NORTHWEST CROPS & SOILS PROGRAM

2018 Organic Spring Wheat Variety Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2018 ORGANIC SPRING WHEAT VARIETY TRIAL

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In 2018, the University of Vermont Extension Northwest Crops and Soils Program evaluated twenty-five hard red spring wheat varieties to determine which would thrive in organic production systems in the Northeast. The trial was established at the Borderview Research Farm in Alburgh, Vermont. Varieties that did not perform well in previous years were eliminated from the 2018 trial and new varieties were added.

MATERIALS AND METHODS

The experimental plot design was a randomized complete block with four replications. Treatments were 25 spring wheat varieties. Spring wheat varieties evaluated and their sources are listed in Table 1.

Table 1. Twenty-five spring wheat varieties trialed in Alburgh, VT, 2018.

Spring wheat varieties	Type	Seed source
AC Scotia	HR	Semican Atlantic Inc., Canada
AC Walton	HR	2012 saved trial seed, VT
Bolles	HR	Albert Lea Seed, MN
Forefront	HR	South Dakota State University, SD
Glenn	HR	Albert Lea Seed, MN
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 Iguacu	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., Canada
Moka	HR	Semican Atlantic Inc., Canada
Prevail	HR	South Dakota State University, SD
Prosper	HR	Albert Lea Seed, MN
RB07	HR	Minnesota Foundation Seed
Rocket	HR	Semican Atlantic Inc., Canada
Major	HR	SynAgri, Canada
CMW12638	HR	C&M Seeds
Pokona	HR	Seedway
Shelly	HR	Dahlman Seed Co.

HR, hard red wheat.

The seedbed in Alburgh was prepared by conventional tillage methods. All plots were managed with practices similar to those used by producers in the surrounding areas (Table 2). The previous crop planted at the site was corn. In April 2018, the field was fertilized with Pro Booster (10-0-0) and Pro Gro (5-3-4) at a rate of 100 lbs of plant available nitrogen (PAN) per acre. The area was then disked and spike tooth harrowed to prepare for planting. The plots were seeded with a Great Plains NT60 Cone Seeder on 8-May at a seeding rate of 350 live seeds m^2. Plot size was 5' x 20'.

Table 2. General plot management of the spring wheat trial, 2018.

Location	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Corn
Row spacing (in)	6
Seeding rate (live seeds m^2)	350 live seeds m^2
Replicates	4
Planting date	8-May
Harvest date	8-Aug
Harvest area (ft)	5 x 20
Tillage operations	Fall plow, spring disk & spike tooth harrow
Fertility (lbs PAN ac^{-1})	15-15-15 and 5-7-18 = 300lbs of N ac-1

Grain plots were harvested with an Almaco SPC50 plot combine on 8-Aug. The harvest area was 5' x 20' (Image 1). Prior to harvest, plant heights were measured excluding the awns. In addition, grain moisture, test weight, and yield were calculated.

Following harvest, seed was cleaned with a small Clipper cleaner (A.T. Ferrell, Bluffton, IN). 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. Generally, the heavier the bushel of wheat, the higher the baking quality. The acceptable test weight for bread wheat is 56-60 lbs per bushel. 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 and falling number. Mycotoxin levels where tested on one replication to make sure Deoxynivalenol (DON) was below industry standards. Grains were analyzed for protein content using the Perten Inframatic 8600 Flour Analyzer. Grain protein affects gluten strength and loaf volume. The target value for most commercial mills is 12-15% protein. Protein was calculated on a 12% moisture. 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 is related to the level of sprout damage that has occurred in the grain. It is measured by the time it takes, in seconds, for a stirrer to fall through a slurry of flour and water to the bottom of the tube. Falling numbers greater than 350 indicate low enzymatic activity and a sound quality wheat. A falling number lower than 200 indicates high enzymatic activity and poor quality wheat. Deoxynivalenol (DON) analysis was analyzed using Veratox DON 2/3 Quantitative test from the NEOGEN Corp. This test has a detection range of 0.5 to 5 ppm.

Image 1. Spring wheat variety trial harvest, Alburgh, VT.

Samples with DON values greater than 1 ppm are considered unsuitable for human consumption. DON analysis was on one replication to see the general level present.

All data was analyzed using a mixed model analysis where replicates were considered random effects. DON levels were only evaluated on one replication and therefore, were not analyzed for statistical significance. The Least Significant Difference (LSD) procedure was used to separate cultivar 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). LSD 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 temperature recorded at Borderview Research Farm in Alburgh, VT are displayed in Table 3. The growing season this year was marked by higher than average temperatures in May, July, and August and lower than average temperatures in June. Throughout the growing season, there was lower than average rainfall, totaling 5 inches less than normal. There were 4395 growing degree days (GDDs) from May-August in 2018, which is 287 more than the average year.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2018.

Alburgh, VT	May	June	July	August
Average temperature (°F)	59.5	64.4	74.1	72.8
Departure from normal	3.10	-1.38	3.51	3.96
Precipitation (inches)	1.9	3.7	2.4	3.0
Departure from normal	-1.51	0.05	-1.72	-0.95
Growing Degree Days (base 32°F)	853	973	1305	1264
Departure from normal	97	-42	107	125

Weather data was collected from Wunderground.com via the Alburgh weather station.
When daily weather data was unavailable from this weather station, the station at Highgate Center Dam was used.
Historical averages are for 30 years of NOAA data (1981-2010) for Enosburg Falls, VT.

Spring Wheat Growth and Development:

During the 2018 growing season, several observations and measurements were recorded on spring wheat development. There were significant differences in plant height among the spring wheat varieties (Table 4).

Table 4. Plant height of 25 spring wheat varieties trialed, Alburgh, VT, 2018.

Variety	Average heights
	cm
AC Scotia	87.8*
AC Walton	87.8*
Bolles	73.8
CMW12638	71.5
Forefront	72.5
Glenn	69.7
LCS Albany	73.3
LCS Anchor	56.5
LCS Breakaway	63.5
LCS Iquacu	58.8
LCS Nitro	61.3
LCS Prime	66.8
LCS Pro	70.6
LCS Rebel	66.3
LCS Trigger	68.3
LNR13-0627	54.4
Magog	82.8*
Major	82.4
Moka	85.8*
Pokona	**89.5***

Prevail	73.8
Prosper	71.6
RB07	69.1
Rocket	84.0*
Shelley	63.2
LSD (0.10)	6.73
Trial Mean	72.2

*Varieties with an asterisk are not significantly different than the top performer in **bold**.

The tallest variety was Pokona (89.5cm). Variety AC Scotia (87.8cm), AC Walton (87.8cm), Magog (82.8cm), Moka (85.8cm), and Rocket (84.0cm) were all varieties statistically similar to Pokona. The mean plant height was 72.2 cm. Many organic farmers prefer to grow varieties that are tall as they may have better weed suppressive capabilities.

Spring Wheat Yields and Quality:

Varieties differed significantly in yield, harvest moisture, test weight, protein, and falling number (Table 5). The highest yielding variety was AC Scotia (2076 lbs ac^{-1}), which was statistically similar to nine other varieties. The lowest yielding variety was LCS Anchor (1247 lbs ac^{-1}). The variety with the lowest moisture at the time of harvest was Prevail (16.4%), which was significantly similar to five other varieties. No varieties reached optimal grain storage moisture of 14% and therefore had to be dried to reach optimum moisture for storage.

Table 5. Yield and quality results of the 25 spring wheat varieties, Alburgh, VT, 2018.

Variety	Yield @13.5% moisture	Harvest moisture	Test weight	Crude protein @ 12% moisture	Falling number
	lbs ac^{-1}	%	lbs bu^{-1}	%	seconds
AC Scotia	**2076***	18.5	53.5	13.4	339
AC Walton	1692	18.1	55.7	15.1	382*
Bolles	1750*	17.2*	57.0	17.5*	363
CMW12638	1961*	18.7	58.1*	12.8	340
Forefront	1337	17.2	56.6	**17.6***	216
Glenn	1290	17.5	58.7*	17.5*	285
LCS Albany	1996*	18.5	55.7	14.6	178
LCS Anchor	1247	16.6*	57.3	17.0*	236
LCS Breakaway	1611	16.5*	**59.8***	16.7	304
LCS Iquacu	1282	19.6	55.9	14.2	246
LCS Nitro	1527	18.7	54.8	14.9	248
LCS Prime	1621	17.9	58.8*	14.5	315
LCS Pro	1748*	18.1	58.7*	15.9	316
LCS Rebel	1346	18.0	57.5	16.8*	304
LCS Trigger	1991*	19.9	56.6	12.5	341
LNR13-0627	1695	18.5	56.7	13.4	252

Magog	1699	17.5	57.0	15.9	**395***
Major	1777*	21.6	53.6	13.7	316
Moka	1875*	17.6	56.3	14.3	288
Pokona	1856*	18.0	59.0*	14.0	363
Prevail	1571	**16.4***	58.2*	15.9	325
Prosper	1945*	17.7	57.3	15.6	302
RB07	1366	17.1*	57.0	17.6*	291
Rocket	1589	18.5	55.1	13.8	302
Shelly	1325	16.6*	59.2*	14.8	330
LSD (0.10)	352	0.83	1.74	0.87	29.9
Trial Mean	1647	18.0	56.9	15.2	303

*Varieties with an asterisk are not significantly different from the top performer in **bold**.

The common measures used by commercial mills to evaluate wheat quality are grain protein, falling number, test weight, and mycotoxin (DON) content. Varieties differed significantly in terms of crude protein and falling number (Figure 1). Forefront was the variety with the highest percentage of crude protein (17.6%). Other varieties that were significantly similar for protein included RB07 (17.6%), Bolles (17.5%), Glenn (17.5%) LCS Anchor (17.0%), and LCS Rebel (16.8%). The varieties with the lowest crude protein percentages were LCS Trigger (12.5%) and CMW12638 (12.8%). All varieties met or exceeded the industry standard of 12-14% protein. The variety with the highest falling number was Magog (395 seconds) and the only significantly similar variety was AC Walton (382 seconds). The variety with the lowest falling number was LCS Albany (178 seconds). There are four other varieties under the optimal range for falling number: LCS Nitro (248 seconds), LCS Iquacu (246 seconds), LCS Anchor (236 seconds), and Forefront (216 seconds). The variety with the highest test weight was LCS Breakaway (58.9 lbs bu^{-1}). Eighteen of twenty-five varieties met the optimal 56 to 60 lbs bu^{-1} for wheat.

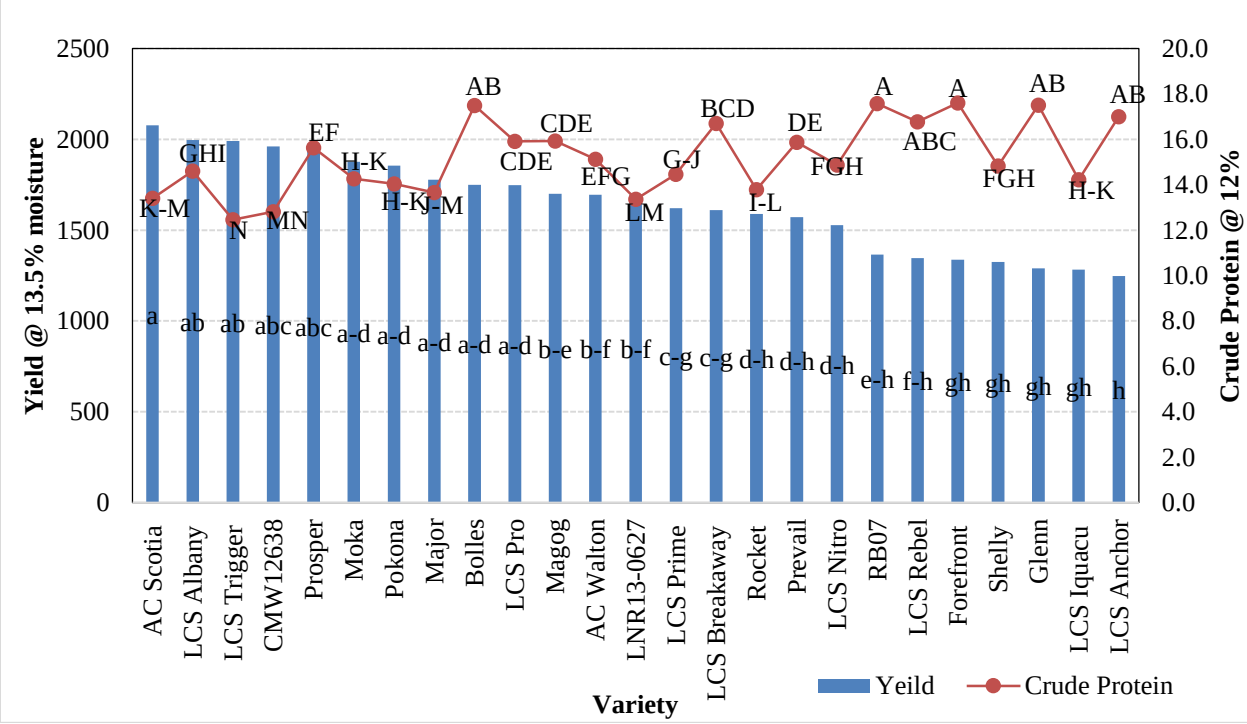

Figure 1. Yield and protein concentrations of twenty-five spring wheat varieties, Alburgh, VT, 2018. Varieties with the same letter did not differ significantly.

In the Northeast, *Fusarium* head blight (FHB) is caused by the species *Fusarium graminearum*. This disease is very destructive and causes yield loss, low test weights, low seed germination, and contamination of grain with mycotoxins. A vomitoxin called Deoxynivalenol (DON) is considered the primary mycotoxin associated with FHB. The spores are usually transported by air currents and can infect plants at flowering through grain fill. Eating contaminated grain greater than 1ppm poses a health risk to both humans and livestock. Only one replication of the 2018 trial was tested for DON to see if high levels were present. All spring wheat varieties in 2018 were below the FDA's 1ppm DON limit.

DISCUSSION

It is important to remember that the results only represent one year of data. The 2018 growing season had low rainfall and high temperature, which likely resulted in low levels of FHB and DON levels. All DON levels tested were below the FDA standard of 1ppm DON. Although the weather was not conducive for disease, it was also not ideal for the growth of cereal grains that prefer cooler weather. Interestingly, the yields in 2017 where much higher likely due to the cool and wet conditions (Figure 2).

As you make variety choices on your farm, it is important that you evaluate data from test sites that are as similar to your region as possible.

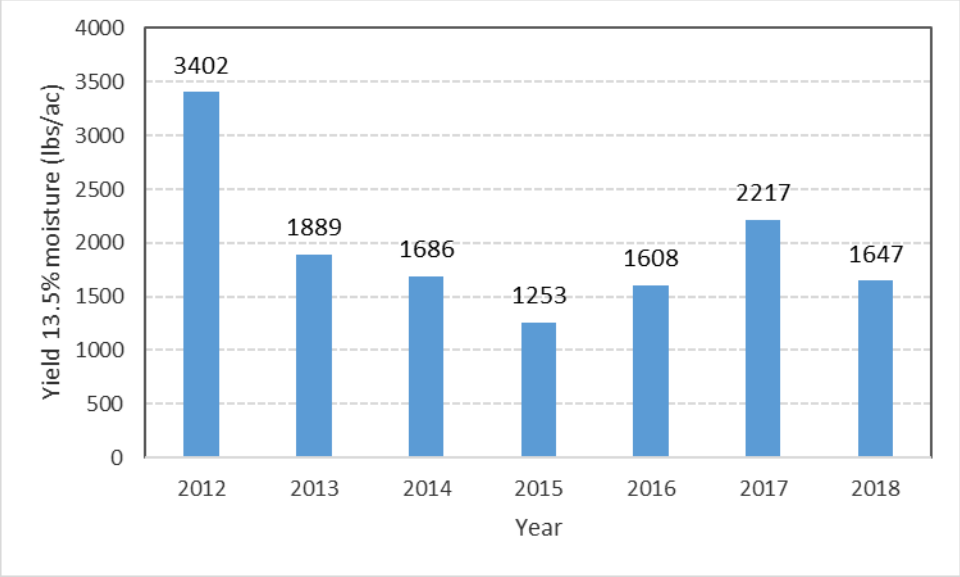

Figure 2. Mean yields from spring wheat variety trials from 2012 to 2018, Alburgh, VT.

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. We would also like to acknowledge Erica Cummings, Catherine Davidson, Abha Gupta, Rory Malone, Freddy Morin, Lindsey Ruhl, and Sara Zeigler 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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