

UNITED STATES DEPARTMENT OF AGRICULTURE  
AGRICULTURAL RESEARCH SERVICE  
MIDWEST AREA

**MISSISSIPPI VALLEY UNIFORM BARLEY NURSERY - 2002 Crop**  
Preliminary Quality Report

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This is a joint progress report of cooperative investigations being conducted in the Agricultural Research Service of the U.S. Department of Agriculture and State Agricultural Experiment Stations. It contains preliminary data that have not been sufficiently confirmed to justify general release; interpretations may be modified with additional experimentation. Confirmed results will be published through established channels. The report is primarily a tool available to cooperators and their official staffs and to those persons who have a direct and special interest in the development of improved barleys.

This report includes data furnished by the Agricultural Research Service as well as 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.

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

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## Mississippi Valley Uniform Barley Nursery - 2002

Nursery samples were received for malting quality evaluation from three experimental stations located in Minnesota, Montana and North Dakota. The parentages of the nursery entries are listed in Table 1. Fourteen of twenty-nine entries (#16 - #29) were new in this year's nursery.

These samples were germinated for 5 days and rotated for 3 minutes every half hour, which should have yielded malts having modification levels that are similar to those produced by industry. The malting conditions and analytical methods employed are listed in Appendix A. The criteria and value assignments used to calculate quality scores have been revised this year and are listed in Appendix B. The most notable changes are a wider range for acceptable diastatic power and  $\alpha$ -amylase levels, a new range of 42 to 47% for S/T ratios and a lowering of the  $\beta$ -glucan upper limit from 300 to 200 ppm.

The mean values of 14 quality factors over the three stations (Table 2) and over all varieties (Table 3) are listed. Individual station data are reported in Tables 4 through 6. Evaluations of data from the individual locations and overall performance evaluations, derived primarily from Tables 2 and 3 are presented below.

Nearly half of the barleys from Morris, MN (Table 4) were too thin and all had unacceptably high protein contents. Half of the extract values fell below the desired limits, but most of the fine – coarse differences were good. The soluble protein and free amino nitrogen levels were high, some extremely high, which contributed to the elevated wort color values. Over half of the  $\beta$ -glucan levels were too high, whereas the amylolytic values were generally quite good. The best performer was Lacey, but even this entry's high total and soluble protein levels would have eliminated it from commercial use.

The barleys from Sidney, MT (Table 5) were plump and had very good protein contents. The extract values were good, except for that of Barbless. These malts appear to have modified well as indicated by their low  $\beta$ -glucan levels and small fine – coarse differences. A third of the soluble protein and two thirds of the S/T values were unacceptably high. The amylolytic values were quite good, except for that of 2ND18365, which had an unacceptably low diastatic power value and a high  $\alpha$ -amylase level. The best performers were Drummond, Lacey, M112, 6B95-2482, M109, ND16922 and BT389. Other lines also performed well, generating an average malt quality score of 53 from this location.

Most of the plump barleys from Bottineau, ND (Table 6) had elevated protein contents, although only six were unacceptably high. The extract, fine – coarse difference and  $\beta$ -glucan values were generally good. Over a third of the free amino nitrogen and wort protein levels were too high, whereas most wort colors and turbidities were good. Most amylolytic values were good, although the diastatic power value for 2ND18365 was too low, while those of MNBrite and ND17687 were too high. The best performers were M109, M111, 6B98-7339, BT478, ND17111 and M113.

Overall, the submissions from Sidney and Bottineau performed much better than those grown at Morris (Table 2). The barleys from Morris were much thinner and had higher protein contents than those from the other locations. These elevated protein levels negatively affected the malt quality by contributing toward very high wort protein and free amino nitrogen values, high turbidity and low extract values. The barleys from Sidney averaged 12.7% protein, which would be considered ‘ideal’, while the 13.5% average protein level in barleys from Bottineau was high, although still within the acceptable range. At Sidney, the average extract value of 80.2% was significantly higher than those from Bottineau and Morris. The higher extract values and good protein contents of the Sidney entries were most responsible for the excellent average quality score. Submissions from Bottineau had slightly higher total and soluble protein levels than entries from Sidney, which resulted in the slightly lower, but still respectable average quality score.

In general, the entries in this nursery were plump and had good extract and fine – coarse difference values when grown in favorable environments. Some of the average barley protein levels were unacceptably high, however this was mostly due to the extremely high levels found in the submissions from Morris. The soluble protein levels were also elevated, with over half being unacceptably high, again affected by the very high levels found in those entries grown at Morris. The average amylolytic values were generally within the recently expanded desired range (Appendix B), the only exception being the average diastatic power value of 2ND18365, which was too low. The  $\beta$ -glucan levels indicated that most of these lines modified well with our malting protocol, and only four lines had an average value higher than that of the Mid-West standard, Robust. Many of these lines performed well, with half of the nursery scoring higher than Robust. The best overall performers were M109, Lacey, 6B95-2482, M113, Drummond and ND17643. M109 was new in this year’s nursery. It performed much better at Bottineau and Sidney than at Morris. This line had a perfect score at Bottineau and also would have at Sidney, except for an elevated S/T ratio due mostly to its low total protein content. Lacey has performed quite well in this nursery since its introduction in 1998. This year’s submission performed well, especially at Sidney, with a perfect score and had the best score at Morris where high protein levels negatively impacted the malting quality. The Lacey from Bottineau had an unacceptably high protein level, which also contributed to a low S/T ratio and a lower quality score. This is the fourth year that 6B95-2482 has been in this nursery. This line has performed well, but seldom has been a top performer. That is the case again this year, where this line performed better than most at Morris, extremely well at Sidney, but ranked in the middle of the experiment at Bottineau. Most quality parameters were good in general, however the diastatic power levels were quite high and this could be a concern. This is the first year for M113 and its performance was very similar to that of Robust. M113 may have modified a bit better than Robust, with slightly lower  $\beta$ -glucan and F-C difference values, and slightly higher soluble protein and free amino nitrogen levels than those of Robust, though none of these measures were significantly different. Drummond has been part of the nursery since the 1997 crop year. It has performed reasonably well throughout the years and did very well at Sidney this year with a top score of 65, good at Bottineau with a score of 49 and poorly at Morris where high protein levels negatively affected nearly all of the submissions. ND17643 is new in this year’s nursery where it performed quite well scoring a bit better than Robust.

**Table 1 Entries in the Mississippi Valley Uniform Barley Nursery - 2002 Crop**

Entry No.	New Entry	Cl# or Contributor	Name	Rowed	Parentage
1		5105	Barbless	6	Oderbrucker/Lion
2		10648	Larker	6	Titan/Kindred/3/Newal/Peatland//Montcalm
3		15773	Morex	6	Cree/Bonanza
4		476976	Robust	6	Morex/Manker
5		Minnesota	Stander (M64)	6	Robust 2*/3/Cree/Bonanza//Manker/4/Robust/Bumper
6		Busch Ag. Res.	Legacy (6B93-2978)	6	Bumper/Karl//Bumper/Manker/3/Bumper/Karl/4/Excel
7		PI 603050	MNBrite (MNS85)	6	M90-89/M69
8		North Dakota	Drummond (ND15477)	6	ND9712//Stander/ND12200
9		Minnesota	Lacey (M98)	6	M78/M79
10		North Dakota	ND16301	6	Foster//ND12200/6B88-3213
11		Busch Ag.	6B95-2482	6	6B89-2126/ND10981
12		Busch Ag.	6B95-2089	6	6B84-2912/B1601//6B88-3213
13		Minnesota	M109	6	Lacey/M95
14		Minnesota	M110	6	M93-117/M95
15		North Dakota	ND16922	6	ND14161/ND14296
16	X	Minnesota	M111	6	M93-9/M92-392
17	X	Minnesota	M112	6	M93-121/M81
18	X	Minnesota	M113	6	M93-109/Lacey
19	X	North Dakota	ND17643	6	ND15245/ND15377
20	X	North Dakota	ND17655	6	ND15245/ND15377
21	X	North Dakota	ND17687	6	ND15246/ND15377
22	X	North Dakota	ND17711	6	ND15246/ND15377
23	X	North Dakota	2ND18365	2	2B91-4947/ND15403
24	X	Busch Ag.	6B98-9105	6	6B93-3192/M82
25	X	Busch Ag.	6B98-9170	6	6B92-7098//6B92-7098/M75
26	X	Busch Ag.	6B98-9339	6	B1614//B1614/M75

## MISSISSIPPI VALLEY UNIFORM BARLEY NURSERY - 2002 Crop

Table 2 - Station Means\* of Barley and Malt Quality Factors for 29 Varieties or Selections\*\*.

Location	Barley		Barley Color (Agtron)	Malt Extract (%)	F-C (%)	Wort		Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°)	Alpha- amylase (20° DU)	Beta- glucan (ppm)	FAN (ppm)	Ave. Quality Score
	Kernel Weight (mg)	on 6/64" (%)				Color (°)	Turbidity (NTU)								
Morris, MN	30.2 C	73.7 B	43.1 B	77.6 C	1.0 B	2.9 C	10.1 B	15.2 C	6.90 B	46.5 AB	156 A	71.1 B	212 B	331 B	27
Sidney, MT	33.7 B	86.6 A	51.9 A	80.2 A	0.7 A	2.0 B	8.7 B	12.7 A	5.83 A	48.1 B	158 A	69.6 B	119 A	266 A	53
Bottineau, ND	35.8 A	89.0 A	52.2 A	78.9 B	1.1 B	1.8 A	6.0 A	13.5 B	5.88 A	45.0 A	171 B	62.6 A	144 A	258 A	49

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

\*\* Barbless, Larker, Morex, Robust, Stander, Legacy, MNBrite, Drummond, Lacey, ND16301, 6B95-2482, 6B95-2089, M109, M110, ND16922, M111, M112, M113, ND17643, ND17655, ND17687, ND17711, 2ND18365, 6B98-0105, 6B98-9170, 6B-9339, BT389, BT478, BT483

**MISSISSIPPI VALLEY UNIFORM BARLEY NURSERY - 2002 Crop**

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

Variety	Rowed	Barley Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C (%)	Wort Color	Turbidity (NTU)	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°)	Alpha- amylase (20° DU)	Beta- glucan (ppm)	FAN (ppm)	Ave. Quality Score
Barbless	6	32.8 B	73.0 AB	46.0	76.2 C	1.2 ABCD	2.2 18.1 C	14.7	5.38 A	37.9 J	155 BCD	51.8 J	225 AB	216 E	29.0	
Larker	6	32.0 B	78.3 AB	48.0	78.7 ABC	1.1 ABCD	2.2 8.6 AB	13.8	5.97 ABCD	45.1 FGHI	157 BCD	65.2 DEFGH	149 ABC	279 ABCDE	43.0	
Morex	6	30.2 B	64.8 B	49.3	78.2 BC	1.0 ABCD	2.0 5.7 A	14.4	6.05 ABCD	43.6 GHI	165 ABCD	68.8 BCDEFGH	152 ABC	242 CDE	40.3	
Robust	6	33.0 B	81.9 AB	47.0	78.7 ABC	1.5 D	1.8 6.7 A	13.7	5.88 ABCD	44.1 GHI	162 ABCD	53.0 IJ	216 AB	261 ABCDE	45.0	
Stander (M64)	6	33.8 AB	87.1 A	48.0	79.9 AB	0.7 ABCD	2.7 6.1 A	13.6	6.81 BCD	51.3 ABC	148 D	77.5 ABC	183 ABC	359 AB	44.3	
Legacy (6B93-2978)	6	32.1 B	82.7 AB	47.0	78.9 ABC	0.9 ABCD	2.4 6.5 A	14.2	6.71 ABCD	48.5 BCDEFG	155 BCD	76.0 ABCD	224 AB	332 ABCD	33.7	
MNBrite (MNS85)	6	32.3 B	79.1 AB	52.7	78.2 BC	0.9 ABCD	2.9 6.6 A	15.5	7.20 D	48.4 BCDEFGH	192 A	66.7 CDEFGH	80 C	333 ABCD	31.0	
Drummond (ND15477)	6	32.6 B	80.8 AB	54.3	78.9 ABC	1.1 ABCD	1.9 6.5 A	13.8	5.85 ABCD	43.4 HI	181 ABC	68.0 BCDFGH	134 ABC	258 ABCDE	48.0	
Lacey (M98)	6	33.9 AB	85.9 AB	47.7	79.0 ABC	1.1 ABCD	1.9 8.3 AB	13.9	5.89 ABCD	43.5 HI	163 ABCD	64.3 EFGH	118 ABC	259 ABCDE	48.7	
ND16301	6	33.5 B	87.5 AB	54.3	78.9 ABC	1.1 ABCD	2.0 8.3 AB	13.3	5.74 ABC	45.5 EFGHI	171 ABCD	66.0 DEFGH	135 ABC	254 ABCDE	46.0	
6B95-2482	6	33.6 B	85.6 A	48.7	78.7 ABC	1.1 ABCD	1.9 8.6 AB	13.9	5.73 ABC	42.8 I	184 AB	63.9 EFGH	156 ABC	233 DE	48.3	
6B95-2089	6	33.3 B	83.2 AB	44.3	79.0 ABC	1.3 ABCD	2.0 9.4 AB	14.0	5.90 ABCD	43.8 GHI	173 ABCD	62.9 FGHI	162 ABC	224 DE	44.0	
M109	6	34.0 AB	81.9 AB	49.3	79.8 AB	0.9 ABCD	2.0 8.0 AB	12.9	5.81 ABC	47.7 BCDEFGHI	165 ABCD	63.6 EFGH	142 ABC	264 ABCDE	51.0	
M110	6	33.3 B	83.7 AB	44.3	79.4 AB	1.4 CD	2.1 13.0 BC	13.1	5.71 ABC	46.0 DEFGHI	164 ABCD	58.2 HIJ	211 AB	257 ABCDE	47.3	
ND16922	6	32.1 B	88.0 A	48.3	78.4 BC	1.4 CD	2.1 8.5 AB	13.7	5.95 ABCD	44.7 FGHI	160 BCD	70.0 BCDEFG	226 AB	248 BCDE	46.0	
M111	6	32.8 B	82.8 AB	51.3	79.0 AB	1.3 BCD	2.0 8.1 AB	13.2	5.90 ABCD	45.8 EFGHI	162 ABCD	62.3 FGHI	108 ABC	245 CDE	47.7	
M112	6	33.9 AB	85.8 A	48.0	78.7 ABC	1.1 ABCD	2.1 11.1 AB	13.3	5.61 AB	43.3 I	161 BCD	59.2 GHIJ	192 ABC	237 CDE	48.0	
M113	6	33.6 B	84.4 A	47.3	79.2 AB	1.3 CD	2.1 6.7 AB	13.5	6.18 ABCD	47.6 BCDEFGHI	163 ABCD	67.4 CDEFGH	158 ABC	271 ABCDE	48.3	
ND17643	6	33.4 B	87.8 A	52.7	78.8 ABC	0.7 ABCD	2.1 7.0 AB	13.7	6.04 ABCD	45.0 FGHI	173 ABCD	67.3 CDEFGH	104 ABC	292 ABCDE	48.0	
ND17655	6	35.3 AB	90.0 A	50.3	79.1 AB	0.6 ABC	2.5 8.0 AB	13.6	6.58 ABCD	50.1 ABCDE	167 ABCD	73.1 BCDEF	102 ABC	320 ABCDE	43.3	
ND17687	6	32.1 B	84.2 A	51.3	77.9 BC	0.4 A	2.2 7.9 AB	14.4	6.46 ABCD	46.4 DEFGHI	179 ABCD	68.1 BCDEFGH	99 BC	279 ABCDE	40.0	
ND17711	6	31.4 B	85.8 A	50.0	78.7 ABC	0.4 AB	2.2 7.6 AB	13.5	6.08 ABCD	47.0 CDEFGHI	161 BCD	66.1 DEFGH	120 ABC	286 ABCDE	46.3	
2ND18365	2	39.4 A	86.4 A	50.0	81.3 A	0.8 ABCD	2.8 5.7 A	13.1	6.80 BCD	53.9 A	95 E	83.9 A	190 ABC	336 ABCD	32.3	
6B98-9105	6	34.3 AB	86.0 A	48.3	79.3 AB	0.8 ABCD	2.4 6.7 A	13.7	6.73 ABCD	50.8 ABCD	152 CD	74.7 ABCDE	157 ABC	327 ABCDE	38.7	
6B98-9170	6	33.8 AB	86.8 A	49.7	78.9 ABC	0.7 ABCD	2.3 6.1 A	14.1	6.65 ABCD	49.4 ABCDEF	156 BCD	74.4 ABCDE	230 A	332 ABCD	38.7	
6B98-9339	6	32.7 B	82.8 AB	48.0	79.1 AB	0.9 ABCD	2.4 7.7 AB	13.7	6.47 ABCD	48.4 BCDEFGH	152 CD	71.3 BCDEF	112 ABC	348 ABC	46.3	
BT389	6	34.1 AB	83.2 AB	49.3	78.2 BC	0.6 ABC	2.6 9.5 AB	14.3	6.58 ABCD	46.6 CDEFGHI	170 ABCD	71.7 BCDEF	192 ABC	332 ABCD	46.0	
BT478	6	32.7 B	79.6 AB	51.0	79.4 AB	0.8 ABCD	2.3 8.5 AB	13.4	6.19 ABCD	47.2 BCDEFGHI	154 BCD	71.2 BCDEF	148 ABC	278 ABCDE	45.7	
BT483	6	31.9 B	81.0 AB	45.7	79.6 AB	0.7 ABCD	2.9 10.2 AB	14.2	7.07 CD	51.9 AB	154 BCD	78.9 AB	169.0 ABC	362 A	34.3	

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

\*\* Morris, MN, Sydney, MT and Bottineau, ND

## 2002 MISSISSIPPI VALLEY BARLEY NURSERY - MORRIS, MN

Table 4

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C (%)	Wort Color	Turbidity (Hach)	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	Free Amino Nitrogen	Quality Score	Overall Rank
4458	BARBLESS	6	30.0	57.9	41	*74.2	2.0	2.4	11.2	1	16.1	5.79	36.6	127	56.5	352	272	18	25
4459	LARKER	6	29.5	65.3	40	75.7	1.1	2.5	15.8	2	15.7	5.98	38.5	158	58.1	219	278	20	24
4460	MOREX	6	*25.3	41.0	45	76.6	1.1	2.6	7.7	2	15.7	6.86	43.9	171	74.7	155	287	23	23
4461	ROBUST	6	30.9	74.0	43	78.1	2.0	2.2	7.6	2	14.9	6.53	44.6	155	56.7	225	341	31	6
4462	STANDER (M64)	6	32.6	85.6	42	78.5	0.8	3.6	9	1	14.6	7.25	51.0	133	78.7	328	437	30	8
4463	LEGACY (6B93-2978)	6	29.4	74.6	45	78.0	0.7	3.0	8.6	1	15.2	7.29	48.8	146	78.6	225	419	25	20
4464	MNBRITE (MNS85)	6	29.1	67.3	47	77.7	0.6	*4.9	10	1	17.5	8.87	51.9	187	70.7	79	530	18	25
4465	DRUMMOND (ND15477)	6	29.4	68.2	49	78.2	1.0	2.4	8.9	1	15.1	6.59	46.0	177	72.3	176	326	30	8
4466	LACEY (M98)	6	31.4	80.1	44	78.3	1.4	2.2	8.2	1	14.7	6.58	46.1	147	66.7	140	335	40	1
4467	ND16301	6	30.4	78.0	48	77.6	1.2	2.4	7.6	1	14.6	6.41	45.8	170	70.6	230	324	28	12
4468	6B95-2482	6	31.4	80.9	42	78.1	1.3	2.5	9.3	2	15.2	6.43	44.1	172	65.8	280	267	33	3
4469	6B95-2089	6	29.9	70.2	39	77.9	1.4	2.6	11.3	2	14.8	6.52	45.1	158	65.3	276	252	26	18
4471	M109	6	30.8	69.8	42	78.2	1.5	2.3	8.7	2	14.7	6.43	46.7	169	64.0	240	295	28	12
4472	M110	6	31.2	75.9	40	78.6	1.4	2.7	16.3	2	14.2	6.26	46.6	165	61.8	263	345	34	2
4473	ND16922	6	29.7	83.4	42	77.4	1.3	2.6	8.5	2	14.9	6.60	45.6	162	73.9	245	330	27	15
4474	M111	6	30.0	72.0	43	77.9	1.6	2.4	11.9	2	14.6	6.37	44.7	147	62.0	151	268	29	10
4475	M112	6	30.0	70.6	43	77.5	1.9	2.6	13.2	2	14.4	6.18	44.8	147	61.9	270	234	24	22
4476	M113	6	30.9	77.6	41	77.8	1.5	2.6	7.7	2	14.7	6.66	46.4	154	68.3	217	229	31	6
4477	ND17643	6	29.2	75.5	48	77.3	0.3	2.6	10.2	1	14.6	6.43	44.4	152	71.6	105	219	33	3
4478	ND17655	6	31.8	82.8	45	77.5	0.1	3.4	12.1	1	15.2	7.49	50.4	160	75.7	162	328	28	12
4479	ND17687	6	28.7	76.3	45	76.8	0.5	2.8	10.7	1	15.6	7.14	46.1	174	71.8	102	389	33	3
4480	ND17711	6	28.6	78.4	43	77.4	0.2	2.5	9.6	1	14.8	6.45	45.8	154	68.0	173	333	29	10
4481	2ND18365	2	33.6	76.4	45	80.0	0.6	3.6	8.3	1	14.2	7.43	55.1	101	85.8	225	306	17	28
4482	6B98-9105	6	30.6	72.9	42	77.5	0.6	3.0	9	1	15.0	7.12	49.1	127	82.5	193	362	17	28
4483	6B98-9170	6	31.5	82.0	42	78.2	0.6	2.9	7.2	1	15.6	7.56	50.1	147	81.5	282	361	26	18
4484	6B98-9339	6	29.0	70.6	40	78.3	1.0	3.1	9.1	1	15.3	7.18	48.4	140	79.8	161	378	25	20
4485	BT389	6	31.3	81.6	39	76.2	0.8	3.5	11.4	1	17.6	8.05	46.0	200	75.3	288	394	27	15
4486	BT478	6	31.7	81.2	43	77.6	0.5	3.2	11.2	1	16.1	7.30	46.2	165	81.5	203	404	27	15
4487	BT483	6	28.3	68.0	41	77.4	0.8	4.2	13.5	1	16.3	8.31	51.1	160	83.1	184	350	18	25
4470	HARRINGTON MALT CHECK	2	39.5	94.7	73	82.1	0.9	1.9	5.1	2	11.4	6.05	53.3	108	66.9	59	438	37	
Minima			28.3	41.0	39	75.7	0.1	2.2	7.2		14.2	5.79	36.6	101	56.5	79	219	17	
Maxima			33.6	85.6	49	80.0	2.0	4.2	16.3		17.6	8.87	55.1	200	85.8	352	530	40	
Means			30.4	73.7	43	77.7	1.0	2.8	10.1		15.2	6.90	46.5	156	71.1	212	331	27	
Standard Deviations			1.3	8.9	3	0.8	0.5	0.5	2.4		0.8	0.70	3.7	19	8.4	66	69	6	
Coefficients of Variation			4.2	12.1	6	1.0	50.9	17.8	23.4		5.6	10.20	7.9	12	11.7	31	21	21	

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 K. Smith, University of Minnesota - St. Paul

## 2002 MISSISSIPPI VALLEY BARLEY NURSERY - SIDNEY, MT

Table 5

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agron)	Malt Extract (%)	F-C (%)	Wort Color	Turbidity (Hach)	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	Free Amino Nitrogen	Quality Score	Overall Rank
4488	BARBLESS	6	32.7	78.2	49	*77.6	0.4	2.5	*28.0	2	13.7	5.19	39.9	169	49.9	184	199	34	29
4489	LARKER	6	34.1	87.3	51	80.9	1.2	2.3	6.5	1	12.5	6.06	49.6	151	71.1	97	295	53	16
4490	MOREX	6	31.7	71.9	50	79.4	0.6	1.8	5.0	1	13.3	5.75	45.4	157	73.9	122	254	55	14
4491	ROBUST	6	33.3	84.2	47	79.9	1.1	1.8	7.1	1	13.1	5.81	46.3	166	55.6	179	242	57	9
4492	STANDER (M64)	6	33.3	88.0	52	81.2	1.0	2.3	5.2	1	12.6	6.46	51.3	144	81.9	86	328	50	22
4493	LEGACY (6B93-2978)	6	31.1	79.6	44	80.0	0.9	2.3	7.0	1	13.8	6.35	47.4	148	77.9	222	300	38	27
4494	MNBRITE (MNS85)	6	33.7	88.1	53	79.6	1.1	2.1	6.3	1	13.9	6.41	49.0	179	66.1	63	291	44	26
4495	DRUMMOND (ND15477)	6	34.0	90.2	58	80.1	1.0	1.7	6.5	1	12.8	5.66	44.6	168	69.9	99	240	65	1
4496	LACEY (M98)	6	34.7	90.0	51	80.6	0.8	2.0	11.1	1	12.6	5.67	45.9	152	67.7	87	245	65	1
4497	ND16301	6	34.1	89.6	57	80.5	0.7	2.0	11.2	1	12.1	5.48	48.8	154	70.6	67	239	56	11
4498	6B95-2482	6	33.5	86.2	52	79.4	0.9	1.8	11.5	1	13.1	5.31	42.5	190	65.9	118	218	62	4
4499	6B95-2089	6	33.5	84.6	45	80.1	1.2	1.9	10.2	1	13.3	5.74	45.6	165	65.8	74	226	57	9
4501	M109	6	34.7	88.0	52	81.1	0.0	2.1	8.5	1	11.5	5.56	51.0	156	69.7	92	252	60	5
4502	M110	6	33.2	81.4	45	80.0	0.7	2.1	15.3	1	11.9	5.14	46.6	145	56.5	227	229	54	15
4503	ND16922	6	31.7	86.7	48	79.3	0.7	1.9	9.0	1	12.9	5.49	43.9	157	71.7	180	212	60	5
4504	M111	6	34.3	88.8	53	80.4	0.8	1.9	6.5	1	12.4	5.76	47.4	171	66.1	64	241	52	18
4505	M112	6	35.5	92.6	50	80.0	0.5	1.9	10.3	1	12.5	5.21	42.9	165	60.7	90	295	65	1
4506	M113	6	34.2	87.8	48	80.5	1.0	1.9	7.1	1	12.4	5.87	49.5	161	70.5	125	247	56	11
4507	ND17643	6	34.5	94.2	57	80.2	0.7	1.9	5.9	1	13.0	5.92	46.3	190	68.3	99	311	58	8
4508	ND17655	6	35.8	93.0	54	80.4	0.3	2.1	7.0	1	12.3	6.06	52.4	175	76.2	63	304	49	23
4509	ND17687	6	32.8	90.8	56	79.6	0.1	1.9	7.4	1	12.8	5.88	49.2	159	68.4	91	295	56	11
4510	ND17711	6	32.1	87.9	56	80.0	0.1	2.1	6.8	1	12.2	5.83	49.4	154	69.1	79	257	52	18
4511	2ND18365	2	*40.9	92.2	53	81.9	0.5	2.4	5.6	1	12.2	6.27	52.8	*86.4	87.1	195	274	38	27
4512	6B98-9105	6	35.3	92.0	56	81.5	0.8	2.1	6.2	1	13.0	6.66	53.6	173	74.8	168	258	49	23
4513	6B98-9170	6	33.2	86.0	54	80.3	0.7	1.9	5.3	1	12.7	5.98	49.6	157	73.4	164	384	52	18
4514	6B98-9339	6	33.4	88.9	50	79.7	0.7	2.3	8.8	1	12.8	6.34	50.9	156	70.8	85	271	53	16
4515	BT389	6	33.2	81.3	59	79.9	0.4	2.1	10.2	1	12.1	5.59	47.7	163	73.9	119	328	60	5
4516	BT478	6	31.9	80.1	54	80.5	1.2	2.0	8.1	1	11.4	5.51	49.4	137	65.5	109	255	51	21
4517	BT483	6	31.9	81.9	50	81.5	1.0	2.3	9.5	1	12.1	6.19	55.7	137	79.1	112	238	49	23
4500	HARRINGTON MALT CHECK	2	39.4	94.6	77	81.8	1.1	1.9	5.4	1	11.5	5.83	53.0	106	72.6	76	339	46	
Minima			31.1	71.9	44	79.3	0.0	1.7	5.0		11.4	5.14	39.9	137	49.9	63	199	34	
Maxima			35.8	94.2	59	81.9	1.2	2.5	15.3		13.9	6.66	55.7	190	87.1	227	384	65	
Means			33.5	86.6	52	80.3	0.7	2.0	8.0		12.7	5.83	48.1	161	69.6	119	266	53	
Standard Deviations			1.2	5.1	4	0.7	0.3	0.2	2.4		0.6	0.40	3.5	13	7.7	49	41	8	
Coefficients of Variation			3.6	5.9	8	0.8	45.8	9.7	30.0		4.9	6.88	7.4	8	11.1	41	15	15	

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 D. B. Cooper, BARI - Ft. Collins, CO

## 2002 MISSISSIPPI VALLEY BARLEY NURSERY - BOTTINEAU, ND

Table 6

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C (%)	Wort Color	Turbidity (Hach)	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	Free Amino Nitrogen	Quality Score	Overall Rank
4556	BARBLESS	6	35.7	83.0	48	76.7	1.1	1.8	*15.2	2	14.4	5.15	37.2	169	48.9	138	176	35	27
4557	LARKER	6	32.5	82.2	53	79.5	0.9	1.7	3.6	1	13.1	5.87	47.1	163	66.5	132	263	56	7
4558	MOREX	6	33.5	81.5	53	78.6	1.2	1.6	4.3	1	14.2	5.55	41.6	167	57.7	178	224	43	21
4559	ROBUST	6	34.9	87.5	51	78.2	1.5	1.4	5.3	1	13.2	5.30	41.5	165	46.8	243	200	47	20
4560	STANDER (M64)	6	35.6	87.8	50	80.0	0.4	2.1	4.2	1	13.5	6.71	51.5	168	71.8	136	325	53	11
4561	LEGACY (6B93-2978)	6	35.9	93.9	52	78.7	1.1	1.9	4	1	13.6	6.49	49.2	171	71.4	224	276	38	24
4562	MNBRITE (MNS85)	6	34.1	81.9	58	77.3	1.0	1.7	3.4	1	15.0	6.31	44.2	209	63.3	97	258	31	28
4563	DRUMMOND (ND15477)	6	34.3	84.0	56	78.4	1.3	1.5	4.2	1	13.6	5.29	39.7	199	61.9	128	208	49	18
4564	LACEY (M98)	6	35.7	87.5	48	78.1	1.0	1.5	5.6	1	14.4	5.43	38.4	189	58.5	126	196	41	23
4566	ND16301	6	36.0	94.8	58	78.6	1.5	1.5	6	1	13.1	5.34	42.0	189	56.9	108	252	54	9
4567	6B95-2482	6	35.9	89.8	52	78.7	1.2	1.5	5.1	1	13.3	5.44	41.8	190	59.9	71	198	50	16
4568	6B95-2089	6	36.4	94.9	49	78.9	1.2	1.5	6.6	1	13.8	5.44	40.6	195	57.5	135	214	49	18
4569	M109	6	36.5	87.8	54	80.1	1.1	1.5	6.8	1	12.4	5.44	45.3	170	57.1	94	194	65	1
4570	M110	6	35.4	93.7	48	79.5	2.2	1.6	7.5	1	13.1	5.72	44.8	182	56.4	142	221	54	9
4571	ND16922	6	34.9	93.9	55	78.4	2.1	1.7	8	1	13.3	5.77	44.5	161	64.4	254	231	51	14
4572	M111	6	34.2	87.5	58	78.8	1.5	1.6	6	1	12.7	5.57	45.2	167	58.9	109	235	62	2
4573	M112	6	36.1	94.3	51	78.6	0.9	1.7	9.8	1	12.9	5.44	42.3	170	55.0	217	209	55	8
4574	M113	6	35.7	87.9	53	79.3	1.5	1.9	5.4	1	13.5	6.00	46.8	174	63.4	132	249	58	5
4575	ND17643	6	36.5	93.7	53	78.8	1.0	1.9	5	1	13.5	5.77	44.3	176	61.9	107	298	53	11
4576	ND17655	6	38.3	94.3	52	79.5	1.5	2.0	4.9	1	13.2	6.19	47.6	167	67.3	82	288	53	11
4577	ND17687	6	34.7	85.6	53	77.4	0.6	2.0	5.6	1	14.7	6.35	43.8	205	64.1	105	326	31	28
4578	ND17711	6	33.5	91.0	51	78.7	1.0	2.0	6.4	1	13.4	5.96	45.7	174	61.2	109	259	58	5
4579	2ND18365	2	*43.8	90.7	52	*82.1	1.4	2.4	3.1	1	13.0	6.70	53.9	*99	78.8	149	264	42	22
4580	6B98-9105	6	37.1	93.2	47	78.8	1.0	2.2	4.8	1	13.0	6.40	49.7	155	66.7	110	366	50	16
4581	6B98-9170	6	36.8	92.4	53	78.2	0.7	2.1	5.8	1	13.9	6.41	48.5	163	68.3	245	250	38	24
4582	6B98-9339	6	35.7	88.8	54	79.3	1.0	1.9	5.3	1	13.1	5.89	45.8	159	63.2	90	361	61	3
4583	BT389	6	37.7	86.8	50	78.5	0.7	2.1	6.8	1	13.3	6.10	46.2	146	65.9	168	339	51	14
4584	BT478	6	34.6	77.5	56	80.2	0.7	1.8	6.2	1	12.6	5.75	45.9	160	66.7	133	352	59	4
4585	BT483	6	35.6	93.2	46	79.8	0.3	2.3	7.7	1	14.3	6.71	48.9	164	74.4	212	261	36	26
4565	HARRINGTON MALT CHECK	2	39.8	94.4	78	82.2	1.3	1.6	3	1	11.8	5.79	53.0	108	66.9	51	324	46	
Minima			32.5	77.5	46	76.7	0.3	1.4	3.1		12.4	5.15	37.2	146	46.8	71	176	31	
Maxima			38.3	94.9	58	80.2	2.2	2.4	9.8		15.0	6.71	53.9	209	78.8	254	366	65	
Means			35.5	89.0	52	78.8	1.1	1.8	5.6		13.5	5.88	45.0	174	62.6	144	258	49	
Standard Deviations			1.3	4.8	3	0.8	0.4	0.3	1.5		0.6	0.48	3.8	15	7.0	52	54	9	
Coefficients of Variation			3.6	5.4	6	1.1	38.4	14.8	26.9		4.7	8.08	8.5	9	11.2	36	21	19	

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 D. B. Cooper, BARI - Ft. Collins, CO

## Appendix A:

## METHODS

**Cleaning** All samples were cleaned on a Carter Dockage Tester and any material not retained on a 5/64" screen was discarded.

**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  $\mu\text{m}$  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 Agron M45-D analyzer.

**Barley Moisture Content** Five g of ground sample was dried for 3 h at 106°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) barley samples were steeped at 16°C for 32-48 h, to 45% moisture, by alternating 4 h of wet steep with 4 h of air rest. The steeped samples were placed in a chamber for 5 d at 17°C and near 100% R.H., in cans that were rotated for 3.0 min every 30 min. The germinated grain (green malt) was kilned for 24 h as follows: 0.5 h from 25°C to 49°C, 9.5 h at 49°C, 0.5 h from 49°C to 54°C, 4.0 h at 54°C, 0.5 h from 54°C to 60°C, 3.0 h at 60°C, 0.5 h from 60°C to 68°C, 2.0 h at 68°C, 0.5h from 68°C to 85°C, and 3.0 h at 85°C.

**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  $\mu\text{m}$  sieve after 3 min of shaking, with tapping. Coarse-grind malts were prepared with a corrugated roll mill that was adjusted so that 75% of the grist remained on a 525  $\mu\text{m}$  sieve. Ground malts for moisture, protein and amyolytic activity analyses were ground in a Labconco Burr mill (see Barley Mill).

**Malt Moisture Content** 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. **F-C** represents the difference in extract % between the finely ground malts and the coarsely ground malts.

**Wort Color** was determined on a Skalar SAN plus analyzer by subtracting the absorbance at 700 nm from that at 430nm and dividing by a factor that was determined by comparison with values obtained in a collaborative test.

**Wort Clarity** was assessed by visual inspection.

**$\beta$ -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-6A (Methods of Analysis of the ASBC, 8th ed, 1992).

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

**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**

**2002 Crop Year**

**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=hazy 2=slightly hazy 1=clear	= 3	0	= 3	0
	= 2	1	= 2	1
	= 1	2	= 1	2
Barley Protein (% db)	≥ 13.5	0	≥ 14.0	0
	13.0–13.5	5	13.5–13.9	5
	11.5–13.0	10	11.5–13.5	10
	≤ 11.5	5	≤ 11.5	5
Wort Protein (% db)	> 6.0	0	> 6.0	0
	5.6–6.0	3	5.7–6.0	3
	4.9–5.6	7	5.2–5.7	7
	4.5–4.9	3	4.8–5.2	3
	< 4.5	0	< 4.8	0
S/T (Soluble/Total Protein, % db)	> 47	0	> 47	0
	42–47	5	42–47	5
	< 42	0	< 42	0
DP (Diastatic Power, ° ASBC)	> 180	0	> 200	0
	160–180	4	180–200	4
	120–160	7	140–180	7
	100–120	4	120–140	4
	< 100	0	< 120	0
Alpha-amylase (20° DU)	> 90	0	> 90	0
	80–90	4	80–90	4
	45–80	7	45–80	7
	35–45	4	35–40	4
	< 35	0	< 35	0
Beta-glucan (ppm)	< 40	0	< 40	0
	40–60	3	40–80	3
	60–115	7	80–140	7
	115–200	3	140–200	3
	> 200	0	> 200	0