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## **MEMORANDUM**

**TO:** Wheat Variety Release Committee

**FROM:** Jason Cook, Hwa-Young Heo and Philip Bruckner, Spring Wheat Breeders

**DATE:** January 4<sup>th</sup>, 2021

**RE:** Proposal for protected MAES public cultivar release of MT1716

The following motion and supporting documentation is presented for consideration at the 2021 MAES Variety Release Meeting in Bozeman, MT:

**Motion:** Release MT1716 hard red spring wheat as a public variety with PVP Title V protection.

**Pedigree:** MT1274/RB07

The rationale for releasing MT1716 is on the basis that it has moderate fusarium head blight (FHB) resistance and high yield potential in Montana rainfed growing environments. MT1716 also has good grain protein content, very good test weight and average end-use quality. MT1716 was derived from the cross MT1274/'RB07' (Anderson et al., 2009). RB07 was released by the University of Minnesota in 2007 for high yield, moderate FHB resistance and good end-use quality. MT1274 came from the cross 'Vida' (Lanning et al., 2006) /'Clear White' (Chicaiza et al., 2005). Vida is the most widely grown hard red spring wheat variety in Montana since 2011 (Table 1). Clear White is a hard white spring wheat variety released by the University of California – Davis for having excellent end-use quality (Chicaiza et al., 2005).

Fusarium head blight resistance testing was carried out by Dr. Frankie Crutcher at the Eastern Ag Research Center located in Sidney, MT. MT1716 was tested for three years (2018-2020), and had lower FHB infection and deoxynivalenol (DON) accumulation than the susceptible checks Dagmar, Lanning, McNeal and Vida (Table 2). In 2020, SY Ingmar, a moderately FHB resistant variety and second most grown variety in Montana (8.6%), was included in the FHB screening nursery. MT1716's FHB resistance level was similar to SY Ingmar.

Yield and other agronomic measurements were collected from the Advanced Yield Trial (AYT) during the 2018 – 2020 growing seasons totaling 20 location-years in 17 rainfed and 3 irrigated growing environments. Average yield performance of MT1716 across all location-years was 4.6 bu/ac higher than SY Ingmar (Table 3). MT1716 average yield was 1.4 bu/ac less than

Vida across all location-years. MT1716 grain protein content was 0.4% higher than Vida, but 0.9% lower than SY Ingmar (Table 4). MT1716 had the highest test weight (61.9 lbs/bu) among all comparisons, and heading date was 3 days earlier than Vida (Table 5). Solid-stem scores measured at Bozeman, MT for MT1716, SY Ingmar and Vida were 9.3, 10.0 and 12.5, respectively. Sawfly cutting data collected from Fort Benton, MT was 60%, 53.3% and 20% for MT1716, SY Ingmar and Vida, respectively (Table 5). Both MT1716 and SY Ingmar are susceptible to wheat stem sawfly.

Data collected from 16 Off-Station Yield Trials consisting of 12 rainfed and 4 irrigated growing environments during the 2020 growing season allowed for additional comparisons between MT1716 and three moderately FHB resistant varieties; Brennan, SY Ingmar and SY Soren. Collectively, Brennan, SY Ingmar and SY Soren were estimated to have been grown on 19.6% of Montana's 2020 spring wheat acreage (Table 1). Averaged across rainfed and all environments, MT1716 had higher yield than Brennan, SY Ingmar and SY Soren (Table 6). In rainfed environments, MT1716 had the second highest test weight (61.4 lbs/bu) among all entries, lagging behind only Brennan (61.9 lbs/bu). Grain protein content for MT1716 averaged across rainfed, irrigated and all environments was 14.1%.

End-use quality was tested at two 2018 AYT locations, three 2019 AYT locations and two 2020 AYT locations. Among 12 varieties, MT1716 ranked sixth or better in six out of eight end-use quality categories (Table 7). MT1716 ranked last for mixing tolerance and eighth for flower protein. Compared to Vida, MT1716 ranked higher in all categories except mixing tolerance and flour yield. SY Ingmar, one of the best end-use quality lines grown in MT, ranked better than MT1716 in all categories. Overall, we consider MT1716's end-use quality as average.

## References:

- Anderson, J.A., G.L. Linkert, R.H. Busch, J.J. Wiersma, J.A. Kolmer, Y. Jin, R. Dill-Macky, J.V. Wiersma, G.A. Hareland and D.V. McVey. 2009. Registration of 'RB07' Wheat. *Journal of Plant Registrations* 3: 175-180. doi:<https://doi.org/10.3198/jpr2008.08.0478crc>.
- Chicaiza, O., L. Jackson and J. Dubcovsky. 2005. Registration of 'Clear White' Wheat. *Crop Science* 45: 2652-2652. doi:<https://doi.org/10.2135/cropsci2005.0007r>.
- Lanning, S.P., G.R. Carlson, D. Nash, D.M. Wichman, K.D. Kephart, R.N. Stougaard, G.D. Kushnak, J.L. Eckhoff, W.E. Grey, A. Dyer and L.E. Talbert. 2006. Registration of 'Vida' wheat. *Crop Science* 46: 2315-2316. doi:10.2135/cropsci2006.03.0167.

Table 1. 2020 Montana Spring Wheat Variety Survey. Percentage of statewide planted acres.<sup>1/</sup>

Variety	Acres (%)
Vida	31.5%
SY Ingmar	8.6%
SY Soren	6.1%
Corbin	6.1%
Reeder	6.1%
Brennan	4.9%
WB Gunnison	4.4%
Duclair	4.1%
Lanning	3.9%
Mott	1.7%
Other	22.6%

<sup>1/</sup> Survey conducted by Dr. Kate Fuller, Department of Agricultural Economics and Economics, Montana State University

Table 2. Fusarium head blight resistance of MT1716 compared to other regionally adapted control varieties evaluated in Sidney, MT from 2018 to 2020.

Variety	% Severity <sup>a</sup>	% Incidence <sup>b</sup>	Disease Index <sup>c</sup>	% FDK <sup>d</sup>	DON (ppm)
<b>2018</b>					
<b>MT1716</b>	<b>0.97 B</b>	<b>12.0 B</b>	<b>0.12</b>	<b>10.00 B</b>	<b>0.13 B</b>
Vida	3.60 AB	28.67 AB	1.44	17.5 AB	0.40 AB
Lanning	2.20 B	16.67 B	0.58	11.39 B	0.63 AB
McNeal	12.63 A	55.33 A	7.61	22.50 A	1.53 A
Mean	4.85	28.2	2.43	15.35	0.68
Prob > F	< 0.05	< 0.05	0.0533	< 0.05	< 0.05
HSD	9.07	38.34	NS	11.02	1.21
<b>2019</b>					
<b>MT1716</b>	<b>21.67 C</b>	<b>74.44</b>	<b>17.40 C</b>	<b>4.67 C</b>	<b>2.49 B</b>
Vida	37.11 BC	82.22	30.57 BC	6.67 BC	5.94 AB
Lanning	46.44 B	87.78	40.69 BC	15.0 B	6.93 AB
McNeal	72.22 A	98.89	71.44 A	38.33 A	10.53 A
Dagmar	50.44 B	91.11	46.67 B	15.0 B	9.33 A
Mean	45.58	86.89	41.65	15.93	7.04
Prob > F	< 0.001	0.15	< 0.001	< 0.0001	< 0.01
HSD	20.78	NS	24.54	9.39	5.10
<b>2020</b>					
<b>MT1716</b>	<b>1.17 B</b>	<b>15.56 C</b>	<b>0.21 B</b>	<b>3.33 B</b>	<b>0.82 B</b>
Vida	5.17 B	34.44 BC	1.96 B	6.0 B	2.66 AB
Lanning	7.44 B	51.11 AB	4.16 B	7.33 B	3.90 A
McNeal	33.89 A	78.89 A	26.91 A	18.33 A	4.10 A
Dagmar	7.94 B	50.0 AB	4.02 B	5.33 B	2.04 AB
Ingmar	1.11 B	6.67 C	0.10 B	4.0 B	0.74 B
Mean	9.45	39.44	6.23	7.39	2.38
Prob > F	< 0.0001	< 0.0001	< 0.0001	< 0.0001	> 0.001
HSD	8.32	29.70	8.13	4.53	2.98

Letters in common were not statistically different according to a Tukey's HSD test.

<sup>a</sup>Pest Severity: Average percent area of head covered by disease. Thirty heads were evaluated for each plot.

<sup>b</sup>Pest Incidence: Percent of thirty plants per plot that had visible FHB symptoms.

<sup>c</sup>Disease index is calculated as (Severity X Incidence) / 100

<sup>d</sup>Fusarium damaged kernels.

Table 3. Grain yield (bu/ac) comparisons between MT1716 and check varieties grown in 20 Advanced Yield Trial (AYT) location-years from 2018 to 2020. Twenty-six common cultivars were grown all three years and were included in the combined analysis. Underlined values indicate they were not significantly different from the highest yielding line. Table sorted based on combined means.

Loc.	Bozeman	Conrad	Fort Benton	Havre	Huntley	Kalispell	Moccasin	Sidney	Sidney (irrigated)	Combined Means
Year	2018-2020	2018-2019	2020	2018-2020	2018, 2020	2019	2018-2020	2018-2019	2018-2020	n = 20
Vida	<u>103.4</u>	<u>64.6</u>	44.2	<u>53.6</u>	<u>86.6</u>	<u>49.0</u>	<u>54.5</u>	<u>64.5</u>	<u>95.5</u>	<u>68.4</u>
Dagmar	<u>97.6</u>	<u>76.3</u>	44.2	<u>54.7</u>	<u>83.1</u>	<u>50.1</u>	<u>53.3</u>	<u>61.2</u>	<u>94.6</u>	<u>68.3</u>
<b>MT 1716</b>	<b><u>95.9</u></b>	<b><u>61.7</u></b>	<b><u>45.0</u></b>	<b><u>52.1</u></b>	<b><u>92.0</u></b>	<b><u>47.0</u></b>	<b><u>49.4</u></b>	<b><u>63.0</u></b>	<b><u>96.8</u></b>	<b><u>67.0</u></b>
Duclair	<u>98.5</u>	63.6	<u>56.1</u>	49.3	<u>86.2</u>	<u>52.2</u>	48.5	<u>58.8</u>	88.0	<u>66.8</u>
Lanning	94.0	62.8	46.0	<u>50.7</u>	77.5	<u>46.1</u>	<u>54.7</u>	<u>59.7</u>	<u>95.8</u>	<u>65.3</u>
Reeder	92.8	57.7	45.1	49.2	75.3	<u>46.7</u>	<u>49.6</u>	<u>64.6</u>	<u>93.8</u>	63.9
SY Ingmar	92.6	59.5	32.2	47.9	78.0	<u>45.8</u>	<u>49.0</u>	<u>59.1</u>	<u>97.2</u>	62.4
Corbin	89.8	60.5	43.1	47.5	76.8	<u>43.5</u>	<u>50.1</u>	54.3	84.6	61.1
Mean (n=26)	93.7	61.6	46.9	49.9	81.4	47.8	51.0	60.2	90.6	64.6
Prob. (line)	<0.001	<0.01	<0.01	<0.01	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001
LSD (0.05)	8.7	9.0	7.4	5.0	10.1	10.5	6.0	6.4	6.8	4.2

Table 4. Grain protein content (%) comparisons between MT1716 and check varieties grown in 20 Advanced Yield Trial (AYT) location-years from 2018 to 2020. Twenty-six common cultivars were grown all three years and were included in the combined analysis. Underlined values indicate they were not significantly different from the highest grain protein content value. Table sorted based on combined means.

Loc.	Bozeman	Conrad	Fort Benton	Havre	Huntley	Kalispell	Moccasin	Sidney	Sidney (irrigated)	Combined
Year	2018-2020	2018-2019	2020	2018-2020	2018, 2020	2019	2018-2020	2018-2019	2018-2020	n = 20
<u>SY Ingmar</u>	<u>15.2</u>	<u>15.4</u>	16.9	<u>15.6</u>	15.5	<u>16.5</u>	<u>13.0</u>	<u>15.6</u>	15.4	<u>15.5</u>
Lanning	<u>15.5</u>	<u>15.4</u>	14.9	<u>15.8</u>	<u>16.3</u>	15.5	12.2	<u>15.9</u>	<u>16.0</u>	<u>15.3</u>
Dagmar	<u>15.2</u>	<u>15.0</u>	15.5	<u>15.6</u>	15.8	14.9	12.2	15.1	<u>16.2</u>	<u>15.1</u>
Reeder	<u>15.1</u>	<u>15.5</u>	14.7	15.2	15.6	14.6	12.2	15.1	15.5	14.8
Corbin	<u>14.8</u>	14.3	14.8	<u>15.9</u>	15.2	14.3	<u>12.5</u>	15.0	15.4	14.7
<b>MT 1716</b>	<b><u>14.7</u></b>	<b><u>15.3</u></b>	<b><u>14.6</u></b>	<b><u>15.2</u></b>	<b><u>14.9</u></b>	<b><u>15.1</u></b>	<b><u>11.9</u></b>	<b><u>14.5</u></b>	<b><u>15.3</u></b>	<b><u>14.6</u></b>
Duclair	<u>15.0</u>	<u>15.1</u>	14.2	15.4	14.9	14.7	12.1	14.5	15.0	14.5
Vida	<u>14.5</u>	14.3	14.8	14.7	14.6	14.2	11.5	14.4	15.0	14.2
Mean (n=26)	14.9	14.9	15.1	15.4	15.3	15.0	12.3	15.0	15.3	14.8
Prob. (line)	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
LSD (0.05)	0.7	0.7	-	0.4	0.6	0.4	0.6	0.7	0.5	0.4

Table 5. Agronomic comparisons between MT1716 and check varieties grown in 20 Advanced Yield Trial (AYT) location-years from 2018 to 2020. Twenty-six common cultivars were grown all three years and were included in the combined analysis. Underlined values indicate they were not significantly different from the highest value. After MT1716, the table was sorted alphabetically based on variety name.

Line/Variety	Test weight (lb/bu)	Heading date (julian)	Plant height (inch)	Stem solidness (5-25) (Bozeman)	Sawfly cutting (%) (Fort Benton)	Sawfly cutting (%) (Havre)
Year	2018-2020	2018-2020	2018-2020	2018-2020	2020	2020
<b>MT 1716</b>	<b><u>61.9</u></b>	<b><u>173.8</u></b>	<b><u>30.2</u></b>	<b><u>9.3</u></b>	<b><u>60.0</u></b>	<b><u>8.7</u></b>
Corbin	<u>61.7</u>	173.9	30.5	13.1	26.7	2.0
Dagmar	<u>61.6</u>	173.6	<u>31.3</u>	<u>18.1</u>	13.3	0.3
Duclair	60.9	173.6	30.6	<u>20.0</u>	11.7	<u>2.3</u>
Lanning	<u>61.1</u>	174.5	29.8	7.7	45.0	<u>6.7</u>
Reeder	<u>61.4</u>	<u>176.7</u>	<u>31.9</u>	7.9	38.3	<u>5.3</u>
<u>SY Ingmar</u>	<u>61.6</u>	175.8	29.6	10.0	<u>53.3</u>	<u>8.3</u>
Vida	60.6	<u>176.8</u>	30.5	12.5	20.0	2.0
Mean (n=26)	61.3	175.8	30.8	12.6	29.9	5.0
Prob. (line)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
LSD (0.05)	0.8	0.7	1.1	2.4	12.9	6.6

Table 6. Yield and agronomic comparisons of MT1716 with elite varieties grown in the 2020 Spring Wheat Off-Station Yield Trial. Cultivars were grown at 16 locations that included 12 rainfed and and four irrigated environments. Underlined values indicate they were not significantly different from the highest value. After MT1716, the table was sorted alphabetically based on variety name.

No. of environments	YIELD (bu/ac)			GRAIN PROTEIN (%)			TEST WEIGHT (lb/bu)			HEADING DATE (Julian)			HEIGHT (Inches)		
	12	4	16	12	4	16	12	4	16	3	2	5	12	4	16
Line/Variety	RAINFED	IRRI	TOTAL	RAINFED	IRRI	TOTAL	RAINFED	IRRI	TOTAL	RAINFED	IRRI	TOTAL	RAINFED	IRRI	TOTAL
<b>MT 1716</b>	<b>56.5</b>	<b>113.3</b>	<b>70.7</b>	<b>14.1</b>	<b>14.1</b>	<b>14.1</b>	<u>61.4</u>	<b>62.4</b>	<b>61.6</b>	<b>175.4</b>	<b>169.3</b>	<b>173.0</b>	<b>29.5</b>	<b>36.6</b>	<b>31.3</b>
ALUM	57.0	112.1	70.8	14.0	14.1	14.0	60.4	61.3	60.7	<u>177.7</u>	171.1	175.0	29.8	36.4	31.5
BRENNAN	50.9	113.4	66.5	15.2	14.4	15.0	<u>61.9</u>	<u>63.2</u>	<u>62.3</u>	<u>175.5</u>	168.4	172.6	27.0	33.5	28.6
CHOTEAU	55.9	<u>114.8</u>	70.6	14.4	14.3	14.4	60.3	61.4	60.6	<u>177.2</u>	171.3	174.8	29.0	36.6	30.9
CORBIN	52.8	108.7	66.8	14.6	14.2	14.5	60.7	61.2	60.8	175.0	168.6	172.4	29.4	37.3	31.4
DAGMAR	<u>59.7</u>	<u>118.6</u>	<u>74.4</u>	14.7	14.9	14.7	61.0	62.3	61.3	175.7	169.2	173.1	30.1	37.7	32.0
DUCLAIR	<u>57.8</u>	<u>122.2</u>	<u>73.9</u>	14.3	14.0	14.2	59.6	61.4	60.1	175.4	169.2	172.9	29.6	36.5	31.3
EGAN	56.0	105.1	68.3	<u>15.6</u>	<u>16.2</u>	<u>15.8</u>	58.8	61.2	59.4	<u>178.6</u>	172.7	<u>176.2</u>	30.3	37.7	32.1
FORTUNA	47.2	96.0	59.4	14.5	14.4	14.5	60.2	61.2	60.5	<u>177.7</u>	172.2	175.5	<u>36.0</u>	<u>43.9</u>	<u>38.0</u>
LANNING	56.7	<u>116.3</u>	<u>71.6</u>	14.5	15.1	14.6	60.2	62.2	60.7	174.0	168.3	171.7	29.2	35.4	30.8
LCS PRO	53.7	114.2	68.8	14.3	14.3	14.3	60.5	<u>63.0</u>	61.1	175.9	170.2	173.6	32.4	40.5	34.4
NS PRESSER CLP	<u>59.0</u>	98.7	68.9	13.7	14.5	13.9	59.3	59.7	59.4	<u>178.8</u>	<u>174.8</u>	<u>177.2</u>	30.1	39.1	32.3
REEDER	54.0	103.1	66.3	14.4	14.7	14.5	60.6	<u>62.6</u>	61.1	<u>176.9</u>	171.3	174.7	31.2	39.7	33.3
SY INGMAR	52.7	107.2	66.3	14.9	14.6	14.8	61.1	<u>63.3</u>	61.6	<u>177.6</u>	171.9	175.3	28.7	35.3	30.4
SY SOREN	54.0	110.5	68.1	14.8	14.6	14.8	60.8	<u>63.3</u>	61.4	175.7	170.3	173.6	27.7	34.1	29.3
VIDA	<u>61.0</u>	108.0	<u>72.7</u>	13.6	14.5	13.9	60.0	60.6	60.2	<u>177.2</u>	172.8	175.4	29.9	37.5	31.8
WB GUNNISON	54.8	109.6	68.5	13.9	13.4	13.8	60.9	<u>62.6</u>	61.3	<u>177.1</u>	170.0	174.2	28.7	34.9	30.2
WB9879CLP	56.9	<u>120.4</u>	<u>72.7</u>	14.6	13.9	14.5	60.6	<u>62.6</u>	61.1	<u>177.2</u>	172.0	175.1	28.9	37.4	31.0
Mean (n=20)	55.6	110.7	69.4	14.4	14.4	14.4	60.4	61.9	60.8	176.8	170.9	174.4	30.0	37.4	31.9
Prob. (Line)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
LSD (0.05)	3.5	7.8	3.6	0.4	0.6	0.3	0.7	0.8	0.6	2.0	1.1	1.2	0.9	1.5	0.8



Table 7. Combined analysis and ranks of end-use quality between MT1716 and check varieties grown in seven Advanced Yield Trial (AYT) location-years from 2018 to 2020. End-Use quality samples were from Bozeman, MT (2018-2020), Conrad, MT (2019), Havre, MT (2018-2019) and Sidney, MT (2020). Twenty-six entries were common in all locations and used in the combined analysis. Underlined values indicate they were not significantly different from the highest value. After MT1716, the table was sorted alphabetically based on variety name.

Line / Variety	Flour yield		Flour protein		Mixing tolerance		Mixo mixing time (min.)		Mixo water absorption (%)		Bake mix time (min.)		Bake water absorption (%)		Loaf volume	
	(%)	Rank	(%, 14% m.b.)	Rank		Rank		Rank		Rank		Rank		Rank	(cc)	Rank
<b>MT 1716</b>	<u>71.5</u>	<b>4</b>	<u>13.9</u>	<b>8</b>	<u>1.3</u>	<b>12</b>	<u>4.0</u>	<b>5</b>	<u>69.0</u>	<b>6</b>	<u>10.7</u>	<b>4</b>	<u>79.0</u>	<b>6</b>	<u>1163</u>	<b>6</b>
Choteau	70.8	5	14.3	4	1.6	11	2.7	12	68.6	7	5.0	10	78.2	8	1151	8
Corbin	70.2	8	13.7	10	2.4	7	4.7	3	67.9	9	10.6	5	78.0	9	1101	12
Dagmar	70.4	7	14.0	6	3.9	3	3.5	8	70.2	5	6.6	8	79.3	5	1157	7
Duclair	70.1	9	13.7	9	3.4	5	3.8	6	68.3	8	7.2	7	78.3	7	1205	5
Egan	68.7	12	<u>15.6</u>	1	<u>4.9</u>	1	<u>8.0</u>	1	<u>73.1</u>	1	<u>16.8</u>	1	<u>83.9</u>	1	<u>1330</u>	1
Fortuna	<u>72.4</u>	3	13.6	11	2.0	9	2.9	11	65.3	12	5.0	11	75.1	12	1131	11
Lanning	70.4	6	14.7	2	3.0	6	3.7	7	<u>70.9</u>	3	7.9	6	81.0	3	1232	3
McNeal	69.0	11	14.0	7	<u>4.7</u>	2	6.8	2	<u>72.2</u>	2	<u>13.8</u>	2	<u>83.2</u>	2	1256	2
Reeder	69.5	10	14.1	5	2.3	8	3.0	10	67.3	11	4.9	12	76.7	11	1145	9
SY Ingmar	<u>72.4</u>	2	14.5	3	3.7	4	4.6	4	70.4	4	11.8	3	80.6	4	1231	4
Vida	<u>72.7</u>	1	13.5	12	1.7	10	3.0	9	67.6	10	6.1	9	77.1	10	1133	10
Mean (n=26)	70.7	-	14.0	-	3.0	-	4.1	-	68.9	-	8.6	-	79.0	-	1151	-
C.V.	1.1	-	3.5	-	28.1	-	19.9	-	3.2	-	24.7	-	2.8	-	5	-
Prob. (line)	<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-	<0.001	-
LSD(0.05)	1.0	-	0.6	-	0.9	-	1.1	-	2.6	-	3.3	-	2.5	-	58.6	-