2011 VERMONT WINTER WHEAT HARVEST DATE TRIAL

In New England, frequent rainfall and prolonged high humidity are common during the period of wheat ripening. Due to these fluctuating temperatures and moisture conditions, the quality of the wheat can decline considerably from the time of physiological maturity to the time of acceptable storage moisture. Delays in harvesting may not only result in quality losses but also 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 15, 2010. The experimental plot design was a randomized complete block with split plots. There were four replications. Main plots were four wheat varieties (Table 1). Split plots were harvest times beginning near physiological maturity and continuing approximately every 7 days for 4 weeks. Harvest dates are listed in table 2.

Table 1. Winter wheat varieties planted in Alburgh, Vermont.

Species		Seed Source
Winter Wheat Varieties	**Type**	
Arapahoe	Hard Red	Albert Lea Seed House, MN
Borden	Medium-Hard Red	Semican, Canada
Harvard	Hard Red	AgriCulver Seeds, NY
Warthog	Hard Red	Semican, Canada

The experiment was established in Alburgh in a Benson rocky silt loam soil. The previous crop was spring wheat. Two tons of Giroux's composted poultry manure was applied in the first week of September and incorporated. 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 on September 15, 2010. The seeding rate was 130 pounds per acre. Harvest areas were 5'x10' and were harvested with an Almaco SP50 small plot combine. Wheat was harvested on 19-Jul, 29-Jul, 5-Aug, and 12-Aug, 2011. A subsample of wheat was collected near physiological maturity (12-Jul) to determine quality. No yields were recorded at this harvest date. The goal was to evaluate the potential loss in wheat quality from this early harvest date.

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 Quantitative 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	Spring wheat
Row spacing (in.)	6
Seeding rate	130 lbs/acre
Replicates	4
Planting date	15-Sep-2010
Harvest date 1	12-Jul
Harvest date 2	19-Jul
Harvest date 3	29-Jul
Harvest date 4	5-Aug
Harvest date 5	12-Aug
Harvest area (ft.)	5x10
Tillage operations	plow, disc, & spike-toothed harrow

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 (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 729 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	**4615***
B	3886*
C	3161
LSD	**889**

RESULTS

Seasonal precipitation and temperature recorded at a weather station in close proximity to Alburgh are shown in Table 3. As seen in Table 3, March, April and May were cooler and wetter than average years. As a result, early spring growth was delayed. From planting to harvest, there was an accumulation of 6787 Growing Degree Days (GDD), 635 GDDs higher than the 30-year average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2010-2011

South Hero (Alburgh)	2010				2011							
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Average Temperature (F)	64.0	50.6	39.9	27.7	22.8	20.8	32.9	46.6	58.7	67.1	74.4	70.4
Departure from Normal	3.6	1.8	2.2	2.3	4.6	0.5	2.1	3.1	2.1	1.3	3.3	1.6
Precipitation (inches)	4.32	6.73	2.93	3.39	0.90	3.12	3.39	7.88	8.67	3.52	3.68	10.23
Departure from Normal	0.86	3.75	0.00	1.52	-1.05	1.71	1.07	5.00	5.35	0.09	-0.29	6.38
Growing Degree Days (base 32)	990.5	578.2	243.4	17.1	0.0	0.0	144.2	465.0	826.2	1088.1	1314.4	1120.7
Departure from Normal	138.5	57.4	63.4	12.4	0.0	0.0	27.9	120.0	63.6	74.1	103.9	-26.3

*Precipitation from March through July was taken from Burlington.
*Average temperatures from August through October were taken from Burlington.

Yields can decrease as harvest is delayed due to lodging, shattering, weather and animal pressure. Thus, the yield for the first harvest date, July 19, is significantly higher than any of the other harvest dates (Table 4). There was no significant difference among yields for the varieties evaluated in the study (Table 5). 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 dampened by rainfall or dew causing the grain to initiate the germination process before harvesting (pre-harvest 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. The test weight for July 19 (61.1 pounds per bushel) was significantly higher than all the other harvest dates. Borden had the highest test weight of the three varieties, but at 57.3 pounds per bushel, it was statistically the same as Harvard and Warthog.

Table 4. Influence of harvest date on wheat yield.

Variety	Test weight lbs/bu	Yield at 13.5% moisture lbs/acre
July 19	**61.1***	**3479***
July 29	55.5	2730
August 5	58.0	2281
August 12	57.3	2901
Trial mean	58.0	2848
LSD (0.10)	0.5	528

Table 5. Influence of variety on wheat yield.

Variety	Test weight lbs/bu	Yield at 13.5% moisture lbs/acre
Arapahoe	58.1	2438
Borden	**57.3***	**3095**
Harvard	58.3*	2993
Warthog	58.2*	2866
Trial mean	58.1	2848
LSD (0.10)	0.5	NS

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

Wheat harvested on July 12th had the highest harvest moisture of 17.3% (Table 6). This was significantly higher than any of the other harvest dates. Protein levels throughout the study were generally low, averaging 8.55% 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. The July 19 harvest had the highest percent crude protein, which was statistically the same as the August 5 harvest date. The August 12 harvest date resulted in the lowest crude protein. For varieties, Harvard had the highest percent moisture (15.8%), but was not statistically different from Warthog (Table 7). There were no statistical differences among varieties for crude protein (Table 7).

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 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. All of the falling numbers from the harvest dates fall within this range. However, the July 19 and July 29 harvest dates had significantly higher falling numbers. Similarly, the falling numbers for all of the varieties fell within an acceptable range. However, Warthog had a significantly higher falling number than the other varieties.

Table 6. Influence of harvest date on wheat quality.

Variety	Harvest moisture	Crude protein at 12% moisture	Falling number	DON
	%	%	seconds	ppm
July 12	**17.3***	8.34	370	0.36*
July 19	12.9	**9.18***	**403***	0.43
July 29	16.2	8.23	390*	0.33*
August 5	13.7	9.17*	379	**0.28***
August 12	15.4	7.83	345	0.40
Trial mean	15.1	8.55	377	0.36
LSD (0.10)	0.45	0.53	16.8	0.09

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

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 (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 were however some significant differences in DON in both harvest dates and variety treatments. Harvest dates July 12, July 29 and August 5 had significantly less DON than July 19 and August 12 (Table 6). For varieties, Arapahoe and Warthog had significantly less DON than Borden and Harvard (Table 7).

Table 7. Influence of variety on wheat quality.

Variety	Harvest moisture	Crude protein at 12% moisture	Falling number	DON
	%	%	seconds	ppm
Arapahoe	14.4	**8.77**	393	**0.29***
Borden	14.4	8.37	353	0.43
Harvard	**15.8***	8.30	344	0.41
Warthog	15.7*	8.76	**418***	0.32*
Trial mean	15.1	8.55	377	0.36
LSD (0.10)	0.4	NS	15	0.08

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

The interactions between harvest date and variety were also considered however, there were no significant differences in yield, test weight, crude protein, falling number, or DON. This suggests that varieties performed the same regardless of harvest date.

DISCUSSION

Many farmers prefer to leave wheat in the field until proper storage moisture is reached. This has many benefits to the farmer including reduced drying costs and storage issues. However, often during the wheat dry down period (July) there are periods of wet and humid weather that can cause the wheat quality to decline in the field. Few farmers have started to harvest as early as the combine can harvest the grain to make sure high quality parameters of bakers are being met. Our research was designed to evaluate yield and quality declines as wheat harvest is delayed. Weather conditions during July and early August were dry and warm. Therefore falling numbers declined over time but not below acceptable levels. Yields declined as well and were most likely due to shattering losses during the dry weather. More research across variable temperature and precipitation schemes needs to conducted to further determine the impact of harvest date on wheat yield and quality.

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