NORTHWEST CROPS & SOILS PROGRAM

2016 Organic Spring Wheat Variety Trial

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2016 ORGANIC SPRING WHEAT VARIETY TRIAL

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In 2016, the University of Vermont Extension Northwest Crops and Soils Program evaluated eighteen hard red spring wheat to determine which varieties thrive in organic production 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 2016 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. Eighteen spring wheat varieties trialed in Alburgh, VT, 2016.

Spring wheat varieties	Type	Origin and release year	Seed source
AC Scotia	HR	Semican Inc.	Semican Atlantic Inc., Canada
AC Walton	HR	AAFC, PEI, 1995	2012 saved trial seed, VT
Forefront	HR	SDAES, 2012	South Dakota State University, SD
Glenn	HR	NDAES, 2005	Albert Lea Seed, MN
Kingsey	HR	Semican Inc.	Semican Atlantic Inc., Canada
LCS Anchor	HR	Limagrain Cereal Seeds	Limagrain Cereal Seeds, LLC, CO
LCS Iguacu	HR	Limagrain Cereal Seeds	Limagrain Cereal Seeds, LLC, CO
LCS Nitro	HR	Limagrain Cereal Seeds	Limagrain Cereal Seeds, LLC, CO
LCS Prime	HR	Limagrain Cereal Seeds	Limagrain Cereal Seeds, LLC, CO
LCS Pro	HR	Limagrain Cereal Seeds	Limagrain Cereal Seeds, LLC, CO
LCS Trigger	HR	Limagrain Cereal Seeds	Limagrain Cereal Seeds, LLC, CO
Magog	HR	Semican Inc.	Semican Atlantic Inc., Canada
Moka	HR	Semican Inc.	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
Rocket	HR	Semican Inc.	Semican Atlantic Inc., Canada
Sy Rowyn	HR	Syngenta Seeds Inc., 2013	2013 saved trial seed, VT

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 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 a summer annual grown for forage. In April 2016, the field was

disked and spike tooth harrowed to prepare for planting. The plots were seeded with a Great Plains NT60 Cone Seeder on 21-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, 2016.

Location	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Summer annuals
Row spacing (in)	6
Seeding rate (lbs ac^{-1})	125
Replicates	4
Planting date	21-Apr
Harvest date	9-Aug
Harvest area (ft)	5 x 20
Tillage operations	Fall plow, spring disk & spike tooth harrow

In May, wheat populations were determined by taking three one-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.

Insect and disease scouting was conducted on 7-Jul. Research technicians looked for the presence of a variety of foliar diseases, including loose smut, powdery mildew, and *Fusarium* head blight (FHB), as well as the presence of mites or thrips and evidence of insect damage. Five plants in each plot were examined for disease and insect damage.

Grain plots were harvested with an Almaco SPC50 plot combine on 9-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

Image 1. Seeding spring wheat variety trial, Alburgh, VT, 2016.

Image 2. Spring wheat variety trial harvest, Alburgh, VT, 2016.

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. 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 AND DISCUSSION

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 lower than normal temperatures in April, higher than normal temperatures in May and average temperatures in June and July. There was lower than normal rainfall throughout the growing season. From April to July, there was an accumulation of 3312 Growing Degree Days (GDDs) in Alburgh, which is 41 GDDs below the 30 year average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2016.

Alburgh, VT	April	May	June	July
Average temperature (°F)	39.8	58.1	65.8	70.7
Departure from normal	-4.90	1.80	0.00	0.10
Precipitation (inches)	2.60	1.50	2.80	1.80
Departure from normal	-0.26	-1.92	-0.88	-2.37
Growing Degree Days (base 32°F)	291	803	1017	1201
Departure from normal	-98	50	3	4

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.

Spring Wheat Growth and Development:

During the 2016 growing season, several observations and measurements were recorded on spring wheat development. All varieties were in full bloom by 24-Jun. There was minimal bird damage and no lodging was observed (data not shown).

Insect and disease scouting was conducted on 7-Jul. Research technicians looked for the presence of a variety of foliar diseases, including loose smut, powdery mildew, and *Fusarium* head blight (FHB), as well as the presence of mites or thrips and evidence of insect damage. Five plants in each plot were examined for disease and insect damage, shown in (Table 4) as the average percent of each leaf that was affected by either insect damage or foliar disease.

Thrips (various species) were observed on all varieties. Thrips are small insects with fringed wings that feed on a variety of plants by puncturing the cells and sucking up the contents. Damage caused by thrips includes discoloration and leaf scarring, reduced growth of the plant, and they can also act as a disease vector.

Mites (various species) were observed on all 18 varieties. Mites are very small arthropods that feed on the sap of leaves of wheat and other grain crops. Leaves affected by mites may appear yellowish or silvery in early stages of infestation and later take on a scorched appearance. Injury caused by mites can result in stunted plants.

Cereal leaf beetles (*Oulema melanopa)* were observed on thirteen of the eighteen varieties not including 'AC Scotia,' 'LCS Iguacu,' 'LCS Nitro,' 'RB07,' and 'Sy Rowyn.' Cereal leaf beetle is an invasive species native to Europe that was accidentally introduced to the U.S. in the 1960's. The larvae of the beetle can cause significant damage to grain crops.

The variety Forefront (1.28%) was the least damaged by insects (Table 4). Varieties AC Scotia, RB07, LCS Prime, Magog, AC Walton, and LCS Anchor had significantly more insect damage than Forefront.

Table 4. Disease and insect damage of 18 spring wheat varieties, Alburgh, VT, 2016

Variety	Foliar disease	Insect damage
	%leaf affected	%leaf damaged
AC Scotia	0.283*	3.76
AC Walton	**0.183**	2.71
Forefront	0.400*	**1.28**
Glenn	0.633	1.49*
Kingsey	0.200*	1.75*
LCS Anchor	0.567*	2.55
LCS Iguacu	0.283*	2.29*
LCS Nitro	0.217*	1.76*
LCS Prime	0.417*	3.30
LCS Pro	0.700	1.63*
LCS Trigger	0.217*	1.58*
Magog	0.450*	2.94
Moka	0.717	1.70*
Prevail	0.817	1.89*
Prosper	0.333*	2.08*
RB07	0.267*	3.71
Rocket	0.300*	2.18*
Sy Rowyn	0.917	1.59*
LSD (0.10)	0.391	1.13
Trial Mean	0.439	2.23

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.

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. In previous years, several foliar diseases were observed during wheat development, including powdery mildew (*Erysiphe graminis f. sp. Tritici*) and loose smut (caused by the fungus *Ustilago tritici*). Powdery Mildew was observed on eleven of the eighteen varieties. Tan spot is a foliar disease caused by the fungus *Pyrenophora tritici-repentis.* Tan spot can reduce both yield and test weight. The variety AC Walton had the lowest levels of foliar disease damage (Table 4). Sy Rowyn, Prevail, Moka, LCS Pro, Glenn, and LCS Anchors all had significantly more foliar disease than the leading variety.

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. In the 2016 trial, DON levels (Table 7) were significantly lower than in previous years. In the 2015 trial, the mean DON level was 2.53, and in the 2016 trial the mean DON level was 0.12.

Plant populations were not significantly different between varieties (Table 5). The average plant population was 293 plants per m^2. The tallest variety was AC Walton (31.5 inches). Varieties Rocket, AC Scotia, Moka, Forefront, and Magog were statistically similar to AC Walton. The mean plant height was 26.6 inches. Many organic farmers prefer to grow varieties that are tall as they may have better weed suppressive capabilities.

Table 5. Plant populations and heights of the 18 spring wheat varieties trialed, Alburgh, VT, 2016.

Variety	Plant population	Plant height
	m^2	inches
AC Scotia	251	29.9*
AC Walton	260	**31.5**
Forefront	**344**	28.6*
Glenn	323	26.4
Kingsey	319	27.6
LCS Anchor	291	23.7
LCS Iguacu	276	23.9
LCS Nitro	273	26.8
LCS Prime	305	25.2
LCS Pro	278	26.4
LCS Trigger	265	25.5
Magog	287	28.6*
Moka	303	28.9*
Prevail	309	24.1
Prosper	319	25.4
RB07	312	22.8
Rocket	267	30.7*
Sy Rowyn	285	23.2
LSD (0.10)	NS	3.24
Trial Mean	293	26.6

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.

NS, No significant difference was determined.

Spring Wheat Yields and Quality:

Varieties did differ significantly in yield, test weight and moisture at harvest (Table 6). The mean yield was 1608 lbs ac^{-1}. The 2016 yields were higher than in 2015, and lower than earlier years of the variety trial. (Figure 1).

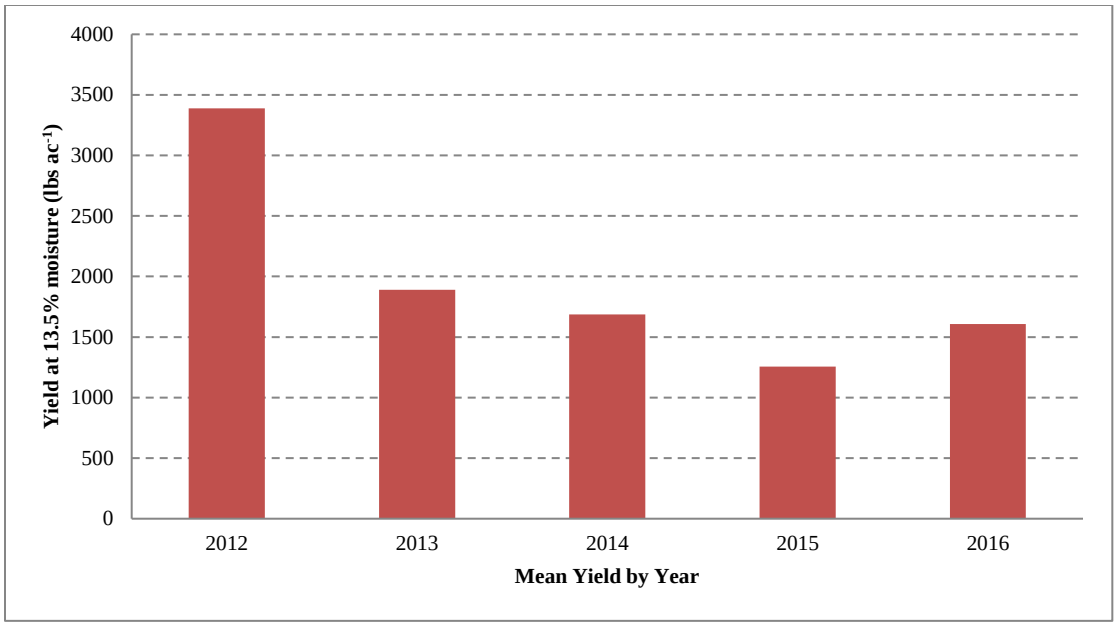

Figure 1. Spring wheat variety trials mean yield comparison for 2012-2016, Alburgh, VT.

The highest yielding variety was LCS Nitro (1975 lbs ac^{-1}), which was statistically similar to ten other varieties (Table 6; Figure 2). The lowest yielding variety was Moka (847 lbs ac^{-1}). The variety with the lowest moisture at the time of harvest was 'Prosper' (11.1%). Rocket, AC Scotia, and 'Kingsey' had not reached optimal grain storage moisture of 14% or less by harvest.

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 7; Figure 2). LCS Anchor was the variety with the highest percentage of crude protein (16.7%). Other varieties that were significantly similar for protein included, Forefront (16.6%), 'Prevail' (16.2%), 'Glenn' (16.1%), RB07 (15.9%), Sy Rowyn (15.8%), and 'LCS Pro' (15.6%). The variety with the lowest crude protein percentage was 'LCS Trigger' (12.7%). All varieties had protein levels that met or exceeded industry standards of 12-14%. The falling number differed statistically among the varieties. The variety Glenn had the highest test weight of 59.5 lbs bu^{-1}. AC Scotia was the only one of the 18 spring wheat varieties trialed that did not reach the optimal 56 to 60 lb bu^{-1} test weight for wheat, it was at 53.8 lbs bu^{-1}. All of the spring wheat varieties trialed were below the FDA's 1ppm DON limit (Table 7). The lowest DON level in Alburgh was LCS Trigger, Glenn, and Prevail (0.03 ppm).

Table 6. Harvest data of the 18 spring wheat varieties, Alburgh, VT, 2016.

Variety	Yield @13.5% moisture	Harvest moisture	Test weight
	lbs ac^{-1}	%	lbs bu^{-1}
AC Scotia	1837*	14.4	53.8
AC Walton	1947*	11.7*	56.5
Forefront	1600*	11.5*	57.2
Glenn	1574*	12.1*	**59.5**
Kingsey	1810*	15.3	58.4*
LCS Anchor	1248	11.2*	57.5
LCS Iguacu	1630*	12.5	57.5
LCS Nitro	**1975**	12.5*	57.3
LCS Prime	1415	13.1	58.6*
LCS Pro	1566*	12.4*	58.0*
LCS Trigger	1843*	12.2*	58.1*
Magog	1542	11.8*	57.0
Moka	847	13.0	58.5*
Prevail	1531	11.4*	58.0*
Prosper	1948*	**11.1**	59.4*
RB07	1676*	11.8*	57.9*
Rocket	1423	15.5	56.4
Sy Rowyn	1529	12.6	58.0*
LSD (0.10)	415	1.43	1.75
Trial Mean	1608	12.6	57.6

Table 7. Quality results of the 18 spring wheat varieties, Alburgh, VT, 2016.

Variety	Crude protein @ 12% moisture	Falling number @ 14% moisture	DON
	%	seconds	ppm
AC Scotia	14.0	233	0.28
AC Walton	14.1	341*	0.18
Forefront	16.6*	237	0.04*
Glenn	16.1*	282	**0.03**
Kingsey	15.0	331*	0.05*
LCS Anchor	**16.7**	264	0.10*
LCS Iguacu	14.6	276	0.13*
LCS Nitro	14.8	273	0.20
LCS Prime	14.0	269	0.13*
LCS Pro	15.6*	256	0.05*
LCS Trigger	12.7	284	**0.03**
Magog	14.5	**389**	0.25
Moka	14.2	362*	0.23
Prevail	16.2*	291	**0.03**
Prosper	15.0	275	0.14
RB07	15.9*	302	0.07*
Rocket	14.1	222	0.28
Sy Rowyn	15.8*	370*	0.05*
LSD (0.10)	1.25	59.3	0.10
Trial Mean	15.0	292	0.12

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.

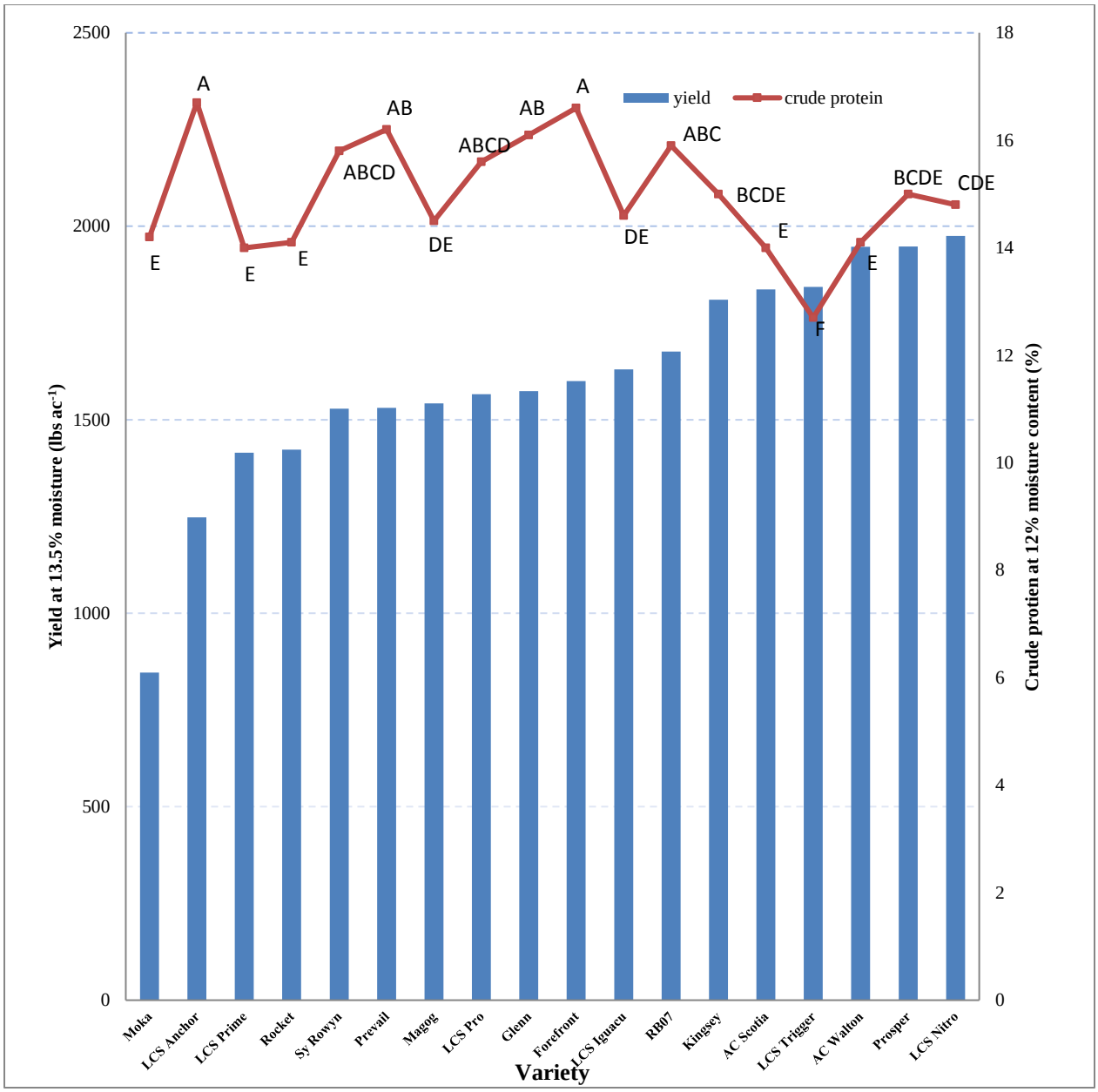

Figure 2. Yield and protein concentrations of 18 spring wheat varieties, Alburgh, VT, 2016.
Varieties with the same letter did not differ significantly.

It is important to remember that the results only represent one year of data. 2016 was a relatively dry growing season. This season had reduced yields compared to previous years and could be attributed to the dry weather conditions. Although weather conditions have varied across years, the variety AC Walton has consistently performed at the top of the trial in terms of yield. 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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