2017

Organic Spring Wheat Variety Trial

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NORTHWEST CROPS & SOILS PROGRAM

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2017 ORGANIC SPRING WHEAT VARIETY TRIAL

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In 2017, the University of Vermont Extension Northwest Crops and Soils Program evaluated twenty-two 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 2017 trial and new varieties were added.

MATERIALS AND METHODS

The experimental plot design was a randomized complete block with four replications. Treatments were 22 spring wheat varieties. Spring wheat varieties evaluated and their sources are listed in Table 1.

Table 1. Twenty-two spring wheat varieties trialed in Alburgh, VT, 2017.

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
Shelly	HR	Dahlman Seed Co.

Abbreviations: AAFC, Agriculture and Agri-Food Canada; HR, hard red wheat; MAES, Minnesota Agricultural Experiment Station; NDAES, North Dakota Agricultural Experiment Station; PEI, Prince Edward Island; and SDAES, South Dakota Agricultural Experiment Station.

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 2017, 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 25-Apr 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, 2017.

Location:	Borderview Research Farm Alburgh VT
Soil type	Bendon rocky silt loam
Previous crop	Corn
Row spacing (in)	6
Seeding rate (live seeds m^2)	350
Replicates	4
Planting date	25-Apr
Harvest date	10-Aug
Harvest area (ft)	5 x 20
Tillage operations	Fall plow, spring disk & spike tooth harrow
Fertility (lbs PAN ac^{-1})	100 - Pro Booster (10-0-0) and Pro Gro (5-3-4)

On 3-Jul, plots were scouted for disease and insect pests. Five plants per plot were randomly selected throughout each plot. The top three leaves on the five plants were scouted and every disease symptom and sign of insect damage was recorded. The Clive James, 'An Illustrated Series of Assessment Keys for Plant Diseases, Their Preparation and Usage' was used to determine the severity of plant disease infection. Each plot was then given an overall health rating between 1 and 9 (1 being minimal damage, 9 being severe damage). Loose smut (*Ustilago tritici*) and Fusarium head blight (*Fusarium graminearum*) was scouted for in each plot and presence/absence was recorded. Plants with unknown discoloration or damage were pulled, placed in a labeled plastic bag, refrigerated, and identified at the UVM Plant Diagnostic Laboratory.

Grain plots were harvested with an Almaco SPC50 plot combine on 10-Aug. The harvest area was 5' x 20' (Image 1). Prior to harvest, plant heights were measured excluding the awns. A visual estimate of the percentage of lodged plants and the severity of lodging was recorded based on a visual rating with a scale of 0 to 5, where 0 indicates no lodging and 5 indicates severe lodging and a complete crop loss. 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, falling number, and mycotoxin levels. 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 is12-15% protein. Protein was calculated on a 12%

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

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. Samples with DON values greater than 1 ppm are considered unsuitable for human consumption.

All data was analyzed using a mixed model analysis where replicates were considered random effects. 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 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 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 April and lower than average temperatures in May, June, July and August. Throughout the growing season, there was higher than average rainfall, totaling 7.39 inches higher than normal. There were 4440 growing degree days (GDDs) from April-August in 2017, which is 51 GDDs less than the average year.

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

Alburgh, VT	April	May	June	July	August
Average temperature (°F)	47.2	55.7	65.4	68.7	67.7
Departure from normal	2.27	-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°F)	459	733	1002	1138	1108
Departure from normal	75.0	-23.0	-12.0	-60.0	-31.0

Weather data was collected from Wunderground.com via the West Berkshire 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 2017 growing season, several observations and measurements were recorded on spring wheat development. There were significant differences in plant height and plant pests and disease among the spring wheat varieties, and there was no significant difference in plant lodging (Table 4). Plots were scouted for disease and insect pests on 3-Jul. Foliar diseases reduce photosynthetic leaf area, use nutrients, and increase respiration and transpiration within colonized host tissues. The diseased plant typically exhibits reduced vigor, growth, and seed fill. The earlier occurrence, greater degree of host susceptibility, and longer duration of conditions favorable for disease development will increase the yield loss. The primary plant diseases identified were; Powdery Mildew (*Erysiphe graminis f. sp. tritici*), Tan spot (*Pyrenophora tritici-repentis*), and Spetoria leaf blotch (*Stagonospora nodorum*). The lowest amount of overall plant disease and insect damage was Rocket (1.50%). Other varieties with low disease and pest damage were; Moka (2.50%), LCS Rebel (3.00%), LCS Trigger (3.00%), AC Walton (3.25%), LCS Iguacu (3.75%), Prosper (3.75%), Forefront (3.75%), and AC Scotia (4.00%). The highest amount of overall plant disease and insect damage was Shelley (7.75%). Loose smut (*Ustilago tritici*) infected spikes were seen in four varieties; Glenn, RB07, LCS Albany, and Bolles. Loose smut caused by the fungus, Ustilago tritici, is carried as dormant mycelium within healthy-looking seed and is spread by planting infected seed. A smut-infected seed or plant cannot be distinguished from an uninfected one until the head starts to emerge. The disease is most obvious just after the time of heading by the characteristic dusty black appearance of diseased heads. The spores are dispersed by the wind during wheat flowering and can infect healthy plants. The predominant insect damage observed was caused by brown wheat mite (*Petrobia latens*) and thrips (species unknown). Additional insect pests identified include, Cereal leaf beetle (*Oulema melanopus (L.)*) Leaf miner (species unknown), and slugs.

Table 4. Plant height, lodging and disease of 22 spring wheat varieties trialed, Alburgh, VT, 2017

Variety	Average heights	Average lodging	Plant pests and disease
	cm	rating (1 to 5)	%
AC Scotia	111*	0.50	4.00*
AC Walton	104	0.25	3.25*
Bolles	85.4	0.50	5.00
Forefront	95.7	0.25	3.75*
Glenn	98.9	**0.00**	7.25
LCS Albany	83.0	0.25	5.50
LCS Anchor	80.1	0.75	6.75
LCS Breakaway	80.8	0.25	4.75
LCS Iguacu	85.8	**0.00**	3.75*
LCS Nitro	81.0	0.50	5.00
LCS Prime	89.1	0.25	7.00
LCS Pro	96.8	0.50	6.50
LCS Rebel	86.3	**0.00**	3.00*
LCS Trigger	88.3	1.00	3.00*
LNR13-0627	76.2	0.50	7.50
Magog	106	**0.00**	5.00
Moka	108	0.50	2.50*
Prevail	86.9	0.25	6.00
Prosper	84.4	**0.00**	3.75*
RB07	82.3	0.75	4.75
Rocket	**113***	0.50	**1.50***
Shelly	77.5	0.25	7.75
LSD (0.10)	4.61	NS	3.22
Trial Mean	90.9	0.35	4.88

*Varieties with an asterisk are not significantly different than the top performer in **bold**.
NS, No significant difference.

The tallest variety was Rocket (113cm). Variety AC Scotia (111 cm) was the only variety statistically similar to Rocket. The mean plant height was 90.9 cm. Many organic farmers prefer to grow varieties that are tall as they may have better weed suppressive capabilities. There was minimal lodging between varieties. Prosper, Magog, LCS Rebel, LCS Iguacu, and Glenn had no recorded lodging.

Spring Wheat Yields and Quality:

Varieties differed significantly in yield, harvest moisture, protein, falling number, and DON concentration (Table 5). The highest yielding variety was Shelly (2687 lbs ac^{-1}), which was statistically similar to seventeen other varieties (Figure 1). The lowest yielding variety was LCS Albany (902 lbs ac^{-1}). The variety with the lowest moisture at the time of harvest was LCS Anchor (13.8%), which was significantly lower than all other varieties. No other varieties reached optimal grain storage moisture of 14% and therefore had to be dried down.

Table 5: Yield and Quality results of the twenty-two spring wheat varieties, Alburgh, VT 2017.

Variety	Yield @13.5% moisture	Harvest moisture	Test weight	Crude protein @ 12% moisture	Falling number @ 14% moisture	DON
	lbs ac^{-1}	%	lbs bu^{-1}	%	seconds	ppm
AC Scotia	2509*	15.8	55.2	14.1*	380	**1.85***
AC Walton	2459*	15.9	55.6	13.8*	377	2.55*
Bolles	1719	15.9	55.5	**14.8***	377	3.50
Forefront	2610*	15.1	57.2	12.6	362	3.88
Glenn	2092*	16.8	57.0	14.4*	304	6.88
LCS Albany	902	16.1	54.4	13.2	369	4.08
LCS Anchor	1744	**13.8***	54.6	13.6*	304	3.95
LCS Breakaway	2113*	14.8	57.6	12.3	357	7.18
LCS Iguacu	2585*	17.0	56.4	11.9	399*	2.20*
LCS Nitro	2169*	15.7	55.3	13.0	363	3.78
LCS Prime	2032*	16.3	55.4	12.7	371	4.43
LCS Pro	1936	16.6	54.9	13.9	328	7.03
LCS Rebel	2397*	17	56.5	13.0	325	6.73
LCS Trigger	2598*	17.0	56.8	11.0	419*	**1.85***
LNR13-0627	1985*	15.4	54.4	11.6	349	2.95*
Magog	2498*	15.3	57.0	12.2	**427***	3.50
Moka	2447*	16.9	54.9	12.8	356	2.98*
Prevail	2349*	14.8	56.2	12.7	375	5.68
Prosper	2510*	15.6	56.4	12.5	361	5.00
RB07	1807	14.8	55.3	13.2	326	4.98
Rocket	2622*	16.6	55.1	13.1	332	2.44*
Shelly	**2687***	15.4	**57.9**	12.3	386	3.00*
LSD (0.10)	740	1.00	NS	1.41	29.6	1.18
Trial Mean	2217	15.8	55.9	12.9	361	4.11

*Varieties with an asterisk are not significantly different than the top performer in **bold**.
NS, No significant difference.

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, falling number, and DON (Table 5, Figure 2). Bolles was the variety with the highest percentage of crude protein (14.8%). Other varieties that were significantly similar for protein included: AC Scotia

(14.1%), AC Walton (13.8%), Glenn (14.4%), and LCS Anchor (13.6%). The varieties with the lowest crude protein percentages were LCS Trigger (11.0%) and LNR-0627 (11.6%). These two varieties had protein levels below industry standards of 12-14%, all others met or exceeded this standard. The variety with the highest falling number was Magog (427 seconds), the varieties with lowest falling number were Glenn and LCS Anchor (304 seconds). However, all varieties trialed met or exceeded 250-300 second optimal range for falling number. There was no significant difference in test weight among varieties. The highest test weight was Shelly with 57.9 lbs bu^{-1} and the lowest recorded test weights were LCS Albany and LNR13-0627 (54.4 lbs bu^{-1}). Eleven of twenty-two varieties did attain the optimal 56 to 60 lbs bu^{-1} for wheat.

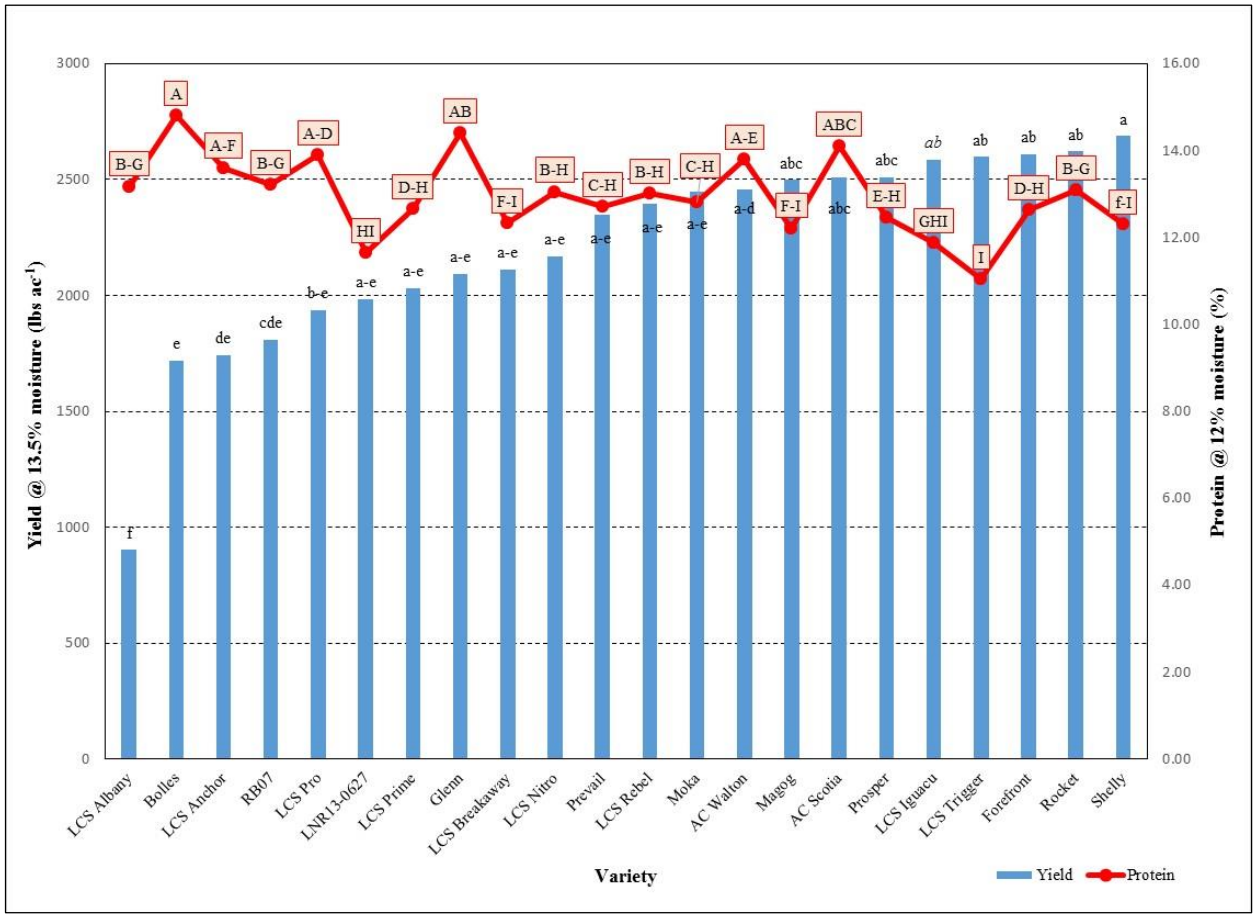

Figure 1. Yield and protein concentrations of twenty-two spring wheat varieties, Alburgh, VT, 2017.
Varieties with the same letter did not differ significantly.

In the Northeast, *Fusarium* head blight (FHB) is predominantly 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. None spring wheat varieties trialed in 2017 were below the FDA's 1ppm DON limit (Figure 2). The varieties with the lowest DON concentration were LCS Trigger and AC Scotia at 1.85 ppm. Other varieties with low DON concentrations included; LCS Iguacu

(2.20 ppm), Rocket (2.44 ppm), AC Walton (2.55 ppm), LNR13-0627 (2.95 ppm), Moka (2.98 ppm), and Shelly (3.00 ppm). The variety with the highest DON concentration was LCS Breakaway at 7.18 ppm.

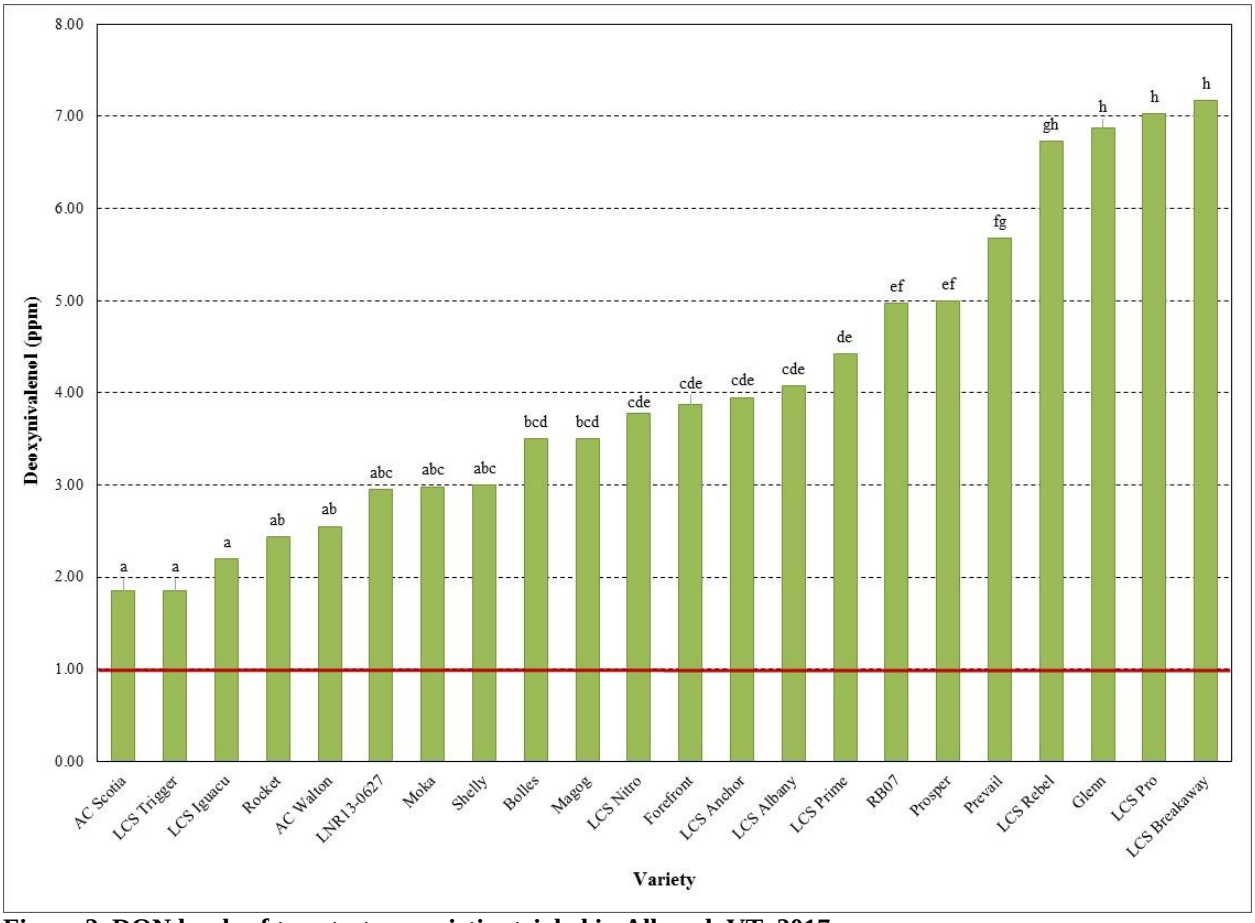

Figure 2. DON levels of twenty-two varieties trialed in Alburgh VT, 2017.
Red line shows FDA limit for DON (1ppm).

DISCUSSION

It is important to remember that the results only represent one year of data. The 2017 growing season was a challenging one due to the cool and wet weather, creating the ideal growing conditions for fungal growth. This is evident in the high DON concentrations. In the 2017 trial, DON levels were much higher than the 2016 trial. The mean DON level was 0.12 ppm in 2016 compared to the 2017 mean DON concentration of 4.11 ppm. Interestingly, yields were much higher than in previous years (Figure 3). This could be attributed to fertilization combined with high moisture making more available nitrogen for plant growth, which could have resulted in more plant tillers and higher yields.

Even in a challenging year like this one, it does provide the opportunity to observe the FHB susceptibility of the different varieties. Varieties such as LCS Trigger and AC Scotia that can maintain lower levels of FHB infection during such a year certainly indicate their strength for being grown in the northeast.

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.

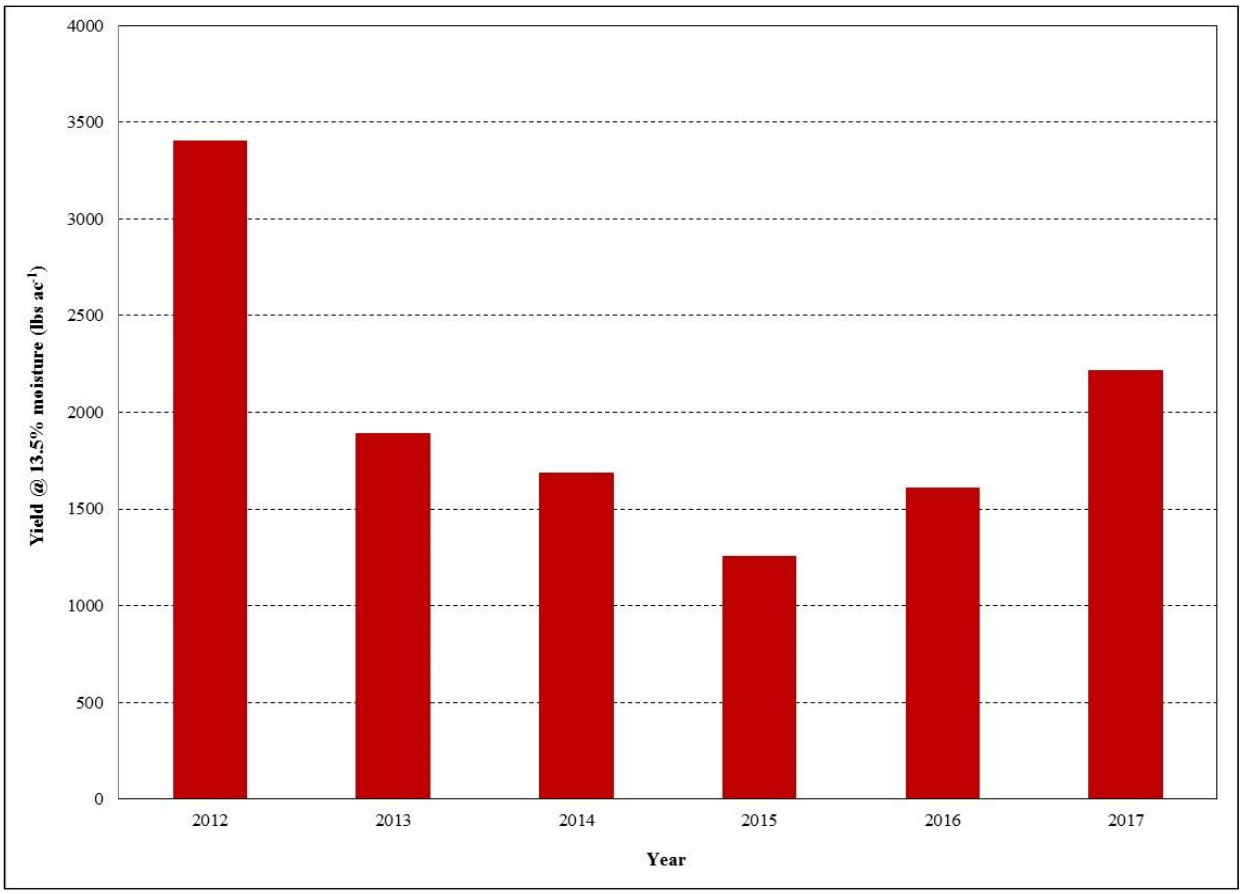

Figure 3. Mean yields from spring wheat variety trials from 2012 to 2017, Alburgh, VT.

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