

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

**MISSISSIPPI VALLEY 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

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Mississippi Valley 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	36.4 a	95.3 a	49.5 a	80.5 a	2.7 a	11.3 b	5.3 b	49.0 a	153 b	69.7 b	107.5 b	253 b	1.47 b	13.8 a
Fargo	36.9 a	92.8 b	50.7 a	80.7 a	3.4 b	12.9 a	6.1 a	49.0 a	165 a	80.2 a	170.6 b	311 a	1.49 a	8.4 b

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

** ABI Balster, ABI Growler, Conrad, Lacey, Legacy, M162, ND Genesis, ND26891, ND28554, ND28555, ND29380, ND31091, 2ND28065, 2ND30837, 2ND31815, 2ND31914, 2ND32184, Pinnacle, Robust, S6M164, S6M165, S6M166, SR460, SR14465, Tradition, 6B10-4748

Mississippi Valley 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)
MOREX	33.6 kl	90.6 ab	54.0 abcd	79.8 de	2.8 def	13.1 ab	5.76 abc	46.0 bc	195 abc	75.6 cdefg	110 cdef	301 abcdef	1.48 abcde	10.1 bcd
ROBUST	35.7 fghijk	95.0 ab	51.0 bcdef	80.2 cde	3.1 bcdef	13.9 a	6.00 abc	46.0 bc	191 abc	70.8 defg	224 ab	321 a	1.47 abcde	6.1 cd
LEGACY	33.9 kl	95.3 ab	61.0 a	80.1 cde	2.7 f	12.8 abc	5.97 abc	48.3 bc	200 abc	67.2 fg	296 a	315 ab	1.49 abcde	6.9 cd
LACEY	35.3 fghijk	94.3 ab	48.0 cdefghi	80.3 cde	2.8 def	12.7 abcd	5.65 abc	47.0 bc	180 abcde	68.6 efg	92 def	285 abcdefg	1.45 de	8.4 bcd
TRADITION	34.5 ijk	94.7 ab	53.5 abcde	80.1 cde	2.8 cdef	12.6 abcd	5.67 abc	46.8 bc	216 a	76.1 cdefg	127 bcdef	297 abcdefg	1.49 abcde	9.9 bcd
PINNACLE	42.3 a	93.9 ab	41.5 ghij	81.2 abc	3.0 bcdef	10.9 de	5.01 c	48.3 bc	104 h	65.9 g	170 bcd	248 g	1.48 abcde	9.0 bcd
M162	34.9 hijk	94.5 ab	55.0 abcd	79.6 e	2.7 ef	13.0 ab	5.53 abc	45.1 bc	191 abc	69.2 efg	141 bcdef	278 abcdefg	1.46 cde	11.2 bcd
ND26891	35.6 fghijk	95.2 ab	49.0 bcdefgh	80.4 bcde	3.6 abc	12.0 bcde	5.69 abc	50.5 abc	136 efgh	71.7 defg	128 bcdef	283 abcdefg	1.50 abcd	18.1 bcd
ND28554	37.7 defgh	97.3 a	50.5 bcdefg	80.1 cde	3.1 bcdef	12.9 ab	5.87 abc	46.5 bc	166 bcdef	67.8 efg	134 bcdef	302 abcde	1.50 abcde	12.6 bcd
ND28555	37.8 defg	96.9 a	54.0 abcd	80.2 cde	3.1 bcdef	12.8 abc	5.90 abc	47.7 bc	162 bcdef	68.8 efg	151 bcdef	297 abcdefg	1.51 ab	12.8 bcd
ND29196	33.8 kl	94.3 ab	57.0 abc	80.1 cde	3.3 abcdef	12.6 abcd	6.07 abc	50.9 abc	179 abcde	80.4 abcdef	119 bcdef	309 abcd	1.47 abcde	8.3 bcd
ND29380	34.1 kl	95.1 ab	49.0 bcdefgh	81.2 abc	3.6 abc	10.6 e	5.23 bc	52.8 ab	107 h	67.9 efg	163 bcde	266 bcdefg	1.50 abcd	19.7 bc
ND31091	34.7 ijk	96.7 a	49.0 bcdefgh	80.1 cde	3.1 bcdef	12.0 bcde	6.27 ab	52.6 ab	138 efgh	66.8 fg	186 bcd	282 abcdefg	1.51 ab	12.8 bcd
ND Genesis	38.6 cde	92.8 ab	39.0 if	81.7 ab	3.3 abcdef	10.6 e	5.37 bc	53.0 ab	115 gh	81.3 abcde	131 bcdef	260 defg	1.46 bcde	8.9 bcd
2ND28065	38.0 def	94.7 ab	44.0 fghij	81.3 abc	2.5 f	12.1 abcde	5.25 bc	44.2 c	115 gh	64.7 g	171 bcd	252 fg	1.46 cde	7.65 bcd
2ND30837	41.5 ab	96.9 a	38.0 j	81.9 a	3.6 abc	11.3 bcde	5.27 bc	47.9 bc	141 defgh	75.3 cdefg	139 bcdef	267 bcdefg	1.52 a	35.5 a
2ND31815	41.3 ab	95.7 ab	38.0 j	80.3 cde	2.6 f	11.8 bcde	5.32 bc	46.9 bc	123 fgh	75.2 cdefg	58 ef	257 efg	1.45 e	8.2 bcd
2ND31914	43.1 a	95.7 ab	49.5 bcdefgh	80.2 cde	2.9 cdef	12.1 abcde	5.62 abc	47.8 bc	162 bcdef	69.0 efg	131 bcdef	272 abcdefg	1.46 bcde	21.0 b
2ND32184	40.9 abc	93.0 ab	40.5 hij	81.0 abcd	3.2 bcdef	11.6 bcde	5.46 abc	48.9 abc	107 h	79.9 abcdef	42 f	265 bcdefg	1.45 e	11.5 bcd
6B10-4748	37.3 defghij	95.9 ab	48.0 cdefghi	80.2 cbe	3.2 bcdef	12.9 ab	5.77 abc	47.0 bc	184 abcd	71.3 defg	184 bcd	308 abcd	1.51 abc	9.9 bcd
CONRAD	37.5 defghl	93.1 ab	44.5 efghij	80.5 bcde	3.6 abcd	12.2 abcde	5.66 abc	49.0 abc	139 defgh	87.1 abc	84 def	270 bcdefg	1.45 e	7.9 bcd
ABI BALSTER	39.0 bcd	92.9 ab	47.0 defghij	82.1 a	3.8 ab	11.6 bcde	5.58 abc	50.8 abc	127 fgh	91.0 ab	125 bcdef	271 bcdefg	1.50 abcde	13.2 bcd
ABI GROWLER	38.6 cde	90.9 ab	48.5 cdefgh	80.0 cde	4.0 a	12.2 abcde	5.60 abc	48.0 bc	155 cdefg	91.9 a	54 ef	263 cdefg	1.48 abcde	17.3 bcd
S6M163	31.7 l	83.5 c	57.5 abc	80.4 cde	2.8 cdef	10.8 de	5.20 bc	50.2 abc	126 fgh	77.2 cdefg	94 def	256 efg	1.46 cde	6.0 cd
S6M164	34.5 jk	96.0 a	58.5 ab	80.3 cde	2.7 ef	12.9 ab	5.78 abc	47.4 bc	201 abc	76.9 cdefg	117 bcdef	275 abcdefg	1.49 abcde	6.8 cd
S6M165	35.0 ghijk	93.7 ab	57.0 abc	81.1 abcd	2.9 cdef	11.5 bcde	5.63 abc	50.4 abc	188 abc	76.1 cdefg	126 bcdef	283 abcdefg	1.52 a	6.6 cd
S6M166	34.4 kl	94.9 ab	53.0 abcdef	80.9 abcde	3.0 bcdef	12.5 abcd	6.05 abc	49.3 abc	203 ab	77.4 cdefg	175 bcd	291 abcdefg	1.50 abcd	6.3 cd
S6M167	33.6 kl	88.5 bc	54.5 abcd	80.0 cde	2.7 f	13.1 ab	6.53 a	52.4 ab	203 ab	78.3 bcdefg	163 bcde	298 abcdef	1.49 abcde	5.2 d
SR460	36.0 efghijk	93.6 ab	58.5 ab	81.1 abcd	3.5 abcde	11.0 cde	5.48 abc	51.9 abc	127 fgh	77.0 cdefg	218 abc	288 abcdefg	1.51 abc	9.1 bcd
SR14465	36.3 defghijk	96.0 ab	53.5 abcde	81.9 a	3.0 bcdef	12.2 abcde	6.56 a	56.7 a	206 ab	83.2 abcd	128 bcdef	312 abc	1.49 abcde	6.2 cd

* 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 MVBN - 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
5267	Morex	2	32.8	90.2	50	79.6	2.5	1	11.8	5.24	46.9	165	67.0	107	268	1.47	14.0	58	5
5268	Robust	2	35.2	94.8	53	80.0	2.2	1	13.1	5.54	45.4	172	57.7	160	281	1.45	6.2	50	21
5269	Legacy	2	33.2	94.8	63	80.8	2.6	1	11.5	5.64	51.2	171	73.5	194	288	1.47	7.7	46	28
5270	Lacey	2	33.0	91.6	46	80.1	2.5	1	11.2	5.17	48.0	168	66.8	42	248	1.43	10.0	57	7
5271	Tradition	2	33.9	94.6	47	80.3	2.4	1	11.2	5.18	47.8	192	71.1	95	258	1.46	13.4	57	7
5272	Pinnacle	2	43.3	96.8	41	81.6	2.4	1	10.3	4.67	47.4	123	56.9	145	221	1.48	10.8	56	12
5273	Genesis	2	38.9	94.2	37	80.9	2.9	1	11.2	5.48	51.9	142	74.9	163	258	1.46	12.0	52	18
5274	ND26891	2	34.9	94.7	53	80.7	n.d.	3	10.6	5.08	52.0	130	63.5	99	239	1.49	28.0	50	21
5275	2ND28065	2	37.2	99.5	40	80.9	2.3	1	12.1	5.04	42.4	115	53.4	118	232	1.44	10.2	55	13
5276	ND28554	2	37.0	97.2	52	80.1	2.7	1	11.3	5.47	48.7	169	62.9	91	263	1.48	16.6	57	7
5277	ND28555	2	36.8	96.9	52	80.4	2.7	1	12.1	5.56	49.0	163	65.5	96	259	1.50	17.1	57	7
5278	ND29196	2	34.1	95.7	58	80.1	2.8	2	11.8	6.05	55.0	179	76.6	99	283	1.46	9.5	49	23
5279	ND29380	2	33.5	95.1	52	80.7	n.d.	3	10.5	5.16	53.6	118	65.0	129	261	1.48	25.0	43	30
5280	2ND30837	2	40.2	99.4	38	81.8	n.d.	3	10.9	5.10	47.9	134	64.9	118	250	1.54	55.0	53	16
5281	6B10-4748	2	36.7	95.8	48	80.0	3.1	2	11.4	5.38	49.0	165	73.4	188	286	1.52	11.3	49	23
5282	Conrad	2	37.7	94.7	43	80.1	2.9	2	11.5	5.19	46.3	141	79.2	96	207	1.46	10.9	61	3
5283	ABI Balster	2	39.0	95.8	41	82.1	3.4	2	11.0	5.29	51.7	123	82.3	139	222	1.52	18.9	52	18
5284	ABI Growler	2	39.9	96.7	45	80.4	3.3	1	10.9	5.14	50.2	143	83.6	61	216	1.48	14.6	54	15
5285	SR460	2	35.5	95.1	61	80.9	3.0	1	10.0	5.09	53.9	112	73.0	137	264	1.49	10.6	45	29
5286	M162	2	33.7	93.6	55	79.4	2.6	2	11.7	5.06	44.8	177	67.5	81	244	1.43	15.1	58	5
5287	S6M163	2	32.5	91.5	58	80.0	2.5	1	10.2	4.93	51.0	120	72.8	83	230	1.44	5.8	49	23
5288	S6M164	2	34.1	97.0	57	79.5	2.2	1	12.3	5.52	47.3	203	74.2	82	240	1.46	7.4	57	7
5289	S6M165	2	35.4	96.6	57	80.2	2.7	1	10.9	5.43	51.6	177	71.1	81	256	1.50	8.4	52	18
5290	S6M166	2	34.7	95.9	52	80.4	2.5	1	12.0	5.95	50.9	201	72.0	124	270	1.48	6.1	49	23
5291	S6M167	2	33.4	88.5	52	79.5	2.2	1	12.0	5.14	46.3	187	71.6	168	251	1.47	5.4	53	16
5293	ND31091	2	34.1	96.6	48	79.7	3.0	2	10.8	5.17	48.7	134	66.6	109	247	1.48	17.3	47	27
5295	2ND31815	2	41.6	97.1	37	80.0	2.6	1	11.1	4.93	44.6	117	67.0	27	247	1.42	9.4	63	1
5296	2ND31914	2	43.7	97.0	55	80.6	2.9	2	10.9	5.04	46.8	158	64.8	84	258	1.44	19.0	61	3
5297	2ND32184	2	41.5	94.0	38	80.9	3.0	1	11.6	5.17	45.2	118	75.2	40	259	1.45	12.9	63	1
5298	SR14465	2	35.3	96.0	55	81.8	2.7	1	10.6	5.41	53.0	178	76.9	69	289	1.46	6.5	55	13
5292	HARRINGTON MALT CHECK	2	40.3	96.5	74	81.3	2.2	1	11.7	5.12	45.4	136	85.9	75	247	1.49	8.1	69	
5294	LACEY MALT CHECK	6	32.9	90.1	42	80.3	2.6	1	13.7	6.51	50.0	180	80.7	27	317	1.43	6.7	53	

Minima	32.5	88.5	37	79.4	2.2		10.0	4.67	42.4	112	53.4	27	207						
Maxima	43.7	99.5	63	82.1	3.4		13.1	6.05	55.0	203	83.6	194	289						
Means	36.4	95.2	49	80.4	2.7		11.3	5.27	48.9	153	69.7	108	253						
Standard Deviations	3.2	2.4	7	0.7	0.3		0.7	0.29	3.1	28	7.1	42	21						
Coefficients of Variation	8.9	2.5	15	0.9	11.6		6.1	5.57	6.4	18	10.2	39	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	26.7	88.1	27	78.3	1.8		9.2	4.39	39.6	69	48.4	-18	189						
Pos Std Dev	46.1	102.4	72	82.6	3.6		13.4	6.16	58.3	238	91.0	233	317						

MVBN - Fargo, ND

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
5234	MOREX	6	34.4	91.0	58	80.0	3.0	1	14.4	6.27	45.0	224	84.2	113	333	1.48	6.2	53	11
5235	ROBUST	6	36.1	95.2	49	80.3	4.0	1	14.7	6.46	46.6	209	83.9	288	360	1.49	6.0	46	22
5236	LEGACY	6	34.6	95.8	59	79.4	2.9	1	14.1	6.29	45.4	228	60.9	398	341	1.51	6.0	46	22
5237	LACEY	6	37.5	97.0	50	80.4	2.8	1	14.1	6.12	46.0	191	70.3	141	322	1.47	6.8	49	18
5238	TRADITION	6	35.8	94.8	60	79.8	3.2	1	13.9	6.15	45.8	240	81.0	158	336	1.52	6.4	54	6
5239	PINNACLE	2	41.3	91.0	42	80.7	3.6	1	11.4	5.35	49.2	85	74.8	194	275	1.48	7.2	47	20
5240	ND GENESIS	2	38.2	91.3	41	82.4	3.6	1	9.9	5.25	54.1	87	87.6	98	261	1.46	5.8	50	15
5241	ND26891	6	36.2	95.6	45	80.1	3.6	1	13.4	6.29	49.0	142	79.9	156	326	1.51	8.2	54	6
5242	2ND28065	2	38.7	89.9	48	81.6	2.6	1	12.0	5.46	46.0	114	76.0	224	271	1.47	5.1	55	5
5243	ND28554	6	38.4	97.3	49	80.0	3.4	1	14.4	6.26	44.2	162	72.6	177	340	1.51	8.5	46	22
5244	ND28555	6	38.7	96.9	56	80.0	3.5	1	13.5	6.24	46.3	161	72.0	206	335	1.52	8.5	51	13
5245	ND29196	6	33.4	92.9	56	80.1	3.7	1	13.4	6.08	46.7	178	84.2	138	335	1.48	7.0	59	1
5246	ND29380	6	34.7	95.1	46	81.7	3.6	2	10.6	5.29	51.9	95	70.8	196	271	1.52	14.4	45	27
5247	2ND30837	2	42.7	94.4	38	81.9	3.6	2	11.6	5.44	47.9	148	85.6	160	284	1.50	15.9	57	2
5248	6B10-4748	6	37.8	95.9	48	80.4	3.3	1	14.4	6.15	44.9	202	69.2	179	329	1.49	8.4	46	22
5249	CONRAD	2	37.3	91.4	46	80.9	4.2	1	12.9	6.12	51.6	136	95.0	71	332	1.43	4.9	50	15
5250	ABI Balster	2	39.0	90.0	53	82.0	4.2	1	12.1	5.87	49.9	131	99.7	111	320	1.47	7.4	54	6
5251	ABI Growler	2	36.1	85.0	52	79.5	4.7	2	13.4	6.06	45.8	167	100.2	46	310	1.48	20.0	47	20
5252	SR460	2	36.4	92.1	56	81.3	4.0	1	11.9	5.87	49.9	141	80.9	298	312	1.52	7.6	49	18
5253	M162	6	36.1	95.4	55	79.8	2.8	1	14.2	6.00	45.3	204	70.9	200	312	1.48	7.3	46	22
5254	S6M163	6	30.8	*75.5	57	80.7	3.1	1	11.4	5.46	49.4	132	81.6	105	281	1.47	6.2	54	6
5255	S6M164	6	34.8	95.0	60	81.1	3.2	1	13.4	6.04	47.4	199	79.6	151	309	1.52	6.2	54	6
5256	S6M165	6	34.5	90.8	57	82.0	3.1	1	12.1	5.82	49.2	198	81.1	170	309	1.53	4.8	57	2
5257	S6M166	6	34.0	93.8	54	81.4	3.5	1	13.0	6.14	47.6	204	82.8	225	311	1.52	6.5	51	13
5258	S6M167	6	33.7	88.5	57	80.4	3.1	1	14.1	7.91	58.4	219	84.9	157	345	1.50	5.0	44	28
5259	ND31091	6	35.3	96.8	50	80.4	3.2	2	13.1	7.37	56.5	142	67.0	263	316	1.54	8.3	50	15
5261	2ND31815	2	40.9	94.2	39	80.6	2.5	1	12.4	5.71	49.2	129	83.3	88	266	1.47	6.9	57	2
5263	2ND31914	2	42.5	94.4	44	79.8	n.d.	3	13.2	6.20	48.7	165	73.2	177	285	1.48	23.0	41	29
5264	2ND32184	2	40.2	91.9	43	81.1	3.4	2	11.5	5.74	52.5	95	84.5	44	271	1.44	10.0	52	12
5265	SR14465	2	37.3	95.9	52	81.9	3.3	1	13.7	7.71	60.3	234	89.4	187	334	1.52	5.9	36	30
5260	HARRINGTON MALT CHECK	2	39.6	96.1	74	82.6	2.1	1	11.2	5.03	45.9	133	84.5	124	233	1.53	6.4	63	
5262	LACEY MALT CHECK	6	33.2	87.7	43	79.9	2.3	1	12.6	6.31	50.3	201	86.4	23	305	1.43	4.7	58	

Minima	30.8	85.0	38	79.4	2.5				9.9	5.25	44.2	85	60.9	44	261	1.43	4.8		
Maxima	42.7	97.3	60	82.4	4.7				14.7	7.91	60.3	240	100.2	398	360	1.54	23.0		
Means	36.9	93.4	51	80.7	3.4				12.9	6.10	49.0	165	80.2	171	311	1.49	8.3		
Standard Deviations	2.8	2.9	6	0.8	0.5				1.2	0.63	4.0	46	9.2	76	28	0.03	4.3		
Coefficients of Variation	7.6	3.1	13	1.0	14.6				9.6	10.29	8.2	28	11.4	44	9	1.75	52.1		

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. Richard Horsley, N.D.S.U.

Neg Std Dev	28.5	84.6	31	78.2	1.9				9.2	4.22	36.9	27	52.8	-57	228	1.42	-4.7		
Pos Std Dev	45.3	102.2	70	83.2	4.9				16.7	7.99	61.1	303	107.7	398	394	1.57	21.4		

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

Quality parameter	2-rowed		6-rowed	
	condition	score	condition	score
Kernel Weight (mg)	> 42.0	5	> 32.0	5
	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 (% db)	≥ 81.0	10	≥ 79.0	10
	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	= 2	1
	2=slightly hazy	= 1	= 1	2
	1=clear			
Barley Protein (% db)	≥ 13.5	0	≥ 14.0	0
	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 (% db)	> 6.0	0	> 6.0	0
	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 Protein, % db)	>47	0	>47	0
	40–47	5	42–47	5
	< 40	0	< 42	0
DP (Diastatic Power, ° ASBC)	>120	7	>140	7
	100–120	4	120–140	4
	< 100	0	< 120	0
Alpha-amylase (20° DU)	>50	7	>50	7
	40–50	4	40–50	4
	< 40	0	< 40	0
Beta-glucan (ppm)	< 100	7	<120	7
	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

	<u>Six-Row</u>	<u>Adjunct Two-Row</u>	<u>All Malt Two-Row</u>	<u>Distillers'</u>
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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