2011 BARLEY VARIETY TRIALS

With the revival of the small grains industry in the Northeast and the strength of the localvore movement, craft breweries and distilleries have expressed an interest in local barley for malting. Malting barley must meet specific quality characteristics such as low protein content and high germination. 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. Many farmers are also interested in barley as a high-energy concentrate source for their livestock. In 2010-2011, UVM Extension conducted both winter and spring barley trials to evaluate the yield and quality of publicly available malting and feed barley varieties.

MATERIALS AND METHODS

Two variety trials, one evaluating winter barley, and one evaluating spring barley were initiated at Borderview Research Farm in Alburgh, VT. Winter barley was planted on September 23, 2010. Six winter varieties (Table 1) were planted in a randomized complete block design with four replicates. The varieties McGregor and Thoroughbred are considered feed-grade barley. The seedbed was prepared by conventional tillage methods. Plots were 3' x 20' and were seeded into a Benson rocky silt loam at 125 lbs ac^{-1} with a Kincaid cone seeder. Rows were spaced at 6". All plots were managed with practices similar to those used by producers in the surrounding areas (Table 2). Fall stand density was measured on October 25, 2010 by counting the barley population in 33 cm increments in two rows. Winter survival was evaluated on April 12, 2011 by counting the barley population in 33 cm increments in two rows. Plots were fertilized with Giroux's Poultry Manure (2-3-2) at a rate of 50 lbs of N ac^{-1}on May 11, 2011. All varieties were harvested with an Almaco SPC50 small plot combine on July 5, 2011, with the exception of Alba, which was harvested on July 19, 2011.

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

Winter barley variety	Type	Seed source
Alba	2-row	Oregon State University
Dan	6-row	Oregon State University
Maja	6-row	Oregon State University
McGregor	6-row	Seedway
Thoroughbred	6-row	Virginia Agricultural Experimental Station
VA06H25	2-row	Virginia Agricultural Experimental Station

When the barley was in the soft dough state, spikes in a 1.08 ft^2 area were counted, and a visual estimate of weed density was recorded on a 1 to 5 scale – 1 representing few weeds and 5 indicating heavy weed pressure. Heights were also recorded for each plot at the soft dough stage.

Table 2. Agronomic and trial information for winter and spring barley variety trials.

	Winter barley	Spring barley
Soil type	Benson rocky silt loam	Benson rocky silt loam
Previous crop	Forage oats	Silage corn
Tillage operations	Fall plow, disc, and spike-toothed harrow	Spring plow, disc, and spike-toothed harrow
Plot area (ft)	3 x 20	6 x 20
Row spacing (in)	6	6
Seeding rate	125 lbs ac^{-1}	125 lbs ac^{-1}
Replicates	4	4
Planting date	9/23/2010	5/13/2011
Harvest date	7/5/2011, 7/19/2011	8/5/2011

Spring barley was planted on May 13, 2011 with a Kincaid cone seeder at a rate of 125 lbs ac^{-1} into a Benson rocky silt loam. The experimental plot design was a randomized complete block with four replications. The treatments were varieties, listed in Table 3. Plot size was 6' x 20'. The seedbed was prepared by conventional tillage methods (Table 2). Plots were fertilized with Giroux's poultry manure (2-3-2) at a rate of 50 lbs of N ac^{-1}on May 11, 2011. Barley populations were measured by counting the number of plants in 33 cm in two different rows per plot on May 25, 2011. Plots were tineweeded on June 4, 2011, and covered with bird netting on July 27, 2011. Barley height was measured and plots harvested on August 5, 2011, with an Almaco SPC50 small plot combine.

Table 3. Spring barley varieties trialed at Borderview Research Farm in Alburgh, VT.

Spring barley variety	Type	Seed source
Robust	6-row	Albert Lea Seeds
Conlon	2-row	North Dakota State University
Scarlett	2-row	Worley Seed
Famosa	2-row	La Coop Fédérée
Rasmussen	6-row	Albert Lea Seeds
Pinnacle	2-row	North Dakota State University
Newdale	2-row	SemiCan
AC Newport	2-row	SemiCan

Following the harvest of both spring and 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 and mycotoxin levels. Grains were analyzed for protein content using the Perten Inframatic 8600 Flour Analyzer. In addition, falling number for winter barley varieties was determined using the AACC Method 56-81B, AACC Intl., 2000 on a Perten FN 1500 Falling Number Machine. Deoxynivalenol (DON) analysis was performed using the

Veratox DON 5/5 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. 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 hybrids is real or whether it might have occurred due to other variations in the field. Least Significant Differences (LSDs) at the 0.10 level of significance are shown. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two treatments. Treatments that were not significantly lower in performance than the highest hybrid in a particular column are indicated with an asterisk. In the example below, hybrid C is significantly different from hybrid A but not from hybrid B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these hybrids did not differ in yield. The difference between C and A is equal to 3.0 which is greater than the LSD value of 2.0. This means that the yields of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

Hybrid	**Yield**
A	6.0
B	7.5*
C	**9.0***
LSD	**2.0**

RESULTS

October 2010 and April and May 2011 brought excessive rainfall and floods to Vermont, saturating many fields and delaying planting and early spring growth on many farms. In mid-summer drought-like conditions were experienced. Weather data is based on National Weather Service data from cooperative observer stations in South Hero, and Burlington, VT, which are in close proximity to Borderview Farm. Historical averages are for 30 years of data (1971-2000).

Table 4. Weather data for winter and spring barley variety trials in Alburgh, VT.

	Sept 2010	Oct 2010	Nov 2010	Dec 2010	Jan 2011	Feb 2011	Mar 2011	Apr 2011	May 2011	Jun 2011	Jul 2011
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
Departure from normal (°F)	3.6	1.8	2.2	2.3	4.6	0.5	2.1	3.1	2.1	1.3	3.3
Precipitation (inches)*	4.32	6.73	2.93	3.39	0.90	3.12	3.39	7.88	8.67	3.52	3.68
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
Growing Degree Days (base 32°F)	991	578	243	17.1	0.0	0.0	144	465	826	1088	1314
Departure from normal	139	57.4	63.4	12.4	0.0	0.0	27.9	120	63.6	74.1	104

*Precipitation from March through July 2011 was taken from Burlington.
*Average temperature for August 2011 was taken from a weather station in Burlington.

Winter Barley Results

All winter barley varieties were equally weed-competitive, and had similar establishment and winter survival rates (Table 5). The trial averaged 60.2 spikes per ft^2 at harvest. There was no difference in straw yield among the winter barley varieties. Barley straw yields were over 2.5 tons per acre. McGregor was the highest yielding variety, outperforming all other varieties (Table 6; Figure 1). Varieties did not differ significantly in germination rates with an average of 94.2%. Dan had the highest test weight and crude protein compared to the other winter barley varieties. The high protein may be due to the fact that Dan is a hulless type of barley. With the exception of McGregor, Alba, and Maja, all varieties met the target test weight of barley at 48 lbs per bushel. Alba had the highest falling number, although all varieties were at the optimal 220 seconds. There was no statistical significance between DON levels, and all varieties were below the FDA limit of 1 ppm for DON in grains destined for human consumption.

Table 5. Winter barley agronomic characteristics in Alburgh, VT.

Variety	October population plants ac^{-1}	April population plants ac^{-1}	Spikes spikes ft^{-2}	Weeds	Height in	Straw yield lbs ac^{-1}
McGregor	1,428,000	**1,408,000**	56.3	1.25	29.8*	4588
VA06H25	1,790,000	1,217,000	53.6	1.25	28.1	4682
Thoroughbred	1,680,000	1,036,000	**65.8**	1.50	29.1	3988
Alba	1,368,000	1,267,000	58.2	1.50	**31.4***	-
Dan	1,609,000	1,338,000	64.9	1.75	28.0	**4913**
Maja	**1,901,000**	1,237,000	62.8	**1.00**	29.2	4895
LSD (0.10)	NS	NS	NS	NS	1.8	NS
Trial mean	1,629,000	1,251,000	60.2	1.38	29.3	4613

*Barley that did not perform significantly lower than the top performing treatment (in bold) in a particular column is indicated with an asterisk.
NS - None of the varieties were significantly different from one another.

Table 6. Winter barley yield and quality data in Alburgh, VT.

Variety	Harvest moisture	Yield at 13.5% moisture	Test weight	Crude protein at 12% moisture	Falling number at 14% moisture	DON	Germination
	%	lbs ac^{-1}	lbs bu^{-1}	%	seconds	ppm	%
McGregor	18.2	**4983***	42.8	10.38	368.3*	0.48	92.5
VA06H25	17.5	3314	48.4	10.03	324.5	**0.30**	94.0
Thoroughbred	17.5	3215	48.9	9.63	325.5	0.55	93.8
Alba	**11.1***	3154	46.5	9.71	**383.8***	0.40	94.0
Dan	17.6	2344	**55.5***	**11.6***	382.0*	0.55	94.8
Maja	14.6	2318	44.6	9.07	330.3	0.38	96.0
LSD (0.10)	2.4	1361	4.8	1.02	35.4	NS	NS
Trial mean	16.1	3221	47.8	10.06	352.4	0.44	94.2

*Barley that did not perform significantly lower than the top performing treatment (in bold) in a particular column is indicated with an asterisk.
NS - None of the varieties were significantly different from one another.

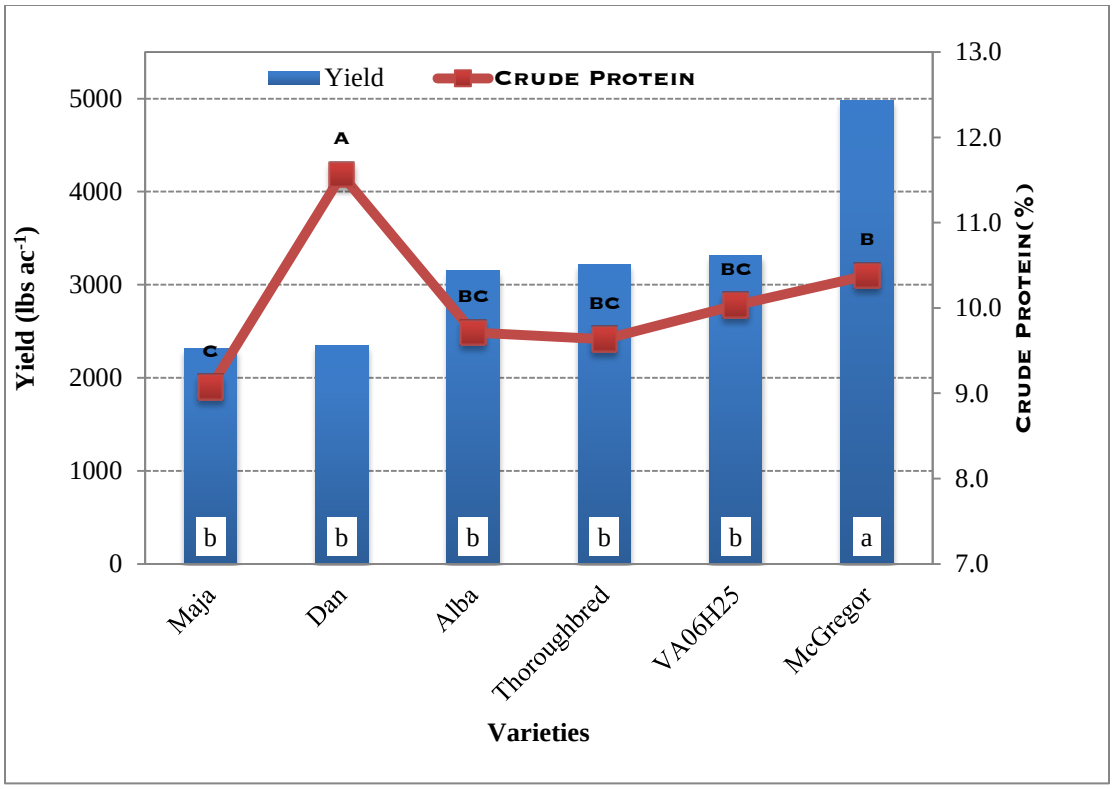

Figure 1. Yield and crude protein for winter barley varieties trialed in Alburgh, VT.

Spring Barley Results

All varieties were similar in plant height with a trial average of 24.5 inches (Table 7). Newdale and Conlon had the lowest harvest moisture. This indicates that these varieties mature a bit earlier than other varieties. Rasmussen was the highest yielding variety, although Conlon, Scarlett, and Robust performed statistically similarly (Table 7; Figure 2). In general, yields were lower than the average 2000 lbs per acre observed in past years. AC Newport had the highest test weight, although not statistically different from Robust, Scarlett, or Rasmussen. The test weights recorded in this trial did not meet the target feed barley test weight of 48 lbs per bushel. Low-test weight may be a result of poor weather conditions during the growing season. Famosa had the highest CP, although not statistically different from Newdale, Robust, or Scarlett (Table 7; Figure 2). All varieties had DON levels below the FDA limit of 1 ppm. Newdale had the lowest germination rate of 90.8%.

Table 7. Spring barley agronomic characteristics, yield, and quality data in Alburgh, VT.

Variety	Population	Height	Harvest moisture	Yield at 13.5% moisture	Test weight	Crude protein at 12% moisture	DON	Germination
	plants ac^{-1}	in	%	lbs ac^{-1}	lbs bu^{-1}	%	ppm	%
Rasmussen	1,106,000	26.3	11.5	**1976***	43.0*	9.9	0.40	96.0*
Conlon	**1,465,000**	24.4	9.8*	1772*	38.0	10.6	0.17*	95.7*
Scarlett	1,292,000	23.6	11.0*	1513*	43.0*	10.9*	0.23	**97.0***
Robust	826,000	**27.1**	13.1	1512*	42.3*	10.8*	0.23	93.7*
Newdale	1,226,000	22.4	**9.2***	1093	37.0	11.2*	0.27	90.8
AC Newport	1,319,000	23.3	15.2	925	**45.0***	10.2	0.30	96.5*
Famosa	1,239,000	24.0	12.8	787	40.0	**11.7***	0.13*	95.5*
Pinnacle	932,000	24.5	14.7	612	35.7	10.1	**0.10***	95.8*
LSD (0.10)	NS	NS	2.1	594	4.4	1.0	0.12	3.3
Trial mean	1,176,000	24.5	12.2	1274	40.5	10.7	0.23	95.1

*Barley that did not perform significantly lower than the top performing treatment (in bold) in a particular column is indicated with an asterisk.
NS - None of the varieties were significantly different from one another.

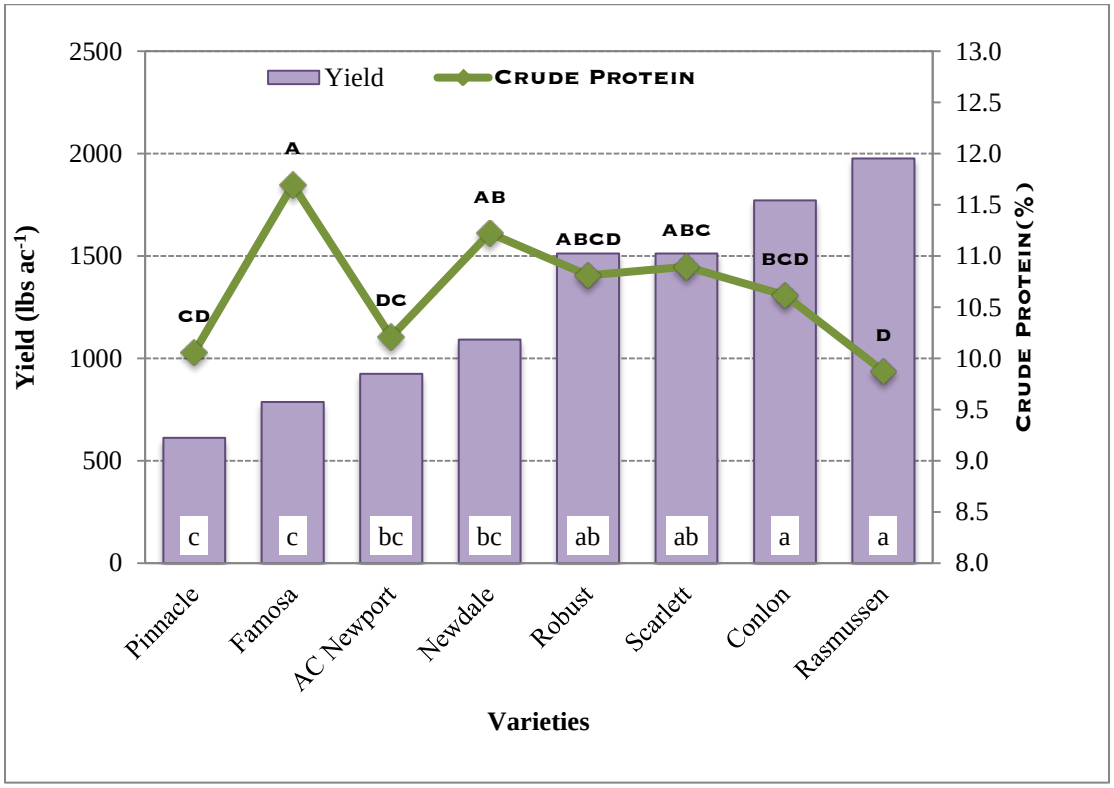

Figure 2. Yield and crude protein for spring barley varieties trialed in Alburgh, VT.

DISCUSSION

The winter wheat variety trial yielded three times greater than the spring wheat variety trial. In general winter grains (wheat and triticale) commonly out-yield their spring counterparts. The spring barley in the trials was also planted two to three weeks beyond optimal planting date. Weed pressure, later planting, and other weather conditions attributed to low yields in the spring barley. On average, six-row varieties yielded greater than two-row varieties.

A characteristic of quality malting barley is low to moderate protein levels, generally 9.0 - 11.2% crude protein at 14% moisture. Six-row barley usually has higher protein content, ranging from 9.24-12.3%, compared to two-row barley, which ranges from 9.24-11.9%. Overall, most varieties met the malting standard for protein content. Lower crude protein is more desirable from a malting/brewing perspective, as high protein levels can make beer hazy. Higher crude protein levels are also usually 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. Test weight, a measure of grain plumpness, is also an indicator used to determine malt quality. The standard barley test weight is 48 lbs per acre. In the spring barley variety trial the barley did not meet this standard, most likely due to poor weather conditions.

High germination levels, preferably over 95% (three-day test), are essential for a good malting barley. Germination levels in the winter barley were lower than preferred by the industry; only the variety Maja was above 95% germination. With the exception of Newdale, all spring barley varieties met the 95% germination requirement. Because the falling number for the winter barley was very high, this suggests that there was minimal sprout damage in the field during harvest. 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. Falling number is related to the level of sprout damage found in the grain.

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