Winter Barley Cultivar Trial Report: 2015-2016

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Rational/Introduction:

There is a wide variety of winter cultivars currently commercially available to growers in our region considering malt barley production on their farms. The University of Massachusetts Amherst tested 27 cultivars over the 2015-2016 season at the University Research Farm in S. Deerfield. Phenotypic parameters, yield, and malting quality indices are reported below to aid regional growers in selecting the cultivar most suited to their farm's environment and needs.

Materials and Methods:

Experimental Site: This trial was conducted at the University of Massachusetts Agricultural Experiment Station Farm in S. Deerfield, MA (42 N, 73 W). Soil at this site in the Connecticut River Valley is characterized as fine Hadley loam. A pre-planting baseline soil sample of the top 6" inches of soil was collected in both years by sampling a 5x4 grid of 20 sub-samples across the block. The block was then amended appropriately as recommended by the UMass soil testing lab for barley production. On September 25, 2015, all cultivars were planted into an experimental block, which had been left fallow over the preceding season, following a 2014 winter rye planting. All plots were 15x5 feet, seeded at 110 lbs/ac. While the majority of months were slightly warmer than average, temperatures during the trial did not deviate significantly from regional norms over the past 19 years (Table 1).

Table 1. Weather Data for the Winter Malting Barley testing trial for the University of Massachusetts. Agricultural Research Farm, South Deerfield, MA, 2015-2016*

Year	Month	Avg. Temp. (F)	Departure from avg.	Max Temp. (F)	Departure from avg.	Min Temp. (F)	Departure from avg.	Total Rain (in)**	Departure from avg.	GDD 32***	Departure from avg.
2015	September	65.0	3.7	91.4	5.6	40.8	6.4	6.4	2.2	1044.9	126.5
	October	48.6	-0.1	73.9	-2.5	18.7	-5.2	2.2	-2.0	520.3	-20.6
	November	43.1	4.1	73.6	7.9	15.9	2.1	2.0	-1.1	348.7	99.5
	December	39.2	9.8	61.6	3.3	22.1	20.5	4.7	1.4	250.3	164.4
2016	January	27.1	4.4	51.8	0.3	4.1	13.9	1.5	-1.2	34.4	-5.7
	February	28.6	3.2	58.9	7.3	-15.0	-11.0	4.1	1.6	100.1	62.7
	March	40.5	6.8	77.9	13.5	17.6	14.3	3.3	-0.2	310.7	146.4
	April	45.4	-0.5	79.2	-1.8	12.2	-9.1	2.1	-1.0	414.0	-37.6
	May	57.5	0.5	90.6	3.4	29.0	-0.7	2.6	-0.8	807.5	-1.5
	June	66.3	0.8	87.7	-2.5	41.6	0.7	1.4	-3.2	1039.1	-0.3
	July	72.2	1.7	93.9	2.5	49.9	1.6	1.7	-2.0	1263.9	36.0

* Averages of weather data were obtained from the airport weather station in Orange, MA 23 mi from the South Deerfield location.

**Rain data was obtained from the airport weather station in Orange, MA.

***GDD: Growing degree days, were calculated using the following formula: GDD = [_____] - _____ , where

= The maximum and minimum daily temperatures and = (32 F)

Experimental design: Treatments consisted of 27 winter cultivars (Table 2) supplied to the University of Massachusetts through its participation in the national Winter Malting Barley Trial, organized by the University of Minnesota. All cultivars were replicated 3 times in a randomized complete block design. The entire block of experimental plots was surrounded by a buffer of Wintmalt to prevent edge effects.

Table 2. Winter Malting Barley trial entry list for the University of Massachusetts. Agricultural Research Farm, South Deerfield, MA, 2015-2016

Cultivar Entry	Submitter	Row type	Commercially Available
Charles	Check	2	x
Strider	Check	6	x
McGregor	Check	6	x
Thoroughbred	Check	6	x
Endeavor	Check	2	x
Wintmalt	Check	2	x
05ARS561-208	USDA	2	
06ARS633-10	USDA	2	
02Ab669	USDA	2	
04ARS640-1	USDA	2	
SU-Mateo	Ackermann	2	
Hirondella (08/258/17)	Ackermann	6	
Vincenta	Ackermann	2	
10/069/1	Ackermann	6	
Puffin	Ohio State	6	x
10.0777	Oregon State	2	
10.086	Oregon State	2	
DH130004	Oregon State	2	
DH130718	Oregon State	2	
MW11S4024-004	U. Minnesota	6	
MW11S4029-002	U. Minnesota	6	
MW12_4007-008	U. Minnesota	6	
MW12_4042-002	U. Minnesota	6	
6W11-0003	Busch Ag	6	
6W11-0064	Busch Ag	6	
6W13-7041	Busch Ag	6	
Calypso	Limagrain	2	x

Statistical Analysis: Data were analyzed using PROC GLM in SAS version 9.4, and the significance of relationships between seeding rate to any of the measured indices was determined by Tukeys HSD at $P \leq 0.05$.

Field Measurements: Winter survival was determined by a visual assessment of the surviving area of the plot. Each plot was ranked from 0-10 to reflect the percentage of the plot surviving as

of March 14, 2016. Heading date was declared when 50% of tillers had emerged heads and was reported in Julian days. Foliar disease was determined on June 16, 2016 as a percentage of leaf surface area infected using the diseases specific percentage guides in the American Phytopathological Society's 'A manual of assessment keys for plant disease' (Clive, J., 1971). Height was measured to the top of the spike (not including awns) on June 23, 2016 in 3 subsamples per plot and the mean per plot reported and analyzed in this report. Lodging/stem breakage was given a visual ranking on a 0-10 scale on July 12, 2016.

Harvest: Barley was harvested using a 1995 ALMACO SPC20 plot combine on July 21, 2016. All yields were standardized to 13.5% moisture. Sub samples from each plot were stored in a 100 F cabinet until being processed and shipped to the University of North Dakota cereal grains testing facility for malt quality analysis.

Quality Analysis: Percent protein (reported on a dry-matter basis) was determined by near infrared transmittance on a Foss Infratec 1241 grain analyzer. Barley plumpness (100 g) kernel assortment was determined using a Pfeuffer Sortimat. Percent plump is the percentage of all kernels retained above the 6/64 x 3/4-inch screen, and the highest percentages are most desirable. Percent thin is the percentage of kernels passing through the 5/64 x 3/4-inch screen. Deoxynivalenol (DON) was expressed in ppm, and was determined by gas chromatography. Germinative Energy is the percentage of kernels germinated following 72 hours. Falling number was determined via a Perten TecMaster RVA unit.

Results:

Winter survival: Winter survival was acceptable for, and not significantly different among, all except DH130004 and DH130718. These two suffered significant losses with DH130718 having significantly lower winter survival than did DH130004.

Heading date: Thoroughbred, MW11S4024-004, 10.0777, MW12_4007-008, and MW11S4029-002, were not significantly different from one another and had the earliest heading dates (133.3, 133.7, 135.3, 135.7, and 136.0 Julian days, respectively), whereas 05ARS561, Puffin, DH130718, Wintmalt, and 6W13-7041 were not significantly different from one another and had the latest heading dates (141.7, 142.0, 142,7, 143.3, and 144.3 Julian days, respectively).

Foliar disease: Foliar disease was variable throughout the trial with Calypso showing the least (0.8). Only Wintmalt, MW12_4042-002, 6W11-0064, DH130718, Thoroughbred, 6W13-7041, MW11S4024-004, DH130004, and MW11S4029-002 had significantly higher rates of foliar disease than Calypso (4.3, 4.3, 4.3, 4.5, 5.0, 5.0, 5.5, 5.8, and 6.8, respectively).

Mean height: Mean height was also variable, with Charles being the shortest (23.25 in) and only Calypso, Hirondella, 6W11-0003, McGregor, 6W13-7041, MW11S4029-002, MW11S4024-004, MW12_4007-008, MW12_4042-002, and, 6W11-0064 being significantly taller than Charles (34.8, 35.7, 36.6, 36.7, 36.9, 37.0, 38.9, 39.0, 39.1, and 40.0 in, respectively).

Lodging/Stem breakage: DH130718 had the lowest level of Lodging/Stem breakage (1.0) and was not significantly different from any treatment except Vincenta, which had the highest level of Lodging/Stem breakage (6.8) (Table 3).

Table 3. Phenotypic parameters for the Winter Cultivar trial for the University of Massachusetts. Agricultural Research Farm, South Deerfield, MA, 2015-2016*

Cultivar Entry	Winter survival rating	50% heading date (Julian)	Foliar disease ranking	Mean height (in)	Lodging/ breakage
Charles	8.7 a	136.3 ijkl	2.2 cdefg	23.3 f	6.0 ab
Strider	9.0 a	140.0 cdefg	2.2 cdefg	33.5 abcdef	3.5 ab
McGregor	8.9 a	138.3 fghij	2.5 bcdefg	36.7 abc	2.8 ab
Thoroughbred	9.0 a	133.3 m	5.0 abcd	29.5 abcdef	2.5 ab
Endeavor	8.6 a	137.7 ghijk	4.2 abcdefg	29.9 abcdef	3.2 ab
Wintmalt	8.6 a	143.3 ab	4.3 abcdef	28.7 bcdef	2.0 ab
05ARS561	8.4 a	141.7 abcde	3.7 abcdefg	24.8 def	5.5 ab
06ARS633	8.4 a	140.7 bcdef	1.3 efg	30.8 abcdef	6.2 ab
02Ab669	8.8 a	139.0 efghi	2.8 bcdefg	32.4 abcdef	3.5 ab
04ARS640	9.0 a	136.7 hijk	2.0 defg	24.9 def	2.3 ab
SU-Mateo	8.8 a	140.3 cdefg	1.3 efg	32.5 abcdef	4.7 ab
Hirondella	8.8 a	140.3 cdefg	3.0 bcdefg	35.7 abcd	3.0 ab
Vincenta	8.5 a	139.3 defgh	1.7 defg	28.2 bcdef	6.8 a
10/069/1	8.9 a	138.3 fghij	3.3 bcdefg	30.5 abcdef	1.3 ab
Puffin	8.8 a	142.0 abcde	1.0 fg	31.2 abcdef	3.3 ab
10.0777	9.0 a	135.3 klm	3.5 abcdefg	26.3 cdef	2.3 ab
10.086	8.8 a	136.7 hijk	1.5 efg	23.6 ef	5.3 ab
DH130004	2.0 b	140.3 cdefg	5.8 ab	26.9 cdef	2.7 ab
DH130718	0.3 c	142.7 abc	4.5 abcde	27.0 cdef	1.0 b
MW11S4024-004	8.8 a	133.7 lm	5.5 abc	38.9 ab	4.5 ab
MW11S4029-002	8.8 a	136.0 jklm	6.8 a	37.0 abc	4.7 ab
MW12_4007-008	8.9 a	135.7 jklm	3.3 bcdefg	39.0 ab	5.0 ab
MW12_4042-002	8.8 a	141.0 bcdef	4.3 abcdef	39.1 ab	3.0 ab
6W11-0003	8.7 a	140.3 cdefg	3.2 bcdefg	36.6 abc	5.5 ab
6W11-0064	8.8 a	141.0 bcdef	4.3 abcdef	40.0 a	2.7 ab
6W13-7041	8.8 a	144.3 a	5.0 abcd	36.9 abc	5.3 ab
Calypso	8.8 a	140.0 cdefg	0.8 g	34.8 abcde	3.2 ab
Trial mean	8.2	139.0	3.3	31.8	3.8
2-row mean	7.6	139.3	2.8	28.1	3.9
6-row mean	8.9	138.8	3.8	35.7	3.6

*Means with the same letter in each column are not significantly different (Tukey's HSD ranking at p≤0.05)

Yield: Calypso had the highest yield (136.5 bu/ac) and only 04ARS640, 05ARS561, MW11S4029-002, Endeavor, 06ARS633, 10.086, Charles, DH130004, and DH130718 were

significantly lower yielding than Calypso (85.2, 77.9, 77.4, 75.8, 74.7, 72.4, 64.9, 53.9, and 17.4 bu/ac, respectively).

Test weight: 02Ab669 had the highest test weight, (48.3 lb/bu), but was not significantly higher than Calypso, DH130718, Strider, 10.086, 10.0777, MW11S4024-004, 04ARS640, or MW12_4007-008, (47.9, 47.2, 46.9, 46.1, 45.6, 45.3, 45.2, or 44.8 lb/bu, respectively). McGregor had the lowest test weight (38.8 lb/bu), but was not significantly different from Charles, DH130004, SU-Mateo, 06ARS633, or Thoroughbred (38.9, 39.0, 41.1, 41.6, or 42.1 lb/bu respectively).

Plumpness: Calypso had the highest percentage of plump kernels (97.4%), however only SU-Mateo, Puffin, 06ARS633, MW11S4024-004, and Thoroughbred had significantly lower percentage of plump kernels (73.1, 69.0, 66.7, 59.5, and 54.6 %, respectively).

Thinness: Thoroughbred had the highest percentage of thin kernels (6.7%), followed by 06ARS633 (5.9%). These were the only cultivars that had significantly higher rates of thin kernels than DH130718, which had the lowest rate (0.3%) (Table 4 A.)

Table 4 A. Yield and malting quality parameters for the Winter Cultivar trial for the University of Massachusetts. Agricultural Research Farm, South Deerfield, MA, 2015-2016*

Cultivar Entry	Yield (bu/ac)	Test weight (lb/bu)	Percent plump	Percent thin
Charles	64.9 fde	38.9 i	91.3 ab	1.4 c
Strider	95.9 abcde	46.9 abcd	86.7 abc	1.3 c
McGregor	126.5 ab	38.8 i	77.1 abcd	4.0 abc
Thoroughbred	91.7 abcde	42.1 fghi	54.6 e	6.7 a
Endeavor	75.8 cde	44.2 cdefgh	94.8 a	0.6 c
Wintmalt	101.6 abcde	44.5 bcdefgh	85.7 abc	1.0 c
05ARS561	77.9 abcde	43.4 efgh	81.3 abc	1.7 c
06ARS633	74.7 cde	41.6 ghi	66.7 cde	5.9 ab
02Ab669	88.0 abcde	48.3 a	93.7 ab	1.1 c
04ARS640	85.2 bcde	45.2 abcdef	81.7 abc	1.5 c
SU-Mateo	108.3 abcd	41.1 hi	73.1 bcde	2.8 abc
Hirondella	115.4 abc	44.2 cdefgh	92.0 ab	1.0 c
Vincenta	110.9 abcd	44.4 bcdefgh	94.0 ab	1.0 c
10/069/1	115.9 abc	43.4 efgh	95.2 a	1.5 c
Puffin	104.9 abcd	43.2 efgh	69.0 cde	2.1 bc
10.0777	92.7 abcde	45.6 abcdef	82.2 abc	1.9 c
10.086	72.4 cde	46.1 abcde	96.0 a	0.6 c
DH130004	53.9 fe	39.0 i	81.6 abc	2.2 bc
DH130718	17.4 f	47.2 abc	97.0 a	0.3 c
MW11S4024-004	91.3 abcde	45.3 abcdef	59.5 de	3.2 abc
MW11S4029-002	77.4 cde	43.1 efgh	94.5 a	1.3 c
MW12_4007-008	98.0 abcde	44.8 abcdefg	79.3 abcd	1.2 c
MW12_4042-002	101.4 abcde	42.9 efgh	91.6 ab	1.0 c
6W11-0003	106.9 abcd	43.4 defgh	82.8 abc	1.9 c
6W11-0064	96.5 abcde	42.6 fgh	91.6 ab	1.4 c
6W13-7041	87.9 abcde	44.7 bcdefg	78.2 abcd	1.7 c
Calypso	136.5 a	47.9 ab	97.4 a	0.6 c
Trial mean	91.5	43.8	84.0	1.9
2-row mean	82.9	44.1	86.9	1.6
6-row mean	100.8	43.5	80.9	2.2

*Means with the same letter in each column are not significantly different from one another (Tukey's HSD ranking at [illegible])

Germinative energy: The majority of cultivars had germination rates above 95%. The only cultivars with significantly lower germinations rates than DH130718 (100%) were McGregor (74.0%), followed by MW11S4029-002, 6W11-0003, Charles, 6W13-7041, DH130004, 10.0777, 6W11-0064, MW12_4042-002 (73.7, 66.0, 60.3, 53.3, 39.7, 38.7, 34.3, and 30.7, respectively).

Protein: 02Ab669 had the lowest protein concentration, at 10.6%, no treatment was significantly different from 02Ab669 but 6W11-0003, at 14.9%. However, the mean protein levels of Wintmalt, McGregor, Strider, 10/069/1, and Puffin were all above the acceptable limit of 13.5% (13.6, 13.7, 13.8, 14.5, and 14.8%, respectively).

DON: All cultivars had DON levels below 0.1 ppm, and there were no significant differences among any of the cultivars in DON levels.

Falling number: Calypso had the highest falling number (350 sec), but was not significantly different from Puffin, Thoroughbred, SU -Mateo, 10/069/1, Hirondella, MW11S4024-004, McGregor, Strider, MW11S4029-002 or MW12_4042-002 (321.3, 311.3, 310.7, 297.7, 272.3, 237.7, 235.7, 200.0, 199.7, and 176.3, respectively). Charles, Endeavor, 05ARS561, 06ARS633, 04ARS640, 10.0777, 10.086, DH130004, DH130718 all had the lowest falling number at 60 sec, and were only significantly different from Calypso, Puffin, Thoroughbred, SU-Mateo, 10/069/1 and Hirondella (Table 4 B).

Table 4 B. Yield and malting quality parameters for the Winter Cultivar Trial for the University of Massachusetts Agricultural Research Farm, South Deerfield, MA, 2015-2016*.

Cultivar Entry	Germinative energy	Percent protein	DON	Falling number
Charles	60.3 ef	12.1 ab	d a	60.0 d
Strider	98.7 abc	13.2 ab	abcd a	200.0 abcd
McGregor	74.0 bcde	11.4 ab	abcd a	235.7 abcd
Thoroughbred	99.0 abc	12.0 ab	ab a	311.3 ab
Endeavor	96.7 abc	11.6 ab	d a	60.0 d
Wintmalt	96.7 abc	12.3 ab	bcd a	142.3 bcd
05ARS561	99.0 abc	14.8 ab	d a	60.0 d
06ARS633	89.7 abcd	12.4 ab	d a	60.0 d
02Ab669	98.7 abc	13.3 ab	cd a	127.3 cd
04ARS640	96.7 abc	13.1 ab	d a	60.0 d
SU-Mateo	99.0 abc	13.0 ab	ab a	310.7 ab
Hirondella	98.0 abc	12.8 ab	abc a	272.3 abc
Vincenta	99.7 ab	13.0 ab	cd a	122.7 cd
10/069/1	74.7 abcde	13.7 ab	abc a	297.7 abc
Puffin	99.7 abc	12.9 ab	ab a	321.3 ab
10.0777	38.7 fg	13.8 ab	d a	60.0 d
10.086	97.3 abc	11.0 ab	d a	60.0 d
DH130004	39.7 fg	11.4 ab	d a	60.0 d
DH130718	100.0 a	10.6 b	d a	60.0 d
MW11S4024-004	99.0 abc	14.9 a	abcd a	237.7 abcd
MW11S4029-002	73.7 cde	14.5 ab	abcd a	199.7 abcd
MW12_4007-008	99.3 abc	13.5 ab	d a	61.7 d
MW12_4042-002	30.7 g	13.6 ab	abcd a	176.3 abcd
6W11-0003	66.0 de	11.9 ab	cd a	120.7 cd
6W11-0064	34.3 g	12.4 ab	bcd a	150.0 bcd
6W13-7041	53.3 efg	13.1 ab	bcd a	160.7 bcd
Calypso	99.3 abc	13.3 ab	a a	350.0 a
Trial mean	81.9	12.8	0.01	160.7
2-row mean	86.5	12.5	0.01	113.8
6-row mean	76.9	13.1	0.02	211.2

*Means with the same letter in each column are not significantly different from one another (Tukey's HSD ranking at [illegible])

Conclusions:

In general, 2015-2016 growing season was dryer and warmer compared to the norm in the trial location. Between planting and harvest, rainfall was 6.3" below the area norm of 38.2". During the primary growth period, from March to July 2016, rainfall was 7.2" below the area norm of 18.2". The 2015-2016 growing season was also warmer than the norm for the location where crop collected 570 more GDD.

High yielding and poor yielding cultivars could be found among both 6-row and 2-row cultivars. However, on average, the 6-row cultivars out-yielded the 2-row cultivars partly due to better winter survival rate. When the two cultivars with the lowest survival rate (DH130004 and DH130718) are disregarded, the difference in mean yields between 2 and 6-row cultivars is halved. Overall, 2-row cultivars performed better in almost all quality indices and had higher test weight, higher percent plump, lower percent thin, higher germination energy, and lower protein content.

When both grain yield and quality were considered**, Hirondella** performed best among the 6-row cultivars and **Calypso**, **Wintmalt** and **Vincenta** were preferred cultivars among the 2-rows cultivars. In this trial, **Calypso** had the lowest rate of foliar disease, highest yield, and highest percentage of plump kernels and falling number, as well as one of the highest test weights in this trial. However, many cultivars were not significantly different from the best performer in any given category, and amongst these cultivars, growers should select based on their needs, seed availability, and row-type preference. These conclusions are based on results from only one year and a more definitive conclusion requires multiple trials.

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Reference:
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