



2020 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 in recent years. As a result, farmers and end-users are requesting yield and quality information on cereal rye varieties. In 2020, 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 Akusti, Aroostock, Bono, Brasetto, Danko, Dolero, Hazlet, ND Dylan, Progas, Rymin, Sangasti, Serafino, and Wheeler.

MATERIALS AND METHODS

The experimental design was a randomized complete block with twelve varieties replicated four times. Treatments were thirteen varieties of cereal rye including Aroostock, Bono, Brasetto, Danko, Dolero, Hazlet, ND Dylan, Progas, Rymin, Sangasti, Serafino, and Wheeler (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 20-Sep 2019. Plots were 5' x 20' (Table 1). On 15-Apr, winter survival was visually assessed. Each plot was scored on a percent scale of 0-100%, with 0 indicating no plants survived and 100 indicating 100% survival. Prior to harvest, on 22-Jul 2020, three plant heights per plot were measured for each plot.

Table 1: Agronomic and trial information for the rye cover crop variety trial, 2019-2020.

	Borderview Research Farm, Alburgh, VT
Soil Type	Benson rocky silt loam
Previous Crop	Spring grains
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	20-Sep 2019
Harvest Date	22-Jul 2020

Grain plots were harvested at the Alburgh site with an Almaco SPC50 plot combine on 22-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 indirectly measures enzymatic activity in the grain which is typically used as an indicator of pre-harvest sprouting. It is measured by the time it takes, in seconds, for a stirrer to fall through a cooked 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, 2020.

Variety	Source
Aroostock	Albert Lea Seed
Bono	Albert Lea Seed
Brassetto	Seedway LLC
Danko	Knight Seed
Dolero	Albert Lea Seed
Hazlet	SeCan
ND Dylan	Seedway LLC
Progass	Albert Lea Seed
Rymin	University of Minnesota
Sangasti	Ruth Fleischmann
Serafino	Ruth Fleischmann
Wheeler	Moore Seed Farm

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 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

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

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

Seasonal precipitation and temperature recorded at Borderview Research Farm in Alburgh, VT are displayed in Table 3. The winter temperatures were warmer than average, leading to strong winter survival. A cooler than average spring but warmer and drier summer led to 3,433 Growing Degree Days (GDDs) accumulated April to July, which was 55 GDDs above the 30-year average. Precipitation from April to July was 3.81 inches below normal. Overall, precipitation across the entire growing season from September to July, was 1.61 inches below average, with a total of 5317 GDDs from September through July, which was 30 less than average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2019 and 2020.

	2019				2020						
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Average temperature (°F)	60.0	50.4	31.2	26.0	23.5	21.8	35.0	41.6	56.1	66.9	74.8
Departure from normal	-0.51	2.32	-6.76	0.46	4.62	0.41	3.94	-3.19	-0.44	1.08	4.17
Precipitation (inches)	3.87	6.32	2.38	1.29	2.63	1.19	2.79	2.09	2.35	1.86	3.94
Departure from normal	0.21	2.76	-0.74	-1.06	0.63	-0.53	0.57	-0.72	-1.04	-1.77	-0.28
Growing Degree Days (32°-95°F)	840	571	128	67	37	48	193	315	746	1046	1326
Departure from normal	-15	58	-122	-13	-12	-8	27	-99	-13	35	132

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 2020 and is presented as a percentage, 1% showing severe winter kill within plots and 100% showing little to no winter kill within plots. There were significant differences between some of the varieties in terms of survival (Table 4). Aroostock, Sangasti and Dolero had the highest winter survival, 100%, but was statistically similar to every other variety except Brasetto. Brasetto had the lowest winter survival, a statistically significant difference from the other varieties, with 93.75% survival. Across the board, there were much higher rates of winter survival in the 2020 growing season for the Rye Variety Trial than there were in the 2019 growing year.

Table 4. Winter survival for winter rye varieties, Alburgh, VT, 2020.

Variety	Winter survival 0-100% rating†
Aroostook	100 ^{at}
Bono	97.5 ^{ab}
Brasetto	93.8 ^b
Danko	98.8 ^a
Dolero	100 ^a
Hazlet	199 ^a
ND Dylan	96.3 ^{ab}
Progass	97.5 ^{ab}
Rymin	98.8 ^a

Sangasti	100. ^a
Serafino	98.8 ^a
Wheeler	96.3 ^{ab}
Trial mean	98.0
LSD (p=0.10)	4.48

†Winter survival rated on a 0 to 100% scale where 0 = 0% survival and 100 = 100% survival.

‡Within a column, values labelled with the same letter have no significant difference between treatments (p=0.10).

Heading date, heights, yield and test weight measurements were taken prior to rye harvest (Table 5). There were significant differences in each measurement. Wheeler and Sangasti were the tallest varieties at 169 and 170 cm, respectively, and were also among the latest to head out, and among the lowest yield and test weight. The average height across the variety trial was 135 cm. There was very little lodging in the variety trial this year so measurements were not recorded. Yields are adjusted for a 13.5% moisture basis. Yields ranged between 2410 and 6524 lbs ac⁻¹ with Dolero and Bono as the top performing varieties. The ideal test weight for rye is 56 lbs bu⁻¹; only Hazlet reached this test weight, at 56.3, with every other variety ranging from 50.1 to 55.6. The ideal moisture content for grain storage is below 13.5%. Moisture measurements were recorded at harvest with every variety except for Wheeler and Serafino measuring below 13.5% moisture. Harvesting grain with high moisture requires additional drying prior to storage, adding time and labor costs.

Table 5: Harvest and pre-harvest measurements of winter rye varieties, Alburgh, VT, 2020.

Variety	Heading date	Height cm	Yield @ 13.5% moisture lbs ac ⁻¹	Harvest moisture %	Test weight lbs bu ⁻¹
Aroostook	20-May ^{e†}	154 ^b	3214 ^c	13.2 ^{bc}	53.2 ^{c-e}
Bono	26-May ^c	108 ^f	6414 ^a	13.0 ^c	55.3 ^{ab}
Brasetto	26-May ^{bc}	112 ^{fe}	5477 ^b	13.2 ^{bc}	54.4 ^{b-d}
Danko	23-May ^d	128 ^{cd}	4885 ^b	13.2 ^{bc}	55.1 ^{ab}
Dolero	26-May ^b	105 ^f	6525 ^a	13.5 ^{a-c}	54.8 ^{bc}
Hazlet	26-May ^c	135 ^c	5053 ^b	12.9 ^{cd}	56.3 ^a
ND Dylan	26-May ^c	151 ^b	3823 ^c	13.1 ^c	54.6 ^{bc}
Progass	26-May ^{bc}	127 ^{cd}	4982 ^b	12.4 ^d	53.1 ^e
Rymin	26-May ^c	138 ^c	5096 ^b	13.2 ^{bc}	55.6 ^{ab}
Sangasti	27-May ^a	171 ^a	3531 ^c	13.5 ^{a-c}	50.1 ^f
Serafino	26-May ^c	122 ^{de}	5274 ^b	13.9 ^a	54.8 ^{bc}
Wheeler	26-May ^b	170 ^a	2411 ^d	13.7 ^{ab}	53.2 ^{ed}
Trial mean		135	4724	13.2	54.3
LSD (p=0.10)		11	711	0.6	1.3

†Within a column, values labelled with the same letter have no significant difference between treatments (p=0.10).

The 13 winter rye varieties were analyzed for crude protein, 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 1.0 ppm threshold required for human consumption (data not shown). Wheeler had the highest crude protein at 12.8% and was significantly

higher than all other varieties in the trial. Falling number ranged between 206 (Wheeler) and 368 (Serafino). The ideal falling number range for wheat is 250-350, however lower falling numbers around 150 seconds have been acceptable, or even preferable, to bakers using rye flours. See the 2020 Rye Harvest Date Trial Report for more details about falling number in rye.

Variety	Crude protein @ 12% moisture %	Falling number seconds
Aroostook	11.0 ^{bf}	291 ^{ed}
Bono	7.8 ^h	333 ^{a-c}
Brasetto	8.4 ^{fg}	337 ^{ab}
Danko	9.0 ^{d-f}	284 ^{d-f}
Dolero	8.2 ^{hg}	296 ^{cd}
Hazlet	8.6 ^{e-g}	251 ^f
ND Dylan	9.2 ^{ed}	274 ^{d-f}
Progasst	-	-
Rymin	8.5 ^{fg}	252 ^{ef}
Sangasti	10.2 ^c	245 ^{fg}
Serafino	8.1 ^{gh}	368 ^a
Wheeler	12.8 ^a	206 ^g
Trial mean	9.3	287
LSD (p=0.10)	0.6	40

†Within a column, values labelled with the same letter have no significant difference between treatments (p=0.10).

‡Prograss is a rye variety best suited for forage so grain quality not analyzed.

DISCUSSION

The rye varieties in this trial, consistent with all of the winter grain trials at Borderview Research Farm in 2020, had strong winter survival rates. The weather during the 2019-20 season was warmer and drier than average, with 55 more growing degree days than the 30-year average. This allowed for better winter survival and considerably higher yields than the 2018-2019 season, which was cooler and wetter with 74 fewer growing degree days than average. 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, and finally the 2020 season yield average was over 4700 lbs ac⁻¹ with Dolero and Bono both yielding well over 6000 lbs ac⁻¹. Harvest moisture, test weight and crude protein were adequate, and falling number was slightly higher than the ideal range for rye flour, averaging 287 seconds with Bono, Brasetto and Serafino exceeding 300 seconds. 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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