NORTHWEST CROPS & SOILS PROGRAM

2022 Rye Variety Trial

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2022 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 2021-2022, University of Vermont Extension Northwest Crops and Soils (NWCS) Program conducted a variety trial to evaluate yield and quality of cereal rye.

MATERIALS AND METHODS

The rye variety trial was initiated at Borderview Research Farm in Alburgh, VT in the fall of 2021. Plots were managed with practices similar to those used by producers in the surrounding area. Agronomic information is displayed in Table 1. The experimental design was a randomized complete block with four replicates. The field was plowed, disked, and prepared with a spike tooth harrow to prepare the seedbed for planting. Plots were seeded in 5' x 20' plots with a Great Plains Cone Seeder on 22-Sep 2021 at a seeding rate of 350 live seeds m^{-2}. Treatments were eleven (11) varieties of cereal rye including Aroostook, Bono, Brasetto, Danko, Dylan, Hazlet, Receptor, Rymin, Serafino, Spooner, and Tayo (Table 2). All varieties survived the winter.

Table 1. Agronomic and trial information for the rye cover crop variety trial, 2021-2022.

	Borderview Research Farm, Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Perennial grass
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 2021
Harvest date	22-Jul 2022

Table 2. Winter rye varietal information, Alburgh, VT, 2021-2022.

Variety	Source
Aroostook	Albert Lea Seed
Bono	Albert Lea Seed
Brasetto	Seedway LLC
Danko	Albert Lea Seed
Dylan	University of North Dakota
Hazlet	Albert Lea Seed
Receptor	Pitura Seeds
Rymin	University of Minnesota

Serafino	Albert Lea Seed
Spooner	Albert Lea Seed
Tayo	Albert Lea Seed

On 21-Jul 2022, one day prior to harvest, three plant heights per plot were measured for each plot, excluding awns. Lodging was assessed visually as percent lodged, with 0% indicating no lodging and 100% indicating the entire plot was lodged. Grain plots were harvested at the Alburgh site with an Almaco SPC50 plot combine on 22-Jul. Seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN) and a one-pound subsample was collected to analyze quality characteristics (Table 4). Grain quality was determined at the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, VT). Grains were analyzed for crude protein and starch content using the Perten Inframatic 9500 NIR Grain Analyzer (Perkin Elmer, Waltham, MA). The samples were then ground into flour using the Perten LM3100 Laboratory Mill (Perkin Elmer). Falling number for all rye varieties were determined using the AACC Method 56-81B, AACC Intl., 2000 on a Perten FN 1500 Falling Number Machine Mill (Perkin Elmer). The falling number indirectly measures enzymatic activity in the grain, which is typically used as an indicator of pre-harvest sprouting. It is determined by the time it takes, in seconds, for a stirrer to fall through a slurry of flour and water to the bottom of a test-tube. Deoxynivalenol (DON) analysis was done using Veratox DON 2/3 Quantitative test from the NEOGEN Corp (Lansing, MI). 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. Samples from one replicate were evaluated for DON and all samples tested below the FDA threshold for human consumption (1 ppm) (data not shown).

Standard 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

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

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

Seasonal precipitation and temperature were recorded with a Davis Instrument Vantage Pro2 weather station (Hayward, CA) at Borderview Research Farm in Alburgh, VT and are displayed in Table 3. The winter temperatures were slightly warmer than average, leading to strong winter survival. This growing season was wetter than past years with a total precipitation of 22.6 inches, which is over twice the precipitation during the 2021 growing season (total precipitation of 10.2 inches). The average temperature of the primary growing season (April to July) was 1.44° F below normal. From September 2021 to July 2022, there were 5546 Growing Degree Days (GDDs), which is consistent with historical means GDD trends over the last 30 years.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2021 and 2022 growing season.

	2021			2022				
	Sep	**Oct**	**Nov**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
Average temperature (°F)	63.1	54.6	37.6	32.3	44.8	60.5	65.3	71.9
Departure from normal	0.40	4.31	-1.68	-0.03	-0.81	2.09	-2.18	-0.54
Precipitation (inches)	4.49	6.23	2.26	2.52	5.57	3.36	8.19	3.00
Departure from normal	0.82	2.40	-0.44	0.28	2.50	-0.40	3.93	-1.06
Growing Degree Days (32°-95°F)	933	701	232	170	391	883	1000	1236
Departure from normal	11	133	-3	32	-20	65	-64	-17

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2020) for Burlington, VT.

Table 4. Agronomic characteristics, yield, and quality data by rye variety, Alburgh, VT, 2022.

Variety	Height	Lodging	Moisture	Test weight	Yield @ 13.5% moisture	Crude protein @ 12% moisture	Starch	Falling number
	cm	**%**	**%**	**lbs bu^{-1}**	**lbs ac^{-1}**	**%**	**%**	**seconds**
Aroostook	143*†	43.8	14.0	48.9	3358	**11.0**	58.5	245
Bono	126	58.3	17.5	50.1	7422	6.90	61.9	313*
Brasetto	130	7.50*	11.9*	52.2	8622	6.60	**62.6***	306
Danko	139	**5.00***	**9.40***	**55.1***	7191	7.40	61.9	268
Dylan	146*	46.3	13.5	51.4	4602	8.70	60.6	246
Hazlet	140	30.0	14.1	52.5	5592	7.90	61.5	208
Receptor	127	21.5*	14.5	54.0*	8745*	6.50	62.5*	322*
Rymin	143*	25.0	11.5*	53.0	4870	8.50	60.7	261
Serafino	131	41.3	14.7	53.9*	9543*	7.00	62.0	**360***
Spooner	**151***	18.8*	10.9*	53.4*	4544	8.30	61.6	200
Tayo	130	16.2*	9.40*	52.0	**9751***	7.00	61.8	271
LSD (p=0.10)‡	8.70	19.9	3.80	2.50	1096	0.60	0.60	50.8
Trial mean	136.8	28.5	12.8	52.4	6749	7.80	61.4	273

†Within a column, varieties with an asterik (*) were not different from the top performer (in **bold**).

‡LSD; least significant difference at the p=0.10 level.

There were significant differences among varieties for all agronomic categories tested except for starch content (Table 4). The tallest variety was Spooner (151 cm) which was statistically similar to Dylan (146 cm) and Aroostook (143 cm); the shortest variety was Bono (126 cm). Overall, lodging was relatively high, with this year's rye varieties exhibiting about twice the rates of lodging as observed in 2021. Bono and Dylan had the most lodging (58%, 46% respectively) and Danko the least amount of lodging (5.0%).

The 2022 winter rye variety trial had excellent yields, with this year resulting in the greatest average yield than all previously recorded rye trials (Table 4). This year the average winter rye yield was 6749 lbs ac^{-1} adjusted at 13.5% moisture. Tayo was the highest yielding variety (9751 lbs ac^{-1}), and also had a low percent moisture at harvest (9.4%). Serafino and Receptor had statistically similar yields to Tayo. Of the varieties tested in 2022, Aroostook had the lowest yields (3358 lb ac^{-1}), but the highest amount of crude protein. Spooner (4544 lbs ac^{1}), Dylan (4602 lbs ac^{-1}), and Rymin (4870 lbs ac^{-1}) also had relatively low yields for the 2022 season.

Test weight is the measure of grain density, which is determined by weighing a known volume of grain. The trial average test weight this year was 52.4 lbs bu^{-1}. Danko, Receptor, Serafino, and Spooner had the highest test weights (55.1, 54.0, 53.9, and 53.4 lbs bu^{-1} respectively) and were statistically similar, and Aroostook the lowest (48.9 lbs bu^{-1}). Wheat with 12% crude protein is generally considered ideal for baking bread; however, it is unclear how protein concentrations in rye impact the baking characteristics. This year's varieties resulted in a trial mean of 7.8% crude protein. The low protein levels are characteristic of rye.

Falling number is a laboratory test that measures the viscosity of flour. There are well established ranges for falling number as an indicator of baking and malting quality in wheat and barley, but the ideal range for rye is not yet clearly documented. The ideal falling number range for wheat is 250-350, however lower falling numbers around 150 seconds are acceptable and may be preferable to bakers using rye flours. The mean falling number in this year's winter rye variety trial was 276 seconds, which is consistent with data from previous years. The variety with the highest falling number this year was Serafino with 360 seconds, and Receptor, Bono, and Serafino had statistically similar falling numbers. Spooner and Hazlet had the lowest falling numbers, approximately 200 seconds.

DISCUSSION

Interestingly, despite the majority of Vermont experiencing drought conditions, the 2022 growing season at Borderview farm (Alburgh, VT) had over twice the precipitation than the growing season in 2021. Despite the relatively high rates of lodging, this year's winter rye had very good yields. On average there were acceptable levels of moisture, with a trial mean at 12.8%. Bono was the only variety that had an average moisture content exceeding the threshold for ideal grain storage (14%). None of the varieties reached the ideal test weight of 56 lbs bu^{-1}, with Danko coming the closest at 55.1 lbs bu^{-1}.

One replicate per variety were tested for deoxynivalenol (DON) vomitoxin, and all varieties were below the FDA threshold of 1 ppm which is considered safe for human consumption (data not shown).

Because rye bread relies on different grain components to create high-quality bread and ferments more quickly than wheat, rye has a different range of falling numbers that are ideal for bread baking. The falling number results in this trial are consistent with our prior studies, but more research is needed to characterize potential end uses for rye with different falling numbers. See the 2020 Rye Harvest Date Trial Report for more details about the impact of harvest date and variety on falling number in rye.

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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