NORTHWEST CROPS & SOILS PROGRAM

2021 Rye Variety Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2021 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 2020-2021, 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 experimental design was a randomized complete block with twelve varieties replicated four times. Treatments were twelve varieties of cereal rye including Akusti, Aroostock, Brasetto, Danko, Hazlet, KWS Tayo, ND Dylan, ND Gardner, Rymin, Sangaste, Serafino, and Svedje (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 25-Sep 2020. Plots were 5' x 20' (Table 1). Heading date data was collected through the month of May, captured when 50% of the heads had fully emerged. Populations were measured by counting plants in 3 one-foot sections of row. On 22-Jul 2021, one day prior to harvest, three plant heights per plot were measured for each plot. Lodging for each plot was visually assessed using a 0-5 scale, with 0 indicating no lodging and 5 indicating entire plot was too lodged to be harvested.

Table 1. Agronomic and trial information for the rye cover crop variety trial, 2020-2021.

	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	25-Sep 2020
Harvest Date	22-Jul 2021

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 2/3 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. DON testing was performed on 1 replication, and all samples tested were below the detectable limit for the test (data not shown).

Table 2. Winter rye varietal information, Alburgh, VT, 2020-2021.

Variety	Source
AC Hazlet	Albert Lea Seed
Akusti	Finnish variety supplied by Ruth Fleischman
Aroostock	Albert Lea Seed
Danko	Knight Seed
Dylan	Seedway LLC
KWS Tayo	Albert Lea Seed
KWS Brasetto	Seedway LLC
ND Gardner	Albert Lea Seed
Rymin	University of Minnesota
Sangasti	Great Lakes Staple Seeds
Serafino	Albert Lea Seed
Svedje	Borderview Farm, Saved Seed

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 ($p<0.10$).

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

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 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. A cooler than average fall but warmer and drier summer led to 2705 Growing Degree Days (GDDs) accumulated April to July, which was 273 GDDs above the 30-year average for those months. The precipitation from April to July was 5.12" below normal. Overall, precipitation across the entire growing season from Sep to Jul, was 3.08" below average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2020 and 2021 growing season.

	2020			2021				
	Sep	**Oct**	**Nov**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
Average temperature (°F)	68.8	59.2	48.3	19.8	33.2	48.1	58.4	70.3
Departure from normal	-1.89	-3.53	-2.01	-3.07	0.93	2.52	-0.03	2.81
Precipitation (inches)	6.77	2.75	3.56	0.47	0.97	3.52	0.66	3.06
Departure from normal	3.23	-0.92	-0.27	-1.30	-1.27	0.45	-3.10	-1.20
Growing Degree Days (32°-95°F)	1141	816	521	32	241	497	818	1149
Departure from normal	-58	-107	-48	21	103	85	-1	86

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).

Disease and pest scouting occurred on 17-Jun 2021 (Table 4). The top two leaves from three plants per plot were examined and percentage of the foliar surface that was damaged by several different pests and foliar diseases was recorded. Foliar diseases reduce photosynthetic leaf area, use nutrients, and increase respiration and transpiration within colonized host tissues. Diseased plants may exhibit reduced vigor, growth, and seed fill. Earlier occurrence, greater degree of host susceptibility, and longer duration of conditions favorable for disease development can increase the yield loss. When scouted on 17-Jun, each plot was assessed for several distinct diseases. These individual disease ratings were combined into a single foliar disease rating for statistical analysis.

There was a large span of disease with varieties ranging from 6-25% of foliar area affected. The most prevalent disease issues were fungal diseases. Rust and powdery mildew were detected, but rust was more prevalent than powdery mildew. A variety of diseases causing brown foliar lesions were present, but none were as prevalent as rust. The variety with the lowest disease burden was KWS Tayo with 5.6% of the foliar surface affected in the average plant of this variety. Aroostock and Brasetto showed statistically similar results with 10.3% and 11.7% affected by disease. Seven of the remaining varieties, Serafino, Danko, Svedje, Ssangaste, Akusti, Hazlet and Rymin all reported statistically similar results to each other, with between 16.7 % and 25% of their foliar surfaces affected by disease, Rymin being the highest.

Damage was noted from several arthropod pests including thrips, mites, aphids, and cereal leaf beetle. Leaf damage from all pests was combined into a single arthropod pest damage category for statistical analysis. The most common arthropod pests noted were thrips. Overall, pest damage was minimal, with all varieties reporting under 7%. Akusti had the least pest damage, with 2.6% of foliar surface affected on

average. All other varieties except Serafino which reported 6.8% damage, had statistically similar results as Akusti.

Table 4. Agronomic data by rye variety, Alburgh, VT, 2021.

	Heading date	Population	Arthropod Pest Damage	Disease	Height	Lodging
		plants m^2	% foliar surface affected	% foliar surface affected	cm	0-5†
Akusti	19-May	229*	**2.6***‡	22.0	143	2.75
Aroostock	17-May	248*	3.6*	11.1 *	162	4.25
Brasetto	19-May	241*	3.1*	10.3 *	132	3.00
Danko	18-May	221	2.7*	16.9	143	**0.75***
Hazlet	18-May	251*	3.8*	24.1	146	2.00*
KWS Tayo	18-May	207	4.2*	**5.6***	133	2.25*
ND Dylan	19-May	221	2.9*	16.4	149	3.75
ND Gardner	17-May	238*	4.7*	16.2	151	4.25
Rymin	19-May	241*	4.3*	25.0	165	4.25
Sangaste	20-May	**256***	3.4*	20.5	**183**	2.75
Serafino	19-May	234*	6.8	16.7	146	1.75*
Svedje	20-May	242*	3.4*	20.2	155	4.00
LSD (p=0.10)§	0.936	32.9	2.6	8.5	13	1.65
Trial Mean	18-May	236	3.8	17.1	151	2.98

†Lodging was rated on a 0 to 5 scale where 0 indicates no lodging and 5 indicates entire plot lodged.
‡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.

Heading date, heights, lodging and target populations were assessed by variety (Table 4). There were significant differences in each measurement. Sangasti was the tallest variety at 183 cm, and was also among the latest to head out, along with Svedje. The average height across the variety trial was 151 cm. Lodging varied across varieties, ranging from 0.75 to 4.25 on a scale from 1-5. Danko experiencing the most minimal lodging with 0.75. The target population was 350 plants m^{-2}. None of the varieties met or exceeded this target with Sangaste having the highest population at 256 plants m^{-2}. In the remaining varieties, all but three varieties (Danko, ND Dylan, and KWS Tayo) showed statistically similar results as Sangaste. It is possible that the varieties experienced less germination because of the dry and cold fall.

Yields are adjusted for a 13.5% moisture basis. Yields ranged between 1995 and 6429 lbs ac^{-1} with KWS Tayo and Brasetto as the top performing varieties (Table 5). The ideal test weight for rye is 56 lbs bu^{-1}; none of the varieties met or exceeded this test weight. Hazlet had the highest test weight at 46.1 lbs bu^{-1} with Akusti, Aroostock, Brasetto and KWS Tayo all having statistically similar results. The ideal moisture content for grain storage is below 13.5%. Moisture measurements were recorded at harvest. None of the

varieties were below 13.5%. Hazlet was the lowest at 18.3% along with all but three varieties being statistically similar.

Table 5. Yield and quality of winter rye varieties, Alburgh, VT, 2021.

Variety	Yield @ 13.5% moisture	Harvest moisture	Test Weight	Crude protein @ 12% moisture	Falling number
	lbs ac^{-1}	%	lbs bu^{-1}	%	seconds
Akusti	3681	19.9*†	41.9*	9.90	197
Aroostock	3419	19.7*	42.1*	12.7*†	196
Brasetto	6073*	19.6*	42.4*	9.60	**284***
Danko	4978	22.5	36.5	9.20	205
Hazlet	4463	**18.3**	**46.1***	9.20	154
KWS Tayo	**6429***	19.9*	42.0*	8.70	230
ND Dylan	3639	19.8*	40.0	10.4	173
ND Gardner	3827	20.9	38.7	11.8	146
Rymin	3846	19.0*	41.1	11.0	153
Sangaste	3391	20.8*	34.3	11.2	155
Serafino	5003	20.5*	41.7*	9.60	241*
Svedje	1995	21.5	32.9	**13.4***	81.0
LSD (p=0.10) ‡	684	2.5	4.9	1.4	44.4
Trial mean	4229	20.2	40	10.6	184

‡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.

The 12 winter rye varieties were analyzed for crude protein and falling number (Table 5). Svedje and Aroostock had the highest crude protein measures at 13.4% and 12.7% respectively. Falling number ranged between 80 (Svedje) and 284 (Brasseto). 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.

DISCUSSION

The average trial yields for the 2019 season were 2093 lbs ac^{-1} with top performing varieties (Brasetto and Dolero) topping out over 3600 lbs ac^{-1}. Comparatively, the 2020 season trial was much higher with a yield average over 4700 lbs ac^{-1} with Dolero and Bono both yielding well over 6000 lbs ac^{-1}. Finally, the 2021 season yield fell in between the 2019 and 2020 data with an average of 4229 lbs. The top performing varieties were KWS Tayo yielding 6429 lbs and Brasetto yielding 6073 lbs.

Overall, pest damage was minimal, with thrips causing the most destruction. Disease ranged widely, with some varieties experiencing between 20-25% foliar surfaces affected, rust being the most prevalent disease. KWS Tayo, Aroostock and Brasetto appeared to be the most disease resistant of the varieties.

None of the varieties reached the ideal test weight of 56 lbs bu^{-1}, with Hazlet coming the closest with a weight of 46.1 lbs bu^{-1}. The average falling number was 184 with all varieties likely suitable for baking. Aroostock and Svedje reported the highest crude protein measures at 12.7% and 13.4%, respectively.

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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