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MEMORANDUM

FROM: Phil Bruckner, Winter wheat breeder *Phil Bruckner*
DATE: 6/15/18
RE: Motion for Release of MTW1491 with supporting documentation

I move that MTW1491 hard white winter wheat be approved for release fall, 2018.

Pedigree: MT08189//MT08187/ MTW08166 (WB3768 sib), MT08187 and MT08189 are unreleased low PPO selections of Yellowstone (PI 643428)

Recommendation: License release. [Rationale: specialized marketing required]

Selection history: MTW1491 derives from two crossing cycles of low PPO Yellowstone selections to a sib line closely related to WB3768 (MTW08168, previously licensed to Monsanto). MTW1491 was selected as an F3-derived F4 plant row at Bozeman in 2012. After evaluation as an F5 line in Bozeman nurseries in 2013, the line 08X348x2wC-1 was designated MTW1491 and entered into statewide 2014 preliminary yield trials.

MTW1491 has been tested in the 2014 Montana Preliminary Trial, the 2015 Montana Advanced trial, the 2016, 2017, & 2018 Montana Intrastate trial, and in the 2017 & 2018 Montana Off-station nursery. In 2017, MTW1491 was an entry in regional evaluation trials, NRPN [Northern Regional Performance Nursery] and WQC [Wheat Quality Council]. Quality has been evaluated in multi-location Montana trials from 2014-2017.

General performance and characteristics: MTW1491 is a high yielding hard white winter wheat line averaging 2.5 bu./acre (3.5%) higher than parental type Yellowstone over 25 environments, 2014 to 2016 (Table 1b). Although performing great in 2017 [#3 of 49 entries for yield], MTW1491 could not be directly compared to Yellowstone since the Yellowstone check was not planted correctly. Relative to Yellowstone in 2016 & 2017 (Table 2b), MTW1491 was +0.9lb* per bu. test weight; -0.3%^{ns} grain protein; 0.6 day^{ns} later in heading; and +0.3^{ns} taller. MTW1491 also yielded similarly to the highest yielding commercial checks, Keldin and SY Monument, in another analysis involving 32 Montana environments and exhibited high yield potential in all cropping districts (Table 1a). MTW1491 is resistant to dwarf bunt and stripe rust but susceptible to stem rust (2017 NRPN). MTW1491 did have 22% lodging at Kalispell in 2016 at a 139 bu/acre yield level.

Quality evaluations indicate MTW1491 has low polyphenol oxidase levels and relatively low flour protein but strong dough mixing characteristics and loaf volume, similar to Yellowstone (Table 3b). Color stability in Chinese salted noodles is good (data not shown). Mean performance of MTW1491 by 17 baking cooperators from the US in the 2017 Wheat Quality Council is summarized in the attached series of bar charts.

Purification/seed stocks: Purification and increase of MTW1491 was initiated in 2016 when 126 F₇-derived F₈ headrows were grown at Bozeman with selection for phenotypic uniformity, retaining 121 linerows which were bulked as breeder seed. Breeder and Foundation seed of MTW1491 was increased at Bozeman in 2017 and 2018, respectively.

Table 1a. Yield of MTW1491 vs. a set of varieties, 2016-2017^{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	1	2	7	7	6	6	3	32
MTW1491	138.8	111.9	81.8	63.1	80.1	60.1	55.3	74.5
Keldin	101.1	91.6	83.0	64.6	83.4	59.0	54.6	73.0
SY Monument	127.0	96.1	81.8	62.2	83.2	56.4	57.0	73.0
MT1465	135.0	96.4	83.5	61.2	77.4	55.7	50.1	71.5
SY Wolf	98.6	79.2	82.6	63.4	79.0	54.6	56.1	70.3
Northern	133.7	87.3	77.5	58.0	77.0	55.7	48.6	68.7
Decade	18.5	46.9	69.6	58.2	70.7	52.7	52.6	59.5
LSD (0.05)	10.2	14.7	7.4	4.2	4.7	ns	ns	4.8

bold = indicates highest value within a column

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

1/ = 2016-17 Intrastate and 2017 Off Station tests

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

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

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

6/ includes data from Carter, Loma, Turner

Table 1b. Yield of MTW1491 vs. a set of varieties (including Yellowstone), 2016-2017^{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	1	1	6	6	5	4	2	25
MTW1491	138.8	108.1	74.5	62.5	81.9	62.0	64.4	74.2
SY Monument	127.0	92.9	73.7	60.9	84.0	60.2	63.0	72.6
Keldin	101.1	85.5	74.3	63.8	84.1	60.0	66.9	72.4
MT1465	135.0	88.3	78.0	61.5	78.6	57.8	54.7	71.7
SY Wolf	98.6	80.8	76.0	64.1	78.9	56.8	67.5	71.0
Yellowstone	94.9	95.1	75.9	59.1	77.8	59.8	61.2	70.0
Northern	133.7	84.1	71.6	57.6	77.5	59.9	54.5	69.1
CDC Falcon	43.5	54.5	65.8	53.5	71.9	52.0	55.3	59.7
Decade	18.5	51.1	64.4	58.1	71.3	53.7	53.6	59.3
LSD (0.05)	10.2	12.9	7.0	4.3	5.5	ns	ns	5.4

bold = indicates highest value within a column

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

1/ = 2016 Intrastate and 2017 Off Station tests

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

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

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

6/ includes data from Carter, Loma, Turner

Table 2a. Agronomic characteristics of MTW1491 vs. a set of varieties, 2016-2017^{1/}

Variety	Test weight lb/bu	Winter survival %	Heading date		Plant height in	Lodging %	Protein %	Sawfly cutting %	Stripe rust %	Coleoptile length in
			Julian	Calendar						
location-years	32	1	15		30	5	31	4	4	1
Decade	60.0	62	155.2	4-Jun	30.2	34	12.1	36	75	2.9
Keldin	61.0	29	155.8	5-Jun	30.6	42	11.7	47	45	2.8
MT1465	60.8	46	155.7	5-Jun	29.8	36	11.9	43	14	2.8
MTW1491	60.8	45	156.8	6-Jun	32.1	33	11.6	49	19	2.7
Northern	60.1	37	158.0	7-Jun	30.3	40	12.3	34	20	2.6
SY Monument	59.6	49	154.4	3-Jun	30.4	34	11.2	49	11	3.1
SY Wolf	61.7	37	153.9	3-Jun	30.0	39	11.9	40	27	3.1
LSD (0.05)	0.6	16	0.7		0.6	ns	0.2	ns	14	0.2

1/ = 2016-17 Intrastate and 2017 Off Station tests

bold = indicates highest value within a column

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

Table 2b. Agronomic characteristics of MTW1491 vs. a set of varieties, 2016-2017^{1/}

Variety	Test weight lb/bu	Winter survival %	Heading date		Plant height in	Lodging %	Protein %	Sawfly cutting %	Stripe rust %	Coleoptile length in
			Julian	Calendar						
location-years	25		9		24	5	24	3	2	
CDC Falcon	59.9		155.6	5-Jun	28.6	25	11.7	49	69	
Decade	59.9		155.6	5-Jun	30.2	34	11.9	36	75	
Keldin	60.9		155.8	5-Jun	30.6	42	11.5	47	50	
MT1465	60.7		155.9	5-Jun	29.9	36	11.7	34	22	
MTW1491	60.8		156.9	6-Jun	32.2	33	11.3	45	31	
Northern	60.1		158.2	7-Jun	30.6	40	12.1	24	33	
SY Monument	59.6		154.8	4-Jun	30.5	34	11.0	42	18	
SY Wolf	61.9		154.1	3-Jun	30.0	39	11.7	38	33	
Yellowstone	59.9		156.3	5-Jun	31.9	30	11.6	28	51	
LSD (0.05)	0.7		0.9		0.7	ns	0.3	ns	25	

1/ = 2016 Intrastate and 2017 Off Station tests

bold = indicates highest value within a column

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

**Table 3a. Mill and bake characteristics of MTW1491 vs. a set of varieties, 2016:
Intrastate Tests only**

Variety	PPO ^{1/}	Kernel hardness	Flour			Mixograph			Baking		
			yield %	protein %	Ash %	tolerance (1-6)	mix time min	absorption %	mix time min	absorption %	volume cc
location-years	4	4	4	4	4	4	4	4	4	4	4
Decade	0.223	69.9	70.1	10.0	0.41	3.8	6.3	64.4	20.0	74.1	924
Keldin	0.331	61.2	70.3	9.9	0.43	3.0	4.6	63.1	10.1	73.8	901
MT1465	0.245	64.4	71.3	11.1	0.42	2.8	5.8	66.2	14.1	75.9	1030
MTW1491	0.107	68.9	71.7	9.7	0.41	3.5	7.1	62.7	17.3	73.9	950
Northern	0.116	77.6	71.4	11.2	0.46	2.8	4.1	64.3	6.9	74.5	999
SY Monument	0.159	68.4	71.5	9.9	0.39	3.8	8.5	64.4	17.9	75.3	900
SY Wolf	0.235	67.5	70.3	10.4	0.40	2.3	4.1	60.1	7.9	70.3	918
Yellowstone	0.228	67.7	68.9	10.6	0.43	3.3	8.0	66.1	18.0	76.8	989
LSD (0.05)	0.060	5.3	1.5	0.8	0.02	1.0	1.7	ns	5.0	3.6	71

bold = indicates highest value within a column

bold = 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

**Table 3b. Mill and bake characteristics of MTW1491 vs. a set of varieties, 2014-2016:
Combined Preliminary A Tests (2014), Advanced (2015) and 2016 Intrastate Tests**

Variety	PPO ^{1/}	Kernel hardness	Flour			Mixograph			Baking		
			yield %	protein %	Ash %	tolerance (1-6)	mix time min	absorption %	mix time min	absorption %	volume cc
location-years	10	10	10	10	10	10	10	10	10	10	10
Decade	0.251	72.3	70.0	11.1	0.41	4.2	7.6	65.3	21.0	75.5	992
MT1465	0.230	70.5	71.6	11.6	0.41	3.3	5.9	65.4	14.0	75.2	1061
MTW1491	0.094	74.1	71.6	10.8	0.40	4.0	8.8	64.0	21.0	75.3	1018
Yellowstone	0.209	74.4	69.4	11.2	0.42	3.5	8.0	64.9	15.9	75.7	1032
LSD (0.05)	0.037	ns	0.9	0.4	0.01	0.5	1.5	ns	4.7	ns	40

2017 Wheat Quality Council MONTANA

17-2418	Yellowstone
17-2419	MT1465
17-2420	Jagalene (CC05)
17-2421	MTW1491

Results of Flour Protein Analysis

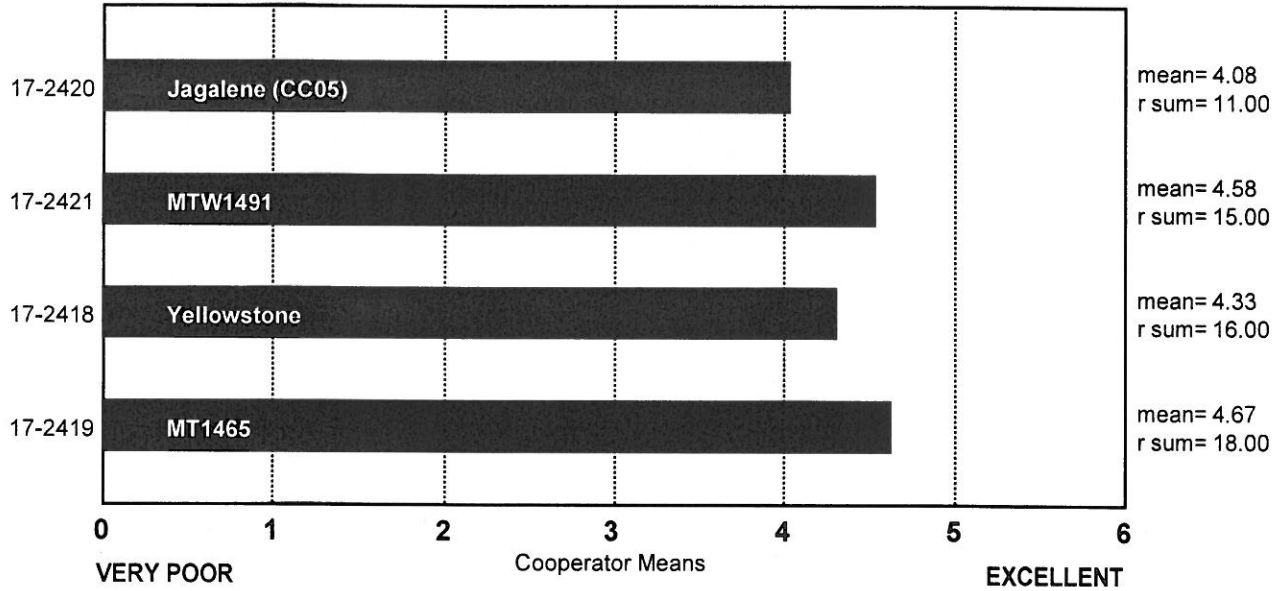
HMW GLUTENIN SUBUNITS				
SAMPLE	GLU-A1	GLU- D1	GLU- B1	TMP/TPP
17-2401	2*	5+10	7+9	0.82
17-2402	2*	5+10	17+18	0.76
17-2403	2*	5+10	17+18/7+9	0.77
17-2404	2*,1	5+10	17+18	0.88
17-2405	2*,1	5+10	17+18	0.82
17-2406	2*	2+12	7+9	0.79
17-2407	2*	5+10	7+8	0.83
17-2408	2*,1	5+10	7+9	0.59
17-2409	2*	5+10	7+8	1.00
17-2410	1	5+10	7+8	0.79
17-2411	2*,1	5+10	17+18	0.97
17-2412	2*	5+10	7+8	0.89
17-2413	1	5+10	7 ^{oe} +8	0.87
17-2414	2*,1	5+10	17+18	1.04
17-2415	2*	5+10	7 ^{oe} +8	0.97
17-2416	2*	5+10	7+9	0.96
17-2417	2*	5+10	7+9	0.93
17-2418	Yell 1	5+10	7+8	0.84
17-2419	1465 2*	5+10	7+8	0.85
17-2420	Jag 2*,1	5+10	17+18	0.95
17-2421	1491 1	5+10	7+8	0.83
17-2422	2*	2+12	7+9	0.85
17-2423	2*	5+10	17+18/7+9	0.94
17-2424	2*,1	5+10	17+18	1.09
17-2425	2*,1	5+10	17+18	1.00
17-2426	neg	5+10	7+8	0.85
17-2427	2*	5+10	7+8	0.79
17-2428	2*	2+12	7+8	1.15
17-2429	2*	5+10	7+8	1.17
17-2430	2*	5+10	17+18	1.07
17-2431	2*	5+10	7+9	0.98
17-2432	2*,1	5+10	17+18	0.99

SPONGE CHARACTERISTICS

(Small Scale) Montana

ncoop= 6
 chisq= 2.60
 chisqc= -3.71
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.
 No samples different at 5.0% level of significance.

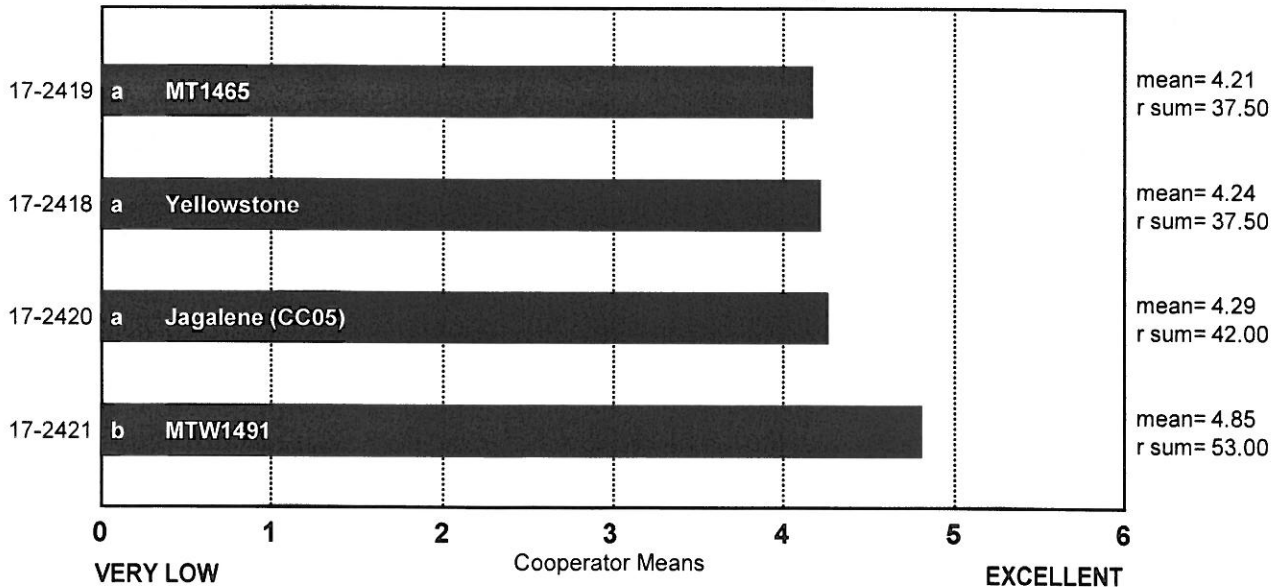


BAKE ABSORPTION

(Small Scale) Montana

ncoop= 17
 chisq= 5.66
 chisqc= 9.63
 cvchisq= 7.82
 crdiff= 10.78

Variety order by rank sum.
 Samples with the same letter not different at 5.0% level of significance.

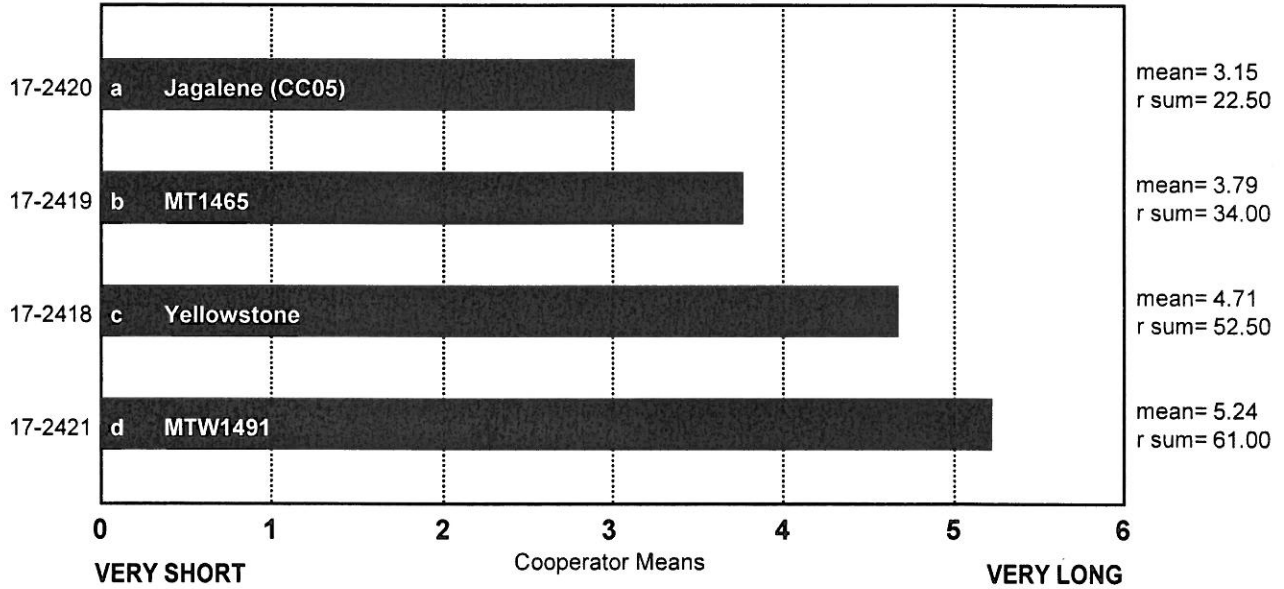


BAKE MIX TIME (Small Scale) Montana

ncoop= 17
 chisq= 32.28
 chisqc= 40.95
 cvchisq= 7.82
 crdiff= 6.15

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.

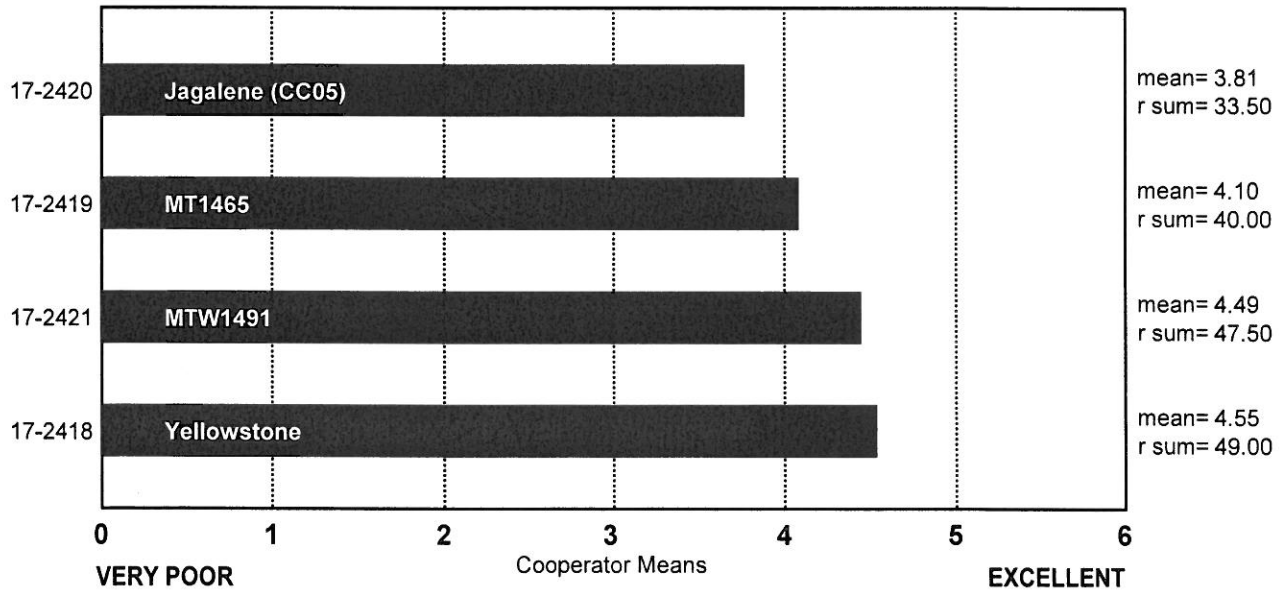


MIXING TOLERANCE (Small Scale) Montana

ncoop= 17
 chisq= 5.45
 chisqc= 7.54
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.

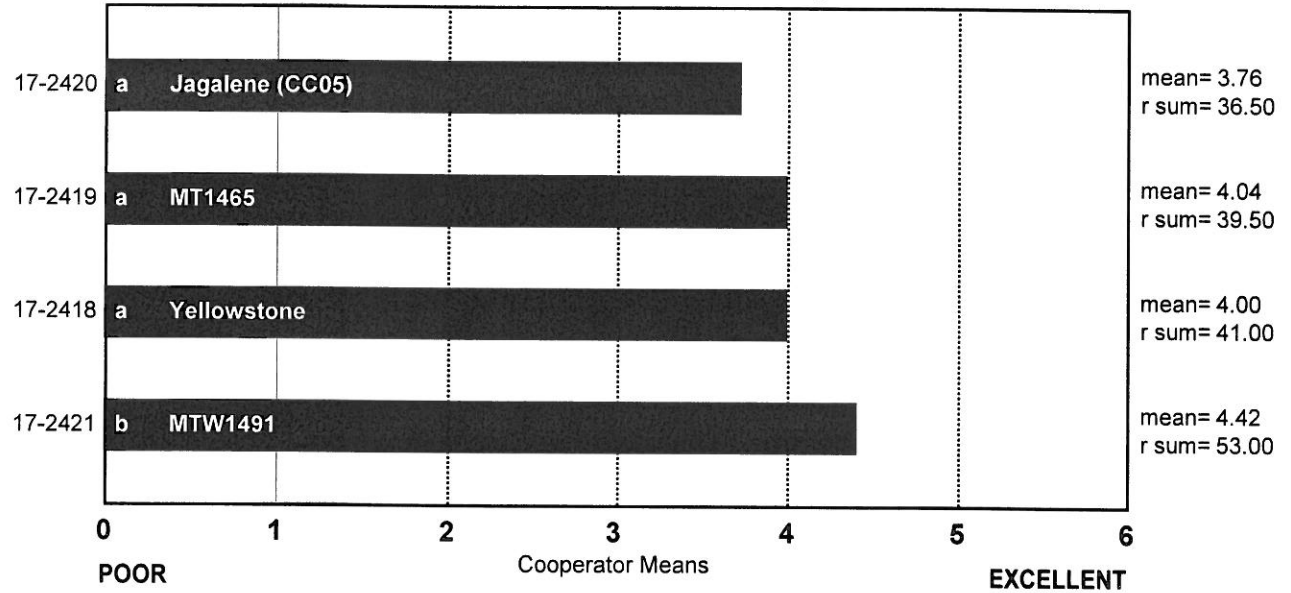
No samples different at 5.0% level of significance.



CRUMB GRAIN (Small Scale) Montana

ncoop= 17
 chisq= 5.56
 chisqc= 8.59
 cvchisq= 7.82
 crdiff= 11.45

Variety order by rank sum.
 Samples with the same letter not different at 5.0% level of significance.



CRUMB GRAIN, DESCRIBED (Small Scale) Montana

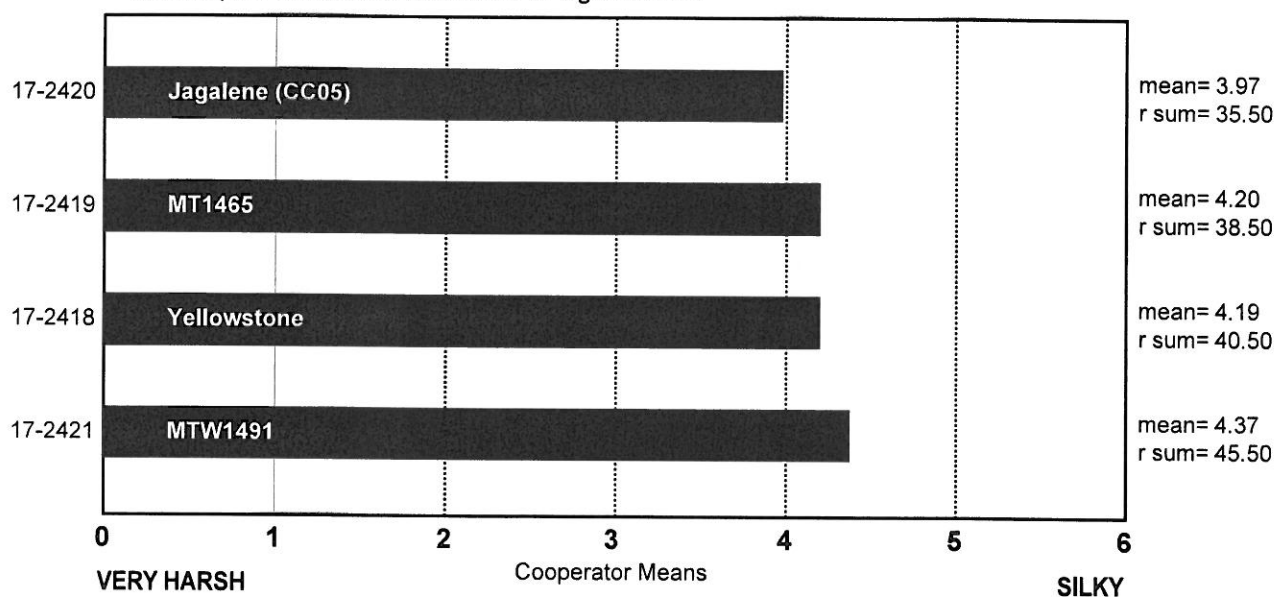
	Open	Fine	Dense
17-2418 Yellowstone	8	8	1
17-2419 MT1465	5	11	1
17-2420 Jagalene (CC05)	5	8	4
17-2421 MTW1491	3	13	1

Frequency Table

CRUMB TEXTURE (Small Scale) Montana

ncoop= 16
 chisq= 1.99
 chisqc= 3.88
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.
 No samples different at 5.0% level of significance.



CRUMB TEXTURE, DESCRIBED (Small Scale) Montana

	Harsh	Smooth	Silky
17-2418 Yellowstone	1	10	6
17-2419 MT1465	0	13	4
17-2420 Jagalene (CC05)	4	8	5
17-2421 MTW1491	0	11	6

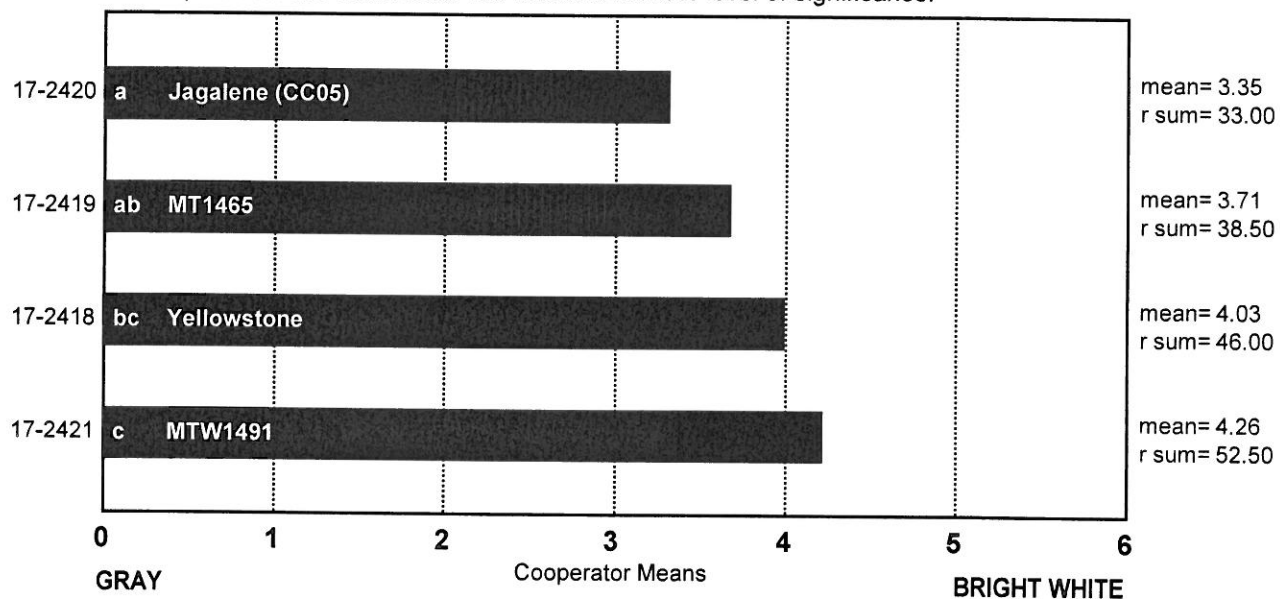
Frequency Table

CRUMB COLOR (Small Scale) Montana

ncoop= 17
chisq= 7.71
chisqc= 12.03
cvchisq= 7.82
crdiff= 10.92

Variety order by rank sum.

Samples with the same letter not different at 5.0% level of significance.



CRUMB COLOR, DESCRIBED (Small Scale) Montana

	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
17-2418 Yellowstone	1	0	0	3	9	4	0
17-2419 MT1465	0	0	2	5	9	0	1
17-2420 Jagalene (CC05)	0	0	8	2	6	0	1
17-2421 MTW1491	0	0	1	1	11	3	1

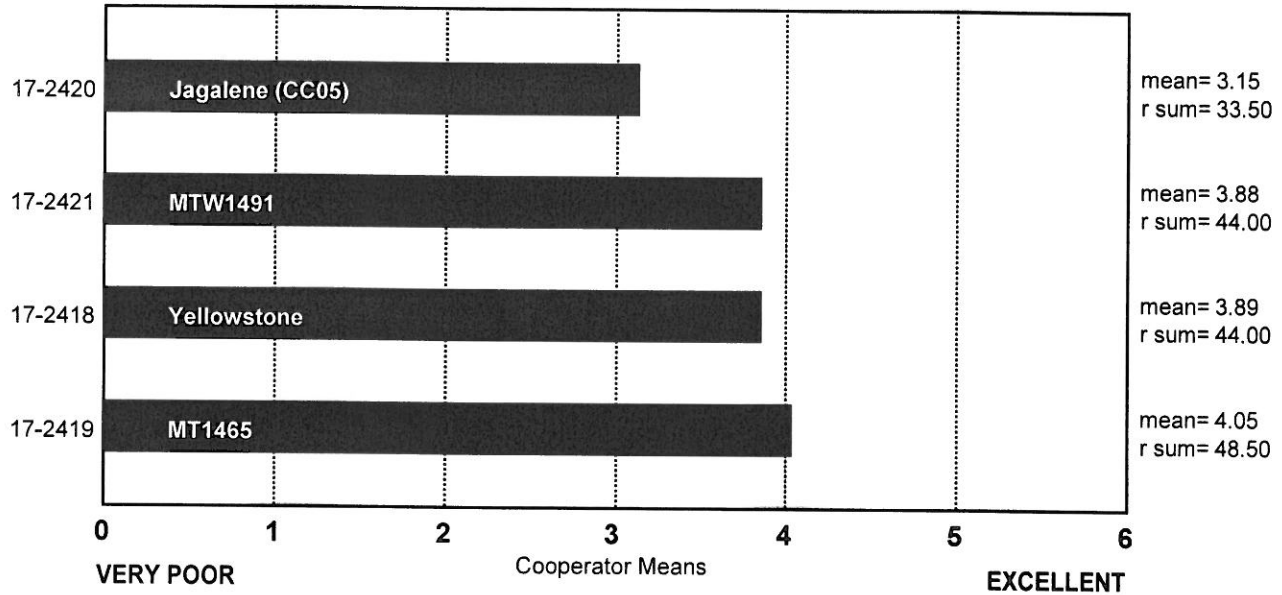
Frequency Table

LOAF VOLUME

(Small Scale) Montana

ncoop= 17
 chisq= 4.29
 chisqc= 5.17
 cvchisq= 7.82
 crdiff=

Variety order by rank sum.
 No samples different at 5.0% level of significance.



OVERALL BAKING QUALITY

(Small Scale) Montana

ncoop= 17
 chisq= 11.03
 chisqc= 12.42
 cvchisq= 7.82
 crdiff= 12.79

Variety order by rank sum.
 Samples with the same letter not different at 5.0% level of significance.

