NW CROPS & SOILS PROGRAM

UNIVERSITY OF VERMONT EXTENSION

CULTIVATING HEALTHY COMMUNITIES

2010 Winter Wheat Harvest Date Trial

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INTRODUCTION

In New England, frequent rainfall, and prolonged high humidity are common during the period of wheat ripening. From the time of physiological maturity of the grain to acceptable storage moisture, the quality of the wheat can decline considerably due to these fluctuating temperatures and moisture conditions. Delays in harvesting may not only result in quality losses but reductions in yield due to lodging, shattering, or hail damage (Farrer, et al 2006).

Baking quality of wheat suffers when high levels of the enzyme alpha amylase are present in the grain. This enzyme, which breaks starch down into sugars, is present when the grain begins to germinate. Pre-harvest sprouting occurs in the field if there is a delay in harvest during periods of high humidity or frequent rainfall. The objective of this research was to determine if timing of harvest affects yield and quality parameters of winter wheat.

METHODS

Four hard red winter wheat varieties were planted at Borderview Research Farm in Alburgh, Vermont on September 19, 2009. The experimental plot design was a randomized complete block with four replications. Wheat varieties evaluated are listed in Table 1.

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

Species		Seed Source
Winter Wheat Varieties	**Type**	
Arapahoe	Hard Red	Albert Lea Seed House
AC Borden	Medium-Hard Red	Butterworks Farm
Harvard	Hard Red	Agriculver/ Seedway
AC Warthog	Hard Red	Semican

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 plots were seeded with a John Deere 750 grain drill and harvested with an Almaco SP50 small plot combine.

This trial evaluated wheat quality based on standard testing parameters used by commercial mills. Yield, moisture, and test weight were recorded at the time of harvest. Samples were ground into flour using a Perten LM3100 Laboratory Mill (Springfield, IL). Protein content was determined using a Perten Inframatic 8600 Flour Analyzer. Falling Number was determined with a Perten NF 1500 Falling Number Machine (AACC Method 56-81B, AACC Intl., 2000). Deoxynivalenol (DON) analysis was done using Veratox DON 5/5 Quantitaive test from the NEOGEN Corp. (Lansing, MI). This test has a detection range of 0.5 to 5 ppm. DON values greater than 1 ppm are considered unsuitable for human consumption (FDA, 1993).

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 trial.

Location	Borderview Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Sod
Row spacing (in.)	6
Seeding rate	150 lbs./acre
Replicates	4
Planting date	9/19/09
Harvest date 1	7/7/10
Harvest date 2	7/15/10
Harvest date 3	7/21/10
Harvest date 4	7/29/10
Harvest area (ft.)	5x20
Tillage operations	Fall plow, disc, & spike-toothed harrow

WEATHER

Seasonal precipitation and temperature recorded at a weather station in close proximity Alburgh are shown in Table 3. The 2010 growing season was ideal for growing wheat. Due to early season warmth, wheat grew quickly in the spring and its growth stages were about 2 weeks ahead of past years. Below average rainfall during flowering periods led to low disease levels on wheat in 2010. From planting to harvest, there was an accumulation of 5094 Growing Degree Days (GDD), 273 GDDs higher than the 30-year average.

Table 3: Temperature and precipitation summary for Alburgh, VT, 2010.

South Hero (Alburgh)	September 2009	October 2009	March	April	May	June	July
Average Temperature (F)	57.7	44.1	37.8	49.3	59.6	66.0	74.1
Departure from Normal	-2.7	-4.7	7.0	5.8	3.0	0.2	3.0
Precipitation (inches)	4.01	5.18	2.79	2.76	0.92	4.61	4.30
Departure from Normal	0.55	0.79	0.73	0.25	-2.01	1.40	0.89
Growing Degree Days (base 32)	771	396	229	521	854	1019	1305
Departure from Normal	-81.0	-125	113	176	91.5	4.50	94.6

*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

Overall there were few interactions between harvest date and variety. This means that varieties performed similarly across harvest dates. Therefore the impact of the main effects (harvest date and variety) on yield and quality are reported in the report.

Yields from the July 15th (second) harvest were significantly higher than any other harvest time, averaging 3,038 pounds per acre (Table 4). Yields from each harvest date were significantly different from each other (Figure 1). Yields can decrease as harvest is delayed due to lodging, shattering, weather and animal pressure. There were also yield differences seen by wheat variety (Figure 2). Borden, Warthog, and Harvard were all higher yielding than Arapahoe.

Harvest moisture was lowest at the latest harvest date, July 29th, which is what we would expect due to the accumulated heat units and the generally good drying conditions that were recorded in July.

Table 4: Harvest data by harvest date.

Harvest Date	Harvest moisture	Test weight	Yield @13.5% moisture
	%	lbs/bu	lbs/ac
July 7, 2010	20.1	**60.3***	2613
July 15, 2010	17.5	55.9	**3038***
July 21, 2010	16.2	55.2	1879
July 29, 2010	**10.8***	55.4	1522
Trial Mean	16.2	56.7	2263
LSD (0.10)	0.547	0.880	357

Table 5: Harvest data by variety.

Variety	Harvest moisture	Test weight	Yield @13.5% moisture
	%	lbs/bu	lbs/ac
Arapahoe	16.0	55.9	1692
Borden	15.9	56.3	**2538***
Harvard	16.3	57.2*	2367*
Warthog	16.5	**57.4***	2454*
Trial Mean	16.2	56.7	2263
LSD (0.10)	NS	0.880	357

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

The highest test weight (60.3 lbs. per bushel) resulted from the earliest harvest, July 7th (Table 4). 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. 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 rewetted 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.

Table 6: Quality data by harvest date

Harvest Date	Crude protein @14% moisture	Falling number @14% moisture	DON
	%	seconds	ppm
July 7, 2010	8.85	344	0.181
July 15, 2010	8.71	369	0.138
July 21, 2010	8.91	362	0.194
July 29, 2010	8.99	366	0.188
Trial Mean	8.86	360	0.175
LSD (0.10)	NS	NS	NS

Table 7: Quality data by variety.

Variety	Crude protein @14% moisture	Falling number @14% moisture	DON
	%	seconds	ppm
Arapahoe	8.98*	343	**0.131***
Borden	8.44	365	0.169*
Harvard	**9.32***	336	0.244
Warthog	8.70	**397***	0.156*
Trial Mean	8.86	360	0.175
LSD (0.10)	0.338	20.8	0.0765

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

Although the test weight was a little low for the three later harvest dates, pre-harvest sprouting was likely not the cause because the falling number results were all above 250 seconds (Table 6). Falling number is a measure of the level of sprout damage in grain. It records the time it takes for a stirrer to fall through a flour and water slurry to the bottom of a test tube. High 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. An acceptable range for falling number is between 250-400 seconds. Falling numbers for this trial were excellent for baking quality. Although differences were seen by variety, all results were well within the acceptable range.

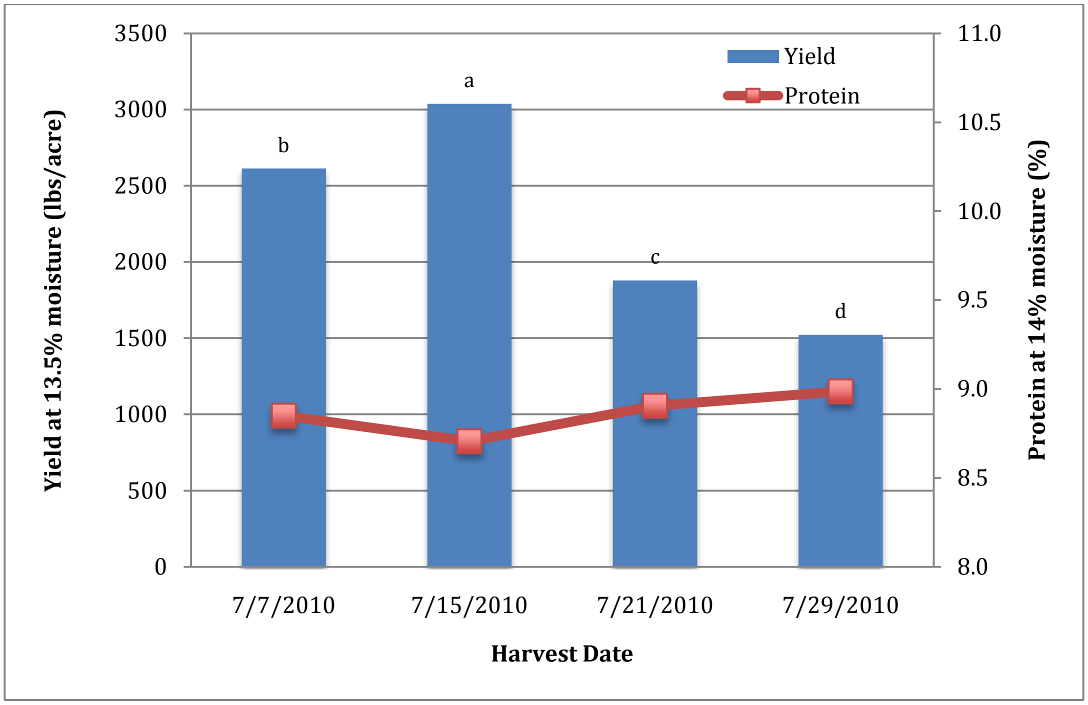

Figure 1: Yield and protein by harvest date. Data points with the same letter or no letters are not significantly different from each other (p<0.10).

Protein levels throughout the study were generally low, averaging 8.86% protein (Table 6). Most commercial mills target 14-15% protein for high quality bread, as grain protein affects gluten strength and loaf volume (Wall, 1979). Lower protein levels are relatively common in winter wheat. Harvest date did not significantly impact crude protein (Figure 1). However, varieties were statistically different in protein concentration (Figure 2).

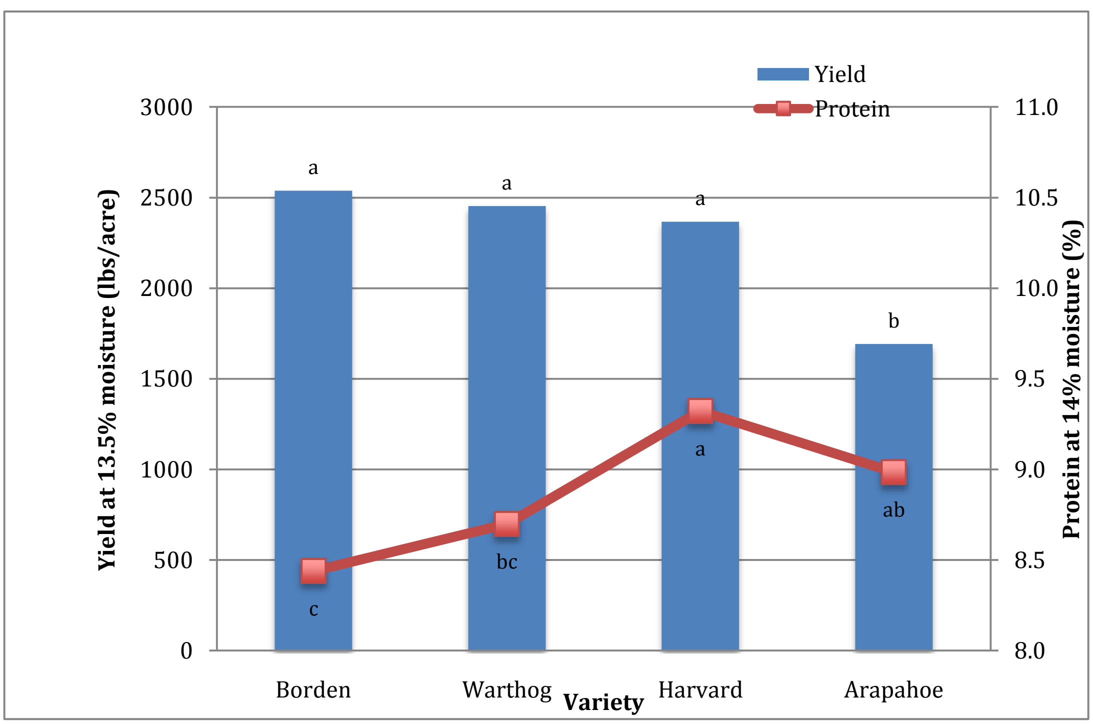

Figure 2: Yield and protein by variety. Data points with the same letter or no letters are not significantly different from each other (p<0.10).

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 (grain with DON levels >1ppm) poses a health risk to humans. All DON levels in this trial were within acceptable levels for human and animal consumption. There was no statistical difference in DON levels based on harvest date (Table 6), but there was a statistical difference by variety, with Harvard having the highest DON levels, 0.244 ppm (Table 7).

This means that varieteis performed similarly across harvest dates. There was a significant harvest date by variety interaction for DON (P=0.1052), meaning that not all varieties had the same outcome from each harvest date. Arapahoe had very low DON levels at the first harvest, July 7th (Figure 3). Harvard's DON levels were much higher than the other varieties on the July 21st harvest. Although the varieties resulted in different DON levels from each harvest date, all DON levels were less than 1 ppm and acceptable for human consumption.

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