2016 Winter Barley Planting Date and Nitrogen Amendment Trial

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With the revival of the small grains industry in the Northeast and the strength of the locavore movement, craft breweries and distilleries have expressed an interest in sourcing local barley for malting. Malting barley must meet specific quality characteristics such as low protein content and high germination. Many farmers are also interested in barley as a concentrated, high-energy feed source for livestock. Depending on the variety, barley can be planted in either the spring or fall, and both two- and six-row barley can be used for malting and livestock feed. Winter barley has not been traditionally grown in the Northeast due to severe winterkill. However, newly developed varieties and a changing climate have encouraged our team to investigate this crop for the area. In 2015, we undertook this project in coordination with the University of Massachusetts to evaluate the effects of winter barley planting date and quantity of fall and spring nitrogen amendments on barley yields and quality.

MATERIALS AND METHODS

The winter barley trial was carried out at Borderview Research Farm in Alburgh, VT. The experimental design was a randomized complete block with split plots and four replicates. The main plots were planting date. Wintmalt winter barley was planted at a seeding rate of 400 seeds m^{2-1} on 5-Sep, 15-Sep, and 25-Sep 2015. The split plot was nitrogen amendments. Plots received differing amounts of nitrogen in both fall 2015 and spring 2016. Plots were fertilized on 7-Oct 2015 with either no nitrogen or 25 lbs ac^{-1}. Plots received either 0, 25, 50, 75 lbs ac^{-1} on 10-May 2016. Nitrogen was applied as calcium ammonium nitrate (27-0-0). The seedbed was prepared by conventional tillage methods. Plots were 5' x 20' and were seeded into a Benson rocky silt loam at 125 lbs ac^{-1} with a Great Plains cone seeder. Rows were spaced at 6". All plots were managed with practices similar to those used by producers in the surrounding areas (Table 1).

Fall barley populations were taken on 14-Oct 2015 by counting the number of plants in two twelve inch sections. Winter survival was assessed by a visual estimate on 25-Apr 2016.

Table 1. Winter barley agronomic characteristics and trial information.

Trial information	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	corn
Seeding rate (plants m^{2-1})	400
Row spacing (in)	6
Replicates	4
Planting date	5, 15, and 25-Sep 2015
Harvest date	8 and 21-Jul 2016
Harvest area (ft)	5 x 20
Tillage operations	Fall plow, spring disk & spike tooth harrow

The first planting date was harvested with an Almaco SPC50 small plot combine on 8-Jul 2016. Planting dates two and three were harvested on 21-Jul 2016. Following the harvest of winter barley, seed was cleaned with a small Clipper cleaner. A one-pound subsample was collected to determine quality. Quality measurements included standard testing parameters used by commercial malt houses. Harvest moisture was determined for each plot using a DICKEY-john M20P moisture meter. Test weight was measured using a Berckes Test Weight Scale, which weighs a known volume of grain. Subsamples were ground into flour using the Perten LM3100 Laboratory Mill, and were evaluated for crude protein content using the Perten Inframatic 8600 Flour Analyzer. In addition, falling number for all barley varieties was determined using the AACC Method 56-81B, AACC Intl., 2000 on a Perten FN 1500 Falling Number Machine. Samples were also analyzed for Deoxynivalenol (DON) using the Veratox DON 2/3 Quantitative test from the NEOGEN Corp. This test has a detection range of 0.5 to 5 ppm. Each variety was evaluated for seed germination by incubating 100 seeds in 4.0 mL of water for 72 hours and counting the number of seeds that did not germinate.

Data was analyzed using mixed model analysis procedure of SAS (SAS Institute, 1999). Replications were treated as random effects, and treatments were treated as fixed. 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 due to experimental treatments, or whether it might have occurred due to other variations in the field. At the bottom of each table, a p value is presented for each variable (i.e. yield). A small p value (close to zero) indicates strong statistical differences between varieties. A large p value (close to one) indicates weak statistical differences between varieties. A p value of 0.10 indicates that the differences between varieties are significant at 10% level of probability. Where the p value is 0.10, you can be sure in 9 out of 10 chances that there is a real difference between the varieties. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk.

RESULTS AND DISCUSSION

Seasonal precipitation and temperature recorded at a weather station in Alburgh, VT are shown in Table 2. Historical averages are for 30 years of data (1981-2010). Fall conditions were above average for temperature and below average for precipitation. While April was colder than normal, the rest of the spring and summer growing season was also both warmer and drier than average. There were 5323 Growing Degree Days (GDDs) in the eight month winter barley growing season, 278 more growing-degree-days than the 30-year average.

Table 2. Weather data for winter barley variety trial in Alburgh, VT.

Alburgh, VT	Sep-15	Oct-15	Nov-15	Mar-16	Apr-16	May-16	Jun-16	Jul-16
Average temperature (°F)	65.2	46.5	42.2	33.9	39.8	58.1	65.8	70.7
Departure from normal	4.70	-1.60	4.00	2.90	-4.90	1.80	0.00	0.10
Precipitation (inches)	0.3	2.5	1.8	2.51	2.56	1.53	2.81	1.79
Departure from normal	-3.30	-1.09	-1.30	0.29	-0.26	-1.92	-0.88	-2.37
Growing Degree Days (base 32°F)	1010	464	329	209	291	803	1017	1201
Departure from normal	158	-37	117	85	-98	50	3	4

*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.

There were significant differences in winter survival between planting dates (Table 3). There were no significant differences in populations, test weight, DON levels, germination rate, crude protein, falling number, yield, or harvest moisture by planting date or nitrogen amendment. Across trial, there were low DON levels, slightly low test weight, and low harvest moisture. There was high falling number across the trial, with all treatments well above the 250 second industry minimum standard. Crude protein across the trial was within the industry standard of 9-12% for malting barley.

Impact of Planting Date:

There were significant differences between planting dates in winter survival. The earliest planting dates had the highest winter survival. Winter survival did not have a significant effect on harvest yield, however. The two later planting dates had higher yields that the earliest date, although this was not significantly different.

Table 3. Impact of planting date on barley harvest and quality, Alburgh, VT, 2016.

Planting date	Populations	Winter Survival	Harvest moisture	Test weight	Harvest yield
	plants m^{2-1}	%	%	lbs bu^{-1}	lbs ac^{-1}
5-Sep	434	**66***	**13.7**	39.5	1956
15-Sep	**439**	**66***	14.0	39.7	**2170**
25-Sep	435	47	14.9	**42.1**	2093
p value	0.93	0.03	0.20	0.21	0.26
Trial mean	436	59	14.2	40.3	2072

Planting date	Crude protein @ 12% moisture	DON	Falling number	Germination
	%	ppm	seconds	%
5-Sep	11.46	**0.10**	316	**95.6**
15-Sep	11.61	0.11	316	94.2
25-Sep	**11.64**	0.15	**340**	94.1
p value	0.94	0.39	0.18	0.64
Trial mean	11.57	0.11	323	94.8

*Treatments with an asterisk are not significantly different than the top performer in **bold**.
NS – No significant difference amongst treatments.

Impact of Nitrogen Amendment:

Plots were fertilized on 7-Oct 2015 with either no nitrogen or 25 lbs ac^{-1}. Plots received either 0, 25, 50, 75 lbs ac^{-1} on 10-May 2016. Nitrogen amendment had no significant effect across the trial. Spring nitrogen did appear to have a beneficial effect on crude protein levels, with both of the treatments receiving 75 lbs ac^{-1} in the spring having greater than 12% crude protein content, although this difference was not statistically significant.

Table 4. Impact of nitrogen amendment on barley harvest and quality, Alburgh, VT, 2016.

Fall-Spring nitrogen lbs ac^{-1}	Populations plants m^2	Winter Survival %	Harvest moisture %	Test weight lbs bu^{-1}	Harvest yield lbs ac^{-1}
0-0	396	60	13.5	39.8	**2239**
0-25	453	61	15.0	40.6	2134
0-50	456	60	14.4	38.7	2196
0-75	446	**62**	14.8	**41.8**	2100
25-0	422	59	**13.2**	40.6	1834
25-25	436	61	14.2	40.7	1936
25-50	422	59	14.0	40.7	2184
25-75	**457**	54	14.2	40.0	1959
p value	0.68	0.99	0.78	0.96	0.99
Trial mean	436	59	14.2	40.3	2072

Fall-Spring nitrogen lbs ac^{-1}	Crude protein @ 12% moisture %	DON ppm	Falling number seconds	Germination %
0-0	10.85	0.06	314	93.9
0-25	10.92	0.11	320	92.7
0-50	11.54	0.08	**330**	95.6
0-75	**12.39**	0.23	329	**98.7**
25-0	10.95	0.08	312	95.9
25-25	11.57	**0.04**	327	96.2
25-50	12.08	0.17	320	91.5
25-75	12.10	0.13	328	92.9
p value	0.34	0.17	0.99	0.49
Trial mean	11.57	0.11	323	94.8

Top performing treatments are shown in **bold**.

Interactions between treatments:

There were no statistically significant interactions between treatments in this study.

DISCUSSION

The warm, dry weather through most of the 2015-2016 winter barley growing season resulted in relatively good yields and quality in winter barley. There was little snow cover to insulate the overwintering barley from cold damage, which affected some plots far more than others. The earlier planting dates were better established than the later dates and had significantly less winterkill. However, the later planting dates of

15-Sep and 25-Sep had higher yields despite the poorer winter survival rate compared to the earliest planting date of 5-Sept. This may be partially explained by higher weed pressure observed in the first planting date replicates, which were at a slightly higher elevation and with rockier soil than the later dates. The dry weather reduced disease pressure and there was little evidence of fusarium blight or the associated DON vomitoxin. The test weights for all barley treatments fell below the industry standard of 48 lbs bu^{-1}. Crude protein levels were within the industry standards for crude protein of 9.0-12.0%, regardless of planting date or nitrogen amendment. These data in this study represent only one year and should not alone be used to make management decisions.

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