UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
MIDWEST AREA
CEREAL CROPS RESEARCH UNIT

Western REGIONAL SPRING BARLEY NURSERY
2014 Crop

Preliminary Quality Report

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Detailed Data:

Aberdeen, ID

Appendix:
Methods
Criteria for Quality Score

Samples were malted and analyzed by the Cereal Crops Research Unit, Madison, WI

May 2015
CCRU-MWA-133

The Western Regional Spring Barley Nursery (WRSBN) is an annual agronomic project coordinated by Dr. Charles Erickson of the USDA-ARS National Small Grains Germplasm Research Facility, Aberdeen, ID. Table 1 is an entry list, supplied by Dr. Erickson, with parentages for the 2014 submissions. WRSBN samples were received from only one location this season – Aberdeen, ID. Thus, the data presented here should be viewed more cautiously than the WRSBN data from prior years generated from averages of the more typical 3-4 locations, and will be limited to rank order differences between the lines.

The malting was performed in a Joe White (JW) micro-malter, under conditions that should generate malts having modification levels similar to those produced industrially. Detailed descriptions of the malting conditions and analytical methods employed are listed in Appendix A. The criteria and value assignments used to calculate quality scores are based upon the traditional "Ideal Commercial Malt Criteria" developed by the American Malting Barley Association (AMBA) for industrial lager brewing. AMBA, and its brewing and malting members, have recently expanded the guidelines for ideal malt criteria to include the needs of craft brewers, and they are listed in Appendix B.

Table 2 shows quality parameters for the barley submissions and their subsequent malts. The performance of each line was evaluated with the limitation discussed above in mind.

Even with only one location, the samples displayed a range in average Kernel Weights (Thousand Corn Weight). UT2136-96 and UT2183-85 were the smallest with average Kernel Weights of 32.9mg and 36.4mg, respectively. Conversely, 09WA-228.13, 2ND30724, and 10WA-106.19 topped the range of Thousand Corn Weights: 44.9mg, 45.1mg, and 45.2mg. These larger samples weren't necessarily the plumpest samples, with 09WA-231.5 topping that measurement at 98.8% plump, but 2ND30724 was near the top with 97.6% plump. UT2136-96, which had the smallest average Kernel Weight, was also the least plump at 91.2%.

Not only did 2ND30724 display one of the largest average Kernel Weight scores, it was also the brightest, with an Agtron surface coloration score of 52. 2Ab04-X01084-27 had the darkest surface coloration with a score of 35.

Barley protein contents were determined. Steptoe (9.5% d.b.) had the lowest protein percentage by almost a full percentage point under the next lowest barley 10WA-106.19 (10.3% d.b.). MT090190 and 2Ab09-X06F058HL-31 both showed relatively high barley protein, with 2Ab09-X06F058HL-31 exceeding the ideal range at 14.1% d.b.

The relatively poor malting quality for the feed variety Steptoe was exposed in these data. Its Malt Extract % (76.5% d.b.) was not bolstered by its extremely low barley protein content. In fact that value only surpassed 2Ab09-X06F084-51, with its 74.0% Malt Extract %. 2Ab07-X031098-31 and 2Ab07-X04M219-46 yielded excellent Malt Extract percentages of 81.9% and 82.0%, respectively.

Eight of these samples had relative viscosities greater than 1.50. Here again, the mash extract generated from Steptoe malt was represented. Its viscosity was 1.64, which was exceeded only by the food barleys 2Ab09-X06F084-51 (3.79) and 2Ab09-X06F058HL-31 (4.25).

Another broad range among samples was seen for the amylolytic enzymes. The aforementioned food barleys showed the lowest Diastatic Powers – 45° and 60°. Meanwhile, 2B11-5166 had a relatively high D.P. (for 2-rowed barleys) of 141°. As expected, Steptoe was very low in α-amylase (42.3DU), but the food barley 2Ab09-X06F084-51 was lower still at 35.3DU. Five of the WRSBN submissions topped 70DU for the α-amylase parameter: 2Ab04-X01084-27, 2Ab07-X04M219-46, AC Metcalfe, Harrington, and 2Ab08-X05M010-82.

The malt extracts made from 2Ab09-X06F084-51, Steptoe, and Baronesse malts showed the lowest soluble protein levels: 3.01%, 3.32%, and 3.66%. (2Ab09-X06F084-51 also had the lowest Kohlbach Index, coupled with a medium barley protein content, indicating very limited protein modification for this line). Conversely, 2Ab07-X031098-31 showed the third highest malt soluble protein percentage (5.03%), and second highest S/T. 2Ab07-X04M219-462 and Ab08-X05M010-82 yielded malts with the highest, and third highest S/T ratios, respectively. The mash extract from 2Ab09-X06F084-51 also had the lowest FAN content, with 09WA-231.5 and Steptoe giving the second and third lowest values. MT090190 showed the highest FAN level (269ppm), as well as highest soluble protein content (5.14%).

Unsurprisingly, the food barleys, 2Ab09-X06F084-51 and 2Ab09-X06F058HL-31 malts had the highest levels of β-Glucan content in the WRSBN – 1460ppm and 1492ppm. However, Steptoe and 10WA-105.33 were also very high in this parameter: 702 and 526ppm, respectively. 2Ab07-X04M219-46 and 2Ab08-X05M010-82 were on the opposite end of the scale for β-Glucan at 24 and 27ppm. 2B11-4949 was also extremely low in β-Glucan with 25ppm; so malting processing changes could be used to slow its protein modification, without cell wall modification being unduly slow.

With respect to overall malt quality, bearing in mind the limitations of only one location (Aberdeen, ID) and industrial, not craft, brewery specifications, the line 2Ab07-X031098-31 yielded the highest quality malt. It had good Malt Extract (81.9%), decent amylolytic enzyme levels, and very low β-Glucan, relative viscosity, and turbidity levels. 2B11-4949 and 2B11-5166 also produced malts of excellent quality with the second and third highest overall quality scores. The varieties AC Metcalfe and Harrington also yielded high quality malts when grown at Aberdeen. The two food barleys, 2Ab09-X06F058HL-31 and 2Ab09-X06F084-51, however, produced the lowest ranked malts for malting quality in the 2014 WRSBN. The feed barley Steptoe showed its usual malting quality profile: low Malt Extract %, extremely high β-Glucan, Turbidity, and Viscosity, and low protein modification measures (Soluble Protein, S/T, and FAN). The malt from 10WA-105.33 was also of very low quality with low Malt Extract (77.8%), low protein modification measures and high β-Glucan, Viscosity, and Turbidity.

*We wish to thank the American Malting Barley Association (AMBA) for supporting this project. This report could not have been produced without the commitment and excellent technical work of our staff contributors: Keith Gilchrist, USDA-ARS Physical Science Technician; Brian Lemmenes, USDA-ARS Biological Science Technician; Michael Marinac, USDA-ARS Physical Science Technician; Leslie Zalapa,

USDA-ARS Biologist; Laura Oesterle, USDA-ARS Biological Science Technician, and Andrew Standish, U. of Wisconsin Research Specialist (AMBA-funded).

Seed Source	Entry No.		Entry	Parentage	Type	Grade	Years Tested	Cooperator
WSU	1		Steptoe	CI 15229	6 row	feed		Check, Ulrich, Wood
WPB	2		Baronesse	PI 568246	2 row	feed		Check, Erickson
USDA-ARS	3		Harrington		2 row	malting		Check, Erickson
USDA-ARS	4		AC Metcalfe		2 row	malting		Check, Erickson, Beattie
BARI	5		2B09-3425	2B05-0550 / 2B99-2763-10	2 row	malting	1	Askelson
BARI	6		2B10-4162	MERIT 57 / 2B05-0712	2 row	malting	1	Askelson
BARI	7	*	2B10-4378	2B99-2763-10 / 2B03-3669 // 2B05-0822 / 2B99	2 row	malting	0	Askelson
BARI	8	*	2B11-4949	MERIT 57 / MT050118	2 row	malting	0	Askelson
BARI	9	*	2B11-5166	2B03-3604 / 2B06-1161	2 row	malting	0	Askelson
HSG	10	*	BZ509-216	CDC Copeland/Xena	2 row	feed	0	McKay
HSG	11	*	BZ509-448	Champion/ YU501-312	2 row	feed	0	McKay
USDA-ARS	12	*	2Ab04-X01084-27	98Ab11993/Garnet	2 row	malting	3	HU
USDA-ARS	13		2Ab07-X031098-31	2B97-4004/Newdale	2 row	malting	2	HU
USDA-ARS	14		2Ab07-X04M219-46	95SR316A/2B97-4004	2 row	malting	2	HU
USDA-ARS	15		2Ab08-X05M010-82	2B98-5312/98Ab11993	2 row	malting	1	HU
USDA-ARS	16	*	2Ab09-X06F084-51	03AH3054/98Ab12019	2 row	hulled, high BG, food	0	HU
USDA-ARS	17	*	2Ab09-X06F058HL-31	02HR4590/CDC Fibar	2 row	hulled, high BG, food	0	HU
MSU	18		MT090190		2 row	feed	1	Blake
MSU	19		MT090180		2 row	feed	1	Blake
MSU	20		MT100126		2 row	feed	1	Blake
MSU	21		MT100120		2 row	feed	1	Blake
NDSU	22		2ND27705	2ND24393/TR05285	2 row	malting	1	Horsley
NDSU	23		2ND28065	2ND21867/2ND24238	2 row	malting	1	Horsley
NDSU	24	*	2ND30724	2ND25265/2ND26328	2 row	malting	0	Horsley
USU	25	*	UT2183-85		6 row	feed	0	Hole
USU	26	*	UT2136-96		6 row	feed	0	Hole
WSU	27		09WA-231.5	02WNZ-1015/YU-501-385N	2 row	Feed	1	Murphy, Wood
WSU	28	*	10WA-105.33	02WA-7052.9/YU501-385	2 row	Feed	0	Murphy, Wood
WSU	29		09WA-228.13	02WNZ-1100/YU501-385	2 row	Feed	1	Murphy, Wood
WSU	30		09WA-203.24	YU501-385/02WNZ-1100	2 row	Feed	1	Murphy, Wood
WSU	31	*	10WA-106.19	YU501-385/02WNZ-1095	2 row	Feed	0	Murphy, Wood
WSU	32	*	10WA-113.16	WA 9820-98/CDC Candle//02WNZ-1100	2 row	Feed	0	Murphy, Wood
WSU	33	*	10WA-106.18	YU501-385/02WNZ-1095	2 row	Feed	0	Murphy, Wood

* new entries

Table 1. 2014 Western Regional Spring Barley Nursery

Table 2. 2014 Western Regional Spring Barley Nursery

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Rel. Visco.	Turbidity (Hach)	Quality Score	Overall Rank
5489	Steptoe	6	42.8	97.6	50	76.5	n.d.	3	9.5	3.32	35.7	69	42.3	*702	148	1.64	55.0	19	33
5490	Baronesse	2	43.3	98.0	36	79.1	n.d.	3	11.4	3.66	34.4	92	51.6	134	157	1.49	35.0	34	27
5491	Harrington	2	40.8	97.1	44	78.9	2.9	1	11.8	4.80	41.4	124	72.2	64	247	1.44	7.0	63	5
5492	AC Metcalfe	2	39.6	97.2	48	80.1	3.5	1	12.3	4.85	40.4	133	71.4	38	242	1.46	9.3	64	3
5493	2B09-3425	2	39.0	96.6	41	80.7	4.6	2	11.2	4.60	41.3	117	69.8	83	236	1.49	22.0	60	7
5494	2B10-4162	2	37.9	92.2	51	81.1	3.7	1	10.5	4.43	42.8	122	68.4	56	233	1.46	11.2	60	7
5495	2B10-4378	2	40.0	96.7	46	80.5	3.3	2	11.4	4.71	42.1	127	66.2	119	190	1.49	20.0	59	9
5496	2B11-4949	2	38.6	96.4	44	81.5	3.1	1	12.5	5.04	43.5	124	66.1	25	228	1.44	9.6	67	2
5497	2B11-5166	2	39.3	96.3	44	80.1	3.2	1	12.2	4.88	40.6	141	62.6	60	210	1.45	12.5	64	3
5498	BZ509-216	2	39.7	91.8	41	79.4	2.4	1	11.6	4.38	39.6	93	57.6	109	197	1.45	8.1	44	20
5499	BZ509-448	2	40.0	93.6	47	79.6	2.0	1	11.7	3.91	36.4	81	48.2	442	152	1.51	7.2	32	28
5500	2Ab04-X01084-27	2	39.5	94.6	35	80.5	2.8	1	11.1	4.58	42.0	118	70.7	46	198	1.46	7.4	61	6
5501	2Ab07-X031098-31	2	40.0	96.7	47	81.9	2.9	1	11.7	5.03	45.6	121	67.0	41	223	1.44	6.7	69	1
5502	2Ab07-X04M219-46	2	37.1	93.9	47	82.0	2.6	1	10.4	4.73	47.8	103	71.1	24	239	1.44	5.1	52	13
5503	2Ab08-X05M010-82	2	37.7	92.2	36	80.5	2.9	1	11.2	4.76	45.1	112	77.4	27	232	1.44	10.2	59	9
5504	2Ab09-X06F084-51	2	42.1	95.5	38	74.0	n.d.	3	11.9	3.01	27.1	45	35.3	1460	107	3.79	20.0	20	32
5505	2Ab09-X06F058HL-31	2	38.7	91.8	51	80.0	n.d.	3	14.1	4.23	31.1	60	49.5	1492	163	4.25	17.2	21	31
5506	MT090190	2	37.5	98.2	38	79.8	4.2	2	13.1	5.14	41.7	119	66.1	287	269	1.56	24.0	46	19
5507	MT090180	2	39.8	96.2	40	79.7	2.9	1	11.6	4.52	40.1	112	60.4	248	222	1.48	14.3	54	12
5508	MT100126	2	40.4	97.4	44	79.9	2.9	2	10.7	4.47	43.9	103	57.5	413	224	1.53	13.3	50	16
5509	MT100120	2	39.4	96.3	42	79.6	2.4	1	11.6	4.36	40.9	117	60.1	192	197	1.48	9.5	50	16
5510	2ND27705	2	40.4	96.7	48	80.9	2.5	1	11.0	4.47	42.6	111	67.1	114	220	1.45	7.6	59	9
5511	2ND28065	2	39.9	95.7	36	80.3	1.9	1	11.9	4.52	39.5	103	56.2	175	214	1.47	5.6	49	18
5512	2ND30724	2	45.1	97.6	52	78.6	2.8	2	12.4	4.42	36.1	126	57.1	204	217	1.50	14.9	51	14
5513	UT2183-85	6	36.4	94.8	46	77.7	2.5	1	12.0	4.05	35.1	82	49.9	297	171	1.53	15.0	26	29
5514	UT2136-96	6	32.9	91.2	48	80.4	3.1	1	10.5	4.12	43.1	64	58.5	67	226	1.48	14.4	51	14
5515	09WA-231.5	2	42.0	98.8	42	79.8	2.1	1	11.5	3.88	34.7	93	52.5	269	147	1.50	6.7	35	25
5516	10WA-105.33	2	44.3	97.1	38	77.8	2.4	2	12.5	3.76	31.6	92	48.0	526	156	1.53	20.0	25	30
5518	09WA-228.13	2	44.9	97.5	36	79.8	1.8	1	12.6	4.10	35.3	88	56.9	241	205	1.48	5.6	44	20
5520	09WA-203.24	2	42.3	97.7	38	80.0	1.9	1	11.3	3.69	35.6	78	52.2	299	190	1.50	6.1	39	23
5521	10WA-106.19	2	45.2	96.6	45	81.5	2.2	1	10.3	3.95	39.8	79	50.3	222	196	1.50	6.9	39	23
5522	10WA-113.16	2	42.4	97.2	37	79.6	3.4	2	11.6	3.85	34.3	66	46.4	357	190	1.50	28.0	35	25
5523	10WA-106.18	2	44.3	96.5	45	80.2	2.1	1	11.8	4.12	35.6	97	56.2	249	215	1.47	5.3	44	20
5517	HARRINGTON MALT CHECK	2	40.1	96.0	73	82.5	2.3	1	12.1	4.92	41.4	111	81.3	139	259	1.51	6.3	62	
5485	HARRINGTON MALT CHECK	2	40.9	96.7	74	83.2	2.5	1	11.7	5.04	46.8	116	83.7	125	248	1.52	4.7	62	
5487	LACEY MALT CHECK	6	33.5	89.0	44	80.5	3.6	1	13.5	6.03	46.8	171	80.8	29	309	1.43	6.6	58	
Minima			32.9	91.2	35	74.0	1.8		9.5	3.01	27.1	45	35.3	24	107				
Maxima			45.2	98.8	52	82.0	4.6		14.1	5.14	47.8	141	77.4	1492	269				
Means			40.4	95.9	43	79.8	2.8		11.6	4.31	39.0	100	58.9	262	202				
Standard Deviations			2.7	2.1	5	1.6	0.7		0.9	0.50	4.7	24	9.9	345	36				
Coefficients of Variation			6.8	2.2	12	2.0	24.6		7.6	11.68	11.9	24	16.7	132	18				

Malt Check Data are Excluded from Rank Sorting and Statistics
Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics
For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by USDA ARS Aberdeen

Neg Std Dev			32.2	89.6	28	75.1	0.7		9.0	2.80	25.0	29	29.3	-774	95				
Pos Std Dev			48.7	102.1	58	84.4	4.8		14.2	5.82	53.0	172	88.4	1297	309				

Appendix A: METHODS

Cleaning All samples were cleaned on a Carter Dockage Tester and only grain between 5 and 7/64" was used.

Barley Mill Ground barley was prepared with a Labconco Burr mill that was adjusted so that only 35% of the grist remained on a 525 μm sieve after 3 min of shaking and tapping.

Kernel Weight The number of kernels in a 20 g aliquot of each sample was counted electronically and the '1000 kernel weight' was calculated.

Plumpness Samples were sized on a Eureka-Niagra Barley Grader and the percentage of the seeds retained on a 6/64" screen was determined.

Barley Color The brightness of the grains was measured using an Agtron M45-D analyzer.

Barley Moisture Content (Barley 5B) Five g of ground sample was dried for 3 h at 104°C. The percentage of weight loss that occurred during this drying was calculated.

Barley Protein Content Total nitrogen values were obtained using an automated Dumas combustion procedure with a LECO FP-528 analyzer. Nitrogen values were converted to protein percentages by multiplication by 6.25.

Malting Conditions 170 g (db) aliquots of barley were processed in Joe White micro-malters. Samples were hydrated to 47% moisture via a 32 h steep at 19°C: 8 h wet, 8 h air, 5 h wet, 5 h air, 2 h wet, 2 h air, 2 h wet. (Larger barleys, > 42 mg/kernel, received a continuous, wet pre-steep (16°C) of between 1 and 3 h). The samples were germinated for 48 h (18°C), 24 h (17°C), and 24 h (16°C), with moisture adjustment to 47% at 0, 24, and 48 h. The samples received 4 full turns every 2 h. The germinated grain was kilned for 24h as follows: 49°C, 10 h; 54°C, 4 h; 60°C, 3 h; 68°C, 2 h; and 85°C, 3 h, with 30 min. ramps between stages. All stages received 40% total flow, with 0% recirculation for stages 1-3, 50% for stage 4, and 75% for stage 5.

Malt Mill Fine-grind malts were prepared with a Miag laboratory cone mill that was adjusted so that 10% of the grist remained on a 525 μm sieve after 3 min of shaking, with tapping. Malts to be used for moisture, protein and amylolytic activity analyses were ground in a Labconco Burr mill (see Barley Mill).

Malt Moisture Content Determined by Malt 3 (Methods of Analysis of the ASBC, 8th ed, 1992) See Barley Moisture Content.

Malt Protein Content See Barley Protein Content.

Malt Extract Samples were extracted using the Malt-4 procedure (Methods of Analysis of the ASBC, 8th ed, 1992), except that all weights and volumes specified for the method were halved. The specific gravity of the filtrate was measured with an Anton Parr DMA5000 density meter. The density data were used to calculate the amount of soluble material present in the filtrate, and thus the percentage that was extracted from the malt.

Wort Color was determined on a Skalar SAN plus analyzer by measuring the absorbance at 430nm and dividing by a factor determined by collaborative testing.

Wort Clarity was assessed by visual inspection.

β-Glucan Levels were determined on a Skalar SAN plus analyzer by using the Wort-18 fluorescence flow injection analysis method with calcofluor as the fluorescent agent (Methods of Analysis of the ASBC, 8th ed, 1992).

Free Amino Nitrogen Levels were determined on a Skalar SAN plus analyzer using an automated version of the Wort-12 protocol (Methods of Analysis of the ASBC, 8th ed, 1992).

Soluble (Wort) Protein Levels were determined on a Skalar SAN plus analyzer using the Wort-17 UV-spectrophotometric method (Methods of Analysis of the ASBC, 8th ed, 1992).

S/T Ratio was calculated as Soluble Protein / Total Malt Protein

Diastatic Power Values were determined on a Skalar SAN plus analyzer by the automated ferricyanide procedure Malt-6C (Methods of Analysis of the ASBC, 8th ed, 1992).

α-Amylase activities were measured on a Skalar SAN plus analyzer by heating the extract to 73°C to inactivate any β-amylase present. The remaining (α-amylase) activity was measured as described for Diastatic Power Values.

Viscosities were measured on an Anton Paar AMVn rolling ball viscometer. Relative viscosities were reported: flow time of mash extract over the flow time of distilled water.

Turbidities were determined in Nephelometric Turbidity Units (NTU) on a Hach Model 18900 Ratio Turbidimeter.

Quality Scores were calculated by using a modification of the method of Clancy and Ullrich (Cereal Chem. 65:428-430, 1988). The criteria used to quantify individual quality factors are listed in Table A1.

Overall Rank Values were ordered from low to high based on their Quality Scores. A rank of '1' was assigned to the sample with the best quality score.

American Malting Barley Association, Inc.

MALTING BARLEY BREEDING GUIDELINES
IDEAL COMMERCIAL MALT CRITERIA

	Six-Row	Adjunct Two-Row	All Malt Two-Row
Barley Factors			
Plump Kernels (on 6/64)	> 80%	> 90%	> 90%
Thin Kernels (thru 5/64)	< 3%	< 3%	< 3%
Germination (4ml 72 hr. GE)	> 98%	> 98%	> 98%
Protein	≤ 13.0%	≤ 13.0%	≤ 12.0%
Skinned & Broken Kernels	< 5%	< 5%	< 5%
Malt Factors			
Total Protein	≤ 12.8%	≤ 12.8%	≤ 11.8%
on 7/64 screen	> 60%	> 70%	> 75%
Measures of Malt Modification			
Beta-Glucan (ppm)	< 120	< 100	< 100
F/C Difference	< 1.2	< 1.2	< 1.2
Soluble/Total Protein*	42-47%	40-47%	38-45%
Turbidity (NTU)	< 10	< 10	< 10
Viscosity (absolute cp)	< 1.50	< 1.50	< 1.50
Congress Wort			
Soluble Protein*****	5.2-5.7%	4.8-5.6%	< 5.3%
Extract (FG db)	> 79.0%	> 81.0%	> 81.0%
Color (°ASBC)	1.8-2.5	1.6-2.5	1.6-2.8
FAN	> 210	> 210	140-190
Malt Enzymes			
Diastatic Power (°ASBC)*****	> 150	> 120	110-150
Alpha Amylase (DU)*****	> 50	> 50	40-70

General Comments

Barley should mature rapidly, break dormancy quickly without pregermination and germinate uniformly.

The hull should be thin, bright and adhere tightly during harvesting, cleaning and malting.

Malted barley should exhibit a well-balanced, modification in a conventional malting schedule with four day germination.

Malted barley must provide desired beer flavor.

April, 2014 DRAFT