NORTHWEST CROPS & SOILS PROGRAM

2022 Winter Barley Variety Trial

Dr. Heather Darby, UVM Extension Agronomist
Sophia Wilcox Warren
UVM Extension Crop and Soil Technicians
(802) 524-6501

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2022 WINTER BARLEY VARIETY TRIAL
Dr. Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

With the development of a robust localvore movement and the revival of the small grains industry in the Northeast, craft breweries and distilleries have expressed an interest in sourcing local barley for malting. Malting barley must meet specific quality characteristics, such as moderate protein content and high germination rate. Winter barley has not been traditionally grown in the Northeast due to severe winterkill. However, newly developed varieties and a changing climate have encouraged our team to investigate this crop for the area. In 2021-2022, UVM Extension's Northwest Crops and Soils Program conducted a winter barley trial to evaluate the yield, quality and agronomic characteristics of malting barley varieties.

MATERIALS AND METHODS

A winter barley variety trial was initiated at Borderview Research Farm in Alburgh, VT. Winter barley was planted on 22-Sep 2021. Thirty-two winter varieties (Table 1) were planted in a randomized complete block design with three replicates. The seedbed was prepared by conventional tillage methods. Plots were 5' x 20' and were seeded into a Benson rocky silt loam at 125 lbs ac^{-1} with a Great Plains cone seeder. Rows were spaced at 6". All plots were managed with practices similar to those used by producers in the surrounding areas (Table 2).

Table 1. Winter malting barley varieties and seed sources.

Variety	Row Type	
13ARS503-1*	2	USDA experimental variety
13ARS506-8*	2	USDA experimental variety
13ARS514-5*	2	USDA experimental variety
2MW18-4662-008	2	University of Minnesota
Avalon	2	Virginia Tech
Charles	2	Univ of Idaho Foundation Seed
Dementiel	6	Secobra
DH0214-0077	2	Ohio State University
DH02FL-028	2	Ohio State University
DH141222	2	Oregon State University
DH141225	2	Oregon State University
DH141917	2	Oregon State University
DH150683	2	Oregon State University
Endeavor	2	Univ of Idaho Foundation Seed
Flavia	2	Ackermann
Hirondella	6	Ackermann
KWS Donau	2	KWS
KWS Faro	6	KWS
KWS Orbit	6	Albert Lea Seed

KWS Somerset	2	KWS
Marouetta	6	Ackermann
MW12_4007-001	6	University of Minnesota
Pixel	6	Secobra
RIL02FL-029	2	Ohio State University
RIL02WI-013	2	Ohio State University
SC 104865	6	Secobra
SC113669	6	Secobra
Thoroughbred	6	Virginia Tech
VA17M-13DH1720	6	Virginia Tech
VA19M-16DH2261	2	Virginia Tech
VA20MFHB-18DH541	2	Virginia Tech
Wintmalt	2	Tri State Seeds

*Experimental variety, not commercially available.

Table 2. Winter barley agronomic practices and trial information.

Trial information	Alburgh, VT Borderview Research Farm
Soil type	Benson rocky silt loam
Previous crop	Corn silage
Seeding Rate (lbs ac^{-1})	125
Row spacing (in)	6
Replicates	3
Planting date	22-Sep 2021
Harvest date	18-Jul 2022
Harvest area (ft)	5 x 20
Tillage operations	Pottinger TerraDisc®

Winter survival was measured on 5-May 2022 by comparing the number of live tillers to winterkilled tillers in 2 one-foot sections of row. Heading date was recorded through the spring as the date when at least 50% of the plot had headed. Heights and lodging were recorded on 18-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 was 1 to 10% of the plants were lodged and a rating of 9 meant that greater than 90% of the plants were lodged. Winter barley was harvested with an Almaco SPC50 small plot combine on 18-Jul 2022.

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 yields were recorded. 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 350 indicate low enzymatic activity and sound quality barley. 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. 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 with 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.

Data was analyzed using mixed model analysis procedure of SAS (SAS Institute, 1999). Replications were treated as random effects, and treatments were treated as fixed. 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 AND DISCUSSION

Seasonal precipitation and temperature recorded at Borderview Research Farm in Alburgh, VT are displayed in Table 3. The average fall temperature (Sep-21 to Nov-21) was 51.8°F, which was 3.03°F warmer than the 30-year normal. The average temperature from Mar-22 to Jul-22 was 1.44°F cooler than the 30-year normal. This growing season was wetter than past years with a total precipitation of 22.6 inches from Mar-22 to Jul-22. From September 2021 to July 2022, there were 5546 Growing Degree Days (GDDs), which is consistent with historical means GDD trends over the last 30 years.

Table 3. Weather data for winter barley variety trial in Alburgh, VT.

Alburgh, VT	Sep-21	Oct-21	Nov-21	Mar-22	Apr-22	May-22	Jun-22	Jul-22
Average temperature (°F)	63.1	54.6	37.6	32.3	44.8	60.5	65.3	71.9
Departure from normal	0.40	4.31	-1.68	-0.03	-0.81	2.09	-2.18	-0.54
Precipitation (inches)	4.49	6.23	2.26	2.52	5.57	3.36	8.19	3.00
Departure from normal	0.82	2.40	-0.44	0.28	2.50	-0.40	3.93	-1.06
Growing Degree Days (base 32°F)	933	701	232	170	391	883	1000	1236
Departure from normal	11	133	-3	32	-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 NOAA data (1981-2020) from Burlington, VT.

The average winter survival for the trial was 96.5%, with 22 varieties having 100% survival rates (Table 4). 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. The tallest variety was Marouetta at 85.0 cm tall, however, it was not significantly different to the other varieties. Hirondella and Wintermalt had the lowest degree of lodging at 2.33%, but was not significantly different to the other varieties. The variety with the highest degree of lodging was Dementiel at 50.0%.

Table 4. Agronomic characteristics for winter barley variety trial in Alburgh, VT.

Variety	Winter survival %	Height cm	Lodging %
13ARS503-1	83.3	73.1	10.0
13ARS506-8	100	69.1	23.3
13ARS514-5	100	77.9	13.3
2MW18-4662-008	100	81.1	34.0
Avalon	100	78.8	2.33
Charles	83.3	70.2	48.3
Dementiel	93.3	71.6	50.0
DH0214-0077	100	82.3	17.3
DH02FL-028	100	82.8	4.33
DH141222	98.3	78.4	34.3
DH141225	100	78.6	3.33
DH141917	98.3	69.2	10.0
DH150683	98.3	79.3	4.67
Endeavor	96.7	77.6	11.7
Flavia	100	68.7	13.3
Hirondella	100	80.7	2.33
KWS Donau	96.7	82.7	6.00
KWS Faro	100	78.3	5.67
KWS Orbit	98.3	80.2	3.33

KWS Somerset	100	76.4	5.67
Marouetta	100	85.0	12.0
MW12_4007-001	100	83.6	35.7
Pixel	100	79.0	31.7
RIL02FL-029	100	74.8	35.0
RIL02WI-013	75.0	81.0	17.3
SC 104865	100	74.6	24.7
SC113669	100	78.6	19.0
Thoroughbred	100	77.8	6.67
VA17M-13DH1720	100	74.2	25.0
VA19M-16DH2261	100	81.6	15.0
VA20MFHB-18DH541	73.3	75.1	8.33
Wintermalt	93.3	73.1	2.33
LSD (p=0.10)	NS†	NS	NS
Trial Mean	96.5	77.4	16.8

† NS; indicates that no significant difference was detected.

Table 5. Yield and harvest data for winter barley variety trial in Alburgh, VT.

Variety	Yield @13.5% moisture content lbs ac⁻¹	Moisture %	Test weight lbs bu⁻¹
13ARS503-1	3414	15.1	41.8
13ARS506-8	3794	13.8	42.6
13ARS514-5	5451	14.8	45.1
2MW18-4662-008	4050	16.1	46.8
Avalon	3779	15.8	46.6
Charles	3937	14.1	41.7
Dementiel	3569	16.4	46.6
DH0214-0077	4768	15.0	46.1
DH02FL-028	5433	14.0	45.6
DH141222	3604	14.5	44.4
DH141225	4014	14.3	46.0
DH141917	5642	14.2	47.3
DH150683	4847	15.1	45.7
Endeavor	4621	14.6	46.4
Flavia	5624	15.7	45.8
Hirondella	5578	13.9	45.5
KWS Donau	5161	16.5	46.1
KWS Faro	4918	15.4	43.6
KWS Orbit	4100	17.6	46.6
KWS Somerset	3920	14.5	42.6

Marouetta	5458	15.7	47.1
MW12_4007-001	3552	13.6	44.3
Pixel	5421	16.9	46.0
RIL02FL-029	3626	17.2	42.7
RIL02WI-013	3288	14.6	44.9
SC 104865	4436	15.8	44.8
SC113669	3158	14.1	44.4
Thoroughbred	5578	16.0	47.0
VA17M-13DH1720	4411	15.0	46.6
VA19M-16DH2261	4643	15.1	43.5
VA20MFHB-18DH541	3698	14.1	45.6
Wintermalt	4616	14.7	47.1
LSD (p=0.10)	NS†	NS	NS
Trial Mean	4441	15.1	45.2

†NS; indicates that no significant difference was detected.

The trial mean for yields was 4441 lbs ac^{-1} with DH141917 as the variety with the highest yield of 5642 lbs ac^{-1}. The variety with the lowest harvest moisture was MW12_4007-001 at 13.6% moisture. All varieties were above 12% moisture content at harvest and required drying for storage. No variety reached the industry standard for test weight of 48 lb bu^{-1}. DH141917 had the highest test weight of 47.3 lbs bu^{-1}. There were no statistically significant differences in yield, moisture, or test weight between the thirty-two varieties (Table 5).

Table 6. Quality data for winter barley variety trial in Alburgh, VT.

Variety	Crude protein @ 12% moisture content %	Starch %	Falling number seconds	Germination %	Plumpness %
13ARS503-1	9.70	56.0	301*†	98.0	88.6
13ARS506-8	9.10	56.5	248	98.7	90.6
13ARS514-5	8.90	56.9	166	99.0	88.2
2MW18-4662-008	9.60	56.0	325*	97.7	96.3
Avalon	9.70	56.0	326*	96.7	96.8
Charles	9.70	56.1	177	98.0	88.4
Dementiel	9.70	55.7	215	95.7	92.1
DH0214-0077	9.50	56.5	300*	99.0	93.9
DH02FL-028	10.0	55.7	319*	93.3	96.4
DH141222	9.80	55.9	296*	97.0	94.4
DH141225	10.7	55.2	321*	98.0	96.1
DH141917	9.50	56.0	309*	99.3	96.4
DH150683	9.40	56.1	312*	99.7	96.4
Endeavor	9.40	56.7	247	98.7	94.8
Flavia	9.10	56.4	304*	95.0	96.9
Hirondella	9.30	56.5	300*	92.0	97.5

KWS Donau	9.30	56.7	329*	97.3	**97.7**
KWS Faro	9.10	56.5	315*	98.0	96.7
KWS Orbit	9.10	**57.0**	302*	**100**	96.9
KWS Somerset	9.40	56.6	358*	99.3	96.5
Marouetta	9.40	56.6	297*	98.7	96.6
MW12_4007-001	10.4	55.0	**368***	96.3	95.9
Pixel	9.10	56.7	332*	98.7	95.4
RIL02FL-029	9.00	56.5	199	96.7	90.4
RIL02WI-013	9.90	55.5	337*	**100**	87.2
SC 104865	9.60	56.4	289*	98.7	94.0
SC113669	**11.2**	54.0	261	90.0	89.8
Thoroughbred	9.10	56.7	327*	99.0	95.6
VA17M-13DH1720	9.30	56.4	331*	98.7	95.5
VA19M-16DH2261	10.6	54.8	286*	92.3	95.7
VA20MFHB-18DH541	9.00	56.9	311*	99.7	87.1
Wintermalt	9.70	55.9	322*	97.7	97.1
LSD (p=0.10)	NS‡	NS	57.2	NS	NS
Trial Mean	9.60	56.1	295	97.4	94.1

†The top performer for each parameter/column is indicated in **bold.** Varieties with an asterisk* are statistically similar to the top performer.
‡NS indicates that no significant difference was detected.

Almost all the varieties were within the industry standard of crude protein content between 9-11% (Table 6). SC113669 had the highest crude protein content of 11.2%, but was not significantly different than any of the other varieties. KWS Orbit had the highest starch content of 57.0% and was not significantly different than the other varieties. All but three varieties had a falling number above 200 seconds, indicating sufficient enzymatic activity. MW12_4007-001 had the highest falling number at 368 seconds and was statistically similar to twenty-four other varieties. KWS Orbit and RIL02WI-013 had germination rates of 100%, however there were not significant differences between the varieties. All varieties had plumpness above the 80% industry standard with KWS Donau having the highest plumpness of 97.7% (Table 6, Figure 1). There were no significant differences between varieties for plumpness.
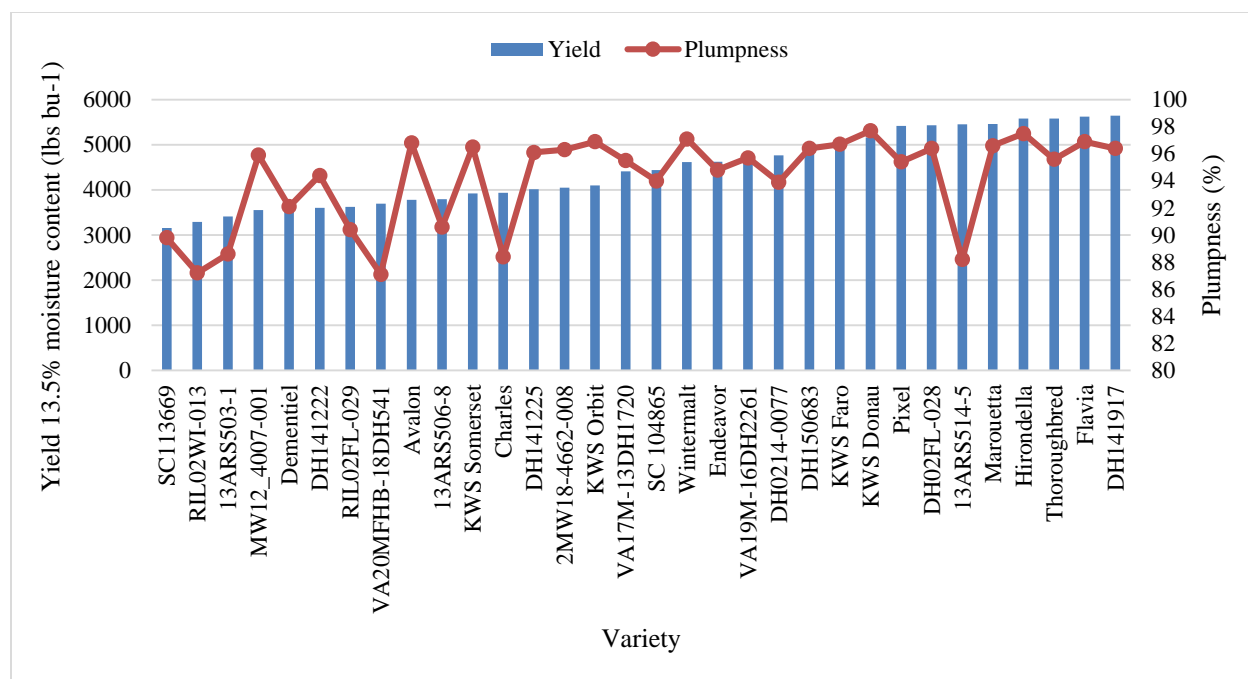
Figure 1. Yield and plumpness of winter malting barley varieties, Alburgh, Vermont

DISCUSSION

Compared to previous winter barley variety trials, 2022 had a relatively high trial mean yield of 4441 lbs ac[-1], just slightly less than the 2020 winter barley variety trial with the highest trial mean yield of 4482 lbs ac[-1]. No varieties outperformed the others. There were no statistically significant differences detected in agronomic, harvest, and most 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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