2014

Organic Spring Wheat Variety Trial

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NORTHWEST CROPS & SOILS PROGRAM

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2014 ORGANIC SPRING WHEAT VARIETY TRIAL

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In 2014, the University of Vermont Extension Northwest Crops and Soils Program evaluated nineteen hard red spring wheat to determine which varieties thrive in organic systems. The trial was established at the Borderview Research Farm in Alburgh, Vermont. Several varieties that did not perform well in previous trial years were eliminated from the 2014 variety trial. Newly released varieties were also sought for evaluation.

MATERIALS AND METHODS

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

Table 1. Nineteen spring wheat varieties trialed in Alburgh, VT.

Spring Wheat Varieties	Type†	Origin and Release Year‡	Seed Source
AC Walton	HR	AAFC, PEI, 1995	2012 Saved trial seed, VT
Advance	HR	SDAES, 2011	South Dakota State University, SD
Barlow	HR	NDAES, 2009	North Dakota Foundation Seed
Elign	HR	NDAES, 2012	North Dakota Foundation Seed
Faller	HR	NDAES, 2007	Albert Lea Seed House, MN
Forefront	HR	SDAES, 2012	South Dakota State University, SD
Glenn	HR	NDAES, 2005	Albert Lea Seed, MN
Kaffé	SW	Semican, Canada	2013 Saved trial seed, VT
Magog	HR	Semican Inc.	Semican Atlantic Inc., Canada
Megantic	HR	SynAgri, 2008	2013 Saved trial seed, VT
Moka	HR	Semican, Canada	Semican Atlantic Inc., Canada
Prevail	HR	SDAES, 2014	South Dakota State University, SD
Prosper	HR	NDAES & MAES, 2012	Albert Lea Seed, MN
RB07	HR	MAES, 2007	Minnesota Foundation Seed
Sy Rowyn	HR	Sygenta Seeds Inc., 2013	2013 Saved trial seed, VT
Sy Soren	HR	Agripro Syngenta, 2011	Albert Lea Seed House, MN
Tom	HR	MAES, 2008	2012 Saved trial seed, VT
Velva	HR	NDAES, 2011	North Dakota Foundation Seed
Yorkton	HR	Western Canada, 2013	Semican, Canada

† HR = hard red, SW = soft white‡ Year of release was not always available. Abbreviations: ACRS = Agriculture Canada Research Station, AAFC = Agriculture and Agri-Food Canada, MAES = Minnesota Agricultural Experiment Station, NDAES = North Dakota Agricultural Experiment Station, NPSAS = Northern Plains Sustainable Agriculture Society, PEI = Prince Edward Island, SDAES = South Dakota Agricultural Experiment Station, NDSU = North Dakota State University, SWP = Saskatchewan Wheat Pool, ARD = Agricultural Research and Development.

The seedbed at the Alburgh location 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 sod. In April 2014, the field was 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 125 lbs ac^{-1} (Image 1). Plot size was 5'x 20'.

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

Trial Information	Spring wheat variety trial
Location	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Sod
Row spacing (in)	6
Seeding rate (lbs ac^{-1})	125
Replicates	4
Planting date	25-Apr
Harvest date	8-Aug
Harvest area (ft)	5 x 20
Tillage operations	Fall plow, spring disk & spike tooth harrow

On 2-Jun, wheat populations were determined by taking three, 1 foot counts per plot.

Flowering dates of the wheat were recorded, when at least 50% of the spikes were in bloom. Throughout the growing season other pertinent observations such as disease and wheat development were recorded. Disease incidence was noted but severity not recorded.

Image 1. Seeding spring wheat variety trial, Alburgh, VT, 2014.

Grain plots were harvested in Alburgh with an Almaco SPC50 plot combine on 8-Aug, the harvest area was 5' x 20' (Image 2). 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 0 – 5 scale, 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 wheat is per bushel, the higher 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. Most commercial mills target 12-15% protein. Protein was calculated on a 12% moisture and 14% moisture basis. 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 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 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 was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate cultivar means when the F-test was significant ($P< 0.10$). There were significant differences among the two locations for most parameters and therefore data from each location is reported independently.

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 below, 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 weather stations in close proximity to the 2014 site are shown in Table 3. The growing season this year was marked by lower than normal temperatures in April, July, and August and higher than normal rainfall throughout the growing season (Apr-Aug). From April to August, there was an accumulation of 4510 Growing Degree Days (GDDs) in Alburgh which is 53 GDDs below the 30 year average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2014.

Alburgh, VT	April	May	June	July	August
Average temperature (°F)	43.0	57.4	66.9	69.7	67.6
Departure from normal	-1.80	1.00	1.10	-0.90	-1.20
Precipitation (inches)	4.34	4.90	6.09	5.15	3.98
Departure from normal	1.52	1.45	2.40	1.00	0.07
Growing Degree Days (base 32°F)	330	789	1041	1171	1108
Departure from normal	-53.9	32.8	27.3	-26.9	-30.9

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
October data represents weather recorded through the last corn harvest, 14-Oct 2014.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Spring Wheat Growth and Development:

During the 2014 growing season, several observations and measurements were recorded on spring wheat development. The majority of the varieties were in full bloom by 2-Jul. In general, there was minimal bird damage and lodging. Overall there was moderate to high weed pressure.

Several foliar diseases were observed during wheat development including; Powdery Mildew (*Erysiphe graminis f. sp. Tritici*), Ascochyta Leaf Spot (*Didymella exitialis*), and Leaf Rust (*Puccinia recondite*) (data not shown). 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.

Loose smut caused by the fungus, *Ustilago tritici*, was observed at both locations. In Alburgh, five varieties, Yorkton, Barlow, Velva, Sy Soren, and Sy Rowyn, had infected plants (data not shown). The loose smut fungus 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.

In thirteen of the 19 varieties trialed, bleached grain heads were observed which is associated with the presence of *Fusarium* head blight (data not shown). 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.

Plant populations were significantly different between varieties (Table 4). The variety with the highest plant population per square meter was RB07, 468 m^2, and Sy Rowyn had the lowest plant population at 264 m^2. Plant heights were significantly different among varieties. The mean plant height was 32.8 inches. The soft white variety Kaffé was the tallest variety measuring 41.1 inches. Other tall varieties included; Megantic (39.8 in.), AC Walton (38.5 in.), and Magog (37.9 in.). Many organic farmers prefer to grow varieties that are tall as they generally have better weed suppressive capabilities.

Image 2. Spring wheat variety trial harvest, Alburgh, VT.

Table 4. Plant populations and heights of the 19 spring wheat varieties trialed, Alburgh, VT, 2014

Variety	Plant population	Plant height
	m^2	inches
AC Walton	343	38.5*
Advance	378	25.7
Barlow	407*	32.3
Elign	429*	31.3
Faller	366	32.5
Forefront	423*	33.7
Glenn	380	33.6
Kaffe	321	**41.1***
Magog	430*	37.9*
Megantic	294	39.8*
Moka	346	37.2
Prevail	344	31.8
Prosper	421*	29.6
RB07	**468***	32.1
Sy Rowyn	264	27.2
Sy Soren	418*	25.5
Tom	386*	31.7
Velva	296	28.7
Yorkton	341	32.9
LSD (0.10)	84	3.59
Trial Mean	371	32.8

<u>Spring Wheat Yields and Quality</u>:

Varieties differed significantly in yield and quality (Table 5 and 6). The 2014 yields were lower than those in 2013 and 2012. The mean yield 1686 lbs ac^{-1}, 203 lbs ac^{-1} less than the average yield in 2013 and 1703 lbs ac^{-1} less than 2012 (Figure 1).

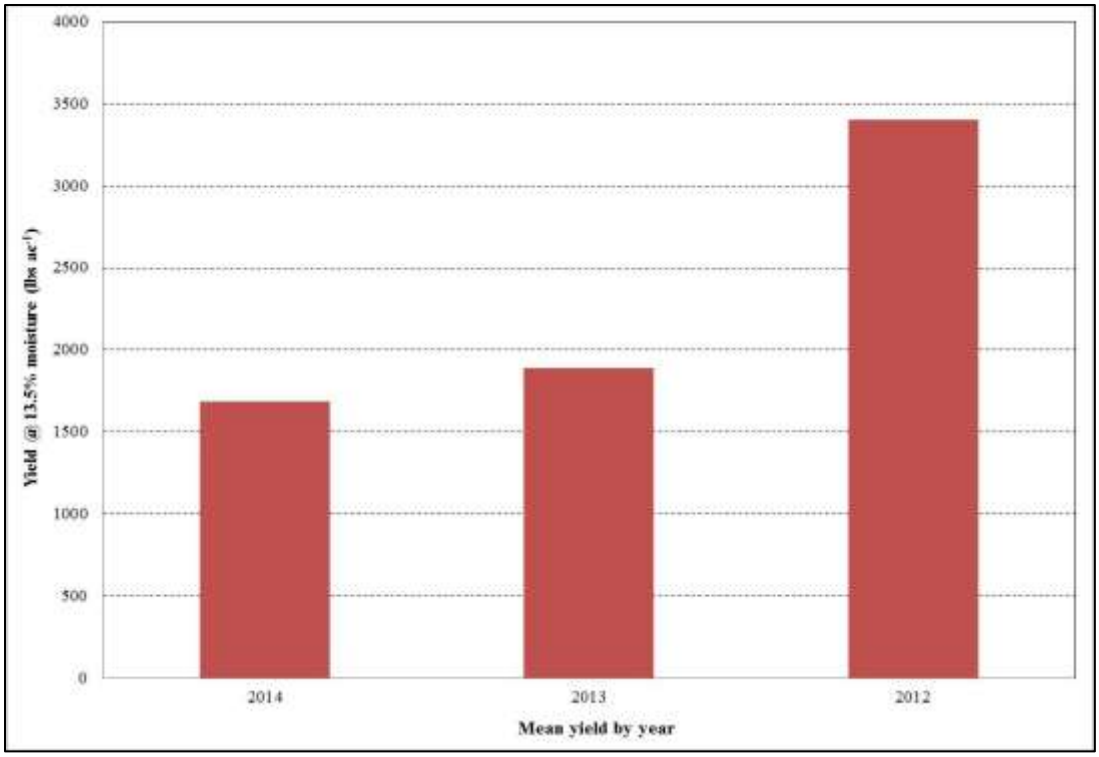

Figure 1. Spring wheat variety trials mean yield comparison for 2012-2014, Alburgh, VT.

The highest yielding variety was Faller (2512 lbs ac^{-1}) (Table 5 and Figure 2). Other top yielding varieties include AC Walton, Kaffé, Forefront and RB07. The lowest yielding variety was Advance (986 lbs ac^{-1}). The variety with the lowest moisture at the time of harvest was Megantic (17.7%). All of the varieties had to be dried down to below 14% moisture, necessary for optimal grain storability. Forefront had the highest test weight of 56.0 lbs bu^{-1}. Eighteen of the 19 spring wheat varieties trialed did not reach the optimal 56 to 60 lb bu^{-1} test weight for wheat.

Table 5. Harvest data of the 19 spring wheat varieties, Alburgh, VT, 2014.

Variety	Yield @13.5% moisture	Harvest moisture	Test weight
	lbs ac^{-1}	%	lbs bu^{-1}
AC Walton	2302*	20.6	52.3
Advance	986	19.7	53.8
Barlow	1791	19.3	54.8*
Elign	1543	19.5	54.6
Faller	**2512***	19.6	54.0
Forefront	2116*	17.7*	**56.0***
Glenn	1118	19.0	54.4
Kaffe	2127*	20.0	53.8
Magog	1791	19.6	54.0
Megantic	1351	**17.7***	55.5*

Table 6. Quality results of the 19 spring wheat trialed in Alburgh, VT, 2014.

Variety	Crude protein @ 12% moisture	Crude protein @ 14% moisture	Falling number @ 14% moisture	DON
	%	%	seconds	ppm
AC Walton	13.1	12.8	295	0.60*
Advance	13.7	13.4	292	2.57
Barlow	14.9	14.6	246	3.20
Elign	14.7	14.3	290	1.00*
Faller	12.7	12.4	354	0.80*
Forefront	14.9	14.6	312	0.47*
Glenn	**16.4***	**16.0***	238	1.87
Kaffe	12.6	12.3	299	1.37*
Magog	13.8	13.5	**409***	0.60*
Megantic	13.8	13.4	378*	0.97*

Moka	1791	20.3	55.0*		Moka	13.9	13.6	392*	0.67*
Prevail	1894	18.1*	54.1		Prevail	14.3	14.0	360	2.23
Prosper	1878	20.0	53.8		Prosper	13.0	12.7	378*	1.00*
RB07	2047*	19.4	53.5		RB07	14.9	14.6	332	1.30*
Sy Rowyn	1243	18.3*	55.1*		Sy Rowyn	14.2	13.9	398*	0.63*
Sy Soren	1368	19.0	54.4		Sy Soren	15.3	15.0	341	1.07*
Tom	1613	19.5	54.4		Tom	14.3	13.9	395*	1.37*
Velva	1264	19.6	51.3		Velva	14.3	14.0	262	5.27
Yorkton	1298	19.0	54.4		Yorkton	15.5	15.2	376*	**0.30***
LSD (0.10)	528	0.68	1.32		*LSD (0.10)*	0.72	0.70	41.9	1.30
Trial Mean	1686	19.2	54.2		*Trial Mean*	14.2	13.9	334	1.44

Values shown in bold are of the highest value or top performing.
* Wheat varieties that are not significantly different than the top performing variety in a column are indicated with an asterisk.

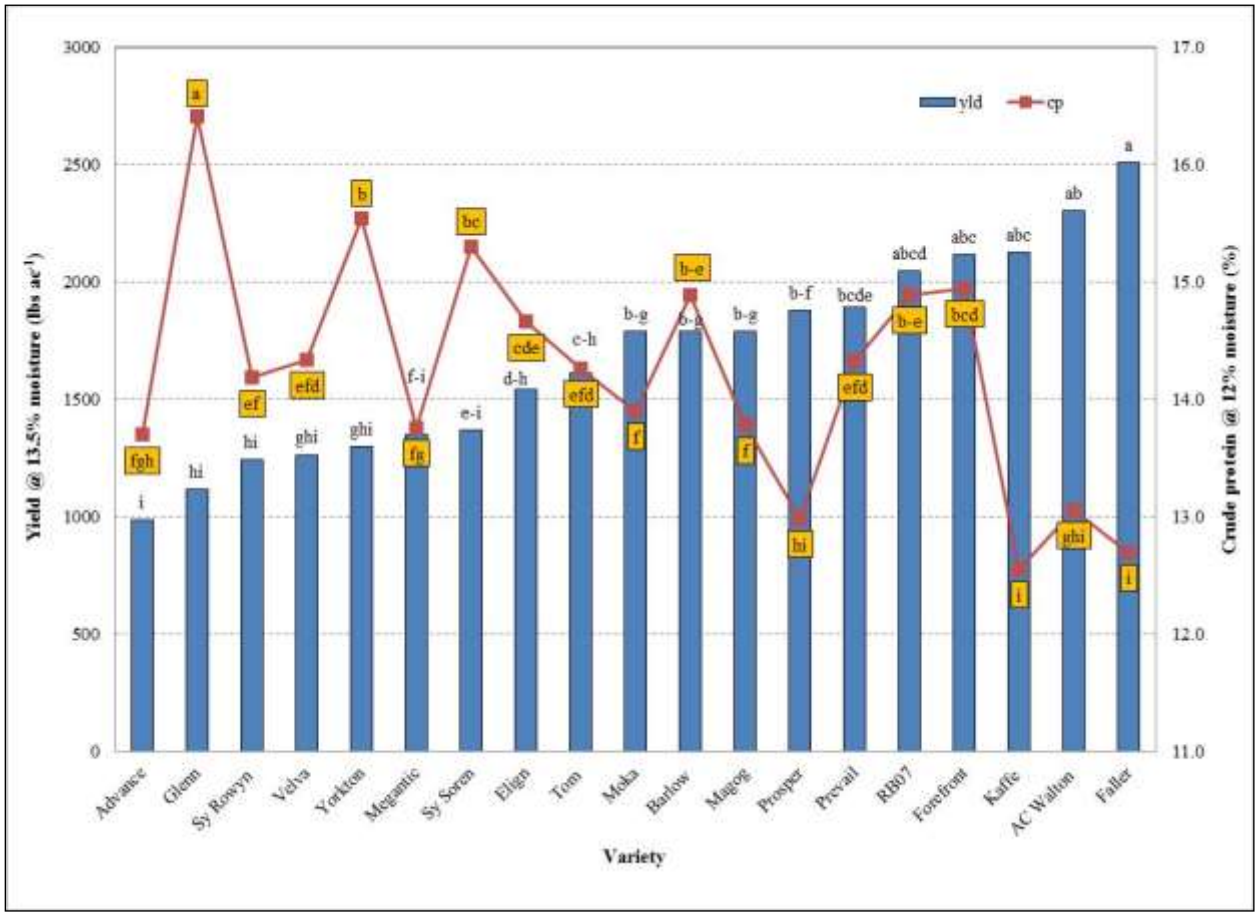

Figure 2. Yield and protein concentrations of 19 spring wheat varieties, Alburgh, VT.
Varieties with the same letter did not differ significantly.

The common measures used by commercial mills to evaluate wheat quality are: grain protein, falling number, test weight, and mycotoxin (DON) content. The variety with the highest protein content was Glenn (16.4% at 12% moisture) (Table 6 and Figure 1). All varieties had protein levels that met or

exceeded industry standards of 12-14%. Seventeen of the 19 varieties trialed had falling numbers that were above 250 seconds. The highest falling number was Magog (409 seconds). Other varieties with high falling numbers include; Sy Rowyn, Tom, Moka, Meganitc, Propser, and Yorkton. All varieties, except for Glenn and Barlow, had acceptable protein and falling number levels based on mill standards. The concentration of DON in spring wheat varieties varied greatly in 2014 (Table 6; Figure 2). Nine of the 19 spring wheat varieties trialed were above the FDA's 1ppm limit. The lowest DON level in Alburgh was Yorkton (0.30 ppm). Additional varieties below 1ppm include: Forefront, Magog, AC Walton, Sy Rowyn, Moka, Faller, Megantic, Elign, and Prosper.

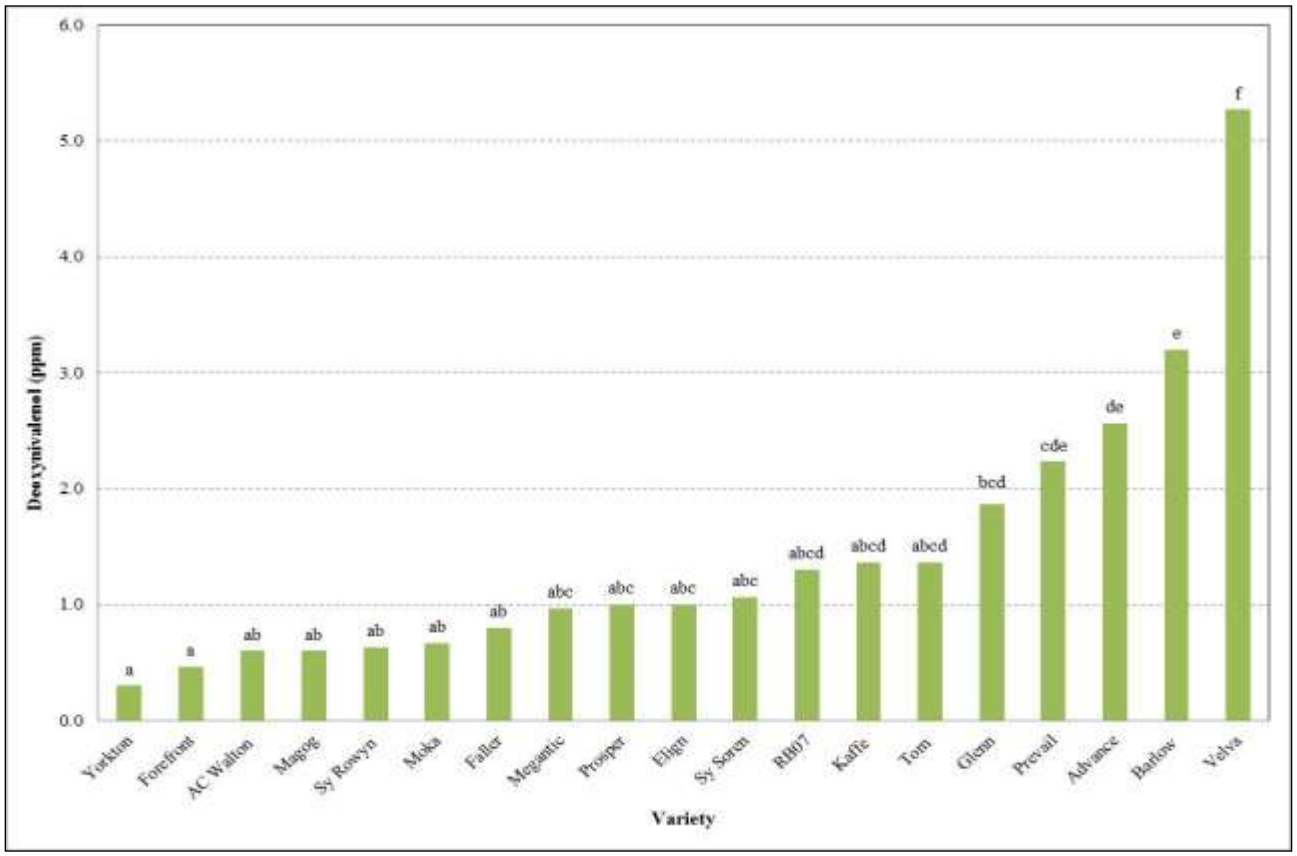

Figure 2. Deoxynivalenol (DON) concentrations of 19 spring wheat varieties, Alburgh, VT.
Varieties with the same letter did not differ significantly.

DISCUSSION

It is important to remember that the results only represent one year of data. 2014 was another challenging growing season. The prolonged cool and wet spring delayed wheat planting and impacted stand establishment and plant tillering. This could help explain the increase in weed pressure which could have contributed to the reduction in grain yields this season. The below average temperatures, and above average rainfall, persisted throughout the growing season which resulted in delayed wheat development and dry down. Although weather conditions have varied across years, some varieties such as AC Walton, Faller, and Forefront consistently outperform other varieties in yield. Interestingly, DON levels were not nearly as high as they were in 2013. Ten varieties were at or below the 1ppm FDA recommend limit for

DON concentration. The average DON level in 2014 was 1.44 ppm, 3.53ppm below average DON level in 2013.

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

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