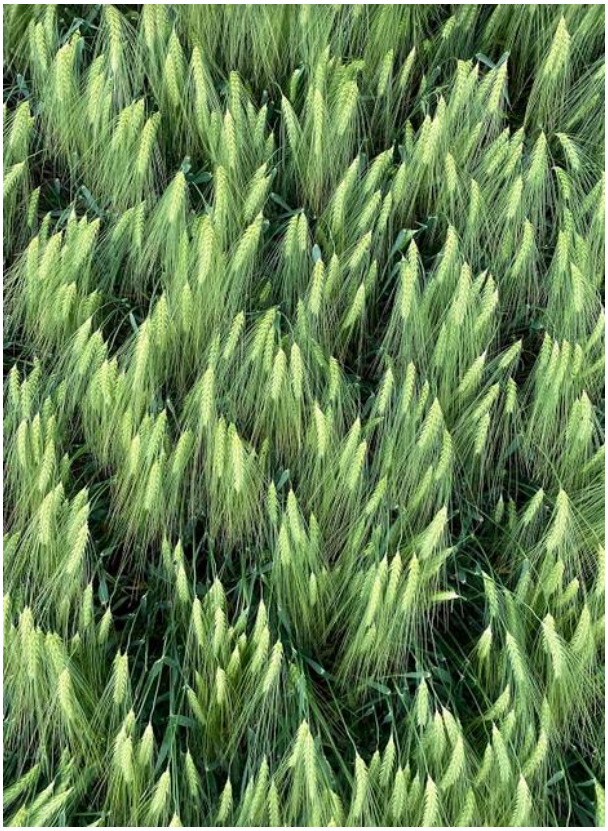
NORTHWEST CROPS & SOILS PROGRAM

2023 Hulless Barley Variety Trial



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THE UNIVERSITY OF VERMONT EXTENSION

2023 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 2023, the University of Vermont Extension's Northwest Crops and Soils Program continued the fourth year of a field trial of 25 heirloom hulless barley varieties.

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 25 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 14-Apr into 5' x 20' plots (Table 2). The previous crop was industrial hemp and the soil type was Benson rocky silt loam.

Table 1. Hulless barley varieties, Alburgh, VT, 2023.

Variety	Source
Arabian Blue	Solstice Seeds
Burbank	Solstice Seeds
Burbank Purple	Solstice Seeds
CDC Ascent	SeCan
CDC Carter	SeCan
CDC Clear	SeCan
CH-2909-162-95	SeCan
Dolma	Solstice Seeds
Dolma Purple	Solstice Seeds
Ethiopian	Solstice Seeds
Excelsior	Solstice Seeds
Excelsior Purple	Solstice Seeds
Faust	Solstice Seeds
Glutinous	Solstice Seeds
L94	Solstice Seeds
Purple	Solstice Seeds
Purple Valley	Solstice Seeds
Queen of Sheba	Solstice Seeds
Sangatsuga	Solstice Seeds
Sheba	Solstice Seeds
TB-106	Cornell
Tibetan	Solstice Seeds
Tibetan Purple	Solstice Seeds

Valsergeste	Solstice Seeds
Zwerggeste	Solstice Seeds

Table 2. Spring hulless barley agronomic information, Alburgh, VT, 2023.

Trial information	Alburgh, VT Borderview Research Farm
Soil type	Benson rocky silt loam
Previous crop	Industrial hemp
Seeding rate	350 live seeds m^{-2}
Row spacing (in)	6
Planting date	14-Apr
Harvest date	20-Jul
Harvest area (ft)	5 x 20
Tillage operations	Pottinger TerraDisc™

Heading date was recorded when 50% of the heads had fully emerged. Prior to harvest on 20-Jul, heights were measured, excluding awns, for three plants per plot. Lodging for each plot was visually assessed using a 0-100 scale, with 0 indicating no lodging and 100 indicating entire plot was too lodged to be harvested.

Grain plots were harvested with an Almaco SPC50 plot combine on 20-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. 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 water for 72 hours and counting the number of seeds that did not germinate.

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, an LSD value is presented for each variable (e.g. yield). Least Significant Differences (LSD's) at the 10% level of probability are shown. 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

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

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

Seasonal precipitation and temperature recorded at a weather station at Borderview Research Farm are displayed below in Table 3. The growing season was cooler than normal, although the month of May was warmer than average. There were 3591 Growing Degree Days (GDDs) in the season, 44 growing degree days more than the 30-year normal. There were 22.1 inches of precipitation, 6.62 inches more than the 30-year normal.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2023.

Alburgh, VT	April	May	June	July
Average temperature (°F)	48.3	57.1	65.7	72.2
Departure from normal	2.70	-1.28	-1.76	-0.24
Precipitation (inches)	4.94	1.98	4.40	10.75
Departure from normal	1.87	-1.78	0.14	6.69
Growing Degree Days (32-95°F)	524	766	1027	1274
Departure from normal	112	-53	-37	22

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 15-Jun (Table 4). 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. The average trial height was 80.9 cm. The tallest variety in the 2023 trial was Valsergeste at 103 cm and was statistically similar to L94 (Table 4). The average trial lodging was 37.9%, with Sheba having the lowest rate of lodging at 0% and was statistically similar to nine other varieties (Table 4). Harvest moisture below 14% is necessary for grain storage. Grain above this moisture content must be dried down after harvest, adding time and cost to the farm. There were 22 of the 25 varieties that tested above the 14% moisture threshold and required additional drying. Ethiopian had the lowest harvest moisture at 13.1% and was statistically similar to 12 other varieties (Table 4).

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. CDC Carter had the highest test weight of 53.0 lbs bu^{-1}, which was statistically similar to 15 other varieties (Table 4).

Hulless barley yields were lower than the previous year, with a trial mean yield of 1573 pounds per acre (Table 4, Figure 1). CDC Ascent had the highest yield at 2615 lbs ac^{-1} which was statistically similar only to CDC Carter, which had the highest yield in 2022.

Table 4. Spring hulless barley varieties and agronomic characteristics, Alburgh, VT, 2023.

Variety	Heading date	Height	Lodging	Harvest moisture	Test weight	Yield @ 13.5% moisture
		cm	0-100	%	lbs bu^{-1}	lbs ac^{-1}
Arabian Blue	14-Jun	86.9	59.5	19.8	51.6*†	1432
Burbank	20-Jun	75.9	50.0	16.3*	49.4	1288
Burbank Purple	13-Jun	76.9	65.0	16.3*	51.9*	1038
CDC Ascent	19-Jun	85.9	2.50*	18.4	50.6*	**2615***
CDC Carter	16-Jun	84.8	2.50*	14.1*	**53.0***	2302*
CDC Clear	18-Jun	91.7	28.8	18.6	47.9	1824
CH-2909n-162-95	17-Jun	88.8	7.50*	14.7*	47.6	2061
Dolma	15-Jun	75.9	13.0*	16.2*	48.6	1533
Dolma Purple	13-Jun	76.3	60.0	20.9	50.0*	1523
Ethiopian	11-Jun	82.8	11.5*	**13.1***	49.8*	1333
Excelsior	13-Jun	81.0	20.5*	15.8	51.0*	1538
Excelsior Purple	13-Jun	77.9	48.8	17.4*	52.3*	1194
Faust	9-Jun	83.9	52.5	18.3	47.5	1405
Glutinous	18-Jun	61.6	1.00*	14.6*	48.1	2021
L94	16-Jun	95.5*	28.8	13.7*	51.2*	1605
Purple	12-Jun	72.0	68.8	18.4	49.9*	1240
Purple Valley	9-Jun	82.4	54.3	18.4	51.9*	1295
Queen of Sheba	14-Jun	80.6	77.5	20.2	48.3	1255
Sangatsuga	14-Jun	75.8	18.8*	17.8	47.8	1928
Sheba	16-Jun	78.1	**0.00***	13.6*	48.9	1330
TB-106	18-Jun	76.8	0.50*	14.7*	50.3*	1727
Tibetan	12-Jun	66.3	60.0	17.3	52.6*	1242
Tibetan Purple	14-Jun	78.9	71.3	19.1	50.3*	1513
Valsergeste	19-Jun	**103***	81.3	14.4*	52.4*	1887
Zwerggeste	14-Jun	82.7	63.8	15.6*	52.8*	1209
LSD (p= 0.10)	NS‡	8.83	22.4	3.32	3.23	379
Trial mean	15-Jun	80.9	37.9	16.7	50.2	1573

†Treatments that are followed by an asterisk (*) performed statistically similar to the top performer shown in **bold**.
‡NS; no significant difference.

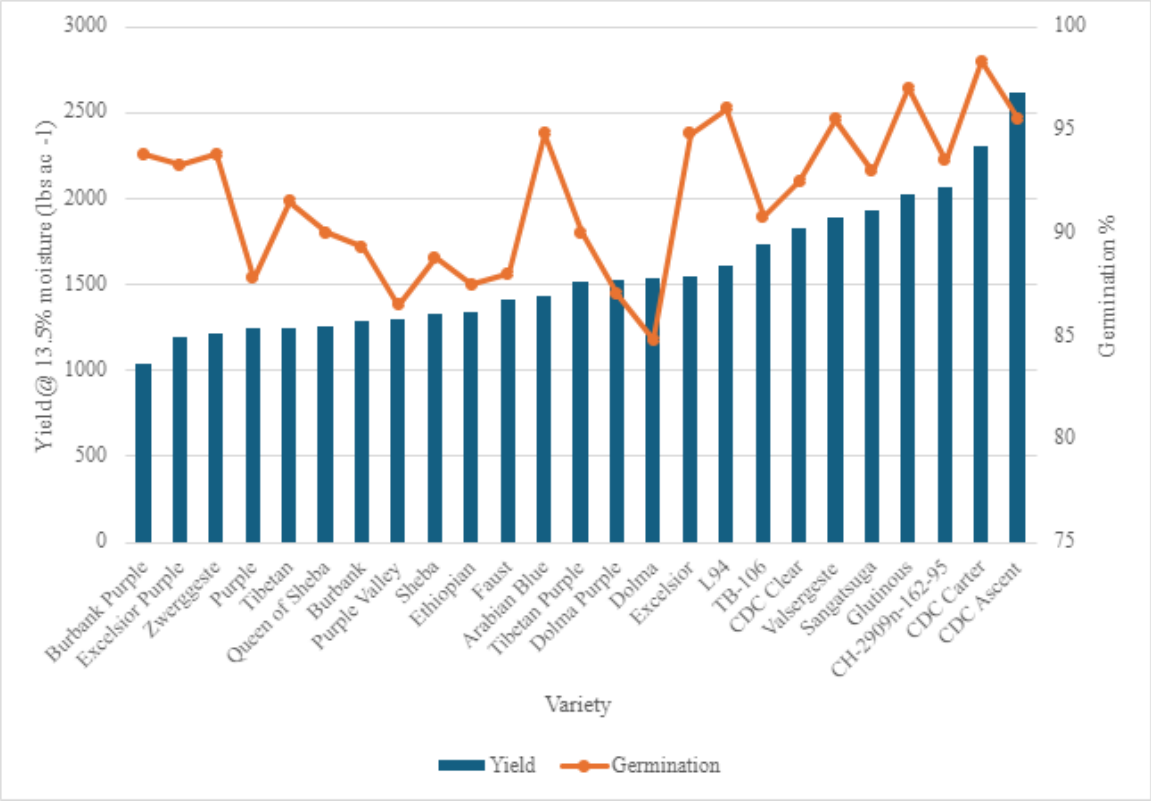

Figure 1. Spring hulless barley yield and germination, Alburgh, VT, 2023.

Protein concentrations averaged 12.2%, slightly higher than ideal for malting barley (which needs to be between 10-12% for optimum malting) but acceptable for culinary barley. The highest protein variety was Ethiopian at 13.7%, statistically similar to four other varieties: Sheba, Excelsior, Queen of Sheba, and Sangatsuga (Table 5).

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 may indicate slow fermentation and germination/ malting. The trial average for falling number was 272, ranging from 76 to 374. CDC Carter had the highest falling number, which was statistically similar to nine other varieties (Table 5).

Zwerggeste had the highest plumpness at 83.9% and was statistically similar to 12 other varieties (Table 5). CDC Carter had the highest germination rate at 98.3% and was statistically similar to six other varieties. Only five varieties were above the industry standard of 95% for germination: CDC Carter, Glutinous, L94, CDC Ascent, and Valsergeste (Table 5, Figure 1). Deoxynivalenol (DON) is a mycotoxin produced by fusarium, a common fungus that infects grain. Grain with over 1 ppm DON is not safe for human consumption. The trial mean was 0.66 ppm, with the lowest being Purple Valley with 0.30 ppm. Only three varieties exceeded the 1 ppm threshold: Sheba, Dolma, and Ethiopian.

Table 5. Spring hulless barley varieties and quality parameters, Alburgh, VT, 2023.

Variety	Crude protein @ 12% moisture %	Falling number seconds	Plumpness %	Germination %	DON Ppm
Arabian Blue	12.7	362*†	76.6*	94.8*	0.30*
Burbank	11.7	295	57.2	89.3	0.93
Burbank Purple	12.8	336*	77.0*	93.8	0.57*
CDC Ascent	10.7	270	72.0	95.5*	0.90
CDC Carter	10.1	**374***	59.2	**98.3***	0.43*
CDC Clear	9.70	213	61.1	92.5	0.63*
CH-2909n-162-95	11.4	204	66.4	93.5	0.57*
Dolma	12.5	76.0	52.3	84.8	1.33
Dolma Purple	12.8	333*	78.1*	87.0	0.50*
Ethiopian	**13.7***	203	66.8	87.5	1.30
Excelsior	13.3*	249	77.3*	94.8*	0.70*
Excelsior Purple	12.1	327*	77.8*	93.3	0.40*
Faust	12.2	210	72.7	88.0	0.60*
Glutinous	11.5	162	69.8	97.0*	0.57*
L94	12.7	248	77.5*	96.0*	0.63*
Purple	12.7	369*	81.1*	87.8	0.33*
Purple Valley	12.2	361*	81.8*	86.5	**0.30***
Queen of Sheba	13.0*	339*	79.5*	90.0	0.70*
Sangatsuga	13.0*	288	63.3	93.0	0.57*
Sheba	13.5*	135	47.0	88.8	1.50
TB-106	10.9	158	76.6*	90.8	0.40*
Tibetan	12.7	369*	82.4*	91.5	0.60*
Tibetan Purple	12.5	362*	78.8*	90.0	0.53*
Valsergeste	11.6	258	12.1	95.5*	0.50*
Zwerggeste	12.9	305	**83.9***	93.8	0.63*
LSD (p= 0.10)	0.69	51.9	7.71	4.29	0.49
Trial mean	12.2	272	69.1	91.7	0.66

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

DISCUSSION

Market outreach has been generating demand for hulless barley in recent years. Hulless barley has 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. 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 2023 results are encouraging that many of these varieties are suitable for production in the Northeast. This trial will be continued in 2024.

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