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

WESTERN REGIONAL SPRING BARLEY NURSERY
2016 Crop

Malting Quality Data

*Cereal Crops Research Unit Staff

Detailed Data:

Aberdeen, ID
Bozeman, MT
Tetonia, ID

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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Table 2 - Station Means of Barley and Malt Quality Factors for 17 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	**38.2**	**85.0**	**83**	**79.5**	**2.1**	**14.4**	**4.80**	**34.5**	**175**	**75.0**	**189**	**209**	**1.50**	**4.6**
Bozeman	**42.5**	**99.8**	**82**	**80.6**	**1.7**	**12.6**	**4.71**	**39.4**	**161**	**83.6**	**133**	**196**	**1.52**	**6.1**
Tetonia	**33.9**	**82.7**	**88**	**78.4**	**1.9**	**14.4**	**4.93**	**35.2**	**222**	**75.8**	**111**	**186**	**1.47**	**8.8**

** Harrington, AC Metcalfe, 08ARS112-75, 08ARS116-91, 08ARS028-20, 2B10-4162, 2B10-4378, 2B11-4949, 2B11-5166, 2B12-5582, MT090182, MT090190, MT100120, MT100126, MT124555, 2ND28065, 2ND30837

WESTERN REGIONAL SPRING BARLEY NURSERY - 2016 Crop

Table 3 - Varietal Means of Barley and Malt Quality Factors for Three 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	**36.8**	**87.1**	**87**	**79.0**	**1.8**	**14.6**	**4.94**	**34.6**	**199**	**85.9**	**168**	**212**	**1.48**	**4.6**
AC Metcalfe	**36.7**	**84.9**	**94**	**80.0**	**2.1**	**14.1**	**5.03**	**37.7**	**193**	**101.9**	**42**	**224**	**1.44**	**4.2**
08ARS112-75	**38.0**	**86.1**	**88**	**79.0**	**1.9**	**14.2**	**4.98**	**37.0**	**192**	**97.3**	**170**	**216**	**1.49**	**3.2**
08ARS116-91	**36.4**	**88.8**	**87**	**81.0**	**2.0**	**13.9**	**5.22**	**38.8**	**195**	**69.1**	**69**	**238**	**1.46**	**3.7**
08ARS028-20	**37.4**	**83.5**	**85**	**79.0**	**1.9**	**14.4**	**4.94**	**35.6**	**212**	**84.5**	**104**	**203**	**1.47**	**3.8**
2B10-4162	**36.5**	**78.8**	**89**	**80.0**	**2.1**	**14.1**	**4.83**	**35.0**	**186**	**85.1**	**93**	**215**	**1.48**	**3.8**
2B10-4378	**37.4**	**83.4**	**81**	**79.4**	**2.0**	**14.1**	**5.05**	**37.3**	**204**	**93.8**	**127**	**212**	**1.48**	**4.7**
2B11-4949	**36.9**	**80.7**	**85**	**80.9**	**2.2**	**14.3**	**5.26**	**38.3**	**188**	**82.2**	**81**	**242**	**1.47**	**3.5**
2B11-5166	**36.8**	**82.6**	**87**	**80.5**	**2.0**	**14.4**	**5.13**	**36.7**	**204**	**89.7**	**126**	**228**	**1.48**	**3.8**
2B12-5582	**38.9**	**89.8**	**86**	**80.3**	**2.1**	**15.0**	**5.02**	**35.7**	**189**	**78.5**	**178**	**226**	**1.53**	**4.6**
MT090182	**38.9**	**92.0**	**88**	**79.0**	**1.6**	**12.5**	**4.22**	**35.5**	**179**	**64.2**	**201**	**150**	**1.53**	**5.6**
MT090190	**40.0**	**92.3**	**87**	**79.0**	**1.7**	**12.9**	**4.60**	**37.4**	**195**	**70.1**	**151**	**183**	**1.51**	**4.8**
MT100120	**40.1**	**92.6**	**85**	**80.0**	**1.8**	**12.7**	**4.40**	**36.7**	**180**	**67.9**	**163**	**166**	**1.54**	**5.3**
MT100126	**39.0**	**91.2**	**81**	**79.0**	**1.8**	**13.1**	**4.59**	**36.2**	**195**	**67.7**	**263**	**182**	**1.54**	**6.1**
MT124555	**39.6**	**94.8**	**71**	**79.0**	****n.d.**	**13.5**	**4.47**	**34.9**	**97**	**65.4**	**234**	**159**	**1.53**	**52.0**
2ND28065	**39.2**	**90.9**	**92**	**80.0**	**1.6**	**13.5**	**4.68**	**36.3**	**155**	**60.8**	**196**	**185**	**1.51**	**3.5**
2ND30837	**40.5**	**90.6**	**70**	**80.0**	**2.3**	**13.9**	**5.01**	**36.9**	**189**	**76.6**	**96**	**209**	**1.50**	**7.3**

*Aberdeen, ID; Bozeman, MT; Tetonia, ID

**n.d.: Sample's clarity reported as hazy at all 3 locations, hence the wort color was not defined.

2016 Western Regional Spring Barley Nursery -- 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)	Relative Viscosity	Turbidity (Hach)
5843	Harrington	2	36.9	79.3	87	78.4	1.9	1	15.3	5.07	33.7	174	81.7	211	223	1.49	5.1
5844	AC Metcalfe	2	38.2	84.5	89	79.9	2.3	1	14.8	5.08	35.8	184	101.1	66	234	1.45	5.1
5845	2B10-4162	2	35.6	75.1	86	79.1	2.4	1	14.8	4.89	33.6	176	83.7	159	225	1.49	3.4
5846	2B10-4378	2	36.2	79.8	81	78.7	2.1	1	14.9	4.88	33.5	202	83.7	171	215	1.48	4.8
5847	2B11-4949	2	37.5	83.9	70	81.2	2.6	1	14.9	5.22	37.1	175	75.9	149	247	1.49	4.2
5848	2B11-5166	2	37.0	84.2	83	79.9	2.2	1	14.9	4.85	32.7	204	78.1	189	222	1.49	4.3
5849	2B12-5582	2	38.9	89.4	84	80.7	2.3	1	15.1	4.85	33.5	165	73.3	243	228	1.56	5.9
5850	08ARS112-75	2	39.0	84.7	86	79.1	2.0	1	15.4	4.90	33.7	177	92.0	280	227	1.50	3.4
5851	08ARS116-91	2	38.1	91.3	80	79.9	2.1	1	14.4	4.99	34.8	169	64.8	134	233	1.49	3.8
5852	08ARS028-20	2	36.8	81.9	88	78.9	2.1	1	14.8	4.78	33.7	201	82.7	140	215	1.48	3.9
5853	MT090182	2	39.1	84.9	84	78.6	1.8	1	13.7	4.32	32.3	170	63.5	254	164	1.52	4.9
5854	MT090190	2	39.7	88.7	90	79.6	1.9	1	13.0	4.49	35.9	178	63.2	195	184	1.51	4.9
5855	MT100120	2	40.7	91.1	86	80.1	2.2	1	13.0	4.56	37.5	170	66.2	157	187	1.51	5.8
5856	MT100126	2	38.7	82.7	80	79.2	2.1	1	13.4	4.57	36.5	168	61.9	278	191	1.52	7.1
5857	MT124555	2	40.2	92.6	69	79.1	n.d.	3	13.7	4.43	33.9	89	59.8	314	161	1.53	*60.0
5858	2ND28065	2	39.9	88.0	91	79.6	1.6	1	13.6	4.70	35.4	139	59.4	194	193	1.48	2.5
5859	2ND30837	2	41.9	85.8	70	80.0	2.6	1	14.1	4.94	36.3	155	73.5	142	216	1.51	*11.5
5861	Harrington	2	32.8	82.6	90	78.0	2.0	1	15.7	4.90	31.2	248	85.0	129	206	1.45	4.8
5860	LACEY MALT CHECK	6	33.1	88.9	46	79.9	3.2	1	13.3	5.39	42.2	166	77.6	27	260	1.44	14.7
5862	CONRAD MALT CHECK	2	40.0	97.6	54	82.5	2.4	1	14.8	4.92	42.3	147	80.6	146	224	1.49	5.0
Minima			32.8	75.1	69	78.0	1.6		13.0	4.32	31.2	89	59.4	66	161	1.45	2.5
Maxima			41.9	92.6	91	81.2	2.6		15.7	5.22	37.5	248	101.1	314	247	1.56	7.1
Means			38.2	85.0	83	79.5	2.1		14.4	4.80	34.5	175	75.0	189	209	1.50	4.6
Standard Deviations			2.1	4.6	7	0.8	0.3		0.8	0.24	1.7	32	12.0	64	24	0.03	1.1
Coefficients of Variation			5.6	5.4	8	1.0	12.6		5.8	5.08	5.0	18	16.0	34	12	1.76	24.2

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			31.8	71.3	62	77.0	1.3		11.9	4.07	29.3	80	39.0	-3	137	1.42	1.3
Pos Std Dev			44.6	98.8	104	81.9	2.9		16.9	5.53	39.7	269	110.9	381	282	1.58	8.0

2016 Western Regional Spring Barley Nursery - Bozeman, Montana

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)	Relative Viscosity	Turbidity (Hach)
5879	08ARS028-20	2	43.2	99.7	72	80.9	1.8	1	11.7	4.61	40.3	150	83.9	94	180	1.49	3.0
5880	08ARS112-75	2	42.2	99.9	86	80.4	1.8	1	12.9	4.98	40.8	173	98.1	137	213	1.50	2.7
5881	08ARS116-91	2	40.2	99.4	87	81.6	1.8	1	13.3	5.36	42.6	197	70.4	31	239	1.45	3.2
5882	10WA-106.18	2	42.8	99.6	95	80.1	1.4	1	12.3	4.13	34.9	119	55.3	355	149	1.59	3.8
5883	10WA-117.17	2	41.4	99.8	90	79.7	1.4	1	11.9	4.02	35.9	117	46.1	289	131	1.61	4.0
5884	10WA-117.24	2	41.7	99.7	87	78.6	1.8	2	12.2	3.97	33.1	114	43.5	525	112	1.81	6.5
5885	11WA-107.20	2	43.8	99.8	89	79.9	1.4	1	13.1	4.39	35.1	111	56.2	373	155	1.60	4.1
5886	11WA-107.43	2	43.4	99.8	92	81.7	1.3	1	11.5	4.12	36.5	104	56.8	205	145	1.54	3.3
5887	11WA-107.58	2	46.6	99.9	82	79.5	1.4	1	12.7	4.24	34.6	105	56.2	378	144	1.61	3.3
5888	12WA-120.14	2	47.2	99.8	92	80.5	1.8	1	13.5	4.89	39.5	157	69.4	151	192	1.49	3.2
5889	2Ab09-X06F058HL-31	2	41.6	99.8	*48	80.4	n.d.	3	15.0	4.25	29.1	72	51.1	821	121	1.58	24.0
5890	2Ab09-X06F084-51	2	45.4	99.9	78	74.5	n.d.	3	13.4	3.66	27.4	62	28.3	828	88	8.86	20.0
5891	2B10-4162	2	42.1	99.9	86	81.7	1.8	1	12.6	4.66	37.5	160	82.9	64	200	1.49	3.0
5893	2B10-4378	2	43.8	99.8	76	80.6	1.8	1	12.8	4.90	40.7	180	105.9	72	205	1.49	3.5
5895	2B11-4949	2	40.5	*98.6	89	82.0	2.0	1	12.8	5.12	41.4	162	86.3	48	241	1.47	2.9
5896	2B11-5166	2	41.0	*98.4	81	82.1	*4.3	1	13.1	5.25	42.0	161	105.4	50	236	1.48	3.0
5897	2B12-5582	2	43.8	99.7	81	81.0	1.9	1	14.4	5.01	38.0	170	87.2	147	228	1.52	3.5
5898	2ND28065	2	42.5	99.8	88	79.8	1.4	1	13.2	4.56	36.9	143	66.4	237	183	1.53	3.4
5899	2ND30837	2	44.1	99.9	69	80.6	1.9	1	12.5	4.74	38.6	164	81.1	77	196	1.50	4.5
5900	Baronesse	2	41.8	99.5	85	76.9	n.d.	3	13.8	3.99	30.6	114	55.5	234	126	1.57	16.6
5901	BZ509-601	2	44.7	99.8	91	77.3	1.2	1	13.0	4.06	32.1	104	59.4	462	128	1.63	4.5
5902	Harrington	2	40.6	99.5	83	80.2	1.5	1	12.8	4.85	39.0	175	91.0	163	206	1.51	4.0
5903	Hays	2	42.9	99.7	83	78.1	1.5	1	11.7	3.90	33.9	108	42.5	465	124	1.66	4.2
5904	Hockett	2	45.5	99.8	96	80.2	1.3	1	12.5	4.43	37.1	187	88.8	227	163	1.52	4.0
5905	Metcalfe	2	40.8	99.9	94	81.2	1.7	1	12.1	4.78	40.8	158	100.6	32	204	1.46	2.8
5906	MT090182	2	42.8	99.8	88	79.5	1.4	1	11.2	4.03	39.3	163	66.9	168	140	1.56	6.6
5907	MT090190	2	43.7	99.7	82	79.3	1.7	1	11.9	4.53	41.3	167	78.9	151	190	1.54	5.4
5908	MT100120	2	45.3	99.9	79	80.1	1.6	1	11.6	4.25	39.0	153	74.4	213	163	1.62	4.7
5909	MT100126	2	43.4	99.8	82	79.2	1.5	1	12.3	4.27	35.7	177	71.6	353	159	1.62	4.9
5910	MT124555	2	43.3	99.9	69	79.8	n.d.	3	12.6	4.24	36.5	90	70.9	219	156	1.56	43.0

2016 Western Regional Spring Barley Nursery - Bozeman, Montana

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)	Relative Viscosity	Turbidity (Hach)
5911	Steptoe	2	45.9	99.8	91	75.9	n.d.	3	12.8	3.78	31.3	63	41.9	731	132	2.78	32.0
5912	UTSB10902-91	2	42.6	99.9	86	77.1	1.6	1	12.4	3.85	32.9	104	43.5	506	134	1.83	5.7
5913	UTSB10905-72	2	46.0	99.8	86	77.1	n.d.	3	13.0	3.76	30.4	89	42.6	616	133	1.98	16.4
5892	LACEY MALT CHECK	6	33.3	90.0	43	79.5	3.1	2	13.3	5.57	44.9	159	74.4	56	268	1.45	16.1
5894	CONRAD MALT CHECK	2	40.4	97.6	54	81.5	2.4	1	12.3	5.19	45.9	138	86.4	125	245	1.50	6.2
Minima			40.2	99.4	69	74.5	1.2		11.2	3.66	27.4	62	28.3	31	88	1.45	2.7
Maxima			47.2	99.9	96	82.1	2.0		15.0	5.36	42.6	197	105.9	828	241	8.86	43.0
Means			43.2	99.8	85	79.6	1.6		12.7	4.41	36.5	136	68.5	285	167	1.83	7.9
Standard Deviations			1.8	0.1	7	1.8	0.2		0.8	0.46	4.0	38	20.6	226	41	1.28	9.4
Coefficients of Variation			4.3	0.1	8	2.3	14.5		6.4	10.52	11.0	28	30.1	79	24	70.13	119.1

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. Jamie Sherman, Montana State University

Neg Std Dev		37.7	99.4	64	74.2	0.9		10.3	3.02	24.5	22	6.6	-392	45	-2.02	-20.2
Pos Std Dev		48.8	100.2	106	85.0	2.3		15.1	5.80	48.6	249	130.3	963	289	5.69	36.0

2016 Western Regional Spring Barley Nursery -- 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)	Relative Viscosity	Turbidity (Hach)
5861	Harrington	2	32.8	82.6	90	78.0	2.0	1	15.7	4.90	31.2	248	85.0	129	206	1.45	4.8
5863	AC Metcalfe	2	31.2	70.4	98	78.7	2.3	1	15.3	5.22	36.4	236	104.1	28	234	1.42	4.6
5864	2B10-4162	2	31.8	61.4	95	79.1	2.0	1	15.0	4.94	33.8	222	88.6	56	221	1.46	5.0
5865	2B10-4378	2	32.1	70.7	87	79.0	2.1	2	14.6	5.36	37.7	231	91.9	138	218	1.48	5.7
5866	2B11-4949	2	32.7	77.4	97	79.7	1.9	1	15.0	5.44	36.4	228	84.4	47	236	1.44	3.4
5867	2B11-5166	2	32.3	80.9	97	79.6	1.8	1	15.3	5.28	35.3	247	85.6	139	226	1.49	4.0
5868	2B12-5582	2	34.0	80.3	94	79.3	2.0	1	15.5	5.20	35.7	232	75.1	143	222	1.50	4.5
5869	08ARS112-75	2	32.7	73.6	91	78.1	1.8	1	14.4	5.06	36.4	227	101.8	93	207	1.46	3.5
5870	08ARS116-91	2	30.9	75.7	95	80.1	2.0	1	14.0	5.30	38.9	219	72.2	41	241	1.45	4.0
5871	08ARS028-20	2	32.3	69.0	95	76.6	1.9	1	16.7	5.42	32.7	284	86.8	78	215	1.43	4.4
5872	MT090182	2	34.8	91.2	91	78.6	1.6	1	12.7	4.31	34.9	203	62.1	181	147	1.50	5.4
5873	MT090190	2	36.6	88.4	88	78.1	1.6	1	13.9	4.78	35.0	241	68.1	107	176	1.47	4.0
5874	MT100120	2	34.4	86.7	91	78.2	1.6	1	13.5	4.39	33.5	217	63.0	119	149	1.49	5.4
5875	MT100126	2	34.9	91.2	81	78.3	1.9	1	13.7	4.92	36.5	240	69.5	157	195	1.49	6.4
5876	MT124555	2	35.2	92.0	74	78.5	n.d.	3	14.3	4.75	34.2	112	65.6	168	160	1.51	*53.0
5877	2ND28065	2	35.3	84.9	96	79.3	1.7	2	13.7	4.77	36.6	184	56.6	156	180	1.51	4.6
5878	2ND30837	2	35.6	86.1	71	78.5	2.5	2	15.0	5.36	35.8	248	75.2	70	216	1.48	6.0
5860	LACEY MALT CHECK	6	33.1	88.9	46	79.9	3.2	1	13.3	5.39	42.2	166	77.6	27	260	1.44	14.7
5862	CONRAD MALT CHECK	2	40.0	97.6	54	82.5	2.4	1	14.8	4.92	42.3	147	80.6	146	224	1.49	5.0
Minima			30.9	61.4	71	76.6	1.6		12.7	4.31	31.2	112	56.6	28	147	1.42	3.4
Maxima			36.6	92.0	98	80.1	2.5		16.7	5.44	38.9	284	104.1	181	241	1.51	6.4
Means			33.5	80.1	90	78.7	1.9		14.6	5.02	35.4	225	78.6	109	203	1.47	4.7
Standard Deviations			1.7	9.0	8	0.8	0.2		1.0	0.35	1.9	36	13.9	48	30	0.03	0.9
Coefficients of Variation			5.1	11.2	9	1.1	12.4		6.7	6.88	5.3	16	17.7	44	15	1.87	18.4

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			28.4	53.2	66	76.2	1.2		11.7	3.99	29.7	117	36.9	-36	112	1.39	2.1
Pos Std Dev			38.6	107.1	114	81.2	2.6		17.5	6.06	41.0	333	120.2	253	293	1.56	7.3

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	Distillers'
AMBA Member Interest*	10%	61%	25%	4%
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

** Based on 2017 dues weighted survey of Regular members*

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.

April, 2017