Technical Report TR19-2 January 2019

Colorado State University

Agricultural Experiment Station

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

Plainsman Research Center
2018 Research Reports

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

Kevin Larson, Superintendent and Research Scientist II

Plainsman Research Center
Box 477
42790 Hwy 160
Walsh, CO 81090

(719) 324-5643

Kevin.Larson@colostate.edu

This current and past research reports of the Plainsman Research Center can be downloaded from the publication list at the Colorado Agricultural Experiment Station:

http://aes.agsci.colostate.edu/publications/caes-publications-list/caes_pub_list/

Funded by the Colorado Agricultural Experiment Station,

Crop Management and Sorghum Improvement, USDA, NIFA Project No. COL00654

in cooperation with the Plainsman Agri-Search Foundation

This Plainsman Research Center booklet is dedicated to:

The Neill Foundation Board:

James Hume, Corwin Brown, Doyle Wilson, Pat Cooper, and Larry Bishop

This grant from the Neill Foundation will allow Plainsman to more effectively handle and transport harvested grain from research and commodity acres. This funding helps support agronomic research studies that are the first step to create cost effective change, helping growers become economically viable and sustainable stewards of the land. Thank you.

The spirit of Bernard lives on through your generous funding decisions. We truly appreciate your continued support.

Plainsman Research Center, 2018 Research Reports

Content | Page

2018 Plainsman Research Center Staff and Personnel with Projects

Kevin Larson (719) 324-5643	Superintendent and Research Scientist II, Plainsman Research Center, Agricultural Experiment Station, Colorado State University.
Brett Pettinger (719) 324-5643	Research Associate II, Plainsman Research Center, Agricultural Experiment Station, Colorado State University.
Perry Jones (719) 324-5643	Technician II, Plainsman Research Center, Agricultural Experiment Station, Colorado State University.
Jerry Johnson (970) 491-1454	Associate Professor and Extension Specialist, Soil and Crop Sciences Department, Colorado State University.
Sally Jones-Diamond (970) 491-1914	Research Assistant/Crop Testing Program, Soil and Crop Sciences Department, Colorado State University.
Scott Haley (970) 491-6483	Professor, Soil and Crop Sciences Department, Colorado State University.
Kelly Roesch (719) 336-7734	Cropping System Specialist, Extension Southeast Area, Colorado State University.

PLAINSMAN AGRI-SEARCH FOUNDATION BOARD

<u>2019</u>

Paul Hinds (Vice President)
12785 Road 34
Campo, CO 81029

James Hume
21491 Road 55
Walsh, CO 81090

Brian Brooks
19511 Road 36
Walsh, CO 81090

Don Wood
36663 Road UU
Two Buttes, CO 81084

Lyndell Herron
Box 64
Manter, KS 67862

Truman Wright (Secretary/Treasurer)
19625 Road 50
Walsh, CO 81090

<u>2020</u>

Tanner Dunivan
Box 282
Walsh, CO 81090

Jordan Jones
Box 253
Walsh, CO 81090

Brian Wood
165 E. 3rd Ave.
Springfield, CO 81073

Calvin Melcher
300 N. Main
Holly, CO 81047

Matt Tedder
20923 Road 49
Walsh, CO 81090

Todd Randolph (President)
53766 Road GG
Walsh, CO 81090

<u>2018</u>

Curtis Miller
53805 Road SS
Walsh, CO 81090

Kim Wood
721 Barkley
Springfield, CO 81073

Jack Walker
30780 Road 51
Walsh, CO 81090

Ron Batterton
1550 Hwy 89
Holly, CO 81047

Robert Wood
721 Barkley
Springfield, CO 81073

Douglas Melcher
12845 Hwy 89
Holly, CO 81047

2018 Climatological Summary
Plainsman Research Center

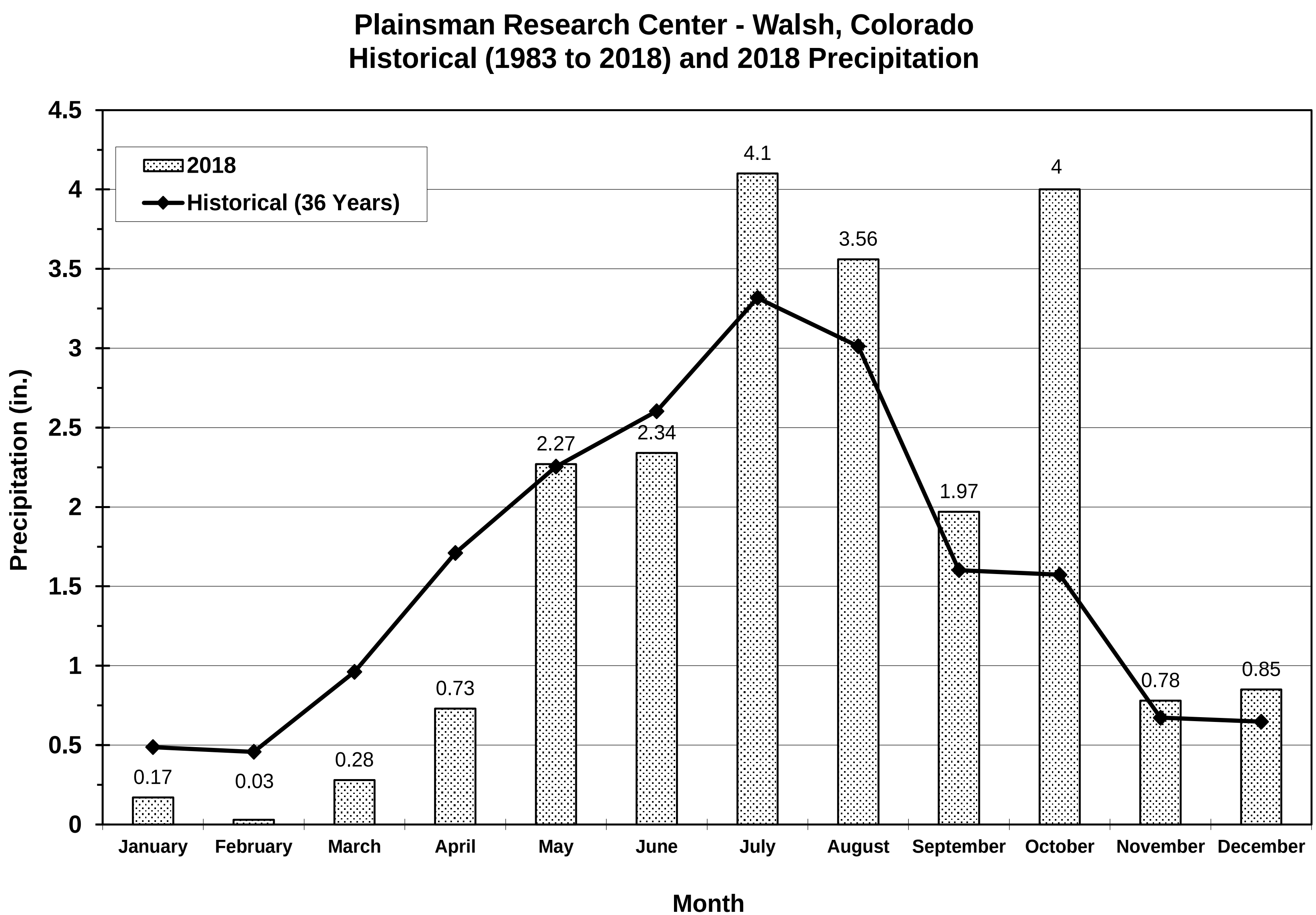
Month	Temperature Max. F	Min. F	Max. Mean F	Min. Mean F	Precip. In.	Greatest Day of Precip-atation	Snow-Fall In.	Greatest Snow Depth In.	Average Soil Temp.	Evapor-ation In.
Jan.	77	-6	51.4	17.6	0.17	0.17	0.80	0.80	34.74	
Feb.	75	11	50.2	18.6	0.03	0.02	2.10	1.10	36.71	
Mar.	87	15	64.9	29.6	0.28	0.11	0.00	0.00	43.26	
Apr.	91	16	65.9	33.4	0.73	0.43	0.20	0.20	46.77	4.47
May	95	38	85.0	52.1	2.27	1.18	0.00	0.00	59.81	12.05
Jun.	105	50	94.0	61.5	2.34	1.11	0.00	0.00	67.27	14.41
Jul.	107	51	94.1	62.5	4.10	2.01	0.00	0.00	72.19	12.57
Aug.	98	51	87.9	60.0	3.56	1.42	0.00	0.00	69.16	8.29
Sept.	100	38	83.4	54.6	1.97	1.54	0.00	0.00	66.20	8.44
Oct.	93	23	64.3	39.8	4.00	1.22	0.50	0.50	54.16	2.40
Nov.	70	5	52.7	25.7	0.78	0.71	4.50	4.50	42.30	
Dec.	66	14	47.7	19.2	0.85	0.49	2.00	2.00	36.68	
Total			**70.1**	**39.54**	**21.08**		**10.10**			**62.63**

*** NOTE: Evaporation read April 15 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.

	2018	2017
Highest Temperature:	107 on July 21	102 on June 23, July 12
Lowest Temperature:	-6 F on January 16	-7 F on January 7
Last freeze in spring:	31 F on April 27	30 F on May 1
First freeze in fall:	32 F on Oct. 10	29 F on Oct. 10
Frost free season:	166 frost free days	162 frost free days
Avg. Precip for 36 yrs:	19.30 Inches	

Maximum Wind:

Jan.	46 mph on 22nd	July.	35 mph on 1st
Feb.	43 mph on 13th	Aug.	31 mph on 6th
Mar.	48 mph on 19th	Sept.	34 mph on 16th
Apr.	52 mph on 14th	Oct.	45 mph on 14th
May	39 mph on 28th	Nov.	44 mph on 25th
Jun.	53 mph on 15th	Dec.	41 mph on 14th


Plainsman Research Center - Walsh, Colorado
Historical (1983 to 2018) and 2018 Precipitation
2018
Historical (36 Years)
Precipitation (in.)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0.17
0.03
0.28
0.73
2.27
2.34
4.1
3.56
1.97
4
0.78
0.85
January
February
March
April
May
June
July
August
September
October
November
December
Month

Overview of 2017-2018 Eastern Colorado Winter Wheat Trials

Jerry Johnson and Sally Jones

Colorado State University researchers provide current, reliable, and unbiased wheat variety information to Colorado producers. Support of our research keeps public variety testing thriving in Colorado. Farmer support of public variety testing is our hope for the future. Our work in Colorado is possible due to the support and cooperation of the entire Colorado wheat industry, especially support from the Colorado Wheat Administrative Committee (wheat assessment) and the Colorado Wheat Research Foundation (seed and trait royalties).

We test under a broad range of environmental conditions to best determine expected performance of new varieties. We have a uniform variety testing program, meaning that all dryland varieties are tested in all eleven dryland test locations and all irrigated varieties are tested in all three irrigated trials. There were 56 varieties including experimental lines in each of the 11 dryland trials. The three irrigated trials each had 38 varieties and the 20 collaborative on-farm tests (COFT) each had five varieties. The trials included a combination of public and private varieties and experimental lines. Varieties from other states came from Kansas and Nebraska. Seed companies with entries in the variety trials included AgriMaxx Wheat, AgriPro Syngenta, Dyna-Gro Seed, Limagrain Cereal Seeds, and WestBred Monsanto. There were entries from two marketing organizations: PlainsGold (Colorado) and the Kansas Wheat Alliance.

All dryland and irrigated trials were planted in a randomized complete block design with three replicates. Plot sizes were approximately 150 ft^2 (except the Fort Collins irrigated trial, which was 80 ft^2) and all varieties were planted at 700,000 seeds per acre for dryland trials and 1.2 million seeds per acre for irrigated trials. Plot sizes for the COFT ranged from 0.15 to 2.2 acres per variety in side-by-side strips and seeding rates conformed to the seeding rate used by the collaborating farmer. Yields were corrected to 12% moisture. Variety trial plot weight, test weight, and grain moisture content information was obtained from a Harvest Master weighing system on a plot combine.

General Growing Season Comments – the tale of two regions

There was good subsoil moisture from above-average rainfall during summer 2017. Dry fall conditions in southeast Colorado made stand establishment difficult. Some timely rain events in May 2018 and good subsoil moisture led to above-average yields in parts of Prowers and Kiowa counties. Most of northeast Colorado trials, and wheat acres, were late-planted. Above-average and well distributed precipitation at the end of April as well as during May and June led to above-average yields despite more severe sawfly infestations, hail, and widespread virus infections. A heat wave in late May and early June reduced the threat of widespread stripe rust infections.

General Growing Conditions in Southeast Colorado - Kelly Roesch

The summer of 2017 was wetter than normal through July, then the rain stopped and dryness prevailed. Subsoil moisture was plentiful at the time of planting but finding good topsoil 6 moisture was a challenge. The area received a good rain (2-3 inches) on the 24th -25th of September leading to good stands of wheat.

The winter was warmer and drier than normal but the moisture received in September and subsoil moisture carried the wheat crop through until spring. Spring conditions were warmer and drier than normal. There were some areas that received rain showers but the whole area was gradually moving into drought conditions.

A large portion of the wheat crop was sprayed for brown wheat mites in April. The warm dry conditions in May and June all but eliminated rust infections. Plants showing virus infection symptoms were less prevalent than in the past few years.

Harvest got underway by June 25th and warm dry weather allowed for the harvest to progress well – the majority of the crop was harvested by mid-July. Yields in the southeast ranged from 15 to 50+ bu/ac with the average in the range of 35 bu/ac. Considering the severity of the drought conditions throughout spring and summer the wheat crop did remarkably well. Protein levels improved overall from last year but there was still significant production of wheat at protein contents of 10% or below.

2018 Dryland Winter Wheat Variety Performance Trial at Lamar

Variety	Brand/Source	Market Class	Yield bu/ac	Test Weight lb/bu	Plant Height in
Sunshine	PlainsGold	**HWW**	**78.0**	56.7	29
Antero	PlainsGold	**HWW**	**76.7**	57.1	31
Winterhawk	WestBred Monsanto	HRW	**75.7**	58.6	32
Langin	PlainsGold	HRW	**75.7**	58.0	28
Hatcher	PlainsGold	HRW	72.6	57.1	31
Brawl CL Plus	PlainsGold	HRW	71.7	58.9	31
WB4721	WestBred Monsanto	HRW	71.7	59.3	31
WB4418	WestBred Monsanto	HRW	70.7	57.7	27
LCS Chrome	Limagrain Cereal Seeds	HRW	70.3	57.3	32
Breck	PlainsGold	**HWW**	70.1	58.7	31
Avery	PlainsGold	HRW	69.8	57.4	32
WB-Grainfield	WestBred Monsanto	HRW	69.6	57.4	31
LCS Mint	Limagrain Cereal Seeds	HRW	69.5	59.3	33
Byrd	PlainsGold	HRW	69.4	58.1	31
Long Branch	Dyna-Gro Seed	HRW	68.9	57.5	31
Snowmass	PlainsGold	**HWW**	68.8	58.4	32
SY Monument	AgriPro Syngenta	HRW	68.6	55.1	31
SY Rugged	AgriPro Syngenta	HRW	68.0	55.3	27
Oakley CL	Kansas Wheat Alliance	HRW	67.8	57.9	30
WB4462	WestBred Monsanto	HRW	66.2	58.3	33
Denali	PlainsGold	HRW	65.5	58.9	29
AM Eastwood	AgriMaxx Wheat	HRW	65.0	57.1	22
SY Legend CL2	AgriPro Syngenta	HRW	64.7	57.2	28
SY Wolf	AgriPro Syngenta	HRW	63.4	55.6	28
Incline AX	PlainsGold	HRW	63.0	54.1	30
Experimentals					
CO14A070	Colorado State University exp.	HRW	**76.8**	58.0	32
CO13D1299	Colorado State University exp.	**HWW**	**75.8**	59.0	31
CO13D1383	Colorado State University exp.	**HWW**	**75.7**	58.5	28
CO15D094R	Colorado State University exp.	HRW	**75.1**	59.0	34
CO15D098R	Colorado State University exp.	HRW	**74.4**	58.4	35
CO15D127R	Colorado State University exp.	HRW	73.0	57.8	28
CO15A018	Colorado State University exp.	HRW	73.0	56.6	27
CO14A050	Colorado State University exp.	HRW	71.2	58.4	28
CO14A136	Colorado State University exp.	HRW	71.1	58.4	30
CO12D296	Colorado State University exp.	HRW	70.8	58.4	27
CO13D1714	Colorado State University exp.	**HWW**	70.8	57.5	31
CO15D129R	Colorado State University exp.	HRW	70.7	59.7	28
CO13007	Colorado State University exp.	HRW	70.6	58.4	31
CO13D1486	Colorado State University exp.	**HWW**	70.3	57.8	28
CO13003C	Colorado State University exp.	HRW	69.7	57.6	30
CO15SFD092	Colorado State University exp.	HRW	69.2	57.6	27
CO12D597	Colorado State University exp.	HRW	69.2	57.5	30
CO15SFD061	Colorado State University exp.	HRW	69.2	52.5	26
CO13D1783	Colorado State University exp.	HRW	68.7	56.4	32
CO13D1479	Colorado State University exp.	**HWW**	68.6	58.8	30
CO12D1770	Colorado State University exp.	HRW	68.2	57.4	27
CO15SFD107	Colorado State University exp.	HRW	66.4	57.1	30
CO13D1164	Colorado State University exp.	**HWW**	66.2	58.9	29
CO15D130W	Colorado State University exp.	**HWW**	66.0	57.1	26
CO15D027RC	Colorado State University exp.	HRW	65.5	59.6	30
CO13D0787	Colorado State University exp.	HRW	65.1	58.9	30
CO15D092R	Colorado State University exp.	HRW	63.9	57.9	29
CO15SFD095	Colorado State University exp.	HRW	63.5	60.6	27
CO13D1638	Colorado State University exp.	**HWW**	62.1	55.0	28
NHH144913-3	University of Nebraska exp.	HRW	61.0	53.9	25
CO15D063RC	Colorado State University exp.	HRW	60.8	58.1	28
Average			**69.4**	**57.6**	**30**
aLSD (P<0.30)			3.8		

aIf the difference between two variety yields equals or exceeds the LSD value, there is a 70% chance the difference is significant. Variety yields in bold are in the top LSD group.

Site Information

Cooperator: Stulp Farms
Harvest date: June 28, 2018
Planting date: September 21, 2017

2018 Dryland Winter Wheat Variety Performance Trial at Sheridan Lake

Variety	Brand/Source	Market Class	Yield bu/ac	Test Weight lb/bu	Plant Height in
Antero	PlainsGold	**HWW**	**62.8**	58.9	32
Breck	PlainsGold	**HWW**	**61.6**	61.0	32
Long Branch	Dyna-Gro Seed	HRW	**60.7**	59.4	31
Langin	PlainsGold	HRW	59.2	58.4	28
Sunshine	PlainsGold	**HWW**	58.1	59.4	29
Brawl CL Plus	PlainsGold	HRW	57.4	60.1	31
Avery	PlainsGold	HRW	57.0	58.4	28
LCS Mint	Limagrain Cereal Seeds	HRW	56.2	60.9	33
Oakley CL	Kansas Wheat Alliance	HRW	55.6	59.0	27
WB-Grainfield	WestBred Monsanto	HRW	55.5	59.1	30
WB4418	WestBred Monsanto	HRW	54.2	58.4	28
SY Monument	AgriPro Syngenta	HRW	53.3	59.3	29
Snowmass	PlainsGold	**HWW**	53.1	59.9	31
Denali	PlainsGold	HRW	53.1	60.5	30
WB4462	WestBred Monsanto	HRW	52.9	59.9	31
Byrd	PlainsGold	HRW	52.5	59.5	29
WB4721	WestBred Monsanto	HRW	52.3	60.7	30
SY Rugged	AgriPro Syngenta	HRW	52.0	58.2	27
SY Wolf	AgriPro Syngenta	HRW	52.0	60.0	29
Hatcher	PlainsGold	HRW	51.6	59.8	25
SY Legend CL2	AgriPro Syngenta	HRW	50.1	60.7	27
Winterhawk	WestBred Monsanto	HRW	49.5	61.5	31
AM Eastwood	AgriMaxx Wheat	HRW	48.9	59.5	23
Incline AX	PlainsGold	HRW	48.7	58.5	29
LCS Chrome	Limagrain Cereal Seeds	HRW	46.7	58.8	31
Experimentals					
CO15SFD092	Colorado State University exp.	HRW	**61.6**	59.3	26
CO13D1638	Colorado State University exp.	**HWW**	59.6	59.3	32
CO15D094R	Colorado State University exp.	HRW	58.2	60.8	31
CO15D098R	Colorado State University exp.	HRW	58.1	61.5	32
CO15SFD061	Colorado State University exp.	HRW	58.1	54.6	31
CO13D1383	Colorado State University exp.	**HWW**	57.6	60.3	29
CO14A070	Colorado State University exp.	HRW	57.3	60.4	30
CO13D1783	Colorado State University exp.	HRW	57.3	57.7	30
CO13D0787	Colorado State University exp.	HRW	56.9	61.7	30
CO12D1770	Colorado State University exp.	HRW	56.7	60.5	29
CO13D1486	Colorado State University exp.	**HWW**	56.5	59.9	29
CO15D129R	Colorado State University exp.	HRW	56.2	62.2	27
CO13D1299	Colorado State University exp.	**HWW**	56.2	60.3	30
CO13003C	Colorado State University exp.	HRW	56.0	59.8	31
CO13007	Colorado State University exp.	HRW	55.8	60.3	32
CO15D127R	Colorado State University exp.	HRW	55.8	60.3	27
CO13D1479	Colorado State University exp.	**HWW**	55.3	60.5	30
CO12D296	Colorado State University exp.	HRW	55.1	60.5	29
CO13D1714	Colorado State University exp.	**HWW**	54.3	59.9	31
CO12D597	Colorado State University exp.	HRW	53.8	60.2	31
CO15D092R	Colorado State University exp.	HRW	53.6	59.6	30
CO15A018	Colorado State University exp.	HRW	53.0	59.4	28
CO15D027RC	Colorado State University exp.	HRW	52.7	60.3	33
CO15SFD107	Colorado State University exp.	HRW	52.7	60.4	31
CO15D130W	Colorado State University exp.	**HWW**	51.7	59.5	27
CO13D1164	Colorado State University exp.	**HWW**	51.2	59.6	28
CO14A136	Colorado State University exp.	HRW	49.6	59.8	27
CO14A050	Colorado State University exp.	HRW	48.5	60.3	30
NHH144913-3	University of Nebraska exp.	HRW	48.2	56.2	30
CO15D063RC	Colorado State University exp.	HRW	47.7	61.4	28
CO15SFD095	Colorado State University exp.	HRW	46.7	61.0	28
Average			**54.4**	**59.8**	**29**
aLSD (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 significant. Variety yields in bold are in the top LSD group.

Site Information

Cooperator: Scherler Farms
Harvest date: June 27, 2018
Planting date: September 20, 2017

2018 Dryland Winter Wheat Variety Performance Trial at Walsh

Variety	Brand/Source	Market Class	Yield	Test Weight	Plant Height
			bu/ac	lb/bu	in
Avery	PlainsGold	HRW	**50.7**	57.6	25
Antero	PlainsGold	**HWW**	**49.4**	57.8	25
Langin	PlainsGold	HRW	**47.3**	58.3	24
WB4418	WestBred Monsanto	HRW	43.9	57.3	24
Breck	PlainsGold	**HWW**	43.9	60.5	24
Sunshine	PlainsGold	**HWW**	42.3	59.2	21
SY Monument	AgriPro Syngenta	HRW	41.6	57.6	24
Hatcher	PlainsGold	HRW	41.5	58.0	23
Oakley CL	Kansas Wheat Alliance	HRW	40.8	58.9	24
WB4721	WestBred Monsanto	HRW	39.6	58.5	23
WB-Grainfield	WestBred Monsanto	HRW	39.5	58.4	25
SY Rugged	AgriPro Syngenta	HRW	39.0	57.0	22
Denali	PlainsGold	HRW	38.8	58.1	25
LCS Mint	Limagrain Cereal Seeds	HRW	38.5	60.9	25
Winterhawk	WestBred Monsanto	HRW	38.3	59.6	26
WB4462	WestBred Monsanto	HRW	37.6	57.9	24
Long Branch	Dyna-Gro Seed	HRW	37.3	58.7	23
Byrd	PlainsGold	HRW	36.6	58.1	24
LCS Chrome	Limagrain Cereal Seeds	HRW	34.9	56.8	24
Snowmass	PlainsGold	**HWW**	34.6	58.2	26
AM Eastwood	AgriMaxx Wheat	HRW	33.6	57.3	21
Brawl CL Plus	PlainsGold	HRW	33.3	58.5	24
Incline AX	PlainsGold	HRW	32.6	56.0	23
SY Legend CL2	AgriPro Syngenta	HRW	31.7	57.7	24
SY Wolf	AgriPro Syngenta	HRW	31.6	57.8	23
Experimentals					
CO12D296	Colorado State University exp.	HRW	44.8	59.4	23
CO15D098R	Colorado State University exp.	HRW	44.7	60.1	26
CO13D1783	Colorado State University exp.	HRW	43.4	56.9	27
CO15SFD061	Colorado State University exp.	HRW	43.0	56.1	25
CO15SFD092	Colorado State University exp.	HRW	43.0	58.8	24
CO13D1714	Colorado State University exp.	**HWW**	42.8	58.3	25
CO12D1770	Colorado State University exp.	HRW	42.2	60.5	25
CO13003C	Colorado State University exp.	HRW	41.4	57.8	26
CO13D1299	Colorado State University exp.	**HWW**	41.0	59.1	24
CO13007	Colorado State University exp.	HRW	40.1	58.2	25
CO15D127R	Colorado State University exp.	HRW	40.0	58.0	22
CO13D1383	Colorado State University exp.	**HWW**	39.4	57.9	23
CO15D027RC	Colorado State University exp.	HRW	38.8	58.8	25
CO12D597	Colorado State University exp.	HRW	37.3	58.8	25
CO13D1479	Colorado State University exp.	**HWW**	36.9	57.1	24
CO15SFD107	Colorado State University exp.	HRW	36.8	57.8	25
CO13D0787	Colorado State University exp.	HRW	36.5	60.2	25
CO15A018	Colorado State University exp.	HRW	36.5	57.6	23
CO13D1638	Colorado State University exp.	**HWW**	36.5	56.3	25
NHH144913-3	University of Nebraska exp.	HRW	36.5	53.0	25
CO13D1486	Colorado State University exp.	**HWW**	36.0	58.5	23
CO14A070	Colorado State University exp.	HRW	36.0	58.6	24
CO14A050	Colorado State University exp.	HRW	34.5	57.8	24
CO14A136	Colorado State University exp.	HRW	34.2	56.5	23
CO15D130W	Colorado State University exp.	**HWW**	33.8	58.2	22
CO13D1164	Colorado State University exp.	**HWW**	32.8	55.7	26
CO15D129R	Colorado State University exp.	HRW	32.1	59.4	23
CO15D063RC	Colorado State University exp.	HRW	30.2	58.4	24
CO15D094R	Colorado State University exp.	HRW	29.8	58.3	24
CO15SFD095	Colorado State University exp.	HRW	27.4	59.9	24
CO15D092R	Colorado State University exp.	HRW	26.3	58.4	24
Average			**38.1**	**58.1**	**24**
aLSD (P<0.30)			3.9		

[a]If the difference between two variety yields equals or exceeds the LSD value, there is a 70% chance the difference is significant. Variety yields in bold are in the top LSD group.

Site Information

Cooperator: Plainsman Research Center (Kevin Larson, Brett Pettinger, and Perry Jones)
Harvest date: June 28, 2018
Planting date: October 12, 2017

Summary of 2-Year (2017-2018) Dryland Variety Performance Results

Variety[b]	Brand/Source	Market Class[c]	Yield	2-Year Average[a] Yield	Test Weight	Test Weight	Plant Height
			bu/ac	% trial avg.	lb/bu	% trial avg.	in
Langin	PlainsGold	HRW	73.8	111%	60.0	100%	31
CO12D296	Colorado State University	HRW	73.4	110%	61.0	102%	31
Whistler	PlainsGold	HRW	72.8	109%	58.7	98%	34
Snowmass 2.0	PlainsGold	**HWW**	71.5	107%	60.1	100%	31
Antero	PlainsGold	**HWW**	71.1	107%	59.5	99%	34
CO13D1638	Colorado State University	**HWW**	70.9	106%	59.4	99%	33
Canvas	PlainsGold	HRW	70.4	106%	60.5	101%	31
CO12D597	Colorado State University	HRW	70.0	105%	60.5	101%	33
CO13D1714	Colorado State University	**HWW**	69.6	104%	60.1	100%	33
Breck	PlainsGold	**HWW**	69.5	104%	61.4	103%	33
Avery	PlainsGold	HRW	69.3	104%	60.0	100%	34
Byrd	PlainsGold	HRW	69.1	104%	60.2	100%	33
CO13D0787	Colorado State University	HRW	68.8	103%	61.2	102%	32
Monarch	PlainsGold	**HWW**	68.8	103%	60.0	100%	31
Byrd CL Plus	PlainsGold	HRW	67.7	102%	59.3	99%	33
Sunshine	PlainsGold	**HWW**	67.4	101%	58.9	98%	31
CO13D1479	Colorado State University	**HWW**	67.1	101%	59.9	100%	33
Snowmass	PlainsGold	**HWW**	65.4	98%	60.2	100%	34
WB-Grainfield	WestBred Monsanto	HRW	65.3	98%	60.0	100%	32
Oakley CL	Kansas Wheat Alliance	HRW	65.0	98%	59.6	100%	33
CO13D1164	Colorado State University	**HWW**	64.9	97%	60.0	100%	34
Denali	PlainsGold	HRW	64.8	97%	59.9	100%	34
LCS Mint	Limagrain	HRW	64.6	97%	60.9	102%	33
SY Monument	AgriPro Syngenta	HRW	64.0	96%	59.0	99%	31
SY Rugged	AgriPro Syngenta	HRW	63.5	95%	58.7	98%	29
WB4462	WestBred Monsanto	HRW	63.3	95%	60.4	101%	34
SY Wolf	AgriPro Syngenta	HRW	62.9	94%	59.8	100%	31
Hatcher	PlainsGold	HRW	62.6	94%	59.5	99%	31
Brawl CL Plus	PlainsGold	HRW	62.6	94%	60.2	101%	32
Winterhawk	WestBred Monsanto	HRW	61.7	93%	60.1	100%	34
WB4721	WestBred Monsanto	HRW	60.2	90%	60.8	102%	31
Incline AX	PlainsGold	HRW	59.2	89%	57.0	95%	32
LCS Chrome	Limagrain	HRW	58.3	87%	59.6	100%	32
Average			**66.7**		**59.9**		**32**

[a]The 2-year average yield, test weight, and plant heights are based on 17 trials (nine 2018 and eight 2017 trials).
[b]Varieties ranked according to average 2-year yield.
[c]Market class: HRW=hard red winter wheat; **HWW**=hard white winter wheat.

Dryland Wheat Variety Performance Summary, 3 Years (2015, 2016 & 2017)

			3-Year Average[a]			
Variety[b]	Brand/Source	Market Class[c]	Yield	Yield	Test Weight	Plant Height
			lb/bu	% test avg.	lb/bu	
Langin	PlainsGold	HRW	77.5	111%	59.7	31
Antero	PlainsGold	**HWW**	75.9	109%	58.8	34
Breck	PlainsGold	**HWW**	73.9	106%	61.0	33
Avery	PlainsGold	HRW	73.5	105%	59.5	34
Byrd	PlainsGold	HRW	72.6	104%	59.9	33
Sunshine	PlainsGold	**HWW**	72.0	103%	58.1	32
WB-Grainfield	WestBred Monsanto	HRW	70.5	101%	59.8	33
LCS Mint	Limagrain	HRW	69.7	100%	60.4	33
Oakley CL	Kansas Wheat Alliance	HRW	69.4	100%	59.2	33
Denali	PlainsGold	HRW	69.4	100%	59.8	34
Hatcher	PlainsGold	HRW	69.0	99%	58.9	32
Snowmass	PlainsGold	**HWW**	68.6	98%	59.8	34
SY Monument	AgriPro Syngenta	HRW	68.5	98%	58.8	32
Brawl CL Plus	PlainsGold	HRW	67.0	96%	59.5	33
Winterhawk	WestBred Monsanto	HRW	67.0	96%	59.9	34
SY Wolf	AgriPro Syngenta	HRW	66.7	96%	58.6	32
WB4721	AGSECO	HRW	65.9	95%	60.7	32
LCS Chrome	Limagrain	HRW	63.8	92%	59.5	32
Incline AX	PlainsGold	HRW	63.7	91%	56.5	32
Average			**69.7**		**59.4**	**33**

[a]The 3-year average yield and test weights are based on 25 trials (nine 2018, eight 2017, and eight 2016 trials). Plant heights are based on 24 trials (eight 2018, eight 2017, and eight 2016 trials).
[b]Varieties rank according to average 3-year yield.
[c]Market class: HRW=hard red winter wheat; **HWW**=hard white winter wheat.

Dryland Wheat Strips for Forage and Grain Yield at Walsh, 2018

Kevin Larson, Brett Pettinger, and Perry Jones

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

MATERIALS AND METHODS: Fifteen wheat varieties were planted on October 18, 2017 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). Express 0.4 oz/a, dicamba 2oz/a and 2,4-D ester 0.38 lb/a was sprayed for weed control. Two 2 ft. by 2.5 ft. forage samples were taken at jointing (April 10) and at boot (May 8). We measure the forage for fresh weight, oven-dried the samples, and recorded dry weight at 15% moisture content. Conditions were dry at planting, which cause spotty stands. We harvested the plots on July 9 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 due planting conditions, which resulted in non-uniform stands, and conditions remained dry until mid-June. The trial averaged 18.3 bu/a. About 6 bu/a separated the highest yielding variety, Byrd, from the lowest yielding variety, TAM 204. Hatcher had the highest forage yield at jointing and Antero had the highest forage yield at boot. Six varieties: Antero, Avery, Byrd, Hatcher, WB Grainfield and Winterhawk, had above average two-year averages compared to the other wheat tested. Antero, Byrd, Hatcher and WB Grainfield produced above average three-year average yields.

DISCUSSION: This year I chose Antero and Hatcher as the best overall dual-purpose wheat varieties of the 15 wheat varieties tested. Antero produced the second highest grain yield, the fourth highest forage yield at jointing, and the highest forage yield at boot. Hatcher produced the highest forage yields at jointing, the third highest forage yield at boot, and the fourth highest grain yield. If jointing forage production is a high priority, then Hatcher is a more desirable dual-purpose variety; but if grain production is a higher priority than jointing forage production, then Antero is a more desirable dual-purpose variety. This is the fourth consecutive harvest year that Antero was honored as one of the best overall dual-purpose wheat varieties.

Grain yield averages for this trial, during the last three harvest years, have been below our long-term average in 2018 at 18 bu/a, (the wheat failed in 2017 due to dry planting conditions), near our long-term average in 2014 at 33 bu/a, (the wheat was hailed out in 2015), and above our long-term average in 2016 at 50 bu/a. Three wheat varieties tested: Antero, Byrd and Hatcher, had at least average grain yields each of the last three production seasons. Producing above average yields in response our wide-ranging seasonal conditions suggests that these three wheat varieties can handle our weather extremes. We recommend planting these three varieties for high grain yields to counter our diversity weather conditions.

Table .Dryland Wheat Strips, Forage and Grain Yield at Walsh, 2018.

Variety	Jointing		Boot		Plant	Test	Grain
	Fresh Wt.	Dry Wt.	Fresh Wt.	Dry Wt.	Height	Weight	Yield
	------------------------lb/a		------------------------		in	lb/bu	bu/a
Byrd	2540	828	12026	3630	25	58.0	21.5
Antero	2607	766	13719	4470	25	58.3	21.3
Avery (untreated)	2153	609	9645	3054	25	57.8	20.3
Hatcher	2889	957	14047	4096	24	58.5	20.2
Breck	1585	434	9008	2930	24	59.9	19.9
Joe	2835	925	14808	4463	26	58.3	19.7
Avery (treated)	2246	692	11848	3796	25	58.2	19.6
Langin	2741	773	11269	3430	22	57.3	17.9
Grainfield	2460	821	9951	2956	25	58.1	17.1
SY Monument	2253	660	9268	2806	25	57.1	16.8
Winterhawk	1628	503	12648	4031	26	60.3	16.8
Snowmass	2231	652	8654	2782	25	57.6	16.3
TAM 114	1279	388	6776	2225	23	59.5	16.0
T158	2289	736	9214	3021	22	57.2	15.5
TAM 204	1824	578	9172	2881	23	53.6	15.1
Average	2237	688	10804	3371	24	58.0	18.3
LSD 0.20	647.7	201.1	2501.1	769.3			2.64

Planted: October 18, 2017; 50 lb seed/a; 5 gal/a 10-34-0.
Grain Harvested: July 9, 2018
Jointing sample taken April 10, 2018.
Boot sample taken May 8, 2018.
Wet Weight is reported at field moisture.
Dry Weight is adjusted to 15% moisture content.
Grain Yield is adjusted to 12% moisture content.

Table .--Summary: Dryland Wheat Strips Variety Performance Tests at Walsh, 2014, 2016, and 2018.

		Grain Yield					Yield as % of Trial Average				
Firm	Variety	2014	2016	2018	2-Year Avg	3-Year Avg	2014	2016	2016	2-Year Avg	3-Year Avg
		----------------bu/a----------------					------------------%------------------				
Colorado State	Avery	--	54	20	37	--	--	108	111	109	--
Colorado State	Antero	35	56	21	39	37	106	112	116	114	110
Colorado State	Byrd	37	52	22	37	37	112	104	117	108	108
Colorado State	Hatcher	34	53	20	37	36	103	106	110	108	105
Colorado State	Snowmass	32	50	16	33	33	97	100	89	98	96
Limagrain	T158	--	46	16	31	--	--	92	85	90	--
Westbred	Winterhawk	31	53	17	35	34	94	106	92	103	99
Westbred	WB Grainfield	32	54	17	36	34	97	108	93	105	101
Average		33	50	18	34	34					

Grain Yields were adjusted to 12.0 % seed moisture content.

No wheat yields recorded for 2015 due to hail, and for 2017 due to dry planting conditions.

Dryland Forage Sorghum Hybrid Performance Trial at Walsh, 2018

COOPERATOR: Plainsman Agri-Search Foundation, Walsh, Colorado.

PURPOSE: To identify high yielding hybrids under dryland conditions with 3150 sorghum heat units in a silt loam soil.

PLOT: Four rows with 30 in. row spacing, 50 ft. long. SEEDING DENSITY: 69,700 seed/a. PLANTED: June 1. HARVESTED: October 7.

PEST CONTROL: Preemergence Herbicides: Atrazine 1 lb/ac, S-Metolachlor 24 oz/ac, Mesotrione 6.4 oz/ac, Glyphosate 32 oz/ac. Post Emergence Herbicides: None. Cultivation: None. Insecticides: None.

FIELD HISTORY: Previous Crop: Grain sorghum. FIELD PREPARATION: Strip-till.

Summary: Growing Season Precipitation and Temperature Walsh, Baca County.[a]

Month	Rainfall	GDD[b]	>90 F	>100 F	DAP[c]
	In		--------no. of days--------		
June	2.34	833	20	10	30
July	4.10	877	25	5	61
August	3.56	742	11	0	92
September	1.97	595	9	1	122
October	0.38	98	2	0	129
Total	12.35	3145	67	16	129

[a]Growing season from June 1 (planting) to October 7 (harvest).
[b]GDD: Growing Degree Days for sorghum.
[c]DAP: Days After Planting.

COMMENTS: Planted in limited soil moisture. Seed germination and plant stand were poor and often non-uniform. Weed control was good, but volunteer grain sorghum was abundant. No sugarcane aphids were detected. The growing season precipitation was well above average. July and August were wet. June was hot and dry until the later part of the month. Good silage yields.

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	S
		mmhos/cm	%	----------------ppm----------------				
0-8"	8.0	0.4	1.7	5	5.8	435	0.5	12
8"-24"				7				
Comment	Alka	VLo	Mod	Mod	Lo	VHi	Lo	Marg

Iron was low.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	S
	--------------------lb/ac------------------			
Recommended	10	20	0	0
Applied	75	30	0	0

Yield Goal: 8 tons/ac.
Actual Yield: 12.0 tons/ac.

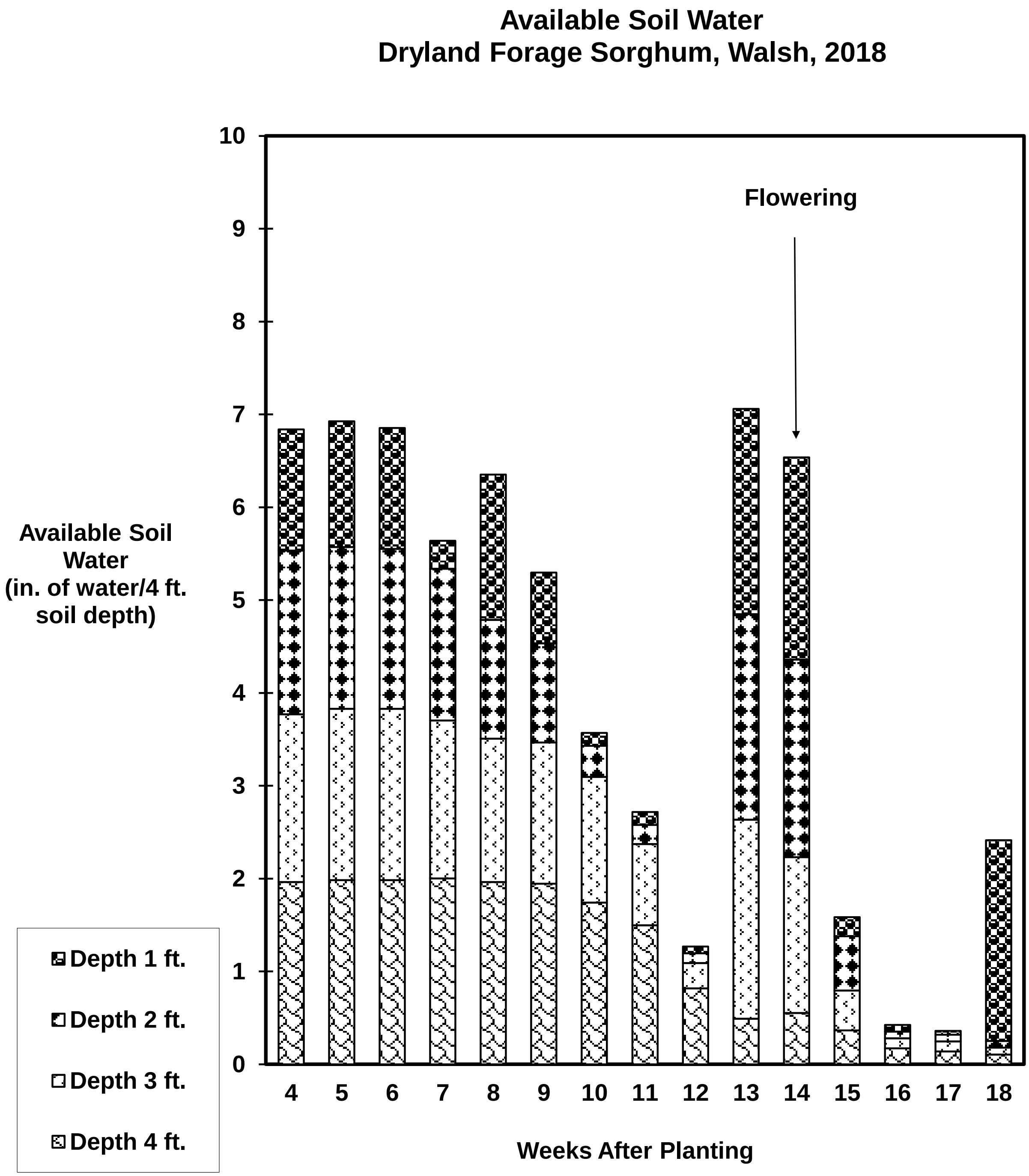


Fig. 1. Available soil water in dryland forage sorghum at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to harvest was 12.35 in. Any increase in available soil water between weeks is from rain.

2018 Dryland Forage Sorghum Hybrid Performance Trial at Walsh

Brand	Hybrid	Forage Yield[a]	Yield	Moisture	Stem Sugar	Harvest Density	Plant Height	Days to Boot	Harvest Maturity	Relative Maturity[b]	Forage Type[c]	Traits[d]
		tons/ac	% of test avg.	% at harvest	%	plants/ac	in	days after planting				
Dyna-Gro Seed	Fullgraze II	15.3	127	64.0	17.5	21,300	124	90	Milk	M	SS	-
Dyna-Gro Seed	F76FS77 BMR	15.1	126	65.3	18.0	27,500	58	97	Blister	ML	FS	BMR, BD
Dyna-Gro Seed	Super Sile 30	14.7	123	63.1	14.7	26,700	64	92	Milk	M	FS	-
Dyna-Gro Seed	705F	14.2	118	65.6	13.1	29,000	64	92	Milk	M	FS	SS
Alta Seeds	ADV S6504	14.1	117	71.2	12.5	24,400	84	111	Flowering	PS	SS	BMR-6
Dyna-Gro Seed	FX18878 BMR	13.4	112	62.6	13.4	23,600	77	85	Soft Dough	ME	FS	BMR
Alta Seeds	AF8301	13.1	110	64.6	9.0	28,300	61	93	Milk	M	FS	SS
Dyna-Gro Seed	FX18811	13.0	108	67.6	15.4	27,100	84	98	Blister	ML	FS	-
Dyna-Gro Seed	FX18311	13.0	108	67.8	11.0	29,100	84	78	Hard Dough	E	FS	-
Dyna-Gro Seed	FX18152	12.6	105	64.4	15.1	26,800	69	81	Hard Dough	E	FS	BMR, SS
Dyna-Gro Seed	Danny Boy BMR	12.5	104	72.0	13.0	27,900	107	97	Blister	PS	SS	BMR
LG Seeds	LG 5643	12.5	104	54.1	9.3	21,700	79	72	Hard Dough	M	Corn	-
Alta Seeds	ADV XF033	12.5	104	65.8	19.5	25,600	51	98	Blister	ML	FS	SS
Dyna-Gro Seed	Super Sile 20	12.0	100	65.2	12.5	26,900	86	94	Milk	M	FS	-
Dyna-Gro Seed	FX18317	11.8	98	65.2	15.5	26,700	71	80	Hard Dough	E	FS	-
Dyna-Gro Seed	FX18130	11.7	98	63.1	15.0	23,200	80	84	Soft Dough	ME	FS	BMR
Dyna-Gro Seed	FX18851 BMR	11.2	93	66.7	15.4	19,400	66	96	Blister	ML	FS	BMR, SS
Alta Seeds	AF7401	10.4	87	70.3	15.2	29,300	55	96	Blister	ML	FS	BMR-6, BD
Alta Seeds	ADV XF372	10.4	87	68.3	18.1	24,400	47	105	Flowering	L	FS	BMR-6, BD
Dyna-Gro Seed	F74FS23 BMR	9.7	81	66.7	14.9	24,000	81	92	Milk	M	FS	BMR
Dyna-Gro Seed	Fullgraze BMR	9.3	78	65.5	16.4	18,200	86	109	Flowering	L	SS	BMR
Dyna-Gro Seed	Fullgraze II BMR	8.9	74	67.2	15.0	17,400	93	105	Flowering	L	SS	BMR
Dyna-Gro Seed	GX16921	8.9	74	66.5	13.4	24,400	46	86	Soft Dough	ME	FS	Dual Purpose, SS
Dyna-Gro Seed	FX18340	7.3	61	62.3	8.0	18,600	80	78	Hard Dough	E	FS	-
Average		**12.0**		**65.6**	**14.2**	**24,646**	**75**	**92**				
[e]LSD (P<0.20)		1.85										

[a]Yields are adjusted to 65% moisture content based on oven-dried samples.

[b]Relative maturities are provided by the companies. E=early; ME=medium-early; M=medium; ML=medium-late; L=late; PS=photoperiod sensitive

[c]Forage Type: FS=forage sorghum; SS=sorghum sudangrass.

[d]Traits are provided by the companies. Dashes mean conventional (no traits) or information isn't available. BD=brachytic dwarf; BMR=brown mid-rib; BMR-6=one of the three main brown mid-rib genes.

[e]If the difference between two varieties yields equals or exceeds the LSD value, there is an 80% chance the difference is significant.

2018 Dryland Forage Sorghum Hybrid Performance Trial Feed Quality at Walsh

Brand	Hybrid[a]	Forage Type[b]	RFQ	CP	ADF	aNDFom	Lignin	Starch	NDFD 30hr	NDFD 240hr	TDN	Milk/Ton
				percent								
Alta Seeds	ADV XF372	FS	137	13.0	32.5	52.1	3.3	0.1	66.2	82.1	61.5	2818
Dyna-Gro Seed	Fullgraze BMR	SS	129	11.9	34.3	52.2	3.9	0.1	61.4	78.6	60.3	2816
Dyna-Gro Seed	FX18317	FS	129	13.3	34.2	52.0	3.8	1.3	60.3	75.5	60.1	2817
Dyna-Gro Seed	FX18130	FS	126	11.8	36.4	56.1	3.8	0.1	64.1	79.1	59.2	2664
Alta Seeds	AF7401	FS	126	9.9	38.3	59.3	4.1	0.1	66.0	79.3	60.6	2728
Dyna-Gro Seed	FX18152	FS	121	10.7	36.9	55.6	3.6	0.1	63.8	80.6	58.3	2589
Alta Seeds	ADV S6504	SS	121	12.1	35.5	54.0	3.6	0.1	61.7	78.3	58.1	2617
Dyna-Gro Seed	FX18340	FS	120	13.4	36.0	57.2	3.8	0.1	63.2	77.2	59.3	2688
Dyna-Gro Seed	GX16921	FS	117	11.9	34.1	54.7	3.7	0.1	58.9	77.3	58.3	2694
Dyna-Gro Seed	FX18311	FS	117	13.6	37.0	57.8	4.5	0.1	61.1	76.0	59.3	2735
Dyna-Gro Seed	Fullgraze II BMR	SS	116	12.1	37.9	58.0	3.9	0.1	62.3	77.0	58.2	2611
Alta Seeds	AF8301	FS	116	10.6	35.2	57.0	4.3	0.1	59.7	75.4	58.9	2736
Dyna-Gro Seed	FX18878 BMR	FS	112	15.4	36.1	55.9	4.5	0.1	59.6	74.8	56.4	2516
Dyna-Gro Seed	FX18811	FS	111	7.3	40.0	58.5	5.5	0.1	58.5	73.8	57.6	2654
Dyna-Gro Seed	Danny Boy BMR	SS	108	11.3	38.6	55.8	4.4	0.1	58.3	75.3	55.7	2487
Dyna-Gro Seed	F76FS77 BMR	FS	106	12.9	38.0	58.6	5.7	0.1	59.5	75.4	56.5	2533
Dyna-Gro Seed	F74FS23 BMR	FS	106	10.7	37.7	59.8	5.1	0.1	57.5	72.1	56.9	2618
Dyna-Gro Seed	FX18851 BMR	FS	105	12.7	37.8	59.6	5.2	0.1	57.3	71.5	56.4	2575
Dyna-Gro Seed	Super Sile 20	FS	103	11.5	37.9	58.8	5.1	0.1	56.0	71.1	55.8	2555
Dyna-Gro Seed	Super Sile 30	FS	103	10.1	38.8	60.4	5.3	0.1	56.8	72.6	55.9	2545
Dyna-Gro Seed	705F	FS	103	11.9	36.9	59.2	4.6	0.1	55.8	71.9	55.7	2553
Alta Seeds	ADV XF033	FS	95	12.0	37.1	55.9	4.9	0.1	51.8	69.2	52.7	2360
Dyna-Gro Seed	Fullgraze II	SS	80	7.3	42.2	64.5	6.3	0.1	48.8	69.5	52.5	2473
LG Seeds	LG 5643	Corn	N/A	12.7	35.0	59.6	4.4	0.1	58.0	73.4	58.5	2360
Average			**113**	**11.7**	**36.8**	**57.2**	**4.5**	**0.1**	**59.4**	**75.3**	**57.6**	**2614**

[a]Hybrids ranked according to relative forage quality score (RFQ)

[b]Forage Type: FS=forage sorghum; SS=sorghum sudangrass

All analyses results are dry basis values. RFQ=relative forage quality; CP=crude protein; ADF=acid detergent fiber; aNDFom=ash free neutral detergent fiber; NDFD=neutral detergent fiber digestibility; Milk/ton=Calculated using MILK2006.

Sprinkler Irrigation on Corn and Grain Sorghum Hybrids, Walsh 2018

Kevin Larson, Brett Pettinger and Perry Jones

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

MATERIALS AND METHODS: We tested 17 corn hybrids and 16 grain sorghum hybrids under sprinkler irrigation. We planted the corn study on May 4 at 26,000 seeds/a, and the grain sorghum study on May 25 at 50,000 seeds/a. We fertilized both studies using a strip-till implement with 200 lb N/a to the corn and 175 lb N/a to the grain sorghum with 20 lb P_2O_5/a as 10-34-0, and at planting we seedrow applied an additional 20 lb P_2O_5/a, and 0.33 lb/a of Zn chelate. We applied 12.7 acre-in./a of water to the corn and grain sorghum using a center pivot sprinkler. The plot size was at least four 30 in. rows, 600 ft. long that we harvested with a self-propelled combine and weighed them in a digital weigh cart. Seed moisture was adjusted to 15.5% for corn and 14% for grain sorghum.

RESULTS: Yields and test weights for both corn and grain sorghum were good. Although, we were not able to irrigate for early stand establishment, because both of our generators were nonfunctional. Late season rains contributed to high yields and test weights of these studies. June was dry until the later part of the month. July, August and October were wet.

DISCUSSION: Production was good for both the irrigated corn and grain sorghum studies. Typical yield goals for these studies are 150 bu/a for corn and 90 bu/a for grain sorghum. To exceed our yield goal by more than 10 bu/a for both studies is quite good. Overall rainfall for the season was well above average. The corn and grain sorghum crops may have stressed during the first part of June, because June was hot and dry, and both our portable generators were not working. Fortunately, abundant rains fell the later part of June through August, and we got one of our generators back in service. Generally, the rain events were well timed, which contributed to the good yields.

Sprinkler Irrigated Grain Sorghum Hybrid Study at Walsh, 2018

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

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

RESULTS: The 16 grain sorghum hybrids tested averaged 101 bu/a. The yield ranged from 78 bu/a for Dyna-Gro M71GB01 to 112 bu/a for Integra Seed. Medium early and later maturing hybrids produced the highest yields.

PLOT: Four rows with 30 in. row spacing, at least 600 ft. long. SEEDING DENSITY: 50,000 seeds/a. PLANTED: May 25. HARVESTED: November 27 and 29.

PEST CONTROL: Preemergence Herbicides: Atrazine 1lb/a, S-Metolachlor 24 oz/a, Mesotrione 6.4 oz/a; Post Herbicides: Alley 0.05 oz/a, Low Vol 6 at 8 oz/a. INSECTICIDE: None CULTIVATION: Once.

FIELD HISTORY: Previous Crop: Corn. FIELD PREPARATION: Vertical tillage 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	0.11	0.00	152	5	0	6
June	2.34	3.00	833	20	10	36
July	4.10	3.70	877	25	5	67
August	3.56	3.00	742	11	0	98
September	1.97	3.00	595	9	1	128
October	2.90	0.00	114	2	0	142
Total	14.98	12.70	3313	72	16	142

\1 Growing season from May 25 (planting) to October 14 (freeze, 30F).
\2 Total in-season water from irrigation and precipitation was 27.68 in/a.
\3 GDD: Growing Degree Days for sorghum.
\4 DAP: Days After Planting.

COMMENTS: Planted in adequate soil moisture for seed germination. Stand establishment was good. Weed control was good, except for volunteer corn. The growing season precipitation was well above average. June was dry until the later part of the month. July and August were wet. Grain yields and test weights were good. We applied 12.7 in/a of irrigation.

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

Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	S
		mmhos/cm	%	----------------ppm----------------				
0-8”	8.1	0.5	2.0	10	5.4	476	0.9	141
8”-24”				9				
Comment	Alka	VLo	Hi	Mod	Lo	VHi	Marg	Adeq

Iron was low.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	S
	--------------------lb/a------------------			
Recommended	38	20	0	0
Applied	175	40	0.3	0

Yield Goal: 90 bu/a.
Actual Yield: 101 bu/a.

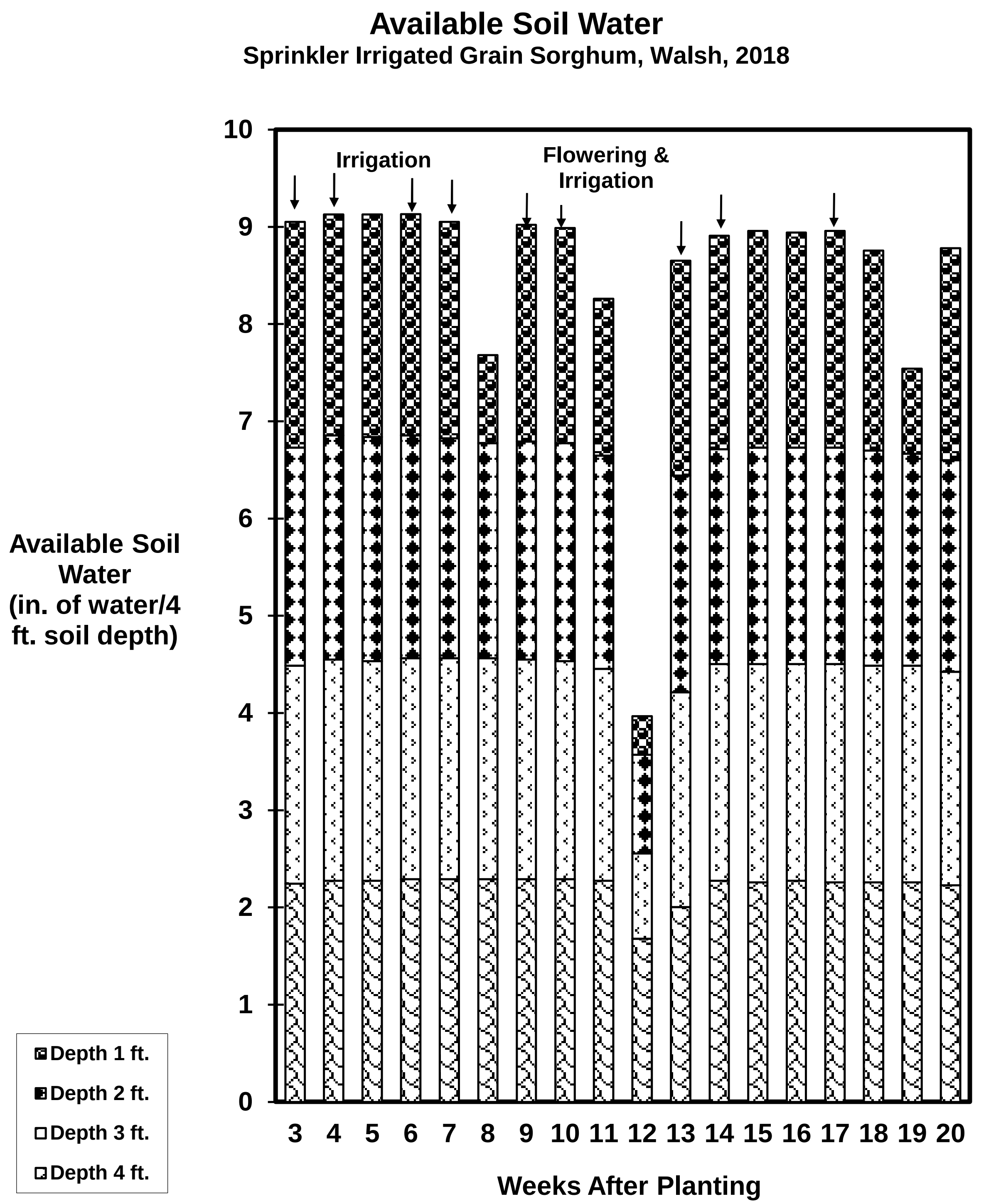


Fig. . Available soil water in limited sprinkler irrigation grain sorghum at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to first freeze was 14.98 in. Any increase in available soil water between weeks not attributed to applied irrigation is from rain.

Table .Limited Sprinkler Irrigated Grain Sorghum, Plainsman Research Center, Walsh, 2018.

Brand	Hybrid	Grain Yield	Seed Moisture Content	Test Weight	Plant Density	Plant Height	50% Flowering Date	50% Maturity Date
		bu/a	%	lb/bu	plants/a (1000X)	in		
Integra Seed	G3630	112.4	12.4	60.2	36.0	50	8/1	9/15
Pioneer Seed	84P68	111.9	12.8	59.2	42.0	51	8/8	9/26
Integra Seed	G3701	110.5	13.4	59.3	33.2	53	8/16	10/6
Dyna-Gro Seed	M60GB31	109.0	13.1	60.2	39.2	49	8/2	9/15
Dyna-Gro Seed	M69GR88	105.3	12.8	56.5	44.0	52	8/8	9/23
Integra Seed	G3670	105.0	13.5	58.4	40.4	50	8/10	9/28
Dyna-Gro Seed	GX17914	104.5	12.1	59.4	44.0	46	7/24	9/7
Golden Acres Genetics	2840B	103.2	12.8	60.5	35.6	48	7/27	9/10
Golden Acres Genetics	2730B	102.0	12.0	60.0	41.6	46	7/24	9/10
Dyna-Gro Seed	GX17912	100.1	12.6	58.4	39.6	46	7/23	9/2
Golden Acres Genetics	2620C	98.0	12.8	59.5	43.6	47	7/25	9/8
Dyna-Gro Seed	M60GB88	96.7	12.8	59.0	39.2	48	7/29	9/9
Dyna-Gro Seed	M59GB57	96.1	12.1	57.9	42.0	42	7/22	9/2
Golden Acres Genetics	H-390W	94.8	13.1	59.0	37.2	46	8/3	9/17
Dyna-Gro Seed	GX17917	92.4	12.0	59.0	37.2	45	7/23	9/4
Dyna-Gro Seed	M71GB01	78.0	13.2	58.2	36.0	44	7/22	9/3
Average		101.2	12.7	59.0	39.4	48	7/30	9/13
LSD 0.20		5.6						

Planted: May 25; Harvested: November 27 and 29, 2018.
50% Flowering Date: minimum date on which a hybrid flowers on half of its population.
50% Maturity Date: minimum date on which a hybrid has mature seed on half of its population.
Sprinkler irrigated grain sorghum received 12.7 acre-in of applied water.
Yields are adjusted to 14.0% seed moisture content.

Sprinkler Irrigation Corn Hybrid Study at Walsh, 2018

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

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

RESULTS: The average yield for all 17 hybrids tested was 162 bu/a. All four seed firms (Channel Seed, Dyna-Gro, Legend Seeds, and LG Seeds) entered in this trial had at least one hybrid that produced above the trial average.

PLOT: Four rows with 30" row spacing, at least 600' long. SEEDING DENSITY: 26,000 seeds/a. PLANTED: May 4. HARVESTED: November 3 and 5.

PEST CONTROL: Preemergence Herbicides: Atrazine 1lb/a, S-Metolachlor 24 oz/a, Mesotrione 6.4 oz/a; Post Herbicides: Glyphosate 32 oz/a, Dicamba 8 oz/a. CULTIVATION: Once. INSECTICIDE: Comite 54 oz/a for mites, Reveal 6.7 oz/a for grasshoppers.

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	2.77	0.00	546	9	0	27
June	2.34	3.00	833	20	10	57
July	4.10	3.70	877	25	5	88
August	3.56	3.00	742	11	0	119
September	1.97	3.00	595	9	1	149
October	2.90	0.00	114	2	0	163
Total	17.64	12.70	3707	76	16	163

\1 Growing season from May 4 (planting) to October 14 (freeze, 30F).
\2 Total in-season water from irrigation and precipitation was 30.34 in/a.
\3 GDD: Growing Degree Days for sorghum.
\4 DAP: Days After Planting.

FIELD HISTORY: Previous Crop: Grain sorghum. FIELD PREPARATION: Vertical tillage and strip-tilled.

COMMENTS: Planted in adequate soil moisture for seed germination. Stand establishment was good. Weed control was good, except for volunteer corn. The growing season precipitation was well above average. June was dry until the later part of the month. July and August were wet. Grain yields and test weights were good. We applied 12.7 in/a of irrigation.

SOIL: Wiley loam for 0-8" and loam 8"-24" depths from soil analysis.

Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	S
		mmhos/cm	%	----------------ppm----------------				
0-8"	8.0	0.6	2.3	12	7.2	477	1.3	16.2
8"-24"				9				
Comment	Alka	VLo	Hi	Mod	Med	VHi	Marg	Adeq

Iron was low.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	S
	--------------------lb/a------------------			
Recommended	101	20	0	0
Applied	200	40	0.3	0

Yield Goal: 150 bu/a.
Actual Yield: 162 bu/a.

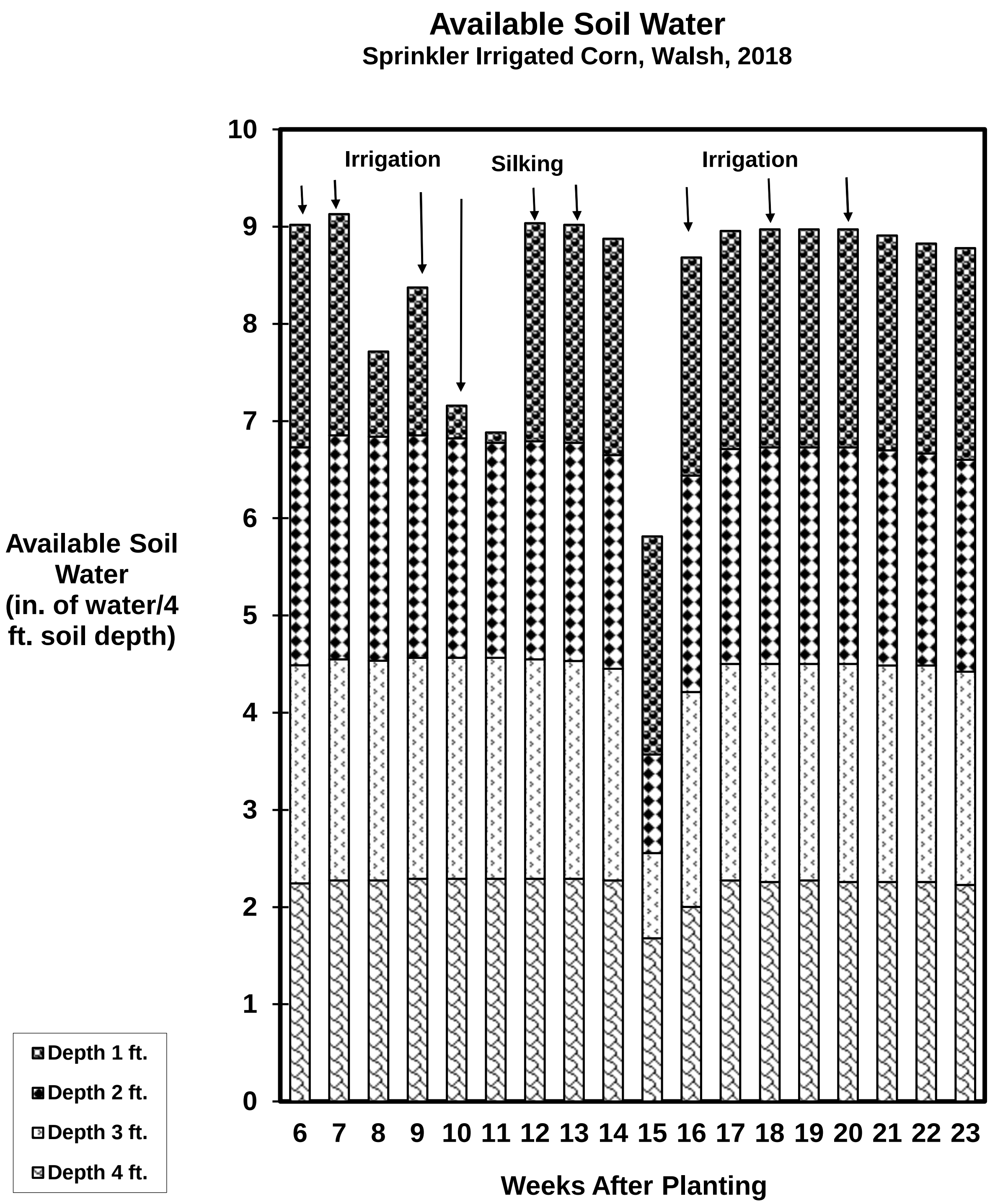


Fig. . Available soil water in limited sprinkler irrigation corn at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to first freeze was 17.64 in. Any increase in available soil water between weeks not attributed to applied irrigation is from rain.

Table .Sprinkler Irrigated Corn, Plainsman Research Center, Walsh, 2018.

Firm	Hybrid	Grain Yield	Seed Moisture	Test Weight	Plant Density	50% Silking Date
		bu/a	%	lb/bu	plants/a (X 1000)	
Channel Seed	214-00 DGVT2RIB	178	15.9	60.2	25.6	21-Jul
Dyna-Gro	D52VC63 RIB	177	15.0	59.0	25.8	21-Jul
Legend Seeds	LR99A09-3220	174	14.7	58.5	25.2	25-Jul
LG Seeds	LG5643 STXRIB	172	16.3	58.6	25.6	25-Jul
LG Seeds	LG61C48 STXRIB	171	14.7	59.5	26.0	25-Jul
Legend Seeds	XP18-12	170	14.8	61.2	24.8	21-Jul
Dyna-Gro	D55VC45	169	15.4	59.8	25.0	20-Jul
Dyna-Gro	D54VC14	166	15.1	61.0	25.6	20-Jul
Dyna-Gro	D54DC94 RIB	165	15.7	58.7	24.0	25-Jul
Dyna-Gro	D50VC30 RIB	165	14.8	59.4	24.8	23-Jul
Dyna-Gro	D52VC91 RIB	163	14.5	60.8	24.8	24-Jul
Legend Seeds	LR9714 GenSSRIB	162	15.3	58.3	24.6	24-Jul
Legend Seeds	XP18-14	161	14.2	60.1	25.0	20-Jul
Channel Seed	211-97R (non Bt)	157	15.2	59.6	25.6	19-Jul
Legend Seeds	LR 9907 GenSSRIB	148	14.0	58.7	25.6	20-Jul
LG Seeds	LG54C01 STX	132	14.5	59.0	24.0	18-Jul
LG Seeds	LG59C41 STX	121	14.6	59.8	25.6	17-Jul
Average		162	15.0	59.5	25.2	21-Jul
LSD 0.20		4.9				

Planted: May 4; Harvested: November 3 and 5, 2018.
Grain Yield adjusted to 15.5% moisture content.
This corn trial received a total of 12.7 acre-in./acre of irrigation.

Corn Borer Resistant and Nonresistant Hybrid Comparisons, Walsh, 2018

Kevin Larson, Brett Pettinger and Perry Jones

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

RESULTS: Only 8% of the plant of the non Bt hybrid had first generation corn borer shot holes. There were no second-generation corn borer stalk holes, or second-generation corn borer lodging on any of the hybrids. Grain yields were good, averaging 162 bu/a.

DISCUSSION: There was only minor first-generation and no second-generation corn borer damage. First-generation corn borer damage has been quite low for years, and this year was no exception. The lack of second-generation corn borer damage was due to the aerial application of Reveal to control grasshoppers, which also controlled the corn borer. Since there was only first-generation corn borer damage to the non Bt hybrid and no corn borer damage to any of the Bt hybrids, all 16 hybrids Bt hybrids tested showed excellent resistance to first-generation corn borer. The inclusion of Reveal controlled the second-generation corn borers; therefore, no second-generation corn borer resistance could be evaluated. In previous years, the low level of corn borer damage was attributable to our region’s extensive use of corn borer resistant hybrids. Even though we could not evaluate second-generation damage, we still advocate the use of corn borer resistant hybrids. However, 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 or use Refuge In a Bag (RIB) seed mixtures to help delay corn borer resistance to the Bt events.

Sprinkler Irrigated Corn, Corn Borer Ratings, Plainsman Research Center, 2018.

Firm	Hybrid	Grain Yield	Test Wt.	1st Gen. Shot Holes	2nd Gen. Plants Lodged	Non Corn Borer Plant Lodging	50% Silking Date
		bu/a	lb/bu	----------plants/a-----------			
Channel Seed	214-00 DGVT2RIB	178	60	0	0	0	21-Jul
Dyna-Gro	D52VC63 RIB	177	59	0	0	0	21-Jul
Legend Seeds	LR99A09-3220	174	59	0	0	0	25-Jul
LG Seeds	LG5643 STXRIB	172	59	0	0	0	25-Jul
LG Seeds	LG61C48 STXRIB	171	60	0	0	0	25-Jul
Legend Seeds	XP18-12	170	61	0	0	0	21-Jul
Dyna-Gro	D55VC45	169	60	0	0	0	20-Jul
Dyna-Gro	D54VC14	166	61	0	0	0	20-Jul
Dyna-Gro	D54DC94 RIB	165	59	0	0	0	25-Jul
Dyna-Gro	D50VC30 RIB	165	59	0	0	0	23-Jul
Dyna-Gro	D52VC91 RIB	163	61	0	0	0	24-Jul
Legend Seeds	LR9714 GenSSRIB	162	58	0	0	0	24-Jul
Legend Seeds	XP18-14	161	60	0	0	0	20-Jul
Channel Seed	211-97R (non Bt)	157	60	8	0	0	19-Jul
Legend Seeds	LR 9907 GenSSRIB	148	59	0	0	0	20-Jul
LG Seeds	LG54C01 STX	132	59	0	0	0	18-Jul
LG Seeds	LG59C41 STX	121	60	0	0	0	17-Jul
Average		162	60	0.7	0.0	0	21-Jul
LSD 0.20		4.9		1.1			

Planted: May 4; Harvested: November 3 and 5, 2018.
Grain Yield adjusted to 15.5% moisture content.
Sprinkler irrigated corn received a total of 12.7 in./acre of applied water.

Dryland Corn Hybrid Study, Plainsman Research Center at Walsh, 2018

COOPERATORS: Plainsman Agri-Search Foundation, Kevin Larson and Perry Jones, Walsh.

PURPOSE: To identify dryland corn hybrids that produce highest yields under dryland conditions.

RESULTS: The average yield for the seven Dyna-Gro hybrids tested was 54 bu/a. All hybrids produced significantly more yield than the D45VC65 hybrid.

PLOT: Four rows with 30 in. row spacing, 1300 ft. long. SEEDING DENSITY: 12,000 seeds/a. PLANTED: May 18. HARVESTED: October 30.

PEST CONTROL: Preemergence Herbicides: S-Metolachlor 24 oz/a, Atrazine 1.0 lb/a, Mesotrione 6.4 oz/a, Glyphosate 32 oz/a; Post Herbicides: Glyphosate 32 oz/a. CULTIVATION: None. INSECTICIDE: None.

FIELD HISTORY: Previous Crop: Grain sorghum. FIELD PREPARATION: Strip-tilled.

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

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	in		-------no. of days--------		
May	1.56	275	6	0	13
June	2.34	833	20	10	43
July	4.10	877	25	5	74
August	3.56	742	11	0	105
September	1.97	595	9	1	135
October	2.90	114	2	0	149
Total	16.43	3436	73	16	149

\1 Growing season from May 18 (planting) to October 14 (freeze, 30F).
\3 GDD: Growing Degree Days for sorghum.
\4 DAP: Days After Planting.

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

FERTILIZATION: Strip tilled N at 75 lb/a, 10-34-0 at 7.5 gal/a; and seedrow at planting 10-34-0 at 5 gal/a, Zn at 0.33 lb/a.

COMMENTS: Planted in marginal soil moisture, but fair seed germination and stand establishment. Weed control was good. The growing season precipitation was well above average. June was hot and dry until later in the month. All corn hybrids displayed stress symptoms in June. July and August were wet. Grain yields were fair and test weights were good.

Table .Dryland Corn, Plainsman Research Center, Walsh, 2018.

Firm	Hybrid	Grain Yield	Seed Moisture	Test Weight	Plant Density	50% Silking Date	Ear Height
		bu/a	%	lb/bu	plants/a (X 1000)		in
Dyna-Gro	D49VC70	57.2	16.0	58.0	11.0	28-Jul	15
Dyna-Gro	D48VC76 RIB	56.5	14.7	57.0	11.4	28-Jul	16
Dyna-Gro	D41VC71 RIB	54.3	13.7	58.3	11.6	25-Jul	15
Dyna-Gro	D44VC36 RIB	53.8	14.9	58.1	11.4	26-Jul	15
Dyna-Gro	D39DC43 RIB	53.4	13.3	57.5	11.8	25-Jul	16
Dyna-Gro	D47VC29	53.3	14.2	58.5	11.6	27-Jul	17
Dyna-Gro	D45VC65	48.9	13.2	58.4	12.0	26-Jul	15
Average		53.9	14.3	58.0	11.5	26-Jul	16
LSD 0.20		4.5					

Planted: May 18; Harvested: October 30, 2018.
Grain Yield adjusted to 15.5% moisture content.

Skip-Row Corn and Conventional Row Grain Sorghum Planting Comparison

Kevin Larson and Perry Jones

Skip-row planting is an old idea that is being revitalized for dryland row crop production in the drier areas of the High Plains. The two main advantages of skip-row planting compared to solid planting are reported to be late-season water availability from water stored in the skip-row (Klein et al., 2005) and less input costs (Jost and Brown, 2001). In this study, we compared skip-row planted corn to conventionally planted corn and grain sorghum to determine which planting system provides highest yields and incomes under dry conditions.

Materials and Methods

The site was strip-tilled with a 20 ft., eight-row Yetter implement to a depth of 8 in. into grain sorghum stubble. Our planting treatments were: 1) corn, all rows planted at 12,000 seeds/a; 2) grain sorghum, all rows planted at 32,000 seeds/a; and 3) corn, skip one row/plant two rows at 12,000 seeds/a (19,000 seeds/a in planted rows). With an eight-row 7300 John Deere vacuum planter, we planted corn, Channel 214-00 GVT2PRIB, on May 22, and grain sorghum, Pioneer 86P20, on June 6. We strip-tilled N at 75 lb/a and P at 30 lb P_2O_5/a, and we seedrow applied 20 lb P_2O_5/a and 0.33lb/a of Zn chelate. For preplant weed control, we sprayed glyphosate at 32 oz/a, atrazine at 1.0 lb/a, S-Metolachlor at 24 oz/a, and Mesotrione at 6.4 oz/a. For postemergence weed control we applied glyphosate at 32 oz/a two times. We harvested the corn on October 29 and the grain sorghum November 20 (grain sorghum yield results are from the surround bulk field) with a self-propelled combine equipped with a digital scale. Grain yields were adjusted to 15.5% for corn and 14% for grain sorghum.

Results and Discussion

The corn and grain sorghum yields ranged from 42 bu//a for the all rows planted grain sorghum to 62 bu/a for the all rows planted corn. There was no benefit from skip row planting when comparing the dryland corn treatments: the all rows planted corn treatment produced significantly more than the skip row/plant two corn treatment. Nonetheless, the skip row/plant two corn treatment did produce 7 bu/a more than the solid planted grain sorghum treatment. Because solid planted corn produced the highest yield, it also provided the highest variable net income, $47/a more than skip row corn. Even with the higher seed cost of corn compared to grain sorghum, the higher yield of skip row corn compared to solid planted grain sorghum gave skip row corn an income increase of $6/a. One reason that the skip row/plant two corn treatment yielded more than the all rows planted grain sorghum treatment was because the plant stand of the grain sorghum was poor and non-uniform due to dry planting conditions.

June was hot and dry, and the corn in both the skip row and solid planted treatments appeared quite stressed. Skip row is designed to take advantage of dry conditions by tapping into the fallow area in the skip row zone. However, there is no skip row advantage if there is insufficient stored water in the skip row zone. Typically skip row performs best when compensating for dry conditions during grain filling. This year, there were plentiful rains during grain filling (July and August). For Southeastern

Colorado, our highest rainfall months are July and August; therefore, skip row may not be the best strategy for our area.

Skip-row planting is not a new practice. For many years, cotton growers in Texas have used skip-row to take advantage of government programs. The skip-row area was considered set-aside acres and only the cotton in the planted rows was counted as production acres. The expansion of skip-row planting for other row crops caused a potential insurance problem because only 20 inches on each side of the planted row was considered planted area (Little, 2002). Only the crop area that was considered planted was insurable; therefore, insurance coverage was dependent on growers' skip-row planting patterns. With an alternate skip row pattern on 40 in. rows, only 50% of the field was considered planted and insurable. Recent rulings changed the insurability of skip-row plantings. Skip-row plantings are now considered fully planted and fully insurable by FSA.

Literature Cited

Jost, P.H. and S.M. Brown. March 2001. Skip row cotton – a cost savings concept. Georgia Cotton Newsletter, March 28, 2001. http://www.griffin.peachnet.edu/caes/cotton/cnl32801.pdf.

Klein, R.N., J.A. Golus, D. Baltensperger, R. Elmore, S. Knezevic, D. Lyon, S. Mason, L. Nelson, A. Pavlista, A.J. Schlegel, C. Shapiro, and M. Vigil. November 9, 2005. Skip-row corn for improved drought tolerance in rainfed corn. (Presentation and handout) Presented at the ASA-CSSA-SSSA International Annual Meetings (Noverber 6-10, 2005), Salt Lake City, Utah. http://crops.confex.com/crops/2005am/techprogram/P3948.htm.

Little, J. (Signed). December, 2002. Skip row and strip crops. EPA Federal Register, December, 2002. www.epa.gov/fedrgstr/EPA-IMPACT/2002/December/Day-03/i30702.htm.

Table. -Dryland Corn Skip-Row Study, Walsh 2018.

Crop and Row Treatment	Seeding Density	Seed Moisture	Test Weight	Grain Yield	Variable Net Income[b]
	seeds/ac (1000 x)	%	lb/bu	bu/ac	$/ac
Corn					
Plant all rows	12.0/(12.0)[a]	18.6	57.0	62.0	180.84
Skip row, plant two rows	12.0/(19.0)	20.5	55.0	49.5	133.34
Grain Sorghum					
Plant all rows	32.0/(32.0)	13.9	55.9	42.1	127.56
Average		17.7	56.0	51.2	147.25

Corn Planted: May 22, 2018, Channel 214-00 GVT2PRIB, 30 in. row spacing.
Corn Harvested: October 29, 2018.
Grain Sorghum Planted: June 6, 2018, Pioneer 86P20 in 30 in. row spacing.
Grain Sorghum Harvested: November 20, 2018 (yield results from bulk field).
[a]Seeding Density: 12.0=12K seeds/ac, (19.0)=19K seeds/ac in planted rows.
[b]Variable Net Income: yield (bu) x price ($/bu) - seed and herbicide costs.
Corn price: $3.80/bu; grain sorghum price: $3.25/bu.
Corn seed cost: $3.75/K seed; grain sorghum seed cost: $4.12/lb.
Corn had an additional glyphosate application: $9.76/ac (herbicide + app.).

Twin Row and Conventional Row Spacing Comparison for W-S-F Production

Brett Pettinger, Perry Jones, and Kevin Larson

To conduct a recent dryland wheat row spacing study, in which we tested five row spacing arrangements of 6 in., 7.5 in., 12 in., 15 in., and twin 7.5 in. (two rows 7.5 in. apart, centered on 30 in., with a 22.5 in. space between the outside rows), we used two different cone planters. The cone planter we used to achieve the 7.5 in., 15 in., and twin 7.5 in. row spacings was our small plot, twin row, row crop planter that had eight planter row units in a 7.5 in. twin row arrangement. By using GPS guidance to offset planting rows, we were able to achieve the necessary row spacing configurations. For example, to get uniform 7.5 in. spacing, we used the twin row, row crop planter to make the initial planting pass and then we shifted over and placed the 7.5 in. twin rows in the unplanted space and planted between the original 7.5 in. twin row pass, thus creating uniformly spaced 7.5 in. spacing. We included the twin 7.5 in. treatment because we thought growers would find it humorous, and because it was easy to identify even without a plot map. At our wheat field days, we were surprised by the positive reaction to the twin 7.5 in. treatment. Many growers felt that, even if the 7.5 in. twin did not produce the highest wheat yield, if next season, we planted grain sorghum in 7.5 in. twin rows in the 22.5 in. gap between the twin row wheat stubble that the additional grain sorghum yield would more than compensate for the lower wheat yield. True to grower experiences about achieving relatively high yields from partial plant stand failures that resembled twin row planted wheat. There were no significant grain yield differences in the wheat row spacing study between the twin row wheat spacing and any of the other wheat row spacings, except for the 12 in. row spacing which produced significantly higher grain yield than any of the other row spacings. Because of growers' research suggestions for this twin row system, we developed this twin row study for Wheat-Sorghum-Fallow rotation production to compare twin row and conventional single row spacing arrangements.

Materials and Methods

We tested three row spacing arrangements: 1) twin 7.5 in. rows (two rows 7.5 in. apart, centered on 30 in., with a 22.5 in. space between the outside rows) for twin rows of both wheat and grain sorghum; 2) single rows with uniform 10 in. spacing for single row wheat; and 3) single rows with uniform 30 in. spacing for single row grain sorghum. Our row spacing and crop sequencing treatments in Wheat-Sorghum-Fallow (W-S-F) rotation were 1) twin 7.5 in. rows of wheat followed by twin 7.5 in. rows of grain sorghum planted in the unplanted areas (22.5 in. gaps) between the twin row wheat stubble, (Twin W:Twin GS); 2) twin 7.5 in. rows of wheat followed by single uniformly spaced 30 in. rows of grain sorghum planted between the twin rows and in the unplanted areas (22.5 in. gaps) between the wheat stubble, (Twin W:Single GS); and 3) single uniformly spaced 10 in. rows of wheat followed by single uniformly spaced 30 in. rows of grain sorghum planted in the single uniformly spaced 10 in. rows of wheat stubble, (Single W:Single GS). For the twin row planting, we used our newly fabricated 20 ft., double disc, twin row planter with 8 sets of 7.5 in. twin rows, which the fabrication team (Brett and Perry) call, the "Great Plains Buffalo Tye Deere Twin Row Planter" for obvious reasons. For the uniform 10 in. spacing single row wheat planting, we used a 20 ft.

United Farm Tools double disc drill with 10 in. spacing. For the uniform 30 in. spacing single row grain sorghum planting, we used a 20 ft. John Deere 7300 vacuum planter with eight rows spaced 30 in. apart. This is our first wheat crop and second grain sorghum crop harvested in comparing the twin rows and single uniform rows of the Wheat-Grain Sorghum-Fallow (W-S-F) rotation. Next year we will harvest wheat and grain sorghum crops from established rotations for complete row-spacing interactions. We planted grain sorghum, Pioneer 86P20, at 32,000 seeds/a on May 30. We planted wheat, Snowmass, at 50 lb/a on October 10, 2017. This year, all wheat and grain sorghum treatments followed drilled 10 in. spacing wheat stubble. We applied 75 lb/a of N to the study site and seedrow applied 10-34-0 at 5 gal/a at planting. Before planting we sprayed one application of glyphosate at 32 oz/a, LoVol at 0.5 lb/a, and dicamba 6 oz/a. For in-season weed control for the grain sorghum, we applied pre-emergence: Sharpen 2.0 oz/a and glyphosate 32 oz/a, and post emergence: Brox 2EC 24 oz/a and Stare Down 6.4 oz/a. For fallow, we applied glyphosate 32 oz/a, dicamba 6 oz/a, LoVol 0.5 lb/a two times, and one of these applications we included Stare Down 6.4 oz/a to all the fallow plots to control glyphosate-resistant kochia. We harvested the wheat crop on June 29 and the grain sorghum crop on November 10 with a self-propelled combine equipped with a digital scale. We sampled the grain for test weights and moistures and used 12% for wheat and 14% for grain sorghum for moisture-adjusted grain yield comparisons. We recorded cost of production and yields to determine treatment revenues.

Results and Discussion

Wheat grain yields were poor, averaging only 12 bu/a. The poor wheat yields were due to dry planting conditions, which caused poor plant stands. Grain sorghum yields were very good, averaging 79 bu/a for all row arrangements. Although the grain sorghum was planted in marginal soil moisture, plentiful rains fell in July and August. Total seasonal precipitation was 14.87 in. from May (planting) to the first freeze in October. This year combining both wheat and grain sorghum crop production, the annual row spacing productions of the W-S-F rotation were quite similar, 1693 lb/a for Twin W:Single GS, 1714 lb/a for Twin W:Twin GS, and 1768 lb/a for Single W:Single GS. This is not surprising since both the wheat and grain sorghum crops for all row spacing arrangements were planted in uniformly spaced 10 in. row wheat stubble. The only relevant comparisons were twin row wheat compared to single row wheat, where single row wheat produced 3 bu/a more than twin row wheat, and twin row grain sorghum compared to single row grain sorghum, where less than 1 bu/a separated them. This indicates, with these partially established rotations, that there may be no yield advantage or disadvantage between twin row planted wheat and grain sorghum and single row planted wheat and grain sorghum.

The income difference between all row spacing arrangements was $19/a or less. 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. This year, we harvested both wheat and grain sorghum crops and the total rotation production difference was only 225 lb/a between the highest and lowest yielding row arrangement treatments. The 2018 total production for the Single W:Single GS in the W-S-F rotation was 5305 lb/a. The yields from the crop rotational phases were: wheat, 870 lb/a; grain sorghum, 4435 lb/a; and, of course, no production for fallow. The annual rotation production was 1768 lb/a, which is one-third the total production because the W-S-F rotation takes three years to complete one rotation cycle.

Since this is a new row spacing arrangement comparison study and we are still establishing the rotational treatments effects, no long-term rotational outcomes can be evaluated at present.

Twin Row and Convention Row Spacing for W-S-F, Crop Production, 2018

Crop	Row Arrangement & Spacing	-------2018 Crop------- Wheat	Grain Sorghum	Fallow	2018 Total Rotation Production	Annual Rotation Production
		---------------------lb/a----------------------				
1 Wheat:	Twin, 7.5 in.	684		--	5142	1714
1 Grain Sorghum	Twin, 7.5 in.		4458			
2 Wheat:	Twin, 7.5 in	684		--	5080	1693
2 Grain Sorghum	Single, 30 in.		4396			
3 Wheat:	Single, 10 in.	870		--	5305	1768
3 Grain Sorghum	Single, 30 in.		4435			
Average		746	4430	--	5176	1725
LSD 0.20		190.5	136.0			

Annual Rotation Production is Total Rotation Production divided by the number of years to complete one rotation cycle.
This is a new rotational study. Wheat planted October 10, 2017 for 2018 harvest.
Wheat planted October 10, 2017 in 10 in. spaced wheat stubble.
Grain sorghum planted May 30, 2018 in 10 in. spaced wheat stubble.

Twin Row and Conventional Row Spacing in W-S-F Rotation, Income Comparison, Walsh, 2018.

Crop	Row Spacing Arrangement	Test Weight	Grain Yield	Gross Income	Comparison to Conventional Spacing
		lb/bu	bu/ac	$/ac	$/ac
Wheat	Twin Row 7.5 in.	57.8	11.4	61.45	
Grain Sorghum	Twin Row 7.5 in.	58.9	79.6	254.72	
Treatment Total				316.17	-15.43
Wheat	Twin Row 7.5 in.	57.4	11.4	61.45	
Grain Sorghum	Single Row 30 in.	57.8	78.5	251.2	
Treatment Total				312.65	-18.95
Wheat	Single Row 10 in.	57.9	14.5	78.16	
Grain Sorghum	Single Row 30 in.	58.2	79.2	253.44	
Treatment Total				331.6	--
Average Wheat		57.7	12.4	67.02	
Average Grain Sorghum		58.3	79.1	253.12	
Wheat LSD 0.20			2.27		
Grain Sorghum LSD 0.20			3.40		

Wheat planted: October 10,2017; Harvested: June 29, 2018.
Grain Sorghum planted: May 30, 2018; Harvested: November 10, 2018.
Both wheat and grain sorghum planted in 10 in. spaced wheat stubble.
Wheat crop price: $5.39/bu (Snowmass premium).
Grain Sorghum price: $3.20/bu.

Herbicide and Single Tillage Control of Kochia in Wheat-Sorghum-Fallow Rotation

Kevin Larson, Brett Pettinger and Perry Jones

Kochia (*Kochia scoparia*) is an introduced plant that was originally grown as an ornamental but has become a pervasive weed in many cultivated fields. Soon after ALSs were first registered for long term broadleaf control in cereals, kochia developed resistant to these sulfonureals. In recent years, some kochia populations have become resistant to glyphosate. Continual dependence on glyphosate for broad spectrum weed control has led to kochia becoming resistant. Since kochia has become difficult to control with glyphosate, we conducted this study to investigate alternative kochia controlling herbicides and practices.

Materials and Methods

We conducted this dryland Wheat-Sorghum-Fallow rotation study at the Plainsman Research Center in which the previous crop rotation was Wheat-Sunflower-Fallow rotation. The kochia population on this site became glyphosate resistant after extensive reliance on glyphosate for weed control for the 10-year duration of the no till Wheat-Sunflower-Fallow rotation study. The kochia-controlling treatments prior to grain sorghum in 2018 were: 1) Valor 2.5 oz/a; 2) dicamba 16 oz/a and atrazine 1.0 lb/a; 3) dicamba 16 oz/a; and 4) dicamba 16 oz/a plus a single sweep plow tillage operation. The application dates for the herbicide treatments prior to grain sorghum in 2018 were March 1 and 2, 2018, and the sweep plow tillage portion of treatment 4 was performed May 8, 2018. No kochia-controlling rescue treatment was necessary before sorghum planting. The kochia-controlling treatments prior to wheat in 2018 were: 1) Valor 2.5 oz/a; 2) Balance Pro 2.5 oz/a; 3) dicamba 16 oz/a; and 4) dicamba 16 oz/a, plus a single sweep plow tillage operation. The application dates for the treatments before wheat in 2018 were February 21, 2017 for the herbicide treatments, and May 22, 2017 for the sweep plow treatment. A rescue weed control application consisting of Sharpen 2.0 oz/a, Stare Down 6.4 oz/a, glyphosate 32 oz/a, HSMSO 64 oz/100 gal of water, AMS 15 lb/100 gal of water was applied on May 18, 2017 to treatment 3. A second rescue weed control application consisting of Stare Down 6.4 oz/a, glyphosate 32 oz/a, 2,4-D 0.5 lb/a, AMS 1 lb/a was applied on June 6, 2017 to treatments 1 and 2. We planted wheat, Snowmass, at 50 lb seed/a on October 10, 2017. We planted grain sorghum, Pioneer 86P20, at 32,000 seeds/a on June 6, 2018. A post emergence application of Stare Down 6.4 oz/a and Brox 2EC 24 oz/a was applied to all grain sorghum treatments on July 13, 2018. A post application of Express 0.4 oz/a, Low Vol 8 oz/a and dicamba 1.5 oz/a was applied on March 27, 2018 to all wheat treatments. For fertilization, we surface streamed 50 lb N/a to the entire site and we seedrow applied at planting 10-34-0 at 5 gal/a to both the grain sorghum and wheat crops. We harvested the 20 ft. wide by 1000 ft. long grain plots of grain sorghum on November 30, 2018 and the wheat plots on July 3, 2018 with a self-propelled combine and weighed them in a digital scale cart. Grain samples were collected for seed moistures and test weights. Grain yields were adjusted to 14.0% seed moisture content for grain sorghum and 12% for wheat.

Results and Discussion

Prior to wheat planting, we had to rescue all of the herbicide treatments because they all had weeds appear. The dicamba at 16 oz/a treatment was the first we had to rescue because kochia broke through the treatment; therefore, we used a mix with Sharpen, an effective (and expensive) post emergence kochia control rescue treatment. We had to apply an herbicide rescue treatment to both the Valor at 2.5 oz/a and the Balance Pro to control mainly Russian thistle before wheat planting. Without the need to include Sharpen in the mix, the rescue treatment for the Valor and the Balance Pro was much less expensive than the rescue treatment used for the dicamba alone treatment. The tillage treatment with the dicamba at 16 oz/a followed by a single sweep plow operation provided very good kochia control.

The dicamba/tillage treatment had the highest wheat yield, and it was significantly higher than the other kochia-controlling treatments ($P>0.20$). The dicamba/tillage treatment probably had the highest grain yield because sweep plowing allowed greater, more uniform planting depth and provided more consistent plant stands. Grain yields were low and ranged from 14 bu/a for the Balance Pro treatment to 23 bu/a for the dicamba/tillage treatment. The dicamba/tillage treatment had the highest variable net income of $103/a, because it had the highest wheat yield and, unlike the other treatments, did not require a rescue treatment.

The Valor treatment produced the highest grain sorghum yields, but it was not significantly higher than the dicamba/atrazine treatment nor the dicamba alone treatment. The Valor, dicamba/atrazine, and dicamba alone treatments averaged 15.4 bu/a more grain sorghum than the dicamba/tillage treatment. The Valor treatment provided the highest variable net income of $181/a. The Valor, dicamba/atrazine, and dicamba alone treatments averaged $57/a more variable net income than the dicamba/tillage treatment, because the tillage (sweep plow) treatment dried out the soil and made planting conditions too dry for uniform germination and plant stands.

For the overall Wheat-Sorghum-Fallow rotation, less than $9/a of rotational variable net income separated the kochia-controlling treatments. Although there were wide income fluctuations for the dicamba/tillage treatment between wheat and grain sorghum, the total income was similar to the other treatments. Tillage had a distinct advantage for producing more uniform plant stands in wheat, but tillage caused weaker, less uniform plant stands in grain sorghum. Since there were only minor differences in rotational variable net incomes between the kochia-controlling treatments, all these treatments (along with the complementary rescue treatments) worked well for kochia control, grain production, and resultant income.

Table .--Herbicide and Single Tillage Control of Kochia in W-S-F Rotation, Wheat Crop, Walsh, 2018.

Treatment	Product Dosage	Dosage Unit	Application Date	Seed Moisture %	Test Weight lb/bu	Grain Yield bu/a	Treatment Cost $/a	Rescue Treatment Cost $/a	Variable Net Income $/a
1 Valor SX	2.5	oz/a	2/21/2017	9.6	58.5	14.4	17.75	16.28	43.59
2 Balance Pro	2.5	oz/a	2/21/2017	9.9	58.6	13.6	18.99	16.28	38.03
3 Dicamba	16	oz/a	2/21/2017	9.8	58.9	15.5	11.46	28.39	43.70
4 Tillage (sweep plow)			5/22/2017	9.3	58.7	23.0	21.46		102.51
4 Dicamba	16	oz/a	2/21/2017						
Average				9.7	58.7	16.6	17.42	20.32	56.96
LSD 0.20						2.71			

Planted: October 10, 2017, wheat variety: Snowmass at 50 lb seed/a.
Herbicide treatments applied: February 21, 2017 to 20 ft. by 1000 ft. with 2 replications, prior to kochia emergence.
Treatment cost is herbicide cost plus application cost at $6.50/a. Sweep plow cost is $10/a.
Rescue treatment applied May 18, 2017 to treatment 3 (dicamba 16 oz/a treatment).
The rescue treatment was: Sharpen 2.0 oz/a, Staredown 6.4 oz/a, Glyphosate 32 oz/a, 2,4-D 0.5 lb/a, HSMSO 64 oz per 100 gal. water, AMS 1 lb/a. Rescue treatment herbicide cost, $21.89/a.
Another rescue treatment applied June 6, 2017 to treatments 1 and 2 (Valor and Balance treatments).
The rescue treatment was: Staredown 6.4 oz/a, Glyphosate 32 oz/a, 2,4-D 0.5 lb/a, AMS 1 lb/a. Cost $9.78/a.
In-season weed control applied to all treatments March 27, 2018: Express 0.4 oz/a, Low Vol 8 oz/a, Dicamba 1.5 oz/a.
Variable Net Income: gross income (grain yield x $5.39/bu) minus treatment cost.
Snowmass wheat price plus protein premium: $5.39/bu.

Table .--Herbicide and Single Tillage Control of Kochia in W-S-F Rotation, Grain Sorghum Crop, Walsh, 2018.

Treatment	Product Dosage	Dosage Unit	Application Date	Seed Moisture %	Test Weight lb/bu	Grain Yield bu/a	Treatment Cost $/a	In-Season Treatment Cost $/a	Variable Net Income $/a
1 Valor SX	2.5	oz/a	3/2/2018	14.5	55.6	66.8	17.75	18.10	181.25
2 Dicamba	16	oz/a	3/2/2018	13.8	56.1	64.9	14.92	18.10	177.91
2 Atrazine	1	lb/a	"						
3 Dicamba	16	oz/a	3/1/2018	13.8	56.5	63.8	11.46	18.10	177.79
4 Tillage (sweep plow)			5/8/2018	16.0	53.2	49.8	21.46	18.10	122.29
4 Dicamba	16	oz/a	3/1/2018						
Average				14.5	55.4	61.3	16.40	18.10	164.81
LSD 0.20						10.84			

Planted: June 6, 2018, grain sorghum hybrid: Pioneer 86P20 at 32,000 seeds/a.

Herbicide treatments applied: March 1 & 2, 2018 to 20 ft. by 1000 ft. with 2 replications, prior to kochia emergence.

In-season weed control applied to all treatments July 13, 2018: Staredown 6.4 oz/a, Brox 2EC 24 oz/a.

Treatment cost is herbicide cost plus application cost at $6.50/a. Sweep plow cost is $10/a.

Variable Net Income: gross income (grain yield x $3.25/bu) minus treatment cost.

Grain sorghum price: $3.25/bu.

Table .--Herbicide and Single Tillage Control of Kochia for W-S-F Rotation, Walsh, 2018.

Treatment	Product Dosage	Dosage Unit	Application Date	Test Weight lb/bu	Grain Yield bu/a	Treatment Cost $/a	Wheat Rescue Treatment Cost $/a	Variable Net Income $/a	Rotational Variable Net Income $/a
1 Valor SX (Wheat)	2.5	oz/a	2/21/2017	58.5	14.4	17.75	16.28	43.59	224.84
1 Valor SX (Milo)	2.5	oz/a	3/2/2018	55.6	66.8	17.75		181.25	
2 Balance Pro (Wheat)	2.5	oz/a	2/21/2017	58.6	13.6	18.99	16.28	38.03	215.94
2 Dicamba (Milo)	16	oz/a	3/2/2018	56.1	64.9	14.92		177.91	
2 Atrazine (Milo)	1.0	lb/a	3/2/2018						
3 Dicamba (Wheat)	16	oz/a	2/21/2017	58.9	15.5	11.46	28.39	43.70	221.49
3 Dicamba (Milo)	16	oz/a	3/2/2018	56.5	63.8	11.46		177.79	
4 Tillage (Wheat)			5/22/2017	58.7	23.0	21.46		102.51	224.80
4 Dicamba (Wheat)	16	oz/a	2/21/2017						
4 Tillage (Milo)			5/8/2018	53.2	49.8	21.46		122.29	
4 Dicamba (Milo)	16	oz/a	3/2/2018						
Average				57.0	39.0	16.91	20.32	110.88	
LSD 0.20 (Wheat)					2.71				
LSD 0.20 (Milo)					10.84				

Wheat planted: 10-10-17, Snowmass at 50 lb seed/a. Milo planted: 6-6-18, Pioneer 86P20 at 32,000 seeds/a.
Herbicide treatments applied to 20 ft. by 1000 ft. with 2 replications, prior to kochia emergence.
Treatment cost is herbicide cost plus application cost at $6.50/a. Sweep plow cost is $10/a.
Rescue treatments applied 5-18-17 to dicamba 16 oz/a treatment and 6-6-17 to Valor and Balance treatments.
Rescue treatment: Sharpen 2.0 oz/a (May 18 only), Staredown 6.4 oz/a, Glyphosate 32 oz/a, 2,4-D 0.5 lb/a,
HSMSO 64 oz/100 gal. water, AMS 1 lb/a. Rescue treatment herbicide cost, $21.89/a (May 18) & $9.78/a (June 6).
Variable Net Income: gross income (grain yield x $5.39/bu for wheat; $3.25/bu for milo) minus treatment cost.

Four-Year (W-C-M-F) and Three-Year (W-S-F) Rotation Comparison

Kevin Larson, Brett Pettinger and Perry Jones

Wheat-Fallow (W-F), with tillage to control weeds in the fallow period, was the standard crop rotation in Eastern Colorado until the 1990's, when the adoption of no-till farming practices began to predominate. These no-till practices retain crop residues that reduced soil erosion and conserved water. With more water available for crop use, no-till practices allowed more extensive and successful crop rotations than W-F (Anderson, Bowman, Nielson, Vigil, Aiken, and Benjamin, 1999). Three-year and four-year crop rotations, such as, Wheat-Sorghum-Fallow (W-S-F), Wheat-Corn-Fallow (W-C-F), Wheat-Millet-Fallow (W-M-F), Wheat-Corn-Millet-Fallow (W-C-M-F), and Wheat-Corn-Sunflower-Fallow (W-C-Sun-F) began to emerge. Randy Anderson reported that some of these three-year and four-year rotations were much more effective in controlling weeds than others (Anderson, 2005). In rotations where one cool-season crop was followed by one warm-season crop (1 cool crop: 1 warm crop), such as winter wheat-millet, were compared to four-year rotations of two cool-season crops followed by two warm season crops (2 cool crops: 2 warms crops), he found over multiple rotation cycles that weeds increased in the 1 cool crop: 1 warm crop rotations and declined in the rotations of 2 cool crops: 2 warm crops. Because of the reduction in weeds and associated weed control savings, Anderson recommended using rotations of two cool-season crops followed by two warm season crops, such as W-C-M-F (Anderson considers fallow as a cool-season or warm-season crop alternative). After growers read of the potential production and weed control savings by switching to rotations of 2 cool crops: 2 warm crops, they suggested that we conduct a study to investigate if the W-C-M-F rotation would provide more income than our well adapted W-S-F rotation.

This is the second cropping year for our dryland W-C-M-F and W-S-F rotation comparison study. In fact, this rotation study is so new that 2018 was the first year of winter wheat harvest for the rotations. To make rotation comparisons on a yearly basis, we planted all phases of the rotations. For example, each crop (including fallow) of the W-C-M-F rotation is present every year. Each year, there are four study plots for the W-C-M-F rotation: one plot of wheat, one plot of corn, one plot of millet, and one plot of fallow. By having all rotation phases each year, we can annually compare multi-year rotations.

Materials and Methods

This is our second crop harvest year in comparing the following rotations: Wheat-Corn-Millet-Fallow (W-C-M-F) and Wheat-Grain Sorghum-Fallow (W-S-F). We planted: proso millet, Huntsman, at 12 lb/a on June 20; grain sorghum, Pioneer 86P20, at 32,000 seeds/a on May 30; and corn, Channel 214-00, at 12,000 seeds/a on May 18, 2018. We planted wheat, Snowmass, at 50 lb/a on October 10, 2017. This year, the wheat in both rotations followed dryland corn. We applied 75 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: the millet failed because of dry planting condition, therefore, we applied glyphosate as a cleanup; grain sorghum, glyphosate 32 oz/a, Brox 2EC 24 oz/a, Stare Down 6.4 oz/a; corn, atrazine 0.75, mesotrione 6.4 oz/a, glyphosate 32 oz/a. For fallow, we applied glyphosate 32 oz/a, dicamba 6 oz/a, LoVol 0.5 lb/a two times, and one of these applications we included Stare Down 6.4 oz/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: wheat, June 27; millet failed and was not harvested; grain sorghum, November 10; and corn, October 29. We sampled the grain for test weights and moistures and used moisture-adjusted grain yields for comparisons: wheat, 12%; grain sorghum, 14%; and corn, 15.5%. We recorded cost of production and yields to determine rotation revenues.

Results and Discussion

The W-S-F rotation produced marginally higher total rotation production (177 lb/a more) than the W-C-M-F rotation because the millet crop failed due to dry planting conditions. The W-S-F rotation produced higher annual rotation production and higher annual rotation variable net income than the W-C-M-F rotation. This income difference was $29.40/a. The higher income of the W-S-F rotation, $84.48/a, compared to the W-C-M-F rotation, $55.08/a, was due to the expensive of planting the millet crop, which failed and was not harvested. 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 2018 total production for the W-S-F rotation was 5126 lb/a. The crop rotational phases were: wheat, 1044 lb/a; grain sorghum, 4082 lb/a; and, of course, no production for fallow. The annual rotation production was 1709 lb/a, which is one-third the total production because the W-S-F rotation takes three years to complete one rotation cycle.

Since this is only the second cropping year for this rotation study, no long-term rotational effects can be fully evaluated.

Literature Cited

Anderson, R.L., R.A. Bowman, D.C. Nielsen, M.F. Vigil, R.M. Aiken, and J.G. Benjamin. 1999. Alternative crop rotations for the central Great Plains. J. Prod. Agric. 12:95-99.

Anderson, R.L. 2005. A multi-tactic approach to manage weed population dynamics in crop rotations. Agron. J. 97:1579-1583.

Table .-WCMF and WSF Rotation Comparison Study, Walsh, 2018.

Crop Rotation	Seeding Density	Seed Cost	Weed Control Cost	Yield	Crop Price	Gross Income	Variable Net Income
		--------------------	--------------------	--------------$/a	--------------------	--------------------	--------------------
Wheat	50 lb	8.33	15.23	0 bu	5.39/bu	87.86	64.30
W-C-M-F				15.2	5.39	81.93	58.37
W-S-F				17.4	5.39	93.79	70.23
Corn	12,000 seeds	45.00	28.51	73.4 bu	3.80/bu	278.92	205.41
W-C-M-F				73.4	3.80	278.92	205.41
Millet	12 lb	4.20	13.14	0.0 bu	5.88/bu	0.00	-17.34
W-C-M-F				0.0	5.88	0.00	-17.34
Grain Sorghum	32,000 seeds	9.48	18.10	72.9 bu	3.25/bu	236.93	209.35
W-S-F				72.9	3.25	236.93	209.35
Fallow	---	---	26.14	---	---	-26.14	-26.14
Average			20.22			115.51	87.11

Planted: Grain Sorghum, Pioneer 86P20 at 32,000 seeds/a on May 30; Millet, Huntsman at 12 lb/a on June 20; and Corn, Channel 214-00 at 12,000 seeds/a on May 18; Wheat, Snowmass at 50 lb/a on October 10, 2017.
Harvested: Wheat, June 27; Grain Sorghum, November 10; Corn, October 29.
Millet failed due to dry planting conditions.
Weed control cost is herbicide cost and $6.50/a application cost for each application.

Dryland WCMF and WSF Rotation Comparison Study, Crop Production, 2018.

	Crop Production						
	--------------------------2018 Crop--------------------------					2018 Total	Annual
Rotation	Wheat	Grain Sorghum	Millet	Corn	Fallow	Rotation Production	Rotation Production
	------------------------------------lb/a---------------------------------						
W-S-F	1044	4082			0	5126	1709
W-C-M-F	912		0	4037	0	4949	1237
Average	978	4082	0	4037	0	5038	1473

Annual Rotation Production is Total Rotation Production divided by the number of years to complete one rotation cycle.
This is only the second cropping year of this new rotational study.
Wheat planted in corn stalks for both rotations.
The millet crop failed due to dry planting conditions.

Dryland WCMF and WSF Rotation Comparison Study, Variable Net Income, 2018.

	-------------------------2018 Crop-------------------------					2018 Total Crop	Annual Rotation Variable
Rotation	Wheat	Grain Sorghum	Millet	Corn	Fallow	Net Income	Net Income
	---$/a---						
W-S-F	70.23	209.35			-26.14	253.44	84.48
W-C-M-F	58.37		-17.34	205.41	-26.14	220.30	55.08
Average	64.30	209.35	-17.34	205.41	-26.14	236.87	69.78

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.
New rotation study, therefore all wheat planted in corn stalks.
Millet failed due to planting in dry conditions.

Dryland Crop Rotation Study

Kevin Larson, Brett Pettinger and Perry Jones

This is the fourteenth 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. In 2015, we changed the Wheat-Sunflower-Fallow to Wheat-Corn-Fallow because the sunflower crops failed too often.

Materials and Methods

This is our twelfth harvest year in testing the following rotations: Wheat-Grain Sorghum-Fallow (W-S-F) and Sorghum-Millet (S-M). We added a fourth rotation of Millet/Wheat-Fallow (M/W-F) in 2006. In 2015, we changed the Wheat-Sunflower-Fallow rotation to Wheat-Corn-Fallow. In 2008 and 2011, no crops were harvested because of drought. We planted wheat, Snowmass, at 50 lb/a on October 10, 2017; proso millet, Huntsman, at 12 lb/a on June 20; grain sorghum, Pioneer 86P20, at 32,000 seeds/a on May 30; and corn, Channel 214-00, at 12,000 seeds/a on May 18, 2018. We applied 75 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 0.4 oz/a, LoVol 8 oz/a, dicamba 2 oz/a, Penetrant II 8 oz/a; millet, (failed) Glyphosate 32 oz/a as a cleanup; grain sorghum, Brox 2EC 24 oz/a, Stare Down 6.4 oz/a; corn, atrazine 0.75, mesotrione 6.4 oz/a, glyphosate 32 oz/a. For fallow, we applied glyphosate 32 oz/a, dicamba 6 oz/a, LoVol 10.7 oz/a two time, and one of these applications we included Stare Down 6.4 oz/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, failed, not harvested; grain sorghum, November 10; corn, October 29, and wheat, June 27. The millet crop was not harvest because of dry planting conditions that caused the millet to germinate and fail. We recorded cost of production and yields to determine rotation revenues.

Results and Discussion

This year with both wheat and corn crops harvested, the W-C-F rotation produced the highest total rotation production of 3818 lb/a. The W-C-F rotation made 895 lb/a more total rotation production than the S-M rotation. However, the S-M rotation had the highest annual rotation production of 1462 lb/a, even though there was no millet production. Wheat yields were low, averaging only 1216 lb/a (20 bu/a), because dry conditions at planting reduced plant stands. The low wheat yields contributed only a small portion to the overall rotation production. For example, wheat production for the W-C-F rotation account for only one-third of the total rotation production. 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 2018 total production for the W-C-F rotation was 3818 lb/a. The crop rotational phases were: wheat, 1236 lb/a; corn, 2582 lb/a; and, of course, no production for fallow. The annual rotation production was 1273 lb/a, which is one-third the total production because the W-C-F rotation takes three years to complete one rotation cycle. Not only did the S-M rotation produced higher annual rotation production than the W-C-F rotation, but the S-M rotation also generated $9.86/a more annual rotation variable net income than the W-C-F rotation. The higher income is due to S-M being a two-year rotation without a summer fallow period, whereas the W-C-F rotation is a three-year rotation with a summer fallow period. The M/W-F rotation produced the least income because the millet crop failed, and the wheat crop was less productive than the corn and grain sorghum crops.

The long-term annual rotational income, after the last seven harvest years, favors the S-M rotation with $79.82/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 $57.47/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. During the dry years, 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. However recently, the wheat crop failed in four of the last seven years: two times it was lost to hail, one year it winterkilled, and one year it was too dry and failed to emerge. Corn replaced sunflower in the W-Sunflower-F rotation because the sunflower crops failed six out of seven cropping years. This year even with no millet crop, rotations containing grain sorghum and corn 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, 2018.

Rotation	Wheat	Grain Sorghum	Millet	Corn	Fallow	2018 Total Rotation Production	Annual Rotation Production
	Crop Production						
	--2018 Crop--						
	--lb/a--						
S-M	0	2923	0			2923	1462
W-S-F	1278	1932			0	3210	1070
M/W-F	1134		0		0	1134	567
W-C-F	1236			2582	0	3818	1273
Average	1216	2428	0	2582	0	2771	1093
LSD 0.20	144.7	1422.1	--				

Annual Rotation Production is Total Rotation Production divided by the number of years to complete one rotation cycle.
The millet in all rotations germed and died due to dry planting conditions.

Table .-Dryland Crop Rotation Study, Variable Net Income, 2018.

Rotation	Wheat	Grain Sorghum	Millet	Corn	Fallow	2018 Total Crop Net Income	Annual Rotation Variable Net Income
	--2018 Crop--						
	--$/a--						
S-M		142.07	-13.70			128.37	64.19
W-S-F	91.25	84.55			-26.14	149.66	49.89
M/W-F	78.31		-13.70		-26.14	38.47	19.24
W-C-F	87.47			101.67	-26.14	163.00	54.33
Average	85.68	113.31	-13.70	101.67	-26.14	119.87	46.91

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 crop was not harvested because conditions were too dry to emerge.

Table .-Dryland Crop Rotation Study, Walsh, 2018.

Crop Rotation	Seeding Density	Seed Cost	Weed Control Cost	Yield	Crop Price	Gross Income	Variable Net Income
		---------------------------	----------	--$/a--	----------	----------	----------------------------
<u>Wheat</u>	50 lb	8.33	15.23	20.3 bu	5.39/bu	109.24	85.68
M/W-F				18.9	5.39	101.87	78.31
W-C-F				20.6	5.39	111.03	87.47
W-S-F				21.3	5.39	114.81	91.25
<u>Millet</u>	12 lb	4.20	9.50	0.0 bu	5.88/bu	0.00	-13.70
S-M				0.0	5.88	0.00	-13.70
M/W-F				0.0	5.88	0.00	-13.70
<u>Grain Sorghum</u>	32,000 seeds	9.48	18.10	43.4 bu	3.25/bu	140.89	113.31
S-M				52.2	3.25	169.65	142.07
W-S-F				34.5	3.25	112.13	84.55
<u>Corn</u>	12,000 seeds	45.00	28.51	46.1 bu	3.80/bu	175.18	101.67
W-C-F				46.1	3.80	175.18	101.67
Fallow	---	---	26.14	---	---	-26.14	-26.14
Average			19.50			79.83	52.16

Planted: Grain Sorghum, Pioneer 86P20 at 32,000 seeds/a on May 30; Millet, Huntsman at 12 lb/a on June 20; and Corn, Channel 214-00 at 12,000 seeds/a on May 18; Wheat, Snowmass at 50 lb/a on October 10, 2017.
Harvested: Wheat, June 27; Grain Sorghum, November 10; Corn, October 29.
Millet was too dry to emerge and was not harvested.
Weed control cost is herbicide cost and $6.50/a application cost for each application.

Table .-Dryland Crop Rotation Study, Annual Rotation Income, 2012 to 2018.

Rotation	Annual Rotation Variable Net Income 2012	2013	2014	2015	2016	2017	2018	Total Crop Net Income	Average Annual Rotation Variable Net Income
	$/a								
S-M	98.38	27.79	105.98	117.98	50.52	93.93	64.19	558.76	79.82
W-S-F	39.81	56.60	56.59	18.81	89.46	91.11	49.89	402.26	57.47
M/W-F	52.97	41.67	-21.87	-2.02	53.43	30.61	19.24	174.03	24.86
W-Sun-F	-32.88	8.17	-32.93	--	--	--	--	-57.64	-19.21
W-C-F				18.09	81.16	44.73	54.33	198.31	49.58
Average	39.57	33.55	26.94	38.21	68.64	65.09	46.91	318.93	48.13

No crops were harvested in 2008 and 2011 because of drought.
The 2012 (hail), 2014 (winterkill), 2015 (hail), 2017 (too dry, no emergence) wheat crops were not harvested.
The sunflower crops were not harvested in 2006, 2009, 2012, 2013, and 2014.
The 2016 millet crop was not harvested because of poor stand.
The 2017 millet crop in the S-M rotation failed to make a stand.
The 2018 millet crop failed to make a stand.
In 2015 corn replaced sunflower in the W-Sun-F rotation.
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, Brett Pettinger and Perry Jones

This was the twelfth 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 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 eleventh 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 winter wheat, Snowmass, at 50 lb/a on October 10, 2017 and Proso millet, Huntsman, at 12 lb/a on June 20, 2018. 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 and applied Sharpen 2.0 oz/a once to the fallow plots to control glyphosate resistant kochia. For in-season weed control, we chose short-residual herbicides that should not interfere with crop rotations: wheat, Express 0.4 oz/a, LoVol 0.38 lb/a, dicamba 1.5 oz/a and Penetrant II 8 oz/a; millet, Stare Down 6.4 oz/a and 2,4-D ester 6 oz/a; and fallow, glyphosate 32 oz/a, dicamba 6 oz/a and LoVol 0.5 lb/a two times. The millet failed so we applied glyphosate 32 oz/a as a cleanup. There was no millet harvested. We harvested the wheat on July 2, 2018 with a self-propelled combine equipped with a digital scale. Grain yields were adjusted to 12% moisture content for the wheat. We recorded cost of production and yields 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. There was no wheat harvested in 2017, because it was too dry to emerge. No millet was harvested in 2018 due to poor stands from dry planting conditions.

Results and Discussion

The millet did not produce a crop because it was planted in dry soil and produced inadequate stands. Wheat yields were fair, averaging 27 bu/a. There was marginal moisture at planting, so the stands were somewhat spotty. This year because of the millet failure, only rotations with wheat produced positive annual rotation variable net incomes. The W-M-F rotation had the highest wheat yield, but the W-W rotation made $97/a more annual rotation variable net income than the W-M-F rotation. The W-F rotation had the second highest annual rotation variable net income, even though, like the W-M-F rotation, it had a higher wheat yield than the W-W rotation. The higher annual rotation variable net income of the W-W rotation compared to the W-F rotation is because the W-W rotation has income from a wheat crop each year without a summer fallow period, whereas the W-F rotation income is spread over two years and it has a costly summer fallow period. The M-M rotation had the lowest income of -$29/a because the millet crop failed, and the M-M rotation is solely reliant on millet income.

For the twelve years that we have conducted this study, we have had multiple crop failures and missed plantings, therefore rotational affects are, at best, difficult to generalize and quantify. This year, the wheat yields were fair, but the millet crop failed due to dry planting conditions, which caused poor stands. Over the past seven harvest years, the continuous wheat (W-W) rotation provided the highest average annual rotational variable net return of $15/a. For the past seven harvest years, and acknowledging crop failures and missed plantings, less than $7/a separate the top four rotations: W-W, W-M-F, M-M, and W/M-F. The remaining two rotations, W-F and M/W-F averaged less than a quarter as much annual income over the last seven harvest years as the W-W rotation.

Last year, millet yields were very good, but the wheat crop failed due to dry conditions that caused a lack of emergence. In 2016, wheat yields were very good, but millet yields were reduced by a late planting date. In 2015, both wheat and millet yields were low. The wheat yields were low because a hailstorm caused considerable lodging and seed shattering. The millet yields were low because of a late planting date. In 2014, late planting dates for both wheat and millet reduced yields (and the M-M rotation failed to establish a stand). In 2013, dry conditions reduced yields of both wheat and millet crops, and we failed to plant millet in the W/M-F rotation. In 2012, 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. 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. In 2009, we did not plant millet in the W/M-F rotation because of delayed volunteer wheat control. 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 rotation) to establish a stand.

There appears to be no relationship between fallow length and yields and incomes of the wheat and millet rotations in this study. The rotation with the highest annual rotation variable net income after the past seven cropping years is W-W, which has the shortest fallow period of 3 months. The W-M-F rotation has the second highest annual rotation variable net income after seven years and it has the longest fallow length of 23 months (when totaling both fallow periods between the wheat and millet). When correlating production performance against precipitation, the W-W rotation tended to perform better in wetter years (except 2007, which was a dry year but had good winter moisture), while the W-M-F rotation tended to perform better in drier years.

Table .Dryland Millet-Wheat Rotation, Crop Production, 2018.

Rotation	Wheat	Millet	Fallow	2018 Total Rotation Production	Annual Rotation Production
	-----------2018 Crop----------				
	-------------------------lb/a----------------------------				
W-F	1776			1776	888
W-W	1668			1668	1668
W-M-F	1848	0		1848	616
M/W-F	1200	0		1200	600
W/M-F	1434	0		1434	717
M-M		0		0	0
Average	1585	0		1321	748
LSD 0.20	208.6				

Annual Rotation Production is Total Rotation Production divided by the number of years to complete one rotation cycle.

Table .Dryland Millet-Wheat Rotation, Variable Net Income, 2018.

Rotation	Wheat	Millet	Fallow	2018 Total Crop Net Income	Annual Rotation Variable Net Income
	-----------2018 Crop----------				
	-------------------------$/a----------------------------				
W-F	135.81		-26.14	109.67	54.84
W-W	126.11			126.11	126.11
W-M-F	142.28	-28.68	-26.14	87.46	29.15
M/W-F	74.57	-28.68	-26.14	19.75	9.88
W/M-F	105.09	-28.68	-26.14	50.27	25.14
M-M		-28.68		-28.68	-28.68
Average	116.77	-28.68	-26.14	60.76	36.07

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.
Millet crop failed, planting conditions too dry caused poor stands.

Table .-Dryland Millet and Wheat Rotation Study, Walsh, 2018.

Crop Rotation	Seeding Density	Seed Cost	Weed Control Cost	Yield	Crop Price	Gross Income	Variable Net Income
	lb/a	$/a	$/a	bu/a	$/bu	$/a	$/a
Wheat							
W-F	50	8.33	15.40	29.6	5.39	159.54	135.81
W-W	50	8.33	15.40	27.8	5.39	149.84	126.11
W-M-F	50	8.33	15.40	30.8	5.39	166.01	142.28
M/W-F	50	8.33	24.90	20.0	5.39	107.80	74.57
W/M-F	50	8.33	15.40	23.9	5.39	128.82	105.09
Wheat Average	**50**	**8.33**	**17.30**	**26.4**	**5.39**	**142.40**	**116.77**
Millet							
M-M	12	3.60	25.08	0.0	5.88	0.00	-28.68
W-M-F	12	3.60	25.08	0.0	5.88	0.00	-28.68
M/W-F	12	3.60	25.08	0.0	5.88	0.00	-28.68
W/M-F	12	3.60	25.08	0.0	5.88	0.00	-28.68
Millet Average	**12**	**3.60**	**25.08**	**0.0**	**5.88**	**0.00**	**-28.68**
Fallow	---	---	26.14	---	---	0.00	-26.14
Average			20.76			142.40	20.65

Planted: Millet, Huntsman at 12 lb/a on June 20; Wheat, Snowmass at 50 lb/a on October 10, 2017.
Harvested: Wheat on July 2; Millet was not harvested due to poor stands.
Wheat herbicides: Express 0.4 oz/a, 2,4-D 0.38 lb/a, dicamba 1.5 oz/a, Penetrant II 8 oz/a;
Wheat herbicide cost: $8.90/a
Millet herbicides: Staredown 6.4 oz/a, 2,4-D ester 6 oz/a; Glyphosae 32 oz/a for failed millet cleanup.
Millet herbicide cost: $9.08/a
Fallow herbicides: glyphosate 32 oz/a, 2,4-D 0.5 lb/a, dicamba 6 oz/a;
Fallow herbicide cost: $6.57/a per application (two applications, $6.50/a per application)
Applied Sharpen 2.0 oz/a to control kochia. Kochia control cost: $11.72/a
Wheat in M/W-F additional herbicide: glyphosate 32 oz/a cost $3.00/a.
Weed control cost is herbicide cost and $6.50/a application cost for each application.

Table .Millet-Wheat Rotation, Annual Rotation Income, 2012 to 2018.

Rotation	Annual Rotation Variable Net Income 2012	2013	2014	2015	2016	2017	2018	Total Crop Variable Net Income	Average Annual Rotational Variable Net Income
	$/a								
W-F	-21.47	-27.93	-15.78	-13.01	57.92	-20.95	54.84	13.62	1.95
W-W	-19.04	-26.02	-25.42	12.23	56.06	-16.46	126.11	107.46	15.35
W-M-F	-1.65	12.05	-21.12	11.03	34.04	31.50	29.15	95.01	13.57
M/W-F	-25.79	-1.95	-24.21	-2.00	26.80	45.74	9.88	28.48	4.07
W/M-F	-21.47	-23.58	-12.48	-24.78	61.89	54.96	25.14	59.68	8.53
M-M	47.39	-0.56	-23.09	4.21	-12.02	102.90	-28.68	90.15	12.88
Average	-7.00	-11.33	-20.35	-2.05	37.45	32.95	32.95	65.73	9.39

No millet was harvested in 2018 (poor stands).
No wheat was harvested in 2012 (hail) and 2017 (too dry to emerge).
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, Brett Pettinger and Perry Jones

One of the Natural Resource Conservation Service (NRCS) current foci is on cover crops and their effects 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 or canola 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 winter cover crops: triticale at 60 lb/a or wheat at 50 lb/a, rapeseed or canola 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). 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 were present each year. We inserted gypsum blocks at 6 in., 18 in., and 30 in. depths to measure soil water use by the cover crops.

This year, we were able to harvest the grain sorghum crop in the W-S-F rotation and the wheat crops in both the W-S-F and the W-F rotations. Both the winter and spring cover crops preceding the W-S-F rotation survived, but the winter cover crops prior to the wheat in the W-F rotation failed. Thus far, 2016 was the only year that the winter and spring cover crops survived, and we were able to harvest both grain sorghum and wheat crops. In all other years, either the cover crops did not survive, or the wheat crop was lost to hail or was winterkilled. We planted the W-F winter cover crops on August 15, 2016 after wheat harvest. The conditions were too dry for seedling emergence and the cover crops failed. For the wheat phase of the W-S-F rotation, we planted the spring cover crops in the W-S-F rotation on February 28, 2017 during the fallow period after sorghum harvest. On June 12, 2017, we terminated the spring cover crops and controlled weeds in the N plots with an application of glyphosate, 2,4-D, dicamba and Comet (for kochia control). We planted both the W-S-F and the W-F wheat on October 10, 2017 with Snowmass at 50 lb/a and seedrow applied 10-34-0 at 5 gal/a at planting. To control weeds in the wheat, we applied Express, 2,4-D, dicamba and surfactant after tillering. We planted the winter cover crops prior to sorghum planting in the W-S-F rotation on August 18, 2017 into wheat stubble 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 May 2, 2018. We planted Pioneer 86P20 at 32,000 seeds/a on May 30, 2018 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 Stare Down and Brox 2EC.

We harvested the W-S-F grain sorghum on November 30, 2018, and the W-F and W-S-F wheat on June 29, 2018 with a self-propelled combine equipped with a digital scale. Grain yields were adjusted to 14.0% seed moisture content for grain sorghum and 12% seed moisture content for wheat.

Results and Discussion

Grain Sorghum Phase, W-S-F Rotation

Precipitation from planting to termination of the winter cover crops (eight months, September 2017 through April 2018) for the grain sorghum phase of the W-S-F rotation was 5.90 in. After eight months of growth, the average dry matter production of the cover crops was 364 lb/a. The cover crops forage yields ranged from 126 lb/a for canola to 921 lb/a for hairy vetch. Hairy vetch had significantly higher forage yield than the three other cover crops tested at the 0.20 alpha level.

When terminated after eight months of growth, the cover crops preceding the grain sorghum had these changes in available soil water (at termination minus at planting): -1.57 in. for wheat, -1.57 in. for canola, -2.34 in. for hairy vetch, and -1.96 in. for Winter N Mix of soil water to a depth of three feet. The fallow 0N check (at termination minus at planting) lost -0.89 in. of soil water to a depth of three feet during the same eight-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: 0.68 in. for wheat, 0.68 in. for canola, 1.45 in. for hairy vetch, and 1.07 in. for Winter N Mix. Wheat and canola had the lowest water use of the cover crops tested.

The treatment with the highest grain sorghum yield was 25 N with 41 bu/a, which was significantly higher than all the cover crops and N treatments tested, except for the 50 N treatment. The grain yield from the 50 N treatment was significantly higher than the Winter N Mix and hairy vetch treatments. The Winter N Mix treatment had the lowest grain yield and it was significantly lower than any of the cover crops and N treatments, except for the hairy vetch treatment. The 25 lb N/a treatment yielded significantly more than the 0 lb N/a treatment, but the yield of the 25 N treatment was not significantly higher than the 50 N treatment.

The 25 N treatment produced the highest variable net income, $115/a, because it had the highest grain yield and the second lowest treatment cost. The 25 N and 0 N treatments had higher net incomes than all the cover crop treatments. The lowest variable net income of $45/a was from the hairy vetch treatment, which had the second to the lowest yield and the highest treatment cost. The 25 N treatment had higher yield, from water saved by not growing cover crops, and variable net income, because N application was less expensive than planting cover crops.

<u>Wheat, W-F Rotation</u>

The winter cover crops preceding the wheat failed because of dry conditions at planting. However, the expense for planting the cover crops and for applying the N to the N treatments was deducted from the gross grain sorghum revenue, because these operations were already performed.

The treatments with the highest wheat yields were following the failed hairy vetch and the failed winter N mix treatments with 17 bu/a, which were significantly higher than any of the other failed cover crops and N treatments tested. The 25 N treatment had the lowest wheat yield. The 25 N treatment produced significantly less wheat yield than the wheat cover crop. There was no significant yield difference between any of the N treatments. Wheat grain yields were low, averaging 13.7 bu/a for all the failed cover crops and N treatments, because it was dry at planting, which caused poor plant stands, and only 1.33 inches precipitation fell from November to mid-May. The wheat crop did not directly follow cover crops this year; however, the wheat crop did follow the cover crops from previous years. Therefore, the wheat yields may reflect residual effects of past cover crops.

The 0 lb N/a treatment produced the highest variable net income, $63/a, because it had average grain yield, but no treatment cost. The lowest variable net income of $22/a was from the hairy vetch treatment, which had the highest yield, but also the highest treatment cost. With dry conditions and low wheat yields, treatment costs overwhelmed production incomes, making it most profitable to do nothing: not plant cover crops, nor fertilize with nitrogen.

<u>Wheat Phase, W-S-F Rotation</u>

Precipitation from planting to termination of the spring cover crops (three and one-half months, March 2017 through mid-June 2017) for the wheat phase of the W-S-F rotation was 12.88 in. This high precipitation amount for the three-month period was due mainly to the 11.43 inches of rain that occurred in April and May. After three months of growth, the average dry matter production of the cover crops was 1334 lb/a. The cover crops dry matter yields ranged from 520 lb/a for hairy vetch to 2088 lb/a for canola and the forage yield difference between the canola and hairy vetch was significant at the 0.20 alpha level.

When terminated after three and one-half months of growth, the cover crops preceding wheat planting gained: +4.06 in. for oats, +2.64 in. for canola, +5.68 in. for hairy vetch, and +2.03 in. for Spring N Mix of available soil water (at termination minus at planting) to a depth of three feet. The fallow 0N check (at termination minus at planting) stored +6.37 in. in soil water to a depth of three feet during the same three- and one-half-month period. During the three and one-half months of cover crop growth, all the cover crops used more available soil water than the fallow 0N check. Therefore, subtracting soil water used by the cover crops from soil water stored 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: 2.31 in. for oats, 3.73 in. for canola, 0.69 in. for hairy vetch, and 4.34 in. for Spring N Mix.

The treatment with the highest wheat grain yield was the 25 lb N/a treatment with 15.2 bu/a, which was significantly higher than oats and 50 N treatments. The oats and 50 N treatments tied for the lowest grain yield of 12.1 bu/a.

The 0 lb N/a and the 25 lb N/a treatments had higher variable net incomes than all the cover crops. The 0 lb N/a treatment produced the highest variable net income, $68/a, because it had only below average wheat grain yield but no treatment cost. The hairy vetch treatment had the lowest variable net income of $4/a because it had above average wheat yield, but the highest treatment cost. Wheat production of the cover crops averaged 13.1 bu/a, which was much less than expect considering that 31.62 inches of precipitation that occurred from cover crop planting to wheat maturity (March 2017 through May 2018). Dry conditions at wheat planting through flowering (only 1.33 in of precipitation fell from November to mid-May) caused poor plant stands and poor yields.

Reference Cited
Conservation Tillage & Technology Conference. February 23-24, 2011. 2011 proceedings of the Midwest Cover Crop Council. Ohio Northern University, Ada, Ohio. http://www.mccc.msu.edu/meetings/2011/2011_MCCC_Proceedings_web2.pdf Accessed: January 15, 2013.

Larson, K. J., 1995. Legumes for cover and N in Wheat-Fallow and continuous grain sorghum at Walsh, 1993-94. *In*: Plainsman Research Center, 1994 Research Results, Larson, et al. CAES, CE, CSU, Fort Collins, Colorado.

Schlegel, Alan J. and John L. Havlin. 1997. Green fallow for the Central Great Plains. Agron. J. 89:762-767 (1997).

Vigil, Merle F. and David C. Nielsen. 1998. Winter wheat depression from legume green fallow. Agron. J. 90:727-734 (1998).

Table .-Cover Crop Study, Grain Sorghum (W-S-F) after Winter Cover Crop, Walsh, 2018.

Treatment	Grain Sorghum Yield	Test Wt.	Cover Dry Matter	Cover N	Fixed N	Treatment Cost	Fixed N Income	Variable Net Income
	bu/a	lb/bu	lb/a	lb/a	lb/a	$/a	$/a	$/a
Canola	35.3	59	126	3.3		16.75		97.98
Wheat	34.9	58	162	6.1		20.33		93.10
Hairy Vetch	30.9	59	921	33.9	30.6	69.00	13.64	45.07
Winter N Mix	28.9	59	249	9.0	5.7	46.25	2.51	50.19
0 N	33.7	58				0.00		109.53
25 N	40.8	60				17.50		115.10
50 N	37.3	58				28.50		92.73
Average	34.5	59	364	13.1		28.33		86.24
LSD 0.20	4.16		186.5					

Cover crops planted: August 18, 2017.
Cover crops terminated May 2, 2018.
Grain sorghum planted: May 30; Harvested: November 30, 2018.
Cover crop seeding rate: Winter N Mix, 43 lb/a; hairy vetch, 30 lb/a; canola, 5 lb/a; wheat, 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; wheat, $8.33/a.
N fertilizer cost: 28-0-0, $0.44/lb.
Treatment application cost: cover crop planting, $12/a; N application, $6.50/a.
Grain sorghum price: $3.25/a.

Table .-Cover Crop Study, Wheat (W-F) after Winter Cover Crop, Walsh, 2018.

Treatment	Wheat Yield	Test Wt.	Cover Dry Matter	Cover N	Fixed N	Treatment Cost	Fixed N Income	Variable Net Income
	bu/a	lb/bu	lb/a	lb/a	lb/a	$/a	$/a	$/a
Canola	12.9	57.8	0	0.0		16.75		52.78
Wheat	14.1	58.3	0	0.0		20.33		55.67
Hairy Vetch	16.9	57.7	0	0.0	0.0	69.00	0.00	22.09
Winter N Mix	16.8	58.1	0	0.0		46.25		44.30
0 N	11.6	58.4				0.00		62.52
25 N	10.6	58.0				17.50		39.63
50 N	12.7	56.9				28.50		39.95
Average	13.7	57.9	0	0.0		28.33		45.28
LSD 0.20	2.44		0.0					

Cover crops planted: August 15, 2016.
Cover crops failed because it was too dry,
Wheat planted: October 10, 2017, Snowmass at 50 lb seed/a, 5 gal/a of 10-34-0.
Wheat harvested: June 29, 2018.
Cover crop seeding rate: Winter N Mix, 43 lb/a; hairy vetch, 30 lb/a; canola, 5 lb/a; wheat, 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; canola, $4.75/a; wheat, $8.33/a.
N fertilizer cost: 28-0-0, $0.44/lb.
Treatment application cost: cover crop planting, $12/a; N application, $6.50/a.
Wheat price (Snowmass with protein premium): $5.39/bu.

Table .-Cover Crop Study, Wheat (W-S-F) after Spring Cover Crop, Walsh, 2018.

Treatment	Wheat Yield	Test Wt.	Cover Dry Matter	Cover N	Fixed N	Treatment Cost	Fixed N Income	Variable Net Income
	bu/a	lb/bu	lb/a	lb/a	lb/a	$/a	$/a	$/a
Canola	12.6	57.4	2088	54.5		16.75		51.16
Oats	12.1	56.6	908	29.4		20.33		44.89
Hairy Vetch	13.5	57.7	520	19.2	0.0	69.00	0.00	3.77
Spring N Mix	14.2	58.2	1821	65.9	24.0	46.25	10.56	40.85
0 N	12.6	58.3				0.00		67.91
25 N	15.2	57.3				17.50		64.43
50 N	12.1	57.1				28.50		36.72
Average	13.2	57.5	1334	42.3		28.33		44.25
LSD 0.20	2.85		445.8					

Cover crops planted: February 28, 2017.
Cover crops terminated: June 12, 2017.
Wheat planted: October 10, 2017, Snowmass at 50 lb seed/a, 5 gal/a of 10-34-0.
Wheat harvested: June 29, 2018.
Spring cover crop seeding rate: Spring N Mix, 58 lb/a; hairy vetch, 30 lb/a; canola, 5 lb/a; oats, 60 lb/a. Spring N Mix: lentil, 10 lb/a; common vetch, 10 lb/a; spring forage pea, 15 lb/a; oats, 20 lb/a; canola, 2 lb/a; flax, 5 lb/a.
Cover seed cost: Spring N Mix, $29.65/a; hairy vetch, $57/a; canola, $4.75/a; oats, $12.60/a.
N fertilizer cost: 28-0-0, $0.44/lb.
Treatment application cost: cover crop planting, $12/a; N application, $6.50/a.
Wheat price (Snowmass with protein premium): $5.39/bu.

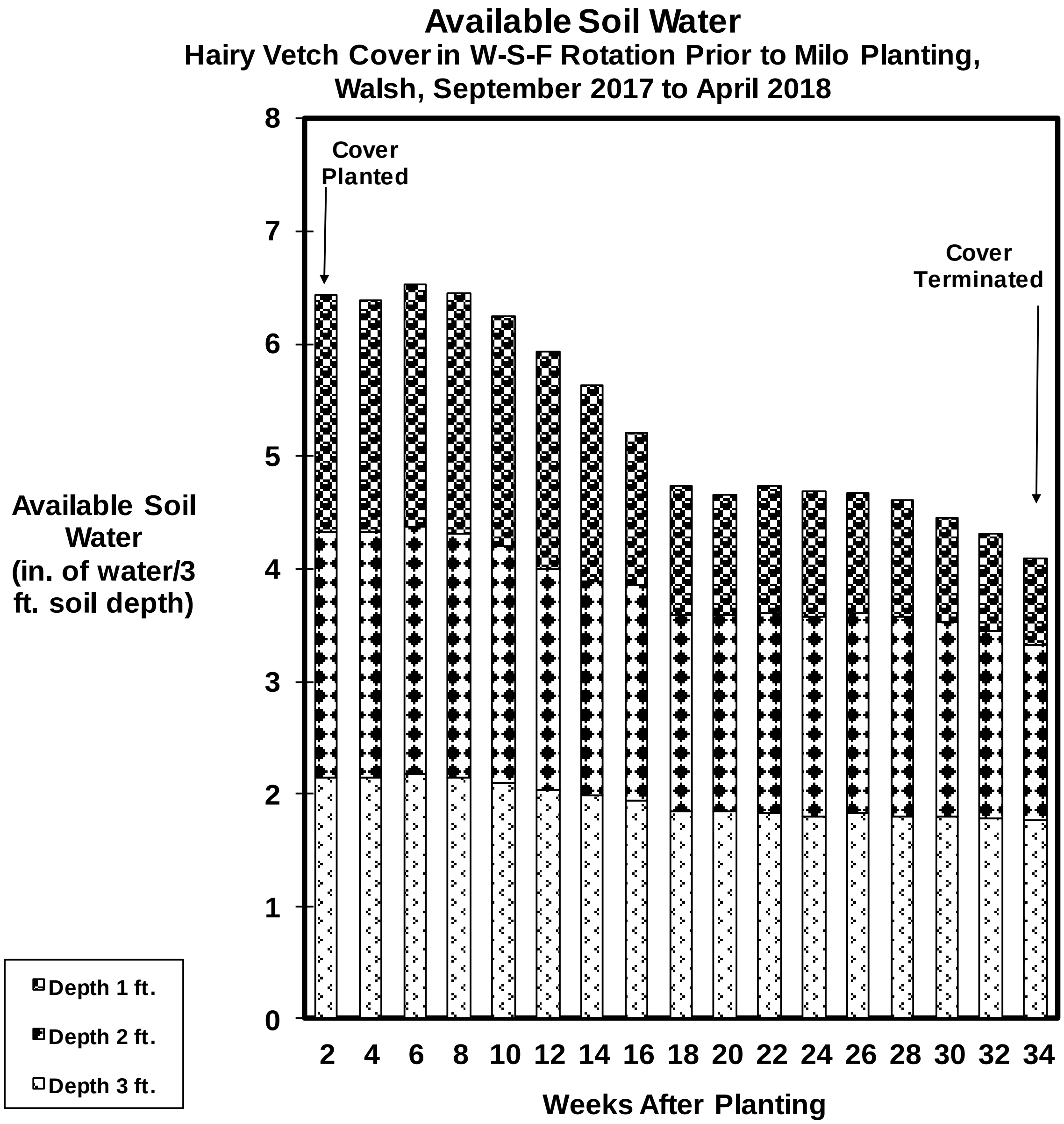


Fig. . Available soil water of hairy vetch cover in W-S-F Rotation prior to wheat planting at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 5.90 in. Any increase in available soil water between weeks is from rain.

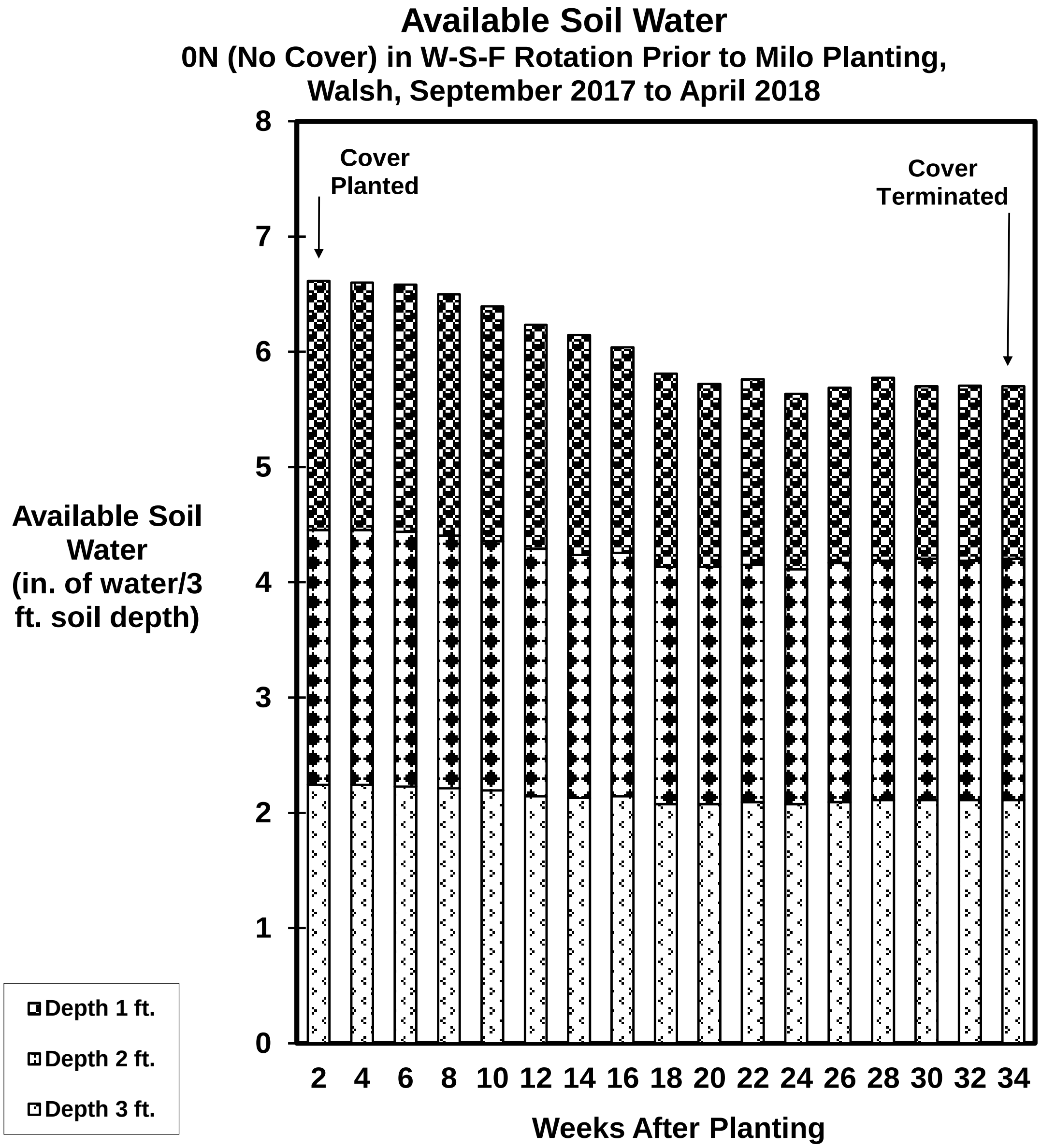


Fig. . Available soil water of 0N (no cover) in W-S-F Rotation prior to wheat planting at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 5.90 in. Any increase in available soil water between weeks is from rain.

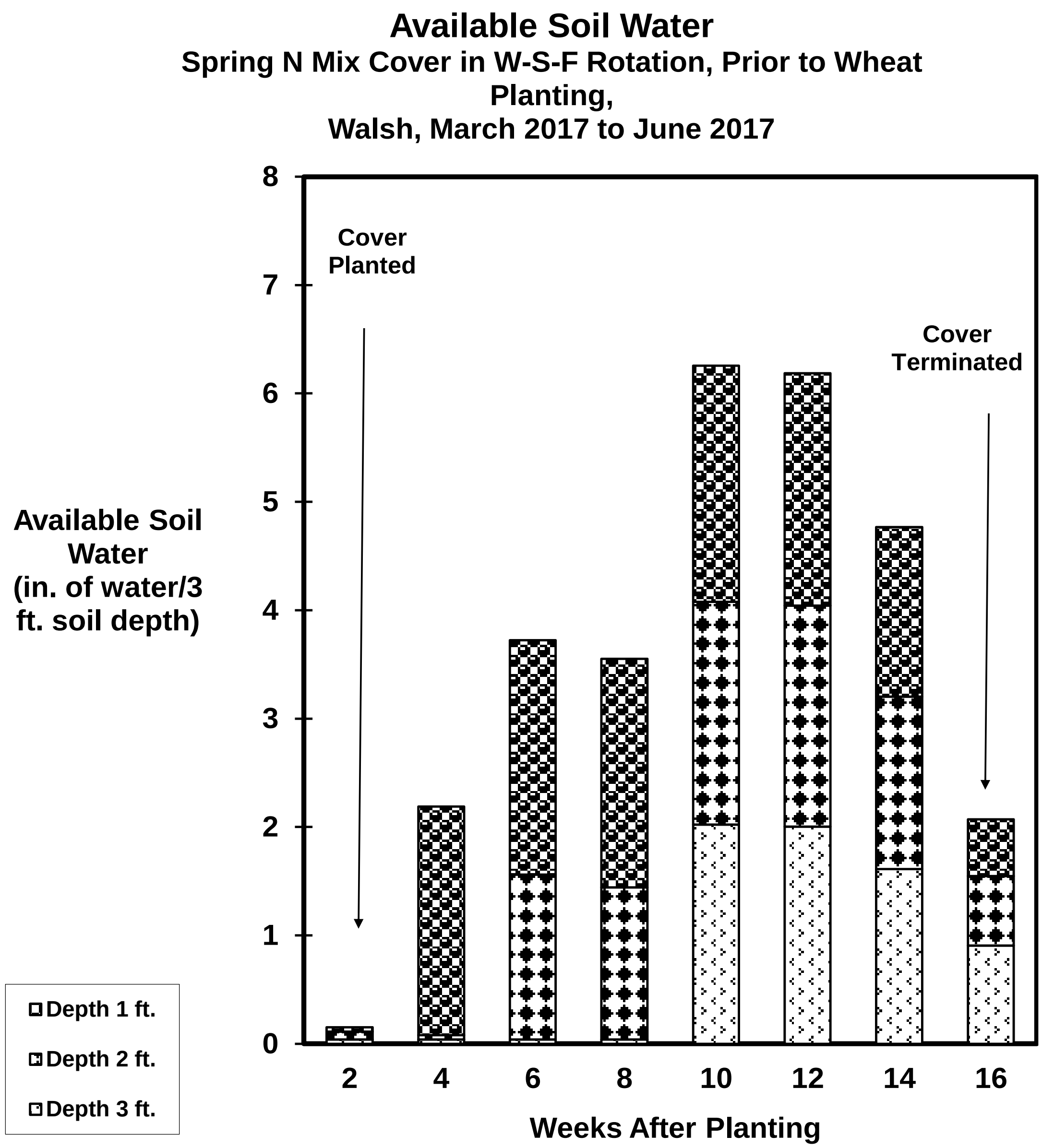


Fig. . Available soil water of Spring N Mix cover in W-S-F rotation prior to wheat planting at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 12.88 in. Any increase in available soil water between weeks is from rain.

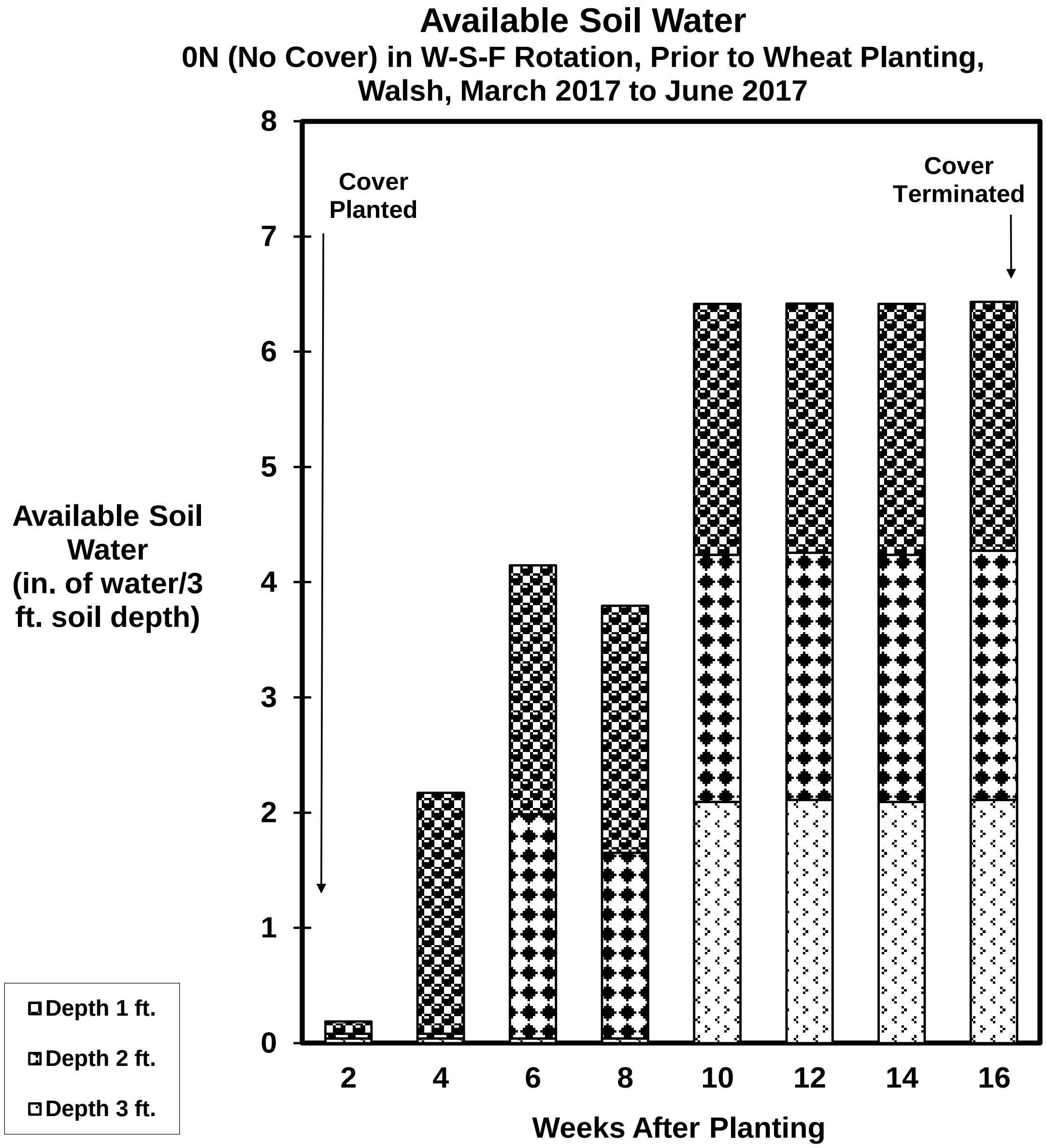


Fig. . Available soil water of 0N (no cover) in W-S-F rotation prior to wheat planting at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 12.88 in. Any increase in available soil water between weeks 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 were 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 were 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 this seventh cropping season, we treated both the chemical and tillage treatments the same starting in March 2015. The chemical treatment for the fallow periods, we sprayed glyphosate 32 oz/a, dicamba 6 oz/a, 2,4-D 10 oz/a, AMS 2 lb/a three times prior to the wheat and grain sorghum crops for the W-S-F rotation and five times for the W-F rotation. For post emergence weed control, we applied Brox 2EC 24 oz/a and Stare Down 6.4 oz/a for the grain sorghum, and Express 0.4 oz/a, LoVol 8 oz/a, dicamba 2 oz/a, and Penetrant II 8 oz/a for the wheat. For N fertilization, we streamed 28-0-0 at 50 lb N/a on 20 in. spacing. We planted wheat, Snowmass at 50 lb/a and seedrow applied 5 gal 10-34-0/a, on October 10, 2017. For the sorghum crop, we planted Pioneer 86P20 at 32,000 seeds/a on May 30, 2018 and seedrow applied 5 gal 10-34-0/a at planting. We harvested the wheat July 3 and the grain sorghum on

November 10, 2018 with a self-propelled combine equipped with a digital scale. Yields were adjusted to 12% seed moisture content for wheat and 14% for grain sorghum.

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. So far, only three wheat crops have been harvested, but this is our seventh harvested grain sorghum crop. The first wheat crop, following our initial burn down or tillage to control the perennial grasses, and the 2016 and 2018 wheat crops have been our only harvested wheat crops.

For our initial wheat crop, 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 costlier than tillage conversion for this first wheat crop, and thus lost as much as -$24/a more than tillage conversion.

Early in the process of establishing the crop rotations, we were able, in 2013, to create our first summer fallow period before the sorghum crop. In 2013, 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.

In 2014, the grain sorghum crop produced high yields, 70.6 bu/a for the chemical treatment and 52.7 bu/a for the tillage treatment. Since we have already controlled the perennial grasses, we no longer needed the additional tillage operations and extra chemical rates to maintain the tillage and no-till plots. With fewer tillage and chemical operations in 2014, the cost of both treatments was lower and the difference between chemical and tillage treatments was less. However, the chemical treatment still costs $16.64/a more than the tillage treatment, but because of its higher yield, the chemical treatment provided $50.48/a more than the tillage treatment.

In 2015, grain sorghum was the only crop harvested because the wheat crop was severely damaged by hail. The chemical treatment produced 10.1 bu/a more grain sorghum yield than the tillage treatment. There were fewer chemical and tillage operations, resulting in $4.52/a higher chemical treatment cost. However, the higher grain yield of the chemical treatment more than compensated for its higher treatment cost by producing $28.31/a more income than the tillage treatment.

In 2016, we were able to harvest both the wheat and the grain sorghum crops. This is only the second time that we harvested wheat for this study. We suspended the tillage operations for the tillage treatment and treated both chemical and tillage treatments using the same no-till methods. We suspended tillage operations to determine the length of the recovery period required for the tillage treatment to produce yields equivalent to the chemical treatment. The tillage treatment produced higher grain sorghum yield than the chemical treatment, although the 2.7 bu/a yield difference was not significant. Likewise, the W-F tillage treatment produced significantly higher wheat yield, 7.4 bu/a more than the chemical treatment. The greater production for the tillage treatment did not hold true for the wheat yield in the W-S-F rotation, where the chemical treatment produced 3.5 bu/a more yield than the tillage treatment. It appears that the length of recovery period for the tillage treatment to produce at a similar yield level as the chemical treatment was only one season without tillage.

Last year, we harvested only the grain sorghum crop. The chemical and tillage treatments were treated the same, since we suspended the tillage operations in March of 2015. Grain sorghum yields were very high averaging 111.7 bu/a and only 1.2 bu/a separated the chemical and old tillage treatments. With similar yields and the same treatment cost, there was only $3.60 difference between the treatments in variable net income. These minor yield and income differences verify that suspending tillage operations requires only one or two years for full yield recovery.

This year, we harvested both the wheat and grain sorghum crops. This is only the third time that we have harvested a wheat crop in the seven years of this study. The chemical and tillage yields for both the wheat and the sorghum produce very similar yields. This is not surprising because the chemical and tillage treatments have been treated the same since March 2015. Only 1.3 bu/a separated the wheat yields between the chemical and old tillage treatments, and there was only 0.3 bu/a difference in grain sorghum yields between the chemical and old tillage treatments. The grain yields were fair for the wheat, averaging 21.7 bu/a, and very good for the grain sorghum, averaging 70.9 bu/a. With similar yields and the same treatment costs, the maximum variable net income difference between the wheat treatments was $7/a, and $1/a for the grain sorghum treatments.

Total rotational variable net income (rotational income minus CRP conversion cost and treatment maintenance cost) for the last six years of this study (2013 to 2018) produced negative incomes for the W-F rotation, -$30/a for the chemical treatment and -

$19/a for the tillage treatment. The negative incomes for the W-F rotation are due to harvesting only three wheat crops in six years. By 2013, after the second grain sorghum crop, the W-S-F rotation was producing positive rotational variable net incomes. Grain sorghum production accounted for most of the total rotational variable net incomes from 2013 to 2018, $170/a for the chemical treatment and $150/a for the tillage treatment. For the last six years of this CRP crop conversion study, the chemical treatment produced an average of $9/a more than the tillage treatment.

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, Seventh Season, Wheat-Sorghum-Fallow & Wheat-Fallow, Wheat Crop, Walsh, 2018.

CRP Conversion	Rotation	Test Weight	Wheat Yield	Gross Income	Treatment Cost	Variable Net Income
		lb/bu	bu/a	$/a	$/a	$/a
Tillage	W-F	58.9	22.4	120.74	83.53	37.21
Chemical	W-F	58.4	22.2	119.66	83.53	36.13
Tillage	W-S-F	55.1	21.2	114.27	83.53	30.74
Chemical	W-S-F	55.9	21.1	113.73	83.53	30.20
Average		57.1	21.7	117.10	83.53	33.57
LSD 0.20			NS			

Chemical: glyphosate 32 oz/a, dicamba 6 oz/a, 2,4-D 10 oz/a, AMS 2lb/a applied five times.
Chemical cost: $7.16/a and $6.50/a for each application.
Post chemical: Express 0.4 oz/a, LoVol 8 oz/a, dicamba 2.0 oz/a, NIS 8 oz/a.
Post chemical cost: $8.73/a; application cost: $6.50 oz/a.
Tillage and no till treated the same.
N fertilizer applied at 50 lb/a as 28-0-0.
Wheat , Snowmass, 50 lb seeds/a, 5 gal 10-34-0/a.
seedrow applied 5 gal 10-34-0/a at planting.
Wheat planted on October 10, 2017; harvested on July 3, 2018.
wheat price: $5.39/bu (Snowmass includes protein premium).
Variable Net Income is Gross Income minus Conversion Cost.

Table .Long Term CRP Conversion After Using Tillage or Chemical, Seventh Season, Wheat-Sorghum-Fallow, Grain Sorghum Crop, Walsh, 2018.

CRP Conversion	Rotation	Test Weight	Grain Sorghum Yield	Gross Income	Treatment Cost	Variable Net Income
		lb/bu	bu/a	$/a	$/a	$/a
Tillage	W-S-F	57.5	71.0	230.75	59.08	171.67
Chemical	W-S-F	57.3	70.7	229.78	59.08	170.70
Average		57.4	70.9	230.26	59.08	171.18
LSD 0.20			NS			

Fallow chemical: glyphosate 32 oz/a, dicamba 6 oz/a, 2,4-D 10 oz/a, AMS 2 lb/a applied three times.
Fallow chemical cost: $7.16/a and $6.50/a for each application.
Post chemical: Brox 2EC 24 oz/a and Stare Down 6.4 oz/a.
Post chemical cost: $11.60/a and $6.50/a for application.
Tillage and no till treated the same.
N fertilizer applied at 50 lb/a as 28-0-0.
Grain sorghum, Pioneer 86P20, planted at 32,000 seeds/a and seedrow applied 5 gal 10-34-0/a at planting.
Grain sorghum planted on May 30; harvested on November 10, 2018.
Grain sorghum price: $3.25/bu.
Variable Net Income is Gross Income minus Treatment Cost.

Table .-CRP Conversion, Chemical and Tillage Comparison, Annual Rotational Income, 2013 to 2018.

Rotation & Conv. Trt	Conver-sion Cost	Variable Net Income						2013-18 Total Rotation Net Income	Average Annual Rotation Variable Net Income
		2013	2014	2015	2016	2017	2018		
		$/a							
Chem									
W-S-F	113.10	86.04	200.11	47.94	213.66	269.62	200.90	1018.27	169.71
W-F	113.10	-102.23	-80.80	-57.04	90.90	-66.20	36.13	-179.24	-29.87
Tillage									
W-S-F	84.00	50.50	149.63	19.63	209.91	266.02	202.41	898.10	149.68
W-F	84.00	-97.88	-60.00	-40.52	113.10	-66.20	37.21	-114.29	-19.05
Average		-15.89	52.24	-7.50	156.89	100.81	119.16	405.71	67.62

The first wheat crop was 2013. There was no wheat harvested in 2014 (winterkill), 2015 (hail), and 2017 (too dry, poor emergence).
Variable Net Income is gross income minus Conversion Cost and treatment cost.
Annual Rotation Variable Net Income is Total Rotation Variable Net Income divided by years.

2017-2018 National Winter Canola Variety Trial
Plainsman Research Center (PRC), Walsh

We planted the canola trials on September 20, 2017 at the Plainsman Research Center at Walsh. We planted the canola seed at 5 lb/acre in dry soil. Fortunately, we received a germinating rain four days after planting. Unfortunately, the rain caused some crusting and buried some seed too deep to emerge, which reduced plant stands. The canola trials averaged between 42 to 48% plant stands. We have received very little precipitation since the germinating rain. Because of the dry, cold winter, the canola severely winterkilled and was not harvested.

Table .-National Canola Hybrid Trial, Walsh, 2018.

Variety (Line)	Entry Number	Stand %
DK Severnyi	21	65
MH 15AY085	7	60
Hidylle	3	55
Event	14	55
Temptation	17	55
DK Imiron CL	18	55
Edimax CL	9	53
Mercedes	11	53
Popular	12	53
Phoenix CL	15	53
Plurax CL	16	53
Wichita	1	45
MH 15HIB001	5	45
Hamour	4	43
MH 15HT229	8	43
Inspiration	10	43
DK Sensei	20	43
Quartz	2	38
DK Imistar CL	19	38
MH 15HIB002	6	33
Atora	13	33
Average		48
LSD 0.05		19.0

Table .-National Canola Open Pollenated Trial, Walsh, 2018.

Variety (Line)	Entry Number	Stand %
DKW45-25	17	60
KSUR1211	5	55
HyCLASS115W	11	55
Star 930W	15	55
KSR4723	3	53
KSR4724S	4	50
DKW46-15	18	50
Riley	6	48
KS4675	2	43
Torrington	9	43
Sumner	7	40
Quartz	10	40
HyCLASS320W	13	40
KS4670	1	38
Wichita	8	38
Star 915W	14	38
HyCLASS225W	12	35
DKW44-10	16	33
Average		45
LSD 0.05		15.2