FM 1740 B2F	1202.0	45.7	4.9	1.13	30.2	82.7
Dow Agro Sciences	PHY 367 WRF	1200.6	45.5	4.8	1.15	30.6	82.2
Bayer CropScience	ST 5288 B2F	1182.7	45.4	5.1	1.12	30.0	81.8
Dow Agro Sciences	PHY 565 WRF	1173.1	44.0	4.6	1.17	32.4	83.1
Bayer CropScience	ST 5458 B2RF	1152.2	44.7	4.9	1.14	31.1	81.8
Monsanto	DP 0924 B2RF	1143.7	44.2	5.1	1.12	30.3	82.8
Monsanto	DP 0920 B2RF	1138.1	46.6	5.1	1.13	29.1	82.3
Bayer CropScience	ST 4288 B2F	1102.4	43.5	5.1	1.14	30.0	82.8
	Mean	1191.8	45.2	5.0	1.13	30.1	82.5
	LSD	409.4	2.31	0.21	0.025	1.09	0.85

Table 4. Location, cooperator, and agent at all variety strip trials, 2011.

Location	Cooperator	Agent
City of Suffolk	Mike Griffin	Rex Cotten
Dinwiddie	Randy Everett	Mike Parrish
Sussex	Jared Webb	Kelvin Wells
Isle of Wight	Loften Braswell	Janet Spencer
Surry	Fulton Faison	Glenn Slade
Southampton	M.L. Everett	Chris Drake

Table 5. Combined yield, fiber quality, and performance of county variety strip trials (6 locations), 2011.

				Fiber Properties			
Seed Company	Variety	Lint Yield lb/A	Lint %	Mic.	Len. (in.)	Str. (g/ tex)	Uni. (%)
Dow Agro Sciences	PHY 499 WRF	1203.6	43.3	4.8	1.10	30.8	81.8
Monsanto	DP 1028 B2RF	1123.9	43.6	4.8	1.11	29.1	82.4
Monsanto	DP 1137 B2RF	1093.2	43.6	4.8	1.10	30.8	81.7
Dow Agro Sciences	PHY 375 WRF	1041.7	43.1	4.7	1.10	29.2	81.8
Americot	AM 1550 B2RF	1027.7	41.6	4.7	1.09	28.3	81.6
Bayer CropScience	ST 5288 B2F	1006.6	41.6	4.7	1.12	28.9	81.6
	Mean	1082.8	42.8	4.8	1.10	29.5	81.8
	LSD	146.17	1.23	0.45	0.035	1.68	1.13

Disease Control

P.M. Phipps, Extension Plant Pathologist, Tidewater AREC

Seed and Seedling Diseases

Rapid emergence and strong early-season growth are recognized as being most important to success in cotton production. Seedling diseases occur more frequently under cool, wet conditions immediately after planting. Soil temperatures at the 4-inch depth should average above 60°F and the forecast should favor continuation of these conditions over the next three days. Daily soil temperatures and cotton degree-days are available on the World Wide Web at *http://www.ipm.vt.edu/infonet/*. It is also important to check the ten-day forecast at *http://www.weather.com*. Other factors, such as planting too deep, heavy soil crusting, sting and reniform nematodes, and misuse of herbicides may increase disease problems. Seedling diseases do not usually kill an entire seedling population, but rather cause uneven, slow-growing stands with skips in the row.

The first line of defense against seedling disease is to plant high-quality seed that is coated with seed protectant fungicides and insecticides. Try to obtain seed with cool germination levels of 80 percent or higher. Avoid seed with cool germination levels below 70 percent. All commercial seed is routinely sold with protectant fungicide coatings, which include three or more fungicides for broad-spectrum activity against fungi. Examples of treatments include Dynasty CST (azoxystrobin, fludioxonil, mefonoxam) and Trilex Advanced (Trilex, Baytan, Allegiance) for seeding diseases, and Avicta Complete Pak (Dynasty CST, Cruiser, Avicta), and Aeris (thiodicarb, imidiacloprid) for control of thrips and nematodes.

If additional protection is desired, an in-furrow fungicide treatment, or hopper-box treatment can be used (Table 6). Benefits would most likely be seen in fields with a history of seedling disease problems when planting early or when cold, wet weather is expected shortly after planting. Field trials at multiple locations in Virginia since 1990 have not shown an economic benefit from use of in-furrow or hopper-box fungicide treatments on seed.

Table 6. In-furrow and hopper-box fungicides for cotton.

Disease	Fungicide Common Name	Fungicide Trade Name	Formulated Rate	Remarks
Seedling disease; Damping-off; Seed rot	PCNB + etridiazole	Terraclor Super X 12.5G Terraclor Super X 18.8G (Note: also available in liquid formulation)	8-12 lb/A 6-9 lb/A	Apply to seed furrow at planting. Read and follow all label restrictions.
	metalaxyl + PCNB	Ridomil PC	7.0-10.0 lb/A	Same as above.
	azoxystrobin	Quadris	5.8-8.7 fl oz/A	Same as above.
	carboxin + PCNB + metalaxyl	Prevail	8.0-16.0 oz/cwt	Apply to seed in hopper at planting.

Nematodes

Nematodes cause significant damage to cotton in some fields in southeastern Virginia. The sting nematode is recognized as highly destructive to cotton because of the crop's high sensitivity to this nematode. Root knot nematodes are generally not a problem when peanut and cotton are rotated in the same field. However, southern root knot and reniform nematodes have become an increasing problem where cotton is grown continuously for five or more years. Stubby root nematodes are parasitic on cotton and may represent the most common cause of crop damage in Virginia.

Diagnostic assays for nematodes in soil planted to cotton are provided free of charge by the Plant Disease Clinic at Virginia Tech. Nematode population thresholds for damage to cotton are available on the Web at *http://ipm-www.ento.vt.edu/states/va/html*. The Virginia Predictive Nematode Assay Program offers growers an opportunity to locate problem fields prior to planting. The best time to collect soil samples for assay is in the fall. Assay forms, sample bags, and instructions should be obtained from a local Extension office before collecting samples. A service charge of $11.00 for vermiform or $19.00 for cyst nematodes is levied on each sample. Counts of vermiform species are all that is needed if cotton is the only crop to be grown. However, if soybean or possibly tobacco might be considered as alternative crops, then counts of cyst nematodes would be more important or even critical. Nematode control is best accomplished by preventing the buildup of harmful numbers of nematodes in soil through crop rotation and good weed control. If nematodes pose a threat to cotton production, chemical control can be used to minimize the risk of crop damage (Table 7).

The most common and important nematodes that parasitize cotton in Virginia are southern root-knot and stubbly root nematodes. Cotton is also damaged by sting and reniform nematodes, but these species are more widely scattered in the soils planted to cotton in Virginia.

Table 7. Nematicides for use in cotton.

Disease	Nematicide Common Name	Nematicide Trade Name	Formulated Rate	Remarks[1]
Sting, reniform, lesion, lance, root knot, stubby root	aldicarb	Temik 15G[2]	5.0 lb/A	Apply in seed furrow. Higher rates can reduce seedling emergence. Sidedress in a furrow that is one 6-10 inches to one or both sides of row and to a depth of 2 or 3 inches. **IMPORTANT:** A new label for Temik 15G was approved on 08/16/2010 that reduced rate/A and adds application restrictions for protection of groundwater. READ THE LABEL AND FOLLOW THE INSTRUCTIONS.
	1,3-D	Telone II	3.0 gal/A	Apply 8-12 inches deep in row and bed soil. Wait 7-14 days before planting.
	abamectin	Avicta Complete Pak (also contains Dynasty CST and Cruiser)	Mixture of abamectin, azoxystrobin, fludioxinil, mefenozam thiamethoxam	Supresses early-season root damage by nematodes. Must be applied by seed vendors with commercial application equipment.
	thiodicarb	Aeris seed-applied system	Mixture of thiodicarb + Gaucho	Same as above, except lacks fungicide unless requested with Trilex Advanced.
		Poncho/ VOTIVO seed treatment		Contains insecticide (clothianidin) for early season insect control and bacteria (Bacillus firmus) which colonizes the surface of rocks to provide a layer of protection against nematode feeding and root damage.

[1] *Read product label carefully. Note application hazards, re-entry statements, restrictions on feeding livestock, rotation restrictions, and protective clothing required before treatment. Read and observe all requirements as defined on labels.*

[2] *Bayer Crop Science ceased production of Temik 15G in 2010. Currently, no alternative sources of Temik 15G (aldicarb) are being marketed in the U.S. The last date for sale of Temik 15G by Bayer Crop Science is 31 December 2014; the last date for sale by distributors to growers is 31 December 2016; and the last date for application by growers is 31 August 2018. If using Temik 15G, growers should read all label directions and be aware of changes concerning safety, use patterns, and protection of drinking water wells in soils vulnerable to leaching.*

Boll Rot

Foliar applications of fungicides have not been shown to reduce boll rot in Virginia. Boll rot is often a result of excessive insect damage coupled with excessive moisture. Management of boll rot is best achieved indirectly through control of boll damage by insects and use of growth regulator to manage vegetative growth.

Hardlock

Hardlock is a problem that causes seed cotton to remain compact in the shape of locules. Although the bolls open, the cotton fibers do not “fluff out” of the open boll. As a result, hardlocks often fall to the ground during harvest with spindle-type pickers.

Insect Control

D.A. Herbert, Jr., Extension Entomologist, Tidewater AREC

Thrips

Insect pests such as aphids, spider mites, cutworms, plant bugs, and thrips affect cotton in the early stages of development. At present, only thrips must be controlled annually. These tiny, spindle-shaped insects complete several generations per season under favorable conditions. They feed primarily by puncturing and rasping the outer cells of the young leaves and buds. Damage results in ragged looking plants with crinkled or "possum-eared" leaves. The damage associated with thrips feeding can stunt growth, resulting in fruiting at higher positions and delayed maturity. Damage is most severe if young cotton is subjected to adverse growing conditions such as cool or dry weather or when alternate thrips hosts, such as small grains, dry down prematurely, forcing large numbers of thrips to seek other hosts. Adverse growing conditions during the early stages of cotton development may reduce the uptake of systemic insecticides; therefore, early inspection of the crop is important due to the length of the growing season in most of Virginia.

Orthene 97 and Admire Pro in-furrow: Orthene 97 and Admire Pro can be dribbled or sprayed in-furrow during the planting operation. Applications are usually made at 5 to 10 gal/A and are compatible with several liquid fungicides.

Iimidacloprid (Gaucho Grande, Aeris) and thiamethoxam (Avicta CP, Cruiser 5FS) seed treatment: Gaucho and Cruiser treated seed provide good thrips control, but a foliar treatment may be needed to provide season-long control.

There is no formal threshold for thrips based on insect numbers or plant injury. Treatment is thought to be justified if the following conditions are met: 1) thrips injury is common, 2) 10 percent or more plants show extensive bud damage, 3) immature thrips can be easily found, and 4) plant growth is poor.

Table 8. Recommended insecticides for thrips control.

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
In-furrow	acephate (Orthene 97)	8.0-16.0 oz	21	Apply as a liquid into the seed furrow in 5-10 gal of water/A with a system that insures good seed coverage. **Do not feed treated forage or hay to livestock or allow animals to graze treated areas.**
	imidacloprid (Admire Pro)	7.4-9.2 oz		
	imidacloprid (Gaucho Grande) seed treatment	0.375 mg ai/seed	–	
	phorate (Thimet 20G)	2.5-9.0 oz/1000 ft		**RESTRICTED USE.** Do not graze or feed treated hay or forage to livestock.
	thiamethoxam (Cruiser 5FS)	0.30-0.34 mg ai/seed	–	

Table 8. Recommended insecticides for thrips control. (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	bifenthrin (Brigade 2EC)	1.3-6.4 oz	14	**RESTRICTED USE**.
	acephate (Orthene 97)	2.5-3.0 oz	21	May be tank mixed with Roundup Ultra or Roundup Ultra Max (on Roundup Ready cotton) or Glyphosate materials labeled for use on Roundup Ready Cotton, Buctril (on BXN cotton), or Staple.
	lambda-cyhalothrin (Warrior T) (Karate Z) (Karate EC) (Kaiso 24WG)	 1.92-2.56 oz 0.96-1.28 oz 1.92-2.56 oz 1.0-1.33 oz	 21 21 21 21	**RESTRICTED USE**. Do not graze livestock in treated areas.
	beta-cyfluthrin (Baythroid XL)	0.8-1.6 oz	0	**RESTRICTED USE**.
	gamma-cyhalothrin (Proaxis) (Prolex)	 1.92-2.56 oz 0.77-1.02 oz	 21 21	**RESTRICTED USE.** Do not graze livestock in treated fields.
	zeta-cypermethrin (Mustang Max)	1.28-1.92 oz	14	**RESTRICTED USE.** Do not graze or feed cotton for forage.
	chlorpyrifos + gamma-cyhalothrin (Cobalt)	19.0-38.0 oz	21	**RESTRICTED USE.** Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
	spinetoram (Radiant SC)	4.25-8.0 oz	28	

Plant Bugs

Prebloom: Prior to bloom, plant bugs, or Lygus, damage cotton by feeding on tender terminals and small squares causing the squares to turn black and abort. Excessive square loss can reduce yields or slow plant maturity. In prebloom cotton, Lygus has required treatment on an average of only 6 percent of the cotton acreage in North Carolina over the past 8 years, and on only a few hundred acres in Virginia. The best way to determine the need for prebloom plant bug control is to assess square retention rates (percent missing squares). Treatment should be considered if square retention drops below 80 percent (see threshold table below) and plant bugs are still active.

After blooming: Once blooming begins, plant bugs continue feeding on smaller squares and blooms, both of which can cause "dirty blooms" (white blooms with brown pollen anthers or brown-streaked petals). The presence of dirty blooms indicates that plant bugs are, or have very recently been, active. Levels at or above 1 percent dirty bloom indicate a large and active plant bug population and the need for sampling of bolls for damage (see threshold chart below).

Boll damage: Once bolls are formed, plant bugs prefer feeding on small bolls up to three weeks old. Damage to bolls can range from warts or calluses on the insides of boll walls, to small areas of stain lint, to deformed and rotting fruit that is due to direct feeding on seed. This damage is identical to damage caused by stink bugs. Virginia studies indicate that treatments may be justified if boll damage by plant bugs (and/or stink bugs) exceeds 15 percent of a random sample of quarter-size bolls (see threshold table below).

Untreated or minimally treated cotton, such as Bollgard cotton, is most susceptible to plant bug damage. Also, fields treated later in the season are open to invasion for a longer period of time.

Sampling for plant bugs and thresholds in cotton.	
Prebloom	below 80% square retention and plant bugs active
After blooming	15% dirty blooms indicates the presence of an active population 8 plant bugs per 100 sweeps indicates a large, active population
Boll damage	15% or more damaged quarter-size bolls (up to 14 days old) and plant bugs active

Table 9. Recommended insecticides for plant bug control.

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	4.0-16.0 oz	21	GENERAL. Treatment not recommended if square retention is in excess of 80%. If square retention is less than 80%, confirmation of threshold levels of plant bugs should be met prior to treatment. Although cotton fields exceeding the treatment thresholds for plant bugs are relatively rare, fields adjacent to Irish potatoes, weed fields, and other sources of plant bugs may be at higher risk of plant bug injury.
	chlorpyrifos (Lorsban 4EC)	6.1 oz	14	
	chlorpyrifos + gamma-cyhalothrin (Cobalt)	19.0-38.0 oz	21	**RESTRICTED USE.** Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
	dicrotophos (Bidrin XP)	4.0-8.0 oz	30	**RESTRICTED USE**.
	imidacloprid (Admire Pro)	0.9-1.7 oz	14	
	thiamethoxam (Centric 40WG)	1.25-2.0 oz	21	
	acetamiprid (Assail 70WP)	1.1-2.3 oz	28	
	methyl parathion (4EC) (Penncap-M 2F)	0.5-2.0 pt 0.5-1.0 pt	7 7	**RESTRICTED USE**.
	methomyl (Lannate 2.4 LV) (Lannate 90SP)	12.0 oz 0.5 lb	15 15	**RESTRICTED USE**.

Table 9. Recommended insecticides for plant bug control. (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar (cont.)	oxamyl (Vydate 2.4 LV)	8.5 oz	21	**RESTRICTED USE**.
	lambda-cyhalothrin (Warrior T) (Karate Z) (Karate EC) (Kaiso 24WG)	 2.56-3.84 oz 1.28-1.92 oz 2.56-3.84 oz 1.33-2.0 oz	 21 21 21 21	**RESTRICTED USE**. Do not graze livestock on treated fields.
	lambda-cyhalothrin + thiamethoxam (Endigo ZC)	3.5-5.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	beta-cyfluthrin (Baythroid XL)	1.6-2.6 oz	0	**RESTRICTED USE**.
	bifenthrin (Brigade 2EC)	2.6-6.4 oz	14	**RESTRICTED USE.**
	gamma-cyhalothrin (Proaxis) (Prolex)	 2.56-3.84 oz 1.02-1.54 oz	 21 21	**RESTRICTED USE**.
	zeta-cypermethrin (Mustang Max)	2.64-3.6 oz	14	**RESTRICTED USE**.
	esfenvalerate (Asana XL 0.66EC)	5.8-9.6 oz	21	**RESTRICTED USE**.
	clothianidin (Belay)	3.0-4.0 oz	21	
	dinotefuran (Venom 20SG)	0.44-0.67 oz	14	

Tobacco Budworm/Cotton Bollworm

Bollworms (corn earworms) occur primarily on field corn during their first two generations. Third generation moths usually emerge in large numbers from mid-July to early August when corn is drying, and fly to the more attractive blooming cotton.

Regular weekly scouting for the bollworm and its cousin, the tobacco budworm, should begin in early to mid-June. Weekly scouting is adequate until egg laying or blacklight trap catches increase. Fields should then be scouted twice a week, with the emphasis placed upon finding eggs, until insecticide treatments begin. After that, a four- to seven-day scouting schedule will usually suffice. A four- to five-day scouting schedule is suggested for conventional pyrethroid rates and a six- to seven-day schedule for high rates. Once the egg threshold has been met and treatments made, the primary focus of scouting shifts toward finding small bollworms feeding on squares and bolls, including those under bloom tags, and boll damage.

Tobacco budworm adults are not readily attracted to backlight traps and sometimes begin laying eggs on cotton prior to the time at which the bollworm egg threshold has been met. Occasional fields may reach a 3 percent larval threshold prior to bollworm treatment initiation. Under these circumstances, tobacco budworm pheromone trap deployment and correct sight identification of adult tobacco budworms can assist in recognition of this situation.

After the upper bolls that will be harvested have become difficult to cut with a pocketknife (approximately three weeks after bloom), they are normally safe from bollworm attack. Bollworm scouting can normally be stopped at that time – usually in late August to early September. Spot scouting for fall armyworms and European corn borers should continue through early September, especially in fields of late-maturing cotton or in green areas.

Table 10. Bollworm and tobacco budworm thresholds in conventional cotton.

Timing Stage	Infestation Level	Remarks
Prebloom	8 bollworms/100 terminals or 6 bollworms/100 squares	Limiting this treatment to one well-timed non-pyrethroid application is strongly recommended.
Egg threshold	10+ eggs/100 terminals or 2 eggs/100 fruiting forms	After the onset of the major (third generation) bollworm moth flight.
Postbloom larval threshold	3 live worms/100 terminals, or 3% fresh damage, squares, blooms, or bolls	Usually after the egg threshold has been employed; also used after blooming begins and before major bollworm flight, particularly if tobacco budworms present.

Table 11. Bollworm and tobacco budworm thresholds in Bollgard cotton.

Timing Stage	Infestation Level	Remarks
Egg threshold	75 to 100 eggs/100 terminal or 15 to 20 eggs/100 blooms or bloom tags	Applies only following a period of high egg deposition. Should not be used within 1 week or less of an insecticide application.
Larval threshold	3 second-stage (1/8 inch or larger) bollworms/100 squares or bolls or 2 second-stage bollworms on 2 consecutive scouting trips or 1 second-stage bollworm on 3 consecutive scouting trips	Use against the major bollworm generation. Pay particular attention to bollworms in or under yellow, pink, or dried blooms, but only sample in proportion to their occurrence.
Damage threshold	3-6% significantly damaged squares (would cause square to abort) or bolls	

Table 12. Recommended insecticides for bollworm control.

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar (pyrethroids)	cypermethrin (Ammo 2.5EC)	3.1*-5.1** oz	14	**RESTRICTED USE**. High-pressure (50-70 psi) and low-volume (6-10 gpa) advised for pyrethroid application.
	esfenvalerate (Asana XL 0.66EC)	5.8*-9.7** oz	21	**RESTRICTED USE**.
	beta-cyfluthrin (Baythroid XL)	1.6*-2.6** oz	0	**RESTRICTED USE**.
	bifenthrin (Brigade 2EC)	3.2*-6.4** oz	14	**RESTRICTED USE**.
	zeta-cypermethrin (Mustang Max)	2.64*-3.6** oz	14	**RESTRICTED USE**.
	lambda-cyhalothrin			**RESTRICTED USE**. Do not graze livestock on treated fields.
	(Warrior T)	3.2*-5.1** oz	21	
	(Karate Z)	1.6*-2.56** oz	21	
	(Karate EC)	3.2*-5.1** oz	21	
	(Kaiso 24WG)	1.67*-2.67** oz	21	
	lambda-cyhalothrin + thiamethoxam (Endigo ZC)	3.5-5.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	tralomethrin (Scout X-Tra 0.9EC)	2.6*-3.4** oz	28	**RESTRICTED USE**.

*Standard rate
**High rate

Table 12. Recommended insecticides for bollworm control. (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
	deltamethrin (Decis 1.5EC)	1.9*-2.56** oz	21	**RESTRICTED USE**.
	fenpropathrin (Danitol 2.4EC)	10.6*-16.0** oz	21	**RESTRICTED USE**.
	gamma-cyhalothrin (Proaxis)	3.2*-5.12** oz	21	**RESTRICTED USE. Do not graze livestock in treated fields.**
	(Prolex)	1.28*-2.05** oz	21	
	chlorpyrifos + gamma-cyhalothrin (Cobalt)	19.0-38.0 oz	21	**RESTRICTED USE.** Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
Foliar (others)	spinosyn (Tracer 4SC)	2.14-2.9 oz	28	For second generation tobacco budworms, 1.4 oz is adequate; for postbloom bollworms, use the 2.9 oz rate.
	indoxacarb (Steward EC)	11.3 oz	14	
	emamectin benzoate (Denim)	8.0-12.0 oz	21	**RESTRICTED USE. Do not allow livestock to graze treated areas.**
	profenophos (Curacron 8EC)	1.0 pt	14	**RESTRICTED USE.**
	thiodicarb (Larvin 3.2F)	24.0-36.0 oz	28	

*Standard rate
**High rate

Table 12. Recommended insecticides for bollworm control. (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar (others) (cont.)	methomyl (Lannate 2.4LV) (Lannate 90SP)	 1.5 pt 8.0 oz	 15 15	**RESTRICTED USE.**
	spinetoram (Radiant SC) (prebloom) (postbloom)	 2.8-8.0 oz 4.25-8.0 oz	 28	
	flubendiamide (Belt SC)	 2.0-3.0 oz	 28	
	rynaxypyr (Coragen)	 3.5-7.0 oz	 21	
	spinosad + gamma-cyhalothrin (Consero)	 2.8-4.0 oz	 28	**RESTRICTED USE.** Do not allow livestock to graze treated areas.

*Standard rate
**High rate

European Corn Borer

European corn borer (ECB) larvae damage cotton by feeding on large bolls from early August through mid-September. In rank or late-maturing cotton, this damage can be significant. An earlier tunneling type of damage may occur within stems and leaf petioles, usually in mid-July through late August. Although this damage looks serious, with wilting and eventual death of the tissue above the feeding site, it causes no known economic loss. The major moth flight for the ECB often occurs a few days to three weeks later than the major bollworm flight. The female moths lay egg masses that contain 15 to 75 eggs each. These small, flat, scale-like masses are deposited on the underside of cotton leaves deep within the canopy. At first, early instars feed within the leaf petioles and stems, but they begin to enter and feed upon large bolls, sometimes within 48 hours, particularly after mid-August. Although the caterpillars of this species generally do not feed as extensively within the bolls as do bollworms, most bolls are destroyed.

Controlling ECB damage presents an unusual problem. The flat egg masses are almost impossible to find, even by the trained scouts searching heavily infested fields. By the time the larvae are found feeding on or within bolls, insecticide treatments usually are ineffective. Thus, scouting for this pest benefits the producer little during the present year. However, scouting to detect the caterpillars is advised. If small larvae are present (3 percent or more), treatment may be prescribed if an active flight is confirmed. This situation may indicate a late, rank-cotton crop that should be avoided in the future.

No control threshold has been developed since finding the egg masses is virtually impossible, and live caterpillars are spotted too late to achieve effective control. Growers must depend on another observation as a trigger for directing insecticide against the pest. Fortunately, because corn earworm egg laying usually occurs somewhat earlier that the ECB flight, employing the egg threshold for bollworm control usually works well for ECB if treatments are extended into the ECB infestation period. An insecticide should be selected that is effective against both insects. If the major part of the ECB flight occurs after the bollworm flight has subsided and spraying has been completed, fields can be particularly susceptible. Under this condition, three to six total applications may be required for adequate suppression. This approach is recommended only where late rank growth points toward a high probability of ECB damage. Finding moths of this species in local light of pheromone traps or flushing the adults from around or within cotton fields can help confirm the need for this extended treatment.

Table 13. Recommended insecticides for European corn borer control.

Treatment	Insecticide (Formulation)	Amount product per acre	Time limit: days before harvest	Remarks
Foliar	cypermethrin (Ammo 2.5EC)	3.1-4.1 oz	14	**RESTRICTED USE**. European corn borer populations are generally higher in rank cotton. Multiple applications may be necessary for control. Other bollworm materials may provide some control.
	beta-cyfluthrin (Baythroid XL)	1.6-2.6 oz	0	**RESTRICTED USE**.
	bifenthrin (Brigade 2EC)	1.3-6.4 oz	14	**RESTRICTED USE**.
	deltamethrin (Decis 1.5EC)	1.9-2.6 oz	14	**RESTRICTED USE**.
	zeta-cypermethrin (Mustang Max)	2.64-3.6 oz	14	**RESTRICTED USE**.
	lambda cyhalothrin (Warrior T) (Karate Z) (Karate EC) (Kaiso 24WG)	 3.2 oz 1.6 oz 3.2 oz 1.67-2.67 oz	 21 21 21 21	**RESTRICTED USE**. Do not graze livestock on treated fields.
	lambda cyhalothrin + thiamethoxam (Endigo ZC)	3.5-5.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	tralomethrin (Scout X-Tra 0.9EC)	2.6-3.4 oz	28	**RESTRICTED USE**.

Table 13. Recommended insecticides for European corn borer control. (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limit: days before harvest	Remarks
	gamma-cyhalothrin			**RESTRICTED USE. Do not graze livestock in treated fields.**
	(Proaxis)	3.2-5.12 oz	21	
	(Prolex)	1.28-2.05 oz	21	
	chlorpyrifos + gamma-cyhalothrin			**RESTRICTED USE.**
	(Cobalt)	19.0-38.0 oz	21	Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
	spinetoram			
	(Radiant SC)	2.8-8.0 oz	28	
	flubendiamide			
	(Belt SC)	2.0-3.0 oz	28	
	rynaxypyr			
	(Coragen)	3.5-7.0 oz	21	

Stink Bugs

Stink bugs typically begin invading cotton fields in mid-July and build to damaging levels in August. The insecticide applications for the bollworm usually keep stink bug numbers below damaging levels. Problems with stink bugs usually develop where the bollworm applications are limited or not applied at all. Stink bugs damage cotton by puncturing the carpal walls of bolls and feeding on the soft developing seeds. If bolls are small when feeding occurs, the boll will dry up, turn brown, and either remain on the plant or be shed. Boll rot pathogens are sometimes introduced when feeding is concentrated on medium and larger bolls, resulting in portions of the boll being destroyed, hardlock, and lower grades. External feeding damage appears as small round purplish depressions about the size of a pencil point. The feeding sites are slightly larger but closely resemble the spots that naturally appear on maturing bolls. Stink bug feeding sites can be confirmed by slicing the bolls open under the depressions. The damaged bolls will have a brown stain (boll rot organisms) in the seed area under these spots.

Stink bugs often occur in a clumped distribution within a cotton field; therefore, at least ten samples should be taken throughout a field to determine if a problem exists. Both sweep nets and shake cloths can be used to sample for stink bugs, but research is showing that of the two, shake cloths tend to do a better job. A sweep net sample should consist of 25 hard sweeps using a pendulum-like motion with enough speed and force to end up with some leaves and small bolls in the net. An average of one stink bug per 25 sweeps could indicate a problem. A shake cloth sample should consist of placing a 3-foot long cloth on the ground between the rows, bending the bordering plants on either side (first one side, then the other) and vigorously shaking those plants to dislodge any insects. An average of one bug per 6 row feet (one 3-foot long shake cloth sample, both sides of the cloth) could indicate a problem.

However, because of recent trends in other eastern cotton states and results of ongoing field research, the recommendation is to base the decision to treat for stink bug on the percentage of damaged bolls, and presence of stink bugs (see threshold table below).

Sampling for stink bugs and thresholds in cotton	
Indicates presence	an average of 1 per 6 row feet using a 3-foot shake cloth an average of 1 per 25 sweeps using a 15-inch diameter sweep net
Boll damage	15% or more damaged quarter-size bolls (up to 14 days old) and stink bugs active

Table 14. Recommended insecticides for control of stink bugs.

Treatment	Insecticide (Formulation)	Amount product per acre	Time limit: days before harvest	Remarks
Foliar	methyl parathion (4EC) (Penncap-M 2F)	 1.0 pt 1.0-3.0 pt	 7 7	**RESTRICTED USE**.
	Pyrethroids (see product labels)			Pyrethroids, when applied 2 or more times against bollworms, usually provide adequate suppression of stink bugs. Penncap is highly toxic to bees. Do not apply this product or allow to drift to blooming cotton if bees are in treated areas.
	acephate (Orthene 97)	8.0-12.0 oz	21	**Do not feed treated forage or hay to livestock or allow animals to graze treated areas.** Use for brown and green stink bugs.
	dicrotophos (Bidrin XP)	 4.0-8.0 oz	 30	**RESTRICTED USE**. Use for brown and green stink bugs.
	oxamyl (Vydate C-LV)	 8.5 oz	 21	**RESTRICTED USE**.
	thiamethoxam (Centric 40 WG)	2.0 oz	21	
	lambda-cyhalothrin + thiamethoxam (Endigo ZC) (green stink bug) (brown stink bug)	 3.5-5.5 oz 5.5 oz	 21 21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	imidacloprid (Admire Pro)	 0.9-1.7 oz	 14	
	chlorpyrifos + gamma-cyhalothrin (Cobalt)	 26.0-38.0 oz	 21	**RESTRICTED USE.** Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
	clothianidin (Belay)	 3.0-4.0 oz	 21	

Aphids

A number of beneficial insects and fungal diseases can hold aphid numbers below economic threshold levels. By limiting early-season insecticide applications, the grower is allowing beneficial insect populations to build, decreasing the chances of developing resistant aphid populations (observed in North Carolina and Virginia), and possibly reducing or eliminating the need for insecticide applications later in the season. An aphid rating level of four or more just before boll opening, plus the presence of honeydew, is probably a good indicator of the need to treat.

Aphid Rating Scale	
0	No aphids
1	Occasional plants with low numbers of aphids
2	Plants with low numbers common; heavily infested plant rare; honeydew visible occasionally
3	Most plants with some aphids; occasional plants heavily infested; honeydew visible in most areas of the field
4	Heavily infested plants common; aphids clumped on upper leaves
5	Many heavily infested plants

Table 15. Recommended insecticides for aphid control.

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	imidacloprid (Admire Pro)	0.9-1.7 oz	14	Aphid control with insecticides should be attempted only as a last resort, particularly in early season (before major bollworm flight).
	dicrotophos (Bidrin XP)	4.0 oz	30	**RESTRICTED USE**.
	dimethoate (Cygon 4EC)	8.0 oz	14	
	phosphorothioate (Metasystox-R 2EC)	16.0 oz	14	**RESTRICTED USE**.
	bifenthrin (Brigade 2EC)	2.6-6.4 oz	14	**RESTRICTED USE**.
	acetamiprid (Assail 70WP)	0.6-1.1 oz	28	
	thiamethoxam (Centric 40WG)	1-25-2.0 oz	14	
	clothianidin (Belay)	3.0-4.0 oz	21	

Table 16. Recommended insecticides for aphid/bollworm control.

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
	cyfluthrin + imidacloprid (Leverage 360)	2.8-3.2 oz	14	**RESTRICTED USE**.
	lambda-cyhalothrin + thiamethoxam (Endigo ZC)	3.5-5.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.

Spider Mites

Spider mites can occur at anytime during the season, but are favored by dry weather and/or the removal of alternative hosts. Mite damage first appears as a slight yellowing of the leaves, which later changes to a purplish or bronze color and is usually associated with webbing. Damage occurs especially in spots or on field edges but widespread defoliation is not uncommon if favorable conditions persist.

Spider mites can be checked while scouting for other insect pests. Active mite populations should be confirmed before applications are made. Delaying treatment should also be considered if rainy, humid conditions are predicted in the near future. Rainy, humid conditions favor a fungus that preys upon mites and may greatly reduce mite numbers.

Table 17. Recommended insecticides for spider mite control.

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits:days before harvest	Remarks
Foliar	bifenthrin (Brigade 2EC)	3.8-6.4 oz	14	**RESTRICTED USE**.
	propargite (Comite 6.55EC*)	1.0-2.0 pt	14	
	dicofol (Kelthane MF 4E)	1.5-3.0 pt	30	Do not make more than 2 applications/season. **Do not feed cotton stalks or trash to meat or dairy animals.**
	methidathion (Supracide 2E*)	2.0 qt	60	**RESTRICTED USE**.
	fenpropathrin (Danitol 2.4EC)	10.6-16.0 oz	21	**RESTRICTED USE**.
	etoxazole (Zeal)	0.66-1.0 oz	28	Apply with adequate water for uniform coverage (3-10 gal/A by air or 10-50 gal/A by ground). Best results are achieved if applied when mite populations are low. ZEAL is predominately an ovicide/ larvicide and should be used early in the life cycle of mites.
	spiromesifen (Oberon 4SC)	3.0 oz (early season) 4.0-8.0 oz (mid-late season)	30	

* not after bolls begin to open

Loopers

Cabbage and soybean loopers rarely damage cotton because they prefer foliage, are prone to virus attack, and occur sporadically. Scouting for this pest, which normally appears late in the season, is done by observing foliage during scouting for other pests. As a general rule, if defoliation exceeds 3 percent in cotton with a significant portion (25 percent or more) of the bolls still immature and filling out, treatment may be needed. Soybean loopers are difficult to control with insecticides. Because foliage feeding typically begins at the bottom of the cotton plant and proceeds upward and outward, foliage feeding may be beneficial in preharvest cotton that has begun to open. The brownish larval frass (droppings) can be plentiful and temporarily stain opening cotton; however, this is not thought to be an economic problem. Since loopers are usually controlled by naturally occurring diseases and chemical controls are sometimes not effective due to resistance, recommendations will be available on a year-to-year basis through your local Extension office.

Fall Armyworms

The presence of fall armyworms (FAW) and their damage is recorded as part of bollworm scouting. Additional samples are unnecessary. FAW migrate into Virginia from the south so numbers are generally highest in the southern part of the state. FAW prefer blooms and bolls of all sizes. These caterpillars can be extremely damaging if present in moderate numbers and can become established late in the season. They can feed on mature bolls normally resistant to bollworm penetration. Because FAW are not always controlled effectively by the same insecticides as bollworms, it is very important that they be identified correctly. Also, because fall armyworms are difficult to control with insecticides, treatments are best applied at an early boll bract feeding stage. Fall armyworms have a more difficult time becoming established under a bollworm spray regime with certain pyrethroids.

Table 18. Recommended insecticides for fall armyworm control.

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	protenophos (Curacron 8EC)	0.5-1.0 pt	14	Various rates and combinations may be recommended for armyworm control, depending upon the phenology and the age distribution and population levels of larvae. Pyrethroids will provide some control of fall armyworms hatching from egg masses. Fall armyworms may have more difficulty becoming established following Karate or Capture treatments used for bollworm control.
	methomyl (Lannate 2.4LV) (Lannate 90SP)	1.5 pt 0.5 lb	15 15	
	thiodicarb (Larvin 3.2F)	1.5-2.0 pt	28	
	chlorpyrifos (Lorsban 4E)	1.0-2.0 pt	14	
	chlorpyrifos + gamma-cyhalothrin (Cobalt)	19.0-38.0 oz	21	**RESTRICTED USE.** Do not allow meat or dairy animals to graze in treated areas. Do not feed gin trash or treated forage to meat or dairy animals.
	spinosyn (Tracer 4SC)	2.14-2.9 oz	28	
	indoxacarb (Steward EC)	9.2-11.3 oz	14	
	methoxyfenozide (Intrepid 2F)	4.0-10.0 oz	14	
	emamectin benzoate (Denim)	6.0-12.0 oz	21	**RESTRICTED USE.** Do not allow livestock to graze in treated areas.
	lambda-cyhalothrin + thiamethozxam (Endigo ZC)	3.5-5.5 oz	21	**RESTRICTED USE.** Do not graze livestock in treated areas.
	flubendiamide (Belt SC)	2.0-3.0 oz	28	
	rynaxypyr (Covagen)	3.5-7.0 oz	21	
	spinosad + gamma-cyhalothrin (Consero)	2.8-4.0 oz	28	**RESTRICTED USE.** Do not graze livestock in treated areas.

Beet Armyworms

Table 19. Recommended insecticides for beet armyworm control.

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	spinosyn (Tracer 4SC)	2.14-2.9 oz	28	
	indoxacarb (Steward EC)	9.2-11.3 oz	14	
	methoxyfenozide (Intrepid 2F)	4.0-10.0 oz	14	
	emamectin benzoate (Denim)	6.0-12.0 oz	21	**RESTRICTED USE.** Do not allow livestock to graze in treated areas.
	flubendiamide (Belt SC)	2.0-3.0 oz	28	
	rynaxypyr (Coragen)	3.5-7.0 oz	21	
	spinosad + gamma-cyhalothrin (Consero)	4.0 oz	28	**RESTRICTED USE.** Do not graze livestock in treated areas.

Cutworms

Table 20. Recommended insecticides for cutworm control.

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	lambda-cyhalothrin			**RESTRICTED USE**. Do not graze livestock in treated areas.
	(Karate Z)	0.96 oz	21	
	(Karate EC)	1.92 oz	21	
	(Kaiso 24 WG)	1.0-1.33 oz	21	
	(Warrior T)	1.92 oz	21	
	thiodicarb			
	(Larvin 3.2)	24.0 oz	28	
	beta-cyfluthrin			**RESTRICTED USE**.
	(Baythroid XL)	0.8-1.6 oz	0	
	esfenvalerate			**RESTRICTED USE**.
	(Asana XL 0.66EC)	5.8 oz	21	
	cypermethrin			**RESTRICTED USE**.
	(Ammo 2.5EC)	1.3-5.0 oz	14	
	zeta-cypermethrin			**RESTRICTED USE**.
	(Mustang Max)	1.28-1.92 oz	14	
	bifenthrin			**RESTRICTED USE**.
	(Brigade 2EC)	2.6-6.4 oz	14	
	deltamethrin			**RESTRICTED USE**.
	(Decis 1.5EC)	1.1-1.6 oz	21	
	tralomethrin			**RESTRICTED USE**.
	(Scout X-Tra 0.9EC)	2.28-2.84 oz	28	
	fenpropathrin			**RESTRICTED USE**.
	(Danitol 2.4 EC)	8.0 oz	21	
	acephate			Control is most effective when ground application is made in the evenings and sprays are directed toward the base and lower portion of plants.
	(Orthene 97)	12.0 oz	21	
	gamma-cyhalothrin			**RESTRICTED USE.** Do not graze livestock in treated fields.
	(Proaxis)	1.92-2.56 oz	21	
	(Prolex)	0.77-1.02 oz	21	

Beneficial Insects

About a dozen beneficial insects are common in Virginia cotton. Ambush bugs, big-eyed bugs, minute pirate bugs, green lacewings, two species of ladybird beetles, and several types of spiders are examples. They are of two types: 1) predators that prey upon an insect pest, or 2) parasites that live within the host insect. These insects, particularly the predators, reduce the number of eggs and larvae of bollworms, caterpillars, and aphids. Because these allies lessen the impact of pest insects, common sense dictates that producers use them as a management tool. Their presence often means that growers can delay and on occasion, eliminate some insecticide applications.

Many complex factors are involved in determining just how many of each beneficial insect species are needed to influence a given level of pests. Therefore, it is usually not possible to assess the value of these insects except in a very general way. If relatively high numbers of beneficial insects are eating a large portion of aphids or bollworm eggs and larvae, the treatment threshold will be reached later than would otherwise be the case, reducing the number of insecticide applications needed. However, the rapid increase in pest populations, the third generation of bollworms, will often overwhelm the beneficial population and applications become necessary. The careful observation of sound economic thresholds offers the producer the best odds of balancing beneficial insect numbers.

WEED CONTROL

Henry Wilson, Weed Scientist, Eastern Shore AREC

Roundup Ready Flex Cotton

Roundup Ready Flex cotton became commercially available in 2006. In Virginia, we included Roundup Ready Flex varieties (See Cotton Variety Trials section) in the 2006-2009 variety trials and examined crop tolerance and herbicide efficacy in 2004-2009. The advantage of this technology is that it has expanded the window of opportunity for applying glyphosate past the four-leaf stage (previous Roundup Ready technology over top limitation). A consideration for producers who adopt this technology is selection for weed resistance. This system increases the overall amount of glyphosate utilized in the cotton production system, thus increasing the selection pressure for weed resistance. Resistance has been documented in several weed species including Palmer amaranth (*Amaranthus palmeri*), horseweed (*Conyza canandensis*), and common ragweed (*Ambrosia artemisiifolia*). In 2006, we documented the presence of Palmer amaranth in several cotton fields in Virginia. It would be negligent to assume that Virginia will not see increased weed resistance in the upcoming years and it is critical that producers growing Roundup Ready Flex cotton utilize resistance management strategies (See Resistance Management section). For this publication, rates will be referred to utilizing the Roundup PowerMax rates. For other formulations of glyphosate, please refer to the label for rate conversions.

Labeling for Roundup PowerMax restricts the maximum quantity of this product that may be applied for all preplant, at-plant, and preemergence applications combined to 3.3 quarts per acre per season. The combined total of PowerMax applications from cotton emergence through harvest must not exceed 4 quarts per acre and the maximum quantity of this product for all applications in a season is 5.3 quarts per acre (see table below).

Table 21. Maximum PowerMax Application Rates	
Combined total per year for all applications	5.3 qt/A
Total of all preplant, at-plant, and preemergence	3.3 qt/A
Total of all in-crop applications from cracking to 60% open bolls	4.0 qt/a
Total of all in-crop applications between layby and 60% open bolls	44 fl oz/A
Maximum allowed from 60% open bolls to 7 days prior to harvest	44 fl oz/A

Please see labels and this guide for recommendations for specific herbicides that may be mixed with glyphosate. These mixtures relate to pre-plant burndown, preemergence, and in-crop herbicides.

For effective weed control, glyphosate will need to be applied near the 1-, 6-, and 12-leaf stages. It is important to eliminate weeds when small, not holding off application to allow for greater emergence. Withholding application will result in 1) weeds that are more difficult to control and 2) potential yield losses due to weed competition. The timing of glyphosate applications can vary depending upon several factors including crop growth, use of other herbicide chemistries in combination with glyphosate, and weed emergence. Residual herbicides (See below) are recommended.

Resistance management

In studies at Virginia Tech, the Roundup Ready Flex system has provided very good weed control and there are several steps that should be taken to protect the value of this technology. First, growers should use effective burndown strategies, starting the season with clean fields. Residual herbicides should be utilized preemergence to aid in the control of glyphosate-tolerant or resistant species. The first in-sea¬son glyphosate application to cotton should occur around the first true-leaf stage to maintain clean fields. This will coincide with foliar insecticide applications for thrips control. Second applications applied prior to cutout should incorporate other chemistries if problem weeds are present that glyphosate does not adequately control. At layby, a residual herbicide should be included where difficult to control weeds are present or if canopy closure is delayed. These applications are primarily post-directed. Do not apply glyphosate below the labeled rates. Other considerations for delaying weed resistance include proper crop rotations to eliminate suspected weeds and alternating herbicide-tolerance technologies such as Liberty Link with glyphosate-tolerant.

Glyphosate Resistant Horseweed

Glyphosate resistant horseweed (marestail) has been reported in numerous Virginia cotton fields. Horseweed emergence occurs both in the fall and the spring. It should be controlled during the rosette stage (early spring). A preplant burndown treatment applied in early March of glyphosate mixed with either 1.5-2.0 pt/A of 2,4-D (3.8 a.e./gal formulation) or 0.5 pt/A Clarity should be used to control glyphosate resistant horseweed. Applications of 2,4-D must occur 30 days before planting. Clarity should be applied 21 days before planting and one inch of rainfall must accumulate after applications and prior to planting. To reduce spring emergence of susceptible weeds, the preemergence residual herbicide Valor can be applied with the preplant burndown treatment in early March. See Valor label for times required between Valor applications and planting. Research has demonstrated that Cotoran applied preemergence is also an effective means of controlling late emerging horseweed.

Gramoxone and Direx with crop oil concentrate can provide fair to good control of glyphosate-resistant horseweed if applied under warm temperatures (greater than 70 degrees). This mixture should be applied at least 45 days before planting.

Ignite 280 will provide burndown control of spring emerged glyphosate-resistant horseweed and can be applied up to planting. It should be applied at a minimum rate of 29 fl oz/A of Ignite 280 when temperatures are at least a minimum of 75°F for burndown of existing weeds. If environmental conditions prevent timely applications, a single burndown application of up to 43 fl oz/A of Ignite 280 may be made. If more than 29 fl oz/A are used in any single application, the season total may not exceed 72 fl oz/A including all application timings. If 29 fl oz/A are applied for burndown, two in-season applications at 22-29 fl oz/A for a total of 87 fl oz/A for a season maximum may be made. If 30-42 fl oz/A of Ignite 280 are applied for burndown, a single in-crop application of 22-29 fl oz/A may be made for a total of 72 fl oz/A. See label for registered tank mixes with other labels and plant back intervals to rotational crops.

Table 22. Preplant incorporated.

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Barnyardgrass, broadleaf signalgrass, carpetweed, crabgrass, fall panicum, Florida pusley, foxtails, goosegrass, johnsongrass seedlings, lambsquarters, pigweed, purslane, sandbur, Texas panicum, wild cane, shattercane	Pendimethalin 0.5-0.75 lb ai	Prowl 3.3EC 1.2-1.8 pt or Prowl H_2O 1.1-1.6 pt	Apply and incorporate 1-2 inches deep within 7 days after application. Follow label for proper soil incorporation procedures. Lower rate is safest to cotton.
Barnyardgrass, broadleaf signalgrass, carpetweed, crabgrass, fall panicum, Florida pusley, foxtails, goosegrass, johnsongrass seedlings, lambsquarters, pigweed, purslane, sandbur, Texas panicum, wild cane, shattercane	Trifluralin 0.5-0.75 lb ai	Treflan 4EC 1.0-1.5 pt and others such as Trilin 4EC	Incorporate within 24 hours after application. Follow label for proper soil incorporation procedures. Lower rate is safest to cotton.

Table 23. Preplant incorporated or split application.

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Barnyardgrass, broadleaf signalgrass, carpetweed, crabgrass, fall panicum, foxtails, goosegrass, johnsongrass seedlings, lambsquarters, pigweed, purslane, prickly sida, spurred anoda, tropic croton, nutsedge suppression	Norflurazon 1.0-1.2 lb ai	Zorial 80DF 1.25-1.5 lb	See label for specific rates on various soils. Incorporate 2-3 inches deep. The full rate of Zorial may be incorporated or a half rate incorporated and a half rate applied preemergence. Rotate only to cotton, soybeans, or peanuts within 16 months of application. Do not rotate to corn or vegetable crops within 16 months of application. Provides suppression of yellow and purple nutsedges. May be tank mixed with trifluralin or pendimethalin. On light, sandy soils, low in organic matter, use the lower rate.

Table 24. Preemergence: Band application.

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Velvetleaf, spurred anoda, lambsquarters, and suppression of jimsonweed, spurge, prickly sida, common ragweed	Clomazone 0.5 lb ai	Command 3ME 21 oz	Command 3ME may be applied either banded at 7 oz/A (comparable to 21 oz/A broadcast) or broadcast at 21 oz/A. Use disulfoton or phorate organophosphate insecticides at 0.75 lb ai/A in furrow to protect against Command injury to cotton. Follow the Command label closely to prevent damage to desirable plants as a result of off-site movement. Observe buffer restrictions and do not apply within 1,500 feet of towns or housing developments, commercial fruit/nut or vegetable production, greenhouses, or nurseries. Fluometuron is generally still needed for improved control of annual weeds including pigweed species, common ragweed, common lambsquarters, and others, but should be applied at low labeled rates.

Table 25. Preemergence.

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Fair control of cocklebur, morninglories, jimsonweed, sicklepod, and tropic croton; good control of lambsquarters, pigweed species, prickly sida, ragweed	Fluometuron 1.0-2.0 lb ai	Cotoran 4L 1.0-2.0 qt or Cotoran 80DF 1.25-2.5 lb	Apply to soil surface after planting, before crop and weeds emerge. On light, sandy soils, low in organic matter, use no more than 1 lb ai/A. Not labeled for use on sandy or loamy sand soils. May be tank mixed with Zorial. Plant only cotton within 6 months of last application. See previous Zorial remarks.

Table 25. Preemergence. (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Annual grasses, yellow-nutsedge suppression	s-Metolachlor 0.71-0.95 lb ai	Dual Magnum 7.62EC 0.75-1 pt or Dual II Magnum 7.64EC 0.75-1.0 pt	Apply to soil surface at planting or after planting, but before weeds or crop emerge. **Do not incorporate.** Crop injury has been observed, especially when heavy rainfall is received shortly after planting or shortly after cotton emergence. Rates should be kept at the minimum for various soil types. Do not apply to sands or loamy sand soils. May be most useful in no-till cotton and for suppression of yellow nutsedge.
Controls most annual grasses and broadleaf weeds in conventional and reduced tillage production systems. Control or temporary suppression of many weeds including hemp dogbane, yellow nutsedge, and rhizome johnsongrass. Provides residual control of large crabgrass, goosegrass, fall panicum, foxtails, yellow-nutsedge suppression	Glyphosate 0.703-0.984 lb ae + s-Metolachlor 0.938-1.31 lb ai	Sequence 2.5-3.5 pt	Apply to soil surface at planting or after planting, but before crop emerges. **Do not incorporate.** Crop injury has been observed, especially when heavy rainfall is received shortly after planting or shortly after cotton emergence. Do not exceed 2.5 pt/A of Sequence on sandy-loam soils or 3.5 pt/A of Sequence on medium- or fine-textured soils. Do not apply to sands or loamy-sand soils. May be useful in no-till cotton and for suppression of yellow nutsedge.
Barnyardgrass, broadleaf signalgrass, carpetweed, crabgrass, fall panicum, Florida pusley, foxtails, goosegrass, johnsongrass seedlings, lambsquarters, pigweed, purslane, sandbur, Texas panicum, wild cane, shattercane	Pendimethalin 0.5-0.75 lb ai	Prowl 3.3EC 1.2-1.8 pt or Prowl H_2O 1.1-1.6 pt	Apply at planting or up to 2 days following planting to a firm seedbed.

Table 25. Preemergence. (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Redroot pigweed, smooth pigweed, prickly sida, spotted spurge, spurred anoda, velvetleaf, and suppresses jimsonweed, ladysthumb smartweed, Pennsylvania smart, several morningglory species	Pyrithiobac 0.031-0.042 lb ai	Staple Herbicide 0.6-0.9 oz	Use the higher rate for harder to control weeds but do not exceed 0.8 oz/A and do not use on soils with less than 0.5% organic matter. Staple Herbicide may be mixed with several other preemergence herbicides (Cotoran, Direx, Karmex, or Cotton Pro), taking care not to exceed recommended rates of these herbicides for soil types. Do not apply more than 2.4 oz Staple/A/ year.

Table 26. Postemergence over-the-top: Annual grasses.

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Barnyardgrass, broadleaf signalgrass, fall panicum, foxtails, johnsongrass seedlings, crabgrass, shattercane, Texas panicum, volunteer corn	Clethodim 0.094-0.125 lb ai + crop-oil concentrate	Select 2EC 6.0-8.0 oz or SelectMax 0.97EC 12.0-16.0 oz + COC 2.0 pt	Apply to actively growing grasses at the rate and size range indicated on the label for the individual grass species. Apply with 10-20 gal of water/A and 30-60 psi. Do not use flood type nozzles. Always add 2 pt/A crop-oil concentrate to Select. For SelectMax, add 0.25% nonionic surfactant, 1% crop-oil concntrate or 1% methylated seed oil. May be weak on goosegrass.
Barnyardgrass, broadleaf signalgrass, fall panicum, foxtails, johnsongrass, crabgrass, shattercane, Texas panicum, and volunteer corn	Sethoxydim 0.19-0.28 lb ai + crop-oil concentrate	Poast 1.5EC 1.0-1.5 pt or Poast Plus 1.5-2.25 pt + COC 2.0 pt	Apply to actively growing grasses at the rate and size range indicated on the label for the individual grass species with 10-20 gal of water/A and 40 psi. Do not use flood type nozzles. Always add 2 pt/A crop-oil concentrate.

Table 26. Postemergence over-the-top: Annual grasses. (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Barnyardgrass, broadleaf signalgrass, fall panicum, crabgrass, foxtails, johnsongrass seedlings, Texas panicum, goosegrass, shattercane and volunteer corn	Fluazifop-P 0.19 lb ai + crop-oil concentrate or nonionic surfactant	Fusilade DX 2EC 12.0 oz + COC 0.5-1.0% v/v or NIS 0.25% v/v	Apply to actively growing grasses at the rate and growth stage indicated on the label. Apply with a minimum of 10 gal of water/A and 30-60 psi. Do not use flood-type nozzles. Add 0.5-1.0% v/v crop-oil concentrate or 0.25% v/v nonionic surfactant to the spray mixture.
Barnyardgrass, broadleaf signalgrass, crabgrass, fall panicum, field sandbur, seedling johnsongrass, shattercane, Texas panicum, volunteer small grains	Fluazifop-P + fenoxaprop-P 0.12-0.16 lb ai + crop-oil concentrate or nonionic surfactant	Fusion 2EC 8.0-10.0 oz + COC 0.5-1.0% v/v or NIS 0.25-0.5% v/v	Apply to actively growing grasses at the rate and growth stage listed on the label in 5-20 gal water/A at 30-60 psi. Do not apply Fusion with recirculating sprayers, rope-wick applicators, controlled droplet applicators, or any similar devices. Add 0.5-1.0% v/v crop-oil concentrate or 0.25-0.5% v/v nonionic surfactant to the spray mixture.
Barnyardgrass, broadleaf, signalgrass, fall panicum, field sandbur, seedling johnsongrass, shattercane, Texas panicum	Quizalofop 0.034-0.055 lb ai + crop-oil concentrate or nonionic surfactant	Assure II 0.88EC 5.0-8.0 oz + COC 1.0% v/v or NIS 0.25% v/v	Apply to actively growing grasses at the rate and growth stage listed on the label. Apply with a minimum of 10 gal water/A and 25-60 psi. May be weak on crabgrass. See label for rate to control specific grasses.

Table 27. Postemergence over-the-top: Perennial grasses.

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Bermudagrass (wiregrass)	Clethodim 0.125-0.25 lb ai + crop-oil concentrate + (sequential trt on regrowth) Clethodim 0.125-0.25 lb ai + crop-oil concentrate	Select 2EC 8.0-16.0 oz or Select Max 0.97EC 12.0-32.0 oz + COC 2 pt + (sequential trt on regrowth) Select 2EC 8.0-16.0 oz or Select Max 0.97EC 12.0-32.0 oz + COC 2 pt	Apply to actively growing bermudagrass at the rate and stage indicated on the label. Apply the first application to bermudagrass with 3- to 6-inch runners. Apply regrowth treatments to bermudagrass with 3- to 6-inch runners. Always add 2 pt/A crop-oil concentrate to Select. For SelectMax, add 0.25 nonionic surfactant, 1% crop-oil concentrate, or 1% methylated seed oil.
	Fluazifop-P + fenoxaprop-ethyl 0.19 lb ai + crop-oil concentrate or nonionic surfactant + (sequential trt on regrowth) Flazifop-P + fenoxaprop-ethyl 0.12 lb ai + crop-oil concentrate or nonionic surfactant	Fusion 2EC 12.0 oz + COC 0.5-1.0% v/v or NIS 0.25-0.5% v/v + (sequential trt on regrowth) Fusion 2EC 8.0 oz + COC 0.5-1.0% v/v or NIS 0.25-0.5% v/v	Make first application to 4- to 8-inch runners. Apply a second treatment to 4- to 8-inch runners if regrowth occurs. Use a minimum of 15 gal/A spray solution. Add 0.5-1.0% v/v crop-oil concentrate or 0.25-0.5% v/v nonionic surfactant to the spray mixture.

Table 27. Postemergence over-the-top: Perennial grasses. (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Bermudagrass (wiregrass) (cont.)	Sethoxydim 0.28 lb ai + crop-oil concentrate + (sequential trt on regrowth) Sethoxydim 0.19 lb ai + crop-oil concentrate	Poast 1.5 pt or Poast Plus 2.25 pt + COC 2.0 pt + (sequential trt on regrowth) Poast 1.0 pt or Poast Plus 1.5 pt + COC 2.0 pt	Apply to actively growing grass. Apply first treatment to bermudagrass plants with runners less than 6 inches in length. Apply regrowth treatments to bermudagrass plants with runners less than 4 inches in length. Add 2 pt/A crop-oil concentrate per acre.
Bermudagrass (wiregrass), rhizome johnsongrass	Fluazifop-P 0.19 lb ai + crop-oil concentrate or nonionic surfactant + (sequential trt on regrowth) Fluazifop-P 0.125 lb ai + crop-oil concentrate or nonionic surfactant	Fusilade DX 2EC 12.0 oz + COC 0.5-1.0% v/v or NIS 0.25-0.5% v/v + (sequential trt on regrowth) Fusilade DX 2EC 8.0 oz + COC 0.5-1.0% v/v or NIS 0.25-0.5% v/v	Apply to actively growing johnsongrass 8-18 inches high. Apply regrowth treatments when johnsongrass is 6-12 inches high. Add 0.5-1.0% v/v crop-oil concentrate or 0.25-0.5% v/v nonionic surfactant to the spray mixture. OR Apply to actively growing bermudagrass with 4- to 8-inch runners. Apply regrowth treatments to bermudagrass with a runner length of 4-8 inches. Add 0.5-1.0% v/v crop-oil concentrate or 0.26-0.5% v/v nonionic surfactant to the spray mixture.

Table 27. Postemergence over-the-top: Perennial grasses. (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Bermudagrass (wiregrass), rhizome johnsongrass (cont.)	Quizalofop 0.07 lb ai + crop-oil concentrate or nonionic surfactant + (sequential trt on regrowth) Quizalofop 0.05 lb ai + crop-oil concentrate or nonionic surfactant	Assure II 0.88EC 10.0-12.0 oz + COC 1.0% v/v or NIS 0.25% v/v + (sequential trt on regrowth) Assure II 0.88EC 10.0 oz + COC 1.0% v/v or NIS 0.25% v/v	Apply to actively growing johnsongrass when 10 to 24 inches tall or bermudagrass with up to 6-inch runners. Apply regrowth treatments to 6 to 10-inch johnsongrass, or bermudagrass with 3 to 6-inch runners. Add 0.5-1.0% v/v crop-oil concentrate or 0.25-0.5% v/v nonionic surfactant to the spray mixture.
Rhizome johnsongrass	Clethodim 0.125-0.25 lb ai + crop-oil concentrate + (sequential trt on regrowth) Clethodim 0.094-0.16 lb ai + crop-oil concentrate	Select 2EC 8.0-16.0 oz or Select Max 0.97EC 12.0-32.0 oz + COC 2.0 pt + (sequential trt on regrowth) Select 2EC 6.0-8.0 oz or Select Max 0.97EC 12.0-32.0 oz + COC 2.0 pt	Apply to actively growing johnsongrass at the rate and stage indicated on the label. Apply the first application when johnsongrass is 12-24 inches high. Apply regrowth treatment to 6- to 18-inch johnsongrass. Always add 2 pt/A crop-oil concentrate to Select. For SelectMax, add 0.25 nonionic surfactant, 1% crop-oil concentrate, or 1% methylated seed oil.

Table 27. Postemergence over-the-top: Perennial grasses. (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Rhizome johnsongrass (cont.)	Fluazifop-P + fenoxaprop-ethyl 0.16-0.19 lb ai + crop-oil concentrate or nonionic surfactant + (sequential trt on regrowth) Fluazifop-P + Fanoxaprop 0.12 lb ai + crop-oil concentrate or nonionic surfactant	Fusion 2EC 10.0-12.0 oz + COC 0.5-1.0% v/v or NIS 0.25-0.5% v/v + (sequential trt on regrowth) Fusion 2EC 8.0 oz + COC 0.5-1.0% v/v or NIS 0.25-0.5% v/v	Make first application to actively growing johnsongrass before the boot stage and a second application when regrowth is 4-6 inches tall. Add 0.5-1.0 % v/v crop-oil concentrate or 0.25-0.5 % v/v nonionic surfactant to the spray mixture.
	Sethoxydim 0.28 lb ai + crop-oil concentrate + (sequential trt on regrowth) Sethoxydim 0.19 lb ai + crop-oil concentrate	Poast 1.5 pt or Poast Plus 2.25 pt + COC 2.0 pt/A + (sequential trt on regrowth) Poast 1.0 pt or Poast Plus 1.5 pt + COC 2.0 pt	Apply to actively growing johnsongrass. Apply first treatment to johnsongrass 15-20 inches high. Apply regrowth treatments to 6- to 10-inch johnsongrass.

Table 28. Early postemergence: Over-the-top.

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Controls most annual grasses and broadleaf weeds in conventional and reduced tillage production systems. Control or temporary suppression of many perennial weeds including bermudagrass, hemp dogbane, horsenettle, nutsedges, rhizome johnsongrass, trumpetcreeper.	Glyphosate 0.75-1.0 lb ai	Numerous brands and formulations	**FOR USE ONLY ON COTTON VARIETIES DESIGNATED ROUNDUP READY OR ROUNDUP READY FLEX.** Some brands of glyphosate are not registered for use on these varieties (see labels). For Roundup Ready cotton, glyphosate may be applied over-the-top from emergence to the four true leaf stage. For Roundup Ready Flex cotton, glyphosate may be applied throughout the season over-the-top although there are maximum allowable rates set for various stages of cotton development (see label). Separate all over-the-top applications by at least 10 days. Glyphosate will be most effective as a component of a program that includes use of standard preplant incorporated, preemergence, and postemergence herbicides. Adjuvant recommendations vary by glyphosate products. **See labels for specification. Observe all labels regarding seasonal maximums and take extreme caution to avoid drift to adjacent vegetation.**

Table 28. Early postemergence: Over-the-top. (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Controls many annual broadleaf weeds and suppresses annual grasses in conventional and reduced tillage production systems. Suppression may be expected of pigweed spp. and most grasses after just a single glufosinate application.	Glufosinate 0.42-0.55 lb ai	Ignite 280 2.43 lb ai/gal 22.0-29.0 fl oz	**FOR USE ONLY ON COTTON VARIETIES DESIGNATED LIBERTY LINK.** Apply postemergence over-the-top to cotton at emergence until the early bloom stage of cotton development. Most weeds require an initial Ignite 280 application of no less than 22.0 fl oz/A, and some biennial weeds may require an initial rate of 39 oz. Ignite 280 can be applied as a burndown herbicide prior to planting or prior to emergence of any conventional or transgenic cotton variety. Apply a minimum of 29.0 fl oz/A of Ignite 280 for burndown of existing weeds. For best results apply to emerged, young actively growing weeds. If environmental conditions prevent timely applications, a single burndown application of up to 43.0 fl oz/A of Ignite 280 may be made. If more than 29.0 fl oz/A are used in any single application, the season total may not exceed 72.0 fl oz/A including all application timings. If 29.0 fl oz/A are applied for burndown, two in-season maximum maybe made. If 30.0-42.0 fl oz/A of Ignite 280 are applied for burndown, a single in-crop application of 22.0-29.0 fl oz/A may be made for a total of 72.0 fl oz/A. See label for registered tank mixes with other labels and plant back intervals to rotational crops. The planting restriction to cotton or soybean is 0 days following application of Ignite 280; the restriction for small grains, root and tube vegetables, and leafy vegetables is 20 days and other crops are 180. Ignite 280 may be mixed with Dual or Staple herbicides for postemergence over-the-top applications to enhance weed control and/or provide residual control. **Extreme care must be used to avoid drift to adjacent crops or other desirable vegetation.** Do not graze or feed treated cotton. See label for more details.

Table 28. Early postemergence: Over-the-top. (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Controls most annual grasses and broadleaf weeds in conventional and reduced tillage production systems. Control or temporary suppression of many weeds including hemp dogbane, yellow nutsedge, and rhizome johnsongrass. Provides residual control of large crabgrass, goosegrass, fall panicum, foxtails, and the suppression of yellow-nutsedge.	Glyphosate 0.703-0.984 lb ae + s-Metolachlor 0.938-1.31 lb ai	Sequence 2.5-3.5 pt	**FOR USE ONLY ON COTTON VARIEITES DESIGNATED ROUNDUP READY.** Apply postemergence over-the-top to cotton that is 3 inches tall to the four-leaf stage of cotton development. Do not apply later or severe crop injury will occur, including yield loss. Do not exceed 2.5 pt/A of Sequence per application or 3.5 pt/A of Sequence per growing season. In Roundup Ready Flex cotton, glyphosate can be applied throughout the season with maximums from ground cracking to 60% open boll at 4 quarts (Roundup Weathermax) If tank mixing or applications follow other s-Metolachlor products, do not exceed 1.9 lb ai/A s-Metolachlor per season on coarse-textured soils. Over-the-top postemergence applications should not be made later than 100 days before harvest. At least 1/2 inch of rainfall is required within 10 days after application to activate the s-Metolachlor. Do not add additional spray adjuvants, surfactants, or fertilizers to Sequence when applied postemergence over-the-top, or unacceptable cotton injury may occur. USE EXTREME CARE TO AVOID DRIFT TO ADJCENT CROPS OR OTHER DESIRABLE VEGETATION. **Do not graze or feed treated cotton.**
Cocklebur and suppression of yellow nutsedge	MSMA 0.75-1.0 lb ai	MSMA Plus 1.0-1.25 pt MSMA 6Plus 1.0-1.25 pt MSMA 6.6 Plus 1.0-1.25 pt Weed-Hoe 108 1.0-1.25 pt	May be applied over-the-top of crop and weeds when cotton is 3 to 6 inches tall. Crop response may include stunting, stem reddening, and delay of maturity. Check label for surfactant recommendations.

Table 28. Early postemergence: Over-the-top. (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Cocklebur, jimsonweed, pigweed	Fluometuron 1.0 lb ai	Cotoran 4L 1.0 qt or Cotoran 80DF 1.25 lb	May be applied over-the-top of crop and weeds when cotton is 3 to 6 inches tall. For use only where crop loss due to weeds is likely. Moderate to severe crop injury may occur and may include maturity delay and yield reduction.
Large crabgrass, goosegrass, fall panicum, foxtails and suppression of yellow nutsedge	s-metolachlor 0.96-1.25 lb ai	Dual Magnum 1.0-1.3 pt	Apply over-the-top postemergence or directed to the soil surface to cotton at least 3 inches tall. Applications should be prior to weed emergence or after clean cultivation since Dual Magnum does not control emerged weeds. At least 1/2 inch of rainfall is required within 10 days after application. If rainfall does not occur, a shallow, uniform incorporation will improve control. Over-the-top postemergence applications should be made no later than 100 days before harvest and directed postemergence applications may be made no later than 80 days before harvest. TANK MIXTURES WITH TOUCHDOWN OR ROUNDUP CAN BE APPLIED TO ROUNDUP READY COTTON ONLY. Apply Dual Magnum as a tank mixture with Touchdown or Roundup in water postemergence directed according to Touchdown or Roundup labels for control of emerged weeds and for residual preemergence control of weeds listed on the Dual Magnum label. Do not add additional spray adjuvants, surfactants, fertilizers, or their additives to these tank mixtures if applied over-the-top, or unacceptable cotton injury may occur. Follow Dual Magnum instructions on the Dual Touchdown or glyphosate labels for rates, application methods, and application timing restrictions.

Table 28. Early postemergence: Over-the-top. (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Pigweed species, Pennsylvania smartweed, spurred anoda, velvetleaf, jimsonweed. May be weak against tall morningglory, common cocklebur, and prickly sida.	Pyrithiobac 0.065-0.095 lb ai + nonionic surfactant 0.25% v/v	Staple LX 2.6-3.3 oz + NIS 1.0-2.0 qt/100 gal	Apply Staple with 0.25% v/v nonionic surfactant to control small annual broadleaf weeds. Staple may be applied postemergence broadcast over-the-top of cotton, in a band over-the-top of cotton, or post-directed to cotton but over-the-top of weeds. Make applications to small, actively growing weeds after cotton has a true leaf. Cotton may be injured from Staple applied under cool, wet conditions. For best control, rainfall should not occur for 4 hours. See label.
Bristly starbur, common cocklebur, coffee senna, volunteer corn (non-IT/IR), Florida beggarweed, hemp sesbania, common lambsquarters, morningglory spp., common ragweed, redweed, sicklepod, velvetleaf, volunteer soybean (non-STS), wild poinsettia, yellow nutsedge	Trifloxy-sulfuron-sodium 0.0047-0.0070 lb ai + nonionic surfactant 0.25% v/v	Envoke 0.10-0.15 oz + NIS 1 qt/100 gal	Apply 0.10-0.15 oz/A Envoke with 0.25% v/v (1 qt/100 gal) non-ionic surfactant to control small annual broadleaf weeds listed. Envoke may be applied postemergence broadcast over-the-top of cotton, or post-directed to cotton but over-the-top of weeds. Make applications to small, actively growing weeds after cotton has a minimum of 5 true leaves. Cotton may be injured from Envoke applied under cool, wet conditions and if cotton is less than in the 5-leaf stage of growth. For best control, rainfall should not occur for 3 hours. The higher rates of Envoke may be required to adequately control yellow nutsedge and velvetleaf. Envoke tank mixed with glyphosate on Roundup Ready cotton can cause injury by way of boll loss, delayed maturity, and/or loss of yield. Sequential Envoke applications must be 14 days apart.

Table 28. Early postemergence: Over-the-top. (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Postemergence overtop of cotton with at least 5 true leaves. Compaired to Envoke alone, mix is beter on jimsonweed and spurred anoda. Compared to Staple alone, mixture is better on common ragweed, common lambsquarter, tall morning glory, and sicklepod.	Pyrithiobac 0.027-0.040 lb/A + Trifloxysulfuron-Sodium 0.007 lb ai + nonionic surfactant 0.25 % v/v	Staple LX 3.2lb/gal at 1.3-1.9 fl oz or Staple Herbicide at 0.5-0.75 oz/A + Envoke 0.15 oz + NIS 1 qt/100 gal	Use a minimum of 10.0 gal water/A and apply to cotton with at least 5 true leaves. Occasional yellowing of cotton leaves can occur but yields are not affected.

Table 29. Early postemergence directed: Cotton 3-6 inches tall (Post-directed recommendations are based on broadcast rates).

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Cocklebur, yellow nutsedge, purple nutsedge	*MSMA 2.0 lb ai	Various brands and formulations MSMA 2.66 pt (6.0 lb/gal formulations)	Apply as a directed spray to cotton at least 3 inches tall. Do not apply MSMA after first blooms appear. Refer to the product label to determine if surfactant should be added. Two applications/season may be made. May be tank mixed with fluometuron.
Cocklebur, jimsonweed, lambsquarters, morningglory, pigweed, ragweed	Fluometuron 1.0-2.0 lb ai + *MSMA 2.0 lb ai	Cotoran 4L 1.0-2.0 qt or Cotoran 80DF 1.2-2.4 lb + MSMA 2.66 pt (6.0 lb/gal formulations)	Apply as a directed spray to cotton at least 3 inches tall. Best results are obtained if applied to weeds 2 inches tall or less. Refer to the MSMA product label to determine if surfactant should be added.

**Do not apply MSMA tank mix after first bloom. Some brands of MSMA contain surfactant while others do not. Refer to product labels for information on surfactant use.*

Table 30. Late postemergence directed: Cotton 6-8 inches or larger (Post-directed recommendations are based on broadcast rates).

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Cocklebur, yellow nutsedge, purple nutsedge	*MSMA 2.0 lb ai	Various brands and formulations MSMA 2.66 pt (6.0 lb/gal formulations)	Apply as a directed spray. Do not apply MSMA after first blooms appear. Refer to the product label to determine if a surfactant should be added. Two applications/season may be made. Primarily controls nutsedge and cocklebur. May be tank mixed with dimethipin, fluometuron, lactofen, or oxyfluorfen to broaden the control spectrum.
Cocklebur, ragweed, jimsonweed, lambsquarters, pigweed, prickly sida, smartweed, morningglory (suppression)	Fluometuron 1.0-2.0 lb ai + *MSMA 2.0 lb ai	Cotoran 4L 1.0-2.0 qt or Cotoran 85DF 1.2-2.4 lb + MSMA 2.66 pt (6.0 lb/gal formulations)	Apply as directed spray. Use 1-1.5 lb ai/A fluometuron for weeds up to 3 inches tall. Apply with 4.0 pt/100 gal nonionic surfactant.
Ragweed, lambsquarters, pigweed, cocklebur, morningglory (suppression)	Linuron 0.5-1.5 lb ai	Linex 1.0-3.0 pt	Apply as a directed spray, at 1 pt/A when cotton is at least 12 inches tall and emerged weeds do not exceed 2 inches in height. Add 1 pt surfactant/25 gal spray mixture. If needed, a second application of same rate may be made 1 week or later after initial treatment. Alternatively, after cotton is 20 inches tall, make a single application of 2-3 pt/A following last cultivation; if emerged weeds are present, add surfactant as directed. Do not plant rotational crops other than corn, soybeans, or potatoes within 4 months after application.

** Do not apply MSMA tank mix after first bloom. Some brands of MSMA contain surfactant while others do not. Refer to product labels for information on surfactant use.*

Table 30. Late postemergence directed: Cotton 6-8 inches or larger (Post-directed recommendations are based on broadcast rates). (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Cocklebur, ragweed, jimsonweed, lambsquarters, pigweed, prickly sida, smartweed, tropic croton, velvetleaf, morningglory (suppression)	Oxyfluofen 0.25-0.5 lb ai + *MSMA 2.0 lb ai	Goal 2.0E 1.0-2.0 pt + MSMA 2.66 pt (6.0 lb/gal formulations)	Apply to cotton at least 6 inches tall (preferably 8-10 inches tall). Make 2 applications/season. Apply only with precision directed spray equipment. Do not exceed 0.5 lb ai/A oxyfluofen per year.
Cocklebur, ragweed, jimsonweed, lambsquarters, pigweed, prickly sida, smartweed, tropic croton, velvetleaf	Lactofen 0.2 lb ai + *MSMA 2.0 lb ai	Cobra 2EC 12.5 oz + MSMA 2.66 pt (6.0 lb/gal formulations)	Apply to cotton at least 6 inches tall. Apply with nonionic surfactant (2 pt/100 gal spray mix) or crop-oil concentrate (0.5 to 1 pt/A). Apply only with precision directed spray equipment. Make only one application of Cobra/season.
Cocklebur, ragweed, jimsonweed, lambsquarters, pigweed, prickly sida, smartweed, tropic croton, morningglory (suppression)	Prometryn 0.5-0.65 lb ai + *MSMA 2.0 lb ai	Caparol 4L 1.0-1.3 pt or Cotton-Pro 4L 1.0-1.3 pt + MSMA 2.66 pt (6.0 lb/gal formulations)	Apply to cotton at least 6 inches tall. Apply only with precision directed spray equipment.

** Do not apply MSMA tank mix after first bloom. Some brands of MSMA contain surfactant while others do not. Refer to product labels for information on surfactant use.*

Table 30. Late postemergence directed: Cotton 6-8 inches or larger (Post-directed recommendations are based on broadcast rates). (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Bristly starbur, common cocklebur, coffee senna, volunteer corn (non-IT/IR), Florida beggarweed, hemp sesbania, johnsongrass (seedling), morningglory spp., smooth pigweed, redroot pigweed, common ragweed, redweed, sicklepod, velvetleaf, volunteer soybean (non-STS), wild poinsettia, yellow nutsedge	Prometryn 0.790-1.185 lb ai + Trifloxy-sulfuron-sodium 0.007-0.0105 lb ai + nonionic surfactant 0.25% v/v	Suprend 1.0-1.5 lb	Apply 1.0-1.5 lb/A Suprend to control small annual broadleaf weeds listed and provide some residual control of these weeds. Suprend must be applied post-directed to cotton but over-the-top of weeds. Apply to cotton at least 6 inches tall and only with precision-directed spray equipment. Sequential Suprend applications must be at least 14 days apart. **Do not exceed 2.7 lbs/A of Suprend per growing season from all applications. Do no exceed a total of 0.0188 lb ai/A of trifloxysulfuron-sodium per growing season resulting from all applications of Suprend or Envoke. Do not exceed a total of 5.15 lb ai/A of prometryn per growing season resulting from all applications of Suprend, Caparol 4L, or Cotton-Pro 4L.** If these totals for trifloxysulfuron-sodium and/or prometryn are exceeded, injury to cotton may result in addition to alternations in crop rotation restriction intervals. With Suprend's limited activity on grass weeds, MSMA may be tank mixed with Suprend to improve the control of the grasses.
Common ragweed, jimsonweed, smartweed, pigweed, and others	Fomesafen 0.25-0.375 lb ai	Reflex 2E 1.0-1.5 pt	Apply as directed. Spray when cotton is at least 6 inches tall. All post-directed applications should avoid spray contact with any green nonbarked parts of cotton plants or foliage since unacceptable injury will occur. Apply Reflex in a minimum of 10 gallons spray solution per acre. Applications may be made broadcast (not overtop) or banded. Crop rotation is a minimum of 4 months for wheat and 10 months for corn. Do not apply within 70 days of harvest. See label for additional instructions including mixtures with other herbicides, adjuvants, etc. Do not apply Reflex over-the-top of emerged cotton.

** Do not apply MSMA tank mix after first bloom. Some brands of MSMA contain surfactant while others do not. Refer to product labels for information on surfactant use.*

Table 30. Late postemergence directed: Cotton 6-8 inches or larger (Post-directed recommendations are based on broadcast rates). (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Cocklebur, jimsonweed, lambsquarters, morningglory, pigweed, ragweed, sicklepod	Dimethipin 0.31-0.39 lb ai + *MSMA 2.0 lb ai + crop-oil concentrate	Harvade 5F 8.0-10.0 oz + MSMA 2.66 pt (6.0 lb/gal formulations) + COC 1 pt	Apply as a directed spray to cotton at least 10 inches tall for control of weeds less than 4 inches tall. Do not apply more than 10 oz/A/year for combined post-directed and defoliation applications. Apply with 1 pt/A crop-oil concentrate.

** Do not apply MSMA tank mix after first bloom. Some brands of MSMA contain surfactant while others do not. Refer to product labels for information on surfactant use.*

Table 31. Layby: Cotton at least 12 inches tall (Post-directed recommendations are based on broadcast rates).

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Cocklebur, jimsonweed, lambsquarters, morningglory, pigweed, ragweed, tropic croton	Flumeturon 1.0 lb ai	Cotoran 4L 1.0 qt or Cotoran 85DF 1.2 lb	Apply as a directed spray. Apply with a nonionic surfactant at 2 qt/100 gal spray solution. Do not apply within 60 days of harvest. Do not plant to rotation crops within 6 months of the last fluometuron application.

Table 32. Layby: Cotton at least 16 inches tall (Post-directed recommendations are based on broadcast rates).

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Lambsquarters, morningglory species, nightshade species, pigweed species, velvetleaf, spurred anoda, purslane, hemp sesbania, prostrate spurge, Pennsylvania smartweed	Carfentrazone 0.016-0.025 lb ai	Aim EC 1.0-1.6 oz	Aim may be applied lay-by in tank mixtures to cotton that is 16 inches or taller with sufficient bark development and height differential between the bottom crop leaves and the soil. Direct spray to avoid contact with green-stem tissue or foliage while achieving maximum coverage of broadleaf weeds. Always use crop-oil concentrate at 1% v/v (1 gal/100 gal of spray). Do not apply more than 3.2 oz of Aim total/A for post-directed and lay-by applications. For best control, apply to weeds up to 4 inches tall. When applied with glyphosate or MSMA, the combination will control larger morninglories, annual grasses, and yellow nutsedge. See directions and precautions on Aim label relative to potential cotton injury and sprayer cleanout.
Lambsquarters, morningglory species, nightshade species, pigweed species, velvetleaf, spurred anoda, purslane, hemp sesbania, prostrate spurge, Pennsylvania smartweed	Flumioxazin 0.064 lb ai	Valor SX 2.0 oz	Valor should only be applied to cotton that is 16 inches in height or taller with sufficient bark development and height differential between bottom crop leaves and the soil. Avoid contact with green stem tissue or foliage. Use an approved nonionic surfactant at one quart per 100 gallon spray soluion. Do not add crop oil, methylated seed oil, or organisilicone adjuvants to solution. When applied with MSMA, the combination will control larger morninglories, annual grasses, and yellow nutsedge. Follow sprayer cleanout directions closely after applying Valor.

Table 32. Layby: Cotton at least 16 inches tall (Post-directed recommendations are based on broadcast rates). (cont.)

Problem Weeds	Chemical rate per acre	Product per acre	Remarks & Precautions
Common cocklebur, common dayflower, dogfennel, Florida beggarweed, Florida pusley, hemp sesbania, common lambsquarters, annual morningglory spp., pigweed spp., prickly sida, purslane, common ragweed, redweed, sicklepod, smartweed, velvetleaf, most annual grasses	Linuron 0.4-0.5 lb ai + Diuron 0.4-0.5 lb ai	Layby Pro 1.6-2.0 pt	Apply 1.6-2.0 pt/A Layby Pro to control small annual broadleaf and grass weeds listed that are up to 4 inches tall; Layby Pro will also provide residual control of these susceptible weeds following the application. Layby Pro must be applied post-directed to cotton but over-the-top of weeds. Apply to cotton at least 16 inches tall and only with precision-directed spray equipment. The use of a nonionic surfactant at 2 qt/100 gal or a crop-oil concentrate at 1 gal/100 gal is recommended for the control of emerged weeds. Layby Pro can be tank mixed with Aim or MSMA to enhance the control of emerged weeds. Do not exceed the following Layby Pro rates: 1.6 pt/A for coarse soils and 2 pt/A on medium soils. Do not use Layby Pro on sand or loamy-sand soils, on soils with less than 1% organic matter, or within 76 days of harvest. Only cotton, corn, and grain sorghum can be planted the spring following the Layby Pro post-directed application. No other crops can be planted in the treated area within 1 year after the last Layby Pro application, or severe injury to subsequent crops may occur.

Table 33. Relative effectiveness* of grass-weed herbicides for cotton.

	Goosegrass	Broadleaf signalgrass	Crabgrass	Fall panicum	Foxtails	Johnsongrass (seedling)	Johnsongrass (rhizome)	Texas panicum	Purple & Yellow nutsedge	Shattercane	Bermudagrass
Preplant Incorporated											
Prowl	G	G	E	G	E	G	P	G	N	G	P
Treflan	G	G	E	G	E	G	P	G	N	G	P
Zorial	F-G	G	E	G	E	G	P	F	P	G	P
Preemergence											
Cotoran	F-G	P	F-G	F	G	P	P	P	P	P	P
Dual	F-G	P-F	F-G	F-G	F-G	P	N	P	P-F	P	N
Sequence	F-G	P-F	F-G	G-F	G-F	P	N	P	P-F	P	N
Zorial	G	G	E	G	E	G	P	F	P-F	G	P-F
Postemergence											
Assure II	E	E	F	E	E	E	E	E	N	E	G
Caparol/ Cotton-Pro	P	P	P	P	P	P	P	P	P	P	P
Cobra	P	P	P	P	P	P	P	P	P	P	P
Cotoran	P	P	P	P	P	P	P	P	P	P	P
Dual	N	N	N	N	N	N	N	N	P-F	N	N
Envoke	P	P	P	P	P	P	N	P	P-G	P	N
Fusilade	E	G-E	G	E	E	E	G-E	G	N	E	G-E
Fusion	E	E	G	E	E	E	G	G	N	E	G
Goal	G	G	G	G	G	P	P	P	F-G	P	P
Harvade	P	P	P	P	P	P	P	P	P-F	P	P
Ignite	G	G	G	G	G	G	P-G	G	P-G	F	P
Layby Pro	G-E	G-E	G-E	G-E	G-E	P	P	G-E	N	P	N
Linex	P	P	P	P	P	P	P	P	N	P	N
MSMA/ DSMA	G	G	G	G	G	G	F	P-F	F-G	G	P
Poast	E	E	G	E	E	E	G	E	N	E	F-G
Glyphosate	E	E	E	E	E	E	G	E	F-G	E	F
SelectMax	F	E	G	E	E	E	G	E	N	E	G
Sequence	E	E	E	E	E	E	G	E	F-G	E	P-F
Staple	N-P	N-P	N-P	N-P	N-P	N-P	N-P	N-P	N-F	N-P	N-P
Suprend	P	P	P	P	P	F	P	P	P-G	P	P

**E (Excellent) = 90% to 100% control, G (Good) = 80% to 90% control or better, F (Fair) = 60% to 80%control, P (Poor) = 20% to 60% control, N (None) = less than 20% control*

Table 34. Relative effectiveness* of broadleaf-weed herbicides for cotton.

	Cocklebur	Jimsonweed	Lambsquarters	Morningglory (annual spp)	Pigweed	Tropic Croton	Common Ragweed	Sicklepod	Smartweed	Spurred Anoda	Prickly sida or teaweed	Velvetleaf
Preplant Incorporated												
Prowl	N	N	G	P	G	P	N	N	P	N	N	P-F
Treflan	N	N	G	P	G	P	N	N	P	N	N	N
Zorial	F	P	G	F	F-G	G-E	G	P	F	G	G-E	F-G
Preemergence												
Command	P	G	G	P	P	F-G	F-G	N	F-G	G-E	F-G	E
Cotoran	F	F	E	F	G	F	G	F	F	F	F-G	F
Dual	N	N	P	N	G	N	P	N	P	G	N	P
Sequence	N	N	P	N	F	N	P	N	P	G	N	P
Zorial	F	F	G	F	F-G	G-E	G	P	G-E	G	G-E	F-G
Postemergence												
Aim	G	F	G	G	G	-	P	N-P	G	G	P	G
Assure II	N	N	N	N	N	N	N	N	N	N	N	N
Caparol/ Cotton-Pro	E	F-G	G	F	G	G	G-E	F	G	P	F-G	F
Cobra	E	G-E	P-F	P-F	E	F-G	G	P-F	F	F	E	G
Cotoran	E	F-G	G	F	G	P-F	G-E	F	G	P	F-G	P
Envoke	E	E	G-E	E	G-E	P-G	G-E	E	-	P-F	F-G	G
Fusilade	N	N	N	N	N	N	N	N	N	N	N	N
Fusion	N	N	N	N	N	N	N	N	N	N	N	N
Goal	E	E	G	G	E	E	G	G	E	F	E	E
Harvade	G	G	G	G-E	G	F-G	G	G	F-G	F-G	G	F-G
Ignite	E	E	G-E	E	F-G	E	E	E	E	G-E	E	G-E
Layby Pro	G-E	G	G-E	G-E	G-E	F-G	G-E	G-E	G-E	P-F	G-E	G-E
Linex	G	G	G	F-G	G-E	P-F	F-G	G	F	P	F-G	P-F
MSMA/DSMA	E	F	P-F	P	P-F	P-F	F	P	P	P	P	P
Poast	N	N	N	N	N	N	N	N	N	N	N	N
Glyphosate	E	E	F-G	F	G-E	G	F	G-E	F	G	F-G	G
SelectMax	N	N	N	N	N	N	N	N	N	N	N	N
Sequence	E	E	F-G	F	G-E	G	F	G-E	G	G	F-G	G
Staple	G-E	E	P	G	E	N	P	N-P	G-E	F-G	F-G	E
Suprend	E	E	G-E	E	G-E	P-G	G-E	E	G	G	F-G	G
Valor	G	F	G	G	G	–	P	N-P	G	G	P	G

**E (Excellent) = 90% to 100% control, G (Good) = 80% to 90% control or better, F (Fair) = 60% to 80% control, P (Poor) = 20% to 60% control, N (None) = less than 20% control*

Table 35. Burndown herbicides for stale seedbed and conservation tillage cotton for application 30 to 40 days prior to planting.

	Herbicide & Rate per Acre				
Weed Species/ Cover Crop	**2-4,D[1] 1 pt**	**Gramoxone Inteon 1.66 pt**	**Glyphosate (see labels for rates)**	**Harmony Extra[2] 0.5 oz**	**Valor SX[3] 1.0-1.5 oz**
Annual grasses	N	G-E	E	P	P
Carolina geranium	P-F	G-E	P-F	G	G
Chickweed, common	P	E	G	E	P
Curly dock	F-G	N	P-F	G	P
Cutleaf evening primrose	G	P	P	E	G
Henbit	P	G	G	E	F-G
Horseweed (marestail)	P-F	P	G	G	P
Wheat/rye	N	E	E	P	P
Wild mustard	G-E	P-F	F	G	F
Wild radish	G-E	P-F	F	G	F

E (Excellent) = 90% to 100% control G (Good) = 80% to 90% or better, F (Fair) = 60% to 80%, P (Poor) = 20% to 60%, N (None) = less than 20%.

[1]Apply at least 30 days prior to planting.

[2]Apply at least 45 days prior to planting.

[3]Apply at least 30 days prior to planting (tank mixed with glyphosate products).

Table 36. Burndown herbicides for stale seedbed and conservation tillage cotton for application 7 to 21 days prior to planting.

	Herbicide & Rate per Acre		
Weed Species/ Cover Crop	**Clarity[1] 8 oz**	**Gramoxone Inteon 1.66 pt**	**Glyphosate (see labels for rates)**
Annual grasses	N	G-E	E
Carolina geranium	G	G-E	P-F
Chickweed, common	P-F	E	G
Curly dock	F-G	N	P-F
Cutleaf evening primrose	F-G	P	P
Henbit	F	G	G
Horseweed (marestail)	F	P	G
Wheat/rye	N	E	E
Wild mustard	F	P-F	F
Wild radish	F	P-F	F

E (Excellent) = 90% to 100% control, G (Good) = 80% to 90% or better, F (Fair) = 60% to 80%, P (Poor) = 20% to 60%, N (None) = less than 20%.

[1]Following application of Clarity a minimum accumulation of 1-inch rainfall or irrigation water and a waiting interval of 21 days is required prior to planting cotton.

Table 37. Application rates and perennial grass sizes for treatment with Assure, Fusilade DX, Fusion, Poast, Poast Plus, and Select.[a]

		Weed size and herbicide rate (oz/A)	
Herbicide[b]	**Weed**	**First Application**	**Second Application[c]**
Assure II	Rhizome johnsongrass	10-24 inches tall 5.0 oz	6-10 inches tall 5.0 oz
	Bermudagrass	up to 6-inch runners 10.0-12.0 oz	up to 6-inch runners 7.0 oz
Fusilade DX	Rhizome johnsongrass	8-18 inches tall 12.0 oz	6-12 inches tall 8.0 oz
	Bermudagrass	4- to 8-inch runners 12.0 oz	4- to 8-inch runners 8.0 oz
Fusion	Rhizome johnsongrass	8-18 inches tall 10.0-12.0 oz	6-12 inches tall 8.0 oz
	Bermudagrass	4- to 8-inch runners 12.0 oz	4- to 8-inch runners 8.0 oz
Poast	Rhizome johnsongrass	15-25 inches tall 24.0 oz	6-12 inches tall 16.0 oz
	Bermudagrass	6-inch runners 24.0 oz	4-nch runners 16.0 oz
Poast Plus	Rhizome johnsongrass	15-25 inches tall 36.0 oz	6-12 inches tall 24.0 oz
	Bermudagrass	6-inch or less runners 36.0 oz	4-inch runners 24.0 oz
Select	Rhizome johnsongrass	12-24 inches tall 8.0-16.0 oz	6-18 inches tall 6.0-8.0 oz
	Bermudagrass	3- to 6-inch runners 8.0-16.0 oz	3- to 6-inch runners 8.0-16.0 oz
SelectMax	Rhizome johnsongrass	12-24 inches tall 12.0-16.0 oz	6-18 inches tall 9.0-24.0 oz
	Bermudagrass	3- to 6-inch runners 12.0-32.0 oz	3-6 inches tall 12.0-32.0 oz

[a]Taken from product labels.
[b]Rain-free period is 1 hour after application for each herbicide listed.
[c]Make second application only if needed to control regrowth or new plants. Size refers to regrowth or new plants.

Table 38. Application rates and annual grass sizes for treatment[1] with Assure II, Fusilade DX, Fusion, Poast, Poast Plus, and Select.[2]

Species	POAST		POAST PLUS		FUSILADE DX		FUSION		ASSURE II		SELECT		SELECT MAX	
	Height (in)	Rate (oz/A)	Height (in)	Rate (oz/A0	Height (in)	Rate (oz/A)	Height (in)	Rate (oz/A)	Height (in)	Rate (oz/A)	Height (in)	Rate (oz/A)	Height (in)	Rate (oz/A)
Barnyardgrass	8	16	8	24	2-3	12	2-4	8	2-6	8-10	2-8	6-8	2-8	9-16
Broadleaf signalgrass	8	16	8	24	2-4	12	2-4	8-10	2-6	10	2-6	6-8	2-6	9-16
Crabgrass	6	16	6	24	1-2	12	1-4	8	2-6	8-10	2-6	6-8	2-6	9-16
Crowfootgrass	–	–	–	–	–	–	–	–	2-6	7-8	2-6	6-8	2-6	9-16
Fall panicum	8	16	8	24	2-6	12	2-6	8	2-6	7-8	2-8	6-8	2-6	9-16
Foxtails, giant	8	16	8	24	2-6	12	2-8	6	2-8	7-8	2-12	6-8	2-12	9-16
Foxtails, Green	8	16	8	24	2-4	12	2-4	6	2-4	7-8	2-8	6-8	2-8	9-16
Foxtails, Yellow	8	16	8	24	2-4	12	2-4	6	2-4	7-8	2-8	6-8	2-8	9-16
Goosegrass	6	16	6	24	2-4	8	2-4	8	2-6	7-8	2-6	6-8	2-6	9-16
Seedling johnsongrass	8	16	8	24	2-8	6	2-8	6	2-8	5-8	4-10	6-8	4-10	9-16
Sandbur	3	20	3	30	2-6	12	2-6	8	2-6	7-8	2-6	6-8	2-6	9-16
Shattercane	18	16	18	24	6-12	6	6-12	6	6-12	5-8	4-10	6-8	4-10	9-16
Texas panicum	8	16	8	24	2-8	12	2-8	8	2-4	8-10	2-6	6-8	2-6	9-16
Volunteer corn	20	16	20	24	12-24	6	12-24	6	6-18	5-8	4-12	4-6	4-12	6-12

[1]Rain-free period is 1 hour after application for each herbicide listed.
[2]Taken from product labels; "–" control not claimed on label.

Table 39. Rotational restrictions.

Herbicide[1]	Rotation Restrictions
Aim	Corn, sweet corn, popcorn, soybeans, grain sorghum, rice, wheat, barley, oats, buckwheat, pearl millet, proso millet, rye, teosinte, tritcale, and wild rice may be planted any time following an application of Aim. Root and leafy vegetables may be planted after 30 days following application. All other crops may be planted after 12 months following application.
Assure II	Do not rotate to crops other than soybeans or cotton within 120 days of application. See label for additional rotational crops allowed.
Caparol/ Cotton-Pro	Do not plant rotational crops until the following year.
Cobra	No crop rotation restrictions.
Command	Rotate to crops as listed on label or crop injury may occur. Cover crops may be planted anytime but stand reductions may occur.
Cotoran	Do not plant crops other than cotton within 6 months of the last application of Cotoran/Meturon.
MSMA/DSMA	No restrictive statements listed on label.
Dual	Barley, oats, rye, or wheat may be planted 4.5 months following application. Alfalfa may be planted 4 months after application and tomatoes may be planted 6 months after application. Any crop listed on the label may be planted 12 months after application.
Envoke	See label for specific crop restrictions.
Fusilade DX	Do not plant rotational grass crops such as corn, sorghum, and cereals within 60 days of last application.
Fusion	Do not plant rotational grass crops such as corn, sorghum, and cereals within 60 days of last application.
Glyphosate	No rotational restrictions.
Goal	Do not rotate to barley, corn, oats, sorghum, tritcale, or wheat with 10 months following application. Do not direct seed any crops other than Goal-labeled crops, within 60 days of treatment. Do not transplant seedling crops, other than Goal-labeled crops within 30 days of treatment.
Harvade	Do not plant rotational crops within 6 months after application.

[1]The herbicides listed, when used in cotton, may have a negative impact on your ability to rotate crops in a normal fashion. The labeled rotational intervals discussed may be influenced by many factors, such as the addition of other residual herbicides, soil type, soil pH, etc. Do not use these herbicides unless you understand all rotational restrictions.

Table 39. Rotational restrictions. (cont.)

Herbicide[1]	Rotation Restrictions
Ignite 280	Canola, corn, cotton, rice, soybeans, and sugar beets may be planted at any time. Root and tuber crops, leafy vegetables, and small grains may be planted in 70 days. All other crops may be planted in 180 days.
Layby Pro	Only cotton, corn, and grain sorghum can be planted the spring following the Layby Pro post-directed application. All other crops cannot be planted in the treated area within 1 year after the last Layby Pro application, or severe injury to subsequent crops may occur.
Linex	Do not plant rotational crops other than corn, soybeans, or potatoes within 4 months after application.
Poast/Poast Plus	No rotational restrictions.
Prowl	Winter wheat or winter barley may be planted 120 days after application. Any crop other than sugar beets, red beets, or spinach may be planted the year following application.
Reflex	Cotton, dry beans, snap beans, and soybeans may be planted any time after last Reflex application. Small grains may be planted in 4 months; corn, peanuts, peas, rice, and seed corn in 10 months. To avoid injury, do not plant alfalfa, sunflower, sugar beets, sorghum or any other crop within 18 months after last Reflex application. A maximum of 1.5 pt/A of Reflex may be applied in alternate years in Region 2 (Virginia).
Select/ Select Max	No rotational restrictions.
Sequence	Barley, oats, rye, or wheat may be planted 4.5 months following application. Alfalfa may be planted 4 months after application and tomatoes may be planted 6 months after application. Any crop listed on the label may be planted 12 months after application.
Staple	Crop rotation interval restrictions for Staple are as follows: winter wheat (4 months); field corn, peanut, soybean, and transplanted tobacco (10 months); and all other crops are based on field bioassay or a minimum 10 months. If there is a cotton crop failure following a Staple application, cotton may be replanted anytime (without disturbing original seedbed) or STS-soybean (sulfonylurea tolerant soybean) may be replanted 30 days after the Staple application.

[1]The herbicides listed, when used in cotton, may have a negative impact on your ability to rotate crops in a normal fashion. The labeled rotational intervals discussed may be influenced by many factors, such as the addition of other residual herbicides, soil type, soil pH, etc. Do not use these herbicides unless you understand all rotational restrictions.

Table 39. Rotational restrictions. (cont.)

Herbicide[1]	Rotation Restrictions
Suprend	Crop rotation interval restrictions based on a total of 2.69 lb/A of Suprend (0.0188 lb ai/A of trifloxysulfuron-sodium) per season are as follows: winter wheat and transplanted tomato (3 months); cotton, field and sweet corn, grain sorghum, peanut, soybean, and transplanted tobacco (7 months); transplanted bell pepper and Irish potato (12 months but based on field bioassay); and all other crops (18 months). If there is a cotton crop failure and no more than 1.0 lb/A of Suprend has been applied, cotton or STS-soybean (sulfonylurea tolerant soybean) may be replanted 30 or more days after the Suprend application, or 14 more days after the first significant rainfall (≥ 0.5 inches) following the Suprend application.
Treflan	Sugar beets, red beets, or spinach should not be planted within 12 months of a spring applications. Vegetable crops other than those listed on the Treflan label should not be planted within 5 months of application.
Valor	Crop rotation interval restrictions based on a total of 2 oz/A of Valor per season are as follows: cotton, field corn, sorghum, sunflower, tobacco, and wheat (30 days); barley, dry bean, field pea, rye, and sweet corn (4months); alfalfa, canola, clover, oats, and all other crops not listed (12 months). At least one inch of rainfall/irrigation must occur between application and planting or crop injury may occur. Successful soil bioassay must be performed prior to planting alfalfa, canola, sugar beets, and other crops not listed.
	Preplant burndown applications of Valor 51 WDG may injure cotton if planted too soon. Valor at 1.0 oz/A will give 2 to 4 weeks control of lambsquarter, pigweed, prickly sida, spurge, and Florida pusley; and at 2.0 oz/A will give 6 to 8 weeks control of these species. Application to cover crop or dense weed stand may reduce residual control. Tillage after application will reduce or eliminate residual control. A minimum of 14 days and a 1-inch rainfall must occur between Valor application and cotton planting when Valor is applied at 1.0 oz/A; 21 days must pass and a 1-inch rainfall when applied at 1.5 to 2.0 oz/A. Valor at 2.0 oz/A may be applied up to 14 days prior to planting strip-till cotton. A tillage application must occur between application and cotton planting in order to prevent any potential injury to emerging cotton plants. Failure to conduct strip-tillage operation prior to planting may result in cotton injury. Strip-tillage operation must incorporate soil to a depth of 1 to 2 inches.
Zorial	Rotate only to cotton, soybeans, or peanuts within 16 months of application.

[1]The herbicides listed, when used in cotton, may have a negative impact on your ability to rotate crops in a normal fashion. The labeled rotational intervals discussed may be influenced by many factors, such as the addition of other residual herbicides, soil type, soil pH, etc. Do not use these herbicides unless you understand all rotational restrictions.

COTTON HARVEST-AID SUGGESTIONS

Henry Wilson, Extension Weed Scientist, Eastern Shore AREC

Although the cliché has been overused, defoliation is truly "an art and a science." Selecting harvest aids can be one of the toughest but most critical decisions a producer will make all year. At this point in the season, the producers' investments in the crop have peaked, and timing is also critical. Unfortunately, there is no one encompassing prescription. Producers have to assess their current situations and environmental conditions and make adjustments.

Boll maturity should be an important part of the decision. Once the leaves are removed, the bolls will come close to, or altogether cease maturation. The goal of defoliation is to eliminate leaves from the plant. To do this, the harvest aid must not kill the leaf immediately, but keep it alive long enough to form an abscission zone that allows leaf and petiole separation from the plant. If the leaf desiccates too rapidly, the leaves will stick to the plant, possibly resulting in grade reductions.

Advantages associated with harvest-aid applications prior to harvest include: increased harvester efficiency, reduced leaf and trash content in harvested lint, and quicker drying of dew from the lint surface. This can increase picking hours, retard boll rot, straighten lodged plants, maintain or improve certain fiber quality characteristics (trash content, micronaire, color, etc.), and stimulate boll opening (increased earliness). Weed control afforded by defoliants with desiccating activity can also increase harvest efficiency.

Factors that influence defoliation include environmental and crop conditions, crop maturity, and harvest scheduling. Harvest scheduling is especially important in Virginia where most cotton producers also have a valuable peanut crop to harvest. Due to changes in the weather and the crop, the appropriate harvest-aid materials and rates are subject to rapid change.

Defoliants should be applied in the morning or late afternoon when the wind is calm and humidity is high. In general, defoliants work best when nighttime temperatures are above 60˚ to 65˚F. Most defoliants are not mobile in the plant and therefore complete coverage is essential.

Defoliation Timing

Properly timing defoliation involves balancing the value of potential increases in yield with the value of changes in fiber quality. Early defoliation can be critical in maximizing yield. Delaying defoliation increases the risks of yield loss due to damaging early frosts and late season inclement weather, both of which are possible in the Virginia cotton-growing region. However, delaying defoliation allows immature bolls to develop, thus enhancing yields. Defoliating too late or too early may negatively impact fiber quality, including micronaire and staple. Several methods for timing defoliation can be used.

Using the percentage of open bolls is one method for timing defoliation. The traditional recommendation for harvest-aid application has been 60 percent open boll in most areas. Research has demonstrated that most varieties can be defoliated between 40 percent to 60 percent open boll without adversely affecting yield or micronaire. This method, focusing on the opened portion of the crop, has two disadvantages, one being that it does not account for fruiting gaps and the second being the time it takes to perform this measurement. Percent open boll can be measured by marking a section of row (e.g., 10 feet) and counting the number of total bolls within that row distance. Then, the open bolls are counted. The number of open bolls divided by the total bolls times 100 is the percent open boll for that area. Keep in mind, that number only represents the area measured and may not be representative of the entire field. Also, the bolls counted should only include harvestable bolls. Bolls where anthesis (flowering) took place prior to August 15 should be considered harvestable in a typical year. As defoliation nears, questionable bolls can be tested with the sharp knife technique to determine harvest potential. If the boll is very difficult to cut in cross sections, seed coats are brown to black, and no jelly is present within the seed walls, the boll is at a point where harvest-aid application will not negatively impact its yield potential.

Nodes above cracked boll (NACB) is a method of timing defoliation whereby only plants containing a first-position cracked boll are observed. Beginning with the node (branch) above the sympodial (fruiting) branch containing the highest first position cracked boll, nodes are counted upward **to the node containing the highest harvestable boll** (see above). The number of nodes traversed equals the NACB. Research has demonstrated that an optimal time to apply harvest aids relative to changes in yield and micronaire is when the crop reaches NACB < 3. This method, in contrast to the percent open boll method, focuses on the unopened portion of the crop. One advantage of this method is that it takes less time than percent open boll. Like all methods of defoliation timing, measurements need to be taken in numerous areas of the field to accurately represent the overall condition.

Harvest Timing

Harvest timing is also an important part of managing for yield and fiber quality. As cotton harvest is delayed, open bolls can be exposed to adverse weather conditions. Research has demonstrated that rainfall during the harvest period can cause significant yield losses and fiber-quality discounts.

In years when the reproductive cycle is completed but plants continue to grow vegetatively at the end of the season, regrowth may become an issue and it will be important to carefully coordinate defoliation with the time you anticipate harvesting. Unless you intend to come back with a second application to control regrowth, apply a chemical that controls regrowth, defoliating only what you can pick in 10 to 14 days.

In some cases, picking without defoliating may be an option. If cotton is completely cutout and has dropped leaves naturally (possibly older, tough leaves remaining), cotton harvested with care may not require defoliation to eliminate leaf trash and prevent excess staining. If the decision is made to not defoliate,

avoid picking too early or late in the day as this may result in excessive moisture. Producers are strongly urged to harvest an adequate sample to evaluate effects on ginning efficiency prior to performing this on a large scale.

Product Selection - General

As mentioned, the objectives of harvest-aid applications include defoliation, inhibition of regrowth, boll opening, and weed desiccation. There are few stand-alone products that can accomplish all objectives and tank-mix combinations typically are required. Harvest-aid compounds have either herbicidal or hormonal activity. Herbicidal compounds (Aim, Def, Folex, Harvade, ET) injure the plant, reduce auxin levels, and stimulate ethylene production. Ethylene is a hormone that causes the leaf petiole to form an abscission layer and ultimately, drop from the plant. If herbicidal defoliants kill the leaf before the abscission zone is formed, leaves are likely to "stick." Dropp, FreeFall, Finish, FirstPick, and Prep are examples of hormonal defoliants. Through several methods, they promote synthesis of ethylene in the plant.

Defoliation Materials

DEF 6, Folex

These phosphate-based compounds have been a standard defoliant for many years and provide good defoliation of older more mature leaves in well cutout (mature) cotton. These products provide minimal regrowth inhibition and are typically mixed with other products (e.g. ethephon, Prep, Super Boll, etc.). They are similar in efficacy and will perform well over a wide range of environmental conditions. However, the high end of the labeled rate performs best in cool conditions. Leaf drop is fast and they only require a rain-free period of two hours. The activity of these compounds improves with increased cutout of the crop. The addition of surfactants or crop oils can increase activity under adverse conditions. The pungent odor of these products may be a consideration in populated areas.

Dropp SC, Freefall, etc. (thidiazuron)

Dropp and FreeFall defoliate mature leaves, have excellent activity on juvenile leaves, and suppress or delay regrowth. A minimum of 1.6 SC fl oz/A is needed for ten to 14 days of regrowth inhibition. Higher rates will result in longer periods of regrowth inhibition. Thidiazuron alone is usually equal to or better than other defoliants in drought-stressed situations where leaves have thicker cuticles. Dropp and FreeFall are somewhat slower acting than other defoliants and their activity is temperature dependent. Temperatures less than 65°F will reduce activity; however, the addition of crop-oil concentrate, or a phosphate-type defoliant will help the activity of thidiazuron under cooler conditions. The addition of 2 to 4 oz/A of DEF or Folex will shorten the required 24-hour rain-free period. The label provides specific tank clean-out procedures when using thidiazuron. This strategy avoids the premature defoliation associated with sprayer use the following year. When thidiazuron is tank mixed with a phosphate-type defoliant or insecticide, the label recommends a surfactant to aid in tank clean out.

Ginstar

Ginstar is a premix emulsifiable concentrate of thidiazuron (active ingredient in Dropp and Freefall) and diuron. Ginstar has been found to be more active under cool conditions than most thidiazuron containing materials. Ginstar is a strong inhibitor of terminal regrowth. It is more likely to cause unwanted desiccation and sticking of cotton leaves than thidiazuron alone. Tank mixing and higher rates increase the potential for leaf sticking. Labeled rates are 6.4 to 16 oz/A and growers are cautioned not to exceed 8 oz with this product until more information is available from Virginia. Growers are cautioned that rates in excess of 10 oz have shown a tendency to desiccate leaves. The label does not allow mixing of phosphate type defoliants (DEF, Folex). However, ethephon-containing materials (Prep, SuperBoll, Finish, FirstPick, etc.) can be tank mixed at low rates for enhanced defoliation. The use of adjuvants with Ginstar is not recommended. Research in Virginia with this product is limited. *Pay attention to the label for Virginia, some other state labels differ greatly. Pay close attention to rotational restrictions on the label.*

Harvade (dimethipin)

Harvade is an herbicidal-type defoliant that provides effective defoliation of mature leaves but minimal inhibition of terminal regrowth. It has little activity on emerged juvenile growth. Harvade is less temperature-sensitive than phosphate defoliants and is reported to have better activity at lower temperatures. In combinations with ethephon, it has demonstrated the ability to desiccate morning glory and prickly sida. The addition of 1 pt/A of crop oil is required by the federal label and is needed for acceptable defoliation. Harvade needs a 6-hour rain-free period following application. **Pay attention to precaution statements on label.**

Leafless

Leafless is a combination of the active ingredients in Dropp/Freefall (thidiazuron) and Harvade (dimethipin). It combines effective defoliation of mature leaves (dimethipin) with regrowth inhibition and removal of juvenile growth (thidiazuron). Limited research is available for this product in Virginia. The recommended rate of 10 to 12 oz/A delivers the equivalent of 0.125 to 0.15 lb. Dropp/FreeFall and 6.4 to 7.7 oz/A Harvade. If morning glory desiccation is desired, additional Harvade can be added. Crop-oil concentrate at 0.5 to 1.0 pt/A should be added to Leafless for acceptable activity.

Aim, ET, Blizzard, and Resource

These products have different active ingredients (carfentrazone, pyraflufen, fluthiacet, and flumiclorac, respectively) but similar modes of actions. They are all contact herbicidal defoliants that do not appear to be extremely temperature sensitive. Research indicates they can cause excessive desiccation at high rates under warm conditions where rank, juvenile growth is not present. They perform best in well-cutout cotton and can be beneficial when used as a second application. They provide regrowth control but have no residual activity and are good morning glory desiccants. These products can be mixed with most other defoliants/boll openers. See labels for adjuvant requirements and use restrictions.

Finish

Finish contains the active ingredient in Prep (ethephon) and a synergist (cyclanilide) that aids in defoliation. Finish tends to open bolls more rapidly than Prep alone and thus shortens time to harvest. It is less temperature sensitive than most products. In situations where regrowth or added defoliation is needed, thidiazuron (Dropp, FreeFall, etc.) and/or DEF/Folex should be added to the tank.

FirstPick

FirstPick weighs 12.45 lb/gal and contains 2.28 lb of ethephon (Prep) and 7.30 lb of a synergist (AMADS). Like Finish, it is an excellent boll opener. Acceptable defoliation with FirstPick typically occurs within seven days in well-cutout cotton containing mature leaves. FirstPick also provides limited control of terminal regrowth. Where thick regrowth is a concern, add thidiazuron (Dropp, Prepp, etc.). DEF/Folex may be added to enhance defoliation of juvenile or rank growth. Thorough rinsing of the tank is recommended following application.

Roundup (glyphosate, many formulations)

Glyphosate can be applied as a harvest-aid material. Tank mixed with defoliants or ethephon, it provides regrowth inhibition in conventional (non-Roundup Ready) cotton. It also provides excellent control of perennial grasses. Check specific product labels for registrations as a harvest aid.

Sodium chlorate

Sodium chlorate is most effective in defoliating mature leaves although it is not good at removing juvenile growth and provides no regrowth inhibition. However, sodium chlorate may be the best defoliant choice when temperatures are below 55˚F. Application should not be made before cotton has 85 percent or greater open bolls. *At higher rates, sodium chlorate tends to stick cotton leaves. It is not safe to tank mix sodium chlorate with other defoliants, oils, surfactants, or insecticides due to the potential for formation of toxic fumes. Limited research exists on this product in Virginia.*

Boll-opening Materials

Although some boll openers are used to enhance the activity of defoliants, they typically are used to hasten the maturity of boll opening. Boll openers are meant to open mature bolls and can alter micronaire and fiber length if applied too early. They are not systemic, making thorough coverage essential. Boll openers are most beneficial for cotton that needs to be picked between 7 to 14 days following application. The active ingredient in Prep (ethephon) is also found as a premix in several products but is below the boll-opening rate. Check labels to make sure the boll-opening rate is applied, if this is the objective.

Ethephon 6, Prep, Super Boll, Cottonquik, Finish (ethephon)

With adequate spray coverage, ethephon products expedite natural boll opening. While ethephon can enhance defoliation, tank mixing with products such

as DEF, Folex, Dropp, FreeFall, Ginstar, ET, Blizzard and/or Aim is necessary for acceptable defoliation and/or regrowth control. Allow at least seven days following application before harvest for optimum boll-opening effect. If cotton is not picked within 14 days following application, there is likely no advantage to ethephon use. FirstPick and Finish are combinations of ethephon and a synergist to increase defoliation and speed boll opening over ethephon alone. Bolls that are not mature at the time of application have little chance of opening in 14 days regardless of ethephon use. *Do not mix with sodium chlorate due to the potential for toxic fume formation.*

Gramoxone Max, Gramoxone Extra, and Starfire (paraquat)

Paraquat can enhance defoliation of juvenile growth when applied in combination with other defoliants although it will not inhibit regrowth. It can stimulate boll opening. High rates may result in excessive desiccation and "freezing" of closed bolls. It also can be used as a spot treatment for weed desiccation. It should not be applied at weed desiccation rates before cotton is at least 90 percent open and the remaining 10 percent is mature. It is necessary to pick within seven days following paraquat application to avoid bark contamination. *Consult the label for use rates and pay close attention to precautions.*

Defoliating Cotton under Adverse Conditions

Drought-stress

Dryland cotton producers are often faced with the task of defoliating drought-stressed cotton. When soil moisture conditions become low and daytime temperatures are above 90°F, cotton can quickly become stressed. Because the leaves of drought-stressed cotton often have thick cuticles that inhibit uptake of many defoliants, the response of cotton to defoliants can be less than desirable. Additionally, the potential for regrowth often is high due to residual nitrogen and early cutout. The uptake of thidiazuron-containing products (i.e. Leafless and Ginstar) can be reduced in drought-stressed cotton, thus higher rates may be required. Research suggests uptake of certain thidiazuron containing products can be higher in drought-stressed cotton than thidiazuron alone (Dropp or FreeFall). The addition of a surfactant, ammonium sulfate, or DEF/Folex can increase uptake of Dropp or FreeFall on drought-stressed cotton. However, the use of adjuvants such as crop-oil concentrate or ammonium sulfate in high temperatures will increase the probability of leaf sticking. If regrowth is not a concern, DEF/Folex is often an adequate defoliant choice in drought-stressed cotton. If only Leafless or Ginstar is utilized, high rates of these defoliants should be avoided.

Cool temperatures

Because of geographic location, defoliating cotton when temperatures are cool (high temperature less than 80°F and low temperature less than 60°F) is often a concern for Virginia producers. Most harvest aids are temperature sensitive and do not perform as well when temperatures are cool. Harvade has traditionally been recommended in most states as a good cool-weather defoliant. Though Harvade is the least sensitive to low temperatures, high rates of DEF/Folex also

can be used to effectively defoliate mature cotton in cool weather. With the labeling of Aim and ET for cotton defoliation, these two products now can be used to defoliate cotton when temperatures are low. Because of the leaf-sticking potential with high temperatures, Aim and ET are probably better suited for use when high temperatures are below 80°F. Adjuvants are essential for achieving successful defoliation with many of these products, thus crop-oil concentrate must be added to Harvade and a nonionic surfactant to Aim or ET. For boll opening, higher rates of ethephon (Prep) are needed as temperatures decrease. Because regrowth potential is often less when temperatures are cool, Dropp/FreeFall can sometimes be omitted if temperatures are likely to remain below 70°F.

Rank growth

The most important aspect to defoliating rank cotton is coverage. This is challenging and the tendency is to increase the rate. Rate increases are not advised; however, as they increase the possibility of desiccation and leaf sticking. Excessively rank cotton in most situations will require a two-application defoliation program. Deliver the first application as normal with the goal of knocking all the leaves off except a skirt around the base of the plant. A product such as Aim or ET works well as an affordable second application. A boll opener used in conjunction with this program will be more effective with the second application when good coverage can be achieved. Rank cotton is also more prone to damage from boll-rot pathogens. A close examination of the crop prior to defoliation can be beneficial in determining boll-rot levels. If the bottom crop is severely damaged due to boll rot, it may be desirable to allow more time for the top crop to mature, given that most of the yield will come from the top of the plant. However, historical weather patterns in Virginia suggest little potential for making a late-season crop. The best solution for avoiding late-season difficulties with rank cotton is proper in-season mepiquat chloride (Pix) and nitrogen management.

Table 40. Cotton Harvest Aids

	Defoliation Only, Field Cutout	Defoliation with Regrowth Anticipated	Defoliation and Boll Opening	Defoliation and Boll Opening With Regrowth Anticipation
Def 6/Folex 6EC	1.33-1.5 pt			
Def 6/Folex 6EC + Dropp SC		1.0-1.5 pt + 1.6-6.4 (9.6 NTE fl oz)[1]		
Def 6/Folex 6EC ethephon 6EC[2]			1.0-1.5 pt + 5.3 fl oz	
Def 6/Folex 6EC ethephon 6EC[2] Dropp SC				1.0-1.5 pt + 5.3 fl oz + 1.6-6.4 (9.6 NTE fl oz)[1]
ethephon 6EC[2]			1.33-2.67 pt	
Harvade 5F + COC[3]	8.0-10.0 fl oz + 1.0-2.0 pt			
Harvade 5F + COC[3] + Dropp SC		6.5-8.0 oz + 1.0 pt + 1.6-6.4 (9.6 NTE fl oz)[1]		
Harvade 5F + COC[3] + Def 6/Folex 6EC + ethephon 6 EC[2]			6.5-8.0 fl oz + 1.0 pt + 8.0-16.0 fl oz + 1.33-2.67 pt	
Harvade 5F + COC[3] + ethephon 6EC[2]			6.5-8.0 fl oz + 1.0 pt + 1.33-2.67 pt	
Harvade 5F + COC[3] + ethephon 6EC[2] Dropp SC				6.5-8.0 fl oz + 1.0 pt + 1.33-2.67 pt 1.6-6.4 (9.6 NTE fl oz)[1]
Finish 6SC	1.3-2.0-2.67 pt temperature related		1.3-2.0-2.67 pt temperature related	
Finish 6SC + Dropp SC		1.3-2.0 pt + 1.6-6.4 (9.6 NTE fl oz)[1]		1.3-2.0 pt + 1.6-6.4 (9.6 NTE fl oz)[1]
Finish 6SC + Def 6/Folex 6EC			1.3-2.0 pt + 1.0-1.5 pt	
FirstPick	3.0-3.5 qt		3.0-3.5 qt	
FirstPick + Dropp SC		1.5-2.0 qt + 0.8-3.2 fl oz		1.5-2.0 qt + 0.8-3.2 fl oz
FirstPick + Def 6/Folex 6EC			1.5-2.0 qt + 4.0-12.0 fl oz	
FirstPick + Harvade SF + COC[3]			1.5-2.0 qt + 4.0-6.4 fl oz + 1.0 pt	
Dropp SC		1.6-6.4 (9.6 NTE fl oz)[1]		
Dropp SC + ethephon 6EC[2]			1.6-6.4 (9.6 NTE fl oz)[1] + 1.33-2.67 pt	1.6-6.4 (9.6 NTE fl oz)[1] + 1.33-2.67 pt

[1]NTE = not to exceed
[2]The active ingredient Ethephon is available as 6EC formulations as a number of trade name products such as Prep, Ethephon, Super Boll, etc.
[3]COC = crop oil concentrate

Revised 2012 Publication AREC-8

www.ext.vt.edu

Produced by Communications and Marketing, College of Agriculture and Life Sciences,
Virginia Polytechnic Institute and State University, 2012

VT/019/0112/250/AREC-8