2018

Winter Barley Planting Date and Nitrogen Amendment Trial

Heather Darby
University of Vermont

Hillary Emick
University of Vermont

Haley Jean
University of Vermont

2018 Winter Barley Planting Date and Nitrogen Amendment Trial

Dr. Heather Darby, UVM Extension Agronomist
Hillary Emick and Haley Jean
UVM Extension Crops and Soils Coordinators
(802) 524-6501

Visit us on the web at: http://www.uvm.edu/nwcrops

THE UNIVERSITY OF VERMONT
EXTENSION

2018 WINTER BARLEY PLANTING DATE AND NITROGEN AMENDMENT TRIAL

Dr. Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

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 2017/2018, we undertook this project to evaluate the effects of winter barley planting date and quantity of fall and spring nitrogen (N) amendments on barley yields and quality.

MATERIALS AND METHODS

The winter barley trial was carried out at Borderview Research Farm in Alburgh, Vermont. The experimental design was a randomized complete block with split plots and four replicates. The main plots were planting dates. Wintmalt barley was planted on 1-Sep, 15-Sep, and 28-Sep 2017. The split plots were N amendments. Plots received differing amounts of N in both fall 2017 and spring 2018. Plots were fertilized on 3-Oct 2017 with 25 lbs N ac^{-1} or did not receive N. Additional N was added at 0, 25, 50, or 75 lbs ac^{-1} on 10-May 2018. 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} (400 seeds m^{-2}) 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 measured post-emergence and prior to tillering on 4-Oct 2017 for the first two planting dates and on 17-Oct for the third planting date. The number of plants in two twelve inch sections were counted. Winter survival was assessed on 10-May 2018 by examining 25 plants per plot and counting how many were alive.

Table 1. Winter barley agronomic characteristics and trial information.

Trial information	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Spring barley
Seeding rate (plants m^{-2})	400
Row spacing (in)	6
Replicates	4
Planting date	1-Sep, 15-Sep, and 28-Sep 2017
Harvest date	12-Jul 2018
Harvest area (ft)	5 x 20
Tillage operations	Fall plow, spring disk & spike tooth harrow

Plant heights and lodging were assessed on 11-Jul 2018. Three plants per plot were measured in centimeters, including the barley head but not the awns. Lodging was assessed visually and rated on a scale from 0-9, where 0 indicated no lodging and 9 indicated that the entire plot was too lodged to harvest. The Wintmalt barley was harvested with an Almaco SPC50 small plot combine on 12-Jul 2018. 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-17	Oct-17	Nov-17	Mar-18	Apr-18	May-18	Jun-18	July-18
Average temperature (°F)	64.4	57.4	35.2	30.4	39.2	59.5	64.4	74.1
Departure from normal	3.76	9.16	-2.96	-0.66	-5.58	3.10	-1.38	3.51
Precipitation (inches)	1.8	3.3	2.3	1.5	4.4	1.9	3.7	2.4
Departure from normal	-1.80	-0.31	-0.84	-0.70	1.61	-1.51	0.05	-1.72
Growing Degree Days (32-95°F)	971	786	202	90	272	853	973	1305
Departure from normal	113	284	17	90	-112	97	-42	107

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.

Impact of Planting Date:

There were significant differences between planting dates for population, winter survival, height, harvest moisture, test weight, harvest yield, crude protein, DON, falling number and germination. The last planting date performed the best in all categories except crude protein. It had both the highest fall populations and winter survival, likely contributing to the higher yield than the other planting dates. The third planting date was the only one that did not need to be dried down for storage (harvest moisture less than 14%) and also the only planting date with a test weight above the industry minimum of 48 lbs bu^{-1}. The first planting date had the highest crude protein of 10.5%. All three planting dates were within the desirable range of 9-11% for malting barley. Although the third planting date had the lowest DON concentration at 0.1 ppm, all planting dates were well below the FDA threshold for human consumption of 1 ppm. All planting dates had a falling number above 220. The third planting date was the only one with germination above 95%, which is desirable for malting barley.

Table 3. Impact of planting date on barley harvest and quality, Alburgh, VT, 2018.

Planting date	Populations	Winter survival	Height	Harvest moisture	Test weight	Harvest yield
	plants m^{-2}	%	cm	%	lbs bu^{-1}	lbs ac^{-1}
5-Sep	344^{b}	47.6^{c}	57.1^{c}	18.4^{b}	40.3^{c}	1208^{c}
15-Sep	361^{b}	59.6^{b}	64.1^{b}	17.7^{b}	44.5^{b}	2170^{b}
28-Sep	**438^{a}**	**87.3^{a}**	**72.5^{a}**	**13.8^{a}**	**49.6^{a}**	**3851^{a}**
LSD (0.10)	35.3	10.0	2.05	1.29	1.25	262
Trial mean	381	64.8	64.6	16.6	44.8	2410

Planting date	Crude protein @ 12% moisture	DON	Falling number	Germination
	%	ppm	seconds	%
5-Sep	**10.5^{a}**	0.29^{c}	276^{c}	85.2^{c}
15-Sep	10.1^{a}	0.18^{b}	326^{b}	91.6^{b}
28-Sep	9.2^{b}	**0.10^{a}**	**356^{a}**	**97.6^{a}**
LSD (0.10)	0.52	0.05	12.5	2.55
Trial mean	9.9	0.19	319	91.4

Top performer treatments are shown in **bold**.
Within a column, planting dates with the same letter performed statistically similar.

Impact of Nitrogen Amendment:

Plots were fertilized on 3-Oct 2017 with either no N or 25 lbs N ac^{-1}. Additional N was added on 10-May 2018 at either 0, 25, 50, or 75 lbs ac^{-1}. There were significant differences between nitrogen treatments in population, harvest moisture, test weight, yield, protein, DON, falling number and germination. The highest population was observed in the 25-25 treatment. The average population for the plots receiving N in the fall was 382, just over the trial average, while the average population for the plots that did not receive N in the fall was 379, just under the trial average. Winter survival ranged from 71.3% (0-25 nitrogen treatment) to 57.3% (25-75 N treatment). There was no discernable effect of fall fertilization on winter survival. When averaged by N treatment, all treatments were above 14% moisture and below the desired test weight of 48 lbs bu^{-1}. The 0-75 treatment had the lowest moisture at 15% and the highest test weight at 46.2 lbs bu^{-1}. The 0-75 treatment also had the highest yield at 2774 lbs ac^{-1}. This was statistically similar to the 0-50, 25-0, and 25-75 yields, which were all above 2500 lbs bu^{-1}. The two highest yielding treatments that were amended with 75 lbs N ac^{-1} in the spring were in the highest yielding, implying that spring nitrogen application may have been more beneficial than fall application for increasing yield.

Table 4. Impact of nitrogen amendment on barley harvest and quality, Alburgh, VT, 2018.

Fall-Spring nitrogen lbs ac^{-1}	Populations plants m^{-2}	Winter Survival %	Height cm	Harvest moisture %	Test weight lbs bu^{-1}	Harvest yield lbs ac^{-1}
0-0	374^{ab}	69.7	60.9^{c}	16.6^{ab}	44.7^{ab}	1988^{c}
0-25	375^{ab}	**71.3**	61.9^{bc}	15.3^{a}	46.0^{a}	2286^{bc}
0-50	401^{a}	61.3	66.4^{a}	16.4^{ab}	44.8^{ab}	2521^{ab}
0-75	365^{ab}	63.3	64.9^{ab}	**15.0^{a}**	**46.2^{a}**	**2774^{a}**
25-0	339^{b}	67.0	65.1^{ab}	17.7^{bc}	43.8^{b}	2547^{ab}
25-25	**421^{a}**	65.0	64.7^{ab}	17.1^{ab}	44.8^{ab}	2258^{bc}
25-50	406^{a}	63.7	65.8^{a}	15.6^{ab}	44.3^{ab}	2281^{bc}
25-75	366^{ab}	57.3	**66.7^{a}**	19.3^{c}	43.5^{b}	2622^{ab}
LSD (0.10)	57.6	NS	3.35	2.1	2.04	429
Trial mean	381	64.8	64.6	16.6	44.8	2410

Fall-Spring nitrogen lbs ac^{-1}	Crude protein @ 12% moisture %	DON ppm	Falling number seconds	Germination %
0-0	9.1^{c}	0.18^{ab}	296^{c}	88.8^{b}
0-25	9.8^{bc}	**0.13^{a}**	**337^{a}**	91.5^{ab}
0-50	10.2^{b}	0.18^{ab}	332^{a}	92.1^{ab}
0-75	9.6^{b}	0.19^{ab}	333^{a}	**94.1^{a}**
25-0	9.7^{bc}	0.17^{ab}	318^{ab}	92.3^{ab}
25-25	9.7^{bc}	0.23^{b}	311^{bc}	92.9^{a}
25-50	10.1^{b}	0.23^{b}	320^{ab}	91.4^{ab}
25-75	**11.5**^{a}	0.23^{b}	308^{bc}	88.3^{b}
LSD (0.10)	0.85	0.07	20.5	4.16
Trial mean	9.95	0.19	319	91.4

Top performer treatments are shown in **bold**.
Within a column, planting dates with the same letter performed statistically similar.
NS indicates no significant differences between treatments.

The highest crude protein was in the 25-75 treatment, the treatment that received the most total N. This treatment produced grain slightly above the desirable range for malting barley of 9-11%. Protein for all other treatments was in the desirable range. This indicates that 75 lbs of N ac^{-1} applied in the spring with a modest addition of fall applied N can increase yield and protein concentrations. The lowest DON concentrations were in the 0-25 nitrogen treatment, which had DON levels of 0.13 ppm. All treatments had DON below the 1 ppm FDA standard. The highest falling number was 337 seconds (0-25 treatment). Falling number for all treatments was above 220. The germination for all N treatments averaged below the industry standard of 95% for malting barley. The 0-75 nitrogen treatment had the highest germination at 94.1%

Interactions between treatments:
There was a significant interaction between planting date and nitrogen amendment for yield (p=0.0488) (Figure 1). This indicates that planting dates responded differently to nitrogen treatments. The third planting date had the highest yield, and barley in this planting date had an increased yield with fall nitrogen amendment of 25 lbs ac^{-1} compared to the plots in this planting date that were not fertilized in the fall. The two treatments that had a spring nitrogen application of 75 lbs ac^{-1} were also high yielding. There was no discernable effect of nitrogen application within the first or second planting dates.

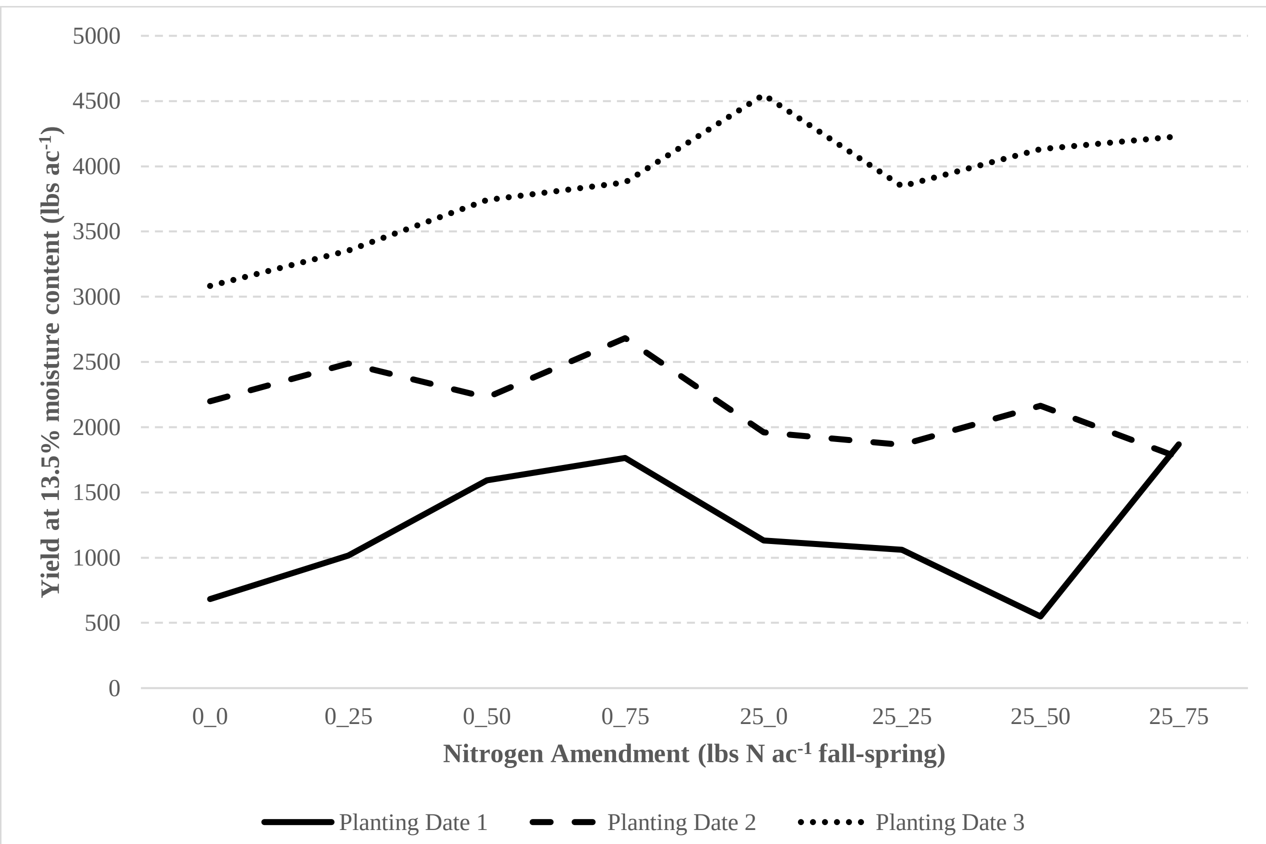

Figure 1: Interaction between planting date and nitrogen amendment for yield (p=0.0488).

DISCUSSION

Barley planted on the 28-Sep yielded significantly higher compared to the early to mid-Sep planting dates. The winter survival and quality were also superior for this planting date. This indicates that winter barley planting dates similar to planting dates for winter wheat may be optimum for our region. The weather conditions in September 2017 were slightly above average temp but quite dry. October 2017 was very warm compared to normal and had more precipitation than September. The warm, moist early October weather following the final planting date was more conducive to germination and barley establishment than the weather following the earlier planting dates.

Nitrogen treatments that included a spring application of 75 lbs N ac^{-1} were among the highest yielding treatments. Fall nitrogen application increased barley yields in the third planting date, but spring nitrogen application had a more significant impact in the earlier planting dates. Clearly, nitrogen applications to the winter barley helped to improve yield and in some cases quality. Spring applications seem to be most effective to optimize yield.

There was little evidence of *fusarium* head blight or the associated DON vomitoxin. Birds were a challenge in all barley trials at Borderview Research Farm and may have reduced yields for this trial, although the trial was harvested before the most severe damage occurred later in the summer.

These data in this study represent only one year and should not alone be used to make management decisions.

ACKNOWLEDGEMENTS

The UVM Extension Crops and Soils Team would like to thank USDA SARE for funding this important research (project number LNE15-339-29994). A special thanks to Roger Rainville and the staff at Borderview Research Farm for their generous help with this research. We would like to acknowledge John Bruce, Erica Cummings, Catherine Davidson, Abha Gupta, Rory Malone, Freddy Morin, Lindsey Ruhl, and Sara Ziegler for their assistance with data collection and entry. This information is presented with the understanding that no product discrimination is intended and neither endorsement of any product mentioned, nor criticism of unnamed products, is implied.

UVM Extension helps individuals and communities put research-based knowledge to work.

THE UNIVERSITY OF VERMONT EXTENSION