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MEMORANDUM

TO: Wheat Cultivar Release & Recommendation Committee

FROM: Phil Bruckner and Jim Berg, Winter wheat breeders

DATE: January 28, 2015

RE: Proposal for protected MAES public (F.2.b) cultivar release of **MT0978**

The following motion and supporting documentation is presented for consideration at the 2015 MAES Cultivar Release and Recommendation Meeting in Bozeman:

Motion: That MT0978 hard red winter wheat be approved for release in 2015, that MT0978 be named 'NARC1915,' and that NARC1915 be recommended for districts 2, 3, 4, and 5.

Pedigree: MT0978 derives from a composite of 2 topcrosses made to the same 1999 F1 population: 00X248, MT9982 (Yellowstone sib)//MTW0072/NW97151, and 00X249, MTW0047// MTW0072/NW97151.

Recommendation: Protected MAES Public Release (F.2.b).

Name: To be named 'NARC1915' in honor of the centennial of the establishment of the Northern Agricultural Research Center [originally designated Northern Branch Station] in 1915. NARC is located in Montana's primary winter wheat production area and is an important selection and evaluation site contributing to the development of improved wheat cultivars.

Selection history: MT0978 originated from two topcrosses made in the greenhouse in 2000. The F_1 populations were grown at Bozeman in 2001. Composite F_2, F_3, F_4, and F_5 bulk populations were grown at Fort Ellis, Williston, N.Havre, and Bozeman from 2002 to 2005, respectively, using a modified bulk breeding method, with mass selection for survival, reduced plant height, favorable head morphology, disease resistance, and kernel plumpness. One hundred-fourteen heads which were selected from the F_5 population in 2005 were grown as F_6 headrows at Bozeman in 2006. Headrow 00X248cE97 was selected based on visual criteria for uniformity, productivity, and acceptable agronomic type, and heads harvested for a second round of headrow selection. F7 headrows were evaluated in 2007 and headrow 00X248cE97-2 was selected and harvested in bulk. 00X248cE97-2 was subsequently tested in the 2008 Single Row A Observation Nursery (SROA) grown at Bozeman, Moccasin, Conrad, and Fort Ellis. In 2009, 00X248cE97-2 was designated MT0978 and subsequently tested in in the preliminary A yield trial (3 LY) in 2009, in the Advanced trial planted in 2010 (5 LY), in the Montana Intrastate trial from 2011 to 2014 (28 LY), and in the Off-station nursery planted in 2013 and 2014 (28 LY). Quality has been evaluated in multi-location Montana trials since 2009. In 2013, MT0978 was an entry in the USDA Northern Regional Performance Nursery (NRPN) planted at approximately 20 sites

across the Northern Great Plains.

Purification/seed stocks: Purification and increase of NARC1915 was initiated in 2011 when 120 F_5-derived F_{10} headrows were grown at Bozeman with selection for visual uniformity, retaining 83 linerows. Individual linerows were bulked as breeder seed and increased at Bozeman in 2012. Foundation seed of NARC1915 was produced in 2013 (~400 bushels). NARC1915 has been genetically uniform and stable over three generations of seed increase with few visually obvious plant variants. NARC1915 contains a tall plant variant at a frequency less than 15 per 10,000 plants.

Description: NARC1915 is an awned, white-glumed, hollow-stem, semi-dwarf hard red winter wheat. NARC1915 has medium-late maturity, 169 d heading from 1 January, similar to 'Yellowstone' and 'Colter' (Table 1). NARC1915 is semi-dwarf (*Rht1*) and medium-short (31.9 inches, n=56), similar to 'Jagalene' and 'Decade'and shorter than Colter and Yellowstone. NARC1915 is resistant to prevalent races of stem rust including UG99 and stripe rust, but susceptible to leaf rust.

Table 1. Agronomic characteristics of NARC1915 vs. a set of recommended varieties, 2011-2014[1/]

Variety	Test weight lb/bu	Winter survival %	Heading date Julian	Heading date Calendar	Plant height in	Lodging %	Protein %	Sawfly cutting %	Stripe rust %	Coleoptile length in
location-years	56	4	31		56	12	55	6	6	2
CDC Falcon	59.3	**47***	165.8	15-Jun	30.1	7	12.9	**5****	55	2.9
Colter	59.8	**38***	168.4	17-Jun	33.3	11	**13.1***	13	**23****	2.9
Decade	59.3	**49***	165.0	14-Jun	31.7	13	**13.3****	9	72	3.2
Jagalene	**61.7****	26	164.5	14-Jun	31.5	12	12.8	10	37	3.3
Jerry	58.7	**52****	167.4	16-Jun	36.0	15	**13.2***	10	73	3.2
NARC1915	59.8	34	168.5	18-Jun	31.9	14	**13.2***	**7***	**28***	2.5
Yellowstone	59.4	33	168.0	17-Jun	33.5	11	12.9	**8***	**31***	2.7
LSD (0.05)	**0.6**	**13**	**0.5**		**0.5**	**ns**	**0.2**	**4**	**13**	**0.2**

1/ = includes 2011-2014 Intrastate and 2013-2014 Off Station tests

** = indicates highest value within a column

* = indicates varieties with values equal to highest variety within a column based on Fisher's protected LSD (p=0.05)

Table 2. Yield of NARC1915 vs. a set of recommended varieties, 2011-2014[1/]

Variety	Districts							All Locations
	1 Kalispell	2 Bozeman	3 Huntley[2/]	4 Moccasin[3/]	5 Conrad[4/]	5 Havre[5/]	6- Sidney & Williston	
location-years	4	4	14	12	11	6	5	56
Yellowstone	**114.6***	**93.4****	**70.5***	**55.6***	**79.9****	**59.5***	62.3	**72.0****
Colter	**125.0****	**90.2***	**72.5***	52.6	**75.9***	**57.9***	62.0	**71.4***
NARC1915	**109.4***	**88.7***	**70.9***	**56.3****	**76.2***	**60.5****	60.2	**70.8***
Jagalene	95.7	**89.3***	**73.6****	52.6	**76.6***	52.6	50.2	68.1
CDC Falcon	73.2	75.4	67.0	51.4	72.4	**56.2***	58.2	63.8
Decade	45.3	80.5	67.3	52.5	74.7	54.1	58.0	62.7
Jerry	51.9	80.1	61.7	47.8	68.5	49.2	61.5	59.3
LSD (0.05)	**19.8**	**11.8**	**5.7**	**3.2**	**4.3**	**5.6**	**ns**	**3.8**

** = indicates highest value within a column

* = indicates varieties with values equal to highest variety within a column based on Fisher's protected LSD (p=0.05)

1/ = includes 2011-2014 Intrastate and 2013-2014 Off Station tests

2/ includes data from Fort Smith, Hardin area, Hysham Molt, Rapelje

3/ includes data from Denton, Geraldine, Winifred, Belt

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

5/ includes data from Loma, Turner

Characteristics/comparisons:

Yield. In 56 location-years (LY) of testing in the Montana Winter Wheat Intrastate and Off-station nurseries average yield of NARC1915 (70.8 bu/a) was similar to the yield of Yellowstone, Colter, and Jagalene, but greater than the yields of CDC Falcon, Decade, and Jerry (Table 2). NARC1915 is most competitive for yield in Districts 2 to 5 (Table 2).

Test weight. Test weight of NARC1915 (59.8 lb/bu, n=56) is below that of Jagalene and similar to CDC Falcon, Colter, Decade, and Yellowstone (Table 1).

Grain protein content of NARC1915 is medium to high, higher than CDC Falcon, Jagalene, and Yellowstone (Table 1).

Disease and insect resistance. Characterization of NARC1915 for disease and insect resistance included Montana trials and cooperative evaluations by the USDA Regional Testing Program. NARC1915 is susceptible to wheat stem sawfly and Hessian fly. NARC1915 is resistant to stem rust based on field and seedling evaluations conducted at Bozeman, MT using races TLMKD and QFCS and seedling stem rust evaluations conducted by the USDA-ARS Cereal Disease Lab in 2010, 2011, and 2013. In seedling evaluations at St. Paul, MN, NARC1915 was susceptible to moderately susceptible to stem rust races TPMKC, TTTTF, TRTTF and moderately resistant or resistant to stem rust races QFCSC, QTHJC, MCCFC, SCCSC, QCCSM, TTKSK, TTKST, and TTTSK. Field adult-plant evaluations in 2013 at St. Paul, MN and Njoro, Kenya, indicated NARC1915 was moderately resistant to North American stem rust races and to Ug-99 and its derivatives. NARC1915 is susceptible to leaf rust based on screening evaluations in the 2013 NRPN. NARC1915 is resistant to stripe rust based on field observations in Montana (Table 1) and screening at Pullman and Mount Vernon, WA over multiple years.

Table 3. Mill and bake characteristics of NARC1915 vs. a set of recommended varieties, 2011-2013

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	12	12	12	12	12	12	12	12	12	12
CDC Falcon	0.361	76.4	63.2	11.0	0.44	5.9	60.5	9.4	70.8	1060
Colter	0.299	82.1	66.9	11.0	**0.42***	8.9	62.8	15.5	73.7	1023
Decade	0.317	81.5	66.4	**11.3***	**0.42***	8.0	**64.5****	16.1	**74.9****	1043
Jagalene	0.332	83.1	**68.3****	10.8	**0.41****	4.8	59.9	7.2	70.3	1042
NARC1915	**0.115****	88.9	67.3	**11.3****	0.44	4.5	61.1	6.1	71.0	1065
Yellowstone	0.217	81.2	67.3	11.0	0.43	8.7	63.2	14.2	73.7	1061
LSD (0.05)	**0.038**	**3.4**	**0.7**	**0.3**	**0.01**	**1.1**	**1.0**	**1.9**	**1.1**	**ns**

** = indicates highest value within a column

* = indicates varieties with values equal to highest variety within a column based on Fisher's protected LSD (p=0.05)

[1/] low is best for noodles

Milling and baking quality. Based on experimental milling using a Brabender Automat Mill, flour yield of NARC1915 is medium to high with relatively high flour ash content and high flour protein (Table 2). NARC1915 has medium dough mixing characteristics with moderate water absorption, and relatively short mixing time. Baking qualities of NARC1915 are acceptable with good loaf volume similar to Yellowstone and

other check cultivars (Table 3). NARC1915 has low polyphenol oxidase (*PPO-A1b*) activity (Table 3) and average to good Asian noodle brightness (L24) and color stability (Table 4). NARC1915 carries the 2* subunit at the Glu-A1 locus, the 7+8 subunits at the Glu-B1 locus, and the 5+10 subunits at the Glu-D1 locus. NARC1915 does not carry either the T1BL-1RS or T1AL-1RS translocation. Although not well documented at this time, NARC1915 may have potential for tortilla utilization based on in the 2012 crop Wheat Quality Council evaluations.

Table 4. Noodle characteristics of NARC1915 vs. a set of varieties, 2011-2013

Variety	Noodle Color							Noodle score	Texture Profile Analysis									
	0 hour			24 hour					at 0 minutes					at 5 minutes				
	L* (bright-ness	a* (green - red)	b* (blue -yellow)	L* (bright-ness	a* (green - red)	b* (blue -yellow)	L* Stab-ility		Springi-ness	Cohesive-ness	Adhesive-ness	Hard-ness	Chewi-ness	Springi-ness	Cohesive-ness	Adhesive-ness	Hard-ness	Chewi-ness
location-years	12	12	12	12	12	12	12	12	11	11	11	11	11	11	11	11	11	11
Colter	**87.7****	0.23	15.2	**79.2****	0.92	22.4	**8.5***	**316***	0.94	0.62	-42.3	1342	776	0.93	0.56	-38.8	1105	576
NARC1915	86.6	0.28	16.7	78.0	1.11	24.6	**8.6***	**319***	0.94	0.60	-36.0	1204	681	0.92	0.54	-31.6	970	480
WB3768	86.7	-0.08	17.9	**78.5***	0.88	26.4	**8.2****	**327****	0.94	0.61	-44.4	1285	733	0.92	0.55	-35.1	1037	522
Yellowstone	87.0	0.39	15.0	77.8	1.16	22.3	9.2	310	0.94	0.61	-43.0	1303	749	0.92	0.56	-36.7	1070	554
LSD (0.05)	**0.4**	**0.10**	**0.5**	**0.7**	**0.16**	**0.7**	**0.5**	**12**	**ns**	**0.01**	**5.3**	**32**	**24**	**ns**	**0.01**	**3.1**	**26**	**21**

NARC1915 is proposed as a supplement to the current high-yielding, stripe rust-resistant, hollow-stem cultivar set that includes Yellowstone and Colter, adding diversity to the cultivars available for production in Montana. NARC1915 combines high yield potential, acceptable test weight, grain protein content, and milling and baking quality with stem and stripe rust resistance and short plant height.