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Colorado State University

Agricultural Experiment Station

College of Agricultural Sciences
Department of Soil and Crop Sciences
Plainsman Research Center
Extension

Plainsman Research Center 2013 Research Reports

For a full list of authors for this research report refer to the personnel with projects page

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This Plainsman Research Center report is dedicated to:

Bill Wright

On the 40th Anniversary of the Plainsman Agri-Search Foundation

Bill is one of the founding fathers of the Plainsman Agri-Search Foundation and its first president. Without Bill and the other founding fathers, there would be no Plainsman, no premiere research and grower association model.

We are forever grateful to Bill's foresight and dedication.

Plainsman Research Center, 2013 Research Reports

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2013 Climatological Summary
Plainsman Research Center, Walsh, Colorado

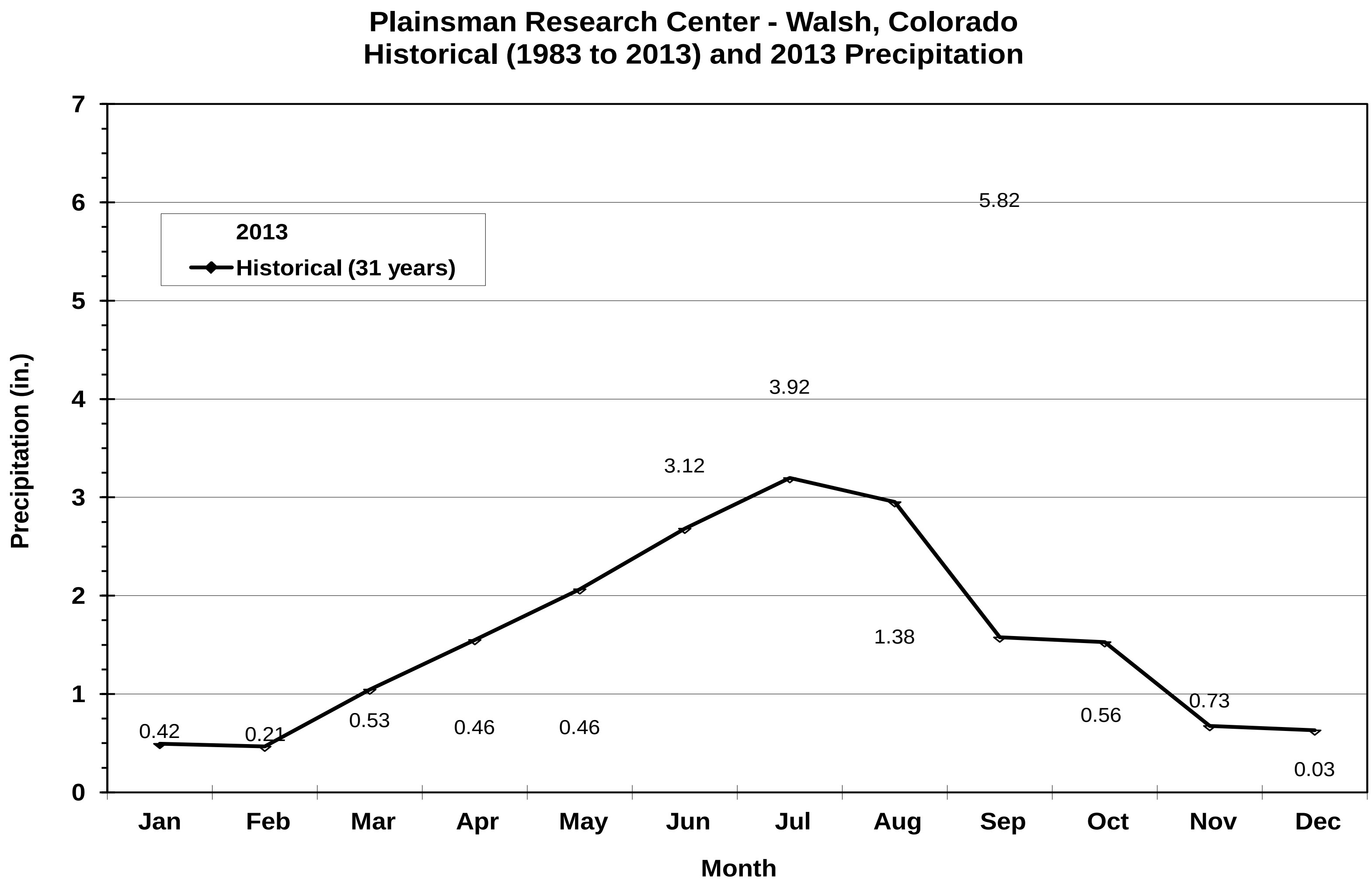
Month	Temperature Max. F	Min. F	Max. Mean F	Min. Mean F	Precip. In.	Greatest Day of Precip-atation	Snow-Fall In.	Greatest Snow Depth In.	Average Soil Temp F	Evapor-ation In.
Jan.	73	2	44.7	18.0	0.42	0.37	3.25	2.50	30.16	
Feb.	69	11	48.7	20.9	0.21	0.17	0.70	0.70	33.96	
Mar.	82	9	58.3	27.0	0.53	0.18	3.60	1.80	39.87	
Apr.	87	12	61.8	30.6	0.46	0.15	1.50	1.50	47.20	3.91
May	98	27	79.9	45.9	0.46	0.25	0.70	0.70	59.19	12.16
Jun.	107	43	92.9	60.0	3.12	0.79	0.00	0.00	71.77	14.29
Jul.	103	52	90.8	62.3	3.92	1.24	0.00	0.00	71.29	10.75
Aug.	102	53	90.9	62.2	1.38	0.95	0.00	0.00	72.71	11.25
Sep.	104	38	84.4	57.1	5.82	3.36	0.00	0.00	69.90	9.77
Oct.	86	27	68.7	37.2	0.56	0.27	0.00	0.00	51.35	4.84
Nov.	76	14	54.5	25.7	0.73	0.43	6.00	4.00	41.50	
Dec.	70	0	44.7	17.6	0.03	0.02	0.90	0.40	31.16	
Total Annual			**68.4**	**38.7**	**17.64**		**16.65**			**66.97**

*** NOTE: Evaporation read April 15th through October 15th.
Wind velocity is recorded at two feet above ground level.
Total evaporation from a four foot diameter pan for the period indicated.

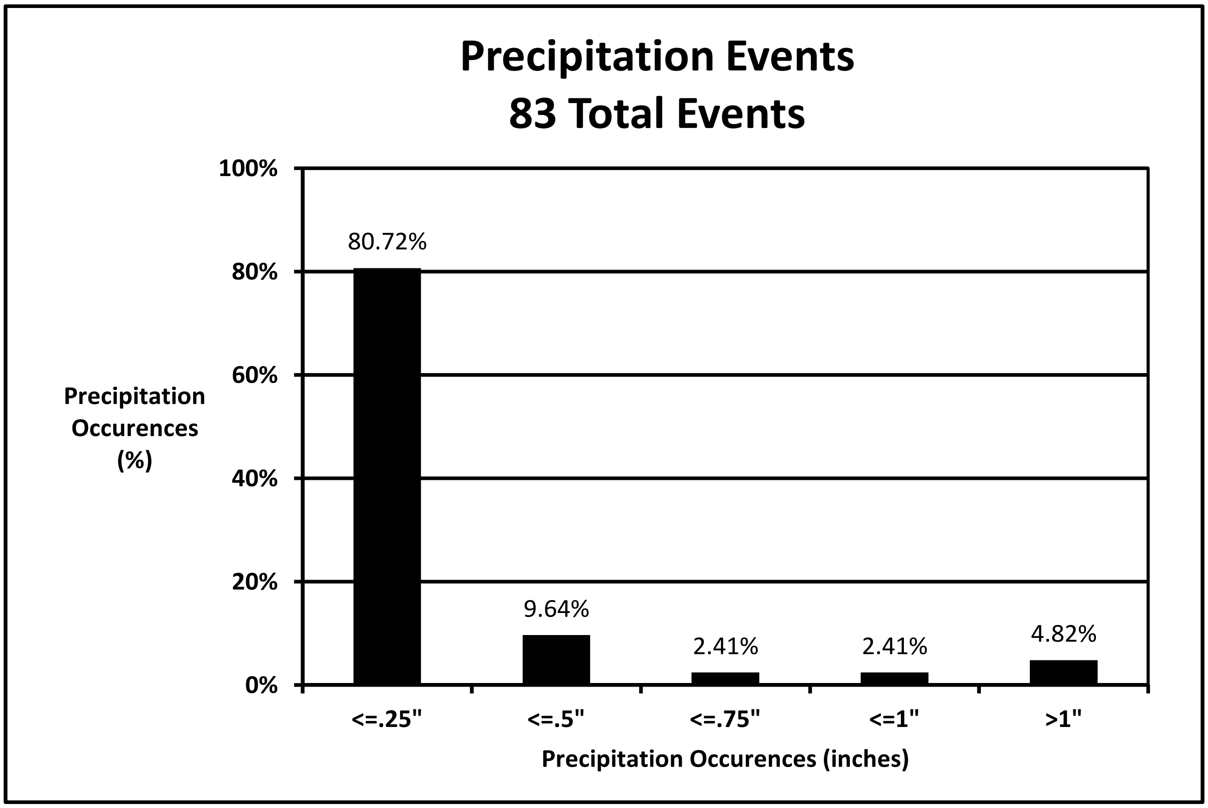
	2013	2012
Highest Temperature:	107 F on June 11 & 12	106 F on June 28
Lowest Temperature:	0 F on Dec 9	-2 F on Dec 26
Last freeze in spring:	30 F on May 6	31 F on April 16
First freeze in fall:	32 F on Oct 5	31 F on Oct 8
Frost free season:	152 frost free days	175 frost free days
Avg. Prec. for 31 years	18.86 inches	

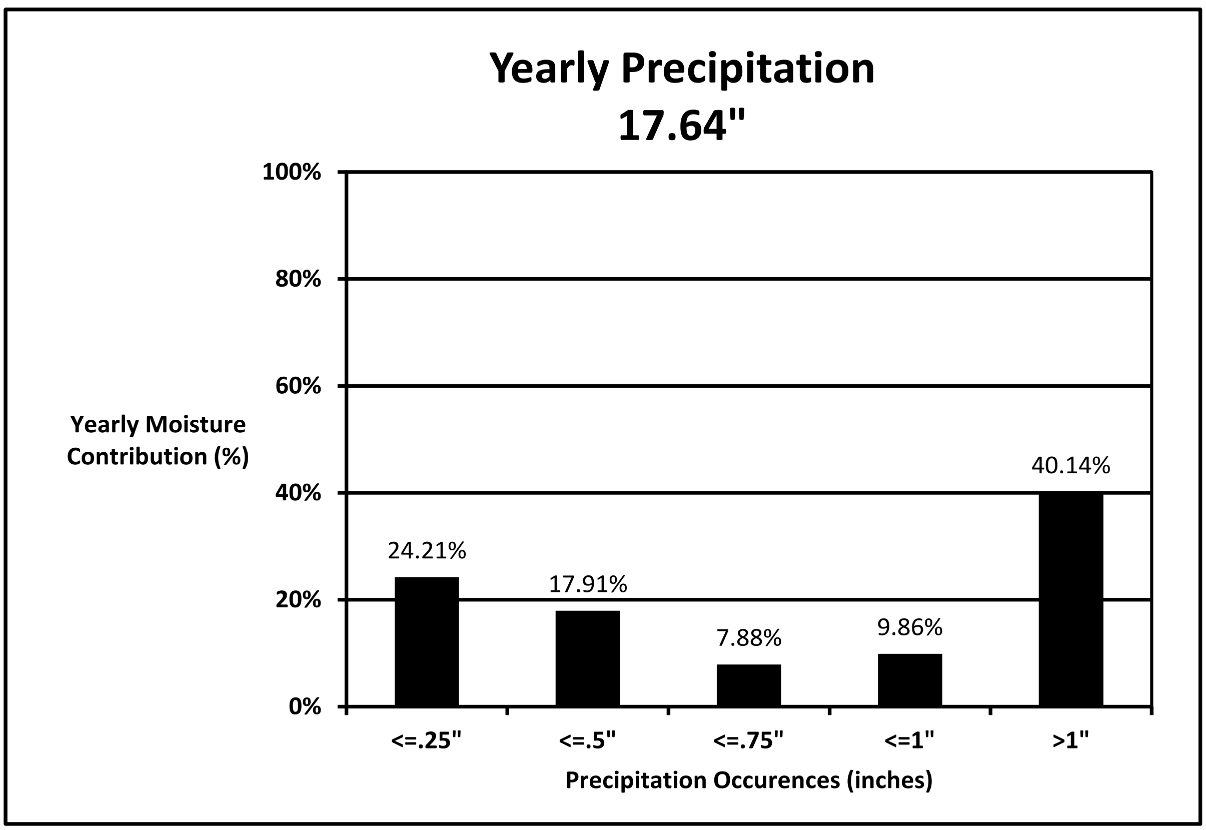
Maximum Wind:

Jan.	47 mph on 12th	July.	36 mph on 10th
Feb.	40 mph on 9th & 10th	Aug.	31 mph on 2nd & 25th
Mar.	45 mph on 10th	Sept.	34 mph on 27th & 28th
Apr.	48 mph on 9th	Oct.	46 mph on 11th
May	44 mph on 25th	Nov.	40 mph on 25th
Jun.	46 mph on 18th	Dec.	38 mph on 8th



Plainsman Research Center - Walsh, Colorado
Historical (1983 to 2013) and 2013 Precipitation
2013
Historical (31 years)
Precipitation (in.)
0
1
2
3
4
5
6
7
0.42
0.21
0.53
0.46
0.46
3.12
3.92
1.38
5.82
0.56
0.73
0.03
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


Precipitation Events
83 Total Events
Precipitation Occurences (%)
100%
80%
60%
40%
20%
0%
80.72%
9.64%
2.41%
2.41%
4.82%
<=.25"
<=.5"
<=.75"
<=1"
>1"
Precipitation Occurences (inches)


Yearly Precipitation
17.64"
Yearly Moisture Contribution (%)
100%
80%
60%
40%
20%
0%
24.21%
17.91%
7.88%
9.86%
40.14%
<=.25"
<=.5"
<=.75"
<=1"
>1"
Precipitation Occurences (inches)

2013 Eastern Colorado Winter Wheat Variety Performance Trials

Jerry Johnson and Scott Haley

The Colorado State University Crops Testing and Wheat Breeding and Genetics programs provide current, reliable, and unbiased wheat variety information as quickly as possible to Colorado producers for making better variety decisions. CSU has an excellent research faculty and staff, a focused breeding program, graduate and undergraduate students, and dedicated agricultural extension specialists. Wheat improvement in Colorado would not be possible without the support and cooperation of the entire Colorado wheat industry. On-going and strong producer support for our programs is critical for sustained public variety development and testing.

Our wheat variety performance trials and Collaborative On-Farm Test (COFT) represent the final stages of a wheat breeding program where promising and newly released experimental lines are tested under an increasingly broad range of environmental conditions. As a consequence of large environmental variation, Colorado State University annually conducts a large number of performance trials and on-farm tests. These trials serve to guide producer variety decisions and to assist our breeding program to more reliably select and advance the most promising lines toward release as new varieties.

There were 40 entries in the dryland performance trials (UVPT) and 28 entries in the irrigated performance trials (IVPT). All trials included a combination of public and private varieties and experimental lines from Colorado, Texas, Kansas, Oklahoma, Nebraska, and Montana. All dryland and irrigated trials were planted in a randomized complete block design with three replicates. Plot sizes were approximately 175 ft2 (except the Fort Collins IVPT, which was 60 ft2) and all varieties were planted at 700,000 viable seeds per acre for dryland trials and 1.2 million viable seeds per acre for irrigated trials. Yields were corrected to 12% moisture. Test weight information was obtained from an air blower-cleaned sample of the first replication or from a combine equipped with a Harvest Master measuring system.

2013 Dryland Variety Performance Trials

Without a doubt, 2013 will go down in the books as one of the toughest in history for winter wheat in eastern Colorado. As a result of an extremely dry spring and summer 2012, very dry planting conditions were experienced at most trial locations at planting time in fall 2012. In spite of extremely dry conditions, decent plant stands were achieved at several sites, in some cases due to timely rains that came after the trials had been “dusted in”. One trial location, Roggen, crusted in the fall due to rain after being “dusted in” and a new field location was replanted in early October. Unfortunately, incomplete or extremely variable plant stands at the Lamar, Arapahoe, and Genoa dryland trial locations led to abandonment of these trials.

Drought conditions persisted throughout the winter, most critically in southeast Colorado. In many areas of southeast Colorado, lack of precipitation coupled with very short subsoil moisture, led to complete stand loss as the crop came out of the winter. The dryland trial location at Sheridan Lake (Brandon) had decent stands in the fall (after being “dusted in”) but was abandoned in early spring due to complete death of the plants from extreme drought.

By early spring, dryland trials and the crop in many areas of northeast Colorado looked extremely good with high yield potentials. Subsoil moisture was not plentiful, yet expectations for above-average wheat yields were high. Unfortunately, the crop in many areas, including the trials at five of the seven remaining dryland locations in northeast Colorado (Akron, Julesburg, Orchard, Roggen, and Yuma), received inadequate precipitation to meet these expectations. While each of these five trial locations were successfully harvested, average trial yields were at least 50% less than visual estimates made during site visits in late April and early May. The remaining two dryland trials, Walsh and Burlington, also suffered from continued drought throughout the spring and although they were successfully harvested, the trial yields were extremely low. Very little or no hail affected the trials, with the exception of a light hail at Akron (estimated 10% damage) a week prior to harvest.

While 2012 and 2013 will both be remembered as “drought years”, the patterns of the stresses and the temperature regimes experienced were markedly different. First, the 2012 crop emerged extremely well with good fall moisture conditions whereas the 2013 crop had a tough time moisture-wise from the start, hindering good fall root development. Second, warm temperatures in spring 2012 resulted in accelerated plant development and a crop that was 2-3 weeks early whereas in 2013 cool temperatures in early spring resulted in much delayed plant development and jointing that was roughly 2-3 weeks later than “average” (and thus three to four weeks later than in 2012). Interestingly, the wheat showed a remarkable ability to “catch up” (responding to the high temperatures in mid- and late-May), as heading dates recorded at the Fort Collins and Akron trial locations were right on the long-term average for these locations. Finally, several severe spring freezes occurred from March through May that damaged the 2013 crop. Although plant development was behind normal, it was far enough along in southeast Colorado to cause severe damage to the growing points of the plants, especially for wheat under irrigation. From east-central to northeast Colorado, due to delayed plant development, the growing point was still at or below ground when the freezes occurred and thus damage was restricted to burning off of the above-ground foliage, which undoubtedly reduced yields.

In 2013, there was a general lack of foliar disease pressure due to the drought conditions. Isolated leaf and stripe rust was observed only at the irrigated trial location at Fort Collins. With the prolonged drought, root rot symptoms were observed at several trial locations, though perhaps not as severe as in 2012. As has become common in eastern Colorado, dry conditions in early spring favored severe brown wheat mite infestations as the wheat came out of the winter. Russian wheat aphid and Bird cherry-oat aphids were observed at several locations and isolated wheat streak mosaic virus and barley yellow dwarf observations were recorded.

2013 Dryland Winter Wheat Variety Performance Trial at Walsh

Variety	Yield
	bu/ac
LCS Mint	23.2
Settler CL	20.4
Clara CL	20.4
CO08W218	20.4
KS09H19-2-3	19.6
Antero	19.4
Byrd	19.2
WB-Grainfield	18.3
CO05W111	17.4
Iba	17.4
Robidoux	17.3
Above	17.2
TAM 112	16.8
CO07W722-F5	16.7
Brawl CL Plus	16.7
Winterhawk	16.4
Bill Brown	16.3
Ripper	16.1
CO08346	16.0
SY Wolf	16.0
LCH08-80	15.8
T154	15.6
NE05496	15.6
1863	15.5
NI08708	15.3
T158	15.2
TAM 113	15.2
Freeman	14.9
Gallagher	14.9
Denali	14.5
CO08263	14.4
McGill	14.3
TAM 111	13.3
T153	13.2
Bearpaw	12.4
T163	12.3
Bond CL	11.8
Hatcher	11.1
Snowmass	10.3
Protection	4.7
Average	**15.8**

[a]LSD (P<0.30) 2.9 [a]If the difference between two variety yields equals or exceeds the LSD value, there is a 70% chance the difference is statistically significant.

†Test weights could not be measured in a large number of plots due to insufficient grain.

Summary of 2-Year (2012-2013) Southeast Colorado Dryland Variety Performance Results

Brand/Source	Variety[a]	Market Class[b]	2-Year Average[c] Yield bu/ac	Yield % trial average	Test Weight lb/bu	Plant Height in
PlainsGold	Byrd	HRW	39.0	125%	61.5	26
CO State Univ. exp.	CO08263	HRW	34.2	110%	62.1	23
PlainsGold	Ripper	HRW	34.1	109%	60.7	25
CO State Univ. exp.	CO07W722-F5	**HWW**	33.8	108%	61.5	22
PlainsGold	Antero	**HWW**	33.4	107%	63.0	25
Watley Seed	TAM 112	HRW	33.0	106%	62.6	25
CO State Univ. exp.	CO08W218	**HWW**	32.7	105%	62.4	22
AGSECO	TAM 113	HRW	32.0	103%	62.8	26
Husker Genetics	Robidoux	HRW	31.9	102%	61.9	26
PlainsGold	Brawl CL Plus	HRW	31.6	101%	62.8	24
CO State Univ. exp.	CO08346	HRW	31.3	100%	62.8	24
Limagrain	T163	HRW	31.3	100%	62.5	28
Husker Genetics	Settler CL	HRW	31.3	100%	62.3	24
PlainsGold	Hatcher	HRW	31.3	100%	61.7	22
PlainsGold	Bill Brown	HRW	31.0	100%	63.0	21
WestBred Monsanto	Winterhawk	HRW	31.0	100%	62.4	28
CO State Univ. exp.	CO05W111	**HWW**	30.9	99%	61.2	23
PlainsGold	Above	HRW	30.8	99%	61.8	25
KS Wheat Alliance	Clara CL	**HWW**	30.7	99%	63.2	24
Limagrain	T158	HRW	30.4	98%	61.8	30
AgriPro Syngenta	TAM 111	HRW	30.1	97%	62.1	29
PlainsGold	Snowmass	**HWW**	29.7	95%	61.5	27
PlainsGold	Denali	HRW	29.7	95%	62.4	24
AgriPro Syngenta	SY Wolf	HRW	29.4	94%	61.3	27
Nebraska exp.	NE05496	HRW	28.8	92%	60.9	21
PlainsGold	Bond CL	HRW	28.7	92%	59.5	24
KS Wheat Alliance	1863	HRW	28.2	90%	59.3	29
Husker Genetics	McGill	HRW	27.0	87%	60.8	29
AGSECO	Protection	HRW	26.7	86%	59.5	26
Average			**31.2**		**61.8**	**25**

[a] Varieties ranked according to average 2-year yield.

[b] Market class: HRW=hard red winter wheat; **HWW**=hard white winter wheat.

[c] The 2-year average yield, test weight, and plant height are based on three 2012 trials and one 2013 trial.

Summary of 3-Year (2011-2013) Southeast Colorado

Dryland Variety Performance Results

Brand/Source	Variety[a]	Market Class[b]	3-Year Average[c] Yield	Yield	Test Weight	Plant Height
			bu/ac	% trial average	lb/bu	in
PlainsGold	Byrd	HRW	42.9	117%	60.8	26
PlainsGold	Antero	**HWW**	40.2	110%	61.8	25
PlainsGold	Ripper	HRW	38.6	106%	60.0	24
PlainsGold	Hatcher	HRW	37.9	104%	61.0	22
Watley Seed	TAM 112	HRW	37.8	104%	61.4	25
PlainsGold	Bill Brown	HRW	37.2	102%	61.6	21
Husker Genetics	Settler CL	HRW	36.8	101%	60.8	23
PlainsGold	Above	HRW	36.4	100%	60.6	24
PlainsGold	Denali	HRW	36.3	100%	61.6	24
CO State Univ. exp.	CO05W111	**HWW**	36.2	99%	60.6	23
PlainsGold	Snowmass	**HWW**	35.9	98%	60.5	26
Husker Genetics	Robidoux	HRW	35.6	97%	61.0	25
WestBred Monsanto	Winterhawk	HRW	35.3	97%	61.4	27
Limagrain	T163	HRW	35.3	97%	61.2	26
PlainsGold	Brawl CL Plus	HRW	35.0	96%	61.8	24
PlainsGold	Bond CL	HRW	33.8	93%	59.0	24
AgriPro Syngenta	SY Wolf	HRW	33.2	91%	60.2	25
Husker Genetics	McGill	HRW	32.5	89%	59.6	28
Average			**36.5**		**60.8**	**24**

[a] Varieties ranked according to average 3-year yield.

[b] Market class: HRW=hard red winter wheat; **HWW**=hard white winter wheat.

[c] The 3-year average yield, test weight, and plant height are based on two 2011 trials, three 2012 trials, and one 2013 trial.

Dryland Wheat Strips for Forage and Grain Yield at Walsh, 2013

Kevin Larson, Brett Pettinger, and Deborah Harn

Purpose: To determine which wheat varieties are best suited for dual-purpose forage and grain production in Southeastern Colorado.

Materials and Methods

Fourteen wheat varieties were planted on October 2, 2012 at 50 lb seed/a in 20 ft. by 800 ft. strips with two replications. We stream applied 50 lb N/a and seedrow applied 5 gal/a of 10-34-0 (20 lb P_2O_5, 6 lb N/a). Ally Extra 0.3 oz/a and 2,4-D 0.38 lb/a was sprayed for weed control. Two 2 ft. by 2.5 ft. forage samples were taken at jointing (April 8) and at boot (May 16). We measure the forage for fresh weight, oven-dried the samples, and recorded dry weight at 15% moisture content. Russian Wheat Aphid did not reach the critical threshold and the field was not sprayed. We harvested the plots on July 24 and 25 with a self-propelled combine and weighed them in a digital weigh cart. Grain yields were adjusted to 12% seed moisture content.

Results

Grain yields were poor due to dry conditions and multiple late freezes, which damaged tillers. The trial averaged 12 bu/a. About 6 bu/a separated the highest yielding variety, Antero, from the lowest yielding variety, Bond CL. Antero had the highest grain yield, 14.6 bu/a, but it was not significantly higher than Denali, Brawl CL+ and Byrd. Hatcher had the highest forage yield at jointing, and Brawl CL+ had the highest forage yield at boot. Four varieties had higher three-year grain yield averages than the trial averages. The variety that produced the highest three-year average yield was Ripper.

Discussion

My choice for the best overall dual-purpose wheat variety is Antero. Antero produced the highest grain yield, the fourth highest forage yield at jointing, and the third highest forage yield at boot. The high forage yield of Hatcher at jointing indicated that it was on track for the best overall dual-purpose wheat this year. However, the response of Hatcher to drought and late, tiller-damaging freezes resulted in below average grain yield.

Grain yield averages for this trial during the last three harvest years have been near the long-term Baca County average for 2011, higher than the Baca County average for 2010, and below the Baca County average for 2013. Only Winterhawk had at least average grain yields each of the last three seasons. Producing average yields in response our wide-ranging seasonal conditions shows that Winterhawk is well adapted for our environment. Winterhawk would be a good standard choice for our variable year-to-year precipitation fluctuations.

Table .Dryland Wheat Strips, Forage and Grain Yield at Walsh, 2013.

Variety	Jointing		Boot		Plant	Test	Grain	Grain
	Fresh Wt.	Dry Wt.	Fresh Wt.	Dry Wt.	Height	Weight	Protein	Yield
	-----------------------lb/a			-----------------------lb/a-----------------------	in	lb/bu	%	bu/a
Antero	2804	910	5738	2259	15	56	14.8	14.6
Denali	3131	808	4157	1545	16	56	15.6	13.8
Brawl CL+	2876	802	7188	2962	17	57	15.4	13.7
Byrd	3298	1045	5052	2142	15	56	15.0	13.2
Jagalene	1613	684	6098	2210	16	56	15.8	12.5
TAM 111	2382	761	4785	2143	17	56	15.1	12.5
Winterhawk	2737	842	4293	1810	17	58	15.5	11.9
TAM 113	2862	881	4974	2083	14	58	15.8	11.2
Snowmass	4264	829	3645	1500	16	56	14.7	11.0
Ripper	2612	961	2825	1206	17	55	15.9	10.8
Hatcher	3443	1220	5745	2478	13	56	15.4	10.7
Above	2694	786	3778	1559	15	57	14.8	10.6
Bill Brown	2142	791	4359	1868	16	58	15.7	10.0
Bond CL	2488	752	3431	1431	15	55	15.1	8.9
Average	2810	862	4719	1943	16	56	15.3	11.8
LSD 0.05	1752.6	425.7	1975.7	837.0				1.79

Planted: October 2, 2012; 50 lb seed/a; 5 gal/a 10-34-0.
Grain Harvested: July 24 and 25, 2013.
Grain Yield and Grain Protein are adjusted to 12% moisture content.
Jointing sample taken April 8, 2013.
Boot sample taken May 16, 2013.
Wet Weight is reported at field moisture.
Dry Weight is adjusted to 15% moisture content.

Table .--Summary: Dryland Wheat Strips Variety Performance Tests at Walsh, 2010-2013.

		Grain Yield					Yield as % of Trial Average				
Firm	Variety	2010	2011	2013	2-Year Avg	3-Year Avg	2010	2011	2013	2-Year Avg	3-Year Avg
AgriPro	TAM 111	45	21	13	17	26	102	88	108	94	98
AgriPro	Jagalene	43	25	13	19	27	98	104	108	106	100
Colorado State	Hatcher	45	26	11	19	27	102	108	92	103	101
Colorado State	Bond CL	42	20	9	15	24	95	83	75	81	88
Colorado State	Ripper	45	28	11	20	28	102	117	92	108	104
Colorado State	Bill Brown	46	26	10	18	27	105	108	83	100	101
Colorado State	Snowmass	44	26	11	19	27	100	108	92	103	100
Colorado State	Above	--	26	11	19	--	--	108	92	103	--
Westbred	Winterhawk	46	24	12	18	27	105	100	100	100	101
Average		44	24	12	18	27					

Grain Yields were adjusted to 12.0 % seed moisture content.

No wheat yields recorded for 2012 due to hail.

N Timing on Dryland Wheat for Protein and Yield at Walsh, 2013

Kevin Larson, Brett Pettinger, Deborah Harn, and Wilma Trujillo

The impetus for this study comes from the Con Agra program that pays protein premiums for two white wheat varieties, Snowmass and Thunder CL. Southeast Colorado tends to raise winter wheat with lower than the standard 12% protein level during years of good production. Con Agra's protein premium scale starts at 12.2% protein and ends at 15% protein (Johnson, et al., 2013). For each 0.2% protein increase, they pay a premium of $0.03 per bushel. At 12.6%, 13.0%, and 13.4% protein, an additional $0.05 per bushel is added to the premium. The maximum protein premium is $0.60 per bushel at 15% protein. In this study, we tested N application timing for potential increase of protein and yield.

Materials and Methods

Nitrogen was applied at 40 lb N/a as 28-0-0 or 32-0-0 streamed in 18 in. spacing at five application dates: September 24 (pre-plant), February 1 (pre-jointing), April 12 (jointing), May 18 (boot), and May 29 (flowering). We also included a check with no N applied. The flowering treatment was applied to one half of each N timing treatment plot. Snowmass was planted on October 2, 2012 at 50 lb seeds/a. The plot size was 10 ft. by 160 ft. (subplots were 10ft. by 80ft.) with two replications. The plot design was split plot with N timing as the main plots and N at flowering as subplots. For weed control, a tank mix of Ally Extra 0.3 oz/a and 2,4-D 0.38 lb/a was applied. The study was harvested on July 18 with a self-propelled combine equipped with a digital scale. Grain yields were adjusted to 12% seed moisture content.

Results

Grain yields were very low, and subsequently, grain protein levels were very high. The yield average for this study was only 5.9 bu/a, and the average protein level was 14.7%. Lack of winter and late-spring precipitation, combined with late freezes greatly reduced yields. There was only 2.08 in. of precipitation from January through May. Moreover, multiple late freezes throughout April (21F, April 4; 12F, April 10; 20F, April 18; 17F, April 24) damaged tillers and lowered yields. The soil test analysis revealed that no N was needed for our 35 bu/a yield goal (nitrate N: 21ppm for 0-8 in. soil depth and 16ppm for 8-24 in. soil depth). There were no yield increases with N timing applications. The N timing yield range was 4.1 bu/a to 8.1 bu/a. The highest yield for N timing occurred with the 0 N check. The N timing yield response of Snowmass was relatively flat for the 0 N check, pre-jointing and jointing stages, but dropped by 1.4 bu/a at boot compared to the 0 N check.

The 0 N check had the highest protein level, 15.3%. Less than 1% protein separated the highest and lowest N timing protein levels.

Overall, the addition of 40 lb N/a at flowering to the N timing and 0 N check treatments lowered both yield and protein. The protein levels did not increase with 40 lb N/a applied at flowering (with the marginal exception of N at boot where the addition of 40 lb N/a applied at flowering increased the protein level by 0.1%). By applying 40 lb N/a at flowering to all of the N timing applications and to the 0 N check, we expected increased protein levels and no yield response for all N timing stages and the 0 N check. Instead, applying 40 lb N/a at flowering had little, or often negative, effects on yields or protein levels compared to the N timing applications without the addition of N at flowering.

Discussion

Dry winter and late-spring conditions, plus multiple freezes throughout April, caused a very low yielding, but very high protein winter wheat environment. Applications of nitrogen at various developmental stages did not increase yields or protein levels to this drought-stressed, freeze-damaged wheat. Since our N timing applications and N at flowering treatments did not increase yields or protein, the cost of these N applications treatments were not recouped and produced negative incomes. The overall average net income loss for the N timing applications and N at flowering treatments was -$53.64/a.

This study demonstrated (albeit unplanned) that stress, in this case drought and freeze damage, produced very low grain yields with very high protein levels.

Literature Cited

Johnson, J.J., et al. 2013. Making Better Decision, 2012 Colorado Winter Wheat Variety Performance Trials. Technical Report 2013 Field Days Edition. CSU, Crop Testing Program, AES, Extension, Dept. of Soil and Crop Sciences, Colorado State University, Fort Collins.

Table .--Dryland Wheat, N Timing for Protein and Yield, Walsh, 2013.

N Timing	N Applied	N at Flowering	Protein	Grain Yield	Test Weight	Protein & Grain Income	Applied N Net Income	Applied N Loss
	lb N/a	lb N/a	%	bu/a	lb/bu	$/a	$/a	$/a
Check	0	0	15.3	8.1	52.5	64.31	64.31	0.00
Preplant	40	0	15.0	5.4	51.0	42.34	12.84	-51.47
Pre-jointing	40	0	14.4	4.1	53.5	32.02	2.52	-61.79
Jointing	40	0	14.7	7.0	52.5	54.80	25.30	-39.01
Boot	40	0	14.6	5.0	52.5	38.89	9.39	-54.92
Average (without N at flowering)			**14.8**	**5.9**	**52.4**	**46.47**	**22.87**	**-41.44**
Check	0	40	14.6	6.3	52.0	49.39	49.39	-14.92
Preplant	40	40	15.0	7.1	52.0	55.85	-3.15	-67.46
Pre-jointing	40	40	14.2	4.7	55.0	36.49	-22.51	-86.82
Jointing	40	40	14.4	6.2	53.0	48.19	-10.81	-75.12
Boot	40	40	14.7	4.9	51.0	38.42	-20.58	-84.89
Average (with N at flowering)			**14.6**	**5.8**	**52.6**	**45.67**	**-1.53**	**-65.84**
Test Average			**14.7**	**5.9**	**52.5**	**46.07**	**10.67**	**-53.64**

Income grain yield x $7.30/bu for Snowmass ($7.00/bu plus $0.30/bu premium).
Protein Premium: $0.03 per 0.2 % greater than 12% protein to 15% protein maximum with additional $0.05 added at 12.6%, 13.0%, and 13.4% protein levels.
Applied N cost $0.60/lb of N as 28-0-0 or 32-0-0; application cost $5.50/a.
Applied N Net Income is applied N income of protein premium and grain income minus N and application costs.

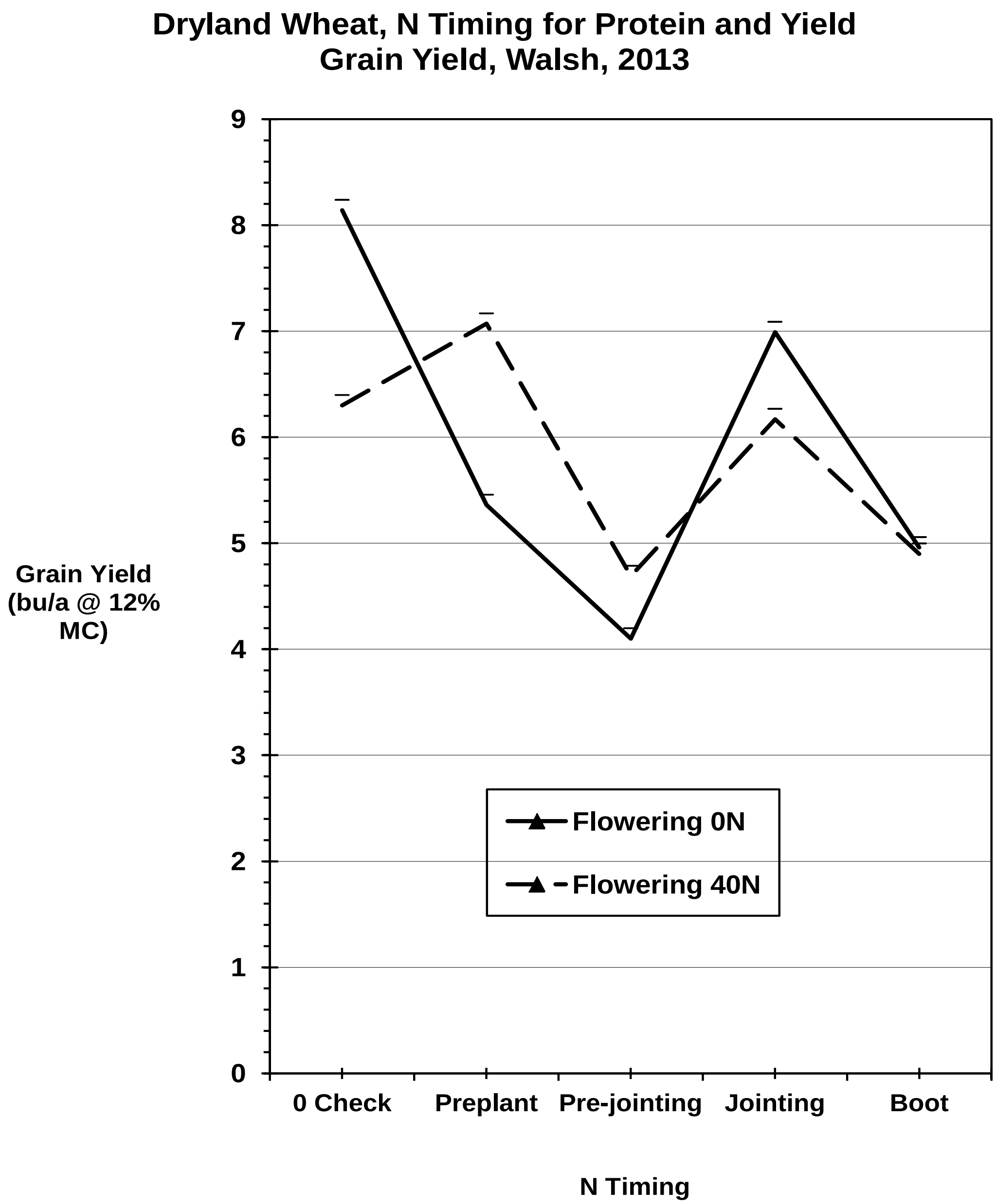


Fig. .Dryland Wheat, N Timing Yield at Walsh, 2013. N Timing: Check, 0 lb/a; Preplant, 40 lb/a; Pre-jointing, 40 lb/a; Jointing, 40 lb/a; Boot, 40 lb/a; and Flowering, 40 lb/a. All N Timing treatments were streamed 28-0-0 or 32-0-0. The Flowering treatment was applied to one side of all treatment plots. Planted: October 2, 2012 at 50 lb seed/a. Harvested: July 18, 2013.

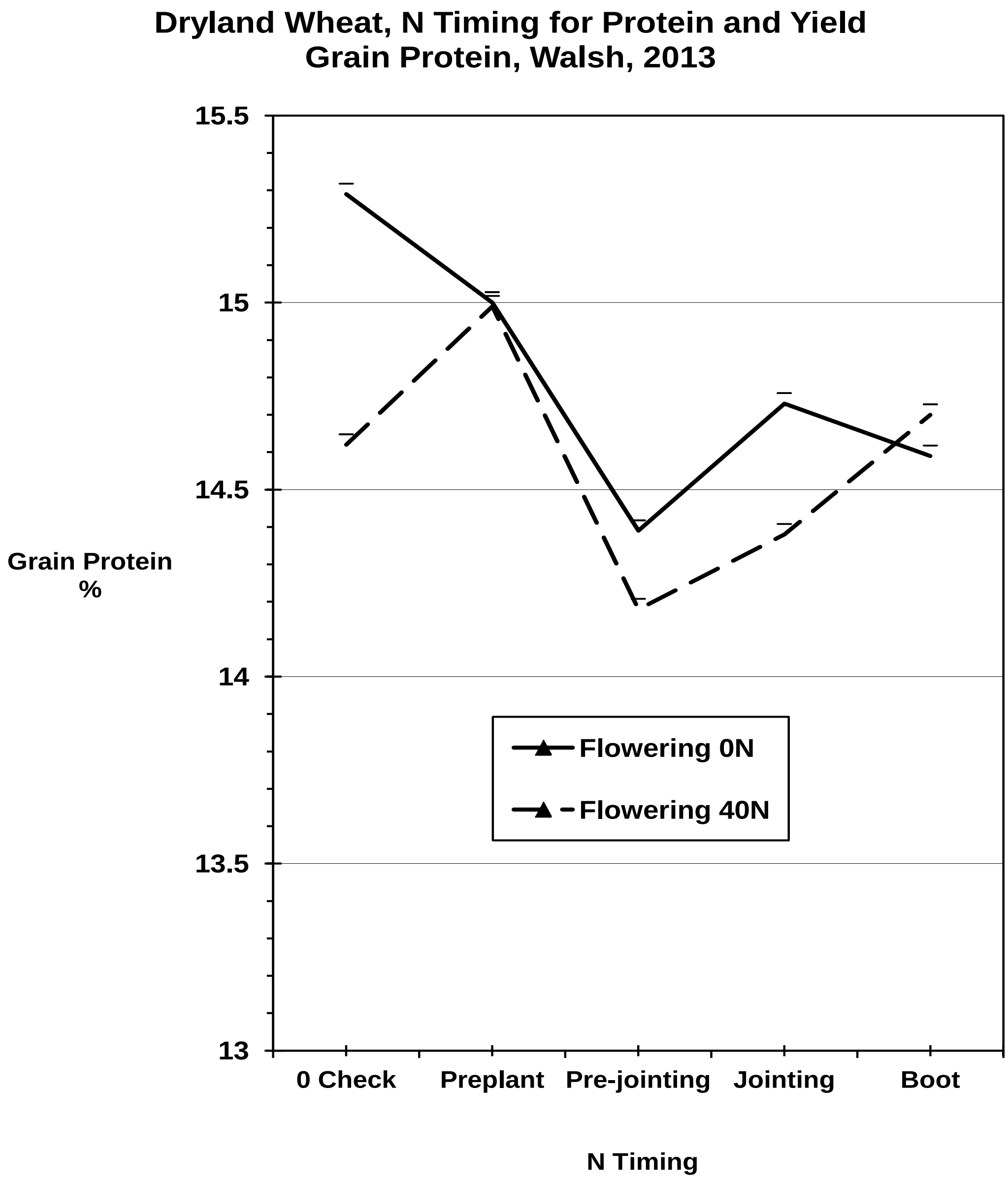


Fig. .Dryland Wheat, N Timing Protein at Walsh, 2013. N Timing: Check, 0 lb/a; Preplant, 40 lb/a; Pre-jointing, 40 lb/a; Jointing, 40 lb/a; Boot, 40 lb/a; and Flowering, 40 lb/a. All N Timing treatments were streamed 28-0-0 or 32-0-0. The Flowering treatment was applied to one side of all treatment plots. Planted: October 2, 2012 at 50 lb seed/a. Harvested: July 18, 2013.

Dryland Grain Sorghum Seeding Rate and Seed Maturation, Brandon, 2013

Kevin Larson and Brett Pettinger

In Eastern Colorado, dryland seeding rates vary greatly from 20,000 to 60,000 seeds/a. Lower seeding rates are typically used in the extreme southeastern part of the state where the growing season is longer, and higher seeding rates are used northward where the growing season is shorter. With lower seeding rates, abundant tillering is expected, whereas with higher seeding rates single headed plants are desired. We have observed that the main head on a sorghum plant matures earlier and more uniformly than its tillers. To determine if there are yield and maturation benefits from increased seeding rates at a short season site, we tested a wide range of seeding rates using an early maturing and a medium early maturing grain sorghum hybrid.

Materials and Methods

The six seeding rates we tested were 20, 30, 40, 50, 60, and 70 seeds/a X 1000. We planted on June 10 with a four-row cone planter on 30 in. row spacing. The early maturing grain sorghum hybrid was Triumph TR424 and the medium early grain sorghum hybrid was Sorghum Partners K35Y5. The site was fertilized with 60 lb N/a and 5 gal/a 10-24-0, 6 S, 0.1 Zn. Weed control was achieved with pre and post emergence herbicides (pre, glyphosate 32 oz/a, Metal 1.5 pts/a, atrazine 0.9 lb/a; post, 2,4-D amine 0.5 lb/a applied with drops). Puncture vine and glyphosate- resistant kochia were not adequately controlled and impacted yields. We harvested the study on October 28 with a self-propelled combine equipped with a digital scale. Grain yields were adjusted to 14% moisture content.

Results and Discussion

The early maturing hybrid had its optimum yield around 60,000 seeds/a (around 35.5 plants/a) and the medium early maturing hybrid had its optimum yield around 50,000 seeds/a (around 30,000 plants/a). The high seeding rate optimum is partly attributable to earlier and more uniform seed maturation from increased numbers of single headed plants. Time to maturation was shortened with increased seeding rates for both the early hybrid and the medium early hybrid. For each 10,000 seeds/a increment, between 20,000 and 70,000 seeds/a, maturation time was shortened by an average of three-quarters of a day (time to maturation was 0.66 days earlier for the early maturing hybrid and 0.83 days earlier for the medium early hybrid). The reason this occurred was because of reduced tillering. High seeding densities produce more single headed plants than lower seeding densities, and single headed plants mature earlier and more uniformly than plants with multiple tillers.

Again this year, we selected a medium early hybrid on the early side of its class and it matured before the first freeze. Not only did this medium early hybrid mature before the first freeze, it exhibited the shortened time to maturation response to increasing seeding rate like the early maturing hybrid. From past studies, we have reported that time to maturation was reduced by approximately one day with increasing seeding rate. This year, instead of the whole day reduction in time to maturation, we reported as little as two-thirds of a day reduction in time to maturation. The reason the early and medium early hybrids took longer to mature may be due to drought and weed pressure stresses. These stresses resulted in a lack of available water during flowering and grain fill, which delay maturation time and reduced yields. Even under stressful, lower yielding conditions increased seeding rates shortened the maturation time, although not to the same degree as when grown under more favorable conditions. Shortening maturation time by increasing seeding rates is a tool sorghum growers can utilize when planting late, or when planting in short season conditions.

Table .-Dryland Grain Sorghum Seeding Rate Study at Brandon, 2013.

Seeding Rate	Plant Density	Flowering Date	Maturation Date	Plant Height	Plant Lodging	Test Weight	Grain Yield
seeds/a (X1000)	plants/a (X1000)	DAP	DAP	In	%	lb/bu	bu/a
Early Maturing Hybrid							
20	14.5	70	106	34	2	58	12.7
30	18.5	68	104	35	2	59	13.4
40	23.1	68	104	35	4	58	13.5
50	28.9	68	104	36	4	59	24.3
60	35.5	67	103	37	3	60	22.5
70	37.5	67	102	37	1	59	18.2
Early Average	26.3	68.0	103.8	36	2.7	59	17.4
Medium Early Maturing Hybrid							
20	14.1	77	113	35	2	59	10.8
30	19.6	77	113	35	0	60	17.1
40	24.0	75	111	35	1	59	18.0
50	30.1	75	111	35	1	60	18.6
60	34.5	74	110	37	1	59	16.4
70	40.3	75	109	36	1	59	15.3
Medium Early Average	27.1	75.5	111.2	36	1.0	59	16.0

Planted: June 10; Harvested: October 28, 2013.
Early Maturing Hybrid: Triumph TR424.
Medium Early Hybrid: Sorghum Partners K35Y5.
Grain yields were adjusted to 14% seed moisture content.

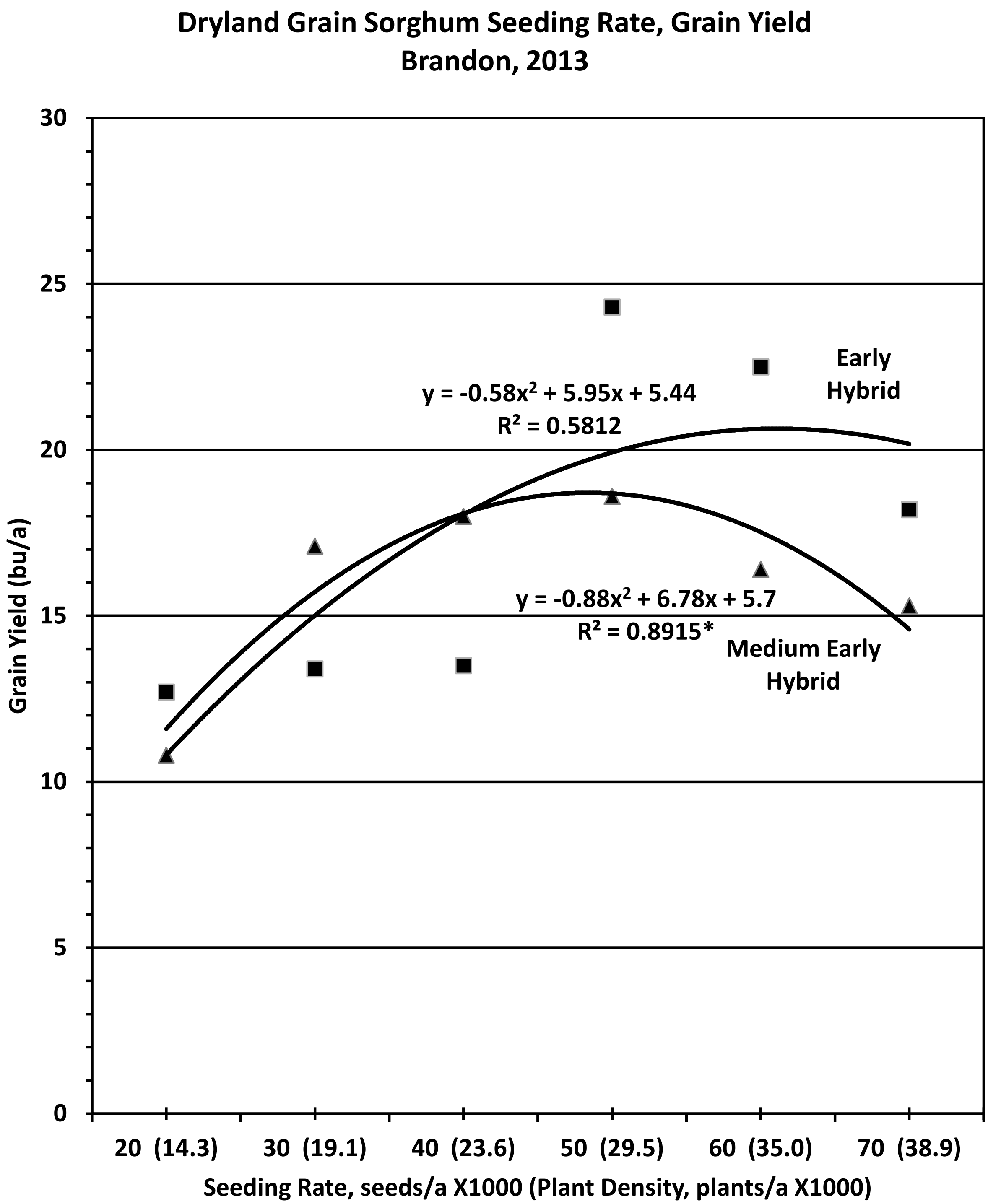


Fig. 1. Grain yield of dryland grain sorghum seeding rate study at Brandon. Seeding rates were 20, 30, 40, 50, 60, and 70 seeds/a X1000. The early maturing hybrid was Triumph TR424 and the medium early maturing hybrid was Sorghum Partners K35Y5 planted on June 10, 2013.

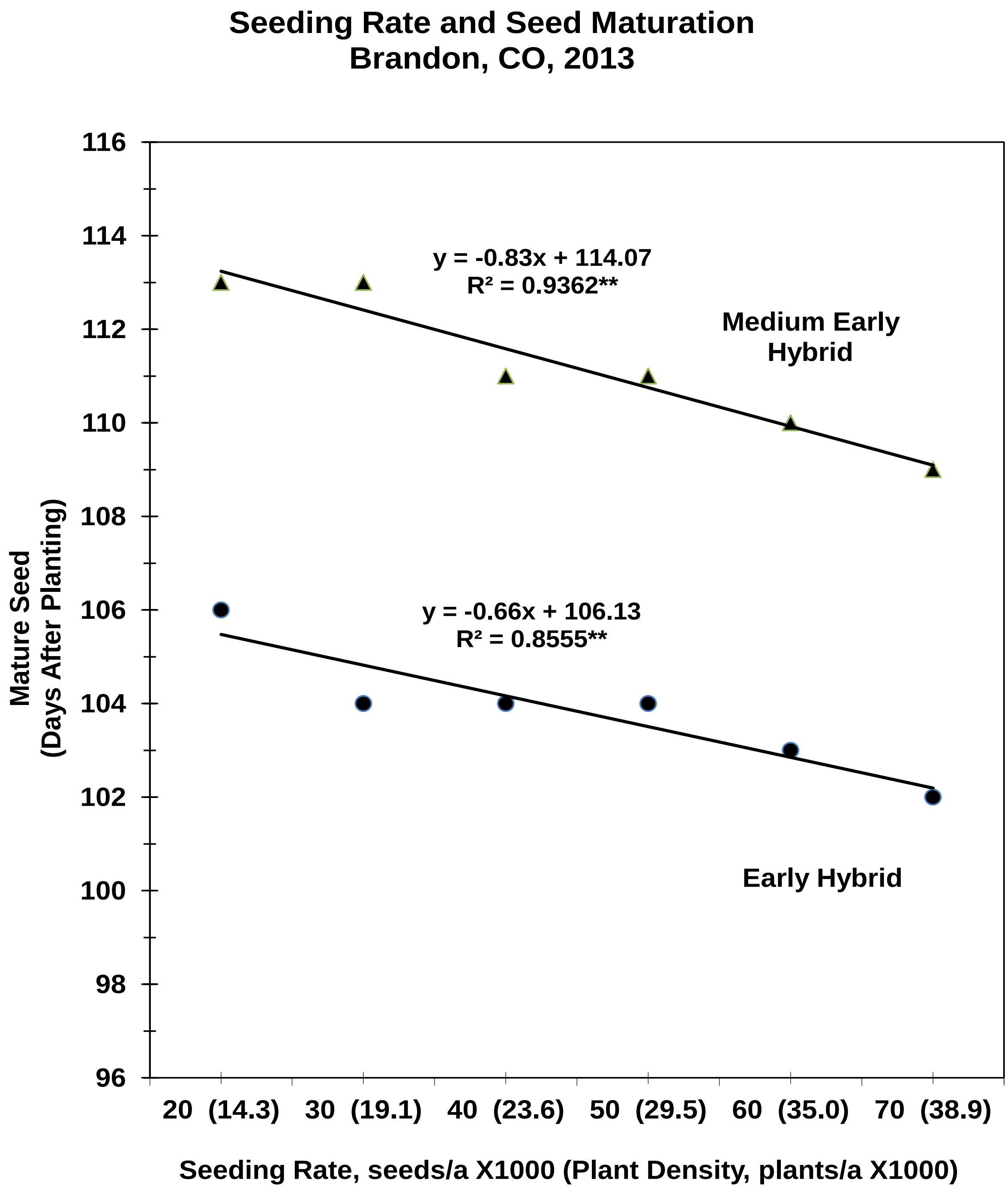


Fig. 2. Dryland grain sorghum seeding rate and days to seed maturation at Brandon. The seeding rates were 20, 30, 40, 50, 60, and 70 seeds/a (X1000). The early maturing grain sorghum hybrid was Triumph TR424 and the medium early grain sorghum hybrid was Sorghum Partners K35Y5 planted June 10, 2013.

Dryland Grain Sorghum Hybrid Performance Trial at Brandon, 2013

COOPERATOR: Burl Scherler, Sand Creek, Inc., Brandon, Colorado.
PURPOSE: To identify high yielding hybrids under dryland conditions with 2750 sorghum heat units in loam soil.

PLOT: Four rows with 30 in. row spacing, 50 ft. long. SEEDING DENSITY: 43,600 seed/a. PLANTED: June 10. HARVESTED: October 28.

PEST CONTROL: Preemergence Herbicides: Glyphosate 32 oz/a, Atrazine 0.9 lb/a, Metal 24 oz/a. Post Emergence Herbicides: 2,4-D amine (with drops). CULTIVATION: None. INSECTICIDES: None.

FIELD HISTORY: Previous Crop: Wheat. FIELD PREPARATION: No-till.

Summary: Growing Season Precipitation and Temperature \1
Chivington, Kiowa County.

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	In		--------no. of days--------		
June	0.85	569	17	8	20
July	1.92	799	19	5	51
August	5.30	755	16	1	82
September	1.61	580	8	0	112
October	0.00	54	0	0	117
Total	9.68	2757	60	14	117

\1 Growing season from June 10 (planting) to October 5 (first freeze, 23 F).
\2 GDD: Growing Degree Days for sorghum.
\3 DAP: Days After Planting.

COMMENTS: Planted in dry soil. Weed control was poor with puncture vine and kochia predominating. Precipitation for the growing season was near the average of the past 27 years, although precipitation timing was skewed: it was dry early in the season and August was very wet. No greenbug infestation. Yields and test weights were fair, especially considering the lack of early season precipitation and heavy infestation of puncture vine. Because of the early season dry weather, later maturing hybrids did not fully mature and subsequently had low test weights and poor yields.

SOIL: Loam for 0-8” and loam 8”-24” depths from soil analysis.

Summary: Soil Analysis of Plant Available Nutrients.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------ppm----------------				
0-8”	7.6	0.4	0.9	3	8.2	364	0.5	2.7
8”-24”				7				
Comment	Alka	VLo	Low	Lo	Lo	VHi	VLo	Lo

Manganese and Copper levels were adequate.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	0	20	2	0
Applied	60	0	0	0

Yield Goal: 40 bu/a.
Actual Yield: 15 bu/a.

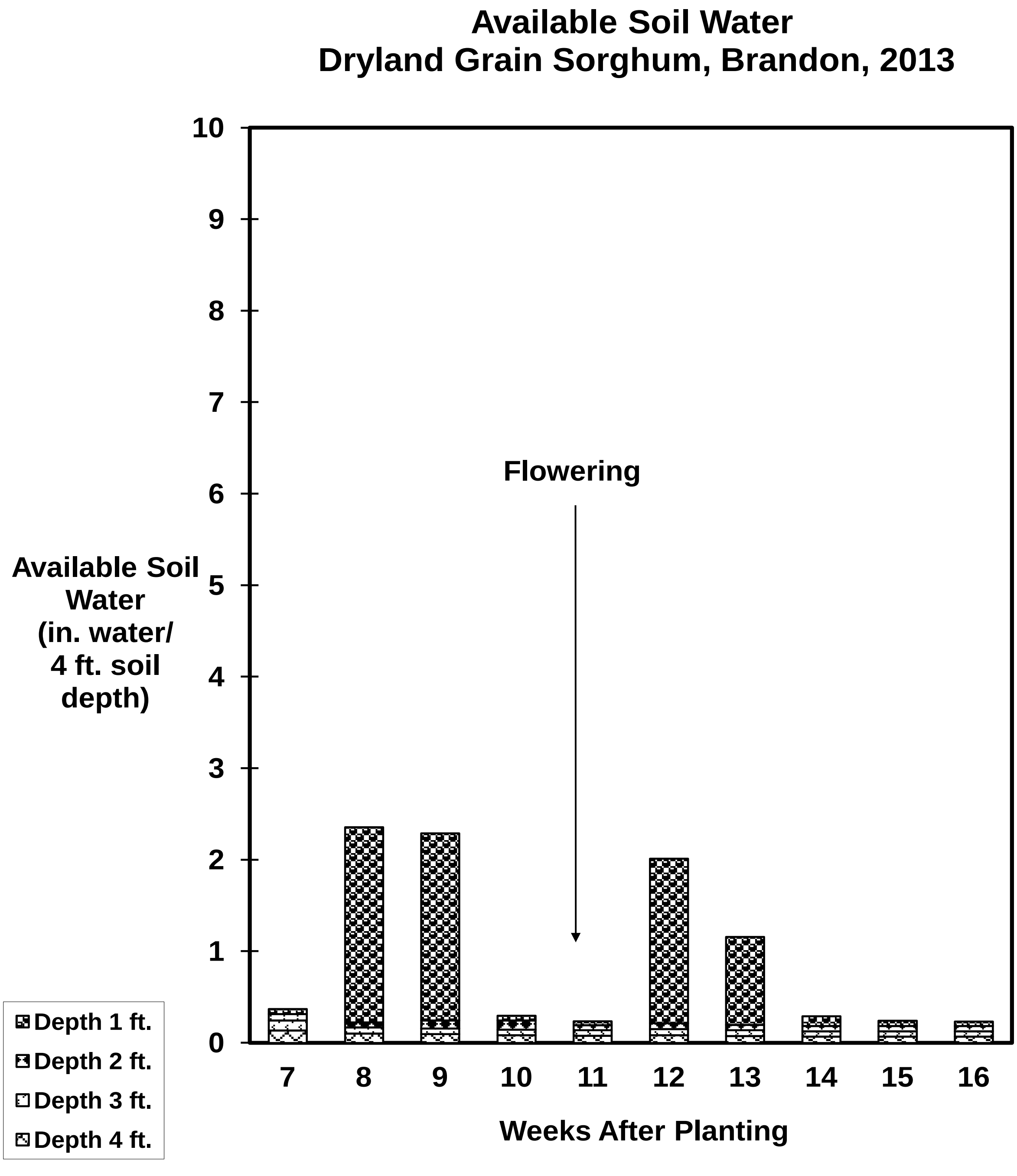


Fig. 1. Available soil water in dryland grain sorghum at Brandon. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Brandon from planting to first freeze was 9.68 in. Any increase in available soil water between weeks is from rain.

Table .--Dryland Grain Sorghum Hybrid Performance Trial at Brandon, 2013. \1

Brand	Hybrid	Grain Yield	Yield % of Test Average	Test Wt.	Plant Ldg.	Harvest Density	Plant Ht.	50% Bloom DAP	50% Bloom GDD	50% Mature DAP	50% Mature Group
		bu/a	%	lb/bu	%	plants/a (1000 X)	in				
MONSANTO	DKS29-28	24.2	166	58	0	25.8	36	70	1793	106	E
ADVANTA	AG1202	21.5	147	59	11	28.9	40	69	1768	105	E
MYCOGEN	1G557	18.1	124	58	2	28.7	30	70	1793	106	E
TRIUMPH SEED	TR424	17.9	123	59	2	24.0	41	71	1819	107	E
ADVANTA	AG1101	17.4	119	57	1	20.7	33	71	1819	107	E
AERC	CGSH-28	16.3	112	58	4	21.9	45	68	1744	104	E
MONSANTO	DKS28-05	12.2	84	57	16	25.4	41	71	1819	107	E
ADVANTA	AG1201	16.7	114	57	1	24.2	32	80	2064	114	ME
RICHARDSON SEEDS	O413	15.2	104	56	0	23.2	38	85	2195	117	ME
RICHARDSON SEEDS	92123	14.9	102	57	1	25.2	32	81	2093	115	ME
RICHARDSON SEEDS	96173	13.9	95	56	1	24.2	45	86	2224	117	ME
TRIUMPH SEED	TR438	13.4	92	57	1	28.1	42	82	2143	115	ME
RICHARDSON SEEDS	10413	12.3	84	57	0	27.3	42	83	2143	117	ME
MYCOGEN	E32294	10.8	74	57	1	29.4	33	80	2064	115	ME
RICHARDSON SEEDS	50113	5.1	35	54	1	29.2	41	90	2361	ED	M
RICHARDSON SEEDS	O6173	3.5	24	53	0	27.1	34	92	2386	ED	M
Average		14.6		57	3	25.8	38	78	2014	111	ME
LSD 0.05		13.42			5.2						
LSD 0.20		8.61			3.4						

\1 Planted: June 10; Harvested: October 28, 2013.
Yields are adjusted to 14.0% seed moisture content and hybrids ranked by maturity group.
DAP: Days After Planting or maturation of seed at first freeze; ED, early dough.
GDD: Growing Degree Days for sorghum to 50% bloom date.
Maturity Group: E, early; ME, medium early; M, medium.
If the difference between two hybrids yields equals or exceeds the LSD value, there is a 95% (at P<0.05) or 80% (P<0.20) chance the difference is statitstically significant.

Table 3. Summary: Dryland Grain Sorghum Hybrid Performance Trials at Brandon, 2011-2013.

Brand	Hybrid	Maturity Group[a]	Grain Yield 2011	2012	2013	2-Year Avg	3-Year Avg	Yield as % of Test Average 2011	2012	2013	2-Year Avg	3-Year Avg
MONSANTO	DKS29-28	E	--	45	24	35	--	--	133	166	138	--
MONSANTO	DKS28-05	E	37	40	12	26	30	197	118	84	104	129
MYCOGEN	1G557	E	26	45	18	32	30	139	131	124	126	129
TRUIMPH SEED	TR424	E	32	51	18	35	34	172	149	123	138	146
TRUIMPH SEED	TR438	ME	--	45	13	29	--	--	132	92	116	--
Average			19	34	15	25	23					

[a]Maturity Group: E, early; ME, medium early; M, medium.
Grain Yields were adjusted to 14.0% seed moisture content.

Dryland Grain Sorghum Hybrid Performance Trial at Walsh, 2013

COOPERATOR: Plainsman Agri-Search Foundation, Walsh, Colorado.
PURPOSE: To identify high yielding hybrids under dryland conditions with 2900 sorghum heat units in a silt loam soil.

PLOT: Four rows with 30 in. row spacing, 50 ft. long. SEEDING DENSITY: 43,600 seed/a. PLANTED: June 12. HARVESTED: October 24.

PEST CONTROL: Preemergence Herbicides: Atrazine 1lb/a, Dual II Magnum 21 oz/a, Glyphosate, 28 oz/a; 2,4-D, 0.5 lb/a, Banvel 4 oz/a. Post Emergence Herbicides: Huskie 16 oz/a, Banvel 4.0 oz/a, Atrazine 0.5 lb/a, AMS 1 lb/a. CULTIVATION: None. INSECTICIDES: None.

Summary: Growing Season Precipitation and Temperature \1
Walsh, Baca County.

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	In		--------no. of days--------		
June	2.89	527	15	6	18
July	3.92	824	19	5	49
August	1.38	823	20	3	80
September	5.82	633	9	2	110
October	0.00	79	0	0	116
Total	14.01	2886	63	16	116

\1 Growing season from June 12 (planting) to October 6 (first freeze, 31 F).
\2 GDD: Growing Degree Days for sorghum.
\3 DAP: Days After Planting.

FIELD HISTORY: Previous Crop: Wheat. FIELD PREPARATION: No-till.

COMMENTS: Planted in dry soil. Weed control was good. No greenbug infestation. The growing season precipitation was above average, but the flowering period (August) was very dry and the majority of rains during September came too late to increase yields. Grain yields were poor due to dry weather during flowering.

SOIL: Richfield silt loam for 0-8” and silt loam 8”-24” depths from soil analysis.

Summary: Soil Analysis of Plant Available Nutrients.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------ppm----------------				
0-8”	7.8	0.5	1.3	14	8.3	292	0.6	2.7
8”-24”				31				
Comment	Alka	VLo	Mod	VHi	Lo	VHi	Lo	Lo

Manganese and Copper levels were adequate.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	0	20	2	0
Applied	50	0	0	0

Yield Goal: 40 bu/a.
Actual Yield: 5 bu/a.

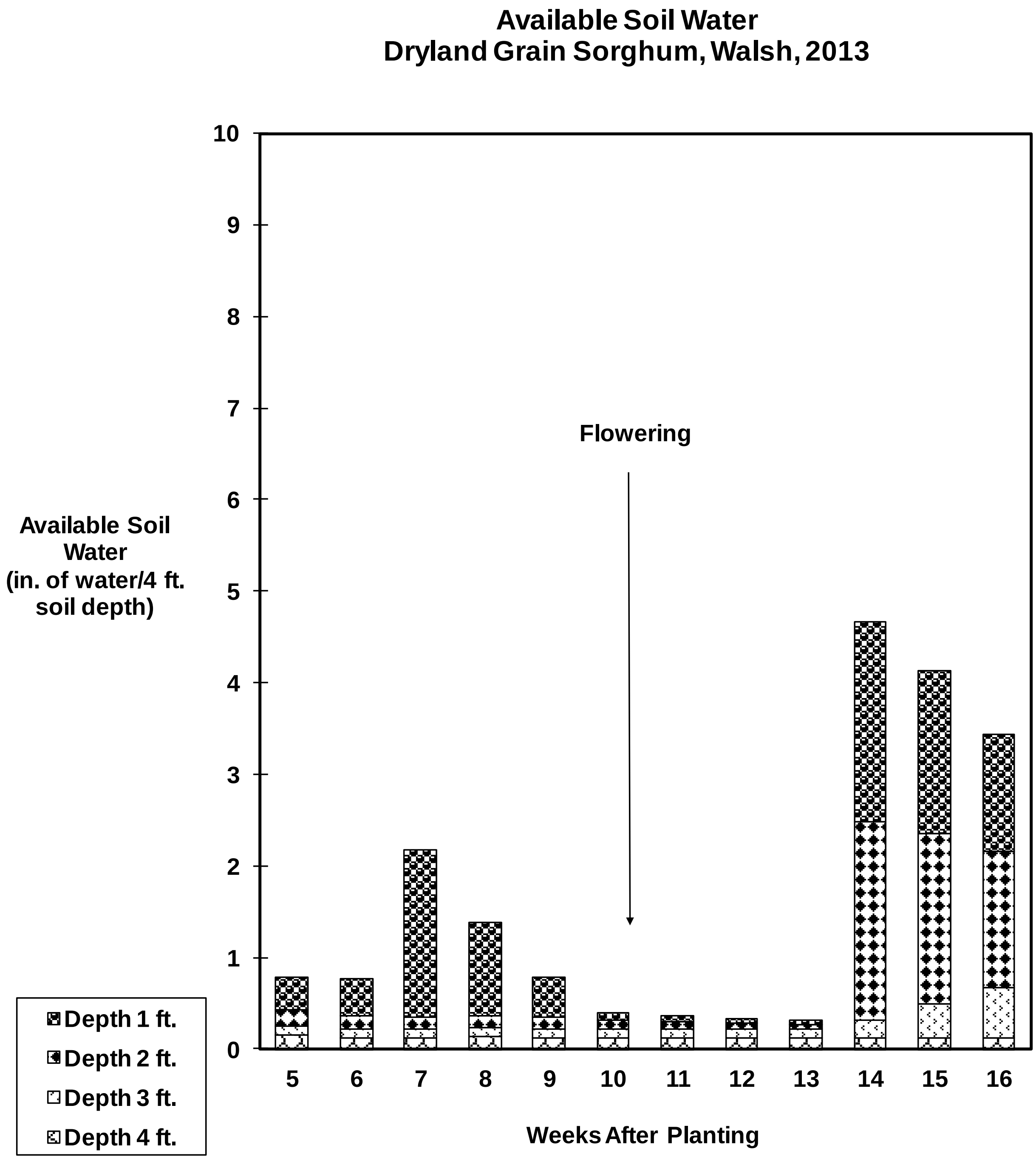


Fig. 2. Available soil water in dryland grain sorghum at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to first freeze was 14.01 in. Any increase in available soil water between weeks is from rain

Table .--Dryland Grain Sorghum Hybrid Performance Test at Walsh, 2013. \1

Brand	Hybrid	Grain Yield	Yield % of Test Average	Test Weight	Harvest Density	Plant Ht.	50% Bloom DAP	50% Bloom GDD	50% Mature DAP	50% Mature Group
		bu/a	%	lb/bu	plants/a (1000 X)	in				
TRIUMPH SEED	TR424	10.4	217	59	21.7	33	68	1810	98	E
SORGHUM PARTNERS	251	5.7	119	59	19.2	32	65	1733	93	E
SORGHUM PARTNERS	SP3303	4.5	94	58	23.4	37	69	1838	101	E
ADVANTA	AG1202	3.6	75	57	17.4	34	68	1810	98	E
ADVANTA	AG1101	3.4	71	57	18.2	30	69	1838	99	E
TRIUMPH SEED	TR438	7.1	148	58	20.3	37	72	1931	104	ME
AERC	CGSH-28	5.9	123	57	11.2	35	74	1991	112	ME
ADVANTA	AG1201	4.8	100	57	19.0	31	73	1961	105	ME
RICHARDSON SEEDS	92123	4.3	90	56	16.5	36	82	2231	116	ME
SORGHUM PARTNERS	KS310	4.2	88	56	23.8	35	72	1931	106	ME
MONSANTO	DKS44-20	4.2	88	56	17.4	35	82	2231	115	ME
MONSANTO	DKS38-88	3.7	77	56	20.3	36	80	2174	114	ME
RICHARDSON SEEDS	10413	2.7	56	55	17.8	37	83	2258	HD	ME
RICHARDSON SEEDS	O413	2.7	56	55	19.4	34	83	2258	HD	ME
RICHARDSON SEEDS	O6173	--	--	--	16.8	42	B	--	B	M
RICHARDSON SEEDS	96173	--	--	--	20.5	38	B	--	B	M
RICHARDSON SEEDS	50113	--	--	--	17.4	37	B	--	B	M
Average		4.8		57	18.8	35	74	2000	105	ME
LSD 0.05		5.78								
LSD 0.20		3.73								

\1 Planted: June 12; Harvested: October 24, 2013.
Yields are adjusted to 14.0% seed moisture content and hybrids ranked by maturity group.
DAP: Days After Planting or plant and seed development. B, boot; HD, hard dough.
GDD: Growing Degree Days for sorghum to 50% bloom date.
Maturity Group: E, early; ME, medium early; M, medium.
If the difference between two hybrids yields equals or exceeds the LSD value, there is a 95% (at P<0.05) or 80% (P<0.20) chance the difference is statitstically significant.

Table 5. Summary: Dryland Grain Sorghum Hybrid Performance Trials at Walsh, 2011-2013.

Brand	Hybrid	Maturity Group[a]	Grain Yield 2011	2012	2013	2-Year Avg	3-Year Avg	Yield as % of Test Average 2011	2012	2013	2-Year Avg	3-Year Avg
MONSANTO	DKS44-20	ME	56	36	4	20	32	130	143	88	133	133
SORGHUM PARTNERS	KS310	E	43	24	4	14	24	99	98	88	93	99
SORGHUM PARTNERS	251	E	32	18	6	12	19	75	74	119	80	78
TRUIMPH SEED	TR424	E	48	37	10	24	32	111	149	217	157	132
TRUIMPH SEED	TR438	ME	50	29	7	18	29	115	116	148	120	119
Average			43	25	5	15	24					

[a]Maturity Group: E, early; ME, medium early, M, medium.
Grain Yields were adjusted to 14.0% seed moisture content.
The site was pre-irrigated with furrow irrigation in 2011.

Subsurface Drip Irrigated Grain Sorghum Study at Walsh, 2013

COOPERATORS: Plainsman Agri-Search Foundation; K. Larson, B. Pettinger, D. Harn, Plainsman Research Center, Walsh, Colorado.
PURPOSE: To identify grain sorghum hybrids that produce highest yields given subsurface drip irrigation.

RESULTS: The yield ranged from 62 bu/a for Sorghum Partners KS310 to 92 bu/a for Triumph TR4941. Plant establishment was a problem. The hybrids with low plant density, below 25,000 plants/a, tended to have the low yields.

PLOT: Four rows with 30 in. row spacing, at least 1000 ft. long. SEEDING DENSITY: 35,000 seeds/a. PLANTED: June 3. HARVESTED: November 1.

IRRIGATION: Subsurface drip applied 12.8 acre-in/a.

PEST CONTROL: Preemergence Herbicides: Glyphosate 32 oz/a, Sharpen 3.0 oz/a, Atrazine 1.0 lb/a; Post Herbicides: Glyphosate 32 oz/a (shielded sprayer). CULTIVATION: None.

FIELD HISTORY: Previous Crop: Sorghum. FIELD PREPARATION: No-till.

Summary: Growing Season Precipitation and Temperature \1
Walsh, Baca County.

Month	Rainfall	Irrigation \2	GDD \3	>90 F	>100 F	DAP \4
	in	in	--------no. of days--------			
June	3.12	4.50	771	19	8	28
July	3.92	0.00	824	19	5	59
August	1.36	5.50	823	20	3	90
September	5.82	2.80	633	9	2	120
October	0.00	0.00	79	0	0	126
Total	14.22	12.80	3130	67	18	126

\1 Growing season from June 3 (planting) to October 6 (freeze, 31F).
\2 Total in-season water from irrigation and precipitation was 27.02 in/a.
\3 GDD: Growing Degree Days for sorghum.
\4 DAP: Days After Planting.

COMMENTS: Planted in dry soil. Irrigated for seed germination and stand establishment. Plant stands were poor to fair. Weed control was good; however, some areas were damaged by shielded sprayer misalignment. The growing season precipitation was above average, but the flowering period (August) was very dry and the majority of rains during September came too late to increase yields. Yields were good.

SOIL: Silty clay loam for 0-8” and silty clay loam 8”-24” depths from soil analysis.

Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------ppm----------------				
0-8”	7.8	0.8	1.8	57	4	433	0.8	2.6
8”-24”				6				
Comment	Alka	VLo	Hi	VHi	Lo	VHi	Lo	Lo

Manganese and Copper levels were adequate.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	0	20	2	0
Applied	100	20	0.3	0

Yield Goal: 80 bu/a.
Actual Yield: 79 bu/a.

Table .Subsurface Drip Irrigation Grain Sorghum, PRC, Walsh, 2013.

Brand	Hybrid	Grain Yield	Seed Moisture Content	Test Wt.	Plant Density	Plant Ht.	50% Bloom Date	50% Maturity Date
		bu/a	%	lb/bu	plants/a (1000X)	in		
TRIUMPH	TR4941	92	13.9	59	26.8	48	8/26	10/5
SORGHUM PARTNERS	SP3425	89	13.8	62	30.0	42	8/19	10/1
MYCOGEN	E32294	86	13.9	60	28.4	51	8/19	9/25
MYCOGEN	627	85	13.8	60	24.0	48	8/22	9/29
MYCOGEN	M3838	82	13.6	61	28.4	45	8/23	10/6
SORGHUM PARTNERS	KS585	82	14.0	61	28.6	48	8/25	10/1
TRIUMPH	TR438	81	13.5	61	27.7	51	8/21	9/24
MYCOGEN	1G557	81	13.6	61	27.0	46	8/12	9/22
TRIUMPH	TR424	77	13.7	61	22.2	43	8/13	9/22
TRIUMPH	TR448	74	14.1	59	22.4	46	8/24	10/6
SORGHUM PARTNERS	K35-Y5	73	13.7	60	24.8	44	8/19	9/26
TRIUMPH	TRX85131	68	15.7	55	26.2	50	8/28	HD
SORGHUM PARTNERS	KS310	62	13.7	61	21.2	46	8/16	9/27
Average		79	13.9	60	26.0	47	8/20	9/28
LSD 0.20		12.0						

Planted: June 3; Harvested: November 1, 2013.
50% Flowering Date: minimum date on which a hybrid flowers on half of its population.
50% Maturity Date or maturation of seed at first freeze; HD, hard dough.
The subsurface drip irrigation grain sorghum received 12.8 acre-in of applied water.
Yields are adjusted to 14.0% seed moisture content.

Sprinkler Irrigation Corn Study at Walsh, 2013

COOPERATORS: Plainsman Agri-Search Foundation; K. Larson, B. Pettinger, D. Harn, Plainsman Research Center, Walsh, Colorado.

PURPOSE: To identify corn hybrids that produce highest yields given sprinkler irrigation.

RESULTS: The average yield for all 16 hybrids tested in this trial was 177 bu/a. All three seed firms (Golden Harvest, Mycogen, and Triumph) entered in this trial had at least one hybrid that produced between 184 bu/a to 188 bu/a.

PLOT: Four rows with 30” row spacing, at least 600’ long. SEEDING DENSITY: 22,000 seeds/a. PLANTED: May 6. HARVESTED: November 8.

PEST CONTROL: Preemergence Herbicides: Balance 1.75 oz/a, Glyphosate 32 oz/a, Sharpen 3.0 oz/a, Atrazine 1.0 lb/a; Post Herbicides: Glyphosate 32 oz/a, Dicamba 8 oz/a. CULTIVATION: None. INSECTICIDE: None.

FIELD HISTORY: Previous Crop: Corn. FIELD PREPARATION: Disked and strip-tilled.

Summary: Growing Season Precipitation and Temperature \1
Walsh, Baca County.

Month	Rainfall	Irrigation \2	GDD \3	>90 F	>100 F	DAP \4
	in	in	--------no. of days--------			
May	0.34	2.50	467	10	0	25
June	2.89	7.50	527	15	6	56
July	3.92	10.00	824	19	5	87
August	1.38	6.50	823	20	3	118
September	5.82	2.00	633	9	2	148
October	0.00	0.00	79	0	0	168
Total	14.35	28.50	3678	78	22	168

\1 Growing season from May 6 (planting) to October 6 (freeze, 31F).
\2 Total in-season water from irrigation and precipitation was 42.85 in/a.
\3 GDD: Growing Degree Days for sorghum.
\4 DAP: Days After Planting.

COMMENTS: Planted in marginal soil moisture for seed germination and stand establishment. Weed control was good. The growing season precipitation was average, but variable (June was wet and July was dry). Grain yields and test weights were good. The study was not limited irrigated: we applied 28.5 in/a of irrigation.

SOIL: Silty clay loam for 0-8” and silty clay loam 8”-24” depths from soil analysis.

Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------ppm----------------				
0-8”	7.7	0.7	1.3	27	4.5	287	0.4	2.0
8”-24”				11				
Comment	Alka	VLo	Mod	Hi	Lo	VHi	VLo	Lo

Manganese and Copper levels were adequate.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	25	40	2	0
Applied	150	40	0.4	0

Yield Goal: 150 bu/a.
Actual Yield: 177 bu/a.

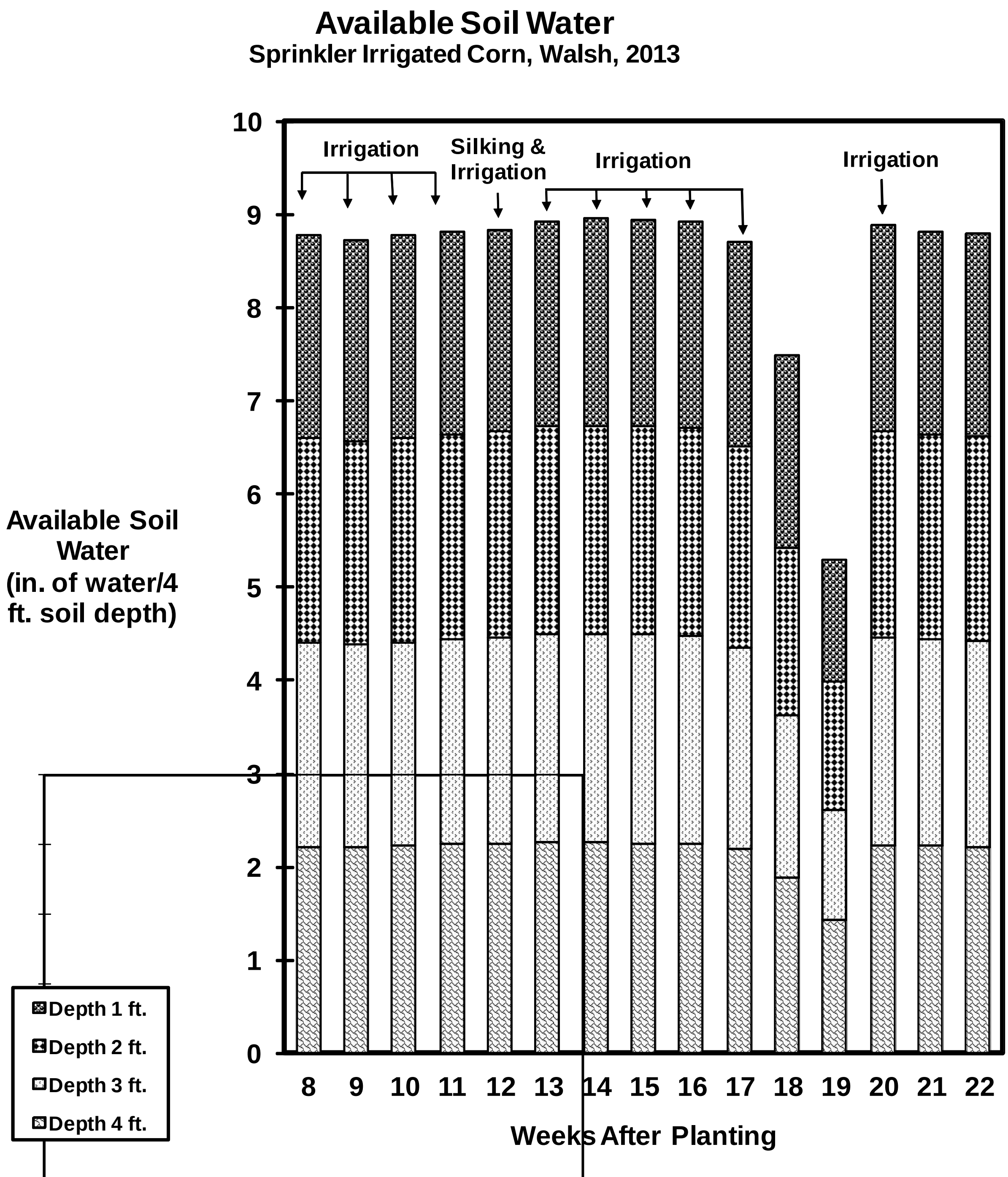


Fig. . Available soil water in limited sprinkler irrigation corn at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to first freeze was 14.35 in. Any increase in available soil water between weeks not attributed to applied irrigation is from rain.

Table .Sprinkler Irrigation Corn, Plainsman Research Center, 2013.

Firm	Hybrid	Grain Yield	Seed Moisture	Test Wt.	Plant Density	50% Silking Date
		bu/a	%	lb/bu	plants/a (X 1000)	
MYCOGEN	2Y767	188	14.8	59	21.8	24-Jul
TRIUMPH	1329S	188	13.8	59	21.6	26-Jul
MYCOGEN	2K757	188	14.9	59	21.7	24-Jul
TRIUMPH	1217S	185	14.2	59	21.2	23-Jul
GOLDEN HARVEST	82K01-3111	184	14.7	58	21.2	25-Jul
MYCOGEN	2V709	183	14.0	60	19.8	23-Jul
TRIUMPH	1375S	183	14.5	60	21.8	24-Jul
MYCOGEN	2V717	180	14.2	59	19.6	24-Jul
MYCOGEN	2A787	176	14.6	59	21.2	24-Jul
MYCOGEN	2T777 (non Bt)	175	14.2	59	20.6	25-Jul
TRIUMPH	1366S	174	14.7	60	21.4	24-Jul
GOLDEN HARVEST	83E90-3122	173	14.4	60	18.4	24-Jul
GOLDEN HARVEST	84U58-3111	172	14.1	57	19.2	22-Jul
GOLDEN HARVEST	83R38-3000GT	168	14.5	60	20.2	25-Jul
MYCOGEN	2A749	161	14.6	59	18.4	24-Jul
TRIUMPH	5425RA	148	11.4	59	20.4	23-Jul
Average		177	14.2	59	20.5	24-Jul
LSD 0.20		5.6				

Planted: May 6; Harvested: November 8, 2013.
Grain Yield adjusted to 15.5% moisture content.
This corn trial received a total of 28.5 acre-in./acre of water.

Corn Borer Resistant and Nonresistant Hybrid Comparisons, Walsh, 2013

Kevin Larson, Brett Pettinger, and Deborah Harn

Purpose: To evaluate corn borer resistant (Bt gene insertion) and nonresistant hybrids under sprinkler irrigation.

Results

Only the nonresistant corn borer hybrid displayed any first-generation corn borer damage and this shot-hole damage was very minor. The nonresistant corn borer hybrid and one corn borer resistant hybrid had second-generation corn borer damage, but their damage was minimal, 13% and 3% stalk holes, respectively. Grain yields were good, averaging 177 bu/a.

Discussion

All 15 Bt hybrids tested showed excellent resistance to corn borer compared to the nonresistant hybrid. The nonresistant corn borer hybrid had 8% of plants lodged due to corn borer girdling. This low level of corn borer lodging is comparable to recent corn borer damage levels since Bt corn hybrids became widely accepted. The low level of corn borer damage may be attributable to our region's extensive use of corn borer resistant hybrids. Even with a few years of low corn borer levels, we still advocate the use of corn borer resistant hybrids. Nonetheless, if these low infestation levels continue, it may be economical to replace some acreage with less expensive nonresistant corn borer hybrids. Growers can monitor the corn borer infestation levels in their refuges to indicate if switching is warranted. Corn borer resistant Bt hybrids continue to be a very effective tool against corn borer damage. Therefore, to keep Bt hybrids effective in controlling corn borer, always remember to plant nonresistant hybrids as a mating refuge to help delay corn borer resistance to the Bt events.

This study was not limited irrigated. We applied 28.5 in/a of irrigation because this study was part of another irrigation study, a diurnal irrigation study.

Table .Sprinkler Irrigated Corn, Corn Borer Ratings, Plainsman Research Center, 2013.

Firm	Hybrid	Grain Yield	Test Wt.	1st Gen Shot Holes	2nd Gen Stalk Holes	2nd Gen Plants Lodged	Plant Density	50% Silking Date
		bu/a	lb/bu	-------------plants/a---------------			(X 1000)	
MYCOGEN	2Y767	188	59	0	0	0	21.8	24-Jul
TRIUMPH	1329S	188	59	0	0	0	21.6	26-Jul
MYCOGEN	2K757	188	59	0	0	0	21.7	24-Jul
TRIUMPH	1217S	185	59	0	0	0	21.2	23-Jul
GOLDEN HARVEST	82K01-3111	184	58	0	0	0	21.2	25-Jul
MYCOGEN	2V709	183	60	0	0	0	19.8	23-Jul
TRIUMPH	TRX31375S	183	60	0	0	0	21.8	24-Jul
MYCOGEN	2V717	180	59	0	0	0	19.6	24-Jul
MYCOGEN	2A787	176	59	0	0	0	21.2	24-Jul
MYCOGEN	2T777(non Bt)	175	59	3	13	8	20.6	25-Jul
TRIUMPH	1366S	174	60	0	0	0	21.4	24-Jul
GOLDEN HARVEST	83E90-3122	173	60	0	3	3	18.4	24-Jul
GOLDEN HARVEST	84U58-3111	172	57	0	0	0	19.2	22-Jul
GOLDEN HARVEST	83R38-3000GT	168	60	0	0	0	20.2	25-Jul
MYCOGEN	2A749	161	59	0	0	0	18.4	24-Jul
TRIUMPH	5425RA	148	59	0	0	0	20.4	23-Jul
Average		177	59	0.2	1.0	0.7	20.5	24-Jul
LSD 0.05		9.0		1.88	2.75	2.75		

Planted: May 6; Harvested: November 8, 2013.
Grain Yield adjusted to 15.5% moisture content.
This corn trial received a total of 28.5 acre-in./acre of water.

Diurnal Sprinkler Irrigation on Corn

Kevin Larson and Brett Pettinger

We theorize that crop yields may increase by reducing water stress through managing night and day sprinkler irrigation frequency. Increasing nighttime rotation speed so that crops receive effective water more often may increase yields. It makes common sense that nighttime sprinkler irrigations are more effective than daytime irrigations because there is greater evaporative loss during the day. In order to determine the nighttime rotation speed, we need to measure the effectiveness of sprinkler irrigations at night compared to sprinkler irrigations during the day. We conducted this sprinkler irrigation on corn to quantify the production increase from continual nighttime irrigations as an initial step toward managing diurnal irrigation frequency.

Materials and Methods

We planted Mycogen 2K757 at 22,000 seeds/a on May 6. We seedrow applied 5 gal/a of 10-34-0 and 0.38 lb/a of Zn chelate at planting. We strip-tilled 150 lb N/a and 5 gal/a of 10-34-0 to the site. For weed control in the corn, we applied preemergence herbicides: Balance 1.75 oz/a, glyphosate 32 oz/a, Sharpen 3.0 oz/a, atrazine 1.0 lb/a; and post emergence herbicides: glyphosate 32 oz/a, dicamba 8 oz/a. All diurnal irrigations were applied to the same plot site either during the day (9:00am to 9:00pm) or during the night (9:00pm to 9:00am) at 2.5 in/a per irrigation until tasseling, then 1.0 in./a thereafter. The corn crop received 28.5 in/a in total irrigation. We harvested the corn plots on November 8 with a self-propelled combine and weighed the grain in a digital scale cart. Grain yields were adjusted to 15.5% seed moisture content.

Results and Discussion

There was no significant yield difference between sprinkler irrigations applied during the day or during the night.

We expected larger yield differences between nighttime sprinkler irrigations and daytime sprinkler irrigations. There was only 0.6 bu/a difference between these diurnal sprinkler irrigations. We believe the reason we did not have significant yield differences between nighttime and daytime irrigations was because of the large amount of water we applied (28.5 in/a). Our frequent and abundant irrigation schedule may have masked daytime evaporative losses, reducing nighttime and daytime yield differences. For a subsequent study, we will use a more limiting irrigation schedule to reveal potential nighttime and daytime irrigation differences.

Table .--Diurnal Sprinkler Irrigation on Corn, Walsh, 2013.

Treatment	Grain Yield	Test Weight	Moisture
	bu/a	lb/bu	%
<u>Diurnal</u>			
Night	179.4	58.0	14.1
Day	180.0	57.9	14.0
Diurnal LSD 0.05	NS		
Average	**179.7**	**58.0**	**14.1**

Planted: May 6; Harvested: November 8.
The study received 28.5 in. of irrigation.
Night irrigations were applied 9:00pm to 9:00am with 2.5 in/a each time until tasseling then 1.0 in./a thereafter.
Day irrigations were applied 9:00am to 9:00pm with 2.5 in/a each time until tasseling then 1.0 in./a thereafter.

Long-Term N Effects on Irrigated Sunflower-Corn Rotation, Walsh, 2013

Kevin Larson, Brett Pettinger, and Deborah Harn

Purpose: To study the long-term N fertilizer effects on irrigated Sunflower-Corn and Corn-Corn (continuous corn) rotations where N rate are applied to the same treatment site for multiple years.

Materials and Methods

All crop phases (corn and sunflower) of Sunflower-Corn and Corn-Corn rotations were planted each year, except in 2012. We did not plant sunflowers in 2012 because we mistakenly applied corn herbicides over all the plots, including the plots reserved for sunflower planting. This year, all crop phases (corn and sunflower) of Sunflower-Corn and Corn-Corn rotations were planted. We planted corn, Mycogen 2K757, on May 14 at 22,000 seeds/a, and sunflower, Mycogen 2H449CL, on June 27 at 21,500 seeds/a. We planted the corn in dry soil, therefore we furrow irrigated the corn site to establish a stand. At sunflower planting, there was sufficient soil moisture to germinate the sunflowers, therefore, unlike the corn site, the sunflower site was not furrow irrigated for stand establishment. For our N treatments, we streamed liquid N (32-0-0) at 100, 150, or 200 lb/a with two replications. We seedrow applied 20 lb P_2O_5/a to the corn, but not the sunflowers. In addition to the seedrow applied P, the corn received 0.38 lb/a of Zn chelate. For weed control, we applied pre-emergence glyphosate 32 oz/a, 0.5 lb/a of 2,4-D, and Banvel 4 oz/a to both the corn and sunflower plots. The corn also received pre-emergence Balance Pro 2.0 oz/a, Sharpen 3.0 oz/a, Atrazine 1.0 lb/a, and COC 16 oz/a. For postemergence weed control in the corn, we applied two applications of Glystar Plus at 32 oz/a. For weed control in the sunflower, we applied pre-emergence Spartan 2 oz/a. For postemergence weed control in the sunflower, we applied Select 12 oz/a. The corn received approximately 19.3 in/a of irrigation (14.3 in/a from drip and 5 in/a from furrow irrigation). The sunflower received 8.3 in./a of drip irrigation. The sunflower had an aerial application of Warrior to control head moth. We harvested two replications of the 20 ft. by 650 ft. plots on November 7 for corn and November 4 for sunflower with a self-propelled combine and weighed them in a digital weigh cart. Yields were adjusted to 15.5% for corn and 10% for sunflower.

Results and Discussion

The corn in Sunflower-Corn (actually Corn-Corn) and continuous corn rotations responded similarly to increasing N rates: both the Sunflower-Corn (Corn-Corn) rotation and the continuous corn rotation increased linearly with increasing N rates. This linear response to increasing N rates is not surprising since the Sunflower-Corn rotation was actually Corn-Corn rotation, because last year we mistakenly planted corn in the plots reserved for sunflowers. In the past, we reported low or no response to increasing N for the Sunflower-Corn rotation. But since the Sunflower-Corn rotation was actually corn following corn, the linear response to increasing N rates mimicked the continuous corn rotation. Continuous corn required high rates of N for high grain yields. High rates of N for high yields would be the acceptable practice for corn production. Therefore, the increased yields with increased N for continuous corn and Corn-Corn rotations were expected.

Sunflower following corn had its optimum N response at 150 lb/a. After reviewing the soil test recommendation, the large residual nitrate N indicated that there would be no sunflower or corn yield response to increasing N rates. However, sunflower produced its optimum yield at 150 lb N/a and corn produced its highest yield at the highest N rate. In the past, we reported no or declining sunflower yield with increasing N in combination with lower residual soil N than this year. We have no explanation for the sunflower yield optimum at 150 lb N/a, especially with such high residual soil N. The recommended N fertilizer rates for our yield goals were 0 lb/a for sunflower and 0 lb/a for corn. Our yield goal for the corn was 150 bu/a, our actual average grain yield was 138 bu/a, and the yield goal for the sunflowers was 1500 lb/a, our actual average seed yield was 1005 lb/a or 387 lb/a oil yield. Typically we have reported oil percentages decreasing with increasing N rates. This year, the oil percentages declined with increasing N rates; however, there was little difference between the 100 and 150 lb N/a rates. The oil percentages were: 38.7, 38.6, and 38.0, respectively for 100, 150, and 200 lb N/a.

Table .-Soil Analysis.

Depth	pH	Salts mmhos/cm	OM %	N	P	K	Zn	Fe	Mn	Cu
				--------------------------			ppm		------------------------	
0-8”	7.8	0.7	1.8	41	5	406	0.7	2.6	13.5	2.4
8-24”				10						

This is the eighth year of this long-term N on Sunflower-Corn rotation study. We started this study because of 1) the lack of N response for dryland sunflower in our long-term N on Wheat-Sunflower-Fallow study, 2) the role of N in reducing oil yield, and 3) reports from growers that their irrigated corn following sunflower often produced their highest yields. This year, the difference in average corn yield between the Sunflower-Corn (Corn-Corn) and continuous corn rotations was 11 bu/a with the continuous corn producing higher yields than the corn following sunflower. The higher continuous corn production recorded this year is contrary to our previous results and to growers observations.

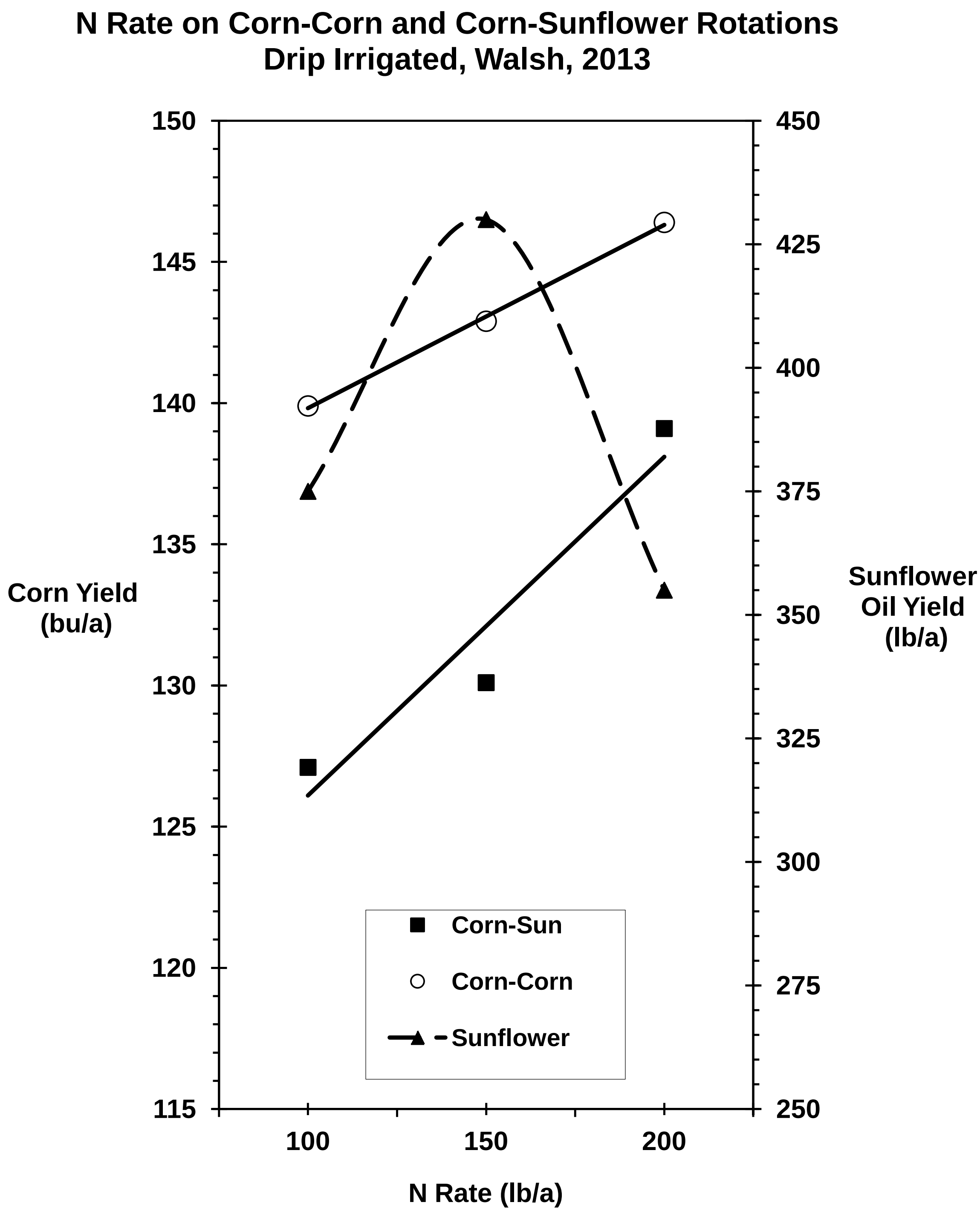


Fig. . N rate on drip irrigated sunflower and corn in Sunflower-Corn rotations at Walsh. The N rates were 100, 150, and 200 lb N/a as 32-0-0. The sunflower hybrid was Mycogen 8H449CL planted at 21,500 seeds/a. The corn hybrid was Mycogen 2K757 planted at 22,000 seeds/a.

Long-Term N Effects on Wheat-Sunflower-Fallow Rotation, Walsh, 2013

Kevin Larson, Brett Pettinger, and Deborah Harn

Purpose: To study the long-term N fertilizer effects on a wheat-sunflower-fallow rotation where N is applied to the same treatment plots for multiple years.

Materials and Methods

We planted wheat, Hatcher, at 50 lb seed/a on October 4, 2012, and because of dry conditions the sunflowers were not planted. We banded liquid N (28-0-0 or 32-0-0) at 0, 30, 60, and 90 lb N/a to the treatment plots with two replications to both N and N residual sides of the wheat on April 24, 2013. We seedrow applied 5 gal/a of 10-34-0 (20 lb P_2O_5/a) at planting to the wheat. For weed control in the wheat, we applied pre-emergence glyphosate 28 oz/a, dicamba 4.0 oz/a, and 2,4-D 0.5 lb/a and post emergence Express, 0.33 oz/a and 2,4-D, 0.38 lb/a. We harvested two replications of the 20 ft. by 1100 ft. plots on July 26 with a self-propelled combine and weighed the grain in a digital weigh cart. Yields were adjusted to 12% for wheat.

Results

There was no yield trend with increasing N rates for wheat: the yield response to applied N was flat (R^2 = 0.014) with less than 2 bu/a separating the high and low yields. Wheat yields were low, ranging from 11.2 bu/a to 12.9 bu/a. Wheat grain protein percentages increased linearly with increasing N rates. Because of dry conditions, the sunflowers were not planted.

Discussion

This is the twelfth harvest year of this long-term N on wheat-sunflower-fallow rotation study. We started this study to test reports of no yield response from applied N on dryland sunflower (Vigil and Bowman, 1998).

This year, there was no wheat yield response to increasing N rates. Obviously, the net return from N fertilizer application was negative for all N rates. The 2012 wheat crop for this study was hailed out. In 2011, the wheat had a slightly negative response to applied N. Only one time in eleven harvest years did the wheat positively respond to applied N. The lack of response of wheat yields to increasing N rates for ten out of eleven years can be explained by sufficient residual N for the first year and low to average yields for the subsequent years. In 2007, there was sufficient winter moisture to produce very good wheat yields (over 50 bu/a), and in 2009 the wheat responded to N rates. However in 2009, this positive response to applied N was not economical. Generally, however, moisture has been the primary yield-limiting factor for this study, not N.

This is the first year that we have performed protein analyses on the wheat grain. We speculated that grain protein percentage would increase with increasing N rates and our predictions were correct. The protein percentage increased 0.3% for every 30 lb N/a applied.

This year, the sunflower crop was not planted due to dry conditions. For most years of this study, sunflower yields increased with increasing N rates; however the yield response failed to offset the cost of the N fertilizer. The no N fertilizer treatment produced the highest income every year of sunflower production (there were no sunflower crops in 2002, 2008, 2011, and 2013 because of drought). This lack of N response suggests that N fertilizer is not needed for dryland sunflower production if the expected yield is 1200 lb/a or less.

Last year, the oil content was widely scattered with a slight declining trend with increasing N rates. Generally in previous years, we observed no response or a decline in oil content with increasing N rates. This negative correlation of oil content with N rate has been previously reported (Vigil and Bowman, 1998).

With the exception of 2007, we have reported no wheat yield response to N rates since establishing this wheat-sunflower-fallow rotation study. For ten out of eleven harvest years, wheat yields in this rotation were very low to average, 6 to 33 bu/a. The low to average wheat yields can be attributed to the lack of moisture remaining after the sunflower crops extracted all available soil water and to insufficient soil water replenishment due to dry conditions during fallow.

Literature Cited

Vigil, M.F., R.A. Bowman. 1998. Nitrogen response and residue management of sunflowers in a dryland rotation. 1998 Annual Report, Central Great Plains Research Station. ARS, USDA.

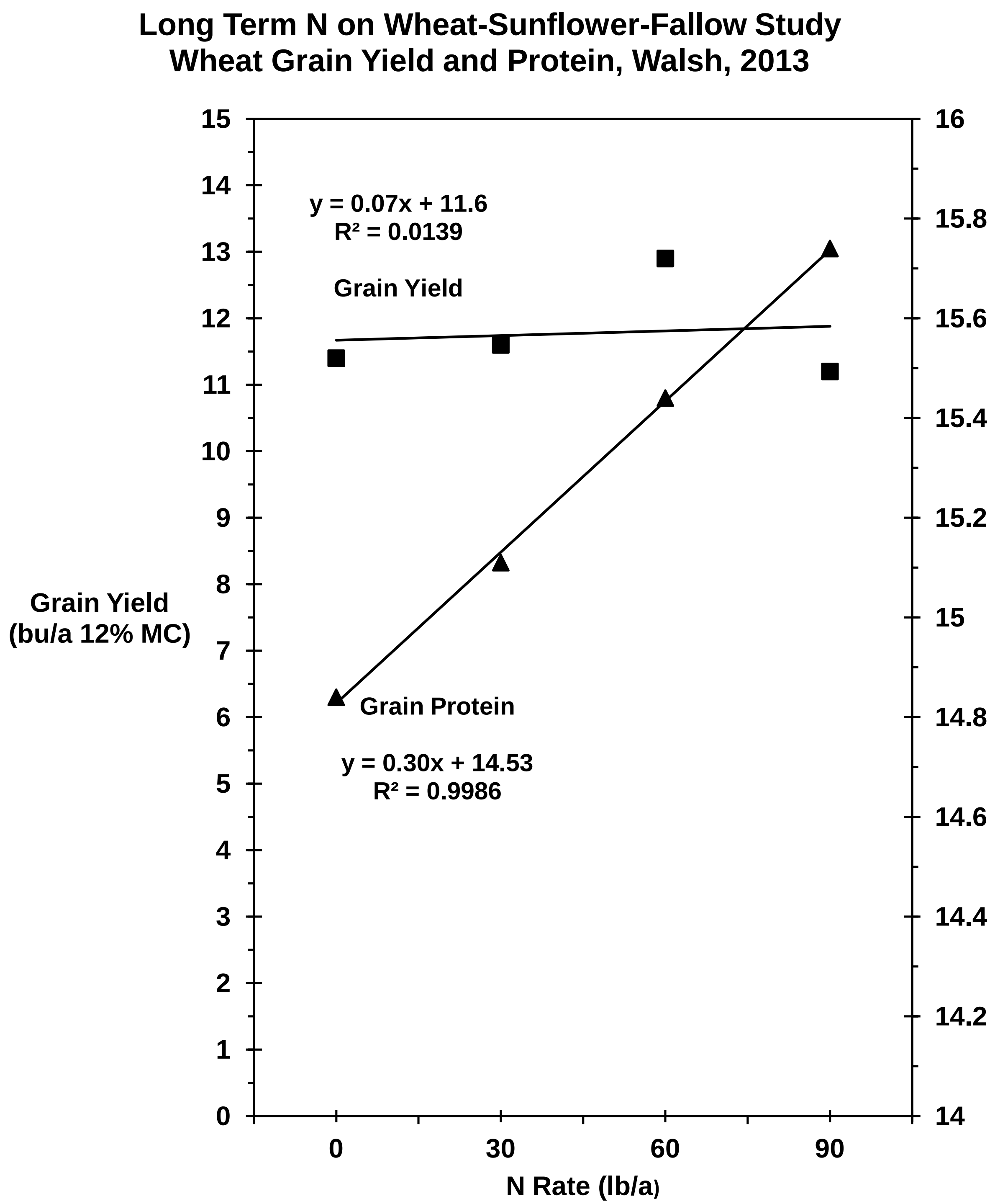


Fig. . N rates on yield and protein of dryland wheat in Wheat-Sunflower-Fallow rotation at Walsh. The N rates were 0, 30, 60, and 90 lb N/a as 32-0-0. The wheat variety was Hatcher sown at 50 lb/a.

Dryland Crop Rotation Study

Kevin Larson and Brett Pettinger

This is the ninth cropping year for our dryland rotation study. We established these rotations because of results from our dryland rotation sequencing study and growers' desire to include winter wheat in the rotations. The dryland rotation sequencing study was designed for spring crops, and the inclusion of winter wheat with its fall planting and early summer harvesting times would not fit into the design pattern of the sequencing study. To include winter wheat into a dryland rotation study, we began a new dryland rotation study with these three rotations in 2005: 1) Wheat-Sorghum-Fallow, 2) Wheat-Sunflower-Fallow, and 3) Sorghum-Millet. In 2006, we added a fourth rotation, Millet/Wheat-Fallow, to this rotation study.

Materials and Methods

This is our seventh harvest year in testing the following rotations: Wheat-Grain Sorghum-Fallow (W-S-F), Wheat-Sunflower-Fallow (W-Sun-F), and Sorghum-Millet (S-M). We added a fourth rotation of Millet/Wheat-Fallow (M/W-F) in 2006. In 2008 and 2011, no crops were harvested because of drought. We planted wheat, Hatcher, at 50 lb/a on October 4, 2012; Proso millet, Huntsman, at 12 lb/a on July 5; grain sorghum, Sorghum Partners KS310, at 23,000 seeds/a on June 24; and sunflower, Mycogen 8H449CL, at 16,500 seeds/a on June 27, 2013. We applied 50 lb/a of N to the study site. Before planting we sprayed two applications of glyphosate at 32 oz/a, LoVol at 0.5 lb/a, and dicamba 6 oz/a. For in-season weed control, we chose short-residual herbicides that should not interfere with crop rotations: wheat, Express 0.33 oz/a, LoVol 0.38 lb/a, and Activator 90 8 oz/a; millet, dicamba 4 oz/a and amine 10 oz/a; grain sorghum, atrazine 0.75 lb/a, Sharpen 2.0 oz/a, Huskie 16 oz/a, atrazine 0.5 lb/a, dicamba 4 oz/a; sunflower, glyphosate 32 oz/a, Spartan 2 oz/a; and fallow, glyphosate 32 oz/a, dicamba 6 oz/a and LoVol 0.5 lb/a two times. In addition, we applied paraquat 48 oz/a and atrazine 0.1 lb/a to all the fallow plots to control glyphosate-resistant kochia. We harvested the crops with a self-propelled combine equipped with a digital scale: millet, September 9; grain sorghum, October 23; and wheat, July 15. The sunflower crop was not harvested because of a poor stand. We recorded cost of production and yields in order to determine rotation revenues.

Results and Discussion

The W-S-F rotation produced the highest total rotation production of 1032 lb/a. The W-S-F rotation had relatively high yields for both wheat and grain sorghum. The high yields may be traced to fallow: summer fallow before the wheat crop and winter fallow before the grain sorghum crop. In the past we have stated: “Less fallow, more crops, more income.” This statement is still true in the long term under average moisture conditions, but when conditions are dry fallow produces more yield. For example, the M/W-F rotation with almost no fallow between millet harvest and wheat planting produced very poor wheat yields under dry conditions; whereas, the M/W-F rotation produced good millet yields because of the summer fallow before millet planting.

Along with the highest annual rotation production, the W-S-F rotation also returned the highest annual rotation variable net income of $56.60/a for 2013. The W-S-F rotation was able to return the highest annual rotation income despite having only two crops in three years; whereas, the S-M rotation had a crop each year. Because we have all phases of each crop rotation present each year, we can compare annual rotation production and income even without a full crop rotational cycle. For example, the 2013 total production for the S-M rotation was 1294 lb/a. The crop rotational phases were: grain sorghum, 1137 lb/a; millet 157 lb/a. The annual rotation production would be 647 lb/a, which is half the total production because the S-M rotation takes two years to complete one rotation cycle.

In 2013, M/W-F had the second highest annual rotation income of $41.67/a, because it had relatively high millet yields in its rotation. The majority of the 2013 income for the S-M was from lower-priced grain sorghum, whereas the majority of the income for the M/W-F was from higher-priced millet. In 2007, 2009, 2010, 2012, and 2013 the W-Sun-F rotation produced the least variable net incomes because the sunflower crop either outright failed or had poor stands.

The long term annual rotational income, after six harvest years, favors the S-M rotation with $126.69/a. The S-M rotation is an annual cropping rotation of grain sorghum and proso millet with no summer fallow period. The S-M rotation has typical winter fallow periods between the summer crops, which are sufficient fallow periods under average winter moisture conditions. The rotation with the second highest long term income is W-S-F with $106.18/a. The W-S-F rotation has extended fallow periods with a summer fallow preceding the wheat and a long winter fallow before the sorghum. The past couple of years have been quite dry and the extended fallow periods of the W-S-F rotation have contributed to its higher production and income.

In past years, winter wheat performed better than the spring crops in both yield and income. This year, wheat production was comparable to the spring crops, but the price of wheat was better. The sunflower crop was not harvest because of poor stand (the fifth failed sunflower crop in six cropping years). Without sunflower crop income this year, rotations containing wheat, grain sorghum and millet had higher incomes. This suggests that rotations that include adapted crops will spread income risk and may increase crop rotation revenue over multiple years.

Table .-Dryland Crop Rotation Study, Crop Production, 2013.

	Crop Production						
	---2013 Crop---					2013 Total	Annual
Rotation	Wheat	Grain Sorghum	Millet	Sunflower	Fallow	Rotation Production	Rotation Production
	---lb/a---						
S-M		1137	157			1294	647
W-S-F	1182	1915			0	3097	1032
M/W-F	354		1215		0	1569	785
W-Sun-F	1170			0	0	1170	390
Average	902	1526	686	0	0	1783	713
LSD 0.20	211.2	382.5	224.0				

Annual Rotation Production is Total Rotation Production divided by the number of years to complete one rotation cycle.
The sunflower crop was not harvested because of poor stand.

Table .-Dryland Crop Rotation Study, Variable Net Income, 2013.

						2013	Annual
	---2013 Crop---					Total	Rotation
		Grain				Crop	Variable
Rotation	Wheat	Sorghum	Millet	Sunflower	Fallow	Net Income	Net Income
	---$/a---						
S-M		52.56	3.02			55.58	27.79
W-S-F	116.81	100.94			-47.96	169.79	56.60
M/W-F	16.76		114.53		-47.96	83.33	41.67
W-Sun-F	115.36			-42.90	-47.96	24.50	8.17
Average	82.98	76.75	58.78	-42.90	-47.96	83.30	33.55

Variable Net Income is gross income minus seed cost and weed control cost.
Annual Rotation Variable Net Income is Total Crop Net Income divided by the number of years to complete one rotation cycle.
The sunflower crop had a poor stand and was not harvested.

Table .-Dryland Crop Rotation Study, Walsh, 2013.

Crop Rotation	Seeding Density	Seed Cost	Weed Control Cost	Yield	Crop Price	Gross Income	Variable Net Income
		---------------------	-------------	$/a	-------------	-------------	---------------------
<u>Wheat</u>	50 lb	10.00	16.02	15.0 bu	7.25/bu	108.99	82.97
M/W-F				5.9	7.25	42.78	16.76
W-Sun-F				19.5	7.25	141.38	115.36
W-S-F				19.7	7.25	142.83	116.81
<u>Millet</u>	12 lb	4.20	9.30	12.3 bu	5.90/bu	72.28	58.78
S-M				2.8	5.90	16.52	3.02
M/W-F				21.7	5.90	128.03	114.53
<u>Grain Sorghum</u>	23,000 seeds	3.45	29.25	27.3 bu	4.20/bu	114.45	81.75
S-M				20.3	4.20	85.26	52.56
W-S-F				34.2	4.20	143.64	110.94
<u>Sunflower</u>	16,500 seeds	24.75	18.15	0 lb	0.20/lb	0.00	-42.90
W-Sun-F				0	0.20	0.00	-42.90
Fallow	---	---	47.96	---	---	-47.96	-47.96
Average			24.14			49.55	26.53

Planted: Grain Sorghum Sorghum Partners KS310 at 23,000 seeds/a on June 24; Millet, Huntsman at 12 lb/a on July 5; and Sunflower Mycogen 8H449CL at 16,500 seeds/a on June 27; Wheat, Hatcher at 50 lb/a on October 4, 2012.
Harvested: Millet, September 9; Grain Sorghum, October 23; Wheat, July 15.
Sunflower crop weas not harvested.
Weed control cost is herbicide cost and $6.00/a application cost for each application.

Table .-Dryland Crop Rotation Study, Annual Rotation Income, 2006 to 2013.

Rotation	Annual Rotation Variable Net Income 2006	2007	2009	2010	2012	2013	2006-2013 Total Crop Net Income	Average Annual Rotation Variable Net Income
	$/a							
S-M	12.70	118.18	141.76	262.97	196.76	27.79	760.16	126.69
W-S-F	36.67	120.47	105.16	198.75	119.44	56.60	637.08	106.18
M/W-F	30.79	121.22	143.26	135.55	105.94	41.67	578.42	96.40
W-Sun-F	8.01	103.07	27.69	99.95	-98.64	8.17	148.25	24.71
Average	22.04	115.74	104.47	174.31	80.87	33.55	530.98	88.50

No crops were harvested in 2008 and 2011 because of drought.
The 2012 wheat crop was lost to hail.
The 2013 sunflower crop was not harvested because of poor stand.
Variable Net Income is gross income minus seed cost and weed control cost.
Annual Rotation Variable Net Income is Total Crop Variable Net Income divided by years to complete one rotational cycle.

Dryland Millet and Wheat Rotation Study

Kevin Larson and Brett Pettinger

This was the seventh cropping year for our dryland millet and wheat rotation study. We established these rotations to identify which millet and wheat and fallow rotation sequences produce the highest net incomes. Each rotation represents different fallow length. We began this new dryland rotation study with these six rotations in 2006: 1) Wheat-Fallow (15-month fallow period), 2) Wheat-Wheat (3-month fallow period), 3) Millet-Millet (8-month fallow period), 4) Wheat-Millet-Fallow (23-month fallow period, 11 months between wheat harvest and millet planting, and 12 months between millet harvest and wheat planting), 5) Millet/Wheat-Fallow, (no fallow between millet harvest and wheat planting and 11 months between wheat harvest and millet planting), and 6) Wheat/Millet-Fallow (no fallow between wheat harvest and millet planting and 11 months between millet harvest and wheat planting).

Materials and Methods

This was our sixth crop harvest for the following rotations: Wheat-Fallow (W-F), Wheat-Wheat (W-W), Millet-Millet (M-M), Wheat-Millet-Fallow (W-M-F), Millet/Wheat-Fallow (M/W-F), and Wheat/Millet-Fallow (W/M-F). We planted wheat, Hatcher, at 50 lb/a on October 4, 2012 and proso millet, Huntsman, at 12 lb/a on July 5, 2013. We applied 50 lb N/a to the study site. Before planting we sprayed two applications of glyphosate at 32 oz/a, dicamba 6.0 oz/a, and LoVol 0.5 lb/a. For in-season weed control, we chose short-residual herbicides that should not interfere with crop rotations: wheat, Express 0.33 oz/a, LoVol 0.38 lb/a, and Activator 90 8 oz/a; millet (except W/M-F) dicamba 4 oz/a and 2,4-D amine 10 oz/a; and fallow, glyphosate 32 oz/a, dicamba 6 oz/a and LoVol 0.5 lb/a two times. To control glyphosate-resistant kochia, we applied paraquat 48 oz/a and atrazine 0.1 lb/a. The millet in the W/M-F rotation was not planted, therefore no in-crop millet herbicides were used. We harvested the millet on September 10 and the wheat on July 26 with a self-propelled combine equipped with a digital scale. Grain yields were adjusted to 14% moisture content for the millet and 12% moisture content for the wheat. We recorded cost of production and yields in order to determine rotation revenues. There were no crops harvested in 2008 because of drought. Only wheat was harvested in 2011: the millet was not planted because of drought.

Results and Discussion

Because of the dry conditions this year, crops following abbreviated fallow periods either performed poorly or outright failed. For example, with a three-month fallow period, the wheat in the W-W rotation was planted but it failed to produce a wheat crop. This year, the only rotation to produce positive annual rotation variable net income was W-M-F, which made $12.05/a. Despite the complete wheat crop failure this year for the W-W rotation, this continuous wheat rotation produced the highest net return of $83.77/a after six harvest years.

For the seven years that we have conducted this study, we have had crop multiple failures and missed plantings, therefore rotational affects are, at best, difficult to generalize and quantify. This year, dry conditions reduced yields of both wheat and millet crops, and we failed to plant millet in the W/M-F rotation. After six harvest years, and acknowledging crop failures and missed planting, the W-W rotation produced the highest and the W-M-F the second highest rotation average annual rotation variable net income of $83.77/a and $55.34, respectively. The four other rotations provided around $39/a to $49/a in average annual rotation variable net income after six harvest years. Last year, millet was the only crop harvested because the wheat crop was completely lost to hail, and we failed to plant millet in the M/W-F and W/M-F rotations. In 2011, we had wheat production, but no millet production; therefore, we were able to plant and harvest only the wheat for in all phases of the rotations containing wheat. In 2010, there was sufficient precipitation to plant and harvest all wheat and millet crops in all rotations. The W-W rotation had the highest annual rotation variable net income in 2010. In 2009, adequate spring and summer moisture produced good yields for most crops with the wheat and millet producing similar yields. No crops were harvested in 2008 because of drought. Winter wheat performed better than millet in both yield and income in 2007. In 2007, it was too dry for the millet planted immediately after wheat harvest (millet in the W/M-F) to establish a stand. We missed planting wheat in the M/W-F rotation in 2008. In 2009, we did not plant millet in the W/M-F rotation because of delayed volunteer wheat control.

Table .Dryland Millet-Wheat Rotation, Crop Production, 2013.

Rotation	Wheat	Millet	Fallow	2013 Total Rotation Production	Annual Rotation Production
	-----------2013 Crop---------				
	-------------------------lb/a---------------------------				
W-F	150			150	75
W-W	0			0	0
W-M-F	522	577		1099	366
M/W-F	96	778		874	437
W/M-F	222	0		222	111
M-M		123		123	123
Average	198	370		411	185

Annual Rotation Production is Total Rotation Production divided by the number of years to complete one rotation cycle.
The millet in the W/M-F rotation was not planted because of dry conditions.

Table .Dryland Millet-Wheat Rotation, Variable Net Income, 2013.

Rotation	Wheat	Millet	Fallow	2013 Total Crop Net Income	Annual Rotation Variable Net Income
	-----------2013 Crop---------				
	-------------------------$/a---------------------------				
W-F	-7.90		-47.96	-55.86	-27.93
W-W	-26.02			-26.02	-26.02
W-M-F	37.06	47.06	-47.96	36.16	12.05
M/W-F	-24.17	68.23	-47.96	-3.90	-1.95
W/M-F	0.81	0.00	-47.96	-47.15	-23.58
M-M		-0.56		-0.56	-0.56
Average	-4.04	28.68	-47.96	-16.22	-11.33

Variable Net Income is gross income minus seed cost and weed control cost.
Annual Rotation Variable Net Income is Total Crop Net Income divided by the number of years to complete one rotation cycle.
The millet in the W/M-F rotation was not planted.

Table .-Dryland Millet and Wheat Rotation Study, Walsh, 2013.

Crop Rotation	Seeding Density	Seed Cost	Weed Control Cost	Yield	Crop Price	Gross Income	Variable Net Income
	lb/a	$/a	$/a	bu/a	$/a	$/a	$/a
Wheat							
W-F	50	10.00	16.02	2.5	7.25	18.13	-7.90
W-W	50	10.00	16.02	0	7.25	0.00	-26.02
W-M-F	50	10.00	16.02	8.7	7.25	63.08	37.06
M/W-F	50	10.00	25.77	1.6	7.25	11.60	-24.17
W/M-F	50	10.00	16.02	3.7	7.25	26.83	0.81
Wheat Average	**50**	**10.00**	**17.97**	**3.3**	**7.25**	**23.93**	**-4.05**
Millet							
M-M	12	4.20	9.30	2.2	5.88	12.94	-0.56
W-M-F	12	4.20	9.30	10.3	5.88	60.56	47.06
M/W-F	12	4.20	9.30	13.9	5.88	81.73	68.23
W/M-F	0	0.00	0.00	0	5.88	0.00	0.00
Millet Average	**18**	**4.20**	**7.78**	**6.6**	5.88	**38.81**	**28.68**
Fallow	---	---	47.96	---	---	0.00	-47.96
Average			14.12			23.93	-7.77

Planted: Millet, Huntsman at 12 lb/a on July 5; Wheat, Hatcher at 50 lb/a on October 4, 2012.
Harvested: Millet on September 10; Wheat on July 26.
Wheat herbicides: Express 0.33 oz/a, 2,4-D, 0.38 lb/a; Wheat hericide cost: $10.02/a.
Millet herbicides: dicamba 4 oz/a, 2,4-D amine 10 oz/a: Millet herbicide cost: $3.30/a
Fallow herbicides: glyphosate 32 oz/a, 2,4-D 0.5 lb/a, dicamba 6 oz/a;
Fallow herbicide cost: $8.65/a per application (two applications, $6.00/a per application)
Fallow herbicides to control glyphosate resistant kochia: paraquat 48 oz/a, atrazine 0.1 lb/a.
Kochia control cost: $12.66/a.
Wheat in M/W-F additional herbicide: glyphosate 32 oz/a cost $3.75/a.
Millet in W/M-F herbicides: none, not planted.
Weed control cost is herbicide cost and $6.00/a application cost for each application.

Table .Millet-Wheat Rotation, Annual Rotation Income, 2007 to 2013.

Rotation	Annual Rotation Variable Net Income 2007	2009	2010	2011	2012	2013	2007-2013 Total Crop Net Income	Average Annual Rotation Variable Net Income
	$/a							
W-F	108.22	52.13	112.08	63.66	-21.47	-27.93	286.68	47.78
W-W	193.14	105.30	170.76	78.46	-19.04	-26.02	502.60	83.77
W-M-F	95.53	72.66	116.42	37.05	-1.65	12.05	332.05	55.34
M/W-F	141.03	32.87	123.45	-34.96	-25.79	-1.95	234.66	39.11
W/M-F	95.36	38.57	118.77	59.48	-21.47	-23.58	267.13	44.52
M-M	102.97	73.83	93.66	-23.30	47.39	-0.56	293.99	49.00
Average	122.71	62.56	122.52	30.07	-7.00	-11.33	319.52	53.25

No crops were harvested in 2008 because of drought.
No millet was harvested in 2011 because of drought.
No wheat was harvested in 2012 because of hail damage.
Variable Net Income is gross income minus seed cost and weed control cost.
Annual Rotation Variable Net Income is Total Crop Variable Net Income divided by years to complete one rotational cycle.

The Effects of Spring and Winter Cover Crops on Dryland Crop Production

Kevin Larson and Brett Pettinger

One of the Natural Resource Conservation Service (NRCS) current foci is on cover crops and their affects on soil health. Much of this recent work with cover crops is from much higher precipitation and much lower evaporation locations, such as the Upper Midwest (Conservation Tillage & Technology Conference, 2011), than we have in Southeastern Colorado. Few cover crop studies have been conducted on dryland rotations in low moisture, high evaporation climates such as we experience in our region and the reports from these dryland cover crop studies have been less than favorable (Larson, 1995; Schlegel and Havlin, 1997; Vigil and Nielsen, 1998). We began this study to measure the effects of cover crops on yields of common dryland crop rotations in our semi-arid climate where water conservation is the key to successful dryland crop production.

Materials and Methods

We tested cover crops and N rates in two common crop rotations: Wheat-Fallow (W-F) and Wheat-Sorghum-Fallow (W-S-F) .Our treatments for this cover crop study were: four spring and four winter cover crops, three N rates, and two crop rotations. We planted spring cover crops: oats at 60 lb/a, rapeseed at 5 lb/a, hairy vetch at 30 lb/a, and Spring N Mix at 58 lb/a (lentil, 10 lb/a; common vetch, 6 lb/a; spring forage pea, 15 lb/a; oats, 20 lb/a; rapeseed, 2 lb/a; flax, 5 lb/a). We planted the spring cover crops for the W-S-F rotation in early April, during the summer fallow period after sorghum harvest and terminated them before wheat planting. We planted winter cover crops: triticale at 60 lb/a, rapeseed at 5 lb/a, hairy vetch at 30 lb/a, Winter N Mix at 43 lb/a (hairy vetch, 8 lb/a; winter pea, 8 lb/a; sweet clover, 2 lb/a; triticale, 20 lb/a; rapeseed, 2 lb/a; sorghum sudan grass, 3 lb/a). We planted the winter cover crops in August after wheat harvest and terminated them in the spring before planting sorghum in the W-S-F rotation and before planting wheat in the W-F rotation. All cover crop seeds were from Green Cover Seed in Bladen, Nebraska. Our three N rates were 0, 25, and 50 lb/a stream applied as 28-0-0 or 32-0-0. No N was applied to the cover crop plots. After establishing the rotations, all phases of each rotation will be present each year. We were only able to test grain sorghum in the W-S-F rotation because we are still establishing these rotations. We planted the winter cover crops on August 28, 2012 and we sprayed a tank mix of glyphosate, 2,4-D and dicamba to terminate the cover crops and to control weeds in the N plots on April 3, 2013. We planted Sorghum Partner KS310 at 23,000 seeds/a on June 24, 2013 and seedrow applied 5 gal 10-34-0/a at planting. For in-season broadleaf weed control in the grain sorghum crop, we applied a tank mix of Huskie 16 oz/a, atrazine 0.5 lb/a, and AMS 1 lb/a. We inserted gypsum blocks at 6 in., 18 in., and 30 in. depths to measure soil water use by the cover crops and the subsequent grain crops. We harvested the grain sorghum on October 23, 2013 with a self-propelled combine equipped with a digital scale. Grain sorghum grain yields were adjusted to 14.0% seed moisture content.

Results and Discussion

Total precipitation for the sorghum phase of the W-S-F rotation, from winter cover crop planting (August 28, 2012) to first freeze (October 6, 2013), was 23.64 in. Precipitation during the growth and termination of the winter cover crops (seven months, September to March) was 5.36 in. Between cover crop termination and sorghum planting, an additional 4.04 in. of rainfall occurred from April to June. From sorghum planting to first freeze (June 24 to October 6), there was 14.24 in. of rain. The precipitation for this sorghum phase of the study, from September to September, was above average, 3.20 in. more than our 31-year average. The precipitation from September, 2012 to September, 2013 was 23.64 in. and our 31-year average for this same period is 20.44 in. For this thirteen-month precipitation period, March, April, May and August were drier than average, and June, July and September were wetter than average. Sorghum grain yields were poor, in part, because of the very dry flowering and early filling period during August.

Winter cover crops were terminated after seven months of growth, twelve weeks prior to planting the grain sorghum. Because this is our first winter cover crop season with these newly established crop rotations, we were only able to test grain sorghum in the W-S-F rotation. After seven months of growth, the average dry matter production of the cover crops was 4097 lb/a. The forage yield of the rapeseed was 6093 lb/a, which was significantly higher than any of the other cover crops. Nitrogen in the forage of the non N fixing cover crops was 170.6 lb/a for rapeseed and 114.6 lb/a for triticale. The leguminous hairy vetch produced 134.5 lb/a of forage N, which was 36.1 lb/a less N than the rapeseed, the non N fixing broadleaf comparative. The Winter N Mix was a mixture of legumes and non N fixing plants. The N in the Winter N Mix was 6.6 lb/a less than the forage N averages of triticale and rapeseed, the non N fixing grass and broadleaf crop comparatives. Since the amount of N in the N fixing crops was less than the non N fixing crops, the N in the forages is considered uptake from the soil and not fixed from the atmosphere by legumes.

When terminated after seven months of growth, the cover crops used: 2.93 in. for hairy vetch, 5.27 in. for Winter N Mix, 3.74 in. for rapeseed, and 4.87 in. for triticale of soil water to a depth of three feet. The fallow 0N check used 0.86 in. of soil water to a depth of three feet during the same seven month period. Therefore, subtracting soil water used by cover crops from soil water used during no-till fallow equals the water use cost of cover crops. The water use cost to a soil water depth of three feet was 2.07 in. for hairy vetch, 4.41 in. for Winter N Mix, 2.88 in. for rapeseed, and 4.01 in. for triticale. Rapeseed and hairy vetch had the lowest water use of the cover crops tested and the highest grain yields, although the range of the grain yields for the cover crops was only 2.0 bu/a to 3.3 bu/a.

The treatment with the highest grain sorghum yield was N at 25 lb/a with 8.0 bu/a. The grain sorghum yields of the N treatments were significantly higher than any of the cover crop treatments. The average grain yield of the N treatments was 2.7 times higher than the average grain yield of the cover crops; however, the overall grain yield of the entire study was quite low, only 4.6 bu/a. The low grain yields of this study were obtained despite receiving above average moisture during the 13 months of the study.

The grain sorghum stands of the N treatments were quite low, averaging 6667 plants/a, only about half the plant density average of the sorghum following the cover crops. Because of the higher, more consistent grain sorghum plant populations following the cover crops, we predicted that the grain yields following the cover crops would be higher than the N treatments. However, the dry conditions during grain sorghum flowering and early grain-filling dispelled our earlier predictions. The very low plant and tiller populations of grain sorghum were beneficial for the N treatments under the dry conditions and produced higher grain yield than the cover crops. From this and other studies, we observed that sorghum plant stands were higher (near the typical dryland optimum) where there was sufficient residue from stubble or cover crops.

The 0 N check produced the highest variable net income, $22.26/a, because it had comparatively higher yield than most of the other treatments and no treatment cost. The only other treatment to produce a positive variable net income was the 25 lb N/a fertilizer treatment with $13.10/a. The variable net income loss from the cover crops ranged from -$2.89/a for rapeseed to -$58.50/a for hairy vetch. The rapeseed cover treatment had a higher variable net income (lost less) than the 50 lb N/a treatment. Because this first winter cover crop planting produced less grain yield than the no-till fallow planted grain sorghum, there was no income advantage to planting cover crops this season. However, there was a potential agronomic benefit from planting grain sorghum into cover crops: the grain sorghum plant stands following cover crops were much higher than no-till fallow plant stands.

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Table .-Cover Crop Study, Grain Sorghum after Winter Cover Crop, Walsh, 2013.

Treatment	Grain Sorghum Yield	Test Wt.	Plant Density	Tiller Density	Cover Dry Matter	Cover N	Treatment Cost	Variable Net Income
	bu/a	lb/bu	plants/a	tillers/a	lb/a	lb/a	$/a	$/a
Winter N Mix	2.0	55	16,500	39,900	3890	136.9	46.25	-37.85
Hairy Vetch	2.5	54	11,100	26,900	3459	134.5	69.00	-58.50
Rapeseed	3.3	55	16,500	38,400	6093	170.6	16.75	-2.89
Triticale	2.1	54	14,400	33,600	2947	114.6	28.80	-19.98
0 N	5.3	51	7,300	13,500			0.00	22.26
25 N	8.0	52	7,500	15,100			20.50	13.10
50 N	6.7	52	5,200	9,400			35.50	-7.36
Average	4.3	53	11,200	25,300	4097	139.2	30.97	-13.03
LSD 0.20	0.95		3,440	9,900	92.9			

Cover crops planted: August 28, 2012; Terminated: April 3, 2013.
Cover crop dry matter reported at 0% moisture.
Cover crop N is calculated from dry matter protein divided by 6.25.
Grain sorghum planted: June 24; Harvested: October 23, 2013.
Cover crop seeding rate: Winter N Mix, 43 lb/a; hairy vetch, 30 lb/a; rapeseed, 5 lb/a; triticale, 50 lb/a.
Winter N Mix: hairy vetch, 8 lb/a; sweet clover, 2 lb/a; winter forage pea, 8 lb/a; triticale, 20 lb/a; rapeseed, 2 lb/a; sorghum sudangrass BMR, 3 lb/a.
Cover seed cost: Winter N Mix, $34.25/a; hairy vetch, $57/a; rapeseed, $4.75/a; triticale, $16.80/a.
N fertilizer cost: 28-0-0, $0.60/lb.
Treatment application cost: cover crop planting, $12/a; N application, $5.50/a.
Grain sorghum price: $4.20/a.

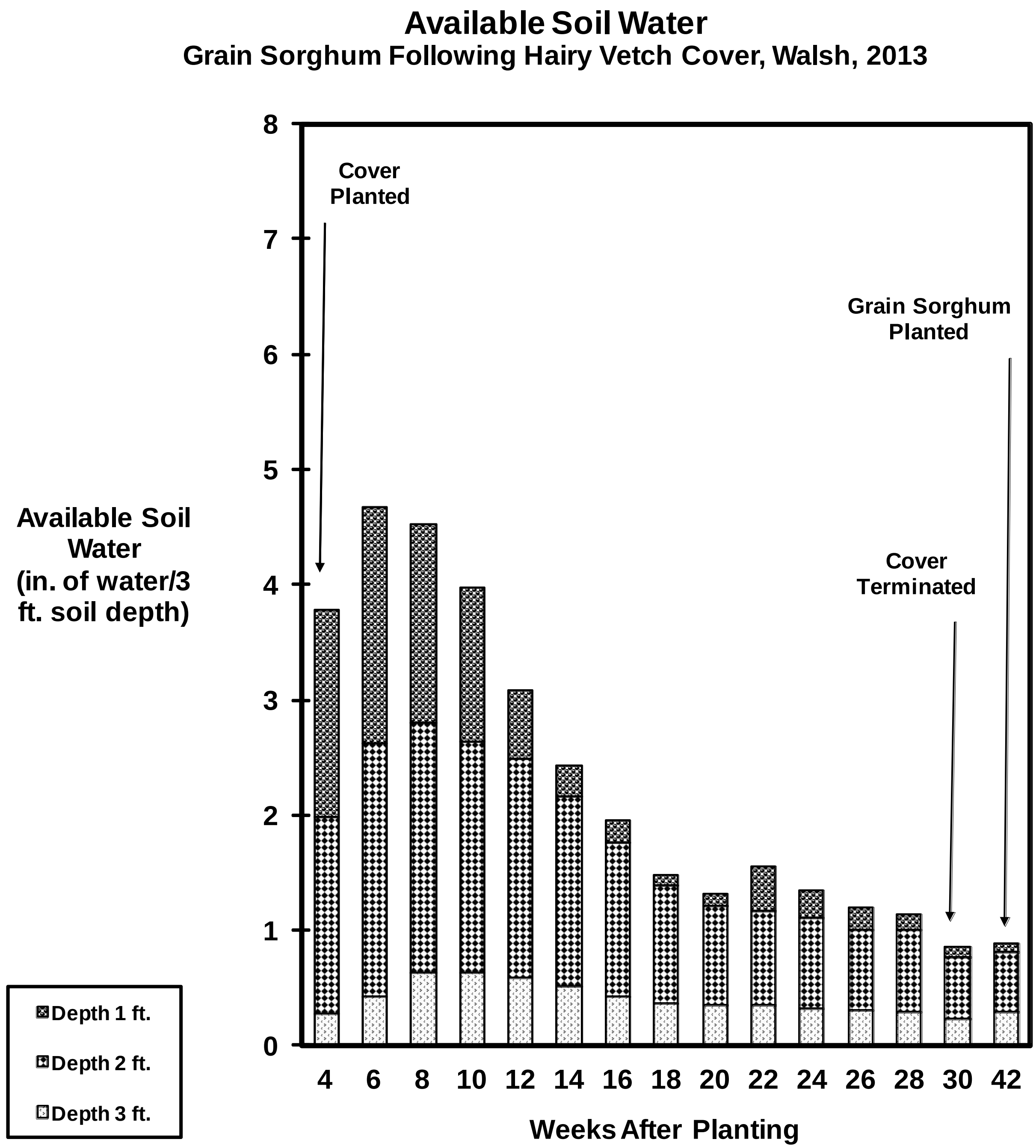

Fig. . Available soil water in grain sorghum following Hairy Vetch Cover at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 5.36 in. Any increase in available soil water between weeks is from rain.

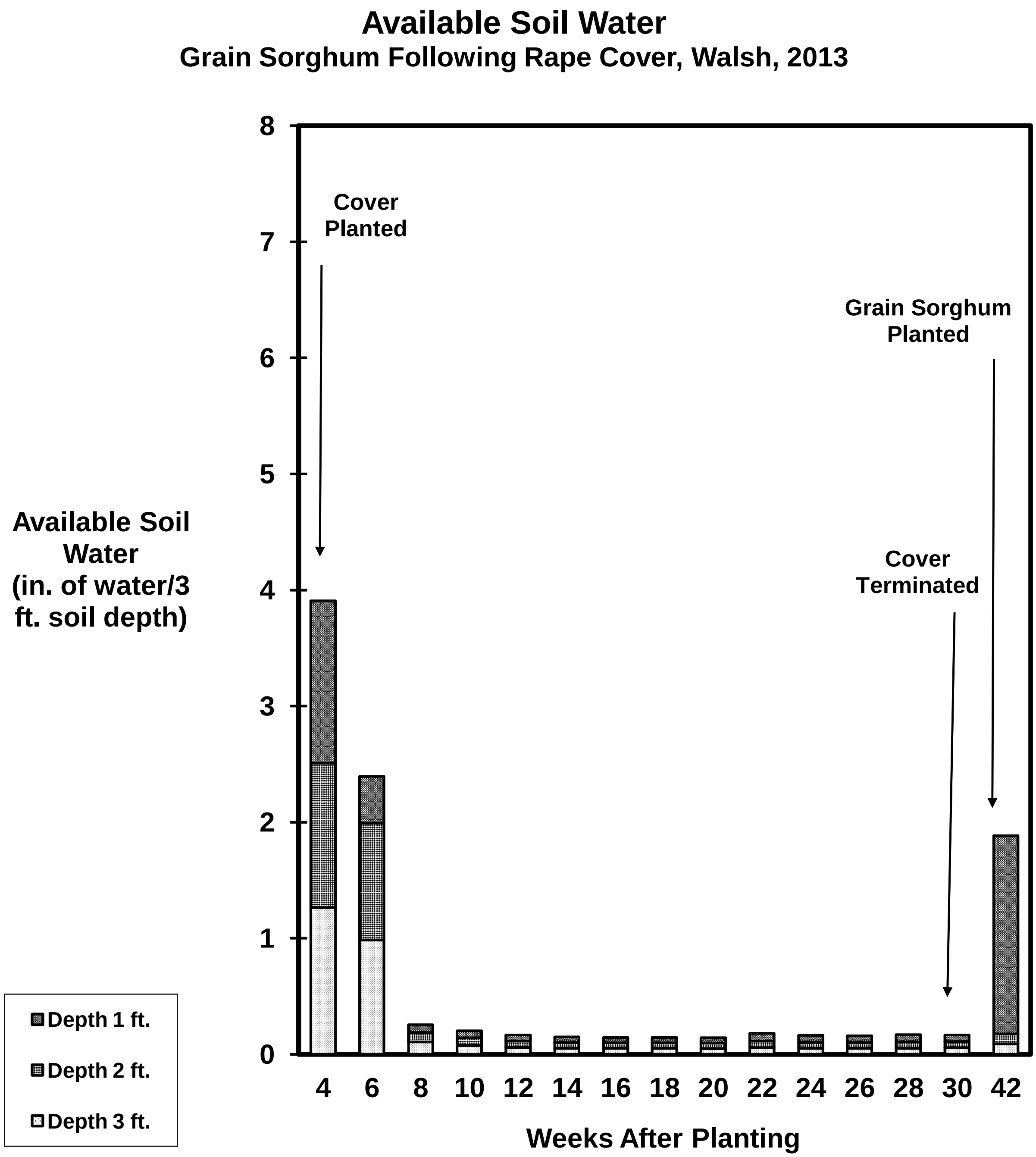

Fig. . Available soil water in grain sorghum following Rape Cover at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 5.36 in. Any increase in available soil water between weeks is from rain.

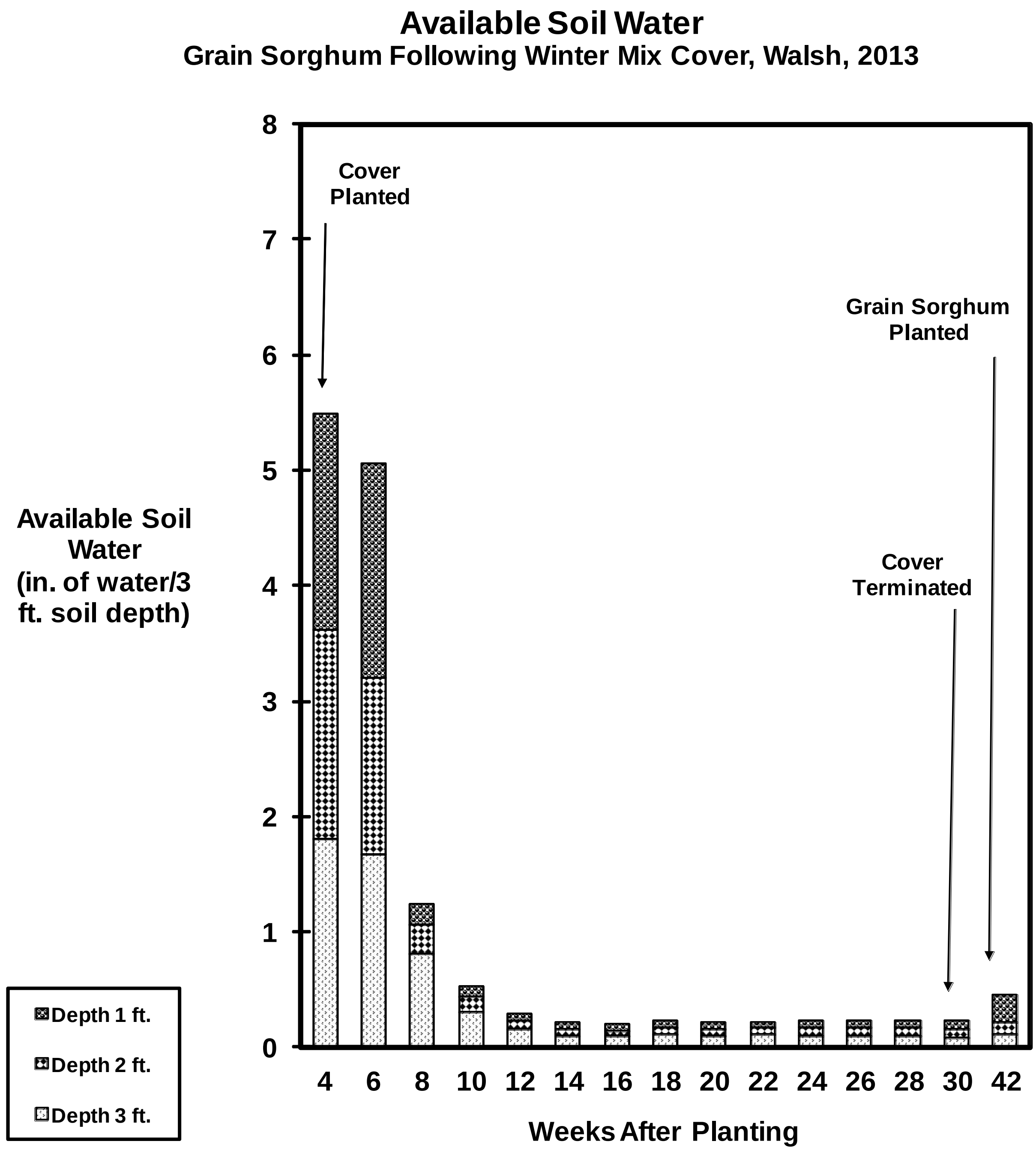

Fig. . Available soil water in grain sorghum following Winter Mix Cover at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 5.36 in. Any increase in available soil water between weeks is from rain.

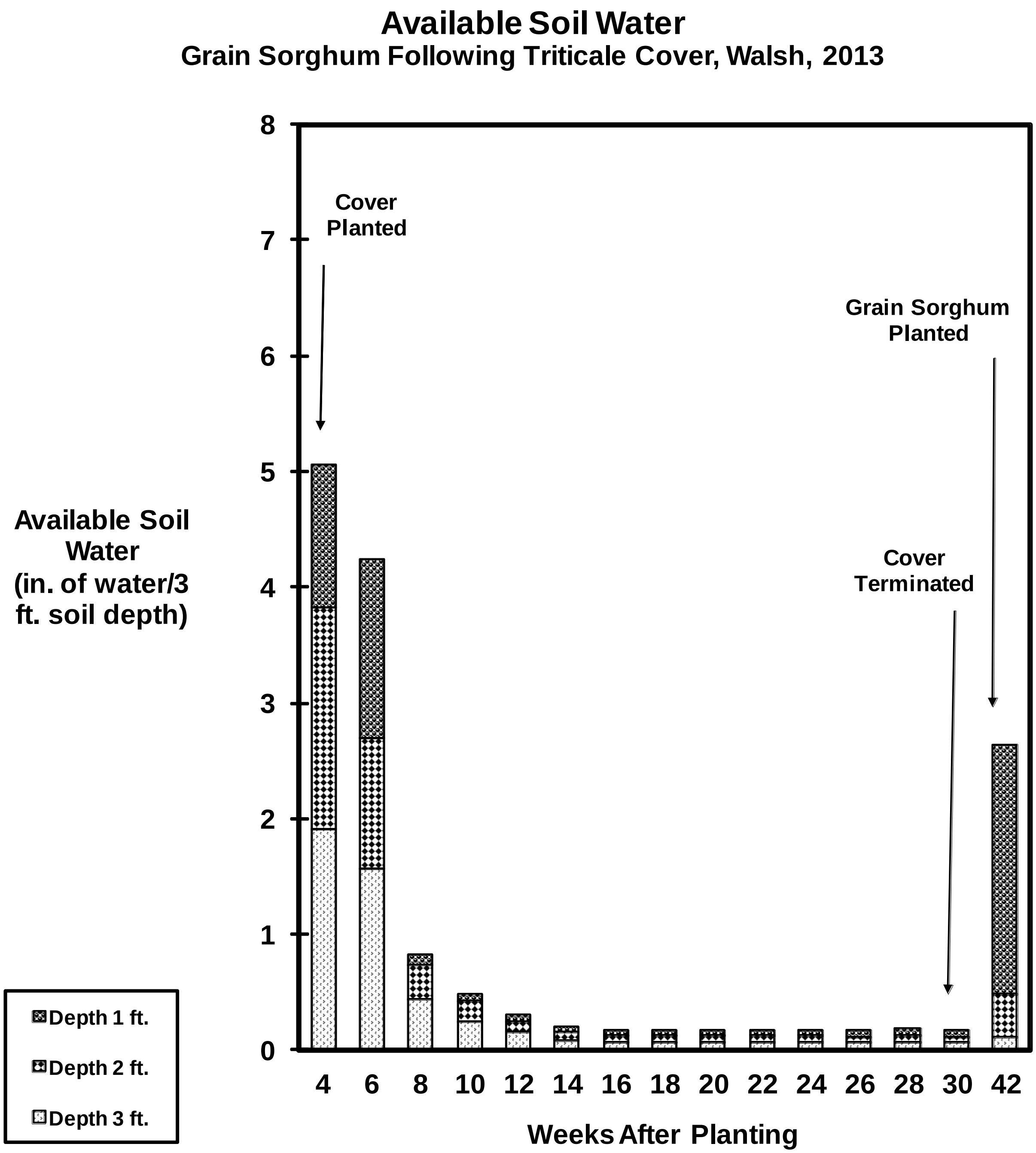

Fig. . Available soil water in grain sorghum following Triticale Cover at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 5.36 in. Any increase in available soil water between weeks is from rain.

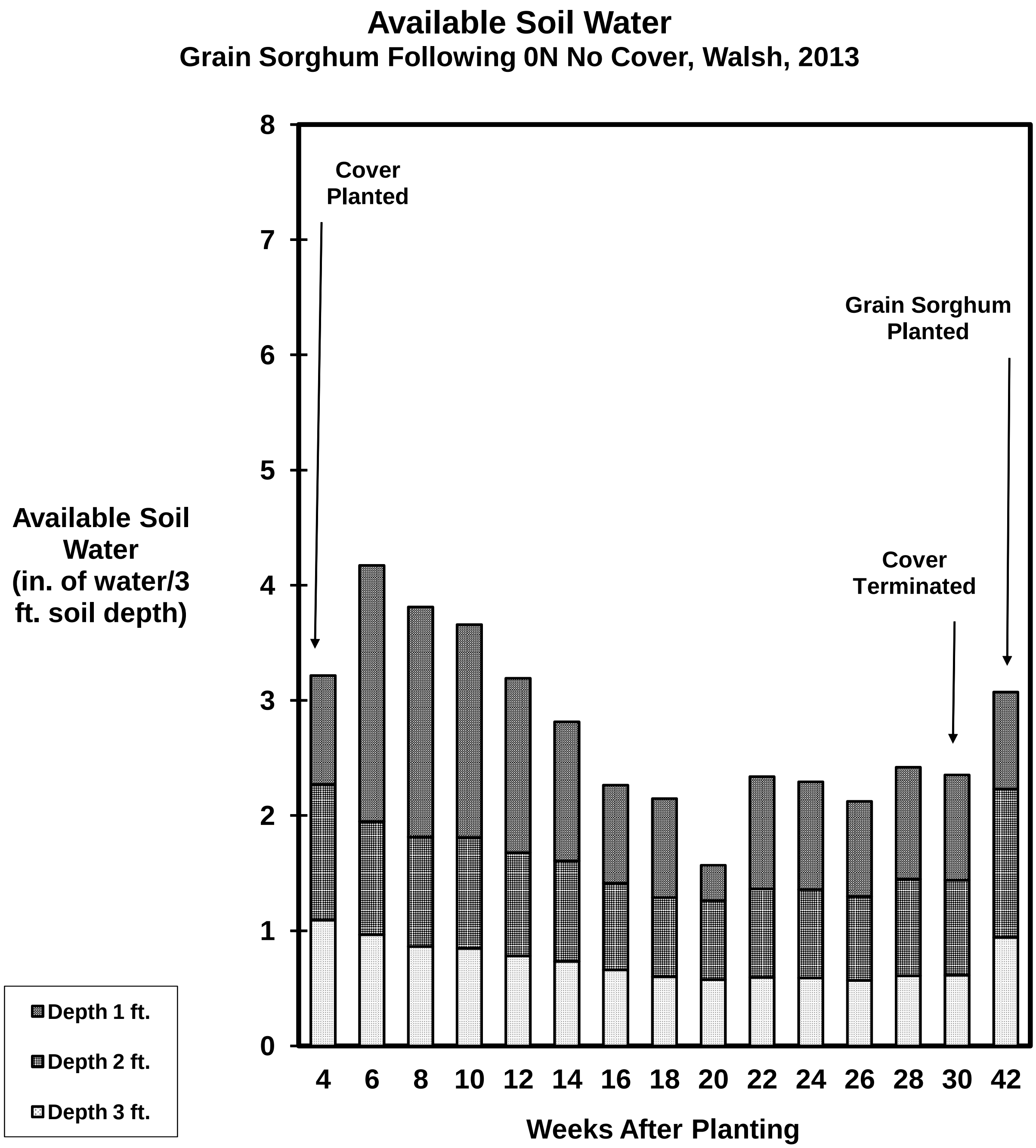

Fig. . Available soil water in grain sorghum following 0N No Cover at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 5.36 in. Any increase in available soil water between weeks is from rain.

Long Term Evaluation of CRP Conversion Back into Crop Production

Kevin Larson and Brett Pettinger

The Conservation Reserve Program has been one of the most important USDA programs for Colorado. It has added millions of dollars to Colorado farm income, regardless of weather and commodity fluctuations. In 2011, Colorado had 1.87 million acres in CRP, and of that total, 571,000 acres expired October, 2012 (USDA, FSA, 2011). Because of high commodity prices and funding uncertainty for CRP extensions, many CRP acres may continue to be converted back into crop production. CRP has provided soil erosion protection by growing perennial grass cover. We developed this study to see which CRP grass conversion method, chemical (no-till) or tillage, provides the highest variable net return over multiple years for two common crop rotations, Wheat-Fallow (W-F) and Wheat-Sorghum-Fallow (W-S-F).

Materials and Methods

We are testing our long term CRP conversion in two common crop rotations: Wheat-Fallow (W-F) and Wheat-Sorghum-Fallow (W-S-F). After establishing the rotations, all phases of each rotation will be present each year. We began our long term CRP conversion study on March 29, 2012 using chemical or tillage. Because we were still establishing the crop rotations, grain sorghum was the only crop studied for the 2012 cropping season. For the 2013 cropping season, we were able to harvest the first wheat crops and the extended-fallow grain sorghum crop. For chemical CRP conversion prior to wheat and extended-fallow grain sorghum crops, we applied glyphosate at 128 oz/a and ammonium sulfate (AMS) at 2 lb/a on six application dates: March 29, April 25, May 18 and June 21, July 27, and October 3, 2012. For tillage CRP conversion prior to wheat and extended-fallow grain sorghum crops, we disked four times with an offset disk on four dates: March 29, April 23, May 18 and June 21, 2012, and swept two times on July 27 and October 9, 2012. For in-season broadleaf weed control in the grain sorghum crop, we applied a tank mix of Huskie 16 oz/a, atrazine 0.5 lb/a, and AMS 1 lb/a. For in-season broadleaf weed control in the wheat crop, we applied Ally Extra 0.4 oz/a, 2,4-D ester 0.38 lb/a, and Activator 90 8oz/a. For N fertilization, we streamed 32-0-0 at 75 lb N/a on 18 in. spacing. We planted wheat, Hatcher at 50 lb/a and seedrow applied 5 gal 10-34-0/a, on October 11, 2012. For the sorghum crop, we planted Sorghum Partners KS310 at 23,000 seeds/a on June 28, 2013 and seedrow applied 5 gal 10-34-0/a at planting. We harvested the wheat on July 18, 2013 and the grain sorghum on October 24, 2013 with a self-propelled combine equipped with a digital scale. Wheat yields were adjusted to 12% seed moisture content and grain sorghum yields were adjusted to 14% seed moisture content.

Results and Discussion

On August 3, 1990, Ken Lair, Soil Conservation Service, planted these 11 perennial grass strips: Hycrest, crested wheat grass; Bozorsky, Russian wildrye; Oahe, intermediate wheatgrass; Luna, pubescent wheatgrass; 9053823, smooth brome; Paiute, orchard grass; Granada, yellow bluestem; WWSpar, old world bluestem; Caucasian, bluestem; Ironmaster, bluestem; Morpa, weeping lovegrass. Each of our CRP conversion treatments transects all 11 perennial grass strips.

For this CRP conversion study, we are investigating the effects of maintaining the grass cover on subsequent crop yields over multiple years. This is the first wheat harvested and the second-season grain sorghum harvested; therefore, we are still establishing our rotations. This is the first wheat crops for both the W-F and W-S-F rotations after our initial burn down or tillage control of the perennial grasses. With six chemical treatments or six tillage treatments, we were able to control most of the perennial grasses prior to planting the 2013 wheat and grain sorghum crops.

Dry conditions and multiple late freezes damaged tillers and resulted in very poor wheat yields for both chemical and tillage CRP conversion treatments. Wheat yields ranged from 0.3 bu/a to 2.1 bu/a. Both CRP conversion methods had significant cash losses in variable net incomes, averaging -$80/a for tillage and -$100/a for chemical. Wheat production was too low to offset the high cost of CRP conversion, regardless of conversion method. Nonetheless, chemical conversion was more costly than tillage conversion for this first wheat crop, and thus lost as much as -$24/a more than tillage conversion.

We are in the process of establishing the crop rotations, which this year created a summer fallow period before the sorghum crop. The extended fallow period produced good grain sorghum yields for both CRP conversion methods, 35.3 bu/a for chemical and 24.6 bu/a for tillage. The higher cost of chemical conversion compared to tillage conversion was more than offset by the higher grain sorghum production obtained with chemical conversion compared to tillage conversion. Chemical CRP conversion provided $16/a more variable net income than tillage conversion with the summer fallow grain sorghum crop.

Reference Cited

USDA, FSA. December 30, 2011. Conservation Reserve Program - Monthly CRP Acreage Report, Summary of Active and Expiring CRP Acres by State. Accessed: January 12, 2012. ftp://ftp.fsa.usda.gov/crpstorpt/RMEPEGG/MEPEGGR1.HTM

Table .Long Term CRP Conversion Using Tillage or Chemical, First Season, Wheat-Sorghum-Fallow & Wheat-Fallow, Wheat Crop, Walsh, 2013.

CRP Conversion	Rotation	Test Weight	Wheat Yield	Gross Income	Conversion Cost	Variable Net Income
		lb/bu	bu/a	$/a	$/a	$/a
Chemical	W-S-F	54	1.5	10.88	113.10	-102.23
Tillage	W-S-F	57	0.8	5.80	84.00	-78.20
Chemical	W-F	54	2.1	15.23	113.10	-97.88
Tillage	W-F	57	0.3	2.18	84.00	-81.83
Average		56	1.2	8.34	98.55	-90.21
LSD 0.20			0.30			

Chemical: glyphosate 128 oz/a and AMS 2 lb/a applied six times.
Chemical cost: $13.35/a and $5.50/a for each application.
Chemical application dates: March 29, April 25, May 18, June 21, July 27 and October 3, 2012.
Tillage: disked four times and swept two times.
Tillage cost: $15/a per disking and $12/a per sweeping.
Tillage application dates: March 29, April 23, May 18, June 21, July 25, and October 9, 2012.
N fertilizer applied at 75 lb/a as 32-0-0.
Wheat , Hatcher, 50 lb seeds/a, 5 gal 10-34-0/a.
seedrow applied 5 gal 10-34-0/a at planting.
Wheat planted on October 11, 2012; harvested on July 18, 2013.
wheat price: $7.25/bu.
Variable Net Income is Gross Income minus Conversion Cost.

Table .Long Term CRP Conversion Using Tillage or Chemical, Second Season, Wheat-Sorghum-Fallow, Grain Sorghum Crop, Walsh, 2013.

CRP Conversion	Rotation	Test Weight	Grain Sorghum Yield	Gross Income	Conversion Cost	Variable Net Income
		lb/bu	bu/a	$/a	$/a	$/a
Chemical	W-S-F	58	35.3	148.26	113.10	35.16
Tillage	W-S-F	56	24.6	103.32	84.00	19.32
Average		57	30.0	125.79	98.55	27.24
LSD 0.20			5.08			

Chemical: glyphosate 128 oz/a and AMS 2 lb/a applied six times.
Chemical cost: $13.35/a and $5.50/a for each application.
Chemical application dates: March 29, April 25, May 18, June 21, July 27, and October 3, 2012.
Tillage: disked four times and swept two times.
Tillage cost: $15/a per disking and $12/a per sweeping.
Tillage application dates: March 29, April 23, May 18, June 21, July 27, and October 9, 2012.
N fertilizer applied at 75 lb/a as 32-0-0.
Grain sorghum, Sorghum Partners KS310, planted at 23,000 seeds/a and seedrow applied 5 gal 10-34-0/a at planting.
Grain sorghum planted on June 28; harvested on October 24, 2013.
Grain sorghum price: $4.20/bu.
Variable Net Income is Gross Income minus Conversion Cost.

Irrigated Mid and High Oleic Sunflower Hybrid Performance Trial at Walsh, 2013

COOPERATORS: Plainsman Agri-Search Foundation; Kevin Larson, Brett Pettinger, and Deborah Harn, Plainsman Research Center, Walsh, Colorado.

PURPOSE: To identify high yielding hybrids under irrigated conditions with 2500 heat units in a silty clay loam soil.
RESULTS: Of the 5 hybrids tested, Triumph s870CL had the highest seed yield, 650 lb/a (267 lb/a of oil yield). For this limited irrigation trial, we applied 8.3 in./a of water.

PLOT: Four rows with 30 in. row spacing, at least 600 ft. long. SEEDING DENSITY: 21,500 seeds/a. PLANTED: June 27. HARVESTED: November 4.

IRRIGATION: Subsurface Drip Irrigated: total water applied approximately 8.3 a-in./a.

PEST CONTROL: Preemergence Herbicides: Glyphosate 32 oz/a, 2,4-D 0.5 lb/a, Spartan 2.0 oz/a. Post Emergence Herbicides: Select 12 oz/a, COC 16 oz/a. CULTIVATION: None. INSECTICIDES: Warrior (Sunflower Head Moth control).

FIELD HISTORY: Last Crop: Grain sorghum. FIELD PREPARATION: No-till.

Summary: Growing Season Precipitation and Temperature \1
Walsh, Baca County.

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	In		--------No. of Days--------		
June	0.22	92	4	2	4
July	3.92	824	19	5	35
August	1.38	823	20	3	66
September	5.82	633	9	2	96
October	0.00	79	0	0	112
Total	11.34	2451	52	12	112

\1 Growing season from June 27 (planting) to October 6 (first freeze, 30 F).
\2 GDD: Growing Degree Days for sorghum.
\3 DAP: Days After Planting.

COMMENTS: Planted in adequate soil moisture. Weed control was good. The growing season precipitation was above average, but the flowering period (August) was very dry and September was very wet. Warrior was applied once at first ray petals to control head moth; however, multiple head moth flights were not controlled and head moth larvae feeding caused severe *Rhizopus* head damage. Seed yields were poor because of the considerable *Rhizopus* head damage. Oil percentages were average.

SOIL: Silty clay loam for 0-8” and silty clay loam 8”-24” depths from soil analysis.

Summary: Soil Analysis from Drip Site.

Depth	pH	Salts	OM	N	P	K	Zn	Fe
		mmhos/cm	%	----------------ppm----------------				
0-8”	7.8	0.7	1.8	41	5	406	0.7	2.6
8”-24”				10				
Comment	Alka	Vlo	Hi	VHi	Lo	VHi	Lo	Lo

Manganese and Copper levels were adequate.

Summary: Fertilization for Drip Site.

Fertilizer	N	P_2O_5	Zn	Fe
	--------------------lb/a------------------			
Recommended	0	0	0	0
Applied	100	0	0	0

Yield Goal: 2000 lb/a.
Actual Yield: 620 lb/a.

Drip Irrigated Sunflower, Mid and High Oleic Variety Trial, PRC, Walsh, 2013.

Firm	Hybrid	Mid or High Oleic	50% Flower	Plant Density	Plant Ht.	Test Wt.	Oil	Seed Yield	Oil Yield
			date	plants/a (X1000)	in	lb/bu	%	lb/a	lb/a
TRIUMPH	s870CL	mid	8/24	17.0	30	29	41.1	650	267
TRIUMPH	s673	mid	8/26	15.6	34	28	39.7	627	249
TRIUMPH	s668	mid	8/26	14.8	35	29	39.3	618	243
MYCOGEN	8H449CL	high	8/26	15.0	44	28	37.6	627	236
TRIUMPH	849CLD	mid	8/25	15.2	45	29	37.8	580	219
Average			8/25	15.5	38	29	39.1	620	243
LSD 0.20								93.9	

Planted: June 27; Harvested: November 4, 2013.
Seed Yield adjusted to 10% seed moisture content.
Total water applied was 8.3 in./a of drip irrigation.
Rhizopus infestation (from head moth larvae feeding) significantly lowered yields.

National Winter Canola Variety Performance and Great Plains Trials, Walsh 2013

Kevin Larson, Mike Stamm, and Brett Pettinger

Purpose: To identify the best adapted, highest yielding varieties of winter canola.

Results and Discussion

There was adequate soil moisture at planting for seed germination. For our area, it is atypical to have adequate soil moisture for planting winter canola. This is because canola has such small seeds, which requires shallow planting depths; moreover, its narrow planting window (late August to mid-September) is frequently too short for sufficient rain to occur. This past winter was dry; however all of the varieties and lines had good plant stands and high winter survival rates. Frequently, this scenario of a dry and cold winter creates severe canola winterkill conditions. We had multiple late freezes throughout April that damaged the canola flowers. This freeze damage was so extensive that few seeds were set and no seed harvest was conducted. Since all of the canola varieties and lines in the National and Great Plains trials had severe freeze damage, only plant stands, winter survivals, and flowering dates were recorded.

Materials and Methods

We planted 50 winter canola varieties and lines for the National Winter Canola Trial on September 7, 2012, and we planted 39 winter canola varieties and lines for the Great Plains Winter Canola Trial on September 10, 2012. The trial was planted at 5 lb seed/a with a 12 in. row-spaced drill to a depth of 1.0 inch in adequate soil moisture. We stream-applied 50 lb N/a as 32-0-0 on 18 in. spacing. No other fertilizers were applied. For weed control, we applied Sonalan at 32 oz/a and did not incorporate the herbicide. The canola was not harvested because multiple late freezes killed most of the flowers.

Table .--National Winter Canola Variety Trial, Walsh, 2013.

Variety (Line)	Stand %	Winter Survival %	Bloom date
Virginia	87	100	5/10
VSX-3	95	95	5/12
NK PETROL	95	85	5/12
NK Technic	94	88	5/12
Gladius	93	92	5/12
SY Regata	95	82	5/13
Claremore	92	83	5/13
HPX-7228	80	97	5/8
HPX-7341	91	75	5/8
KS4428	82	100	5/8
KS4476	95	97	5/7
KSUR21	74	92	5/9
KSR07363	87	88	5/13
Riley	78	100	5/7
Sumner	91	97	5/10
Wichita	90	88	5/10
HyCLASS115W	91	62	5/12
HyCLASS125W	97	98	5/11
CHROME	91	93	5/13
MH07J14	91	93	5/14
MH09E3	91	93	5/14
MH09H19	93	88	5/13
Rossini	95	92	5/13
TCI16	97	80	5/14
TCI17	99	90	5/13
TCI/F13	86	92	5/14
Baldur	92	97	5/9
Edimax	93	83	5/10
Inspiration	98	83	5/11
NPZ1005	91	100	5/10
Rumba	93	85	5/12
Sitro	81	100	5/13
Dimension	90	93	5/14
Dynastie	77	97	5/10
Flash	92	97	5/10
Aveage	90	92	5/11
LSD 0.05	13.3	21.7	2.4

Variety (Line)	Stand %	Winter Survival %	Bloom date
Hornet	94	97	5/9
Safran	87	97	5/10
Visby	94	97	5/8
DKW41-10	87	95	5/14
DKW44-10	99	100	5/14
DKW46-15	93	97	5/6
DKW47-15	95	95	5/12
46W94	90	95	5/14
46W99	77	95	5/12
PT211	93	92	5/14
X10W443C	95	100	5/12
X10W665C	91	100	5/10
X12W377C	89	100	5/8
RG29101	82	100	5/14
RG29102	95	78	5/14
Aveage	90	92	5/11
LSD 0.05	13.3	21.7	2.4

Table .-Great Plains Canola Variety Trial, Walsh, 2013.

Variety (Line)	Stand %	Winter Survival %	Flowering date
KS4441	97	100	5/7
KS4545	97	100	5/8
KS4517	96	100	5/7
HPX-8H55	95	98	5/7
HPX-8197	94	100	5/7
KS4518	93	100	5/7
HPX-8162	93	100	5/7
Baldur	89	100	5/10
Riley	89	98	5/7
KS4410	88	100	5/6
KSNT09	88	100	5/8
HPX-8023	88	100	5/8
KS4549	86	100	5/7
KS4561	84	100	5/7
KS4576	84	100	5/8
KSNT128	83	100	5/8
KSUR138	83	100	5/9
KS4507	82	100	5/7
KS4524	82	100	5/8
KS4503	81	100	5/9
KSNT149	81	100	5/11
Wichita	81	100	5/10
KS4452	80	98	5/7
HPX-8048	80	95	5/9
KSUR111	79	100	5/9
HPX-8275	79	100	5/8
KS4498	79	99	5/7
KS4594	78	100	5/9
KS4541	77	100	5/8
KS4546	75	100	5/8
HPX-9H26	75	90	5/11
KSNT127	73	100	5/9
KSUR07	73	98	5/10
HPX-8117	73	98	5/9
KS4430	70	100	5/10
KS4513	70	99	5/9
Sumner	69	97	5/13
KSUR18	66	98	5/10
KS4506	65	99	5/11
Average	82	99	5/8
LSD 0.05	21.2	6.0	1.2

Efficacy of Pre-emergence and Post Emergence Herbicides on Winter Canola

Kevin Larson and Brian Caldbeck

There are very few registered herbicides for canola production. There is a particular lack of herbicides available for post emergence broadleaf weed control in canola. Mustards, especially late-emerging mustards, are problematic. We conducted this study to test pre and post emergence herbicides for mustard control in winter canola.

Materials and Methods

We planted Sitro on September 10, 2012 in 10 ft. by 50 ft plots with three replications. The trial was planted at 3 lb seed/acre with a 12 in. row-spaced drill in adequate soil moisture for germination. We used small shovels in front of the drill disks. These shovels made furrows about three inches deep. We planted less than one in. below the bottom of the furrow. We tested 8 treatments: 7 herbicide treatments and one untreated control. We applied five pre-emergence treatments on September 11, 2012 and two post emergence treatments on November 1, 2012 with a CO_2 backpack sprayer at 3 liters per 10 ft. by 150 ft. and 20 psi pressure. The five pre-emergence treatments were: 1) Command 3 ME, 4.5 oz/acre and Glystar Plus (glyphosate), 32 oz/acre; 2) Command 3 ME, 9 oz/acre and Glystar Plus, 32 oz/acre; 3) Command 3 ME, 4.5 oz/acre and Dual II Magnum, 12 oz/acre and Glystar Plus, 32 oz/acre; 4) Command 3 ME, 9 oz/acre and Dual II Magnum, 12 oz/acre and Glystar Plus, 32 oz/acre; 5) Dual II Magnum, 12 oz/acre and Glystar Plus, 32 oz/acre. The two post emergence treatments were: 6) Tordon 22K, 1.34 oz/acre and Stinger, 3.55 oz/acre; 7) Rifle (dicamba), 4 oz/acre. We fertilized the site with 50 lb N/acre by surface banding 32-0-0. No other fertilizers were applied. We recorded winter survival, crop injury, and mustard control. The trial was not harvested because late freezes killed most of the flowers.

Results and Discussion

There was complete mustard control for the all pre-emergence treatments recorded 59 days after treatment (DAT) and mustard control was at least 96% recorded 226 DAT. The two post emergence treatments did not control any mustard 8 DAT, but improved to 79% control for the Tordon 22K and Stinger treatment and 70% control for the Rifle (dicamba) treatment 167 DAT. Surprisingly, there was no crop injury for any of the treatments, even the post emergence treatments. With dry winter conditions, we expected low winter survival rates. However, all eight winter canola treatments had winter survival rates 97% and greater.

The pre-emergence Command 3ME and Dual II Magnum treatments are not registered for canola production in the United States. Both of these pre-emergence treatments completely controlled the mustard and had no crop injury. Of the post emergence treatments, only Stinger is registered for canola. Tordon 22K and Rifle are not registered for canola production. Both post emergence treatments gave only marginal control of mustard and neither the Tordon 22K and Stinger treatment nor the Rifle treatment caused crop injury.

Since neither pre, nor post emergence treatments resulted in crop injury, further studies with slightly higher rates may be warranted for mustard control in canola.

Winter Canola Herbicide Study, Mustard Control, Walsh, 2013.

Treatment	Rate oz/acre	Timing	8 DAT Post 59 DAT Pre Mustard Control %	167 DAT Post 226 DAT Pre Mustard Control %
1 Command 3ME	4.50	Pre	100	96
1 Glyphosate	32.00	Pre		
2 Command 3ME	9.00	Pre	100	100
2 Glyphosate	32.00	Pre		
3 Command 3ME	4.50	Pre	100	100
3 Dual II Magnum	12.00	Pre		
3 Glyphosate	32.00	Pre		
4 Command 3ME	9.00	Pre	100	100
4 Dual II Magnum	12.00	Pre		
4 Glyphosate	32.00	Pre		
5 Dual II Magnum	12.00	Pre	100	100
5 Glyphosate	32.00	Pre		
6 Tordon 22K	1.34	Post	0	79
6 Stinger	3.55	Post		
7 Rifle (dicamba)	4.00	Post	0	70
8 Untreated			0	0
Average			63	81
LSD 0.05				19.5

Planted Winter Canola: September 10, 2012,
Variety: Sitro at 3 lb/acre.
Plots: 10 ft. by 50 ft. with 3 replications.
Pre-emergence treatment applied: September 11, 2012.
Post emergence treatment applied: November 1, 2012; canola, 5.5 leaves; mustard, averaged 16 plants per untreated plot with 5% coverage.

Winter Canola Herbicide Study, Crop Injury, Walsh, 2013.

Treatment	Rate	Timing	8 DAT Post 59 DAT Pre Crop Injury
	oz/acre		%
1 Command 3ME	4.50	Pre	0
1 Glyphosate	32.00	Pre	
2 Command 3ME	9.00	Pre	0
2 Glyphosate	32.00	Pre	
3 Command 3ME	4.50	Pre	0
3 Dual II Magnum	12.00	Pre	
3 Glyphosate	32.00	Pre	
4 Command 3ME	9.00	Pre	0
4 Dual II Magnum	12.00	Pre	
4 Glyphosate	32.00	Pre	
5 Dual II Magnum	12.00	Pre	0
5 Glyphosate	32.00	Pre	
6 Tordon 22K	1.34	Post	0
6 Stinger	3.55	Post	
7 Rifle (dicamba)	4.00	Post	0
8 Untreated			0
Average			0
LSD 0.05			

Planted Winter Canola: September 10, 2012,
Variety: Sitro at 3 lb/acre.
Plots: 10 ft. by 50 ft. with 3 replications.
Pre-emergence treatment applied: September 11, 2012.
Post emergence treatment applied: November 1, 2012; canola, 5.5 leaves; mustard, averaged 16 plants per untreated plot with 5% coverage.

Winter Canola Herbicide Study, Winter Survival, Walsh, 2013.

Treatment	Rate oz/acre	Timing	Winter Survival %
1 Command 3ME	4.50	Pre	100
1 Glyphosate	32.00	Pre	
2 Command 3ME	9.00	Pre	100
2 Glyphosate	32.00	Pre	
3 Command 3ME	4.50	Pre	100
3 Dual II Magnum	12.00	Pre	
3 Glyphosate	32.00	Pre	
4 Command 3ME	9.00	Pre	98
4 Dual II Magnum	12.00	Pre	
4 Glyphosate	32.00	Pre	
5 Dual II Magnum	12.00	Pre	100
5 Glyphosate	32.00	Pre	
6 Tordon 22K	1.34	Post	100
6 Stinger	3.55	Post	
7 Rifle (dicamba)	4.00	Post	97
8 Untreated			97
Average			99
LSD 0.05			4.6

Planted Winter Canola: September 10, 2012,
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