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MEMORANDUM

FROM: Greg Lutgen, Hannah Turner, Sarah Olivo, Traci Hoogland, Joseph Jensen, Jessica Williams, Trevor Palone and Jamie Sherman, Spring Barley

DATE: January 4, 2023

RE: Release of MT Bounty (MT18H02702) spring food/feed barley

Pedigree: MT110065/09WA215.12

Recommendation: Public, protected

Name: MT Bounty (MT18H02702)

Summary:

MT18H02702 is well-suited for production across all food/feed barley growing regions of Montana as well as the surrounding region and is being released due to grain yield performance comparing well to Havener.

Agronomic Strengths

- High performing food/feed line
- Earlier heading
- Taller
- Suited for dry-land production
- Smooth awns, short hairs increase grower comfort

Quality Strengths

- High protein
- High beta glucans
- Higher percentage of plump seed
- White seed, targeted to Asian market

Selection history:

MT18H02702 is a spring, 2-row, smooth awned barley developed for food/feed production in Montana. MT18H02702 has a short to medium tall, erect growth habit, lax head type, white aleurone and short rachilla hairs. MT18H02702 is an F4 derived selection from a Montana hull-less experimental line (MT110065, Haxby/Prowashonupana) by a Washington State University experimental hull-less line (09WA215.12) made in 2017. Haxby, a high grain yield and test weight line, developed at the Montana Agricultural Experiment Station (MAES) by Tom Blake was a parent of MT110065 to increase grain yield of the hull-less Prowashonupana, which was developed by MAES in the late 1970's in a conventional barley breeding program directed by Professor R.F. Eslick. Prowashonupana was given the acronym PWSNP. Pro - for high protein, wa - for waxy starch, sho - for short awns, nu - for nude (hullless) and pana - for the parent variety 'Compana'. 09WA215.12 is a sister line to Havener, which was released by WSU due to high yield, with the pedigree X04041-T32/X04041-T34. X04041-T32 and X04041-T34 are spring, hull-less barley lines with high β -

glucan content that were derived from a cross between 01WA-13862.3, a hull-less, waxy barley and Radiant. 01WA-13862.3 is a hull-less waxy spring barley derived from a cross between SH 97110, a hull-less barley, and Merlin, a hull-less, waxy barley. MT18H02702 was increased from a F4 plant in 2018 to produce seed for preliminary yield testing in 2019. MT18H02702 was tested for agronomic traits around the state, beginning in 2020, and was selected primarily for grain yield performance.

Purification/seed stocks:

We purified MT18H02702 in 2021 by planting 100 F9-derived F10 headrows at Bozeman Post farm. We evaluated for phenotypic uniformity before bulking all headrows. The 2022 breeder strips appeared uniform and were regularly rogued by barley breeding employees and Foundation staff. MT18H02702 will be in Foundation seed in 2023.

Agronomic performance and characteristics:

Table 1 compares MT18H02702 to control variety Havener. Note that MT Bounty's mean performance is reported by dryland or irrigated sites in column 2, while Havener's performance is reported in column 3. The percent performance of MT Bounty compared to Havener and the number of observations are reported in columns 4 and 5. MT18H02702 was similar to Havener in yield in both environments, although performing better in dryland and worse in irrigated. MT Bounty had lower test weight, but higher plump than Havener in both environments and equal to higher percent grain protein. MT Bounty may be more suited for dryland with an earlier heading date and greater height.

Dryland Sites				
Trait	2702 Mean	Havener Mean	%	# obs
Yield	69.19	68.3	101.3	17
Test Wt	59.4	60.56	98.1***	16
Plump	69.9	54.68	127.8***	5
Protein	13.15	13.12	100.2	13
Heading	179.88	181.74	99***	13
Height	66.07	62.09	106.4***	17
Irrigated Sites				
Trait	2702 Mean	Havener Mean	%	# obs
Yield	103.66	105.09	98.6	8
Test Wt	60.41	61.54	98.2***	8
Plump	79.35	63.53	124.9*	4
Protein	13.27	12.53	105.9**	6
Heading	182.13	183.12	99.5	6
Height	86.8	81.83	106.1***	8

* p<0.05, **p<0.01, ***p<0.001

Table 2 compares MT Bounty with Havener by location of the Food intrastate trial grown from 2020 to 2022, which consists of 16 lines replicated three times and is grown and analyzed as a lattice square. The locations varied from year to year. Yields were not significantly different across locations, but MT Bounty tended to perform better in dryer locations e.g. Sidney, Havre and Moccasin. Test weights were not significantly different across locations, while MT Bounty tended to have earlier heading in many locations. MT Bounty was taller than Havener in most locations, with higher protein under irrigation.

Table 2: 2020-2022 Food Intrastate Agronomic Data by Location Comparing Bounty and Havener

Variety	Yield (bu/ac)								
	Bozeman		Sidney		Havre	Kalispell	Moccasin	All Loc	
	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Dry	Irr
# loc years	3	3	3	3	3	1	1	11	6
Havener	94.8	120.5	47.7	97.5	57.3	135.6	48.4	68.6	109
MT18H02702	82.1	122.3	51.2	93.9	59.2	126.7	58.6	65.7	108.1
LSD	8.5	9.1	4.6	5.8	3.9	9.9	16.5	3.4	5.4

Variety	Test Weight (lb/bu)								
	Bozeman		Sidney		Havre	Kalispell	Moccasin	All Loc	
	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Dry	Irr
# loc years	3	3	3	3	3	1	1	11	6
Havener	62.3	63.7	62.6	61.6	58.9	56	64.4	60.9	62.7
MT18H02702	61.6	63.9	62.4	60.5	58.7	52.5	64.1	60.5	62.2
LSD	0.9	1	0.5	0.9	0.6	1.7	2.2	1.3	1.4

Variety	Heading (julian)								
	Bozeman		Sidney		Havre	Kalispell	Moccasin	All Loc	
	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Dry	Irr
# loc years	3	3	3	3	3	0	1	10	6
Havener	187	186.6	179.2	179.8	177.8		189.4	180.8	183.2
MT18H02702	183.9	185.6	177.2	178.4	178.8		187.4	175.9	182
LSD	1	0.9	1.6	1.4	1		1.6	0.7	4

Variety	Height (cm)								
	Bozeman		Sidney		Havre	Kalispell	Moccasin	All Loc	
	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Dry	Irr
# loc years	3	3	3	3	3	1	1	11	6
Havener	72.2	83.6	60.2	76.2	60.1	77.1	64.4	66.5	79.9
MT18H02702	74.8	90	66.7	82.9	64	81.7	54.2	75.1	86.4
LSD	3.3	4.8	4.5	4	2.3	10.1	5.8	2	6.2

Variety	Protein (%)								
	Bozeman		Sidney		Havre	Kalispell	Moccasin	All Loc	
	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Dry	Irr
# loc years	2	2	3	3	3	1	0	9	5
Havener	11.7	11	15.2	13.6	13.5	10.9		14.6	12.4
MT18H02702	12	10.8	15.1	14.7	13	11.5		12.9	13.3
LSD	0.3	0.6	0.4	0.4	0.4	0.7		0.3	1.2

Lattice Square design, 16 entries, 3 replications

Quality:

The Asian food barley market requires a white hull-less, high protein, high β glucan barley as a rice additive or substitute. MT Bounty has good percent protein and large plump seeds (Tables 1 and 2). Table 3 reports percent β glucan levels for grain. Havener variety release documents report grain β glucan at 6%, where in the dry and irrigated environments we tested, Havener's % β glucan was somewhat higher. MT Bounty had equal to or higher % grain β glucan than Havener. More data is needed to determine the significance of the difference. However, Havener at 6% was reported to be higher than most food varieties. Therefore, MT Bounty also seems to be a high β glucan line.

Table 3: Percent Grain β glucan

Trial	Entry	β glucan (%)
2022 Bozeman	Havener	9.34
Offstation Dry	MT18H02702	9.98
2022 Hull-less	Havener	7.38
Intrastate Irr	MT18H02702	10.04

Another use for a hull-less barley other than food or feed is for the distilling market. Glycosidic nitriles (GNs) are compounds that can form during malting. Under certain circumstances during distilling, GNs can be converted into the potentially harmful ethyl carbamate, which is or soon will be regulated in beverages (125 ppb – 150 ppb). EC precursors build up in barley acrospires during germination and can be problematic for distillers. However, in hull-less lines, acrospires tend to be removed along with rootlets during the malt cleaning phase, which occurs post kilning, when the rootlets/acrospires have become brittle. Therefore, little or no EC will be produced from distilled spirits utilizing malted hull-less barley. To determine if MT Bounty could be used in distilling, we report malt quality data in Table 4, comparing MT18H02702 to Havener. We malted 3 different MT18H02702 samples, two dry and one irrigated, using two different steep recipes, one with two water changes and the other with three. Note irrigated had higher extract than dryland, and 3 steep higher than 2 steep. Generally, extracts are elevated in hull-less type grains as compared to hulled because the hull dilutes the amount of starchy endosperm included by weight. With the 3 steep, modification of the grain approached the typically desired level with MT Bounty having a higher S/T than Havener. Enzymatic activity is low, particularly α amylase. However, this could be increased with greater modification. Another issue is the high β glucans. While they can be less of an issue in distilling than brewing, they may still be too high. However, we think with some malting adjustments these issues could be overcome.

Table 4: Potential of MT18H02702 for distilling malt

Treatment	ID	Extract	β -Glucan	Soluble	Total	S/T	FAN	Diastatic	α -Amylase
				Protein	Protein			Power	
		%	mg/L	%	%	%	mg/L	°L	D.U.
Irrigated - 2 steep	MT18H02702	84.1	1412	5.4	14.2	37.9	154	97	35
Dry- 2 steep	MT18H02702	83.3	1412	5	14.1	35.5	144	103	31
Dry- 3 steep	MT18H02702	85.2	500.4	6.0	14.2	42.3	174.1	118.1	41.3
Dry - 3 steep	Havener	85.2	462.8	5.8	14.2	40.8	180.9	117.1	41.2

Disease screening:

MT18H02702 is moderately susceptible to stem rust (Table 5). MT18H02702 is being tested in 2022 for stripe rust, Havener is known to be stripe rust susceptible.

Table 5:2021 USDA African Stem Rust Nursery							
Entry name	Field Evaluations, Njoro, Kenya KALRO/CIMMYT			Field Evaluations, Debre Zeit, Ethiopia EIAR			
	4/22	4/29	5/5	4/5	5/13	5/21	late maturing 6/4
	Stem Rust	Stem Rust	Stem Rust	Stem Rust	Stem Rust	Stem Rust	Stem Rust
Buzz			10MS	5MS	5MS	10MSS	
MT16M02201			10MS	0	TMS	TMS	10MS
MT17M02507			5MS	5MS	10MSS	10MSS	15MSS
MT18H02702			5MS	5MS	20MS	20MS	30MSS
Morex			15MS	TMS	TMR	TMR	10M
Robust			15MS	TMS	TMS	5MSS	10MSS
Stephoe			15MS	TS	TMS	5MS	
UC Tahoe			0	5MS	5MS	10MS	20MS
UC 1410			0	0	0	TMS	15MS
Butta 12			5MS	5MSS	10MSS	20MSS	25MS
ABI Voyager			1MS	10MSS	20S	25MSS	30MSS
AC Metcalfe			5MS	TMS	5MS	20MSS	
AAC Synergy			1MS	TMS	TMS	15MSS	25MSS
ND Genesis			1MS	TMS	TMS	10MS	15MS
CDC Copeland			5MS	TMS	5MS	10MS	
ABI Eagle			0	TMS	5MS	20MSS	

Infection Response Key

T= trace

R = resistant

MR = moderately resistant

M = moderately resistant to moderately susceptible

MS = moderately susceptible

MSS = moderately susceptible to susceptible

S = susceptible

Severity Key

0-100 modified Cobb scale to determine percentage of possible tissue rusted, T = trace (approximately 1%)

MSU Barley Breeding Program:

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MSU Malt Quality Laboratory - Hannah Turner, Sarah Olivo

Data Provided By:

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