

Identifying and Developing Improved Spring Barley Varieties for Montana

Spring 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, and a severe drought in 2021. The drought in 2021 caused a shortage in barley feed and hay, resulting in higher prices for both. 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

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. Several of our higher yielding lines for feed and forage are stay-green.

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. The acid trials failed in 2021. We are pursuing greenhouse screening since field trials seem unreliable. 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. In 2021, we have found resistance to bacterial leaf streak and are pursuing the development of resistant lines.

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. We are working with a food scientist to develop new food markets for barley. 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 is 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

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 2021:

- 1) Continue the now fully functional plant breeding pipeline for spring barley.
- 2) Make 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) Continue 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.
- 7) Tested quality of lines early to ensure high quality is maintained in breeding pipeline

Support from the Montana Wheat and Barely Committee makes 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

The crosses for spring barley in 2021 show continued efforts to improve yield and quality of malt, feed, forage and food barley. Crosses were also made to improve resistance to scab, stem rust, stripe rust, and bacterial leaf streak.

Table 1: Spring barley crosses since the inception of the program in 2015

	Breeding Goals	2015	2016	2017	2018	2019	2020	2021
	High yield, high quality malt and feed	90	87	29	39	9	23	36
	Heirloom malt			75	90	94	76	25
	Food	19	21	23			16	35
	Forage	12	12	11	14	5	56	50
	FHB resistance	14	22	13	12	8	23	21
	Lodging resistance	11	1					
	Extended grain-fill	31	12	7				
	Spot form of Net Blotch	3	12				14	
	Nematode Resistance	4	10	1				
	Stem Rust							11
	Stripe Rust			2		4	12	10
	Beer Stalling	6						
	Bacterial leaf streak resistance							10
	Acid tolerance			20	11	4		
Spring	Total	190	177	181	166	124	197	178

Current and Future Release: MT16F02902 (Cowgirl) is the newest spring barley release. Table 2 compares Cowgirl's performance to Hays, Haymaker and Lavina. Cowgirl has equal or better grain and forage yield, similar % protein and slightly better digestibility (= lower NDF and ADF) than the controls.

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

Table 3 compares the performance of a feed line we hope to release in 2022 with Hockett and Odyssey, with MT17M02507 out yielding Hockett and equal to Odyssey across more than 20 environments. However, the experimental lines can outperform Odyssey under limited water or high temperatures during grainfill (data not shown). This line is a daughter of Haxby and a Stay-green line. Table 4 reports 2021 Western Regional data, indicating top performance across 9 regional environments. It was also the top yielder across location in Montana in 2021 (Table 5). In Table 5 the green highlighted lines have a stay-green line as one parent. Malt Quality for dryland and irrigated is reported in Table 6.

Table 3: Agronomic data for future feed release of a Haxby by staygreen with improved yield

Trait	Control Variety	Number of Observations	MT17M02507 MEAN	Control Mean	MT17M02507 % of Control	
YIELD (BU/AC)	Hockett	30	84.21	74.6	112.9	***
	Odyssey	22	75.7	76.3	99.1	ns
PROTEIN (%)	Hockett	26	11.32	12.89	87.9	---
	Odyssey	18	11.79	12.91	91.3	---
HEIGHT (CM)	Hockett	28	67.3	68.1	98.8	ns
	Odyssey	20	64.17	58.11	110.4	***
HEADING (JULIAN)	Hockett	22	178.73	180.05	99.3	--
	Odyssey	14	181.22	186.46	97.2	---

Table 4: 2021 Western Regional Spring Barley Nursery

2021 Western Regional Spring Barley Nursery											
Mean Data											
Ent #	Entry	YIELD		Test Wt.		HEADING	HEIGHT		LODGING	Plump	Protein
		Bu/A	Mg/ha	lbs./Bu	kg/m3	Julian	in.	cm	0-10	>2.4mm	%
1	AAC Synergy	96.2	5.2	49.6	638.8	179.1	26.8	68.0	0.8	92.2	13.4
2	ABI Eagle	95.3	5.1	50.3	647.2	179.4	24.1	61.2	0.4	88.2	13.9
3	ABI Voyager	91.4	4.9	49.6	639.0	179.2	26.5	67.4	0.6	95.9	14.1
4	AC Metcalfe	85.4	4.6	50.2	646.4	178.9	27.6	70.2	1.3	91.2	14.3
5	CDC Copeland	89.5	4.8	50.3	647.0	179.1	27.0	68.6	0.7	91.5	13.9
6	ND Genesis	80.9	4.4	49.5	637.4	177.2	27.9	70.8	0.7	89.3	12.6
7	2IM14-8212	97.5	5.2	48.9	629.4	177.9	24.6	62.5	0.4	94.2	13.1
8	2IM15-9456	97.5	5.2	49.9	642.7	177.4	25.8	65.6	0.4	90.7	13.5
9	2IM16-0141	96.9	5.2	50.5	649.7	178.9	24.6	62.4	0.3	89.0	13.6
10	2IM16-0154	95.1	5.1	51.1	657.4	178.4	25.2	64.1	0.7	93.3	13.4
11	HO516-429	101.2	5.4	50.8	653.9	178.9	27.2	69.1	0.3	92.1	13.4
12	HO517-245	104.8	5.6	50.5	649.7	178.2	24.1	61.3	0.6	83.5	12.4
13	MT16M01801	98.5	5.3	50.1	644.4	178.2	28.0	71.2	0.3	93.3	12.0
14	MT16M01902	98.5	5.3	49.7	639.7	176.8	25.6	65.0	0.9	94.8	12.6
15	MT17M02507	101.8	5.5	50.4	648.5	177.7	26.3	66.8	0.3	93.5	12.0
16	MT17M04801	94.2	5.1	51.4	661.2	177.0	26.8	68.2	0.3	95.0	13.0
17	2ND32529	93.4	5.0	49.3	634.5	176.6	26.3	66.9	0.3	92.8	12.2
18	2ND36638	89.3	4.8	49.3	634.5	176.6	25.4	64.5	1.2	93.9	12.3
19	2ND36642	92.6	5.0	49.7	640.4	176.9	25.6	65.1	0.7	94.5	11.8
20	11ARS183-9	95.2	5.1	49.8	640.6	178.9	26.7	67.8	0.6	95.3	13.9
21	14ARS147-1	101.2	5.4	50.0	643.4	179.4	25.5	64.7	0.8	87.4	13.3
22	15ARS019-5	97.3	5.2	49.8	641.5	179.1	24.7	62.8	0.3	90.8	13.9
23	15ARS182-1	97.7	5.3	49.0	631.3	181.8	24.7	62.8	0.6	93.7	13.3
24	CDC Churchill	99.1	5.3	51.3	660.5	180.2	25.5	64.8	0.3	89.8	13.2
25	TR19175	98.4	5.3	50.4	648.5	178.8	25.1	63.8	0.3	93.5	13.0
MEAN:		95.6	5.1	50.1	644.3	178.4	25.9	65.8	0.6	91.8	13.1
CHECK'S MEAN:		89.8	4.8	49.9	642.6	178.8	26.6	67.7	0.8	91.4	13.7
Locations		9	9	8	8	6	7	7	3	7	6

Table 5: MALT INTRASTATE 2021: AGRONOMIC ACROSS NINE LOCATIONS

name	Yield (BU/AC)	Plump (%)	Protein (%)	Test Wt (LBS/BU)	Heading (JULIAN)	Height (CM)
# Locations	9	9	9	9	6	9
MT17M02507	96.9	75.6	12.2	49.9	176.1	71.2
MT18M10106	94.8	79.6	12.6	50.2	179.4	72.2
MT18M11002	94.3	70.3	13.7	50.9	178.6	76.5
MT18M11006	93.9	71.2	13.6	50.1	176.8	74.9
MT16M01902	93.6	83.5	13	49.6	174.8	69.1
MT16M01801	92.9	75.4	12.5	49.3	178.8	75.5
Odyssey	92.6	75.7	13.6	48.5	181	63.9
MT18M11101	91.6	68.2	13.2	50.6	177.1	68.1
MT17M01906	90.9	79.1	12.9	49.4	174.3	70.6
MT17M04801	90.7	80.1	13.2	51.6	176.6	74.1
MT18M11004	90.3	65	13.6	51	178.6	72.1
MT18M11103	90.2	70.6	13.5	48.1	180.3	70.4
MT18M09904	89	73.4	14.3	49.5	180.1	71.3
MT18M09301	88.9	81.3	13.9	48.6	180.1	71.6
MT17M00302	88.8	73.4	12.7	50.9	179.4	72.6
MT18M11105	88.3	73.1	13.7	50.3	181.1	70.9
MT18M11106	86.9	79.3	13.5	50.6	177.2	70.3
MT17M01711	86.5	73.3	13	48.5	175.6	67.2
MT17M05508	86.4	69.1	13.7	50	178.8	74.3
MT16M00709	86.1	78	12.3	50	176.8	78.6
MT18M10204	86	75.5	13.2	50.2	173.8	67.2
MT18M10401	85.8	74.3	13.9	49.7	179.6	70.9
MT16M00707	85.5	83.6	12.6	50.9	177.7	76.4
MT16M02201	85.3	85.1	12.8	49.1	176.2	70.5
MT18M09902	85.3	77	13.5	50	180	73.6
MT18M10107	85.2	77.8	14.2	50.8	179.4	71.8
MT16M05403	85.1	72.9	13.2	50.7	179.5	70.2
Merit 57	85.1	66.5	13.9	48	178.1	70.6
MT17M01908	84.4	88.4	12.4	50.7	174.8	72.9
MT18M10207	84.1	83.3	13.8	50.6	175	74
MT18M06011	83.7	81.9	12.7	51.3	172.2	68.8
MT17M05416	83.2	71.8	13.3	49.1	178.2	68.9
MT16M05610	82.5	86.2	13.3	49.6	179.5	68.7
MT18M09602	82.4	81.4	12.1	50.5	177.6	70.7
MT18M10208	82.4	79.1	13.3	50.9	175.4	72.4
Hockett	82.2	81.1	13.9	50.6	179	71.2
MT18M06009	81.6	86.5	12.3	50.2	173.1	66.6
MT18M09205	81.5	78.9	12.8	48.4	179.1	75.4
MT17M05502	81	80.1	13.9	49.8	178.2	78.2
MT18M09804	80.2	70.5	13.6	49.8	178.5	72.4
MT18M09901	79.8	76.4	14.4	47.2	181.6	71.2
MT18M06012	79.7	85.1	12	50.5	174.3	65.8
MT16M09602	78.6	89	12.5	51.9	174	66.4
MT18M06008	78.6	84.4	12.4	51.5	172.6	69.9
MT17M05808	78.3	79	14.1	48.9	177.9	73.6
MT18M09403	77.8	88.4	13.8	50	177.8	71.3
MT18M09802	77.2	70.4	14	49.2	180.9	70.2
MT18M10205	74.4	87.7	13.6	50.9	174.1	70.8
MT17M06305	70.5	82	13.4	49.7	179.6	75.9
GRAND MEAN	85.325	77.936	13.251	49.965	177.527	71.473
LSD	4.75	3.693	0.34	0.673	0.881	2.297
CV	10.421	8.87	4.803	2.52	0.758	6.016

Table 6: MALT INTRASTATE 2021: QUALITY BOZEMAN DRY AND SARC IRRIGATED

name	Extract (%)	S Protein (%)	S/T Protein (%)	FAN (PPM)	B Glucan (PPM)	A Amylase (DU)	DP (ASBC)
MT16M02201	82.8	5.2	44.6	207.3	236	85.9	133.1
MT16M01801	82.3	4.7	43.9	184.5	451.8	74.9	130.2
MT18M06008	81.8	5.2	44.5	208.8	216.1	79.1	141.8
MT18M06011	81.8	5.2	44.1	206.7	202.7	85.6	157.6
MT17M01908	81.2	4.8	42	173.8	122.9	66.7	156.5
MT16M09602	81.1	5	43.7	203.6	364.9	80.2	110.3
MT17M05808	81	5	42.7	194	97.5	94.4	152.3
MT18M06009	81	4.5	39.2	170.3	194.8	69	144.8
MT18M11006	80.6	5.1	43.7	187.7	105.3	80.3	111.2
MT18M11101	80.6	5	42.6	198	218.7	77.5	116.3
Merit 57	80.4	4.9	41.3	203.7	107.5	116.4	168.7
MT17M05416	80.2	4.9	43	187.6	213.1	83.9	137.8
MT18M11103	80.2	4.8	41.7	194.2	182.1	79.3	138.8
MT16M05610	80.1	5	43.7	208.6	189.2	94.3	156.5
MT18M06012	80	4.8	42.3	189.2	290.6	76.4	114.1
MT18M11105	79.8	4.5	39.1	172.8	300.8	65.7	120.3
MT16M00707	79.7	4.3	37.8	158	301.4	62.7	140.8
MT16M01902	79.7	4.4	37.3	173.7	395.8	73	144.7
MT18M09602	79.6	4.2	39.8	156.5	368.2	68.5	122.2
MT18M10401	79.6	5	41.6	192.2	225.1	90.8	162.1
Hockett	79.6	4.6	38.2	178.6	355.2	89.3	158.9
MT17M02507	79.5	3.9	35.8	138.3	491	58.8	79.1
MT18M09301	79.3	4.1	35.7	150	164.5	65.2	128.5
MT17M06305	79.2	4.7	39	196.7	243.9	101	158
MT17M01711	79.1	4.1	35.8	154.6	358.5	63.4	136.1
MT17M05508	79.1	4.6	39.1	180.2	285.7	92	156
MT18M09205	79.1	4.2	36.8	160.2	197.5	65.1	121.7
MT18M11106	79.1	4.8	39	189.4	182.6	77	151.7
MT18M09904	78.8	4.9	39.3	214.2	365.3	108.7	146.6
Odyssey	78.8	3.8	32.2	133.5	133.1	54.7	128
MT18M10204	78.7	4.3	36.8	159.8	302.5	67.5	147
MT18M09403	78.6	3.7	31.6	130.5	199.2	52.4	100.2
MT18M09902	78.6	4.7	40.2	191.3	382.7	101.9	153
MT17M00302	78.5	4.3	38.7	150.4	270.6	60.6	135.3
MT17M01906	78.5	3.8	33.4	133.6	362.6	49.7	140.3
MT17M04801	78.2	4	35.3	132.8	478.9	50.6	118
MT18M09901	78.1	4.3	36.1	173.7	157.3	85	187.3
MT18M10106	78.1	3.7	34.8	122.2	426.1	55.5	162.2
MT16M00709	78	3.4	31.8	117.9	604.9	48.2	110
MT16M05403	77.9	4.3	37	152.7	355.5	66.8	145.9
MT17M05502	77.9	4	34.3	137.3	448.7	56.7	124.1
MT18M10208	77.5	4.2	35.6	151.1	376.7	56.3	149.6
MT18M10207	77.4	4.4	36.1	153.6	276.7	58.7	137.5
MT18M11002	77.4	3.8	33.2	128.7	426.4	49.4	115.4
MT18M09804	77.2	3.8	32.8	130	448.1	58.6	147.9
MT18M09802	77.1	4.1	34.7	148	363.6	62.7	137.9
MT18M10205	76.8	4.5	35.4	174.8	205.4	67.8	142.3
MT18M10107	75.7	3.7	30	120.5	551.3	48.1	146.8
MT18M11004	75.2	3.4	28.9	114.8	664.3	42.9	96.2
GRAND MEAN	79.168	4.392	38.058	167.131	303.309	71.799	137.147
LSD	1.987	0.491	5.323	33.101	188.488	18.19	27.303
CV	1.248	5.558	6.956	9.85	30.908	12.6	9.901

The lines are sorted by extract, which is the maltsters measure of yield. Note that many of the highest extract lines are also staygreen. The top performing lines for the most part have good quality. Although many of the stay green lines have beta glucans that are too high in irrigated environments, beta glucans as well as other quality measures are acceptable in dryland (data not shown). The 2021 Fertility trial was grown at SARC (irrigated) and WTARC(dryland). SARC is flood irrigated and all lines had elevated beta glucans (data not shown). Two of the experimental lines (1902 and 5610) had higher proteins and lower plumps under dryland that also seemed to be negatively impacted by N (Table 7). However, Buzz and MT16M02201 had stable plumps and protein in dryland and across N treatments. Note that both Buzz and MT16M02201 had good malt quality in dryland even during the drought, although the diastatic power maybe too low for adjunct malt. MT16M02201 had the highest extract in dryland (Table 7).

Table 7: Malt Quality in a Dry Location

Nitrogen Level	Variety	Malt Protein %	Extract %	Soluble Protein %	Soluble/Total Protein %	Alpha amylase (DU)	Diastatic Power (ASBC)	Beta glucan (ppm)	FAN (ppm)	Grain Yield (bu/ac)	Plumps (% 6/64)	Test weight (lbs/bu)
Lowest N	Buzz	12.2	79.8	5.2	42.8	139.9	137.1	34.3	223.2	56.7	95.8	48.7
	Hockett	13.5	77.4	4.9	36.5	89.4	172.9	90.5	187	39.3	87.7	48.3
	MT16M01902	13.2	76.1	4.5	33.9	71.4	168.4	106.7	169.8	43.2	86.9	46.8
	MT16M02201	12.4	82.7	5.7	45.6	92.9	139.1	47.8	221.9	44.3	92.1	47.3
	MT16M05610	13.7	78	5.8	42	108.5	206.7	39.5	259.6	31	92.5	48.9
Low N	Buzz	12.4	79.6	5.4	43.5	149.1	142.8	25.2	238.4	50.1	95.1	48
	Hockett	13.5	77.9	4.9	36.4	93.5	165.2	73.8	188.3	41.4	89.2	49.7
	MT16M01902	12.8	76.8	4.5	35.1	76.3	167.7	70.1	175.5	44.8	87.1	46.7
	MT16M02201	12.4	82.5	5.8	46.7	92.4	131.6	52.1	235.1	49.6	93.1	47
	MT16M05610	13.2	78.8	5.5	42.1	112.5	206.4	27.1	257	38.6	94.9	48
High N	Buzz	12.6	79.5	5.8	45.5	154.6	147.4	32.7	254.2	54.4	96.6	48.2
	Hockett	14	77.2	4.9	35.1	93.3	169.1	87.2	186.7	52.6	91.7	47.3
	MT16M01902	13.3	76.5	4.6	34.6	72.7	169.9	58.3	180	51.2	92.8	45.2
	MT16M02201	12.9	82.1	5.9	46.1	86.9	138.3	56.4	238.1	45.9	94.9	46.7
	MT16M05610	13.6	78.2	5.8	42.7	109.1	202.3	30.8	262.7	40.7	95.4	46.8
Highest N	Buzz	12.9	79	5.5	43.1	151.6	151.4	30.3	245.3	51.6	95.7	47.6
	Hockett	14.4	76.6	5.2	35.5	102.5	182.9	67.6	200.2	36.2	88.5	48.2
	MT16M01902	13.4	76.1	4.8	35.6	77.6	179.5	74.1	189.7	38.6	88.4	45.1
	MT16M02201	13	82.2	6.1	47.1	97.1	143.4	51	256.4	39.1	91.1	45.9
	MT16M05610	14.2	78	6.1	42.6	116.2	218.2	27.4	271.6	36.7	92.8	48.2
GRAND MEAN		13.18	78.74	5.35	40.62	104.38	167.02	54.15	222.04	44.30	92.12	47.43
CV		3.11	0.65	3.44	3.79	8.19	5.96	48.65	5.18	23.92	2.63	3.03
LSD		0.34	0.43	0.15	1.27	7.06	8.22	21.77	9.51	8.76	2.00	1.19

The Forage Intrastate was grown in 6 locations in 2021 all dryland (Table 8). The lines are sorted by biomass production. Several lines were equal to the controls Haymaker and Lavina. The green highlighted lines have a stay-green parent, while the blue highlighted lines had a parent with improve digestibility (lower NDF and ADF). The drought compressed differences in biomass and grain yield.

Table 8: Forage Intrastate 2021 Across 6 Locations								
name	Heading	Height	Grain Yield	Tons/Acre	NDF	ADF	Test Wt	Protein
MT18F00803	145.2	60.8	73.3	3.06	55.6	29.7	42.7	15.1
Lavina	142.3	64.5	77.9	3.02	57.2	31.1	45.5	14.3
MT18F00503	143.9	62.1	71.8	3.01	57.1	30.9	45	15.3
Haymaker	143.8	65.2	65.6	2.99	58.6	32.2	46.6	16
MT19_F04_02	143.1	65.9	68.7	2.95	56.0	30.5	43.7	14.8
MT18F00403	144.3	66.6	68.3	2.94	59.4	32.0	43.7	15.9
MT17F01611	142.3	66.1	68.8	2.92	56.4	30.8	45.4	14
MT16F02902	142.9	69.3	73.6	2.89	58.6	32.2	46.6	14.7
MT18F00507	144.7	64	72.9	2.88	57.8	31.2	44.3	15.6
MT18F01104	142.4	71.9	55.1	2.87	58.3	32.8	45.5	14.5
MT17F02406	142.6	68.8	74.1	2.86	58.4	32.2	47.1	13.7
MT16F01601	141.1	67.4	82.4	2.81	56.2	30.4	46.2	13.9
MT19_F06_02	142.1	58.4	70.7	2.81	57.8	30.5	43.3	15.5
MT19_F05_04	142.3	63.4	71.1	2.81	58.0	30.9	44.2	12.7
MT19_F05_03	139.5	63	74.5	2.79	56.8	30.8	45.3	13.3
MT18F00607	145.9	68.1	70.5	2.77	62.0	33.0	44.6	15.2
MT19_F03_05	143.4	61.3	72.4	2.73	58.7	31.6	45.6	14.6
MT16F02408	140.9	65.2	73.4	2.71	55.7	30.2	47.8	14.7
Hays	145.1	60.5	74.9	2.70	58.8	31.5	45.9	14.7
MT19_F07_02	142.1	64.6	35	2.68	56.0	30.7	48.3	16.6
MT16F02410	143	64	72.3	2.66	56.3	30.3	45.5	14.5
MT19_F07_04	140.2	59.5	75.1	2.63	55.0	30.4	44.5	13.7
MT18F01010	144.5	62.1	56.7	2.63	58.9	32.7	45	15.3
MT19_F06_04	143.1	57.2	66	2.53	53.9	28.6	42.7	15.1
MT19_F04_03	141	60.2	69.8	2.43	56.5	31.0	47.4	14.1
GRAND MEAN	142.875	64.003	69.389	2.80	57.4	31.1	45.289	14.702
LSD	0.543	2.531	6.267	0.31	2.8	1.7	0.571	0.434
CV	0.529	6.028	12.556	15.22	6.9	7.4	1.754	3.668

Table 9 reports the performance of the most advanced food barley in 2021. Of the material close to release (MT18 H0 line) Havener yielded better over all. However, there are lines in the pipeline that may out perform Havener (e.g. MT19_H11_17), although these lines require more testing. Interestingly, the highest yielding purple lines still lag behind white lines. However, we are not testing against the most commonly grown purple hull-less, because it performs so poorly we have had weed issues when testing. We hope to share some purple lines with organic farmers in 2022 to see if it would be a good replacement.

Table 9: Agronomic performance of Hull-less lines 2021 at six locations

name	Yield	Protein	Test Wt	Plump	Height	Heading	Maturity	COLOR
MT18H02702	83.5	14.4	56.8	75.2	72	175.7		White
MT16H09302	75.7	14.2	56.8	35.5	71.2	173.2		White
MT18H03003	63.4	15	54.8	47.4	70.6	171.3		Purple
MT18H03101	62.4	15.2	57.8	2.7	66.7	176.5		Purple
MT19_H14_05	74.1	16.6	55	67.1	67.8	177		white
MT19_H11_05	80.6	16.1	56.3	64.2	70.6	178.3		white
MT19_H11_04	76.2	15.8	55.8	63.8	75.3	179.5		white
Havener	89.7	14.1	58	64	67	177.5		
MT19_H11_17	98.4	13.6	59.5	61.7	67.7	179.7	206.4	White
MT19_H14_11	95.1	13.6	57.7	47.3	65.1	181.1	204.5	White
MT19_H11_03	93.5	12	60.1	44.3	61.7	181	208.4	White
MT19_H14_06	92.4	12.8	59.7	20.9	65.3	180.6	207.7	White
MT19_H11_01	92.2	13.1	60	67.6	73.6	181.4	202.5	White
MT19_H09_09	83.4	n/a	62.6	68.4	71.3	179.6	207.3	Purple
MT19_H09_12	77.4	n/a	63	50	75.8	180.3	207.8	Purple
MT19_H14_02	87.4	13.1	61.5	80.7	69.2	180.5	208.3	White

Although MT18H02702 tends to yield less than Havener across location, when dryland locations are compared to irrigated, MT18H02702 perform equal to Havener. We will test this line again in 2022 to determine if we should release.

ENVIRONMENT	NUMBER	YIELD (BU/AC)		PERCENT	
		MT18H02702	Havener	DIFFERENCE	
DRYLAND	10	67.0	67.7	98.9	NS
IRRIGATED	8	108.5	115.7	93.8	**

The following Tables report Feed/malt intrastate trial data by location.

Malt Intrastate 2021 Bozeman Dry

name	Yield (BU/AC)	Plump (%)	Protein (%)	Test Wt (LBS/BU)	Heading (JULIAN)	Maturity (JULIAN)	Height (CM)	Extract (%)	S Protein (%)	S/T Protein (%)	FAN (PPM)	B Glucan (PPM)	A Amylase (DU)	DP (ASBC)
MT17M02507	111.9	96.1	11.4	52.2	176.6	205.6	62.5	79.5	4.2	36.7	153	338.3	62.2	80.7
MT18M10106	111	96.1	11.2	53.5	179.3	206.9	63.6	77.3	3.7	33.1	115.9	421.1	55.6	185
MT16M01801	110.3	95.9	11.5	52.2	178	206.5	72	80.6	4.8	42	197.4	325.7	77.3	149.7
MT18M11002	110.2	92.5	12.6	53.3	179.8	205.7	<u>75.1</u>	75.6	3.7	29.2	117.1	511.6	40.5	116.5
MT17M01711	106.9	95	12.1	51.2	176.2	201.1	64.9	79.4	4.1	34.9	162.6	255.6	58.1	151.9
MT16M01902	106.7	97.4	12.3	52.2	175.4	204.6	68	78.9	4.1	33	163.1	501.1	64.5	157.5
MT18M11103	105.5	92.6	12.5	51.6	179.5	206.6	63.9	80	5.1	41.2	214.6	136.6	90.4	152.9
MT16M00709	104.8	96.1	10.7	53	177.1	207	73.2	77.8	3.5	32.9	114.5	481.3	42	108.6
MT18M11006	104.7	93.5	12.3	52.4	176.2	203.2	69.9	79.3	5.3	43.3	189.6	80.9	79.2	115.5
MT18M11004	103.5	92.6	13	53.5	178	205.7	67.1	74.2	3.7	28.2	116.4	639.5	44.4	101.2
MT18M10204	102.2	97.4	11.8	51.6	173.2	199.5	61.6	78.6	4.4	36.7	164.6	254.7	69.2	152.9
MT18M09904	102.1	93.3	13.4	52.3	179.9	202.2	63.8	77.1	5	36.1	230.5	283.7	126.5	188
MT18M11105	101.7	94.8	12.3	52.9	182.1	205.8	67.5	78.8	4.5	36.5	177.6	276.9	72.9	133.4
MT18M09602	101.3	95.4	10.7	53.7	176.8	207.8	65	79.6	4.1	39.7	141.7	368.7	60.5	120
MT18M10401	100.6	94.7	13.2	52.9	180.5	206.8	67.5	77.6	5	37.7	187.4	210.3	89	179.8
MT18M09301	100.4	96.8	12.4	52.1	181.2	206.1	71.3	79	4	32	140.6	126.8	54.1	127.9
MT18M11101	100.4	94.3	11.9	52.7	175.9	202.1	64.3	79.5	5.2	42.7	212.2	146.4	76.1	125.8
MT18M09205	99.9	94.8	12	51.3	179.6	202	71.2	78.5	4.4	35.6	172	150.3	70.7	129.7
MT17M04801	99.4	96.6	12.3	54.3	176.3	204.1	70.6	77.5	4.1	34	137.6	500.8	49.8	122
MT18M10107	99.3	97.9	13.5	53.8	180	204.8	67	74.7	3.9	29	128.8	480.1	49.9	171.1
Odyssey	98.7	96.1	12.6	52	181.8	206	63.7	78.5	3.7	28.3	130.9	123.4	48.2	124.6
MT17M05416	98.2	92.8	11.9	52	178.6	206.6	65.2	79.5	5.2	43.2	213.3	70.4	94.7	153.8
Merit 57	98.1	86.7	12.9	51.8	177.4	207.7	67.5	79.8	5	38.7	211.6	71.5	119.5	185.5
Hockett	98	96.6	12.8	53.8	178.2	202.8	65.9	78	4.3	33.1	165.1	421.9	81.2	176.1
MT17M01906	97.2	97	12.2	51.7	175	203.9	63.6	78	4	33.3	143.7	246.6	51.1	162.6
MT16M02201	97.1	97.1	11.9	52.3	176	200.9	65.3	83.4	5.4	45.9	208.2	157.8	82.4	144.8
MT18M09802	97.1	92.7	12.5	51.8	179.7	204.2	67.3	75.5	4.2	33.3	158.7	362.5	66.3	155
MT18M09804	97.1	95.9	12.2	53	179.2	206.5	65.9	76.7	4	32.5	127.5	509.4	59	158.2
MT16M00707	96.3	97.2	11.8	53.4	178.7	206.8	74.7	79.4	4.7	40.3	171	238.4	67.4	151.5
MT17M05508	95.7	91.3	12.5	53.3	178.4	201.7	66.7	78.7	5	40	208.5	155.1	106.2	175.6
MT18M10208	94.7	98.4	12.5	52.6	175.7	204.5	67	76.7	4.4	35.9	158	319.6	63.2	167.5
MT16M05610	94.5	96.3	12.9	51.9	179.2	207	64.7	79	5.3	41.8	229	143.7	103.3	193
MT18M06011	94.5	97.6	12.1	52.9	171.6	199.8	64	82.2	5.6	46.1	232.7	83	90.7	183.4
MT17M05502	92.5	95.8	12.9	54	177.7	205.4	68.1	76.5	4.1	32	145.1	360.6	61	140.2
MT17M00302	92.2	95.4	11.4	53.3	179.9	208.7	68.8	77.7	4.3	37.6	150	211.5	53.3	147.5
MT18M09901	91.6	93.9	12.9	50.6	182.2	203.8	60.2	77.4	4.5	35.2	180.9	172.4	87	209.7
MT17M05808	91.1	94.7	12.8	52	177.3	199.7	71.3	79.8	5.5	43	224.9	60.2	103.8	171.6
MT18M06009	90.8	98.7	11.6	52.4	173.2	201.1	64.9	80.6	4.6	39.6	165.5	144.3	63.3	159.9
MT18M09902	90	94.6	12.7	52.3	180	206.6	67.3	76.3	4.8	37.4	201.6	502.6	109.6	167.1
MT18M06008	89.6	97.4	11.9	53	172.4	199.9	65.2	82.5	5.6	46.2	233.4	77	78.7	164.3
MT18M09403	89.5	98.5	13.4	53.1	178.7	205.9	68.4	76.6	4	29.5	132.1	220.2	53.3	103.5
MT18M11106	89.4	95.2	13.2	51.7	177.8	203.1	64.9	77.9	4.8	36.9	190.3	153.9	68.5	183.6
MT16M09602	89.1	98.2	11.6	52.9	173.4	204.5	65.5	80.8	5.2	44.5	209.9	209.9	83.8	127
MT16M05403	88.4	93.5	12	54.3	179.1	208	60.2	77.1	4.3	35.8	150.8	411.7	67.5	154.5
MT17M01908	86.8	98.4	11.7	52.6	174.2	205.6	66.8	80.3	4.8	41.2	176.9	96.1	62.4	170.5
MT18M10207	85.5	98.6	12.6	52.3	176.1	206	68.4	76.2	4.5	35.2	153.8	230.6	56	152.4
MT18M06012	85.1	97.6	11.3	52.7	174.1	202.3	62	80.6	5.1	46.4	222.2	243.9	81.7	114.5
MT18M10205	78.3	97.8	13.2	51	175	202.6	63.9	76.3	4.5	34.3	171.5	188.9	67.7	149.9
MT17M06305	75.5	96.1	12.3	52.1	180.1	207.8	67.5	78.9	4.7	39.2	194.9	278.1	99.3	168
GRAND MEAN	96.847	95.593	12.27	52.556	177.599	204.571	66.633	78.457	4.549	37.161	173.453	264.4	72.714	150.733
LSD	9.689	2.055	0.423	0.859	1.787	2.602	5.399							
CV	5.829	1.306	2.159	0.952	0.621	0.786	5.037	2.431	12.196	13.265	20.14	55.59	27.866	18.006

Malt Intrastate 2021 Bozeman Irrigated

name	Yield (BU/AC)	Heading (JULIAN)	Maturity (JULIAN)	Height (CM)	Xantho
MT17M02507	137.2	174.2	206.5	89.8	1
MT17M00302	132.8	174.8	207.8	88.4	3
MT16M05403	129.7	174.8	207.3	86.9	4
MT17M01906	128.2	168.8	205.8	88.2	4
MT17M05416	126.9	174	206.8	90.1	3
MT18M10106	125.6	173.9	206.4	91.2	1
MT18M10107	125	174	206.8	91.4	0
MT16M01801	124.6	174	206.5	90.9	3
MT18M11002	124.6	174.1	205.9	96.6	1
MT17M04801	124.4	174.1	206.5	88	1
MT16M00707	124.2	173.8	204.8	96.3	1
MT18M11103	124.1	174.4	206.8	88.7	2
MT18M09403	122.4	174	205	95.2	3
MT18M10401	121	174	207.1	89.8	2
Odyssey	121	175.4	208.5	70.7	0
MT18M09904	120.9	174.4	205.2	89.8	1
MT17M05502	119.7	173.8	205.6	98.9	3
MT16M05610	119.1	172	207.4	92.2	4
MT18M09301	118.9	175.9	209.1	84.1	1
MT18M11106	118.1	173.9	207.2	90.6	4
MT18M11004	117.7	174	206.2	88.7	0
MT16M00709	117.4	174.3	206.9	95.2	2
MT18M06012	116.8	172.2	207.3	80.6	5
MT18M11101	116.8	174.3	204.2	86.3	0
MT16M01902	116.7	174	204.8	81.7	2
MT18M11105	116.4	173.9	207.2	93.3	1
Merit 57	115.9	173.9	207	85	3
MT18M09602	115.9	173.7	207	88.4	4
MT17M01908	115.8	170.7	206.9	90.3	3
MT18M10208	115.7	173.8	205.5	92.7	2
MT16M02201	114.3	174.1	206.4	86	2
MT17M05508	113.8	174.2	204.5	91	3
MT18M11006	113.8	173.9	206.4	98.2	2
MT16M09602	113.5	170.7	206.8	77.5	4
MT17M05808	111.1	173.9	202.8	95.8	1
MT18M10205	110.5	172.3	204.6	82	2
MT17M06305	110.4	174.7	208.3	91.6	1
MT18M09902	108	174.2	204.7	93.5	2
MT18M10207	107.9	174.8	205.6	94.6	2
MT18M10204	106.9	172.4	201.4	77.6	3
MT18M09802	105.4	174.9	203.9	86.1	1
Hockett	103.7	174	204	92.7	2
MT17M01711	103.1	172.2	203.3	80.1	4
MT18M06009	100.5	169.3	204.2	73.7	5
MT18M09205	100.1	173.8	202.1	94	4
MT18M09901	99.9	175.2	204.5	92.8	1
MT18M09804	99.8	174.1	206	96.3	3
MT18M06011	97.5	168.9	204.5	77.4	5
MT18M06008	89.3	169.3	202.9	79.1	4
GRAND MEAN	115.574	173.469	205.769	88.571	2.347
LSD	13.607	2.099	2.739	6.199	2.372
CV	6.296	0.618	0.682	3.763	53.04

Malt Intrastate 2021 CARC DRY

name	Yield (BU/AC)	Plump (%)	Protein (%)	Test Wt (LBS/BU)	Height (CM)
MT16M09602	29.1	68	13.6	52.9	46.5
MT18M11101	29.1	26.7	14.4	50.9	49.2
MT16M01902	28.9	60.7	13.3	52.2	48
MT17M02507	27.4	30	13.6	50.9	42.7
MT18M06011	26.6	35	13.7	51.6	45.7
MT18M06008	26.3	46.5	13.1	52.4	49.1
MT18M11004	26.3	50.5	15.2	52.9	48.6
MT18M09205	24.8	54	13.6	50	53.3
MT17M01906	23.9	40.7	13.3	50.1	47.1
Odyssey	23.7	46.1	15.3	50.9	50.3
MT16M00709	23.4	36.5	14	52.7	53.8
MT18M10205	22.9	57	14	52.6	49.3
MT18M09301	22.2	79.5	16.1	52.8	55.4
MT18M10208	22.2	33.6	14.6	51	47.4
MT18M10204	21.9	29.9	14.5	50.6	44.4
MT18M11106	21.8	50.4	14.9	51.4	46.9
MT18M06009	21.4	61.3	12.5	51.3	47.9
MT18M11006	21.3	43.1	16.1	51.1	46.3
MT16M00707	20.6	59.5	13.5	51.7	50.6
MT16M01801	20.5	35.7	14.4	49.9	50.7
MT17M01908	20.2	71.9	12.9	53.3	51
MT18M09802	20.1	81.3	14.5	54.3	49.5
MT17M05508	20	38.1	16.2	54.1	51.7
MT18M09602	19	63.6	13.3	51.5	48.3
MT17M01711	18.9	30.1	15.3	49.4	48
MT17M06305	18.9	83.2	12.8	54.5	50.6
MT18M10207	17.6	38.6	15.6	52	47.8
MT18M06012	17.3	75.9	13.1	52.4	45.5
MT16M02201	17.2	78.3	14.1	52.7	47.5
MT18M09804	16.8	39.5	15.3	52	44.5
MT18M10106	16.3	56	14.4	45.3	46.8
MT18M09902	16.1	82.9	13.7	54.7	47
MT17M05416	15.9	39.1	15.5	51.1	43.1
MT17M00302	15.6	46	14	53.9	47.3
MT18M11103	15	40.4	15.2	50.6	46.1
MT18M10107	13.8	61.6	16.5	51.1	52
MT17M05808	13.7	78.3	15.6	47	50.8
MT18M11105	13.6	52.4	15.5	53.4	48.9
MT17M05502	13	76.2	16.3	45.8	54.9
MT16M05610	12.9	90.7	13.8	53.4	43.1
MT18M09403	12.7	78	14.6	50.1	50.3
MT18M11002	12.3	24.3	16	51.4	51.6
MT18M10401	12.1	81.3	15.3	51.5	51.2
MT16M05403	12	67.3	14.8	49.6	49
Merit 57	11.9	47.8	14.3	47.1	47
MT17M04801	11	58.1	15.5	54.5	52.6
Hockett	8.5	87.3	15.9	50	48.6
MT18M09904	7.9	76.8	15.9	52.1	48.4
MT18M09901	7.6	86	16.2	48.7	45.1
GRAND MEAN	18.612	56.651	14.608	51.37	48.6
LSD	12.336	24.58	1.409	4.84	4.719
CV	34.884	22.01	4.952	4.846	5.214

Malt Intrastate 2021 EARC DRY

name	Yield (BU/AC)	Plump (%)	Protein (%)	Test Wt (LBS/BU)	Heading (JULIAN)	Height (CM)
MT18M10106	68.9	71	13.3	50.6	172.1	54.9
MT17M02507	68.7	64.9	12.9	49.1	167.1	48.9
MT18M11002	68.4	49.7	14	49.9	169.2	51.5
MT18M11004	67.5	28.2	13.9	49	170.7	52.7
MT17M01711	65.7	63.4	13.5	47.1	165.8	52.8
MT18M09904	65.6	45.5	14.9	47.4	175.2	50
MT16M01902	65.2	82.2	13.9	49.3	165.3	50.8
MT18M10204	65.1	76.8	13.6	51.2	165.6	49.9
MT18M11106	64.8	71.7	14	51.1	165.7	56.8
MT16M00707	64.3	81	13	50.8	168.5	57.3
MT16M01801	64.3	59.6	13.5	47.6	171.5	55.7
MT18M11006	63.2	47.5	14	48.6	167.9	53.5
MT18M11103	62.2	41.1	14.6	44.4	176.2	54.3
MT17M04801	61.7	66.3	13.9	50.1	167.8	59.5
MT17M01906	61.6	81.5	13.4	49.6	166.1	51.9
MT16M00709	61.2	68.5	13	48.4	168.8	56
MT16M05403	61	49.7	13.8	50.2	172.8	51.1
MT18M11101	60.8	39.1	14	47.5	169.5	50.1
MT17M01908	60.4	90.4	12.6	51.4	167.1	54.5
MT18M09403	60.3	83.1	14.2	50.5	168.5	57.7
MT18M06009	59.7	91	12.6	50.5	165.4	51.5
MT18M06011	59.7	88.4	13.1	53.4	164.4	50.3
MT18M10208	59.5	66.5	14.1	50.8	168.1	55.6
MT17M05416	59.1	55.3	14.2	47.8	168.3	49.9
MT18M06012	59.1	85.1	12.5	50.2	166.2	47.2
MT17M00302	59	47.2	14	49.5	171.8	56.5
MT17M05502	58.6	57.5	14.6	48.5	171.6	58.9
MT17M05508	58.1	50	13.9	48.2	168.7	55.5
MT18M09301	58.1	62	14.9	45.4	173.7	56
MT16M02201	57.8	79.5	13.4	48	165.4	53.8
MT16M05610	57.3	69.5	14.7	47.6	174.1	51.4
MT18M09902	57.2	49	14.6	48	173.5	54.5
MT18M11105	57.2	46.1	14.5	48.1	176.4	47.7
MT17M05808	56.8	62.8	14.7	47.6	168.9	50.2
MT18M10207	56.1	82.8	14.2	50.1	166.6	53.6
MT18M09602	55.8	68.5	13.3	49.8	169.5	53.7
MT18M09205	55.7	62.1	13.9	46.1	170.5	49.2
MT16M09602	55.4	87.3	13	52.7	166.6	46
MT18M09804	55	53.8	14.8	48.3	171.1	54.2
MT18M10107	54.2	53.9	15.2	49.5	174.5	54.1
MT18M10205	54.1	88.2	13.9	52.4	165.7	52.4
MT18M09901	53.6	46.4	15.8	44.4	177.2	50.3
MT18M09802	53.1	43.5	15.1	47	177	51.7
MT18M10401	52.7	38.9	15.4	46.5	172.7	55.5
MT18M06008	51.9	89.8	12.7	53.5	165.7	47.7
MT17M06305	51.7	59.6	13.9	46.7	173.5	58.7
Hockett	64.7	61.5	14.2	50.1	170	52.7
Merit 57	48.8	26.8	15.8	44.3	172.6	51.5
Odyssey	62.1	63.9	14.1	46.8	178.2	48.2
GRAND MEAN	59.652	63.235	13.985	48.892	169.98	52.823
LSD	4.924	9.132	0.752	1.238	3.177	6.574
CV	4.535	7.818	2.95	1.346	0.949	6.549

Malt Intrastate 2021 EARC IRRIGATED

name	Yield (BU/AC)	Plump (%)	Protein (%)	Test Wt (LBS/BU)	Heading (JULIAN)	Height (CM)
MT16M01902	75.1	76.9	12.5	46.5	175.4	63.9
MT17M02507	70.3	75.7	11.2	48.2	178.2	68.9
MT17M01711	70	71.2	12.5	45.2	173.8	62.6
MT18M10208	69.8	80.7	12	49.5	176.3	65.8
MT18M11106	69.7	74.8	12.6	48.6	178.7	64
MT18M10207	69.5	82.4	12.8	48.9	174.6	63.1
MT18M06008	68.4	83	11.5	48	172	64.2
MT18M11105	68.3	73.3	12.7	47.9	180.8	62.1
MT18M11002	68.1	64.8	12.8	47.7	180.3	63.5
MT17M01908	67.5	82	11.4	47.4	173.4	69.8
MT18M11101	66.6	67.2	12.7	47.8	177.5	57.9
MT16M01801	66.2	70.8	12.1	46.6	180.4	72.8
MT18M06011	65.9	84.1	12.1	48.6	172.3	59.3
MT16M00707	65	75.6	11.9	47.7	177.8	68.9
MT16M00709	64.8	74.5	11.4	46.9	177.3	70
MT18M11103	64.6	69.9	12.7	44.7	181.2	64.1
MT18M11004	64.4	60.2	12.6	47.8	180.7	64
MT16M09602	63.1	84.7	11.6	49.3	175.9	61.6
MT18M10204	62.9	75.4	13.2	46.7	173.5	56.9
MT17M00302	61.8	71.9	12	48	181.4	64.8
MT18M11006	61.7	61.7	12.5	47.3	178.4	61.5
MT17M01906	60.8	71	12.7	45.8	173	64.7
MT18M10205	60.1	83.9	13.2	49.5	172.8	64.1
MT18M09804	60	69.7	12.8	46.9	180.4	63.4
Merit 57	59.6	72.5	12.9	47.3	179.1	68.1
MT16M02201	59	80.9	11.9	43.9	173.6	61
MT18M10106	58.8	72	12.1	48	179.9	69.1
MT17M04801	58.3	69.2	12.9	46.8	177.6	67.2
MT18M09904	58.2	70.6	13.6	46.2	181.3	64.8
MT18M09403	57.6	83.7	13.9	47.2	179.6	67.5
MT18M09602	56.4	76.4	11.7	46.8	179.1	62.8
MT18M06012	56.3	81.3	11.8	46.2	173.8	60.5
MT18M06009	55.6	81.2	12.1	45.5	173	56.9
Hockett	55.6	73.6	13.7	47	180.9	66.2
Odyssey	55.6	79.8	13.3	45.9	180.6	57.9
MT18M10401	54.7	64.8	13.3	47.1	180.7	63.4
MT18M09901	53.9	74.9	13.2	45.2	182.9	66.5
MT18M09902	53.8	67.2	12.7	45.2	180.9	73.9
MT17M05508	53.6	67.2	13.5	46.1	180.4	71.7
MT16M05610	52.2	75.9	13.1	46.8	180.6	63.3
MT16M05403	51.4	72.1	12.9	47.1	180.8	67.3
MT17M05416	50.5	64.2	13.3	45.2	180.6	62.3
MT18M09301	50.2	79.6	13.4	46.5	181.2	69.1
MT17M05808	50.1	69.2	14.1	45.2	178.1	66.1
MT18M09205	49.6	73.1	12.3	44.9	180.6	72.8
MT18M10107	42	68.1	14.5	46.5	180.5	64.9
MT17M05502	40	74.5	14.5	47.8	180.9	69.4
MT18M09802	38.8	60.1	14.2	45.1	182.4	61.8
MT17M06305	28.9	79.3	14.1	46.6	181.2	74.4
GRAND MEAN	58.882	73.818	12.749	46.896	178.293	65.122
LSD	11.723	7.028	0.857	1.702	2.558	8.224
CV	10.686	5.075	3.667	1.807	0.742	6.564

Malt Intrastate 2021 NARC DRY

name	Yield (BU/AC)	Plump (%)	Protein (%)	Test Wt (LBS/BU)	Heading (JULIAN)	Maturity (JULIAN)	Height (CM)	Sawfly Cut
MT17M01711	50	60.7	14.9	43.8	173.9	191.5	55	9
MT18M06011	49.3	69.8	13.8	47.5	166.1	189.6	61.8	12
MT17M02507	48.8	56.7	14.3	44	170.7	192.2	57.2	2
MT17M01908	48.1	84.4	14	46.9	172.3	191.1	59.8	7
MT18M11006	47.7	61.7	16	47.2	173.9	192.9	61.2	2
MT17M01906	47.5	64	14.7	44.4	171.5	191.6	55.8	4
MT16M00707	47.2	74.3	14.5	47.8	176.8	195.3	62	7
MT16M01801	46.7	56.8	14.5	44.6	176.9	190.7	62.2	5
MT18M11002	45.2	65.3	16.6	48	176.8	194.3	59.6	4
MT18M10106	45	66.1	15.6	47	177.3	195.5	57.3	5
MT18M06009	43.8	78.6	14	46.3	166.8	190.9	55.4	7
MT16M01902	43.5	74.8	15.1	45.4	167.8	191.8	59	5
MT18M06008	43.5	67.1	14	47.3	167.1	189.2	60.5	10
MT18M09301	42.6	74.8	16.7	44.6	176.6	193.8	58.9	2
MT18M10207	42.3	83.8	15.4	47.1	167.5	194.6	55.7	1
MT18M10204	42.3	52.9	14.8	46.2	167.1	189	56.5	4
MT18M10401	41.5	61.9	16.4	45.7	177.1	193.5	54.7	0
MT18M11101	41.2	45	15.3	46.5	175.1	192.5	54	5
MT16M00709	41.1	73.8	14.6	47.2	173.6	195.4	63	4
MT18M09205	41.1	68.9	15.7	44.4	178.4	193.4	60.8	15
MT18M11004	40.7	39.1	17	47.5	176.7	194.1	52.2	2
MT18M09904	40	43.9	17.3	43.4	179.6	192.4	56.2	1
MT18M09804	39.8	47.5	16	45.5	174.6	193.5	55.1	2
MT18M09901	39.7	62.9	18.1	43	178.7	193.5	55.1	0
MT18M10208	39.6	76.5	15.8	48	168.7	192.5	56.5	6
MT18M11106	39.2	70.5	15.7	47.7	175.8	194.2	53.9	3
MT18M09602	38.8	69.3	14.5	46.6	174.3	196.5	57.6	8
MT17M05416	38.5	56.4	16.3	44.8	176.6	195.6	55.1	2
MT17M05508	38	51.6	16.5	45.6	178.4	192.5	57.8	14
MT16M05610	37.3	76	16.4	44.2	177.7	196.2	54.9	2
MT17M04801	37.2	72.7	16	49.1	173.3	195.2	57.2	4
MT18M11103	37.1	60.4	16.4	44.6	177.4	196.9	58.5	3
MT18M10205	37.1	83.6	14.5	47.7	168.1	193.7	62.7	6
MT18M10107	36.8	60	17.1	47.2	176.8	194.1	59	0
MT16M09602	36.1	81.7	14.4	48.6	167.5	196.4	53.4	8
MT18M09802	36	49.8	16.9	45.5	179.1	194.2	56.8	0
MT17M05502	35.8	67.1	16.9	46.6	174.4	195.1	62.5	8
MT18M11105	35.1	52	16.9	45.6	179	195.8	53.5	0
MT17M00302	35.1	52	15	47.2	176.4	197	56.8	2
MT16M05403	35.1	43.1	15.7	47.3	177	197.2	55.7	3
MT18M09403	34.7	80.9	16	46.3	174.1	195.8	58.2	2
MT16M02201	34.6	74.4	15	44	176.9	194.2	54.2	8
MT18M09902	33.5	53	16.5	44.3	179	194.2	54.8	4
MT18M06012	31.1	75.5	13.2	46.3	168	193.9	53.1	4
MT17M05808	28.2	64.5	17.7	44.5	178.3	194.6	55.2	13
MT17M06305	26.1	70.3	16.5	46	177.1	197.4	59.8	0
Hockett	33.5	69.1	17.3	46.9	179	194.3	57.6	11
Merit 57	32.3	45.4	17.7	42.9	174.2	196	56.4	1
Odyssey	44.4	60.6	16.2	44	177.2	193.2	55.5	1
GRAND MEAN	39.786	64.304	15.72	45.977	174.435	193.857	57.261	4.619
LSD	4.356	6.336	0.479	0.94	1.495	1.343	2.585	4.187
CV	6.626	6.176	1.912	1.296	0.55	0.442	2.838	55.53

Malt Intrastate 2021 NWARC DRY

name	Yield (BU/AC)	Plump (%)	Protein (%)	Test Wt (LBS/BU)	Height (CM)	Lodging
MT17M01906	167.5	95.6	12.3	52.4	93.7	7
MT18M10106	167.1	97.8	11.2	53.6	93.5	45
MT18M09804	165.8	98.6	12.6	53.4	101	18
MT17M00302	164.9	97.4	11.5	53.3	99.9	23
MT18M09902	164.8	97.6	12.4	52.8	98.7	28
MT17M04801	161	96.9	11.4	53.6	95.4	23
MT17M05508	160.9	93.8	12.4	52.1	95.7	62
MT16M01801	158.9	97.7	11.6	52.5	98	23
MT16M01902	158.6	95.9	12.2	51.3	88.8	18
MT18M10207	158.4	99	13.1	53	100.9	0
MT17M01908	156.9	98.9	12	53.4	91.8	2
MT18M10107	156.8	98.2	12.3	53	97.6	14
MT18M11006	155.9	96.8	12.2	53	97.2	30
MT18M11103	153.4	94.7	11.9	51.4	97.4	21
MT16M05403	153	96.1	12	53.8	94.1	40
Merit 57	150.9	92.1	12.5	51.8	92.4	38
MT18M10401	150.8	98.9	12	53.8	92.3	19
MT18M09403	148.1	97.8	12.4	51.5	89.1	15
MT18M09602	147.7	97.1	10.9	53.4	96	25
MT16M02201	147.6	97.2	12	51.7	99.4	27
MT18M09301	147.4	95.4	12.4	50.3	82.8	18
MT17M02507	146.6	97.9	11	52.5	94.4	50
MT18M09802	145.7	95.4	12.2	52.3	96.5	40
MT18M09904	145.2	93	12	51.5	94	43
MT18M11101	145	94.9	11.7	53.3	84.4	6
MT18M10204	144.7	95.2	12.2	52	88.8	31
MT18M11004	144.5	94.6	13.3	53.9	97	34
MT18M11105	143.1	96.8	12	53.3	92.7	29
MT16M05610	142.6	95.9	11.9	51.3	91.3	31
MT18M11002	141.9	95.3	13.1	53.8	100.8	50
Odyssey	140.8	96.5	11.4	49.8	74.1	23
MT18M06008	140	93.9	12.2	52.9	94	35
MT16M00709	138.8	97.3	11.5	53.1	107.4	36
MT17M06305	138.6	98.3	12	53.2	102.9	37
MT18M06009	137.8	95.7	11.6	52.6	85.6	13
MT18M09901	137.3	97.7	12.5	51.8	101.1	44
MT18M06011	137.2	94.1	12.1	53.1	86.7	3
MT16M00707	136.6	98.4	12.4	53.3	100.6	13
Hockett	136.6	92.3	12.7	52.9	91.8	26
MT17M01711	136.4	93.4	11.7	51.1	87.7	24
MT18M09205	136	97.6	11.4	51	98.1	29
MT18M06012	134.3	97.8	11.6	53.1	84.7	2
MT16M09602	132.2	97.4	11.9	53.1	87.5	15
MT17M05502	131.3	94.7	12.6	53	105	58
MT18M11106	128.2	96.5	12.5	51.4	91.8	33
MT18M10208	126.9	97.7	12.8	52.3	96.2	14
MT18M10205	126.6	97.6	13.6	51.9	85.5	10
MT17M05416	124	94.8	12.1	51.4	94.1	34
MT17M05808	115.6	88.4	13.3	50.5	98.3	51
GRAND MEAN	145.522	96.173	12.137	52.461	94.052	26.61
LSD	25.167	3.272	0.909	1.289	8.42	27.74
CV	9.204	1.83	4.181	1.293	4.963	57.41

Malt Intrastate 2021 SARC DRY

name	Yield (BU/AC)	Plump (%)	Protein (%)	Test Wt (LBS/BU)	Height (CM)
MT17M02507	69.8	71.2	12.6	49.2	85
MT18M11006	67.5	51.9	14.9	48.5	84.1
MT18M11002	66	63.7	14.3	49.5	83.6
Odyssey	65.9	52	14.5	46.4	70.3
MT18M11101	65.7	56.7	13.8	50.8	75.1
MT18M09205	65.6	66.2	14.3	47	81
MT18M11106	65.6	64	13.8	49.8	74.9
MT18M10401	64.1	41	15.3	47.6	78.7
MT17M04801	62.3	59.4	14.3	50.8	79.3
MT17M05416	61.8	59.5	14.2	48.8	76.7
MT18M09301	61.5	55.2	15	45.4	75.7
MT18M11103	60.8	58.4	14.5	46.8	74.1
MT17M01711	60.5	56.7	14.4	48.3	77.8
MT18M11105	59.4	57.6	15.1	49	78.1
MT16M01902	59.3	73.9	13.8	49.3	77.7
MT17M05508	58.8	43.2	14.9	49	76.5
MT18M11004	57.1	43.8	14.5	49.6	82.6
MT16M01801	57	67.3	12.9	48.2	84.5
MT18M09904	56.9	42.4	15.6	48.4	74.2
MT18M10106	56.1	68.4	13.5	50.5	77.6
MT17M05808	55.8	61.3	15.6	49.4	80.4
MT17M05502	54.8	65	14.9	49.6	82.4
MT17M00302	54.4	67.2	12.9	50.8	79.1
MT16M02201	53.8	74.3	12.9	49.3	82.3
MT16M05610	53.4	78.6	13.8	49.2	74.3
MT18M09901	52.8	52	15.7	46.7	75.9
MT18M09902	52.5	60.9	14.2	49.6	77.3
MT18M06009	52.2	83.5	12.9	51	82
MT18M10107	52.1	65.5	14.8	50.6	80.8
MT17M01906	52	77	13.1	49.9	82.8
MT16M00707	51.5	84.7	12.9	51.5	82.2
MT18M06012	50.5	65.9	<u>12.1</u>	50.6	76.9
MT16M05403	49.6	54.2	14	51.5	76
MT18M10208	49.3	66	14.5	50.9	81.6
MT18M10207	48.2	83	14.2	50.5	82.5
Hockett	47.9	70.5	14.5	51.4	82.6
MT18M09802	47.4	40.4	15.3	49	72.4
MT18M06011	47.1	84.3	12.9	52.5	85.9
MT18M10204	46.8	60.7	14.4	50.7	81.8
MT16M00709	45.6	66.2	13.2	49.5	<u>87.7</u>
MT18M10205	45.2	84.8	13.9	51	83.6
MT18M09403	42.5	78.9	15.2	50.8	80.1
MT17M06305	41.6	72.5	14	50.2	80.7
MT18M06008	40.2	86.6	13	52.2	85.5
Merit 57	39.7	55.5	15	48	74.8
MT16M09602	39.4	85.4	12.5	<u>52.5</u>	77.7
MT18M09602	39	78.5	12.6	51.3	80.5
MT17M01908	38.9	79.7	12.8	49.9	80.4
MT18M09804	34.1	49.3	14.3	47.8	78.7
GRAND MEAN	53.474	64.999	14.046	49.603	79.516
LSD	10.824	15.017	0.762	1.503	5.535
CV	10.401	12.307	2.907	1.56	3.712

Malt Intrastate 2021 SARC IRRIGATED

name	Yield (BU/AC)	Plump (%)	Protein (%)	Test Wt (LBS/BU)	Height (CM)	Extract (%)	S Protein (%)	S/T Protein (%)	FAN (PPM)	B Glucan (PPM)	A Amylase (DU)	DP (ASBC)
MT16M01801	131.2	97.2	10.1	54.4	94.6	84	4.6	45.7	171.6	577.9	72.4	110.7
MT17M05808	115.3	97.1	10.6	54.2	95	82.2	4.5	42.4	163.1	134.7	85	132.9
MT16M02201	119.8	93.6	11.6	54.2	89.6	82.1	5	43.2	206.3	314.2	89.3	121.4
MT17M01908	112.9	98.5	10.9	54.3	89.3	82	4.7	42.8	170.6	149.7	71	142.4
MT18M11006	139.3	94.6	10.8	54.5	97.3	81.8	4.8	44	185.7	129.7	81.3	106.8
MT18M11101	139.6	93.8	11	55.1	86.4	81.6	4.7	42.4	183.8	291	78.9	106.7
MT18M10401	126.9	95.7	11.2	54.2	91	81.5	5	45.4	197	239.8	92.6	144.3
MT18M06009	120.8	96.6	11	53.3	81.7	81.3	4.3	38.7	175	245.3	74.6	129.7
MT16M09602	115.7	96.9	11.2	54.3	85.3	81.3	4.7	42.8	197.2	519.8	76.5	93.5
MT18M06011	113.3	93.5	11.2	54.2	87	81.3	4.7	42.1	180.6	322.3	80.5	131.7
Hockett	132.9	89.7	11.3	54.3	85.8	81.2	4.8	43.2	192	288.5	97.4	141.6
MT16M05610	122.5	94.7	10.3	53	90.7	81.2	4.7	45.5	188.1	234.6	85.3	119.9
MT18M06008	109.3	95.7	11.6	54	86.3	81.1	4.8	42.7	184.2	355.1	79.5	119.2
Merit 57	136	86.4	10.7	51.9	92.1	81	4.7	43.8	195.8	143.4	113.3	151.8
MT18M11105	135.4	96.2	10.9	54.3	94.8	80.8	4.5	41.6	168	324.7	58.4	107.1
MT18M09902	130.1	92.5	10.9	53.9	91.7	80.8	4.6	42.9	180.9	262.8	94.1	138.8
MT17M05416	120.9	95.2	10.8	52.9	88.6	80.8	4.6	42.7	161.9	355.8	73	121.7
MT18M09403	112.7	97	10.1	53.5	87	80.6	3.4	33.7	128.8	178.2	51.5	96.9
MT16M01902	130.6	93.7	11.1	52.6	86.9	80.5	4.6	41.5	184.2	290.5	81.5	131.9
MT18M11103	132.2	93.1	10.6	52.3	89.1	80.4	4.4	42.1	173.7	227.6	68.2	124.6
MT18M09904	130.7	96.6	11	54.8	94.3	80.4	4.7	42.5	197.8	446.8	90.9	105.1
MT18M11106	124.1	96.8	11.3	54.6	93.8	80.3	4.7	41.1	188.4	211.3	85.5	119.7
MT16M00707	117.8	97.2	10.8	54.3	96.5	79.9	3.8	35.2	145	364.4	57.9	130
MT18M09301	145.5	93.5	10.5	52.5	85.5	79.6	4.1	39.4	159.3	202.1	76.3	129.1
MT18M09205	126.7	96	10.4	51.9	96.1	79.6	4	38	148.4	244.6	59.4	113.7
MT17M05508	127.2	94.9	10.8	53.9	97	79.5	4.1	38.2	151.8	416.3	77.7	136.4
MT18M09602	117.4	92.5	10.7	54.5	88.1	79.5	4.3	39.9	171.3	367.6	76.4	124.3
MT17M06305	103.8	88.4	11.8	51.2	94.7	79.5	4.6	38.8	198.4	209.6	102.6	147.9
MT17M02507	133.3	94	10.2	53.9	91	79.4	3.5	34.9	123.6	643.7	55.4	77.5
MT17M00302	125.8	93	10.6	54.4	91	79.3	4.2	39.7	150.8	329.6	67.9	123.1
MT18M06012	115.1	98	11.4	54.5	82.4	79.3	4.4	38.1	156.1	337.3	71	113.6
MT17M05502	129	97.1	10.4	55.2	101.2	79.2	3.8	36.6	129.5	536.7	52.3	107.9
Odyssey	160.2	90.2	10.4	51.3	80.6	79.1	3.8	36.1	136.1	142.7	61.2	131.3
MT18M11002	134.8	90.4	10.6	54.6	100.9	79.1	3.9	37.1	140.3	341.1	58.3	114.3
MT17M01906	127.8	96.6	10.6	53.5	89.2	79	3.6	33.4	123.5	478.6	48.2	118
MT17M04801	130.8	95.4	10.5	56.3	94.4	78.9	3.9	36.5	128	457	51.4	113.9
MT18M10106	134.6	95.6	10.1	54.3	93.1	78.8	3.7	36.5	128.4	431.1	55.3	139.4
MT18M10204	123.8	94.8	11.2	54	84.2	78.8	4.1	36.8	155	350.2	65.8	141
MT17M01711	119.9	94.6	10.7	52.4	82.2	78.8	4	36.6	146.6	461.4	68.7	120.2
MT18M09901	119	92.5	10.9	50.5	89.7	78.7	4	37	166.4	142.1	83	164.9
MT16M05403	117.6	87.5	11.3	54.9	89.3	78.7	4.3	38.2	154.6	299.2	66.1	137.3
MT18M09802	113.9	92.8	10.9	52.5	91.2	78.6	3.9	36.1	137.2	364.6	59.1	120.7
MT18M10207	117.3	97.6	11.1	54.4	92.1	78.5	4.2	37	153.3	322.8	61.4	122.6
MT18M10208	119.4	96.8	11	54.6	94.7	78.3	3.9	35.3	144.2	433.8	49.3	131.7
MT16M00709	131	96.7	10.6	53	98.8	78.1	3.3	30.7	121.3	728.5	54.3	111.3
MT18M09804	108	94.2	10.9	53.4	92	77.7	3.6	33	132.4	386.7	58.1	137.6
MT18M10205	101.5	96.7	12.3	53.5	89	77.2	4.5	36.5	178.1	221.8	67.9	134.7
MT18M10107	122.3	97.1	10.9	54.9	89.4	76.7	3.4	30.9	112.1	622.4	46.3	122.5
MT18M11004	134.8	95.3	10.5	54.8	91	76.1	3.1	29.5	113.2	689.1	41.3	91.2
GRAND MEAN	124.703	94.586	10.865	53.755	90.682	79.88	4.235	38.955	160.808	342.218	70.884	123.561
LSD	15.167	6.799	0.828	1.281	5.355	0	0	0	0	0	0	0
CV	6.346	3.722	3.987	1.25	3.263	1.911	11.305	10.295	15.898	42.969	22.2	13.251

Malt Intrastate 2021 WTARC DRY

name	Yield (BU/AC)	Plump (%)	Protein (%)	Test Wt (LBS/BU)	Heading (JULIAN)
MT18M11002	86.7	87.3	12.9	48.9	191
MT18M11006	82.8	89.5	12.9	48.3	190.8
MT16M01902	81.1	92.2	12.7	46.9	190.3
MT18M11004	79.8	81.4	13.5	49.4	191
MT17M01711	78.4	93	12.4	47	191.8
MT17M02507	77.6	94.3	11.9	48.8	190.7
MT18M10204	77.2	99.2	12.5	49.2	190.4
MT18M10106	76.8	94.4	11.6	49.7	192.4
MT18M11106	75.3	91.7	13.6	48.7	190.6
MT18M11103	74.7	83	13.3	46.4	191.9
MT18M09904	74.3	89.5	13.9	47.7	191.9
MT18M11101	73.5	89.1	12.7	48.7	191.1
MT17M05808	73.2	92.6	13	48	191
MT18M10208	72.5	95.7	13.3	49.1	189.4
Merit 57	72.3	86	13	47.7	190.9
MT16M01801	72.1	93.1	12.3	47.4	191.5
MT16M02201	71.7	94.8	12.6	46.6	191.4
Odyssey	71.6	94.9	13.6	48.1	192.5
MT18M09901	71.2	88.1	14.4	45.3	192.7
MT17M01906	71.1	92.8	12.9	47.5	191.8
MT18M10107	70.6	90.7	14.3	49.7	192.1
MT18M11105	70.5	86.7	13.2	47.6	193
MT17M04801	70.2	93.8	12.5	48.5	190
MT17M01908	68.3	95.7	12.6	48.1	191.2
MT18M09902	68	93.6	13.1	48.2	192.6
MT18M06009	67.8	95.4	11.7	48.5	191.2
MT18M09205	67.6	97.9	12.2	48.3	191.9
MT18M06008	67.5	94.6	11.9	49.3	190
MT18M10401	67.5	87.8	14	47.5	191.9
MT18M09804	67.3	95.5	13.2	48.9	191.5
MT16M00709	66	95.1	11.4	48.1	190.4
MT17M05416	66	91.1	12.5	47	192.8
MT16M00707	65.3	94.7	12	48.8	191.2
Hockett	65	87.1	13.8	48.8	191.9
MT18M06011	65	93.3	12.6	48.8	190
MT18M10207	63.3	94.7	13.9	47.9	190.4
MT18M06012	63.2	96.5	11	48.5	191.3
MT16M05610	62.8	92.8	13.5	47.6	193.5
MT17M00302	62.8	92.6	12.4	48.8	193.1
MT17M05508	62.5	87.9	13.5	47.8	191.2
MT16M05403	62.1	90.7	12.4	49.3	191.9
MT18M09602	62	90.4	11.7	47.8	191.8
MT18M09301	61.8	91.2	13.5	46.8	191.9
MT16M09602	60.6	94.8	12.6	49.6	190.9
MT18M09802	59.3	83.8	13.5	46.8	191.9
MT18M10205	58	97.8	13.2	48.3	190.5
MT17M05502	57.4	91.8	12.4	48.7	190.3
MT17M06305	56.2	92.2	13.2	48.8	191.4
MT18M09403	52.6	98.5	14	48.6	190.8
GRAND MEAN	68.796	92.07	12.882	48.178	191.388
LSD	14.943	5.943	1.122	1.464	1.059
CV	11.454	3.43	4.436	1.615	0.364

2021 Barley, Malt & Brewing Quality Lab work summary:

Research:

Completed analysis for the MSU breeding program:

- 2020 Winter – 82 Micro
- 2020 128.148 – 403 Micro
- 2020 BA Malt/Kiln – 15 Milli
- 2020 High Low Protein – 140 Micro
- 2021 Winter – 39 Micro
- 2021 Hull-less – 16 Micro
- 2021 Intrastate – 174 Micro samples
- 2021 EYT – 80 Micro samples
- 2021 F5s – 397 Pico (In progress 2021/2022)
- 2021 PYT – 185 Micro samples (In progress 2021/2022)

Totals:
 1119 Micro samples
 397 Pico samples
 15 Milli samples

Collaborative Research & Publications:

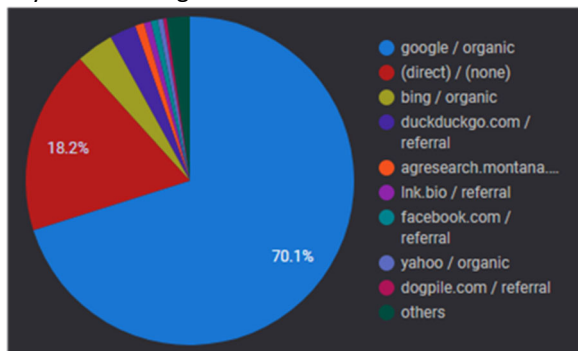
- Improving nutrition and flavor of food products by sprouting and malting diverse grains: developing new products, sustainable practices, and industry standards.* – a MSU inter-departmental collaborative grant effort.
- Glycosidic Nitrile – Hartwick College: Paper submitted, pending review: *Review 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:

Tour groups increased in 2021 with the majority being in the second half of the year, 11 in total. Tours included local maltsters, regional constituents, brewers, distillers, students and press. Over the year we maintained a position of leadership within the malting and brewing community, actively working as technical leadership for the Craft Maltster’s Guild, the ASBC Malt Subcommittee, and Pink Boots. We participated in multiple live and virtual speaking events including: MT Brewers Association, Craft Maltsters Guild, MT Fresh Hop Fest, Wheat & Barley, American Craft Spirits Association, and MT Pink Boots. We also increased our website and social media impact, nearly doubling our website sessions and page views and gaining 269 follows across all social media platforms.

Website:

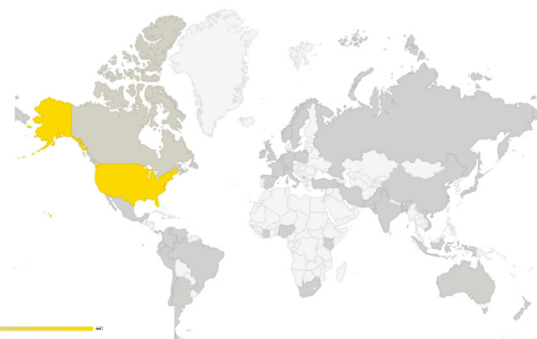
In 2020 our website had 9,132 sessions for a total of 22,245 page views.
 In 2022 we will expand the field aspect of the site to include a variety tool allowing easier access to our field data.



Social Media:

We post about what the program is working on, educational pieces, share events we participate in & more!
 Instagram: 1123 followers, Facebook: 600 followers, Twitter: 44 followers, YouTube: 10 subscribers

We have followers all over the world!!



Service:

Active clients: 50
 107% increase of Weekly testing Compared to 2020.

Third Party samples tested:

Malt: 574 samples
 Grain: 408 samples
 Hops: 45
 2021 Total Revenue: \$94,266

Clientele include maltsters, brewers, peer researchers, and Ag constituents. Clients are local, regional, and international including 4 countries and 25 states. In 2020 we slowed but remained stable while in 2021 we experienced a full recovery and growth of our third party testing.

