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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 Boy Howdy (MT17M02507) spring feed barley

Pedigree: Haxby/ND24388

Recommendation: Public, protected **Name:** MT Boy Howdy (MT17M02507)

Summary:

MT17M02507 is well-suited for production across all feed barley growing regions of Montana as well as the surrounding region and is being released to replace Haxby (Montana State University, 2003) due to superior grain yield performance.

Agronomic Strengths

- High performing feed line
- Longer grain fill period due to earlier heading
- Smooth awns and fewer hairs increase grower comfort

Quality Strengths

- Higher percentage of plump seed than Haxby

Selection history:

MT17M02507 is a spring, 2-row, awned barley developed for feed barley production in Montana. MT17M02507 has a tall, erect growth habit, lax head type, white aleurone and reduced hairiness on leaves, glumes and rachis relative to Haxby. MT17M02507 is an F4 derived selection from a cross of Haxby by ND24388 made in 2015. Haxby (MT950186) with the pedigree MT860756/MT83533 was released by Montana Experiment Station in 2003 for grain yield, high test weight, and smooth awns. MT17M02507 was advanced by single seed descent from the F1 thru F4 generations. It was increased from a F4 plant to produce seed for preliminary yield testing in 2017 and advanced to state-wide trials in 2018.

We purified MT17M02507 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. MT17M02507 will be in foundation seed in 2023.

Agronomic performance and characteristics:

Table 1 compares MT17M02507 to control varieties Hockett, Haxby and LCS Odyssey, where the 3rd column reports MT17M02507 mean performance where direct comparisons to control are made. Control

means are reported in the 4th column, MT17M02507 percentage of control is in column 5 and number of observations comparing MT17M02507 with control in the 6th column. Note that Boy Howdy's mean yield performance across locations is equal to or greater than all three controls. Although test weight and protein are slightly less, MT17M02507 has higher plumps, is equal or taller in height and is earlier heading. When MT17M02507 is compared to commonly grown lines it tends to head earlier and mature later such that it has a longer grainfill. The extended grainfill likely increases plump seed.

Boy Howdy can out-perform Odyssey in test weight and all three controls in grain yield under dryland conditions (Table 2), while out-performing Hockett and Haxby in grain yield under irrigation (Table 3). Table 4 reports the Intrastate data by location showing similar patterns.

Table 5 reports the 2021 data from the Western Regional Spring Barley Nursery including the following locations: three in Idaho, two in North Dakota, and one in Montana, Washington, Wyoming, and Canada. MT17M02507 was the second highest yielding line across the environments and had good test weight (Table 5).

Tables 6-9 report the agronomic data from the offstation nurseries 2021 and 2022. The offstation agronomic averages for 2021 and 2022 are reported in Table 6 and Table 8 respectively, while the yield by location data for 2021 and 2022 are reported in Table 7 and Table 9 respectively. The location specific yield data shows that MT17M02507 outperforms Hockett in most locations, outperforms or is equal to Odyssey in most dryer locations (Bozeman, Huntley, Havre) and performs equal to or better than Haxby.

Trait	Control	2507 Mean	Control Mean	2507 % of	# obs.
				Control	
Yield (bu/ac)	Hockett	99.25	87.57	113.3***	36
	Haxby	102.33	94	108.9	4
	LCS Odyssey	96.6	95.98	100.6	23
Test Wt (lbs/bu)	Hockett	52.25	52.74	99.1***	33
	Haxby	51.98	53.5	97.1**	4
	LCS Odyssey	51.3	49.61	103.4***	20
Protein (%)	Hockett	11.19	12.67	88.3***	34
	Haxby	11.53	13.13	87.8	3
	LCS Odyssey	11.66	12.69	91.9***	21
Plump (%)	Hockett	88.21	87.67	100.6	35
	Haxby	87.03	74.13	117.4	4
	LCS Odyssey	84.85	83.44	101.7	22
Height (cm)	Hockett	74.04	73.46	100.8	35
	Haxby	82.8	77.8	106.4	4
	LCS Odyssey	73.58	64.27	114.5***	22
Heading (Julian)	Hockett	178.23	179.36	99.4***	28
	Haxby	181.6	181.35	100.1	2
	LCS Odyssey	179.01	184.1	97.2***	15
p < 0.05, *p < 0.01					

Table 2: MT Boy Howdy (2507) Compared to Controls in Dryland

Trait	Control	2507 Mean	Control Mean	2507 % of	# obs.
				Control	
Yield (bu/ac)	Hockett	90.15	79.93	112.8***	23
	Haxby	84.45	80.2	105.3	2
	LCS Odyssey	92.53	90.44	102.3	15
Test Wt (lbs/bu)	Hockett	51.95	52.7	98.6***	22
	Haxby	50.85	52.9	96.1	2
	LCS Odyssey	50.97	49.51	102.9***	14
Protein (%)	Hockett	11.27	12.76	88.3***	22
	Haxby	12.5	14.3	87.4	1
	LCS Odyssey	11.74	12.88	91.1***	14
Plump (%)	Hockett	88.54	86.73	102.1	23
	Haxby	82.9	62.9	131.8**	2
	LCS Odyssey	86.14	83.65	103	15
Height (cm)	Hockett	68.52	69.08	99.2	22
	Haxby	66.05	63.1	104.7	2
	LCS Odyssey	69.24	61.29	113***	14
Heading (Julian)	Hockett	178.31	179.9	99.1***	20
	Haxby	181.6	181.35	100.1	2
	LCS Odyssey	179.07	183.93	97.4***	12

p < 0.05, *p < 0.01

Table 3: MT Boy Howdy (2507) Compared to Controls under Irrigation

Trait	Control	2507 Mean	Control Mean	2507 % of	# obs.
				Control	
Yield (bu/ac)	Haxby	120.2	107.8	111.5	2
	Hockett	122.83	108.85	112.8***	12
	LCS Odyssey	115.47	118.39	97.5	7
Test Wt (lbs/bu)	Haxby	53.1	54.1	98.2	2
	Hockett	53.06	53.09	99.9	10
	LCS Odyssey	52.28	49.62	105.4**	5
Protein (%)	Haxby	11.05	12.55	88	2
	Hockett	10.82	12.2	88.7***	11
	LCS Odyssey	11.17	11.8	94.6	6
Plump (%)	Haxby	91.15	85.35	106.8	2
	Hockett	92.81	89.65	103.5***	11
	LCS Odyssey	90.77	89.15	101.8	6
Height (cm)	Haxby	99.55	92.5	107.6	2
	Hockett	86.77	83.58	103.8	12
	LCS Odyssey	86.69	72.23	120***	7
Heading (Julian)	Haxby	n.a	n.a	n.a	0
	Hockett	178.01	178	100	8
	LCS Odyssey	178.8	184.8	96.8	3

p < 0.05, *p < 0.01

Table 4: 2020-2022 Malt Intrastate Agronomic Data by Location

Variety	Yield (bu/ac)											
	Bozeman		Huntley		Sidney		Havre	Moccasin	Conrad	Kalipsell	All Loc	
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Dry	Dry	Irr
# loc years	3	3	2	2	3	3	3	1	1	1	14	8
Merit 57	94.8	129.7	78.8*	134.4**	58.8	115.7	55.1	52.8	67.7*	141.4	78.1	109.8
Hockett	99.4	114.1	68	115.5	59.5	110.5	55.4	50.8	60.9	128	81	98.9
MT17M02507	113.3**	150.4**	79.2**	112.6	72.5**	131.5**	64.9**	50	72.7**	137.3	93.5**	146.6**
LSD	6.6	8.9	8	8.1	6.1	7.7	4.2	13.8	11.7	19.7	3.1	4.8

Variety	Test Weight (lb/bu)											
	Bozeman		Huntley		Sidney		Havre	Moccasin	Conrad	Kalipsell	All Loc	
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Dry	Dry	Irr
# loc years	3	2	2	2	3	3	3	1	1	1	14	7
Merit 57	50.9	51.6	51.7	52.6	50.2	50.1	47.9	nd	47.7	51.8	46.5	51.4
Hockett	53.2**	52.7	52.1	53.6*	51.7**	52.3	50.5**	nd	48.8**	52.9	49.4	52.9
MT17M02507	52.9*	54.6**	52.2	53.9**	50.2	52.2	49.4	nd	48.8*	52.5	50.9**	54.3**
LSD	0.6	1	0.7	0.7	0.6	2.5	0.6		1.5	1.3	0.3	1.3

Variety	Protein (%)											
	Bozeman		Huntley		Sidney		Havre	Moccasin	Conrad	Kalipsell	All Loc	
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Dry	Dry	Irr
# loc years	3	2	2	2	3	3	3	1	1	1	14	7
Merit 57	12.4**	12.3**	14.1**	10.8	13.9**	13**	13.2*	8	13*	12.5*	12.6**	12.3**
Hockett	12*	11.6	13.8*	11.3**	13.1	12.3	13.4**	7.8	13.8**	12.7**	12.2	11.3
MT17M02507	10.8	10.4	12.8	9.5	11.2	11.1	11.7	7.4	11.9	11	9.7	10.3
LSD	0.4	0.3	0.5	0.4	0.5	0.4	0.4	1	1.1	0.9	0.2	0.3

Variety	Heading (julian)											
	Bozeman		Huntley		Sidney		Havre	Moccasin	Conrad	Kalipsell	All Loc	
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Dry	Dry	Irr
# loc years	3	3	1	1	3	3	3	1	1	0	12	7
Merit 57	185.9	182.5	170.5	171.9	175.4	179.2	175.4	186.3	190.9	nd	180.5**	178
Hockett	184.9**	181.3**	169.4	163.3**	175	175.9**	175.7	187	191.9	nd	183.6	176**
MT17M02507	185.2*	181.5*	166.2	164.4*	169.5**	178.2	170.7**	185	190.7	nd	182.7	176.2*
LSD	1	0.9	4.4	3	1.4	1.1	1.3	1.9	1.1		0.7	0.7

Variety	Height (cm)											
	Bozeman		Huntley		Sidney		Havre	Moccasin	Conrad	Kalipsell	All Loc	
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Dry	Dry	Irr
# loc years	3	3	2	2	3	3	3	1	0	1	13	8
Merit 57	71.5	87.9**	83.2*	92.6	62.5	80	53.9**	50.7	nd	92.4	71.5	85.1
Hockett	73.5	88.5*	85.9	93.6	54.2**	73.9**	56.8	53.1	nd	91.8	71.5	84.1
MT17M02507	66.2**	93.1	81.2**	94.5	60.8	76.4*	59.9	52.9	nd	94.4	65.5**	84.7
LSD	3.4	3.4	3.4	3.9	4.1	3.5	2.6	7.2		8.4	1.7	2.1

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

Table 5: 2021 Western Regional Spring Barley Nursery Agronomic Data

Source	Entry	Yield (bu/ac)	Test Wt. (lbs/bu)	Heading (julian)	Height (cm)	Plump (%)	Protein (%)
Check	AAC Synergy	96.2	49.6	179.1	68.0	92.2	13.4
Check	ABI Eagle	95.3	50.3	179.4	61.2	88.2	13.9
Check	ABI Voyager	91.4	49.6	179.2	67.4	95.9	14.1
Check	AC Metcalfe	85.4	50.2	178.9	70.2	91.2	14.3
Check	CDC Copeland	89.5	50.3	179.1	68.6	91.5	13.9
Check	ND Genesis	80.9	49.5	177.2	70.8	89.3	12.6
AB-Inbev	2IM14-8212	97.5	48.9	177.9	62.5	94.2	13.1
AB-Inbev	2IM15-9456	97.5	49.9	177.4	65.6	90.7	13.5
AB-Inbev	2IM16-0141	96.9	50.5	178.9	62.4	89.0	13.6
AB-Inbev	2IM16-0154	95.1	51.1	178.4	64.1	93.3	13.4
HSG	HO516-429	101.2	50.8	178.9	69.1	92.1	13.4
HSG	HO517-245	104.8	50.5	178.2	61.3	83.5	12.4
MSU	MT16M01801	98.5	50.1	178.2	71.2	93.3	12.0
MSU	MT16M01902	98.5	49.7	176.8	65.0	94.8	12.6
MSU	MT17M02507	101.8	50.4	177.7	66.8	93.5	12.0
MSU	MT17M04801	94.2	51.4	177.0	68.2	95.0	13.0
NDSU	2ND32529	93.4	49.3	176.6	66.9	92.8	12.2
NDSU	2ND36638	89.3	49.3	176.6	64.5	93.9	12.3
NDSU	2ND36642	92.6	49.7	176.9	65.1	94.5	11.8
USDA-ARS	11ARS183-9	95.2	49.8	178.9	67.8	95.3	13.9
USDA-ARS	14ARS147-1	101.2	50.0	179.4	64.7	87.4	13.3
USDA-ARS	15ARS019-5	97.3	49.8	179.1	62.8	90.8	13.9
USDA-ARS	15ARS182-1	97.7	49.0	181.8	62.8	93.7	13.3
USK	CDC Churchill	99.1	51.3	180.2	64.8	89.8	13.2
USK	TR19175	98.4	50.4	178.8	63.8	93.5	13.0
	Trail Mean	95.6	50.1	178.4	65.8	91.8	13.1
	Check Mean	89.8	49.9	178.8	67.7	91.4	13.7
	# loc*	9	8	6	7	7	6

*Locations: Aberdeen ID, Ruberd ID, Tetonia ID, Bozeman MT, Osabrock ND, Williston ND, Rosalia WA, Powell WY, Saskatoon SK

Table 6: 2021 Offstation Agronomic Data Across Four Locations

Name	Yield (bu/ac)	Height (cm)	Plump (%)	Protein (%)	Test Wt (lbs/bu)
MT17M02507	95	72.1	88	12.8	50.9
Hockett	88	73.8	85.9	14.3	52.1
LCS Odyssey	100.2	64.9	85.1	13.9	49.4
GRAND MEAN	90.328	69.948	77.313	14.186	50.769
LSD	2.019	1.397	1.639	0.201	0.212
CV	7.611	6.801	7.216	4.828	1.423

Table 7: 2021 Montana Offstation Yield (bu/ac) by Location

Name	All Loc	Bozeman	Huntley	Hysham Irr	Fromberg Irr
MT17M02507	95	104*	50.1*	135.5	90.3
Hockett	88	99.5	35.7	130.1	86.5
LCS Odyssey	100.2**	100.5	48.4*	149.9*	102*
GRAND MEAN	90.33	97.57	42.15	132.00	89.60
LSD	2.02	9.82	9.98	13.60	11.13
CV	7.61	6.16	14.49	6.31	7.60

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

Table 8: 2022 Offstation Agronomic Data Across Five Locations

Name	Yield (bu/ac)	Plump (%)	Protein (%)	Test Wt (lbs/bu)	Height (cm)
MT17M02507	106*	87.7	8.6	52	82.6
Hockett	93.4	81	9.9	52.1	76.8
LCS Odyssey	106*	86.5	9.2	49.5	71.1
GRAND MEAN	97.118	76.073	9.647	51.283	78.037
LSD	8.676	5.69	0.433	1.206	3.922
CV	11.094	9.29	5.577	2.92	6.242

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

Table 9: 2022 OffStation Yield (bu/ac) by Location

Name	Bozeman	Kalispell	Havre	Hysham Irr	Fromberg Irr
MT17M02507	100*	47.4	77.6*	117.8	122.6*
Haxby	90.5	47.8	78.4**	98.9	116.7
Hockett	91.7	59.2	63.9	98.6	109.6
LCS Odyssey	100.5*	86.8*	64.6	132.7*	120.6*
GRAND MEAN	95.187	76.328	67.789	108.831	116.665
LSD	7.483	25.98	4.996	14.516	14.109
CV	4.6	19.094	4.216	8.772	6.973

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

Disease screening:

MT17M02507 had a high incidence of FHB in 2021 EARC misted and corn spawn infested nursery, but lower than 1 ppm DON (Table 10). MT17M02507 is reported to be moderately susceptible to stem rust in Africa 2021-22 (Tables 11 and 12). MT17M02507 is being tested for stripe rust in 2022.

Table 10: 2021 Barley FHB Screening

Line	Sidney		
	Severity	Incidence	DON ppm
MT16M02201	1.8	23.3	1.5
MT17M02507	3.0	43.3	0.7
Bearpaw	2.7	43.3	0.3
Buzz	1.7	18.4	0.5
Chevron	3.2	32.2	0.1
Haybet	1.3	23.4	0.1
Hockett	1.8	26.7	0.2
Lavina	4.5	58.4	0.4
Stander	3.4	30.0	0.8
Pinnacle	1.9	23.4	0.0

Table 11: 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
	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
Steptoe						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%)

Table 12: 2022 USDA African Stem Rust Nursery							
Entry name	Field Evaluations, Njoro, Kenya				Field Evaluations, Debre Zeit, Ethiopia		
	KALRO/CIMMYT			Cumulative COI	EIAR		Cumulative COI
	4/21	4/27	5/5		10/27	11/7	
	Stem Rust	Stem Rust	Stem Rust	Stem Rust	Stem Rust	Stem Rust	Stem Rust
MT Cowgirl	5MS	5MS	5MS	12	30MSS		26.1
MT17M01711	0	1MS	1MS	1.6	20SMS		18.6
MT17M02507	1MS	1MS	1MS	2.4	15MRMS		7.95
MT18M11004	0	0	0	0	20MS		16
MT18M11006	0	0	0	0	30MSS		26.1
Morex	1MS	5MS	10MS	12.8	10MRMS		5.3
QSM20	0	0	5MR	2	0		0
Robust	15MSS	20MS	30MSS	55.15	15MS		12
SM127a	15MSMR	20MS	30MS	50.05	30MSS		26.1
Heitpas-5	0	0	5MR	2	0		0
Q21861a	0	5MS	5MS	8	TR		0.4
Steptoe	0	5MS	5MS	8	35MSS		30.45
UC Tahoe	0	5MS	5MS	8	25MS		20
Butta 12	15MSMR	15MRMS	15MRMS	25.95	15MS		12

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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