On-Farm Cereal Variety and Advanced Breeding Line Testing across Montana for Environment Specific Cultivar Recommendations:

Winter Wheat Off-Station Variety Performance, Turner, MT

Principal Investigator:
Peggy Lamb, Research Scientist, Northern Ag Research Center, Havre

Project Personnel:
Sue Mondal, Breeder/Geneticist, Winter Wheat, Bozeman
Eleri Haney, Research Associate, Havre
Tracy Runner, Research Assistant II, Havre
Julianne Snedigar, Blaine County Extension

Cooperator:
Max Cederberg, Landowner, Turner

Objectives:
Commercially available winter wheat varieties and advanced breeding lines were evaluated for agronomic performance and fit at on-farm locations across the state of Montana. Sites chosen for the research considered the environment, growing conditions and soil types, and represent the major land areas for producers in those regions served by Northern Agricultural Research Center. The Blaine County location near Turner entered its thirteenth year of winter wheat testing in crop year 2023.

Methods:
The uniform off-station winter wheat variety performance trial was seeded into chemical fallow ground during 2023. The trial consisted of 25 entries seeded in replicated, three-row, 22-foot plots on a 12-inch row spacing, utilizing a self-propelled cone seeder with Atom Jet paired row openers. All plots were trimmed to a harvest length of approximately 17 feet with a three-point rototiller. Plant height was measured from the soil surface to the top of the head, excluding awns, and percent sawfly cutting was visually estimated for each plot immediately prior to harvest. A 'Wintersteiger' small plot combine, funded in part by the Montana Wheat and Barley Committee, was used to harvest each three-row plot. Prior to measuring plot weight for yield determination, seed was either cleaned or weighed in-dirt as per protocols. Protein, test weight and moisture content were determined on a clean sample using a Foss Infratec 1241 near infrared analyzer. Falling number was determined using a Perten FN1700 according to the FGIS Directive 9180.38. Other variables specific to each individual trial are listed with the current year data tables.

Please note that research trial seed yield results recorded under wheat stem sawfly pressure are likely much higher than a producer should expect. Small plot variety trials are managed to assess maximum yield potential and are harvested in such a way that all stems and heads are picked up by the combine, regardless of lodging or cutting due to wheat stem sawfly. Pickup guards coupled with an extremely slow ground speed and an exceptionally low cutting height help researchers collect all heads in order to assess seed yield potential. If you are a producer in a wheat stem sawfly environment, although hollow stemmed varieties may be high yielding in research trials in your area, we strongly recommend against growing those

hollow stemmed varieties. Please be aware that if you seed hollow stemmed varieties with wheat stem sawfly present, you are only creating a breeding ground for future generations of sawfly in your area and not helping combat the pest population.

Results:

This report contains both single-year and long-term data summaries limited to the most recent ten years. It should be noted that the 2023 data table in this report represents varietal performance for a single crop year at a single location, therefore cannot be considered representative of performance expected when differing conditions due to location, year and management are imposed. By itself, 2023 data shall not constitute in any form a recommendation for or against any variety or breeding line included.

Winter wheat seed yields at Turner averaged just over 36 bu/ac (Table 1). Montana State University breeding line 'MTCS20151' was the top yielding entry producing over 51 bu/ac. Three MSU releases including 'MT WarCat', 'Loma' and 'Bobcat', along with 'AAC Wildfire' and two additional MSU breeding lines produced yields between 42 and 50 bu/ac, equal to the highest yielding entry. Test weights of all winter wheat entries for this site averaged just over 60 lb/bu. After several years of less extreme wheat stem sawfly infestation, cutting in the winter wheat trial at Turner increased to an average of 14 percent. Bobcat, Loma, MT WarCat, 'Warhorse' and four MSU breeding lines had the least cutting, statistically, ranging from one to seven percent. Yield, test weight, protein, falling number, plant height and sawfly cutting data for the 2023 Turner dryland winter wheat trial are summarized in Table 1.

Comparable averages are calculated using a standard check variety when not all entries are present in a specific trial for all years. Variety means are adjusted by multiplying the actual check mean by the ratio of the individual variety mean compared to the check mean for the same years as tested. All varieties are then directly comparable to each other when in the same nursery. A minimum of three years of data is necessary to be included in the comparable average calculation. Eight-year comparable averages (2014-2023) for winter wheat seed yield and test weight at Turner are summarized in Table 2, while eight-year comparable averages for protein content and wheat stem sawfly cutting are summarized in Table 3. Based on the comparable average calculations, MT WarCat, AAC Wildfire, Bobcat and Loma are the highest yielding varieties at Turner, while MT WarCat, Bobcat and Warhorse showed the least amount of wheat stem sawfly cutting.

Summary:

Overall, the growing season started out drier than average, with many later fall-seeded crops not emerging until adequate moisture was received in early 2023. Once established, winter wheat stands were thin in areas, but it was decided to take the trial to harvest then make the determination on reporting the results after looking at the statistical variation. Snow cover and cool temperatures persisted through mid-April and there were minimal meaningful rain events during May and June, resulting in reduced seed yields compared to the long-term average.

This work has been strongly supported by producers in the Turner-Hogeland area, and by the Northern Agricultural Research Center Advisory Board. With budget and other resources allowing, it is planned to continue the off-station winter wheat variety and breeding line testing in this area. The Blaine County location near Turner hosted it's tenth year of winter wheat testing in crop year 2023.

Recognition:

This research would not have been possible without the assistance of the following seasonal employees: Clara Haslem, Brady Kueffler, Cleta Lamb, Teresa Miller, and Nevaeh Phillips.

TABLE 1. Dryland Fallow Winter Wheat Cultivar Evaluation Nursery Grown Off-Station at the Max Cederberg Farm, Turner. Northern Agricultural Research Center. Havre, Montana. 2023. (Exp# 23-3851-WW)

ID	ORIGIN or PEDIGREE	1/ YIELD bu/ac	TEST WT lb/bu	2/ PROTEIN %	3/ FN seconds	PLNT HT inches	4/ SAWFLY %
AAC Wildfire	Alberta: SECAN, 2015	**50.6**	59.9	14.8	404	24.1	26.7
Bobcat	Montana, 2019	**44.5**	**61.2**	14.9	434	23.0	**2.3**
Brawl CL Plus	Colorado Res. Foundation, 2011	13.8	**61.8**	15.6	421	21.5	13.3
Bridger CL Plus	Montana/Circle S, 2023 (MTCL19151)	34.9	**60.8**	14.9	**477**	21.5	21.7
Flathead	Montana, 2019	33.0	**61.3**	14.9	455	23.2	21.7
FourOsix	Montana, 2018	28.4	59.9	14.8	426	23.9	25.0
Keldin	Westbred, 2011	21.6	60.1	15.4	424	**24.2**	18.3
Loma	Montana, 2016	**45.9**	**60.9**	15.6	395	21.6	**7.0**
MT WarCat	Montana, 2022	**49.8**	60.4	15.0	426	21.1	**2.3**
Northern	Montana, 2015	39.0	60.7	15.3	**498**	22.3	28.3
StandClear CLP	Montana/Nutrien, 2020	37.1	**61.1**	14.9	445	23.8	10.0
SY Monument	Syngenta, 2015	25.6	60.2	14.3	421	21.5	21.7
Warhorse	Montana, 2013	23.8	59.5	**16.2**	441	21.3	**2.3**
Yellowstone	Montana, 2005	33.9	59.4	15.1	463	22.8	30.0
MTS2068	potential release, 2024	41.2	60.2	14.4	411	23.5	**1.0**
MT2019	MT10114/MT10128//MTW1251	33.8	60.3	15.3	**485**	21.8	16.7
MTAX21187	FourOsix*2/Crescent AX	28.5	59.2	14.7	459	**24.8**	30.0
MTCL2010	MT0871/(06X445B1-2, SY Clearston	**42.5**	**61.2**	15.3	465	21.1	18.3
MTCS20151	Loma//(Bobcat sib, MTS1589)/Stan	**51.6**	**61.5**	15.3	394	23.4	**3.7**
MTCS20156	Bobcat//(Bobcat sib, MTS1589)/Sta	42.2	**61.2**	14.5	453	23.9	**2.3**
MTCS20158	Bobcat//(Bobcat sib, MTS1589)/Sta	35.6	**61.4**	14.8	427	20.9	**1.0**
MTFH20170	09x257cD9-2/DecadeFhb1-DH7	28.1	60.7	**16.6**	449	**24.3**	18.3
MTS1908	(Judee sib, MTS0819)//08X350-A6/	**48.5**	**60.9**	14.2	424	**25.5**	**5.0**
MTS2197	Bobcat//LCS Jet/MTS1703	38.2	**60.9**	14.6	414	18.8	**2.3**
MTV2164	MT1265*2/Joe	31.5	60.0	14.7	440	**24.9**	25.0
EXPERIMENTAL MEANS		36.1	60.6	15.1	438.1	22.7	14.2
LSD (0.05)		10.0	0.9	0.5	25.7	1.5	11.5
C.V.%		16.8	0.9	2.1	3.6	3.9	49.6
P-VALUE (Varieties)		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

1/ Volumetric yields are based on plot weights adjusted to uniform 13 percent grain moisture and 60 lbs/bu as the standard test weight for wheat.

2/ Protein values are adjusted to 13 percent grain moisture.

3/ FN is the falling number value reported in seconds adjusted to 14 percent flour moisture.

4/ Sawfly rating is reported as the percentage of cut stems.

Bold indicates the highest or lowest value within a column (whichever is most desirable for the specific characteristic).

Bold indicates values equal to the underlined value within a column based on Fisher's protected LSD (P=0.05).

Management Information (23-3851-WW)

Seeding Date:	October 6, 2022
Harvest Date:	August 17, 2023
Fertility:	89-14-7-7 side banded
System:	No Till
Herbicide:	Vendetta, 32 oz/ac; Discover, 16 oz/ac
Insecticide:	none
Previous Crop:	Chemical Fallow - Durum
Precipitation:	4.44" April 1 to Harvest Maturity

TABLE 2. Eight-Year Yield and Test Weight Summary of Selected Entries from Dryland Fallow Winter Wheat Variety Nurseries Grown Off-Station at the Max Cederberg Farm, Turner. Northern Agricultural Research Center. Havre, Montana. 2014-2023. (Exp# 3851-WW).

			[1/] YIELD (Bushels Per Acre)								TEST WEIGHT (Pounds Per Bushel)							
[2/] VARIETY	or SELECTION	[3/] No. of YEARS TESTED	2019	2020	2021	[3/] 2022	2023	[3/] AVE. for YEARS TESTED	[4/] % of CHECK YIELD	[5/] **8-YR COMP. AVE. YIELD**	2019	2020	2021	[3/] 2022	2023	[3/] AVE. for YEARS TESTED	[4/] % of CHECK TEST WT	[5/] **8-YR COMP. AVE. TEST WT**
MTS18149	MT WARCAT (++)	3		66.9	22.5		49.8	46.4	136.9	**57.7**		60.4	58.9		60.4	59.9	100.9	**59.7**
SECAN 2015	AAC WILDFIRE (++)	4	58.3	59.7	20.1		50.6	47.2	107.0	**45.1**	58.1	59.5	56.7		59.9	58.6	98.6	**58.4**
MTS1588	BOBCAT (++)(sawfly res)	6	73.4	55.7	15.8		44.5	41.1	106.6	**44.9**	59.8	60.5	55.0		61.2	59.4	100.5	**59.5**
MTS1224	LOMA (++)	8	70.9	58.0	20.4		45.9	43.9	104.2	**43.9**	58.9	60.3	59.0		60.9	59.7	100.9	**59.7**
MT00159	YELLOWSTONE (+)	8	74.7	51.2	16.5		33.9	42.2	100.0	**42.2**	59.3	60.3	58.6		59.4	59.2	100.0	**59.2**
MTCS1601	STANDCLEAR CLP (P+)	5	55.9	57.9	24.0		37.1	42.1	99.1	**41.8**	60.3	61.9	59.6		61.1	61.0	102.0	**60.4**
MT0978	NORTHERN (+)	8	65.4	56.9	15.7		39.0	41.7	99.0	**41.7**	59.7	60.2	57.2		60.7	59.5	100.6	**59.5**
MTS0713	JUDEE (+)(sawfly tol)	7	59.0	57.1	15.2			40.6	93.6	**39.5**	60.2	61.1	58.1			59.1	99.8	**59.1**
MTF1432	RAY (++)	5	61.7	51.8	18.2			37.0	93.5	**39.4**	57.6	58.5	57.1			58.0	98.2	**58.2**
MTCL1077	SY CLEARSTONE 2CL (P+)(CL)	7	61.8	54.5	14.3			40.2	92.9	**39.1**	59.1	60.0	59.3			59.2	100.1	**59.2**
MT0552	DECADE (+)	6	59.4	53.4				44.2	92.4	**39.0**	58.9	60.6				59.2	100.0	**59.2**
CWRF, 2018	BYRD CL PLUS (+,CL)	3	56.4	55.8	18.3			43.5	91.7	**38.6**	59.7	61.1	58.5			59.7	100.6	**59.6**
MT1465	FOUROSIX (++)	6	61.7	51.0	17.6		28.4	35.3	91.5	**38.6**	58.6	60.1	57.9		59.9	59.2	100.2	**59.3**
ACS55017	KELDIN (P+)	7	63.9	56.3	15.7		21.6	37.1	85.6	**36.1**	59.7	60.0	57.6		60.1	59.4	100.5	**59.5**
MTS0808	WARHORSE (+)(sawfly tol)	8	51.9	49.7	14.1		23.8	35.3	83.7	**35.3**	58.7	60.2	57.0		59.5	59.4	100.3	**59.4**
Syngenta 201	SY MONUMENT (P+)	6	55.2	51.9	14.2		25.6	32.2	83.3	**35.1**	58.8	60.0	57.4		60.2	58.8	99.5	**58.9**
MT1564	FLATHEAD (++)	5	52.2	43.4	18.7		33.0	35.1	82.5	**34.8**	59.3	60.9	59.4		61.3	60.5	101.2	**59.9**
LCS, 2015	LCS JET (P+)	4	55.4	45.1	11.5			36.1	81.0	**34.1**	56.4	58.1	55.7			57.3	95.6	**56.6**
CWRF, 2011	BRAWL CLP (++) (CL)	6	46.6	33.9	16.3		13.8	24.8	64.4	**27.1**	59.8	61.8	60.7		61.8	60.8	102.8	**60.9**
MEANS (For Entries Listed)			60.2	52.4	16.9		33.1			**39.7**	59.0	60.3	57.9		60.5			**59.3**
[6/] Growing Season Precipitation (in.)			2.98	5.93	3.73	n/a	6.00	6.91										
Soil PAW (in.) to SD @ Planting			7.56	9.36	6.10	n/a	n/a	7.02										
Total Plant Available Water (in.)			10.50	15.30	9.80	n/a	n/a	14.54										
Soil NO3 (lbs.) to SD at Planting			115	231	106	n/a	n/a	92										
SD (Sampling Depth in Inches)			48	45	42	n/a	n/a	44										
Fertilizer Applied		(# N)	125	125	125	125	89	111										
		(# P_2O_5)	20	20	20	20	14	19										
		(# K_2O)	10	10	10	10	7	10										
		(# S)	10	10	10	10	7	6										

Check Variety is Yellowstone.

1/ See MCES Bulletin 1098 or the Plant Sciences & Plant Pathology website at http://plantsciences.montana.edu/ for evaluation of other important variety performance characteristics to include protein, quality, winter hardiness, disease resistance, etc. before making cultivar selecton decisions.

2/ P = Private Variety, + = Protected Variety, ++ = PVP Title 5 Pending, CL = Clearfield Line, HW = Hard White.

3/ Only the most recent 5 years shown, but summary calculations include all years noted. No harvest in 2014 due to hail and in 2022 due to drought related poor stand.

4/ Percent of Yellowstone yield or test weight for the same data years as those in which a given entry was tested.

5/ 8-Yr Comparable Average = (x/y) * z where x = average yield or test weight of a given entry for years tested, y = average yield or test weight for Yellowstone for the same years, and z = 8-Yr average yield or test weight for the check variety Yellowstone.

6/ April 1 to 14 days prior to harvest.

TABLE 3. Eight-Year Protein and Sawfly Summary of Selected Entries from Dryland Fallow Winter Wheat Variety Nurseries Grown Off-Station at the Max Cederberg Farm, Turner. Northern Agricultural Research Center. Havre, Montana. 2014-2023. (Exp# 3851-WW).

			[1/] PROTEIN % (Adjusted to 13% Grain Moisture)								SAWFLY RATING (% of Cut and Lodged Stems)							
[2/] VARIETY	or SELECTION	[3/] No. of YEARS TESTED	2019	2020	2021	[3/] 2022	2023	[3/] AVE. for YEARS TESTED	[4/] % of CHECK PROTEIN	[5/] 8-YR COMP. AVE. PROTEIN	2019	2020	2021	[3/] 2022	2023	[3/] AVE. for YEARS TESTED	[4/] % of CHECK SAWFLY	[5/] 8-YR COMP. AVE. SAWFLY
MTS18149	MT WARCAT (++)	3		13.9	15.2		15.0	14.7	99.0	**13.8**		0.0	0.0		2.3	0.8	3.5	**0.3**
MTS1588	BOBCAT (++)(sawfly res)	6	13.8	14.0	16.3		14.9	14.7	100.8	**14.1**	0.7	4.5	0.7		2.3	1.5	12.8	**1.1**
MTS0808	WARHORSE (+)(sawfly tol)	8	14.4	14.5	16.3		16.2	14.7	105.5	**14.7**	0.3	5.0	1.0		2.3	1.2	13.5	**1.2**
LCS, 2015	LCS JET (P+)	4	13.7	13.8	16.0			14.5	98.7	**13.8**	0.0	5.0	1.0			1.5	15.5	**1.3**
MTS0713	JUDEE (+)(sawfly tol)	7	14.6	14.7	17.1			14.8	106.9	**14.9**	0.0	4.1	2.3			0.9	16.3	**1.4**
MTS1224	LOMA (++)	8	14.7	14.3	15.4		15.6	14.5	103.6	**14.5**	0.0	4.5	1.0		7.0	1.6	18.9	**1.6**
MTCS1601	STANDCLEAR CLP (P+,CL)	5	14.0	13.6	13.9		14.9	14.5	97.7	**13.6**	0.3	9.4	0.7		10.0	4.1	29.6	**2.6**
CWRF, 2011	BRAWL CLP (+,CL)	6	15.2	14.5	15.3		15.6	14.9	102.2	**14.3**	0.7	11.1	3.7		13.3	4.8	41.8	**3.6**
MT1564	FLATHEAD (++)	5	14.7	14.3	15.0		14.9	15.0	101.6	**14.2**	1.0	4.7	2.3		21.7	5.9	43.2	**3.8**
Syngenta 20:	SY MONUMENT (P+)	6	13.4	13.0	14.2		14.3	13.6	93.3	**13.0**	0.3	8.5	5.3		21.7	6.1	52.6	**4.6**
ACS55017	KELDIN (P+)	7	13.9	14.1	14.9		15.4	14.0	99.3	**13.9**	1.0	10.1	20.0		18.3	7.3	74.0	**6.4**
MT1465	FOUROSIX (++)	6	14.3	13.9	15.4		14.8	14.7	100.5	**14.0**	0.3	13.0	13.3		25.0	8.8	75.8	**6.6**
MT0978	NORTHERN (+)	8	14.3	14.1	15.8		15.3	14.5	103.5	**14.5**	0.3	15.4	8.3		28.3	6.6	75.9	**6.6**
SECAN 2015	AAC WILDFIRE (+)	4	13.8	13.7	15.2		14.8	14.4	97.9	**13.7**	0.7	12.8	26.7		26.7	16.7	98.0	**8.5**
MT0552	DECADE (+)	6	14.7	14.4				14.3	105.7	**14.7**	0.0	17.5				3.2	98.6	**8.6**
MT00159	YELLOWSTONE (+)	8	14.1	14.0	15.5		15.1	14.0	100.0	**14.0**	1.0	17.1	20.0		30.0	8.7	100.0	**8.7**
MTF1432	RAY (++)	5	13.8	13.8	14.5			14.1	97.5	**13.6**	0.7	17.7	20.0			7.9	100.6	**8.7**
CWRF, 2018	BYRD CL PLUS (+,CL)	3	13.2	12.8	14.3			13.4	92.3	**12.9**	0.7	22.1	16.7			13.1	103.4	**9.0**
MTCL1077	SY CLEARSTONE 2CL (P+,CL)	7	14.4	14.1	16.4			14.2	103.1	**14.4**	1.0	23.5	20.0			6.5	116.0	**10.1**
MEANS (For Entries Listed)			14.2	14.0	15.4		15.2			**14.0**	0.5	11.5	9.6		17.2			**5.0**
[6/] Growing Season Precipitation (in.)			2.98	5.93	3.73	n/a	6.00	6.91										
Soil PAW (in.) to SD @ Planting			7.56	9.36	6.10	n/a	n/a	7.02										
Total Plant Available Water (in.)			10.50	15.30	9.80	n/a	n/a	14.54										
Soil NO3 (lbs.) to SD at Planting			115	231	106	n/a	n/a	92										
SD (Sampling Depth in Inches)			48	45	42	n/a	n/a	44										
Fertilizer Applied	(# N)		125	125	125	125	89	111										
	(# P_2O_5)		20	20	20	20	14	19										
	(# K_2O)		10	10	10	10	7	10										
	(# S)		10	10	10	10	7	6										

Check variety is Yellowstone.

1/ See MCES Bulletin 1098 or the Plant Sciences & Plant Pathology website at http://plantsciences.montana.edu/ for of other important variety performance characteristics to include protein, quality, winter hardiness, disease before making cultivar selecton decisions.

2/ P = Private Variety, + = Protected Variety, ++ = PVP Title 5 Pending, CL = Clearfield Line, HW = Hard White.

3/ Only the most recent 5 years shown, but summary calculations include all years noted. No harvest in 2014 due to hail and in 2022 due to drought related poor stand.

4/ Percent of Yellowstone protein or sawfly rating for the same data years as those in which a given entry was tested.

5/ 8-Yr Comparable Average = (x/y) * z where x = average protein or sawfly rating of a given entry for years tested, y = average protein or sawfly rating for Yellowstone for the same years, and z = 8-Yr average protein or sawfly rating for the check variety Yellowstone.

6/ April 1 to 14 days prior to harvest.