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2022 Organic Spring Barley Variety Trial

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2022 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. 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 2022, 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.

MATERIALS AND METHODS

In 2022, 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, 2022.

Spring barley variety	Type	Seed source
10031 U1	2-row	Secobra (France)
2ND32529	2-row	North Dakota State University
2ND36638	2-row	North Dakota State University
2ND36642	2-row	North Dakota State University
2ND37111	2-row	North Dakota State University
2ND37130	2-row	North Dakota State University
2ND37568	2-row	North Dakota State University
3523 U2	2-row	Secobra (France)
AAC Connect	2-row	Agriculture and Agri-Food Canada (Brandon)
AAC Synergy	2-row	Agriculture and Agri-Food Canada (Brandon)
CU198	2-row	Cornell University
Esma	2-row	Ackermann (Germany)
Excelsior Gold	2-row	Cornell University
Explorer	2-row	Secobra (France)
Firefox	2-row	Ackermann (Germany)
Klarinette	2-row	Secobra (France)
KWS Amadora	2-row	KWS (Germany)
KWS Jessie	2-row	KWS (Germany)
KWS Kellie	2-row	KWS (Germany)
KWS Willis	2-row	KWS (Germany)
ND Genesis	2-row	North Dakota State University
Newdale	2-row	Agriculture and Agri-Food Canada
Pinnacle	2-row	North Dakota State University
Revanche	2-row	Ackermann (Germany)
TR17255	2-row	Agriculture and Agri-Food Canada (Brandon)

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 grain corn. In April, the trial area was prepared for planting with a Pottinger TerraDisc. The plots were seeded with a Great Plains NT60 Cone Seeder on 18-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, 2021.

Trial Information	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Grain corn
Tillage operations	Pottinger TerraDisc
Harvest area (ft)	5 x 20
Row spacing (in)	6
Seeding rate (live seeds m^{-2})	300
Replicates	3
Planting date	18-Apr
Harvest date	26-Jul

Heights and lodging were recorded on 26-Jul 2022 prior to harvest. Heights were measured, excluding awns, in centimeters for three plants in each plot. Lodging was assessed by visual estimate on a scale of 0-9 where a rating of 1 meant that 1 to 10% of the plants were lodged and a rating of 9 meant that greater than 90% of the plants were lodged. On 26-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. Samples were evaluated for crude protein and starch content using a Perten Inframatic 9500 NIR Grain Analyzer. The samples were then ground into flour using the Perten LM3100 Laboratory Mill. 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 200 indicate low enzymatic activity and sound quality sample. A falling number lower than 200 indicates high enzymatic activity and poor quality. Grain assortment of plumpness was determined using the Pfeuffer Soritmat using 100g of clean seed and was determined by combining the amount of seed remaining on the 2.78mm and 2.38mm sieves. Deoxynivalenol (DON) analysis was analyzed using Veratox DON 2/3 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.

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. This growing season was wetter than past years with a total of 20.1 inches, 4.97 inches more than normal. The average temperature of the growing season for spring barley (April to July) was 1.44°F below the 30-year average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2022.

Alburgh, VT	April	May	June	July
Average temperature (°F)	44.8	60.5	65.3	71.9
Departure from normal	-0.81	2.09	-2.18	-0.54
Precipitation (inches)	5.57	3.36	8.19	3.00
Departure from normal	2.50	-0.40	3.93	-1.06
Growing Degree Days (32-95°F)	391	883	1000	1236
Departure from normal	-20	65	-64	-17

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.

Spring Barley Yield and Quality

Heights and lodging were measured prior to harvest. Taller plants can be desirable for better competition against weeds; however, very tall plants can be prone to lodging. CU198 was the tallest variety, with a

height of 94.7 cm, being statistically similar to ND Genesis, AAC Synergy, 2ND32529, and Excelsior Gold. Revanche had the most lodging, at 31.7%, which was statistically similar to KWS Amadora, Explorer, and 10031 U1. Yield and quality varied slightly between varieties of spring barley (Table 4, Figure 1). 10031 U1 had the highest yield at 6531 lbs ac^{-1}. This was statistically similar to 2ND32529, 2ND36642, 2ND37130, 3523 U2, AAC Synergy, CU198, Esma, Explorer, Firefox, Klarinette, KWS Amadora, KWS Jessie, KWS Kellie, KWS Willis, ND Genesis, Pinnacle, Revanche, and TRI7255, which all yielded above 4632 lbs ac^{-1}. All varieties were above 12% moisture content at harvest and required drying for storage. None of the barley varieties met the industry standard of 48 lbs bu^{-1} for test weight. CU198 had the highest test weight at 47.1 lbs bu^{-1}, statistically similar to seven other varieties.

Table 4. Agronomic and harvest results for the 25 spring barley trialed in Alburgh, VT 2022.

Variety	Height	Lodging	Yield at 3.5% moisture	Harvest moisture	Test weight
	Cm	%	lbs ac^{-1}	%	lbs bu^{-1}
10031 U1	71.9	13.3*	**6531***	14.3*	43.4
2ND32529	85.1*	3.30	4756*	16.1	45.9*
2ND36638	76.1	0.00	3904	16.8	44.5
2ND36642	74.4	0.00	4753*	16.0	42.9
2ND37111	77.2	0.00	4132	13.3*	40.7
2ND37130	79.8	0.00	4733*	12.6*	42.1
2ND37568	81.1	0.00	3756	12.8*	42.4
3523 U2	72.9	0.00	5413*	17.8	44.6
AAC Connect	79.3	1.70	4373	18.2	46.5*
AAC Synergy	86.0*	1.70	5028*	16.5	44.7
CU198	**94.7***	3.30	5235*	19.3	**47.1***
Esma	65.0	1.70	5298*	16.1	44.3
Excelsior Gold	84.9*	0.00	4425	**12.0***	46.6*
Explorer	65.7	16.7*	6459*	14.3*	43.6
Firefox	79.8	0.00	5396*	16.3	44.2
Klarinette	71.8	0.00	5461*	14.5*	43.8
KWS Amadora	64.9	16.7*	5255*	13.8*	43.7
KWS Jessie	59.3	0.00	6344*	14.4*	45.3*
KWS Kellie	68.9	1.70	6339*	15.4	44.4
KWS Willis	62.9	0.00	5140*	14.8*	43.7
ND Genesis	91.0*	0.00	5434*	19.1	45.2*
Newdale	69.7	0.00	3924	17	45.8*
Pinnacle	81.9	0.00	5048*	16	43.5
Revanche	63.9	**31.7***	5421*	13.3*	41.5
TR17255	81.2	8.30	4851*	16.4	46.3*
LSD (0.10)	12.7	17.6	1899	3.18	2.35
Trial Mean	75.6	4.00	5096	15.5	44.3

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

Table 5. Quality results for the 25 spring barley varieties trialed in Alburgh, VT, 2022.

Variety	Protein at 12% moisture	Starch	Falling number	Germination	Plumpness
	%	%	seconds	%	%
10031 U1	8.50*	56.9	381*	92.3	97.6*
2ND32529	8.60*	57.2	215	94.3	97.9*
2ND36638	8.60*	56.7	352	91.7	98.3*
2ND36642	8.20	57.3*	348	94.7	**98.7***
2ND37111	7.90	57.8*	**393***	98.3*	95.3
2ND37130	7.40	**58.3***	367*	99.3*	97.0*
2ND37568	7.60	58.1*	359*	96.7*	96.5*
3523 U2	8.30	57.5*	327	96.0*	97.6*
AAC Connect	8.90*	58.3*	329	98.7*	95.0
AAC Synergy	8.80*	56.9	341	98.7*	97.6*
CU198	9.20*	56.5	371*	98.3*	96.5*
Esma	8.10	57.5*	309	**99.7***	98.3*
Excelsior Gold	8.30	57.6*	335	98.7*	97.9*
Explorer	8.40	56.9	345	97.3*	96.4
Firefox	8.20	57.5*	245	96.0*	97.4*
Klarinette	8.50*	56.8	388*	92.7	98.3*
KWS Amadora	7.60	57.9*	203	96.3*	96.7*
KWS Jessie	7.20	58.2*	308	95.3	97.2*
KWS Kellie	8.50*	57.2	307	96.7*	98.2*
KWS Willis	7.40	58.0*	325	94.3	98.6*
ND Genesis	8.80*	56.9	342	99.0*	98.6*
Newdale	8.70*	57.1	374*	99.3*	94.9
Pinnacle	8.40	56.9	351	86.7	97.7*
Revanche	7.70	57.6*	374*	96.3*	94.8
TR17255	**9.20***	56.7	257	96.7*	96.2
LSD (0.10)	0.771	1.00	38.4	4.33	2.32
Trial Mean	8.30	57.4	330	96.2	0.972

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

Only two varieties (TR17255, CU198) were within the industry standard of 9-11% for crude protein for malting barley. Ten other varieties were statistically similar to the highest crude protein performing variety TR17255. The variety with the highest starch content was 2ND37130 at 58.3%, with twelve other varieties being statically similar to this high starch content. All varieties had falling numbers above 200 seconds, indicating sufficient enzymatic activity. The highest falling number, 393 seconds, was found in the variety 2ND37111. All varieties except 10031 U1, 2ND32529, 2ND36638, 2ND36642, Klarinette, KWS Willis, and Pinnacle were above the industry standard of 95% germination rate. All varieties were above industry standards for plumpness of >80% for a two-row barley.

One trial rep of the barley was tested for DON. However, all of the plots that were tested were below the FDA standard of 1 ppm, meaning they were all suitable for human consumption (data not shown).

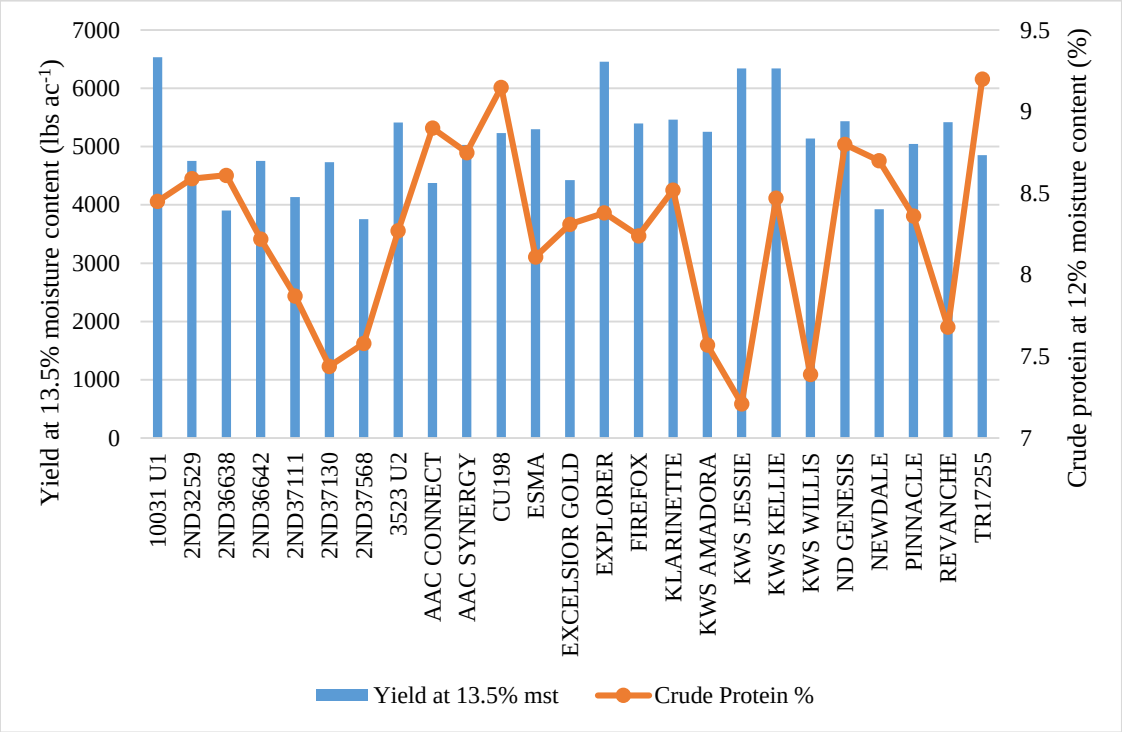

Figure 1. Yield and crude protein for the 25 spring barley varieties trialed in Alburgh, VT, 2022.

DISCUSSION

Overall, most varieties performed well with good quality and above average yields. The 2022 trial had an overall higher average yield of 5096 lbs ac^{-1} than in any of past years this trial was run (2011 to 2021). For instance, the average trial yield for 2021 was 3365 lbs ac^{-1}, 2020's average trial yield was 4244 lbs ac^{-1}, and 2019's average trial yield was 3553 lbs ac^{-1}.

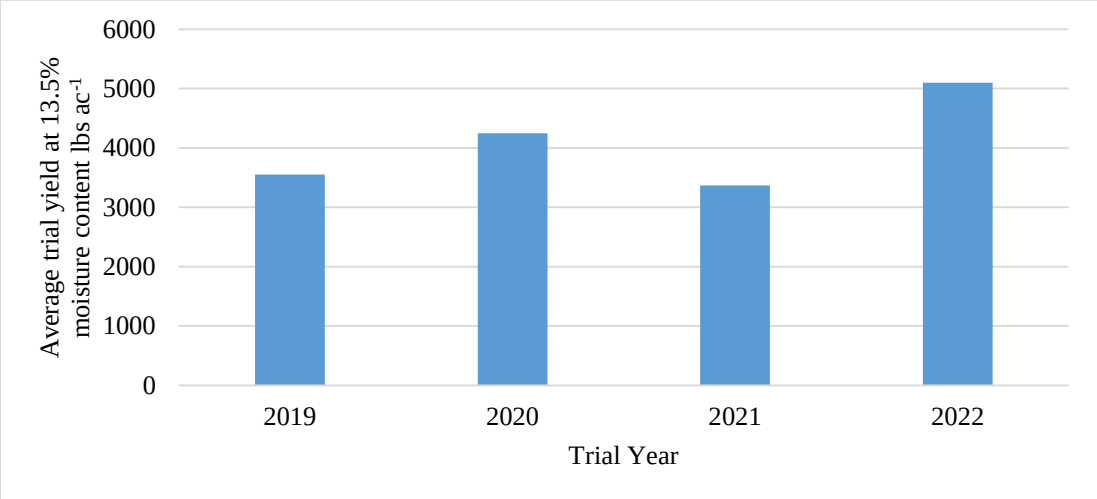

Figure 2. Average trial yield and year for spring barley variety trials in Alburgh, VT 2019-2022.

In terms of quality parameters, all varieties performed within industry standards for plumpness and falling number. All varieties had a plumpness greater than 80%, and all varieties had a falling number greater than 200. All but eight varieties were within the industry standard for germination, with a rate above 95%. While only two varieties were within the industry standard for crude protein, of 9-11%, ten other varieties were statistically similar to the highest crude protein content of 9.2%. The highest starch content was found in 2ND37111 at 58.3%, with twelve other varieties being statically similar.

No varieties outperformed the others. All varieties that were statistically similar as high yielding varieties performed highly in other quality parameters. 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 similar to their own region as possible. It is our intention to continue this research in 2023.

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