NORTHWEST CROPS & SOILS PROGRAM

2014 Organic Winter Wheat Planting Date Trial

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2014 ORGANIC WINTER WHEAT PLANTING DATE TRIAL

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In 2014, the University of Vermont Extension Northwest Crops and Soils Program conducted a winter wheat planting date trial. As the demand for local organic wheat has risen over the last few years, UVM Extension has been trying to determine the best agronomic practices for wheat production in the Northeastern climate. Traditionally, producers have planted winter wheat after the Hessian fly free date, 15-Sep. Producers are interested in knowing how late they can plant their wheat in order to plan rotations and maximize yield while maintaining quality.

MATERIALS AND METHODS

The trial was conducted in 2014 at Borderview Research Farm in Alburgh, VT. The experimental design was a randomized complete block split design with four replications. Main plots were planting date and subplots were varieties (Table 1, 2). Planting dates were initiated on 20-Sep 2013 and continued approximately every week for 4 weeks with a Great Plains Cone Seeder (Table 2). Three hard red spring wheat varieties were selected to represent varieties of varying heights (Table 1).

Table 1. Seed varieties and seed sources for the winter wheat planting date trial at Borderview Research Farm in Alburgh, VT.

Winter Wheat Varieties	Type	Origin	Seed Source
Harvard	Hard red winter wheat	Canada	saved seed-VT
Morley (AC)	Hard red winter wheat	Canada	Bramhill Seeds, Canada
Redeemer	Hard red winter wheat	Canada	Bramhill Seeds, Canada

Table 2. Winter wheat planting and emergence dates at Borderview Research Farm in Alburgh, VT, 2013.

Planting date	Plant emergence date
20-Sep	27-Sep
27-Sep	4-Oct
4-Oct	10-Oct
10-Oct	25-Oct

The soil type at the project site was a Benson rocky silt loam. The seedbed was prepared by fall plow, followed by disk and spike tooth harrow. All plots were managed with practices similar to those used by producers in the surrounding areas (Table 3).

Grain plots were harvested on 1-Aug 2014 with an Almaco SPC50 plot combine, the harvest area was 5’ x 20’. At the time of harvest plant heights were measured, excluding awns, 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.

Table 3. Winter wheat planting date trial specifics in Alburgh, VT, 2014.

Trial information	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	3
Harvest area (ft)	5 x 20
Harvest date	1-Aug 2014
Tillage operations	Fall plow, disk, and spike tooth harrow

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 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. 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.

Data was analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications were treated as random effects and treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$)

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 following example, 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

Seasonal precipitation and temperature recorded at weather stations in close proximity to the trial site is shown in Table 4. The growing season this year was marked by lower than normal temperatures in September, April, and July, and higher than normal rainfall throughout the growing season (Apr-Jul). In Alburgh, there was an accumulation of 4756 Growing Degree Days (GDDs), which is 284 GDDs below the 30 year average.

Table 4. Temperature and precipitation summary for Alburgh, VT, 2013 and 2014.

Alburgh, VT	Sep-13	Oct-13	Apr-14	May-14	Jun-14	Jul-14
Average temperature (°F)	59.3	51.1	43.0	57.4	66.9	69.7
Departure from normal	-1.30	2.90	-1.80	1.00	1.10	-0.90
Precipitation (inches)	2.20	2.39 ◊	4.34	4.90	6.09	5.15
Departure from normal	-1.44	-1.21	1.52	1.45	2.40	1.00
Growing Degree Days (base 32°F)	825	600	330	789	1041	1171
Departure from normal	-33.4	98.2	-53.9	32.8	27.3	-26.9

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.
◊ October 2013 precipitation data based on National Weather Service data from cooperative stations in Burlington, VT (http://www.nrcc.cornell.edu/page_nowdata.html)

Impact of Planting Date

There was no significant difference in plant height, yield, test weight, falling number, and DON concentration by planting date (Table 5). Winter wheat yields averaged 3416 lbs per acre across the planting dates. The second planting date (27-Sep) had the lowest harvest moisture at 18.7% while the highest harvest moisture was the fourth planting date (10-Oct) at 19.4%. All of the planting dates had moisture levels above 14% and therefore had to be dried down to below 14% moisture, necessary for optimal grain storability.

Table 5. Winter wheat harvest and quality results by planting date, 2014.

Planting date	Plant height	Yield @13.5% moisture	Harvest moisture	Test weight	Crude protein @ 12% moisture	Falling number	DON
	inches	lbs ac^{-1}	%	lbs bu^{-1}	%	seconds	ppm
20-Sep	**37.7**	3450	19.3	**52.7**	10.2	264	**0.77**
27-Sep	36.7	3263	**18.7***	52.3	10.0	270	0.98
4-Oct	35.7	3330	18.9*	52.2	10.3	**275**	1.36
10-Oct	36.9	**3622**	19.4	52.4	**11.0***	274	1.26
Trial mean	36.7	3416	19.1	52.4	10.4	271	1.09
LSD (0.10)	NS	NS	0.26	NS	0.56	NS	NS

*Treatments that did not perform significantly lower than the top-performing treatment (in **bold**) in a particular column are indicated with an asterisk.
NS-Treatments were not significantly different from one another.

The fourth planting date (10-Oct) had the highest crude protein level (11.0 %) and the lowest level (10.0%) was the second planting date (27-Sep) (Figure 1). None of the protein levels from any of the planting dates met the industry standards of 12-15% protein. Regardless of planting date, falling number was below 350 seconds indicating some sprout damage. 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. The third and fourth planting dates were above the FDA's 1ppm limit.The lowest DON level was the 20-Sep planting date (0.77 ppm).

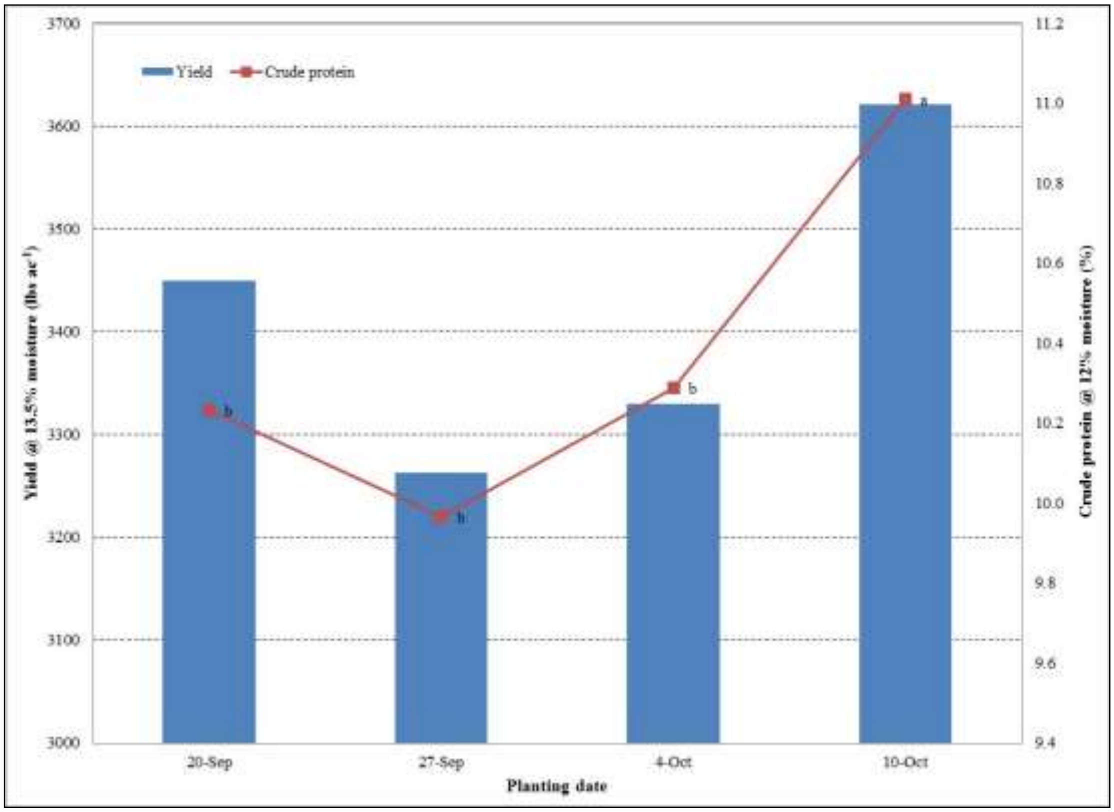

Figure 1. Yield and protein comparison between planting dates across hard red winter wheat varieties in Alburgh, VT, 2014.
Treatments that share a letter did not differ significantly by planting date.

Impact of Variety

Varieties did not differ significantly in yield (Table 6). There were significant differences in plant height, harvest moisture, test weight, crude protein, falling, and DON between varieties (Table 6). Morley (AC) was the tallest variety (41.1 inches) and Harvard was the shortest (33.9 inches). All of the winter wheat varieties had harvest moistures greater than 14%, the optimum moisture for grain storability, and therefore had to be dried down. Redeemer had the lowest harvest moisture out of the three varieties (18.7 %). Morley (AC) had the highest test weight (52.8 lbs bu^{-}1). Redeemer also had a high test weight of (52.6 lbs bu^{-1}). However, none of the varieties attained 56-60 lbs bu^{-1} the desired test weight for wheat. Redeemer had the highest crude protein level (11.4%) and the lowest (9.5%) was Morley (AC) (Figure 2). None of the variety crude protein levels met industry standards of 12-15% protein. Redeemer had the highest falling number of 304 seconds. All the varieties had falling numbers below 350 seconds indicating some sprout damage. The DON levels varied this year. Two of the three varieties had DON levels below the FDA's 1ppm limit. The lowest DON level was Morley (AC) (0.47 ppm) and the highest level was Harvard (1.88 ppm).

Table 6. Winter wheat harvest and quality results by variety, 2014.

Variety	Plant height	Yield @13.5% moisture	Harvest moisture	Test weight	Crude protein @ 12% moisture	Falling number	DON
	inches	lbs ac^{-1}	%	lbs bu^{-1}	%	seconds	ppm
Morley (AC)	**41.1***	**3631**	19.3	**52.8***	9.5	265	**0.47***
Harvard	33.9	3380	19.2	51.8	10.2	243	1.88
Redeemer	35.2	3238	**18.7***	52.6*	**11.4***	**304***	0.92
Trial mean	36.7	3416	19.1	52.4	10.4	271	1.09
LSD (0.10)	2.7	NS	0.23	0.60	0.49	24	0.49

*Treatments that did not perform significantly lower than the top-performing treatment (in **bold**) in a particular column are indicated with an asterisk.
NS-Treatments were not significantly different from one another.

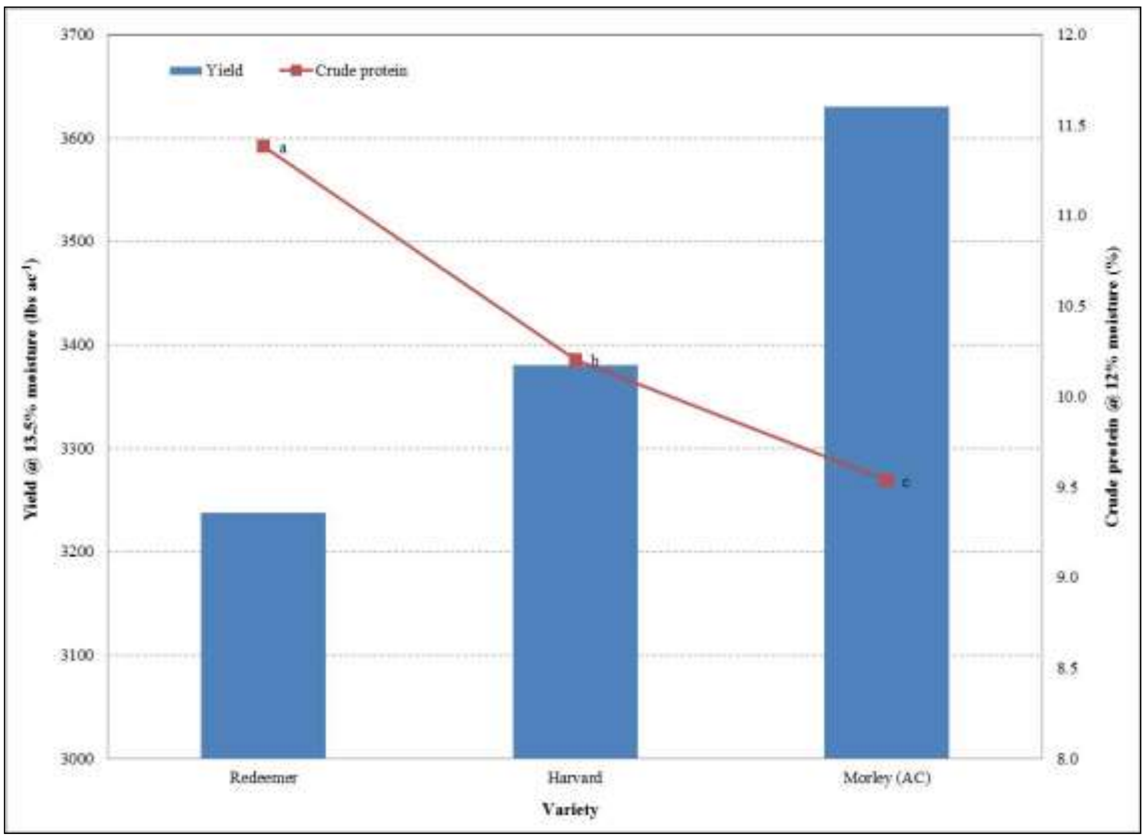

Figure 2. Yield and protein comparison between hard red winter wheat varieties across all planting dates in Alburgh, VT, 2014.
Treatments that share a letter did not differ significantly by variety.

DISCUSSION

It is important to remember that the results only represent one year of data. The 2014 growing season brought many challenges to the grain growing industry. Overall, winter wheat yields were lower than average and likely due to weather conditions. The fluctuating temperatures in the fall, when the wheat was planted, could have impacted wheat germination, stand establishment, and early development resulting in the variable grain yields across planting dates. Below average temperatures in September might have reduced the productivity of early-planted wheat. The above average temperatures in October likely helped later plantings catch up to the September planted wheat. This may partially explain why there was no yield differences observed among the planting dates. In addition, the cold winter and limited snow cover caused some winter kill.

A prolonged cool and wet spring further delayed wheat development; this might help explain the later harvest date, and higher grain moistures at harvest. The below average temperatures, and above average rainfall, persisted throughout the growing season which resulted in delayed wheat development and dry down. This might help explain the overall lower test weights, crude protein, and falling number results. The mean yield in 2014 was 3,416 lbs ac^{-1}, 972 lbs ac^{-1} higher than the 2013 mean yield. Interestingly, DON levels were not nearly as high as they were in 2013. Only Harvard had DON levels above 1 ppm.

Interestingly, in 2014 there were no interactions between planting date and variety. Meaning varieties responded similarly across planting date. In general, planting winter wheat early enough to allow for six to eight weeks of growth before the soil freezes, will provide the best chances of high yield and quality winter wheat

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