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

WESTERN REGIONAL SPRING BARLEY NURSERY
2015 Crop

Malting Quality Data

*Cereal Crops Research Unit Staff

Detailed Data:

Aberdeen, ID
Fargo, ND

Appendix:
Methods
Criteria for Quality Score

These are preliminary data that have not been sufficiently confirmed to justify general release. Confirmed results will be published through established channels. These data are a primarily tool available to cooperators and their official staffs and for those persons who are interested in the development of improved barleys.

These data are furnished by the Agricultural Research Service and by the State Agricultural Experiment Stations. The report is not intended for publication and should not be referred to in literature citations nor quoted in publicity or advertising. Use of the data may be granted for certain purposes upon written request to the agency or agencies involved.

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

*Staff Contributors: Chris Martens, Biological Science Technician; Bryan Lemmenes, Biological Science Technician; Michael Marinac, Physical Science Technician, Andy Standish, U. of Wisconsin Research Specialist, Laura Oesterlie, Biological Science Technician, and Leslie Zalapa, Biologist.

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Western Regional Spring Barley Nursery - 2015 Crop

Table 2 - Station Means* of Barley and Malt Quality Factors for 23 Varieties or Selections**

LOCATION	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (Relative)	Turbidity (HACH)
Aberdeen	**40.5 a**	**94.2 b**	**41.6 b**	**80.6 a**	**3.3 a**	**12.2 b**	**5.32 a**	**45.6 a**	**135 b**	**69.8 b**	**177 a**	**249 a**	**1.48 a**	**15.5 a**
Tetonia	**39.3 b**	**97.2 a**	**48.6 a**	**80.9 a**	**2.0 b**	**13.3 a**	**5.21 a**	**40.7 b**	**188 a**	**75.7 a**	**144 b**	**235 b**	**1.48 a**	**8.0 b**

* Within each column, means followed by the same letter are not significantly different (alpha <0.05), according to Duncan's Multiple Range Test

**10WA-106.19, 10WA-105.33, 09WA-232.16, 09WA-235.11, 10WA-106.18, 2ND30724, 2ND28065, 08ARS112-75, MT124728, MT100126, MT124027, MT100120, 2B11-5283, 2B12-5582, 11WA-107.20, 11WA-105.11, Harrington, 2B11-4949, 2B11-5166, 2B10-4378, AC Metcalfe, 08ARS116-91, 2Ab08-X05M010-82

WESTERN REGIONAL SPRING BARLEY NURSERY - 2015 Crop

Table 3 - Varietal Means* of Barley and Malt Quality Factors for Two Stations**

Variety or Selection	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	Wort Color	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Viscosity (Relative)	Turbidity (HACH)
Harrington	**39.8 bcde**	**96.0 ab**	**48.5 ab**	**80.7 cdef**	**2.5 abcd**	**13.8 a**	**6.40 a**	**49.3 ab**	**189 abc**	**86.3 cde**	**131 defgh**	**299 ab**	**1.46 fg**	**5.4 c**
AC Metcalfe	**39.0 cdef**	**96.2 ab**	**51.5 a**	**80.8 cdef**	**2.9 ab**	**13.4 abcd**	**6.33 a**	**49.0 abc**	**183 abcd**	**91.7 bcd**	**41 h**	**296 ab**	**1.46 efg**	**9.2 c**
2B10-4378	**38.3 def**	**95.9 ab**	**45.5 abcd**	**81.5 abcd**	**2.8 abc**	**12.3 bcdefg**	**5.88 ab**	**49.3 ab**	**180 abcd**	**94.2 b**	**64 fgh**	**290 ab**	**1.47 defg**	**7.5 c**
2B11-4949	**39.2 bcdef**	**95.8 ab**	**45.5 abcd**	**82.9 a**	**2.8 abc**	**12.7 abcdef**	**6.14 a**	**52.5 a**	**174 abcd**	**84.9 de**	**38 h**	**306 a**	**1.45 g**	**5.9 c**
2B11-5166	**39.2 bcdef**	**96.7 ab**	**46.5 abc**	**81.8 abc**	**2.9 ab**	**13.0 abcdef**	**6.15 a**	**48.6 abc**	**200 a**	**86.5 cde**	**63 fgh**	**284 ab**	**1.46 efg**	**7.4 c**
2B11-5283	**40.1 abcde**	**97.4 a**	**49.5 ab**	**82.3 ab**	**3.0 a**	**12.0 efg**	**5.69 abc**	**49.6 ab**	**163 abcde**	**86.1 cde**	**34 h**	**288 ab**	**1.47 cdefg**	**8.6 c**
2B12-5582	**40.0 bcde**	**96.9 ab**	**46.0 abcd**	**81.8 abc**	**2.8 abc**	**13.6 abc**	**5.97 a**	**46.8 bcd**	**177 abcd**	**82.7 e**	**68 efgh**	**306 a**	**1.48 bcdefg**	**8.8 c**
2Ab08-X05M010-82	**37.0 f**	**93.9 b**	**42.0 abcd**	**80.1 defg**	**3.1 a**	**13.1 abcde**	**5.89 ab**	**46.6 bcd**	**203 a**	**92.3 bc**	**46 gh**	**268 bc**	**1.47 cdefg**	**10.2 bc**
08ARS112-75	**41.1 abc**	**95.9 ab**	**50.5 ab**	**81.3 bcde**	**2.6 abcd**	**12.9 abcdef**	**5.91 ab**	**48.5 abc**	**187 abcd**	**101.5 a**	**187 cde**	**279 ab**	**1.48 bcdefg**	**7.0 c**
08ARS116-91	**38.2 ef**	**95.7 ab**	**43.0 abcd**	**81.2 bcdef**	**3.0 a**	**13.1 abcde**	**6.39 a**	**49.8 ab**	**189 abc**	**71.6 f**	**49 gh**	**290 ab**	**1.46 efg**	**7.9 c**
MT100120	**39.6 bcde**	**96.2 ab**	**42.0 abcd**	**80.9 bcdef**	**2.5 abcd**	**11.2 g**	**4.60 defg**	**43.3 def**	**186 abcd**	**70.3 fg**	**112 defgh**	**206 efg**	**1.50 bcd**	**10.5 bc**
MT100126	**40.2 abcde**	**96.4 ab**	**46.0 abcd**	**80.1 defg**	**2.5 abcd**	**12.1 defg**	**4.78 def**	**42.2 defg**	**198 ab**	**66.7 fgh**	**165 cdefg**	**223 def**	**1.48 bcdefg**	**8.8 c**
MT124027	**39.7 bcde**	**96.2 ab**	**38.5 cd**	**81.2 bcdef**	**2.8 abc**	**12.2 cdefg**	**5.07 cde**	**44.2 cde**	**142 def**	**79.6 e**	**107 defgh**	**246 cd**	**1.48 bcdefg**	**7.6 c**
MT124728	**41.1 abc**	**94.8 ab**	**36.5 d**	**81.1 bcdef**	**3.2 a**	**13.2 abcde**	**5.78 abc**	**46.2 bcd**	**181 abcd**	**63.6 ghi**	**156 defgh**	**271 bc**	**1.49 bcdef**	**10.1 bc**
2ND28065	**39.0 cdef**	**95.0 ab**	**42.0 abcd**	**80.8 cdef**	**2.1 cde**	**12.9 abcdef**	**5.19 bcd**	**40.9 efgh**	**153 bcdef**	**61.6 hij**	**150 defgh**	**231 de**	**1.46 efg**	**5.6 c**
2ND30724	**41.5 abc**	**96.5 ab**	**45.5 abcd**	**80.1 defg**	**3.0 a**	**12.1 defg**	**4.74 defg**	**40.9 efgh**	**150 cdef**	**64.8 fghi**	**186 cde**	**211 efg**	**1.47 cdefg**	**14.4 bc**
09WA-232.16	**41.6 ab**	**95.7 ab**	**50.0 ab**	**79.8 fg**	**1.6 e**	**12.3 cdefg**	**3.97 g**	**33.5 jk**	**114 f**	**55.6 jkl**	**376 b**	**162 h**	**1.51 b**	**15.8 bc**
09WA-235.11	**40.1 abcde**	**94.7 ab**	**42.0 abcd**	**80.0 efg**	**2.6 abcd**	**13 abcdef**	**4.73 efg**	**37.7 ghij**	**145 cdef**	**58.7 ijk**	**175 cdef**	**199 efg**	**1.50 bcde**	**11.2 bc**
10WA-105.33	**41.7 ab**	**96.6 ab**	**41.5 bcd**	**78.7 gh**	**1.5 e**	**13.7 ab**	**4.10 fg**	**31.8 k**	**121 ef**	**53.4 kl**	**556 a**	**162 h**	**1.56 a**	**23.5 b**
10WA-106.18	**40.8 abcd**	**94.2 b**	**48.5 ab**	**81.1 bcdef**	**2.1 bcde**	**11.7 fg**	**4.38 efg**	**38.8 fghi**	**122 ef**	**58.7 ijk**	**217 cd**	**194 fgh**	**1.49 bcdef**	**9.0 c**
10WA-106.19	**42.5 a**	**94.3 b**	**47.5 abc**	**80.6 cdef**	**2.1 bcde**	**12.0 efg**	**4.27 fg**	**36.5 hijk**	**130 ef**	**54.2 kl**	**281 bc**	**187 gh**	**1.51 bc**	**13.5 bc**
11WA-105.11	**40.1 abcde**	**95.8 ab**	**42.0 abcd**	**78.0 h**	**n.d.**	**13.5 abcd**	**4.33 efg**	**33.4 jk**	**112 f**	**50.2 l**	**343 b**	**180 gh**	**1.49 bcdef**	**54.5 a**
11WA-107.20	**39.9 bcde**	**94.0 b**	**46.5 abc**	**80.1 defg**	**1.9 de**	**13.3 abcde**	**4.40 efg**	**34.3 ijk**	**123 ef**	**58.1 ijk**	**342 b**	**195 fgh**	**1.51 bc**	**8.0 c**

* Within each column, means followed by the same letter are not significantly different (alpha=0.05), according to Duncan's Multiple Range Test.

**Aberdeen, ID; Tetonia, ID

***n.d.: Sample's clarity reported as hazy, hence the wort color was not defined.

2015 WRSBN - Aberdeen, ID

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. Visc.	Turbid. (Hach)	Quality Score	Overall Rank
5299	Harrington	2	40.4	95.0	47	80.9	2.8	1	13.1	6.30	50.7	147	80.2	142	310	1.44	5.6	45	20
5300	AC Metcalfe	2	39.3	94.6	51	81.2	3.3	1	12.5	6.18	51.5	150	89.8	40	301	1.46	9.8	55	11
5301	2B10-4378	2	39.1	95.0	46	81.7	3.2	1	11.5	5.94	53.0	161	93.6	53	306	1.45	6.2	58	4
5302	2B11-4949	2	39.6	94.1	42	82.8	3.3	1	12.4	6.29	54.1	152	83.8	41	333	1.45	6.8	55	11
5303	2B11-5166	2	39.6	95.6	43	81.7	3.4	1	12.1	5.94	51.0	158	83.3	55	277	1.46	9.3	58	4
5304	2B11-5283	2	41.2	96.7	49	82.4	3.4	1	11.7	5.94	52.2	142	84.3	39	296	1.47	8.0	60	1
5305	2B12-5582	2	40.5	95.9	44	82.3	3.3	1	12.7	5.90	48.6	143	79.0	68	315	1.48	10.8	60	1
5306	2Ab08-X05M010-82	2	37.5	92.6	36	79.9	4.0	2	12.0	5.46	48.2	150	83.8	55	256	1.48	14.7	56	8
5307	08ARS112-75	2	42.7	96.1	50	81.4	3.1	1	11.7	5.40	49.5	138	96.3	258	265	1.50	8.3	58	4
5308	08ARS116-91	2	39.9	94.4	38	80.6	3.5	1	13.0	6.37	49.6	163	71.4	63	298	1.45	6.8	47	17
5309	MT100120	2	38.8	93.6	37	80.3	3.3	2	10.7	4.78	47.4	157	68.8	155	214	1.51	16.6	46	19
5310	MT100126	2	39.4	94.6	36	79.4	3.3	1	11.7	4.92	45.7	168	63.5	205	232	1.47	12.4	54	15
5311	MT124027	2	39.8	95.3	32	81.0	3.7	1	11.3	5.14	48.9	110	73.4	95	253	1.47	10.5	59	3
5312	MT124728	2	42.0	94.6	29	80.7	4.1	1	12.3	5.70	48.0	139	59.3	188	274	1.51	13.4	50	16
5313	2ND28065	2	39.6	92.8	39	80.4	2.6	1	12.8	5.25	41.6	139	59.4	193	234	1.46	7.2	57	7
5314	2ND30724	2	40.6	94.2	47	78.8	3.9	2	12.6	4.88	40.8	153	61.9	297	208	1.48	21.0	55	11
5315	09WA-232.16	2	43.7	94.6	46	79.4	n.d.	3	12.1	4.06	34.4	97	53.6	489	160	1.52	25.0	37	21
5316	09WA-235.11	2	40.9	92.0	37	79.9	3.6	1	12.3	4.87	40.4	114	52.8	203	202	1.50	16.2	56	8
5317	10WA-105.33	2	42.9	95.4	35	79.1	n.d.	3	13.1	4.30	34.7	101	52.2	*706	173	1.55	38.0	33	22
5318	10WA-106.18	2	41.3	90.7	45	80.8	2.7	2	11.2	4.66	42.0	105	56.2	252	205	1.48	11.8	55	11
5319	10WA-106.19	2	43.0	91.3	44	80.7	2.7	2	11.4	4.46	40.1	111	51.9	285	202	1.50	20.0	56	8
5320	11WA-105.11	2	39.4	94.5	38	77.3	n.d.	3	13.5	4.87	38.1	104	49.7	373	207	1.47	67.0	32	23
5321	11WA-107.20	2	40.9	92.0	45	80.4	2.4	1	12.6	4.69	39.0	97	56.5	344	212	1.49	10.3	47	17
Minima			37.5	90.7	29	77.3	2.4		10.7	4.06	34.4	97	49.7	39	160	1.44	5.6		
Maxima			43.7	96.7	51	82.8	4.1		13.5	6.37	54.1	168	96.3	489	333	1.55	67.0		
Means			40.5	94.2	42	80.6	3.3		12.2	5.32	45.6	135	69.8	177	249	1.48	15.5		
Standard Deviations			1.5	1.6	6	1.3	0.5		0.7	0.70	5.9	24	15.0	127	50	0.03	13.5		
Coefficients of Variation			3.8	1.7	14	1.6	14.3		5.8	13.11	13.0	18	21.5	72	20	1.79	87.0		

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 Gongshe Hu, USDA ARS, Aberdeen, ID

Neg Std Dev			35.9	89.4	24	76.8	1.9		10.1	3.23	27.8	63	24.9	-204	100	1.40	-25		
Pos Std Dev			45.1	98.9	59	84.4	4.7		14.3	7.41	63.5	206	114.7	558	398	1.56	56		

2015 WRSBN - Tetonia, ID

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. Visc.	Turbid. (Hach)	Quality Score	Overall Rank
5322	Harrington	2	39.1	97.0	50	80.4	2.2	1	**14.4**	**6.50**	**47.8**	231	92.4	119	287	1.47	5.1	38	20
5323	AC Metcalfe	2	38.6	97.8	52	80.4	2.4	1	**14.2**	**6.48**	46.5	215	93.6	42	290	1.46	8.5	47	14
5325	2B10-4378	2	37.5	96.8	45	81.3	2.4	1	13.1	5.82	45.5	199	94.8	74	273	1.48	8.8	56	7
5327	2B11-4949	2	38.7	97.4	49	83.0	2.3	1	13.0	5.98	50.8	195	86.0	34	279	1.44	4.9	58	5
5328	2B11-5166	2	38.7	97.7	50	81.8	2.3	1	13.9	6.35	46.1	241	89.7	70	290	1.46	5.4	50	11
5329	2B11-5283	2	39.0	98.1	50	82.2	2.6	1	12.2	5.44	47.0	184	87.8	29	280	1.47	9.1	62	4
5330	2B12-5582	2	39.4	97.8	48	81.3	2.3	1	14.4	6.04	45.0	210	86.4	68	297	1.48	6.7	50	11
5331	2Ab08-X05M010-82	2	36.4	95.2	48	80.2	2.1	1	14.2	6.31	44.9	255	100.7	36	279	1.46	5.6	45	15
5332	08ARS112-75	2	39.4	95.6	51	81.1	2.1	1	14.0	6.41	47.4	235	106.7	115	292	1.46	5.7	41	18
5333	08ARS116-91	2	36.4	96.9	48	81.8	2.4	1	13.2	6.41	49.9	214	71.7	35	282	1.47	8.9	48	13
5334	MT100120	2	40.4	98.7	47	81.4	1.6	1	11.6	4.42	39.2	215	71.7	68	197	1.49	4.3	64	2
5335	MT100126	2	40.9	98.2	56	80.7	1.6	1	12.5	4.63	38.7	227	69.8	125	213	1.48	5.1	57	6
5336	MT124027	2	39.6	97.0	45	81.3	1.9	1	13.1	5.00	39.5	174	85.8	118	238	1.48	4.7	53	8
5337	MT124728	2	40.1	94.9	44	81.5	2.3	1	14.1	5.85	44.4	223	67.8	124	267	1.46	6.7	51	9
5338	2ND28065	2	38.4	97.2	45	81.2	1.5	1	13.0	5.12	40.1	166	63.7	107	227	1.46	4.0	63	3
5339	2ND30724	2	42.4	98.7	44	81.4	2.0	1	11.6	4.59	41.0	147	67.6	75	213	1.46	7.8	70	1
5340	09WA-232.16	2	39.5	96.7	54	80.1	1.6	1	12.4	3.88	32.5	130	57.5	263	163	1.50	6.5	40	19
5341	09WA-235.11	2	39.3	97.4	47	80.0	1.6	1	13.7	4.58	34.9	175	64.6	147	195	1.49	6.2	45	15
5342	10WA-105.33	2	40.4	97.8	48	78.3	1.5	1	14.2	3.89	28.9	140	54.6	556	150	1.56	8.9	29	22
5343	10WA-106.18	2	40.3	97.6	52	81.3	1.5	1	12.1	4.10	35.6	139	61.1	182	182	1.49	6.2	51	9
5344	10WA-106.19	2	42.0	97.3	51	80.4	1.5	1	12.5	4.07	32.8	148	56.4	276	171	1.51	7.0	45	15
5345	11WA-105.11	2	37.5	97.1	46	78.6	n.d.	3	13.4	3.79	28.7	120	50.6	312	153	1.51	42.0	28	23
5347	11WA-107.20	2	38.8	96.0	48	79.8	1.4	1	14.0	4.11	29.6	148	59.6	340	177	1.52	5.7	33	21
5324	HARRINGTON MALT CHECK	2	40.3	96.9	74	82.5	2.2	1	11.6	5.15	47.6	125	78.1	160	239	1.52	10.0	57	
5346	HARRINGTON MALT CHECK	2	40.9	96.1	73	83.0	2.3	1	11.6	5.41	49.9	120	82.6	93	237	1.51	9.9	61	
Minima			36.4	94.9	44	78.3	1.4		11.6	3.79	28.7	120	50.6	29	150	1.44	4.0		
Maxima			42.4	98.7	56	83.0	2.6		14.4	6.50	50.8	255	106.7	556	297	1.56	42.0		
Means			39.2	97.2	49	80.9	2.0		13.3	5.21	40.7	188	75.7	144	235	1.48	8.0		
Standard Deviations			1.5	1.0	3	1.1	0.4		0.9	1.00	6.9	40	16.4	128	52	0.03	7.6		
Coefficients of Variation			3.8	1.0	6	1.3	20.3		6.7	19.13	17.1	21	21.7	89	22	1.79	94.8		

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 Dr. Gongshe Hu, USDA ARS, Aberdeen, ID

Neg Std Dev			34.8	94.2	39	77.6	0.8		10.6	2.22	19.9	68	26.4	-239	78	1.40	-15		
Pos Std Dev			43.7	100.2	58	84.1	3.1		15.9	8.20	61.6	309	125.0	528	391	1.56	31		

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.

Appendix B

Quality Score Parameters for 2- and 6-rowed barleys

	2-rowed		6-rowed	
Quality parameter	condition	score	condition	score
Kernel Weight	> 42.0	5	> 32.0	5
(mg)	40.1–42.0	4	30.1–32.0	4
	38.1–40.0	2	28.1–30.0	2
	≤ 38.0	0	≤ 28.0	0
on 6/64 "	≥ 90.0	5	≥ 80.0	5
(%)	85.0–89.9	3	73.0–79.9	3
	< 85.0	0	< 73.0	0
Malt Extract	≥ 81.0	10	≥ 79.0	10
(% db)	79.4–81.0	7	78.2–78.9	7
	78.0–79.4	4	77.7–78.2	4
	<78.0	0	< 77.7	0
Wort Clarity	= 3	0	= 3	0
3=hazy	= 2	1	= 2	1
2=slightly hazy	= 1	2	= 1	2
1=clear				
Barley Protein	≥ 13.5	0	≥ 14.0	0
(% db)	13.0–13.5	5	13.5–13.9	5
	11.0–13.0	10	11.5–13.5	10
	≤ 11.0	5	≤ 11.5	5
Wort Protein	> 6.0	0	> 6.0	0
(% db)	5.6–6.0	3	5.7–6.0	3
	4.4–5.6	7	5.2–5.7	7
	4.0–4.4	3	4.8–5.2	3
	< 4.0	0	< 4.8	0
S/T (Soluble/Total	>47	0	>47	0
Protein, % db)	40–47	5	42–47	5
	< 40	0	< 42	0
DP (Diastatic	>120	7	>140	7
Power, ° ASBC)	100–120	4	120–140	4
	< 100	0	< 120	0
Alpha-amylase	>50	7	>50	7
(20° DU)	40–50	4	40–50	4
	< 40	0	< 40	0
Beta-glucan	< 100	7	<120	7
(ppm)	100–150	3	120 – 170	3
	> 150	0	> 170	0
Free Amino Nitrogen	>190	5	>200	5
	180 – 190	3	190 – 200	3

American Malting Barley Association, Inc.

MALTING BARLEY BREEDING GUIDELINES IDEAL COMMERCIAL MALT CRITERIA

	Six-Row	Adjunct Two-Row	All Malt Two-Row	Distillers'
Barley Factors				
Plump Kernels (on 6/64)	> 80%	> 90%	> 90%	> 70%
Thin Kernels (thru 5/64)	< 3%	< 3%	< 3%	< 5%
Germination (4ml 72 hr. GE)	> 98%	> 98%	> 98%	> 98%
Protein	≤ 13.0%	≤ 13.0%	≤ 12.0%	11.5 -14.0%
Skinned & Broken Kernels	< 5%	< 5%	< 5%	< 5%
Malt Factors				
Total Protein	≤ 12.8%	≤ 12.8%	≤ 11.8%	11.0 - 13.5%
on 7/64 screen	> 60%	> 70%	> 75%	>50%
Glycosidic Nitrile (ppm)				< 1.5
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%	>48%
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%	>6.0%
Extract (FG db)	> 79.0%	> 81.0%	> 81.0%	> 79.0%
Color (°ASBC)	1.8-2.5	1.6-2.5	1.6-2.8	<4.0
FAN	> 210	> 210	140-190	>250
Malt Enzymes				
Diastatic Power (°ASBC)	> 150	> 120	110-150	>200
Alpha Amylase (DU)	> 50	> 50	40-70	>75

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.

Distillers' Malt guidelines are designed to reflect how varieties perform when malted in the normal Brewers' cycles used for AMBA and CCRU variety trials.

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