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NORTHWEST CROPS & SOILS PROGRAM



2019 Rye Variety Trial



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2019 RYE VARIETY TRIAL
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The interest in growing cereal rye for grain to be sold as cover crop seed, or to other value-added markets (distillers and bakers), has increased considerably across the Northeast region. As a result, farmers and end-users are requesting yield and quality information on cereal rye varieties. In 2019, University of Vermont Extension Northwest Crops and Soils (NWCS) Program conducted a variety trial to evaluate yield and quality of cereal rye. The varieties were Wren's Abruzzi, Helltop, Bono, Merced, Dolero, Hazlet, Danko, Brassetto, ND Dylan, Huron, Musketeer, Aroostook, Guardian, Wheeler, and Spooner.

MATERIALS AND METHODS

The experimental design was a randomized complete block with treatment plots replicated four times. Treatments were fifteen varieties of cereal rye including Wren's Abruzzi, Helltop, Bono, Merced, Dolero, Hazlet, Danko, Brassetto, ND Dylan, Huron, Musketeer, Aroostook, Guardian, Wheeler, and Spooner (Table 2). The field was plowed, disked, and prepared with a spike tooth harrow to prepare the seedbed for planting. The plots were planted with a Great Plains cone seeder on 22-Sep 2018; plots were 5' x 20' (Table 1). In the spring, winter survival was assessed for the cereal rye varieties on 6-May. Each plot was scored on a scale of 1 to 5, with 1 indicating 0-20% survival and 5 indicating 81-100% survival. Prior to harvest, on 30-Jul 2019, three plant heights per plot were measured and ergot severity was assessed for each plot. For ergot assessment, two 1ft² quadrats were cut from each plot and a percent total of ergot infected spikes were recorded.

Table 1: Agronomic and trial information for the rye cover crop variety trial, 2017-2018.

	Borderview Research Farm, Alburgh, VT
Soil Type	Benson rocky silt loam
Previous Crop	Corn
Tillage Operations	Fall plow, disc, and spike tooth harrow
Harvest Area (ft.)	5 x 20
Seeding Rate (live seeds m ⁻²)	350
Replicates	4
Planting Date	22-Sep 2018
Harvest Date	30-Jul 2019

Grain plots were harvested at the Alburgh site with an Almaco SPC50 plot combine on 30-Jul. Following harvest, seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN). Grain moisture, test weight, and yield were calculated. An approximate one-pound subsample was collected to determine quality. Quality measurements included standard testing parameters used by commercial mills. Test weight was measured by the weighing of a known volume of grain. Once test weight was determined, the samples were then ground into flour using the Perten LM3100 Laboratory Mill. At this time, flour was evaluated for its protein content, falling number, and mycotoxin levels. Grains were analyzed for protein content using

the Perten Inframatic 8600 Flour Analyzer. The determination of falling number (AACC Method 56-81B, AACC Intl., 2000) was measured on the Perten FN 1500 Falling Number Machine. The falling number is related to the level of sprout damage that has occurred in the grain. It is measured by the time it takes, in seconds, for a stirrer to fall through a slurry of flour and water to the bottom of the tube. Deoxynivalenol (DON) analysis was done using Veratox DON 5/5 Quantitative test from the NEOGEN Corp. This test has a detection range of 0.5 to 5 ppm. Samples with DON values greater than 1 ppm are considered unsuitable for human consumption.

Table 2. Winter rye varietal information, Alburgh, VT, 2019.

Variety	Source
Wrens Abruzzi	Hancock Seed Company
Helltop	Nordic Seed
Bono	Albert Lea Seed
Merced	Hearne Seed
Dolero	Albert Lea Seed
Hazlet	SeCan
Danko	Knight Seed
Brassetto	Seedway LLC
ND Dylan	Seedway LLC
Huron	Kings AgriSeed
Musketeer	Saved Seed; Alburgh, VT
Aroostock	Albert Lea Seed
Guardian	LaCrosse Seed
Wheeler	Moore Seed Farm
Spooner	Albert Lea Seed

Stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within the trial were treated as random effects, and treatments were treated as fixed. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p < 0.10$).

Variations in project results can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field. At the bottom of each table, a LSD value is presented for each variable (e.g. yield). Least Significant Differences (LSD's) at the 10% level of probability are shown. Where the difference between two treatments within a column is equal to or greater than the LSD value at the

Treatment	Yield
A	2100*
B	1900*
C	1700
LSD	300

bottom of the column, you can be sure in 9 out of 10 chances that there is a real difference between the two values. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk. In the previous example, treatment A is significantly different from treatment C but not from treatment B. The difference between A and B is equal to 200, which is less than the LSD value of 300. This means that these treatments did not differ in yield. The difference between A and C is equal to 400, which is greater than the LSD value of 300. This means that the yields of these treatments were significantly different from one another.

RESULTS

Weather data was recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT. September and July had above average temperatures whereas October, April, May, and June were below average (Table 3). Growing months during the growing periods of 2018-2019 season saw below average precipitation with the exception of April and May which saw above average precipitation. There were 4637 growing degree days (GDDs) accumulated over the course of the growing season, 75 less growing degree days than the historical average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2018 and 2019.

Alburgh, VT	2018				2019						
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Average temperature (°F)	63.4	45.8	32.2	25.4	15.0	18.9	28.3	42.7	53.3	64.3	73.5
Departure from normal	2.76	-2.36	-5.99	-0.55	-3.77	-2.58	-2.79	-2.11	-3.11	-1.46	2.87
Precipitation (inches)	3.48	3.53	4.50	2.96	1.53	1.70	1.36	3.65	4.90	3.06	2.34
Departure from normal	-0.16	-0.07	1.38	0.59	-0.52	-0.06	-0.85	0.83	1.45	-0.63	-1.81
Growing Degree Days (32-95°F)	941	435	136	72	23	38	108	346	660	970	1286
Departure from normal	83	-67	-50	72	23	38	108	-38	-96	-44	88

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT. (http://www.nrcc.cornell.edu/page_nowdata.html).

Winter survival was measured in the spring of 2019 and is presented on a 1-5 scale, 1 showing severe winter kill in plots and 5 showing little to no winter kill within plots. There were significant differences between some of the varieties in terms of survival (Table 4). Musketeer had the highest survival, but was statistically similar, in descending order, to Huron, Guardian, Danko, Spooner, Brasetto, ND Dylan, Dolero, Bono, and Wheeler. Wrens Aburzzi and Merced had the lowest winter survival, with nearly complete winterkill, and as a result, no yield or quality data was collected for either variety.

Table 4. Winter survival for winter rye varieties, Alburgh, VT, 2019.

Variety	Winter survival 1 to 5 rating [†]
Aroostook	1.25
Bono	2.75*
Brasetto	3.25*
Danko	3.25*
Dolero	3.00*
Guardian	3.25*
Hazlet	1.50
Helltop	2.50
Huron	3.50*
Merced	1.00
Musketeer	4.25
ND Dylan	3.00*
Spooner	3.25*
Wheeler	2.75*
Wrens Abruzzi	1.00
Trial mean	2.63
LSD (0.01)	1.64

[†]Winter survival rated on a 1 to 5 scale where 1 = 0-20% survival, 2 = 21-40%, 3 = 41-60%, 4 = 61-80% and 5 = 81-100% survival.

Heights, lodging, yield, test weight, and amount of ergot present was measured prior to cereal rye harvest (Table 5). There were significant differences in heights, lodging, yield, and ergot. Huron was the tallest variety at 144 cm, yet was amongst the varieties experiencing the most lodging at 2.00%. The average height within the variety trial was 123 cm. Variety Bono experienced very minimal lodging. It is also worth noting that lodging was very low throughout the trial, with highest amounts seen with ND Dylan showing only 2.89% lodging for the growing season. The average lodging for the trial was 1.18%. Yields are presented at 13.5% moisture. Yields ranged between 480 and 3674 lbs ac⁻¹ with Brasetto and Dolero as the top performing varieties. Brasetto had no ergot present, but ten other varieties were statistically similar. Helltop and Wheeler had highest amount of ergot with 20.9% and 11.4% respectively. The ideal test weight for rye is 56 lbs bu⁻¹; none of the varieties met or exceeded this ideal test weight. Guardian had the highest test weight (54.7 lbs bu⁻¹), but there was no statistical difference between varieties.

Table 5: Harvest and pre-harvest measurements of winter rye varieties, Alburgh, VT, 2019.

Variety	Height cm	Lodging %	Yield @ 13.5% moisture lbs ac ⁻¹	Ergot %	Test weight lbs bu ⁻¹
Aroostook	128 ab	1.95 ab	480.1 b	7.00 a	51.2
Bono	114 ab	0.06 a	2949 ab	4.41 a	52.3
Brasetto	114 ab	0.19 ab	3674 a	0.00 a	53.4
Danko	135 ab	1.00 ab	2011 ab	2.34 a	54.2
Dolero	98.0 b	0.69 ab	3639 a	3.30 a	52.4
Guardian	106 b	0.40 ab	2570 ab	2.50 a	54.7

Hazlet	103 ab	0.19 ab	1605 ab	3.92 a	48.4
Helltop	108 b	0.25 a	1328 ab	20.9 b	52.1
Huron	144 a	2.00 ab	1752 ab	0.66 a	52.3
Musketeer	128 ab	2.25 ab	2263 ab	0.30 a	53.6
ND Dylan	129 ab	2.89 b	1412 ab	0.90 a	51.3
Spooner	131 ab	1.50 ab	1866 ab	0.44 a	52.5
Wheeler	143 ab	1.55 ab	1687 ab	11.4 ab	48.5
Trial mean	123	1.18	2093	4.5	52.3
p-value	<0.05	<0.05	<0.05	<0.05	NS

*Treatments with an asterisk are not significantly different than the top performer in **bold**.

NS – No significant difference between treatments.

The 13 winter rye varieties were analyzed for crude protein concentration, falling number, and the vomitoxin DON (Table 6). There were significant differences in crude protein and in falling number between varieties. Overall, DON levels were low this year and all varieties had DON levels below the 0.5ppm threshold of the Veratox DON 5/5 Quantitative test (data not shown). Wheeler had the highest crude protein at 15.1%, and was significantly higher than the other varieties in the trial. Falling number ranged between 161 and 299; an ideal falling number falls around 260 seconds for most flours, however lower falling numbers around 150 seconds have been acceptable, or even preferable, to bakers while solely using rye flours. The variety with the highest falling number was Dolero at 299 seconds.

Table 6: Grain quality for winter rye varieties, Alburgh, VT, 2019.

Variety	Crude protein	Falling number
	@ 12% moisture	
	%	Seconds
Aroostook	12.7 ab	277 ab
Bono	8.89 c	269 ab
Brasetto	8.20 c	247 abcd
Danko	10.5 bc	235 abcd
Dolero	8.21 c	299 a
Guardian	9.81 c	271 ab
Hazlet	10.2 bc	217 bcde
Helltop	10.6 bc	254 abc
Huron	9.49 c	243 abcd
Musketeer	9.69 c	209 cde
ND Dylan	8.91 c	267 ab
Spooner	9.75 c	195 de
Wheeler	15.1 a	161 e
Trial mean	10.0	239
p-value	<.0001	<.0001

*Treatments with an asterisk are not significantly different than the top performer in **bold**.

DISCUSSION

Most of the winter rye varieties had good survival in the spring, but Merced and Wrens Abruzzi had poor survival and were not harvested. These two varieties are much more prevalent in southern climates and may not be suited for growth in northern climates, especially when experiencing hard winters. The weather during the 2018-2019 season was cooler and wetter than average, with 74 less growing degree days than the 30-year average. Looking back at the 2017-2018 season, it was warmer and drier than average and it resulted in high yields and quality for cereal rye varieties overall when compared to the 2018-2019 growing season for rye. The average trial yields for the 2018 season were 3373 lbs ac⁻¹ with three of the top performing varieties (Brasetto, Guardian, and Bono) yielding over 4000 lbs ac⁻¹ that season. Comparatively, the 2019 season trial had a much lower average trial yield of 2093 lbs ac⁻¹ with top performing varieties (Brasetto and Dolero) topping out over 3600 lbs ac⁻¹. Many of these varieties struggled to yield as high as in the 2018 season in part as a result of the cold winter months and growing conditions over the 2019 growing season. All varieties this season did not grow to be as tall, but experienced less lodging than last year. Test weight, crude protein, and falling number were also lower compared to the previous season with 2018 values of 54.7 lbs bu⁻¹, 11.1%, and 247 seconds respectively. Overall, DON levels were low this year and all varieties had a DON level suitable for human consumption. These data highlight the importance of varietal selection, but also only represent one year of data in ongoing trials. More data and other factors should be considered when making management decisions.

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