



2021 Winter Barley Variety Trial



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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 2020-2021, 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 18-Sep 2020. Twenty-seven 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 | Seed Source |
|----------------------|----------|--------------------------------|
| 0214-007 | 2 | Ohio State University |
| 02WI-13 | 2 | Ohio State University |
| 13ARS537-13 | 2 | USDA-ARS, Idaho |
| 13ARS537-19 | 2 | USDA-ARS, Idaho |
| 13ARS537-25 | 2 | USDA-ARS, Idaho |
| ARS15B12 | 2 | USDA-ARS, North Carolina |
| Avalon (VA16M-81 2R) | 2 | Virginia Tech |
| Charles | 2 | Univ of Idaho Foundation Seed |
| Dementiel | 6 | Secobra |
| DH140963 | 2 | Oregon State University |
| DH141132 | 2 | Oregon State University |
| DH141222 | 2 | Oregon State University |
| DH141225 | 2 | Oregon State University |
| Endeavor | 2 | Univ of Idaho Foundation Seed |
| Flavia | 2 | Ackermann |
| Hirondella | 6 | Ackermann |
| KWS Faro | 6 | KWS |
| KWS Joyau | 6 | KWS |
| KWS Scala | 2 | KWS |
| KWS Somerset | 2 | KWS |
| NB15420 | 6 | University of Nebraska-Lincoln |

| | | |
|--------------|---|-----------------|
| Pixel | 6 | Secobra |
| SC 31450 TH | 2 | Secobra |
| Thoroughbred | 6 | Virginia Tech |
| VA16M-84 2R | 2 | Virginia Tech |
| Visuel | 6 | Secobra |
| Wintmalt | 2 | Tri State Seeds |

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 |
| Seeding Rate (lbs ac⁻¹) | 125 |
| Row spacing (in) | 6 |
| Replicates | 3 |
| Planting date | 18-Sep 2020 |
| Harvest date | 12-Jul 2021 |
| Harvest area (ft) | 5 x 20 |
| Tillage operations | Fall plow, spring disk & spike tooth harrow |

Winter survival was measured on 27-Apr 2021 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 12-Jul 2021 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. Winter barley was harvested with an Almaco SPC50 small plot combine on 12-Jul 2021.

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. The samples were then ground into flour using the Perten LM3100 Laboratory Mill, and were evaluated for crude protein content using the Perten Inframatic 8600 Flour Analyzer. 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

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

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.

RESULTS AND DISCUSSION

Seasonal precipitation and temperature recorded at a weather station in Alburgh, VT are shown in Table 3. Historical averages are for 30 years of data (1981-2010). The fall weather was overall cooler and drier than normal. The spring and summer growing season of 2021 was overall warmer and drier than normal. Over the 8 months of growing season for the winter barley, there were 5510 growing degree days, 98 more than the 30 year average, and 18.85 inches of precipitation, almost 9 inches less than normal.

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

| Alburgh, VT | Sep-20 | Oct-20 | Nov-20 | Mar-21 | Apr-21 | May-21 | Jun-21 | Jul-21 |
|---------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Average temperature (°F) | 59.2 | 48.3 | 42.0 | 33.2 | 48.1 | 58.4 | 70.3 | 68.1 |
| Departure from normal | -3.53 | -2.01 | 2.69 | 0.93 | 2.52 | -0.03 | 2.81 | -4.31 |
| Precipitation (inches) | 2.75 | 3.56 | 1.41 | 0.97 | 3.52 | 0.66 | 3.06 | 2.92 |
| Departure from normal | -0.92 | -0.27 | -1.29 | -1.27 | 0.45 | -3.10 | -1.20 | -1.14 |
| Growing Degree Days (base 32°F) | 816 | 521 | 352 | 241 | 497 | 818 | 1146 | 1119 |
| Departure from normal | -107 | -48 | 117 | 103 | 85 | -1 | 83 | -134 |

*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 variety with the best winter survival was Hiredella; 100% of the plants of this variety survived the winter without any winterkill. This was statistically similar to 18 other varieties with 85% or greater survival (Table 4). Heading dates for all varieties fell within a six day period between May 19 to May 25. The weather at heading date is often related to fusarium infection and presence of deoxynivalenol toxin, with colder, wetter weather associated with higher infection rates and higher toxin concentrations. The late May weather in 2021 was warm and dry and was not conducive to fungus growth. One rep of each variety tested for DON (data not shown). All samples tested below the detectable limit for the DON vomitoxin test (<0.5 ppm).

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

| Variety | Winter survival % | Heading date | Height cm | Lodging % |
|--------------|-------------------|--------------|-----------|-----------|
| 0214-007 | 91.7*† | 20-May | 90.7 | 0.00 |
| 13AR5537-13 | 45.0 | 20-May | 70.3 | 0.00 |
| 13AR5537-19 | 33.3 | 21-May | 67.9 | 0.00 |
| 13AR5537-25 | 58.3 | 20-May | 71.8 | 0.00 |
| ARSS1SB12 | 51.7 | 21-May | 87.1 | 0.00 |
| Avalon | 85.0* | 20-May | 104.0 | 0.00 |
| Charles | 71.7 | 22-May | 76.8 | 1.33 |
| DH140963 | 91.7* | 23-May | 85.4 | 0.00 |
| DH141225 | 96.7* | 21-May | 88.9 | 2.67 |
| DH141ZZZ | 95.0* | 23-May | 87.8 | 2.00 |
| DM141132 | 90.0* | 24-May | 85.2 | 2.00 |
| Dementiel | 93.3* | 21-May | 86.7 | 3.33 |
| Endeavor | 60.0 | 24-May | 87.7 | 0.00 |
| Flavia | 91.7* | 21-May | 80.0 | 4.67 |
| Hiredella | 100.0* | 24-May | 90.9 | 8.00 |
| KWS Faro | 98.3* | 19-May | 87.9 | 6.00 |
| KWS Joyau | 91.7* | 20-May | 73.1 | 2.00 |
| KWS Scala | 90.0* | 23-May | 76.2 | 2.67 |
| KWS Somerset | 85.0* | 25-May | 84.6 | 0.00 |
| NB15420 | 98.3* | 19-May | 109.8 | 8.67 |
| OZWI-13 | 80.0 | 24-May | 84.3 | 2.00 |
| Pixel | 96.7* | 20-May | 80.9 | 3.33 |
| SC 31450T4 | 85.0* | 21-May | 77.1 | 0.67 |
| Thoroughbred | 95.0* | 19-May | 91.7 | 3.67 |
| VA16M-84 ZR | 73.3 | 22-May | 104.3 | 0.00 |
| Visual | 93.3* | 22-May | 79.7 | 6.00 |
| Wintmalt | 90.0* | 25-May | 83.1 | 2.00 |
| Trial Mean | 82.7 | 21-May | 85.0 | 2.26 |
| LSD (0.10) | 17.46 | NS | 6.17 | 2.59 |

†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.

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 NB15420 at 109.8 cm tall. This was statistically similar to VA16M-84 ZR and Avalon, both more than 100 cm tall. The tallest variety, NB15420 had the highest degree of lodging, with an average score of 8.67 on a scale from 0-9. This was statistically similar to Hirondezza, which although 20 cm shorter on average than NB15420, was lodged at a rate of 8 out of 9.

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

| Variety | Yield @13.5% moisture content lbs ac ⁻¹ | Moisture % | Test Weight lbs bu ⁻¹ | Crude Protein @ 12% moisture content % | Falling Number seconds | Germination % | Plumpness % |
|--------------|--|---------------|--|---|------------------------------|------------------|----------------|
| 0214-007 | 4617 | 12.0*† | 45.4 | 13.7 | 397* | 99.3* | 99.3* |
| 13AR5537-13 | 2505 | 13.0 | 41.6 | 12.5 | 65 | 85.3 | 97.4* |
| 13AR5537-19 | 2284 | 15.1 | 46.2* | 12.1 | 100 | 96.3* | 96.9* |
| 13AR5537-25 | 2707 | 13.2 | 43.7 | 12.8 | 82 | 82.0 | 98.1* |
| ARSS1SB12 | 3777 | 13.3 | 44.7 | 12.7 | 317 | 99.7* | 98.8* |
| Avalon | 2852 | 13.1 | 43.9 | 14.3 | 294 | 99.7* | 99.3* |
| Charles | 2749 | 11.7* | 40.0 | 12.1 | 172 | 98.7* | 93.0 |
| DH140963 | 5089* | 12.6* | 43.8 | 11.2* | 309 | 98.3* | 99.5* |
| DH141225 | 4687 | 12.6* | 43.8 | 12.0 | 286 | 100.0* | 96.8* |
| DH141ZZZ | 4522 | 12.2* | 45.7 | 12.3 | 333 | 100.0* | 98.1* |
| DM141132 | 4066 | 12.4* | 42.8 | 11.6 | 341* | 99.7* | 98.0* |
| Dementiel | 4575 | 11.8* | 40.5 | 10.8* | 345* | 100.0* | 89.1 |
| Endeavor | 3144 | 14.4 | 45.1 | 12.1 | 123 | 99.3* | 94.6* |
| Flavia | 4820 | 12.1* | 45.7 | 12.6 | 258 | 99.0* | 98.3* |
| Hirondezza | 6022* | 11.9* | 42.6 | 11.9 | 314 | 99.0* | 91.9 |
| KWS Faro | 5757* | 12.2* | 46.1* | 11.1* | 315 | 99.7* | 96.9* |
| KWS Joyau | 4427 | 11.9* | 42.4 | 11.7 | 262 | 98.7* | 98.3* |
| KWS Scala | 4224 | 11.5* | 43.5 | 12.3 | 326 | 98.7* | 99.4* |
| KWS Somerset | 4436 | 12.2* | 43.0 | 12.4 | 343* | 98.7* | 99.6* |
| NB15420 | 3419 | 11.6* | 38.9 | 12.8 | 381* | 100.0* | 63.4 |
| OZWI-13 | 4058 | 11.6* | 41.5 | 13.7 | 294 | 100.0* | 99.2* |
| Pixel | 5349* | 12.0* | 41.4 | 11.3* | 359* | 100.0* | 92.0 |
| SC 31450T4 | 4007 | 12.4* | 45.4 | 12.7 | 314 | 99.3* | 98.1* |
| Thoroughbred | 4603 | 12.0* | 45.5 | 11.3* | 349* | 100.0* | 90.6 |
| VA16M-84 ZR | 2682 | 14.8 | 48.0* | 13.4 | 374* | 99.7* | 97.2* |
| Visual | 4218 | 12.0* | 42.0 | 11.9 | 309 | 98.7* | 92.1 |
| Wintmalt | 3947 | 12.7* | 44.0 | 12.5 | 293 | 99.7* | 99.5* |
| Trial Mean | 4057 | 12.5 | 43.6 | 12.3 | 283 | 98.1 | 95.4 |
| LSD (0.10) | 1196 | 1.21 | 2.22 | 0.76 | 57.2 | 5.34 | 5.15 |

†The top performer for each parameter/column is indicated in **bold**. Varieties with an asterisk* are statistically similar to the top performer.

Winter barley yields were good, averaging over two tons per acre (Table 5). The highest yielding variety was Hirondeella, with a yield of 6022 lbs ac⁻¹. This was statistically similar to three other varieties that all averaged over 5000 lbs ac⁻¹ (KWS Faro, Pixel, and DH140963). Harvest moisture overall was low and few plots required drying down for storage. Falling number was extremely variable, ranging from 65 to 397 seconds, indicating great variability in grain maturity at harvest. Only five varieties had falling number below the desired value of 250 seconds. Most varieties were within the acceptable range for protein concentrations for malting barley, but 8 varieties had protein concentrations higher than 12.5% and higher than ideal for malting barley. Test weights were somewhat low overall, with no varieties meeting the industry standard of 50 lbs bu⁻¹. Germination was good for most varieties in the trial, with several varieties exhibiting 100% germination. Only two varieties (13AR5537-13 and 13AR5537-25) had germination rates less than 95%. Plumpness, a proxy for starch content and overall malting quality, was very good in this year's winter barley (Figure 1). All varieties except one were above the 80% industry minimum.

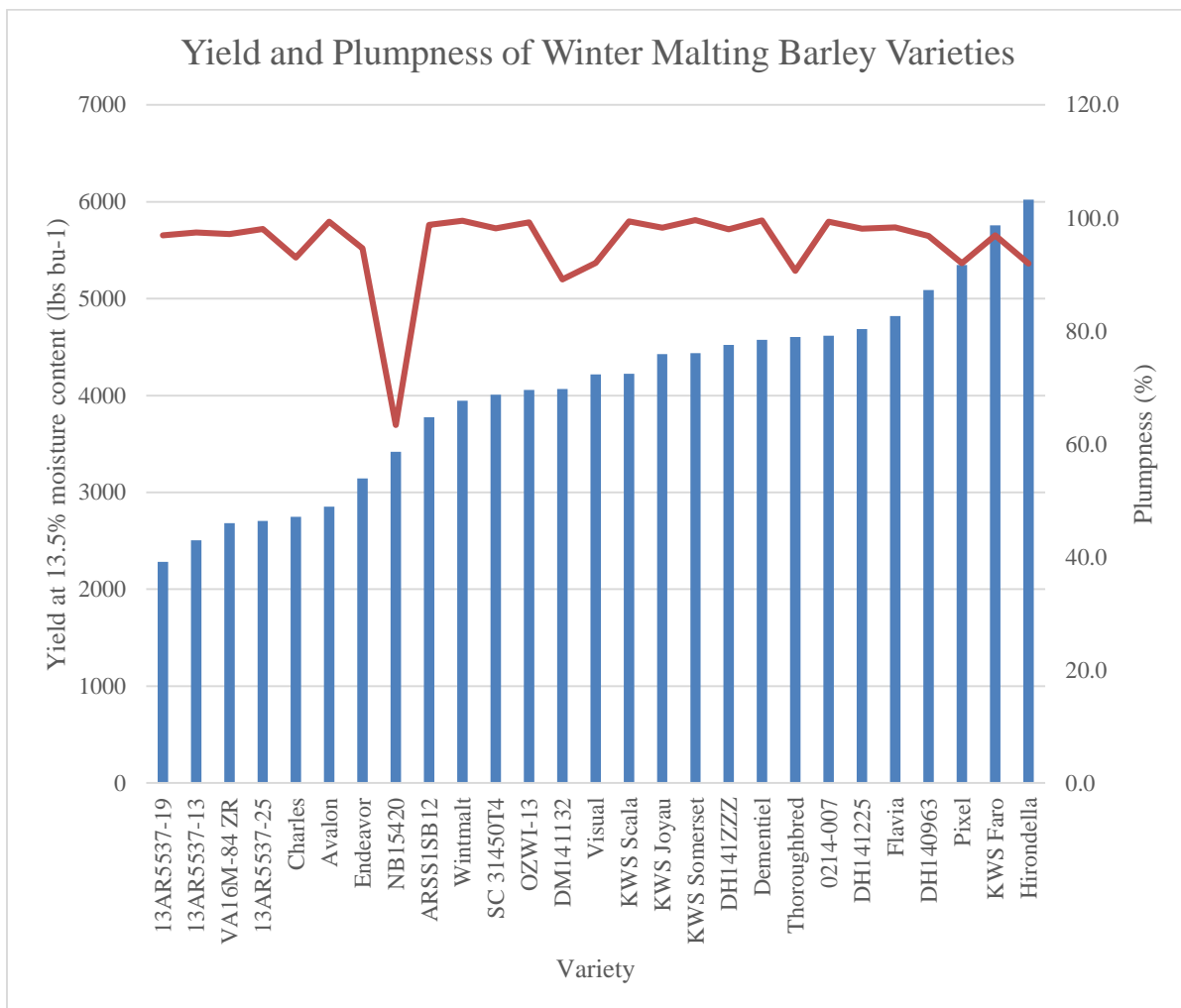


Figure 1. Yield and plumpness of winter malting barley varieties, Alburgh, Vermont

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