

## Identifying and Developing Improved Spring Barley Varieties for Montana

### Opportunity Overview (Characters limited to 2000)\*

Spring Barley is an important crop in Montana. At first, barley was primarily grown as an animal feed, but more recently malt barley has dominated the state. Barley is an important part of crop rotation in Montana, rotating with sugar beets, wheat and more recently pulse crops. Growers need stable markets for barley, although in recent years barley markets have been anything but stable with increased contracts one year followed by cut contracts the next. The climate is also mirroring that lack of stability, from record production in 2016 to drought and crop failure in 2017, to delayed planting and harvest in 2018 and 2019 with fall rains causing pre-harvest sprout damage. Growers need crops that will perform in a changing environment. The MSU Spring Barley breeding program is working to address these concerns. An important goal of the MSU program is to develop barley that is suitable for new markets providing more opportunities for the growers of Montana. We are developing lines with unique malting attributes so that Montana growers can tap into the craft brewing market. Craft brewers are also interested in Montana made from **Grower to Glass**, which is feasible with the development of the Montana craft malt industry. Malt barley is an example of a value-added market for Montana, where Montanan's can benefit from all steps of the supply chain. Growers not only garner higher revenue by selling grain for malt, but some are also malting their own barley, adding value to their crop. We are breeding barley for other high value markets, including organic food barley with improved nutritional value and highly digestible forage barley for livestock feed. Breeding barley to perform in an ever-changing environment is another goal for the program. We are working to make barley more resilient to heat, drought, acid soils, untimely rains as well as several diseases and pests. The MSU Barley breeding program's primary goal is to provide varieties that will be of economic benefit to Montana Growers.

### Innovation (Characters limited to 5000)

As plant breeders, our major innovation is the new combination of genes in the lines we release to benefit Montanan stakeholders for the reasons detailed below:

#### **1) Reduce the impact of factors limiting barley production in Montana**

**Heat and drought:** Extended grain-fill lines are reported to be drought and heat resistant, storing more starch in drought conditions than regular grain-fill lines, reducing percent protein, a quality advantage for malting barley. These lines also seem to have different root development that can provide tolerance to drought.

**Acid tolerance:** Low soil pH is a limiting factor in central and eastern Montana. Barley has stunted growth under low pH conditions. We have acquired germplasm noted to be acid tolerant. We tested Montana lines for acid tolerance in 2020. Differences in root development could provide a new source of acid resistance.

**Pre-harvest Sprouting:** In 2014 and 2019 rains during harvest caused some barley to sprout, reducing quality. We are testing lines for dormancy at harvest, and speed of germination during malting. We have found these two important traits are at least somewhat under separate genetic control. If so, we can breed a line that is dormant at harvest, benefiting growers; but also germinates quickly once dormancy is broken, benefiting maltsters.

**Harvest Damage:** Although most of the barley grown in the state has a hull that tightly adheres to the kernel, varieties that are free-threshing can be grown for feed and food. In fact, free threshing barley is preferred as pig feed. However, free-threshing varieties are more sensitive to damage of the embryo during harvest, which can reduce germination when growing for seed. Genetics as well as cultural practices can help with embryo damage.

**Biotic stress:** Although biotic stress is relatively low in Montana, there are some potential threats we are anticipating in case they become a significant economic liability. New gene combinations are being created for resistance to Fusarium head blight (FHB or scab), the spot form of net blotch, bacterial leaf spot, stripe rust, root lesion nematodes and the wheat stem sawfly. We will continue these efforts in collaboration with other investigators and monitor for potential threats and solutions to include in the program.

## **2) Improve barley yield and quality to provide an economic advantage for Montana**

New gene combinations to improve yield is a constant goal because growers are paid by the amount they produce. However, quality must also be improved, and stabilized so that growers can make a sale. The MWBC was important in the establishment of the MSU Malt Quality Lab. One of the justifications for the lab is that it would provide more malt quality data points for the breeding program. These data points allow us to test malt quality in more environments allowing us to test for malt stability. They also allow us to test at an earlier generation through methodology we have established, allowing us to improve malt quality more efficiently. No other breeding program in the country is taking advantage of malt data points in this way. Providing our own malting and testing has enabled us to better understand the requirements of a high-quality malt variety. Other breeding goals include adaptation to dryland grain production, increased forage biomass, improved forage digestibility, and improved human food nutrition. The ultimate goal is to support and increase markets for barley in Montana.

## **3) Identify new genes for barley improvement**

Several graduate student projects involve identifying new genes to improve barley. The overarching goal of these projects is to better understand the genetic control over malt quality, forage quality, and drought tolerance. This understanding will be directly applied to improve barley for Montana.

## **4) Improve breeding efficiency**

One impact of the genetic dissection projects described above is the identification of molecular markers for important traits. Markers can improve breeding efficiency by tracking genes that

improve traits. We have used markers to track the low protein gene, a potential drought tolerant gene and a gene that reduces beer staling. Markers can be run earlier in the breeding cycle only requiring a single leaf from a plant grown in a greenhouse. We have created a breeder friendly marker platform for barley. With the establishment of our own quality facility, we now can make associations between quality traits and markers. We are currently developing breeder friendly markers for quality traits.

The MSU Barley program is innovating by adopting newer technology to help with the breeding process, including GPS guided planting, remote sensing for phenotyping, barcoded tracking throughout the breeding pipeline, marker assisted selection, and data management and analysis through a relational database. The intention of all the innovations is to increase accuracy and efficiency of improving barley for Montana.

Expected outcomes and impacts (Characters limited to 2000)\*

We will create improved varieties for malt, feed, food and forage adapted to Montana using new genes from other breeding programs and from the World Core Germplasm. We will develop new molecular markers to improve breeding efficiency and solve problems specific to Montana growers and end-users. Montana State University Barley Breeding Program's primary mission is to develop new lines that ensure an adequate supply of high quality malting, feed, forage and food barley, providing growers and the state with important income. Our primary objective is to enhance barley competitiveness by increasing yield and yield stability and reducing risk to growers by improving quality stability. Another objective of the program is to identify, develop and utilize new traits in released varieties that will provide an economic advantage to growers or end-users. Finally by providing lines with new end-uses we hope to provide new markets for Montana Growers.

**Outcomes for 2020:**

- 1) Continued the now fully functional plant breeding pipeline for spring barley.
- 2) Made new crosses focusing on yield, lodging, stress resistance (preharvest sprouting, heat and drought), quality (malt, feed, food and forage), resistance to pests (FHB, stripe rust).
- 3) Continued breeding for acid tolerance.
- 4) Publications on genetic dissection of roots, malt quality and forage quality are in preparation.
- 5) Continued genetic dissection of malt quality.
- 6) Utilized new marker platform created in collaboration with USDA-ARS and made new markers.
- 7) Tested quality of lines early to ensure high quality is maintained in breeding pipeline

Support from the Montana Wheat and Barely Committee will make possible our goal to establish a strong, multifaceted breeding program in Montana, providing economic value to growers and end-users through the release of improved varieties.

### Crosses for Spring Barley

Breeding Goals	2015	2016	2017	2018	2019	2020
High yield, high quality malt and feed	90	87	29	39	9	23
Heirloom malt			75	90	94	76
Food	19	21	23			16
Forage	12	12	11	14	5	56
FHB resistance	14	22	13	12	8	23
Lodging resistance	11	1				
Extended grain-fill	31	12	7			
Spot form of Net Blotch	3	12				14
Nematode Resistance	4	10	1			
Stripe Rust			2		4	12
Beer Stalling	6					
Acid tolerance			20	11	4	
Spring Total	190	177	181	166	124	197

Thanks to contributions of the MT Research Centers, data from INTRASTATE Trials indicates high yielding germplasm in the pipeline. The highest yielding line is a cross between Haxby and a staygreen line we hope to release as a feed variety but might also be useful for the food pearled market. Most of the highest yielding lines are staygreen.

**2020 Intrastate Malt Yield bu/ac**

	<b>BZ dry</b>	<b>BZ irr</b>	<b>NARC</b>	<b>SARC DRY</b>	<b>SARC IRR</b>	<b>CARC</b>	<b>EARC DRY</b>	<b>EARC IRR</b>	<b>AVG</b>
MT17M02507	133.8	161.8	78.9	103.2	103.7	50	76.1	154.1	107.7
ABIEagle	122.6	156.1	79.7	104.3	119.4	45.1	66.7	158.3	106.525
MT17M04801	130.6	163.9	80	101	107.9	48.7	66.1	146	105.525
MT17M02009	117.5	159.9	72.3	102.5	104	49.6	65.6	155.8	103.4
MT16M01902	123.6	151.1	72	108	90.6	56.1	72.3	151.2	103.1125
MT17M01906	133	155.4	87.2	94.3	84	46.6	67.6	154.2	102.7875
MT17M08808	117.1	120.4	84.3	99.8	101.8	49.1	71	161.8	100.6625
Merit57	111.3	140.9	72.7	103.1	114.7	52.8	65.8	143.8	100.6375
MT16M00406	130.1	161.5	76.8	100.1	79.1	49.6	69.3	136.5	100.375
MT16M00806	125.7	137.9	74.7	100.8	102.8	49.1	63.4	148.5	100.3625
MT16M01801	121.5	158.7	76.7	91.1	86.8	42.6	64.5	156.2	99.7625
MT17M01711	113.4	119.4	75	103.5	111	50.4	80.5	141.7	99.3625
MT16M01405	129.4	160.7	75.5	86.5	90.6	46.2	57.4	148.5	99.35
MT16M00209	119.2	160.7	70.8	88	102	57.8	65.4	128.7	99.075
MT16M06404	117.9	137.6	77.2	93.6	111.5	54.1	55.4	142.9	98.775
MT16M00709	115.4	150	83.4	99.9	82.5	55.2	71.4	129.3	98.3875
MT16M00407	126.6	157.6	72.9	96.9	86.5	49.7	59.6	136.4	98.275
AAC Connect	111.7	142	72.3	101.2	113.9	51	65.3	127.7	98.1375
MT17M01908	124.9	150.4	73.1	89.6	89.2	53.1	67	132.8	97.5125
MT17M05508	117.4	142.8	77	90.1	116.1	34.1	62	137.6	97.1375
MT17M00504	125.5	151.2	79	95.6	80.6	45.4	58.7	140.4	97.05
MT16M00305	115.6	136.4	65.9	99.1	110.5	46	66.2	133.6	96.6625
MT16M00707	119.4	143	72.5	95	95.7	45	64.3	136.7	96.45
MT16M00603	124.7	157.2	59.2	93.3	81.7	50.3	58.3	146.5	96.4
Hockett	117.8	130.4	76.7	95.9	94.4	50.8	71.3	130.2	95.9375
MT17M00302	122.7	143.8	65.3	90.9	77.7	52.9	72.3	139.1	95.5875
MT16M02107	116.2	130.5	69.3	99.3	91.8	43.3	65.3	149	95.5875
MT17M05502	112.4	138.1	72.2	99	95.2	47.4	59.8	137	95.1375
MT16M00504	123.9	152.5	66.4	90.2	81.1	53.5	62.1	130.4	95.0125
MT16M01901	126.7	158.3	64	80.6	76.5	58	65.4	129	94.8125
MT16M02101	125.6	106	73.4	105.1	94.9	44.8	69.3	137.7	94.6
MT16M05610	110.4	149.8	67.5	93.9	102.9	49.1	62.4	120.2	94.525
MT17M05416	119.3	136.3	63	88.9	93.2	54.3	61.3	136.5	94.1
MT16M00610	127.2	150.4	70.3	81.6	80.3	46.5	60.7	135.1	94.0125
MT17M07704	115.8	124.2	70.3	89.7	103.5	42.2	61.4	139.8	93.3625
MT16M02201	119.8	138	71.8	92.2	74.1	43.7	73.9	131.9	93.175
MT17M05808	110.3	125.2	74.5	98.3	91.4	47.5	69.8	123.2	92.525
Buzz	126.4	155.4	62.1	82.8	65.8	40.5	70.2	131.8	91.875
MT16M05403	89.6	143.2	78.3	96	69.6	55.8	67.3	133.4	91.65
MT17M08702	104.3	140.3	70.6	71.5	76.5	54.4	64.3	147.2	91.1375
GRAND									
MEAN	118.5524	143.6748	73.28707	94.18435	93.73673	49.24	65.29252	139.19864	97.14626
CV	10.20432	6.28213	6.27589	8.34262	5.90717	14.41	8.7435	6.39194	
LSD	23.46025	17.50355	8.91951	15.23771	10.69611	13.76	11.071	17.25464	

Quality data from the malt intrastate indicates high quality lines even under dryland conditions. Many of the experimental lines include the low protein genes and the recently identified stable plumps genes (we are submitting in 2021 the paper describing these genes). Highest extracts were found in Hockett by staygreen lines; other high quality lines are low protein by staygreen and low protein by Metcalfe.

Name	2020 Malt Intrastate Dryland Quality							
	Grain Protein	Extract (CG db)	S. Protein	FAN	B-Glucan	AA	DP	S/T
MT16M02201	11.3	84.2	6.01	238	106	82	169	53.2%
MT16M02101	11.1	82.0	5.39	208	140	82	163	48.4%
MT16M01801	10.9	81.2	5.49	211	112	69	192	50.4%
MT16M09602	11.4	81.1	5.56	198	127	69	138	48.9%
MT16M00707	11.7	81.0	5.67	210	132	74	170	48.6%
MT17M01908	10.7	80.9	5.28	196	143	63	161	49.6%
AAC Connect	12.6	80.8	6.37	235	64	85	193	50.5%
Hockett	12.3	80.5	5.69	193	82	70	192	46.2%
MT17M05808	12.1	80.5	5.71	241	52	96	214	47.3%
ABI Eagle	12.9	80.4	6.00	259	45	107	201	46.4%
Buzz	11.0	80.3	5.23	203	66	105	157	47.7%
MT17M05416	12.2	80.2	6.16	259	29	101	189	50.6%
Merit 57	12.4	80.2	6.05	252	25	109	201	48.6%
MT17M01711	11.3	80.1	4.87	178	111	70	172	43.0%
MT16M05610	12.2	80.0	5.72	245	72	101	244	46.8%
MT16M06404	12.8	80.0	5.81	245	78	80	179	45.4%
MT17M05508	11.7	79.9	5.43	225	57	94	187	46.5%
MT17M07704	13.0	79.9	5.50	220	152	88	225	42.2%
MT16M00305	11.9	79.8	5.73	263	64	86	125	48.2%
MT16M00603	11.9	79.8	5.34	210	82	51	176	45.0%
MT16M07806	12.0	79.7	5.56	209	142	70	124	46.3%
MT16M05403	11.8	79.6	5.36	207	134	73	227	45.6%
2IM14-8212	11.8	79.4	5.86	281	72	141	220	49.6%
MT16M00406	11.1	79.3	5.35	218	153	66	182	48.1%
MT16M01902	11.6	79.1	4.96	203	100	83	223	42.6%
MT17M00302	11.0	79.0	5.00	181	93	68	197	45.6%
MT17M05502	11.8	78.3	4.67	180	89	72	168	39.6%

2020 EYT indicates high yielding lines in the pipeline



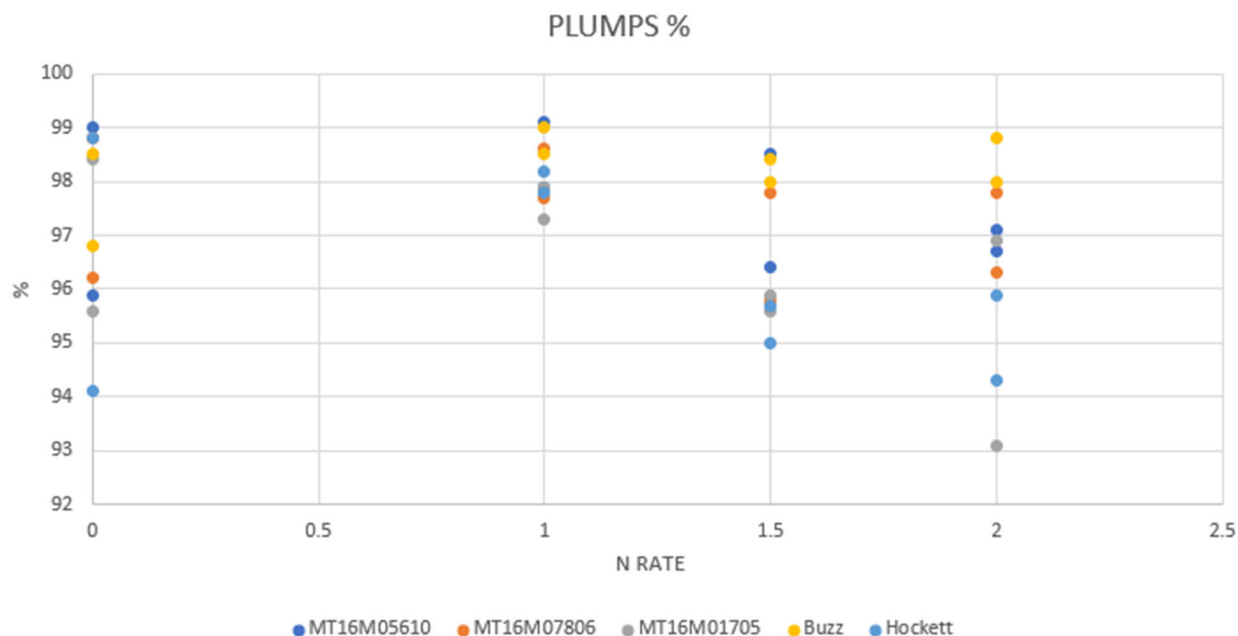
name	2020 EYT YIELD						AVG
	CARC - bu/a -	EARC - bu/a -	NARC - bu/a -	BZN - bu/a -	SARC DRY - bu/a -	SARC IRR - bu/a -	
MT18M09904	77	92	80.4	127.7	<b>113.1**</b>	116.6	98.74
MT18M11105	67.9	95.9	73.6	127.2	<b>105.1*</b>	123.2	97.56
MT18M11004	70.6	94.9	85.5	115.7	<b>110.3*</b>	120.6	97.46
MT18M11002	71.1	96.6	81.7	110.6	<b>111.1*</b>	126.9	97.38
MT18M05603	68.2	94.9	76.4	130.6	<b>109.2*</b>	115.6	97.14
MT18M10401	72.4	89.6	76	121.6	<b>103.9*</b>	118.0	95.52
MT18M08802	74.5	84.7	74.1	132.9	100.3	105.0	95.25
MT18M09205	79.7	90.2	75.1	128.9	94.6	102.6	95.18
MT18M09902	70.5	96.1	70.8	119.8	101.0	112.3	95.08
MT18M11006	71.6	86.5	77	124.7	<b>111.6*</b>	114.9	94.94
Merit 57	70.9	81.7	73.3	123.3	102.2	117.1	94.75
MT18M09005	71.4	90.3	80.9	133.6	102.9	89.2	94.72
MT18M05402	70.8	93.2	71.1	124.4	99.9	108.9	94.72
MT18M10704	79.4	89.2	75.3	106.6	101.4	116.3	94.70
MT18M10107	73.5	87.9	71.1	122.4	<b>105.0*</b>	118.1	94.60
MT18M09203	80.5	91.2	78	116.3	96.8	100.8	93.93
MT18M08901	68	93.6	74.4	127.7	97.5	102.2	93.90
MT18M09901	74.9	92.4	77.7	119.7	<b>107.8*</b>	104.7	93.88
MT18M10705	78.4	87.6	67.9	121.1	97.5	107.8	93.38
Hockett	78.1	97.7	70	121.1	97.9	95.3	93.35
MT18M11101	70.4	91.1	76.1	119.3	98.9	104.3	93.35
MT17M06004	74.4	87.2	73.6	119.7	93.8	110.5	93.20
MT18M09802	74	92.4	71.2	115.2	<b>110.7*</b>	107.6	92.08
MT18M11103	67.6	93.3	73.4	115.2	<b>105.5*</b>	110.2	91.94
MT18M05305	73.7	88.5	73.3	119	93.1	103.0	91.77
MT18M10106	68.9	97.6	70.6	130.1	<b>104.0*</b>	91.3	91.70
MT17M06102	70.2	85.7	73	124.1	91.4	102.1	91.08
Odyssey	71	83.5	80.9	126.8	<b>112.1*</b>	<b>143.9**</b>	90.55
MT18M09301	68.7	83.9	75.3	122.5	101.3	<b>141.6*</b>	90.34
MT18M08803	85.5	88.7	73.3	117.2	83.9	93.2	90.30
MT18M09202	71.7	88.7	66.7	119.3	93.4	100.6	90.07
MT18M09403	70.1	83.6	70.5	121	93.5	96.1	89.13
MT18M11106	71.4	88	68.6	128.3	83.1	92.2	88.60
MT18M10105	65.2	95	82.9	128.1	<b>107.7*</b>	70.8	88.40

Malt Early Yield Trial in 2020 indicates high quality lines under dryland conditions with high extract, low beta glucans and varying other qualities useful for adjunct and/or all-malt brewers. Low protein by stay green crosses are high performing.

Name	2020 Early Yield Trial Malt Quality							
	MALT_PROT	Extract_	S_Protein	FAN	B_GLUCAN	A_AMYLASE	DP	ST_PROTEIN
Buzz	11.16	80.3	5.27	225	73	123	148	47.2%
Hockett	11.79	79.3	4.27	169	242	92	180	36.2%
Merit 57	12.60	79.5	5.87	255	30	122	173	46.6%
MT18M06008	10.20	84.4	5.69	302	89	93	151	55.8%
MT18M05402	10.30	83.1	5.35	208	126	93	161	51.9%
MT18M11103	10.10	83.1	5.74	278	100	91	135	56.8%
MT18M11105	10.50	83.0	5.11	266	72	85	135	48.7%
MT17M06305	9.90	82.9	5.74	248	98	94	128	58.0%
MT18M11006	10.40	82.8	5.57	250	53	80	104	53.5%
MT18M10401	9.80	82.7	5.74	268	113	80	140	58.6%
MT18M06011	11.44	82.6	5.60	269	119	93	186	48.9%
MT18M06009	10.40	82.6	5.11	251	78	80	155	49.2%
MT18M09301	10.00	82.6	4.97	236	45	66	144	49.7%
MT18M11204	9.40	82.3	4.91	226	91	74	133	52.3%
MT18M09203	10.80	82.3	5.41	278	32	98	138	50.1%
MT18M09202	11.00	82.0	5.77	171	56	82	119	52.5%
MT17M06102	11.70	81.9	5.94	286	97	83	162	50.7%
MT18M10105	10.10	81.8	5.67	272	104	94	145	56.2%
MT18M09401	10.80	81.5	5.08	244	116	76	118	47.0%
MT18M09205	10.10	81.4	5.30	260	82	83	125	52.4%
MT18M09103	9.90	81.4	4.99	216	103	60	131	50.4%
MT18M11106	10.50	81.3	5.21	248	67	71	152	49.7%
MT18M10207	11.00	81.2	5.19	230	68	71	135	47.2%
MT18M06012	10.87	81.2	5.98	269	109	88	135	55.0%
MT18M10705	10.70	81.0	5.63	272	92	85	151	52.6%
MT18M09804	9.70	80.9	5.26	215	124	83	155	54.3%
MT18M09203	12.45	80.7	5.46	266	27	120	171	43.9%
MT18M10704	11.10	80.7	5.60	269	110	94	150	50.5%
MT17M06102	12.71	80.7	6.01	251	51	109	175	47.3%
MT18M09502	10.95	80.6	5.20	233	71	87	148	47.4%
MT18M06009	11.46	80.6	5.31	202	79	72	181	46.3%
MT17M06305	11.90	80.2	5.44	229	75	107	156	45.7%
MT18M09104	10.75	80.1	4.20	152	112	64	122	39.1%
MT18M11103	12.04	80.1	5.41	257	72	102	180	44.9%

A fertility study with four different N levels at Post farm and SARC in collaboration with Kent Mc Vay confirm Buzz has stable agronomic and malt quality across treatments. Including stable plumps -





Lower grain protein –

name	Pedigree	PROTEIN %							
		BZN Dry				SARC Irr			
		0	1	1.5	2	0	1	1.5	2
MT16M05610	MT100126/METCALFE	10.4	11.1	12	12.2	8.6	10.3	11.6	11.9
MT16M07806	MT124688/HARRINGTON	10	10.9	12	12.3	9	10.7	11.7	11.8
MT16M01705	MT070157/ND24388	10	11.4	12.2	12.1	9.3	11.1	12.3	12.5
Buzz		9.3	9.9	10.7	11	9	10.4	11.1	11.4
Hockett		9.9	11.6	12	12.3	9	11	12.4	12.8
GRAND MEAN		9.9	10.97	11.74	11.985	8.96	10.695	11.81	12.065
CV		2.90861	2.22046	1.92361	2.62309	2.36755	3.22434	2.42346	2.09136
LSD		0.54589	0.46178	0.42812	0.59598	0.40215	0.65374	0.54258	0.47834

And similar yield without lodging

name	Pedigree	YIELD bu/ac							
		BZN Dry				SARC Irr			
		0	1	1.5	2	0	1	1.5	2
MT16M05610	MT100126/METCALFE	83.4	<b>135.9</b>	<b>120.3</b>	<b>124.9</b>	87.3	124	125.5	130.2
MT16M07806	MT124688/HARRINGTON	89.1	118.2	106.4	115.8	93	122	122.7	124.3
MT16M01705	MT070157/ND24388	74.2	108	95.1	103.6	80.2	119	112.9	117.2
Buzz		85.1	132.7	125.8	135.3	74.7	94.7	108.4	105.6
Hockett		<b>99.5</b>	<b>135.9</b>	<b>120.1</b>	<b>126.1</b>	85.4	104	117.2	120.1
GRAND MEAN		86.3	126.1	113.5	121.1	84.1	113	117.3	119.5
CV		4.2	5.775	8.622	5.9	6.54	5.03	7.724	7.012
LSD		6.9	13.81	18.56	13.5	10.4	10.7	17.18	15.88

**Significant Lodging**

## **Why Hull-less barley?**

### **Emerging market for Montana growers**

- White barley as rice additive
- Organic food market
- Fiber additive for wheat products
- Sprouted grains?

### **Improved nutritional value**

- **Soluble fiber**
- **Anthocyanins**

**Agronomic performance of Hull-less lines:** MT18 lines were first tested in intrastate in 2020. Note that they compete well with Havenar a WA release.

name	COLOR	BZN DRY	BZN IRR	CARC	EARC DR	EARC IRR	NARC	
		yield	yield	yield	yield	yield	yield	
MT18H02702	White	102.3	143.3	58.6	54.6	129.9	81.5	95.03333
MT18H02801	White	106.9	145.8	56.4	57.6	124.5	69.4	93.43333
09WA-265.12	White	106.4	143.9	58.4	51.7	119.5	77.2	92.85
Havener	White	106.6	143.3	48.4	47.8	128.8	79.7	92.43333
OR29-2-B	White	96.5	137.2	54.3	43.4	129.9	71.6	88.81667
MT18H02901	White	107.3	126.9	55.7	49.4	118.1	65.1	87.08333
MT16H09308	White	98.9	137.7	48	41.2	130	60.7	86.08333
MT16H09302	White	92.9	138.1	50	44.7	124.6	49.4	83.28333
MT18H01302	Blue	96.9	132.1	47.6	42.2	120.9	54.7	82.4
MT18H01901	Purple	86	108.7	54.3	40.9	111.1	55.2	76.03333
MT18H03101	Purple	94.7	118.3	58.3	37.1	90.3	57.3	76
MT18H03003	Purple	90.2	114	50	34.3	105.1	55.7	74.88333
MT18H03102	Purple	94	107.2	43.4	35.4	108.3	56.2	74.08333
MT18H01402	Blue	86.8	120.7	36.2	40.1	106.2	49.4	73.23333
MT18H03002	Purple	84.9	109.8	41.7	40.5	86.5	47.4	68.46667
MT18H03001	Purple	67.6	77.4	31.6	19.4	77.1	39.7	52.13333
GRAND MEAN		94.9375	125.2771	49.55417	42.525	113.1771	60.6375	
CV		9.40232	7.61397	19.98988	12.10169	7.05436	9.24022	
LSD		17.9093	19.13766	19.87449	10.32514	16.01851	11.24164	

Upcoming forage release is equal to Lavina and Hays for grain yield, significantly better than controls for forage yield and similar in digestability and protein.

Comparison of MT16F02902 with Controls					
Trait	Variety	Mean		MT16F02902 % of Variety	# of locations
		Variety	MT16F02902		
<b>Grain YIELD bu/ac</b>	Lavina	89.11	87.34	98	12
	Hays	91.38	87.34	95.6	12
	Haymaker	95.7	101.2*	105.7	3
<b>Forage YIELD tons/ac</b>	Lavina	3.91	4.21*	107.7	14
	Hays	3.81	4.21*	110.5	14
	Haymaker	4.75	5.73*	120.5	4
<b>PROTEIN %</b>	Lavina	12.43	12.25	98.6	8
	Hays	12.2	12.25	100.4	8
	Haymaker	12.47	12.17	97.6	3
<b>NDF %</b>	Lavina	58.37	56.91	97.5	13
	Hays	57.66	56.91	98.7	13
	Haymaker	60.46	56.04	92.7	4
<b>ADF %</b>	Lavina	35.44	34.94	98.6	13
	Hays	34.82	34.94	100.3	13
	Haymaker	34.61	31.88	92.1	4

\*ttest indicates difference at p<.05

Data provided by the MSU Malt quality lab 2020

Type of work	Trial	Number of samples	Type	Status
Breeding Program	2020 Intrastate	113	Micro	Data used to make selections
	EYT 2019/2020	115/146	Micro	
	PYT 2019/2020	203/226	Micro	
	F5s 2019/2020	457/506	Pico	
	2019 Winter	39	Micro	
Research	2018/2019 Off-station	148/300	Micro	Research continues
	Pico method publication	(Fertility) 0	Micro	In prep for publication
		120	Pico	
	2019 Fertility	85	Micro	Research continues
	Heirloom	181	Micro	In prep for publication
	Brewer's Association Flavor Trial	36/6	Micro/Macro	In progress
Anthocyanin/B-Glucan	16/96	Analysis	Completed	
Service	Malt 2020 (2019 reference)	387 (361)		Generating \$39,034 (as of Dec 11)
	Grain	64 (31)		
	Beverage	9 (11)		
	Hops (new)	13 (0)		

## Broadview 2020

name	yield	protein	height	plump	test_weigh
	bu/ac	%	cm	% 6/64	lbs/bu
Opera	31.9	8.1	60.3	95.5	52.7
Odyssey	39.2	8.3	60.3	96.9	52.9
MT16M05610	18.5	9.7	71	96.5	52.9
MT16M01902	4.3	9	70	90.9	44.2
MT16M01801	18.4	8.4	73.7	96.5	52
MT16M01405	13.1	9.5	69	97.2	51.7
MT16M00406	15.6	8.8	75.3	97.2	53.6
Metcalfe	27.9	9.8	77	97.3	54
Merit 57	25.9	8.9	72	93.6	52.6
Leandra	46.7	9	55.7	97.6	51.9
Lavina	32.4	9.7	75	88.2	51.4
Hockett	18.2	9.3	73.3	97.6	54.7
Hays	45.3	9.5	69	91.9	51.5
Haxby	22.8	9.1	68	95.5	55.3
Growler	28.3	9.2	71.3	91.8	51.9
Genie	34.4	8.8	66.7	95.7	53.5
Expedition	31.3	9.6	62.3	96.7	54.1
Ellinore	52.4	8.2	60.7	91.6	49.8
Diablo	36.3	8.1	60.7	95.7	50.7
Craft	20.3	10.8	82.7	96.9	54.8
CDC Copeland	36.8	10.7	79.3	97.6	54
Buzz	8.7	9.2	64.3	96.9	54.5
Balster	19.9	9.4	75	91.5	51.9
ABI Voyager	14.6	10.4	81	96.1	53.1
AAC Synergy	34.1	9.8	73.3	96.6	51.9
GRAND MEAN	27.09	9.25	69.88	95.19	52.46
CV	23.33	4.22	5.63	1.27	2.07
LSD	12.42	0.77	7.73	2.38	2.14

## Bozeman 2020

name	yield	protein	heading	height	plump	test_weigh	maturity
	bu/ac	%	Julian days	cm	% 6/64	lbs/bu	Julian days
Opera	146.7	11.6	181.3	71	81.1	51	219
Odyssey	142	10.7	181	77	93.5	51.3	217
MT16M05610	130.8	11.3	180.3	81.5	94.4	52.7	216
MT16M01902	145.2	11.1	182	76.2	92.8	51.8	216.3
MT16M01801	150.7	10.4	180.3	80.7	94.4	53.4	218.7
MT16M01405	138.4	10.8	180	72	96.3	54.6	221
MT16M00406	145.6	10.9	180.7	77.3	96.9	53	215.3
Metcalfe	134.4	12.2	179.7	82.8	88.4	52.7	214.7
Merit 57	138.5	12	180.7	75	84	51.8	219.3
Leandra	135.4	11.3	181	73	82.4	50.4	218
Lavina	136.4	12.5	180	73.5	55.4	49.2	217.3
Hockett	130.4	11	181	78.2	93.8	54.7	218.3
Hays	143.8	12.2	181.3	81.3	68	50.4	218.3
Haxby	136	11.8	180.7	81.5	88.4	55.6	215.3
Growler	118.8	12.8	182	71.3	89.1	51.9	220
Genie	145	10.9	180.7	86.3	90.8	54.1	217
Expedition	132.4	11	182	71.5	89.1	54.2	217.3
Ellinore	143.6	10.6	183.7	73.2	91.6	50.6	218.7
Diablo	140	11.3	184.7	68.2	90.1	48.7	220.3
Craft	133.3	12.3	180.7	77	93.1	55.3	218
CDC Copeland	130.8	12.2	182.3	82.7	93.4	53.3	217
Buzz	141.9	10.4	182	78.5	96.9	54.7	216.7
Balster	139.8	11.9	182.7	79.5	93.6	53.2	219.3
ABI Voyager	113.7	12.5	179.7	76.3	96.1	53.2	216.7
AAC Synergy	130.7	11.8	180	75	93.5	53.6	216
GRAND MEAN	136.97	11.49	181.21	76.82	89.07	52.61	217.67
CV	6.88	3.83	1.21	11.49	3.27	1.02	1.05
LSD	18.53	0.87	4.30	17.34	5.72	1.05	4.48

## CARC 2020

name	yield	protein	heading	height	plump	test_weigh
	bu/ac	%	Julian days	cm	% 6/64	lbs/bu
Opera	50.8	7.4	191	44.9	76.6	48.7
Odyssey	43.6	8.1	192	43.2	87.3	50.1
MT16M05610	40.6	8.1	189	50	90.6	48.7
MT16M01902	44.1	7.7	185.7	47.4	93.9	49.8
MT16M01801	47.9	7.4	186	51.7	92	50
MT16M01405	40.6	8.3	189	50	97.4	44.8
MT16M00406	43.2	7.9	188.3	49.1	95.9	48.6
Metcalfe	50.1	7.8	186.3	55	87.1	50.2
Merit 57	44.4	7.8	188.3	49.1	70.5	49.3
Leandra	43.8	8.4	192	38.1	88.1	50.7
Lavina	44.3	7.9	189	50.8	74.3	46.8
Hockett	45	7.7	186.3	46.6	93.2	49.3
Hays	49	8.4	190.7	48.3	74.6	50.2
Haxby	45.5	8.9	186.3	46.6	86.3	50.5
Growler	42	8.7	188.3	49.1	82.2	49.4
Genie	42.1	8	192	42.3	90.6	50
Expedition	47.8	8.7	191	44.9	88.1	49.5
Ellinore	55.8	7.4	192	47.4	90.2	51.4
Diablo	45.5	8.6	192	47.4	89.4	47.4
Craft	46.2	8.9	185.7	54.2	94.4	50.7
CDC Copeland	42.8	9	187	50	92.2	48.2
Buzz	44	7.9	186	49.1	95.6	47.7
Balster	41.1	8	187.7	49.1	86.3	50.4
ABI Voyager	38.8	8.5	186.7	54.2	91.8	50.4
AAC Synergy	43.7	8.5	188.3	48.3	90.5	49.9
GRAND MEAN	44.90	8.16	188.67	48.27	87.97	49.31
CV	12.28	6.06	0.40	5.12	2.58	5.48
LSD	10.84	0.97	1.47	4.85	4.46	5.32



2020 Off-Station Means Tables:

**Denton 2020**

name	yield	protein	height	plump	test_weigh
	bu/ac	%	cm	% 6/64	lbs/bu
Opera	32.7	8.2	24.8	87.9	56.1
Odyssey	26	10.5	24.5	87.5	55.9
MT16M05610	17.7	8.5	23.5	91.1	55.9
MT16M01902	19.8	8.8	22.5	92.1	56.5
MT16M01801	18.1	9.1	23.6	88.4	56.6
MT16M01405	19.3	8.7	25.7	94.1	56
MT16M00406	18.3	8.7	21.5	94.8	56.1
Metcalfe	23.5	8.9	21	92.4	57.9
Merit 57	20.9	9.6	23.6	84.2	56.1
Leandra	31.9	8.9	24.6	94.8	55.8
Lavina	18.5	10.7	24.7	81.6	56.1
Hockett	24.4	9.7	26.5	93.3	57.6
Hays	23.4	10.4	27	89.3	56.6
Haxby	22.5	10.5	24.8	89.3	57.7
Growler	19.8	12.1	24.2	84.5	54.4
Genie	24.6	9.7	25.3	94.1	57.4
Expedition	27.2	9.9	26.9	94.2	57.1
Ellinore	32.4	9.6	24.4	92.1	55.7
Diablo	27.1	9.4	26.8	89.7	55
Craft	21.1	9.3	16.3	95.3	57.4
CDC Copeland	18	10.7	25.6	92.9	56.3
Buzz	19.9	8.5	23.8	95	57
Balster	24	9.4	22.2	92.7	56.5
ABI Voyager	18.1	10	23.4	96.8	56.6
AAC Synergy	18.70	9.40	25.10	94.70	56.40
GRAND MEAN	22.72	9.56	24.09	91.31	56.43
CV	15.10	10.34	14.52	4.77	1.57
LSD	6.74	1.94	6.87	8.56	1.74

**EARC 2020**

name	yield	protein	heading	height	plump	test_weigh
	bu/ac	%	Julian days	cm	% 6/64	lbs/bu
Opera	70	14	179.7	55.7	96.3	53.9
Odyssey	56.9	14.9	181.7	56.3	97.5	54.5
MT16M05610	58.5	14.9	178	62	96.6	53.8
MT16M01902	60.7	14.1	175.3	58.3	95.8	53.2
MT16M01801	61.6	13.5	176	62.3	95.1	53.8
MT16M01405	57	13.7	174.3	53.7	97.2	53.6
MT16M00406	57.3	13.7	177	57.3	96.5	53.4
Metcalfe	59.3	15.6	176.7	66.3	95.7	54.8
Merit 57	58.1	15.3	178	56.7	91.3	53.2
Leandra	70.4	14.7	183	53.3	96.7	53.1
Lavina	61.4	15.9	176	58.7	82.8	51.2
Hockett	57.7	14.4	175.3	54.3	95.9	55
Hays	58.8	15.8	179.7	55.3	80.7	51.7
Haxby	68.3	14.9	174.3	56	96	56.1
Growler	58.9	16.1	178.3	56.7	94.8	53.3
Genie	55.5	15.4	182.7	53.3	93.8	53.9
Expedition	52.5	15.4	179.3	54.7	93	54.5
Ellinore	60.6	14.8	178.7	57	96.9	53.4
Diablo	66.7	14.6	180.7	56.7	97.5	53
Craft	55.2	15.9	175	64.7	96.7	54.7
CDC Copeland	53.3	15.4	179.7	61.7	94.2	53.6
Buzz	61.4	13	173.7	64.7	97.4	54.6
Balster	60	15.3	177.7	59.3	95.1	54.2
ABI Voyager	50.8	15.5	178.3	60.3	97.1	52.4
AAC Synergy	61.6	14.5	176	61	95.7	54.2
GRAND MEAN	59.69	14.86	177.80	58.25	94.66	53.72
CV	9.57	1.67	0.92	7.83	1.13	1.03
LSD	11.22	0.49	3.21	8.96	2.11	1.09

**Fromberg 2020**

name	yield	protein	height	plump	lodging	test_weigh
	bu/ac	%	cm	% 6/64	%	lbs/bu
Opera	104.1	12.2	80	72	78	45.2
Odyssey	146.7	12.1	83.7	91.3	48	49.5
MT16M05610	108.8	12.3	105	92.7	85	51.6
MT16M01902	141.7	12.8	102.3	93.4	37	50.3
MT16M01801	110.8	11.5	103.7	94.7	67	52.1
MT16M01405	114.7	12.8	96.7	93.4	37	51.8
MT16M00406	107.3	12.5	108	91.4	74	51
Metcalfe	119.4	14.4	104	87.5	78	52.4
Merit 57	130.5	13.1	97.7	88.6	74	50.9
Leandra	110.2	13.5	89.7	77.4	70	47.2
Lavina	117.4	15.3	109.3	55.1	78	46.2
Hockett	137.8	12.6	96.7	87.9	74	52.1
Hays	94	15.2	108	46.9	93	45.8
Haxby	128.5	13.9	100	90.7	71	53.2
Growler	129.1	13.3	96.3	89.1	63	50.4
Genie	126.8	12.9	87.7	80.6	41	49
Expedition	141.3	12.5	85.3	85.6	56	51.3
Ellinore	126.2	12.6	85	89	52	47.4
Diablo	127.4	12.5	84.7	82.7	67	45.4
Craft	107.1	14	99.7	89.4	89	52
CDC Copeland	92.3	14.2	118.7	83.9	96	50.7
Buzz	106.1	11.5	97.3	94.9	33	52
Balster	117	14.6	99	84.1	89	49.5
ABI Voyager	120.8	13.1	109	93.9	30	53.2
AAC Synergy	132.7	13.1	106	93.5	67	52.2
GRAND MEAN	119.94	13.13	98.13	85.19	65.83	50.09
CV	12.33	6.08	4.70	6.14	37.82	2.12
LSD	29.07	1.57	9.06	10.28	48.91	2.09



## Geraldine 2020

name	yield	protein	height	plump	test_weigh
	bu/ac	%	cm	% 6/64	lbs/bu
Opera	64.6	8	53.3	84.5	48.8
Odyssey	56.3	9	52.5	86.8	51.5
MT16M05610	33.7	9.2	60.1	92.7	49.1
MT16M01902	24.6	8.4	52.5	93.5	51.3
MT16M01801	32	8.3	60.1	91.1	50.8
MT16M01405	27.4	8.3	58.4	95.6	52.4
MT16M00406	29.1	8.5	61	94.9	50.4
Metcalfe	44.8	8.9	60.1	92.8	53.6
Merit 57	41.3	9.1	58.4	79.7	49.4
Leandra	73.1	8.7	51.6	91.7	49
Lavina	36.1	10.1	64.4	80	51.7
Hockett	23.9	8.6	57.6	94.4	49.8
Hays	51.5	10.4	60.9	82.2	51
Haxby	44.6	9.9	60.9	91.5	50.3
Growler	46.9	10.1	60.1	91.9	51
Genie	47	8.4	50.8	83.4	48.6
Expedition	55.3	9.4	55	92.4	52.1
Ellinore	36.9	9.4	50.8	84.2	49.9
Diablo	46.7	8.9	51.6	83.4	49.2
Craft	50.4	8.9	65.2	94.1	50.3
CDC Copeland	45.5	10.1	64.3	90	50.8
Buzz	21.7	7.4	51.6	94.3	49.9
Balster	47.1	9	59.3	88.5	51.3
ABI Voyager	26.5	10.1	59.3	94.1	50
AAC Synergy	47	9.4	61.8	91.2	51.7
GRAND MEAN	42.16	9.06	57.67	89.57	50.56
CV	23.34	8.68	6.01	3.51	7.38
LSD	19.34	1.54	6.81	6.17	7.33

## Hysham 2020

name	yield	protein	height	plump	lodging	test_weigh
	bu/ac	%	cm	% 6/64	%	lbs/bu
Opera	127.2	11.8	77.3	80.7	29	48
Odyssey	138.8	11.6	76.3	89.9	33	48.7
MT16M05610	102.9	12.1	100	92	40	51.5
MT16M01902	104.6	11.8	93.7	91.7	26	50.6
MT16M01801	77.7	11.6	104.3	88.1	67	50.7
MT16M01405	97.1	11.9	87	95.6	11	52.6
MT16M00406	80.1	11.8	94.7	95.1	30	51.8
Metcalfe	101.6	13	101.3	92.1	33	53.5
Merit 57	116.6	12.8	98.3	80.6	33	48.2
Leandra	137.7	11.5	74	88.4	33	49
Lavina	97.9	13.5	101.3	49.7	52	45.9
Hockett	105.7	12.8	91.3	92.5	56	52.6
Hays	102.9	13.4	99	57.1	63	47.1
Haxby	97.3	12.5	90.3	86.7	74	51.5
Growler	138.1	12.6	90.3	93.8	7	51.9
Genie	135.2	10.9	82.3	94.9	7	52
Expedition	132.6	12.1	81	83.5	11	51
Ellinore	110.4	11.3	81	87	33	46.4
Diablo	148.9	11	82.7	91.7	37	47.8
Craft	89	13.7	97	86.4	63	52.1
CDC Copeland	101.5	13.6	100	87.4	67	51.6
Buzz	68	11.5	91.7	92.2	29	51.7
Balster	119.3	12.8	93.3	92.5	29	51.8
ABI Voyager	104.6	12.5	100.7	94.5	11	53.2
AAC Synergy	122.8	12.4	94.7	91.3	33	52.1
GRAND MEAN	110.34	12.26	91.35	87.01	36.37	50.53
CV	14.49	3.93	5.72	5.65	52.94	2.73
LSD	31.41	0.947	10.27	9.67	37.83	2.71

## EARC 2020

name	yield	protein	heading	height	lodging	test_weigh	maturity
	bu/ac	%	Julian days	cm	%	lbs/bu	Julian days
Opera	79.1	13.1	180	72.2	0	50.8	203.7
Odyssey	86.2	13.6	180	75.3	0	50.8	203
MT16M05610	63	12.7	173	88	0	52	204.3
MT16M01902	85	12.6	163.3	82.1	0	51.2	204
MT16M01801	57.7	11.9	171.3	87.7	0	51.6	203.3
MT16M01405	72	12.7	164.3	84.6	0	52.7	202.7
MT16M00406	73.7	12.4	170.7	92	0	51.2	201.7
Metcalfe	77.7	14.7	168	90.9	7	52.8	197.3
Merit 57	45.7	14.7	174.3	80.6	4	50.8	204
Leandra	95.1	13.8	179	76.5	0	50.3	202
Lavina	93.9	14.5	169	95.4	0	49	196
Hockett	59.6	13	171.7	83.2	0	53.4	198.7
Hays	109.3	14.5	170	90.9	4	49.1	198.7
Haxby	81.6	14.5	170.7	82.1	0	54	202.3
Growler	66.9	15.2	173	84	0	51.1	204.3
Genie	89.2	13.5	178.7	79.8	0	52.5	201
Expedition	45.3	13.7	178.7	75	4	52.6	202
Ellinore	59.9	13.4	178	71.9	0	48.8	204.3
Diablo	96.2	13.5	179.3	76.8	0	49.4	202.7
Craft	83.4	14.4	169	91	0	53.3	202
CDC Copeland	81.9	14.7	172.3	95.1	4	51.7	203.3
Buzz	65.9	11.9	165	84.3	0	52.6	204
Balster	86	14.4	171.7	90.4	0	51.5	199.3
ABI Voyager	52.7	14.5	172.7	91.8	4	51.2	204.3
AAC Synergy	79.9	14	170.3	93.9	0	51.8	201
GRAND MEAN	75.47	13.67	172.56	84.62	1.03	51.45	202.00
CV	20.26	1.96	0.991	5.57	367.70	0.943	1.14
LSD	30.04	0.526	3.36	9.27	7.42	0.953	4.54

## WARC 2020

name	yield	protein	heading	height	test_weigh	maturity
	bu/ac	%	Julian days	cm	lbs/bu	Julian days
Opera	75	7.7	186	47.5	50.4	217
Odyssey	74.1	8.1	188	47	49.8	218
MT16M05610	63.1	8.2	171.7	59.8	51.3	216
MT16M01902	57.3	9.3	169	55.3	50.4	215
MT16M01801	59.4	8.7	171.7	64	52.7	218
MT16M01405	59.4	9	169	53.2	52	217
MT16M00406	60.7	8.7	173	58.8	51.4	218
Metcalfe	64.4	9.3	169	60.7	53.3	212
Merit 57	60	8.4	173	61.2	50.9	215
Leandra	72.4	8.5	188	46	49.1	218
Lavina	65.5	8.5	169	57.7	51.1	209
Hockett	67.1	8.8	170.3	57	52.9	209
Hays	65.4	8.6	173	56	50.2	209
Haxby	67.5	8.8	169	59.2	55.6	209
Growler	60.8	9.3	174.3	59.3	49.8	216
Genie	58.9	8.7	181	45.3	51.4	218
Expedition	66.9	9.1	173	51.2	53.1	217
Ellinore	75.4	8.2	178	51.2	49.3	218
Diablo	69.8	8.5	183	44.2	48.7	218
Craft	66.7	9.2	169	66.2	54	215
CDC Copeland	63.7	9.2	177.3	64.7	51.1	215
Buzz	63.7	8.8	169	54.7	52.2	217
Balster	66.1	9.4	173	60.2	52	217
ABI Voyager	60.1	9.4	171.7	60.8	51.2	218
AAC Synergy	61.3	8.9	169	57.2	51	218
GRAND MEAN	64.99	8.78	174.32	55.93	51.40	215.48
CV	11.61	5.37	1.71	5.44	1.97	0.763
LSD	14.82	0.927	5.87	5.98	1.99	3.23

## 2020 Barley, Malt & Brewing Quality Lab work summary:

### **Research:**

#### Completed analysis for the MSU breeding program:

2019 & 2020 F5s – 472 Pico samples, 480 Pico samples  
2019 Offstation – 300 Micro samples  
2019 Heirloom – 196 Micro samples  
2019 128.148 – 156 Micro  
2019 BA Malt/Kiln – 41 Micro, 8 Milli  
2020 AMBA Trial (malt tested for AMBA's report) – 40 Micro samples  
2020 Fertility – 120 Micro samples  
2020 Intrastate – 98 Micro samples  
2020 PYT – 200 Micro samples  
2020 EYT – 128 Micro samples

Totals:  
1279 Micro samples  
952 Pico samples  
8 Mill samples

#### Collaborative Research & Publications:

-Glycosidic Nitrile – Hartwick College: Paper in review: *Review of Ethyl Carbamate management in distilling with specific analysis of Glycosidic Nitrile production in North American grown barley varieties.*  
-Optimization of Pico Malting for improved barley breeding: Data generation complete, writing in process.

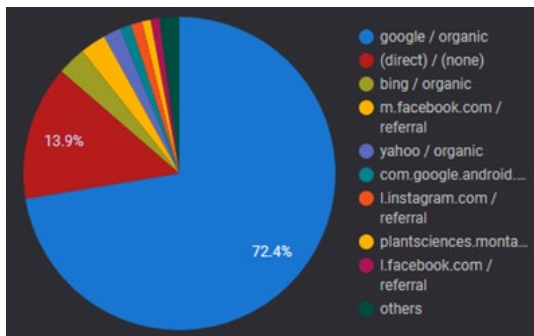
### **Education:**

Tours were significantly cut back in 2020 due to COVID with only 3 for the year. The few tours we did give included local maltsters looking to train their personnel, and local and visiting breweries. Over the year we participated in multiple live and virtual speaking events including: MT Wheat & Barley, MT Pink Boots and Big Sky's Grains & Grog. We spoke in several webinars such as a technical presentation for Select Science, a poster session for the American Society of Brewing Chemists, a discussion of Malt Flavor: Beyond the Kiln for the Homebrew Club, and a session discussing current events in malt research with the North American Beer Writers Guild. We also expanded our website and social media efforts to reach more folks virtually.

#### Website:

In 2020 our website had 4,707 sessions for a total of 12,796 page views.

In 2021 we will expand the field aspect of the site, add a variety tool allowing easier access to our field data, and complete development of a variety dictionary resource for the industry

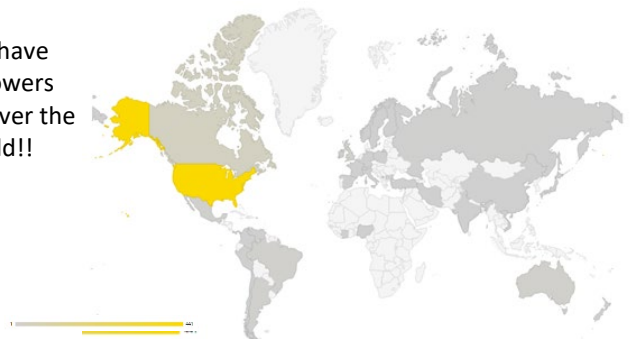


#### Social Media:

We post about what the program is working on, educational pieces, share events we participate in & more!

Instagram: 956 followers, Facebook: 521 followers, Twitter: 25 followers, YouTube: 6 subscribers

We have followers all over the world!!



### **Service:**

Active clients: 31

#### Third Party samples tested:

Malt: 406 samples  
Barley: 63 samples  
Beverage: 10

Clientele include Maltsters, brewers, and peer research programs. Clients are both local, regional, and international including 4 countries and states all across the US. Despite 2020 being a rough year we held steady with only 1.6% reduced income compared to 2019.