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2020

Organic Spring Wheat Variety Trial

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NORTHWEST CROPS & SOILS PROGRAM

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2020 ORGANIC SPRING WHEAT VARIETY TRIAL
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In 2020, the University of Vermont Extension's Northwest Crops and Soils Program evaluated 34 spring wheat varieties to identify varieties that perform well in production systems in northern Vermont. The trial was established at the Borderview Research Farm in Alburgh, Vermont.

MATERIALS AND METHODS

The spring wheat variety trial was initiated at Borderview Research Farm in Alburgh in April 2020. 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 previous crop was corn silage. The field was disked and spike tooth harrowed prior to planting. The field was fertilized with 19-19-19 at a rate of 300 lb ac^{-1} prior to seeding. Plots were seeded in 5' x 20' plots with a Great Plains Cone Seeder on 8-Apr at a seeding rate of 350 live seeds m^{-2}. Thirty-four varieties were planted. Field season data were collected on all varieties. From 12-Jun to 18-Jun, heading dates were recorded. When 50% of heads were emerged in the plot, the plot was determined to be headed out. Heights were determined on 20-Jul by taking three measurements per plot.

Table 1. Trial agronomic information, Alburgh, VT, 2020.

Trial information	Alburgh, VT Borderview Research Farm
Soil type	Covington silty clay loam, 0 to 3 percent slopes
Previous crop	Corn silage
Seeding rate	350 live seeds m^{-2}
Row spacing (in)	6
Replicates	4
Planting date	8-Apr 2020
Harvest date	20-Jul 2020
Harvest area (ft)	5 x 20
Tillage operations	Fall plow, disk & spike tooth harrow

Table 2. Thirty-four spring wheat varietal information.

Spring wheat varieties	Type	Seed source
AC Scotia	HR	Semican Atlantic Inc., QC, Canada
AC Walton	HR	2012 Saved trial seed, VT
Alaska	HR	Semican Atlantic Inc., QC, Canada, 2018
Barracuda	HR	Meridian Seeds, ND, 2018
Bolles	HR	Albert Lea Seed, MN

Camaro	HR	2017 Meridian Seeds, ND
Chevello	HR	2014 Meridian Seeds, ND
CMV12638	HR	C&M Seeds, ON, Canada
Forefront	HR	South Dakota State University, SD
Glenn	HR	Albert Lea Seed, MN
Lang-MN	HR	University of Minnesota, MN, 2017
LCS Albany	HR	Limagrain Cereal Seeds, LLC, CO
LCS Anchor	HR	Limagrain Cereal Seeds, LLC, CO
LCS Breakaway	HR	Limagrain Cereal Seeds, LLC, CO
LCS Iquaco	HR	Limagrain Cereal Seeds, LLC, CO
LCS Nitro	HR	Limagrain Cereal Seeds, LLC, CO
LCS Prime	HR	Limagrain Cereal Seeds, LLC, CO
LCS Pro	HR	Limagrain Cereal Seeds, LLC, CO
LCS Rebel	HR	Limagrain Cereal Seeds, LLC, CO
LCS Trigger	HR	Limagrain Cereal Seeds, LLC, CO
LNR13-0627	HR	Limagrain Cereal Seeds, LLC, CO
Magog	HR	Semican Atlantic Inc., QC, Canada
Major	HR	SynAgri, QC, Canada
Moka	HR	Semican Atlantic Inc., QC, Canada
MS_19SW1	HR	Meridian Seeds, ND
MS_19SW2	HR	Meridian Seeds ND
MS Ranchero	HR	Meridian Seeds, ND
ND Vitpro	HR	North Dakota State University, ND, 2017
Pokona	HR	Semican Atlantic Inc., QC, Canada, 2018
Prevail	HR	South Dakota State University, SD
Prosper	HR	Albert Lea Seed, MN
RB07	HR	Minnesota Foundation Seed, MN
Rocket	HR	Semican Atlantic Inc., QC, Canada
Shelly	HR	Dahlman Seed Co., MN

HR- Hard Red.

Plots were harvested with an Almaco SPC50 small plot combine on 20-Jul. Grain moisture, test weight, and yield were determined at harvest. Seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN) and a subsample was collected to determine quality characteristics. Grain quality was determined at UVM Extension's Northwest Crop and Soils Quality Testing Laboratory (Burlington, Vermont). Samples were ground using the Perten LM3100 Laboratory Mill. Flour was analyzed for protein content using the Perten Inframatic 8600 Flour Analyzer. Most commercial mills target 12-15% protein content for bread wheat. Falling number was measured (AACC Method 56-81B, AACC Intl., 2000) on the Perten FN 1500 Falling Number Machine. The falling number indicates the level of enzymatic activity in the grain. 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. Falling numbers between 300-350 indicate low enzymatic activity and sound quality wheat. A falling number lower than 200 indicates high enzymatic activity and poor quality wheat, typically as a result of pre-harvest sprouting damage in the grain. Falling number above 400 is suitable but may retard fermentation when used for baking. Deoxynivalenol (DON),

a vomitoxin, was analyzed 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. One sample of each variety was run and all tested well below the threshold for human consumption (data not shown).

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).

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. An early period of dry weather allowed for early planting at the beginning of April. Cooler than average spring but warmer and drier summer led to 3433 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.

Table 3. Seasonal weather data collected in Alburgh, VT, 2020.

	Apr	May	Jun	Jul
Average temperature (°F)	41.6	56.1	66.9	74.8
Departure from normal	-3.19	-0.44	1.08	4.17
Precipitation (inches)	2.09	2.35	1.86	3.94
Departure from normal	-0.72	-1.04	-1.77	-0.28
Growing Degree Days (32°-95°F)	315	746	1046	1326
Departure from normal	-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) for Burlington, VT.

Table 4 shows heading date and harvest data for the spring wheat trial. Spring wheat varieties had an average yield of 3181 lbs ac^{-1} adjusted for 13.5% moisture, which was higher than previous years. The top yielding variety was LCS Pro at 3842 lbs ac^{-1}. Every variety in the trial yielded above 2000 lbs ac^{-1}. AC Scotia had the highest average plant height at 94.9 cm and Chevello the lowest at 66.2 cm.

Harvest moisture below 14% is desirable for grain storage. Wheat above this moisture content must be dried down after harvest, adding time and cost to farmers. Most varieties in this trial had moistures at or above 14% and required drying before storage with the exception of Prevail, Forefront, MS Ranchero, Lang-MN, Barracuda, LNR13-0627, and LCS Anchor. LCS Anchor had the lowest harvest moisture at 13.0%. Test weight is the measure of grain density, which is determined by weighing a known volume of grain. Industry standard for wheat is 60 lbs bu^{-1}. Forefront had the highest test weight at 61.1 lbs bu^{-1} with ND Vitpro, Lang-MN, Glenn, and Barracuda testing at or above 60 lbs bu^{-1}.

Table 4. Spring wheat harvest data, Alburgh, VT, 2020.

Variety	Heading date	Height cm	Test weight lbs bu^{-1}	Moisture %	Yield 13.5% moisture lbs ac^{-1}
AC Scotia	17-Jun	94.9^{af}	53.2^{e-j}	17.9^{c-g}	3705^{a-c}
AC Walton	16-Jun	91.7^{ab}	54.6^{c-h}	17.7^{c-g}	3004^{a-e}
Alaska	15-Jun	87.9^{a-e}	54.9^{b-g}	16.6^{d-i}	3448^{a-e}
Barracuda	14-Jun	69.4^{j-l}	60.0^{a-d}	13.2^{i-k}	2898^{c-f}
Bolles	16-Jun	79.3^{e-i}	54.2^{d-i}	19.1^{b-e}	3567^{a-c}
Camaro	15-Jun	72.6^{i-l}	58.3^{a-f}	14.6^{g-k}	3283^{a-e}
Chevello	15-Jun	66.2^{l}	59.5^{a-d}	14.7^{g-k}	3126^{a-e}
CMV12638	17-Jun	88.7^{a-d}	48.7^{h-j}	22.3^{b}	3768^{ab}
Forefront	15-Jun	87.9^{a-e}	**61.1^{a}**	13.4^{i-k}	3681^{a-c}
Glenn	14-Jun	82.7^{c-h}	60.3^{a-c}	15.7^{f-k}	2731^{d-f}
Lang-MN	15-Jun	74.9^{g-k}	60.5^{ab}	13.3^{i-k}	2919^{b-f}
LCS Albany	15-Jun	73.2^{i-l}	56.4^{a-g}	15.2^{f-k}	2966^{b-e}
LCS Anchor	14-Jun	66.7^{kl}	57.2^{a-g}	**13.0^{k}**	2085^{f}
LCS Breakaway	14-Jun	73.6^{i-l}	58.2^{a-g}	16.4^{d-i}	3263^{a-e}
LCS Iquaco	16-Jun	80.2^{d-i}	56.1^{a-g}	17.5^{c-h}	3276^{a-e}
LCS Nitro	16-Jun	67.6^{j-l}	56.4^{a-g}	14.6^{g-k}	3209^{a-e}
LCS Prime	15-Jun	80.3^{d-i}	58.0^{a-g}	17.0^{c-h}	3347^{a-e}
LCS Pro	15-Jun	83.6^{b-g}	56.8^{a-g}	17.7^{c-g}	**3842^{a}**
LCS Rebel	15-Jun	74.4^{h-l}	58.1^{a-g}	15.8^{e-k}	2737^{d-f}
LCS Trigger	17-Jun	76.2^{f-j}	52.4^{g-j}	20.0^{bc}	3352^{a-e}
LNR13-0627	14-Jun	66.8^{kl}	59.9^{a-d}	13.1^{jk}	2979^{b-e}
Magog	16-Jun	89.7^{a-c}	57.6^{a-g}	16.5^{e-k}	2949^{b-e}
Major	18-Jun	90.8^{a-c}	47.4^{j}	26.2^{a}	3053^{a-e}
Moka	15-Jun	84.7^{b-f}	55.2^{a-g}	16.3^{d-k}	2635^{ef}
MS Ranchero	14-Jun	72.3^{i-l}	56.9^{a-g}	13.4^{i-k}	2982^{b-e}
MS_19SW1	15-Jun	89.3^{a-c}	56.7^{a-g}	16.4^{d-k}	3353^{a-e}

Variety		Col2	Col3	Col4	Col5
MS_19SW2	15-Jun	81.2[d-i]	59.5[a-d]	15.4[f-k]	3361[a-e]
ND Vitpro	15-Jun	79.6[e-i]	60.9[a]	14.9[g-k]	3096[a-e]
Pokona	16-Jun	89.1[a-c]	56.2[a-g]	18.6[c-f]	3117[a-e]
Prevail	15-Jun	73.2[i-l]	59.9[a-d]	13.5[i-k]	3333[a-e]
Prosper	16-Jun	79.3[e-i]	59.1[a-e]	14.2[h-k]	3523[a-d]
RB07	15-Jun	73.9[i-l]	48.6[ij]	14.1[h-k]	3219[a-e]
Rocket	16-Jun	87.8[a-e]	53.2[f-j]	19.6[b-d]	3345[a-e]
Shelly	16-Jun	72.7[i-l]	56.3[a-g]	16.2[e-k]	3008[a-e]
LSD (p=0.10)	NS‡	8.72	5.9	3.4	857
Trial mean	15-Jun	79.5	56.5	16.3	3181

† Within a column, values labelled with the same letter have no significant difference between treatments (p=0.10). Highest values are shown in **bold**.
‡ NS; no significant difference between treatments at the p=0.10 level.

All varieties tested above 12% protein, adjusted for 12% moisture, which is within the range for high quality bread flour (Table 5). The ideal range for bread wheat is 12-15% crude protein, though some artisan bread bakers have found success working with wheat in the 10-12% range, depending on the end-product. The trial mean is 14.6% protein and 13 varieties tested above 15%.

The falling number trial mean was 403 seconds. LCS Albany had the lowest falling number at 344, within the ideal range for bread baking. As mentioned previously, 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 indicates high enzymatic activity, or more pre-harvest sprouting damage. This is most common if there are rain events as the grain is ripening prior to harvest. Low falling number, below 250, has a negative impact on bread quality and can lead to lower prices paid for the wheat or possible rejection at the mill. The ideal range for wheat is 250-350. High falling numbers, over 400 seconds, can potentially lead to slower fermentation, poorer loaf volume and drier bread texture, depending on the end product.

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

Table 5. Spring wheat quality data, Alburgh, VT, 2020.

Variety	Crude protein @ 12.5% moisture %	Falling Number seconds
AC Scotia	14.2[g-l†]	390[e-i]
AC Walton	14.2[g-l]	419[a-e]
Alaska	15.1[b-g]	423[a-e]
Barracuda	15.1[b-g]	433[a-d]
Bolles	16.1[a-c]	419[a-e]
Camaro	16.9[a]	393[e-h]

Variety	Protein (%)	Falling Number (sec)
Chevello	13.8[h-l]	381[f-j]
CMV12638	13.9[g-l]	414[a-f]
Forefront	14.1[g-l]	398[e-g]
Glenn	16.2[ab]	380[f-j]
Lang-MN	15.1[b-g]	439[a-c]
LCS Albany	13.5[k-m]	344[k]
LCS Anchor	16.1[a-d]	424[a-e]
LCS Breakaway	15.9[a-e]	395[e-g]
LCS Iquaco	15.0[b-i]	354[jk]
LCS Nitro	13.8[i-l]	441[ab]
LCS Prime	13.3[lm]	396[e-g]
LCS Pro	15.0[b-h]	397[e-g]
LCS Rebel	14.9[c-j]	403[d-g]
LCS Trigger	12.5[m]	407[b-g]
LNR13-0627	13.5[l-m]	413[a-g]
Magog	14.0[g-l]	444[a]
Major	14.9[d-j]	358[h-k]
Moka	14.7[f-k]	377[i-k]
MS_19SW1	15.5[b-f]	422[a-e]
MS_19SW2	13.7[j-m]	401[d-g]
MS Ranchero	13.2[lm]	424[a-e]
ND Vitpro	15.8[a-f]	407[b-g]
Pokona	13.9[g-l]	405[c-g]
Prevail	14.6[f-k]	411[a-g]
Prosper	13.9[h-l]	405[c-g]
RB07	15.0[b-i]	402[d-g]
Rocket	14.7[e-j]	358[i-k]
Shelly	14.2[g-l]	419[a-e]
LSD (p=0.10)	1.2	35
Trial mean	14.6	403

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

DISCUSSION

The 2020 growing season was warmer and drier than the 30-year average. This allowed for early planting in April and quality targets within ideal ranges across the grain trials at Borderview Research Farm. Warm, dry weather during grain dry down is favorable for most cereal grain crops. Spring wheat trial yields were higher in 2020 than each of the previous seven seasons. Protein was high for every spring wheat variety planted, all well within the ideal range for bread baking, the most common end-use for hard red spring wheat. Falling numbers were high, indicating low pre-harvest sprouting damage, a result of little to no rainfall in the days leading up to harvest. DON levels were very low. Early planting and relatively cool weather during the vegetative phase of cereal grain development helped to promote these high yields.

It is important to remember that this only represents one year of data. The weather this growing season was challenging for many crops at Borderview Research Farm, and across much of Vermont and New England. The hot and dry weather led to drought stress, disease and pest pressures. However, the cereal grains performed well overall. They are better adapted to these types of conditions than the cooler and wetter weather that is more common for this area. Though spring wheat was high yielding and most quality targets were met or exceeded this year, many years can be challenging for this crop. It is important, as you make variety choices on your farm, that you evaluate data from test sites that are as similar to your region as possible. Wheat is generally considered a specialty crop in the Northeast and it is recommended growers consider quality standards, consider post-harvest handling requirements and communicate with potential buyers during variety selection and prior to planting large acreage of grain.

Vomitoxin is produced by Fusarium Head Blight (FHB), a widespread grain disease in the Northeast. Grain is most susceptible to FHB during rainy or especially humid weather when the grain heads are flowering. FHB incidence was low this year due to the dry weather during the flowering periods in June, and throughout most of the growing season. Infected heads appear bleached and kernels can be tinted pink and/or be shriveled. Because there is a threshold for safe human consumption many mills and malthouses will request a DON test on grain prior to purchase, even in a low-incidence year.

ACKNOWLEDGEMENTS

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

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