NW CROPS & SOILS PROGRAM

UNIVERSITY OF VERMONT EXTENSION

CULTIVATING HEALTHY COMMUNITIES

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Spring Wheat Planting Date Trial

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INTRODUCTION

Growing demand for local organic food has inspired new efforts to revive a staple element of the New England food system. Weed management is one of the foremost production related challenge for organic growers.
The objective of this research was to determine the impact of spring wheat cultivar selection and planting date on weed biomass, *Fusarium* head blight incidence and grain yield and quality.

METHODS

Four hard red spring wheat varieties were planted at Borderview Research Farm in Alburgh, Vermont. The experimental plot design was a randomized complete block with four replications. Wheat varieties evaluated are listed in Table 1.

Table 1: Spring wheat varieties planted in Alburgh, VT.

Species		Seed Source
Spring Wheat Varieties	**Type**	
AC McKenzie	Hard Red	Semican
Ladoga	Hard Red	USDA-ARS
RB07	Hard Red	University of Minnesota
Surprise	Hard Red	USDA-ARS

CULTURAL PRACTICES

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 site in Alburgh 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 were seeded with a Kincaid Cone Seeder the first planting date was planted on April 13, 2010 and the plantings continued weekly until May 13, 2010. The first planting date was harvested on July 27, 2010; the all remaining plots were harvested on August 19, 2010. All of the plots were harvested with an Almaco SP50 small 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 between 56-60 lbs. per bushel. A common cause of low-test weight is when grain in the field is reweted by rainfall or dew causing the grain to initiate the germination process before harvesting (preharvest sprouting). During germination, oil, starch, and protein are digested to provide energy to produce a new seedling. This process leaves small voids inside the grain. Although the grain may again dry in the field, the seed size does not change and the small voids inside the seed result in a decreased test weight. Maximum test weight is generally achieved when grain is harvested prior to frequent wetting and drying cycles, which generally means wheat is higher in moisture. 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 ($P< 0.10$).

Table 2: General plot management for the trial.

Location	**Borderview Farm Alburgh, VT**
Soil type	Benson rocky silt loam
Previous crop	Sod
Row spacing (in.)	6
Seeding rate (lbs/acre)	150
Replicates	4
Planting date 1	13-Apr
Planting date 2	21-Apr
Planting date 3	30-Apr
Planting date 4	7 May
Planting date 5	13-May
Planting date 6	21-May
Harvest date of planting date 1	27-Jul
Harvest date of all others	13-Aug
Harvest area (ft.)	5 x 20
Tillage operations	Fall plow, spring disk, & spike-toothed harrow

Image 1. Planting wheat with the Kincaid Cone Seeder.

Image 2. Wheat harvest with the Almaco SP50 small plot combine.

WEATHER

Seasonal precipitation and temperature recorded at a weather station in close proximity Alburgh are shown in Table 3. 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, there was an accumulation of 4890 Growing Degree Days (GDD), 411 GDDs higher than the 30-year average.

Table 3: Temperature and precipitation summary for Alburgh, VT, 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

*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)

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 Difference (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. 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**

RESULTS

Wheat Growth and Development:

During the 2010 growing season several observations and measurements were recorded on wheat development (Table 4). Interestingly, the wheat from the first planting date took more than two weeks to emerge. It was observed the later the planting date the shorter the amount of time it took for wheat emergence. This could be attributed to the warming of the soil which increased the rate of seed germination. The relative flowering date was recorded for each of the varieties. In general, all varieties from a given planting flowered within the same week. All of the planting dates took about 8 weeks to develop from emergence to flowering. The flowering date for the sixth planting date could not be determined due to the severe weed pressure in these plots.
Bird deterrents; squawk boxes, owl and coyote decoys, were place in and around the plot area which appeared to help reduce bird presence as a result, minimal bird damage was recorded. Lodging amongst the varieties trialed, in general was minimal.

Image 2. Flowering wheat

Table 4. Spring wheat development

Planting Date	Wheat Emergence	Flowering Date
13-Apr	30-Apr	4th Wk June
21-Apr	3-May	1st Wk July
30-Apr	10-May	2nd Wk July
7 May	17-May	3rd Wk July
13-May	19-May	3rd Wk July
21-May	28-May	--

After the wheat reached physiological maturity 12" X 13" biomass samples were taken, the wheat and weeds were seperated from each sample and the results are reported in Tables 5 and 6. The May 13th planting date had the highest amount of wheat bimass averaging 5947 DM lbs ac^{-1} (Table 5 and Firgure 1). Other top yielding planting dates include, April 21st and May 7th. The lowest wheat biomass was taken from the last planting date, May 21st, 2677 DM lbs ac^{-1}. Its no surpirse that this same plot had the highest weed biomass, 3448 DM lbs ac^{-1}. The weed pressure was so severe in the sixth planting date that it was a challege to identify wheat in the plots. Other planting dates with high weed biomass include, the second, April 21st and the third, April 30th , planting dates. The high weed biomass in the second and third planting date was most likely related to warmer soil temperatures, soil disturbance during planting and the type of weed seed present in the weed seed bank in the trial area. The highest yielding wheat biomass, 6031 DM lbs ac^{-1} and the lowest in weed biomass was Ladoga. Ladoga is an heirloom variety that is a favorite amoung researchers for it plant height, stalk strength, head size and weed competiveness (Table 6 and Figure 2). The lowest wheat biomass yields were from RB07, 3525 DM lb ac^{-1}. Not surpisingly this variety had one of the higher weed biomass results. RB07 was the shortest variety trialed, based on heights measured from the spring variety trial. The variety with the highest weed biomass was AC Superb, 3158 DM lbs ac^{-1}. Other varieties with high weed biomass were RB07 and AC McKenzie.

Table 5. Wheat and weed biomass by planting date

Planting Date	Wheat biomass	Weed biomass
	DM lbs ac^{-1}	DM lbs ac^{-1}
13-Apr	3737	2282
21-Apr	5867*	2741*
30-Apr	3674	3324*
7-May	5739*	1692
13-May	**5947***	1397
21-May	2677	**3448***
LSD (0.10)	1212	1115
Trial means	4607	2481

Table 6. Wheat and weed biomass by variety

Variety	Wheat biomass	Weed biomass
	DM lbs ac^{-1}	DM lbs ac^{-1}
AC McKenzie	4548	2636*
Ladoga	**6031***	1433
RB07	3525	2695*
AC Superb	4323	**3158***
LSD (0.10)	990	910
Trial means	4607	2481

*Results that are not significantly different than the top performer in a particular column are indicated with an asterisk
NS - None of the varieties were significantly different from one another

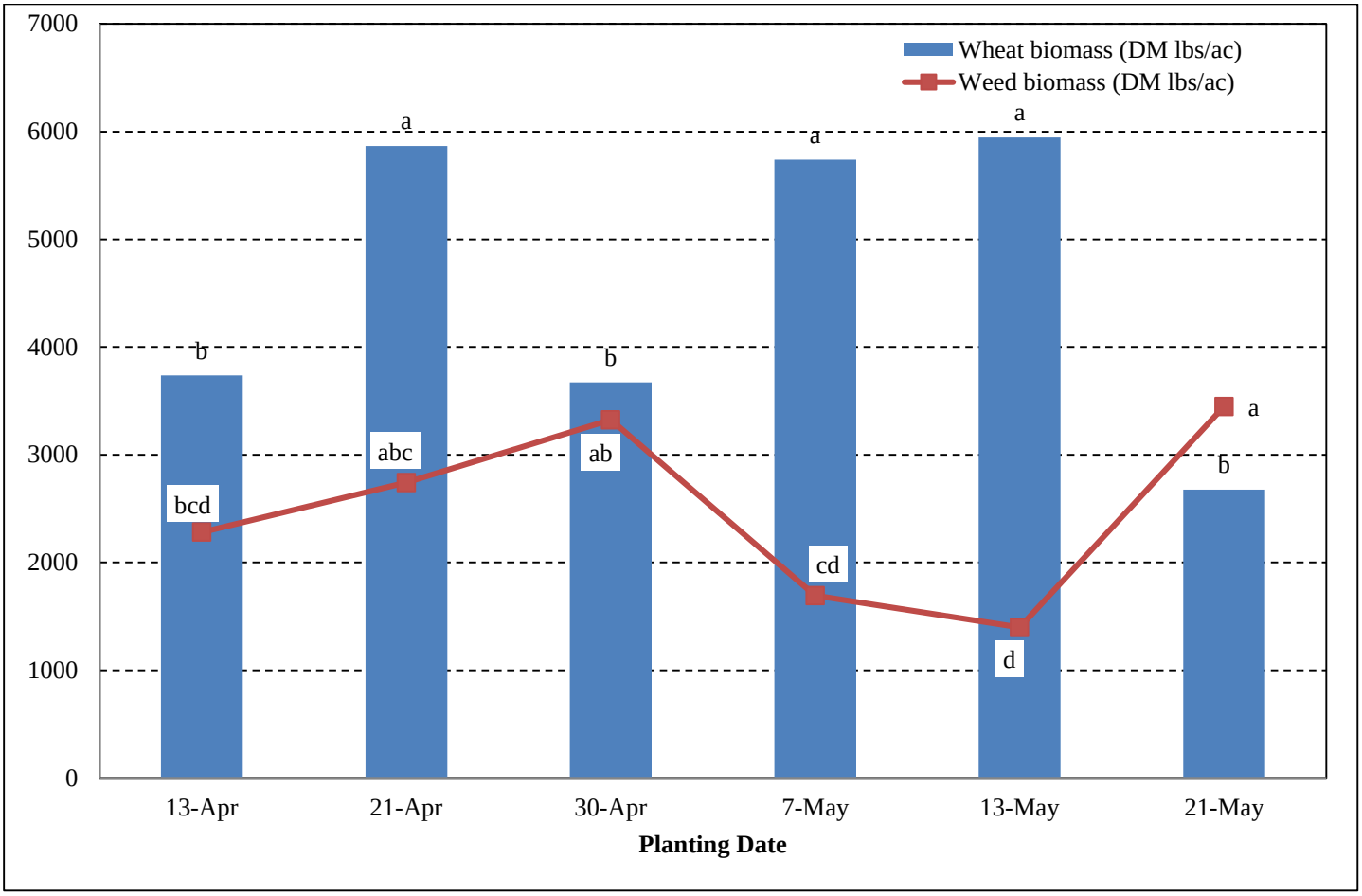

Figure 1. Wheat and weed biomass by the planting date
*Data points with the same letter or no letters are not significantly different from each other ($p<0.10$).

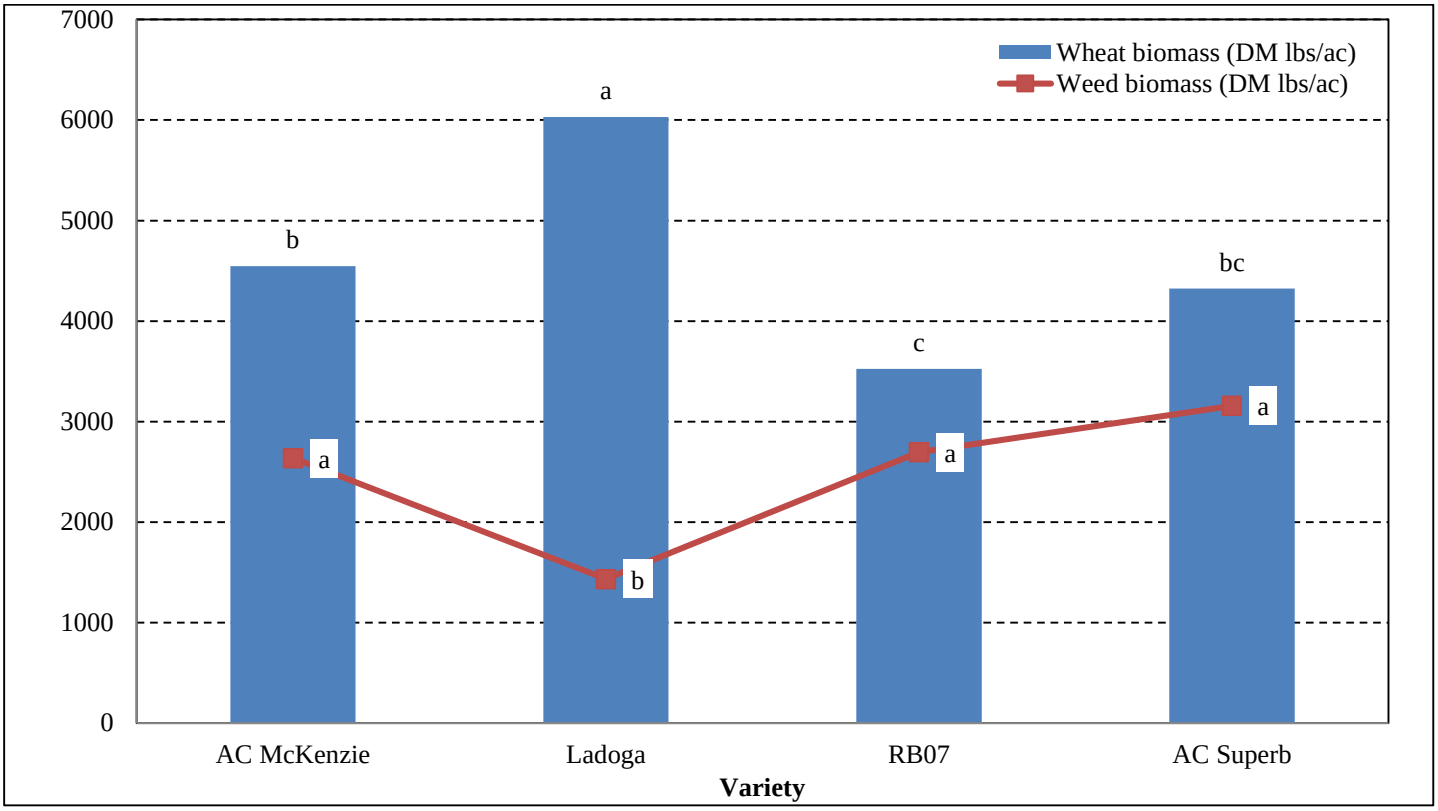

Figure 2. Wheat and weed biomass by spring wheat variety

*Data points with the same letter or no letters are not significantly different from each other ($p<0.10$).

Wheat Yield:

Yields from the April 13th planting date were significantly higher than any other planting date, averaging 1627 lbs ac^{-1} (Table 6 and Figure 3). The lowest yield was from the April 30th planting date averaging 1037 lbs ac^{-1}. This is not surprising considering the April 30th planting date had the highest amount of weed biomass recorded. There were also yield differences seen by wheat variety (Table 7 and Figure 4). The highest yielding was Ladoga averaging 1670 lbs ac^{-1}, the lowest yielding among the varieties was AC McKenzie, 1058 lbs ac^{-1}.

Harvest moisture was not significant among the planting dates. The highest harvest moisture between varieties was AC McKenzie at 10.4% and the lowest was Ladoga, 8.93%.

Table 6: Harvest data by planting date.

Planting Date	Moisture	Test weight	Yield @ 13.5% moisture
	%	lbs bu^{-1}	lbs ac^{-1}
13-Apr	**10.2**	54.9*	**1627***
21-Apr	9.83	53.0	1330
30-Apr	8.60	52.8	1037
7-May	9.53	55.0*	1354
13-May	10.1	**55.5***	1057
LSD (0.10)	NS	1.36	158
Trial means	9.66	54.2	1281

Table 7: Harvest data by variety.

Variety	Moisture	Test weight	Yield @ 13.5% moisture
	%	lbs bu^{-1}	lbs ac^{-1}
AC McKenzie	**10.4***	**55.0**	1058
Ladoga	8.93	53.9	**1670***
RB07	9.59*	54.6	1215
AC Superb	9.69*	53.4	1179
LSD (0.10)	0.85	NS	141
Trial means	9.66	54.2	1281

*Results that are not significantly different than the top performer in a particular column are indicated with an asterisk.

NS - None of the varieties were significantly different from one another

The highest test weight (55.5 lbs bu^{-1}) resulted from the latest planting date, May 13th. The lowest test weight, 52.8 lbs bu^{-1} was the April 30th planting date. There was no significant difference in test weight among varieties. Test weight is the measure of grain density determined by weighing a known volume of grain. Generally, the heavier the wheat is per bushel, the higher baking quality.

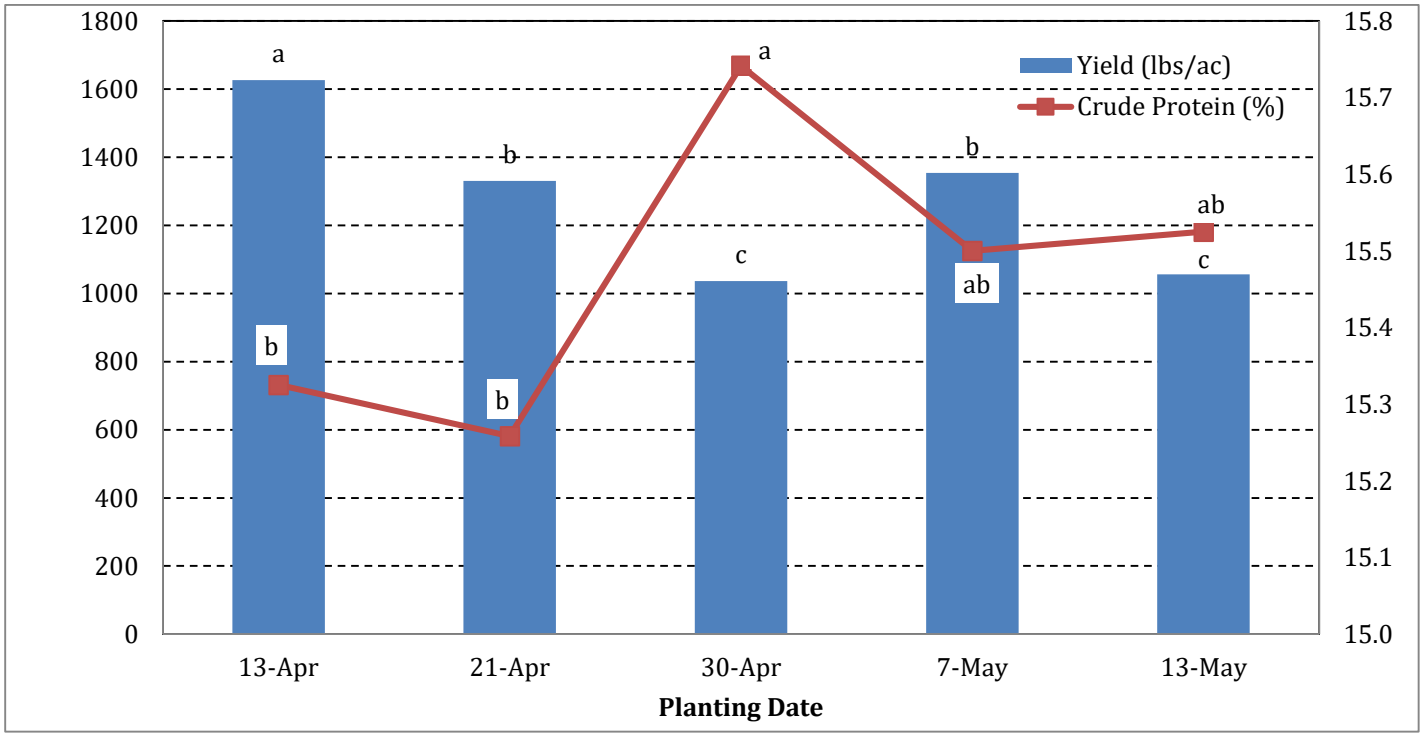

Figure 3: Yield and protein by planting date.

*Data points with the same letter or no letters are not significantly different from each other ($p<0.10$).

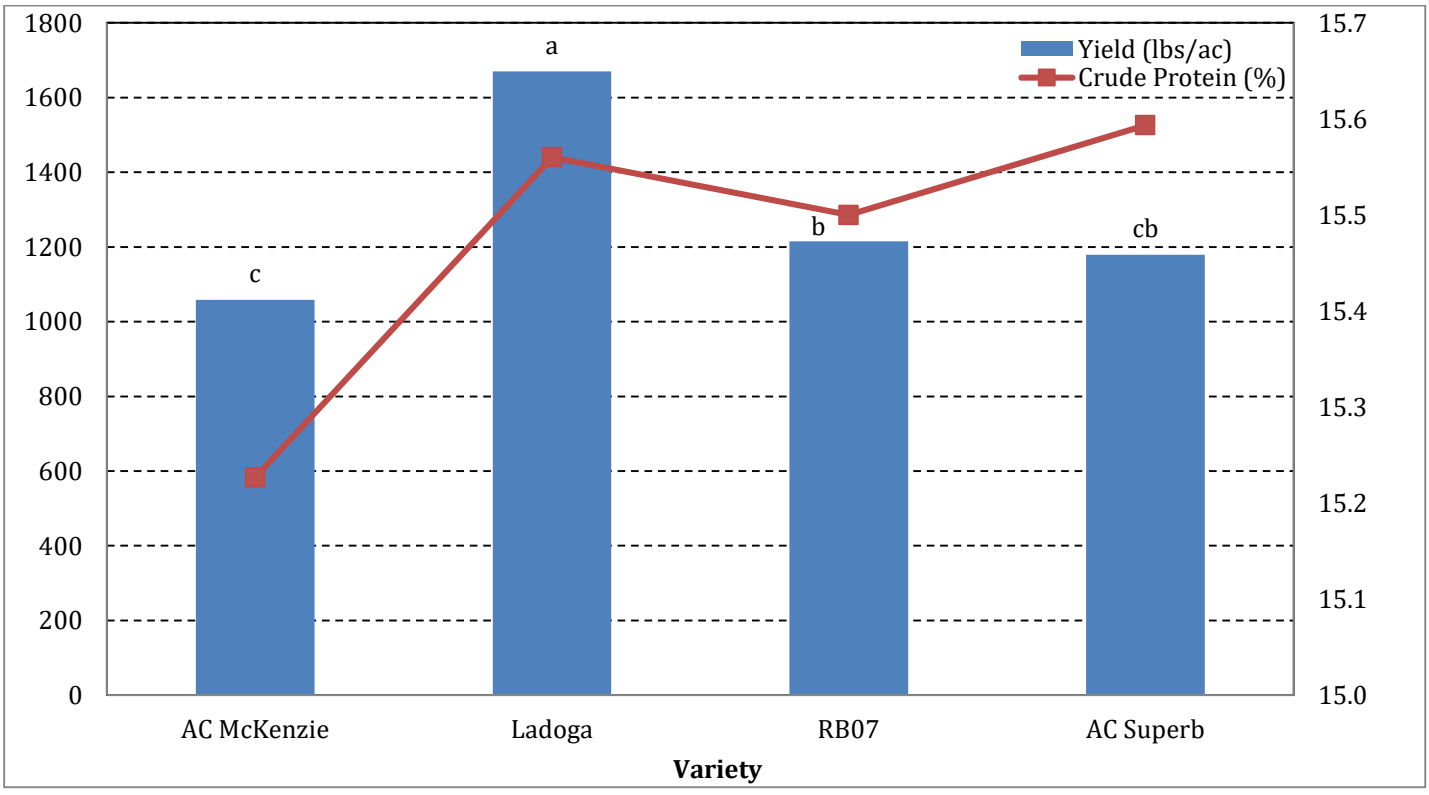

Figure 4: Yield and protein by wheat variety.

*Data points with the same letter or no letters are not significantly different from each other ($p<0.10$).

Spring Wheat Quality:

The common measures used by commerial mills to evaluate wheat quality are: grain protein, falling number, test weight, and Deoxynivalenol (DON) content. The amount of crude protien was the highest in the April 30th planitng date at 15.7%. Other planting dates with high crude protein levels were May 5th and May 13th . The first and second planting dates at 15.3% protien had the lowest protein levels. (Table 8 and Figure 3) . There was no significant difference in the crude protien levels among varieties (Table 9 and Figure 4). The falling number, which determines the amount of sprout damage that has occurred was highest in the first planting date, April 13th , at 366 seconds. Other planting dates with high falling numbers include May 7th and May 13th. The lowest falling numbers recorded, still above industry standards, were from April 12th and April 30th. This could be attributed to the severe weed pressure in these plots creating excess moisture and increased grain sprouting.The variety with the highest falling number was AC McKenzie at 356 seconds. Two of the varieties with lower falling numbers, here again,still above industry satndards, were Ladoga and RB07. Every variety and planting date had acceptable protein and falling number levels based on mill standards.

Table 8: Quality data by planting date

Planting Date	Crude protein @ 14% moisture	Falling number @ 14% moisture	DON
	%	seconds	ppm
13-Apr	15.3	**366***	2.21
21-Apr	15.3	266	2.43*
30-Apr	**15.7***	275	**2.73***
7-May	15.5*	337*	1.08
13-May	15.5*	345*	0.94
LSD (0.10)	0.32	29.9	0.46
Trial means	15.5	318	1.88

Table 9: Quality data by variety

Variety	Crude protein @ 14% moisture	Falling number @ 14% moisture	DON
	%	seconds	ppm
AC McKenzie	15.2	**356***	1.53
Ladoga	**15.6**	281	1.60
RB07	15.5	293	1.79
AC Superb	**15.6**	342*	**2.59***
LSD (0.10)	NS	26.7	0.41
Trial means	15.5	318	1.88

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

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

It was a relatively dry season, but a rainy period occurred during the first three planting date spring wheat flowering stage resulting in ideal environmental conditions for disease infection. The highest DON level was found the April 30th planting date with 2.73 ppm., another planting date with high DON levels was April 21st. The high weed pressure in these plots; most likely increased humidity and created an ideal environment for fungal growth. Interestingly, the May 7th and May 13th planting dates had the lowest DON levels. This could be the result of their later flowering date. The variety with the highest DON level was AC Superb at 2.59 ppm. Interestingly only the May 13th planting date had DON levels below the FDA's <1ppm regulation.

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. The April 30th planting date; which would not be considered too late a date to plant by many grain growers, had severe weed pressure thus impacting both yield and quality. However it's interesting to note that this planting date also had the highest crude protein levels. The last planting date, May 21st, had the most severe weed pressure, so severe that we were not able to harvest any grain from of these plots. We observed the later the planting date and therefore the later wheat flowering, appears to decrease the level of DON. This could be a result of the later flowering date missing the "window" when the majority of the spores are blown in on air currents. The May 13th planting date was one of the lowest yielding but had high quality. Ladoga was the highest yield and had the lowest weed pressure of all the varieties trialed.

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