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MEMORANDUM

FROM: Suchismita Mondal, Winter wheat breeder
DATE: January 16, 2023
RE: Licensed release of MTCL 19151 Clearfield hard red winter wheat

Pedigree: **MTCL 19151:** MT0871/06X445B1-2 (SY Clearstone sib)

MTCL 19151 resulted from a 2011 cross of MT0871 (HW winter experimental line) to a sister line of SY Clearstone designated as 06X445B1-2 (segregating for two *als* genes conveying tolerance to imidazolinone herbicides)

Recommendation: Licensed release. [Rationale: contains patented traits] **Name:** To be determined

Selection history: The line resulted from a cross in 2011 and followed a selected bulk method in F2-F4 that is from 2013-2015 with treatment of Beyond herbicide (2X dose) at every stage. In 2016, 120 heads were selected from the F5 population treated with Beyond herbicide (2X dose) in Fort (Ft.) Ellis. The head rows (HRs) were treated with Beyond herbicide (2X dose) at Ft. Ellis and 20 HRs with desired agronomic characteristics were selected for advancing. In 2018, 20 HRs were part of a single rep Observation nursery at Ft. Ellis under Beyond Herbicide treatment (2X doses). The selected line 11x270E2 was designated MTCL 19151 and entered into multi-location Preliminary Yield Trials and Clearfield Qualification Trials in 2019. The following year MTCL 19151 was entered into multi-location Advanced Yield Trials and also in Clearfield Qualification Trial. Based on the performance of MTCL19151 it was part of Clearfield Qualification Trials in 2021, Intrastate trials (9 locations) in 2021 and 2022 and Off-station trials (7 locations) in 2022.

BASF approval: *Prior to cultivar release, data demonstrating adequate crop tolerance to Beyond herbicide must be submitted to BASF for approval. To follow this process, data from the Qualification trial conducted in 3 years across 2 locations will be submitted to BASF for evaluation and potential approval. A summary of the trial performance is included in this document.*

General performance and characteristics

Yield performance data of MTCL 19151 from 2020-2022 is presented in Table 1 in comparison to released Clearfield and non-Clearfield varieties. The yield of MTCL 19151 on an average is similar to that of Yellowstone with yield advantages in certain locations such as Huntley, Sidney and Williston compared to SY Clearstone. It also shows comparable higher yield to Brawl CL Plus.

MTCL 19151 is 3 days earlier on average compared to most varieties except Brawl CL Plus (Table2). It is shorter by about 4 inches compared to SY Clearstone and 2 inches compared to Brawl CL Plus. MTCL 19151 has better winter hardiness than SY Clearstone and Brawl CL Plus. Test weight and protein are similar to the other varieties included for comparison.

Being a hollow line, wheat stem sawfly cutting was similar to other hollow varieties in the trial (Table 2). Stripe rust resistance is moderate in 3 years of testing at Pullman and Mt Vernon, WA, though better resistance than Brawl CL Plus (Table 3). It is moderately susceptible to stem rust, similar to that of Yellowstone.

Clearfield qualification trials conducted between 2019-2021 in Ft. Ellis and Huntley, show that the performance of MTCL 19151 was comparable to SY Clearstone and Stand Clear CLP, with no significant difference between 0X and 2 X treatment across years and no injuries were noted for 2X dose during the trial years. MTCL 19151 was consistently shorter by about 4 inches compared to SY Clearstone and 2 inches compared to Stand Clear CLP in these trials as well.

Mill and bake characteristics compared in the Preliminary and Advanced Yield Trials in 2019-2020 show that performance is similar to that of Yellowstone and has consistently low PPO values (Table 5). In the Intrastate trial of 2021, MTCL 19151 shows a consistent low PPO as previous years, however had high protein values, mix time and absorption which may be due to the effect of severe drought conditions in 2021 (Table 6).

Table 1 Yield of MTCL19151 in comparison to check varieties (and Clearfield varieties) in various districts from 2020-2022

Cultivar/Line	District ¹									All Locations
	1	2	3	4	5	5	5	6	6	
	Kalispell ²	Bozeman	Huntley ³	Moccasin ⁴	Ft Benton	Conrad	Havre ⁵	Sidney	Williston	
Brawl CL Plus	96.9	95.7	52.1	38.3	36.5	73.2	41.1	44.7	18.2	53.0
FourOsix	110.7	89.2	50.9	38.5	34.1	83.4	39.4	53.0	23.9	54.9
Northern	104.0	90.9	50.5	37.2	31.7	79.1	39.7	52.2	22.1	55.3
Stand Clear CLP	104.4	89.5	51.5	37.3	35.7	74.2	40.2	54.0	20.0	54.9
SY Clearstone	116.1	90.0	48.5	42.0	28.9	79.0	38.9	51.2	23.4	54.6
Yellowstone	113.3	93.4	48.3	40.6	33.4	79.5	42.0	57.4	25.4	56.8
MTCL19151	99.9	94.8	54.7	39.1	33.6	75.3	42.0	56.1	25.3	56.0
LSD (0.05)	12.9*	6.3	6.8	5.7	15.4	7.2	3.6	8.5*	5.7*	3.4

Bold indicates significantly higher value for the trait based on LSD

* significant genotypic differences at p<0.05

1/ includes 2020 advanced, 2021 & 2022 Intrastate and 2022 Off Station

2/ includes data from Creston

3/ includes data from Denton, Geraldine, Belt,

4/ includes data from Huntley Irr, Rapelje, Hysham, Molt, Fly Creek

5/ includes data from Loma

Table 2 Agronomic characteristics of MTCL 19151 in comparison to check varieties (and Clearfield varieties) in from 2020-2022

Cultivar/Line ¹	Test Weight (lb/bu)	Heading Date (Julian)	Plant Height (in)	Winter Hardiness	Stem Solidness (5-25)	Sawfly Cutting (%)	Protein (%)
Locations	17	12	16	3	6	4	17
Brawl CL Plus	59.3	161.7	28.0	37.7		48.5	13.7
FourOsix	58.3	166.9	28.2	51.1		54.1	13.3
Northern	57.9	168.4	28.5	58.1		49.6	13.5
Stand Clear CLP	59.3	167.0	28.9	72.9	18.0	30.4	13.3
SY Clearstone	57.3	167.8	30.5	56.6		52.9	13.2
Yellowstone	57.7	167.7	30.0	83.0		56.4	13.2
MTCL19151	58.5	164.8	26.3	73.5		54.9	13.4
LSD (0.05)	0.85*	0.83*	0.86*	29.4		10.3	0.64*

1/ includes 2020 advanced, 2021 & 2022 Intrastate and 2022 Off Station

*significant at p<0.05

Table 3 Stripe and stem rust resistance (% infection) characteristics of MTCL 19151 in comparison to check varieties (and Clearfield varieties across 2021-2022

Cultivar/Line	Stripe Rust 10.5		Stem Rust
	Pullman, WA	MT. Vernon, WA	St Paul, MN
Years	4	4	2
Brawl CL Plus	68.0	31.5	
FourOsix	15.8	15.0	
Northern	18.8	13.8	
Stand Clear CLP	22.9	13.5	
SY Clearstone	12.8	14.7	
Yellowstone	15.8	22.8	40MS
MTCL19151	14.3	15.1	30MS
LSD (0.05)	19.5*	16.1*	

Bold highlight significant high disease incidence or % infection

*significant difference at p<0.05

Table 4. Performance of MTCL 19151 in Clearfield Qualification Trials 2019-2021 across locations

Cultivar/Line	Yield (bu/ac)	Injury (%)	Test Weight (lb/bu)	Plant Height (in)	Protein (%)
Locations	6	4	6	6	6
Stand Clear CLP	94.6	0	61.9	32.9	12.9
SY Clearstone	90.4	0	59.4	35.1	12.6
MTCL 19151	98.8	0	60.5	30.6	12.3
LSD (0.05)	12.4		1.7	3.6	1.0

Table 5. Mill and Bake characteristics of MTCL 19151 in multi-location trials from 2019-2020

Cultivar/Line	PPO	Kernel Hardness	Flour		Mixograph			Baking		
			yield (%)	protein (%)	Tolerance (1-6)	Mixing time (min)	Water absorption (%)	Mixing time min	Water Absorption (%)	Loaf Volume
Locations	8	8	8	8	8	8	8	8	8	8
SY Monument	0.160	80.3	71.4	10.9	3.9	8.0	63.3	17.2	74.8	970.3
Yellowstone	0.213	80.3	71.3	11.6	3.7	8.1	64.1	16.7	74.7	997.2
MTCL 19151	0.103	80.3	72.2	11.7	3.6	8.3	65.0	16.8	75.7	1029.5
LSD (0.05)	0.038*	ns	1.9	0.6*	1.0	1.4	4.0	4.5	2.6	146.1

*significant at p<0.05

Table 6. Mill and Bake characteristics of MTCL 19151 in comparison to check varieties in Intrastate trial of 2021

Cultivar/Line	PPO	Kernel Hardness	Flour		Mixograph			Baking		
			yield (%)	protein (%)	Tolerance (1-6)	Mixing time (min)	Water absorption (%)	Mixing time min	Water Absorption (%)	Loaf Volume
Locations	4	4	4	4	4	4	4	4	4	4
BrawlCLPlus	0.205	73.1	66.9	15.0	3.6	5.6	69.2	10.9	78.9	1228.3
FourOsix	0.216	71.6	67.5	14.9	3.6	6.2	68.6	11.4	78.6	1221.7
Northern	0.129	85.4	66.4	15.1	3.0	4.3	67.0	7.0	76.7	1198.3
StandClearCLP	0.267	72.6	67.1	14.6	3.4	5.0	66.8	10.4	77.2	1160.0
SYClearstone2CL	0.241	76.3	64.6	14.7	3.4	6.0	65.4	9.5	75.3	1125.0
Yellowstone	0.197	74.8	66.3	14.4	4.0	8.6	68.8	16.5	79.4	1128.3
MTCL 19151	0.108	80.9	67.5	15.0	3.6	10.5	70.3	18.2	80.0	1285.0
LSD (0.05)	0.060*	8.8*	1.4*	0.5*	0.8	1.9*	1.9*	3.3*	2.2*	178.2

Bold indicated significantly higher/lower desired values

*significant differences at $p < 0.05$

Purification/seed stocks: Increase of MTCL19151 was initiated in 2020 when a phenotypically-uniform, herbicide-treated plot of MTCL 19151 was harvested and threshed after collection of 130 individual heads. Multiplication and purification plots were grown at Ft. Ellis in 2021 following Clearfield seed increase protocols. Selected uniform rows were bulked and sown at Post Farm for Breeder seed increase in 2022. As a backup seed purity option, MTCL 19151 was also grown at Ft. Ellis in 2022 and evaluated for phenotypic uniformity using Clearfield seed increase protocols and was then bulked as breeder seed.

Summary:

MTCL 19151 is an early-heading medium-maturity, semi-dwarf HRW wheat line with two gene-resistance to Beyond® herbicide, average grain protein content, and good test weight. MTCL 19151 does have good yield potential and has performed well in Montana relative to other Clearfield lines in similar environments. MTCL 19151 has good winter hardiness and moderate resistance to stripe rust and adequate end-use qualities for commercial production.