NORTHWEST CROPS & SOILS PROGRAM

2017 Organic Heirloom Spring Wheat Variety Trial

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2017 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 2017, an heirloom spring wheat variety trial was established at Borderview Research Farm in Alburgh, Vermont. The experimental design was a randomized block design with three 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 (Table 1). 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 25-Apr at a seeding rate of 350 live seeds per square meter. The eighteen 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, 2017.

Location	Alburgh, VT Borderview Research Farm
Soil type	Benson rocky silt loam
Previous crop	corn
Seeding rate (seeds m^{2-1})	350
Replicates	3
Planting date	25-Apr
Harvest date	10-Aug
Harvest area (ft)	5 x 20
Tillage operations	Fall plow, spring disk & spike tooth harrow

Table 2. Varietal information of the heirloom spring wheat, 2017.

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	Canada	-	1860
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

Heights and lodging were measured on 3-Aug. Plots were harvested with an Almaco SPC50 small plot combine on 10-Aug. The harvest area was 5' x 20'. Grain moisture, test weight, and yield were determined at harvest. Per acre yields were calculated and normalized to 13.5% so varieties could be compared. 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 12-15% 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 the 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). April weather in Alburgh was warm and wet, promoting good germination and establishment of the trial. The rest of the growing season was colder and wetter than normal. From April to August there was an accumulation of 4440 Growing Degree Days (GDDs) in Alburgh, VT, 51 GDDs lower than the 30 year average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2017.

Alburgh, VT	Apr	May	Jun	Jul	Aug
Average Temperature (F)	47.2	55.7	65.4	68.7	67.7
Departure from Normal	2.37	-0.75	-0.39	-1.90	-1.07
Precipitation (inches)	5.20	4.10	5.60	4.90	5.50
Departure from Normal	2.40	0.68	1.95	0.73	1.63
Growing Degree Days (base 32)	459	733	1002	1138	1108
Departure from Normal	75	-23	-12	-60	-31

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 3-Aug. Three plants in each plot were measured. The average height was 49.4 inches (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 3-Aug. 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 5 scale with 0 indicating the entire plot could be harvested with the plot combine and 5 signifying that none of the plot could be harvested. Some lodging was observed in almost all plots in the 2017 trial.

Table 4. Growth and harvest characteristics of heirloom spring wheat for Alburgh, VT, 2016.

Variety	Height	Lodging	Yield at 13.5% moisture	Moisture @ harvest	Test weight	Crude protein @ 12% moisture content	DON	Falling number
	in	%	lbs ac^{-1}	%	lbs bu^{-1}	%	ppm	seconds
AC Barrie	53.4*	2.67	1108*	14.7*	53.6*	16.1*	5.43	331*
Ceres 05	47.8	2.00*	899	14.5*	52.7	15.9*	5.53	349*
Champlain	49.1	3.33	833	14.2*	52.5	15.3*	4.33*	322
Defiance	52.1*	3.00	1089*	14.5*	52.5	15.6*	5.63	326*
Hope	48.5	2.67	1072*	14.4*	52.9	15.4*	6.40	348*
Komar	48.2	2.00*	1115*	14.7*	54.2*	14.1	4.23*	337*
Ladoga	48.5	3.67	1191*	14.2*	52.6	14.0	**3.30***	347*
Marquis	52.7*	3.67	1076*	14.4*	52.4	**16.5***	4.33*	319
Mida 05	42.0	2.00*	878	14.7*	**55.1***	14.6	5.20	338*
Mida 06	50.0*	3.00	1095*	14.6*	53.2	16.0*	4.33*	**359***
Red Bobs	48.2	2.00*	**1331***	14.7*	52.4	15.2	6.37	355*
Red Fife	48.6	3.67	931	15.1	52.4	15.6*	4.43*	311
Reliance	51.0*	**1.00***	1176*	14.6*	53.1	14.1	4.60*	320
Scarlett	47.8	4.00	1136*	**14.1***	52.8	15.6*	4.37*	341*
Spinkcota	**53.9***	3.67	890	14.7*	54.1*	15.9*	5.33	316
Supreme	48.9	3.33	1113*	15.0	52.7	14.8	4.67*	334*
Surprise	48.4	2.67	1325*	14.6*	53.9*	14.6	4.37*	352*
Thatcher	49.5	2.67	838	14.9	53.2	16.1*	4.60*	306
LSD	4.09	1.21	274	0.78	1.58	1.22	1.63	33.7
Trial mean	49.4	2.83	1061	14.6	53.1	15.3	4.86	334

*Treatments that did not perform significantly lower than the top-performing treatment, shown in **bold**, in a particular column are indicated with an asterisk.
NS – shows no significate difference.

Spinkcota was the tallest variety at 53.9 inches. This was statistically similar to AC Barrie, Defiance, Marquis, Mida 06, and Reliance, all with heights of 50 inches or taller. All varieties displayed some

degree of lodging. Despite being one of the tallest varieties, Reliance had the lowest degree of lodging, with an average score of 1 (less than 20% of the plot was lodged). This was statistically similar to Ceres 05, Komar, Mida 05, and Red Bobs, which all had an average score of 2 or less (less than 40% of each plot was lodged on average).

The average yield at 13.5% moisture for the trial was 1061 lbs per acre. The highest yielding variety was Red Bobs, with a yield of 1331 lbs per acre. Ten other varieties (AC Barrie, Defiance, Hope, Komar, Ladoga, Marquis, Reliance, Scarlett, Supreme and Surprise) were statistically similar with yields over 1000 lbs per acre.

All varieties were above 14% harvest moisture and required drying down for storage. The average harvest moisture was 14.6%. The lowest harvest moisture was Scarlett at 14.1%. This was statistically similar to 15 other varieties with harvest moisture under 14.9%. Test weight is the measure of grain density. It is determined by weighing a known volume of grain. Generally the heavier the wheat is per bushel, the higher baking quality. The acceptable test weight for bread wheat is 56-60 lbs per bushel. None of the varieties in the 2017 trial had test weight within this optimal range. The highest test weight was 55.1 lbs per bushel for Mida 05.

Protein levels ranged from 14.0% to 16.5%. All varieties had crude protein levels above the 12% crude protein level considered optimal for commercial flour production. Marquis had the highest crude protein concentrations but was not significantly different than AC Barrie, Ceres 05, Champlain, Defiance, Hope, Mida 06, Red Fife, Scarlett, Spinkcota, and Thatcher. All of the varieties had falling numbers over 300 seconds, indicating indicates low enzymatic activity and sound quality wheat. The average falling number was 334. In this year's trial, all the varieties grown had DON levels above the 1.0 ppm threshold acceptable for human consumption. The lowest variety level was Ladoga at 3.30 ppm. The highest was Red Bobs at 6.37 ppm.

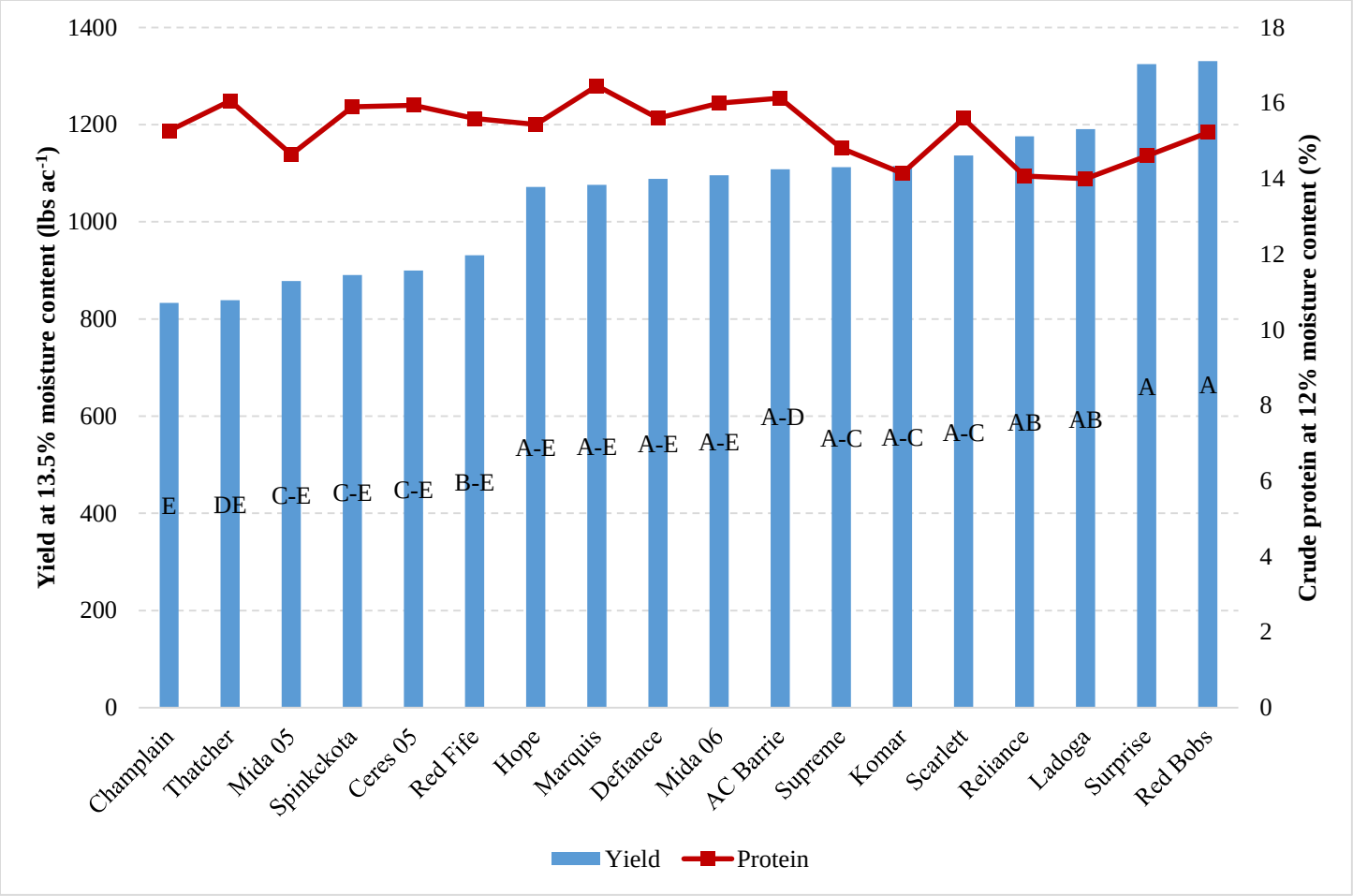

Figure 1. Yield and protein of heirloom spring wheat varieties grown in Alburgh, VT, 2017. Treatments that share a letter did not differ significantly by variety in yield (p=0.10.)

There is often an inverse relationship seen between yield and protein, and this was somewhat true of the winter wheat varieties assessed in 2017, with most of the higher yielding varieties among the lower crude protein levels (Figure 1). While crude protein was high across the trial, the yields were the lowest of the five years of heirloom spring wheat variety trials.

DISCUSSION

Cooler temperatures and higher precipitation encountered during 2017 contributed to lower yields than in previous years of heirloom spring wheat trials. Quality was generally high across the trial, with the exception of test weights slightly below the optimal range. The DON toxin levels were high across all grains trials at Borderview Research Farm in 2017, including the heirloom spring wheat variety trial. This is typical of seasons with wet weather during grain flowering, leading to widespread infection with the fusarium fungus which produces the toxin.

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