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MONTANA AGRICULTURAL
EXPERIMENT STATION

2017 ANNUAL REPORT

Central Agricultural Research Center

ACKNOWLEDGEMENTS

Research at the MSU Central Agricultural Research Center (CARC) is only possible through the hard work of a dedicated staff at the center, and through the generosity and support of the farmers and ranchers throughout central Montana and the citizenry of the state, among others. We receive grant funding support from a growing number of public and private entities, as well as individuals, to supplement the state and federal funds which enable us to conduct research at the CARC. Much of this support is acknowledged in the summaries of research at CARC throughout this report. Those providing funding support that is not tied to a specific research project or study are listed below, but we extend a sincere thanks to all those providing funding support, whether it is project-directed or given for more general use in support of the research program at the CARC. We also are grateful for the interaction we have, and suggestions we receive, from CARC advisory board members, and from others who provide comments to us on the research that we are conducting. We welcome suggestions from others at any time.

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INTRODUCTION

The 2017 MSU Central Agricultural Research Center (CARC) summarizes much, though not all, of the results conducted at CARC over the past 12-month period. Our goal is to provide those results in an easy-to-understand format that is easily accessible by farmers and anyone interested in the research conducted at the CARC. A limited number of copies of the report are printed each year; however, it can be accessed on the web at http://agresearch.montana.edu/carc/reports-pdf/2017%20Annual%20Report.pdf.

There are several people who deserve credit for this year's annual report. Simon Fordyce, a research associate in cropping systems at the CARC, was a major contributor, being the lead author and creator of many of the sections and tables that are contained within it. He also provided valuable suggestions on formatting and improving overall design, and assisted in proof reading its' contents. Dr. Jed Eberly, Assistant Professor of Agronomy and Microbiology at the CARC, provided the sections summarizing results of small-grain crop variety trials at the research center and at associated off-station locations. Heather Fryer, a research assistant III at the CARC, helped organize and compile the report, contributed a section summarizing how the CARC is using social media, and lined up printing of this year's report. Lorrie Linhart, administrative assistant III, contributed to sections of the report and took on additional day-to-day office tasks so that others could work on compiling and printing this report.

Other CARC share some of the credit for this year's annual report because of their contributions in the field and in the lab. These include Sally Dahlhausen, research assistant III in the cropping systems program, and Sherry Bishop, research assistant III with responsibilities in grain/seed/forage processing. Darryl Grove, the CARC farm manager, and Tim Bishop, the CARC farm mechanic, both assisted in the management of field experiments during the 2016-17 growing season, as did several seasonal staff: Clay Boyce, Research Assistant II; Sarah Spear and Meghan Tomczyk, two MSU student interns; and Hayden Hammontree, Alyssa Thomas, and Zach Thomas, three Hobson high school students. Rodney Eberly assisted in harvesting small-grain variety trials, and Andy Burkhart, a graduate student at MSU, assisted in the planting and harvesting of field experiments at the CARC which are part of his Ph.D. research project.

A special thanks is extended to Drs. Darrin Boss, Head of the Department of Research Centers, and to Charlie Boyer, Dean of the College of Agriculture and Director of MAES, for their capable leadership of MSU-directed research conducted at CARC and across the state.

I hope you find this report useful as a source of information for some of the research conducted at the CARC during the 2016-17 growing season. Feel free to call, send an email, or let me know face-to-face what you think about it. You are always welcome at the MSU Central Agricultural Research Center!

Patrick Carr

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USEFUL STATISTICAL TERMS AND DEFINITIONS

Simon Fordyce and Patrick Carr

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Observation: The measured value of a particular variable, such as grain yield, test weight, soil nitrate, daily precipitation, etc.

Variable: An attribute describing some entity (person, place, thing, idea) with values that ‘vary’ from one entity to the next. For instance, if variable *x* represents crops on a farm, then *x* can take on the value ‘winter wheat’ in one case and ‘barley’ in another. In experimental design, two major variable types exist: dependent and independent. The independent variable is manipulated to determine its relationship (if any) to the dependent variable.

Factor: An independent variable such as seeding date or crop variety that can be manipulated by the experimenter. Factors always have two or more levels.

Factor Levels: Different values of a factor. For example, if our factor is ‘seeding date’, one factor level might take on the value September 15th and the other October 1st.

Treatments: Combinations of factor levels. The table below shows factors, factor levels, and treatments for a hypothetical experiment which tests the effects of seeding date and variety on winter wheat performance.

Table 1. Hypothetical experiment testing effects of seeding date and variety on crop performance.

Seeding Date	**Variety**		
	Keldin	Loma	Yellowstone
September 1st	Treatment 1	Treatment 2	Treatment 3
October 1st	Treatment 4	Treatment 5	Treatment 6

In this experiment there are two factors: seeding date and variety. The variety factor has three levels: Keldin, Loma, and Yellowstone. The seeding date factor has two levels: September 1st and October 1st. Thus, the experiment has six total treatments. Treatment 1 is *Keldin seeded on September 1st*, Treatment 2 is *Loma seeded on September 1st*, and so on.

NOTE: If we eliminate the seeding date factor from the above experiment, our treatment number drops from six to three—one treatment for each factor level. Because the experiment now contains a single factor with factor levels represented by individual varieties, we refer to the experiment as a variety trial. Variety trials are a type of single-factor experiment in which treatments are represented by the varieties themselves, i.e., the different levels of the variety factor.

Replicate: Experimental groups to which each treatment is randomly assigned. Experiments led by the Central Ag Research Center typically include three or four replicates. Replication is necessary to account for variation among treatments.

Treatment Mean: Treatment observations averaged across replicates. Cell values of summary tables in this report often represent treatment means. For example, Table 15 (Pg. 35) reports grain yield treatment means for several spring lentil varieties. The reported yield of the CDC Richlea variety, for instance, is an average of yields from three different plots seeded to CDC Richlea in three separate treatment groups or replicates.

Grand Mean, Mean, or Average: An average of treatment means. By definition, 50% of treatment means are greater than the overall mean, and vice versa. In Table 15 (Pg. 35), a summary of spring lentil variety trial results shows that average grain yield of the CDC Richlea variety is much greater than the overall mean, (reported as 'Mean' in the lowermost section), while test weight for the same variety is much less than the (test weight) overall mean.

***P*-Value**: A measure of statistical significance. A *P*-Value of 0.05 indicates that 19 times out of 20, a difference would be detected among treatment means if the study was repeated. A *P*-Value of 0.001 probability indicates that 999 times out of 1000, a difference would be detected among treatment means if the study was repeated.

Coefficient of Variation (CV): A statistic used as an indicator of variation of large and small treatment observations among replicates. Larger CVs indicate more variation and vice versa. At the Central Ag Research Center, grain yield CVs of 15% and greater are considered to be problematic. In most cases, the grain yield LSD value will be replaced by 'NS' for 'non-significant', meaning grain yield treatment differences are not likely to be real.

Least Significant Difference (LSD): A statistic used to determine whether treatment means are significantly different from one another. In Table 15 (Pg. 35), note the LSD value for test weights. Since the test weight of the CDC Impala CL variety, for instance, exceeds that of the CDC Maxim CL variety by an amount *greater* than the LSD value, we may conclude that—all else constant—CDC Impala CL is expected to outperform CDC Maxim CL with regard to test weight under conditions similar to those that occurred during the trial in 2017. Conversely, the test weight of the CDC Impala CL variety exceeds that of the CDC Imvincible CL variety by an amount *smaller* than the LSD value, so we can have little confidence that CDC Impala CL will outperform CDC Imvincible CL under similar environmental conditions.

WEATHER SUMMARY

Simon Fordyce

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Precipitation

Above-average precipitation characterized the 2017 crop year through June 14 (September 1, 2016-June 14, 2017), after which dry conditions persisted. Total annual precipitation exceeded the 108-year average, despite the low rainfall in the months of June (55% of average), July (40% of average), and August (20% of average). A total of 6.13 inches (40% of long-term average) fell during the months of September and October, equating to 237% and 297% of respective monthly averages. This late-summer precip delayed seeding of winter crops, while above-average rainfall during the months of April and May (180% and 112%, respectively) delayed seeding of 2017 spring crops. Together the months of September, October, April, and May received 11.26 inches, or nearly three-quarters of the annual total (Table 2). These large rain events in late summer and spring months help explain the yield discrepancies observed between fall- and spring-seeded crops in 2017. Spring wheat yields averaged 53% of winter wheat yields at the Central Ag Research Center this year. For comparison, statewide yields for spring wheat averaged 78% of those for winter wheat from 2014 to 2016.

Temperature and Growing Degree Days

The 2017 crop year was characterized by above-average temperatures and above-average wheat Growing Degree Day (GDD) accumulation. A total of 4098 Growing Degree Days (GDD_{32}) accumulated at CARC from 1 April to 31 August, equating to 108% of the 106-year mean. 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 monthwith an average monthly temperature of 71.4°F (5.4°F above normal), and a total of 14 days above 90°F. Interestingly, the month of November was 10°F above the long-term average, while December was 9.3°F below average, representing nearly a 20°F swing in average monthly temperatures from one month to the next (Table 2).

In spite of this year's above-average temperatures, unusually late frosts were observed in mid- and late June. Light frosts on 11 June and 23 June damaged a number of CARC's warm season crops (e.g., navy beans, pinto beans, cowpeas) and set back some winter wheat and late-flowering varieties of spring canola. The frost was spotty on those nights, with recorded temperatures at on-site weather stations remaining above 32^{o}F. The last recorded temperature below 32^{o}F (30°F) was observed on 19 May (8 days earlier than the long-term average) while the first recorded temperature below 32^{o}F in fall (30°F) was observed 22 September (15 days later than the long-term average), equating to a frost-free period of 126 days, or 113% of the 107-year average. The minimum winter temperature was observed on 17 December (-25°F), while the maximum summer temperature was observed on 14 July (97°F).

Table 2. Observed temperature, growing degree days, and precipitation by month with long-term averages and anomalies, 2017 crop year.

Month/Year	Temperature			Growing Degree Days			Precipitation		
	2017	1912-2017	Δ	2017	1912-2017	Δ	2017	1910-2017	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	6310	5721	588	15.47	15.27	0.20

SMALL GRAIN VARIETY TRIALS

WINTER WHEAT VARIETY TRIAL

Jed Eberly[1,2], Phil Bruckner[1,3], and Jim Berg[1,3] (Co-Principal Investigators)

Montana State University[1]; Dep. Research Centers, Central Agricultural Research Center, Moccasin, MT[2]; Dep. Plant Sciences and Plant Pathology[3]

Summary

Agronomic performance was evaluated for 25 winter wheat varieties and experimental lines. Average yield for the winter wheat trial at Moccasin in 2017 was 60.3 bu/ac and average protein was 13.9%. Grain yield differences among varieties was not detected. The top varieties for protein were Northern (15.0%), Loma (14.6%), and WB-Quake (14.6%). Average heading date was 10 June. Average plant height at Moccasin was 28.1 inches and varietal differences in height were not detected.

Introduction

Montana is one of the leading producers of winter wheat and the development of new and improved varieties is important for enhancing the economics of wheat production in the state. The objective of this study was to identify new varieties with enhanced yield, quality, and resistance to disease and pests compared to the most commonly grown varieties in central Montana. The 2017 growing season was challenging due to the extended drought experienced by much of the region this past summer. July rainfall was less than half of the historic monthly average while August recorded less than 1/5 of the historic monthly average.

Methods

On-farm winter wheat performance trials were established at Moccasin, Denton, Belt, Highwood, and Geraldine. Twenty-two varieties were compared for height, propensity to lodge, heading date, yield, test weight, and protein. Each variety was planted in three 4.5 x 15 ft plots in a randomized experimental design to determine differences between varieties. Seeding dates were 27 September 2016 at Denton, 28 September at Highwood and Belt, 30 September at Moccasin, and 25 October at Geraldine. Planting depth was 1 inch at a rate of 20 kernels/ft^2. Starter fertilizer, 20-30-20-10 NPKS, was applied at seeding at a rate of 50 lb/ac. An additional 190 lb/ac of urea was broadcast applied at the CARC location on 16 May. Broadleaf and grass weeds were controlled with a burndown of glyphosate at 1.25 pt/ac prior to planting. Trials were also sprayed 16 May with Vendetta at a rate of 24 oz/ac to control field pennycress, flixweed, kochia, and prickly lettuce. Power Flex HL was applied at a rate of 2 oz/ac for the control of cheat grass. Plots were harvested with a small-plot harvester on 26 July at Moccasin and Denton, 31 July at Belt, 1 August at Geraldine, and 4 August at Highwood.

Results and Discussion

Winter wheat yields are reported on moisture content of 13.5%. Average yield for all winter wheat trials (including experimental lines) at Moccasin in 2017 was 60.3 bu/ac and average protein was

13.9%. Varietal differences in yield were not significant (*P* > 0.05). The top varieties for protein were Northern (15.0%), Loma (14.6%), and WB-Quake (14.6%). The highest test weights were Brawl CLP (61.1 lb/bu), SY Wolf (60.6 lb/bu), and Judee (60.4 lb/bu). The average height for the Moccasin winter wheat trial was 28.1 inches and differences in height were not statistically significant across the named varieties. Average heading date was 10 June and Brawl had the earliest heading date on 2 June. No lodging was observed with any of the varieties.

Table 3 shows average heading date, yield, test weight, and protein for all named varieties tested. Gross returns per acre were also calculated for each variety and location based on prices and protein premiums and discounts obtained from United Grain Corporation on 30 August, 2017. Average gross return at Moccasin was $313.95/ac and differences in return were not statistically significant between named varieties. Note that this calculated return does not take into account any expenses but does account for dockage and premiums associated with the test weight and protein.

Average yield at the Belt, MT location was 51.1 bu/ac and varietal differences in yield were not statistically significant (*P* > 0.05: Table 4). Average protein was 8.9%. Average test weight was 62.1 lb/bu and the variety with the highest test weight was Brawl CLP (64.4 lb/bu). Gross return averaged $129.46/ac but violated statistical assumptions so an LSD could not be computed.

Grain yield of SY Wolf (50.5 bu/ac) was comparable or greater than that produced by other varieties at the Denton, MT location (Table 5). Other varieties that produced grain yields comparable statistically to that of SY Wolf included Brawl CLP (49 bu/ac), Keldin (46 bu/ac), and CDC Falcon (44.3 bu/ac). Brawl also produced grain with the heaviest test weight (64.4 lb/bu). The top varieties for protein included Loma (14.4%), Bearpaw (14%), and CDC Falcon (13.9). Gross return averaged $197.52/ac but violated statistical assumptions so an LSD could not be computed. At Geraldine, top performers for yield included Brawl CLP along with Bearpaw, Decade, Keldin, Northern, SY Monument, SY Wolf, and Yellowstone (Table 6). Top performers for test weight at Geraldine included Brawl CLP and SY Wolf, while Brawl CLP, CDC Falcon, Decade, and Warhorse were top performers for protein. Average gross returns were $328.60/ac across the varieties at Geraldine but violated statistical assumptions so an LSD could not be computed.

Average yield at Highwood was 56.7 bu/ac (Table 7). Top performing varieties were SY Clearstone 2CL (68.0 bu/ac), Decade (67.5 bu/ac), and SY Monument (65.0 bu/ac). The variety with the highest protein was Brawl CLP at 14.7%. Average test weight was 62.0 lb/bu and the varieties with the highest test weights were SY Wolf (63.9 lb/bu) and Brawl CLP (63.4 lb/bu). Average gross returns were $255.68/ac but violated statistical assumptions so an LSD could not be computed.

Acknowledgements

MSU winter wheat breeder Phil Bruckner and associate breeder Jim Berg coordinated the selection of entries and the preparation of seed for the on-farm variety trials. This work was supported by the Montana Wheat & Barley Committee and the Montana Agriculture Experiment Station. Additional information on variety trials can be found at http://agresearch.montana.edu/carc/.

Table 3. 2017 Winter wheat variety trial, Moccasin, MT.

Variety/Pedigree	Year of Release	Source	Heading Date		Grain Yield (bu/ac)		Test Weight	Protein	Gross Return
			cal	jul	2017	2016	(lb/bu)	(%)	($/ac)
Bearpaw	2011	MAES	8-Jun	159	56.6	38.1	58.5	14.2	293.30
+ Brawl CLP	2017	Colorado Research Foundation, 2011	**2-Jun**	**153**	61.4	-	**61.1**	12.9	286.60
CDC Falcon	1999	WPB/SK	11-Jun	162	57.7	35.8	57.7	13.7	276.70
Decade	2010	MAES/NDSU	8-Jun	159	58.2	38.2	58.2	14.1	290.30
Judee	2011	MAES	8-Jun	159	59.7	32.6	**60.4**	14.3	300.00
Keldin	2011	Seed Linc./Westbred LLC	10-Jun	162	71.5	**47.4**	59.7	13.5	351.20
Loma	2016	MAES	12-Jun	163	55.7	**41.5**	57.5	**14.6**	295.80
Northern	2015	MAES	14-Jun	165	60.5	**39.3**	58.4	**15.0**	333.20
SY Clearstone 2CL	2012	Syngenta	10-Jun	161	68.5	**44.4**	58.3	13.7	340.90
+ SY Monument	2017	Syngenta, 2015	7-Jun	158	61.6	-	58.4	12.4	273.80
SY Wolf	2010	AgriPro/Syngenta	7-Jun	158	63.3	**40.6**	**60.6**	13.3	307.40
Warhorse	2013	MAES	8-Jun	160	57.8	**39.3**	58.2	14.3	302.50
WB-Quake	2011	WestBred LLC	12-Jun	163	51.5	30.1	57.7	**14.6**	273.20
Yellowstone	2005	MAES	11-Jun	162	63.1	**42.0**	57.5	14.5	333.00
Average			10-Jun	161	60.3	39.1	58.6	13.9	313.95
CV%			0.9	0.9	10	9.4	1	1.9	9.7
LSD (0.05)			2.4	2.4	9.9	8.1	1	0.4	N.S
P-value			<0.0001	<0.0001	0.1119		<0.0001	<0.0001	0.078

+ = New for 2017

*Gross returns calculated based on protein premiums\dockages as of September 2017, United Grains Elevator, Moccasin, MT.

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.

Note: Yellowstone plots, for 2017, were planted with varying amounts of 'Warhorse' seed depending on location.

N.S. = Not Significant

Table 4. 2017 Winter wheat variety trial, Belt, MT.

Variety/Pedigree	Year of Release	Source	Grain Yield (bu/ac)	Test Weight	Protein	Gross Return
			2017	(lb/bu)	(%)	($/ac)
Bearpaw	2011	MAES	41.0	62.8	8.6	100.75
+ Brawl CLP	2017	Colorado Research Foundation, 2011	60.0	**64.4**	**9.7**	178.71
CDC Falcon	1999	WPB/SK	50.5	61.5	**9.3**	144.17
Decade	2010	MAES/NDSU	49.5	62.4	**9.6**	148.57
Judee	2011	MAES	47.0	63.2	**8.7**	119.00
Keldin	2011	Seed Linc./Westbred LLC	50.6	63.0	8.3	119.97
Loma	2016	MAES	45.4	61.7	**9.1**	124.73
Northern	2015	MAES	51.6	61.4	**9.1**	143.35
SY Clearstone 2CL	2012	Syngenta	56.4	61.0	8.6	148.55
+ SY Monument	2017	Syngenta, 2015	50.5	60.9	7.9	110.23
SY Wolf	2010	AgriPro/Syngenta	52.7	63.5	8.3	123.21
Warhorse	2013	MAES	45.0	62.6	**8.9**	120.10
WB-Quake	2011	WestBred LLC	44.6	62.7	8.3	104.56
Yellowstone	2005	MAES	53.7	61.4	8.3	126.51
Average			51.1	62.1	8.9	129.46
C.V.(%)			5.5	0.7	7.8	9.8
LSD (0.05)			N.S.	0.7	1.1	N.S.
P-value			0.084	<0.0001	<0.0001	0.019

+ = New for 2017

*Gross returns calculated based on protein premiums\dockages as of September 2017, United Grains Elevator, Moccasin, MT.

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.

Note: Yellowstone plots, for 2017, were planted with varying amounts of ‘Warhorse’ seed depending on location.

Note: No trial performed at this site in 2016.

N.S. = Not Significant

Table 5. 2017 Winter wheat variety trial, Denton, MT.

	Variety/Pedigree	Year of Release	Source	Grain Yield (bu/ac) 2017	Test Weight (lb/bu)	Protein (%)	Gross Return ($/ac)
	Bearpaw	2011	MAES	22.1	62.8	**14.0**	116.36
+	Brawl CLP	2017	Colorado Research Foundation, 2011	**49.0**	**64.4**	12.7	231.55
	CDC Falcon	1999	WPB/SK	**44.3**	61.5	**13.9**	227.81
	Decade	2010	MAES/NDSU	41.9	62.4	13.2	206.70
	Judee	2011	MAES	37.3	63.2	13.8	190.60
	Keldin	2011	Seed Linc./Westbred LLC	**46.0**	63.0	13.2	226.30
	Loma	2016	MAES	22.1	61.7	**14.4**	120.71
	Northern	2015	MAES	37.3	61.4	14.3	201.53
	SY Clearstone 2CL	2012	Syngenta	40.3	61.0	13.3	201.28
+	SY Monument	2017	Syngenta, 2015	36.1	60.9	12.7	169.63
	SY Wolf	2010	AgriPro/Syngenta	**50.5**	63.5	12.7	238.46
	Warhorse	2013	MAES	34.3	62.6	13.8	176.30
	WB-Quake	2011	WestBred LLC	26.6	62.7	13.8	136.39
	Yellowstone	2005	MAES	40.3	61.4	13.8	209.83
	Average			39.2	62.1	13.5	197.52
	CV%			12.8	0.72	2.5	11.7
	LSD (0.05)			8.2	0.73	0.56	N.S.
	P-value			<0.0001	<0.0001	<0.0001	<0.0001

+ = New for 2017

*Gross returns calculated based on protein premiums\dockages as of September 2017, United Grains Elevator, Moccasin, MT.

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.

Note: Yellowstone plots, for 2017, were planted with varying amounts of 'Warhorse' seed depending on location.

Note: No trial performed at this site in 2016.

N.S. = Not Significant

Table 6. 2017 Winter wheat variety trial, Geraldine, MT.

Variety/Pedigree	Year of Release	Source	Grain Yield (bu/ac)		Test Weight	Protein	Gross Return
			2017	2016	(lb/bu)	(%)	($/ac)
Bearpaw	2011	MAES	**83.0**	76.9	63.6	10.8	350.50
+ Brawl CLP	2017	Colorado Research Foundation, 2011	**83.8**	-	**64.7**	**12.3**	373.20
CDC Falcon	1999	WPB/SK	78.1	77.5	62.0	**12.2**	342.60
Decade	2010	MAES/NDSU	**82.9**	71.8	63.4	**11.8**	350.00
Judee	2011	MAES	71.1	71.6	62.2	11.6	301.70
Keldin	2011	Seed Linc./Westbred LLC	**90.4**	**101.1**	63.2	10.4	372.90
Loma	2016	MAES	75.0	77.3	62.2	11.3	315.90
Northern	2015	MAES	**84.0**	90.1	62.6	**11.7**	354.00
SY Clearstone 2CL	2012	Syngenta	82.2	92.7	61.3	10.9	343.10
+ SY Monument	2017	Syngenta, 2015	**88.1**	-	62.0	10.5	362.10
SY Wolf	2010	AgriPro/Syngenta	**93.6**	94.0	**64.2**	11.2	384.70
Warhorse	2013	MAES	72.0	80.6	62.7	**12.4**	323.00
WB-Quake	2011	WestBred LLC	73.0	73.7	63.2	11.0	302.90
Yellowstone	2005	MAES	**85.1**	89.8	61.9	11.2	359.40
Average			82.1	85.4	62.6	11.4	328.60
C.V. (%)			5.6	3.8	1.0	4.2	9.5
LSD (0.05)			7.6	6.0	1.1	0.8	N.S.
P-value			<0.0001	-	<0.0001	<0.0001	<0.001

+ = New for 2017

*Gross returns calculated based on protein premiums\dockages as of September 2017, United Grains Elevator, Moccasin, MT.

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. Trial seeded 9/30/16 and harvested 7/26/17.

Note: Yellowstone plots, for 2017, were planted with varying amounts of 'Warhorse' seed depending on location.

N.S. = Not Significant

Table 7. 2017 Winter wheat variety trial, Highwood, MT.

	Variety/Pedigree	Year of Release	Source	Grain Yield (bu/ac)		Test Weight	Protein	Gross Return
				2017	2016	(lb/bu)	(%)	($/ac)
	Bearpaw	2011	MAES	56.4	48.1	61.8	12.9	253.30
+	Brawl CLP	2017	Colorado Research Foundation, 2011	35.6	-	**63.4**	**14.7**	188.00
	CDC Falcon	1999	WPB/SK	54.8	58.5	61.9	12.6	241.60
	Decade	2010	MAES/NDSU	**64.2**	55.0	63.3	12.0	290.10
	Judee	2011	MAES	56.5	**66.0**	62.5	13.1	252.80
	Keldin	2011	Seed Linc./Westbred LLC	55.4	58.3	61.6	12.4	254.00
	Loma	2016	MAES	60.9	55.4	61.9	12.4	264.40
	Northern	2015	MAES	60.5	58.5	62.3	12.6	262.60
	SY Clearstone 2CL	2012	Syngenta	**67.6**	**68.5**	61.2	11.6	284.20
+	SY Monument	2017	Syngenta, 2015	**65.0**	-	62.3	11.2	267.30
	SY Wolf	2010	AgriPro/Syngenta	60.4	43.1	**63.9**	12.1	268.70
	Warhorse	2013	MAES	51.2	68.3	60.7	13.3	264.90
	WB-Quake	2011	WestBred LLC	46.8	51.6	62.4	13.0	183.70
	Yellowstone	2005	MAES	53.2	51.2	61.8	13.3	241.20
	Average			57.2	56.1	62.0	12.4	255.68
	CV%			8.4	8.7	0.6	4.5	10.2
	LSD (0.05)			8.9	8.7	0.6	0.9	N.S.
	P-value			<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

+ = New for 2017

*Gross returns calculated based on protein premiums\dockages as of September 2017, United Grains Elevator, Moccasin, MT.

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.

Note: Yellowstone plots, for 2017, were planted with varying amounts of 'Warhorse' seed depending on location.

N.S. = Not Significant

SPRING WHEAT VARIETY TRIAL

Jed Eberly[1,2] and Luther Talbert[1,3] (Co-Principal Investigators)

Montana State University[1]; Dep. Research Centers, Central Agricultural Research Center, Moccasin, MT[2]; Dep. Plant Sciences and Plant Pathology[3]

Summary

Agronomic performance was evaluated for 22 spring wheat varieties and experimental lines. Average yield for all spring wheat trials at Moccasin in 2017 was 32.0 bu/ac and average protein was 17.1%. Varietal differences in yield were not detected ($P > 0.05$). The top varieties for protein were Alum and Egan at 18.5% and Sy Soren at 18.1%. Average heading date was 24 June. Average plant height at Moccasin was 24.5 inches and varietal differences in height were not different statistically.

Introduction

Spring wheat is an important crop throughout Montana. Ongoing breeding programs are focused on improving the performance of spring wheat varieties. Performance targets include yield and protein content that are higher than the most commonly grown varieties, as well as increased resistance to pathogens and insects. The 2017 growing season was challenging in central Montana. Spring precipitation delayed planting and the subsequent extended drought contributed to overall low yields in spring wheat trials throughout the region.

Methods

On-farm spring wheat variety trials were established at Moccasin, Denton, and Highwood. The Moccasin trials were established at a site that was fallowed the previous year. Twenty-two varieties were compared for height, propensity to lodge, heading date, yield, test weight, and protein. Each variety was planted in three 4.5 x 15 ft plots in a randomized experimental design to determine differences between varieties. Seeding dates were 17 April at Moccasin, 19 April at Highwood, and 4 May at Denton. Planting depth was 1 inch at a rate of 20 seeds/ft^2. Starter fertilizer, 20-30-20-10 NPKS, was applied at seeding at a rate of 50 lb/ac. An additional 95 lb/ac of urea was broadcast applied on 23 May. Broadleaf and grass weeds were controlled with a burndown of glyphosate at 1.25 pt/acre prior to planting. Trials were also sprayed 24 June with Vendetta at a rate of 24 oz/ac for control of field pennycress, flixweed, and prickly lettuce. Plots were harvested with a small-plot harvester on 9 August at Moccasin, 16 August at Denton, and 22 August at Highwood.

Results and Discussion

Spring wheat yields are reported on a moisture content of 13.5%. The average yield for the spring wheat trial at Moccasin in 2017 was 32.0 bu/ac and average protein was 17.1%. We were unable to detect a difference in grain yield across the varieties ($P> 0.05$). The top varieties for protein were Alum and Egan at 18.5% and Sy Soren at 18.1%. The highest test weights were Brennan and Camaro at 58.9 and 58.2 lb/bu, respectively. The average heading date was 24 June with the earliest varieties heading on 23 June and the average height for all the spring wheat varieties at Moccasin was 24.5 inches. Gross returns were calculated based on prices and protein premiums and discounts obtained from United Grain Corporation on 30 October 2017. No lodging was observed with any of the varieties.

Average yield for all varieties at Denton was 20.0 bu/ac. No statistically significant difference in yield was observed between the varieties based on the C.V. value. The top varieties for protein were Egan and SY Ingmar (18.5%), Sy Soren (18.1%), and Alum (17.8%). Highest test weights were Camaro (61.8 lb/bu) and Cheville (61.4 lb/bu). Gross return was highest for Cheville at $223.80/ac.

Average yield for all varieties at Highwood was 32.5 bu/ac. No statistically significant difference was observed between the top 10 varieties. The highest protein was Camaro at 17.2% and the highest test weights were Brennan (61.4 lb/bu), Sy Ingmar (60.6 lb/bu), and Corbin and WB Gunnison (60.3 lb/bu). Average gross return was $202.20/bu and differences in gross return were also not significant at Highwood based on the unfavorably high LSD value. Table 10 shows the average height, yield, test weight, and protein for all named varieties tested. Gross returns per acre were also calculated for each variety and location. Note that this calculated return does not take into account any expenses but does account for dockage and premiums associated with the test weight and protein.

Acknowledgements

MSU spring wheat breeder Luther Talbert coordinated the selection of entries and the preparation of seed for the on-farm cultivar trials. This work was supported by the Montana Wheat & Barley Committee and the Montana Agriculture Experiment Station. Additional information on variety trials can be found at http://agresearch.montana.edu/carc/.

Table 8. 2017 Spring wheat variety trial, Moccasin, MT.

Variety/Pedigree	Year of Release	Source	Heading Date		Yield (bu/ac)		Test Weight	Protein	Gross Return
			cal	jul	2017	2016	(lb/bu)	%	($/ac)
Alum	2014	WSU	25-Jun	176	29.6	**37.5**	54.3	**18.5**	188.10
+ Camaro	--	Meridian Seeds	**23-Jun**	**175**	33.4	--	**58.2**	16.8	211.40
+ Cheville	--	Meridian Seeds	**23-Jun**	**174**	33.8	--	55.8	16.3	222.90
Brennan	2009	Syngenta/AgriPro	**23-Jun**	**175**	35.2	31.1	**58.9**	16.4	227.40
Choteau	2003	MAES	24-Jun	176	28.3	35.9	55.1	17.3	177.90
Corbin	2006	Westbred, LLC	**22-Jun**	**173**	31.1	30.3	55.9	17.3	200.60
Duclair	2011	MAES	**23-Jun**	**174**	32.1	35.4	53.2	17.4	206.10
Egan	2013	Westbred, LLC	25-Jun	176	32.5	37.4	54.3	**18.5**	206.70
Fortuna	1966	MAES/NDSU	25-Jun	176	30.5	35.1	55.8	16.7	191.50
+ Lanning	--	--	**23-Jun**	**174**	33.8	--	53.8	16.9	215.90
+ LCS Pro	--	--	25-Jun	176	30.1	--	53.0	17.3	193.30
+ NS Presser CL+	--	--	25-Jun	176	32.1	--	52.7	17.3	207.60
Oneal	2008	Westbred, LLC	25-Jun	177	32.1	33.1	56.4	17.4	200.30
+ Reeder	1999	NDSU	25-Jun	176	33.0	36.3	56.1	16.9	205.90
+ Sy Ingmar	--	Syngenta/AgriPro	25-Jun	176	33.7	--	55.6	17.3	211.80
Sy Soren	2011	Syngenta/AgriPro	24-Jun	176	31.2	32.4	55.3	**18.1**	196.40
Vida	2005	MAES	26-Jun	177	31.1	33.5	54.2	16.9	204.10
WB Gunnison	--	Westbred, LLC	**23-Jun**	**175**	32.7	33.2	55.7	16.3	215.50
Average			24-Jun	175	32.0	33.9	55.5	17.1	204.8
C.V. (%)			0.003	0.665	8.4	14.5	1.3	2.5	9.4
LSD (0.05)			1.9	1.9	N.S.	8.1	1.2	0.7	N.S.
P-value			0.001	0.001	0.3672	--	<0.0001	<0.0001	0.3012

+ = 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.

Note: Yellowstone plots, for 2017, were planted with varying amounts of ‘Warhorse’ seed depending on location.

N.S. = Not Significant

Table 9. 2017 Spring wheat variety trial, Denton, MT.

Variety/Pedigree	Year of Release	Source	Yield (bu/ac) 2017	Test Weight (lb/bu)	Protein %	Gross Return ($/ac)
Alum	2014	WSU	18.2	55.2	**17.8**	114.20
Camaro		Meridian Seeds	26.0	**61.8**	17.3	164.50
Cheville		Meridian Seeds	35.8	**61.4**	16.3	**223.80**
Brennan	2009	Syngenta/AgriPro	20.5	56.6	17.4	127.50
Choteau	2003	MAES	20.1	54.7	17.0	127.10
Corbin	2006	Westbred, LLC	18.2	54.5	17.6	115.30
Duclair	2011	MAES	21.8	53.8	16.6	142.80
Egan	2013	Westbred, LLC	18.6	53.9	**18.5**	118.30
Fortuna	1966	MAES/NDSU	16.9	55.1	17.1	106.50
+ Lanning			21.5	54.1	17.1	136.60
+ LCS Pro			19.0	54.5	16.8	124.20
+ NS Presser CL+			16.6	53.5	17.0	109.10
Oneal	2008	Westbred, LLC	19.6	56.6	17.3	122.10
+ Reeder	1999	NDSU	17.2	55.8	17.3	107.90
+ Sy Ingmar		Syngenta/AgriPro	16.1	53.3	**18.5**	103.00
Sy Soren	2011	Syngenta/AgriPro	17.5	53.7	**18.1**	112.10
Vida	2005	MAES	19.8	55.2	16.5	132.20
WB Gunnison		Westbred, LLC	19.3	54.7	16.6	124.30
Average			20.0	55.5	17.2	127.3
C.V. (%)			15.2	1.7	3.1	15.4
LSD (0.05)			N.S.	1.5	0.9	32.4
P-value			<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.

Note: Yellowstone plots, for 2017, were planted with varying amounts of ‘Warhorse’ seed depending on location.

N.S. = Not Significant

Table 10. 2017 Spring wheat variety trial, Highwood, MT.

Variety/Pedigree	Year of Release	Source	Yield (bu/ac)		Test Weight (lb/bu)	Protein %	Gross Return ($/ac)
			2017	2016			
Alum	2014	WSU	**37.7**	**46.4**	59.1	15.0	231.80
Camaro		Meridian Seeds	17.1		57.2	**17.2**	109.20
Cheville		Meridian Seeds	18.6		56.4	15.3	117.80
Brennan	2009	Syngenta/AgriPro	27.6	27.6	**61.4**	16.2	169.90
Choteau	2003	MAES	**37.7**	35.1	59.7	16.0	231.50
Corbin	2006	Westbred, LLC	28.6	35	**60.3**	14.8	175.90
Duclair	2011	MAES	32.0	37.2	58.1	15.6	202.00
Egan	2013	Westbred, LLC	**37.5**	42.2	57.5	16.5	231.60
Fortuna	1966	MAES/NDSU	30.1	28.7	59.1	15.3	185.20
+ Lanning			**40.3**		59.4	15.1	247.50
+ LCS Pro			31.2		59.0	15.5	197.50
+ NS Presser CL+			**34.7**		57.5	15.2	220.60
Oneal	2008	Westbred, LLC	**38.9**	30.4	59.8	14.6	238.80
+ Reeder	1999	NDSU	**37.0**	37.8	58.8	16.1	228.30
+ Sy Ingmar		Syngenta/AgriPro	**37.8**		**60.6**	15.6	232.90
Sy Soren	2011	Syngenta/AgriPro	**34.2**	29.3	59.2	15.6	210.60
Vida	2005	MAES	**34.9**	33.9	59.9	15.0	228.00
WB Gunnison		Westbred, LLC	29.7	29.5	**60.3**	14.5	185.00
Average			32.5	32.4	59.2	15.6	202.2
C.V. (%)			13.1	9.3	1.5	1.8	13.7
LSD (0.05)			7.0	4.9	1.5	0.5	N.S.
P-value			<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.

Note: Yellowstone plots, for 2017, were planted with varying amounts of ‘Warhorse’ seed depending on location.

N.S. = Not Significant

SPRING BARLEY VARIETY TRIAL

Jed Eberly[1,2] and Jamie Sherman[1,3] (Co-Principal Investigators)

Montana State University[1]; Dep. Research Centers, Central Agricultural Research Center, Moccasin, MT[2], Dep. Plant Sciences and Plant Pathology[3]

Summary

Agronomic performance was evaluated for 25 barley varieties and experimental lines. The average yield for all barley varieties at Moccasin was 34.3 bu/ac and the average protein was 14.1%. We were unable to detect differences among the varieties in grain yield ($P > 0.05$). Average yield for all varieties at Denton was 27.8 bu/ac and 28.4 bu/ac at Highwood; protein averaged 18.4% at Denton and 16.7% at Highwood. We were unable to detect grain yield differences among the top 13 varieties at Denton and among any of the varieties tested at Highwood. Similarly, differences in grain protein were not detected among the varieties at Highwood, though differences were detected among the varieties at Denton.

Introduction

Barley is an important agriculture commodity in Montana for feed, food, and malt. The MSU barley breeding program is focused on developing improved varieties of both hulled and hull-less barley varieties for food and feed. The 2017 central Montana crop year was generally a poor production year. The drought resulted in below average yields and poor overall performance for the varieties tested.

Methods

The barley variety trial tested the agronomic performance and potential of 25 varieties and experimental lines. Both malt and feed varieties were evaluated. On-farm variety trials were established at Moccasin, Denton, and Highwood. The Moccasin trials were established at a site that was fallowed the previous year. Twenty-two varieties were compared for height, propensity to lodge, heading date, yield, test weight, and protein. Each variety was planted in three 4.5 x 15 ft plots in a randomized experimental design to determine differences between varieties. Seeding dates were 18 April at Moccasin, 19 April at Highwood, and 4 May at Denton. Planting depth was 1 inch at a rate of 20 seeds/ft^2. Starter fertilizer, 20-30-20-10 NPKS, was applied at seeding at a rate of 50 lb/ac. An additional 95 lb/ac of urea was broadcast applied on 23 May. Trials were also sprayed 24 June with Vendetta at a rate of 24 oz/ac for control of field pennycress, flixweed, and prickly lettuce. Plots were harvested with a small-plot harvester on 21 August at Moccasin, 16 August at Denton, and 22 August at Highwood.

Results and Discussion

Barley yields are reported on a moisture content of 14.5%. The average yield for all barley varieties at Moccasin was 34.3 bu/ac and the average protein was 14.1%. Among the named varieties, there was no significant difference in yield statistically ($P > 0.05$). The varieties with the highest protein were Growler and Metcalfe (15.0%), Copeland, Haybet, and Odyssey (14.6%), Bill Coors 100 and Hays (14.1%), Moravian 165 (14.0%), and Merit (13.9%). Average test weight was 51.2 lb/bu and average gross return was $133.60. Differences in gross return were not statistically significant between varieties. The percentage of plump kernels was very low and highly variable, ranging from 2.7-55.6%. No lodging was observed with any of the varieties.

Average yield for all varieties at Denton was 27.8 bu/ac and average protein was 18.4%. There was no significant difference in yield among the top 13 varieties which ranged from 26.5-32.6 bu/ac. The top varieties for test weight were Merit (51.6 lb/bu), Haxby (50.5 lb/bu), and Hocket (50.4 lb/bu). Varieties with the highest protein were Bill Coors (20.3%), Growler (19.8%), Copeland (19.7%), Haybet and Moravian 165 (19.5%), and Merit (19.3%). Average heading date was 2 July with the earliest varieties heading from 27 June – 2 July. Average plump kernel percentage was 10.7% and there was no significant difference between varieties. Gross return for the top 10 varieties ranged from $99.60-121.90/ac.

Performance of the varieties in the trial at Highwood were highly variable, presumably due to the acidic soil conditions. Due to the low yield in part of the trial it was not possible to measure test weight, protein, or plump in several plots. Average grain yield was 28.4 bu/ac and average protein was 16.7%. Average test weight and plump kernels were 54.4 lb/bu and 73.8%, respectively. Average gross return for all varieties was $116.60/ac.

Acknowledgements

MSU barley breeder Jamie Sherman coordinated the selection of entries and the preparation of seed for the on-farm cultivar trials. This work was supported by the Montana Wheat & Barley Committee and the Montana Agriculture Experiment Station. Additional information on variety trials can be found at http://agresearch.montana.edu/carc/.

Table 11. 2017 Spring barley variety trial, Moccasin, MT.

	Variety/Pedigree	Year of Release	Source	Type	Heading Date		Yield (bu/ac)		Test Weight (lb/bu)	Protein (%)	Plump (%)	Gross Return ($/ac)
					cal	jul	2017	2016				
+	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 12. 2017 Spring barley variety trial, 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 13. 2017 Spring barley variety trial, Highwood, MT.

	Variety/Pedigree	Year of Release	Source	Type	Yield (bu/ac)		Test Weight (lb/bu)	Protein (%)	Plump (%)	Gross Return ($/ac)
					2017	2016				
+	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

ALTERNATIVE CROP VARIETY TRIALS

SPRING PEA VARIETY TRIAL

Yesuf Mohammed[1,2] and Chengci Chen[1,2] (Principle Investigators)

Patrick Carr[1,3], Simon Fordyce[1,3], and Sally Dahlhausen[1,3], CARC (Co-Principal Investigators)

Montana State University, Dep. Research Centers[1]; Eastern Agricultural Research Center, Sydney, MT[2]; Central Agricultural Research Center, Moccasin, MT[3]

Summary

More growers are incorporating field peas into crop rotations as a means of improving soil fertility. Selection of pea varieties that are well adapted to growing conditions can boost grower yields and profits. We evaluated performance of 26 spring field pea varieties and experimental lines[1] (15 yellow cotyledon types and 11 green cotyledon types) in a small plot trial at the MSU Central Agricultural Research Center. Varietal differences in grain yield were found to be non-significant due to an unfavorably high CV statistic (>15%). Overall, the trial averaged 15.2 bu/ac, down from 22.9 bu/ac in 2016.

Introduction

Field pea can improve soil fertility and break pest cycles when incorporated into rotations with wheat and other cereals. In 2016, Montana led the nation in total dry pea acreage (6.1 x 10^5 acres), but the state's yields (32.5 bu/ac) lagged behind Oregon (43.3 bu/ac), Idaho (41.7 bu/ac), Washington (40.0 bu/ac), and North Dakota (37.5 bu/ac; USDA 2017). This yield depression likely results from many factors, but one contributor may be the failure to grow pea varieties adapted to the wide range of production environments in Montana. The objective of this study was to identify spring pea varieties well-adapted to regional growing conditions.

Methods

Twenty-six varieties and experimental lines were compared for height, propensity to lodge, vine length, date of first flowering, grain yield, test weight, and kernel weight. Each variety was planted in four, 4.5 by 15 ft plots in an experimental design to determine varietal differences. The study was located in a field that was planted to barley in 2016. Peas were planted on 19 April at a depth of 1.5 inches and at a rate of 8 PLS/ft^2 into a no-till seedbed using a high-disturbance hoe drill. Soil temperature at time of planting was 49 °F. Broadleaf and grass weeds were controlled with a pre-plant burn down of glyphosate (i.e., Roundup) at 1.25 pt/ac. Assure II at 10 oz/ac, Raptor at 4 oz/ac, and Basagran at 1.6 pt/ac were applied for in-crop weed control. Grizzly Too at 1.5 oz/ac was applied on 15 May and 30 May for the control of pea leaf weevil. Plots were harvested on 25 July with a small-plot harvester.

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[1] Agronomic performance data for seven experimental lines are excluded unless otherwise noted.

Results and Discussion

The trial averaged 15.2 bu/ac overall, with yellow cotyledon types averaging 15.9 bu/ac and green cotyledon types averaging 13.6 bu/ac. No statistical differences in yield were observed, but CDC Treasure was among the tallest of the yellow peas (23 inches), and CDC Raezer was among the tallest of the green peas (20 inches). Lodging was not a significant factor in this year's trial, averaging just 2.3 on a 9-point scale. Delta was among the top performing yellow types for test weight (66.9 lb/bu), while Hampton was among the top performing green types (66.3 lb/bu). Of the yellow types, CDC Saffron exhibited the lowest thousand kernel weight (145.3 g), as did Arcadia (133 g) and CDC Patrick (138.2 g) of the green types. Varietal differences in establishment were statistically significant despite entries having been seeded on a pure-live-seed basis. Trial establishment averaged 9.0 plants/ft^2, slightly higher than the target of 8 plants/ft^2.

In 2016, Durwood (30 bu/ac) and CDC Amarillo (28 bu/ac) were the highest yielding yellow peas, while Hampton (24 bu/ac) and CDC Patrick (23 bu/ac) were among the highest yielding green peas. Of the yellow cotyledon types, only DS Admiral has been grown at the CARC for four consecutive years, averaging 31 bu/ac. Two varieties of the green cotyledon type have been grown over this same period: Majoret and Arcadia, averaging 29 bu/ac and 27 bu/ac, respectively (Mohammed and Chen 2016).

Acknowledgements

We are grateful to the Montana Pulse Advisory Committee and the Montana Agriculture Experiment Station for funding this research.

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Table 14. 2017 Spring pea variety trial, Moccasin, MT.

Variety	Plant Count	Flower Date		Plant Height	Vine Length	Lodging Score[1]	Grain Yield[2]	Test Weight	1000 Kern. Wt
	ft^2	cal	jul	------in------		0-9	bu/ac	lb/bu	g
Yellow Cotyl. Type									
AAC Carver	**11.3**	19-Jun	170.2	**20.9**	**22.4**	**0.8**	13.7	65.9	160.3
AC Earlystar	9.0	21-Jun	172.2	**21.4**	**23.1**	**2.0**	15.2	65.5	152.2
CDC Amarillo	9.4	22-Jun	173.2	19.7	21.7	**0.5**	12.4	65.7	163.0
CDC Inca	8.9	23-Jun	173.8	**21.2**	**22.8**	**0.2**	16.5	65.8	151.4
CDC Meadow	5.7	22-Jun	172.8	**21.3**	**22.9**	**2.2**	15.8	66.4	152.3
CDC Saffron	8.0	21-Jun	171.8	**20.8**	**22.4**	**0.5**	16.5	**66.8**	**145.3**
CDC Treasure	8.3	20-Jun	171.0	**23.0**	**24.6**	2.8	18.0	66.2	161.5
Delta	8.9	20-Jun	171.5	16.1	17.0	4.5	13.3	**66.9**	158.0
DS Admiral	8.1	22-Jun	172.5	**21.6**	**23.7**	**0.2**	19.3	64.7	186.8
Jetset	**10.2**	21-Jun	172.2	20.5	**22.3**	**1.0**	20.4	65.3	174.4
Navarro	9.6	16-Jun	**166.8**	18.4	20.3	4.0	10.2	66.0	194.4
Nette 2010	**10.8**	19-Jun	170.0	20.6	**22.4**	2.5	19.2	**66.6**	178.5
Green Cotyl. Type									
Aragorn	9.7	20-Jun	170.5	17.5	19.3	4.5	13.1	64.8	146.9
Arcadia	**11.8**	22-Jun	172.5	15.4	16.7	6.2	14.6	65.8	**133.0**
CDC Greenwater	**11.0**	24-Jun	174.8	17.8	19.7	**1.0**	12.7	64.8	161.1
CDC Patrick[3]	6.2	26-Jun	177.0	18.5	20.9	**2.2**	10.9	65.9	**138.2**
CDC Raezer	7.0	22-Jun	173.5	20.4	**22.4**	**2.2**	19.2	65.6	178.4
Hampton[3]	9.6	21-Jun	171.8	15.4	17.2	**2.2**	10.6	66.3	153.2
Majoret	**10.0**	22-Jun	172.8	19.8	21.4	**0.8**	14.0	65.8	164.9
Mean	8.9	21-Jun	171.7	19.4	21.2	2.3	15.2	65.8	162.4
CV%	14.2	-	0.9	8.2	8.9	65.1	19.7	0.4	5.4
LSD (0.05)	1.8	-	2.1	2.2	2.7	2.1	NS[4]	0.4	12.5
P-Value	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

[1] Lodging score: 0 = All plants upright; 9 = All plants prostrate

[2] Adjusted to 13% moisture

[3] Up to 30% harvest loss

[4] LSD considered non-significant when grain yield CV% > 15

Bold indicates top-performing cultivar(s) in a column

Bold indicates cultivar performing statistically equivalent to top-performing cultivar(s)

Seeding Date: 4/19/17

Harvest Date: 7/25/17

Note: Summary statistics include experimental lines not reported in the body of the table

SPRING LENTIL VARIETY TRIAL

Yesuf Mohammed[1,2] and Chengci Chen[1,2] (Principle Investigators)

Patrick Carr[1,3], Simon Fordyce[1,3], and Sally Dahlhausen[1,3], CARC (Co-Principal Investigators)

Montana State University, Dep. Research Centers[1]; Eastern Agricultural Research Center, Sydney, MT[2]; Central Agricultural Research Center, Moccasin, MT[3]

Summary

Spring lentil production in Montana is on the rise as more farmers seek to capitalize on the benefits of pulse crops. It is important for growers to select lentil varieties well-suited to the growing conditions of the region. Agronomic performance of eight spring lentil varieties was assessed at the MSU Central Agricultural Research Center (CARC) in a small plot trial, with the objective of identifying varieties best-suited to this environment. Yields in 2017 were disappointing due to excessive heat and persistent drought during July. The trial averaged just 11.7 bu/ac, and varietal differences in yield were not detected statistically. Over the past four years, CDC Richlea has averaged 20.7 bu/ac.

Introduction

In 2016, Montana led the nation in total lentil acreage (505,000 acres), but the state's production on a per acre basis (24.3 bu/ac) fell to second place, behind Idaho (25.8 bu/ac; USDA 2017). Identifying top-performing varieties for Montana is one way to close the yield gap with Idaho. The development of new and improved varieties is also important for enhancing the economics of lentil production. Twenty-four experimental lines were compared for agronomic performance in a separate trial, results of which are excluded from this report for confidentiality purposes. Here we summarize agronomic data for eight commercial spring lentil varieties only.

Methods

Eight varieties were compared for height, propensity to lodge, vine length, date of first flowering, grain yield, test weight, and kernel weight. Each variety was planted in four, 4.5 by 15 ft plots in an experimental design to determine differences. The study was located in a field that was planted to barley in 2016. Lentils were planted on 19 April at a depth of 1.5 inches and at a rate of 12 pure live seed/ft^2 into a no-till seedbed using a high-disturbance hoe drill. Soil temperature at time of planting was 49 °F. Broadleaf and grass weeds were controlled with a pre-plant burn down of glyphosate at 1.25 pt/ac. Metribuzin (Sencor 4) at 8 oz/ac was applied for in-crop weed control. Plots were harvested on 26 July using a small plot harvester.

Results and Discussion

Lentil establishment in the 2017 trial was consistent, i.e., varietal differences were not detected ($P > 0.05$), averaging just 1.3 plants/ft^2 below the target of 12 plants/ft^2. Avondale and CDC Impress CL were among the earliest flowering and tallest varieties in the trial. CDC Impala and CDC Viceroy were among the top performers for test weight (65.3 lb/bu). Varietal differences in both yield and kernel weight were not detected, and lodging this year was not a major factor, averaging 1.4 on a 9-point scale.

In 2016, CDC Richlea (25.2 bu/ac) and Avondale (24.1 bu/ac) were among the highest-yielding varieties. The yield of all varieties in the trial averaged 22.1 bu/acre in 2016, up from 12.6 bu/ac in 2015 (Mohammed and Chen 2016). Only two lentil varieties have been grown at CARC for four consecutive years. These varieties (with four-year averages) are CDC Richlea (20.7 bu/ac) and Avondale (18.5 bu/ac).

Acknowledgments

We are grateful to the Montana Pulse Advisory Committee and the Montana Agriculture Experiment Station for funding this research.

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Table 15. 2017 Spring lentil variety trial, Moccasin, MT.

Variety	Plant Count	Flower Date		Plant Height	Lodging Score[1]	Grain Yield[2]	Test Weight	1000 Kern. Wt
	ft^2	cal	jul	in	0-9	bu/ac	lb/bu	g
Avondale	11.2	20-Jun	**171.0**	**13.2**	**0.8**	13.4	61.7	34.6
CDC Imigreen	11.8	21-Jun	**171.8**	**14.8**	2.8	8.9	62.2	43.1
CDC Impala CL	10.1	24-Jun	174.8	11.5	1.5	9.3	**65.3**	34.0
CDC Impress CL	9.7	20-Jun	**171.0**	**13.5**	1.8	13.8	62.0	40.3
CDC Imvincible CL	10.2	24-Jun	175.2	12.0	1.5	11.4	**64.8**	36.6
CDC Maxim CL	9.9	20-Jun	**171.0**	11.6	**0.0**	10.7	64.1	33.3
CDC Richlea	11.7	20-Jun	**171.5**	12.5	2.0	13.8	61.1	36.7
CDC Viceroy	10.9	23-Jun	174.0	12.9	**0.8**	12.3	**65.3**	36.8
Mean	10.7	22-Jun	172.5	12.7	1.4	11.7	63.3	36.9
CV%	14.9	-	0.4	8.4	61.0	19.8	0.8	28.8
LSD (0.05)	NS	-	1.2	1.7	1.3	NS[3]	0.8	NS
P-Value	0.408	-	<0.0001	0.005	0.005	0.033	<0.0001	0.899

[1] Lodging score: 0 = All plants upright; 9 = All plants prostrate

[2] Adjusted to 13% moisture

[3] LSD considered non-significant when grain yield CV% > 15

Bold indicates top-performing cultivar(s) in a column

Bold indicates cultivar performing statistically equivalent to top-performing cultivar(s)

Seeding Date: 4/19/17

Harvest Date: 7/26/17

SPRING CHICKPEA VARIETY TRIAL

Yesuf Mohammed[1,2] and Chengci Chen[1,2] (Principle Investigators)

Simon Fordyce[1,3], Sally Dahlhausen[1,3], and Patrick Carr[1,3] (Co-Principal Investigators)

Montana State University, Dep. Research Centers[1]; Eastern Agricultural Research Center, Sydney, MT[2]; Central Ag Research Center, Moccasin, MT[3]

Summary

In 2016, Montana ranked second in the nation in total chickpea production, behind only Washington (USDA 2017a). Chickpeas can be a challenging crop for growers due to problems with fungal diseases and other pests like deer and antelope. However, if managed successfully, the crop can be highly lucrative. Selection of varieties well-suited to regional growing conditions is one way to improve yields. Here we assessed agronomic performance of eight spring chickpea varieties at the MSU Central Agricultural Research Center (CARC), with the objective of identifying varieties well-adapted to this environment. Unfortunately, grain yield data were extremely poor due to excessive grazing by deer and antelope, and thus were excluded from the report. CDC Orion and Myles were the earliest flowering varieties (22 June), while Royal, Sierra, and Nash were the tallest (16.2, 16.0, and 15.1 in, respectively). Varietal differences in establishment were observed despite entries having been seeded on a pure-live-seed (PLS) basis. Trial establishment averaged 5.4 plants /ft^2, slightly above the target of 5 plants/ft^2. Lodging was not a significant factor this year, with the trial averaging just 0.3 on a 9-point scale.

Introduction

It is estimated that Montana farmers planted more chickpeas[2] in 2017 (198,000 acres) than in the previous four years combined (USDA 2017b). This increased chickpea acreage creates a need for reliable information regarding differences in varietal performance by region. Here, we summarize agronomic data for eight commercial chickpea varieties grown at the CARC.

Methods

Eight varieties were compared for establishment, plant height, propensity to lodge, and date of first flowering. Each variety was planted in four, 4.5 by 15 ft plots in an experimental design to determine varietal differences. The study was located in a field that was planted to barley in 2016. Chickpeas were planted on 4 May at a depth of 1.5 inches and at a rate of 5 PLS/ft^2 into a no-till seedbed using a high-disturbance hoe drill. Soil temperature at time of planting was 50°F. Broadleaf and grass weeds were controlled with a pre-plant burn down of glyphosate at 1.25 pt/ac. Plots were harvested on 16 August using a small plot harvester.

Results and Discussion

Generating useful grain yield data in the chickpea variety trial has been problematic. Yield data for the 2017 trial were not summarized due to excessive grazing by deer and antelope. Likewise, a harvest mix up resulted in abandonment of the trial in 2016, and varietal differences in the 2015

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[2] Based on intended plantings, as indicated by reports from farmers

trial were found to be non-significant. The 2015 trial averaged 19.9 bu/ac, up from 15.0 bu/ac in 2014 (Mohammed and Chen 2016).

No chickpea variety has been grown at CARC in each of the past three years, and only three varieties have been grown at CARC for three consecutive years since 2013. These varieties include the Desi type Myles, averaging 23.7 bu/ac over this period, and the large Kabuli types CDC Orion and CDC Frontier, averaging 24.6 bu/ac and 21.7 bu/ac, respectively (Mohammed and Chen 2016).

Acknowledgments

We are grateful to the Montana Pulse Advisory Committee and the Montana Agriculture Experiment Station for funding this research.

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USDA (2017b) Prospective Plantings. National Agricultural Statistics Service. http://usda.mannlib.cornell.edu/usda/current/ProsPlan/ProsPlan-03-31-2017.pdf

Table 16. 2017 Spring chickpea variety trial, Moccasin, MT.

Treatment	Plant Count	Flower Date		Plant Height	Lodging Score[1]
	ft^2	cal	jul	in	0-9
CDC Alma	3.5	26-Jun	177.0	12.5	0.3
CDC Frontier	**5.9**	27-Jun	178.8	14.4	0.3
CDC Orion	**6.1**	23-Jun	**174.0**	13.5	0.5
Myles	**6.2**	23-Jun	**174.8**	14.3	0.3
Nash	**5.4**	28-Jun	179.3	**15.1**	0.0
Royal	4.8	28-Jun	179.0	**16.2**	0.0
Sawyer	**5.8**	26-Jun	177.0	14.4	0.3
Sierra	**5.7**	25-Jun	176.0	**16.0**	0.5
Mean	5.4	25-Jun	177.0	14.5	0.3
CV%	14.5	-	0.6	7.2	123.4
LSD	1.2	-	1.5	1.5	NS
P-Value	0.001	-	<0.0001	0.001	0.221

[1] Lodging score: 0 = All plants upright; 9 = All plants prostrate.

Bold indicates top-performing cultivar(s) in a column

Bold indicates cultivar performing statistically equivalent to top-performing cultivar(s)

Seeding Date: 5/4/17

Harvest Date: 8/16/17

Note: Yield data not reported due to excessive grazing by deer and antelope

SPRING CANOLA VARIETY TRIAL

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Summary

Montana ranked third both in total canola acreage (62,000 acres) and total production (2 million bu), behind North Dakota (53 million bu) and Oklahoma (2.3 million bu; USDA 2017a) in 2016. However, Montana drops to seventh place nationally (33.4 bu/ac) on a per acre basis, illustrating a need to identify canola varieties best suited to Montana growing conditions. We evaluated agronomic performance of several varieties at six locations across Montana, with an aim of providing growers with reliable information on canola production agronomics across the state. Summarized here are the agronomic data for the trial located at the MSU Central Agricultural Research Center (CARC) only; a subsequent report will summarize results for all six locations. Yields at the Central Ag Research Center were low due to a combination of factors, including late frosts, extreme heat, and below-average precipitation. The trial averaged just 8.4 bu/ac, and we were unable to detect varietal yield differences. Statistics for test weight and oil content were omitted, as it was not possible to measure these variables without bulking seed from all replicates. Varietal differences in establishment were observed despite entries having been seeded on a pure-live-seed (PLS) basis. The trial averaged 12.8 plants/ft^2, slightly below the target of 14 plants/ft^2. Frost damage was a significant factor in this year’s trial, averaging 2.6 on a 5-point scale.

Introduction

Spring canola production in Montana is increasing, with record-breaking acreage[3] predicted in 2017 (USDA 2017b). This increased acreage creates a need for reliable information regarding differences in varietal performance by region. Here we summarize agronomic performance data for 20 spring canola varieties tested at the CARC.

Methods

Twenty varieties from five sponsors (Table 17) were compared for height, propensity to lodge, days to 50% flowering, grain yield, test weight, and percent oil. The study was located in a field that was planted to Willow Creek winter wheat in 2016. Each variety was planted in four, 4.5 by 15 ft plots in an experimental design to determine varietal differences. The trial was planted on 20 April at a depth of 0.75 inches and at a rate of 14 PLS/ft^2 in a no-till seedbed using a high-disturbance hoe drill. Soil temperature at time of planting was 49°F. Broadleaf and grass weeds were controlled with a pre-plant burn down of glyphosate at 1.25 pt/ac. The trial included varieties of four different herbicide tolerance types, which limited chemical control options. Plots were hand-weeded multiple times throughout the growing season. One application of Stinger at 8 oz/ac was made. Plots were harvested on 28 July using a small plot harvester.

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[3] Based on intended plantings, as indicated by reports from farmers

Results and Discussion

Because canola favors cooler temperatures, the extreme heat observed throughout July resulted in low yields. Late frosts (11 June and 23 June) and below-average precipitation also contributed to the yield depression. The low and compressed yields prevented us from detecting varietal differences in yield in the 2017 trial; a spring canola trial was not established at the CARC in 2016. Interestingly, previous research found a negative correlation between days to 50% flowering and spring canola seed yield at the CARC, suggesting that earlier flowering varieties tend to be among the highest yielding. In 2017, the varieties requiring the fewest number of days to 50% flowering (i.e., predicted top yielders) were 15MH6006 (53 days), 11H4030 (54 days), and HyCLASS 955 (54 days). Number of days to 50% flowering for all varieties in the 2017 trial averaged 58 days (16 June).

Acknowledgments

We are grateful to Bayer CropScience®, BrettYoung™, Cargill® Global Edible Oil Solutions, Cibus™, CROPLAN by Winfield®, and Dekalb® for funding this research.

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USDA (2017a) Crop Production 2016 Summary. National Agricultural Statistics Service. http://usda.mannlib.cornell.edu/usda/current/CropProdSu/CropProdSu-01-12-2017.pdf

USDA (2017b) Prospective Plantings. National Agricultural Statistics Service. http://usda.mannlib.cornell.edu/usda/current/ProsPlan/ProsPlan-03-31-2017.pdf

Table 17. 2017 List of spring canola variety trial submissions and sponsors.

Sponsor	Variety	Herbicide Tolerance	Contact
Bayer CropScience	InVigor L233P	LL	Jordan Varberg
	InVigor L140P	LL	1524 Walnut St.
	InVigor L230	LL	Grand Forks, ND 58201
	InVigor L252	LL	jordan.varberg@bayer.com
			(701) 755-2700
BrettYoung	6074 RR	RR	Rene Mabon
	6080 RR	RR	Box 99 ST Norbert Postal Station
	5545 CL	CL	Winnipeg, MB Canada R3V1L5
			rene.mabon@brettyoung.ca
			(204) 261-7932
Cargill Global Edible Oil Solutions	11H4054	RR	Keith Horton
	11H4030	RR	300 Smelter Ave NE #304
	09H7763	RR	Great Falls, MT 59404
	11H4009	RR	keith_horton@cargill.com
	15MH6006	CL	(406) 750-2917
Cibus	C5507	SU	Jameson Hall
	C5522	SU	6455 Nancy Ridge Dr.
	C5513	SU	San Diego, CA 92121
			jhall@cibus.com
			(858) 450-0008
CROPLAN by Winfield	HyCLASS 930	RR	Paul S. Gregor
	HyCLASS 955	RR	10515 115th St NW
	HyCLASS 970	RR	Thief River Falls, MN 56701
			psgregor@landolakes.com
			(218) 964-5168
Dekalb (Monsanto)	DKL 35-23[1]	RR	Courtney Meduna
	DKL 70-10	RR	516 19th Ave SW
			Minot, ND 58701
			courtney.a.meduna@monsanto.com
			(701) 339-0238

[1] G35153 in the 2016 trial

Note: CL = Clearfield; LL = Liberty Link; RR = Roundup Ready; SU = Sulfonylurea

Table 18. 2017 Spring canola variety trial, Moccasin, MT.

Variety	Plant Count	Flower Date		Frost Damage[1]	Plant Height	Grain Yield[2]	Test Weight[3]	Oil Content[2,3]
	ft²	cal	jul	1-5	in	bu/ac	lb/bu	%
Clearfield								
5545 CL	9.6	19-Jun	170.5	3.3	**33.0**	8.5	51.5	43.5
15MH6006	**14.3**	12-Jun	**163.0**	2.7	26.7	7.7	51.6	44.3
Liberty Link								
InVigor L140P	**17.3**	19-Jun	170.8	2.3	28.9	6.2	51.4	42.5
InVigor L230	**14.3**	14-Jun	165.3	**1.5**	**33.0**	10.5	51.0	43.7
InVigor L233P	11.6	18-Jun	169.0	**2.1**	**33.4**	8.2	51.9	42.5
InVigor L252	**15.7**	18-Jun	169.0	2.3	30.1	10.1	50.8	44.7
Roundup Ready								
6074 RR	14.0	18-Jun	169.0	2.3	30.6	9.5	50.0	42.9
6080 RR	12.0	15-Jun	166.0	**1.9**	**33.2**	9.9	51.2	42.9
09H7763	13.9	21-Jun	172.0	3.8	**35.5**	8.8	50.6	44.6
11H4009	12.7	15-Jun	166.3	3.2	30.6	8.0	52.3	44.6
11H4030	13.7	13-Jun	**164.0**	2.6	24.9	8.7	50.3	45.9
11H4054	13.4	17-Jun	168.3	3.5	26.8	6.9	50.5	46.8
HyCLASS 930	10.0	15-Jun	166.0	2.9	29.6	9.9	50.3	44.4
HyCLASS 955	9.0	13-Jun	**164.0**	2.2	30.1	11.1	51.4	44.7
HyCLASS 970	12.2	16-Jun	167.8	2.2	30.9	7.1	50.3	48.0
DKL 35-23	14.1	15-Jun	166.0	**1.8**	31.6	10.4	50.4	45.5
DKL 70-10	10.0	16-Jun	167.3	**2.1**	31.7	8.2	51.5	46.1
Sulfonylurea								
C5507	12.2	21-Jun	172.0	3.9	30.4	5.6	49.2	44.9
C5513	13.1	21-Jun	172.0	2.9	31.1	4.8	51.0	43.2
C5522	12.6	18-Jun	169.5	3.3	30.9	7.3	50.0	44.9
Mean	12.8	16-Jun	167.9	2.6	30.6	8.4	50.8	44.5
CV%	16.5	-	0.4	17.5	6.7	23.9	-	-
LSD	3.0	-	1.0	0.7	2.9	NS[4]	-	-
P-Value	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.001	-	-

[1] Frost Damage: 1 = No plants damaged; 5 = All plants damaged

[2] Adjusted to 8% moisture

[3] Only one replicate summarized

[4] LSD considered non-significant when grain yield CV% > 15

Bold indicates top-performing cultivar(s) in a column

Bold indicates cultivar performing statistically equivalent to top-performing cultivar(s)

Seeding Date: 4/20/17

Harvest Date: 7/28/17

SPRING SAFFLOWER VARIETY TRIAL

Simon Fordyce, Sally Dahlhausen, and Patrick Carr (Co-Principal Investigators)

Montana State University, Dep. Research Centers, Central Agricultural Research Center, Moccasin, MT

Summary

Safflower yields statewide have not increased (or decreased) in the past decade, although total production fell for a second year in a row (USDA 2017). Selection of safflower varieties well adapted to the production environment is one way to increase grower profits. We compared 14 safflower varieties at the MSU Central Agricultural Research Center (CARC) for height, yield, test weight, and oil content. Cardinal and Hybrid 446 were the tallest varieties (24.7 in and 23.3 in, respectively), and Baldy was the top performer for test weight (48.4 lb/bu). NutraSaff outperformed all other varieties with regard to oil content (47.3%). Varietal differences in yield were non-significant due to an unfavorably high CV statistic. The trial averaged 19.4 bu/ac overall, up from 18.4 bu/ac in 2016.

Introduction

In 2016, Montana ranked second both in safflower acreage (37,000 ac) and in total production (~760,000 bu), behind California (62,000 ac; 3.6 million bu). However, on a per acre basis, Montana drops to fifth place nationally (21.3 bu/ac; USDA 2017), highlighting a need to identify safflower varieties better suited to Montana growing conditions. In this study we aim to provide growers with reliable information regarding safflower agronomic performance in the region. We summarize agronomic performance data for 14 safflower varieties tested at the Central Ag Research Center.

Methods

Fourteen varieties and experimental lines were compared for height, grain yield, test weight, and oil content. Each variety was planted in four, 4.5 by 15 ft plots in an experimental design to determine varietal differences. The trial was located in a field that was planted to winter wheat in 2016. Safflower was planted on 4 May at a depth of 0.75 inches and at a rate of 18-20 lb PLS/ac using a high-disturbance hoe drill. Soil temperature at time of planting was 50°F. Broadleaf and grass weeds were controlled with a pre-plant burn down of Roundup at 1.25 pt/ac. Plots were hand-weeded multiple times throughout the growing season and harvested on 28 September with a small plot harvester.

Results and Discussion

Varietal differences in yield were non-significant due to an unfavorably high CV statistic. The trial averaged 19.4 bu/ac, up from 18.4 bu/ac in 2016, though yields in 2016 were dampened due to unusually wet conditions and inaccessible fields during the months of September and October. Baldy was the top-performer for test weight in 2016 and 2017, with a two-year average of 46.9 lb/bu. NutraSaff exhibited the highest oil content in 2016 and 2017, with a two-year average of 47.8%. Oil content averaged 36.3% for both the 2016 and 2017 trials.

Literature Cited

USDA (2017a) Crop Production 2016 Summary. National Agricultural Statistics Service. http://usda.mannlib.cornell.edu/usda/current/CropProdSu/CropProdSu-01-12-2017.pdf

Table 19. 2017 Spring safflower variety trial, Moccasin, MT.

Variety	Plant Height in	Grain Yield[1] bu/ac	Test Weight lb/bu	Oil[2] %
10B6015	19.8	11.0	42.1	36.4
Baldy[3]	21.7	16.0	**48.4**	28.3
Cardinal	**24.7**	24.6	44.0	37.0
Finch	21.5	16.9	45.5	37.5
Hybrid 1601	21.0	29.3	42.4	37.2
Hybrid 200	20.6	22.6	44.1	34.1
Hybrid 300	20.1	26.0	45.3	33.4
Hybrid 446	**23.3**	23.3	45.8	32.4
MonDak	21.4	20.0	43.9	35.9
Montola 2003	18.9	16.8	43.3	36.8
Morlin	18.5	19.9	40.8	38.2
NutraSaff	21.0	12.6	38.5	**47.3**
Rubis Red	21.4	19.3	47.4	30.6
STI 1201	19.4	12.9	37.0	43.6
Mean	21.0	19.4	43.5	36.3
CV%	3.8	15.9	0.9	1.0
LSD (0.5)	1.4	NS[4]	0.6	0.6
P-Value	<0.0001	<0.0001	<0.0001	<0.0001

[1] Adjusted to 8% moisture

[2] Instrument calibration issues led to the underestimation of oil content by aproximately 2.5%

[3] Up to 30% yield loss due to grazing by deer and antelope

[4] LSD considered non-signifciant when grain yield CV% > 15

Bold indicates top-performing cultivar(s) in a column

Bold indicates cultivar performing statistically equivalent to top-performing cultivar(s)

Seeding Date: 5/4/2017

Harvest Date: 9/28/2017

FORAGES

WINTER CEREAL FORAGE TRIAL

Patrick Carr[1,2], Simon Fordyce[1,2], Sally Dahlhausen[1,2] (Principal Investigators)

Peggy Lamb[1,3], John Miller[1,4], Zach Miller[1,5], Emily Glunk[6], and Phil Bruckner[7] (Co-Principal Investigators)

Montana State University, Dep. Research Centers[1]; Central Ag Research Center, Moccasin, MT[2]; Northern Ag Research Center, Havre, MT[3]; Western Triangle Ag Research Center, Conrad, MT[4]; Western Ag Research Center, Creston, MT[5]; Montana State University, Dep. Animal & Range Sciences[6]; Montana State University, Dep. Plant Sciences[7]

Summary

Interest in high quality winter cereal forages is increasing among central Montana producers and livestock owners, suggesting a need to identify cereal forage varieties which can thrive in the growing conditions of this region. We assessed agronomic performance of 19 varieties and experimental lines of winter wheat and winter triticale at the MSU Central Agricultural Research Center (CARC) during 2016-17. Trial averages for forage dry matter (DM) yield (7780 lb/ac) and grain yield (1595 lb/ac) were higher than expected, given dry conditions developing in June. These relatively high yields were likely the result, in part, of the study site being under chem-fallow management in 2016. Forage DM yield of triticale entries averaged 8340 lb/acre compared with 6820 lb/ac for winter wheat. Conversely, grain yield averaged 2072 lb/ac for winter wheat entries compared to 1317 lb/ac for triticale entries. There were four experimental winter wheat lines that produced more forage DM than Willow Creek, the long-time standard among winter wheat varieties grown for forage. Trical 102 produced equal or greater amounts of forage DM compared with other triticale entries. Differences in forage protein concentration were not detected among selected triticale and winter wheat entries for which quality data were determined. Results of the 2016-17 winter cereal forage trial at the CARC suggest that there are winter wheat and triticale experimental lines and varieties that compare favorable to Willow Creek winter wheat.

Introduction

There is a niche for annual crops to provide adequate amounts of high-quality forage in late-summer, early- to mid-fall, and early-spring, or during periods of drought, when traditional forage supplies can be limited. Annual cereal forages can provide large amounts of high-quality forage on a per area basis in most years, if managed properly. Fall-seeded cereal forages tend to yield more DM than spring cereals (see Spring Cereal Forage Trial, Pg. 48), and can spread the workload across fall and spring months. Over 40% of Montana farms have both crop and livestock enterprises represented (Chen, 2010), and it is on these farms that fall-seeded cereal forage crops may have the best fit. Nineteen wheat and triticale lines were evaluated for forage and grain production potential at Bozeman, Conrad, Corvallis, Havre, and Moccasin, MT during 2017. Here we summarize results of the trial at the Moccasin (CARC) location. Our goal was to provide local growers with reliable data on the suitability of these entries to the growing conditions of this region.

Methods

Sixteen winter wheat and winter triticale experimental lines along with Trical® Flex 719 and Trical® 102 (two forage winter triticale varieties), and Willow Creek (a forage winter wheat variety) were seeded on 18 October, 2016, in a field that was chem-fallowed in 2016. Each entry was planted in four, 4.5 by 15 ft plots in an experimental design to determine varietal differences. Entries were compared for plant height, days to heading, forage yield, grain yield, and for a subset, forage quality. Forage plots were harvested at medium milk to early soft dough stage. This range of target growth stages allowed for sampling of all entries on two sampling dates (30 June and 5 July). Grain plots were harvested on 26 July at physiological maturity.

Results and Discussion

Forage DM yield for winter triticale and wheat varieties and experimental lines averaged 7780 lb/ac (Table 20), being greater for triticale entries (average DM yield = 8340 lb/ac) than for winter wheat entries (average DM yield = 6820 lb/ac). A similar trend in forage yield when comparing winter triticale and Willow Creek winter wheat has been observed in the past. For example, DM production of the triticale entries ranged from 7580 to 9390 lb/ac during 2016-17, compared with 5525 lb/ac for Willow Creek. Likewise, DM production ranged from 5620 to 6680 lb/ac for triticale entries in 2015-16, compared with 3285 lb/ac for Willow Creek. Worth noting is a change in management plans of the winter cereal forage trial at the CARC, beginning in 2017-18. Recently, the winter cereal forage trial at the CARC has been located on land previously fallowed. In the future, the trial will be located in fields where cover, forage, or grain/seed crops are grown the previous year.

Results of this trial suggest that there are experimental lines of winter wheat that compare favorably when grown for forage. For example, there were four winter wheat experimental lines that produced greater amounts of forage DM than Willow Creek in the 2016-17 trial. Some of these also compared favorably to Willow Creek in terms of quality, albeit only a subsample of the entries included in the trial have forage quality data because of funding limitations. Additionally, there were triticale experimental lines that compared favorably to both Trical® Flex 719 and Trical® 102 by metrics of quality and DM production. More research is needed to obtain forage quality data for all entries, as opposed to a subset. Other promising experimental lines were likely present in the trial, but lack of forage quality data limited our ability to speak conclusively about the performance of these entries.

Literature Cited

Chen, C. 2010. Survey and Economic Analysis of Montana Farms Utilizing Integrated Livestock-Cereal Grain (Ley Farming) Systems/ Western SARE {rpkect SW06-006 Final Report. Available at http://mysare.sare.org/sare_project/sw06-006/?page=final. (accessed 10 February, 2017)

Acknowledgments

We are grateful to the Montana Agricultural Experiment Station for providing funding for this research.

Table 20. 2017 Winter cereal forage trial, Moccasin, MT.

Variety	Heading Date		Plant Height	Forage Yield	Grain Yield[1]	Test Weight	Protein	Acid Detergent Fiber	Neutral Detergent Fiber	Total Digestible Nutrients	Nitrate	Relative Feed Value
	cal	jul	in	- - - - - lb/ac	- - - - -	lb/bu	- - - - - - - - - - - - - - - -	%	- - - - - - - - - - - - - - - -		ppm	-
Flex 719	5-Jun	**156.3**	46.7	**7972**	1644	46.4	9.4	30.2	57.9	68.1	90.0	105.0
MTF1432	16-Jun	167.3	31.0	7104	2022	54.6	-	-	-	-	-	-
MTF1435	13-Jun	164.3	34.0	7004	2009	55.4	9.7	31.7	61.1	66.4	167.0	97.7
MTF1559	18-Jun	169.3	30.3	6989	**2086**	52.9	-	-	-	-	-	-
MTF1631	13-Jun	164.3	31.7	7926	**2120**	56.7	10.6	**27.6**	**54.7**	**71.1**	67.3	**114.7**
MTF1775	13-Jun	164.3	27.3	6773	**2413**	**58.3**	10.9	**26.2**	**52.6**	**72.7**	125.3	**121.3**
MTF1786	15-Jun	166.0	34.0	6420	**2206**	**57.9**	-	-	-	-	-	-
T-1310-230	8-Jun	159.3	**51.0**	7581	1195	48.9	-	-	-	-	-	-
T1310-218	8-Jun	159.0	**52.3**	**8877**	1065	48.3	-	-	-	-	-	-
T1310-219	7-Jun	157.7	46.0	**8440**	1492	50.8	-	-	-	-	-	-
T1310-221	8-Jun	159.3	**52.3**	**8230**	1487	48.9	-	-	-	-	-	-
Trical 102	10-Jun	161.3	48.3	**9391**	1234	44.3	9.3	30.4	58.5	67.9	147.7	103.7
WCF0013	10-Jun	161.0	**51.7**	**8429**	1198	50.7	-	-	-	-	-	-
WCF1020	7-Jun	158.3	50.3	**8351**	1196	49.0	9.5	**27.7**	56.7	**71.0**	167.7	110.3
WCF1060	9-Jun	160.3	**50.7**	**8221**	1411	45.5	10.0	**28.1**	**55.5**	**70.5**	125.3	**112.3**
WCF1078	7-Jun	158.0	**53.0**	**8369**	1143	48.5	-	-	-	-	-	-
WCF1216	9-Jun	160.3	**52.7**	**8268**	1569	48.7	-	-	-	-	-	-
WCF1440	8-Jun	158.7	**54.0**	**7954**	1170	48.7	-	-	-	-	-	-
Willow Creek	22-Jun	173.0	34.3	5525	1651	53.8	11.9	29.7	58.4	68.7	110.7	105.0
Mean	11-Jun	162.0	43.8	7780	1595	51.0	10.2	29.0	56.9	69.5	125.1	108.8
CV%	-	0.5	4.9	10.0	14.4	1.3	11.4	4.8	3.2	2.3	60.9	5.0
LSD (0.05)	-	1.3	3.6	1450.8	381.4	1.1	NS	2.4	3.2	2.8	NS	9.6
P-Value	-	<0.0001	<0.0001	<0.0001	<.00001	<0.0001	0.171	0.004	0.002	0.004	0.707	0.003

[1] Adjusted to 8% moisture

Bold indicates top-performing cultivar(s) in a column

Bold indicates cultivar performing statistically equivalent to top-performing cultivar(s)

Seeding Date: 10/18/2016

Forage Harvest Dates: 6/30/2017 and 7/5/2017

Grain Harvest Date: 7/26/2017

Note: Entries beginning with MTF (and Willow Creek) are forage winter wheats; all others are forage winter triticales

SPRING CEREAL FORAGE TRIAL

Patrick Carr[1,2], Simon Fordyce[1,2], Sally Dahlhausen[1,2], Sherry Bishop[1,2] (Principal Investigators)

Peggy Lamb[1,3], Emily Glunk[4], and Jamie Sherman[5] (Co-Principal Investigators)

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Summary

Spring-seeded cereals can be grown for high-quality forage as a supplement to, or a replacement of, alfalfa and other perennial forage species that are widely grown in Montana. We evaluated performance of 11 barley entries (eight varieties and three experimental lines), three spring triticale entries, and two oat entries, along with one spring rye, one emmer, and one spring wheat entry in a small-plot trial at the MSU Central Agricultural Research Center (CARC). Yields this year were poor due to late planting coupled with persistent drought in late June and July. The trial averaged 1366 and 686 lb/ac of forage dry matter (DM) and grain, respectively. Compare this to 2595 and 853 lb/ac of forage DM and grain in 2016. Lavina barley was one of five top-yielding barley entries for forage DM, four of which were named varieties and one of which was an experimental line. Lucille emmer and Otana oat were also among the top-yielding entries for forage DM. Gazelle spring rye was both the tallest (35.1 in) and the earliest-heading entry (3 July). Differences in grain yield were not detected among entries ($P > 0.05$). Future work should compare entries for forage yield together with forage quality, including nitrate accumulation, to allow for a comprehensive assessment of performance.

Introduction

Spring-seeded cereals are an alternative source of forage for Montana farmers and ranchers when traditional forage sources are in short supply. Lavina is one of several barley varieties that were developed and released for forage production. Small-grain crop breeders at Montana State University (MSU) continue to develop and provide germplasm for screening as potential new spring-seeded cereal forage varieties. Here, we summarize agronomic performance data for 19 spring cereal forages, including three experimental lines of forage barley provided by Jamie Sherman, the barley breeder at MSU.

Methods

Plots were seeded 16 May, 2017, following a burndown of glyphosate and 2,4-D in a field that was planted to safflower in 2016. This late seeding date was a function of several factors but was beyond the window for optimum production of high-quality forage. Entries were compared for heading date, plant height, forage yield, grain yield, and test weight. Forage harvest targeted medium milk to very early soft dough stages of kernel development. Plots were harvested for forage on 13 July, and for grain on 15 and 22 August, depending on the growth stage and the crop species/variety.

Results and Discussion

Last year, there was a wide range in forage yield among the spring cereal crops and varieties included in the trial (1480 to 3310 lb/ac), but there were factors that confounded statistical analyses and prevented us from saying with much confidence that this range reflected consistent differences in forage DM yield among the crops and varieties that were compared. In 2017, we were more confident statistically that treatment differences in forage yield existed, but forage DM production was low and compressed, making it difficult to tease out differences among many of the entries that were included. For example, there were six other entries that produced comparable amounts of forage DM statistically to that produced by Lavina barley, the top-yielding entry in terms of forage production (1830 lb DM/ac). This highlights the importance of planting cereal varieties early when grown for forage, as should be done when grown for grain, so that yield compression is less likely and making it easier to differentiate high- vs. low-yielding entries. These results also indicate a need to supplement yield data with forage quality analyses so that 'top performing' entries can be identified in environments where a ranking based on DM production is difficult. Neglecting forage quality data, namely forage nitrate analysis, is especially dangerous in the case of oats, as there is a greater chance of high nitrate concentrations in oat forage than in that of other small-grain species.

Acknowledgments

We are grateful to the Montana Agricultural Experiment Station for providing funding for this research study.

Table 21. 2017 Spring cereal forage variety trial, Moccasin, MT.

Variety	Crop	Heading Date		Plant Height	Forage Yield	Grain Yield[1]	Test Weight
		cal	jul	in	------ lb/ac -------		lb/bu
Haxby	Barley	13-Jul	194.3	18.2	**1464.5**	1202.6	51.0
Haybet	Barley	10-Jul	191.8	20.0	1387.6	593.0	42.5
Haymaker	Barley	10-Jul	191.8	20.4	**1447.2**	848.8	45.7
Hays	Barley	12-Jul	193.8	17.4	1218.3	842.1	43.9
Horsford	Barley	10-Jul	191.3	20.5	1310.8	650.1	42.1
Lavina	Barley	10-Jul	191.0	21.3	**1830.5**	574.4	42.2
MT103038-4	Barley	11-Jul	192.0	17.5	1296.7	553.3	44.5
MT103089-3	Barley	12-Jul	193.5	21.1	1393.3	775.9	41.3
MT103099-3	Barley	13-Jul	194.0	21.3	**1691.9**	440.0	41.3
Stepford	Barley	9-Jul	190.0	17.8	1253.8	463.7	41.0
Stockford	Barley	12-Jul	193.0	19.4	**1587.4**	436.5	42.9
Lucille[2]	Emmer	12-Jul	193.3	21.9	**1629.9**	853.3	37.0
Vida[2]	HRSW	10-Jul	191.0	19.6	906.2	1112.2	**58.9**
Otana	Oat	11-Jul	192.0	24.4	**1552.5**	971.1	33.7
Stampede	Oat	16-Jul	197.0	15.6	1007.2	148.2	29.8
Gazelle	Spring rye	3-Jul	**184.0**	**35.1**	1411.0	976.4	**56.3**
Pronghorn	Spring triticale	6-Jul	187.0	25.2	1116.8	585.6	53.2
T202567	Spring triticale	12-Jul	193.0	24.0	1122.8	243.3	50.9
Tritical 141	Spring triticale	12-Jul	193.0	28.5	1333.5	760.7	52.2
Mean		10-Jul	191.9	21.5	1366.4	685.8	44.7
CV%		-	0.3	9.6	20.7	54.6	4.5
LSD		-	0.9	2.9	401.1	NS[3]	2.9
P-Value		-	<0.0001	<0.0001	0.002	0.012	<0.0001

[1] Adjusted to 8% moisture

[2] Up to 10% harvest loss

[3] LSD considered non-significant when grain yield CV% > 15

Bold indicates top-performing cultivar(s) in a column

Bold indicates cultivar performing statistically equivalent to top-performing cultivar(s)

Seeding Date: 5/16/17

Forage Harvest Date: 7/13/17

Grain Harvest Dates: 8/15/17 and 8/22/17

PRODUCTION

FERTILIZER MANAGEMENT AND MALT QUALITY IN LOW PROTEIN BARLEY

Jamie Sherman[1] (Principle Investigator)

Patrick Carr[2,3], Kent McVay[2,4], Simon Fordyce[2,3], and Sally Dahlhausen[2,3] (Co-Principal Investigators)

Montana State University, Dep. Plant Sciences and Pathology[1], Dep. Research Centers[2] Central Agricultural Research Center, Moccasin, MT[3], Southern Agricultural Research Center, Huntley, MT[4]

Summary

Montana's growing craft brewing industry has heightened demand for low-protein malt barley varieties. Previous research has shown that appropriate rates of nitrogen (N) and sulfur (S) fertilizers can improve malt quality. We tested the effects of N rate and S rate on grain yield, percentage of plump kernels, and grain protein of three experimental lines and the variety Hockett in a small plot trial at the MSU Central Agricultural Research Center (CARC). Drought conditions resulted in extremely low and compressed grain yields with a trial mean of 11.8 bu/ac. Low grain protein concentrations (≤11.6%) were observed in the experimental lines which received 0 and 13 lb N/ac rates. The percentage of plump kernels was unaffected by applications of N ($P = 0.89$) and S ($P = 0.63$), but was impacted by variety/cultivar selection. However, there was considerable variation in plump kernel percentage between some plots receiving the same fertilizer treatment where the same barley entry had been planted. Additional research is needed in environments more favorable for barley production to verify these preliminary results.

Introduction

Montana leads the country in malt barley production. Growth in the craft brewing industry is increasing demand for malt barley, but dryland production can be difficult because of uncertainties regarding growing season precipitation and other environmental factors. For example, adequate N is needed for optimum grain yield, but too much can lead to high-protein grain that fails to meet malt-quality standards. Evidence exists that S applications may also be necessary in central Montana soils for optimum malt barley production. The development of promising new barley lines justifies a reexamination of fertilizer recommendations when growing barley for malt in central Montana.

Methods

Nitrogen as urea at 0, 0.5, 1.0, and 1.5 times the recommended rate of 1.2 lb N/bu, and S as gypsum at 0 and 20 lb/ac, were applied to three experimental barley lines along with the variety Hockett in all possible combinations just prior to seeding. Entries were seeded at a depth of 0.75 inches in a no-till seedbed on 10 May. Soil temperature at seeding was 54°F. Bronate and Curtail M were applied for broadleaf weed control. Plots were harvested on 8 August with a small plot harvester.

Results and Discussion

The study was located in a field with < 25 lb N/acre in the top two feet, so it was not surprising that grain protein concentration increased with N rate for virtually all sulfur and variety combinations. Amounts of S contained in the field were comparable to those for N, and though a soil S test is not a good indicator of a crop response, we correctly anticipated a response based on preliminary data collected in 2016. Entries with 20 lb S/ac applied exhibited on average 0.5% less protein than entries with 0 lb S/ac applied.

Drought conditions developed and persisted in July, resulted in low and compressed grain yields across the barley entries and fertilizer rates. Grain yield averaged less than 12 bu/ac across the trial with considerable variability across some plots receiving the same fertilizer treatment and where the same barley entry had been planted. There was similar variation from plot-to-plot receiving the same fertilizer treatment with the same barley entry for plump kernel percentage, in some instances. Overall, average plump kernel percentage was less than 70% across fertilizer treatments and barley entries. All three experimental lines outperformed Hockett in terms of grain protein concentration. Average grain protein across all fertilizer combinations applied to Hockett was 14.1%, compared with 11.8% for the three experimental lines. Among the lowest protein values in the trial were those observed when experimental lines were fertilized with 13 lb N/ac along with 20 lb S/ac. More research is needed to verify these preliminary results, particularly in environments more conducive to dryland malt-barley production.

Acknowledgments

We are grateful to the Montana Fertilizer Tax Fund as well as the Montana Agricultural Experiment Station for providing funding for this research.

Table 22. 2017 Spring barely fertilizer study, Moccasin, MT.

N Rate	S Rate	Plumps	Thins	Protein	Grain Yield[1]
- - - - - - - - lb/ac - - - - - - - -		- - - - - - - - - - - - - % - - - - - - - - - - - - -			bu/ac
Hockett					
0	0	59.6	13.1	13.0	3.7
13	0	72.0	14.1	12.9	9.4
25	0	70.0	13.8	16.0	8.0
38	0	66.9	11.5	15.7	10.7
0	20	65.2	13.6	12.5	6.1
13	20	57.8	15.9	12.8	9.4
25	20	66.3	14.9	13.9	10.4
38	20	59.2	18.3	16.0	11.6
MT090190					
0	0	76.7	11.1	**10.7**	7.4
13	0	74.7	9.3	11.6	8.6
25	0	76.0	12.8	12.7	11.8
38	0	73.8	11.7	13.4	12.6
0	20	79.0	13.4	11.0	6.0
13	20	72.6	12.7	**10.7**	12.4
25	20	78.4	13.0	12.2	15.8
38	20	80.1	18.4	13.4	17.5
MT124112					
0	0	51.6	8.6	**10.6**	6.1
13	0	49.5	10.6	**10.8**	12.1
25	0	42.7	11.3	12.6	13.3
38	0	38.1	14.3	13.7	16.4
0	20	50.1	7.6	**9.8**	8.9
13	20	63.2	12.0	**10.3**	14.4
25	20	55.8	14.3	11.9	17.6
38	20	52.9	21.6	13.1	16.9
MT124128					
0	0	72.0	5.7	10.9	6.4
13	0	76.1	5.0	11.2	15.4
25	0	69.9	5.6	13.0	13.5
38	0	68.2	5.0	13.4	16.2
0	20	68.9	7.3	11.4	4.5
13	20	71.9	6.6	**10.7**	13.6
25	20	72.3	7.8	11.9	17.9
38	20	70.4	7.7	12.6	22.8
Mean		65.7	11.5	12.4	11.8
CV%		29.2	43.5	6.4	29.1
LSD		26.9	7.0	1.1	NS
P-Value (Variety)		<0.0001	<0.0001	<0.0001	<0.0001
P-Value (N)		0.89329	0.03675	<0.0001	<0.0001
P-Value (S)		0.627	0.004	<0.001	<0.001
P-Value (Variety:N)		0.995	0.305	0.285	0.126
P-Value (Variety:S)		0.459	0.978	0.825	0.849
P-Value (N:S)		0.930	0.195	0.058	0.157
P-Value (Variety:N:S)		0.990	0.991	0.308	0.329

[1] Adjusted to 8% Moisture

Seeding Date: 5/11/2017

Harvest Date: 8/28/2017

WARM SEASON CROP SEQUENCE STUDY

Patrick Carr (Principle Investigator)

Simon Fordyce and Sally Dahlhausen (Co-Principle Investigators)

Montana State University, Dep. Research Centers; Central Ag Research Center, Moccasin, MT

Summary

Diversification strategies are needed so that wheat-based cropping systems are economically and environmentally sustainable. Almost 20 different warm-season crop species were screened for their adaptation as cover, forage, and grain/seed crops in one field during 2016 and two fields during 2017 under dryland management at the MSU Central Agricultural Research Center (CARC). Wheat was grown during 2017 in the field where warm-season species were grown the previous year. Sunflower produced equal or greater amounts of above-ground dry matter (DM) compared with other warm-season species when grown as cover crops in each of the three fields, while corn and a corn + pinto bean mixture were among the top performers when warm-season species were grown for forage. Drought and other factors limited grain/seed production by warm-season crops. Wheat grain yield was similar following most warm-season species grown as cover, forage, or grain/seed crops compared with fallow. These results suggest that several warm-season species have potential as cover and forage crops in central Montana, though additional work is needed so that these preliminary observations can be confirmed.

Introduction

There is a need to diversify wheat-based cropping systems in Montana to achieve economic and environment benefits. Research has demonstrated the benefits that cool-season broadleaf crops, particularly pulses, offer in sequence or rotation with wheat compared with wheat-fallow or recrop wheat systems (Miller and Holmes, 2005). There are weed and other pest management benefits that can result when warm-season crops are incorporated into wheat-based cropping systems that cannot be duplicated when limiting diversification to cool-season species (Anderson, 2008). Only limited research on rotating warm-season crops with wheat has been conducted in Montana, particularly in dryland regions (Miller and Holmes, 2005). The purpose of this research project is to identify warm-season species that are adapted as cover, forage, and grain/seed crops in central Montana, and to determine how yield of a subsequent wheat crop is affected.

Study Description

Eighteen warm-season crops were grown along with two-crop combinations of corn + pinto beans and proso millet + pinto beans, as well as a four-crop combination (corn + sorghum x sudangrass + pinto bean + cowpea) in one field during 2016 and two different fields during 2017 at CARC. Multiple phenotypes of some crops species (e.g., bush-type and vining cowpea) were included. The warm-season crop treatments were compared with two cool-season crops (spring wheat and field pea) as well as a four-crop combination (barley + wheat + pea + lentil) when grown as cover, forage, and grain/seed crops. A fallow check treatment also was included. The crop treatments were arranged in an experimental design (i.e., randomized complete block in a split-plot pattern) so that data could be analyzed statistically. Above-ground plant dry matter and grain/seed yield of warm- and cool-season crop treatments were determined. Wheat was planted during 2017 across plots established in 2016, and wheat grain yield determined.

Results and Discussion

Warm-Season Crops – Year 1

Sunflower produced equal or greater amounts of DM compared to other warm- as well as cool-season crop treatments when managed as cover crops in each of the three fields (Table 23). Over 3000 lb DM/ac were produced by the oilseed crop during 2016, and in one of two fields during 2017 (NT1), even though antelope and deer grazing along with persistent drought occurred during the latter year. Sunflower produced over 2600 lb DM/ac in the other field during 2017 (SW10) when grown as a cover crop. Additional warm-season cover crop treatments producing over 2000 lb DM/ac in at least one field included buckwheat, proso millet, and a corn + pinto bean mixture. By comparison, spring wheat produced less than 1500 lb DM/ac when grown as a cover crop in all three fields.

Corn grown alone or in combination with pinto bean produced equal or greater amounts of DM compared to other warm- as well as cool-season crop treatments when grown for forage (Table 23). Corn forage yield averaged almost 3000 lb DM/ac in 2016 and over 4000 lb DM/ac under drought conditions in both fields during 2017. The corn + pinto bean mixture averaged over 3600 lb DM/ac in each of the three fields. Other warm-season crop treatments producing over 3000 lb DM/ac included proso millet and the four species mixture during 2016, and sunflower during 2017. By comparison, spring wheat produced from 1476 to 1800 lb DM/ac and spring pea from 1570 to 2367 lb DM/ac when grown for forage, depending on the field.

Drought and other factors resulted in low grain/seed yields for all crop treatments in each of the three fields (Table 23). Relative to spring wheat, warm-season crop treatments produced less grain/seed during 2016. During 2017, grain yield was comparable between sunflower and spring wheat in one field (SW10) and greater for both corn and the corn + pinto bean treatments in the other field (NT1). It is worth noting that plots of virtually all warm-season crop treatments were grazed during 2017, reducing and, in some cases (e.g., buckwheat), eliminating harvestable grain/seed. Spring pea and wheat plots matured earlier than warm-season crops and were not grazed.

Wheat Grain Yield – Year 2

Yield differences were not detected during 2017 when wheat followed fallow compared with warm-season cover crop treatments grown in 2016 (Table 23). Wheat grain yield was depressed following only three crops treatments when warm-season crops were grown for forage, and following only four treatments when warm-season crops were grown for grain/seed. Additional research is needed to verify these preliminary results, particularly during years when wheat follows warm-season crops that produce greater amounts of DM or grain/seed than that harvested during 2016 and 2017. Still, these preliminary results suggest that there are warm-season species which may be suited as cover, forage, and perhaps grain/seed crops in rotation with wheat in central Montana.

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Acknowledgments

We are grateful to the Montana Wheat and Barley Committee along with the Montana Agricultural Experiment Station for providing funding for this research.

Table 23. 2016-2017 Warm season crop sequence study, Moccasin, MT.

Treatment	Cover crop (CC)			Forage (FOR)			Grain (GR)			Wheat yield		
	SW1	SW10	NT1	SW1	SW10	NT1	SW1	SW10	NT1	CC	FOR	GR
	lb/ac									bu/ac		
Fallow	-	-	-	-	-	-	-	-	-	42.9	**43.0**	**44.3**
Browntop millet	95	426	485	537	990	750	-	-	-	-	-	-
Buckwheat	2328	1180	636	2368	885	-	119	-	-	41.5	**42.1**	**41.3**
Bush cowpea	467	783	397	1167	918	833	-	-	-	43.1	**40.9**	**42.3**
Corn	1661	1822	1592	**2981**	**4490**	**4787**	567	-	**992**	41.9	**38.5**	**42.3**
Corn + pinto	1773	**2567**	1008	**3797**	**3978**	3650	621	-	**1061**	39.7	**39.0**	**39.7**
CS cocktail	1818	2061	1291	2112	2204	1877	**1322**	219	29	39.3	**43.6**	**47.1**
Forage sorghum	1699	1261	703	2713	1631	1328	-	-	-	33.2	**42.5**	**36.8**
German millet	1193	1412	1119	2315	1658	2234	-	10	2	39.4	**38.6**	**45.3**
Grain sorghum	1762	1578	1421	1992	3022	2232	170	35	53	33.6	31.1	**36.0**
Hungarian millet	1980	1358	1427	2520	2008	2290	576	104	14	37.9	33.3	35.0
Mung bean	759	728	467	1606	1106	1041	13	-	-	42.8	**43.1**	**41.6**
Navy bean	1218	921	550	1290	1498	792	96	37	-	47.2	**46.5**	**48.7**
Pearl millet	869	948	616	1733	1690	1871	-	-	-	-	-	-
Pinto bean	1296	1007	457	1736	1396	869	154	79	93	44.1	**44.6**	**42.9**
Proso + pinto	1324	1250	982	1978	814	1321	99	-	45	41.9	**40.5**	**41.3**
Proso millet	2488	1192	1363	**3090**	1889	2366	73	193	-	34.5	28.3	30.4
Sorghum x sudan	1684	1153	777	2450	1855	1296	-	-	-	31.4	**34.8**	32.1
Soybean	1419	717	340	2182	1119	-	168	46	-	42.2	**43.9**	**44.7**
Spring pea	1316	2027	1723	1570	2367	1904	1008	306	124	49.6	**52.2**	**46.3**
Spring wheat	1463	1381	1156	1567	1800	1476	**1492**	**580**	313	40.8	**34.8**	**41.8**
Sudangrass	1728	1451	1125	2840	1714	1382	-	25	2	36.5	**35.5**	**36.1**
Sunflower	**3114**	**2655**	**3068**	2904	**4135**	3279	755	**757**	265	42.3	**41.5**	**40.6**
Teff	-	474	194	-	1651	280	-	-	-	-	-	-
Viney cowpea	705	644	406	1237	1301	863	-	-	-	43.8	**46.3**	**40.8**
WS cocktail	1925	1270	1284	**3124**	2034	1746	-	-	-	38.1	**37.8**	34.3
Mean	1503	1291	983	2159	1926	1759	482	199	249	40.3	40.1	40.5
CV%	29.2	27.0	31.0	27.2	39.0	24.0	40.2	91.7	56.8	19.8	16.3	15.0
LSD (0.05)	620	497	424	830	1056	607	310	263	204	NS	9.3	8.7
P-Value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.113	0.001	0.001

ROTATION AND TILLAGE SYSTEM TRIAL

Patrick Carr (Principal Investigator)

Simon Fordyce, Sally Dahlhausen, and Darryl Grove (Co-Principal Investigators)

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Summary

Diverse crop rotations are needed to maintain the economic and environmental viability of dryland small-grain crop production in Montana. Three- and four-year rotations are being established at the MSU Central Agricultural Research Center (CARC) in conventional-till and no-till environments to determine if agronomic and economic benefits result compared with wheat-fallow and continuous wheat systems. Drought and other factors depressed barley and wheat performance in 2017 but yield trends still were detected. Spring wheat yield averaged 25 bu/ac following millet and was greater than following winter wheat (9 bu/ac) in a conventional-till environment. Similar differences in spring wheat yield following millet and winter wheat occurred in a no-till environment. Barley yield tended to be greater following spring pea than winter wheat in both conventional-till ($P = 0.09$) and no-till ($P = 0.06$) environments. Conversely, differences in winter wheat yield were not detected following fallow, spring wheat, winter lentil, and winter pea in both continuous-till (average yield = 26 bu/ac; $P = 0.13$) and no-till (average yield = 20 bu/ac; $P = 0.28$) environments. These results indicate that previous crop can affect subsequent small-grain crop yield in some instances, but not others, in years when grain yields are depressed because of drought and other factors.

Introduction

Wheat (*Triticum* spp.) dominates dryland grain farming in central Montana (Sommer, 2016). However, profit margins when growing wheat have shrunk or disappeared (Swenson and Haugen, 2017), supporting diversification strategies for wheat-based cropping systems so that economic and environmental sustainability can be achieved. Rotating wheat with pulse and other crops in two-year rotations has been considered in Montana (Chen et al., 2012; Miller and Holmes, 2005). Three- and four-year rotations are being compared for impact on wheat performance in central Montana.

Study Description

Five cropping systems are being established in replicated and randomized plots in two separate environments (conventional-till and no-till) at the CARC, with winter crops (e.g., winter wheat [WW]) planted in 2017 and spring crops (e.g., spring wheat) planted for the first time in 2018. These systems include: (1) WW-fallow; (2) WW-lentil-barley; (3) WW-pea-barley (4) WW-spring pea-safflower-proso millet; and (5) WW-spring wheat. The fallow phase of the WW-fallow system is split into ‘green’ and ‘brown’ subplots, with a multi-species cover crop grown in the green subplot while nothing is planted in the brown subplot (i.e., chem-fallow). Similarly, the lentil phase in the WW-lentil-barley system (2) and the pea phase in the WW-pea-barley system are split into fall and spring types. These cropping systems replace short-lived rotations where wheat and barley were grown following different small-grain and pulse crops. Barley and wheat grain yield were determined and analyzed statistically following those crops in 2017.

Results and Discussion

Grain yield of barley and wheat were low in 2017, primarily because of the drought conditions that developed and persisted at CARC and across much of the state that year. Poor weed control and problems with crop stand establishment also contributed to the yield depression that occurred, particularly in no-till plots. These three factors (i.e., drought, weed control and crop stand issues) all contributed to variability in grain yield from plot to plot, sometimes making it difficult to detect yield differences based on the previous crop. Still, some trends were observed and statistical differences could be detected. For example, there was a non-significant trend for barley grain yield to be greater following spring pea (28 bu/ac) than WW (19 bu/ac) in conventional-till plots ($P = 0.09$). Similarly, grain yield tended to be greater when barley followed spring pea (14 bu/ac) than WW (7 bu/ac) in no-till plots ($P = 0.06$). Spring wheat yields were greater following millet under conventional-till (25 bu/ac) and no-till (24 bu/ac) management than following WW under conventional-till (9 bu/ac) and no-till (7 bu/ac) management, respectively ($P < 0.05$). Conversely, grain yield did not differ for WW grown following fallow, spring wheat, winter lentil or winter pea, whether grown under conventional-tillage (average yield = 26 bu/ac; $P = 0.13$) or no-till (average yield = 20 bu/ac; $P = 0.28$). These results indicate that previous crop impacted grain yield of a subsequent crop in some, but not all, instances under the drought conditions encountered during 2017.

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OUTREACH

COMMUNICATING THROUGH SOCIAL MEDIA

Heather Fryer

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Summary

The Central Agricultural Research Center (CARC) is one of seven remote research centers in the Department of Research Centers in Montana State University's College of Agriculture and the Montana Agricultural Experiment Station (MAES). The CARC addresses production challenges, supports research and outreach programs, explores grain varieties and alternative crops and conducts soil microbiology research. All of the research centers have individual website pages housed at agresearch.montana.edu. Since 2016, the CARC has been striving to enhance outreach through social media by creating Facebook and Twitter accounts. The goal is to educate the public about our research, and social media provides opportunities to share our work with an audience in ways that were not available prior to 2006. Online communication allows users to participate, offer feedback, and receive information and share ideas at no charge to either users or the research center.

Introduction

Faculty and staff at MSU agricultural research centers, including CARC, serve farmers and ranchers in the local area as well as the broader needs of Montana agriculture through research and outreach programs. Social media tools can be used effectively to disseminate knowledge to agriculturalists and others interested in farming and ranching. The CARC is located on the plains of central Montana and is fairly remote. Therefore, we need use outreach tools effectively to provide timely messages, disseminate important research results and stay in touch with Montanans and the agriculture community.

Methods

Our methods of communication include a website page, Facebook and Twitter account. We feel these tools are used by a growing number of scientists, farmers, and local community members. The CARC website was revamped by organizing and updating all of its pages in 2016. The CARC created a Facebook and Twitter account under the same user name during that same year: Central Ag Research @CentralAgCenter. Facebook is the most popular social networking site in the United States (Caverly 2009), including U.S. farmers (Wilson 2016). Facebook also is the most prevalent social media tool in higher education. Besides the current U.S. president, Twitter is also widely used by faculty members and others at Montana State University, national agriculture organizations, large agri-businesses, news sources, federal agencies, professional societies, etc. Facebook and Twitter are both used for communicating local, national and international announcements, as well as updating users about conferences and exciting agricultural news. Social media can be accessed from an individual's internet enabled phone, not only a computer, making it very easy to check frequently and receive information.

Results and Discussion

To date, our Facebook page has 232 followers and our Twitter account has 201 followers. We are hopeful that these numbers will continue to grow and, to that end, are dedicated to improving content with timely and up-to-date information for followers.

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