

“Supporting malting barley production growth in Northern Michigan through performance trials and analysis”

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Executive Summary

The primary goal of this research was to examine a set of malting barley varieties for yield and quality performance in various climatic regions of Michigan. This aligns well with AMBA's mission to support an adequate supply of high quality malting barley because this data informs producers throughout the Great Lakes region on appropriate varietal selection for successful malting barley cultivation. Expanding the knowledge base on variety performance in Michigan enhances crop competitiveness where barley has the potential to financially out-perform other commodities, such as corn, which struggles in the northern regions due to cooler temperatures throughout the growing season.

This research provides the opportunity to fine-tune recommended growing practices for high quality malting barley. Many Michigan farmers only have experience with feed barley, and are unaware of specific management practices that impact grain quality, including crop rotation, fertility requirements, and preventative fungicide application. Also noteworthy, is appropriate varietal selection. Increased understanding of the tested varieties aids in selection of suitable barley cultivars for inclusion within Michigan's certified seed program. Historically, only feed type varieties have been available, which forced producers to source seed from outside the state. This costly step also limited the selection of varieties available. Variety trials, such as this project supports, has allowed researchers to pinpoint varieties with adaptability to the region.

For example, in 2014 Pinnacle was identified as a variety that performed well in terms of yield and resistance to pre-harvest sprout – a phenomena that challenges barley production in Michigan. Previous research has shown malting barley varieties bred for the high plains and intermountain west environments are often not suitable for production in Michigan due to low dormancy levels. Michigan's weather is highly impacted by the Great Lakes that heavily influence humidity and precipitation. This challenge prioritizes pre-harvest sprout resistance as a determining factor in variety suitability. Through our recommendation, certified seed growers were able to increase Pinnacle seed availability for both 2015 and 2016. Likewise, we are currently working with Limagrain Cereal Seeds to do a similar increase of a very promising variety, Odyssey. Positive results have been realized by varieties from the United Kingdom that express higher levels of dormancy than traditional varieties grown currently in North America.

Two diverse regions were selected as locations for the trial; Alger County, located in the Upper Peninsula (U.P.) and Grand Traverse County, located in Northwest Michigan. These areas have a long history of small grain production, and many craft malthouses are due to start production in the area with the intent to source locally grown barley.

Detailed Report on Objectives, Methodology and Results

Objectives:

- 1) Determine select barley lines by consulting with barley breeders at public land grant universities, seed suppliers, Michigan brewers and large scale end users;
- 2) Plant a variety trial within Alger County in the Upper Peninsula of Michigan and Grand Traverse County within northwest Michigan;
- 3) Harvest trial, collect yield data and conduct post-harvest analysis for grain and malt characteristics; and
- 4) Deliver results through Extension programs and applicable publications.

Michigan State University had the unique opportunity to participate in the Eastern Spring Barley Nursery (ESBN) organized by the Craft Maltsters Guild and managed by North Dakota State University. This collaborative effort across eight states allowed simultaneous testing of a group of twenty varieties. In addition, through a relationship we have developed with Limagrain Cereal Seeds, an additional five varieties were added. Finally, two additional experimental lines came from the University of Minnesota breeding program. Twenty-seven barley varieties were laid out in a rectangular lattice experimental design with three replications. Three filler varieties were planted in order to fill out the design. Plot size was 3 feet wide by 20 feet long. Plot edges were cut out before harvest, with the purpose of eliminating edge effect, making total harvest length 18 feet. Plot seed was cleaned in an A.T. Ferrell Eclipse fanning mill and the seed was processed through a Dickey-John GAC 2500 for test weight and grain moisture percentage. Yield was corrected for 13.5% moisture. Test weight was recorded in pounds per bushel. Seed was submitted for grain quality and malt analysis to the testing laboratory at North Dakota State University and USDA ARS Cereal Crops Research laboratory, respectively. Agronomic details for the plot is outlined in Table 1.

Table 1. Plot information for Chatham, MI and Buckley, MI

Agronomic information	Chatham	Buckley
Soil type	Eben Very Cobbly Sandy Loam	Coventry-Newaygo Loams
Previous crop	Buckwheat	Soybeans
Planting date	5-5-15	4-28-15
Fertility applied (lbs/acre)	130 lbs of 46-0-0	108 lbs of 46-0-0
Herbicide applied (oz/acre)	13.5 oz of Huskie	13.5 oz of Huskie
Fungicide applied (oz/acre)	8.2 oz Prosaro applied at anthesis	8.2 oz Prosaro applied at anthesis
Harvest date	8-22-15	8-21-15

Quality and malt analysis results are outlined in Tables 2-5. The Chatham site experienced below average yields, but many varieties had favorable grain and malt quality parameters. The plot mean yield was 52 bushels/acre, although the 7-year average in Chatham is 62 bushels/acre. Despite lower than average yields, the Chatham site experienced no presence of DON in any of the varieties. Twelve of the 27 varieties met the AMBA ideal malt protein criteria for all malt two row, which is under 12.0%. All but four varieties were under 13.0%. Incidence of pre-harvest sprout was much better than years past with 12 varieties with an RVA of over 120, and only 2 below 60. The majority of the varieties had suitable malt quality profiles, with the exception of overall high FAN scores.

The Buckley site was significantly challenged by weather. An excessive rainfall event occurred 12 days before harvest followed by a pattern of heavy dews and consistent rains. This delayed harvest presented the opportunity for considerable sprout damage, as evidenced by the very low RVA numbers. As shown by previous research, varieties native to the United Kingdom fared much better in terms of resistance to pre-harvest sprout than their North American counterparts. Yield at Buckley was significantly higher than Chatham, with a respective plot mean of 75 bushels/acre. DON levels were not a concern and grain protein was consistently below 12.0%. In terms of malt quality, excessive sprout damage likely affected malting profiles. FAN levels were also high.

Results of these trials will be disseminated through the Great Lakes Hop and Barley Conference, other formal and in-formal presentations, our listserv, and posted to our website. Field days were also held at each location in late July 2015.

Table 2. Agronomic and grain quality information for Chatham, MI

Variety	Type	% Moisture	Test wt	Ht (in)	Bu/ac	DON	Protein	RVA	% Plump
AAC Synergy	2	15.1	49.6	26.6	59.8	0.0	11.5	70.2	96.9
AC Metcalfe	2	15.0	50.4	25.6	52.3	0.0	12.6	99.4	91.7
Bentley	2	15.1	48.5	28.0	46.4	0.0	11.7	113.4	93.3
CDC Copeland	2	15.0	48.6	29.6	51.3	0.0	11.4	147.0	95.4
CDC Meredith	2	15.0	48.5	25.6	56.0	0.0	11.6	100.2	90.3
Cerveza	2	15.2	49.2	22.6	60.5	0.0	11.6	66.8	93.2
Conlon	2	15.0	50.7	25.3	37.8	0.0	12.5	153.8	97.2
Full Pint	2	15.3	50.5	17.3	36.2	0.0	13.1	25.0	93.0
Harrington	2	15.3	49.0	26.6	36.0	0.0	13.4	191.3	72.0
Innovation	6	15.1	50.5	26.3	60.9	0.0	13.2	98.6	97.1
Klages	2	15.2	50.6	26.6	57.5	0.0	11.8	125.7	88.0
Lacey	6	15.2	49.9	27.6	63.0	0.0	12.4	112.8	97.5
LCS Genie	2	15.2	49.7	20.6	48.9	0.0	11.2	159.7	95.3
LCS Odyssey	2	15.0	48.2	20.3	50.5	0.0	11.6	173.7	95.6
LCS Overture	2	15.0	47.1	21.3	47.4	0.0	12.0	162.7	91.2
LCS Pilot	2	15.0	49.1	20.3	49.8	0.0	12.5	203.8	94.1
LCS Westminster	2	15.0	49.3	22.6	49.1	0.0	12.2	196.1	95.3
M152	6	14.9	49.9	29.0	57.1	0.0	13.0	73.2	96.5
M159	6	15.2	50.0	30.6	55.9	0.0	12.1	24.0	94.8
ND 22421	6	14.9	48.5	24.0	50.7	0.0	11.9	63.7	97.1
ND Genesis	2	15.0	48.9	26.0	50.2	0.0	10.7	65.5	96.9
Newdale	2	15.1	49.1	22.6	50.1	0.0	12.2	122.9	88.8
Pinnacle	2	15.1	48.7	27.6	57.1	0.0	10.7	142.6	96.6
Quest	6	14.9	49.3	30.6	58.7	0.0	12.7	147.6	92.6
Robust	6	15.2	49.9	30.3	58.9	0.0	12.1	137.3	94.5
Scarlett	2	15.2	50.2	20.3	50.7	0.0	11.5	163.9	89.4
Tradition	6	14.7	49.6	26.6	52.7	0.0	12.3	132.4	97.7
LSD @ 0.05		0.2	1.5	2.9	10.1				
CV %		0.81	1.9	7.2	11.8				
Grand Mean		15.1	49.0	25.2	52.1				

Table 3. Agronomic and grain quality information for Buckley, MI

Variety	Type	% Moisture	Test wt	Ht (in)	Bu/ac	DON	Protein	RVA	% Plump
AAC Synergy	2	14.9	47.8	29.3	73.0	0.1	9.8	3.2	97.8
AC Metcalfe	2	15.0	50.7	31.6	65.9	0.0	10.0	4.0	89.3
Bentley	2	15.0	49.2	32.6	66.8	0.0	9.6	5.8	98.7
CDC Copeland	2	14.6	48.8	33.3	64.7	0.0	10.3	8.5	98.6
CDC Meredith	2	15.0	47.7	31.3	63.0	0.0	9.2	8.2	96.9
Cerveza	2	14.9	48.5	29.3	75.1	0.0	10.1	2.8	96.7
Conlon	2	14.9	51.0	28.3	61.4	0.0	11.6	36.6	99.3
Full Pint	2	15.1	51.0	19.6	67.3	0.0	10.4	2.6	98.1
Harrington	2	15.1	52.1	31.0	68.4	0.1	10.6	78.5	94.9
Innovation	6	14.9	50.5	33.6	82.8	0.0	11.5	36.5	98.1
Klages	2	14.9	51.0	29.3	82.2	0.0	9.9	7.3	94.7
Lacey	6	15.0	51.2	31.0	85.0	0.0	10.7	75.4	97.9
LCS Genie	2	15.0	50.6	25.3	84.5	0.2	10.7	70.8	97.9
LCS Odyssey	2	14.9	50.0	24.0	80.0	0.0	9.9	110.9	99.1
LCS Overture	2	14.9	49.5	23.3	91.3	0.1	10.0	103.4	98.8
LCS Pilot	2	14.8	50.9	27.0	78.9	0.3	10.1	166.6	98.3
LCS Westminster	2	14.8	50.2	29.3	79.7	0.1	10.5	127.9	98.1
M152	6	15.0	49.5	33.6	68.9	0.0	10.7	30.3	97.8
M159	6	14.9	48.5	33.6	65.1	0.0	11.1	6.7	97.5
ND 22421	6	14.8	48.0	28.3	82.7	0.0	11.4	26.6	96.7
ND Genesis	2	14.8	49.6	33.3	74.5	0.0	10.3	34.5	98.8
Newdale	2	14.9	48.8	28.0	72.4	0.1	9.6	4.4	96.2
Pinnacle	2	14.9	49.6	31.6	79.6	0.0	9.5	95.3	98.5
Quest	6	14.7	48.3	34.0	72.7	0.0	11.0	114.3	94.2
Robust	6	14.9	50.0	37.3	70.9	0.0	11.9	97.7	97.2
Scarlett	2	15.0	51.6	23.6	73.8	0.0	10.0	76.5	97.7
Tradition	6	14.6	50.5	33.3	85.6	0.0	10.5	83.3	98.6
LSD @ 0.05		0.41	1.01	2.7	12.3				
CV %		1.69	1.24	5.6	10.0				
Grand mean		14.9	49.8	29.8	74.7				

Table 4. Malt analysis for Chatham, MI

Variety	Type	Kernel Weight	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)
AAC Synergy	2	41.0	98.3	13	81.6	2.5	1	12.1	5.42	48.8	96	107.5	50	258
AC Metcalfe	2	37.0	95.2	16	81.2	2.6	1	12.9	5.46	45.5	104	99.4	127	273
Bentley	2	36.7	94.9	23	81.7	3.0	1	12.2	5.25	46.2	85	100.4	90	326
CDC Copeland	2	37.8	96.4	22	82.1	2.5	1	12.7	4.96	42.3	89	87.9	96	285
CDC Meredith	2	38.9	94.5	21	82.1	2.8	1	12.1	4.89	42.3	91	83.2	212	250
Cerveza	2	38.8	95.0	18	82.0	2.4	1	12.0	4.68	40.2	91	104.4	206	287
Conlon	2	41.9	97.9	15	79.4	2.2	2	12.8	4.09	33.8	101	69.3	690	223
Full Pint	2	36.8	94.7	10	79.2	2.9	1	14.0	5.05	38.5	131	109.5	124	312
Harrington	2	31.8	80.6	11	75.8	2.3	2	13.9	3.96	29.1	67	43.9	733	185
Innovation	6	35.4	97.8	19	79.2	2.5	1	13.3	4.99	38.9	129	73.5	154	260
Klages	2	35.9	90.2	18	80.8	2.6	1	13.2	4.72	37.9	89	78.6	616	270
Lacey	6	36.0	98.2	21	79.2	ND*	3	12.2	4.56	38.0	118	67.5	126	239
LCS Genie	2	37.5	96.3	13	81.6	2.8	2	11.2	3.78	34.7	90	53.7	53	198
LCS Odyssey	2	38.3	96.2	14	81.3	2.5	1	12.1	3.90	34.1	70	54.7	86	207
LCS Overture	2	32.8	93.8	16	80.9	2.2	1	12.0	4.00	34.5	91	68.8	92	205
LCS Pilot	2	38.7	96.3	17	80.6	2.4	1	12.8	4.14	34.0	94	63.6	62	226
LCS Westminster	2	38.2	97.0	15	81.3	2.4	1	12.2	4.08	34.9	98	85.1	59	210
M152	6	35.2	97.8	23	79.7	2.6	1	13.4	5.15	41.1	136	76.4	96	307
M159	6	34.5	96.9	20	80.7	2.7	1	12.2	5.79	48.8	146	95.5	64	289
ND 22421	6	36.0	97.8	25	79.5	ND	3	12.1	4.60	39.5	92	72.0	145	254
ND Genesis	2	39.4	98.1	12	80.8	2.8	1	10.9	4.58	44.8	81	82.6	111	242
Newdale	2	35.9	91.2	13	80.0	2.5	1	12.7	4.80	38.9	82	95.8	359	271
Pinnacle	2	43.2	97.4	12	80.7	ND	3	10.6	3.99	40.4	70	54.2	317	222
Quest	6	32.6	95.9	17	79.6	2.4	1	12.5	4.83	40.5	115	74.2	319	277
Robust	6	33.7	96.8	19	80.0	2.3	1	12.9	4.86	40.9	134	68.0	117	274
Scarlett	2	34.1	95.6	16	80.5	ND	3	12.7	3.95	32.7	88	66.2	246	208
Tradition	6	35.5	98.2	31	80.0	2.3	1	12.8	4.54	37.4	156	79.3	95	275
Lacey check	6	33.3	88.8	42	79.5	2.7	1	13.0	5.93	48.4	161	84.7	27	275
Harrington check	2	40.6	96.1	74	82.3	2.3	1	11.4	4.85	44.6	101	86.9	128	238

*ND- Wort Colors were not determined on hazy samples

Table 5. Malt analysis for Buckley, MI

Variety	Type	Kernel Weight	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)
AAC Synergy	2	42.1	98.6	21	83.7	ND*	3	10.4	5.79	57.1	91	80.8	25	278
AC Metcalfe	2	41.3	97.3	26	83.6	ND	3	10.4	5.51	53.7	113	75.4	31	261
Bentley	2	42.2	98.5	26	83.8	ND	3	10.5	5.31	51.1	97	61.3	33	249
CDC Copeland	2	40.9	98.7	21	83.6	3.6	2	10.6	5.46	53.1	102	57.9	31	253
CDC Meredith	2	42.9	97.9	23	83.3	ND	3	10.1	5.30	52.9	90	56.1	36	239
Cerveza	2	41.7	97.5	23	84.6	ND	3	10.5	5.53	54.8	87	69.8	42	254
Conlon	2	46.9	99.2	21	81.6	ND	3	12.2	4.80	41.8	131	59.9	381	202
Full Pint	2	43.9	98.3	20	83.4	ND	3	11.0	6.05	55.3	124	73.8	36	289
Harrington	2	39.6	96.8	12	81.2	2.2	1	11.3	4.08	37.3	82	42.2	195	167
Innovation	6	38.7	99.1	25	81.7	3.2	2	11.0	5.13	46.7	140	54.3	203	217
Klages	2	40.9	96.6	24	84.1	ND	3	10.3	5.60	55.9	94	59.4	71	255
Lacey	6	38.0	99.1	21	82.2	ND	3	10.6	4.91	48.8	130	57.0	88	211
LCS Genie	2	43.7	98.7	12	84.7	2.3	1	10.1	4.77	50.8	115	65.5	19	214
LCS Odyssey	2	47.3	99.4	15	85.1	2.4	1	9.3	4.60	51.0	84	69.3	26	220
LCS Overture	2	42.9	99.2	16	85.4	2.2	1	9.4	4.60	50.5	84	76.7	30	209
LCS Pilot	2	44.0	98.9	11	84.2	2.3	1	10.1	4.85	49.0	100	75.1	16	203
LCS Westminster	2	44.1	99.2	15	85.2	2.1	1	10.5	4.67	48.3	92	87.9	18	211
M152	6	36.6	98.2	26	82.3	ND	3	10.2	5.10	51.9	159	58.3	66	237
M159	6	35.6	97.7	25	82.7	ND	3	10.9	5.76	55.8	149	53.7	73	264
ND 22421	6	38.1	97.7	30	80.8	ND	3	10.8	5.09	47.9	111	60.4	224	222
ND Genesis	2	43.7	99.3	20	83.6	ND	3	10.8	5.10	49.9	101	69.5	170	222
Newdale	2	39.8	97.1	20	83.9	2.5	1	10.5	5.23	52.4	111	71.4	34	229
Pinnacle	2	46.9	99.0	20	83.1	ND	3	9.4	4.72	51.2	71	55.7	176	207
Quest	6	34.7	96.2	21	81.8	2.2	1	11.1	5.11	50.3	141	67.6	388	233
Robust	6	36.7	98.2	22	81.8	2.1	1	11.5	5.32	49.1	158	55.5	240	234
Scarlett	2	40.1	98.7	16	84.2	ND	3	10.7	4.47	44.8	94	61.0	97	187
Tradition	6	37.2	98.7	33	82.3	ND	3	11.1	4.64	44.9	164	62.6	196	201
Lacey check	6	33.3	88.8	42	79.5	2.7	1	13.0	5.93	48.4	161	84.7	27	275
Harrington check	2	40.6	96.1	74	82.3	2.3	1	11.4	4.85	44.6	101	86.9	128	238

*ND- Wort Colors were not determined on hazy samples

The greatest benefit of this trial is an increase in the knowledge of how certain varieties perform at each location that experienced much different weather patterns through the growing season. Research has once again shown us a trend of pre-harvest sprout resistance amongst certain cultivars that have been developed in the United Kingdom. Identifying these varieties is extremely beneficial as pre-harvest sprout has presented itself to be the greatest limiting factor in high quality Michigan malting barley production. To overcome this challenge, recommend management practices have developed, including harvesting grain at higher than optimal moisture levels and then drying under low heat or in an aeration bin.

Other Barley Research/Future Direction of Program

The MSU malting barley research program has been involved in cultural management trials examining fertility, fungicide application, seeding rate and most recently, harvest practices to mitigate pre-harvest sprout, as mentioned above. Variety trials, initiated in Michigan in 2013, will continue, as will our participation in the ESN. A third site in southern Michigan will be added in 2016. In 2015, MSU also collaborated with the John Innes Center (Norwich, UK) to test breeding material from their heritage barley research program. This partnership will continue into 2016 as will the pre-harvest sprout and seeding rate trial. New research will include a seed increase of up to 20 varieties from the John Innes Center and a spring barley nursery genotype X environment study in collaboration with the University of Minnesota. There is also a pending proposal that would support a winter malting barley nursery trial at two locations in Michigan.

Project Personnel

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Recent Publications

McFarland, A.A.; Kapp, C.; Isleib, J.; Freed, R.; and Graham, S. 2014. Malting Barley Production in Michigan. Extension Bulletin GMI-035. Michigan State University Extension.