NORTHWEST CROPS & SOILS PROGRAM

2023 Organic Winter Malting Barley Variety Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2023 ORGANIC WINTER MALTING 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. To be suitable for malting, barley must meet specific quality characteristics such as low protein content, high starch and high germination. In the fall of 2022, a winter malting barley trial was conducted to evaluate yield and quality of 30 winter malting barley varieties.

MATERIALS AND METHODS

In the fall of 2022, a winter malting barley variety trial was established at Borderview Research Farm in Alburgh, VT. The experimental plot design was a randomized complete block with three replications. The treatments were 30 winter malting barley varieties, listed in Table 1.

Table 1. Varietal information for the 30 winter malting barley varieties, 2022-2023.

Winter barley variety	Type	Seed source
13ARS503-1	2	USDA-ARS
13ARS514-5	2	USDA-ARS
13ARS526-8	2	USDA-ARS
2MW18_3374-001	2	University of Minnesota
2MW18_3374-036	2	University of Minnesota
2MW18_4462-011	2	University of Minnesota
2MW19_3013-004	2	University of Minnesota
Barco	2	Saved seed
Carousel	6	Secobra
Charles	2	Saved seed
Constel	6	Secobra
Dementiel	6	Secobra
DH02FL-028	2	Oregon State University
DH141917	2	Oregon State University
DH150683	2	Oregon State University
DH162310	2	Oregon State University
DH170472	2	Oregon State University
Flavia	2	Saved seed
Hirondella	6	Ackermann
LCS Violetta	2	Saved seed
Marouetta	6	Ackermann
NB21214	2	University of Nebraska
Pixel	6	Secobra
RIL0257-01-011	2	Ohio State University
RIL02FL-029	2	Ohio State University
RIL523-PFFN-033	2	Ohio State University
VA17M-13DH1720 LX	6	Virginia Tech
VA19M-16DH2261	2	Virginia Tech
VA20MFHB-18DH541	2	Virginia Tech
Wintmalt	2	Saved seed

All plots were managed with practices similar to those used by producers in the surrounding area (Table 2). The previous crop planted on this site was spring barley. The trial area was plowed, disked, and spike toothed harrowed before planting. The plots were seeded with a Great Plains NT60 Cone Seeder on 15-Sep 2022 with a seeding rate of 160 lbs ac^{-1} into Benson rocky silt loam. Plot size was 5' x 20'.

Table 2. General plot management, 2022-2023.

Trial information	Alburgh, VT Borderview Research Farm
Soil type	Benson rocky silt loam
Previous crop	Spring barley
Tillage operations	Fall plow, disk & spike tooth harrow
Seeding Rates (lbs ac^{-1})	160
Row spacing (in)	6
Replicates	3
Planting date	15-Sep 2022
Harvest date	12-Jul 2023
Plot size (ft)	5 x 20

Winter survival was assessed visually as the percentage of each plot that had survived the winter on 28-Apr 2023. Heading dates were recorded throughout the month of May as the date when at least 50% of the barley in each plot was fully emerged from the boot. On 12-Jul 2023, the plots were harvested using an Almaco SPC50 small plot combine.

Following harvest, 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 and test weight were 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. Grain quality was determined at the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, Vermont). Grains were analyzed for protein and starch content using the Perten Inframatic 9500 Grain Analyzer. The optimal range for protein concentrations are 9-11% for malting barley. 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. The samples were then ground into flour using the Perten LM3100 Laboratory Mill. Falling number for all barley varieties was 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 250 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 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. One

sample per variety was run and determined that all varieties had DON concentrations less than 1 ppm (data not shown).

Standard characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within the trial were treated as random effects, and treatments were treated as fixed. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in project results 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. 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 the accompanying 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.

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

RESULTS

Table 3. Weather data for winter barley variety trial in Alburgh, VT 2022-2023*.

Alburgh, VT	**22-Sep**	**22-Oct**	**22-Nov**	**23-Apr**	**23-May**	**23-Jun**	**23-Jul**
Average temperature (°F)	60.2	51.3	41.5	48.3	57.1	65.7	72.2
Departure from normal	-2.52	0.96	2.24	2.7	-1.28	-1.76	-0.24
Precipitation (inches)	4.4	2.56	3.01	4.94	1.98	4.4	10.8
Departure from normal	0.73	-1.27	0.31	1.87	-1.78	0.14	6.69
Growing Degree Days (base 32°F)	861	607	346	524	766	1027	1274
Departure from normal	-61	39	111	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 NOAA data (1981-2010) from Burlington, VT.

The weather in the fall of 2022 had very average weather in terms of both precipitation and temperature. The main growing season in the spring and summer of 2023 was slightly cooler than average and much wetter. Over 22 inches of rain fell from April through July, 6.92 inches more than normal. A total of 5405 growing degree days (GDDs) accumulated over the fall of 2022 and spring and summer of 2023, 133 GDDs more than normal.

Table 4. Growing Season and Harvest Characteristics of 30 varieties winter barley, Alburgh VT 2022-2023.

Variety	Winter survival %	Heading[§] Date date	Harvest Moisture %	Test Weight lbs bu^{-1}	Yield @ 13.5% moisture content lbs ac^{-1}
13ARS503-1	32.0	19-May	17.5	41.6	1853
13ARS514-5	54.7	28-May	20.7	38.5	1645
13ARS526-8	56.0	24-May	14.9*†	41.2	2898
2MW18_3374-001	39.0	21-May	15.3	44.4	1907
2MW18_3374-036	49.0	18-May	14.0*	44.5	2857
2MW18_4462-011	62.3	20-May	15.5	39.5	2133
2MW19_3013-004	67.3*	19-May	15.0*	43.5	2706
Barco	58.3	19-May	15.2*	43.6	2361
Caroussel	53.0	22-May	14.7*	47.2*	2661
Charles	64.7	22-May	17.5	36.6	2971
Contsel	63.3	22-May	14.7*	46.5*	2931
DH02FL-028	62.7	23-May	14.0*	44.5	3268*
DH141917	69.7*	23-May	14.1*	44.4	2463
DH150683	69.0*	22-May	15.8	38.3	3797*
DH162310	49.7	20-May	17.1	39.0	2275
DH170472	68.7*	23-May	16.4	40.4	2291
Demential	65.3	22-May	14.3*	44.3	3110*
Flavia	71.7*	22-May	**13.5***	41.6	3317*
Hirondella	56.3	25-May	14.7*	44.0	**4169***
LCS Violetta	75.0*	21-May	14.8*	47.0*	3176*
Marouetta	52.3	25-May	14.5*	46.5*	3537*
NB21214	73.3*	23-May	14.7*	40.2	3131*
Pixel	59.3	23-May	15.0*	45.4	3305*
RIL0257-01-011	41.0	25-May	13.9*	44.7	1607
RIL02FL-029	37.0	25-May	16.1	46.2*	2296
RIL523-PFFN-033	68.7*	23-May	15.5	**48.6***	1758
VA17M-13DH1720LX	70.0*	19-May	14.6*	44.9	2586
VA19M-16DH2261	57.7	22-May	15.8	44.7	2400
VA20MFMB-18DH541	64.7	21-May	14.7*	43.1	3298*
Wintmalt	**87.0***	26-May	14.7*	43.9	1500
LSD (p=0.10) ‡	21.2	3.42	1.78	2.69	1160
Trial mean	60.0	22-May	15.3	43.3	2674

†Within a column, treatments with the same letter were not statistically different from the top performer (in bold).

‡LSD; least significant difference at the p=0.10 level.

[§]No optimal value has been identified for this characteristic.

Wintmalt had the best winter survival at 87% (Table 4). This was statistically similar to nine other varieties with winter survival greater than 67%. No varieties were entirely winter-killed over the winter of 2022-2023, and all varieties were able to be evaluated to harvest. All varieties headed between 18-May and 28-May with an average heading date of 22-May. The lowest harvest moisture was Flavia at 13.5%. Almost all samples collected were above 14% moisture and had to be dried down for storage. The variety with the highest test weight was RIL523-PFFN-033 at 48.6 lbs bu^{-1}. Although five other varieties were statistically similar, no other varieties were at or above the industry standard of 48 lbs bu^{-1}. The highest yielding variety was Hirondella with a yield of 4169 lbs ac^{-1} at 13.5% moisture content. This was statistically similar to nine other varieties that yielded greater than 3000 lbs ac^{-1}.

The variety with the highest germination rate was RIL523-PFFN-033 with 99.3% germination (Table 5). Although 15 other varieties were considered statistically similar, only one other variety (Hirondella) was above the 95% germination considered optimal for malting barley. 2MW18_3374-001 had the best plumpness, with 99.3% of kernels greater than 2.38 mm in diameter. This was statistically similar to 21 other varieties with greater than 96% plumpness. All varieties' plumpness met the industry standard of 90% plump. 14 varieties were within the optimal range for protein concentrations (9-11%). 13 varieties had less than 9% protein concentration, with three varieties over 11%. The highest starch concentration was in the variety Demential with 57.6% starch. This was statistically similar to 12 other varieties with starch concentrations greater than 56%. Only two varieties had falling number greater than 200 seconds, NB21214 with 270 seconds and RIL523-PFFN-033 with 243 seconds. 11 varieties had falling numbers of only 62 seconds which is the lowest possible value for the falling number test.

Table 5. Quality metrics of 30 varieties winter barley, Alburgh VT 2022-2023.

Variety†	Germination	Plumpness	Crude Protein @ 12% moisture content	Starch @ 12% moisture content	Falling number
	%	%	%	%	seconds
13ARS503-1	51.3	93.9	9.20	55.4	62.0
13ARS514-5	36.7	93.1	8.60	57.4	62.0
13ARS526-8	19.0	98.6*	9.00	57.3	62.0
2MW18_3374-001	88.7*	**99.3***	12.2*	52.7	72.7
2MW18_3374-036	45.7	98.9*	**10.6***	54.1	71.7
2MW18_4462-011	61.7	94.2	8.70	56.2	62.0
2MW19_3013-004	54.7	98.6*	9.30	55.6	80.0
Barco	94.0*	94.1	9.90*	54.6	100
Caroussel	89.7*	99.0*	10.2*	54.5	121
Charles	33.7	97.1*	8.60	56.4	62.0
Contsel	89.3*	97.7*	8.80	56.2	75.7
DH02FL-028	84.0*	95.9	8.90	56.2	75.7
DH141917	77.3	98.6*	9.20	55.9	70.3
DH150683	18.3	97.4*	8.40	56.0	62.0
DH162310	27.3	99.1*	9.90*	54.6	62.0

DH170472	45.3	99.0*	8.70	56.6	62.0
Demential	94.0*	96.5*	8.00	**57.6***	95.7
Flavia	69.7	98.6*	8.40	57	62.3
Hirondella	97.0*	98.4*	7.70	57.5	170
LCS Violetta	91.7*	98.9*	9.60*	55.6	175
Marouetta	92.3*	98.2*	8.20	57.3	85.0
NB21214	81.3*	97.5*	10.40*	54.1	**270***
Pixel	94.0*	97.9*	7.90	56.5	133
RIL0257-01-011	79.7*	95.3	11.80*	53.1	118
RIL02FL-029	87.0*	97.4*	9.10	55.9	105
RIL523-PFFN-033	**99.3***	94.6	10.90*	54.2	243*
VA17M-13DH1720LX	87.7*	96.2	8.90	56.6	73.0
VA19M-16DH2261	80.7*	97.9*	11.20*	54.1	63.0
VA20MFMB-18DH541	62.0	98.6*	9.60*	55.7	62.3
Wintmalt	67.0	97.1*	9.40	55.7	62.0
LSD (p=0.10) ‡	21.8	2.93	1.31	1.51	44.5
Trial mean	70.0	97.3	9.40	55.7	96.0

†Within a column, treatments with the same letter were not statistically different from the top performer (in **bold**).
‡LSD; least significant difference at the p=0.10 level.

DISCUSSION

The weather was extremely challenging for growing high quality barley in Vermont during the 2022-2023 growing season. There was little snow cover and some very cold spells in the winter of 2022-2023, leading to low winter survival for many varieties. Between spring thaw in April and harvest in July, there were almost seven inches of rain more than normal. This complicated both the growth of the barley and the harvest timing, as harvest timing had to depend not only on ripeness of the barley, but the ability to get a combine into the water-logged fields. The low overall falling number indicates a high degree of sprouting damage across the trial and that the trial was harvested later than would have been ideal for harvest timing. Poor harvest timing and wet conditions at harvest also explain the low overall germination rates for the trial (Figure 1). Both quality and yields were lower than in many previous years of the winter barley trials at Borderview Research Farm (Figure 2). This research will continue in 2024, with a winter barley variety trial of 22 varieties planted on 12-Sept 2023.

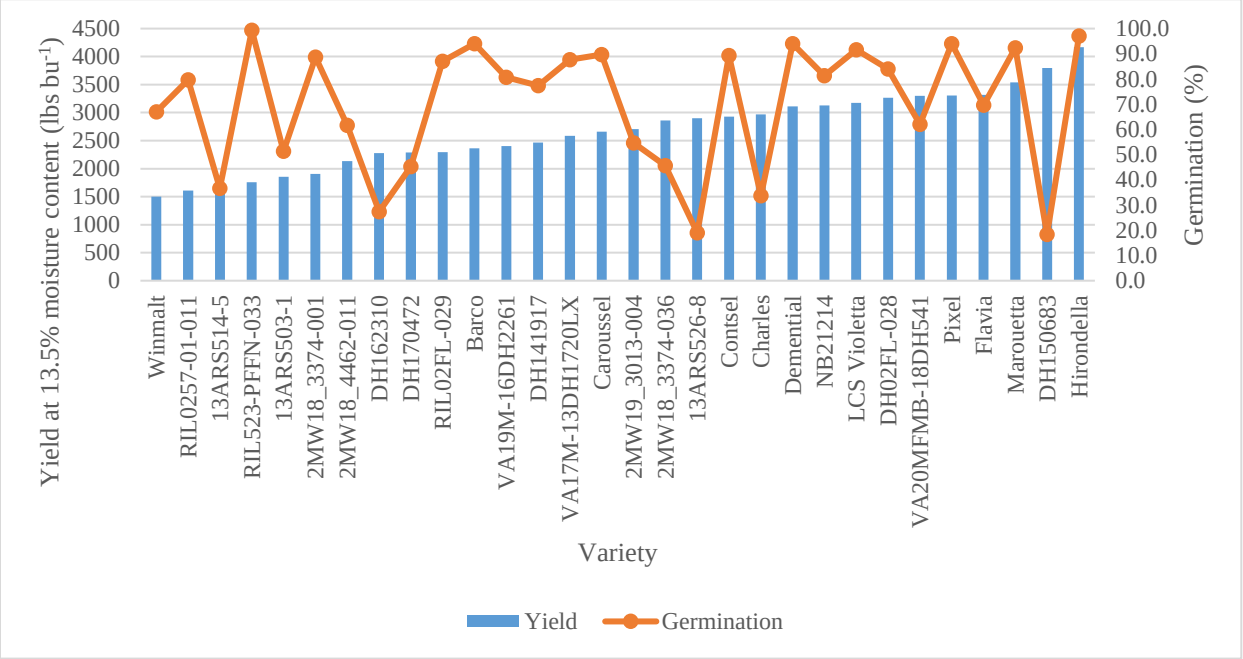

Figure 1. Yield and germination rate for 30 winter barley varieties, Alburgh VT 2022-2023.

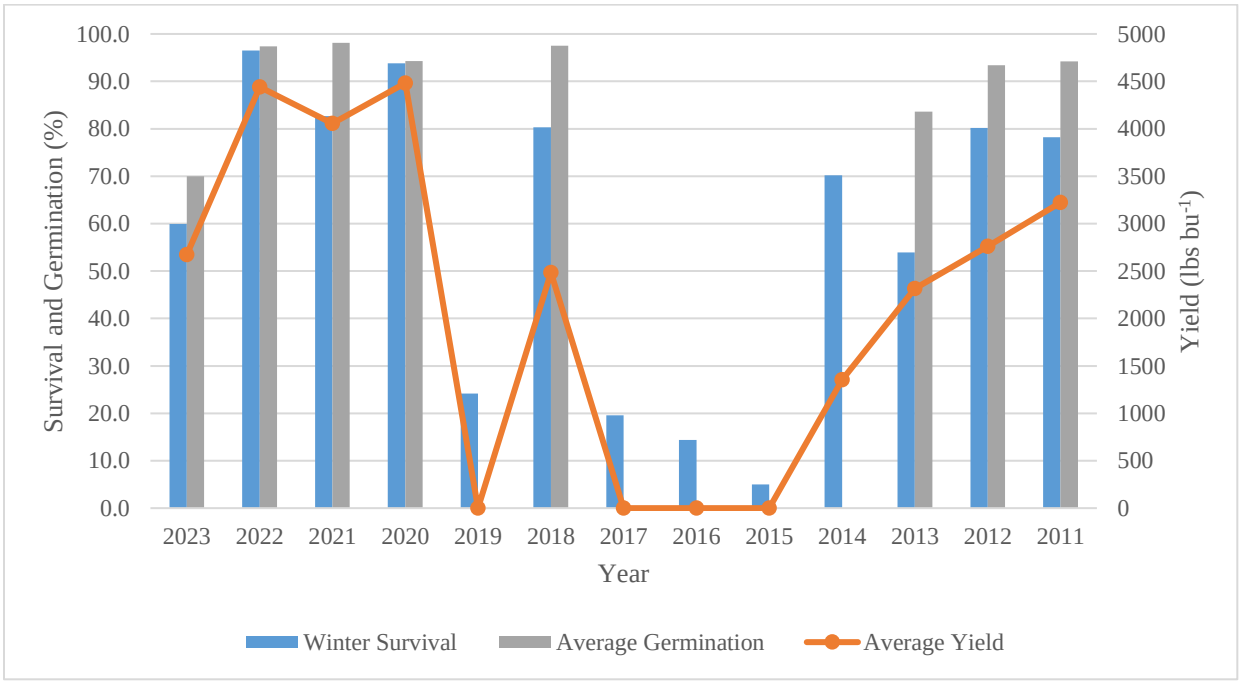

Figure 2. Average winter survival, yield and germination rate for winter barley trials, Alburgh VT 2011-2023

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