2014

Organic Spring Barley Variety Trial

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NORTHWEST CROPS & SOILS PROGRAM

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2014 ORGANIC SPRING BARLEY VARIETY 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. In 2012-2014, UVM Extension conducted a spring barley trial to evaluate the yield and quality of publicly available malting and feed barley varieties.

MATERIALS AND METHODS

A spring barley variety trial was initiated at Borderview Research Farm in Alburgh, VT. The experimental plot design was a randomized complete block with four replications. The treatments were varieties, listed in Table 1. The varieties Valley Malt 1, 2, 3, 4, 5 and Hanna were heirloom barley.

Table 1. Fifteen spring barley varieties trialed at Borderview Research Farm in Alburgh, VT.

Spring barley variety	Type	Seed source
Robust	6-row	Albert Lea Seeds, MN
AC Minoa	2-row	Semican, Canada
Conlon	2-row	Albert Lea Seeds, MN
Full Pint	2-row	Oregon State
Hanna	2-row	USDA Germplasm
Lacey	6-row	Albert Lea Seeds, MN
Newdale	2-row	Semican, Canada
AC Newport	2-row	Semican, Canada
Quest	6-row	Seedway, VT
Rasmussen	6-row	Albert Lea Seeds, MN
Valley Malt 1	unavailable	USDA Germplasm
Valley Malt 2	unavailable	USDA Germplasm
Valley Malt 3	unavailable	USDA Germplasm
Valley Malt 4	unavailable	USDA Germplasm
Valley Malt 5	unavailable	USDA Germplasm

All plots were managed with practices similar to those used by producers in the surrounding areas (Table 2). The previous crop planted at the site was sod. In April 2014, the field was disked and spike tooth harrowed to prepare for planting. The plots were seeded with a Great Plains NT60 Cone Seeder on 25-Apr at a seeding rate of 125 lbs ac^{-1} into a Benson rocky silt loam. Plot size was 5'x 20'.

Table 2. 2014 agronomic and trial information for spring barley variety trial.

Trial Information	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	sod
Tillage operations	Spring plow, disc, and spike tooth harrow
Harvest area (ft)	5 x 20
Row spacing (in)	6
Seeding rate (lbs ac^{-1})	125
Replicates	4
Planting date	25-Apr
Harvest date	4-Aug

Barley populations were measured by counting the number of plants in three 12 inch segments randomly throughout each plot on 2-Jun. Prior to harvest on 31-Jul, three plant heights were measured per plot, excluding the awns. A visual estimate of what percent a plot was lodged 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. On 4-Aug the plots were harvested using an Almaco SPC50 small plot combine. At the time of harvest grain moisture, test weight, and yield were calculated.

Following the harvest of spring barley, seed was cleaned with a small Clipper cleaner (A.T. Ferrell, Bluffton, IN). 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. Generally the heavier the barley is per bushel, the higher malting quality. The acceptable test weight for barley is 48 lbs per bushel. Once test weight was determined, the samples were then 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 were determined using the AACC Method 56-81B, AACC Intl., 2000 on a 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 sample. A falling number lower than 200 indicates high enzymatic activity and poor quality. 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. Percent germination was determined by incubating 100 seeds in 4.0 mL of water for 72 hours and counting the number of seeds that did not germinate. Each variety was done in duplicate.

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 ($P< 0.10$). There were significant differences among the two locations for most parameters and therefore data from each location is reported independently.

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 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

Seasonal precipitation and temperature recorded at weather stations in close proximity to the 2014 site are shown in Table 3. The growing season this year was marked by lower than normal temperatures in April, July, and August and higher than normal rainfall throughout the growing season (Apr-Aug). From April to August, there was an accumulation of 4510 Growing Degree Days (GDDs) in Alburgh which is 53 GDDs below the 30 year average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2014.

Alburgh, VT	April	May	June	July	August
Average temperature (°F)	43.0	57.4	66.9	69.7	67.6
Departure from normal	-1.80	1.00	1.10	-0.90	-1.20
Precipitation (inches)	4.34	4.90	6.09	5.15	3.98
Departure from normal	1.52	1.45	2.40	1.00	0.07
Growing Degree Days (base 32°F)	330	789	1041	1171	1108
Departure from normal	-53.9	32.8	27.3	-26.9	-30.9

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.

Plant populations were not significantly different between varieties (Table 4). The highest plant population was Valley Malt 2 with 388 plant per m^2, and Hanna had the lowest population, 237 plants per m^2. Plant heights, percent lodging, and lodging severity were signifcantly different among varieties. The tallest variety was Valley Malt 5 at 31.9 inches. Other tall varieties included; Hanna, Valley Malt 4, Valley Malt 1, and Quest. There were six varieties; Robust, AC Minoa, Lacey, Newdale, Quest, and Rasmussen that had no reported lodging. The variety with the highest percent of lodged plants was Valley Malt 4 (82.5%) with a severity of 1.25.

Table 4. 2014 Spring barley agronomic characteristics in Alburgh, VT.

Variety	Plant population	Plant height	Lodging	Severity
	m^2	inches	%	(0-5)
Robust	318	26.8	**0.00***	**0.00***
AC Minoa	305	26.7	**0.00***	**0.00***
Conlon	316	24.2	35.0	1.75
Full Pint	316	17.2	37.5	1.25
Hanna	237	31.0*	50.0	1.25
Lacey	366	22.9	**0.00***	**0.00***
Newdale	357	22.7	**0.00***	**0.00***
AC Newport	319	24.0	17.5*	2.25
Quest	355	28.8*	**0.00***	**0.00***
Rasmussen	350	21.2	**0.00***	**0.00***
Valley Malt 1	267	29.0*	10.0*	0.25*
Valley Malt 2	**388**	27.6	35.0	2.00
Valley Malt 3	296	22.5	67.5	0.75*
Valley Malt 4	361	30.7*	82.5	1.25
Valley Malt 5	278	**31.9***	2.50*	0.25*
LSD (0.10)	NS	4.25	27.2	1.00
Trial Mean	322	25.8	22.5	0.73

Values shown in **bold** are of the highest value or top performing.
* Barley varieties that are not significantly different than the top performing variety in a column are indicated with an asterisk.
NS - no significant coefficients ($P < 0.1$).

Spring Barley Yield and Quality:

Varieties differed significantly in yield and quality (Table 5). The 2014 yields were lower than those in 2013 and 2012. The 2014 mean yield of 951 lbs ac^{-1}, was 1,190 lbs ac^{-1} less than the average yield in 2013 and 1,847 lbs ac^{-1} less than 2012 (Figure 1).

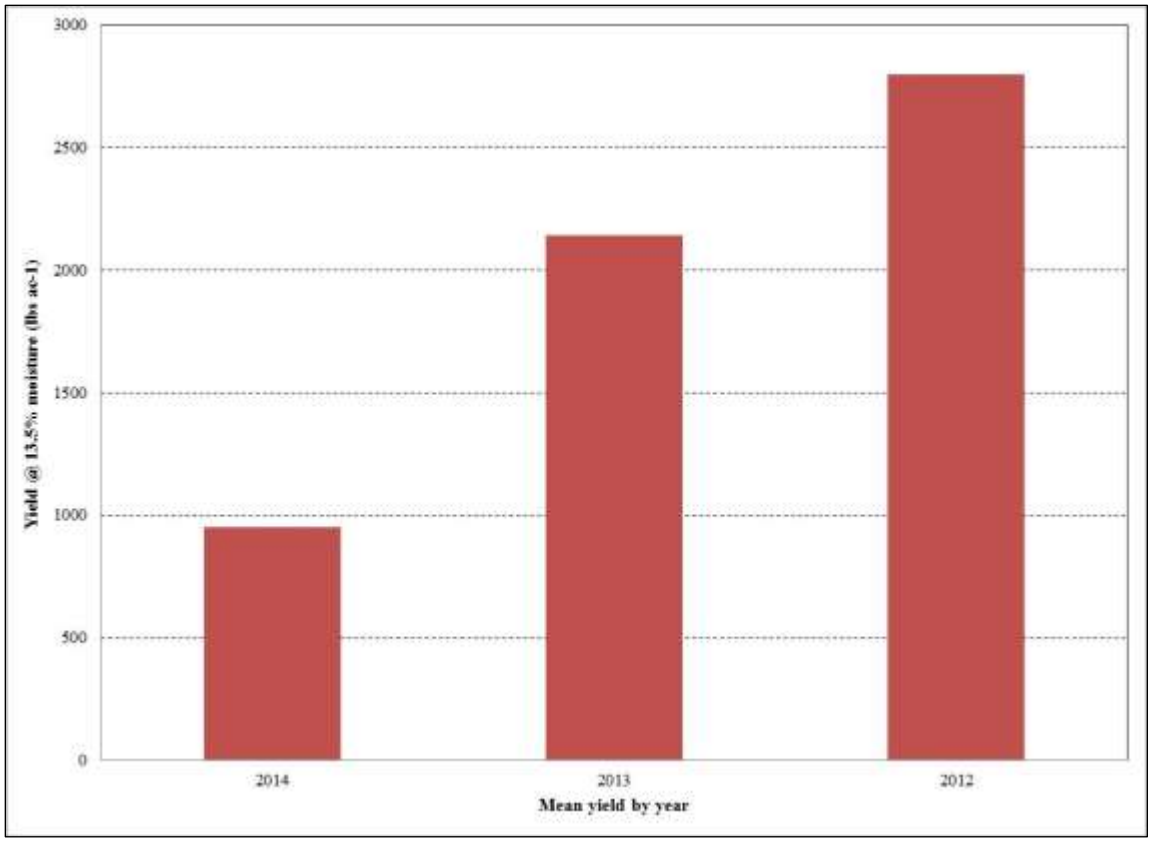

Figure 1. Spring barley variety trial mean yield comparison for 2012-2014, Alburgh, VT.

The highest yielding variety was AC Minoa (1,587 lbs ac^{-1}). Other high yielding varieties included; Rasmussen, Robust, Newdale, Quest, and Lacey (Figure 2). The lowest yielding variety was Conlon (341 lbs ac^{-1}). Valley Malt 2 had the lowest moisture at harvest (6.00%). All fifteen varieties trialed had moistures below 14% at the time of harvest and therefore did not require any additional drying. AC Newport had the highest test weight of 47.8 lbs bu^{-1}. Other varieties with high test weights were AC Minoa and Valley Malt 5. However, none of the varieties met the desired barley test weight of 48 lbs per bushel.

Valley Malt 2 had the highest crude protein content at 13.5%, although only statistically different from Valley Malt 1(Table 5, Figure 2). Ten of the 15 varieties trialed had falling number s above 250 seconds (Figure 3). Valley Malt 5 had the highest falling number (351 seconds). Other varieties with high falling numbers include; Valley Malt 4, Valley, AC Minoa, Malt 2, and AC Newport. The variety with the lowest falling number, indicating sprouting damage, was Full Pint at 62 seconds. Five of the 15 spring barley varieties trialed were above the FDA's 1ppm limit for DON. The lowest DON level was Valley Malt 5 (0.30 ppm). Additonal varieties below 1ppm include; AC Minoa, Quest, Hanna, Full Pint, Robust, AC Newport, Valley Malt 1, Valley Malt 2, and Newdale. The germination rate vary widely between varieties. Only two varieties, Valley Malt 4 (95.5%) and Valley Malt 5 (95.5%), met industry malting standards (95% or above) for seed germination. The lowest germination was Full Pint (3.00%).

Table 5. Harvest and quality results for the 15 spring barley samples trialed in Alburgh, VT, 2014.

Variety	Yield @13.5% moisture	Harvest moisture	Test weight	Crude protein @ 12% moisture	Falling number @ 14% moisture	DON	Germination
	lbs ac^{-1}	%	lbs bu^{-1}	%	seconds	ppm	%
Robust	1337*	8.40	43.1	11.0	305	0.80	94.0
AC Minoa	**1587***	13.1	46.6*	11.5	336*	0.33*	81.5
Conlon	341	12.9	40.8	9.83	228	1.07	75.0
Full Pint	732	11.1	39.3	11.1	62	0.77	3.00
Hanna	572	14.0	42.8	11.2	285	0.67	87.5
Lacey	1054*	10.0	43.0	10.5	291	1.13	86.5
Newdale	1167*	11.4	41.1	10.1	134	1.00	40.0
AC Newport	1019	12.7	**47.8***	10.0	326*	0.83	90.0
Quest	1125*	9.10	40.0	10.9	288	0.63	85.0
Rasmussen	1569*	10.0	43.4	10.4	313	1.65	83.5
Valley Malt 1	658	9.50	35.5	13.1*	270	0.87	80.5
Valley Malt 2	813	**6.00***	31.1	**13.5***	332*	0.97	82.0
Valley Malt 3	404	7.68*	27.5	12.4	271	1.97	71.0
Valley Malt 4	919	7.48*	32.8	12.5	341*	1.17	95.5
Valley Malt 5	973	12.4	44.8*	12.7	**351***	**0.30***	95.5
LSD (0.10)	541	2.21	3.02	0.67	68.5	0.64	NA
Trial Mean	951	10.4	40.0	11.4	275	0.95	NA

Values shown in **bold** are of the highest value or top performing.
* Barley varieties that are not significantly different than the top performing variety in a column are indicated with an asterisk.
NA - was not statistically tested.

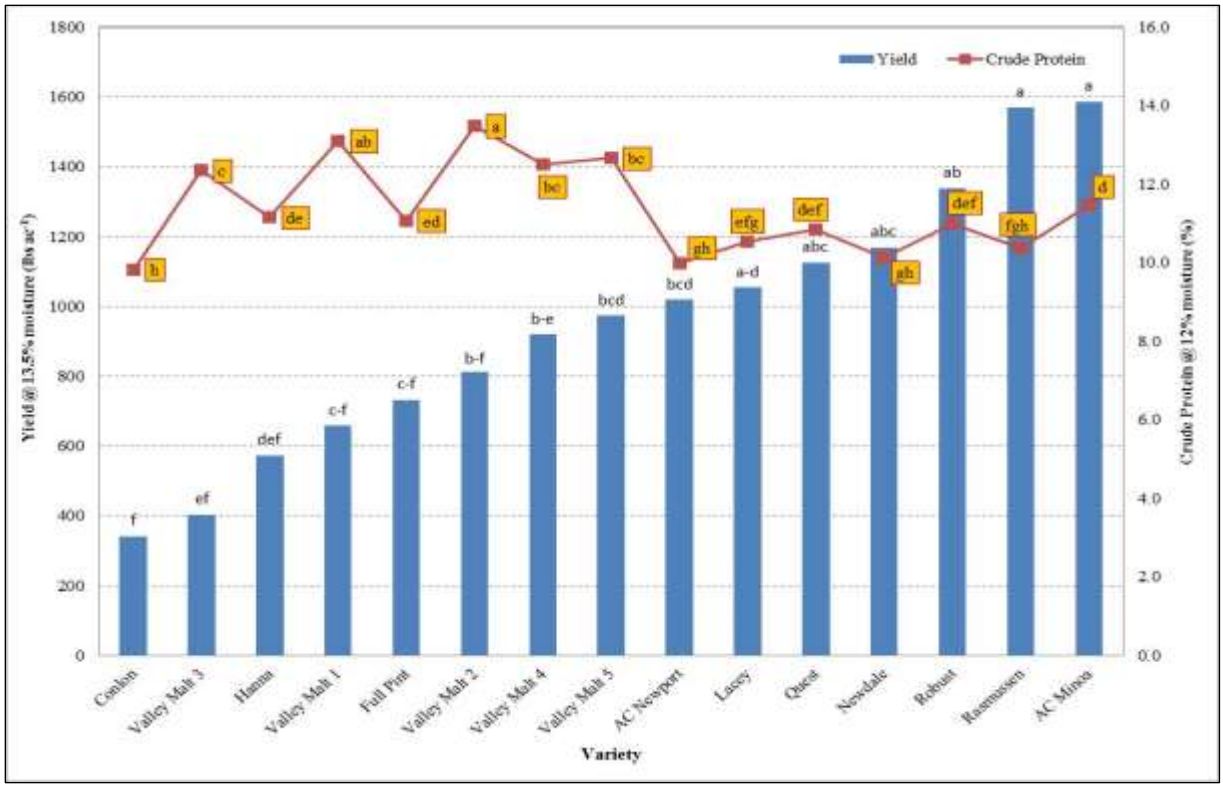

Figure 2. Yield and crude protein for the 15 spring barley varieties trialed in Alburgh, VT.
Varieties with the same letter did not differ significantly.

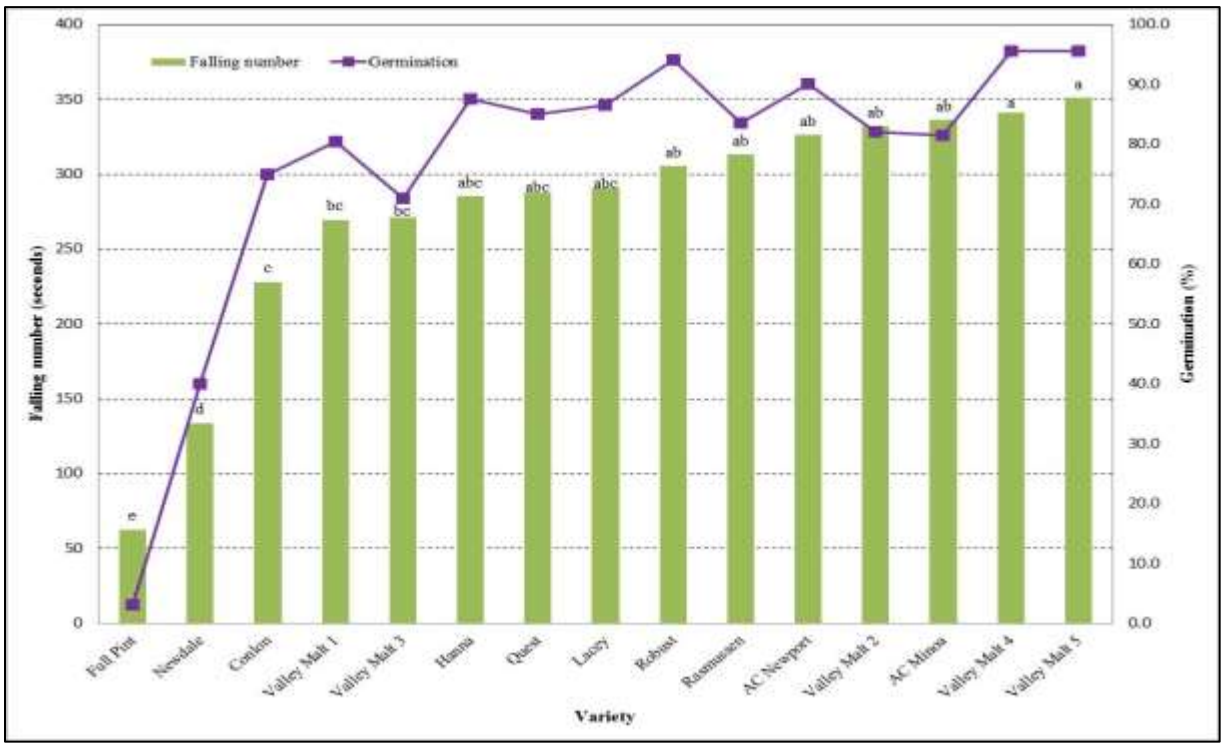

Figure 3. Falling number and germination comparison of the 15 spring barley varieties trialed, Alburgh, VT
Varieties with the same letter did not differ significantly.

DISCUSSION

It is important to remember that the results only represent one year of data. 2014 was another challenging growing season. The prolonged cool and wet spring delayed barley planting and impacted stand establishment and plant tillering. This could help explain the increase in weed pressure which could have contributed to the reduction in grain yields this season. Test weight, a measure of grain plumpness, is also an indicator used to determine malt quality. The below average temperatures, and above average rainfall, may have caused lower test weights as all varieties were below the ideal malting test weight of 48 lbs per bushel. Most varieties in the trial had crude protein levels exceeding 10% with two varieties above 13% crude protein (Valley Malt 1 and 2). For malting purposes, high quality barley typically has low to moderate protein levels ranging from 9.0 – 11.0%. In general, six-row barley varieties usually have higher protein content ranging from 9.0-12.0%, compared to two-row barley varieties, which range from 9.0-11.0%. Lower crude protein is desirable from a malting/brewing perspective as high protein levels can make beer hazy. Higher protein levels are also often associated with lower starch content. Starch is the principal contributor to brewhouse extract, and higher levels of starch result in more beer produced from a given amount of malt, although some small-scale breweries are minimally concerned with brewhouse extract efficiency. High germination levels, preferably over 95% (three-day test), are essential for a good malting barley. Germination levels in the spring barley were lower than preferred by the industry; only the varieties Valley Malt 4 and Valley Malt 5 were above 95%. Germination was not statistically tested as measurements were not taken for all plots but only one plot for each variety. Interestingly, Full Pint which had a germination of 3.00% correlated with its falling number of 62 seconds, indicating severe sprouting damage. Newdale also had a low germination (40%) and a low falling number (134 seconds). Falling number is not a standard quality measurement at malt houses. However, research indicates that a falling number of 220 seconds and greater indicates sound malt barley quality. Thirteen of the 15 varieties trialed had falling numbers above 220 seconds. DON levels were not nearly as high as they were in 2013. Ten varieties were at or below the 1ppm FDA recommend limit for DON concentration. The average DON level in 2014 was 0.95 ppm, 5.33 ppm below average DON level in 2013.

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