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Specialty Small Grains in 2019

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Introduction

The following tables present results from specialty barley and wheat varietal tests conducted in Virginia in 2017-2019. The tests provide information to assist Virginia Cooperative Extension Service agents in formulating cultivar recommendations for small grain producers and to companies developing cultivars and/or marketing seed within the state. Yield data are given for individual locations and across locations and years, where available. Performance of a given variety often varies widely over locations and years which makes multiple location-year averages a more reliable indication of expected performance than data from a single year or location. When available, those data are preferred. Details about management practices for barley and wheat are listed for each experiment location.

The Season - 2019

A wet fall in 2018 resulted in some small grain acres not planted but those acres that were seeded were mostly planted on time, with 44 and 66% of wheat acres seeded by October 21 and November 11, respectively. These proportions mirrored the 5-year average for planting progress. December and January were drier with variable but seasonal temperatures. Due to later planting of some wheat acres and wet soils, only 61% of the small grain crop was rated as good or excellent in January. Significant statewide precipitation in February resulted in a decline in small grain ratings with only 43% of the crop rated good or excellent. Over 80% of acres were reported to have excess topsoil moisture. By March 31, only 15% of acres were reported to have excess topsoil moisture and 55% of the wheat crop was rated as good or excellent. Favorable weather continued through most of April and resulted in 9% of the wheat crop headed by April 21, compared with a 5-year average of 12%. By May 6, half the wheat crop was headed which was very near the 5-year average but well below the 78% headed mark reported by this date in 2018. Rain in early June hampered some harvesting efforts, but farmers were still able to harvest 11% of the crop by June 10. Farmers pushed to harvest fields as quickly as possible but continued periods of heavy rain in mid and late June resulted in delays and declining grain quality. Because of unplanted acres and wet, unfavorable conditions through much of the winter, the Virginia wheat crop was expected to produce only 7.6 million bushels, an 18% reduction from 2018 production. Yields were estimated at 66 bushels per acre, up 6 bushels per acre from 2018 and up 4 bushels from May. Virginia farmers planted a total of 180,000 acres in fall of 2018 with 115,000 acres intended to be harvested for grain. 65,000 acres were planted as cover crop or to be cut as silage or hay.

Figure 1. 2018-19 and 30-yr mean cumulative growing season precipitation for Virginia.



Figure 2. Growing season daily average temperature, 2018-19 and 30-yr mean.



Summary of barley management practices for the 2019 harvest season (All rates are given on a per acre basis.)

Blacksburg - Planted October 8, 2018. Pre-plant fertilizer was 30-50-50-10(S)-3(B)-2(Zn). Site was sprayed with .8 oz. Harmony Extra SG® on March 6, 2019. Site was fertilized with 30 units UAN 30-0-0 March 6, 2019 and 35 units on March 24, 2019. Harvest occurred June 3, 2019.

Blackstone - Planted October 24, 2018. Pre-plant fertilizer was 300 lb. 10-10-10 on October 19, 2018. Site received 60 lb. N using UAN + 0.5 oz. Harmony Extra XP® February 6, 2019. Site received 60 lb. N using UAN + 4 oz. Mustang® Maxx on March 27, 2019. Harvest occurred June 3, 2019.

Warsaw - Planted October 18, 2018. Lime was applied at 1 ton September 21, 2018. Preplant fertilizer was 30-100-100 applied October 10, 2018. (Hulless barley site received 30-80-100.) Site was fertilized using 12-0-0-1.5 at 25 lb. on December 6, 2018 and again on February 1, 2019 (second application on hulless barley was on January 31.) Harmony Extra SG® was applied at .9 oz. with surfactant at 1.5 qt. /100 gal. water on March 13, 2019. Site was fertilized using 12-0-0-1.5 at 30 lb. on March 18, 2019 (hulless site received 60 lb.) Site was treated with 10 oz. Starane® Ultra + 2 qt. surfactant per 100 gallons of water on March 29, 2019 then with 4.5 oz. Endigo® ZC + 1 qt. surfactant per 100 gallons of water on April 11, 2019. Note: intensively-managed replications of the hulless barley test also were treated with 4 oz. Fitness® on March 25, 2019, with 12 oz. Palisade® EC + 1 qt. surfactant per 100 gallons of water on April 18, 2019, and with 8 oz. Prosaro® + 1 qt. surfactant per 100 gallons of water on April 18, 2019, and with 8 oz. Prosaro® + 1 qt. surfactant per 100 gallons of water on March 30, 2019. Harvest occurred May 30, 2019.

Holland - Planted conventional-till November 29, 2018. Pre-plant fertilizer was 451 lb. 7-13-35 on November 25, 2018. Site was fertilized with 60 units N using 24-0-0-3 + 1 qt Mn + 0.75 oz Harmony Extra SG® on February 12, 2019 and again with 60 units N using 24-0-0-3 on March 14, 2019. Site was treated with 16.4 oz. Axial XL® on March 23, 2019. Harvest occurred May 30, 2019.

Orange - Planted October 22, 2018. Pre-plant fertilizer was 30-80-60 October 3, 2018. Sixty lb. N plus 0.6 oz. Harmony Extra SG® was applied February 28, 2019. Harvest occurred June 3-4, 2019.

Summary of wheat management practices for the 2019 harvest season (All rates are given on a per acre basis.)

Blacksburg - Planted October 7, 2018. Pre-plant fertilizer was 30-50-50-10(S)-3(B)-2(Zn). Site was sprayed with .8 oz. Harmony Extra SG® on March 6, 2019. Site was fertilized with 30 units UAN 30-0-0 on March 6, 2019 and 45 units on March 24, 2019. Harvest occurred June 24, 2019.

Blackstone - Planted October 24, 2018. Pre-plant fertilizer was 300 lb. 10-10-10 on October 19, 2018. Site received 60 lb. N using UAN + 0.5 oz. Harmony Extra XP® February 6, 2019. Site received 60 lb. N using UAN + 4 oz Mustang® Maxx on March 27, 2019. Harvest occurred June 12, 2019.

Warsaw - Planted October 22, 2018. Lime was applied at 1.5 tons September 21, 2018. Pre-plant fertilizer was 30-80-100 applied October 10, 2018. Site was fertilized using 12-0-0-1.5 at 25 lb. on December 6, 2018 and again on February 1, 2019. Harmony Extra SG® was applied at .9 oz. with surfactant at 1.5 qt. /100 gallons of water on March 13, 2019. Site was fertilized using 24-0-0-3 at 60 lb. on March 19, 2019. Site was treated with 10 oz. Starane® Ultra + 2 qt. surfactant per 100 gallons of water on March 29, 2019 then with 2.4 oz. Tombstone® on April 11, 2019. Harvest occurred June 16, 2019.

Painter - Planted November 1, 2018. Pre-plant fertilizer was 60 lb. N on October 25, 2018. Application of .75 oz. Harmony Extra SG® was on March 29, 2019. Site was fertilized with 60 lb. N using 30% UAN March 29, 2019. Site was fertilized with 40 lb. N using 30% UAN cut 50/50 with water on April 18, 2019. Harvest occurred June 25, 2019.

Section 1. Hard Red Winter Wheat Varieties

Agronomic Performance

This study has been conducted in Blacksburg, Warsaw, and Painter, Virgina for several years. An additional test site, Blackstone, Virgina, was added in 2019. Three replications were planted in Blacksburg, Warsaw, and Blackstone. Two replications were planted in Painter.

The over-location agronomic performance data is presented in Table 1 and data from individual locations in 2019 are presented in Tables 3 - 6. The two-year average test results (2018 and 2019) are presented in Table 2. A listing of entries along with measured hardness class is provided in Table 7.

Based on the average performance of four locations (Table 1), the grain yields of 11 hard red winter wheat experimental lines and one soft wheat check (Hilliard) are significally higher than the test average (72.3 bu/a). The bread wheat experimental line 14VDH-HRW02-029 (first year in this test) produced the highest yield (83.1 bu/a) which is 2.3, 7.3 and 13.0 bu/a higher than the soft wheat check Hilliard, Shirley, and the hard wheat check Vision 45, respectively. The grain yield of 14VDH-HRW02-029 ranked first at Blacksburg and Warsaw, third at Blackstone, and 12th at Painter. According to the 2018 and 2019 two - year summary (Table 2), the grain yield of two soft wheat checks and six bread wheat experimental lines were significantly higher than the test mean (70.1 bu/a). The first three high-yielding lines are Hardy 2519, DH13HRW07-30 and DH12HRW46-40. Most of our experimental lines also have good resistance to leaf rust and powdery mildew.

Grain, Milling and Baking Quality

Every year, grain samples from the Warsaw test location are sent to the USDA Hard Winter Wheat Quality Lab in Manhattan, KS for grain, flour, and milling and baking quality analyses. The quality results from 2017 and 2018 are presented in Tables 7 – 9. The two quality check varieties are Jagger and Karl 92. The flour yield check variety is Soissons. Generally speaking, the quality of the hard red winter wheats grown in Virginia is similar to our quality checks, but not comparable to the hard red spring wheat grown in the Northern Plains or hard red winter wheat grown in the Great Plains due to rain and other environmental conditions in the Mid-Atlantic region.

The wheat protein contents ranged from 11.6 % to 14.9% with an average of 12.8% in 2018; the protein contents of the two checks were 12.7% (Karl 92) and 13.7% (Jagger). The wheat protein contents were lower in 2017, ranging from 9.0% to 11.3% with an average of 10.1%. The flour yields in 2017 were higher than in 2018. The flour yields in 2017 varied from 63.5% to 74.0% with the check at 72.9%. The flour water absorption of lines tested in 2018 ranged from 59.2% to 64.7% with the checks at 61.9% (Karl 92) and 64.7% (Jagger). The bread loaf volumes of lines tested in 2018 varied from 760 cc to 1000 cc with the checks at 885 cc (Jagger) and 935 cc (Karl 92).

	Grain	1	Test		Date	е	Matu	re	Plant	Powde	ery	Leaf	Leaf	BYD	Flowering	FHB	FHB	;	FHE	}
	Yield	l	Weigh	ıt	Head	ed	Heigl	ht	Lodging	Milde	ew	Rust	Blotch	Virus ¹	Date	Incidence ²	Severi	ty ³	Index	x ⁴
Line	(Bu/a)	(Lb/bı	ı)	(Julia	n)	(In))	(0-9)	(0-9)	(0-9)	(0-9)	(0-9)	(Julian)	(%)	(%)		(0-9)
	(4)		(4)		(2)		(2)		(3)	(1)		(2)	(1)	(2)	(1)	(1)	(1)		(1)	
14VDH-HRW02-029	83.1	+	58.7	+	118		31	-	0	1		1	2	1	119	20	30		1	
Hilliard	80.8	+	56.9		117	-	34	+	0	1		1	1	1	119	35	40		1	
5210	78.2	+	55.7	-	120	+	30	-	0	0		1	2	1	120	40	43		2	
14VDH-HRW02-105	77.7	+	58.5	+	119		31	-	0	2	+	1	2	1	119	23	33		1	
VA14HRW-41	77.7	+	58.2	+	118		34	+	1	0		0	1	1	120	23	58		1	
VA16HRW-22	77.6	+	58.7	+	118		35	+	1	2		0	2	1	119	20	58		1	
Hardy 2519	77.4	+	58.3	+	117	-	35	+	1	1		1	1	1	119	35	53		2	
14VDH-HRW01-019	77.4	+	58.0	+	119		36	+	1	3	+	0	1	1	121	23	31		1	
DH15HRW-65-142	77.4	+	57.1		121	+	32		2 +	0		1	0 -	1	123 +	70 +	58		4	+
VA13MAS15-2194-1-2	77.2	+	54.0	-	117	-	32		1	0		2 +	0 -	1	119	10 -	54		0	
DH15HRW-68-106	76.5	+	56.1	-	117	-	33		0	0		2	2	1	119	28	48		1	
15VDH-HRW19-018	76.4	+	58.3	+	121	+	35	+	0	1		1	1	1	122	35	49		2	
DH15HRW-65-70	76.2		56.4	-	121	+	33		0	2		0	1	1	121	90 +	· 50		4	+
DH12HRW46-40	76.1		57.3		116	-	32		0	0		0	2	1	120	33	60		2	
NVIR17-1	76.1		57.6	+	117	-	32		0	2		0	2	1	119	30	41		1	
Shirley	75.8		56.6	-	118		32		0	0		1	1	1	120	58	44		2	
15VDH-HRW15-081	75.8		55.6	-	122	+	32		0	2		1	2	1	122 +	55	46		2	
VA15HRW-73	75.8		58.1	+	118		34	+	0	1		1	2	1	120	53	52		3	
VA09HRW-43	75.4		56.0	-	118		33		1	0		1	2	1	120	40	45		2	
VA16HRW-44	75.3		55.5	-	118		32		0	3	+	0	3	1	119	43	49		2	
NVIR17-8	75.2		56.2	-	119		29	-	0	1		0	2	1	119	30	55		1	
VA17HRW-33	75.1		54.9	-	121	+	35	+	0	0		1	2	2 +	121	38	37		1	
VA17HRW-55	74.7		57.7	+	118		33		2 +	0		0	2	1	120	58	51		3	
DH13HRW07-30	74.6		57.0		118		34	+	0	1		1	1	1	120	20	47		1	
DH13HRW08-192	74.6		59.0	+	119		33		1	0		1	2	1	120	73 +	57		4	+
15VDH-HRW15-062	74.2		57.2		120	+	30	-	1	1		1	3	1	122 +	63	42		2	
VA13MAS14-1992-3-3	73.8		56.0	-	118		32		1	0		0	1	1	119	30	47		1	
DH12HRW46-8	73.6		56.3	-	117		28	-	0	0		1	2	1	118	15	65	+	1	
DH12HRW50-11	73.6		56.5	-	118		32		0	0		1	2	1	119	20	34		1	

 Table 1. Summary of performance of entries in the Virginia Tech Hard Red Winter Wheat Test over locations, 2019 harvest.

	Grain	Test		Date		Mature	е	Plant	Powdery	Leaf	Leaf	BYD	Flowering	FF	IB	FHE	3	FHB	
	Yield	Weight		Heade	ed	Height	t	Lodging	Mildew	Rust	Blotch	Virus ¹	Date	Incid	ence ²	Severi	ty ³	Index	4
Line	(Bu/a)	(Lb/bu)		(Juliar	n)	(In)		(0-9)	(0-9)	(0-9)	(0-9)	(0-9)	(Julian)	(%	6)	(%)		(0-9))
	(4)	(4)		(2)		(2)		(3)	(1)	(2)	(1)	(2)	(1)	(1	l)	(1)		(1)	
VA15HRW-85	73.5	58.6	+	116	-	31	-	0	1	0	1	1	119	35		49		2	
VA16HRW-42	73.2	58.1	+	117		31	-	1	1	0	2	1	119	35		55		2	
ARS14W0947	73.0	57.8	+	119		35 ·	+	1 +	0	0	2	1 +	121	10	-	27	-	0	
VA17HRW-8	73.0	56.1	-	118		35 ·	+	1	2 +	1	1	1	119	33		56		2	
Vision 50	72.9	55.4	-	122	+	34 ·	+	1	0	1	2	1	123 +	68	+	39		2	
DH13HRW09-81WS	72.5	55.4	-	117	-	31	-	0	0	1	2	1	119	13		42		0	
VA16HRW-51	72.5	58.5	+	117		32		0	0	0	1	1	120	70	+	57		4	+
14VDH-HRW01-063	71.8	55.8	-	122	+	34 ·	+	0	1	1	1	1	123 +	65		52		3	
DH15HRW-68-137	71.8	54.8	-	121	+	36 ·	+	0	1	1	2	1 +	121	38		50		2	
VA16HRW-11	71.6	56.3	-	118		32		0	0	1	2	1	119	30		62		2	
VA17HRW-92	71.1	57.3		117	-	32		1	0	1	3	1	119	28		37		1	
VA15HRW-86	71.1	58.5	+	117	-	30	-	0	0	1	1	1	119	38		35		1	
VA17HRW-36	70.7	56.5	-	118		32		0	1	1	1	1	120	53		56		3	
VA17HRW-43	70.6	57.6	+	119		31	-	0	0	0	1	1	119	35		51		2	
VA15HRW-76-WS	70.6	55.3	-	117		31	-	0	0	0	2	1	119	38		49		2	
VA16HRW-47	70.5	58.6	+	117	-	30	-	0	1	0	2	1	118	40		68	+	2	
VA17HRW-32	70.5	55.6	-	120	+	34 ·	+	0	1	1	2	1 +	122	35		27	-	1	
Vision 30	70.4	57.8	+	117	-	33		2 +	0	2 +	3	1	118 -	25		44		1	
Vision 45	70.1	57.7	+	122	+	39 .	+	0	1	1	2	1	123 +	75	+	52		3	+
VA17HRW-20	70.0	58.7	+	118		32		0	0	1	2	1	121	38		37		1	
VA16HRW-36	70.0	58.7	+	117	-	32		1	0	1	1	1	120	50		42		2	
VA13MAS14-2047-4-2	70.0	58.1	+	117	-	31	-	0	0	1	3	1	119	20		29	-	0	
DH15HRW-69-50	69.6	58.0	+	118		30	-	1	0	0	4 +	1	119	20		33		1	
VA13MAS14-1992-3-4	68.8	56.6	-	117	-	33		0	0	0	3	1	119	25		50		1	
ARS14W0445	68.8	59.1	+	116	-	37 ·	+	0	0	0	2	1	120	73	+	47		3	+
VA17HRW-90	68.7	55.8	-	119		31	-	0	0	2	2	1	119	35		61		2	
DH15HRW-69-55	68.6	57.2		119		33		1	0	1	1	1	121	78	+	48		3	+
DH13HRW09-143	68.4	57.5		120	+	31	-	1	0	1	2	1	121	28		30		1	
NVIR17-3	68.2 -	57.4		120	+	31	-	1	1	0	3	1	122	58		39		2	

 Table 1. Summary of performance of entries in the Virginia Tech Hard Red Winter Wheat Test over locations, 2019 harvest.

	Grain		Test		Date	э	Matur	e	Plant	Powde	ery	Leaf	Leaf	BYD	Flowering	FHB	FHB		FHB
	Yield		Weigh	t	Head	ed	Heigh	t L	Lodging	Milde	w	Rust	Blotch	Virus ¹	Date	Incidence ²	Severity	3	Index ⁴
Line	(Bu/a))	(Lb/bu	l)	(Julia	n)	(In)		(0-9)	(0-9)	(0-9)	(0-9)	(0-9)	(Julian)	(%)	(%)		(0-9)
	(4)		(4)		(2)		(2)		(3)	(1)		(2)	(1)	(2)	(1)	(1)	(1)		(1)
VA17HRW-100	68.0	-	55.6	-	121	+	31	-	1	0		1	1	1	121	35	30		1
Soissons	67.4	-	55.7	-	121	+	30	-	0	0		3 +	2	1	122 +	53	47		2
DH11HRW56-40	67.2	-	55.0	-	118		31	-	0	2		1	2	1	120	30	32		1
VA15HRW-130	66.3	-	57.6	+	116	-	33		0	0		1	2	1	120	23	44		1
KS13DH0053-32	66.2	-	59.1	+	115	-	32		0	5	+	1	3	1	119	25	66	+	2
VA17HRW-9	66.2	-	57.2		117	-	33		1	2		0	3	1	118	15	53		1
VA17HRW-38	65.6	-	56.6	-	119		31	-	0	0		0	2	1	119	48	44		2
Everest	65.6	-	59.2	+	115	-	33		1	1		1	3	1	119	18	39		1
VA17HRW-94	65.1	-	58.2	+	118		32		0	0		1	2	1	120	40	41		1
Jagger	62.3	-	58.1	+	115	-	32		1	5	+	1	3	1	119	40	54		2
Karl 92	61.6	-	58.3	+	116	-	32		1	3	+	0	3	1	119	38	62		2
Average	72.3		57.1		118		32		0	1		1	2	1	120	38	46		2
LSD (0.05)	4.1		0.5		1		1		1	1		1	2	0	2	27	18		1
C.V.	6.8		1.0		1		3		190	99		115	49	21	1	51	28		6

Table 1. Summary of performance of entries in the Virginia Tech Hard Red Winter Wheat Test over locations, 2019 harvest.

Varieties are ordered by descending yield averages.

A plus or minus sign indicates a performance significantly above or below the test average.

The 0-9 ratings indicate a genotype's response to disease or lodging where 0 = highly resistant and

9 = highly susceptible.

The number in parentheses below column headings indicates the number of locations on which data are based.

¹ BYD = Barley Yellow Dwarf Virus.

² Scab Incidence (0-10): Based on infected spikes within 4 ft row.

³ Scab Severity (0-10): Based on infected spikelets in 10 spikes showing disease symptoms.

⁴ FHB Index is an overall indicator of scab resistance/susceptibility level and takes into account both

incidence and severity where 0 = highly resistant and 9 = highly susceptible.

	Grain		Test		Date		Mature		Plant		Powdery		Leaf		BYD	
	Yield		Weigł	nt	Head	ed	Heigl	nt	Lodgi	ng	Milde	w	Rust	t	Virus ¹	
Line	(Bu/a)	(Lb/b	u)	(Julia	n)	(In)		(0-9)	(0-9)	(0-9))	(0-9)	
	(7)		(7)		(4)		(4)		(5)		(4)		(2)		(2))
Shirley	81.5	+	56.3	-	122		32	-	0	-	0	-	1		1	-
Hilliard	78.7	+	56.8		121		35	+	1		2		1		1	-
Hardy 2519	75.3	+	58.0	+	121		35	+	3	+	3	+	1		1	-
DH13HRW07-30	74.9	+	57.2		122	+	34	+	0	-	2		1		1	-
DH12HRW46-40	74.4	+	56.7		119	-	33		1		0	-	0		1	-
DH13HRW09-81WS	74.1	+	56.3	-	120	-	32	-	0	-	0	-	1		1	-
5210	74.1	+	55.4	-	125	+	32	-	0		1	-	1		1	
DH13HRW08-192	73.8	+	59.1	+	123	+	33		2		1	-	1		1	-
VA15HRW-73	73.3		57.8	+	122		34	+	1		2		1		1	-
VA14HRW-41	73.3		57.6	+	122	+	35	+	3	+	1	-	0		1	-
VA16HRW-44	72.9		55.8	-	122		32	-	2		4	+	0		1	-
DH12HRW50-11	72.5		55.9	-	121		33		2		1	-	1		1	-
VA16HRW-51	72.1		58.5	+	121	-	33		0	-	2		0		1	-
VA16HRW-11	71.7		56.2	-	122	+	34	+	0	-	2		1		1	-
ARS14W0445	71.6		59.0	+	120	-	37	+	1		0	-	0		1	-
VA15HRW-85	71.4		58.2	+	120	-	32	-	1		3	+	0		1	-
VA16HRW-22	71.3		58.2	+	122	+	35	+	3	+	2		0		1	-
VA16HRW-47	71.2		58.0	+	120	-	31	-	1		2		0		1	-
DH12HRW46-8	71.0		55.8	-	121		30	-	0	-	0	-	1		1	-
VA15HRW-86	70.7		58.3	+	121		31	-	1		3	+	1		1	-
VA16HRW-42	70.3		57.6	+	121		31	-	1		2		0		1	-
VA09HRW-43	70.1		54.7	-	121		33		2		1		1		1	-
DH13HRW09-143	70.0		57.6	+	123	+	33		1		0	-	1		1	-
VA16HRW-36	70.0		58.6	+	121		33		1		2		1		1	-
Vision 45	69.8		57.1		125	+	39	+	2		2		1		1	-
Vision 50	68.6		54.9	-	125	+	35	+	1		1		1		1	
ARS14W0947	68.4		56.8		123	+	35	+	3	+	0	-	0		1	+
VA15HRW-130	67.6		56.9		120	-	33		1		0	-	1		1	-
VA15HRW-76-WS	67.2		55.4	-	121		31	-	2		4	+	0		1	-
Vision 30	64.6	-	56.5		120	-	33		4	+	1	-	2	+	1	-
DH11HRW56-40	64.4	-	55.3	-	122		33		2		3	+	1		1	-
Soissons	63.0	-	55.0	-	124	+	32	-	1		2		3	+	1	-
Everest	62.7	-	58.7	+	118	-	33		2	+	3	+	1		1	-
Karl 92	55.7	-	57.3		120	-	33		3	+	6	+	0		1	
Jagger	52.1	-	56.6		119	-	32	-	2		7	+	1		1	-
Average	70.1		57.0		121		33		1		2		1		1	
LSD (0.05)	3.7		0.5		1		1		1		1		1		0	
C.V.	8.2		1.4		1		3		96		43		125		14	

Table 2. Two-year summary of performance of entries in the Virginia Tech Hard Red Winter Wheat Test over locations, 2018 and 2019 harvests.

Varieties are ordered by descending yield averages.

A plus or minus sign indicates a performance significantly above or below the test average.

Table 2. Two-year summary of performance of entries in the Virginia Tech Hard Red Winter Wheat Test over locations, 2018 and 2019 harvests.

The 0-9 ratings indicate a genotype's response to disease or lodging where 0 = highly resistant and 9 = highly susceptible.

The number in parentheses below column headings indicates the number of location-years on which data are based.

¹ BYD = Barley Yellow Dwarf Virus.

	Grain		Test		Date	Matur	e	Plant		Leaf		BYD	
	Yield		Weigh	t	Headed	d	Heigh	t	Lodging		Rust		Virus ¹
Line	(Bu/a)	(Lb/bu	l)	(Julian)	(In)		(0-9)		(0-9])	(0-9)
14VDH-HRW02-029	99.6	+	58.3	+	122.0		30.3		0.0		1.0		1.0
Hilliard	96.2	+	57.4		121.0		32.3		0.0		2.0		1.0
Shirley	94.3	+	57.0		122.0		30.7		0.0		2.0		1.0
VA16HRW-44	94.1	+	56.5		121.3		30.7		0.7		0.3		1.0
Hardy 2519	93.9	+	58.1		120.7		34.3	+	1.3		1.0		1.0
DH15HRW-65-70	93.2	+	56.4		123.3		33.7	+	0.0		0.7		1.0
VA14HRW-41	91.9	+	57.3		122.0		33.3	+	1.0		0.7		1.0
DH15HRW-68-106	90.2		55.4	-	120.7		33.3	+	0.0		2.7	+	1.0
VA13MAS15-2194-1-2	89.8		57.1		121.0		31.3		0.3		3.3	+	1.0
VA15HRW-73	89.5		57.6		121.0		33.0	+	0.0		1.0		1.0
VA16HRW-22	88.6		59.0	+	122.0		33.0	+	0.0		0.7		1.0
VA15HRW-85	88.5		58.3	+	120.3		29.7	-	0.0		0.3		1.0
VA09HRW-43	88.1		55.3	-	121.0		32.7		1.3		1.0		1.0
15VDH-HRW15-081	87.7		55.9		125.0	+	30.7		0.0		1.0		1.0
VA17HRW-55	87.2		56.8		121.3		31.7		0.0		0.7		1.0
NVIR17-1	86.8		56.9		120.3		30.0	-	0.0		0.3		1.0
Vision 45	86.7		57.8		124.3	+	38.0	+	0.0		1.0		1.0
14VDH-HRW02-105	86.7		57.6		122.7		30.3		0.0		1.7		1.3 +
VA13MAS14-1992-3-3	86.6		55.8		121.3		31.3		0.7		0.0		1.0
14VDH-HRW01-019	86.6		57.9		122.3		33.7	+	0.7		0.3		1.0
NVIR17-8	86.5		56.1		122.7		27.7	-	0.0		0.7		1.0
VA15HRW-86	86.3		58.1		121.0		28.7	-	0.0		1.0		1.0
VA16HRW-36	86.0		58.5	+	121.3		30.7		0.3		1.0		1.0
VA16HRW-42	85.4		58.1		121.0		29.7	-	0.7		0.0		1.0
VA16HRW-47	85.0		58.7	+	121.0		28.7	-	0.0		0.3		1.0
15VDH-HRW19-018	84.7		58.6	+	124.7	+	34.7	+	0.0		2.0		1.0
DH15HRW-65-142	84.5		57.0		124.3	+	32.0		5.0	+	1.3		1.0
Vision 50	84.1		55.7		124.7	+	32.7		0.0		1.0		1.3 +
VA17HRW-33	83.9		55.6		124.0	+	34.0	+	0.0		1.0		1.0
DH13HRW09-143	83.6		57.8		123.3		31.3		1.3		1.3		1.0
VA17HRW-92	83.4		57.4		121.0		31.3		0.3		1.3		1.0
VA17HRW-8	83.3		55.3	-	122.0		33.3	+	0.7		1.3		1.0
DH12HRW46-40	83.3		56.6		120.0	-	30.7		0.0		0.3		1.0
DH13HRW09-81WS	83.0		56.2		121.0		30.3		0.0		1.3		1.0
Vision 30	83.0		56.9		120.3		32.7		2.3	+	3.7	+	1.0
VA16HRW-11	83.0		55.1	-	122.0		31.0		0.0		1.7		1.0
VA17HRW-32	82.9		55.5		123.3		33.7	+	0.3		2.3		1.3 +
5210	82.8		54.8	-	124.7	+	28.3	-	0.0		1.3		1.0
ARS14W0947	82.2		57.1		122.7		34.3	+	1.3		0.7		1.0
15VDH-HRW15-062	82.1		57.6		123.7	+	28.7	-	1.0		1.0		1.0
DH12HRW50-11	82.1		55.7		121.0		31.0		0.0		1.3		1.0

Table 3. Summary of performance of entries in the Virginia Tech Hard Red Winter Wheat Test, Kentland Farm, Blacksburg, VA, 2019 harvest.

	Grain	Test	Date	Mature	Plant	Leaf	BYD
	Yield	Weight	Headed	Height	Lodging	Rust	Virus ¹
Line	(Bu/a)	(Lb/bu)	(Julian)	(In)	(0-9)	(0-9)	(0-9)
DH12HRW46-8	81.9	55.8	121.7	26.7 -	0.0	1.0	1.0
VA17HRW-20	81.9	57.6	119.3 -	31.0	0.0	1.3	1.0
VA13MAS14-1992-3-4	81.7	55.4 -	121.0	32.0	0.0	0.3	1.0
DH13HRW07-30	81.2	55.8	121.7	33.0 +	0.0	1.7	1.0
DH11HRW56-40	81.1	57.9	122.3	30.3	0.0	1.0	1.0
VA17HRW-36	81.0	56.0	122.0	31.0	0.0	1.3	1.3 +
VA15HRW-76-WS	80.8	55.7	121.3	30.0 -	0.0	0.7	1.0
14VDH-HRW01-063	80.7	55.6	126.3 +	32.7	0.0	0.7	1.0
DH13HRW08-192	80.6	57.5	122.3	31.3	0.0	1.3	1.0
VA13MAS14-2047-4-2	80.4	57.1	120.3	30.7	0.0	1.0	1.0
VA16HRW-51	80.3	58.1	121.0	30.7	0.0	0.7	1.0
DH15HRW-69-50	80.2	56.8	121.3	30.0 -	0.7	0.7	1.0
DH15HRW-68-137	79.3	54.5 -	124.3 +	35.3 +	0.0	2.0	1.0
VA17HRW-100	79.2	54.5 -	125.0 +	30.3	0.0	1.7	1.0
ARS14W0445	78.6	59.1 +	120.0 -	35.3 +	0.0	0.7	1.0
VA17HRW-43	78.5	57.6	123.3	29.0 -	0.0	0.3	1.0
DH15HRW-69-55	78.0	56.0	122.3	32.7	0.0	1.0	1.0
VA17HRW-9	77.5	56.0	121.0	31.7	0.0	0.7	1.0
VA15HRW-130	77.5	57.0	120.0 -	31.7	0.0	1.0	1.0
VA17HRW-38	75.8	56.0	122.3	31.0	0.0	0.7	1.0
NVIR17-3	75.5	56.8	122.7	30.7	0.0	0.0	1.0
VA17HRW-90	74.1 -	55.1 -	122.0	30.0 -	0.0	2.7 +	1.0
Soissons	73.3 -	55.1 -	123.7 +	29.0 -	0.0	3.0 +	1.0
Everest	71.6 -	58.4 +	118.7 -	31.7	0.0	1.0	1.0
VA17HRW-94	69.5 -	56.5	121.3	30.7	0.0	2.3	1.0
Karl 92	68.7 -	57.3	120.3	30.7	1.3	0.3	1.3 +
KS13DH0053-32	67.8 -	58.2 +	119.0 -	30.3	0.0	1.7	1.0
Jagger	67.7 -	57.7	117.3 -	30.3	0.0	1.0	1.0
Average	83.1	56.8	121.9	31.4	0.3	1.1	1.0
LSD (0.05)	8.0	1.4	1.7	1.3	1.3	1.6	0.3
C.V.	5.9	1.5	0.9	2.6	261.3	85.9	15.1

Table 3. Summary of performance of entries in the Virginia Tech Hard Red Winter Wheat Test, Kentland Farm, Blacksburg, VA, 2019 harvest.

Varieties are ordered by descending yield averages.

A plus or minus sign indicates a performance significantly above or below the test average.

The 0-9 ratings indicate a genotype's response to disease or lodging where 0 = highly resistant and

9 = highly susceptible.

¹ BYD = Barley Yellow Dwarf Virus.

	Grain		Test		Date		Matur	e	Plant		
	Yield		Weight		Heade	d	Heigh	t	Lodging		
Line	Yield (Bu/a)		(Lb/bu)		(Julian)	(In)		(0-9)		
14VDH-HRW02-029	(Bu/a) 88.5 +		58.7	+	114.7		31.7		0.0		
5210	87.0	+	56.5		116.0	+	31.3	-	0.0		
15VDH-HRW15-081	86.8	+	55.7	-	118.0	+	33.0		0.3		
14VDH-HRW01-019	86.5	+	58.2	+	115.7		37.3	+	1.0		
DH15HRW-68-106	85.6	+	56.0	-	113.0	-	33.3		0.7		
NVIR17-8	85.2	+	56.7		115.3		31.0	-	0.0		
DH13HRW08-192	85.0	+	59.1	+	115.0		34.0		1.3		
VA13MAS15-2194-1-2	84.9	+	51.3	-	113.3		32.7		2.0 +		
15VDH-HRW15-062	84.4	+	57.4		116.3	+	32.0		1.3		
DH15HRW-65-142	84.3	+	56.8		117.3	+	32.7		0.7		
VA17HRW-55	84.2	+	57.8	+	113.7		35.0		1.3		
Hardy 2519	83.4		58.0	+	113.0	-	36.0	+	0.7		
NVIR17-1	83.0		57.3		113.0	-	33.3		0.7		
VA17HRW-8	82.9		56.3	-	114.7		35.7	+	1.3		
15VDH-HRW19-018	82.8		57.6	+	118.0	+	35.3	+	0.3		
Hilliard	81.5		56.1	-	113.3		35.7	+	0.3		
VA17HRW-33	81.5		54.1	-	117.0	+	36.0	+	0.3		
ARS14W0947	81.3		57.7	+	115.7		34.7		1.0		
VA16HRW-51	81.2		58.5	+	113.7		33.7		0.3		
14VDH-HRW02-105	81.2		58.4	+	115.7		31.0	-	0.3		
DH15HRW-68-137	80.9		54.1	-	118.3	+	36.7	+	0.7		
14VDH-HRW01-063	80.6		56.0	-	117.0	+	34.3		0.3		
DH13HRW07-30	80.4		56.6		115.0		35.3	+	0.3		
VA14HRW-41	80.4		58.3	+	114.3		35.3	+	0.7		
VA13MAS14-1992-3-3	79.9		56.1	-	114.0		32.3		0.7		
DH12HRW50-11	79.9		56.4		114.7		32.3		0.7		
DH12HRW46-8	79.8		57.0		113.0	-	29.0	-	0.3		
VA16HRW-22	79.6		58.3	+	114.3		36.3	+	0.0		
VA17HRW-92	79.4		56.9		113.3		32.7		1.0		
VA15HRW-73	79.2		58.1	+	115.0		34.7		1.0		
VA09HRW-43	79.0		55.8	-	114.7		33.3		1.0		
VA15HRW-76-WS	79.0		54.8	-	113.3		32.0		0.7		
VA16HRW-44	79.0		54.9	-	113.7		33.3		0.3		
VA16HRW-42	78.3		57.8	+	113.7		31.7		0.7		
Vision 50	78.0		54.7	-	119.0	+	36.0	+	0.7		
VA17HRW-43	77.6		57.1		115.0		33.3		0.3		
DH15HRW-65-70	77.5		55.9	-	118.3	+	32.7		0.3		
VA16HRW-11	76.9		56.3	-	114.7		33.3		0.0		
VA17HRW-36	76.7		56.0	-	114.7		32.3		1.0		
VA13MAS14-2047-4-2	76.6		57.9	+	113.0	-	31.7		1.0		
ARS14W0445	76.3		59.0	+	112.0	-	39.0	+	0.7		

Table 4. Summary of performance of entries in the Virginia Tech Hard Red Winter Wheat Test, Eastern Virginia AREC, Warsaw, VA, 2019 harvest.

	Grain	Τ	Test		Date		Mature	è	Plant	t
	Yield	I	Weight		Headeo	b	Height	;	Lodgir	ıg
Line	(Bu/a)		(Lb/bu)		(Julian)	(In)		(0-9))
VA15HRW-86	76.1		58.4	+	112.7	-	31.7		0.3	
DH15HRW-69-50	76.1		58.2	+	113.7		30.0	-	1.0	
VA16HRW-36	76.0		58.6	+	112.7	-	34.0		0.7	
VA15HRW-85	75.9		58.5	+	112.0	-	31.7		0.7	
Vision 30	75.6		57.7	+	112.7	-	33.3		1.7	+
DH12HRW46-40	75.5		57.8	+	112.0	-	32.7		0.0	
DH15HRW-69-55	75.5		57.3		115.3		33.7		1.7	+
Soissons	75.3		55.5	-	117.3	+	31.3	-	0.0	
NVIR17-3	75.0		57.6	+	117.7	+	31.3	-	1.3	
Shirley	74.9		56.5		114.7		32.3		0.0	
Vision 45	74.5		57.8	+	119.3	+	39.0	+	0.7	
Everest	74.2		59.1	+	110.3	-	33.3		1.7	+
VA16HRW-47	74.0		58.4	+	112.7	-	31.3	-	1.0	
DH13HRW09-81WS	73.9		53.1	-	112.7	-	31.0	-	0.0	
VA17HRW-20	73.4		58.9	+	116.7	+	33.3		1.0	
VA13MAS14-1992-3-4	73.2		56.9		112.3	-	33.0		0.3	
KS13DH0053-32	72.8		59.0	+	111.7	-	33.3		0.0	
VA17HRW-100	72.4	-	55.2	-	117.3	+	32.3		0.3	
VA17HRW-32	72.2	-	55.7	-	116.3	+	34.3		0.0	
VA17HRW-38	72.1	-	56.2	-	115.0		31.3	-	0.7	
VA17HRW-90	71.6	-	55.1	-	115.3		31.0	-	0.7	
DH13HRW09-143	71.5	-	57.0		116.7	+	31.3	-	0.0	
Jagger	71.2	-	58.4	+	111.7	-	32.7		1.3	
VA15HRW-130	71.2	-	57.3		112.7	-	33.3		0.3	
VA17HRW-9	70.9	-	57.8	+	112.7	-	33.3		1.0	
VA17HRW-94	70.7	-	58.5	+	114.0		34.0		0.3	
Karl 92	68.0	-	58.4	+	112.0	-	33.7		1.7	+
DH11HRW56-40	65.1	-	51.5	-	114.0		32.3		1.0	
Average	78.1		56.9		114.6		33.3		0.7	
LSD (0.05)	5.7		0.6		1.4		1.8		1.0	
C.V.	4.5		0.6		0.7		3.3		89.9	

Table 4. Summary of performance of entries in the Virginia Tech Hard Red Winter Wheat Test, Eastern Virginia AREC, Warsaw, VA, 2019 harvest.

Varieties are ordered by descending yield averages.

A plus or minus sign indicates a performance significantly above or below the test average.

The 0-9 ratings indicate a genotype's response to disease or lodging where 0 = highly resistant and 9 = highly susceptible.

	Grain	Test	BYD
	Yield	Weight	Virus ¹
Line	(Bu/a)	(Lb/bu)	(0-9)
DH12HRW46-40	65.3 +	56.9	1.0
Hilliard	64.4	55.8 -	1.0
14VDH-HRW02-029	63.8	58.1 +	1.0
VA14HRW-41	63.5	58.1 +	1.0
14VDH-HRW02-105	63.2	58.6 +	1.0
VA13MAS15-2194-1-2	63.0	51.2 -	1.0
VA17HRW-36	62.3	56.1	1.0
DH13HRW07-30	61.9	57.0	1.0
Shirley	61.9	55.9	1.0
15VDH-HRW19-018	61.0	57.9 +	1.0
5210	60.5	55.0 -	1.3
14VDH-HRW01-019	59.5	57.0	1.0
VA16HRW-22	59.1	57.9 +	1.0
VA16HRW-42	59.1	57.3 +	1.0
VA15HRW-73	58.8	57.7 +	1.0
DH12HRW46-8	58.2	55.8 -	1.0
VA17HRW-32	58.2	54.6 -	1.3
VA16HRW-51	58.2	58.1 +	1.0
VA15HRW-85	57.8	58.2 +	1.0
Hardy 2519	57.8	58.0 +	1.0
VA17HRW-33	57.8	53.7 -	2.0 +
Vision 30	57.2	57.2	1.0
ARS14W0947	57.1	57.9 +	1.7 +
DH13HRW09-81WS	57.0	53.8 -	1.0
VA17HRW-55	56.9	57.5 +	1.0
VA17HRW-90	56.7	55.6 -	1.3
VA17HRW-8	56.4	55.7 -	1.0
KS13DH0053-32	56.1	59.0 +	1.0
VA15HRW-76-WS	55.8	53.2 -	1.0
NVIR17-1	55.8	57.5 +	1.0
VA17HRW-43	55.3	57.1	1.0
DH15HRW-68-137	55.2	54.2 -	1.7 +
VA09HRW-43	55.2	55.5 -	1.0
DH15HRW-65-70	54.6	55.8 -	1.0
DH15HRW-65-142	54.6	56.0	1.0
DH12HRW50-11	54.5	55.8 -	1.0
Vision 45	54.3	57.2	1.0
VA13MAS14-1992-3-3	54.3	54.7 -	1.3
15VDH-HRW15-081	54.2	54.5 -	1.0
DH13HRW08-192	54.1	59.1 +	1.0
VA17HRW-9	54.0	56.7	1.0

Table 5. Summary of performance of entries in the Virginia Tech Hard Red Winter Wheat Test, Southern Piedmont AREC, Blackstone, VA, 2019 harvest.

	Grain	Test	BYD
	Yield	Weight	Virus ¹
Line	(Bu/a)	(Lb/bu)	(0-9)
DH15HRW-68-106	54.0	55.7 -	1.0
VA17HRW-92	53.9	56.8	1.0
14VDH-HRW01-063	53.7	54.8 -	1.0
NVIR17-8	53.7	54.9 -	1.0
VA17HRW-100	53.6	56.1	1.0
VA16HRW-11	53.6	56.2	1.0
VA16HRW-47	53.5	57.8 +	1.0
DH13HRW09-143	53.3	57.1	1.0
VA16HRW-44	53.0	53.5 -	1.0
VA17HRW-94	52.9	58.3 +	1.0
VA17HRW-38	52.8	56.1	1.3
Vision 50	52.5	55.1 -	1.0
VA15HRW-86	52.5	58.3 +	1.0
VA17HRW-20	52.0	58.3 +	1.0
DH11HRW56-40	51.9	53.1 -	1.0
Jagger	51.7	57.6 +	1.0
Soissons	51.7	55.4 -	1.0
VA16HRW-36	51.5	58.2 +	1.0
15VDH-HRW15-062	51.3	55.9	1.3
VA13MAS14-2047-4-2	50.6	58.1 +	1.0
VA13MAS14-1992-3-4	50.3	55.9	1.3
VA15HRW-130	50.0	57.5 +	1.0
DH15HRW-69-50	50.0	57.7 +	1.0
NVIR17-3	50.0	56.4	1.0
Karl 92	49.1	58.2 +	1.0
Everest	49.1	58.7 +	1.0
ARS14W0445	48.5	58.4 +	1.0
DH15HRW-69-55	46.5 -	57.1	1.0
Average	55.5	56.5	1.1
LSD (0.05)	9.0	0.8	0.4
C.V.	10.0	0.8	25.1

Table 5. Summary of performance of entries in the Virginia Tech Hard RedWinter Wheat Test, Southern Piedmont AREC, Blackstone, VA, 2019 harvest.

Varieties are ordered by descending yield averages.

A plus or minus sign indicates a performance significantly above or below the test average.

The 0-9 ratings indicate a genotype's response to disease or lodging where 0 = highly resistant and

9 = highly susceptible.

	Grain	Test	Plant	Powderv	Leaf	Leaf
	Yield	Weight	Lodging	Mildew	Rust	Blotch
Line	(Bu/a)	(Lb/bu)	(0-9)	(0-9)	(0-9)	(0-9)
DH15HRW-65-142	90.7 +	59.2	0	0	0	0 -
VA16HRW-22	85.8 +	60.0 +	4 +	2	0	2
5210	84.7 +	57.2 -	0	0	0	2
DH12HRW46-40	82.3	58.0	0	0	0	2
VA09HRW-43	81.4	58.1	0	0	0	2
DH15HRW-65-70	81.3	58.0	0	2	0	1
15VDH-HRW15-062	81.3	58.3	0	1	0	3
Hilliard	81.1	59.1	0	1	0	1
14VDH-HRW02-105	80.9	60.1 +	0	2 +	0	2
DH13HRW08-192	80.6	60.9 +	0	0	0	2
DH12HRW50-11	80.1	59.1	0	0	0	2
NVIR17-1	80.0	59.4	0	2	0	2
14VDH-HRW02-029	79.1	59.9	0	1	0	2
Vision 50	78.8	56.7 -	1	0	0	2
VA17HRW-33	78.5	56.8 -	0	0	0	2
DH13HRW09-81WS	77.8	60.2 +	0	0	0	2
DH15HRW-69-55	77.6	59.3	0	0	0	1
15VDH-HRW19-018	77.6	59.4	0	1	0	1
14VDH-HRW01-019	76.9	59.4	0	3 +	0	1
DH15HRW-68-106	76.3	58.1	0	0	0	2
VA15HRW-73	75.8	59.3	0	1	0	2
NVIR17-8	75.6	57.4 -	0	1	0	2
DH13HRW07-30	75.2	59.1	0	1	0	1
VA16HRW-44	75.1	58.2	0	3 +	0	3
DH12HRW46-8	75.0	57.0 -	0	0	0	2
VA13MAS14-1992-3-3	74.8	58.1	1	0	0	1
NVIR17-3	74.6	59.3	0	1	0	3
VA17HRW-90	74.5	58.3	0	0	0	2
VA17HRW-20	74.2	61.0 +	0	0	0	2
15VDH-HRW15-081	74.1	56.5 -	0	2	0	2
VA16HRW-11	73.5	58.5	0	0	0	2
VA14HRW-41	73.5	59.3	0	0	0	1
VA13MAS14-2047-4-2	73.4	60.0 +	0	0	0	3
Hardy 2519	73.4	59.7	0	1	0	1
ARS14W0445	73.3	60.5 +	0	0	0	2
DH15HRW-69-50	73.1	59.6	0	0	0	4 +
14VDH-HRW01-063	72.5	57.6 -	0	1	1 +	1
DH11HRW56-40	72.4	58.9	0	2	0	2
DH15HRW-68-137	71.7	57.2 -	0	1	0	2
VA17HRW-43	71.4	58.9	0	0	0	1
ARS14W0947	70.8	59.1	2	0	0	2

Table 6. Summary of performance of entries in the Virginia Tech Hard Red Winter Wheat Test, Eastern Shore AREC, Painter, VA, 2019 harvest.

	Grain	Test	Plant	Powdery	Leaf	Leaf
	Yield	Weight	Lodging	Mildew	Rust	Blotch
Line	(Bu/a)	(Lb/bu)	(0-9)	(0-9)	(0-9)	(0-9)
VA15HRW-85	70.6	59.7	0	1	0	1
VA13MAS14-1992-3-4	70.6	58.8	0	0	0	3
Shirley	70.4	57.3 -	0	0	0	1
Soissons	70.0	57.3 -	0	0	2 +	2
KS13DH0053-32	69.3	60.8 +	0	5 +	0	3
VA16HRW-47	69.0	59.7	0	1	0	2
VA16HRW-51	68.9	59.9	0	0	0	1
VA17HRW-94	68.6	60.2 +	0	0	0	2
VA15HRW-86	68.5	59.7	0	0	0	1
VA17HRW-55	68.4	59.3	4 +	0	0	2
Everest	68.3	61.3 +	0	1	0	3
VA16HRW-42	68.2	59.6	0	1	0	2
VA13MAS15-2194-1-2	68.0	57.8	0	0	0	0 -
VA17HRW-8	67.7	57.8	0	2 +	0	1
VA17HRW-32	67.5	57.3 -	0	1	0	2
VA15HRW-130	66.5	59.0	0	0	0	2
VA17HRW-92	66.3	58.4	0	0	0	3
VA17HRW-100	66.1	57.2 -	2	0	0	1
VA16HRW-36	64.8	60.1 +	2	0	0	1
VA15HRW-76-WS	64.7	58.7	0	0	0	2
DH13HRW09-143	64.0	58.3	0	0	0	2
Vision 30	63.4	60.1 +	0	0	0	3
Vision 45	62.3	58.3	0	1	0	2
Jagger	61.1	59.3	0	5 +	0	3
VA17HRW-9	60.5 -	58.6	1	2	0	3
Karl 92	60.3 -	59.6	0	3 +	1 +	3
VA17HRW-38	59.8 -	58.6	0	0	0	2
VA17HRW-36	58.7 -	58.5	0	1	0	1
Average	72.6	58.8	0	1	0	2
LSD (0.05)	11.7	1.1	2	1	0	2
C.V.	8.0	1.0	461	99	373	49

Table 6. Summary of performance of entries in the Virginia Tech Hard RedWinter Wheat Test, Eastern Shore AREC, Painter, VA, 2019 harvest.

Varieties are ordered by descending yield averages.

A plus or minus sign indicates a performance significantly above or below the test average.

The 0-9 ratings indicate a genotype's response to disease or lodging where 0 = highly resistant and 9 = highly susceptible.

Table 7. Entries in the Virginia Tech Hard Red Winter Wheat Elite Test in 2018.

	SKCS‡ Wheat
Cultivar†	Class
5210	HARD
DH11HRW56-40	MIXED
DH12HRW46-40	SOFT
DH12HRW46-8	HARD
DH12HRW50-11	MIXED
DH13HRW07-30	HARD
DH13HRW08-192	MIXED
DH13HRW09-143	MIXED
DH13HRW09-81WS	MIXED
Everest	MIXED
Jagger	HARD
Karl 92	MIXED
Soissons	MIXED
VA09HRW-43	MIXED
Hardy 2519	MIXED
VA14HRW-41	HARD
VA15HRW-130	MIXED
VA15HRW-73	MIXED
VA15HRW-76-WS	SOFT
VA15HRW-85	MIXED
VA15HRW-86	MIXED
VA16HRW-11	SOFT
VA16HRW-22	MIXED
VA16HRW-36	MIXED
VA16HRW-42	SOFT
VA16HRW-44	SOFT
VA16HRW-47	SOFT
VA16HRW-51	SOFT
Vision 30	MIXED
Vision 45	MIXED
Vision 50	MIXED

[†]Cultivars are sorted alphabetically; released lines are in bold print; Jagger is the quality standard check variety.

[‡]Single Kernel Characterization System (SKCS), AACC Method 55-31.01

(http://methods.aaccnet.org/methods/55-31.pdf).

Cultivar†	SKCS‡ Kernel	: 1000 Weight g	SKCS‡ Hard Inc	Kernel lness lex	Adj. Wh Hard Inc	eat NIR Iness Iex	Wheat Protein @ 14% Moist %		
	2018	2017	2018	2017	2018	2017	2018	2017	
5210	29.1	34.9	60	59	62	59	12.7	9.1	
DH11HRW56-40	35.5	35.6	35	60	41	53	12.1	9.4	
DH12HRW46-40	35.5	37.2	30	46	40	47	12.1	10.9	
DH12HRW46-8	29.9	32.6	66	64	65	68	13.4	9.9	
DH12HRW50-11	31.3	35.9	43	62	45	54	13.3	10.2	
DH13HRW07-30	31.2		53		51		12.3		
DH13HRW08-192	30.2		54		44		12.0		
DH13HRW09-143	30.1		52		59		12.5		
DH13HRW09-81WS	33.3		57		65		11.9		
Everest	33.8	34.0	49	63	51	59	11.6	10.0	
Jagger	33.2	31.2	58	70	62	63	13.7	10.8	
Karl 92	33.9	33.1	46	55	47	54	12.7	10.8	
Soissons	28.0	33.6	46	50	50	53	13.2	9.5	
VA09HRW-43	30.5	36.3	47	58	41	52	12.4	9.1	
Hardy 2519	29.1	31.4	57	67	47	64	12.8	10.5	
VA14HRW-41	28.4	30.0	55	63	46	55	11.8	9.6	
VA15HRW-130	27.3	29.6	41	53	41	52	13.3	10.6	
VA15HRW-73	31.2	35.4	51	59	50	62	11.9	10.1	
VA15HRW-76-WS	28.2	31.6	5	14	26	31	12.4	10.2	
VA15HRW-85	28.3	29.9	38	53	48	52	12.4	10.4	
VA15HRW-86	28.1	29.7	45	54	53	54	13.3	10.5	
VA16HRW-11	32.7		-3		28		12.7		
VA16HRW-22	29.8		54		53		13.4		
VA16HRW-36	31.2		38		48		13.2		
VA16HRW-42	29.6		7		27		14.5		
VA16HRW-44	27.3		6		28		12.2		
VA16HRW-47	27.5		3		25		13.3		
VA16HRW-51	30.7		3		26		12.6		
Vision 30	30.5	31.4	50	61	49	53	13.2	10.0	
Vision 45	30.4 34.2		45	56	76	55	14.9	10.4	
Vision 50	31.3	34.3	48	46	52	48	12.7	9.1	
Average	30.5	33.9	40.0	54.5	47	55	12.8	10.1	
Maximum	35.5	41.6	66.2	80.7	76	80	14.9	11.3	
Minimum	27.3	29.5	-3.4	12.3	25	25	11.6	9.0	

Table 8. Kernel Quality of Entries in the Virginia Tech Hard Red Winter Wheat EliteTest, 2018.

[†]Cultivars are sorted alphabetically; released lines are in bold print; Jagger is the quality standard check variety.

[‡]Single Kernel Characterization System (SKCS), AACC Method 55-31.01

(http://methods.aaccnet.org/methods/55-31.pdf).

Cultivar†	Flour %	Yield 6	Flour @14% %	r Ash Moist %	Flour I @14% %	Protein Moist %	Flour Absor %	Water ption 6	Adj. M Tir m	lixing ne in	Mix Toler 0-	ting rance -6	Crumb 0-	Score 6	Loaf V c	olume c	Crumb Color Visual Rating
	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
5210	67.1	71.9	0.45	0.45	11.2	7.6	61.6	57.2	5.43	2.97	4	4	3.5	2.5	875	675	Yellow
DH11HRW56-40	67.0	71.0	0.40	0.37	10.6	8.1	60.7	58.9	5.02	3.97	5	4	3.0	2.5	770	655	Creamy
DH12HRW46-40	64.9	64.4	0.41	0.41	10.6	9.8	60.6	62.7	5.19	4.79	4	4	4.0	3.5	760	700	Creamy
DH12HRW46-8	64.7	67.0	0.48	0.47	11.7	8.3	62.5	59.8	1.94	1.79	2	2	2.5	1.0	770	620	Dull
DH12HRW50-11	70.0	69.1	0.40	0.34	12.0	8.9	63.0	60.4	2.63	2.29	2	2	2.0	2.5	900	720	Yellow
DH13HRW07-30	67.3		0.37		11.1		61.4		6.68		4		3.5		905		Creamy
DH13HRW08-192	66.0		0.37		10.8		60.9		2.77		2		3.0		855		Slightly Yellow
DH13HRW09-143	69.5		0.40		11.1		61.5		2.69		1		3.0		875		Creamy
DH13HRW09-81WS	71.1		0.38		10.3		60.1		3.38		2		5.0		910		Creamy
Everest	67.6	68.3	0.38	0.45	10.6	9.1	62.6	59.2	4.15	2.59	3	2	3.0	3.0	775	670	Slightly Yellow
Jagger	63.6	67.3	0.49	0.50	11.9	9.5	64.7	61.0	4.43	3.13	3	4	4.0	3.0	885	760	Dull
Karl 92	67.5	68.0	0.40	0.42	11.4	9.7	61.9	61.2	5.78	4.23	4	4	2.5	3.0	935	790	Creamy
Soissons	69.9	72.9	0.42	0.43	11.8	8.3	61.7	59.7	7.12	3.51	5	3	4.0	2.5	925	735	Slightly Yellow
VA09HRW-43	65.1	70.1	0.38	0.42	10.8	7.8	62.4	58.1	2.90	1.98	3	2	3.5	2.0	840	665	Slightly Yellow
Hardy 2519	65.6	67.3	0.37	0.39	11.7	9.3	64.4	61.8	5.53	4.11	4	4	2.5	2.5	935	735	Slightly Yellow
VA14HRW-41	69.4	69.7	0.37	0.38	10.7	8.5	60.8	60.3	5.68	3.88	4	4	3.5	2.5	860	675	Dark Yellow
VA15HRW-130	69.7	71.2	0.35	0.41	12.2	9.5	63.3	60.2	7.00	3.48	5	3	4.0	3.0	935	765	Dark Yellow
VA15HRW-73	68.1	68.5	0.41	0.43	10.6	8.6	60.6	60.8	4.77	2.79	4	3	3.0	4.0	825	735	Creamy
VA15HRW-76-WS	68.8	69.6	0.36	0.36	10.6	8.4	59.2	57.3	2.72	2.26	1	0	3.0	2.0	855	745	Slightly Yellow
VA15HRW-85	70.3	70.4	0.40	0.40	11.3	9.2	61.7	59.8	4.79	2.67	4	2	4.0	3.0	930	780	Slightly Yellow
VA15HRW-86	71.0	72.6	0.36	0.43	12.3	9.3	63.4	58.7	5.25	3.33	3	1	3.0	2.5	1000	800	Dull
VA16HRW-11	70.6		0.35		11.1		61.3		4.87		3		4.0		840		Yellow
VA16HRW-22	69.3		0.49		11.9		62.7		4.44		2		4.5		905		Creamy
VA16HRW-36	71.8		0.39		12.1		63.2		4.88		3		5.0		960		Slightly Yellow
VA16HRW-42	64.5		0.40		13.0		64.6		3.13		1		2.5		950		Slightly Yellow
VA16HRW-44	69.6		0.36		10.8		59.5		3.87		2		4.0		910		Yellow
VA16HRW-47	67.3		0.36		11.5		62.1		3.28		2		2.0		880		Slightly Yellow
VA16HRW-51	68.2		0.36		11.0		61.2		4.71		4		4.5		955		Creamy
Vision 30	66.1	67.7	0.39	0.42	11.9	9.0	62.8	61.3	4.70	3.70	4	4	2.5	2.0	950	665	Yellow

 Table 9. Flour and Baking Quality of Entries in the Virginia Tech Hard Red Winter Wheat Elite Test, 2018 harvest.

Cultivar†	Flour ۹	Yield %	Flour @14% %	r Ash Moist %	Flour Protein @14% Moist %		Flour Water Absorption %		Adj. M Tii m	lixing ne in	Mixing Tolerance 0-6		Crumb 0·	Score 6	Loaf Volume cc		Crumb Color Visual Rating
	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Vision 45	69.1	71.2	0.39	0.42	11.0	9.1	61.3	59.5	3.96	2.27	4	3	3.0	3.0	845	740	Slightly Yellow
Vision 50	69.9	74.0	0.38	0.42	11.1	7.9	61.5	58.6	4.61	2.17	3	2	3.0	3.0	830	705	Yellow
Average	68.1	69.1	0.4	0.4	11.3	8.8	61.9	59.9	4.46	3.16	3.1	2.9	3.4	2.6	882	715	
Maximum	71.8	74.0	0.5	0.5	13.0	9.8	64.7	62.7	7.12	4.79	5.0	4.0	5.0	4.0	1000	800	
Minimum	63.6	63.5	0.4	0.3	10.3	7.6	59.2	56.9	1.94	1.67	1.0	0.0	2.0	1.0	760	620	

Table 9. Flour and Baking Quality of Entries in the Virginia Tech Hard Red Winter Wheat Elite Test, 2018 harvest.

[†]Cultivars are sorted alphabetically; released lines are in bold print; Jagger is the quality standard check variety.

[‡]Single Kernel Characterization System (SKCS), AACC Method 55-31.01 (http://methods.aaccnet.org/methods/55-31.pdf).

Section 2. Malt Barley Varieties in Virginia in 2019

Agronomic Performance

Malt barley tests were planted in seven-inch rows at Blackstone and in six-inch rows at Warsaw and Blacksburg. They were seeded at 44 seeds per square foot.

Agronomic performance data for entries in the Eastern Malt Barley Trial (EMBT) conducted at locations in Blacksburg, Blackstone and Warsaw, VA in 2019 are presented in Table 10. Two Virginia winter malt barley experimental lines VA16M-14DH1272 (2R) and VA16M-82 (2R) ranked 1st and 2nd in average grain yield (97 bu/ac) among two-row winter barley lines and were 1 bushel per acre higher than the cultivar Violetta, 7 bu/ac higher than Wintmalt (91 bu/ac), 9 bushels per acre higher than Flavia (88 bu/acre), 11 bushels per acre more than Calypso (86 bu/ac), and 9 bushels per acre higher than the overall test average. The winter malt barley check cultivar (Violetta) ranked 3rd in grain yield among 2-row malt barley lines with average grain yield of 96 bushels per acre that was 5 to 10 bushels per acre higher than the check cultivars Wintmalt, Flavia, and Calypso. Results for these new malt barley lines are encouraging and indicate that significant progress is being made by the breeding program in developing barley cultivars with high yield and improved disease resistance. Two-year performance data are presented in Table 11. KWS Joy, Violetta, Thoroughbred, KWS Scala, SU-Mateo, Hirondella, Flavia and Calypso all had grain yield above the test average over two years. None had higher than average test weight, however. Individual site performance data for 2019 are presented in Tables 12-14.

Malt Quality Performance

Summary of malt quality performance of entries in the 2018 Eastern Malt Barley Trials (EMBT) at the Blacksburg, VA location and conducted by Hartwick College, Center for

Craft Food and Beverage, Oneonta, NY are presented in Table 15. Malt quality values for the Virginia elite malt barley lines VA16M-81 (2R), VA16M-82 (2R), and VA16M-84 (2R) were desirable and are within AMBA adjunct and all-malt specifications for plump kernels, barley protein, malt extract, soluble/total protein, diastatic power, alpha-amylase, betaglucan and FAN. Specifically, the Virginia elite line VA16M-81 (2R) met AMBA distillers' specifications for all categories of all-malt. Malt quality values for the check varieties Violetta, Flavia, Calypso, and Wintmalt changed to varying degrees that were either lower or higher than the upper or lower limits for all-malt specifications. Our breeding program plans to continue to build on the data collected on these varieties and evaluate and select superior malt barley lines each year from the EMBT and the WMBT to determine which lines are best suited to provide the yields and quality sought by craft maltsters and brewers in the eastern U.S.

	Grain		Test	t	Date	è	Matu	ıre	Plan	nt	Floweri	ng	FHB		FHE	}	FH	В
	Yield	ł	Weig	ht	Head	ed	Heig	ht	Lodgi	ng	Date		Inciden	ce^1	Severi	ty ²	Inde	ex^3
Line	(Bu/a	a)	(Lb/b	u)	(Julia	n)	(In)	(0-9)	(Julian	l)	(%)		(%)		(0-9))
	(3)		(3)		(2)		(2))	(3)		(1)		(1)		(1)		(1))
Thoroughbred	106.0	+	45.7	-	112	-	27		0	-	110		13		17		2	
SB 255	103.3	+	46.6		111	-	30	+	1		110		10		12		1	
VA16M-14DH1272 (2R)	97.4	+	50.4	+	112	-	31	+	1		110		10		13		1	
VA16M-82 (2R)	97.3	+	49.3	+	113	-	33	+	1		111		10		11		1	
Violetta	96.0	+	46.6		113	-	23	-	1		110		10		10		1	
ARS15B12	94.9		48.1	+	112	-	27		2		110		8		8		1	
KWS Joy	94.8		43.6	-	118	+	25	-	1		118	+	25		17		4	
12W581-47	91.9		46.6		113	-	23	-	2		111		10		10		1	
VA16M-14DH1269	91.1		46.9		108	-	23	-	1		106	-	8		9		1	
SU-Mateo	91.0		44.5	-	117	+	25		0	-	116		18		13		2	
12W592-18	90.9		47.3		111	-	25	-	2		110		10		11		1	
ARS16B16	90.8		49.9	+	112	-	31	+	2		110		10		15		1	
Wintmalt	90.8		44.8	-	120	+	24	-	1		118	+	23		16		3	
VA16M-81 (2R)	90.7		48.1	+	114		27		1		113		28		15		4	
12W599-49	90.2		45.0	-	111	-	22	-	3	+	108		8		10		1	
VA16M-14DH1294 (2R)	89.1		47.5		118	+	35	+	1		115		28		18		5	
VA16M-14DH1310	89.0		49.7	+	116	+	31	+	1		113		40	+	19	+	8	+
ARS16B24	88.8		50.0	+	114		31	+	2		111		15		19	+	3	
KWS Scala	88.5		43.7	-	114		23	-	1		114		15		13		2	
Hirondella	88.1		43.1	-	117	+	26		1		114		10		13		1	
12W587-78	88.0		45.6	-	117	+	25		2		117	+	10		9		1	
Flavia	87.8		45.7	-	118	+	21	-	1		117	+	40	+	17		7	+
VA16M-115 (2R)	87.0		49.8	+	114		26		1		111		8		7		1	
ARS14B12	86.8		48.8	+	111	-	27		1		107	-	8		7		1	
Calypso	86.1		44.0	-	117	+	26		1		115		10		9		1	
12W590-063	85.6		45.7	-	111	-	24	-	2		109		13		9		1	
VA16M-84 (2R)	85.2		50.1	+	115	+	30	+	1		112		15		9		1	
VA16M-14DH1312 (2R)	85.0		48.9	+	114		25	-	1		112		23		13		3	
ARS14B14	84.0		48.4	+	112	-	25	-	1		109		3		3	-	0	
VA16M-83 (2R)	82.8		50.1	+	115		30	+	1		111		8		6		1	
ARS15B19	80.7		47.2		112	-	32	+	2		111		33	+	14		5	
ARS14B15	80.5	-	49.1	+	112	-	26		1		110		8		6		1	
12W592-41	79.8	-	46.8		112	-	25		2		111		35	+	14		5	
ARS15B24	78.3	-	46.2	-	122	+	24	-	2		117	+	10		9		1	
VA16M-14DH1285	77.0	-	43.9	-	112	-	31	+	1		112		23		18		4	
ARS15B32	73.7	-	47.6		113	-	31	+	2		110		15		15		2	
12W587-66	66.8	-	45.6	-	120	+	24	-	2		118	+	10		11		1	
Average	88.0		47.0		114		27		1		112		15		12		2	
LSD (0.05)	7.5		0.8		1		2		1		4		15		7		3	
C.V.	8.9		1.9		1		6		78		3		69		41		92	

Table 10. Summary of performance of entries in the Virginia Tech Eastern Malting Barley Test over locations, 2019 harvest.

Varieties are ordered by descending yield averages.

Table 10. Summary of performance of entries in the Virginia Tech Eastern Malting BarleyTest over locations, 2019 harvest.

A plus or minus sign indicates a performance significantly above or below the test average.

The 0-9 ratings indicate a genotype's response to disease or lodging where 0 = highly resistant and 9 = highly susceptible.

The number in parentheses below column headings indicates the number of locations on which data are based.

¹ Scab Incidence (%): Based on infected spikes within 4 ft row.

² Scab Severity (%): Based on infected spikelets in 10 spikes showing disease symptoms.

³ FHB Index is an overall indicator of scab resistance/susceptibility level and takes into account both

incidence and severity where 0 = highly resistant and 9 = highly susceptible.

-	Grain		Test	t	Date	è	Matu	ire	Plan	t	Floweri	ng	FHB		FHE	3	FH	В
	Yield		Weig	ht	Head	ed	Heig	ht	Lodgi	ng	Date		Incident	ce ¹	Severi	ty ²	Inde	x^3
Line	(Bu/a)	(Lb/b	u)	(Julia	n)	(In)	(0-9)	(Juliar	ı)	(%)		(%)		(0-9))
	(6)		(6)		(4)		(4))	(5)		(2)		(2)		(2)		(2))
SB 255	99.6	+	46.2		115	-	34	+	2		113	-	55		40		3	
KWS Joy	93.6	+	42.6	-	121	+	28	-	1		121	+	63		36		3	
Violetta	92.9		45.7		117	-	27	-	1		114	-	55		28		2	
ARS15B12	91.8		47.0		116	-	32		1		114	-	54		22		2	
Thoroughbred	91.5		43.8	-	116	-	30		2	+	115		56		47	+	4	+
KWS Scala	91.0		43.1	-	117		26	-	1		117	+	58		36		3	
SU-Mateo	90.7		44.1	-	121	+	29	-	2		119	+	59		26		2	
Hirondella	90.7		42.4	-	120	+	30		1		117	+	55		48	+	4	+
VA16M-14DH1269	90.4		46.7		112	-	27	-	2		110	-	54		46	+	4	+
Flavia	90.3		44.3	-	121	+	25	-	1		120	+	70	+	35		3	
Calypso	89.7		43.5	-	120	+	30		1		119	+	55		27		2	
VA16M-84 (2R)	88.9		49.7	+	118		34	+	1		115		58		19	-	1	-
VA16M-81 (2R)	88.3		47.0		118	+	31		1		116		64		36		3	
VA16M-82 (2R)	87.5		49.4	+	116	-	35	+	2		114		55		18	-	1	-
VA16M-14DH1272 (2R)	87.4		49.8	+	116	-	33	+	2	+	114	-	55		39		3	
VA16M-14DH1310	86.9		49.0	+	119	+	34	+	2		118	+	70	+	51	+	4	+
ARS14B12	86.1		48.7	+	115	-	30		1		113	-	53		25		2	
VA16M-83 (2R)	85.9		49.6	+	118		34	+	1		115		54		21	-	2	
VA16M-14DH1294 (2R)	85.8		46.3		122	+	39	+	3	+	119	+	64		33		2	
ARS14B14	85.6		48.8	+	116	-	29	-	2		113	-	51	-	19	-	2	
VA16M-14DH1285	84.4		44.3	-	116	-	34	+	1		114		61		53	+	4	+
VA16M-115 (2R)	84.2		49.1	+	117	-	31		2		114	-	54		35		3	
VA16M-14DH1312 (2R)	84.2		47.4		117		29	-	1	-	115		61		31		2	
ARS15B19	83.1		46.5		116	-	36	+	0	-	114	-	66	+	32		2	
ARS15B24	81.2	-	44.4	-	124	+	27	-	1		120	+	55		37		3	
ARS14B15	79.6	-	49.1	+	116	-	29	-	2		113	-	54		25		2	
ARS15B32	77.9	-	47.0		116	-	35	+	0	-	113	-	58		28		2	
Average	87.4		46.5		118		31		1		115		58		33		3	
LSD (0.05)	5.7		1.0		1		1		1		1		7		11		1	
C.V.	9.8		3.2		1		5		80		1		11		35		42	

Table 11. Two-year summary of performance of entries in the Virginia Tech Eastern MaltingBarley Test over locations, 2018 and 2019 harvests.

Varieties are ordered by descending yield averages.

A plus or minus sign indicates a performance significantly above or below the test average.

The 0-9 ratings indicate a genotype's response to disease or lodging where 0 = highly resistant and

9 = highly susceptible.

The number in parentheses below column headings indicates the number of location-years on which data are based.

¹ Scab Incidence (%): Based on infected spikes within 4 ft row.

² Scab Severity (%): Based on infected spikelets in 10 spikes showing disease symptoms.

³ FHB Index is an overall indicator of scab resistance/susceptibility level and takes into account both

incidence and severity where 0 = highly resistant and 9 = highly susceptible.

	2-year		Grain	Grain		Test		:	Mature		Plant	
	Av. Yield		Yield		Weight	Weight		ed	Height		Lodging	
Line	(Bu/a)		(Bu/a)		(Lb/bu))	(Julia	1)	(In)		(0-9)	
Hirondella	119.0	+	123.0	+	45.3	-	119	+	26		0	
VA16M-14DH1272 (2R)	106.1		118.6	+	51.9	+	114	-	31	+	1	+
Thoroughbred	90.0	-	117.4	+	47.4	-	114	-	27		1	+
SB 255	115.3	+	117.4	+	48.9		113	-	30	+	1	+
SU-Mateo	108.1	+	113.2	+	48.1	-	119	+	26		0	
VA16M-81 (2R)	104.5		113.0		50.8	+	115		27		0	
KWS Scala	111.4	+	111.0		47.2	-	115		23	-	0	
KWS Joy	100.5		109.7		46.7	-	120	+	24	-	0	
12W599-49			109.0		46.5	-	113	-	21	-	0	
12W592-18			108.7		48.9		114	-	26		0	
VA16M-14DH1294 (2R)	96.2		107.9		47.3	-	122	+	35	+	0	
Violetta	109.2	+	107.9		48.8		115	-	23	-	0	
VA16M-115 (2R)	98.9		107.7		50.6	+	115		27		1	+
VA16M-82 (2R)	95.3		106.9		51.7	+	115	-	33	+	0	
Flavia	104.3		105.2		49.3		119	+	21	-	0	
ARS14B12	98.8		104.8		50.7	+	114	-	27		0	
ARS15B12	97.3		104.5		49.5		114	-	26		0	
Calypso	110.2	+	103.6		46.9	-	120	+	26		0	
Wintmalt			102.5		47.2	-	121	+	24	-	0	
VA16M-14DH1285	101.7		102.3		46.8	-	115	-	31	+	0	
VA16M-14DH1269	105.1		101.7		47.5	-	110	-	22	-	1	
ARS16B24			101.5		52.5	+	116		32	+	0	
VA16M-14DH1310	99.1		100.6		52.1	+	117	+	30	+	1	
VA16M-83 (2R)	96.4		99.5		52.6	+	116		30	+	0	
12W592-41			99.3		49.3		114	-	25		0	
12W590-063			99.1		47.8	-	114	-	25	-	1	+
ARS14B14	95.5		98.9		51.0	+	114	-	25	-	0	
12W581-47			98.8		49.5		115	-	21	-	0	
12W587-78			98.4		45.2	-	120	+	25		0	
VA16M-84 (2R)	98.1		96.0		52.4	+	117		29	+	0	
ARS16B16			95.6		52.2	+	115	-	30	+	1	
ARS14B15	85.8	-	95.1		50.8	+	114	-	25	-	0	
VA16M-14DH1312 (2R)	91.3	-	88.9	-	49.9	+	117		25		0	
ARS15B19	90.9	-	86.9	-	48.9		115	-	31	+	0	
ARS15B32	86.2	-	86.8	-	49.0		115	-	32	+	1	
ARS15B24	83.8	-	79.6	-	44.7	-	123	+	24	-	1	
12W587-66			63.3	-	45.3	-	123	+	25		0	
Average	100.0		102.3		49.0		116		27		0	
LSD (0.05)	8.1		10.9		0.6		1		2		1	
C.V.	7.1		6.6		0.8		1		5		140	

Table 12. Summary of performance of entries in the Virginia Tech Eastern Malting Barley Test, Kentland Farm, Blacksburg, VA, 2019 harvest.

Released cultivars are shown in bold print. Varieties are ordered by descending yield averages.

A plus or minus sign indicates a performance significantly above or below the test average.

The 0-9 ratings indicate a genotype's response to disease or lodging where 0 = highly resistant and

9 = highly susceptible.

	2-year		Grain	Grain		Test			Mature		Plant	
	Av. Yield		Yield		Weight		Headed		Height		Lodging	
Line	(Bu/a)		(Bu/a)		(Lb/bı	ı)	(Julian)	(In)		(0-9)	
KWS Joy	109.0	+	112.1	+	44.8	-	116.0	+	25.0		0.0	
VA16M-14DH1272 (2R)	80.7		106.8	+	50.7	+	110.7		30.3	+	0.3	
12W581-47			103.9	+	47.1		110.3		23.7	-	1.0	+
Thoroughbred	98.2	+	103.1	+	44.9	-	109.3	-	27.7		0.7	
Wintmalt			101.6		45.8	-	118.0	+	24.3		0.0	
SB 255	97.7	+	100.7		44.5	-	109.0	-	29.7	+	0.7	
ARS15B24	89.9		98.9		47.4		119.7	+	23.7	-	0.7	
VA16M-14DH1269	88.9		97.9		47.9		106.0	-	24.0	-	1.3	+
ARS15B12	96.6	+	97.4		47.7		109.0	-	27.7		0.0	
Flavia	96.2	+	97.4		45.7	-	116.7	+	21.3	-	0.0	
VA16M-82 (2R)	82.8		95.6		49.0	+	110.0	-	33.3	+	0.3	
Calypso	94.1		93.9		44.5	-	115.0	+	26.3		0.0	
12W599-49			93.9		44.9	-	108.3	-	21.7	-	1.0	+
ARS16B16			93.3		50.0	+	109.7	-	31.3	+	0.3	
VA16M-14DH1294 (2R)	85.2		91.2		48.2	+	114.7	+	35.7	+	0.3	
SU-Mateo	88.8		90.8		45.7	-	116.0	+	24.7		0.0	
Violetta	86.2		90.4		45.7	-	110.7		23.7	-	0.3	
KWS Scala	92.3		89.6		44.4	-	113.0		22.3	-	0.0	
12W587-78			89.6		46.5		114.0	+	25.3		0.3	
Hirondella	90.8		89.3		42.9	-	114.3	+	25.3		0.0	
ARS14B12	84.4		86.8		49.1	+	108.3	-	26.7		0.0	
VA16M-14DH1312 (2R)	80.6		85.4		48.1		111.3		25.0		0.0	
VA16M-14DH1310	85.3		84.7		49.3	+	114.0	+	32.0	+	0.3	
12W592-41			84.7		47.3		109.0	-	25.7		1.0	+
12W592-18			83.8		46.9		108.7	-	23.7	-	0.7	
ARS14B14	84.6		83.5		49.3	+	109.3	-	25.0		0.0	
VA16M-81 (2R)	82.0		83.4		48.5	+	113.3		26.7		0.0	
12W587-66			82.7		47.7		116.3	+	23.3	-	0.7	
ARS16B24			82.5		50.1	+	111.0		29.0		0.3	
ARS14B15	79.8		81.4		49.5	+	109.3	-	27.3		0.3	
VA16M-84 (2R)	86.3		80.2		49.2	+	113.0		30.3	+	0.0	
12W590-063			80.1		45.5	-	108.0	-	22.7	-	2.0	+
ARS15B19	81.0		78.5		47.4		109.0	-	32.3	+	0.0	
VA16M-83 (2R)	83.3		78.2		49.5	+	112.7		30.3	+	0.7	
VA16M-115 (2R)	76.3	-	78.0		49.6	+	112.0		25.3		0.0	
VA16M-14DH1285	82.6		71.3	-	44.0	-	109.7	-	30.7	+	0.0	
ARS15B32	71.9	-	56.6	-	47.6		110.0	-	29.7	+	0.0	
Average	87.2		89.2		47.2		111.8		26.8		0.4	
LSD (0.05)	8.9		13.7		0.9		1.8		2.7		0.7	
C.V.	8.7		9.1		1.2		1.0		6.2		116.1	

Table 13. Summary of performance of entries in the Virginia Tech Eastern Malting Barley Test, Eastern Virginia AREC, Warsaw, VA, 2019 harvest.

Varieties are ordered by descending yield averages.

A plus or minus sign indicates a performance significantly above or below the test average.

The 0-9 ratings indicate a genotype's response to disease or lodging where 0 = highly resistant and

9 = highly susceptible.

	2-year	Grain	Test	Plant
	Av. Yield	Yield	Weight	Lodging
Line	(Bu/a)	(Bu/a)	(Lb/bu)	(0-9)
Thoroughbred	85.1 +	93.1 +	44.7	1.7
Violetta	83.3	89.8 +	45.2	3.7
SB 255	83.0	86.3 +	46.5	3.0
VA16M-82 (2R)	83.7	85.4 +	47.3	3.7
ARS16B16		83.4	47.5 +	1.3
ARS15B12	81.4	82.8	47.0	3.3
ARS16B24		82.3	47.3 +	2.0
VA16M-14DH1312 (2R)	80.8	80.8	48.6 +	2.0
12W592-18		80.1	45.9	2.7
VA16M-14DH1310	74.1	78.0	46.8	5.0
ARS15B19	77.4	76.8	45.3	0.7
VA16M-84 (2R)	81.1	76.4	48.5 +	3.3
VA16M-81 (2R)	78.4	75.8	44.9	4.0
VA16M-115 (2R)	77.4	75.3	49.3 +	1.7
VA16M-14DH1269	77.1	73.6	45.3	4.7
12W581-47		73.0	43.4	3.7
ARS15B32	74.4	72.1	46.2	0.0 -
12W590-063		71.0	43.8	5.3
VA16M-83 (2R)	77.9	70.8	48.3 +	4.0
VA16M-14DH1272 (2R)	74.3	70.0	48.7 +	2.7
12W587-78		69.9	45.1	4.3
ARS14B12	75.0	68.8	46.5	3.3
VA16M-14DH1294 (2R)	76.0	68.2	46.9	4.7
12W599-49		67.7	43.7	3.3
ARS15B24	71.3	63.2	46.4	4.3
ARS14B14	75.0	62.2	45.0	4.0
Flavia	70.4	61.0	41.9 -	3.3
Calypso	64.8 -	60.7	40.7 -	4.3
12W587-66		59.8	43.8	4.3
SU-Mateo	72.0	58.1	39.8 -	4.0
ARS14B15	71.8	57.5	47.0	2.3
Wintmalt		56.9	41.2 -	3.0
VA16M-14DH1285	68.7	55.4	40.9 -	4.7
12W592-41		55.4	43.9	4.3
KWS Scala	65.0 -	53.0 -	39.4 -	4.0
Hirondella	62.2 -	52.1 -	41.1 -	3.7
KWS Joy	67.0	46.3 -	39.4 -	3.7
Average	75.1	70.1	45.0	3.3
LSD (0.05)	8.7	15.4	2.4	2.8
C.V.	9.8	12.4	3.2	51.1

Table 14. Summary of performance of entries in the Virginia Tech EasternMalting Barley Test, Southern Piedmont AREC, Blackstone, VA, 2019 harvest.

Released cultivars are shown in bold print. Varieties are ordered by descending yield averages.

A plus or minus sign indicates a performance significantly above or below the test average.

The 0-9 ratings indicate a genotype's response to disease or lodging where 0 = highly resistant and 9 = highly susceptible.

Variate en Calasti	Kernel Weight	on 6/64"	Germination Energy 8mL	Malt Extract	Barley Protein	S/T	Diastatic	Alpha- Amylase	Beta- glucan	FAN
variety or Selection	(LD/DU)	(%)	(%)	(%)	(%)	(%)	Power (°L)	(20 DU)	(mg/L)	(mg/L)
Calypso	45.3	95.6	87	80.9	11.3	44.3	162	54.3	73	201
Flavia	45.2	92.4	64	79.8	11.5	44.4	141	50.2	57	199
KWS Joy	43.2	89.0	66	79.8	12.2	44.7	135	56.2	99	218
KWS Scala	45.0	90.2	77	80.1	12.9	48.4	178	61.8	47	246
SU-Mateo	44.2	89.4	92	78.5	11.0	48.3	156	60.9	92	212
Violetta	48.1	88.2	74	79.8	12.4	46.3	208	62.7	89	232
ARS14B12	50.3	93.2	88	78.4	13.8	43.3	121	52.4	175	247
ARS14B14	49.4	88.6	95	78.2	13.3	40.2	117	51.8	153	215
ARS14B15	49.8	92.8	96	78.2	12.9	43.7	124	52.4	82	230
ARS15B12	47.4	84.4	74	78.4	12.4	43.9	114	53.8	279	222
ARS15B19	48.7	98.4	51	79.3	12.7	48.7	84	48.2	445	260
ARS15B24	41.8	57.2	33	77.5	12.3	52.0	154	79.3	58	307
ARS15B32	48.7	98.4	68	79.3	12.6	48.5	94	48.3	389	254
VA16M-115 (2R)	48.9	73.0	81	78.0	13.2	46.4	137	75.7	132	256
VA16M-14DH1269	47.6	56.8	52	76.5	13.8	38.1	183	41.3	268	196
VA16M-14DH1272 (2R)	50.1	91.8	86	79.3	12.4	39.9	105	54.1	373	194
VA16M-14DH1285	48.1	77.2	59	79.7	12.8	53.0	192	79.0	185	308
VA16M-14DH1294 (2R)	50.4	93.4	64	81.6	12.9	55.6	158	65.7	77	325
VA16M-14DH1310	52.2	90.4	80	79.5	13.1	37.6	140	42.5	335	183
VA16M-14DH1312 (2R)	49.3	89.8	56	80.5	12.8	52.6	146	71.8	88	303
VA16M-81 (2R)	50.1	92.2	85	81.9	11.9	44.6	165	65.8	47	228
VA16M-82 (2R)	51.0	89.6	94	80.9	12.4	40.0	135	51.2	144	197
VA16M-83 (2R)	51.1	97.4	79	82.0	11.9	41.9	142	54.0	82	194
VA16M-84 (2R)	51.4	94.6	87	81.3	12.9	41.6	142	55.4	117	195
Mean	48.2	87.7	75	79.6	12.6	45.3	143	57.9	162	234
Minimum	34.3	51.8	33	76.5	11.0	37.6	83	33.2	39	183
Maximum	52.2	99.2	98	82.0	15.1	55.6	214	88.5	769	325

Table 15. Summary of Malt Quality of entries in the 2017-2018 Eastern Winter Malt Barley Trial at Blacksburg,VA performed by Hartwick College, Center for Craft Food and Beverage, Oneonta, NY.

Section 3. Effect of Plant Growth Regulator on Malt Barley

Four replications of malt barley were planted in Blackstone and Holland for the 2017-18 and 2018-19 growing seasons. Each replication included a check plot, a half-rate (7.2 fl oz per acre) of the plant growth regulator (PGR) trinexapac-ethyl applied both early and late, a full-rate (14.4 fl oz per acre) of PGR applied both early and late, and a split application of 7.2 fl oz per acre applied early and late. Each of these six treatments were applied to both Flavia and Violetta, for a total of 12 treatments per replication. The 'full rate' is the maximum labeled rate for barley. Target timings for the early and late applications were Feekes growth stage 4 (Zadoks 29; leaf sheaths erect) and Feekes 7 (Zadoks 32; second node visible), respectively. Applications were made on February 26th and April 20th, 2018 and March 12th and April 7th, 2019.

Effect of PGR application varied by cultivar and site in 2018 (Tables 16 and 17.) In Blackstone both late application rates (half and full) and the split application significantly reduced plant height compared to no application. Flavia height in Holland was significantly reduced by all applications, with split application resulting in shorter plants than all applications but the late full rate. Violetta height was not significantly reduced by early applications.

In 2019 PGR effect differed between sites but cultivar response was not significantly different (Table 18.) In Blackstone, the early half-rate application significantly reduced plant height compared to no application, whereas in Holland it did not. For early applications, only the full rate decreased height at both sites. For late applications the half-rate was not significantly different from the full rate. Neither grain parameters (i.e. yield, moisture, and test weight) nor plant lodging differed significantly between treatments in 2018 for either site.

Plant lodging was significantly reduced with PGR application in 2019 for the Blackstone site, although lodging occurrence was minimal even in untreated plots. Grain yield was significantly decreased by PGR application (Table 19.) Test weight was unaffected by application but was significantly greater for Flavia compared to Violetta. Grain moisture was not affected by cultivar or application.

At the Holland site grain yield was significantly decreased by the late and split applications in 2019. Late PGR application resulted in significantly greater grain moisture at harvest than check plots and early half-rate application. Test weight was significantly less in plots sprayed with the full rate at the late timing than other applications.

In 2019, PGR was applied after relatively cool weather and prior to a relatively large increase in air temperature (Table 20), which presumably resulted in the observed plant injury and subsequent grain yield reduction. These results emphasize the importance of PGR application rate and timing in relation to crop growth and weather forecast. Applications of PGR to barley in which significant growth has already occurred, and is expected to occur for approximately seven days, may minimize risk of injury.

Table 16. Effect of Plant GrowthRegulator Rate and ApplicationTiming on Flavia Growth forthe 2017-2018 Growing Season.

Location	Treatment	Height (inches)*
Blackstone	Check	25.6 A
	Half Early	25.0 A
	Full Early	24.0 AB
	Half Late	20.0 C
	Full Late	19.0 C
	Split	21.3 BC
Holland	Check	24.3 A
	Half Early	22.5 B
	Full Early	20.8 C
	Half Late	20.3 C
	Full Late	19.5 CD
	Split	18.5 D

*Values followed by the same letter within location are not significantly different at $\alpha{=}0.05$

Table 17. Effect of Plant Growth Regulator Rate and Application Timing on Violetta Growth for the 2017-2018 Growing Season.

Location	Treatment	Height (inches)*
Blackstone	Check	27.3 A
	Half Early	24.3 AB
	Full Early	23.5 AB
	Half Late	21.0 B
	Full Late	19.8 B
	Split	21.0 B
Holland	Check	24.3 A
	Half Early	22.5 A
	Full Early	22.0 AB
	Half Late	20.0 BC
	Full Late	19.8 BC
	Split	19.0 C

*Values followed by the same letter within location are not significantly different at α =0.05

Table 18. Effect of Plant GrowthRegulator Rate and ApplicationTiming on Barley Growth forthe 2018-2019 Growing Season.

Location	Treatment	Height (inches)*
Blackstone	Check	23.8 A
	Half Early	19.3 B
	Full Early	16.7 C
	Half Late	16.4 C
	Full Late	14.6 CD
	Split	14.2 D
Holland	Check	24.1 A
	Half Early	22.3 AB
	Full Early	19.5 B
	Half Late	14.3 C
	Full Late	14.2 C
	Split	14.1 C

*Values followed by the same letter within location are not significantly different at $\alpha{=}0.05$

Location	Treatment	Yield (Bu/Acre)*	Moisture (%)	Test Weight (lb/Bu)
Blackstone	Check	59.8 A	13.4 A	45.3 A
	Half Early	49.5 B	13.6 A	44.2 A
	Full Early	50.1 B	13.6 A	45.7 A
	Half Late	42.3 BC	13.4 A	45.2 A
	Full Late	29.9 D	13.8 A	44.7 A
	Split	39.9 C	13.7 A	46.0 A
Holland	Check	60.7 A	11.8 B	48.9 A
	Half Early	54.9 A	11.9 B	48.9 A
	Full Early	49.2 A	12.2 AB	48.3 A
	Half Late	23.4 B	12.8 A	46.3 AB
	Full Late	26.4 B	13.0 A	42.1 B
	Split	26.0 B	12.3 AB	47.4 A

Table 19. Summary of Plant Growth Regulator Effects onGrain Parameters for the 2018-2019 Growing Season.

*Values followed by the same letter within location are not significantly different at $\alpha{=}0.05$

			Average Daily Temperature	Maximum Air e (degrees F)	Precipitation (inches)		
Location	Application	Year	Week Preceeding Application	Week Following Application	Week Preceeding Application	Week Following Application	
Blacktone	Early	2018	67	56	0.26	0.65	
		2019	48	64	0.21	0.00	
	Late	2018	76	67	1.30	1.83	
		2019	63	74	0.52	0.67	
Holland	Early	2018	69	59	0.29	0.65	
		2019	51	63	0.24	0.16	
	Late	2018	73	66	1.2	1.05	
		2019	60	74	0.78	1.61	

Table 20. Summary of Weather Data Preceding and Following PGRApplication to Barley for the 2017-2018 and 2018-2019 Growing Seasons.

Section 4. Malt Barley Fungicide Trials

Fungicide trials were conducted at locations in Blackstone, New Kent, Mount Holly, and Holland (Tables 21-24). Prosaro, Caramba, and Miravis Ace were applied at either early heading (Feekes 10.3), anthesis (early flowering, Feekes stage 10.5), or 4-6 days after anthesis. Two malting barley varieties, Calypso and Flavia, were compared. Trials at Blackstone and New Kent were subjected to natural sources of inoculum whereas trials at Mount Holly and Suffolk were inoculated with Fusarium graminearum to promote development of Fusarium head blight (FHB). Disease pressure varied among sites with relatively high severity of net blotch in Blackstone and Suffolk and high severity of FHB in Mount Holly. Overall, Calypso had greater severity of net blotch compared to Flavia, and Miravis Ace provided the greatest control of foliar disease. When FHB severity was high, Flavia had higher levels of FHB compared to Calypso and all fungicides and application timings reduced disease. Significant differences in yield were not detected among fungicide treatments, but fungicide treated plots generally had greater yields compared to plots that did not receive a fungicide application. Results indicate both variety selection and judicious use of fungicides are needed to maximize malt barley vield and quality.

				Net Blotch	Grain
		Rate	Application	Severity	Yield
Variety	Fungicide	(fl oz/a)	Timing	(%)	(Bu/a)
Calypso	Untreated			14.7 abc	61.8 bc
Calypso	Prosaro 421SC	6.5	Feekes 10.5	11.6 a-d	60.7 bcd
Calypso	Caramba 0.75SL	13.5	Feekes 10.5	20.9 ab	59.2 bcd
Calypso	Miravis Ace SE	13.7	Feekes 10.5	23.2 a	51.0 cd
Calypso	Miravis Ace SE fb Prosaro 421SC	13.7 fb 6.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	1.9 g	67.2 bc
Calypso	Miravis Ace SE fb Caramba 0.75SL	13.7 fb 13.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	4.1 efg	61.8 bc
Calypso	Prosaro 421SC	6.5	Feekes 10.3	14.9 abc	64.3 bc
Calypso	Miravis Ace SE	13.7	Feekes 10.3	3.2 fg	78.0 ab
Calypso	Prosaro 421SC	6.5	Feekes 10.5 + 4-6d	9.3 b-e	67.3 bc
Calypso	Miravis Ace SE	13.7	Feekes 10.5 + 4-6d	1.9 g	96.1 a
Flavia	Untreated			10.1 a-e	63.6 bc
Flavia	Prosaro 421SC	6.5	Feekes 10.5	5.2 d-g	67.4 bc
Flavia	Caramba 0.75SL	13.5	Feekes 10.5	6.3 c-f	64.6 bc
Flavia	Miravis Ace SE	13.7	Feekes 10.5	1.9 g	75.2 ab
Flavia	Miravis Ace SE fb Prosaro 421SC	13.7 fb 6.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	1.9 g	70.9 bc
Flavia	Miravis Ace SE fb Caramba 0.75SL	13.7 fb 13.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	2.3 fg	72.8 b
Flavia	Prosaro 421SC	6.5	Feekes 10.3	3.2 fg	40.5 d
Flavia	Miravis Ace SE	13.7	Feekes 10.3	6.3 c-f	70.3 bc
Flavia	Prosaro 421SC	6.5	Feekes 10.5 + 4-6d	5.2 d-g	73.1 b
Flavia	Miravis Ace SE	13.7	Feekes 10.5 + 4-6d	1.9 g	79.2 ab
P-value				< 0.001	0.094

Table 21. Summary of disease and yield for fungicide treatments in the MaltingBarley Fungicide Test at Southern Piedmont AREC, Blackstone, VA, 2019.

				FHB	Grain
		Rate	Application	Severity	Yield
Variety	Fungicide	(fl oz/a)	Timing	(%)	(Bu/a)
Calypso	Untreated			0.4 a	49.3 a
Calypso	Prosaro 421SC	6.5	Feekes 10.5	0.1 a	55.4 a
Calypso	Caramba 0.75SL	13.5	Feekes 10.5	0.0 a	54.0 a
Calypso	Miravis Ace SE	13.7	Feekes 10.5	0.0 a	53.0 a
Calypso	Miravis Ace SE fb Prosaro 421SC	13.7 fb 6.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	0.0 a	49.4 a
Calypso	Miravis Ace SE fb Caramba 0.75SL	13.7 fb 13.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	0.0 a	54.4 a
Calypso	Prosaro 421SC	6.5	Feekes 10.3	0.3 a	54.1 a
Calypso	Miravis Ace SE	13.7	Feekes 10.3	0.1 a	53.0 a
Calypso	Prosaro 421SC	6.5	Feekes 10.5 + 4-6d	0.1 a	45.3 a
Calypso	Miravis Ace SE	13.7	Feekes 10.5 + 4-6d	0.0 a	51.4 a
Flavia	Untreated			1.0 a	51.2 a
Flavia	Prosaro 421SC	6.5	Feekes 10.5	0.4 a	56.3 a
Flavia	Caramba 0.75SL	13.5	Feekes 10.5	2.0 a	58.2 a
Flavia	Miravis Ace SE	13.7	Feekes 10.5	0.0 a	59.6 a
Flavia	Miravis Ace SE fb Prosaro 421SC	13.7 fb 6.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	0.0 a	54.3 a
Flavia	Miravis Ace SE fb Caramba 0.75SL	13.7 fb 13.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	0.0 a	53.9 a
Flavia	Prosaro 421SC	6.5	Feekes 10.3	0.3 a	59.7 a
Flavia	Miravis Ace SE	13.7	Feekes 10.3	0.4 a	60.2 a
Flavia	Prosaro 421SC	6.5	Feekes 10.5 + 4-6d	0.7 a	74.3 a
Flavia	Miravis Ace SE	13.7	Feekes 10.5 + 4-6d	0.4 a	64.2 a
P-value				0.124	0.248

Table 22. Summary of disease and yield for fungicide treatments in the Malting Barley Fungicide Test at Davis Farm, New Kent, VA, 2019.

				Net Blotch	FHB
Į		Rate	Application	Severity	Severity
Variety	Fungicide	(fl oz/a)	Timing	(%)	(%)
Calypso	Untreated			0.1	5.2 cde
Calypso	Prosaro 421SC	6.5	Feekes 10.5	0.1	3.0 ef
Calypso	Caramba 0.75SL	13.5	Feekes 10.5	0.1	3.6 de
Calypso	Miravis Ace SE	13.7	Feekes 10.5	0.1	3.3 de
Calypso	Miravis Ace SE fb Prosaro 421SC	13.7 fb 6.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	0.1	0.3 h
Calypso	Miravis Ace SE fb Caramba 0.75SL	13.7 fb 13.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	0.1	1.6 fg
Calypso	Prosaro 421SC	6.5	Feekes 10.3	0.1	5.5 cd
Calypso	Miravis Ace SE	13.7	Feekes 10.3	0.1	5.8 cd
Calypso	Prosaro 421SC	6.5	Feekes 10.5 + 4-6d	0.1	0.4 h
Calypso	Miravis Ace SE	13.7	Feekes 10.5 + 4-6d	0.1	0.9 gh
Flavia	Untreated			0.1	23.6 a
Flavia	Prosaro 421SC	6.5	Feekes 10.5	0.1	6.0 cd
Flavia	Caramba 0.75SL	13.5	Feekes 10.5	0.1	13.2 b
Flavia	Miravis Ace SE	13.7	Feekes 10.5	0.0	13.8 b
Flavia	Miravis Ace SE fb Prosaro 421SC	13.7 fb 6.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	0.0	0.9 gh
Flavia	Miravis Ace SE fb Caramba 0.75SL	13.7 fb 13.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	0.0	3.5 de
Flavia	Prosaro 421SC	6.5	Feekes 10.3	0.1	7.6 c
Flavia	Miravis Ace SE	13.7	Feekes 10.3	0.1	15.7 ab
Flavia	Prosaro 421SC	6.5	Feekes 10.5 + 4-6d	0.0	1.5 fg
Flavia	Miravis Ace SE	13.7	Feekes 10.5 + 4-6d	0.1	4.0 de
P-value				0.377	< 0.001

Table 23. Summary of disease for fungicide treatments in the Malting Barley Fungicide Test at VCIA Foundation Seed Farm, Mount Holly, VA, 2019.

				Net Blotch	FHB	Grain
		Rate	Application	Severity	Severity	Yield
Variety	Fungicide	(fl oz/a)	Timing	(%)	(%)	(Bu/a)
Calypso	Untreated			3.7 ab	3.5 ab	44.4 a
Calypso	Prosaro 421SC	6.5	Feekes 10.5	3.7 ab	2.6 a-d	63.6 a
Calypso	Caramba 0.75SL	13.5	Feekes 10.5	4.3 a	4.1 a	48.1 a
Calypso	Miravis Ace SE	13.7	Feekes 10.5	1.7 cd	3.8 ab	50.8 a
Calypso	Miravis Ace SE fb Prosaro 421SC	13.7 fb 6.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	1.7 cd	2.6 a-d	66.8 a
Calypso	Miravis Ace SE fb Caramba 0.75SL	13.7 fb 13.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	1.4 cd	2.7 a-d	47.4 a
Calypso	Prosaro 421SC	6.5	Feekes 10.3	2.3 bc	3.7 ab	51.7 a
Calypso	Miravis Ace SE	13.7	Feekes 10.3	0.4 d	3.4 ab	35.9 a
Calypso	Prosaro 421SC	6.5	Feekes 10.5 + 4-6d	3.7 ab	2.9 abc	47.9 a
Calypso	Miravis Ace SE	13.7	Feekes 10.5 + 4-6d	0.7 cd	4.0 ab	45.9 a
Flavia	Untreated			0.4 d	1.6 def	51.0 a
Flavia	Prosaro 421SC	6.5	Feekes 10.5	1.0 cd	1.8 c-f	53.4 a
Flavia	Caramba 0.75SL	13.5	Feekes 10.5	1.7 cd	1.9 c-f	73.9 a
Flavia	Miravis Ace SE	13.7	Feekes 10.5	0.1 d	2.5 b-e	39.8 a
Flavia	Miravis Ace SE fb Prosaro 421SC	13.7 fb 6.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	0.1 d	1.3 f	61.0 a
Flavia	Miravis Ace SE fb Caramba 0.75SL	13.7 fb 13.5	Feekes 10.5 fb Feekes 10.5 + 4-6d	0.1 d	1.4 ef	49.9 a
Flavia	Prosaro 421SC	6.5	Feekes 10.3	0.7 cd	2.7 a-d	62.7 a
Flavia	Miravis Ace SE	13.7	Feekes 10.3	0.1 d	1.9 c-f	60.5 a
Flavia	Prosaro 421SC	6.5	Feekes 10.5 + 4-6d	1.4 cd	2.0 c-f	36.6 a
Flavia	Miravis Ace SE	13.7	Feekes 10.5 + 4-6d	1.1 cd	1.4 ef	47.2 a
P-value				0.004	0.001	0.503

Table 24. Summary of disease and yield for fungicide treatments in the Malting Barley Fungicide Test at Tidewater AREC, Holland, VA, 2019.

Section 5. Nitrogen Rate and Timing Effects on Yield and Enduse Quality of Malting Barley

Experiments evaluating the effect of spring nitrogen rate and timing on winter malting barley yield, grain protein and test weight, and end-use were planted at seven locations in Virginia from 2016 to 2019. Tests were conducted near Holland and Orange, VA in 2016-2018. Additional sites were installed near Amelia, VA in 2017 and at Blackstone, VA in 2019.

Treatments included the following in-season spring nitrogen rates at the listed physiological timings.

	Timing								
Treatment	GS 25	GS 30							
	N rate, kg ha-1								
1	56	56							
2	34	78							
3	78	34							
4	112	0							
5	0	112							
6	78	0							
7	0	78							

In 2016, split N applications significantly increased yields of Thoroughbred barley only at Orange, while Flavia grain yield was unresponsive at both locations. Where significant differences were found, 0+112 resulted in the highest yields (4712 kg ha⁻¹) for Thoroughbred, while treatment 78+0 produced the lowest yields (3167 kg ha⁻¹). High yields were maintained at the 78 kg N ha⁻¹ level if applied at GS 30, however, if applied at GS 25 with no applications at GS 30, yields declined by an average of 542 kg ha⁻¹. Generally, there were no differences between the two total rates unless all of 112

kg N ha⁻¹ was applied at GS 30 compared to having all 78 kg N ha⁻¹ applied at GS 25. Yield differences between the two rates are due to the effect of N timing on plant physiology. Nitrogen applied at GS 25 is used for tiller formation and vegetative growth, which increases leaf area index and potential number of grain heads and grains per head. Nitrogen application at GS 30 is used for late season N requirements for survival of earbearing tillers, kernel development, survival and fill, and can delay leaf senescence. Applications of 78 kg N ha⁻¹ at GS 25 was not sufficient to support kernel development for high yields, resulting in early leaf senescence especially when no additional N was applied later in the season. The fact that experimental plots that did not have N applied at GS 25 but still had high yields from GS 30 applications of 78 kg N ha⁻¹ gives an indication that tiller development was adequately supported by residual soil N at Orange, VA in 2016.

No effect of rate and timing of N on yield at Orange or Holland was observed for Flavia Results indicate that rate and timing of N was not a contributing factor to yield of Flavia, and N requirements were met at the 78 kg N ha⁻¹ level applied at either GS 25 or GS30.

Flavia yields in 2017 were highest with the 34+78 split (6529 kg ha⁻¹) and 0+112 (6220 kg ha⁻¹) N applications at the Amelia and Holland sites, respectively. At both locations, differing splits of 112 kg N ha⁻¹ between GS 25 and 30 made no difference in yields, as they were all similar at this N level. Depending on timing of 78 kg N ha⁻¹ applications at each location, yields were generally similar to splits of 112 kg N ha⁻¹. At Amelia, high yields were maintained at the 78 kg N ha⁻¹ level if it was applied at GS 30, while at Holland, applying 78 kg N ha⁻¹ at GS 25 gave similar yields as those receiving the 112 kg N ha⁻¹ rate at GS 25 or split between GS 25 and 30. Differing results due to timing of 78 kg N ha⁻¹ at Amelia and Holland is likely due to environmental conditions. At Amelia there was likely enough soil N to support tiller production with 0+78 treatments, indicated by an average grain N uptake of 99 kg N ha⁻¹, allowing GS 30 N applications to support grain development. Grain N uptake of 78+0 treatments averaged 79 kg N ha⁻¹ at Amelia. Results from Holland indicate that plots were N limited up to GS 30 and needed N fertilization at GS 25 in order to produce enough tillers and grain heads for higher yields.

Thoroughbred grain yield did not differ due to N treatments at any location in 2017. However, contrasts of rate and timing interactions at the 112 kg N ha⁻¹ level were significant for Thoroughbred, but not Flavia, at Amelia and Holland for yield, possibly due to differences in the selection environment between the two cultivars. Thoroughbred was selected and released in the Mid-Atlantic USA where a split N application strategy is common practice. Although not significant, Thoroughbred yields tend higher than the other treatments with the 34+78 split at Amelia and Holland. Significant contrasts show that Thoroughbred yield may increase with increasing N rates at GS 30 when sufficient N is available at GS 25. Increasing N rate from 56 to 78 kg N ha⁻¹ at GS 30 resulted in an average yield gain of 1353 and 2013 kg ha⁻¹ at Amelia and Holland, respectively.

When averaged over treatments and locations, Flavia had an average of 1929 kg ha⁻¹ greater yield than Thoroughbred in 2017. However, these results are not comparable to results from local barley variety trials at similar experimental sites and would not be expected due to Thoroughbred being locally adapted. Averages across locations in Virginia show Thoroughbred having an average 484 kg ha⁻¹ greater grain yield than Flavia

In 2018, no differences were observed among differing N rates and timings of application at any location for yields of Thoroughbred and Flavia at a 0.05 probability level. However, differences were seen at a 0.10 probability level at Holland for both cultivars. Similar to previous years, 0+78 tended to have the lowest yields, 3970 and 3843 kg N ha-1, for Flavia and Thoroughbred, respectively. Indicating soil N reserves were not enough at GS 25 to support a high number of tillers. However, these applications tended to be similar to all other applications except the highest. Applying 78 kg N ha⁻¹ at GS 25 without additional N at GS 30 had similar vields to single and split 112 kg N ha⁻¹ rates. Yields tended highest for Flavia (4416 kg ha-¹) and Thoroughbred (4343 kg ha⁻¹) with 78+34 and 78+0 treatments and were similar to all others except the lowest yields

Overall, Flavia tended to have higher lower quality scores than Thoroughbred, which is unsurprising. There was little impact of N timing on most quality factors those final quality score for Flavia when a greater proportion of nitrogen was supplied later in the season. Similarly, the highest Thoroughbred quality score was measured with all 112 kg N ha⁻¹ applied at GS 30, though this was only 0.6 of one point different when all was applied at GS 25.

Year	Location	Factor		Grain (Kg)	Yield ha ⁻¹)	- 8		Test v (Kg	weight m ⁻³)		Lodging (0-9)			
		Cultivar:	Thoroug	Thoroughbred		Flavia		Thoroughbred			Thoroughbred		Flavia	
		N level GS25 + GS30 (kg ha ⁻¹)		SD		SD		SD		SD		SD		SD
2016	Holland	56 + 56	3064 a	2.28	3399 a	356	584 a	9	572 a	10	2.0 a	0	1.3 a	1.15
		34 + 78	2535 a	395	2412 a	334	587 a	12	577 a	12	2.0 a	0	1.7 a	0.58
		78 + 34	3155 a	401	2861 a		564 ab	21	579 a		2.1 a	0.58	1.3 a	1.15
		112 + 0	2814 a	481	3157 a	358	567 ab	12	570 a	22	2.3 a	0.58	2.0 a	0
		0 + 112	3439 a	1196	3451 a	271	580 a	7	571 a	6	3.0 a	1	1.7 a	0.58
		78 + 0	2269 a	132	2268 a	560	529 b	45	555 a	5	2.1 a	0	1.0 a	1
		0 + 78	2604 a	6.6	2706 a	244	572 a	16	577 a	5	1.7 a	0.58	1.3 a	1.15
		Means	2840		2893		569		572		2.2		1.5	
		<i>P>F</i>	0.189		0.1182		0.0143		0.5404		0.1296		0.6084	
2016	Orange	56 + 56	3766 ab	397	3932 a	589	548 a	17	582 ab	68				•
		34 + 78	4178 ab	313	3718 a	307	558 a	13	562 b	2				
		78 + 34	3897 ab	122	3959 a	7.9	552 a	17	570 ab	17				
		112 + 0	3967 ab	369	3984 a	361	547 a	14	567 b	21				
		0 + 112	4712 a	660	3283 a	104	563 a	2	631 a	49				
		78 + 0	3167 b	174	3486 a	386	543 a	13	556 b	17				
		0 + 78	3709 ab	390	3975 a	170	562 a	24	577 ab	18				•
		Means	3914		3763		553		578					
		P > F	0.0233		0.2580		0.0891		0.0243					

Table 25. Grain yield, test weight and lodging response to split nitrogen rates at Holland and Orange, VA, 2016

Means compared by Tukey's HSD, differing letters in columns shows significant difference. α = .05

Year	Location	Factor	C	Frain Yiel	d (Kg ha ⁻¹)		Т	est weigl	ht (Kg m ⁻³)		Lodging (0-9)			
		Cultivar:	T.bred*		Flavi	a	T.bre	ed	Flavi	а	T.bred		Flavi	а
		N level GS25 + GS30												
		(kg ha-1)		SD	(=00	SD		SD		SD		SD		SD
		34 + 78	6137 a	290	6529 a	482	487 a	3	564 a	16	9.0 a	0	5.0 a	4
		78 + 34	3722 a	552	6310 a	282	486 a	10	563 a	13	9.0 a	0	3.0 a	1
		112 + 0	4839 a	973	5902 ab	636	489 a	15	562 a	7	8.0 a	2	4.3 a	3
		0 + 112	4550 a	492	6279 ab	55	487 a	4	572 a	11	9.0 a	0	6.0 a	3
		78 + 0	4490 a	758	5223 b	422	489 a	27	558 a	5	5.0 a	3	2.0 a	0
	-	0 + 78	5200 a	227	5713 ab	1053	479 a	12	569 a	2	7.7 a	2	5.6 a	1
		Means	4817		6007		487		565		8.1		4.5	
		<i>P>F</i>	0.1083		0.0168		0.8982		0.6086		0.0648		0.0688	
2017	Holland	56 + 56	1732 a		5089 ab	469	530 a		562 a	19	3.2 a	0	3.7 a	1
		34 + 78	3745 a	263	4832 abc	244	511 a	0	577 a	4	3.8 a	1	3.7 a	1
		78 + 34	3479 a	624	5043 ab	83	512 a	7	562 a	3	3.7 a	1	4.3 a	2
		112 + 0	3455 a	297	4964 ab	564	507 a	10	565 a	1	3.7 a	1	3.7 a	1
		0 + 112	2707 a	934	6220 a		513 a	10	555 a	41	3.3 a	1	4.3 a	2
		78 + 0	2924 a		4181 bc	24	517 a	1	541 a	23	3.1 a		4.0 a	1
		0 + 78	3415 a	607	3861 c	444	510 a	15	571 a	7	3.8 a	0	4.7 a	1
		Means	3065		4884		514		562		3.5		4.0	
		P>F	0.1669		0.0032		0.5204		0.4221		0.7452		0.8366	
2017	Orange	56 + 56	3398 a	1002	6286 a	284	511 a	6	571 a	14	3.7 a	2	0.3 a	1
		34 + 78	3547 a		5495 a	481	522 a	20	560 ab	13	3.0 a	0	0.7 a	1
		78 + 34	2606 a	1326	5588 a	1094	519 a	10	557 ab	7	1.0 a	2	0 a	0
		112 + 0	2706 a	162	6127 a	377	518 a	9	565 ab	4	2.7 a	2	0.7 a	1
		0 + 112	2680 a	358	5727 a	584	523 a	14	574 a	4	2.3 a	2	0 a	0
		78 + 0	2284 a	69	4929 a	168	517 a	5	545 b	11	2.3 a	2	0 a	0
		0 + 78	2891 a	488	5414 a	487	523 a	12	569 ab	5	3 a	1	0.7 a	1
	-	Means	2873		5653		519		563		2.6		0.3	
		P > F	0.4805		0.0858		0.7593		0.0193		0.3859		0.7376	

Table 26. Grain yield, test weight and lodging response to split nitrogen rates at Amelia, Holland and Orange, VA, 2017

Means compared by Tukey's HSD, differing letters in columns shows significant difference. α = .05 *Thoroughbred abbreviated to 'T.bred'

Year	Location	Factor	Gr (I			Tes (I	t weigl Kg m³)	nt		Lodging (0-9)				
		Cultivar:	Thoroughb	ored	Flavia		Thoroughb	oroughbred			Thoroughbred		Flavia	
		N level GS25 + GS30 (kg ha ⁻¹)		SD		SD		SD		SD		SD		SD
2018	Holland	56 + 56	4059 ab	175	4246 a	210	612 a	16	601 a	10	3.0 a		1.7 a	
		34 + 78	4133 ab	264	4367 a	64	615 a	7	600 a	10	4.3 a		1.7 a	
		78 + 34	4165 ab	220	4416 a	149	610 a	19	595 a	12	2.3 a		1.0 a	
		112 + 0	4184 ab	290	4258 a	210	613 a	14	602 a	16	4.0 a		1.7 a	
		0 + 112	4093 ab	85	4085 a	72	626 a	17	601 a	3	3.0 a		1.3 a	
		78 + 0	4343 a	228	4208 a	340	598 a	19	600 a	19	3.0 a		1.0 a	
		0 + 78	3843 b	87	3970 a	110	625 a	13	589 a	19	3.0 a		1.0 a	
		Means	4117		4221		614		599		3.2		1.3	
		P > F	0.0973		0.0892		0.0712		0.5165		0.6732		0.1927	
2018	Orange	56 + 56	5032 a	462	5320 a	1410	544 a	8	556 a	11				
		34 + 78	5198 a	1176	4590 a	180	562 a	13	549 a	12				
		78 + 34	5103 a		3894 a	721	559 a	26	540 a	2				
		112 + 0	3523 a	2029	4095 a	256	564 a	23	542 a	16				
		0 + 112	3329 a	460	5171 a	442	561 a	11	551 a	8				
		78 + 0	5269 a	910	4681 a	533	560 a	4	543 a	7				
		0 + 78	5787 a	521	4914 a	534	555 a	9	557 a	5	•			
		Means	4749		4666	66 55		558 548						
		P > F	0.1634		0.3116		0.6106		0.2445					

Table 27. Grain yield, test weight and lodging responses to split nitrogen rates Holland and Orange, VA, 2018

Means compared by Tukey's HSD, differing letters in columns shows significant difference. α = .05

	Factor:	Malt Extract r: (g kg ⁻¹)		Kernel Plumpness* (g kg ⁻¹)		S/T (g kg ⁻¹)		Barley Protein (g kg ⁻¹)		Diastatic Power (⁰ ASBC)		FAN (mg kg ⁻¹)		Quality score	
	Cultivar:	T.bred	Flavia	T.bred	Flavia	T.bred	Flavia	T.bred	Flavia	T.bred	Flavia	T.bred	Flavia	T.bred	Flavia
	N level GS25 + GS30 (kg ha-1)														
Holland	56 + 56	804	827	942	977	406	445	113	103	107	93	186	199	34	47
	34 + 78	814	817	963	979	419	395	105	114	107	100	183	221	33	48
	78 + 34	816	832	953	983	423	460	102	94	88	86	157	201	39	47
	112 + 0	812	831	946	979	450	451	93	97	98	76	175	198	38	47
	0 + 112	802	823	933	974	422	416	112	108	120	89	189	220	42	48
	78 + 0	837	818	976	942	494	437	86	89	66	88	182	159	33	34
	0 + 78	815	828	948	978	449	449	101	111	96	84	191	229	31	56
	Means	814	825	952	973	438	436	102	102	97	88	180	204	36	47
Orange	56 + 56	796	824	811	897	391	403	120	107	174	152	164	177	42	46
	34 + 78	791	798	773	828	368	376	110	124	163	182	163	185	33	40
	78 + 34	800	803	828	829	385	408	110	102	155	150	146	155	38	33
	112 + 0	791	799	766	838	367	365	120	133	184	198	140	205	40	40
	0 + 112	793	810	813	904	376	400	115	113	162	167	174	169	37	48
	78 + 0	788	809	756	856	395	376	112	100	164	144	176	163	30	28
	0 + 78	792	821	798	886	420	384	106	111	144	161	173	160	32	42
	Means	793	809	792	863	386	387	113	113	164	165	162	173	36	40

Table 28. Malt quality factor response to split nitrogen rates at Holland and Orange, VA. 2016

No statistical analysis done for data. *measured by the fraction of kernels remaining on a 6/64" slotted screen.

	Factor:	Malt Extract (g kg ⁻¹)		On 6/64" (g kg ⁻¹)		S, (g k	S/T (g kg ⁻¹)		Barley Protein (g kg ⁻¹)		c Power SBC)	FAN (mg kg ⁻¹)		Quality score	
	Cultivar:	T.bred	Flavia	T.bred	Flavia	T.bred	Flavia	T.bred	Flavia	T.bred	Flavia	T.bred	Flavia	T.bred	Flavia
	N level GS25 GS30 (kg ha ⁻	+ 1)													
Amelia	56 + 56	747	809	571	93.4	337	373	116	109	45	107	109	134	10	25
	34 + 78	733	817	541	902	319	382	130	112	45	99	115	137	10	29
	78 + 34	743	819	583	940	325	356	125	104	45	101	121	115	13	28
	112 + 0	738	825	631	942	380	366	117	103	46	100	127	119	13	28
	0 + 112	736	808	492	936	338	354	121	125	49	122	126	140	17	38
	78 + 0	737	824	573	951	333	459	129	90	55	85	140	121	16	34
	0 + 78	750	812	660	903	342	366	122	115	63	115	132	137	17	37
	Means	741	816	579	930	339	379	123	108	50	104	124	129	14	31
Holland	56 + 56	733	776	671	904	307	302	151	145	66	124	119	119	6	20
	34 + 78	724	780	644	949	310	310	152	147	62	142	132	130	4	24
	78 + 34	728	789	665	940	307	318	152	143	63	138	133	129	6	24
	112 + 0	718	777	649	951	304	299	148	153	60	140	130	126	4	20
	0 + 112	717	772	652	881	280	311	170	148	63	133	140	136	6	18
	78 + 0	734	791	704	949	343	343	139	132	57	120	134	107	6	25
	0 + 78	732	790	636	941	309	323	148	142	66	128	125	128	6	23
	Means	727	782	660	931	309	315	151	144	62	132	130	125	5	22
Orange	56 + 56	735	819	592	982	336	360	115	106	48	119	109	115	10	31
	34 + 78	745	823	662	983	318	392	120	96	49	109	115	123	10	33
	78 + 34	749	833	683	976	359	396	111	93	56	103	124	120	14	38
	112 + 0	743	823	686	978	351	365	112	97	52	112	116	112	14	34
	0 + 112	732	816	661	981	320	338	124	123	56	126	122	130	10	45
	78 + 0	754	839	759	977	384	438	97	84	41	83	107	111	9	39
	0 + 78	747	821	658	973	350	382	112	95	51	101	111	119	10	35
	Means	744	825	672	979	345	382	113	99	50	108	115	119	11	36

Table 29. Malt quality response to split nitrogen rates at Amelia, Holland and Orange, VA, 2017