Project Title: Evaluation of spring barley cultivar performance under continuous crop and crop-fallow systems in central Montana

Project Leader: P.M. Carr (pre-March 6) and J.O. Eberly (post-March 6)

Project Personnel:

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Objectives:
Identify top performing spring barley cultivars in central Montana.

Methods:
Standard spring barley variety performance trials were conducted on chemical fallow or minimal tillage during 2017 at Moccasin (CARC) and on farms near Denton and Highwood. Trials consisted of 20 named varieties of barley and additional experimental lines. Each variety was seeded in three 5 row, 16 foot plots in a randomized experimental design. Seeding dates were April 18 at Moccasin, April 19, at Highwood, and May 4 at Denton. All plots were trimmed to a harvest length of approximately 12 feet and harvested with a small plot combine. Plots were harvested on August 21 at Moccasin, August 16 at Denton, and August 22 at Highwood.

Results:
The 2017 growing season at CARC started out with good recharge soil moisture and above average precipitation through June 14, followed by exceptionally dry conditions. Total annual precipitation was above the 108-year average, despite exceptionally low rainfall in the months of June (55% of average), July (40% of average), and August (20% of average). The 2017 crop year was characterized by above-average temperatures. Average annual temperature was 1.7°F higher than the 106-year mean, with individual monthly averages exceeding long-term averages by greater than 6°F in the months of November and March. July was by far the hottest month with an average monthly temperature of 71.4°F (5.4°F above normal), and a total of 14 days above 90°F. By August, central Montana was considered to be in a severe drought based on the Palmer Drought Severity Index monitoring by the National Oceanic and Atmospheric Administration (NOAA).

Dry conditions existed in June (1.7 inches vs. a long-term average of 3.1 inches) and July (0.7 inch vs. a long-term average of 1.65 inches), during the critical grain-fill period. The relatively dry conditions, when combined with warmer-than-average temperatures during June (60^{o}F vs. 58^{o}F) and July (71^{o}F vs. 66^{o}F), resulted in relatively light test weights across cultivars included in the trial at Moccasin. Test weight averaged 51.2 lb/bu and 54.4 lb/bu across the commercial cultivars at Moccasin and Highwood, respectively (Tables 2 and 4). Grain test weight was even lower at Denton with an average of only 49 lb/bu (Table 3). Overall performance at Highwood was very poor due to the acidic soil conditions with some plots having very few mature plants.

Average yields at Moccasin were 34.3 bu/ac compared to 27.8 bu/ac at Denton and 28.4 bu/ac at Highwood. Eslick and Champion were among the highest yielding cultivars at Moccasin. Champion, Haxby, and Metcalfe, a new cultivar for 2017, were among the top performers at Denton. Hays was one of the top yielding varieties at Highwood. Average protein at all locations was too high for quality malting barley ranging from13.6% at Moccasin to 18.4% at Denton. Consequently, gross returns were calculated based only on feed barley prices. The top variety for gross returns at Moccasin and Denton

was Champion while Hays was the top performer at Highwood. Note that gross return calculations do not take into account any expenses. Average plump kernel percentage was also very low ranging from 10.7% at Denton to 73.8% at Highwood.

Summary:

A wet spring combined with drier and warmer conditions through June and July at Moccasin led to lower yields and test weights. While average annual rainfall was slightly above the historic average during the 2016-2017 growing season, lower than average precipitation during June and July negatively impacted yield and test weight. Acidic soils conditions at Highwood negatively impacted performance and results of this study will be useful in identifying cultivars best suited for production in acidic soils.
This work has been strongly supported by producers at the off station locations and by the Central Agricultural Research Center Advisory Council. With budget and other resources allowing, plans are in place to continue off-station cereal variety investigation throughout the central Montana region.

Funding Summary:

An expenditure summary will be provided by OSP. No additional grant support was provided for this project.

MWBC FY 2018 Grant Submission Plans:

A request for continuing this project was submitted for funding consideration for the next fiscal year. Funding was awarded. Thank you!

Table 1: Monthly precipitation and temperature data during the 2016-17 growing season and the long-term average at the Central Ag. Research Center in Moccasin, MT.

Month/Year	Temperature			Growing Degree Days			Precipitation		
	2017	2012-2017	Δ	2017	2012-2017	Δ	2017	2010-2017	Δ
	F			GDD_{32}			in		
September 2016	55.4	54.9	0.5	700	695	5	3.37	1.42	1.95
October 2016	46.3	44.9	1.4	475	459	16	2.76	0.93	1.83
November 2016	42.9	32.9	10.0	398	227	170	0.14	0.56	-0.42
December 2016	15.6	24.9	-9.3	56	136	-80	0.43	0.54	-0.11
January 2017	19.1	21.8	-2.7	105	119	-14	0.23	0.54	-0.31
February 2017	26.9	24.8	2.1	172	125	48	0.39	0.44	-0.05
March 2017	37.2	30.6	6.6	307	196	111	0.37	0.70	-0.33
April 2017	42.2	40.9	1.3	352	344	8	2.20	1.22	0.98
May 2017	52.4	50.1	2.3	636	574	61	2.93	2.62	0.31
June 2017	60.0	57.9	2.1	840	777	63	1.68	3.06	-1.38
July 2017	71.4	66.0	5.4	1220	1051	169	0.66	1.65	-0.99
August 2017	65.9	65.0	0.9	1052	1019	33	0.31	1.59	-1.28
Average/Total	44.6	42.9	1.7	526	477	49	15.47	15.27	0.20

Table 2: Barley variety trial at Moccasin, MT.

	Variety/Pedigree	Year of Release	Source	Type	Heading Date		Yield (bu/ac)		Test Weight	Protein	Plump	Gross Return
					cal	jul	2017	2016	(lb/bu)	(%)	(%)	($/ac)
+	Balster	-	-	-	**1-Jul**	**182**	32.0	-	49.0	13.5	20.2	117.10
+	Bill Coors 100	-	-	-	5-Jul	187	36.8	-	**52.2**	**14.1**	55.6	144.40
	Champion	2007	Westbred, LLC	F	**2-Jul**	**183**	38.3	57.6	**52.6**	12.4	14.4	151.40
+	Claymore	-	-	-	4-Jul	186	37.8	-	49.6	13.7	12.1	140.30
	Conrad	2007	MAES	M/F	8-Jul	189	37.4	46.5	**51.7**	13.7	39.6	145.80
+	Copeland	-	-	-	**1-Jul**	**182**	38.7	-	49.9	**14.6**	33.0	145.40
+	Eslick	2003	MAES	F	11-Jul	192	39.5	70.9	**50.6**	13.5	5.5	150.40
+	Genie	-	-	-	5-Jul	186	37.9	-	**53.0**	13.0	37.3	150.90
+	Growler	-	-	-	6-Jul	188	28.0	-	48.9	**15.0**	26.4	102.80
	Haxby	2003	MAES	F	**27-Jun**	**178**	34.3	60.0	**52.9**	12.5	9.5	136.20
	Haybet	1989	MAES/USDA	F	**28-Jun**	**179**	33.7	36.7	49.6	**14.6**	2.7	125.90
	Hays	2003	MAES	F	6-Jul	188	33.8	53.4	48.5	**14.1**	15.2	123.70
	Hockett	2008	MAES	M/F	**1-Jul**	**182**	34.8	59.3	**53.1**	12.5	43.2	138.50
	Lavina	1989	MAES/USDA	F	**1-Jul**	**182**	36.3	59.8	48.5	12.5	8.4	132.90
+	Merit	-	-	-	4-Jul	186	28.8	52.2	**51.6**	**13.9**	28.0	112.70
+	Metcalfe	-	-	-	**28-Jun**	**179**	36.9	48.4	50.3	**15.0**	25.2	138.70
+	Moravian165	-	-	-	**29-Jun**	**180**	36.5	39.1	50.8	**14.0**	35.6	140.40
+	Odyssey	-	-	-	11-Jul	192	34.3	-	49.7	**14.6**	27.6	127.70
+	Oreana	-	-	-	8-Jul	190	34.2	-	**51.9**	13.5	40.6	134.40
+	Synergy	-	-	-	**29-Jun**	**181**	34.6	-	49.1	13.4	27.0	128.00
	Average				2-Jul	184	34.3	51.4	51.2	13.6	26.9	133.60
	C.V. (%)				0.008	1.9	15.8	19.2	2.7	2.7	43.2	17.6
	LSD (0.05)				5.7	5.7	N.S.	N.S.	2.3	1.2	N.S.	N.S.
	P-value				<0.0001	<0.0001	0.5901	-	<0.0001	<0.0001	<0.0001	0.6225

+ = new for 2017

Bolded and underlined values are the highest mean. Bolded values are not different from the highest value based on the Least Significant Difference (LSD) test.

Note: Study averages include experimental lines not listed here.

Type: M/F = Malt/Forage

N.S. = Not Significant

Table 3: Barley variety trial at Denton, MT.

	Variety/Pedigree	Year of Release	Source	Type	Yield (bu/ac) 2017	Test Weight (lb/bu)	Protein (%)	Plump (%)	Gross Return ($/ac)
+	Balster	-	-	-	**27.5**	48.2	18.8	12.3	**99.60**
+	Bill Coors 100	-	-	-	19.4	45.9	**20.3**	11.9	66.90
	Champion	2007	Westbred, LLC	F	**32.6**	49.9	17.4	3.6	**121.90**
+	Claymore	-	-	-	**29.7**	48.8	17.5	12.1	**108.70**
	Conrad	2007	MAES	M/F	**30.1**	49.3	19.1	15.2	**111.10**
+	Copeland	-	-	-	19.4	47.2	**19.7**	18.0	68.60
+	Eslick	2003	MAES	F	26.5	46.2	18.7	0.7	91.90
+	Genie	-	-	-	25.0	48.5	18.8	6.3	91.20
+	Growler	-	-	-	**27.2**	48.2	**19.8**	14.9	98.30
	Haxby	2003	MAES	F	**31.9**	**50.5**	17.2	3.5	**120.70**
	Haybet	1989	MAES/USDA	F	**29.1**	48.9	**19.5**	0.4	**106.60**
	Hays	2003	MAES	F	26.0	46.2	18.8	5.1	90.00
	Hockett	2008	MAES	M/F	**30.6**	**50.4**	17.2	15.9	**115.40**
	Lavina	1989	MAES/USDA	F	**27.5**	46.0	19.1	1.0	94.70
+	Merit	-	-	-	22.9	**51.6**	**19.3**	11.8	88.60
+	Metcalfe	-	-	-	**31.6**	49.6	18.7	10.6	**117.80**
+	Moravian165	-	-	-	25.7	47.2	**19.5**	9.9	90.90
+	Odyssey	-	-	-	**30.1**	48.6	18.1	17.5	**109.90**
+	Oreana	-	-	-	**26.6**	48.9	18.7	9.3	97.50
+	Synergy	-	-	-	**28.5**	48.2	17.4	15.8	**103.00**
	Average				27.8	48.9	18.4	10.7	102.10
	C.V. (%)				13.3	1.8	3.9	31.7	13.6
	LSD (0.05)				6.1	1.4	1.2	N.S.	22.8
	P-value				<0.001	<0.0001	<0.0001	<0.0001	<0.0001

+ = new for 2017

Bolded and underlined values are the highest mean. Bolded values are not different from the highest value based on the Least Significant Difference (LSD) test.

Note: Study averages include experimental lines not listed here.

Type: M/F = Malt/Forage

N.S. = Not Significant

Table 4: Barley variety trial at Highwood, MT.

	Variety/Pedigree	Year of Release	Source	Type	Yield (bu/ac) 2017	Yield (bu/ac) 2016	Test Weight (lb/bu)	Protein (%)	Plump (%)	Gross Return ($/ac)
+	Balster	-	-	-	18.2	-	18.4	5.4	14.6	59.40
+	Bill Coors 100	-	-	-	37.2	-	53.8	16.4	72.0	153.70
	Champion	2007	Westbred, LLC	F	28.2	38.5	18.1	4.6	23.3	90.70
+	Claymore	-	-	-	22.8	-	53.5	16.6	73.8	92.50
	Conrad	2007	MAES	M/F	21.4	36.3	36.1	17.0	81.8	75.10
+	Copeland	-	-	-	30.9	-	53.9	16.5	69.7	127.30
+	Eslick	2003	MAES	F	19.8	-	36.6	11.3	57.4	73.70
+	Genie	-	-	-	21.2	-	35.5	11.5	51.1	74.20
+	Growler	-	-	-	19.1	-	54.6	17.4	76.0	78.60
	Haxby	2003	MAES	F	24.3	38.6	35.8	10.7	51.4	81.50
	Haybet	1989	MAES/USDA	F	21.5	32.3	35.6	11.5	45.4	70.30
	Hays	2003	MAES	F	42.5	40.9	55.4	16.0	60.7	174.70
	Hockett	2008	MAES	M/F	16.2	42.1	53.7	18.1	71.4	65.30
	Lavina	1989	MAES/USDA	F	23.5	37.6	35.8	11.0	45.1	81.80
+	Merit	-	-	-	29.5	-	36.6	11.0	57.4	117.70
+	Metcalfe		Canada	M/F	31.9	31.0	36.8	10.8	57.0	113.80
+	Moravian165	-	-	-	29.2	31.7	54.3	16.3	72.5	122.40
+	Odyssey	-	-	-	14.6	-	57.8	17.3	61.9	63.60
+	Oreana	-	-	-	23.3	-	53.4	16.0	78.0	93.80
+	Synergy	-	-	-	29.6	-	36.6	10.4	45.8	114.20
	Average				28.4	34.6	54.4	16.7	73.8	116.60
	C.V. (%)				55.1	16.6	3.1	7.8	16.1	55.7
	LSD (0.05)				N.S	N.S.	N.S	N.S.	N.S.	N.S.
	P-value				0.8010		0.4360	0.8560	0.6307	0.8026

+ = new for 2017

Bolded and underlined values are the highest mean. Bolded values are not different from the highest value based on the Least Significant Difference (LSD) test.

Note: Study averages include experimental lines not listed here.

Type: M/F = Malt/Forage

N.S. = Not Significant