NORTHWEST CROPS & SOILS PROGRAM

2019 Organic Heirloom Spring Wheat Variety Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2019 ORGANIC HEIRLOOM SPRING WHEAT VARIETY TRIAL

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University of Vermont Extension began its heirloom spring wheat trials in 2007 to determine whether heirloom varieties developed before 1950 could thrive in Vermont's current climate. Many consumers are interested in heirloom wheat for flavor, perceived health benefits or its history, while many farmers are interested in heirloom wheat because it may have superior genetics better adapted to the challenging growing conditions in the Northeast. Production of heirloom wheat may also provide a farmer with a value added market with increased returns. This variety trial was established to determine heirloom spring wheat varieties that are suitable for production in Vermont's growing conditions.

MATERIALS AND METHODS

In April 2019, an heirloom spring wheat variety trial was established at Borderview Research Farm in Alburgh, Vermont (Table 1). The experimental design was a randomized block design with four replications. The seedbed was prepared by conventional tillage methods. All plots were managed with practices similar to those used by producers in the surrounding areas. The previous crop was corn. The field was disked and spike tooth harrowed prior to planting. Plots were seeded with a Great Plains Cone Seeder on 29-Apr at a seeding rate of 350 live seeds m^{-2}. The nineteen varieties of heirloom spring wheat, their origin, pedigree, and release date are listed in Table 2.

Table 1. General plot management of the heirloom spring wheat variety trial, 2019.

Location	Alburgh, VT Borderview Research Farm
Soil type	Benson rocky silt loam
Previous crop	Corn
Seeding rate (seeds m^{-2})	350
Replicates	4
Planting date	29-Apr
Harvest date	1-Aug
Harvest area (ft)	5 x 20
Tillage operations	Spring plow, spring disk & spike tooth harrow

Table 2. Varietal information of the heirloom spring wheat, Alburgh, VT, 2019.

Variety	Developed in	Pedigree	Release date
AC Barrie	Sask. Canada	Neepawa/Columbus//BW90	1996
Ceres 05	North Dakota	Marquis/Kota	1926
Champlain	Vermont	Black Sea/Golden Drop	1870
Defiance	Vermont	Golden Drop/White Hamburg	1878
Hope	South Dakota	Yaroslav emmer/Marquis	1927
Komar	North Dakota	Marquis/Kota; Sister selection of Ceres	1930
Ladoga	Leningrad, Rus.	-	1916
Marquis	Ont. Canada	Hard Red Calcutta/Red Fife	1910
Mida 05	North Dakota	Mercury//Ceres/Double Cross	1944
Mida 06	North Dakota	Mercury//Ceres/Double Cross	1944
Red Bobs	Sask. Canada	Selection from fields of Bobs	1926
Red Fife	Ontario, Can.	Selection from Halychanka	1840
Reliance	Oregon	Kanred/Marquis	1926
Scarlett	Washington	Too many to list	1998
Spinkcota	Washington	Preston sel./red durum//Preston sel.	1944
Supreme	Sask. Canada	Selection from Red Bobs	1922
Surprise	Vermont	Chile Club/Michigan Club	1909
Thatcher	Minnesota	Marquis/Ilumillo//Marquis/Kanred	1934
Oland	Kalmar län, Swe.	Local eco-type (*Triticum spelta*)	1960

Heights and lodging were measured on 30-Jul. Plots were harvested with an Almaco SPC50 small plot combine on 1-Aug. The harvest area was 5’ x 20’. Grain moisture, test weight, and yield were determined at harvest. The yields were calculated and normalized to 13.5% moisture. Seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN) and a subsample was collected to determine quality characteristics. Samples were ground using the Perten LM3100 Laboratory Mill. Flour was analyzed for protein content using the Perten Inframatic 8600 Flour Analyzer. Crude protein was adjusted to 12% and 14% moisture content for comparison between varieties with different flour moisture. Most commercial mills target 12-14% protein content. Falling number was measured (AACC Method 56-81B, AACC Intl., 2000) on the Perten FN 1500 Falling Number Machine. The falling number is related to the level of sprout damage 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 greater than 350 indicate low enzymatic activity and sound quality wheat. A falling number lower than 200 indicates high enzymatic activity and poor quality wheat. 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.

All data were analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate seeding rate means when the F-test was significant ($P< 0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather and other growing conditions. Statistical analysis makes it possible to determine whether a difference among varieties 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 at the 10% level of probability are shown. Where the difference between two varieties 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 varieties. In this example, variety A is significantly different from variety C, but not from variety B. The difference between A and B is equal to 725, which is less than the LSD value of 889. This means that these varieties did not differ in yield. The difference between A and C is equal to 1454, which is greater than the LSD value of 889. This means that the yields of these varieties were significantly different from one another. The asterisk indicates that variety B was not significantly lower than the top yielding variety.

Variety	Yield
A	3161
B	3886*
C	**4615***
LSD	**889**

RESULTS

Seasonal precipitation and temperatures were recorded with a Davis Instruments Vantage Pro2 with WeatherLink data logger on site in Alburgh, VT (Table 3). Over the 2019 growing season, there was 0.98 inches less rain than in an average year. From May to July, there was an accumulation of 2916 Growing Degree Days (GDDs) in Alburgh, VT, 50 GDDs less than the 30-year average.

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

Alburgh, VT	May	Jun	Jul
Average Temperature (F)	53.3	64.3	73.5
Departure from Normal	-3.11	-1.46	2.87
Precipitation (inches)	4.90	3.06	2.34
Departure from Normal	1.45	-0.63	-1.81
Growing Degree Days (base 32)	660	970	1286
Departure from Normal	-96	-44	88

Based on weather data from Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages for 30 years of NOAA data (1981-2010) from Burlington, VT.

Wheat Yield and Quality

Plant heights were measured on 30-Jul. Three plants in each plot were measured. The average height was 123 cm (Table 4). Taller plants are generally desired for their ability to shade out competing weeds. However, tall wheat may be more prone to lodging depending on many factors such as stalk strength and over-fertilization. A visual estimation of lodging (%) was performed on 30-Jul. Lodging is defined as the collapse of top heavy plants, particularly grain crops because of excess growth or beating by rain. If

lodging was present, its severity was recorded based on a 0 to 9 scale with 0 indicating the entire plot could be harvested with the plot combine and 9 signifying that none of the plot could be harvested.

Table 4. Growth and harvest characteristics of heirloom spring wheat for Alburgh, VT, 2019.

Variety	Height	Lodging	Yield at 13.5% moisture	Moisture @ harvest	Test weight	Crude protein @ 12% moisture content	Falling number
	cm	0-9 scale	lbs ac^{-1}	%	lbs bu^{-1}	%	seconds
AC Barrie	122	2.25	2268*	18.4	55.2*	12.9	392*
Ceres 05	117	2.25	2217*	17.3*	**56.9***	12.9	382
Champlain	123*†	4.00	1422	18.9	53.1	13.6	373
Defiance	128*	2.25	1824	17.6*	55.4*	13.4	378
Hope	119	3.50	1830	19.4	54.3	12.5	392*
Komar	129*	3.50	1675	16.8*	55.5*	13.4	378
Ladoga	129*	2.50	1844	16.7*	55.6*	12.9	398*
Marquis	126*	2.00	2211*	18.3	55.3	13.8	392*
Mida 05	120	2.75	1829	20.6	50.2	13.1	380
Mida 06	121	3.25	2154*	19.1	55.3*	13.5	374
Oland	118	3.00	2198*	23.2	50.8	12.5	**408***
Red Bobs	115	2.25	1814	17.6*	54.4	12.6	394*
Red Fife	125*	4.00	1788	24.6	49.2	12.5	363
Reliance	125*	3.75	2248*	17.8	55.4*	13.1	388
Scarlett	126*	3.75	1928	16.9*	54.3	13.3	395*
Spinkcota	125*	2.75	1637	19.3	55.2*	13.1	390
Supreme	117	3.00	1788	**15.9***	56.5*	12.6	402*
Surprise	125*	3.25	**2304***	17.6*	54.0	**13.8**	393*
Thatcher	**131***	2.00	1811	17.1*	54.8	13.1	394*
LSD (p=0.10)‡	7.87	NS¥	369	1.82	2.22	NS¥	16.0
Trial mean	123	2.95	1936	18.6	54.3	13.1	387

*Within Treatments that did not perform significantly lower than the top-performing treatment, shown in **bold**, in a particular column are indicated with an asterisk.

‡LSD – Least significant difference at p=0.10.

¥NS – shows no significant difference.

Though Thatcher was the tallest variety at 131 cm, it was significantly similar to ten other varieties grown in the 2019 season. All varieties showed signs of lodging but varieties did not differ statistically for lodging and overall the lodging was low for all the heirloom varieties this season (Table 4).

The average yield at 13.5% moisture for the trial was 1936 lbs ac^{-1} (Table 4; Figure 1). The highest yielding variety was Surprise (2304 lbs ac^{-1}); AC Barrie, Reliance, Ceres 05, Marquis, Oland and Mida 06 were all significantly similar. In the 2019 growing season, the average harvest moisture was 18.6%, which is much higher than the recommended 14% moisture for storage. Test weight is the measure of grain density. The acceptable test weight for bread wheat is 56-60 lbs per bushel. The average test weight

for 2019 was below the ideal range at 54.3 bu ac^{-1}. The variety with the highest test weight was AC Barrie at 59.4 lbs bu^{-1}. Nine other varieties were statistically similar to this variety.

The industry standard for protein is 12-14%, and in 2019, protein levels ranged from 12.4% to 13.8%. Surprise (13.8%) had the highest crude protein concentrations; all varieties were statistically similar (Table 4; Figure 1). All of the varieties had falling numbers over 300 seconds, indicating low enzymatic activity and sound quality wheat. The average falling number was 387. The variety with the highest falling number was Oland (408 seconds) and nine other varieties are statistically similar. Only one replication of the trial was tested for DON concentrations and all were below the industry standard of 1ppm and safe for human consumption. Hence, no further analysis was conducted for trial plots.

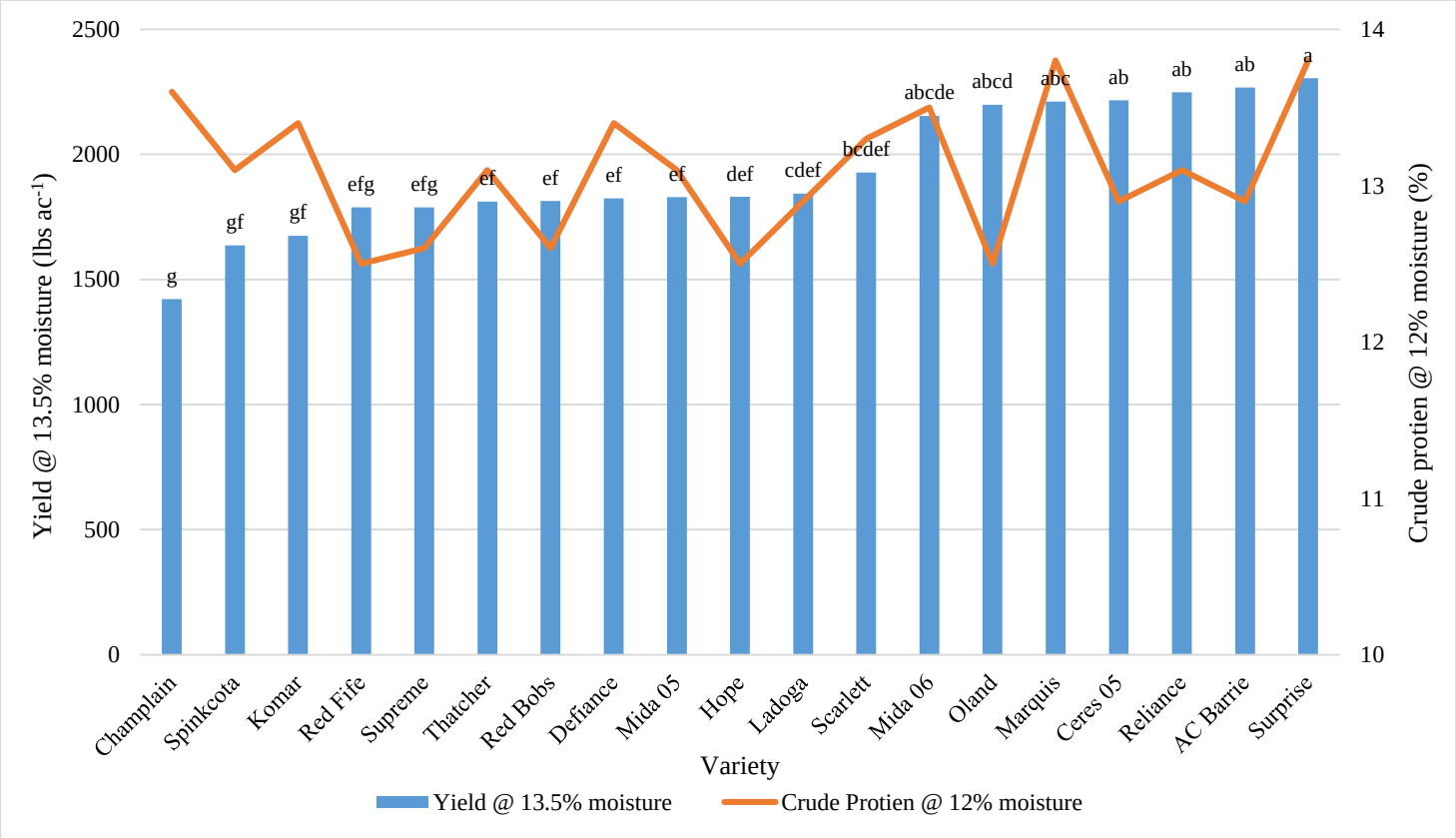

Figure 1. Yield and protein of heirloom spring wheat varieties grown in Alburgh, VT, 2019. Treatments that share a letter did not differ significantly by variety in yield (p=0.10.) Crude protein content did not differ significantly between varieties.

DISCUSSION

The 2019 growing season had high yields compared to previous years (Figure 2). This could be due to a couple of things. The 2019 growing season was also cooler and had less rain then other years, which would have affected the yield and quality of the wheat. The weather in 2019 affected the DON levels, and all DON levels were low across all grains trials at Borderview Research Farm in 2019. The low rainfall likely also helped maintain high CP and falling numbers for all varieties in the trial.

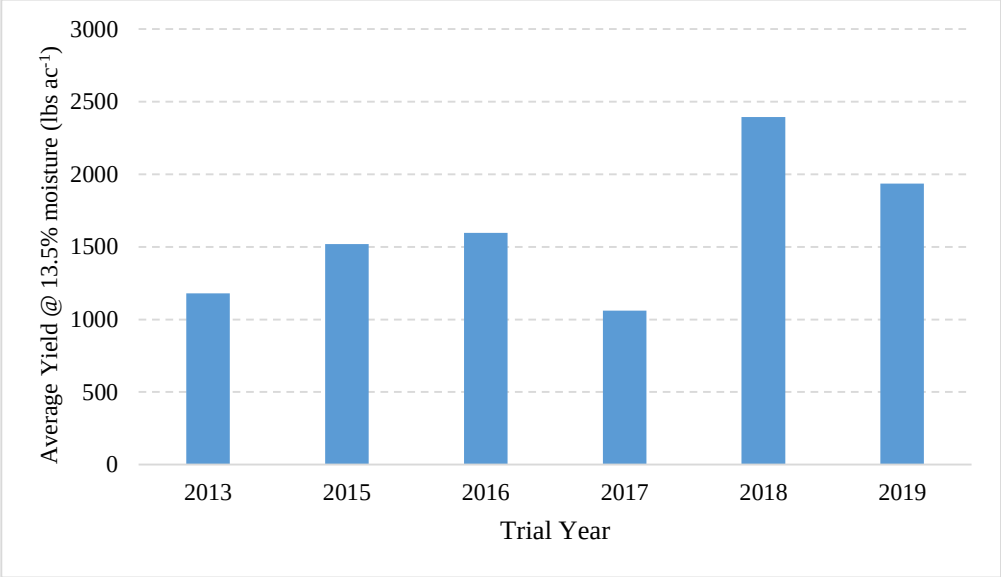

Figure 2. Mean yields from heirloom spring wheat variety trials from 2013 to 2019 (2014 missing), Alburgh, VT.

ACKNOWLEDGEMENTS

The UVM Extension Crops and Soils Team would like to thank the Borderview Research Farm for their generous help with the trials, and to acknowledge the USDA OREI grant program for their financial support (project number 20155130024153 USDA/NIFA). We would also like to acknowledge John Bruce, Catherine Davidson, Rory Malone, Shannon Meyler, Lindsey Ruhl, 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.

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