NORTHWEST CROPS & SOILS PROGRAM

2018 Organic Spring Barley Variety Trial

Dr. Heather Darby, UVM Extension Agronomist
Hillary Emick and Haley Jean
UVM Extension Crop and Soil Technicians
(802) 524-6501

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

THE UNIVERSITY OF VERMONT EXTENSION

2018 ORGANIC SPRING BARLEY VARIETY 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. 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 2018, UVM Extension in collaboration with the Eastern Spring Malting Barley Nursery (ESBN) testing network conducted a spring malting barley trial to evaluate yield and quality of 25 varieties. Some varieties that had not performed well or are no longer commercially available were dropped from the trial and new varieties were added.

MATERIALS AND METHODS

In 2018, a spring barley variety trial was initiated at Borderview Research Farm in Alburgh, VT. The experimental plot design was a randomized complete block with three replications. The treatments were twenty-five spring malting barley varieties, listed in Table 1.

Table 1. Twenty-five spring barley varieties trialed at Borderview Research Farm in Alburgh, VT, 2018.

Spring barley variety	Type	Seed source
2ND28065	6-row	North Dakota State University
2ND32529	2-row	North Dakota State University
2ND33757	2-row	North Dakota State University
2ND33760	2-row	North Dakota State University
2ND33821	2-row	North Dakota State University
2ND34954	2-row	North Dakota State University
2ND34999	2-row	North Dakota State University
2ND35001	2-row	North Dakota State University
AAC Synergy	2-row	Agriculture and Agri-Food Canada
Accordine	2-row	Ackermann (Germany)
Crescendo	2-row	Secobra (France)
Eifel	2-row	Secobra (France)
Esma	2-row	Ackerman, Germany
Expo	2-row	Secobra (France)
KWS Beckie	2-row	KWS Cereals USA LLC, Germany
KWS Fantex	2-row	KWS Cereals USA LLC, Germany
KWS Tinka	2-row	KWS Cereals USA LLC, Germany
LCS Genie	2-row	Limagrain Cereal Seeds
LCS Odyssey	2-row	Limagrain Cereal Seeds
ND Genesis	2-row	North Dakota State University
Newdale	2-row	Agriculture and Agri-Food Canada

Pinnacle	2-row	North Dakota State University
Quest	6-row	University of Minnesota
Sangria	2-row	Ackerman, Germany
Tradition	6-row	Busch Agricultural Resources, LLC

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 corn. In April, the trial area was plowed, disked and spike tooth harrowed to prepare for planting. The plots were seeded with a Great Plains NT60 Cone Seeder on 24-Apr at a seeding rate of 300 live seeds m^{-2} into a Benson rocky silt loam. Plot size was 5' x 20'.

Table 2. Agronomic and trial information for spring barley variety trial, 2018.

Trial Information	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Corn
Tillage operations	Spring plow, disc, and spike tooth harrow
Harvest area (ft)	5 x 20
Row spacing (in)	6
Seeding rate (live seed m^{-2})	300
Replicates	3
Planting date	24-Apr
Harvest date	30-Jul

On 20-Jun, plots were scouted for disease and insect pests. Each plot was visually inspected for presence of foliar disease and arthropod damage and scored on a scale of 0-9, with 0 indicating no visible damage and 9 indicating that the whole plot was severely damaged. The Clive James, 'An Illustrated Series of Assessment Keys for Plant Diseases, Their Preparation and Usage' was used to determine the severity of plant disease infection. Prior to harvest, barley heights were measured, excluding awns, in centimeters, and lodging was rated on a 0 to 9 scale, 0 indicated no lodging and 9 meant the plot was completely lodged and could not be harvested. Bird damage was a major issue in the barley trials and was also assessed on a 0 to 9 scale, with 0 indicating no noticeable bird damage and 9 indicating that the entire plot had been consumed by birds. On 30-Jul, the plots were harvested using an Almaco SPC50 small plot combine.

Following the harvest of spring barley, seed was cleaned with a small Clipper cleaner (A.T. Ferrell, Bluffton, IN). Quality measurements included standard testing parameters used by commercial malt houses. Plot yield was weighed. Harvest moisture was determined for each plot using a DICKEY-john Mini GAC moisture and test weight meter. Generally the heavier the barley is per bushel, the higher malting quality. A one-pound subsample was collected to determine quality. 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. 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 (germination energy) 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 sample was run in duplicate. Grain assortment or plumpness was determined using the Pfeuffer Soritmat using 100g of clean seed, and was determined by the combining the amount of seed remaining on the 2.78mm and 2.38mm sieves.

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 ($p< 0.10$).

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 this 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 a weather station at Borderview Research Farm are displayed in Table 3. The growing season this year was marked by cool, wet conditions in April and June, and warm, dry weather in May and July. Overall temperature throughout the growing season was slightly higher than average, and total precipitation was 1.57 inches less than normal. From April to July, there was an accumulation of 3402 Growing Degree Days (GDDs), which was 50 GDDs above the 30-year average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2018.

Alburgh, VT	April	May	June	July
Average temperature (°F)	39.2	59.5	64.4	74.1
Departure from normal	-5.58	3.10	-1.38	3.51
Precipitation (inches)	4.4	1.9	3.7	2.4
Departure from normal	1.61	-1.51	0.05	-1.72
Growing Degree Days (32-95°F)	272	853	973	1305
Departure from normal	-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 data provided by the NOAA (1981-2010) for Burlington, VT.

There were significant differences among varieties for height, lodging, bird damage, arthropod damage, and foliar disease (Table 4). The tallest variety was Quest (67.1 cm). This was statistically similar to eight other varieties that were over 61 cm in height. Lodging can be correlated with height, with taller varieties potentially more prone to lodging, and this was true of the 2018 spring barley variety trial. The tallest variety, Quest, had the greatest degree of lodging, with an average lodging severity of 2.67 out of 9.00. Most varieties did not lodge during the season. AAC Synergy, Crescendo, and Pinnacle all experienced a small degree of lodging (less than one out of nine severity).

Bird damage was an issue for all the grains trials, particularly barley trials, at the research farm in 2018. Bird netting was deployed after damage was noted but many plots, particularly those on the edges of the trial, were heavily damaged by birds. 2ND34954 had the worst damage, with a three out of nine severity, indicating that about a third of the yield from this barley variety was lost to bird damage.

Foliar diseases reduce photosynthetic leaf area, use nutrients, and increase respiration and transpiration within colonized host tissues. The diseased plant typically exhibits reduced vigor, growth, and seed fill. Earlier occurrence, greater degree of host susceptibility, and longer duration of conditions favorable for disease development will increase the yield loss. When scouted on 20-Jun, each plot was assessed visually and rated 0-9 for several distinct diseases. These individual disease ratings were combined into a single foliar disease rating for statistical analysis. The most problematic disease noted in the spring barley trial was powdery mildew (*Erysiphe graminis f. sp. tritici*). Powdery mildew had the highest overall severity and contributed the most to each variety foliar disease rating. There was a strong effect by variety. Some plots and varieties were very affected by powdery mildew while others had no powdery mildew at all. Eleven varieties did not have any powdery mildew (AAC Synergy, Accordine, Crescendo, Eifel, Esma, KWS Beckie, KWS Fantex, KWS Tinka, LSC Genie, LSC Odyssey, and Sangria). Nine varieties had all replicates infected with powdery mildew (2ND35001, 2ND28065, 2ND33757, 2ND33821, 2ND3454, 2ND3499, Pinnacle, Quest, and Tradition). Spotting, a symptom of a range of foliar diseases was noted in most varieties. Foliar spots were less widespread and less severe than powdery mildew. Some leaf rust was noted at low severity and confined to a small geographic area of the trial. The varieties ND Genesis, KWS Tinka, Eifel, and Esma were notable for not having any foliar disease symptoms during scouting.

Thrips (various species) were the most common insect pest. Thrips are small insects with fringed wings that feed on a variety of plants by puncturing the cells and sucking up the contents. Damage caused by thrips includes discoloration and leaf scarring, reduced growth of the plant, and they can also act as a disease vector. Thrips damage was present in all plots, but at low severity. Mites (various species) were also common, and also at low severity. Some minor damage from cereal leaf beetle and leaf miner was noticed in very few plots.

Table 4. 2018 spring barley agronomic characteristics in Alburgh, VT.

Variety	Height	Lodging	Bird damage	Arthropod damage	Foliar disease
	cm	rating (0-9) †	rating (0-9) †	rating (0-9) †	rating (0-9) †
2ND28065	58.1	**0.00***	1.00*	2.00	2.67
2ND32529	65.4*	**0.00***	1.00*	1.67*	1.67
2ND33757	63.1*	**0.00***	0.67*	1.67*	4.33
2ND33760	57.1	**0.00***	2.00	2.33	2.00
2ND33821	60.8*	**0.00***	0.33*	2.00	4.33
2ND34954	58.7	**0.00***	3.00	2.67	2.67
2ND34999	57.1	**0.00***	2.67	1.67*	3.00
2ND35001	65.1*	**0.00***	2.33	1.67*	5.33
AAC Synergy	63.2*	0.67	0.67*	1.33*	0.33*
Accordine	55.4	**0.00***	0.33*	1.67*	0.67*
Crescendo	63.6*	0.33*	0.33*	1.67*	0.67*
Eifel	50.3	**0.00***	0.67*	2.00	**0.00***
Esma	50.8	**0.00***	0.67*	2.00	**0.00***
Expo	54.2	**0.00***	0.67*	2.00	1.00
KWS Beckie	45.1	**0.00***	0.33*	2.00	0.67*
KWS Fantex	47.0	**0.00***	1.33*	2.00	1.00
KWS Tinka	56.6	**0.00***	**0.00***	1.67*	**0.00***
LCS Genie	53.4	**0.00***	1.00*	1.67*	0.67*
LCS Odyssey	50.1	**0.00***	0.67*	2.00	0.67*
ND Genesis	63.1*	**0.00***	0.67*	1.67*	**0.00***
Newdale	57.1	**0.00***	0.67*	2.33	0.67*
Pinnacle	61.3*	0.33*	0.67*	1.33*	2.33
Quest	**67.1***	2.67	1.67*	**1.00***	6.67
Sangria	50.2	**0.00***	1.00*	2.67	1.33
Tradition	64.3*	**0.00***	1.00*	1.33*	3.00
LSD (0.10)	7.04	0.42	1.96	0.80	0.97
Trial Mean	57.5	0.16	1.01	1.84	1.83

*Varieties with an asterisk are not significantly different than the top performer in **bold**.

†Zero (0) indicates no damage and nine (9) indicates that 100% was severely affected.

Spring Barley Yield and Quality

Yield and quality varied significantly between varieties of spring barley (Table 5, Figure 1). KWS Tinka had the highest yield at 3089 lbs ac^{-1}. This was statistically similar to 2ND32529, AAC Synergy, Accordine, Crescendo, Eifel, Esma, KWS Beckie, KWS Fantex, and Newdale, which all yielded above 2460 lbs ac^{-1}. All varieties were below 14% moisture content at harvest and did not require drying down for storage.

Table 5. Harvest results for the 25 spring barley varieties trialed in Alburgh, VT, 2018.

Variety	Yield at 13.5% moisture	Harvest moisture	Test weight	Protein at 12% moisture	Falling number	DON	Germination	Plumpness
	lbs ac^{-1}	%	lbs bu^{-1}	%	seconds	ppm	%	%
2ND28065	2232	13.1	44.3*	9.10*	357*	0.43*	97.3*	97.4
2ND32529	2632*	13.6	44.2*	6.82	303	0.43*	96.3*	98.8*
2ND33757	2452	13.0	44.5*	8.70*	361*	0.40*	98.0*	97.0
2ND33760	2117	13.1	**45.0***	8.16	342*	0.30*	**99.0***	98.4*
2ND33821	1717	13.2	42.5*	8.29	278	**0.20***	98.0*	97.9
2ND34954	1462	13.2	43.4*	8.25	338*	0.33*	97.0*	98.7*
2ND34999	1729	13.2	44.2*	8.61*	325	0.27*	97.7*	98.6*
2ND35001	2212	13.3	45.2*	9.06*	363*	0.63	99.0*	96.9
AAC Synergy	2618*	12.6*	41.6	7.94	222	0.33*	98.3*	98.4*
Accordine	2911*	12.7*	41.6	7.60	217	0.43*	93.0	98.3*
Crescendo	2989*	12.9	44.5*	7.36	306	0.30*	97.7*	99.1*
Eifel	2820*	12.6*	41.2	7.92	316	0.43*	97.0*	98.6*
Esma	2905*	12.8	42.4*	7.71	297	0.33*	97.7*	98.9*
Expo	2412	13.2	44.0*	8.51*	352*	0.23*	98.3*	98.9*
KWS Beckie	2955*	12.7*	39.6	8.03	321	0.47*	96.3*	**99.0***
KWS Fantex	2486*	13.3	42.9*	**9.23***	**372***	0.47*	94.3	98.1
KWS Tinka	**3089***	12.8	41.3	8.04	250	0.67	96.3*	98.5*
LCS Genie	2364	13.1	43.5*	7.35	340*	0.40*	95.3	98.4*
LCS Odyssey	2407	13.2	42.8*	8.07	346*	0.30*	99.0*	98.9*
ND Genesis	2462	12.0*	40.8	8.19	260	0.50*	95.3	99.0*
Newdale	2866*	12.2*	41.0	8.90*	205	0.30*	98.7*	96.9
Pinnacle	2041	13.4	44.2*	8.17	340*	0.60	98.0*	98.9*
Quest	1842	12.4*	42.9*	9.14*	361	0.33*	98.3*	94.1
Sangria	2023	12.9	39.5	8.71*	221	0.53*	94.3	98.6*
Tradition	2144	12.5*	43.5*	8.95*	366*	0.43*	98.3*	97.9
LSD (0.10)	617	0.76	2.9	0.81	35.5	0.34	3.0	0.85
Trial Mean	2395	12.9	42.8	8.27	310	0.40	97.1	98.2

*Varieties with an asterisk are not significantly different than the top performer in **bold**.

None of the barley varieties met the industry standard of 48 lbs bu^{-1} for test weight. 2ND33760 had the highest test weight at 45 lbs bu^{-1}, statistically similar to sixteen other varieties that were also above 42 lbs bu^{-1} for test weight. Four varieties (2ND28065, 2ND35001, KWS Fantex and Quest) met the industry standard for crude protein (between 9% and 11% for malting barley). All other varieties were below 9% crude protein. Accordine and Newdale had falling numbers below 220, indicating low enzymatic activity in these varieties. All varieties tested below the 1 ppm FDA recommended limit for DON concentration. All varieties except Sangria and KWS Fantex were above the industry standard of 95% germination rate. All varieties were above industry standards for plumpness (>80% for a two-row and >70% for a six row barley).

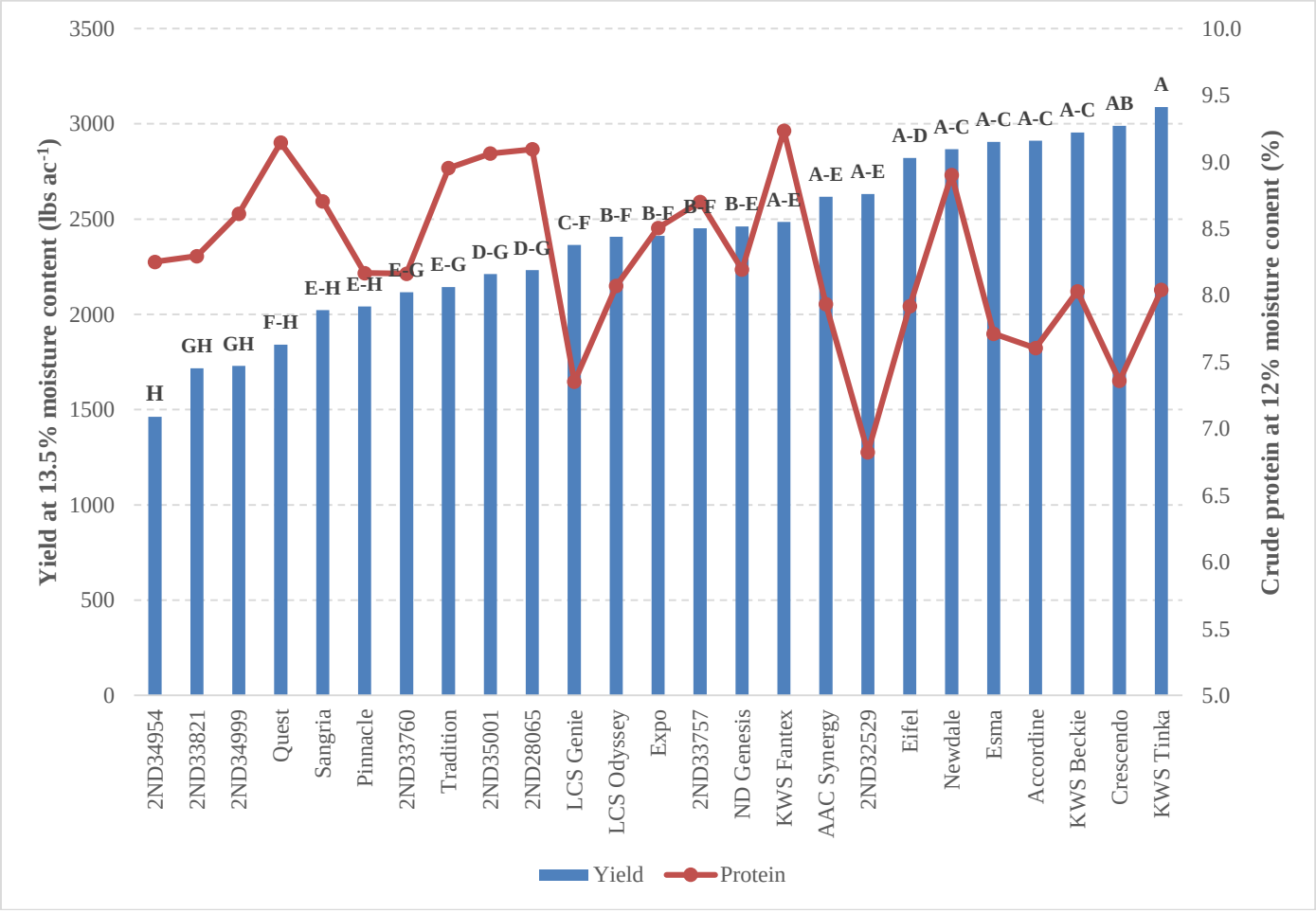

Figure 1. Yield and crude protein for the 25 spring barley varieties trialed in Alburgh, VT, 2018.
Varieties with the same letter did not differ significantly by yield.

DISCUSSION

Despite some notable challenges, 2018 was overall a fairly good year for growing spring barley. Yields were moderate and most quality parameters were excellent. The average yield for the trial was 2395 lbs ac^{-1}, which is slightly higher than the grand mean yield from 2011-2017 spring barley variety trials at Borderview Research Farm of 2289 lbs ac^{-1}. The average yield was adversely impacted by bird damage and likely hot and dry conditions. Varieties with most bird damage showed a strong effect in reduced yields, and it is important to note this when comparing yields. High incidence and severity of powdery mildew may have affected yield and quality in the varieties most affected. Insect damage was minimal.

In terms of quality parameters, the plumpness, germination, DON concentrations, and falling number were all very good, with almost all barley varieties meeting or exceeding industry standards. All varieties performed below the industry standard for test weight, and 21 out of the 25 varieties were below the industry standard for crude protein. This again may have been attributed to the hot and dry conditions experienced during the growing season,

There were no varieties that across the board out-performed the others. All varieties that were statistically similar as high yielding varieties were in the highest category for some quality parameters but not for others. It is important to note that these results represent only one year of data. As farmers make variety selections, they should make sure to evaluate data from test sites that are as similar to their own region as possible. It is our intention to continue this research in 2019.

ACKNOWLEDGEMENTS

Thank you to the American Malting Barley Association, Brewers Association, Northeast SARE (project number LNE15-339-29994), and the U.S. Wheat and Barley Scab Initiative for their financial contribution to this project. UVM Extension would like to thank the Uniform Eastern Spring Malting Barley Nursery and Borderview Research Farm and staff in Alburgh. We would also like to acknowledge John Bruce, Erica Cummings, Catherine Davidson, Abha Gupta, Rory Malone, Freddy Morin, Lindsey Ruhl, and Sara Zeigler 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