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NORTHWEST CROPS & SOILS PROGRAM

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THE UNIVERSITY OF VERMONT
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2019 ORGANIC WINTER WHEAT VARIETY TRIAL
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In 2019, the University of Vermont Extension's Northwest Crops and Soils Program evaluated 30 winter wheat varieties to determine those that perform best in organic production systems in northern Vermont. The trial was established at the Borderview Research Farm in Alburgh, Vermont.

MATERIALS AND METHODS

The winter wheat variety trial was initiated at Borderview Research Farm in Alburgh in the fall of 2018. 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 and the previous crop was corn. The field was disked and spike tooth harrowed prior to planting. Plots were seeded in 5' x 20' plots with a Great Plains Cone Seeder on 22-Sep 2018 at a seeding rate of 350 live seeds m^{-2}. Thirty varieties were planted (22 modern varieties and 8 heirloom varieties, displayed in Tables 2 and 3), and all but one, Pride of Genesee, survived the winter. Field season data were collected on the 29 surviving varieties. On the 6-May 2019, winter survival was visually assessed on a scale of 0-5 where 0 was complete survival and 5 was complete death. Heights were determined on 30-Jul by taking three measurements per plot with a meter stick.

Table 1. Trial agronomic information, Alburgh, VT 2018-2019.

Trial information	Alburgh, VT Borderview Research Farm
Soil type	Covington silty clay loam, 0 to 3 percent slopes
Previous crop	Corn
Seeding rate	350 live seeds m^{-2}
Row spacing (in)	6
Replicates	4
Planting date	22-Sep 2018
Harvest date	30-Jul, 1-Aug 2019
Harvest area (ft)	5 x 20
Tillage operations	Fall plow, disk & spike tooth harrow

Table 2. Winter wheat varietal information.

Variety	Market class[†]	Seed source
112313W	HRWW	Pioneer Seeds, IA
AC Benefit	HRWW	Bramhill Seeds, Ontario CA
AC Morley	HRWW	Bramhill Seeds, Ontario CA
Brome	HRWW	Semican, Quebec CA
Byrd	HRWW	Arrow Seeds, NE
Cedar	HRWW	Arrow Seeds, NE

Emerson	HRWW	Albert Lea Seed House, MN
Expedition	HRWW	Albert Lea Seed House, MN
Grainfield	HRWW	Arrow Seeds, NE
LSC Chrome	HRWW	Limagrain Cereal Seeds, CO
LSC Mint	HRWW	Limagrain Cereal Seeds, CO
LSC Pistol	HRWW	Limagrain Cereal Seeds, CO
LSC T158	HRWW	Limagrain Cereal Seeds, CO
LSC Wizard	HRWW	Limagrain Cereal Seeds, CO
Marker	SRWW	Bramhill Seeds, Ontario CA
Overland	HRWW	Arrow Seeds, NE
Redeemer	HRWW	Semican, Quebec CA
Redfield	HRWW	Albert Lea Seed House, MN
Sy Sunrise	HRWW	Arrow Seeds, NE
Sy Wolf	HRWW	Arrow Seeds, NE
Warthog	HRWW	Semican, Quebec CA
Winterhawk	HRWW	Arrow Seeds, NE

[†]**HRWW**-Hard Red Winter Wheat, **SRWW**-Soft Red Winter Wheat.

Table 3. Heirloom winter wheat varietal information.

Variety	Market class[†]	Year	Origin
Blackhull	HRWW	1917	Kansas
Blue Jacket	HRWW	1946	Kansas
Forward	SRWW	1920	New York
Honor	SWWW	1920	New York
Pride of Genesee	SRWW	1893	New York
Red Chief	SRWW	1901	New York
Turkey Red	HRWW	1873	United States
Wasatch	HRWW	1944	Utah

[†]**HRWW**-Hard Red Winter Wheat, **SRWW**-Soft Red Winter Wheat, **SWWW**-Soft White Winter Wheat.

Plots were harvested with an Almaco SPC50 small plot combine on 30-Jul 2019 and 1-Aug 2019. The fourth replicate was harvested on 30-Jul and the other replicates were harvested 1-Aug. Many plots were not harvested due to poor winter survival and weed pressure. The harvest area was 5' x 20'. 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. 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. One sample of each surviving variety was run. Samples with DON values greater than 1 ppm are considered unsuitable for human consumption.

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. Winter survival data were analyzed using a general linear model procedure of SAS (SAS Institute, 2008). Replications were treated as random effects, and treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure where the F-test was considered significant, at $p<0.10$. Due to poor winter survival, statistical analysis could not be performed on harvest and quality parameters. Statistical analysis was only performed on the winter survival data.

RESULTS AND DISCUSSION

Seasonal precipitation and temperature were recorded with an onsite Davis Instruments Vantage Pro2 weather station equipped with a WeatherLink data logger (Table 4). Many of the varieties in the trial were developed in environments much different than the Northeast, so it is important to evaluate the varieties for tolerance to our climate. In the fall and winter of 2018, conditions were cooler than normal. A cooler than average and a wet spring led to only 1,976 Growing Degree Days (GDDs) accumulated April-Jun, which was 208 GDDs below average. Precipitation in April and May was 2.28 inches above average. GDDs ceased to lag behind the 30-year normal in July, which saw higher than average temperatures, less precipitation, and 1285 accumulated GDDs, 91 above the 30-year normal. Overall, precipitation across the entire growing season was 0.15" above average. Conditions provided a total of 3729 GDDs across the entire season from September through July, which was 334 below the normal.

Table 4. Seasonal weather data collected in Alburgh, VT, 2018-2019.

	2018				2019						
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Average temperature (°F)	63.4	45.8	32.2	25.4	15.0	18.9	28.3	42.7	53.3	64.3	73.5
Departure from normal	2.76	-2.36	-5.99	-0.55	-3.77	-2.58	-2.79	-2.11	-3.11	-1.46	2.87
Precipitation (inches)	3.48	3.53	4.50	2.96	1.53	1.70	1.36	3.65	4.90	3.06	2.34
Departure from normal	-0.16	-0.07	1.38	0.59	-0.52	-0.06	-0.85	0.83	1.45	-0.63	-1.81
Growing Degree Days (32°-95°F)	941	435	136	72	23	38	108	346	660	970	1285
Departure from normal	86	-78	-115	-8	-26	-18	-58	-68	-99	-41	91

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.

Overall winter survival was poor (Table 5). Multiple plots were completely dead, reducing the number of replicates for many varieties. The variety Pride of Genesee did not survive the winter.

Table 5. Winter survival by variety, Alburgh, VT, 2019.

Variety	Survival* (0-5)
112313W	2.50
AC Benefit	2.00
AC Morley	3.50
Black Hul	3.00
Blue Jacket	3.75
Brome	2.75
Byrd	2.00
Cedar	1.50
Emmerson	4.00
Expedition	3.00
Forward	3.25
Grainfield	3.00
Honor	2.75
LCS Chrome	2.50
LCS Mint	2.50
LCS Pistol	3.50
LCS T158	1.50
LCS Wizard	2.75
Marker	3.50
Overland	2.25
Pride of Genesee	4.75
Red Chief	4.50
Redeemer	2.50
Redfield	1.50
Sy Sunrise	**1.00**
Sy Wolf	4.00
Turkey Red	3.00
Warthog	2.50
Wasatch	3.75
Winterhawk	1.75
LSD (p=0.10)	NS
Trial Mean	2.83

*Visually assessed on a scale of 0-5 where 0 was complete survival and 5 was complete death.
Top performer is in **bold.** NS- Not significant.

Due to poor winter survival, not every replicate was harvested, and as a result statistical analysis could not be performed on harvest and quality parameters. Yields were likely depressed due to poor fall growth followed by severe winter conditions and a cool and wet spring. Winter wheat varieties had an average yield of 2815 lbs ac^{-1} (Table 6, Figure 1) at 13.5% moisture, which was lower than previous years. The top yielding variety was Turkey Red, at 6624 lbs ac^{-1}. Other varieties that yielded above 3000 lbs ac^{-1} included Brome, Overland, AC Benefit, LCS Mint, Expedition, Byrd, Winterhawk, and LCS Chrome. Honor had the highest average plant height at 116 cm.

Table 6. Yield and quality of winter wheat varieties, Alburgh, VT, 2019.

Variety	Yield @ 13.5% moisture	Average plant height	Moisture	Test weight	Crude protein @ 12% moisture	Falling number
	lbs ac^{-1}	cm	%	lbs bu^{-1}	%	seconds
112313W	2202	64.9	18.0	54.9	8.65	342
AC Benefit	3946	97.7	16.3	**60.6**	9.65	317
AC Morley	2500	86.2	19.2	55.9	11.0	332
Blackhull	2247	98.3	22.7	50.9	11.2	365
Blue Jacket	2713	106	18.8	41.0	**12.3**	303
Brome	4038	98.3	20.3	49.6	9.69	332
Byrd	3756	71.7	15.9	58.2	9.35	350
Cedar	2397	58.4	16.3	58.9	9.09	383
Emerson	2535	82.4	20.3	27.6	10.8	309
Expedition	3814	79.8	16.2	57.9	7.51	312
Forward	2249	109	15.4	59.1	8.43	325
Grainfield	2260	69.1	15.1	59.9	8.95	338
Honor	2009	**116**	18.6	52.6	8.32	329
LSC Chrome	3098	72.2	17.5	58.5	10.0	383
LSC Mint	3885	72.4	16.0	59.7	8.49	355
LSC Pistol	1520	65.5	**14.4**	59.2	7.45	337
LSC T158	2386	62.6	16.0	59.8	9.61	377
LSC Wizard	2364	63.7	17.6	56.5	10.7	361
Marker	1622	74.0	22.5	49.9	9.92	339
Overland	4013	82.7	16.5	59.6	10.1	377
Red Chief	802	86.0	24.6	46.6	11.5	316
Redeemer	2845	79.2	17.5	56.7	11.2	200
Redfield	2799	67.8	16.6	58.8	10.8	361
Sy Sunrise	2863	66.0	15.9	59.0	9.36	381
Sy Wolf	1754	72.9	21.9	52.9	11.2	332
Turkey Red	**6624[†]**	101	19.9	54.6	11.0	351
Warthog	2619	81.1	16.7	58.0	10.3	362
Wasatch	2633	115	17.7	57.0	11.7	364
Winterhawk	3153	77.5	17.1	48.6	8.88	**400**
Trial Mean	2815	81.9	18.0	54.6	9.9	343

[†]Top performers are in **bold.**

Harvest moisture below 14% is desirable for grain storage. Wheat above this moisture content has to be dried down postharvest at additional time and cost to farmers. All varieties had moistures above 14% and required drying before storage. LSC Pistol had the lowest harvest moisture at 14.4%. Test weight is the measure of grain density, which is determined by weighing a known volume of grain. Generally, the heavier the wheat is per bushel, the higher the baking quality. AC Benefit had the highest test weight; 60.6 lbs bu^{-1}. In 2019, not all of the varieties reached the industry standard for test weight of 56-60 lbs bu^{-1}. AC Morely, 112313W, Turkey Red, Sy Wolf, Honor, Blackhull, Marker, Brome, Winterhawk, Red

Chief, Blue Jacket, and Emerson all had test weights below 56 lbs bu^{-1}. Emerson, at 27.6 lbs bu^{-1}, was the only variety to have a test weight below 40 lbs bu^{-1}.
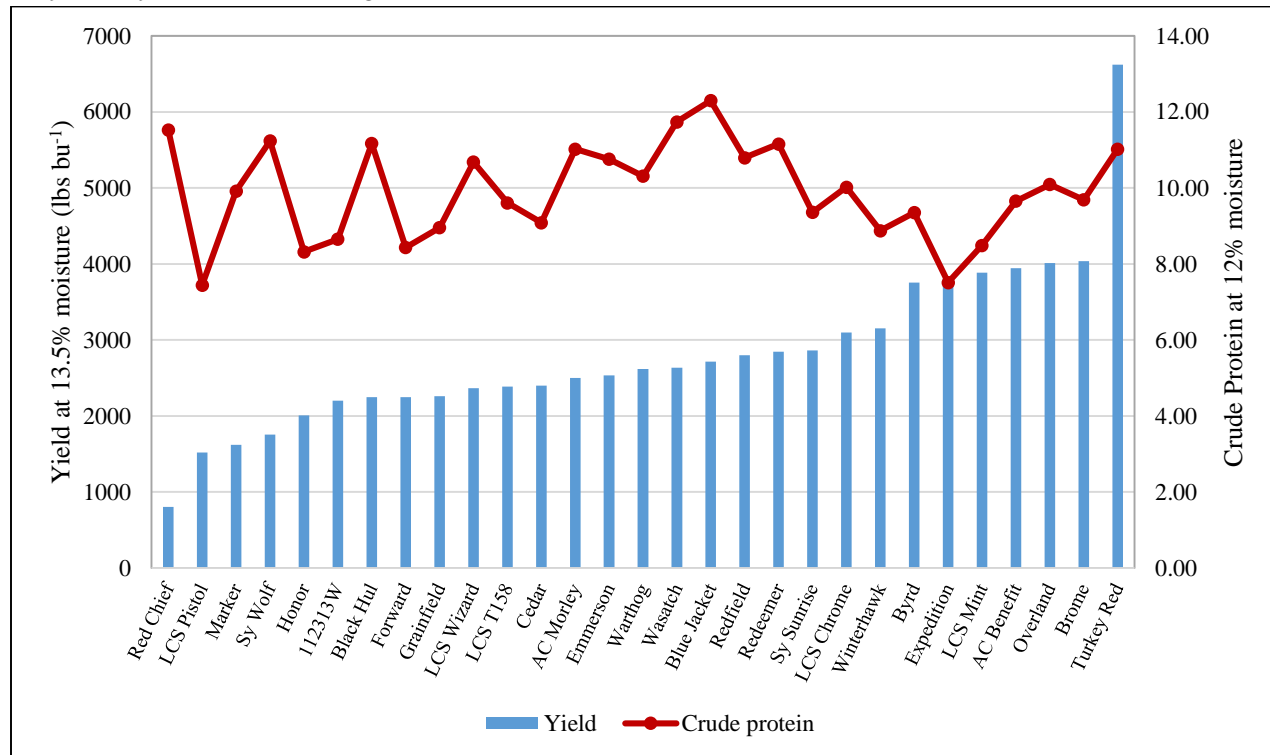

Figure 1. Yield and crude protein of winter wheat varieties, Alburgh, VT, 2019.

Average CP concentration for the trial was 9.9%. None of the varieties had crude protein levels above the industry minimum of 14% (Figure 1). Falling numbers for all varieties, except Redeemer, were above 300 seconds, and all varieties met or surpassed the standard of 200 seconds which indicates sound wheat quality (Table 6). Winterhawk had the highest falling number; 400 seconds. 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).

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