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MEMORANDUM

TO: Wheat Cultivar Release & Recommendation Committee

FROM: Phil Bruckner and Jim Berg, Winter wheat breeders

DATE: January 9, 2012

RE: Removal of Morgan, Neeley, Rocky, & Wahoo from MT Recommended WW List
Proposal for licensed (F.2.c) cultivar release of MTCL1067 and MTCL1077

The following motions and supporting documentation is presented for consideration at the 2012 MAES Cultivar Release and Recommendation Meeting in Bozeman:

1. Motion: That Morgan, Neeley, Rocky, and Wahoo be removed from the Montana Winter Wheat Cultivar recommended list due to: 1) lack of certified seed production in Montana, 2) declining and/or negligible grain production in Montana, 3) superior performance by other available winter wheat cultivars, and 4) lack of future performance data since these cultivars are no longer being tested in Montana winter wheat performance trials.

2. Motion: That MTCL1067 and MTCL1077 two-gene-Clearfield hard red winter wheats be approved for licensed release in 2012, contingent upon approval of crop herbicide tolerance reaction by BASF.

Pedigree: Both lines are Yellowstone backcross derivatives. The pedigree of MTCL1067 is Yellowstone*3/3/MTCL01158/CDC Teal 11A//Jagalene, the pedigree of MTCL1077 is Yellowstone*4/3/MTCL01158/CDC Teal 11A//Jagalene.

Recommendation: Exclusive Licensed Release (F.2.c) of best line (licensee's choice).

Name: To be named by license holder.

Selection history: Both lines resulted from crosses made in 2006 and were selected from 2009 Clearfield Observation Nursery as F_2-derived F_4 lines to enter 2010 preliminary yield trials. For MTCL1067, the F_1 population was grown in the 2nd cycle of the 2006 greenhouse. F_2 seed was grown as a space-planted population (00X47c) at Fort Ellis in 2007 and sprayed with Beyond herbicide at 21 oz./acre (3.5X rate). One hundred-thirty heads which were selected from the F_2 population were grown as F_3 headrows (sprayed with Beyond herbicide at 21 oz./acre) at Fort Ellis in 2008. Headrow 06X47cB111 was selected based on herbicide tolerance and visual criteria for uniformity, productivity, and acceptable agronomic type and harvested in bulk. 06X47cB111 was subsequently tested in, and selected from, the 2009 Clearfield Observation Nursery (CLO) grown at Fort Ellis. In 2010, 06X47cB111 was designated MTCL1067 and tested in a Clearfield Qualification trial at three locations

and the non-treated Preliminary A yield trial at four locations.

For MTCL1077, the F_1 population was grown in the 2007 greenhouse. Approximately 200 F_2 seed were grown in the late cycle 2007 greenhouse and sprayed with Beyond herbicide at 21 oz./acre (3.5X rate). Fifty-six F_3 lines derived from resistant plants were evaluated (sprayed with Beyond herbicide at 21 oz./acre) in the greenhouse in 2008. Line 06X446B54, one of 32 lines selected based on herbicide tolerance, was subsequently tested in, and selected from, the 2009 Clearfield Observation Nursery (CLO) grown at Fort Ellis. Additionally, eight heads were harvested from 06X446B54 in the 2008 greenhouse to initiate a seed increase. In 2010, 06X446B54 was designated MTCL1077 and tested in a Preliminary Clearfield nursery at three locations (2 sprayed with Beyond).

In 2011, both lines were tested in the CL Qualification trial at 4 locations (3 rates x 4 locations). Both lines were tested in a 4 location, non-sprayed Westbred trial. MTCL1067 was tested in the MSU Intrastate and Off-station trials. MTCL1077 was tested in the MSU Advanced trial.

Performance data:
Data is presented for CL lines in comparison to Yellowstone, AP503CL2, and each other.

Table 1a. Yield (bu/acre) of MTCL1067 vs. Yellowstone, 2010-2011[6/]

Variety	Districts							All Locations
	1 Kalispell	**2** Bozeman[1/]	**3** Huntley[2/]	**4** Moccasin[3/]	**5** Conrad[4/]	**5** Havre[5/]	**6**- Sidney & Williston	
location-years	1	4	7	5	6	2	2	27
Yellowstone	**109.1****	76.0	66.9	55.0	72.3	56.0	66.7	68.0
MTCL1067	92.2	75.8	69.6	54.5	62.4	54.5	60.6	65.2
LSD (0.05)	**13.6**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**

1/ includes data from Dry Creek, Willow Creek

2/ includes data from Forsyth, Fort Smith, Hardin area, Lodge Grass, Molt, Rapelje

3/ includes data from Denton, Geraldine, Winifred

4/ includes data from Choteau, Cut Bank, The Knees, Shelby

5/ includes data from North Havre, Loma, Turner

6/ = tests include 2010 Preliminary A, 2011 Intrastate and Off Station tests

Table 1b. Agronomic characteristics of MTCL1067 vs. Yellowstone, 2010-2011[6/]

Variety	Test weight lb/bu	Winter survival %	Heading date Julian	Heading date Calendar	Plant height in	Lodging %	Protein %	Sawfly cutting %	Stripe rust %
location-years	27	1	13		28	5	27	3	3
MTCL1067	59.8	40	175.7	25-Jun	35.6	7	12.4	16	19
Yellowstone	59.8	54	177.1	26-Jun	34.0	4	12.4	15	17
LSD (0.05)	**ns**	**15**	**0.6**		**0.7**	**ns**	**ns**	**ns**	**ns**

6/ = tests include 2010 Preliminary A, 2011 Intrastate and Off Station tests

Table 1c. Mill and bake characteristics of MTCL1067 vs. Yellowstone: 2010 Preliminary 'A' test data

Variety	PPO [1/]	Kernel hardness	Flour yield %	Flour protein %	Flour Ash %	Mixograph mix time min	Mixograph absorption %	Baking mix time min	Baking absorption %	Loaf volume cc
location-years	3	3	3	3	3	3	3	3	3	3
MTCL1067	0.228	64.0	65.2	11.2	0.42	5.9	65.6	9.3	75.8	1108
Yellowstone	0.173	68.6	**68.6****	11.2	0.42	6.9	65.3	13.1	75.7	1058
LSD (0.05)	**ns**	**ns**	**2.7**	**ns**	**ns**	**ns**	**ns**	**3.7**	**ns**	**ns**

[1/] low is best for noodles

MTCL1067 performed similarly to recurrent parent Yellowstone in 27 non-treated trials with exception that MTCL1067 headed 1.4 days earlier than Yellowstone and was 1.6 inches taller than Yellowstone (Tables 1a, 1b). Relative to Yellowstone, MTCL1067 had lower flour yield and shorter baking mix time (3 sites; Table 1c).

Table 2a. Yield (bu/acre) of MTCL1067 vs. AP503 CL2, 2010-2011[7/]

Variety	Districts							All Locations
	1 Kalispell	**2** Bozeman[1/]	**3** Huntley[2/]	**4** Moccasin[3/]	**5** Conrad[4/]	**5** Havre[5/]	**6**- Sidney & Williston	
location-years	4	12	9	6	6	3	2	42
MTCL1067	92.3	**85.1****	**70.5****	**45.9****	**70.5****	50.4	60.6	**71.3****
AP503 CL2	92.1	69.0	56.9	36.8	61.5	45.7	50.1	60.4
LSD (0.05)	**ns**	**4.6**	**6.0**	**7.5**	**5.4**	**ns**	**ns**	**2.6**

7/ = tests include 2010 Qualification, 2011 Intrastate, Off Station, Qualification (MSU and WestBred), and WestBred Yield tests

Table 2b. Agronomic characteristics of MTCL1067 vs. AP503 CL2, 2010-2011[7/]

Variety	Test weight lb/bu	Winter survival %	Heading date		Plant height in	Lodging %	Protein %	Sawfly cutting %	Stripe rust %	Spray injury %
			Julian	Calendar						
location-years	39	1	21		40	10	36	3		4
AP503 CL2	**61.8****	41	175.0	24-Jun	31.1	19	**12.5****	22	15	25
MTCL1067	60.0	40	176.9	26-Jun	35.9	17	12.1	16	26	17
LSD (0.05)	**0.3**	**15**	**0.4**		**0.6**	**ns**	**0.2**	**ns**	**ns**	**ns**

7/ = tests include 2010 Qualification, 2011 Intrastate, Off Station, Qualification (MSU and WestBred), and WestBred Yield tests

Table 2c. Mill and bake characteristics of MTCL1067 vs. AP503 CL2 and MTCL1077: 2011 Clearfield Qualification test data

Variety	PPO [1/]	Kernel hardness	Flour yield %	Flour protein %	Flour Ash %	Mixograph mix time min	Mixograph absorption %	Baking mix time min	Baking absorption %	Loaf volume cc
location-years		6	6	6	6	6	6	6	6	6
AP503 CL2		79.5	64.6	11.0	0.39	4.5	62.8	7.2	72.7	1094
MTCL1067		83.0	64.7	10.5	0.40	5.5	62.1	8.7	72.2	1038
MTCL1077		83.5	64.8	10.7	0.41	5.8	62.0	9.1	71.9	1043
LSD (0.05)		**2.8**	**ns**	**ns**	**ns**	**0.7**	**ns**	**1.3**	**ns**	**ns**

[1/] low is best for noodles, data not availble as of Jan 2012

MTCL1067 averaged about 11 bu/acre higher than AP503 CL2 over 42 sites (Table 2a). AP503 CL2 had significantly higher test weight, earlier heading hade, shorter height, and higher grain protein relative to MTCL1067 (Table 2b). MTCL1067 was similar in most milling and baking qualities to high quality cultivar AP503 CL2 (Table 2c). Exceptions were that MTCL1067 had a harder kernel and longer dough mixing times than AP503 CL2. Sedimentation volume of MTCL1067 was lower than that of AP503 CL2 but higher than that

of Norris (Table 2d).

Table 2d. Sedimentation values of MTCL1067 vs. AP503 CL2 and MTCL1077: WestBred 2011 evaluations

Variety	Sediment-ation
location-years	3
AP503 CL2	**93****
MTCL1067	88
MTCL1077	**93***
Norris	83
LSD (0.05)	**4**

Table 3a. Yield (bu/acre) of MTCL1077 vs. Yellowstone, 2011[8/]

Variety	Districts							All Locations
	1 Kalispell	**2** Bozeman[1/]	**3** Huntley[2/]	**4** Moccasin[3/]	**5** Conrad[4/]	**5** Havre[5/]	**6**- Sidney & Williston	
location-years		1	1	1	1		1	5
MTCL1077		**88.5***	69.2	**101.0***	**52.8***		**66.4***	75.6
Yellowstone		**90.7****	74.4	**100.1***	**54.1***		**65.2***	76.9
LSD (0.05)		**11.2**	**11.8**	**7.1**	**12.5**		**8.1**	**ns**

8/ = includes 2011 Advanced tests

Table 3b. Agronomic characteristics of MTCL1077 vs. Yellowstone, 2010-2011[8/]

Variety	Test weight lb/bu	Winter survival %	Heading date Julian	Heading date Calendar	Plant height in	Lodging %	Protein %	Sawfly cutting %	Stripe rust %
location-years	5		5	5	5		5		
MTCL1077	59.5	-	176.8	26-Jun	36.8	-	11.5	12	**11***
Yellowstone	59.6	-	176.9	26-Jun	36.6	-	11.5	11	**9****
LSD (0.05)	**ns**		**ns**		**ns**		**ns**	**8**	**19**

8/ = includes 2011 Advanced tests

In the 2011 Advanced winter wheat trial MTCL1077 was similar to recurrent parent Yellowstone for grain yield and all agronomic characteristics over five locations (Tables 3a, 3b).

Table 4a. Yield (bu/acre) of MTCL1077 vs. AP503 CL2, 2010-2011[9/]

Variety	Districts							All Locations
	1 Kalispell	**2** Bozeman[1/]	**3** Huntley[2/]	**4** Moccasin[3/]	**5** Conrad[4/]	**5** Havre[5/]	**6**- Sidney & Williston	
location-years	4	8	3	2	1	1		19
MTCL1077	115.7	**92.4****	**71.5****	35.3	102.3	42.6	-	**85.9****
AP503 CL2	108.0	76.2	57.0	39.4	92.6	48.1	-	75.4
LSD (0.05)	**ns**	**11.0**	**10.7**	**ns**				**5.8**

9/ = includes 2010 Preliminary Qualification, 2011 Qualification (MSU and WestBred), and WestBred Yield tests

Table 4b. Agronomic characteristics of MTCL1077 vs. AP503 CL2, 2010-2011[9/]

Variety	Test weight lb/bu	Winter survival %	Heading date Julian	Heading date Calendar	Plant height in	Lodging %	Protein %	Sawfly cutting %	Stripe rust %	Spray injury %
location-years	16		12		16	6	16		7	4
AP503 CL2	**62.2****	-	173.6		32.2	22	12.4	-	13	30
MTCL1077	59.9	-	176.3		35.3	20	12.0	-	24	19
LSD (0.05)	**0.5**		**1.2**		**0.9**	**ns**	**ns**		**ns**	**ns**

9/ = tests include 2010 Qualification, 2011 Intrastate, Off Station, Qualification (MSU and WestBred), and WestBred Yield tests

Table 4c. Mill and bake characteristics of MTCL1077 vs. AP503 CL2: 2010 Preliminary Clearfield test data combined with 2011 Clearfield Qualification Tests

Variety	PPO [1/]	Kernel hardness	Flour yield %	Flour protein %	Flour Ash %	Mixograph mix time min	Mixograph absorption %	Baking mix time min	Baking absorption %	Loaf volume cc
location-years	3	9	9	9	9	9	9	9	9	9
AP503 CL2	0.327	72.1	65.8	11.2	**0.40****	4.4	64.1	7.3	74.0	**1110****
MTCL1077	0.234	75.9	65.6	10.7	0.41	6.2	63.3	8.8	73.2	1039
LSD (0.05)	**ns**	**ns**	**ns**	**ns**	**0.01**	**0.7**	**ns**	**1.5**	**ns**	**48**

[1/] low is best for noodles

MTCL1077 averaged about 10.5 bu/acre higher than AP503 CL2 over 19 sites (Table 4a). AP503 CL2 had significantly higher test weight, earlier heading hade, and shorter height relative to MTCL1077 (Table 4b). MTCL1077 was similar in most milling and baking qualities to high quality cultivar AP503 CL2 (Table 4c). Exceptions were that MTCL1077 has longer dough mixing times and smaller loaf volume than AP503 CL2. Sedimentation volume of MTCL1077 was equivalent to that of AP503 CL2 (Table 2d).

Table 5a. Yield (bu/acre) of MTCL1067 vs. MTCL1077, 2011[10/]

Variety	Districts							All Locations
	1 Kalispell	**2** Bozeman[1/]	**3** Huntley[2/]	**4** Moccasin[3/]	**5** Conrad[4/]	**5** Havre[5/]	**6**- Sidney & Williston	
location-years	3	6	3	2	1	1	-	16
MTCL1067	92.3	92.1	77.3	39.9	101.0	42.3		80.3
MTCL1077	**101.9****	89.3	71.5	35.3	102.3	42.6		79.5
LSD (0.05)	**5.0**	**ns**	**ns**	**ns**				**ns**

10/ = tests include 2011 Qualification (MSU and WestBred), and WestBred Yield tests

Table 5b. Agronomic characteristics of MTCL1067 vs. MTCL1077, 2011[10/]

Variety	Test weight lb/bu	Winter survival %	Heading date Julian	Heading date Calendar	Plant height in	Lodging %	Protein %	Stripe rust %
location-years	13		9		13	6	13	6
MTCL1067	60.1	-	176.1	25-Jun	37.6	23	11.5	29
MTCL1077	59.7	-	177.4	26-Jun	35.2	20	**11.9****	28
LSD (0.05)	**ns**		**0.8**		**1.0**	**ns**	**0.4**	**ns**

10/ = tests include 2011 Qualification (MSU and WestBred), and WestBred Yield tests

MTCL1067 performed similarly to MTCL1077 in 16 trials with exception that MTCL1067 headed 1.3 days earlier, was 2.4 inches taller, and was 0.4% lower in grain protein than MTCL1077 (Tables 5a, 5b). Milling and baking qualities of both MTCL1067 and MTCL1077 are similar to each other and within acceptable ranges for Montana winter wheat (Table 2c).

In summary performance of MTCL1077 was very similar to recurrent parent Yellowstone. MTCL1067 was similar to Yellowstone for grain yield, test weight, and stripe rust resistance but was earlier and taller than Yellowstone. Milling and baking qualities of both lines are acceptable.

Disease resistance: Both lines are resistant to stripe rust (similar resistance to Yellowstone) based on 2011 Montana field evaluations at Kalispell and Bozeman, MT and evaluation by Xingming Chen at Pullman and MT Vernon, WA in 2011. At Kalispell in 2011, stripe rust reaction of Yellowstone, MTCL1067, and MTCL1077 was moderately susceptible, better than susceptible lines but inferior to resistant lines, Promontory, Radiant, Curlew, WB Quake, and Judee. Both lines showed an intermediate (MS/MR) stem rust reaction compared to a susceptible reaction in Yellowstone in our 2011 stem rust nursery at Fort Ellis. Based on seedling testing by Yue Jin in 2011 at the Cereal Disease Laboratory, MTCL1077 exhibits a moderately resistant (2) infection type to US race QFCSC while Yellowstone exhibits a susceptible (4) infection type.

Purification/seed stocks: MTCL1067 and MTCL1077 were not purified using a typical headrow-linerow scheme. For MTCL1067, F_2-derived F_6 seed was increased in 2011 at Yuma, AZ as breeder seed (Fig. 1). For MTCL1077, eight F_5 reselection headrows of 06X446B54 were grown at Fort Ellis in 2009. Four reselection headrows were advanced based on herbicide tolerance and phenotypic uniformity. Four F_6 reselection plots were grown at the Post Farm in 2010 and two phenotypically-uniform lines were harvested and bulked as the source of breeder seed. Breeder seed of MTCL1077 was increased at Fort Ellis in 2011. Foundation seed production of both lines has been planted [MTCL1067 ~20.5A, MTCL1077 ~13.5A) at the Bozeman Lutz farm by the MT Foundation Seed Program (Bill Grey) for 2012 harvest.

Fig. 1. MTCL1067 breeder seed increase at Yuma, AZ in 2011(photo by Bill Grey).

In summary, MTCL1067 and MTCL1077 are Yellowstone backcross lines with 2 gene-resistance to imidazolinone herbicides. Both lines are similar in performance, end-use quality, and disease reaction to their backcross parent with exception that MTCL1067 is earlier and taller than Yellowstone, and both lines appear to have improved stem rust resistance relative to Yellowstone. Both lines are superior in yield performance in Montana to the predominant 2 gene-Clearfield winter wheat cultivar, AP503 CL2.