2010

Spring Wheat Variety Trial

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CULTIVATING HEALTHY COMMUNITIES

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The UNIVERSITY of VERMONT EXTENSION

2010 VERMONT SPRING WHEAT VARIETY PERFORMANCE TRIALS

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In 2010, the University of Vermont Extension in collaboration with the University of Maine began an extensive evaluation of hard red spring wheat varieties grown under organic production in order to determine which varieties thrive in our northern climate. The trials were established at Borderview Research Farm in Alburgh, Vermont and at the Cornell Willsboro Research Farm in Willsboro, New York. This trial is one of several in a USDA Organic Research Education Initiative grant focused on the production of high quality organic bread wheat in New England.

SPRING WHEAT VARIETY TRIALS

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

Table 1. Spring wheat varieties planted in Alburgh, VT and Willsboro, NY.

Species		Seed Source
Spring Wheat Varieties	**Type**	
AC Barrie	Hard Red	McCardle Bros
AC McKenzie	Hard Red	Semican
AC Roblin	Hard Red	Wood Prairie Farm
AC Superb	Hard Red	Seedway
AC Walton	Hard Red	McCardle Bros
Ada	Hard Red	University of Minnesota
Batiscan	Hard Red	Semican
Cabernet	Hard Red	Tristate Seeds
Faller	Hard Red	Albert Lea Seed
FBC Dylan	Hard Red	North Dakota State University
Glenn	Hard Red	Albert Lea Seed
Helios	Hard Red	La Coop de Federee
Howard	Hard Red	North Dakota State University
HRS10181J	Hard Red	JGL, Inc
HRS10182J	Hard Red	JGL, Inc
HRS7001J	Hard Red	Grand Falls Milling
Kaffé	Soft White	Semican
Kelse	Hard Red	Washington State University
Kinsey	Hard Red	Semican
Magog	Hard Red	Semican
Melbec	Hard Red	Tristate Seeds
Nick	Hard Red	Tristate Seeds
Oklee	Hard Red	University of Minnesota
RB07	Hard Red	University of Minnesota
Red Fife	Hard Red	Butterworks Farm
Sabin	Hard Red	University of Minnesota
SD7006J	Durum	Grand Falls Milling
Steele	Hard Red	Albert Lea Seed House
Tom	Hard Red	University of Minnesota
Ulen	Hard Red	University of Minnesota

WEATHER DATA

Seasonal precipitation and temperature recorded at weather stations in close proximity to the 2010 sites are shown in Table 2. This growing season's weather was ideal for growing wheat. Due to the warm spring the wheat got off to an early start and continued to be at least a week early in reaching major developmental stages. From planting to harvest in Alburgh there was an accumulation of 4890 Growing Degree Days (GDDs), 411 GDDs higher than the 30 year average. In Willsboro there was an accumulation of 4884 GDDs, 453 GGDs higher than the 30 year average.

Table 2. Temperature and precipitation summary for Alburgh, VT and Willsboro, NY, 2010.

Alburgh, VT	April	May	June	July	August
Average Temperature (F)	49.3	59.6	66.0	74.1	70.4
Departure from Normal	5.80	3.00	0.20	3.00	1.40
Precipitation (inches)	2.76	0.92	4.61	4.30	5.48
Departure from Normal	0.25	-2.01	1.40	0.89	1.63
Growing Degree Days (base 32)	521	854	1019	1305	1192
Departure from Normal	176	91.5	4.50	94.6	45.0

Willsboro, NY	April	May	June	July	August
Average Temperature (F)	49.8	60.2	65.5	73.8	70.0
Departure from Normal	7.80	5.80	0.20	3.70	2.50
Precipitation (inches)	2.11	1.08	4.84	2.38	4.38
Departure from Normal	0.79	-2.12	1.50	-1.00	0.28
Growing Degree Days (base 32)	532	876	1004	1294	1178
Departure from Normal	189	116	-4.5	7.70	54.3

*Based on National Weather Service data from cooperative observer stations in close proximity to field trials. Historical averages are for 30 years of data (1971-2000)

CULTURAL PRACTICES

The seedbed at both the Alburgh and Willsboro locations were prepared by conventional tillage methods. All plots were managed with practices similar to those used by producers in the surrounding areas (Table 3). The Alburgh site had been perennial forages (reed canary and alfalfa) for the previous 10 years. In the fall of 2009 the area was moldboard plowed and in the spring of 2010 disked and spike-toothed harrowed to prepare for the planting. The plots in Alburgh were seeded with a Kincaid Cone Seeder on April 21st, 2010. Grain plots were harvested with an Almaco SP50 plot combine on July 30th, 2010.

At the Willsboro location planting of the spring wheat followed a crop of food-grade soybeans. After the soybeans were harvested in the fall of 2009 the area was plowed and in the spring of 2010 it was disked and spike-toothed harrowed before planting. The plots were seeded on April 26th, 2010 with a custom made eight-row cone planter and harvested on August 2nd, 2010 with a Hege plot combine.

Following harvest, seed was cleaned with a small Clipper cleaner. 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 14-15% protein. 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 Quantitaive 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.

Table 3. General plot management of the wheat trials.

Trial Information	**Winter wheat variety trial**	
Location	Alburgh, VT Borderview Farm	Willsboro, NY Willsboro Research Farm
Soil type	Benson rocky silt loam	Kingsbury silt clay loam
Previous crop	Grass sod	Food-grade soybeans
Row spacing (in)	6	6
Seeding rate (lbs ac^{-1})	150	150
Replicates	4	4
Planting date	4/21/2010	4/26/2010
Harvest date	7/30/2010	8/2/2010
Harvest area (ft)	5x20	4x13.5
Tillage operations	Fall plow, spring disk & spike-toothed harrow	Fall plow, spring disk & spike-toothed harrow

Image 1. Planting the Alburgh spring wheat trial

Image 2. Counting wheat populations in Willsboro

LEAST SIGNIFICANT DIFFERENCE (LSD)

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. Wheat varieties that were not significantly lower in performance than the highest variety in a particular column are indicated with an asterisk. 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**

Image 3. Wheat harvest in Alburgh

Image 4. Wheat harvest in Willsboro.

RESULTS

Spring Wheat Growth and Development:

During the 2010 growing season several observations and measurements were recorded on wheat development. All varieties at the Alburgh location emerged by May 1, 2010. The relative flowering date was recorded for each of the varieties at the Alburgh site (Table 4). The majority of varieties at both locations flowered during the fourth week of June. Bird deterrents; squawk boxes, owl and coyote decoys, were place in and around the plot area which appeared to help reduce bird presence in the Alburgh plots. There did not appear to be bird issues at the Willsboro location. At both sites minimal bird damage was recorded. Lodging amongst the varieties trialed, in general was minimal. Two varieties, Kinsey and Bastican, were noted to be wispie and leaning at both locations. Ergot, *Claviceps purpurea*, was observed in two varieties, Glenn and Tom, in Willsboro.

Table 4. Relative flowering date of spring wheat, Alburgh.

Variety	Early	Mid	Late
	3rd Wk June	4th Wk June	1st Wk July
AC Barrie		X	
AC Mckenzie			X
AC Roblin		X	
AC Superb		X	
AC Walton			X
Ada		X	
Batiscan		X	
Cabernet		X	
Faller		X	
FBC Dylan	X		
Glenn		X	
Helios		X	
Howard		X	
HRS10181J		X	
HRS10182J		X	
HRS7001J			X
Kaffe		X	
Kelse		X	
Kinsey			X
Magog		X	
Melbec	X		
Nick	X		
Oklee		X	
RB07		X	
Red Fife			X
Sabin		X	
SD7006J			
Steele		X	
Tom		X	
Ulen		X	

Loose smut caused by the fungus, *Ustilago tritici*, was observed at both locations. At the Alburgh location, six varieties; Steele, Sabin, Red Fife, AC Roblin, Glenn, and FBC Dylan infected plants were observed, and in Willsboro loose smut was found in the AC Roblin and Glenn plots. 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 (Image 5). The spores are dispersed by the wind during wheat flowering and can infect healthy plants.

Image 5. A loose smut infected wheat head

After the wheat reached physiological maturity, plant heights were measured. Plant heights and weed biomass are reported in Tables 5 and 6. Plant hieghts were significantly different among varieties. At both locations Red Fife was the tallest variety and the shortest vairety was SD7006J, a durum wheat. There was considerable variation in the amount of weed biomass in plots. This was mostly likely related to varying weed seed banks across the test area. Due to this variation in weed biomass we did not observe significant differences among treatments. The weed pressure at the Alburgh location was severe and there was uneven pressure across the field. There was no correlation between weed biomass and wheat height. We had predicted that taller wheat would be better able to suppress weed growth. However, we observed that some of shorter wheat varieties had the lowest weed biomass. Early season vigor may be another factor that has influence over weed biomass in our fields. In Willsboro there was far less weed pressure and for several varieties there was no weed biomass reported.

Table 5. Plant heights & weed biomass, Alburgh, VT

Variety	Plant height	Weed biomass
	inches	lbs ac^{-1}
AC Barrie	36.2	1788
AC Mckenzie	37.0	1350
AC Roblin	32.4	2744
AC Superb	31.1	2164
AC Walton	37.1	1208
Ada	28.1	1524
Batiscan	39.4	1187
Cabernet	22.1	**3048**
Faller	32.4	1154
FBC Dylan	31.8	923
Glenn	32.4	1306
Helios	33.4	2523
Howard	27.0	1700
HRS10181J	30.8	1733
HRS10182J	28.9	2668
HRS7001J	37.0	1620
Kaffe	39.9	1570
Kelse	29.4	1378
Kinsey	41.1	1410
Magog	38.7	1353
Melbec	25.3	1844
Nick	25.7	1495
Oklee	30.6	2165
RB07	27.2	567
Red Fife	**44.7***	1140
Sabin	29.6	2883
SD7006J	21.3	2009
Steele	30.3	1319
Tom	30.0	2812
Ulen	30.0	1008
Trial Mean	32.0	1720
LSD (0.10)	2.80	NS

Table 6. Plant heights & weed biomass, Willsboro, NY

Variety	Plant height	Weed biomass
	inches	lbs ac^{-1}
AC Barrie	36.3	132
AC Mckenzie	34.9	28.8
AC Roblin	31.4	84.8
AC Superb	31.5	59.0
AC Walton	39.3	28.8
Ada	28.4	144
Batiscan	38.9	0.0
Cabernet	25.3	180
Faller	31.3	35.3
FBC Dylan	29.2	143
Glenn	30.6	0.00
Helios	35.5	0.00
Howard	28.9	39.0
HRS10181J	29.8	114
HRS10182J	29.2	121
HRS7001J	33.8	45.0
Kaffe	38.4	15.8
Kelse	29.2	42.8
Kinsey	38.3	156
Magog	36.1	0.00
Melbec	25.3	**293**
Nick	28.3	2.21
Oklee	29.3	21.5
RB07	28.0	43.8
Red Fife	**42.8***	0.00
Sabin	28.8	8.75
SD7006J	23.6	0.00
Steele	29.8	0.00
Tom	30.7	75.3
Ulen	28.3	46.5
Trial Mean	31.7	62.0
LSD (0.10)	1.35	NS

* Wheat varieties that are not significantly different than the top performing variety in a column are indicated with an asterisk.
NS - None of the varieties were significantly different from one another

Spring Wheat Yield:

The highest yielding variety in Alburgh, 2078 lbs ac^{-1} was HRS7001J (Table 7 and Figure 1). Other top yielding varieties included Kaffe, Kinsey and Batiscan. The lowest yielding variety was SD7006J, a durum wheat, 271 lbs ac^{-1}. Other low yielding varieties included Cabernet, AC Barrie, Howard, and Nick. Weed pressure at this location severely impacted grain yields. At the Willsboro location the highest yielding variety, 3,235 lbs ac^{-1} was Faller (Table 8 and Figure 2). The other top yielding varieties included Kinsey and HRS7001. Kinsey and HRS7001 were among the highest yielding varieties at both locations. At harvest, Red Fife had the highest grain moisture and Nick had the lowest recorded grain moisture at both locations. In Alburgh, Tom had the highest test weight 58.3 lbs bu^{-1} and in Willsboro Ada had the highest test weight, 59.6 lbs bu^{-1}. It's no surprise that the durum, SD7006J, had the lowest test weight at both locations. In general, most varieties reached the optimal 55 to 60 lb bu^{-1} test weight for wheat.

Table 7. Harvest data of the 30 spring wheat, Alburgh, VT

Variety	Harvest moisture	Test weight	Yield @13.5% moisture
	%	lbs bu^{-1}	lbs ac^{-1}
AC Barrie	16.7	54.5	845
AC Mckenzie	13.6	56.0*	1146
AC Roblin	12.0	51.3	1097
AC Superb	16.2	53.1	1297
AC Walton	19.3*	51.6	1222
Ada	12.2	55.9*	1011
Batiscan	16.5	55.3*	1661*
Cabernet	13.9	51.3	517
Faller	16.9	56.4*	1580
FBC Dylan	13.5	55.6*	1286
Glenn	11.1	55.3*	1063
Helios	13.4	55.0*	1148
Howard	16.1	51.0	911
HRS10181J	15.9	50.8	1241
HRS10182J	17.4*	54.5	1345
HRS7001J	15.9	49.3	**2078***
Kaffe	15.0	56.3*	2009*
Kelse	13.2	54.9*	1530
Kinsey	18.7*	53.0	1794*
Magog	15.3	52.6	1281
Melbec	12.6	47.0	1149
Nick	10.9	51.0	981
Oklee	14.2	55.9*	1130
RB07	15.8	57.0*	1113
Red Fife	**19.7***	50.8	1083
Sabin	13.2	55.1*	1247
SD7006J	16.5	39.0	271
Steele	16.3	55.5*	1222
Tom	17.3*	**58.3***	1298
Ulen	12.6	56.6*	1277
Trial Mean	15.1	53.3	1228
LSD (0.10)	2.51	3.38	473

Table 8. Harvest data of the 30 spring wheat, Willsboro, NY

Variety	Harvest moisture	Test weight	Yield @ 13.5% moisture
	%	lbs bu^{-1}	lbs ac^{-1}
AC Barrie	15.1	55.3	1864
AC Mckenzie	14.3	57.9	2527
AC Roblin	12.1	55.6	1838
AC Superb	16.4	56.4	2429
AC Walton	17.5	54.4	2872
Ada	13.2	**59.6***	2215
Batiscan	14.8	56.9	2774
Cabernet	10.9	56.3	2117
Faller	16.8	56.8	**3235***
FBC Dylan	13.0	57.0	2202
Glenn	16.2	58.8	2001
Helios	13.6	57.3	2016
Howard	14.3	58.5	2017
HRS10181J	13.9	56.8	2489
HRS10182J	15.0	57.5	2394
HRS7001J	17.8	54.0	3024*
Kaffe	13.5	58.0	2653
Kelse	15.3	57.8	2383
Kinsey	17.0	56.6	3051*
Magog	17.2	54.3	2582
Melbec	13.2	56.0	2175
Nick	11.3	58.0	2818
Oklee	15.1	58.1	2147
RB07	12.4	58.3	2136
Red Fife	**19.8***	50.4	2325
Sabin	12.3	57.1	2599
SD7006J	13.6	49.0	1266
Steele	15.1	58.3	2183
Tom	13.9	57.9	1980
Ulen	12.7	56.6	1916
Trial Mean	14.6	56.5	2341
LSD (0.10)	1.60	1.36	352

* Wheat varieties that are not significantly different than the top performing variety in a column are indicated with an asterisk.

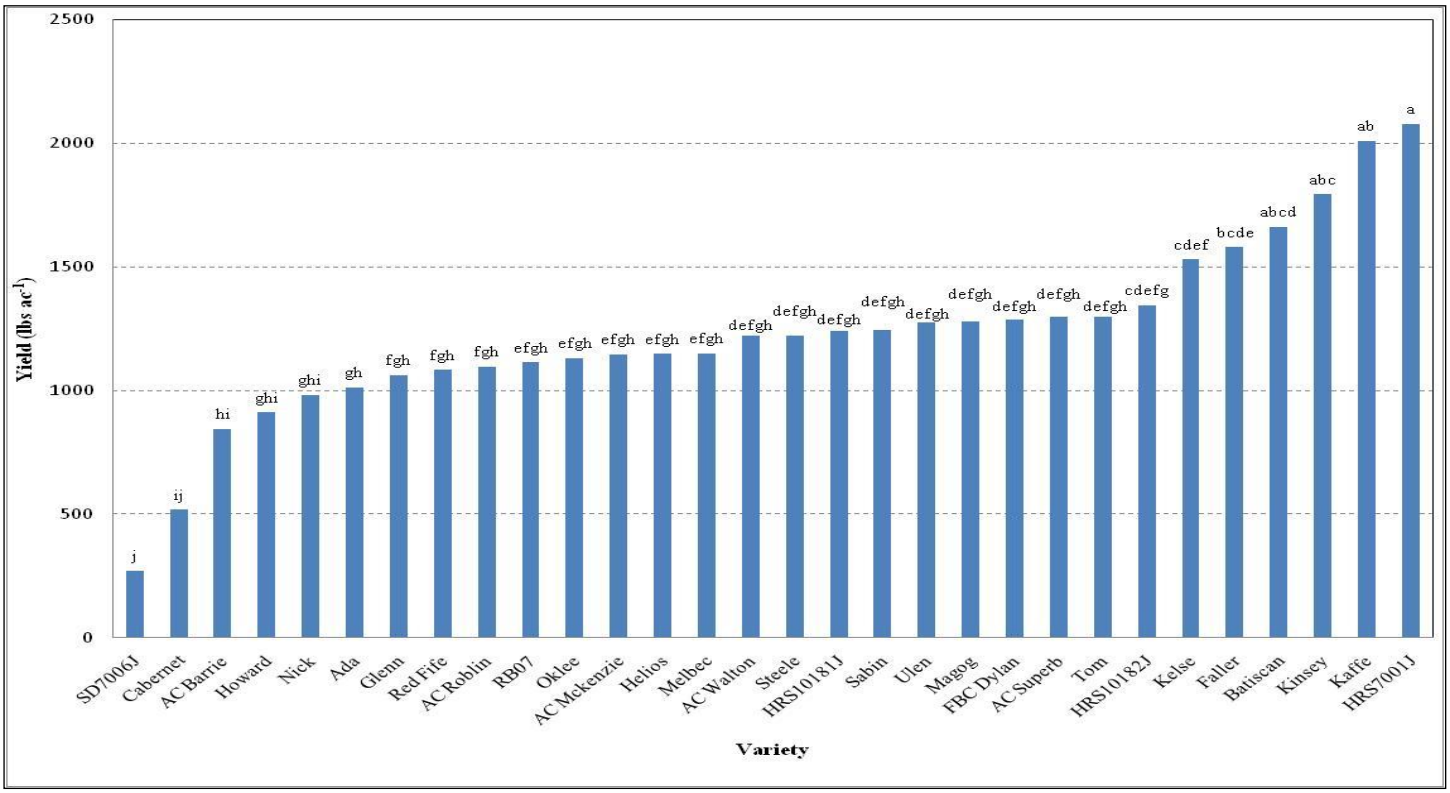

Figure 1. Yields of 30 spring wheat varieties, Alburgh, VT
*Varieties with the same letter did not differ significantly in yield.

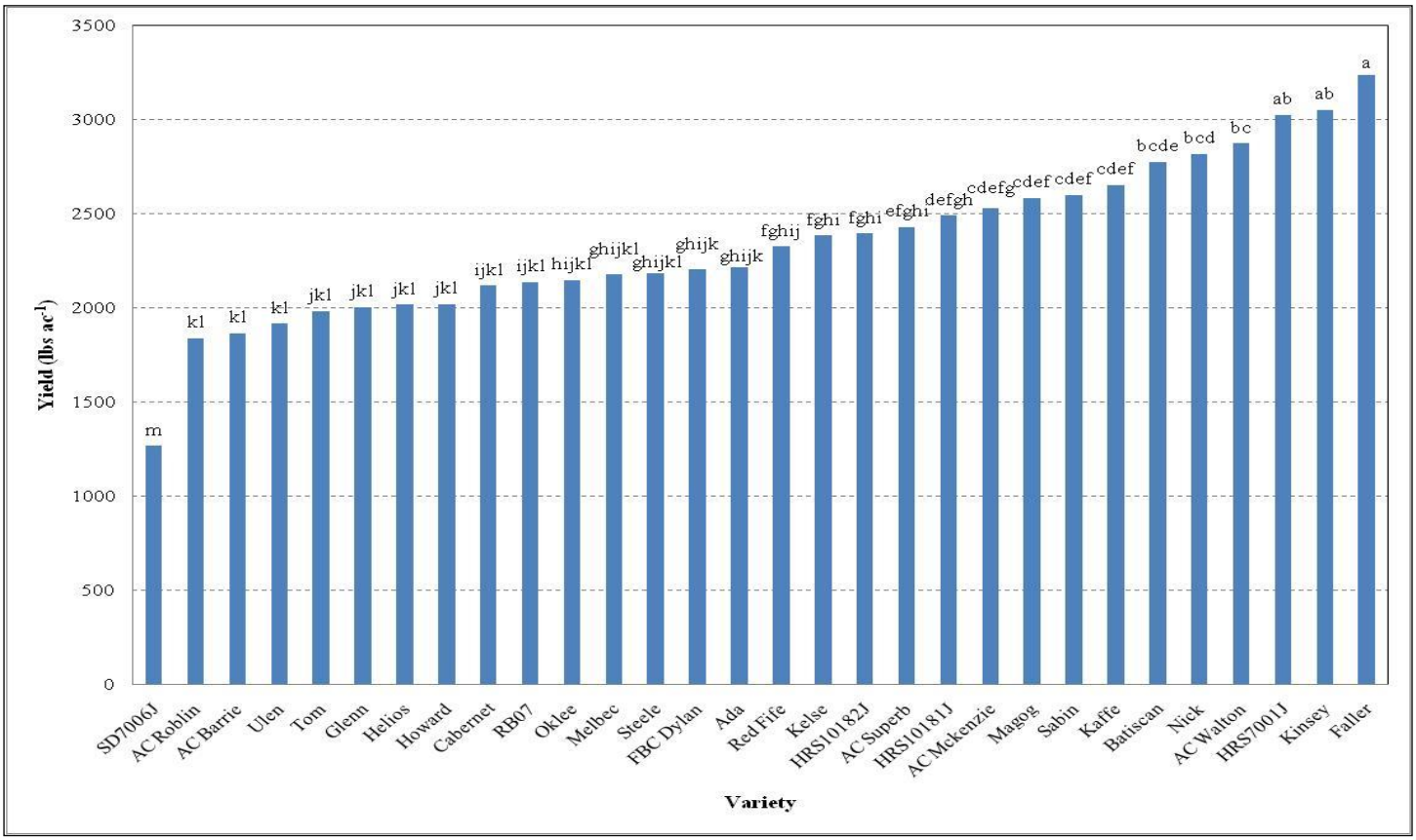

Figure 2. Yields of 30 spring wheat varieties, Willsboro, NY
*Varieties with the same letter did not differ significantly in yield.

Spring Wheat Quality:

The common measures used by commerial mills to evaluate wheat quality are: grain protein, falling number, test weight, and mycotoxin (DON) content. In Alburgh, the varieties with the highest protein content were SD7006J, 17.5% and Melbec, 16.4% (Table 9 and Figure 3). At the Willsboro location AC Roblin had the highest protein level at 17.6% (Table 10 and Figure 4). The lowest protein content was HRS7001J in both locations. Interestingly the lowest protein content of the spring wheat was still 1.5% higher than the highest protein level of winter wheat trialed. Helios had the highest falling number at both locations. In Willsboro, the falling number of AC Barrie was statistically similar to Helios. Other varieties with high falling numbers included Ada and FBC Dylan. Almost every variety had acceptable protein and falling number levels based on mill standards.

Table 9. Quality analyses of the 30 spring wheat vareities, Alburgh, VT

Variety	Crude protein @14% moisture	Falling number @14% moisture	DON
	%	seconds	ppm
AC Barrie	16.4*	394*	3.28
AC Mckenzie	15.0	377	2.18
AC Roblin	15.6	358	2.33
AC Superb	14.7	345	4.93
AC Walton	15.3	357	2.13
Ada	14.3	404*	3.28
Batiscan	12.5	160	5.48
Cabernet	14.6	328	4.45
Faller	14.1	341	2.33
FBC Dylan	13.5	403*	2.78
Glenn	15.6	334	2.03
Helios	15.6	**414***	2.30
Howard	13.4	318	3.28
HRS10181J	15.0	280	3.33
HRS10182J	14.1	326	3.98
HRS7001J	12.1	302	3.35
Kaffe	13.4	288	4.10
Kelse	15.8	315	4.53
Kinsey	13.8	377	3.65
Magog	15.5	384	3.05
Melbec	16.4*	309	4.03
Nick	12.7	187	6.88
Oklee	15.2	362	3.75
RB07	14.9	344	2.43
Red Fife	15.8	305	2.10
Sabin	16.5*	351	1.63
SD7006J	**17.5***	312	**8.88***
Steele	14.9	319	3.40
Tom	13.3	381	1.68
Ulen	15.0	288	3.10
Trial Mean	14.7	332	3.49
LSD (0.10)	1.41	24.0	1.34

Table 10. Quality analyses of the 30 spring wheat vareities, Willsboro, NY

Variety	Crude protein @14% moisture	Falling number @14% moisture	DON
	%	seconds	ppm
AC Barrie	15.7	**461***	0.43
AC Mckenzie	15.0	379	0.45
AC Roblin	**17.6***	400	0.43
AC Superb	15.6	398	2.10
AC Walton	13.4	362	0.30
Ada	14.7	448*	0.83
Batiscan	13.2	213	1.08
Cabernet	13.7	348	2.40
Faller	14.1	358	0.70
FBC Dylan	13.8	435*	0.60
Glenn	16.6	335	0.58
Helios	16.9	**461***	0.63
Howard	15.1	366	1.23
HRS10181J	14.3	320	0.68
HRS10182J	15.2	396	1.75
HRS7001J	11.9	290	0.15
Kaffe	13.9	334	0.40
Kelse	16.2	329	2.35
Kinsey	13.7	400	0.30
Magog	14.6	419	0.38
Melbec	16.0	349	2.15
Nick	12.9	219	2.03
Oklee	15.7	408	0.88
RB07	15.4	380	0.58
Red Fife	15.0	327	0.35
Sabin	14.4	428	0.33
SD7006J	14.5	327	**5.90***
Steele	15.8	371	1.28
Tom	15.2	434*	0.80
Ulen	16.3	317	0.73
Trial Mean	14.9	367	1.09
LSD (0.10)	0.56	27.5	0.71

* Wheat that did not perform significantly lower than the top performing variety in a particular column are indicated with an asterisk.

In the Northeast, *Fusarium* head blight 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, >1ppm, poses a health risk to both humans and livestock

Unfortunately all of the spring wheat trialed at the Alburgh location had DON levels that exceeded the FDA's 1ppm regulation. It was a relatively dry season, but a rainy period occurred during the spring wheat flowering stage resulting in ideal environmental conditions for disease infection. In addition, there was high weed pressure in all of the plots; most likely increasing humidity and creating an ideal environment for fungal growth. The Willsboro site had 10 varieties that exceeded the 1ppm limit.

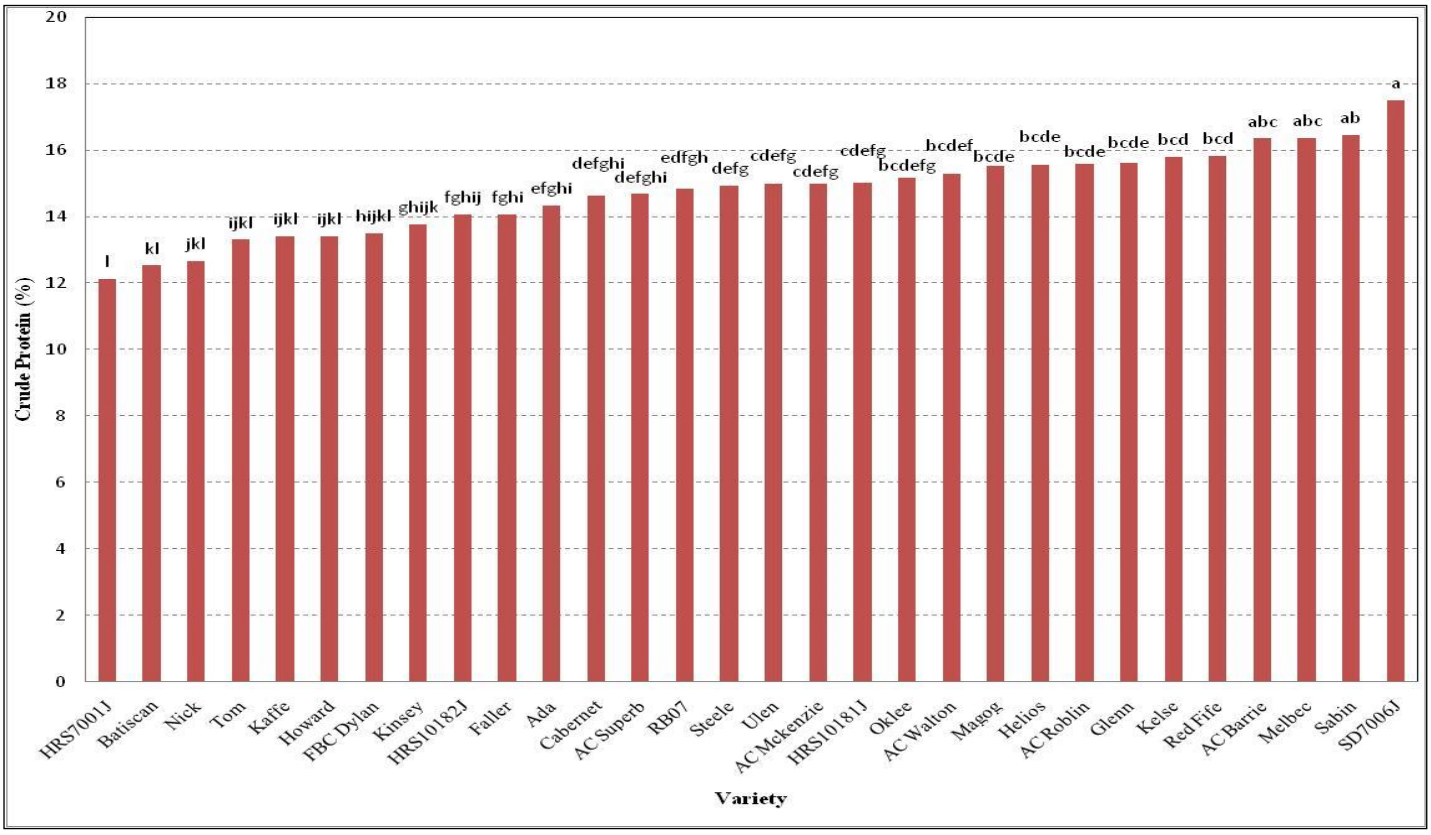

Figure 3. Crude protein of 30 spring wheat varieties, Alburgh, VT

*Varieties with the same letter did not differ significantly in protein content.

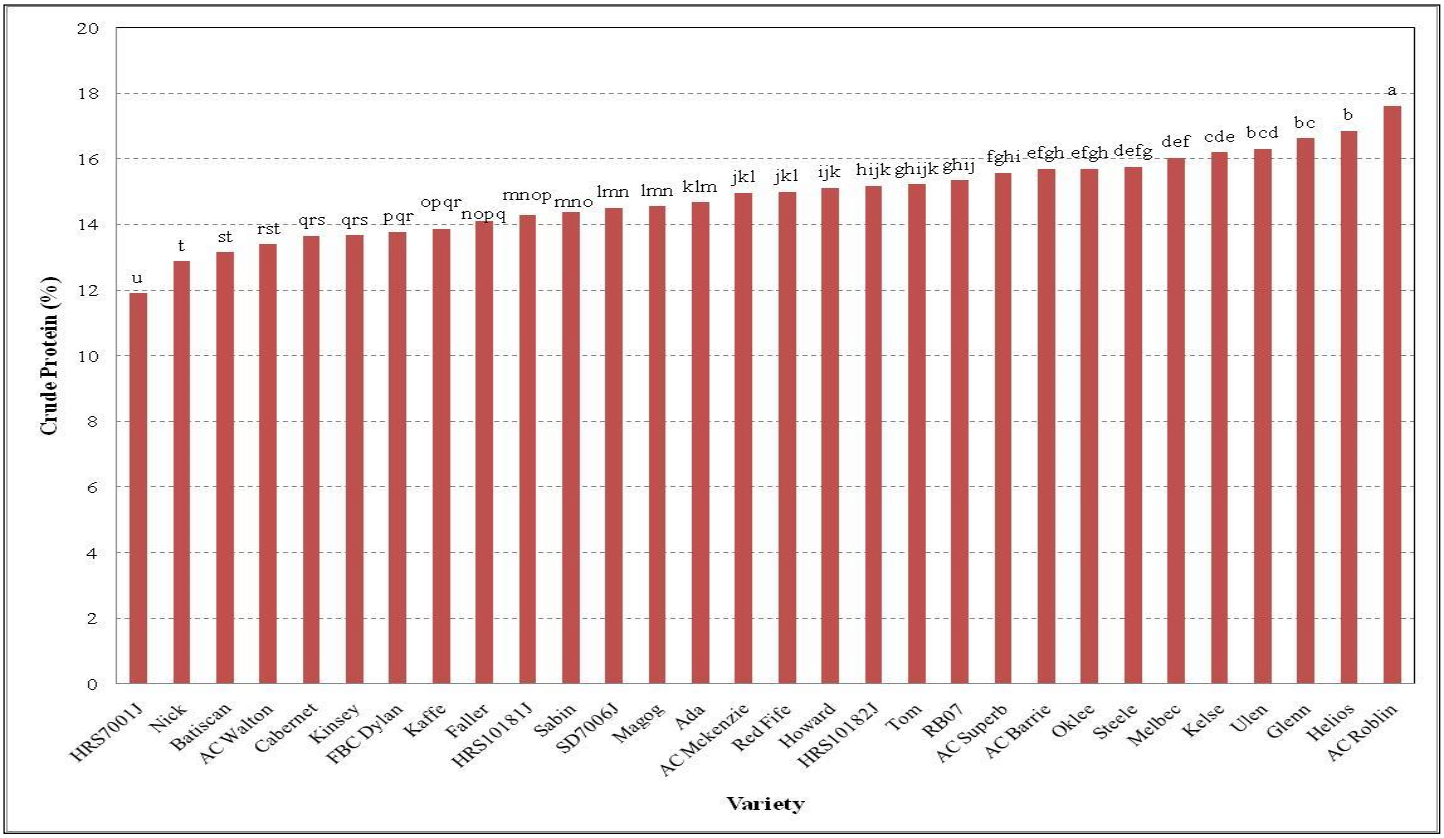

Figure 4. Crude protein of 30 spring wheat varieties, Willsboro, NY
*Varieties with the same letter did not differ significantly in protein content.

DISCUSSION

It is important to remember that the results only represent one year of data. However, a few generalizations can be made from this past season. At the Alburgh location the high weed pressure severely impacted both yield and quality of the wheat. In many cases varieties yielded half as much as compared to the same varieties in Willsboro. The weeds created an ideal micro environment for fungal growth and probably contributed to the high DON readings. It's difficult to make any direct correlations between the two sites since the Alburgh plots were so severely impacted by weeds.
It is interesting to note however that the durum wheat, SD7006J at both locations, had the highest DON levels and the lowest yields. Durum wheat, not traditionally grown in the northeast, tends to thrive in drier climates which may explain the low yields and higher disease susceptibility. Across both sites, the variety Kinsey and HRS7001J were top yielding varieties but did not rank the highest in quality. There were many varieties that met the high baking quality standards.

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