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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 Endurance (MT16M02201) spring malt barley

Pedigree: Hockett/ND24388

Recommendation: Public, protected **Name:** MT Endurance (MT16M02201)

Summary:
With stable plumps, protein and extract under dryland conditions, **MT16M02201** is well-suited for dryland malt barley production in malt growing regions of Montana. MT16M02201 showed superior performance across the state during the drought of 2021, including a fertility trial where it had stable quality across treatments, thus the name proposed is MT Endurance.

Agronomic Strengths
- High performing malt line particularly in dryland
- Low grain protein
- Longer grain fill period due to earlier heading
- Higher percentage of plump seed

Quality Strengths
- Highest extract of any tested line, even under dryland conditions
- Can have acceptable β glucan in dryland

Weaknesses:
- Test Weights can be lower than Hockett and Buzz in some environments
- B glucan can be higher than Buzz particularly under irrigation

Selection history:

MT16M02201 is a spring, 2-row, awned barley developed for dryland malt barley production in Montana. MT16M02201 has a semi-dwarf, erect growth habit, lax head type, white aleurone and long rachilla hairs. MT16M02201 is an F4 derived selection from Hockett (PI 657121, MT910189) by a North Dakota stay green line (ND24388) made in 2015. Hockett, with pedigree Bearpaw/ND7593, was released in 2008 by the Montana Experiment Station as a malt line due to its yield and plump stability in dryland. However, Hockett can have elevated protein, and β glucans, as well as being slow to malt. ND24388 carries the low protein gene as well as other genes that allow for extended grain-fill. MT16M02201 was advanced by single seed descent from the F1 through F4 generations. It was increased from a F4 plant during the winter of 2015-16 in Arizona to produce seed for preliminary yield testing in 2016. MT16M02201 was tested state-wide

beginning in 2017 for agronomic and malt traits. MT16M02201 has also been included in a fertilizer trial for two years.

Purification/seed stocks:

We purified MT16M02201 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. MT16M02201 will be in Foundation seed in 2023.

Performance and characteristics:

Table 1 compares MT16M02201 agronomics to control varieties AC Metcalfe, Buzz, Hockett, LCS Odyssey and Merit 57. Note that MT16M02201's mean performance, across locations where it coincided with the control, is reported in column 3, while each controls mean performance is reported in column 4, with MT16M02201 percent of control in column 5 and number of observations in column 6. Across all environments, MT16M02201 was equal to most controls for grain yield (except Odyssey), lower than most for percent protein (except Buzz), and better than or equal to all controls for percent plumps. MT16M02201 was better or equal to Merit 57 and Odyssey for test weight while poorer than Buzz, Hockett and AC Metcalfe. MT16M02201 is of similar height to most of the controls, but taller than Odyssey and shorter than AC Metcalfe. MT16M02201 is earlier heading than all the controls except equal to Buzz.

Table 2 compares MT16M02201 malt quality to the same controls. MT Endurance has the highest extract of any variety tested. It modified well with S/T values similar to Buzz and AC Metcalfe and better than Hockett and acceptable FAN values. It has adequate enzyme activity with better DP than Buzz, but lower α amylase. A negative to MT16M02201 is β-glucans can be over 100 ppm especially in irrigated environments but were usually under 200 ppm.

Table 3 highlights MT Endurance's performance in dryland conditions. In dryland, MT16M02201 yields more than all controls but Odyssey, and has lower protein than all except Buzz. The line has higher than or equal plumps to all controls, and acceptable test weights although lower than Hockett and Buzz. MT16M02201 was higher for extract than any control under dryland conditions.

Dryland performance is also highlighted in Table 4, which reports the malting results of a fertilizer trial carried out in dryland during the drought of 2021. Five lines were grown at four N levels (0.5X, 1.0X, 1.5X and 2.0X recommendation of 1.2 lbs / expected bushel of malt barley). Note that grain yields were about half of the anticipated grain yield due to the drought and yet plumps and proteins were acceptable at most treatments for MT16M02201. All the malt quality parameters were also acceptable across nitrogen treatments for MT16M02201. Note all β-glucans were below 100 ppm. Importantly, only MT16M02201 had acceptable extract for all treatments in this trial, which is remarkable considering the drought.

Tables 5 and 6 breakdown agronomic performance across the state by location, showing similar results. Table 7 reports similar quality results from 4 offstation nurseries.

Table 1: MT Endurance (2201)Agronomics Compared to Controls Across Environments

Trait	Control	2201 Mean	Control Mean	2201 % of Control	# obs
Yield (bu/ac)	AC Metcalfe	115.2	114.4	100.7	9
	Buzz	98.5	98.3	100.3	23
	Hockett	90.8	88.9	102.1	33
	LCS Odyssey	92.9	101.7	**91.3*****	19
	Merit 57	90.8	92.4	98.3	33
Grain Protein (%)	AC Metcalfe	11.6	12.4	**93.4****	6
	Buzz	11.2	10.8	**103.7*****	20
	Hockett	11.7	12.4	**94.5*****	29
	LCS Odyssey	12.3	12.6	98	15
	Merit 57	11.7	12.5	**93.6*****	29
Plump (% 6/64th)	AC Metcalfe	95.2	92.0	**103.5****	9
	Buzz	95.2	94.7	100.5	22
	Hockett	92.4	88.9	**104*****	31
	LCS Odyssey	90.4	84.1	**107.5****	18
	Merit 57	92.4	79.6	**116.1*****	31
Test Weight (lb/bu)	AC Metcalfe	52.6	54.1	97.2	7
	Buzz	52.4	53.4	**98*****	21
	Hockett	51.4	52.9	**97.1*****	30
	LCS Odyssey	50.7	50.3	100.7	16
	Merit 57	51.4	50.7	**101.5****	30
Height (cm)	AC Metcalfe	73.6	79.6	**92.4*****	9
	Buzz	72.8	72.1	101	23
	Hockett	72.3	72.9	99.2	32
	LCS Odyssey	72.3	63.8	**113.4*****	18
	Merit 57	72.3	74.3	**97.3****	32
Heading (julian)	AC Metcalfe	179.3	181.5	**98.7*****	9
	Buzz	177.5	177.7	99.9	23
	Hockett	177.3	179.4	**98.8*****	29
	LCS Odyssey	178.1	183.9	**96.8*****	15
	Merit 57	177.3	181.0	**97.9*****	29

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

Table 2: MT Endurance (2201) Malt Quality Compared to Controls Across Environments

Trait	Control	2201 Mean	Control Mean	2201 % of Control	# obs
α Amylase (20°DU)	AC Metcalfe	58.4	89	65.6	1
	Buzz	70.46	102.58	**68.7****	5
	Hockett	74.86	75.53	99.1	7
	LCS Odyssey	76.7	55.93	137.1	3
	Merit 57	74.86	111.46	**67.2*****	7
β-Glucan (ppm)	AC Metcalfe	235.8	41.5	568.2	1
	Buzz	157.24	138.84	113.3	5
	Hockett	179.74	391.74	**45.9***	7
	LCS Odyssey	235.93	127.77	184.7	3
	Merit 57	179.74	113.44	158.4	7
DP (°L)	AC Metcalfe	160.4	196.1	81.8	1
	Buzz	152.68	143.7	106.2	5
	Hockett	147.09	161.46	91.1	7
	LCS Odyssey	142.2	132.4	107.4	3
	Merit 57	147.09	177.66	**82.8*****	7
Extract (%)	AC Metcalfe	83.4	81	103	1
	Buzz	83.64	80.8	**103.5*****	5
	Hockett	83.39	79.11	**105.4*****	7
	LCS Odyssey	82.97	79.5	**104.4****	3
	Merit 57	83.39	80.1	**104.1*****	7
FAN (ppm)	AC Metcalfe	244.1	260.6	93.7	1
	Buzz	215.96	193.74	**111.5****	5
	Hockett	213.47	173.59	**123*****	7
	LCS Odyssey	219.53	149.4	**146.9*****	3
	Merit 57	213.47	219.91	97.1	7
Malt Protein (%)	AC Metcalfe	11.4	12.6	90.5	1
	Buzz	11.1	10.64	**104.3*****	5
	Hockett	11.29	11.93	**94.6*****	7
	LCS Odyssey	11.63	11.2	103.9	3
	Merit 57	11.29	12.1	**93.3****	7
S/T Protein (%)	AC Metcalfe	44.6	46.3	96.3	1
	Buzz	44.66	45.1	99	5
	Hockett	44.63	36.64	**121.8*****	7
	LCS Odyssey	44.57	36.9	120.8	3
	Merit 57	44.63	41.94	106.4	7

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

Table 3: MT Endurance (2201) Dryland Agronomic and Malt Quality Stability					
Trait	**Control**	**2201 Mean**	**Control Mean**	**2201 % of Control**	**# obs**
Yield (bu/ac)	AC Metcalfe	102.78	99.04	103.8	5
	Buzz	83.53	80.32	**104***	14
	Hockett	77.09	73.99	**104.2***	21
	LCS Odyssey	80.28	85.85	**93.5*****	12
	Merit 57	77.09	76.34	101	21
Grain Protein (%)	AC Metcalfe	11.43	12.23	93.5	3
	Buzz	11.03	10.73	**102.8***	12
	Hockett	11.8	12.58	**93.8*****	19
	LCS Odyssey	12.62	13.1	96.3	10
	Merit 57	11.8	12.85	**91.8*****	19
Plump (% 6/64th)	AC Metcalfe	94.98	93.06	102.1	5
	Buzz	94.89	94.53	100.4	13
	Hockett	91.46	88.38	**103.5****	20
	LCS Odyssey	89.21	80.76	**110.5****	12
	Merit 57	91.46	75.48	**121.2*****	20
Test Weight (lb/bu)	AC Metcalfe	53.55	54.83	97.7	4
	Buzz	52.76	53.72	**98.2***	13
	Hockett	51.53	52.92	**97.4*****	20
	LCS Odyssey	50.8	50.33	100.9	11
	Merit 57	51.53	50.29	**102.5****	20
Extract (%)	AC Metcalfe	83.4	81	103	1
	Buzz	83.67	80.87	**103.5****	3
	Hockett	83.6	78.93	**105.9*****	4
	LCS Odyssey	83.4	79.7	104.6	2
	Merit 57	83.6	80.03	**104.5****	4

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

Table 4: 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)
	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
Lowest N	MT16M05610	13.7	78	5.8	42	108.5	206.7	39.5	259.6	31	92.5	48.9
	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
Low N	MT16M05610	13.2	78.8	5.5	42.1	112.5	206.4	27.1	257	38.6	94.9	48
	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
High N	MT16M05610	13.6	78.2	5.8	42.7	109.1	202.3	30.8	262.7	40.7	95.4	46.8
	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
Highest N	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

Table 5: 2019-2022 Malt Intrastate Trial, 49 entries, 3 replications, Lattice Square design

Variety	Yield (bu/ac)										
	Bozeman		Huntley		Sidney		Havre	Moccasin	Conrad		Kalispell
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Irr	Dry
# loc years	4	4	2	2	4	3	4	3	2	1	2
AC Metcalfe	102.9	125	-	-	79.3	**136.4****	58.4	49	-	**101.3***	114.4
Merit 57	**109.9***	**136.7**	**78.8****	**134.4****	**90.1***	111.6	64.1	46.2	81.3	96.3	118
Buzz	**110****	**131.9**	-	-	78.2	122.3	62.3	**56.9****	-	**110.9***	115.3
Hockett	89	125.2	68	115.5	72.3	108.4	47.7	37.6	81.3	98.2	**145.9****
MT16M02201	**105.4***	109.8	68.3	83.1	**91.9****	107	**69.6****	47.6	82.8	**114.6****	112.3
LSD	5.8	7.9	8	8.1	6.6	8.5	3.7	7	11.1	14.2	12.8
CV	6.6	7.9	9.7	6.7	10.3	6.7	7.2	15.5	12.5	6.6	9.2

Variety	Test Weight (lb/bu)										
	Bozeman		Huntley		Sidney		Havre	Moccasin	Conrad		Kalispell
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Irr	Dry
# loc years	4	3	2	2	4	3	4	3	2	1	2
AC Metcalfe	**53.9***	-	-	-	52.4	**54.3****	**52.5***	-	-	**53.6****	**53.4***
Merit 57	52.6	50.6	**51.7***	52.7	51.5	51.2	48.2	50.8	47	50.9	51.4
Buzz	**53.8***	**52.6***	-	-	52.7	**52.6***	50.8	53.6	-	51.8	52.2
Hockett	**54.3****	**53****	**52.1****	**53.6****	**54.2****	**52.6***	**52.9****	**54.3***	**52.2****	**52***	**54.1****
MT16M02201	52.2	51	49.8	52.7	50.2	50.4	49	**55.7****	**51.2***	49.9	51
LSD	0.5	0.7	0.7	0.7	0.5	2.5	0.5	1.7	5.1	1.7	1.2
CV	1.1	1.2	1.3	1.2	1.2	5.2	1.2	3.5	8.9	1.7	7.3

Table 5 Continued: 2019-2022 Malt Intrastate Trial, 49 entries, 3 replications, Lattice Square design

Variety	Plump (% 6/64th)										
	Bozeman		Huntley		Sidney		Havre	Moccasin	Conrad		Kalispell
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Irr	Dry
# loc years	4	3	2	2	4	3	4	2	2	1	2
AC Metcalfe	94.1	-	-	-	88.5	**97.2****	**88.7***	-	-	85.5	90.8
Merit 57	94	89	75	91.4	89.3	89.1	77.8	72.1	69	87.1	88.7
Buzz	**97.7****	**96.1****	-	-	90.7	**97***	86.3	**93.2***	-	**93.2****	**93.9***
Hockett	93.8	90.1	80.5	**96.7***	90	87.9	**90****	**95.1****	**93.3***	87.5	**95.5****
MT16M02201	**96.2***	92.6	79.5	**98.3****	**95.2****	**96.4***	**89.8***	**90.3***	**96.1****	**91.8***	**93***
LSD	1.8	1.9	7.7	3.2	2.8	1.5	3.1	5.4	10.9	5.3	3
CV	2.4	1.8	8.2	2.9	4	1.7	4.7	5.2	10.4	3	7

Variety	Protein (%)										
	Bozeman		Huntley		Sidney		Havre	Moccasin	Conrad		Kalispell
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Irr	Dry
# loc years	4	3	2	2	4	3	4	3	2	1	2
AC Metcalfe	12.9	-	-	-	13.7	13.2	13.3	-	-	13.6	12.4
Merit 57	11.9	11.9	14.1	**10.8***	**12***	12.7	12.4	11.2	**13.8***	12.3	11.7
Buzz	**10.9****	**10.7****	-	-	**12****	**11.8****	**11.8****	**10.6***	-	11.6	**11.1****
Hockett	12.3	11.7	13.8	11.3	12.7	12.6	12.8	**10.5****	**13***	12.8	12.1
MT16M02201	12	11.3	14.1	**10.5****	**12.3***	**11.9***	12.7	**10.8***	**12.8****	11.9	11.7
LSD	0.3	0.3	0.5	0.4	0.4	0.3	0.4	0.5	1.4	2.7	0.5
CV	2.9	2	3	3.7	3.9	2.8	3.6	6.2	9.5	14	7.6

Variety	Heading (julian)										
	Bozeman		Huntley		Sidney		Havre	Moccasin	Conrad		Kalispell
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Irr	Dry
# loc years	4	4	1	1	4	3	4	3	2	1	1
AC Metcalfe	**183.2***	183.6	-	-	171.2	176.8	**171***	184.4	-	180.7	**186.7***
Merit 57	185.3	184.8	170.5	171.9	174.3	182.1	173.5	187.8	191	183.3	188.1
Buzz	**183.3***	**180.7****	**163.4***	**162.1***	**170.6***	**173.2****	172.5	**182.1****	-	**178****	**182.9***
Hockett	183.6	181.9	169.4	**163.3***	171.4	175.9	173.4	185.7	**186.5***	180.3	**184.3***
MT16M02201	**182.9****	181.5	**162.7****	**161.6****	**169.7****	**174.1***	**170****	**183.7***	**186.3****	**178.7***	**182.5****
LSD	0.8	0.7	4.4	3	1.1	1.3	1.2	1.8	1.1	1.5	5.1
CV	0.6	0.5	1.4	0.9	0.8	0.8	0.8	1	0.5	0.5	1.4

Variety	Height (cm)										
	Bozeman		Huntley		Sidney		Havre	Moccasin	Conrad		Kalispell
	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Dry	Dry	Irr	Dry
# loc years	4	4	1	2	4	3	4	3	1	1	2
AC Metcalfe	83.1	100.8	-	-	66.8	81.2	**61.7***	**55****	73.4	75.1	90.6
Merit 57	**74.3***	91.1	88.3	92.6	71.3	84.3	76	59.3	74.5	76.8	87.5
Buzz	**71.8****	**86.2***	-	-	63.3	79.8	**61.4***	62.1	**68***	72.6	82.4
Hockett	74.9	88.9	88.6	93.6	65.8	77.4	**60.7****	**55.8***	**69***	66.2	93.2
MT16M02201	77	**86.1****	89.7	95.5	**59.3****	**71.6****	**63***	**58.1***	**65.6****	67.7	**78.4****
LSD	2.7	2.7	4.8	3.9	3.5	3.7	2.3	3.8	5	11.2	4.2
CV	4.4	3.9	2.8	3.7	7	5.1	4.7	7	3.9	8.1	11.4

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

Table 6: Offstation 2021-2022, 25/30 entries, RCBD design

Variety	Yield (bu/ac)										
	Bozeman	Denton	Judith	Havre	Huntley	Corvallis	Kalispell	Hysham	Fromberg	All Loc	All Loc
	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Irr	Irr	Dry	Irr
# loc years	2	2	1	1	1	1	1	2	2	9	4
Merit 57	88	16	42.3	60.6	24.8	**59.3***	**89.5***	**132.2***	**99.2***	42.7	**114.6***
Hockett	**99.6****	**19.8***	51.2	**63.9***	**35.7***	**83.7****	57.1	**135.5****	**107****	46.3	**120.6****
Buzz	**93.5***	**21.6****	39.4	**67.8****	**37.1***	56	**107.8****	106.4	90.9	63.5	96.1
MT16M02201	**99.1***	16.3	51.2	**64.4***	**41.8****	**64.9***	**93.3***	113.7	93.6	**69.9****	105.7
LSD	10.9	5	20.8	5	10	26.2	25.5	11.6	11	5.8	8
CV	9.9	23.8	27.4	4.2	14.5	26	19.2	8.4	9.5	19.4	8.9

Variety	Plump (%)										
	Bozeman	Denton	Judith	Havre	Huntley	Corvallis	Kalispell	Hysham	Fromberg	All Loc	All Loc
	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Irr	Irr	Dry	Irr
# loc years	2	0	0	1	1	1	1	2	2	6	4
Merit 57	79.7	/	/	62	47.3	72.3	87.5	87.3	80.3	68.9	83.8
Hockett	**88***	/	/	64.7	**67.5***	78.6	**93.7***	**97.3****	**93.4****	**86.9****	**95.4****
Buzz	**95.4****	/	/	**76.4***	**62.8***	72.5	**96.3****	**95.3***	86.5	**78.7***	90.9
MT16M02201	**92.7***	/	/	**80.3****	**68.8****	80.4	**95.1***	**95.1***	**90.8***	**83.1***	**92.9***
LSD	9	/	/	4.4	14.4	25	5.7	4.9	5.7	12.1	3.7
CV	9.3	/	/	4.3	18.5	23.5	4	4.9	6.1	26.1	5.5

Variety	Protein (%)										
	Bozeman	Denton	Judith	Havre	Huntley	Corvallis	Kalispell	Hysham	Fromberg	All Loc	All Loc
	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Irr	Irr	Dry	Irr
# loc years	2	2	1	1	1	0	1	2	2	8	4
Merit 57	12.2	14.2	13.9	15.3	20.5	/	14.4	12	15.1	14.3	14.6
Hockett	12.1	**12.7***	**12.9***	13.9	18.9	/	13.8	**11.8***	**13****	14.5	**12.5****
Buzz	**10.9***	**11.6****	**12.2***	**12.4****	**18.1***	/	**12.2****	**11.1****	13.9	**13.5****	**12.9***
MT16M02201	**10.9****	12.2	**11.9****	13.2	**17****	/	**13***	12.2	**13.3***	**13.9***	**12.9***
LSD	0.4	1.1	1.6	0.3	1.2	/	0.9	0.9	0.8	0.5	0.6
CV	3.1	7.4	6.5	1.5	3.9	/	3.7	6.6	5.2	6	5.9

Variety	Test Weight (lbs/bu)										
	Bozeman	Denton	Judith	Havre	Huntley	Corvallis	Kalispell	Hysham	Fromberg	All Loc	All Loc
	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Irr	Irr	Dry	Irr
# loc years	2	1	1	1	1	1	1	2	2	8	4
Merit 57	51.1	51.8	55.5	47.3	46.6	42.3	49.2	52.7	48.1	49.4	50
Hockett	**53.6****	54.2	56.7	49.3	**49.4****	46.9	**51.2***	**55.4****	**52.2****	**53.1****	**53.8****
Buzz	**52.6***	54.1	56.2	**50.2****	**48.6***	45	**51.5****	53.4	**51.4***	50.8	52.9
MT16M02201	**52.1***	53.8	56.6	46.8	45.9	44.7	48.4	52	49.7	51	51.3
LSD	1.9	2.4	2.1	0.7	1.5	5.7	1.9	1.1	1.1	1	0.8
CV	3.2	2.7	2.1	0.8	1.9	7.7	2.5	1.7	1.9	3.6	1.8

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

Table 7: MT Endurance Offstation Quality Head to Head Comparison Irrigated and Dryland

	Control	2201 Mean	Control Mean	%	obs
A Amylase	Buzz	91.35	126.6	**72.2*** **	4
	Hockett	91.35	84.38	**108.3***	4
	LCS Odyssey	91.35	67.23	**135.9*** **	4
	Merit 57	91.35	138.45	**66*** **	4
B Glucan	Buzz	241.65	202.13	119.6	4
	Hockett	241.65	505.58	**47.8****	4
	LCS Odyssey	241.65	171.93	**140.6****	4
	Merit 57	241.65	91.93	262.9	4
DP	Buzz	136.23	138.2	98.6	4
	Hockett	136.23	148.45	91.8	4
	LCS Odyssey	136.23	121.88	111.8	4
	Merit 57	136.23	188.33	**72.3*** **	4
Extract	Buzz	83.2	80.3	**103.6*** **	4
	Hockett	83.2	78.88	**105.5*** **	4
	LCS Odyssey	83.2	79.18	**105.1*** **	4
	Merit 57	83.2	79.15	**105.1*** **	4
FAN	Buzz	216.65	208.3	104	4
	Hockett	216.65	168.18	**128.8*** **	4
	LCS Odyssey	216.65	151.4	**143.1*** **	4
	Merit 57	216.65	235.83	91.9	4
Malt Protein	Buzz	12.4	12.4	100	4
	Hockett	12.4	13.17	94.2	4
	LCS Odyssey	12.4	12.66	98	4
	Merit 57	12.4	13.86	**89.5***	4
S/T Protein	Buzz	47.2	45.35	104.1	4
	Hockett	47.2	37.43	**126.1*** **	4
	LCS Odyssey	47.2	35.58	**132.7*** **	4
	Merit 57	47.2	43.1	**109.5****	4

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

Disease resistance:

MT16M02201 tested moderately resistant to moderately susceptible to stem rust in Africa (Table 8 and 9). MT16M02201 had higher than acceptable DON levels due to FHB at EARC in 2021 disease screening nursery under mist and with corn spawn inoculation (Table 10). MT16M02201 was tested for stripe rust in 2022 but data is not yet available.

	Table 8: 2020 USDA African Stem Rust Nursery						
	Field Evaluations, Njoro, Kenya				Field Evaluations, Debre Zeit, Ethiopia		
	KALRO/CIMMYT				EIAR		
	3/31	4/6	4/20	4/27	5/22	5/30	6/8
Entry name	Stripe Rust	Stripe Rust	Stem Rust	Stem Rust	Stem Rust	Stem Rust	Stem Rust
Hockett	0	0	1MS	15MR	1MS	1MR	1MR
Buzz	0	0	10MS	15MRMS	1MS	5MS	5MS
MT16M02201	0	0	10MR	15MR	1MS	1MS	5MR
Conlon	0	0	15MS	20MRMS	5MS	10MS	15M
Pinnacle	0	0	30MS	40MRMS	1MS	5MS	10MS
ND Genesis	0	0	15MR	20MR	5MS	10MS	10MS
UC Tahoe	0	0	10MS	15MRMS	0	5MS	10MS
UC 1410	0	0	1MS	5MRMS	0	0	0
Butta 12	0	0	10MR	15MR	0	10MS	20M
UC Capay	0	0	1MS	5MRMS	0	1MS	1MR
Steptoe	1MS	1MS	20MSS	20MSS	5MSS	5MS	20MS
Baronesse	0	0	5MS	5MS	10MSS	5MS	10M
Harrington	0	0	5MS	15MRMS	10MS	15S	40MSS
AC Metcalfe	0	0	10MS	15MRMS	0	5MS	10MS
ABI Voyager	0	0	15MS	20MRMS	5M	20MS	60S
ND Genesis	5MS	20MS	15MRMS	15MRMS	5MS	10M	15M

	Table 9:2021 USDA African Stem Rust Nursery						
	Field Evaluations, Njoro, Kenya			Field Evaluations, Debre Zeit, Ethiopia			
	KALRO/CIMMYT			EIAR			late maturing
	4/22	4/29	5/5	4/5	5/13	5/21	6/4
Entry name	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 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

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