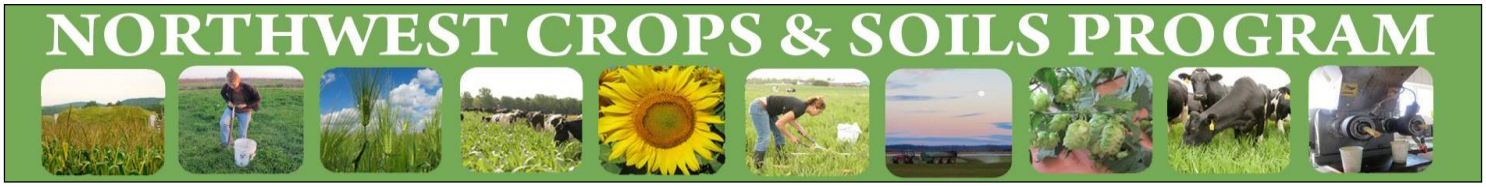
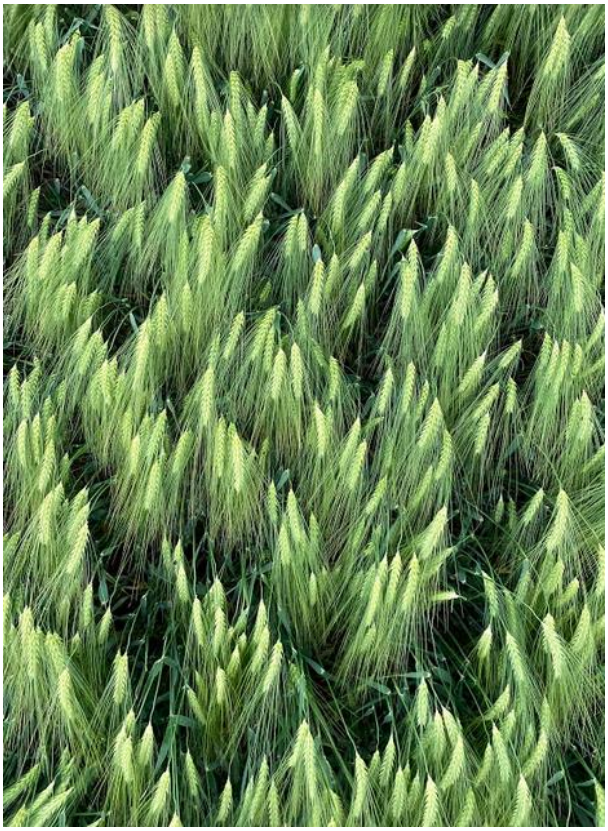


2021 Hulless Barley Variety Trial



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THE UNIVERSITY OF VERMONT EXTENSION

2021 HULLESS BARLEY VARIETY TRIAL

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Hulless barley (also known as naked barley) has generated interest from specialty food markets. Specialty grains, such as hulless barley, can support local farm viability by diversifying crop rotations and revenue streams. Unlike malting barley, hulless barley is free threshing. This means the hull easily separates from the grain kernel during harvest and cleaning, producing whole grain barley for human consumption. This eliminates the pearling processing necessary to produce culinary barley for food markets. Because it is a whole grain, hulless barley has higher flavor and nutritional value than pearled barley, which goes through an abrasion process to remove the hull and bran. In 2021, the University of Vermont Extension's Northwest Crops and Soils Program continued the third year of a field trial of sixteen heirloom hulless barley varieties with seed provided by Sylvia Davatz of Solstice Seeds (Hartland, VT). Seven additional hulless varieties under development in various breeding programs were provided by Cornell University for evaluation in the 2021 trial.

MATERIALS AND METHODS

The trial was established at Borderview Research Farm in Alburgh, VT. Plots were managed with practices similar to those used by organic producers in the surrounding area. Four replicates of 23 varieties were planted for evaluation (Table 1). Plots were seeded with a Great Plains Cone Seeder at a rate of 350 live seeds m^{-2} on 9-Apr into 5' x 20' plots (Table 2). The previous crop was winter canola and the soil type was Benson rocky silt loam.

Table 1. Hulless barley varieties, 2021, Alburgh, VT.

Variety	Source
Arabian Blue	Solstice Seeds
Burbank	Solstice Seeds
Burbank Purple	Solstice Seeds
CDC Ascent	Cornell
CDC Carter	Cornell
CDC Clear	Cornell
CH2909-162-95	Cornell
Dolma	Solstice Seeds
Dolma Purple	Solstice Seeds
Ethiopian	Solstice Seeds
Excelsior Purple	Solstice Seeds
Faust	Solstice Seeds
FB-106	Cornell
Glutinous	Solstice Seeds
L94	Cornell
Purple Valley	Cornell
Queen of Sheba	Solstice Seeds
Sangatsuga	Solstice Seeds
Sheba	Solstice Seeds
Tibetan	Solstice Seeds

Tibetan Purple	Solstice Seeds
Valsergerste	Solstice Seeds
Zwerggerste	Solstice Seeds

Table 2. Spring hulless barley agronomic information, Alburgh, VT, 2021.

Trial information	Alburgh, VT Borderview Research Farm
Soil type	Benson rocky silt loam
Previous crop	Winter canola
Seeding rate	350 live seeds m^{-2}
Row spacing (in)	6
Planting date	9-Apr
Harvest date	19-Jul
Harvest area (ft)	5 x 20
Tillage operations	Fall plow, disk & spike tooth harrow

Heading date data was collected through the month of June, captured when 50% of the heads had fully emerged. On 15-Jul, four days prior to harvest, three heights were measured, excluding awns, for three plants per plot. Lodging for each plot was visually assessed using a 0-5 scale, with 0 indicating no lodging and 5 indicating entire plot was too lodged to be harvested.

Grain plots were harvested with an Almaco SPC50 plot combine on 19-Jul. Grain yield, test weight, and moisture were determined at harvest. Grain quality was determined at the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, Vermont). Samples were ground using the Perten LM3100 Laboratory Mill. Flour was analyzed for protein content using the Perten Inframatic 8600 Flour Analyzer. Falling number was measured (AACC Method 56-81B, AACC Intl., 2000) on the Perten FN 1500 Falling Number Machine. Deoxynivalenol (DON), a vomitoxin, was analyzed using Veratox DON 2/3 Quantitative test from the NEOGEN Corp. This test has a detection range of 0.50 to 5.0 ppm. Samples with DON values greater than 1 ppm are considered unsuitable for human consumption. One sample of each variety was analyzed for DON concentrations.

Variations in agronomic characteristics can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments 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 (LSD's) at the 10% level of probability are shown.

Treatment	Yield
A	**2100***
B	1900*
C	1700
LSD	300

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 in 9 out of 10 chances that there is a real difference between the two values. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk. In this example, treatment A is significantly different from treatment C but not from treatment B. The

difference between A and B is equal to 200, which is less than the LSD value of 300. This means that these treatments did not differ in yield. The difference between A and C is equal to 400, which is greater than the LSD value of 300. This means that the yields of these treatments were significantly different from one another.

RESULTS

The seven entries received from Cornell University arrived and were planted slightly later in the season than the other varieties. As a result, they were behind the other varieties in maturity, affecting data collection and quality at harvest. Four of these varieties were too far behind in maturity and could not be adequately evaluated and the results were dropped from the trial including: CDC Clear, CH2909-162-95, FB 106, and L94. All 23 varieties will be included in the 2022 hulless barley variety trial.

Seasonal precipitation and temperature recorded at a weather station at Borderview Research Farm are displayed below in Table 3. The growing season was warmer than normal overall, although the month of July was cooler than average. There were a surplus of growing degree days early in the season and a deficit in July, resulting in a season just 36 growing degree days (GDDs) above normal. There were 4.99 inches less precipitation than normal.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2021.

Alburgh, VT	April	May	June	July
Average temperature (°F)	48.1	58.4	70.3	68.1
Departure from normal	2.52	-0.03	2.81	-4.31
Precipitation (inches)	3.52	0.66	3.06	2.92
Departure from normal	0.45	-3.10	-1.20	-1.14
Growing Degree Days (32-95°F)	497	818	1149	1119
Departure from normal	85	-1	86	-134

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.

Heading date was recorded throughout the month of June as the date when 50% of the plants in each plot had fully emerged from the boot. The trial average was 8-Jun (Table 4). Due to varied planting dates, there was a large range of heading dates through the month (some later dates not shown as varieties were dropped from the trial).

Table 4. Spring hulless barley varieties and agronomic characteristics, Alburgh, VT, 2021.

Variety	Heading date	Height	Lodging	Harvest moisture	Test weight	Yield @ 13.5% moisture content	Crude protein @ 12% moisture content	Falling number
		cm	0-5	%	lbs bu^{-1}	lbs ac^{-1}	%	seconds
Arabian Blue	7-Jun	73.5	4.00	17.8	56.9*	2043	15.2	345*
Burbank	9-Jun	67.3	4.75	17.6	54.8*	1737	14.4	362*
Burbank Purple	7-Jun	71.8	4.25	17.2	**57.1***	2068	14.9	355*
CDC Ascent	16-Jun	77.6	**0.00***	21.1	53.3	**3481***	14.6	259
CDC Carter	14-Jun	80.8*†	**0.00***	21.1	53.3	3408*	13.1	**409***
Dolma	7-Jun	69.8	3.50	**15.3***	51.2	1797	15.7	63
Dolma Purple	7-Jun	68.8	4.50	16.8	56.1*	1878	15.4	310
Ethiopian	7-Jun	78.7	2.50	16.3*	51.2	1624	16.9*	145
Excelsior	7-Jun	**87.7***	**0.00***	17.2	54.9*	2009	**16.9***	327
Excelsior Purple	7-Jun	75.1	4.75	18.1	54.8*	2077	14.6	295
Faust	7-Jun	82.0*	2.75	18.4	54.3	2299	14.8	350*
Glutinous	10-Jun	63.4	**0.00***	17.1	52.9	2941	14.7	192
Purple	7-Jun	71.8	4.50	18.0	55.2*	1995	15.0	319
Purple Valley	8-Jun	76.4	3.00	20.0	56.8*	1756	14.9	322
Queen of Sheba	7-Jun	74.7	4.50	17.0	55.0*	1979	14.8	292
Sangatsuga	7-Jun	70.0	4.00	15.8*	53.0	2094	16.0	242
Sheba	8-Jun	72.8	1.00	15.4*	52.6	2109	16.5*	204
Tibetan	7-Jun	64.8	3.25	18.1	52.4	1665	15.1	165
Tibetan Purple	7-Jun	69.8	4.25	17.5	56.2*	1929	15.4	356
Valsergeste	9-Jun	64.3	4.00	15.9*	55.2*	2261	15.0	285
Zwerggerste	7-Jun	73.5	**0.00***	21.8	50.9	1649	16.5*	274
LSD (p= 0.10)	2 days	7.96	0.86	1.52	2.46	356	0.51	81.5
Trial mean	8-Jun	73.1	2.83	17.8	54.2	2133	15.3	279

†Treatments that are followed by an asterisk (*) performed statistically similar to the top performer shown in **bold**.

Height and lodging information was collected prior to harvest. Taller plants are generally more desirable to outcompete weeds, but barley that grows too tall risks lodging in wet weather. The tallest variety in the 2021 trial was Excelsior at 87.7 cm. This was one of five varieties that did not have any lodging.

Harvest moisture below 14% is necessary for grain storage. Grain above this moisture content has to be dried down after harvest, adding time and cost to farmers. All hulless barley varieties tested well above the 14% moisture threshold and required additional drying. Dolma had the lowest harvest moisture at 15.3%.

Test weight is the measure of grain density, which is determined by weighing a known volume of grain. The industry standard test weight for malting barley is 48 lbs bu^{-1}. There is not currently a standard test weight for hulless barleys in US markets, but Canadian grain grading standards call for a test weight of 58 lbs bu^{-1} for highest grading, similar to desired test weights for wheat. Test weights for hulless barley are higher than malting barley because the hull is not a component. Hulls are lighter weight and take up volume

which would reduce the test weight. Burbank Purple had the highest test weight of 57.1 lbs bu^{-1}, which was statistically similar to ten other varieties with test weights over 55.5 1 lbs bu^{-1}.

Yields were good across the trial with average yields over a ton per acre (Table 4, Figure 1). The highest yields were from two new entries of the two cultivars developed by the Crop Development Centre at the University of Saskatchewan: CDC Ascent and CDC Carter (3481 and 3408 lbs ac^{-1} respectively). None of the other varieties were statistically similar.

Protein concentrations averaged 15.3%, which is higher than ideal for malting barley (which needs to be between 10-12% for optimum malting) but good for culinary barley. The highest protein variety was Excelsior at 16.9%, similar to Ethiopian, Zwerggeste, and Sheba all with protein over 16%.

The falling number indicates the level of enzymatic activity in the grain. It is determined by the time it takes, in seconds, for a stirrer to fall through a slurry of flour and water to the bottom of a test-tube. Falling numbers between 300 - 350 indicate low enzymatic activity and sound quality grain. A falling number lower than 200 indicates high enzymatic activity and poor quality grain as a result of pre-harvest sprouting damage. Falling number above 400 is suitable, but may retard fermentation when used for baking. Falling number was generally good across the trial. Dolma, Ethiopian, and Tibetan had falling numbers less than 200, indicating low enzymatic activity in these varieties.

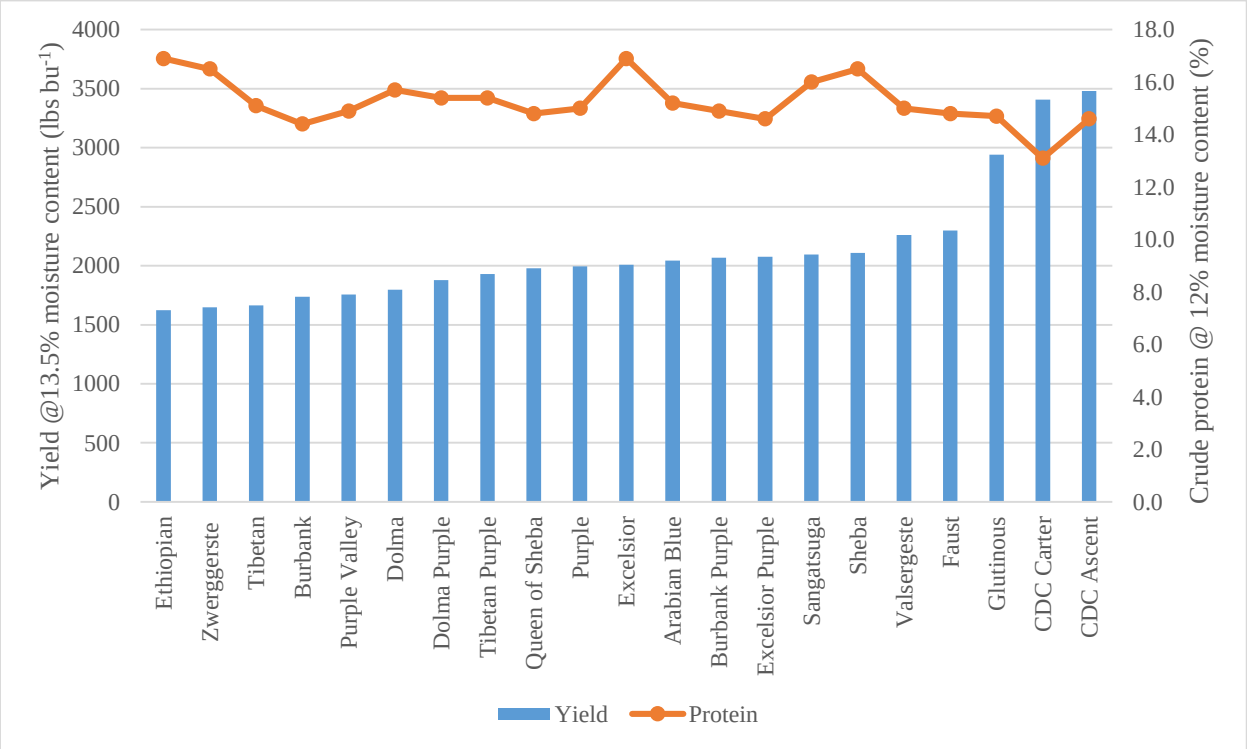

Figure 1. Spring hulless barley yield and protein, Alburgh, Vermont 2021.

DISCUSSION

Market outreach has been generating demand for hulless barley in recent years. Hulless barley in general shows potential as a specialty food grain in the Northeast. Though this data is only based on a single growing season, agronomic performance shows potential for hulless barley as a crop in Vermont and the Northeast. This was only the second year that enough seed was available to conduct multiple replications and quality analysis for this trial. More research is needed to better understand ideal quality parameters for hulless barley that can be achieved in Vermont, including test weight, protein and falling number and the yield potential of these varieties. The 2021 results are encouraging that many of these varieties are suitable for production in the Northeast. This trial will be continued in 2022, and with seed for all varieties already in stock, we will be able to plant all varieties at the same time and evaluate them on an equal basis.

ACKNOWLEDGEMENTS

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