



2023 Rye Variety Trial



Dr. Heather Darby, UVM Extension Agronomist
John Bruce
UVM Extension Crops and Soils Technician
(802) 524-6501

Visit us on the web at: <http://www.uvm.edu/nwcrops>

2023 RYE VARIETY TRIAL
Dr. Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

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 2022-2023, 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 2022. 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 three 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 24-Sep 2022 at a seeding rate of 350 live seeds m⁻². Treatments were twelve varieties of cereal rye including Aroostook, Bono, CoverMax, Danko, Hazlet, ND Dylan, ND Gardner, Progas, Serafino, Spooner, Tayo, and VNS (Ruth's).

Table 1. Agronomic and trial information for the rye cover crop variety trial, 2022-2023.

	Borderview Research Farm, Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Hemp Fiber
Tillage operations	Fall plow, disc, and spike tooth harrow
Harvest area (ft.)	5 x 20
Seeding rate (live seeds m ⁻²)	350
Replicates	3
Planting date	24-Sep 2022
Harvest date	2-Aug 2023

Table 2. Winter rye varietal information, Alburgh, VT, 2022-2023.

Variety	Source
Aroostook	Albert Lea Seed
Bono	Albert Lea Seed
CoverMax	Albert Lea Seed
Danko	Albert Lea Seed
Hazlet	Albert Lea Seed
ND Dylan	University of North Dakota
ND Gardner	University of North Dakota
Progas	Albert Lea Seed
Serafino	Albert Lea Seed

Spooner	Albert Lea Seed
Tayo	Albert Lea Seed
VNS (Ruth's)	Saved Seed

Starting on 18-May through 4-Jun, heading dates and flowering dates were recorded for each variety. On 1-Aug 2023, 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 2-Aug. 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. 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 recorded at Borderview Research Farm in Alburgh, VT are displayed in Table 3. The average fall temperature (Sep 2022 to Nov 2022) was 51.8° F, which was 2.23°F warmer than the 30-year normal. The average temperature from Mar 2023 to Jul 2023 was 1.30° F cooler than the 30-year normal. This growing season was wetter than past years with a total precipitation of 24.1 inches from Mar 2023 to Jul 2023. The catastrophic flash flooding that occurred mid-month in Jul 2023 resulted in 10.75 inches of precipitation, a departure of 6.69 inches more than the 30-year average. From Sep 2022 to Jul 2023, there were 5260 Growing Degree Days (GDDs), which is less than the mean historical GDD trends over the last 30 years.

Table 3. Weather data for rye variety trial in Alburgh, VT.

Alburgh, VT	Sep-23	Oct-23	Nov-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23
Average temperature (°F)	60.2	51.3	41.5	32.2	48.3	57.1	65.7	72.2
Departure from normal	-2.52	0.96	2.24	-0.07	2.7	-1.28	-1.76	-0.24
Precipitation (inches)	4.4	2.56	3.01	2.00	4.94	1.98	4.4	10.8
Departure from normal	0.73	-1.27	0.31	-0.24	1.87	-1.78	0.14	6.69
Growing Degree Days (base 32°F)	861	607	346	103	280	766	1023	1274
Departure from normal	-61	39	111	-35	-132	-53	-40	22

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1991-2020) for Burlington, VT.

There were significant differences across all harvest and quality measurements taken within the trial (Tables 4 and 5). The tallest variety within the trial was Ruth's VNS at 173 cm and was statistically similar to Aroostook, ND Gardner, and Spooner with the shortest variety, Bono, reaching only 122cm. Lodging across a number of varieties was high, largely as a result of weather conditions leading up to harvest, however a few appeared to be significantly less impacted by growing conditions, holding up better in the field. Danko, Progas, and Serafino showed only 1.67% lodging in the trial and were comparable to Bono, Covermax, Hazlet, and Tayo. The ideal moisture content for grain storage is below 13.5%. Moisture measurements were recorded at harvest. Progas was harvested at an ideal moisture (13.1%) and was statistically similar to Spooner, Serafino, ND Dylan, and Covermax, which all remained below or close to the 13.5% mark. The ideal test weight for rye is 56 lbs bu⁻¹; none of the varieties met or exceeded this test weight, however the majority did surpass the 50 lb bu⁻¹, which was comparable to values observed in 2022 (52.4 lbs bu⁻¹ trial average) and far exceeding those in 2021 which had a trial average of 40 lbs bu⁻¹. Across all varieties, yields were significantly lower than past years once again likely to have been impacted by the excessive amounts of rain seen in the month of July leading up to harvest. While Tayo appeared to yield well (5505 lbs ac⁻¹), no other variety showed comparable yields this year with a trial average of 3628 lbs ac⁻¹. The 2022 growing season showed significantly higher yields with a trial mean of 6749 lbs ac⁻¹.

Table 4. Cereal rye harvest measurements. Alburgh, VT 2023.

Variety	Height	Lodging	Moisture	Test weight	Yield @ 13.5% moisture
	cm	%	%	lbs bu-1	lbs ac ⁻¹
Aroostook	166*†	70.0	14.3	50.8*	3070
Bono	122	31.7*	14.4	53.0*	4163
Covermax	137	8.33*	13.4*	52.0*	3906
Danko	141	1.67	14.0	54.4	3566
Hazlet	147	31.7*	14.2	53.2*	3421
ND Dylan	145	61.7	13.6*	50.7*	3324
ND Gardner	161*	70.0	15.2	50.1	3160
Progas	136	1.67	13.1	48.9	3887
Ruth's VNS	173	65.0	14.2	48.1	2881
Serafino	125	1.67	13.8*	52.0*	3305
Spooner	161*	63.3	13.5*	52.0*	3353
Tayo	125	35.0*	14.7	50.7*	5505
LSD (p=0.10) ‡	14.2	45.3	0.866	2.6	880
Trial Mean	145	36.8	14.0	51.3	3628

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

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

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 8.5% crude protein. Lower protein levels are characteristic of rye. Those highest observed values were seen in Aroostook at 10.6% and was statistically similar to Ruth's VNS at 10.1%. Starch measurements were also obtained from grain samples with the highest average starch content observed in Covermax at 62.4%, and was statistically similar to Bono, Danko, Hazlet, Serafino, and Tayo.

Falling number measures viscosity by recording the time in seconds it takes for a plunger to fall through a slurry to the bottom of a test tube. The viscosity is an indicator of enzymatic (alpha-amylase) activity in the kernel, which most often results from pre-harvest sprouting in the grain. Low falling number means high enzymatic activity, or more pre-harvest sprouting damage. This is most common if there are rain events as the grain is maturing prior to harvest. Hazlet, ND Dylan, Ruth's VNS, and Spooner had falling number values below 100 seconds, and likely experienced in-field sprouting damage as a result of growing conditions. Within the 2023 variety trial, Serafino stood alone showing the highest overall falling number at 255 seconds. Overall, the average falling number for the trial was 131 seconds. Aroostook had the lowest concentration of DON within the trial at 0.3 ppm and was statistically similar to Danko (0.6 ppm), and Spooner (0.7 ppm).

Table 5. Cereal rye grain quality. Alburgh, VT 2023.

Variety	Crude protein @12% moisture %	Starch @ 12% moisture %	Falling Number seconds	DON ppm
Aroostook	10.6	59.3	118	0.30
Bono	7.30	62.2*	175	1.10
Covermax	7.50	62.4	176	1.60
Danko	7.70	62.2*	135	0.60*
Hazlet	8.30	62.0*	78.0	1.10
ND Dylan	9.00	60.9	81.0	1.40
ND Gardner	9.40	60.2	85.0	0.90
Progas	8.80	61.5	152	1.30
Ruth's VNS	10.1* †	59.8	63.0	1.30
Serafino	7.80	62.1*	255	0.90
Spooner	8.70	61.9	74.0	0.70*
Tayo	7.20	62.1*	178	1.80
LSD (p=0.10) ‡	0.495	0.466	41.9	0.438
Trial Mean	8.50	61.4	131	1.10

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

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

DISCUSSION

Despite major flood events experienced throughout the state, some rye crop from this trial was able to be harvested. However, some impacts on yields and quality were noticeable. With a number of the varieties impacted greatly by lodging, the few that were relatively unimpacted (Danko, Progas, and Serafino) stood out in terms of harvestability, however, overall yields for the trial were low compared to past years as previously noted. Grain quality also seemed to be impacted by weather as more falling number values for roughly half of the varieties were below 100 seconds, significantly lower than those from years prior.

Three replicates per variety were tested for deoxynivalenol (DON) vomitoxin, and five varieties were below the FDA threshold of 1 ppm which is considered safe for human consumption (Table 5 above). While only Aroostook, Danko, ND Gardner, Serafino, and Spooner were below the FDA threshold, others remained fairly low despite ideal conditions for high disease pressure.

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. Because rye bread relies on different grain components to create high-quality bread, and ferments more readily than wheat, it is expected that lower falling numbers are preferred for rye

than for wheat, possibly closer to 100-200 seconds. 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 and 2022 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.

ACKNOWLEDGEMENTS

The UVM Extension Northwest Crops and Soils Team would like to acknowledge the USDA SARE Grant Award No. LNE22-437 for their support. The NWSC Team would like to thank Roger Rainville and the staff at Borderview Research Farm. We would also like to acknowledge Anna Brown, Catherine Davidson, Hillary Emick, Ivy Krezinski, Andrea Rainville, Lindsey Ruhl, Laura Sullivan, Sophia Wilcox Warren, and Sara Ziegler for their assistance with data collection and entry. This information is presented with the understanding that no product discrimination is intended and neither endorsement of any product mentioned, nor criticism of unnamed products, is implied.

UVM Extension helps individuals and communities put research-based knowledge to work.



Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. University of Vermont Extension, Burlington, Vermont. University of Vermont Extension, and U.S. Department of Agriculture, cooperating, offer education and employment to everyone without regard to race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or familial status.