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University**

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College of
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Department of
Soil and Crop Sciences

Plainsman
Research Center

Extension

Plainsman Research Center 2019 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

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This Plainsman Research Center booklet is dedicated to:

The Neill Foundation Board:

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

The grant from the Neill Foundation will allow Plainsman to more precisely plant our small crops and harvest our forage 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, 2019 Research Reports

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2019 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	Professor and Extension Specialist, Soil and Crop Sciences Department, Colorado State University.
Sally Jones-Diamond (970) 491-1914	Research Associate IV, 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.
Wilma Trujillo (719) 688-9168	Extension Specialist/Area Agronomist, Logan and Morgan Counties, Colorado State University.

PLAINSMAN AGRI-SEARCH FOUNDATION BOARD

2019

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

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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

2020

Tanner Dunivan
Box 282
Walsh, CO 81090

Jordan Jones
Box 253
Walsh, CO 81090

Brian Wood
Box 88
Two Buttes, CO 81084

Calvin Melcher
Box 492
Holly, CO 81047

Matt Tedder
48940 Road X
Walsh, CO 81090

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

2021

Curtis Miller
53805 Road SS
Walsh, CO 81090

Kim Wood
721 Barkley
Springfield, CO 81073

Cordell Herron
Box 64
Manter, KS 67862

Quayde Thompson
Box 692
Vilas, CO 81087

Robert Wood
721 Barkley
Springfield, CO 81073

Douglas Melcher
12845 Hwy 89
Holly, CO 81047

2019 Climatological Summary Plainsman Research Center

Month	Temperature				Precip. In.	Greatest Day of Precip- itation	Snow- Fall In.	Greatest Snow Depth In.	Average Soil Temp.	Evapor- ation In.
	Max. F	Min. F	Max. Mean F	Min. Mean F						
Jan.	66	2	45.8	21.2	0.81	0.48	6.60	1.50	33.42	
Feb.	76	3	46.3	16.1	0.92	0.82	8.60	4.30	33.36	
Mar.	83	0	53.5	26.1	2.79	1.02	4.50	2.20	38.45	
Apr.	89	20	70.0	38.2	0.26	0.18	1.00	1.00	47.67	5.06
May	93	32	71.7	44.5	4.82	1.37	0.00	0.00	53.48	6.19
Jun.	99	42	85.3	54.5	4.00	1.38	0.00	0.00	64.27	9.39
Jul.	104	57	94.9	62.3	2.82	2.53	0.00	0.00	69.29	13.17
Aug.	103	54	94.7	61.2	1.49	0.81	0.00	0.00	71.71	11.48
Sept.	101	46	91.6	58.2	0.58	0.36	0.00	0.00	67.30	12.61
Oct.	92	7	64.8	33.4	0.52	0.19	6.50	2.50	52.29	4.32
Nov.	72	4	56.4	24.7	0.21	0.14	3.00	2.00	38.90	
Dec.	70	9	51.6	22.0	0.77	0.62	4.70	3.70	35.29	
Total			68.9	38.53	19.99		34.90			62.22

*** 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.

2019

2018

Highest Temperature: 104 on July 20

107 on July 21

Lowest Temperature: 0 F on March 5

-6 F on January 16

Last freeze in spring: 32 F on May 22

31 F on April 27

First freeze in fall: 14 F on Oct. 11

32 F on Oct. 10

Frost free season: 142 frost free days

166 frost free days

Avg. Precip for 37 yrs: 19.32 Inches

Maximum Wind:

Jan. 45 mph on 23rd

July. 45 mph on 2nd

Feb. 40 mph on 10th

Aug. 36 mph on 15th

Mar. 52 mph on 14th

Sept. 36 mph on 30th

Apr. 39 mph on 19th

Oct. 39 mph on 10th

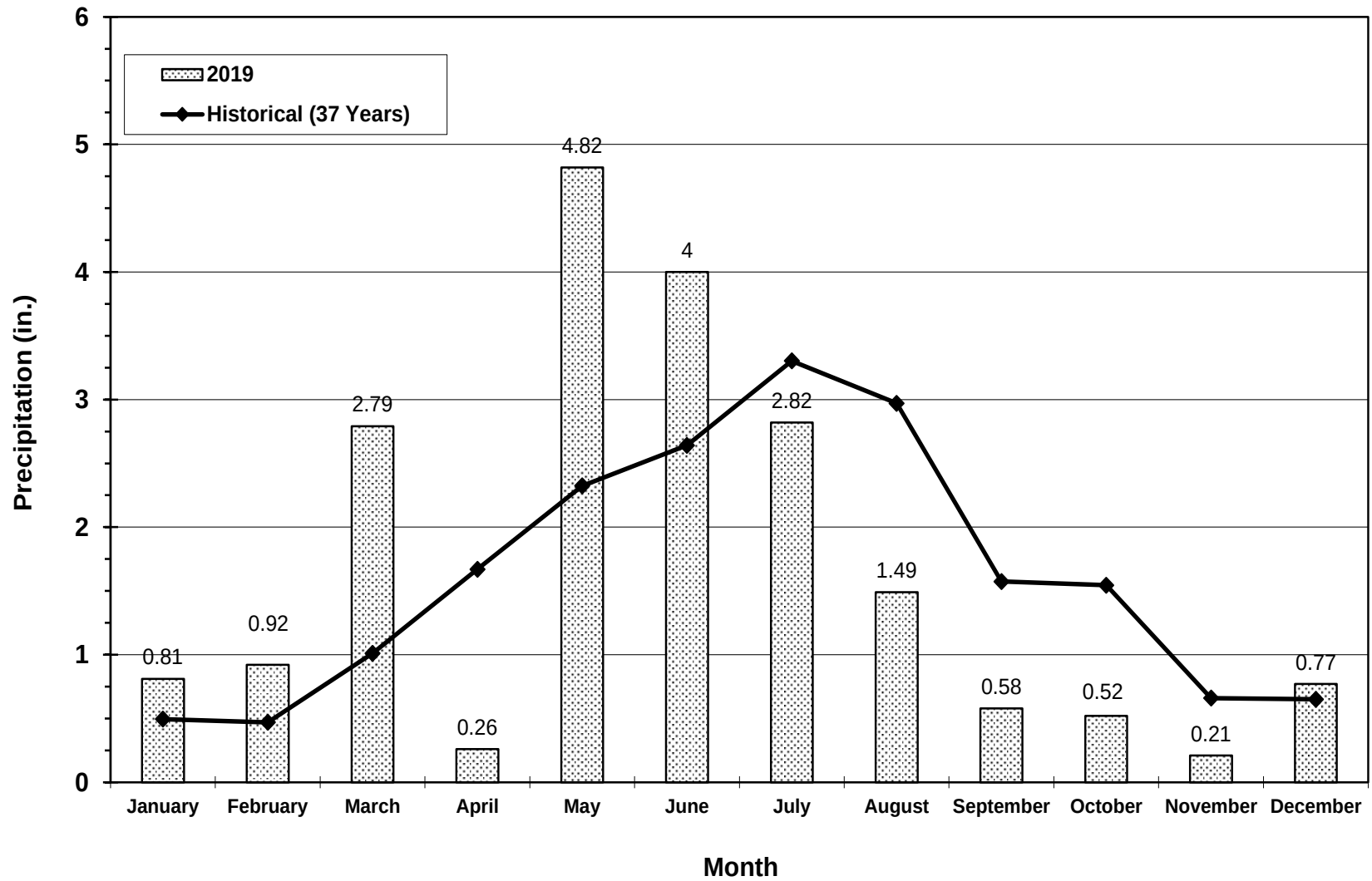
May 50 mph on 7th

Nov. 36 mph on 11th, 30th

Jun. 39 mph on 9th

Dec. 30 mph on 30th

Plainsman Research Center - Walsh, Colorado
Historical (1983 to 2019) and 2019 Precipitation



Overview of 2018-2019 Eastern Colorado Winter Wheat Trials

Jerry Johnson and Sally Jones-Diamond

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 38 varieties including experimental lines in each of the 11 dryland trials. The three irrigated trials each had 24 varieties. The variety trials included a combination of public and private varieties and experimental lines. Seed companies with entries in the variety trials included AgriMaxx Wheat, AgriPro Syngenta, Dyna-Gro Seed, Limagrain Cereal Seeds, and WestBred Bayer. There were entries from the Colorado marketing organization, PlainsGold.

All dryland and irrigated trials were planted in a randomized complete block design with three replicates. Plot sizes were approximately 150 ft² (except the Fort Collins irrigated trial, which was 80 ft²) 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 H2 weighing system on a plot combine.

General Growing Conditions in Southeast Colorado - Kelly Roesch

As is typical in the Southeast Area we received some moisture from the monsoon season in July that was followed by a hot and dry August. Some of the area received moisture in early September which allowed for good conditions for those producers who were willing to plant early. The wheat that was planted later was for the most part planted into dry conditions. Rain received in the last week of November got the crop started and wheat stands across the area looked good going into winter. The winter brought more snow and cooler temperatures than have been experienced recently. As the wheat broke dormancy in the spring moisture remaining from the snow and rain combined with warmer temperatures had the wheat crop looking excellent.

A cold front on May 22nd brought temperatures in the 26-28°F range for several hours. Damage to the wheat depended on what growth stage it was in. Fields in the pollination stage suffered the worst damage. Lower lying portions of the fields had more damage than the hilltops. June and July continued to bring good moisture and growing conditions. Very little virus or rust presence was noted.

Yields ranged from 15-90+ bu/acre across the area depending on the extent of freeze damage. Protein levels were mixed however, with the higher yields there was still a lot wheat with protein at 10 or below. Yields for the area as a whole were generally averaging in the 50 bu/acre range.

2019 Dryland Winter Wheat Variety Performance Trial at Lamar

Variety	Brand/Source	Market Class	Yield	Test Weight	Plant Height
			bu/ac	lb/bu	in
Guardian	PlainsGold	HRW	66.8	62.7	33
Antero	PlainsGold	HWW	66.3	62.5	38
Sunshine	PlainsGold	HWW	66.3	62.1	36
Snowmass 2.0	PlainsGold	HWW	66.2	62.3	36
Incline AX	PlainsGold	HRW	65.8	61.2	33
Whistler	PlainsGold	HRW	65.5	62.3	35
Canvas	PlainsGold	HRW	61.8	62.8	33
Byrd	PlainsGold	HRW	61.6	61.7	34
Breck	PlainsGold	HWW	61.4	63.4	35
Byrd CL Plus	PlainsGold	HRW	60.0	61.0	35
Monarch	PlainsGold	HWW	59.6	61.7	32
Avery	PlainsGold	HRW	59.3	61.0	34
Denali	PlainsGold	HRW	59.2	62.1	37
CO13D1479	Colorado State University exp.	HWW	59.1	61.5	34
CO15D098R	Colorado State University exp.	HRW	58.5	62.0	37
SY Monument	AgriPro Syngenta	HRW	57.1	61.7	33
WB4792	WestBred Bayer	HRW	55.8	62.7	34
WB4595	WestBred Bayer	HRW	54.2	62.2	33
Langin	PlainsGold	HRW	54.1	60.4	33
Snowmass	PlainsGold	HWW	53.6	62.1	36
SY Wolverine	AgriPro Syngenta	HRW	52.1	61.1	32
Long Branch	Dyna-Gro Seed	HRW	51.0	60.8	35
Fortify SF	PlainsGold	HRW	50.2	60.7	32
Crescent AX	PlainsGold	HRW	50.1	61.2	32
SY Wolf	AgriPro Syngenta	HRW	49.6	61.4	32
Hatcher	PlainsGold	HRW	48.2	61.3	33
SY Rugged	AgriPro Syngenta	HRW	47.3	61.0	32
SY Legend CL2	AgriPro Syngenta	HRW	45.1	61.2	30
AM Eastwood	AgriMaxx Wheat	HRW	44.5	59.9	30
CO13D0346	Colorado State University exp.	HRW	43.9	60.4	30
WB-Grainfield	WestBred Bayer	HRW	42.9	61.1	35
WB4462	WestBred Bayer	HRW	42.6	60.4	37
CO15SFD092	Colorado State University exp.	HRW	42.1	61.3	31
LCH15ACC-7-7	Limagrain Cereal Seeds	HRW	41.3	60.9	28
Brawl CL Plus	PlainsGold	HRW	37.2	60.7	32
LCS Valiant	Limagrain Cereal Seeds	HRW	35.2	59.4	32
WB4418	WestBred Bayer	HRW	31.0	58.1	31
Average			53.2	61.4	33
^a LSD (P<0.30)			3.0		

^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

Collaborator: Stulp Farms
 Harvest date: July 8, 2019
 Planting date: September 12, 2018
 Fertilizer: N at 45 and P at 36 lb/ac
 Herbicide: Ally and 2,4-D
 Soil Type: Wilid silt loam
 GPS Coordinates: 38.00259, -102.61349

2019 Dryland Winter Wheat Variety Performance Trial at Sheridan Lake

Variety	Brand/Source	Market Class	Yield	Test Weight	Plant Height
			bu/ac	lb/bu	in
Guardian	PlainsGold	HRW	78.9	59.9	35
Whistler	PlainsGold	HRW	70.5	58.5	34
Canvas	PlainsGold	HRW	69.4	59.4	30
Sunshine	PlainsGold	HWW	66.9	58.6	33
CO13D0346	Colorado State University exp.	HRW	66.5	57.8	31
Byrd CL Plus	PlainsGold	HRW	65.2	57.2	30
Snowmass 2.0	PlainsGold	HWW	65.0	59.0	32
Snowmass	PlainsGold	HWW	64.9	58.4	33
Antero	PlainsGold	HWW	64.5	58.5	32
Langin	PlainsGold	HRW	64.4	57.0	30
Byrd	PlainsGold	HRW	63.4	57.4	29
WB4792	WestBred Bayer	HRW	62.9	60.4	30
Denali	PlainsGold	HRW	62.8	57.7	30
CO15D098R	Colorado State University exp.	HRW	62.7	58.4	34
CO13D1479	Colorado State University exp.	HWW	62.7	57.5	35
WB4595	WestBred Bayer	HRW	62.6	60.0	29
Hatcher	PlainsGold	HRW	62.5	57.3	28
Avery	PlainsGold	HRW	61.1	57.0	29
Monarch	PlainsGold	HWW	60.6	57.8	31
Crescent AX	PlainsGold	HRW	59.9	58.7	30
Incline AX	PlainsGold	HRW	59.9	56.5	30
Breck	PlainsGold	HWW	59.4	59.2	34
LCH15ACC-7-7	Limagrain Cereal Seeds	HRW	58.5	57.8	29
Fortify SF	PlainsGold	HRW	58.4	57.1	29
Long Branch	Dyna-Gro Seed	HRW	58.3	57.5	31
SY Wolverine	AgriPro Syngenta	HRW	56.3	56.6	29
SY Rugged	AgriPro Syngenta	HRW	55.0	57.8	28
SY Legend CL2	AgriPro Syngenta	HRW	52.1	58.0	27
WB-Grainfield	WestBred Bayer	HRW	51.8	58.2	29
CO15SFD092	Colorado State University exp.	HRW	51.6	57.2	28
SY Wolf	AgriPro Syngenta	HRW	50.6	57.1	27
LCS Valiant	Limagrain Cereal Seeds	HRW	49.5	57.6	31
SY Monument	AgriPro Syngenta	HRW	49.4	55.2	27
Brawl CL Plus	PlainsGold	HRW	49.2	57.0	30
AM Eastwood	AgriMaxx Wheat	HRW	48.2	56.1	27
WB4418	WestBred Bayer	HRW	47.3	55.8	26
WB4462	WestBred Bayer	HRW	46.7	57.6	32
Average			59.5	57.8	30
^a LSD (P<0.30)			3.5		

^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

Collaborator: Scherler Farms
 Harvest date: July 12, 2019
 Planting date: September 12, 2018
 Fertilizer: Starter: N at 8 and P at 28 lb/ac; Spring Top-Dress: N at 46 and S at 8 lb/ac
 Soil Type: Wiley loam
 GPS Coordinates: 38.53448, -102.47118

2019 Dryland Winter Wheat Variety Performance Trial at Walsh

Variety	Brand/Source	Market Class	Yield	Test Weight	Plant Height	Heading
			bu/ac	lb/bu	in	days from trial avg ^a
Sunshine	PlainsGold	HWW	101.8	58.4	36	-2
Avery	PlainsGold	HRW	101.4	57.8	36	0
Langin	PlainsGold	HRW	99.7	56.9	33	-4
Whistler	PlainsGold	HRW	98.4	56.8	37	3
Antero	PlainsGold	HWW	96.9	57.3	38	-1
Byrd CL Plus	PlainsGold	HRW	96.0	57.9	37	1
Byrd	PlainsGold	HRW	94.5	58.5	35	-1
SY Wolverine	AgriPro Syngenta	HRW	94.5	58.9	33	-1
Breck	PlainsGold	HWW	94.0	60.5	36	0
CO13D0346	Colorado State University exp.	HRW	93.7	57.4	34	0
WB4595	WestBred Bayer	HRW	92.8	58.8	35	3
WB-Grainfield	WestBred Bayer	HRW	92.5	59.2	36	-4
CO15D098R	Colorado State University exp.	HRW	91.7	60.6	36	0
Guardian	PlainsGold	HRW	90.9	59.6	35	0
Crescent AX	PlainsGold	HRW	90.8	59.2	35	-2
Monarch	PlainsGold	HWW	90.7	58.0	33	2
WB4418	WestBred Bayer	HRW	90.6	57.3	34	-2
Denali	PlainsGold	HRW	90.5	58.8	37	1
SY Wolf	AgriPro Syngenta	HRW	90.3	59.3	35	2
Canvas	PlainsGold	HRW	89.8	60.4	33	1
WB4792	WestBred Bayer	HRW	89.7	57.0	35	3
CO13D1479	Colorado State University exp.	HWW	89.6	58.9	34	1
SY Monument	AgriPro Syngenta	HRW	89.3	58.0	36	2
Hatcher	PlainsGold	HRW	88.0	58.4	36	-1
SY Rugged	AgriPro Syngenta	HRW	87.7	58.2	34	0
WB4462	WestBred Bayer	HRW	87.1	59.2	38	-1
Snowmass 2.0	PlainsGold	HWW	86.8	57.6	32	1
CO15SFD092	Colorado State University exp.	HRW	86.2	59.0	33	-2
AM Eastwood	AgriMaxx Wheat	HRW	85.9	58.1	32	-3
Long Branch	Dyna-Gro Seed	HRW	85.9	56.2	35	0
Incline AX	PlainsGold	HRW	85.2	56.3	36	3
Brawl CL Plus	PlainsGold	HRW	84.9	59.8	36	-2
SY Legend CL2	AgriPro Syngenta	HRW	83.9	59.7	34	-1
Fortify SF	PlainsGold	HRW	81.8	57.8	33	-1
LCS Valiant	Limagrain Cereal Seeds	HRW	81.7	59.2	33	-3
LCH15ACC-7-7	Limagrain Cereal Seeds	HRW	81.5	58.8	30	-5
Snowmass	PlainsGold	HWW	81.0	58.2	32	0
Average			90.2	58.4	34	
^b LSD (P<0.30)			2.7			

^aVarieties with positive values headed later than the trial average and varieties with negative values headed earlier than the trial average.

^bIf 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

Collaborator: Plainsman Research Center (Kevin Larson, Brett Pettinger, and Perry Jones)

Harvest date: July 8, 2019

Planting date: September 18, 2018

Fertilizer: Starter: N at 6 and P at 20 lb/ac; Spring Top-Dress: N at 50 lb/ac

Herbicide: Express at 0.4 oz/ac, 2,4-D ester at 8 oz/ac, and dicamba at 1.5 oz/ac

Soil Type: Wiley loam

GPS Coordinates: 37.43116, -102.31043

Trial Comments: Planted into very good moisture. Very good stand establishment in the fall. Trial received consistent precipitation throughout the season except in April. Over 4" of precipitation in March. Trial may have been impacted by tan spot, which did not develop onto the flag leaves. Minor incidence of leaf rust, stripe rust, and barley yellow dwarf virus. Minor freeze damage from late-freeze down to 32°F on May 22.

Summary of 2-Yr (2018 and 2019) Dryland Variety Performance Results

Variety ^b	Brand/Source	Market Class ^c	2-Year Average ^a				
			Yield		Test Weight		Plant
			bu/ac	% trial average	lb/bu	% trial average	Height
Antero	PlainsGold	HWW	75.4	109%	60.4	100%	34
CO15D098R	Colorado State University Exp.	HRW	74.8	108%	61.7	102%	35
Langin	PlainsGold	HRW	74.7	108%	60.3	99%	31
Sunshine	PlainsGold	HWW	73.6	106%	60.2	99%	32
Whistler	PlainsGold	HRW	72.8	105%	59.6	98%	34
Avery	PlainsGold	HRW	72.2	104%	60.1	99%	33
Snowmass 2.0	PlainsGold	HWW	72.2	104%	60.9	100%	32
Byrd CL Plus	PlainsGold	HRW	71.9	104%	60.3	99%	34
Breck	PlainsGold	HWW	71.8	104%	62.1	102%	33
Monarch	PlainsGold	HWW	71.2	103%	60.7	100%	31
CO13D1479	Colorado State University Exp.	HWW	70.5	102%	60.9	100%	33
Guardian	PlainsGold	HRW	70.5	102%	61.7	102%	33
Denali	PlainsGold	HRW	70.4	102%	61.4	101%	34
Canvas	PlainsGold	HRW	70.2	101%	61.2	101%	31
Crescent AX	PlainsGold	HRW	69.9	101%	61.2	101%	33
SY Monument	AgriPro Syngenta	HRW	69.3	100%	60.0	99%	32
Byrd	PlainsGold	HRW	69.3	100%	60.5	100%	33
WB4462	WestBred Bayer	HRW	69.0	100%	61.3	101%	35
WB-Grainfield	WestBred Bayer	HRW	68.0	98%	60.7	100%	33
Fortify SF	PlainsGold	HRW	67.7	98%	61.0	101%	33
Hatcher	PlainsGold	HRW	67.2	97%	60.4	100%	32
SY Rugged	AgriPro Syngenta	HRW	67.1	97%	60.0	99%	30
Long Branch	Dyna-Gro Seed	HRW	66.8	97%	60.0	99%	32
SY Wolf	AgriPro Syngenta	HRW	66.3	96%	60.7	100%	31
WB4418	WestBred Bayer	HRW	66.2	96%	60.0	99%	30
CO15SFD092	Colorado State University Exp.	HRW	65.6	95%	60.8	100%	31
Brawl CL Plus	PlainsGold	HRW	65.3	94%	61.4	101%	33
AM Eastwood	AgriMaxx Wheat	HRW	64.9	94%	60.5	100%	28
Incline AX	PlainsGold	HRW	64.4	93%	58.9	97%	32
Snowmass	PlainsGold	HWW	63.9	92%	61.0	101%	33
SY Legend CL2	AgriPro Syngenta	HRW	63.7	92%	60.8	100%	31
Average			69.2		60.7		32

^aThe 2-year average yield and test weight are based on 20 trials (eleven 2019 and nine 2018 trials). Plant heights are based on 19 trials (ten 2019 and eight 2018 trials).

^bVarieties ranked according to average 2-year yield.

^cMarket class: HRW=hard red winter wheat; HWW=hard white winter wheat.

Summary of 3-Yr (2017, 2018, and 2019) Dryland Variety Performance Results

Variety ^b	Brand/Source	Market Class ^c	3-Year Average ^a				
			Yield		Test Weight		Plant Height
			bu/ac	% trial average	lb/bu	% trial average	
Langin	PlainsGold	HRW	75.5	108%	60.2	100%	31
Antero	PlainsGold	HWW	74.7	107%	60.1	100%	34
Whistler	PlainsGold	HRW	74.6	107%	59.3	98%	34
Snowmass 2.0	PlainsGold	HWW	73.2	105%	60.6	100%	32
Avery	PlainsGold	HRW	72.6	104%	60.1	100%	34
Canvas	PlainsGold	HRW	72.1	103%	61.0	101%	31
Sunshine	PlainsGold	HWW	72.1	103%	59.8	99%	32
Breck	PlainsGold	HWW	71.9	103%	61.9	103%	33
Byrd CL Plus	PlainsGold	HRW	71.8	103%	59.9	99%	34
Guardian	PlainsGold	HRW	71.7	103%	61.5	102%	33
Monarch	PlainsGold	HWW	71.3	102%	60.5	100%	31
Byrd	PlainsGold	HRW	71.1	102%	60.4	100%	33
CO13D1479	Colorado State University Exp.	HWW	70.4	101%	60.4	100%	33
Denali	PlainsGold	HRW	68.9	99%	60.7	101%	34
WB-Grainfield	WestBred Bayer	HRW	68.0	97%	60.6	100%	33
SY Monument	AgriPro Syngenta	HRW	67.5	97%	59.6	99%	32
WB4462	WestBred Bayer	HRW	67.3	96%	61.0	101%	35
SY Rugged	AgriPro Syngenta	HRW	66.8	96%	59.7	99%	30
Hatcher	PlainsGold	HRW	66.1	95%	60.0	99%	32
SY Wolf	AgriPro Syngenta	HRW	65.9	94%	60.3	100%	31
Snowmass	PlainsGold	HWW	65.8	94%	60.6	101%	34
Brawl CL Plus	PlainsGold	HRW	64.7	93%	60.9	101%	33
Incline AX	PlainsGold	HRW	62.9	90%	58.0	96%	32
Average			69.9		60.3		33

^aThe 3-year average yield and test weights are based on 28 trials (eleven 2019, nine 2018, and eight 2017 trials). Plant heights are based on 26 trials (ten 2019, eight 2018, and eight 2017 trials).

^bVarieties ranked according to average 3-year yield.

^cMarket class: HRW=hard red winter wheat; HWW=hard white winter wheat.

Dryland Wheat Strips for Forage and Grain Yield at Walsh, 2019
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 September 25, 2018 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 P₂O₅, 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 5) and at boot (May 4). We measure the forage for fresh weight, oven-dried the samples, and recorded dry weight at 15% moisture content. The trial was rated for Tan Spot on May 4. Tan Spot infections did not progress onto the flag leaves. 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 excellent, our best yields recorded in more than 30 years. Precipitation was abundant and timely in both the fall and spring. Some varieties had severe Tan Spot infections on their lower leaves, but it did not develop onto the flag leaves. The trial averaged 79.5 bu/a. There was a 14 bu/a separation between the highest yielding variety, Langin, from the lowest yielding variety, Snowmass. Joe had the highest forage yield at jointing and Breck had the highest forage yield at boot. Six varieties: Antero, Avery, Breck, Byrd, Langin, and Joe, had above average two-year averages compared to the other wheat tested. Antero, Avery, Byrd, and WB Grainfield produced above average three-year average yields.

Discussion: This year we chose Antero as the best overall dual-purpose wheat variety of the 15 wheat varieties tested. Antero produced the third highest grain yield, the fourth highest forage yield at jointing, and the fourth highest forage yield at boot. Langin would be a good dual-purpose wheat choice if forage at boot is not a priority. Langin produced the third highest forage yield at jointing, below average forage yield at boot, and the highest grain yield. This is the fifth 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 well above our long-term average in 2019 at 80 bu/a, below our long-term average in 2018 at 18 bu/a, (the wheat failed in 2017 due to dry planting conditions), and moderately above our long-term average in 2016 at 50 bu/a. Three wheat varieties tested: Antero, Avery, and Byrd, had above 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 diverse weather conditions.

Dryland Wheat Strips, Forage and Grain Yield at Walsh, 2019.

Variety	Jointing		Boot		Tan Spot	Plant Ht.	Test Wt.	Grain Yield
	Fresh Wt.	Dry Wt.	Fresh Wt.	Dry Wt.				
	-----lb/a-----				scale 0-9	in	lb/bu	bu/a
Langin	11624	2573	29700	6818	1.5	32	58.9	87.6
Avery (untreated)	10802	2520	30006	7237	1.3	35	59.8	85.1
Antero	11227	2451	32801	7288	1.9	35	60.3	84.8
Avery (treated)	10423	2372	30824	7331	1.6	35	59.2	84.5
Byrd	9638	2245	29145	6597	0.5	33	58.9	83.3
Joe	12426	2787	32830	7278	8.3	37	59.7	80.2
Breck	10274	2355	30994	7817	6.8	35	61.9	79.7
Grainfield	10648	2266	29045	6875	3.6	35	58.9	79.7
Lonerider	11926	2633	30303	7005	2.5	31	58.1	78.7
Tatanka	8045	2100	25679	7236	3.5	34	59.9	76.6
Long Branch	10929	2372	25054	5704	3.3	35	58.5	75.2
TAM 114	9471	2197	26926	6659	1.8	33	60.7	74.7
Winterhawk	10220	2490	31180	7607	0.5	36	60.3	74.3
T158	9314	2116	29920	6597	6.8	33	60.5	73.9
Snowmass	10586	2482	29685	7148	7.8	36	59.4	73.6
Average	10504	2397	29606	7013	3.4	34	59.7	79.5
LSD 0.20	1196.9	226.2	885.6	555.3				2.38
LSD 0.05					0.9			3.79

Planted: September 25, 2018; 50 lb seed/a; 5 gal/a 10-34-0.

Jointing sample taken April 5, 2019.

Boot sample taken May 4, 2019.

Wet Weight is reported at field moisture.

Dry Weight is adjusted to 15% moisture content.

Tan Spot rated: May 4, 2019; 0-no leaves infected; 9-all leaves infected.

Summary: Dryland Wheat Strips Variety Performance Tests at Walsh, 2016, 2018, and 2019.

Firm	Variety	Grain Yield					Yield as % of Trial Average				
		2016	2018	2019	2-Year	3-Year	2016	2018	2019	2-Year	3-Year
					Avg	Avg				Avg	Avg
-----bu/a-----											
AGSECO	TAM 114	--	16	75	45	--	--	87	94	93	--
Colorado State	Avery	54	20	85	52	53	108	111	106	107	108
Colorado State	Antero	56	21	85	53	54	112	116	107	109	110
Colorado State	Breck	--	20	80	50	--	--	109	100	102	--
Colorado State	Byrd	52	22	83	52	52	104	117	105	107	107
Colorado State	Langin	--	18	88	53	--	--	98	110	108	--
Colorado State	Snowmass	50	16	74	45	47	100	89	93	92	95
Kansas State	Joe	--	20	80	50	--	--	108	101	102	--
Limagrain	T158	46	16	74	45	45	92	85	93	91	92
Westbred	Winterhawk	53	17	74	46	48	106	92	93	93	98
Westbred	WB Grainfield	54	17	80	48	50	108	93	100	99	103
Average		50	18	80	49	49					

Grain Yields were adjusted to 12.0 % seed moisture content.

No wheat yields recorded for 2017 due to dry planting conditions.

Nitrogen-Rich Strip: A Strategy for Profit-Maximizing Winter Wheat Yield and Grain Protein Improvement in Colorado.

Wilma Trujillo and Kevin Larson

Introduction

Increasing demand for high-quality wheat within the milling and baking industries—to ensure adequate protein levels in their products—presents both opportunities and challenges to Colorado wheat growers. Notably, high-protein wheat can be marketed at a premium, whereas low-protein wheat incurs a discount. Wheat yield and protein content are influenced by many factors, but the most important management practice under producer control is the rate and timing of nitrogen (N) fertilizer application. As a result, wheat growers have become increasingly interested in implementing profit-maximizing N management practices that account for the quality and pricing factors.

The economically-optimal N rate will vary by location and year due to factors such as soil type, precipitation, and temperature. Because of this variation in optimal input rates, standardized regional N application guidelines may have limited value as compared to more localized knowledge. N fertilizer also represents a significant share of variable production costs and therefore both the under- and over-use of N can reduce potential profits. For example, it can take approximately 2.4 lb. N to produce one bushel of grain (Peairs and Armenta, 2010), resulting in N costs of approximately \$0.84 to \$1.03 to produce a bushel of grain worth about \$4.80.

Wheat producers typically follow one of two options for applying N fertilizer: (i) as a single application where all N is applied pre-plant or at planting; and (ii) as a split application where a small amount of N is applied pre-plant or at planting, followed by a late-winter or early spring topdressing. Dryland winter wheat growers are often reluctant to invest in N fertilizer before they assess the condition of the crop in the spring. Therefore, split N applications provide increased management flexibility by allowing farmers to adjust N rates according to the crop and environmental conditions. Also, a split application is a sustainable and cost-effective way to produce high protein content wheat.

If the optimal N fertilizer rate changes from year to year, how can a farmer accurately calculate the correct amount of N fertilizer to apply? Certainly, yield response to N fertilizer is unpredictable at the time when pre-plant N is being applied. For example, when winters and springs are wet and warm, sufficient N can be mineralized from soil organic matter before and during the growing season. This mineralized-N could be enough to meet the demands for maximum yields.

Since the availability of N in-season is environmentally dependent, the common practice of soil testing before planting is not suitable for detecting N deficiencies and requirements later in the growing season. Field analysis procedures (tiller counts) and chemical analysis of soil and plant tissue are effective for monitoring N status during the growing season. However, the main problem with these methods is the time and cost required for sampling, analysis and recommendations of rates to meet the demands of the growing crop. Delaying N applications may reduce yield, protein quality, and profit potential.

Optimum top-dress N rate for maximum yield, protein and economic profitability can be determined by using the N-Rich Strip method (<http://www.nue.okstate.edu/>). The N-Rich Strip is a newly developed method that accounts for the temporal variability effect on the crop's N requirement during the growing season. The growing crop can accurately show how much N was delivered for “free” (mineralized N) when comparing an N-Rich Strip with an area that represents the farmer's N rate.

The N-Rich strip is used in conjunction with the GreenSeeker™ (manufactured by Trimble) hand held sensor to determine in-season N rate for optimum yield and protein content. The GreenSeeker™ measures

normalized difference vegetative index (NDVI) which is calculated from the reflected light from the canopy of the crop. This value provides a highly accurate estimate of plant biomass. Therefore, yield potential can be predicted in-season using both sensor and some known climatic data (precipitation, growing degree days, soil moisture) from planting to sensing. By knowing the yield potential of the N-Rich Strip and the yield potential of the rest of a field (farmer's N rate or N check), the N rate for optimum yield and protein can be calculated. The N-Rich Strip and GreenSeeker™ technology package can be implemented at a relatively low-cost annualized cost when spread out over multiple years and rotation crops, and stands to increase the profitability of wheat production in Colorado if the yield gains, quality improvements, and N cost savings are sufficient to offset these added technology costs.

Objectives:

1. Develop N management strategies for optimum yield and protein content for wheat production.
2. Determine if the GreenSeeker™ sensor measurements are reliable predictors of yield and protein content in response to N application.
3. Evaluate the agronomic and economic performance of the N-Rich Strip and GreenSeeker™ technology package relative to the N rates chosen by wheat producers.

Experimental Design:

The study was conducted at Plainman Research Center in Walsh, CO during the 2018-2019 growing season. Plots were planted using the wheat variety Avery at seeding rate of 45 lb/ac and fertilized with Rock 40 at 45 lb/ac (12-40-0-6.5 S and 1 Zn). The treatments were arranged in blocks. Plot size was 40 ft × 135 ft.

Pre-plant N treatments were applied on August 28, 2018. The Check plots received 0 lb/ac, Farmer's Practice (FP) plots received 50 lb/ac, and the N-rich treatment received 112.5 lb/ac.

Normalized Difference Vegetation Index (NDVI) readings were taken using the GreenSeeker™ Handheld Crop Sensor at jointing (Feekes 5 – 6) on April 4th. Thirty GreenSeeker™ sensor measurements were taken over the wheat canopy at 24" – 48" height in each N treatment. Comparing the NDVI's from the N-rich plots to the NDVI's from the Check and FP plots and using the Sensor Based Nitrogen Recommendation Calculator (SBNRC) provided information about the wheat crop's N status and gave an N rate recommendation (SBNR) to meet the in-season yield potential. The SBNR rate to optimize yield and protein was 72 lb/ac. This rate was applied on April 15th.

Grain was harvested from four 10 ft x 50 ft areas from each N-Rich, FP, SBNR and Check plot. Grain protein content was estimated at the CSU Wheat Quality Laboratory using approved methods by the American Society of Cereal Chemists. Data was analyzed using an analysis of variance and the least significant difference (LSD) method. Profitability of the proposed N-management strategy was evaluated in a standard partial budgeting framework (Swinton and Lowenberg-DeBoer, 1998).

Results

In the 2018-2019 growing season, weather conditions had a substantial impact on production in Southeastern Colorado. Fall moisture was well above average. The winter was dry and mild, followed by well above precipitation in the spring, which led to higher than normal yield potential.

Grain yield and protein content responses to N are shown in Figure 1 and 2, respectively. Yield and protein responded to N over the range of the N rates. The Check had significantly lower yield and protein than the FP, SBNR and N-Rich treatments. However, yields were not significantly different as N rate increased from the FP rate, to the SBNR and N-rich. Applying N from 50lb/ac to 112.5 lb/ac resulted in an average of 10 more bushels per acre, or a 13.6 % yield increase,

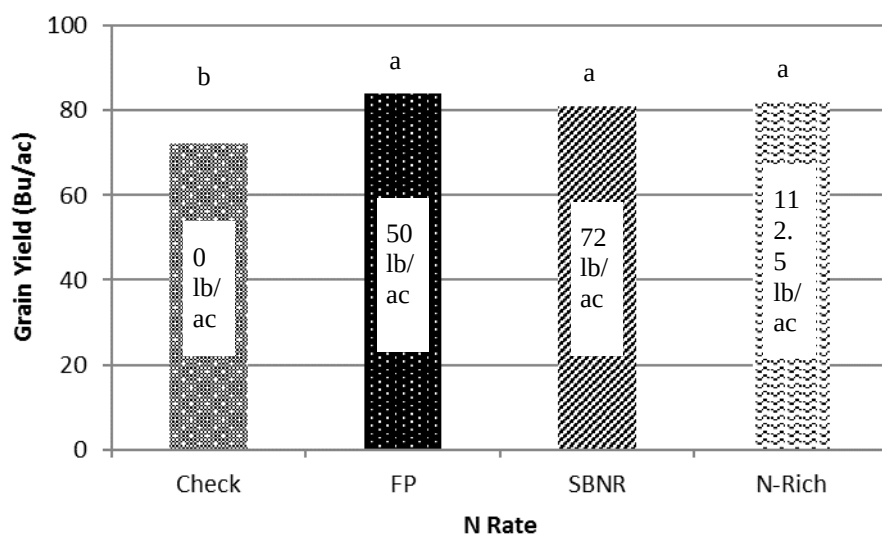


Figure 1. Grain Yield response to different nitrogen rates. Column with same letter are not statistically different ($p < 0.05$). $LSD_{0.05} = 3.36$

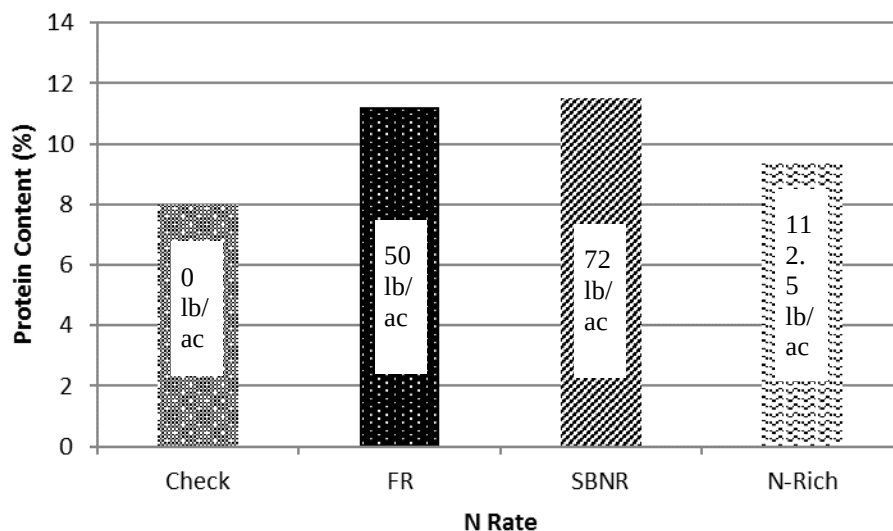


Figure 2. Protein Content response to different nitrogen rates.

The Check and FP rates had high yield and low protein ($\leq 11.5\%$). There may be two possible explanations for this. The wheat crop with no N could have experienced late-season N stress during grain filling. In the case of FP, the rapid biomass accumulation might cause the dilution of protein, a common effect in high-yielding crops. The SBNR rate had high yield and adequate protein. This indicates that the wheat crop did not experience N stress and the N applied optimized both yield and protein. The N-Rich had high yield, but low protein. The low protein could be an experimental (sampling) error as there was adequate N (soil N-nitrate and applied) to maximize both yield and protein.

Wheat yield response to N, along with the economic return is illustrated in Figure 3. The largest yield responses to N occurred with the first increment of applied N. At this stage of the N response curve, gains in economic return per pound of N were also the greatest. The size of these returns is lower as the N

rate approaches the economic optimum (Table 1). The EONR is reached when the cost of the last increment of additional N is equal to the value of the associated crop yield increase and protein premium. It was profitable to increase the N application rate to 72 lb/acre. Additions of N beyond 72 lb/acre do not produced a yield increase and protein premium large enough to offset the cost of the additional N. The result is a negative economic return for N additions beyond the EONR (72 lb N/acre).

Table 1. Relationship between grain yield and economic return.

Treatment	Yield (Bu/ac)	Return (\$/ac) ¹	N Cost (\$/ac) ²	Net Return (\$/ac)	Protein (%)	Premium (\$) ³	Premium (\$/ac)	Net ROI	Gain/Loss (\$)
Check	72.2	346.6	0.0	346.6	7.98	0.00	0.0	346.6	
FP	83.9	402.7	21.0	381.7	11.20	0.18	15.1	396.8	50.3
SBNR	80.9	388.3	30.2	358.1	11.51	0.24	19.4	377.5	30.9
N-Rich	82.0	393.6	47.3	346.4	9.37	0.00	0.0	346.4	-0.2

¹ Return was calculated using \$4.80 per bushel

² Cost of fertilizer was calculated using \$0.42 per pound of N

³ Premium is \$0.03 per each 1/5th of a percent above 10% protein content

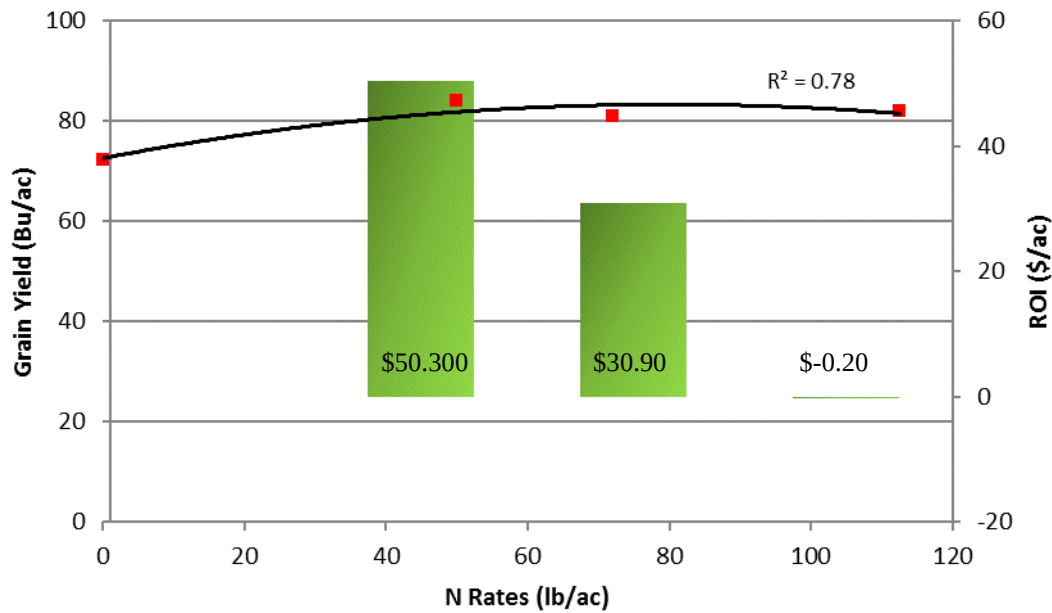


Figure 3. Relationship between grain yield and economic return.

Conclusion

This research demonstrated that the use of sensor based technologies (N-rich strip, GreenSeeker™ and SBNRC) has the potential to optimize yield and grain protein. Producers using the technology will be able to take advantage of those environments that are conducive to higher yields, reduce inputs in those years where yield is limited, or the soil supplies adequate levels of N through mineralization of soil organic matter.

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Sorghum Hybrid Performance Trials at Walsh, 2019

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

PURPOSE: To identify high yielding hybrids under dryland and irrigated conditions with 3200 sorghum growing degree days in a silt loam soil.

PLOT: Four rows with 30 in. row spacing, 50 ft. long. SEEDING DENSITY: 43,600 (dryland grain), 87,100 (irrigated grain), 69,700 (dryland forage) seed/a.

PLANTED: May 28 (irrigated grain), June 6 (dryland grain and forage).

HARVESTED: October 28 (dryland forage), November 15 (dryland grain), November 16 (irrigated grain).

PEST CONTROL: Preemergence

Herbicides: Flumioxazin 2.5 oz, Atrazine

1 lb/ac, S-Metolachlor 24 oz/ac,

Mesotrione 6.4 oz/ac, Glyphosate 32

oz/ac. Post Emergence Herbicides: Huskie 16 oz/a, Atrazine 0.75 lb/a. Cultivation: Once. Insecticides: None.

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	4.00	607	8	0	30
July	2.85	865	23	7	61
August	1.49	868	26	6	92
September	0.58	750	22	3	122
October	0.22	134	1	0	133
Total	9.14	3224	80	16	133

^aGrowing season from June 1 to October 11 (first freeze, 14F).

^bGDD: Growing Degree Days for sorghum.

^cDAP: Days After Planting.

FIELD HISTORY: Previous Crop: Wheat (dryland grain and forage), Corn (irrigated grain). FIELD PREPARATION: Strip-till.

COMMENTS: Planted in good soil moisture. Rapid germination and good plant stands. Weed control was good, except for moderate to severe infestations of sandbur. No sugarcane aphids were detected. The growing season precipitation was below average. June to July 2 was wet and July 3 to October 11 (first freeze) was dry.

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

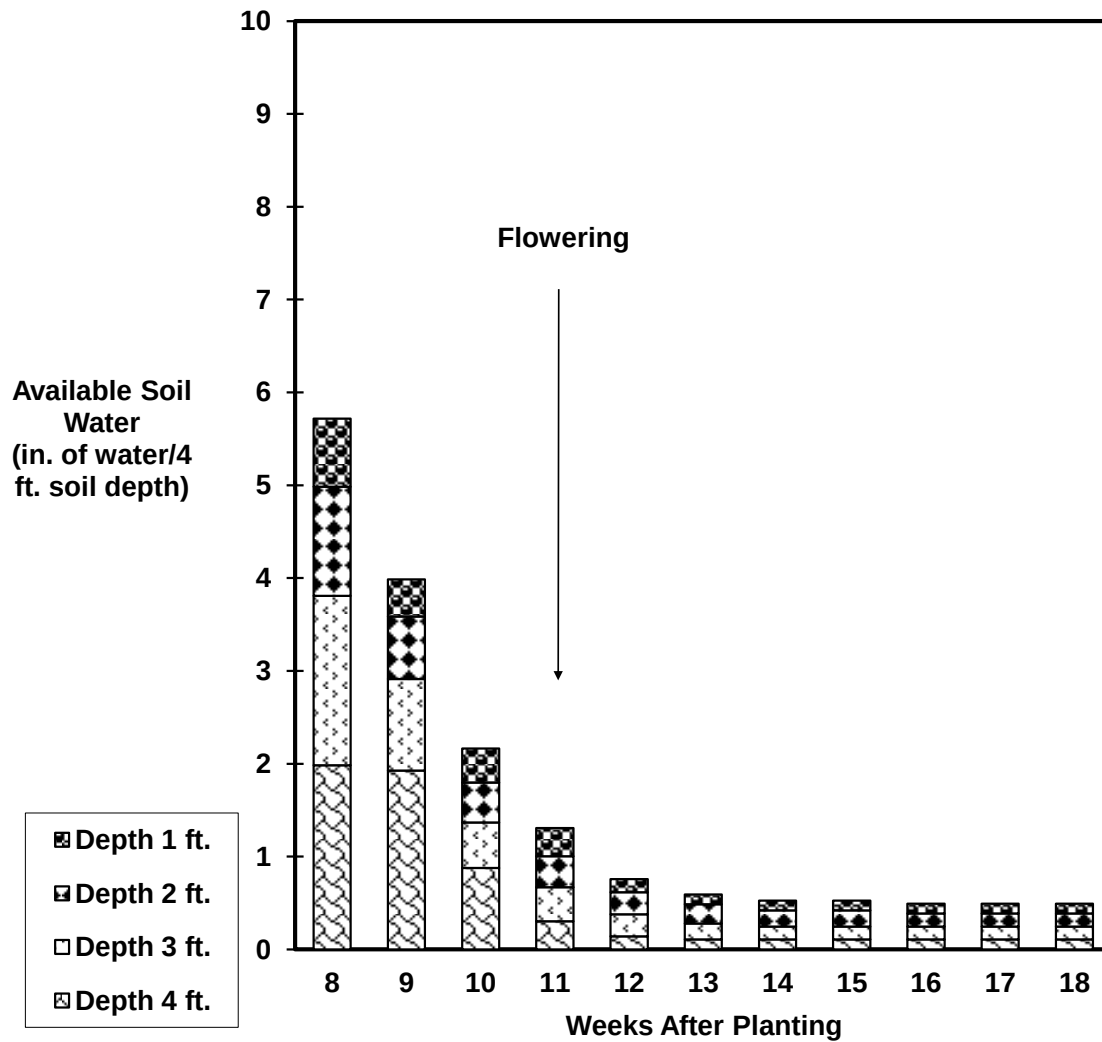
Summary: Soil Analysis of Plant Available Nutrients.

Depth	pH	Salts	OM	N	P	K	Zn	S
		mmhos/cm	%	-----ppm-----				
0-8"	7.8	0.6	1.7	10	9.1	556	2.4	14
8"-24"				8				
Comment	Alka	VLo	Mod	Mod	Med	VHi	Adeq	Marg
Iron was adequate.								

Summary: Fertilization.

Fertilizer	N	P ₂ O ₅	Zn	S
	-----lb/ac-----			
Recommended	15	0	0	0
Applied	125 (irr.), 50 (dry)	20-30	0	0
Yield Goal: 90 (irr), 50 (dry) bu/ac, 8 tons/ac (forage).				
Actual Yield: 74 (irr.) 52 (dry) bu/ac, 6 tons/ac (forage)				

Available Soil Water Dryland Grain Sorghum, Walsh, 2019



Available soil water in dryland grain sorghum at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to first freeze was 9.14 in. Any increase in available soil water between weeks is from rain.

2019 Dryland Grain Sorghum Hybrid Performance Trial at Walsh

Source	Hybrid	Grain Yield ^a	Yield	Test Weight	Plant Lodging	Plant Population ^b	Plant Height	50% Bloom	GDD ^c	50% Mature	Maturity Group ^d	Grain Color
		bu/ac	% of test avg.	lb/bu	%	plants/ac	in	days after planting		days after planting ^e		
Dyna-Gro Seed	M57GB19	64.0	124	59.7	2	35,600	38	65	2075	110	ME	Bronze
Dekalb	DKS29-28	63.0	122	60.1	0	32,500	34	62	1989	105	E	Bronze
Dyna-Gro Seed	M59GB94	61.1	118	60.1	5	36,000	38	67	2140	112	ME	Bronze
Dyna-Gro Seed	GX17912	59.4	115	59.8	0	31,400	36	64	2048	105	E	Cream
Dyna-Gro Seed	M62GB77	58.6	114	60.9	5	36,800	40	67	2140	113	ML	Bronze
Alta Seeds	AG1201	57.8	112	58.2	1	40,300	34	66	2106	108	ME	Bronze
Pioneer	86P20	57.7	112	59.6	1	38,000	38	61	1959	105	E	Bronze
Dyna-Gro Seed	M69GB38	57.6	112	59.2	2	33,700	42	75	2357	122	ML	Bronze
Sorghum Partners	SP68M57	57.5	111	59.4	7	28,700	43	69	2191	115	M	Bronze
Dekalb	DKS33-07	57.4	111	59.1	0	37,200	40	74	2325	121	ML	Bronze
Sorghum Partners	SP31A15	57.2	111	58.4	1	32,900	39	68	2165	112	ME	Bronze
Dekalb	DKS28-05	57.2	111	58.6	1	32,500	37	63	2023	106	E	Bronze
Sorghum Partners	SP43M80	56.9	110	60.1	9	36,000	42	67	2140	112	ME	Bronze
Dyna-Gro Seed	GX18919	56.0	109	59.3	1	34,100	37	59	1901	102	E	Cream
Alta Seeds	ADV G1150	55.1	107	59.7	4	29,000	39	67	2140	112	ME	Bronze
Alta Seeds	ADV G2106	54.5	106	59.2	4	32,100	39	67	2140	112	ME	Bronze
Dyna-Gro Seed	M60GB88	53.4	103	58.2	4	37,600	42	66	2106	108	ME	Bronze
Dyna-Gro Seed	M54GR24	52.8	102	59.2	0	38,000	37	65	2075	106	E	Red
Alta Seeds	ADV G1329	52.0	101	58.9	0	35,200	32	65	2075	108	ME	Cream
Sorghum Partners	SP25C10	51.4	100	59.4	0	39,900	37	58	1874	101	E	Cream
Alta Seeds	ADV XG9127	51.0	99	59.8	1	29,800	42	70	2216	114	M	Bronze
Dyna-Gro Seed	M59GB57	49.7	96	59.4	0	31,000	34	63	2023	106	E	Bronze
Dyna-Gro Seed	M57GC29	46.6	90	58.9	0	36,800	32	67	2140	112	ME	Cream
Dyna-Gro Seed	M60GB31	45.3	88	60.6	29	34,900	41	70	2216	116	ME	Bronze
Gayland Ward Seed	18057	44.5	86	58.7	3	41,800	46	70	2216	114	M	Bronze
Sorghum Partners	SP33S40	44.4	86	59.9	0	41,800	39	68	2165	112	ME	Cream
Advanta	ADV XG390IG	15.5	30	54.8	0	32,100	35	93	2846	SD	L	Red
Advanta	ADV XG009IG	7.3	14	52.7	0	39,900	35	98	2976	LM	L	Red
Average		51.6		59.0	3	35,200	38	68	2170	110	ME	
^f LSD (P<0.20)		3.6			3							

^aYields adjusted to 14% moisture and hybrids ranked by yield. Hybrid yields in bold are in the top LSD group.

^bPlant population taken after final stand. Main plants only, does not include tillers.

^cGDD: Sorghum growing degree days to 50% bloom date.

^dMaturity Group: E=early; ME=medium-early; M=medium; ML=medium late; L=late;

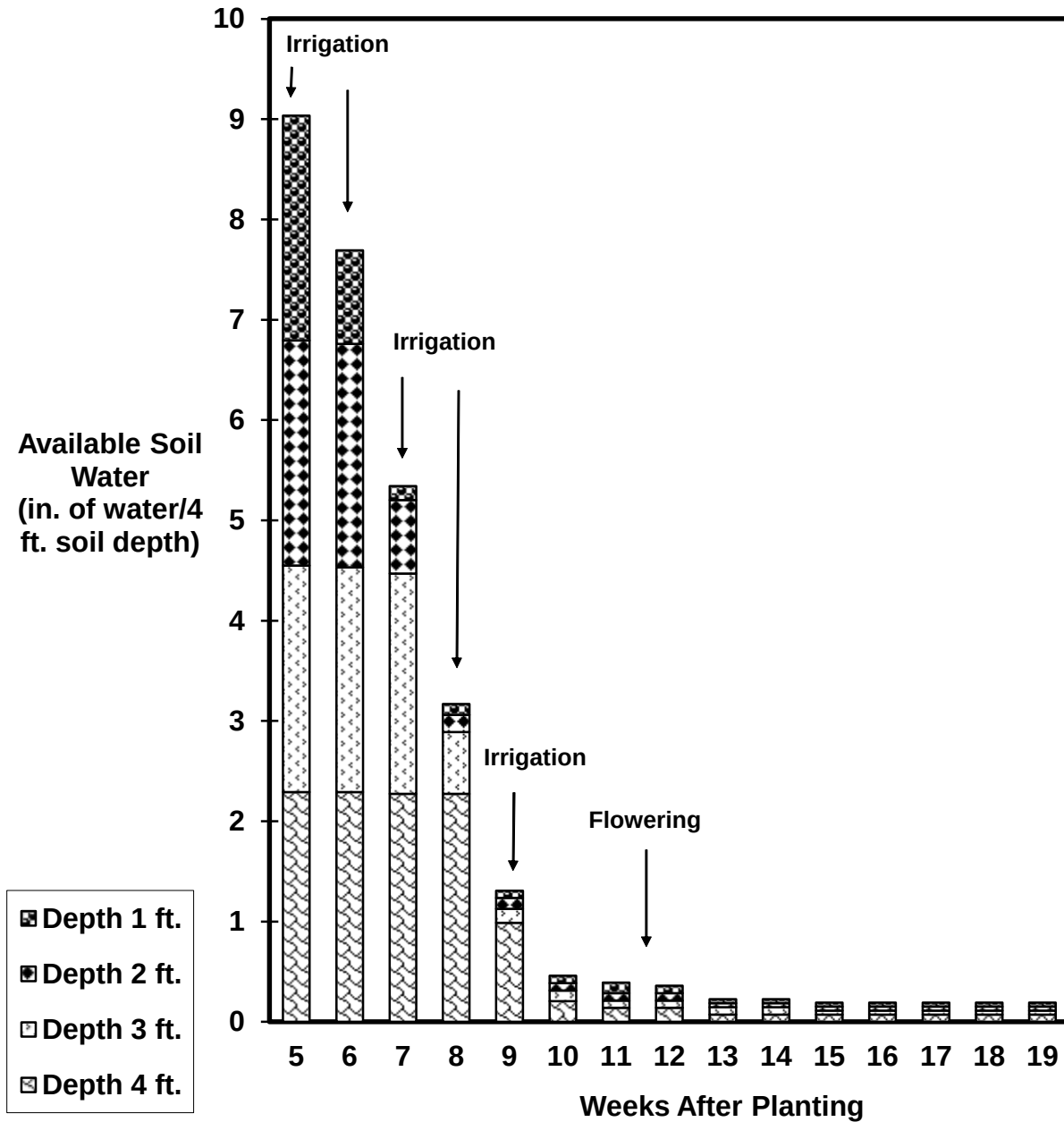
^eDays after planting or seed maturation. LM=late milk; SD=soft dough.

^fIf the difference between two varieties yields equals or exceeds the LSD value, there is an 80% chance the difference is significant.

Site Information

Collaborator: Plainsman Research Center (Kevin Larson & Brett Pettinger)
 Planting Date: June 6, 2019
 Harvest Date: November 14 and 15, 2019
 Previous Crop: Wheat
 Herbicide: Preemergence: Flumioxazin at 2.5 oz/ac; Atrazine at 1.0 lb/ac, Mesotrione at 6.4 oz/ac; and Metolachlor at 1.33 pts/ac; Post emergence: Huskie at 16 oz/ac, Atrazine at 0.75 lb/ac.
 Fertilizer: Anhydrous N at 50 lb/ac and 10-34-0 at 5 gal/ac was strip till applied.
 Soil Type: Richfield silt loam
 Comments: Planted into strip tilled wheat stubble. Rapid emergence and good stands. From planting (June 6) to July 2, the trial received 5.96 inches of rain. The rest of the growing season was dry, totaling 2.61 inches of rain from July 3 to October 11 (first freeze). Weed control was good, except for a moderate infestation of sandbur, which required cultivation. Some, mostly minor, lodging noted at harvest. The two hybrids from Alta at the bottom of the table are new herbicide resistant hybrids that are not adapted to the Colorado growing environment.

Available Soil Water Subsurface Drip Irrigated Grain Sorghum, Walsh, 2019



Available soil water in drip irrigated 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 9,26 in. Any increase in available soil water between weeks not attributed to irrigation is from rain.

2019 Subsurface Drip Irrigated Grain Sorghum Hybrid Performance Trial at Walsh.

Source	Hybrid	Yield											
		Grain Yield ^a	Percent of Trial Average		Test Weight	Plant Lodging	Plant Population ^b	Plant Height	50% Bloom	GDD ^c	50% Mature	Maturity Group ^d	Grain Color
			bu/ac	percent									
Dekalb	DKS45-23	104.6	141	59.9	7	65,100	49	75	1839	120	ML	Bronze	
Dekalb	DKS33-07	90.2	122	59.1	3	58,900	45	76	1873	121	ML	Bronze	
Sorghum Partners	SP 43M90	86.8	117	56.7	18	57,300	48	66	1578	111	ME	Bronze	
Alta Seeds	AG1201	85.3	115	58.1	3	56,500	39	67	1607	111	ME	Bronze	
Dekalb	DKS38-16	84.7	114	60.3	1	55,800	48	72	1756	117	M	Bronze	
Alta Seeds	ADV XG9127	83.7	113	57.1	1	50,000	44	77	1898	122	ML	Bronze	
Dekalb	DKS47-07	81.0	109	57.9	8	49,600	48	76	1873	124	ML	Bronze	
Warner Seed	W5911	80.1	108	59.3	4	60,400	43	71	1722	115	M	Bronze	
Dekalb	DKS29-28	79.4	107	58.5	0	53,400	37	63	1493	108	E	Bronze	
Gayland Ward Seed	18036	79.2	107	58.8	13	58,100	52	73	1781	119	ML	Bronze	
Dyna-Gro Seed	M69GB38	78.6	106	60.0	3	50,300	44	78	1924	125	ML	Bronze	
Dyna-Gro Seed	M59GB57	78.4	106	56.7	1	59,600	37	62	1472	108	E	Bronze	
Gayland Ward Seed	18057	78.2	105	57.4	2	61,200	49	74	1808	119	ML	Bronze	
Alta Seeds	ADV G2106	77.8	105	58.0	12	52,700	47	71	1722	116	M	Bronze	
Golden Acres	2840B	77.3	104	58.4	26	60,800	43	66	1578	110	ME	Bronze	
Warner Seed	W5506	74.2	100	57.4	4	59,200	40	61	1445	107	E	Bronze	
Gayland Ward Seed	18094	74.2	100	56.7	3	59,200	50	75	1839	121	ML	Bronze	
Dekalb	DKS29-05	73.6	99	58.0	2	53,700	39	61	1445	107	E	Bronze	
Alta Seeds	ADV G1329	72.3	97	58.4	3	67,000	37	67	1607	113	ME	Cream	
Gayland Ward Seed	18093	72.2	97	59.0	2	51,900	45	72	1756	116	M	Bronze	
Golden Acres	2730B	71.6	96	57.9	10	67,000	39	65	1544	110	ME	Bronze	
Warner Seed	W5711	69.5	94	57.7	1	53,100	37	66	1578	109	ME	Bronze	
Gayland Ward Seed	18071	68.9	93	57.5	19	56,900	45	77	1898	125	ML	Bronze	
Alta Seeds	ADV G1150	68.9	93	57.3	10	49,600	40	72	1756	116	M	Bronze	
Sorghum Partners	SP 33S40	68.7	93	57.9	3	49,200	41	65	1544	109	ME	Cream	
Dyna-Gro Seed	M62GB77	68.5	92	59.3	2	59,200	42	72	1756	116	M	Bronze	
Sorghum Partners	SP 68M57	68.3	92	58.5	6	53,400	43	67	1607	111	ME	Bronze	
Dyna-Gro Seed	M60GB88	68.1	92	58.4	7	59,600	46	66	1578	110	ME	Bronze	
Gayland Ward Seed	19016	66.4	89	57.8	10	54,200	51	81	2006	127	L	Bronze	
Golden Acres	3960B	64.0	86	59.1	16	55,800	40	71	1722	115	M	Bronze	
Sorghum Partners	SP 31A15	63.7	86	56.7	3	58,100	41	65	1544	109	ME	Bronze	
Dyna-Gro Seed	M60GB31	59.6	80	58.9	7	58,500	42	72	1756	115	M	Bronze	
Warner Seed	W5501	55.5	75	56.0	3	43,000	34	62	1472	108	E	Bronze	
Gayland Ward Seed	19017	43.7	59	52.0	9	50,000	51	87	2169	134	L	Bronze	

^fLSD (P<0.20)

^aYields adjusted to 14% moisture and hybrids ranked by yield.

^bPlant population taken after final stand. Main plants only, does not include tillers.

^cGDD: Sorghum growing degree days to 50% bloom date.

^dMaturity Group: E=early; ME=medium-early; M=medium; ML=medium late.

^eDays after planting or seed maturation.

^fIf the difference between two varieties yields equals or exceeds the LSD value, there is an 80% (at P<0.20) chance the difference is statistically significant.

Site Information

Collaborator: Plainsman Research Center (Kevin Larson & Brett Pettinger)

Planting Date: May 28, 2019

Harvest Date: November 16 and 18, 2019

Previous Crop: Wheat

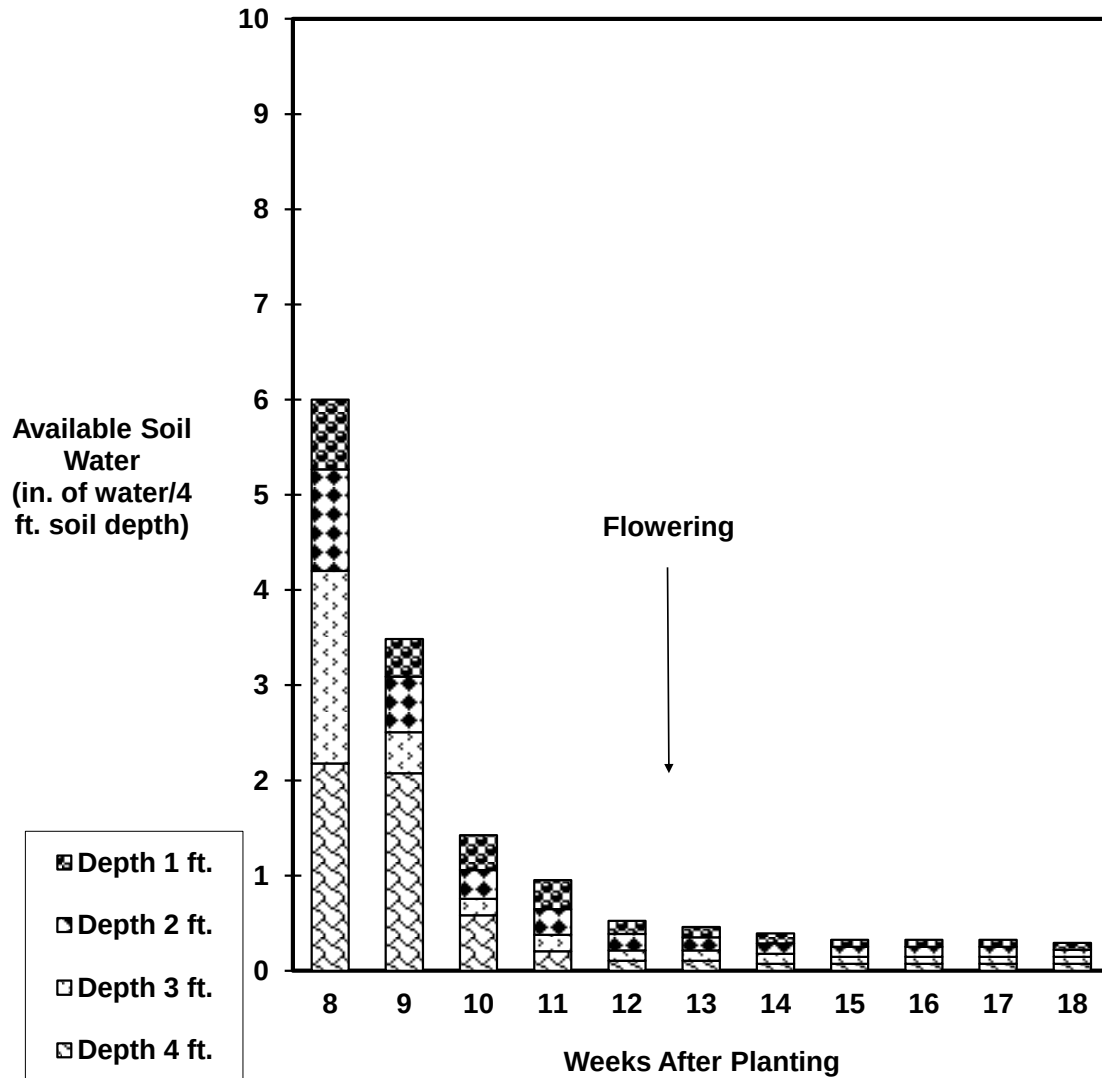
Herbicide: Preemergence: Flumioxazin at 2.5 oz/ac; Atrazine at 1.0 lb/ac, Mesotrione at 6.4 oz/ac; and Metolachlor at 1.33 pts/ac; Post emergence: Huskie at 16 oz/ac, Atrazine at 0.75 lb/ac.

Fertilizer: Anhydrous N at 125 lb/ac and 10-34-0 at 7.5 gal/ac was strip till applied.

Soil Type: Richfield silt loam

Comments: Planted into strip tilled wheat stubble. Rapid emergence and good stands. From planting (May 28) to July 2, the trial received 6.65 inches of rain. The rest of the growing season was dry, totaling 2.61 inches of rain from July 3 to October 11 (first freeze). Weed control was good, except for a heavy infestation of sandbur, which required cultivation. Some, mostly minor, lodging noted at harvest.

**Available Soil Water
Dryland Forage Sorghum, Walsh, 2019**



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 8.54 in. Any increase in available soil water between weeks is from rain.

2019 Dryland Hybrid Forage Sorghum Performance Trial at Walsh

Brand	Hybrid	Forage Yield ^a	Yield	Stem Sugar	Harvest Density	Plant Height	Lodging	Days to Boot	Relative Maturity ^b	Forage Type ^c	Traits ^d
		tons/ac	% of test avg.	%	plants/ac (1000x)	in	%	days after planting			
Sorghum Partners	SP1880	9.1	155	14.1	50.7	83	20	97	ML	FS	-
Dyna-Gro Seed	Fullgraze II	8.6	148	21.6	49.6	81	60	97	ML	SS	-
Alta Seeds	AF8301	8.2	139	17.7	52.7	45	10	90	M	FS	-
Dyna-Gro Seed	F72FS05	8.1	137	20.2	44.5	44	0	100	ML	FS	SCA
Alta Seeds	ADV XF033	7.6	129	21.6	44.1	35	0	109	L	FS	SCA
Dyna-Gro Seed	Super Sile 30	7.3	125	21.4	53.4	59	15	95	ML	FS	-
Dyna-Gro Seed	F74FS72 BMR	7.3	124	21.5	44.9	34	0	107	L	FS	BMR, BD
Dyna-Gro Seed	TopTon	7.2	122	16.4	55.8	61	90	Veg	PS	FS	-
Gayland Ward Seed	18181	6.9	118	16.4	50.7	74	90	Veg	PS	FS	-
Dyna-Gro Seed	Danny Boy II BMR	6.9	117	19.2	47.2	65	40	Veg	PS	SS	BMR
Gayland Ward Seed	19153	6.9	117	22.3	60.8	82	35	89	M	FS	-
Sorghum Partners	NK300	6.8	115	18.9	54.2	44	0	86	M	FS	-
Alta Seeds	AF7401	6.6	112	19.8	50.7	39	0	117	L	FS	BMR, BD
Dyna-Gro Seed	Fullgraze II BMR	6.4	109	16.6	50.0	58	12	Veg	PS	SS	BMR
Mojo Seed	Opal	6.2	105	19.3	38.7	50	4	94	ML	FS	BD
Dyna-Gro Seed	Super Sile 20	6.2	105	19.9	66.6	59	12	94	ML	FS	-
Gayland Ward Seed	19154	6.1	103	20.8	52.7	71	90	101	ML	FS	-
Alta Seeds	ADV F7232	6.0	103	22.5	46.5	41	0	104	ML	FS	BMR, BD
Gayland Ward Seed	19102	5.8	98	16.8	50.0	66	45	Veg	PS	FS	-
Sorghum Partners	SP1615	5.7	97	16.9	52.7	58	50	Veg	PS	FS	-
Sorghum Partners	SS506	5.6	96	15.0	50.3	70	98	99	ML	FS	-
Gayland Ward Seed	18180	5.4	92	18.0	44.5	81	25	72	ME	SS	-
Sorghum Partners	SP3904 BD BMR	5.4	92	19.6	43.8	43	0	107	L	FS	BMR, BD
Dyna-Gro Seed	FX19178 BMR	5.4	91	23.5	43.8	40	0	88	M	FS	BMR, BD
Dyna-Gro Seed	FX19125 BMR	5.0	86	17.3	38.3	70	60	63	E	FS	BMR
Alta Seeds	AF7102	4.9	83	19.7	44.1	52	1	69	E	FS	BMR
Dyna-Gro Seed	FX19819 BMR	4.8	82	19.1	38.0	38	0	97	ML	FS	BMR
Alta Seeds	ADV XF025	4.6	78	15.2	45.3	68	30	62	E	FS	BMR
Gayland Ward Seed	18118	4.5	78	20.1	53.8	68	92	67	E	SS	BMR
Sorghum Partners	SS405	4.4	76	18.8	43.4	72	97	99	ML	FS	-
Dyna-Gro Seed	GX13692	3.9	67	DS ^e	44.5	120	7	71	ME	FS	-
Dyna-Gro Seed	Dual Forage SCA II	3.8	66	DS ^e	48.8	44	35	71	ME	FS	SCA
Sorghum Partners	SP2774	3.8	64	13.0	43.4	67	70	72	ME	FS	BMR
Gayland Ward Seed	18119	3.7	63	20.0	58.9	59	65	67	E	SS	BMR
Gayland Ward Seed	19155	3.6	61	18.3	64.7	61	8	75	ME	FS	BMR
Dyna-Gro Seed	FX19526 BMR	2.7	45	19.7	43.4	42	50	76	ME	FS	BMR
Average		5.9		18.9	49.0	60	34	88			
^f LSD (P<0.20)		3.6									

^aYields are adjusted to 65% moisture content based on oven-dried samples.

^bRelative Maturity: E=early; ME=medium-early; M=medium; ML=medium-late; L=late; PS=photoperiod sensitive.

^cForage Type: FS=forage sorghum; S=sudangrass; SS=sorghum sudangrass.

^dTraits: BD=brachytic dwarf; BMR=brown mid-rib; BMR-6=one of the three main brown mid-rib genes; SCA=Sugar Cane Aphid.

^eStem Sugar: DS=dry stalk, unable to measure stem sugar.

^fIf the difference between two varieties yields equals or exceeds the LSD value, then they are significantly different with less than 20% probability that the difference is due to random error.

Site Information

Collaborator: Plainsman Research Center (Kevin Larson & Brett Pettinger)

Planting Date: June 6, 2019

Harvest Date: October 22, 2019

Previous Crop: Wheat

Herbicide: Preemergence: Flumioxazin at 2.5 oz/ac; Atrazine at 1.0 lb/ac; and Metolachlor at 1.33 pts/ac.

Fertilizer: Anhydrous N at 50 lb/ac and 10-34-0 at 5 gal/ac was strip till applied.

Soil Type: Richfield silt loam

Comments: Planted into strip tilled wheat stubble. Rapid emergence and good stands. From planting (June 6) to July 2, the trial received 5.96 inches of rain. The rest of the growing season was dry, totaling 2.61 inches of rain from July 3 to October 11 (first freeze). Weed control was good, except for a moderate infestation of sandbur, which required cultivation. Some lodging noted at harvest.

2019 Dryland Forage Sorghum Hybrid Performance Trial Feed Quality at Walsh

Brand	Hybrid ^a	Forage Type ^b	RFQ	CP	ADF	aNDFom	Lignin	Starch	NDFD		TDN	Milk/Ton
									30hr	240hr		
							percent					
Dyna-Gro Seed	Fullgraze II BMR	SS	161	8.6	27.9	46.3	1.6	2.5	63.3	80.6	65.7	3253
Dyna-Gro Seed	F74FS72 BMR	FS	153	8.2	29.1	46.3	1.9	2.2	60.2	78.1	64.6	3206
Dyna-Gro Seed	Danny Boy II BMR	SS	151	8.8	30.8	47.1	2.1	3.0	62.1	81.5	63.6	3090
Alta Seeds	AF7401	FS	146	7.9	30.4	46.9	2.6	2.2	58.4	74.9	63.1	3113
Dyna-Gro Seed	FX19526 BMR	FS	146	14.4	30.8	54.6	2.8	0.1	68.2	81.8	64.4	3021
Sorghum Partners	SP3904 BD BMR	FS	145	8.0	30.1	46.4	2.6	0.8	55.8	70.7	64.1	3238
Dyna-Gro Seed	TopTon	FS	141	8.0	29.8	46.8	2.6	2.9	56.4	77.4	62.5	3091
Dyna-Gro Seed	FX19819 BMR	FS	138	10.4	31.4	52.1	2.8	2.0	64.1	77.6	61.6	2876
Gayland Ward Seed	19155	FS	138	12.4	32.9	56.3	2.7	0.1	67.3	81.8	63.5	2957
Gayland Ward Seed	18118	SS	136	13.4	33.9	57.3	2.9	0.1	67.2	81.2	63.6	2969
Alta Seeds	AF7102	FS	132	12.2	33.7	55.9	2.9	0.1	65.5	77.9	61.8	2855
Alta Seeds	ADV F7232	FS	131	9.6	32.6	54.1	3.0	0.2	61.3	76.7	61.2	2899
Gayland Ward Seed	18181	FS	131	8.5	30.7	50.8	2.9	3.6	58.6	77.0	61.6	2901
Dyna-Gro Seed	Super Sile 30	FS	129	10.5	32.5	52.8	3.1	0.1	60.0	76.1	61.5	2953
Alta Seeds	ADV XF025	FS	129	13.1	34.3	58.9	3.4	0.1	66.2	79.2	61.7	2819
Gayland Ward Seed	18119	SS	129	12.7	33.3	57.4	3.0	0.1	64.6	78.0	61.9	2885
Sorghum Partners	SP1615	FS	128	9.0	31.9	54.2	2.8	0.9	60.7	77.6	61.5	2937
Dyna-Gro Seed	F72FS05	FS	127	9.9	31.5	53.7	3.1	0.1	58.5	75.9	61.0	2943
Alta Seeds	ADV XF033	FS	127	8.7	31.9	51.3	3.6	1.3	56.3	70.8	61.5	3023
Dyna-Gro Seed	FX19125 BMR	FS	122	13.2	35.9	53.8	3.5	0.1	60.9	75.8	59.8	2784
Gayland Ward Seed	19102	FS	121	8.2	31.7	52.3	3.2	2.5	56.2	75.5	59.0	2805
Gayland Ward Seed	19153	FS	121	10.9	32.6	55.1	3.2	0.1	57.2	74.8	60.2	2893
Dyna-Gro Seed	Fullgraze II	SS	120	9.4	34.0	56.2	3.5	0.1	58.8	77.8	60.7	2912
Dyna-Gro Seed	GX13692	FS	119	13.5	34.8	56.2	3.7	0.1	60.4	75.5	59.8	2793
Alta Seeds	AF8301	FS	116	10.1	33.8	54.8	3.9	0.1	57.1	72.6	59.4	2832
Sorghum Partners	SP2774	FS	116	13.1	36.3	57.6	3.8	0.1	60.2	73.5	59.2	2750
Dyna-Gro Seed	Super Sile 20	FS	115	10.5	34.3	51.4	4.0	0.1	52.1	69.7	58.6	2846
Sorghum Partners	SS506	FS	115	10.2	35.1	59.3	3.7	0.1	60.8	77.5	58.7	2698
Gayland Ward Seed	19154	FS	115	9.9	33.0	55.4	3.6	0.7	55.6	72.9	59.2	2846
Dyna-Gro Seed	Dual Forage SCA II	FS	112	12.8	36.6	60.2	3.8	0.1	60.5	77.0	58.8	2707
Gayland Ward Seed	18180	SS	111	11.5	34.7	58.4	3.8	0.1	57.7	74.6	59.0	2790
Sorghum Partners	SS405	FS	110	9.1	34.7	58.2	4.0	0.1	56.9	72.7	58.4	2757
Mojo Seed	Opal	FS	103	12.2	34.6	50.4	4.1	0.1	48.6	67.6	55.7	2648
Sorghum Partners	SP1880	FS	103	8.2	36.1	58.7	3.9	0.1	54.2	71.8	57.6	2759
Sorghum Partners	NK300	FS	102	11.4	36.6	56.8	4.6	0.1	53.9	68.8	57.1	2705
Dyna-Gro Seed	FX19178 BMR	FS	89	11.7	36.7	56.2	4.6	0.1	49.5	69.1	53.1	2449
Average			126	10.6	33.1	53.9	3.3	0.8	59.3	75.6	60.7	2889

^aHybrids ranked according to relative forage quality score (RFQ)

^bForage 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; TDN=total digestable nutrients.

Sprinkler Irrigation on Corn and Grain Sorghum Hybrids, Walsh 2019
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 14 corn hybrids and 11 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 29 at 44,000 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 P₂O₅/a as 10-34-0, and at planting we seedrow applied an additional 20 lb P₂O₅/a, and 0.33 lb/a of Zn chelate. We applied 14.0 acre-in./a of water to the corn and 11.4 acre-in./a to the 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 were lower than expected for the corn trial but test weights were high. Yields and test weights were good for the grain sorghum hybrids. The growing season precipitation was below average. June to July 2 was wet and July 3 to October 11 was dry. September was particularly hot and dry. Corn yields were slightly below average and grain sorghum yields well above average. Test weights were above average for grain sorghum and well above average for corn.

Discussion: The hot and dry September impacted the corn by reducing yields to below average production. Grain sorghum yields were above average, because sorghum is more tolerant of hot and dry conditions than corn. Typical yield goals for these studies are 150 bu/a for corn and 90 bu/a for grain sorghum. The average yield for the corn trial was more than 20 bu/a below average; while, the average yield of the grain sorghum trial exceeded our yield goal by more than 10 bu/a. These yield averages support the assumptions of sensitivity of corn and tolerance of grain sorghum to hot and dry conditions.

Sprinkler Irrigated Grain Sorghum Hybrid Study at Walsh, 2019

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 11 grain sorghum hybrids tested averaged 107 bu/a. The yield ranged from 100 bu/a for Dyna-Gro M59GB52 to 118 bu/a for Integra G3665. 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: 44,000 seeds/a. **PLANTED:** May 29.
HARVESTED: November 13.

PEST CONTROL: Preemergence Herbicides: Flumioxazin 2.5 oz/a, Atrazine 1lb/a, S-Metolachlor 24 oz/a, Mesotrione 6.4 oz/a; Post Herbicides: Dicamba at 8 oz/a.
INSECTICIDE: None
CULTIVATION: Once.

FIELD HISTORY: Previous Crop: Corn. **FIELD PREPARATION:** 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	0.12	0.00	22	0	0	2
June	4.00	2.00	607	8	0	32
July	2.85	3.00	865	23	7	63
August	1.49	3.40	868	26	6	94
September	0.58	3.00	750	22	3	124
October	0.22	0.00	134	1	0	135
Total	9.26	11.40	3246	80	16	135

\1 Growing season from May 29 (planting) to October 11 (freeze, 14F).
 \2 Total in-season water from irrigation and precipitation was 20.66 in/a.
 \3 GDD: Growing Degree Days for sorghum.
 \4 DAP: Days After Planting.

COMMENTS: Planted in good soil moisture for seed germination. Stand establishment was good. Weed control was good, except for a severe infestation of sandbur. The growing season precipitation was below average. June to July 2 was wet and July 3 to October 11 was dry. September was particularly hot and dry. Grain yields and test weights were good. We applied 11.4 in/a of irrigation.

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

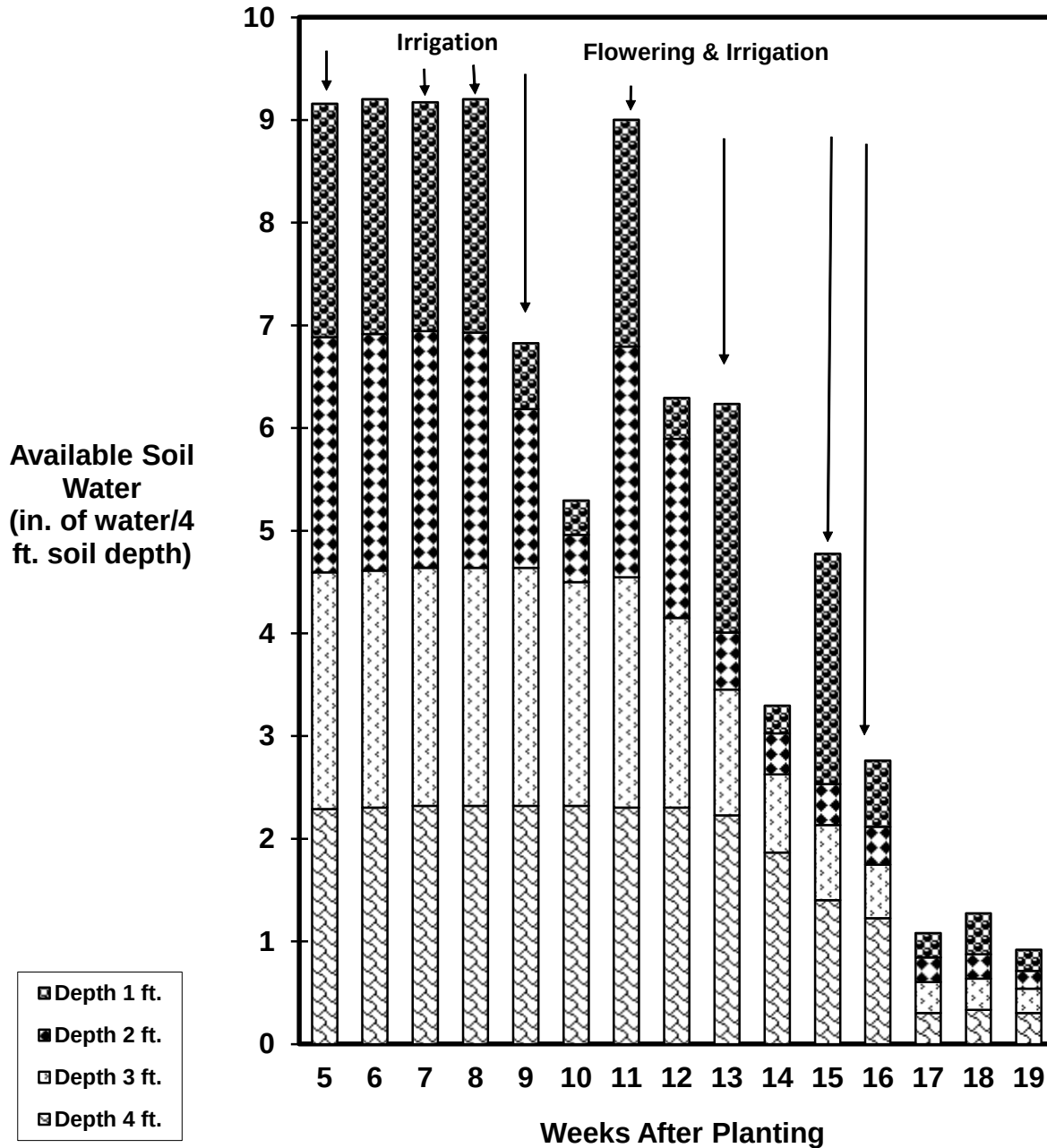
Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	S
		mmhos/cm	%	-----ppm-----				
0-8" 8"-24"	7.7	0.7	2.2	12 9	5.3	549	1.1	15.1
Comment	Alka	VLo	Hi	Mod	Lo	VHi	Marg	Adeq
Iron was adequate.								

Summary: Fertilization.

Fertilizer	N	P ₂ O ₅	Zn	S
	-----lb/a-----			
Recommended	15	20	0	0
Applied	175	40	0.3	0
Yield Goal: 90 bu/a.				
Actual Yield: 101 bu/a.				

Available Soil Water Sprinkler Irrigated Grain Sorghum, Walsh, 2019



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 9.26 in. Any increase in available soil water between weeks not attributed to applied irrigation is from rain.

Limited Sprinkler Irrigated Grain Sorghum, Plainsman Research Center, Walsh, 2019.

Brand	Hybrid	Seed			Plant Lodging	Plant Density	Plant Height	50%	50%
		Grain Yield	Moisture Content	Test Weight				Flowering Date	Maturity Date
		bu/a	%	lb/bu	%	plants/a (1000X)	in		
Integra	G3665	118	12.3	56.6	5	34.8	49	8/12	9/30
Dyna-Gro Seed	M62GB77	117	11.2	60.6	4	39.6	50	8/12	9/26
Dyna-Gro Seed	M60GB88	110	11.5	57.9	4	35.2	47	8/10	9/24
Dyna-Gro Seed	M57GC29	108	11.2	57.5	0	36.0	41	8/8	9/22
Dyna-Gro Seed	M57GB19	108	11.4	58.9	5	38.8	48	8/6	9/22
Pioneer	84P68	107	11.1	59.1	38	36.4	51	8/13	10/1
Dyna-Gro Seed	M60GB31	105	11.2	58.3	8	34.4	47	8/6	9/21
Dyna-Gro Seed	M54GR24	104	11.1	58.7	7	39.2	46	8/2	9/16
Integra	G3630	103	11.3	58.5	33	35.6	47	8/13	9/30
Integra	G19059	103	11.6	59.3	10	36.8	50	8/11	9/29
Dyna-Gro Seed	M59GB52	100	11.1	58.0	0	36.8	42	8/1	9/17
Average		107	11.4	58.5	10	36.7	47	8/8	9/24
LSD 0.20		5.8			3.3				

Planted: May 29; Harvested: November 13, 2019.

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 11.4 acre-in of applied water.

Yields are adjusted to 14.0% seed moisture content.

Sprinkler Irrigation Corn Hybrid Study at Walsh, 2019

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 14 hybrids tested was 129 bu/a. All three seed firms (Channel Seed, Dyna-Gro, and Integra) 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 6.

HARVESTED: November 4.

PEST CONTROL: Preemergence

Herbicides: Flumioxazin 2.5 oz/a,

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:** Portal 32

oz/a for mites.

FIELD HISTORY: Previous Crop:

Grain sorghum. **FIELD PREPARATION:** Strip-tilled.

COMMENTS: Planted in good soil moisture for seed germination. Stand establishment was good. Weed control was very good. The growing season precipitation was average. June to July 2 was wet and July 3 to October 11 was dry. September was particularly hot and dry. Grain yields fair and test weights were good. We applied 14.0 in/a of irrigation.

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

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	4.65	0.00	303	1	0	24
June	4.00	3.00	607	8	0	54
July	2.85	4.00	865	23	7	85
August	1.49	4.00	868	26	6	116
September	0.58	3.00	750	22	3	146
October	0.22	0.00	134	1	0	157
Total	13.79	14.00	3527	81	16	157

\1 Growing season from May 6 (planting) to October 11 (freeze, 14F).
 \2 Total in-season water from irrigation and precipitation was 27.79 in/a.
 \3 GDD: Growing Degree Days for sorghum.
 \4 DAP: Days After Planting.

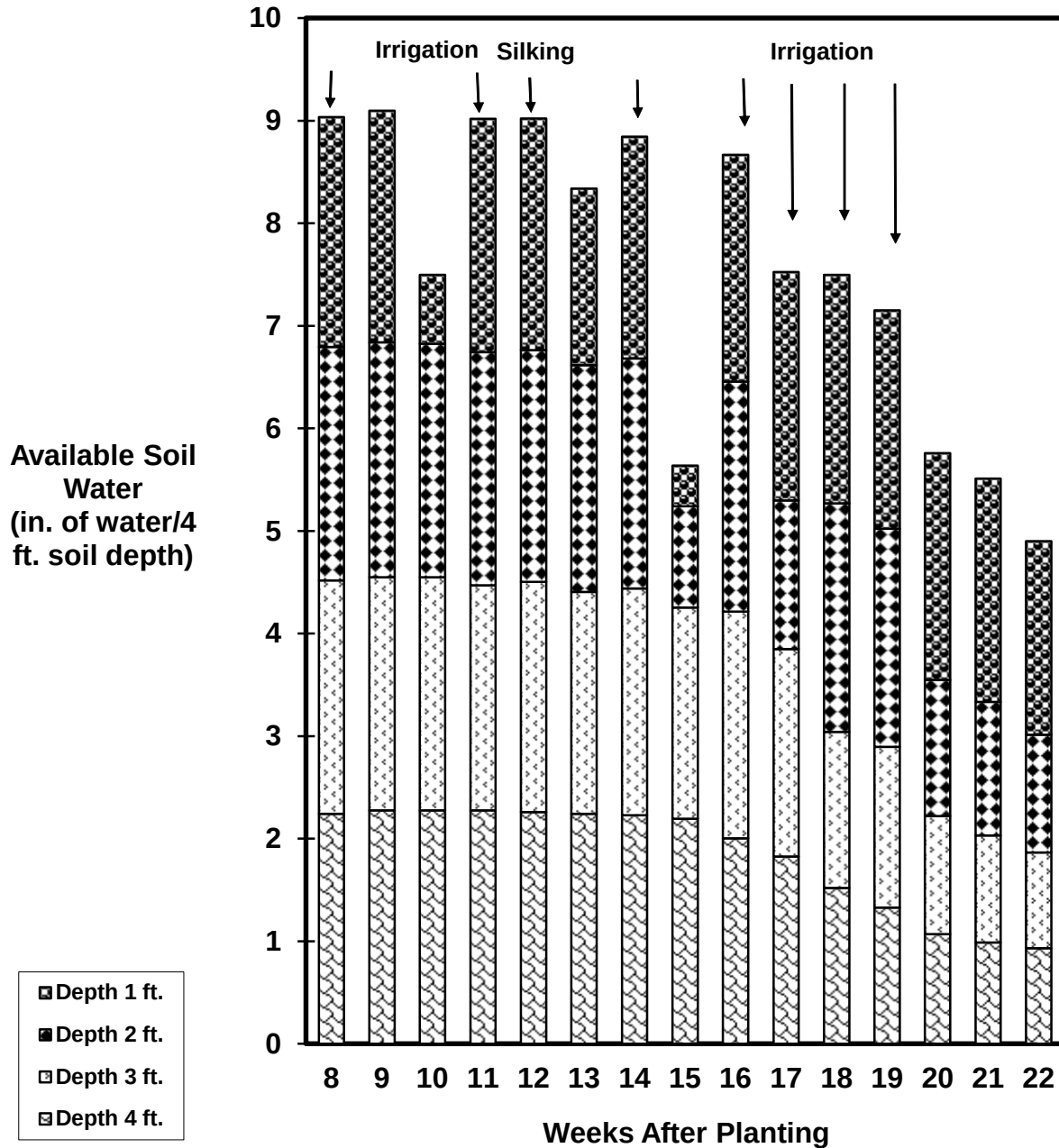
Summary: Soil Analysis.

Depth	pH	Salts	OM	N	P	K	Zn	S
		mmhos/cm	%	-----ppm-----				
0-8"	7.6	0.7	2.1	10	10.6	579	1.8	18.1
8"-24"				9				
Comment	Alka	VLo	Hi	Mod	Med	VHi	Adeq	Adeq
Iron was adequate.								

Summary: Fertilization.

Fertilizer	N	P ₂ O ₅	Zn	S
	-----lb/a-----			
Recommended	110	20	0	0
Applied	200	40	0.3	0
Yield Goal: 150 bu/a.				
Actual Yield: 129 bu/a.				

Available Soil Water Sprinkler Irrigated Corn, Walsh, 2019



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 13.79 in. Any increase in available soil water between weeks not attributed to applied irrigation is from rain.

Sprinkler Irrigated Corn, Plainsman Research Center, Walsh, 2019.

Firm	Hybrid	Grain Yield	Seed Moisture	Test Weight	Plant Density	50% Silking Date
		bu/a	%	lb/bu	plants/a (X 1000)	
Dyna-Gro	D52VC63RIB	146	11.8	58.9	27.2	28-Jul
Dyna-Gro	D57VC17	137	12.3	60.5	28.0	30-Jul
Dyna-Gro	D58VC65RIB	134	13.0	59.9	28.0	30-Jul
Integra	6284 VT2PRIB	133	11.7	59.3	27.2	29-Jul
Dyna-Gro	D54VC14	133	12.0	61.2	26.6	29-Jul
Dyna-Gro	D55VC45RIB	132	12.5	61.8	27.6	29-Jul
Channel Seed	214-00 DGVT2RIB	132	11.7	60.7	26.4	29-Jul
Integra	6588 VT2PRIB	126	12.9	61.7	27.6	29-Jul
Channel Seed	211-97R (non Bt)	125	11.8	60.7	27.2	28-Jul
Dyna-Gro	D50VC30RIB	125	10.9	61.4	28.4	28-Jul
Integra	6533 VT2PRIB	125	12.3	61.4	25.6	28-Jul
Dyna-Gro	D52VC15RIB	123	11.1	60.3	26.8	27-Jul
Dyna-Gro	D52VC50RIB	122	11.2	59.8	27.6	29-Jul
Dyna-Gro	D54DC94RIB	114	12.1	59.0	26.0	29-Jul
Average		129	12.0	60.5	27.2	28-Jul
LSD 0.20		11.2				

Planted: May 6; Harvested: November 4 and 12, 2019.

Grain Yield adjusted to 15.5% moisture content.

This corn trial received a total of 14.0 acre-in./acre of irrigation.

Corn Borer Resistant and Nonresistant Hybrid Comparisons, Walsh, 2019
Kevin Larson, Brett Pettinger and Perry Jones

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

Results: Only 3% of the plants 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 lower than expected due to hot and dry conditions during grain filling. The corn hybrids averaged 129 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. Unlike corn studies in the recent past, the lack of second-generation corn borer damage was not due to the aerial application of insecticides to control grasshoppers or other insects, which also controlled the corn borer. Since we did not apply insecticides, the absence of second-generation corn borer is due to negligible corn borer numbers. 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 13 hybrids Bt hybrids tested showed excellent resistance to first-generation corn borer. As in previous years, we attribute the low level of corn borer damage 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, 2019.

Firm	Hybrid	Grain Yield	Test Wt.	1st Gen. Shot	2nd Gen. Plants	Non Corn Borer Plant	50% Silking Date
				Holes	Lodged	Lodging	
		bu/a	lb/bu	-----plants/a-----			
Dyna-Gro	D52VC63RIB	146	59	0	0	0	28-Jul
Dyna-Gro	D57VC17	137	61	0	0	0	30-Jul
Dyna-Gro	D58VC65RIB	134	60	0	0	0	30-Jul
Integra	6284 VT2PRIB	133	59	0	0	0	29-Jul
Dyna-Gro	D54VC14	133	61	0	0	0	29-Jul
Dyna-Gro	D55VC45RIB	132	62	0	0	0	29-Jul
Channel Seed	214-00 DGVT2RIB	132	61	0	0	0	29-Jul
Integra	6588 VT2PRIB	126	62	0	0	0	29-Jul
Channel Seed	211-97R (non Bt)	125	61	3	0	0	28-Jul
Dyna-Gro	D50VC30RIB	125	61	0	0	0	28-Jul
Integra	6533 VT2PRIB	125	61	0	0	0	28-Jul
Dyna-Gro	D52VC15RIB	123	60	0	0	0	27-Jul
Dyna-Gro	D52VC50RIB	122	60	0	0	0	29-Jul
Dyna-Gro	D54DC94RIB	114	59	0	0	0	29-Jul
Average		129	60	0	0	0	28-Jul
LSD 0.20		11.2		1.3			

Planted: May 6; Harvested: November 4 and 12, 2019.

Grain Yield adjusted to 15.5% moisture content.

Sprinkler irrigated corn received a total of 14.0 in./acre of applied water.

Dryland Corn Hybrid Study, Plainsman Research Center at Walsh, 2019

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 four Dyna-Gro hybrids tested was 24 bu/a. D44VC36 and D41VC71 produced significantly more yield than D45SS65 and D48VC76.

PLOT: Four rows with 30 in. row spacing, 1200 ft. long. SEEDING DENSITY: 14,000 seeds/a. PLANTED: May 15. HARVESTED: October 4.

PEST CONTROL: Preemergence Herbicides: Flumioxazin 2.5 oz/a, 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: Wheat. 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	3.06	207	1	0	16
June	4.00	607	8	0	46
July	2.85	865	23	7	77
August	1.49	868	26	6	107
September	0.58	750	22	3	137
October	0.22	52	1	0	141
Total	12.20	3349	81	16	141
\1 Growing season from May 15 (planting) to October 4 (harvest).					
\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 60 lb/a, 10-34-0 at 5 gal/a; and seedrow at planting 10-34-0 at 5 gal/a, Zn at 0.33 lb/a.

COMMENTS: Planted in good soil moisture, which resulted in good seed germination and stand establishment. Weed control was good. The growing season precipitation was below average. June to July 2 was wet and July 3 to October 11 was dry. September was particularly hot and dry. All corn hybrids displayed stress symptoms in August and September. Grain yields were poor, but test weights were good (kernels were small with little depth).

Dryland Corn, Plainsman Research Center, Walsh, 2019.

Firm	Hybrid	Grain	Seed	Test	Plant	50%
		Yield	Moisture	Weight	Density	Silking
		bu/a	%	lb/bu	plants/a (X 1000)	Date
Dyna-Gro Seed	D44VC36RIB	31	14.5	60.5	13.8	26-Jul
Dyna-Gro Seed	D41VC71RIB	30	13.3	59.0	14.0	28-Jul
Dyna-Gro Seed	D45SS65RIB	18	14.5	59.9	14.2	27-Jul
Dyna-Gro Seed	D48VC76RIB	15	18.8	57.7	14.0	31-Jul
Average		24	15.3	59.3	14.0	28-Jul
LSD 0.20		8.1				

Planted: May 15; Harvested: October 4, 2019.
Grain Yield adjusted to 15.5% moisture content.

Dryland Corn Hybrid Study, Thunderbird Farms at Towner, 2019

COOPERATORS: Chris Stum, Lane Stum, Linly Stum, Thunderbird Farms; Kevin Larson, Plainsman Research Center.

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

RESULTS: The average yield for the fourteen corn hybrids tested was 97 bu/a. Dyna-Gro D45SS65RIB produced the highest yield of 116 bu/a and Midland Genetics 134PRRIB produced the lowest yield, 84 bu/a, of the 14 hybrids tested.

PLOT: Twelve rows with 30 in. row spacing, 1200 ft. long. **SEEDING DENSITY:** 13,000 seeds/a. **PLANTED:** May 29. **HARVESTED:** October 25.

PEST CONTROL: Preemergence Herbicides: Acetochlor 1.5 lb/a, Atrazine 1.5 lb/a, Mesotrione 3 oz/a, Dicamba 8 oz/a, Glyphosate 32 oz/a; Post Herbicides: Glyphosate 32 oz/a. **CULTIVATION:** None. **INSECTICIDE:** None.

FIELD HISTORY: Previous Crop: Wheat. **FIELD PREPARATION:** Sweep plow.

SOIL: Richfield silt loam.

FERTILIZATION: N at 80 lb/a, Zn at 13 lb/a, S at 4 lb/a (applied dry).

COMMENTS: Planted in good soil moisture, which resulted in good seed germination and stand establishment. Weed control was good. The growing season precipitation was well above average. June, July and August were wet, and September was dry. Most corn hybrids tillered because of the dryland seeding rate (13,000 seeds/a) relative to the wet conditions. Grain yields and test weights were very good.

Summary: Growing Season Precipitation and Temperature \1 Chivington, Kiowa County.					
Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	in		-----no. of days-----		
May	0.00	36	0	0	3
June	3.84	519	9	2	33
July	3.48	711	22	5	64
August	5.54	683	15	0	95
September	0.78	594	17	1	125
October	0.01	57	0	0	131
Total	13.65	2600	63	8	131
\1 Growing season from May 29 (planting) to October 6 (first freeze, 25F).					
\3 GDD: Growing Degree Days for corn.					
\4 DAP: Days After Planting.					

Dryland Corn, Thunderbird Farms, Towner, 2019.

Firm	Hybrid	Grain	Seed	Test	Ear	Plant	50%
		Yield	Moisture	Weight	Drop	Tillering	Silking
		bu/a	%	lb/bu	ears/a	tillers/ plant	Date
Dyna-Gro Seed	D45SS65RIB	116	9.7	57.1	581	1	4-Aug
Master Farmer	MF89	111	10.1	58.1	1162	2	1-Aug
PGS Hybrids	PGS 4393	103	10.3	59.0	2033	1	8-Aug
Midland Genetics	MG115PRRIB	100	11.5	56.3	2323	2	5-Aug
Midland Genetics	228PRRIB	100	10.0	57.9	581	1	4-Aug
Dyna-Gro Seed	D48VC76RIB	99	12.5	58.7	581	0	4-Aug
Midland Genetics	MG345	99	9.8	57.8	0	1	31-Jul
Axis	59M29 VT2PRIB	96	10.4	57.8	871	1	5-Aug
Midland Genetics	MG658PRRIB	96	13.9	59.5	290	0	5-Aug
PGS Hybrids	PGS 4394	91	10.7	59.3	4066	2	1-Aug
Dyna-Gro Seed	D41VC71RIB	87	9.9	58.7	2033	2	3-Aug
Dyna-Gro Seed	D44VC36RIB	86	12.0	57.5	1452	1	4-Aug
Integra	6284 VT2PRIB	85	10.4	58.5	2904	1	29-Jul
Midland Genetics	134PRRIB	84	9.5	55.5	1742	1	30-Jul
Average		97	10.8	58.0	1473	1.1	2-Aug

Planted: May 29 at 13,000 seeds/ac; Harvested: October 25, 2019.

Grain Yield adjusted to 15.5% moisture content.

Ear Drop measured from 2 rows 30 ft. long.

Twin Row and Conventional Row Spacing Comparison for W-S-F Production Brett Pettinger, Perry Jones, and Kevin Larson

To conduct a 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. Several growers recalled experiences where the wheat stands winterkilled on top of the beds, leaving only the furrows with wheat stands to harvest. They furthermore recounted that wheat harvested from only the remaining furrows produced nearly as much as their adjacent crops with solid stands. The results from our row spacing study rang 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. 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. 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

For our row spacing and crop sequencing treatments in Wheat-Sorghum-Fallow (W-S-F) rotation, we tested three row spacing arrangements: 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 the first year that we harvested 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 June 7. We planted wheat, Snowmass, at 50 lb/a on October 5, 2018. We applied 60 lb/a of N to the study site and seedrow applied 10-34-0 at 5 gal/a at planting. To control glyphosate-resistant kochia, we applied flumioxazin 2.5 oz/a in the spring. 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: S-metolachlor 24 oz/a, mesotrione 6.4 oz/a, atrazine 1.0 lb/a, and post emergence: Brox 2EC 24 oz/a and Stare Down 6.4 oz/a. For in-season weed control in the wheat, we applied Express 0.4 oz/a, LoVol 8 oz/a, dicamba 2 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 July 17 and the grain sorghum crop on November 19 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 very good, averaging 57 bu/a. The above average wheat yields were due to wet conditions in the fall, which provided uniform stands, and spring, which supplied abundant moisture for grain-filling. Grain sorghum yields were good, averaging 41 bu/a for all row arrangements. The grain sorghum was planted in good soil moisture and plentiful rains fell from June to July 2. However, from July 3 to October 11 (the first freeze), conditions were dry and hot. September was especially dry and hot. Total seasonal precipitation was 9.14 in. from June 7 (sorghum planting) to the first freeze on October 11. This year, combining both wheat and grain sorghum crop production, the annual row spacing productions of the W-S-F rotation had a 306 lb/a range, 1777 lb/a for Twin W:Twin GS, 1870 lb/a for Twin W:Single GS, and 2083 lb/a for Single W:Single GS. The conventional solid planted wheat produced 14.4 bu/a more than the average of the twin row planted wheat. The Twin W:Single GS treatment did produce 5.2 bu/a more grain sorghum than the Single W:Single GS treatment, but the sorghum yield increase was not enough to compensate for the much higher wheat yield of the conventional row wheat.

The income difference between the conventional row spacing arrangement, Single W:Single GS, and the twin row wheat arrangements, Twin W:Single GS and Twin W:Twin GS, ranged from \$65/a to \$79/a, respectively. 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 916 lb/a between the highest and lowest yielding row arrangement treatments. The 2019 total production for the Single W:Single GS in the W-S-F rotation

was 6248 lb/a. The yields from the crop rotational phases were: wheat, 4002 lb/a; grain sorghum, 2246 lb/a; and, of course, no production for fallow. The annual rotation production was 2083 lb/a, which is one-third the total production because the W-S-F rotation takes three years to complete one rotation cycle.

This year we finished the first complete rotational cycle and the conventional row spacing treatment produced more than the twin row wheat treatments. However, this is a new row spacing arrangement comparison study and we are still establishing the rotational treatments effects, only limited long-term rotational outcomes can be evaluated at present.

Twin Row and Conventional Row Spacing for W-S-F, Crop Production, 2019

Crop	Row Arrangement & Spacing	-----2019 Crop-----			2019	Annual Rotation Production
		Wheat	Grain Sorghum	Fallow	Total Rotation Production	
-----lb/a-----						
1 Wheat:	Twin, 7.5 in.	3210		--	5332	1777
1 Grain Sorghum	Twin, 7.5 in.		2122			
2 Wheat:	Twin, 7.5 in.	3072		--	5609	1870
2 Grain Sorghum	Single, 30 in.		2537			
3 Wheat:	Single, 10 in.	4002		--	6248	2083
3 Grain Sorghum	Single, 30 in.		2246			
Average		3428	2302	--	5730	1910
LSD 0.20		110.9	220.3			

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

This is the first year that crops are planted in the correct row arrangements.

Wheat planted October 5, 2018.

Grain sorghum planted June 7, 2019.

Twin Row and Conventional Row Spacing in W-S-F Rotation, Income Comparison, Walsh, 2019.

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.	57.5	53.5	267.50	
Grain Sorghum	Twin Row 7.5 in.	58.0	36.0	<u>191.40</u>	
Treatment Total				458.90	-65.01
Wheat	Twin Row 7.5 in.	57.4	51.2	256.00	
Grain Sorghum	Single Row 30 in.	57.2	45.3	<u>188.76</u>	
Treatment Total				444.76	-79.15
Wheat	Single Row 10 in.	57.4	66.7	333.50	
Grain Sorghum	Single Row 30 in.	57.7	40.1	<u>190.41</u>	
Treatment Total				523.91	--
Average Wheat		57.4	57.1	285.667	
Average Grain Sorghum		57.6	40.5	190.19	
Wheat LSD 0.20			1.85		
Grain Sorghum LSD 0.20			3.93		

Wheat planted: October 5, 2018; Harvested: July 17, 2019.

Grain Sorghum planted: June 7, 2019; Harvested: November 19, 2019.

Both wheat and grain sorghum planted in correct row arrangement stubble.

Wheat crop price: \$5.00/bu (Snowmass premium).

Grain Sorghum price: \$3.30/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 2019 were: 1) Varsity (flumioxazin) 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 2019 were March 18, 2019, and the sweep plow tillage portion of treatment 4 was performed June 6, 2019. No kochia-controlling rescue treatment was necessary before sorghum planting. The kochia-controlling treatments prior to wheat in 2018 were: 1) Varsity 2.5 oz/a; 2) Scoparia 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 2019 were March 2, 2018 for the herbicide treatments, and May 8, 2018 for the sweep plow treatment. No kochia-controlling rescue treatment was necessary before planting wheat. We planted wheat, Snowmass, at 50 lb seed/a on October 3, 2018. We planted grain sorghum, Pioneer 86P20, at 32,000 seeds/a on June 7, 2019. 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 10, 2019. A post application of Express 0.4 oz/a, Low Vol 8 oz/a and dicamba 1.5 oz/a was applied on March 12, 2019 to all wheat treatments. For fertilization, we surface streamed 60 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 18, 2019 and the wheat plots on July 15, 2019 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

This year we did not have to use kochia-controlling rescue treatments on any of the herbicide or tillage treatments for either the wheat or grain sorghum crops.

The Varsity treatment had the highest wheat yield, but it was not significantly higher than the other kochia-controlling treatments ($P>0.20$). There was plentiful precipitation in both the fall and spring for stand establishment and grain-filling that all kochia-controlling treatments performed well. Grain yields were well above average and ranged from 57 bu/a for the dicamba/tillage treatment to 62 bu/a for the Varsity treatment. The Varsity and dicamba treatments tied for the highest variable net income of \$280/a, because both treatments had similarly high yields and their treatment costs were similarly low.

The dicamba/tillage treatment produced the highest grain sorghum yield, 57 bu/a, and it was significantly higher than all the other treatments. The dicamba/tillage treatment provided the highest variable net income of \$147/a. The dicamba treatment had the lowest variable net income of the four treatments tested. The Varsity, dicamba/atrazine, and dicamba/tillage treatments averaged \$16/a more variable net income than the dicamba alone treatment.

For the overall Wheat-Sorghum-Fallow rotation, less than \$3/a of rotational variable net income separated treatment 1 (Varsity) and treatment 2 (Scoparia for wheat, atrazine/dicamba for sorghum) treatments. The average rotational variable net income of treatments 1 and 2 was \$13/a better than treatment 3 (dicamba alone) and \$25/a better than treatment 4 (dicamba/tillage). Last year, tillage had a distinct advantage for producing more uniform plant stands in wheat, but tillage caused weaker, less uniform plant stands in grain sorghum. This year the opposite was true, tillage had a comparative advantage in grain sorghum and a disadvantage in wheat. Since the Varsity and the Scoparia-atrazine/dicamba treatments produced similarly high rotational variable net incomes that averaged \$13/a to \$25/a more than the dicamba alone and dicamba/tillage treatments, we recommend the Varsity or the Scoparia-atrazine/dicamba treatments to control glyphosate-resistant kochia for Wheat-Sorghum-Fallow rotations.

Herbicide and Single Tillage Control of Kochia in W-S-F Rotation, Wheat Crop, Walsh, 2019.

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 Varsity (Flumioxazin)		2.5 oz/a	3/2/2018	9.6	59.0	61.5	14.21	12.85	280.44
2 Scoparia		2.5 oz/a	3/2/2018	9.5	59.3	61.3	19.20	12.85	274.45
3 Dicamba		16 oz/a	3/2/2018	9.3	57.9	60.9	11.44	12.85	280.21
4 Tillage (sweep plow)			5/8/2018	9.7	59.0	56.8	21.44	12.85	249.71
4 Dicamba		16 oz/a	3/2/2018						
Average				9.5	58.8	60.1	16.57	17.13	271.20
LSD		0.20				5.27			

Planted: October 3, 2018, wheat variety: Snowmass at 50 lb seed/a.

Herbicide treatments applied: March 2, 2018 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.

In-season weed control applied to all treatments March 12, 2019: Express 0.4 oz/a, Low Vol 8 oz/a, Dicamba 1.5 oz/a.

Variable Net Income: gross income (grain yield x \$5.00/bu) minus treatment cost.

Snowmass wheat price plus protein premium: \$5.00/bu.

Herbicide and Single Tillage Control of Kochia in W-S-F Rotation, Grain Sorghum Crop, Walsh, 2019.

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 Varsity (Flumioxazin)		2.5 oz/a	3/18/2019	10.9	56.9	52.9	14.21	18.10	142.26
2 Dicamba		16 oz/a	3/18/2019	10.8	56.7	54.1	14.93	18.10	145.50
2 Atrazine		1 lb/a	"						
3 Dicamba		16 oz/a	3/18/2019	10.8	56.2	47.9	11.44	18.10	128.53
4 Tillage (sweep plow)			6/6/2019	10.7	57.3	56.5	21.44	18.10	146.91
4 Dicamba		16 oz/a	3/18/2019						
Average				10.8	56.8	52.9	15.51	18.10	140.80
LSD 0.20						1.40			

Planted: June 7, 2019, grain sorghum hybrid: Pioneer 86P20 at 32,000 seeds/a.

Herbicide treatments applied: March 18, 2019 to 20 ft. by 1000 ft. with 2 replications, prior to kochia emergence.

In-season weed control applied to all treatments July 10, 2019: 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 \$3.30/bu) minus treatment cost.

Grain sorghum price: \$3.30/bu.

Herbicide and Single Tillage Control of Kochia for W-S-F Rotation, Walsh, 2019.

Treatment	Product Dosage	Dosage Unit	Application Date	Test Weight lb/bu	Grain Yield bu/a	Treatment Cost \$/a	In-Season Treatment Cost \$/a	Variable Net Income \$/a	Rotational Variable Net Income \$/a
1 Varsity (Wheat)		2.5 oz/a	2/21/2017	59.0	61.5	14.21	12.85	280.44	422.70
1 Varsity (Milo)		2.5 oz/a	3/2/2018	56.9	52.9	14.21	18.10	142.26	
2 Scoparia (Wheat)		2.5 oz/a	2/21/2017	59.3	61.3	19.20	12.85	274.45	419.95
2 Dicamba (Milo)		16 oz/a	3/2/2018	56.7	54.1	14.93	18.10	145.50	
2 Atrazine (Milo)		1.0 lb/a	3/2/2018						
3 Dicamba (Wheat)		16 oz/a	2/21/2017	57.9	60.9	11.44	12.85	280.21	408.74
3 Dicamba (Milo)		16 oz/a	3/2/2018	56.2	47.9	11.44	18.10	128.53	
4 Tillage (Wheat)			5/22/2017	59.0	56.8	21.44	12.85	249.71	396.62
4 Dicamba (Wheat)		16 oz/a	2/21/2017						
4 Tillage (Milo)			5/8/2018	57.3	56.5	21.44	18.10	146.91	
4 Dicamba (Milo)		16 oz/a	3/2/2018						
Average				57.8	56.5	16.04	35.23	206.00	412.00
LSD 0.20 (Wheat)					2.71				
LSD 0.20 (Milo)					5.27				

Wheat planted: 10-3-18, Snowmass at 50 lb seed/a. Milo planted: 6-7-18, 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.

In-season weed control for wheat applied March 12, 2019: Express 0.4 oz/a, Low Vol 8 oz/a, dicamba 1.5 oz/a.

In-season weed control for milo applied July 10, 2019: Staredown 6.4 oz/a, Brox 2EC 24 oz/a.

Variable Net Income: gross income (grain yield x \$5.00/bu for wheat; \$3.30/bu for milo) minus treatment cost.

Strip Till and Planter Applied P Comparison for Grain Sorghum Production

Perry Jones and Brett Pettinger

Two common methods and timings for application of liquid phosphate are deep placement with a strip still implement and seedrow placement with a planter. There are advantages for both systems. The advantage for strip till chisel applied P is that the deep placement of P allows roots to intercept P (P has low mobility) season long because roots cannot grow where there is no soil water. The advantage for seedrow planter applied P is that P placement with the seed allows the seedlings direct contact and uptake of P for early plant growth. We conducted this study to determine which P placement method produces the highest yields.

Materials and Methods

We strip tilled anhydrous N at 60 lb N/a at 8 in. deep on December 20, 2018 into standing wheat stubble for all treatments for this dryland grain sorghum P placement and rate study. We compared: 1) Strip Till P, deep P placement with a strip tiller at 5 gal/a of 10-34-0; 2) Planter P, seedrow P placement with a twin row planter at 5 gal/a of 10-34-0; and 3) Strip Till P/Planter P, both strip till P and planter P at 5 gal/a of 10-34-0 for each operation. For strip till P placement, we used a 20 ft. tool bar with 8 rows of Yetter strip till chisel units on 30 in. spacing. For planter P placement, we used a shop-built 20 ft. planter, with 8 sets of Great Plains planter row units on twin 7.5 in. rows centered on 30 in spacing. We planted Pioneer 86P20 on June 1 at 40,000 seeds/a for replication 1 and 48,000 seeds/a for replication 2. For pre-emergence weed control, we applied flumioxazin at 2.5 oz/a, S-metolachlor at 24 oz/a, mesotrione at 6.4 oz/a and atrazine at 1.0 lb/a, and no post emergence herbicides were applied. We harvested the 20 ft. wide by 1200 ft. long grain sorghum plots on September 29, 2019 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% seed moisture content.

Results and Discussion

All P placement methods and rates for this dryland grain sorghum study produced similarly high yields, averaging 72 bu/a. There was a nonsignificant trend of increasing yield from single P application, either strip till P or planter P, to double P application and rate with the combination of strip till P/planter P treatment. There was no yield difference between strip till P placement and planter P placement. Both P placement methods yielded the same 72 bu/a. This was our first year studying P placements by comparing strip till P to planter P. Even though we found no yield difference between strip till P and planter P, we plan to continue this study for a few more years to determine the efficacy of these P placement methods.

Strip Till and Planter Applied P Comparison for Grain Sorghum
Production, Walsh, 2019.

Application Method	10-34-0 Rate	Grain Sorghum Yield	Test Weight	Moisture Content	Plant Population
		bu/ac	lb/bu	%	plants/ac
1 Strip Till P	5 gal/a	71.7	59.5	12.5	35.3
2 Strip Till P	5 gal/a	73.1	59.8	12.9	37.3
2 Planter P	5 gal/a				
3 Planter P	5 gal/a	71.6	59.3	12.9	39.8
Average		72.1	59.5	12.8	37.5
LSD (0.20)		8.09			

Planted: Pioneer 86P20 on June 1 at 40,000 seeds/a for rep. 1 and 48,000 seeds/a for rep. 2 with 8-row, 7.5 in. twin planter.

All plots strip tilled on December 20, 2018 applied 60 lb N/a.

Strip till P: 10-34-0 at 5 gal/a applied with strip tiller on December 20, 2018.

Planter P: 10-34-0 at 5 gal/a applied seedrow with planter on June 1, 2019.

Strip till P/Planter P: 10-34-0 at 5 gal/a with strip tiller and 10-34-0 at 5 gal/a with planter, total applied 10-34-0 for strip till P/planter P was 10 gal/a.

Narrow Row Air Seeder and Conventional Row Vacuum Planter Comparison for Grain Sorghum Production

Perry Jones, Brett Pettinger and Kevin Larson

Currently there are two major planting systems for seeding grain sorghum in our area: air seeder with narrow rows (10 in. spacings) and vacuum planter with conventional rows (30 in. spacings). There are advantages for both systems. The advantages for the air seeder are that it increases planted acres and the narrow rows suppress weeds. The advantages for the vacuum planter are precision placement of seeds and the ability to cultivate between rows and harvest lodged plants. We conducted this study because growers were curious if there might be a yield advantage between the planting systems.

Materials and Methods

We used a wheat stubble site with a thick mat of wheat residue for this dryland grain sorghum planting study. We compared a 36-row, John Deere 1990 CCS air seeder with 10 in. row spacings and an eight-row, John Deere 7300 vacuum planter with 30 in. row spacings. For both treatments, we surface applied liquid 28-0-0 in streams 20 in. apart at 60 lb N/a on April 15, 2019. For phosphate fertilization for the air seeder, we applied 10-34-0 at 5 gal/a with a double disced drill on 10 in. spacing prior to planting. For the vacuum planter, we seedrow applied 10-34-0 at 5 gal/a at planting. We planted Pioneer 86P20 on June 5 at 34,000 seeds/a for the vacuum planter and we planted at least 63,000 seeds/a for the air seeder on June 6. For pre-emergence weed control, we applied flumioxazin at 2.5 oz/a, S-metolachlor at 24 oz/a, mesotrione at 6.4 oz/a and atrazine at 1.0 lb/a, and for post emergence weed control, we applied: 2,4-D amine. We harvested the 60 ft. wide by 1200 ft. long grain sorghum plots on November 18, 2019 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% seed moisture content.

Results and Discussion

The dryland grain sorghum planted with the vacuum planter on 30 in. row spacing produced 9.3 bu/a more than the air seeder with 10 in. row spacing. The 30 in. row vacuum planter also had 0.8 lb/bu higher test weight than the 10 in. row air seeder. There are two plausible reasons that contributed to the vacuum planter yielding 9.3 bu/a more than the air seeder. First, we notice that the stand of the air seeder had some gaps down planted rows; whereas, the vacuum planter had more uniform stands. The reason there were planting gaps in the air seeder treatment was because it required a rather long planting distance to properly distribute the seed, particularly for low seeding rates. Even though these are large field size plots, uniform seed distribution was difficult to achieve, particularly at the beginning of the plots. This was not an issue for the vacuum planter with its seed plates.

The second reason the vacuum planter produced higher yields than the air seeder was because of weeds. The gaps from nonuniform seed distribution allowed

weeds (mostly sandbur) to flourish. Cultivation was not an option for the air seeder with its narrow seed rows.

In 2017 with uniform stands from a higher seeding rate, the air seeder produced significantly more yield than the vacuum planter, and the narrow row air seeder also suppressed weeds. In fact, the air seeder suppressed sandburs so well that last year we used the air seeder to plant grain sorghum seed in some of Plainsman's sandbur infested fields, and it worked well.

Narrow Row Air Seeder and Conventional Row Vacuum Planter Comparison
for Grain Sorghum Production, Walsh, 2019.

Planter Type	Row Spacing Arrangement	Grain Sorghum Yield	Test Weight	Moisture Content	Flowering Date
		bu/ac	lb/bu	%	
Air Seeder	10 in. single disc	46.4	60.5	10.7	3-Aug
Vacuum Planter	30 in. double disc	55.7	61.3	10.8	3-Aug
Average		51.1	60.9	10.8	3-Aug
LSD (0.20)		4.05	1.16		

Planted: vacuum planter on June 5 and air seeder June 6, 2019.

Pioneer 86P20, at 34,000 seeds/acre for vacuum planter and at least 63,000 seeds/acre for air seeder.

Harvested vacuum planted on November 15 and air seeded on November 18.

Planters: John Deere 1990 CCS Air Seeder; John Deere 7300 Vacuum Planter.

Strip Till and No Till Comparison for Dryland Grain Sorghum Production

Kevin Larson, Brett Pettinger and Perry Jones

Grower inquiries on the production of strip till compared to no till for dryland grain sorghum were the impetus for this study. In the Southern High Plains, the predominant planting system for irrigated production of row crops is strip till. For dryland row crop production, no till is a far more common practice than strip till. The main advantage of no till is that it causes the least disruption of residue cover, and thereby, conserves more soil and water than strip till or conventional tillage. However, no-till requires liquid fertilizer, the most expensive nitrogen fertilizer; whereas, strip till allows the use of anhydrous N, the least expensive nitrogen fertilizer. Another benefit of strip till is the deeper placement of phosphate fertilizer, which makes the immobile phosphate fertilizer more available for root interception throughout the season compared to no till, where phosphate fertilizer is applied with the seed at planting.

Materials and Methods

We conducted this dryland grain sorghum study at the Plainsman Research Center on a site in which the previous crop was wheat. For the strip till treatment, we applied anhydrous N at 60 lb N/a and 10-34-0 at 5 gal/a in eight, 30 in. rows to a depth of 8 in. on December 11, 2018. For the no till treatment, we surface applied liquid 28-0-0 in streams 20 in. apart at 60 lb N/a on April 15, 2019 and seedrow applied 10-34-0 at 5 gal/a at planting. We planted Pioneer 86P20 at 34,000 seeds/a on June 5, 2019 with a John Deere vacuum planter with eight, 30 in. rows. For pre-emergence weed control we applied Flumioxazin 2.5 oz/a, S-metolachlor at 24 oz/a, mesotrione 6.4 oz/a and atrazine at 1.0 lb/a, and for post emergence weed control, we applied: 2,4-D amine. We harvested the 60 ft. wide by 1200 ft. long grain sorghum plots on November 15, 2019 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% seed moisture content.

Results and Discussion

The no till treatment produced 4.3 bu/a more than the strip till treatment and this yield difference was significant at the 0.20 alpha level. The cost of 60 lb/a of N fertilizer was \$8.40/a less expensive for strip till using anhydrous N than for no till using liquid N (anhydrous cost was \$496/ton and liquid 28-0-0 cost was \$245/ton); however, custom application cost of strip till was \$8.50/a more than boom application for no till (\$15/a for strip till and \$6.50/a for no till). Since the cost of 10-34-0 at 5 gal/a was the same for both treatments, and no application cost was charged for the phosphate fertilizer because applications were performed either with the anhydrous N during the strip till operation, or with the seed at planting for no till, this equated to no difference in total variable cost between the no till and strip till treatments. The variable net income of no till was \$14.29/a more than strip till, due entirely to the higher grain yield of no till (4.3 bu/a @ \$3.30/bu). The production cost of dryland grain sorghum using typical N fertilizer rates is the same or nearly equivalent for strip till and no till for the four years of this study. This year, the yield advantage of no till compared to strip till under our dryland conditions made no till dryland grain sorghum production more profitable than

strip till. For three of the four harvest years that we have conducted this dryland study, no till has produced higher grain sorghum yields and net incomes than strip till. Only in 2017 did strip till produce higher yields and variable net incomes than no till. This year, the reason no till produced significantly higher yields than strip till is because of plant stands. The plant stands were more uniform with no till than strip till.

No Till and Strip Till Comparison on Dryland Grain Sorghum at Walsh, 2019.

Tillage Treatment	Grain Yield	Test Wt.	Flowering Date	N Fertilizer	N Fertilizer Cost	Application Cost	Total Variable Treatment Cost	Variable Net Income
	bu/ac	lb/bu		type	\$/60 lb N	\$/ac	\$/ac	\$/ac
No Till	55.7	61.3	3-Aug	Liquid (28-0-0)	26.40	6.50	32.90	150.91
Strip Till	51.4	59.0	5-Aug	Anhydrous (82-0-0)	18.00	15.00	33.00	136.62
Average	53.6	60.2	4-Aug		22.20	10.75	32.95	143.77
LSD (0.20)	4.05	1.16						

Strip till: anhydrous N applied December 11, 2018 on 30 in. row spacing at a depth of 8 in.

No till: surface applied liquid 28-0-0 on April 15, 2019 in streams 20 in. apart.

Liquid 10-34-0 at 5 gal/ac was applied with the anhydrous N for the strip till treatment and with the seed at planting for the no till treatment.

Anhydrous cost: \$496/ton; 28-0-0 cost \$245/ton.

Grain sorghum price: \$3.30/bu.

Planted Pioneer 86P20 at 34,000 seeds/ac on June 6 and harvested on November 15, 2019.

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 warm 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 third 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 third 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 11; grain sorghum, Pioneer 86P20, at 34,000 seeds/a on June 7; and corn, Channel 214-00, at 14,000 seeds/a on May 16, 2018. We planted wheat, Snowmass, at 50 lb/a on October 3, 2018. We applied 60 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: millet Stare Down 6.4 oz/a, Low Vol 8 oz/a; grain sorghum, atrazine 1.0 lb/a, mesotrione 6.4 oz/a, Medal 24 oz/a; corn, atrazine 1.0 lb/a, mesotrione 6.4 oz/a, Metal 24 oz/a, glyphosate 32 oz/a; wheat, Express 0.4 oz/a, dicamba 1.5 oz/a, Low Vol 8 oz/a. For fallow, we applied

glyphosate 32 oz/a, dicamba 6 oz/a, Low Vol 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, July 16; millet, September 6; grain sorghum, November 19; and corn, October 3. We sampled the grain for test weights and moistures and used moisture-adjusted grain yields for comparisons: wheat, 12%; millet, 14%; 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 slightly higher total rotation production (377 lb/a more) than the W-C-M-F rotation because of low yields of the corn and millet compared to the grain sorghum. 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 \$39/a. The higher income of the W-S-F rotation, \$137/a, compared to the W-C-M-F rotation, \$98/a, was due to primarily to the expensive and low yield of the corn crop. 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 2019 total production for the W-S-F rotation was 6864 lb/a. The crop rotational phases were: wheat, 3588 lb/a; grain sorghum, 3276 lb/a; and, of course, no production for fallow. The annual rotation production was 2288 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 third cropping year for this rotation study, no long-term rotational effects can be fully evaluated.

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WCMF and WSF Rotation Comparison Study, Walsh, 2019.

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	12.86	60.4	5.00/bu	301.75	280.56
W-C-M-F				60.9	5.00	304.50	283.31
W-S-F				59.8	5.00	299.00	277.81
<u>Corn</u>	14,000 seeds	52.50	33.38	36.7 bu	3.85/bu	141.30	55.42
W-C-M-F				36.7	3.85	141.30	55.42
<u>Millet</u>	12 lb	2.40	12.75	13.9 bu	6.72/bu	93.41	78.26
W-C-M-F				13.9	6.72	93.41	78.26
<u>Grain Sorghum</u>	34,000 seeds	9.80	23.70	58.5 bu	3.30/bu	193.05	159.55
W-S-F				58.5	3.30	193.05	159.55
Fallow	---	---	26.42	---	---	-26.42	-26.42
Average			21.82			140.62	109.47

Planted: Grain Sorghum, Pioneer 86P20 at 34,000 seeds/a on June 7; Millet, Huntsman at 12 lb/a on June 11; and Corn, Channel 214-00 at 14,000 seeds/a on May 16; Wheat, Snowmass at 50 lb/a on October 3, 2018.

Harvested: Wheat, July 16; Grain Sorghum, November 19; Corn, October 3, Millet, September 6.

Weed control cost is herbicide cost and \$6.50/a application cost for each application.

Dryland WCMF and WSF Rotation Comparison Study, Crop Production, 2019.

Crop Production							
	-----2019 Crop-----					2019 Total Rotation Production	Annual Rotation Production
Rotation	Wheat	Grain Sorghum	Millet	Corn	Fallow		
	-----lb/a-----						
W-S-F	3588	3276			0	6864	2288
W-C-M-F	3654		778	2055	0	6487	1622
Average	3621	3276	778	2055	0	6676	1955

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

This is the third cropping year of this new rotational study.

Dryland WCMF and WSF Rotation Comparison Study, Variable Net Income, 2019.

Rotation	-----2019 Crop-----					2019	Annual
	Grain					Total	Rotation
	Wheat	Sorghum	Millet	Corn	Fallow	Crop	Variable
	-----\$/a-----					Net Income	Net Income
W-S-F	277.81	159.55			-26.42	410.94	136.98
W-C-M-F	283.31		78.26	55.42	-26.42	390.57	97.64
Average	280.56	159.55	78.26	55.42	-26.42	400.76	117.31

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.

Dryland Crop Rotation Study

Kevin Larson, Brett Pettinger and Perry Jones

This is the 15th 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 thirteenth 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 3, 2018; proso millet, Huntsman, at 12 lb/a on June 11; grain sorghum, Pioneer 86P20, at 34,000 seeds/a on June 7; and corn, Channel 214-00, at 14,000 seeds/a on May 16, 2018. We applied 60 lb/a of N to the study site. Before planting we sprayed two applications of glyphosate at 32 oz/a, Low Vol 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, Low Vol 8 oz/a, dicamba 2 oz/a, Penetrant II 8 oz/a; millet, (failed) Glyphosate 32 oz/a as a cleanup; grain sorghum, atrazine 1.0 lb/a, mesotrione 6.4 oz/a, Metal 24 oz/a; corn, atrazine 1.0 lb/a, mesotrione 6.4 oz/a, Medal 24 oz/a; glyphosate 32 oz/a. For fallow, we applied glyphosate 32 oz/a, dicamba 6 oz/a, Low Vol 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 19; corn, October 3, and wheat, July 17. The millet crop was not harvest because of poor stands and infestations of sandbur. We recorded cost of production and yields to determine rotation revenues.

Results and Discussion

This year with both wheat and grain sorghum crops harvested, the W-S-F rotation produced the highest total rotation production of 6998 lb/a. The W-S-F rotation made 393 lb/a more total rotation production than the W-C-F rotation, the second highest rotation. Wheat yields were high, averaging 3800 lb/a (63 bu/a); therefore, those rotations that included wheat had high rotation production. Even with a relatively high grain sorghum yield of 2806 (50 bu/a), the S-M rotation produced the least rotation production because the millet crop failed. 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 2019 total production for the W-S-F rotation was 6998 lb/a. The crop rotational phases were: wheat, 3996 lb/a; grain sorghum, 3002 lb/a; and, of course, no production for fallow. The annual rotation production was 2333 lb/a, which is one-third the total production because the W-S-F rotation takes three years to complete one rotation cycle. Not only did the W-S-F rotation produced higher annual rotation production than the W-C-F rotation, but the W-S-F rotation also generated \$16/a more annual rotation variable net income than the W-C-F rotation. The higher income of the W-S-F rotation compared to the W-C-F rotation was due to the higher yield and less production cost of grain sorghum compared to corn. The S-M rotation produced the least income because the millet crop failed.

Even though the S-M had the lowest income this year, the long-term annual rotational income, after the last seven harvest years, favors the S-M rotation with \$74.10/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 \$72.20/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 three of the last seven years: one year 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 with no millet crop, and above average wheat crops, rotations containing wheat, 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.

Dryland Crop Rotation Study, Crop Production, 2019.

Crop Production						2019 Total Rotation Production	Annual Rotation Production
-----2019 Crop-----							
Rotation	Wheat	Grain Sorghum	Millet	Corn	Fallow		
-----lb/a-----							
S-M	0	2806	0			2806	1403
W-S-F	3996	3002			0	6998	2333
M/W-F	3246		0		0	3246	1623
W-C-F	4158			2447	0	6605	2202
Average	3800	2904	0	2447	0	4914	1890
LSD 0.20	172.2	336.0	--				

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

The millet had poor stands and sandbur infestations and was sprayed out.

Dryland Crop Rotation Study, Variable Net Income, 2019.

	-----2019 Crop-----					2019	Annual
						Total	Rotation
	Grain					Crop	Variable
Rotation	Wheat	Sorghum	Millet	Corn	Fallow	Net Income	Net Income
	-----\$/a-----						
S-M		131.83	-15.15			116.68	58.34
W-S-F	311.81	143.38			-26.42	428.77	142.92
M/W-F	249.31		-15.15		-26.42	207.74	103.87
W-C-F	325.31			82.37	-26.42	381.26	127.09
Average	295.48	137.61	-15.15	82.37	-26.42	283.61	108.06

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 of poor stands and weeds.

Dryland Crop Rotation Study, Walsh, 2019.

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	12.86	63.3 bu	5.00/bu	316.67	295.48
M/W-F				54.1	5.00	270.50	249.31
W-C-F				69.3	5.00	346.50	325.31
W-S-F				66.6	5.00	333.00	311.81
<u>Millet</u>	12 lb	2.40	12.75	0.0 bu	6.72/bu	0.00	-15.15
S-M				0.0	6.72	0.00	-15.15
M/W-F				0.0	6.72	0.00	-15.15
<u>Grain Sorghum</u>	34,000 seeds	9.80	23.70	51.9 bu	3.30/bu	171.11	137.61
S-M				50.1	3.30	165.33	131.83
W-S-F				53.6	3.30	176.88	143.38
<u>Corn</u>	14,000 seeds	52.50	33.38	43.7 bu	3.85/bu	168.25	82.37
W-C-F				43.7	3.85	168.25	82.37
Fallow	---	---	26.42	---	---	-26.42	-26.42
Average			21.82			125.92	94.78

Planted: Grain Sorghum, Pioneer 86P20 at 34,000 seeds/a on June 7; Millet, Huntsman at 12 lb/a on June 11; and Corn, Channel 214-00 at 14,000 seeds/a on May 16; Wheat, Snowmass at 50 lb/a on October 3, 2018.

Harvested: Wheat, July 17; Grain Sorghum, November 19; Corn, October 3.

Millet had a poor stand and was infested with sandburs and was not harvested.

Weed control cost is herbicide cost and \$6.50/a application cost for each application.

Dryland Crop Rotation Study, Annual Rotation Income, 2013 to 2019.

Rotation	Annual Rotation Variable Net Income							Total Crop Net Income	Average Annual Rotation Variable Net Income
	2013	2014	2015	2016	2017	2018	2019		
	-----\$/a-----								
S-M	27.79	105.98	117.98	50.52	93.93	64.19	58.34	518.72	74.10
W-S-F	56.60	56.59	18.81	89.46	91.11	49.89	142.92	505.37	72.20
M/W-F	41.67	-21.87	-2.02	53.43	30.61	19.24	103.87	224.93	32.13
W-Sun-F	8.17	-32.93	--	--	--	--	--	-24.76	-12.38
W-C-F			18.09	81.16	44.73	54.33	127.09	325.40	65.08
Average	33.55	26.94	38.21	68.64	65.09	46.91	108.06	387.41	57.78

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, 2017, 2018, 2019 millet crops were not harvested because of poor stands.

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 thirteenth 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 twelfth 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 3, 2018 and Proso millet, Huntsman, at 12 lb/a on June 11, 2019. We applied 60 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 Low Vol 0.5 lb/a and applied paraquat 32 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, Low Vol 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 8 oz/a; and fallow, glyphosate 32 oz/a, dicamba 6 oz/a and Low Vol 0.5 lb/a two times. The millet for the W/M-F rotation was not planted because it was too dry after wheat harvest for the millet to germinate. The millet in the M-M rotation was sprayed out because the millet stand was poor and heavily infested with sandburs. In the rotations that the millet failed, we applied glyphosate 32 oz/a as a cleanup. We harvested the wheat on July 15 and the millet on August 28 with a self-propelled combine equipped with a digital scale. Grain yields were adjusted to 12% moisture content for wheat and 14% for millet. 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. In 2019, the millet in the W/M-F rotation was not planted because it was too dry and the millet in the M-M rotation was terminated because of poor stand and sandburs.

Results and Discussion

The millet crop was poor because stands were nonuniform. The millet in the M-M rotation was sprayed out due to poor stand and a heavy infestation of sandburs. No millet was planted in the W/M-F rotation because after wheat harvest it was too dry for seed germination. Wheat yields were quite good, averaging 57 bu/a. There was good

planting moisture and abundant fall and spring rains produced uniform stands and good grain-filling conditions. This year because of the high wheat yields, rotations with wheat produced highly positive annual rotation variable net incomes. The W/M-F rotation had the highest wheat yield of 60 bu/a and the W-W rotation had the lowest wheat yield of 51 bu/a, but the W-W rotation made \$99/a more annual rotation variable net income than the W/M-F rotation. The higher annual rotation variable net income of the W-W rotation compared to the W/M-F rotation is because the W-W rotation has income from a wheat crop each year without a summer fallow period, whereas the W/M-F rotation income is spread over two years and it has a costly fallow period. The M-M rotation had the lowest income of -\$12/a because the millet crop failed, and the M-M rotation is solely reliant on millet income.

For the thirteen 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 above average, but the millet crop was poor due to spotty stands. Over the past seven harvest years, the continuous wheat (W-W) rotation provided the highest average annual rotational variable net return of \$52/a. For the past seven harvest years, and acknowledging crop failures and missed plantings, W-W produced \$23/a more than W/M-F, the second highest rotation. Aside from the continuous wheat rotation, the remaining rotations containing wheat, W/M-F, W-M-F, M/W-F, W-F, were only separated by \$7/a.

This year, the wheat crop was very good because there was abundant precipitation during the fall and spring for uniform stands and grain filling. Millet yields were poor because of nonuniform stands. Because of a poor stand and heavy infestation of sandburs, the M-M rotation was sprayed out. No millet was planted in the W/M-F rotation due to dry conditions after wheat harvest. In 2018, 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 enough 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 one of the 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.

Dryland Millet-Wheat Rotation, Crop Production, 2019.

Rotation	-----2019 Crop-----			2019 Total Rotation Production	Annual Rotation Production
	Wheat	Millet	Fallow		
	-----lb/a-----				
W-W	3072			3072	3072
M/W-F	3552	392		3944	1972
W/M-F	3624	0		3624	1812
W-F	3372			3372	1686
W-M-F	3420	599		4019	1340
M-M		0		0	0
Average	3408	248		3005	1647
LSD 0.20	219.6				

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

Millet was not planted in the W/M-F rotation because it was too dry after wheat harvest for millet germination.

Millet in the M-M rotation was sprayed out because the stand was poor and it was heavily infested with sandburs

Dryland Millet-Wheat Rotation, Variable Net Income, 2019.

Rotation	-----2019 Crop-----			2019 Total Crop Net Income	Annual Rotation Variable Net Income
	Wheat	Millet	Fallow	-----\$/a-----	
W-W	234.19			234.19	234.19
M/W-F	264.51	31.89	-26.42	269.98	134.99
W/M-F	280.19	-9.68	-26.42	244.09	122.05
W-F	259.19		-26.42	232.77	116.39
W-M-F	263.19	56.75	-26.42	293.52	97.84
M-M		-12.08		-12.08	-12.08
Average	260.25	16.72	-26.42	210.41	115.56

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 in M-M had poor stand and weeds so was sprayed out.

Millet in W/M-F was too dry to plant after wheat harvest.

Dryland Millet and Wheat Rotation Study, Walsh, 2019.

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
<u>Wheat</u>							
W/M-F	50	8.33	13.48	60.4	5.00	302.00	280.19
M/W-F	50	8.33	23.16	59.2	5.00	296.00	264.51
W-M-F	50	8.33	13.48	57.0	5.00	285.00	263.19
W-F	50	8.33	13.48	56.2	5.00	281.00	259.19
W-W	50	8.33	13.48	51.2	5.00	256.00	234.19
Wheat Average	50	8.33	15.42	56.8	5.00	284.00	260.25
<u>Millet</u>							
W-M-F	12	2.40	12.75	10.7	6.72	71.90	56.75
M/W-F	12	2.40	12.75	7.0	6.72	47.04	31.89
W/M-F	12	0.00	9.68	0.0	0.00	0.00	-9.68
M-M	12	2.40	9.68	0.0	6.72	0.00	-12.08
Millet Average	12	2.40	25.08	4.4	6.72	29.74	16.72
Fallow	---	---	26.42	---	---	0.00	-26.42
Average			13.16			284.00	83.52

Planted: Millet, Huntsman at 12 lb/a on June 11; Wheat, Snowmass at 50 lb/a on October 3, 2018.
Harvested: Wheat on July 15; Millet on August 28. No millet harvested from M-M and W/M-F.
Wheat herbicides: Express 0.4 oz/a, 2,4-D 0.38 lb/a, dicamba 1.5 oz/a, Penetrant II 4 oz/a;
Wheat herbicide cost: \$6.98/a
Millet herbicides: Staredown 6.4 oz/a, 2,4-D ester 8 oz/a; Glyphosae 32 oz/a for failed millet cleanup.
Millet herbicide cost: \$6.25/a
Fallow herbicides: glyphosate 32 oz/a, 2,4-D 0.5 lb/a, dicamba 6 oz/a;
Fallow herbicide cost: \$6.71/a per application (two applications, \$6.50/a per application)
Applied Paraquat 32 oz/a, 5150 surfactant 4 oz/a to control kochia. Kochia control cost: \$9.43/a.
Wheat in M/W-F additional herbicide: glyphosate 32 oz/a cost \$3.18/a.
Weed control cost is herbicide cost and \$6.50/a application cost for each application.

Millet-Wheat Rotation, Annual Rotation Income, 2013 to 2019.

Rotation	Annual Rotation Variable Net Income							Total Crop Variable Net Income	Average Annual Rotational Variable Net Income
	2013	2014	2015	2016	2017	2018	2019		
	-----\$/a-----								
W-W	-26.02	-25.42	12.23	56.06	-16.46	126.11	234.19	360.69	51.53
W/M-F	-23.58	-12.48	-24.78	61.89	54.96	25.14	122.05	203.20	29.03
W-M-F	12.05	-21.12	11.03	34.04	31.50	29.15	97.84	194.50	27.79
M/W-F	-1.95	-24.21	-2.00	26.80	45.74	9.88	134.99	189.25	27.04
W-F	-27.93	-15.78	-13.01	57.92	-20.95	54.84	116.39	151.48	21.64
M-M	-0.56	-23.09	4.21	-12.02	102.90	-28.68	-12.08	30.68	4.38
Average	-11.33	-20.35	-2.05	37.45	32.95	32.95	115.56	188.30	26.90

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, as well as the winter cover crops prior to the wheat in the W-F rotation. Thus far, this year and 2016 were the only years 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 18, 2017 after wheat harvest. The conditions were dry for uniform seedling emergence, so the cover crop stands were spotty. Only the wheat cover crop produced substantial forage. The cover crops were terminated May 2, 2018 with a mix of glyphosate, dicamba, 2,4-D and Stare Down. For the wheat phase of the W-S-F rotation, we planted the spring cover crops in the W-S-F rotation on March 26, 2018 during the fallow period after sorghum harvest. There was no planting moisture and the spring cover crops did not germinate until May with the spring rains. Because of this late cover crops emergence, kochia grew with the spring cover crops and most of the forage weights of the canola and hairy vetch treatments was from kochia. On July

6, 2018, we terminated the spring cover crops and controlled weeds in the N plots with an application of glyphosate, 2,4-D, dicamba and Stare Down (for kochia control). We planted both the W-S-F and the W-F wheat on October 3, 2018 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 September 13, 2018 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 April 19, 2019. We planted Pioneer 86P20 at 34,000 seeds/a on June 7, 2019 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 20, 2019, and the W-F and W-S-F wheat on July 18, 2019 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 2018 through April 2019) for the grain sorghum phase of the W-S-F rotation was 12.43 in. After eight months of growth, the average dry matter production of the cover crops was 2821 lb/a. The cover crops forage yields ranged from 163 lb/a for canola to 4398 lb/a for the wheat cover crop. The wheat cover crop had significantly higher forage yield than canola and hairy vetch cover crops 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): -4.21 in. for wheat, +0.03 in. for canola, -1.28 in. for hairy vetch, and -0.80 in. for Winter N Mix of soil water to a depth of three feet. The fallow ON check (at termination minus at planting) gained +0.04 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: 4.25 in. for wheat, 0.01 in. for canola, 1.32 in. for hairy vetch, and 0.84 in. for Winter N Mix. Canola had the lowest water use of the cover crops tested and the lowest forage yield of the cover crops tested.

The treatment with the highest grain sorghum yield was 25 N with 44 bu/a, which was significantly higher than the wheat cover crop and the ON check. There were no significant differences between all other cover crops and N treatments, except all treatments produced significantly higher yields than the wheat cover crop.

The 25 N treatment produced the highest variable net income, \$126/a, because it had the highest grain yield and the third 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 \$74/a was from the wheat cover crop, which had the lowest yield and the third 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.

Wheat, W-F Rotation

Precipitation from planting to termination of the winter cover crops (eight and a half months, mid-August 2017 through April 2018) for the W-F rotation was 11.04 in. After eight and a half months of growth, the average dry matter production of the cover crops was 349 lb/a. The cover crops forage yields ranged from 77 lb/a for canola to 989 lb/a for hairy vetch. Hairy vetch had significantly higher forage yield than all other cover crops at the 0.20 alpha level.

When terminated after eight and a half months of growth, the cover crops preceding the wheat had these changes in available soil water (at termination minus at planting): -2.11 in. for wheat, -1.08 in. for canola, -2.69 in. for hairy vetch, and -1.40 in. for Winter N Mix of soil water to a depth of three feet. The fallow 0N check (at termination minus at planting) lost -0.91 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: 1.20 in. for wheat, 0.17 in. for canola, 1.78 in. for hairy vetch, and 0.49 in. for Winter N Mix. Canola had the lowest water use of the cover crops tested and the lowest forage yield of the cover crops tested.

The treatment with the highest wheat yield was hairy vetch 74 bu/a, which was significantly higher than any of the other cover crops and N treatments tested. The 0 N treatment had the lowest wheat yield, but it was not significantly lower than any of the other treatment, except the hairy vetch treatment. Wheat grain yields were exceptional, averaging 69 bu/a for all the cover crops and N treatments, because there was abundant fall and spring precipitation. The high yield of the wheat following the hairy vetch cover crop may be attributed to its N-fixing ability, 30 lb N/a, and forage mat growth for this high precipitation year.

The 0 lb N/a treatment produced the highest variable net income, \$332/a, even though it had the lowest grain yield, it had no treatment cost. The lowest variable net income of \$296/a was from the winter N mix treatment, which had average yield, but also the second highest treatment cost. Less than \$6/a separated most of the cover crops: canola, hairy vetch and wheat, and N treatments: 25 N and 50 N.

Wheat Phase, W-S-F Rotation

Precipitation from planting to termination of the spring cover crops (3.5 months, April 2018 through mid-July 2018) for the wheat phase of the W-S-F rotation was 5.73 in. Most of this precipitation for the three and a half-month period was due mainly to the 4.61 inches of rain that occurred in May and June. After three and a half months of growth, the average dry matter production of the cover crops was 1334 lb/a. Most of the forage production for the canola and hairy vetch cover crops was from kochia. The cover crops dry matter yields ranged from 280 lb/a for oats to 2223 lb/a for canola and the forage yield difference between the canola and oats was significant at the 0.20 alpha level.

The cover crop stands were poor and weeds, mostly kochia, predominated the canola and hairy vetch treatments. Since the cover crop stands were thin and weedy, we decided that to forego soil moisture measurements because cover crop failure seemed inevitable. Therefore, no soil moisture measure were taken and no water use analyses perform for these spring cover crops.

The treatments with the highest wheat grain yield were the 25 N and 50 lb N treatments which tied with 68 bu/a. The 25 N and 50 N treatments produced significantly more grain yield than the oats and canola treatments. The canola treatment had the lowest grain yield of 60 bu/a. Besides the two highest yielding treatments, 25 N and 50 N, only 4 bu/a separated the other cover crops and 0 N treatments.

The 25 N treatment had highest variable net income compared to all the cover crops and N treatments. The 25 N treatment produced the highest variable net income, \$322/a, because it was tied for the highest wheat yield and the third lowest treatment cost. The hairy vetch treatment had the lowest variable net income of \$258/a because it had average wheat yield, but the highest treatment cost. Wheat production of the cover crops averaged 64 bu/a, which was much higher than expected considering that soil moisture at planting was marginal. The low planting moisture caused poor cover crop stands and allow kochia to flourish. Fortunately, the 14 month-period from cover crop planting to wheat maturity (April 2018 to May 2019) was wet with 30.13 inches of precipitation. The abundant precipitation overcame the water used by the kochia-infested cover crops and all treatments produced very good wheat yields.

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Cover Crop Study, Grain Sorghum (W-S-F) after Winter Cover Crop, Walsh, 2019.

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	40.7	58.9	163	4.3		16.75		117.56
Hairy Vetch	41.2	58.3	2964	103.4	23.5	69.00	10.34	77.30
Wheat	28.5	58.8	4398	155.5		20.33		73.72
Winter N Mix	40.1	59.2	3759	131.6	51.7	46.25	22.75	108.83
0 N	37.3	58.5				0.00		123.09
25 N	43.5	59.5				17.50		126.05
50 N	39.7	59.6				28.50		102.51
Average	38.7	59.0	2821	98.7		28.33		104.15
LSD 0.20	5.50		1062.3					

Cover crops planted: September 13, 2018.

Cover crops terminated April 19, 2019.

Grain sorghum planted: June 7; Harvested: November 20, 2019.

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: \$3.30/a.

Cover Crop Study, Wheat (W-F) after Winter Cover Crop, Walsh, 2019.

Treatment	Wheat Yield	Test Wt.	Cover		Fixed N	Treatment Cost	Fixed N Income	Variable Net Income
			Dry Matter	Cover N				
	bu/a	lb/bu	lb/a	lb/a	lb/a	\$/a	\$/a	\$/a
Canola	67.6	57.5	77	2.0		16.75		321.25
Hairy Vetch	74.8	57.2	989	34.5	30.1	69.00	13.24	318.24
Wheat	68.5	58.0	191	6.8		20.33		322.17
Winter N Mix	68.4	57.7	137	4.8	0.4	46.25	0.18	295.93
0 N	66.3	57.5				0.00		331.50
25 N	66.8	57.5				17.50		316.50
50 N	69.6	57.8				28.50		319.50
Average	68.9	57.6	349	12.0		28.33		317.87
LSD 0.20	4.73		178.8					

Cover crops planted: August 18, 2017.

Cover crops terminated: May 2, 2018.

Wheat planted: October 3, 2018, Snowmass at 50 lb seed/a, 5 gal/a of 10-34-0.

Wheat harvested: July 18, 2019.

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): \$5.00/bu.

Cover Crop Study, Wheat (W-S-F) after Spring Cover Crop, Walsh, 2019.

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	59.5	58.7	2223	58.0		16.75		280.75
Hairy Vetch	63.7	58.1	1435	52.9	18.6	69.00	8.18	257.68
Oats	61.1	58.6	280	10.6		20.33		285.17
Spring N Mix	63.2	58.8	599	21.7	0.0	46.25	0.00	269.75
0 N	61.7	58.5				0.00		308.50
25 N	67.8	58.5				17.50		321.50
50 N	68.1	58.7				28.50		312.00
Average	63.6	58.6	1134	35.8		28.33		290.76
LSD 0.20	6.62		486.1					

Cover crops planted: March 26, 2018.

Cover crops terminated: July 6, 2018.

Wheat planted: October 3, 2018, Snowmass at 50 lb seed/a, 5 gal/a of 10-34-0.

Wheat harvested: July 18, 2019.

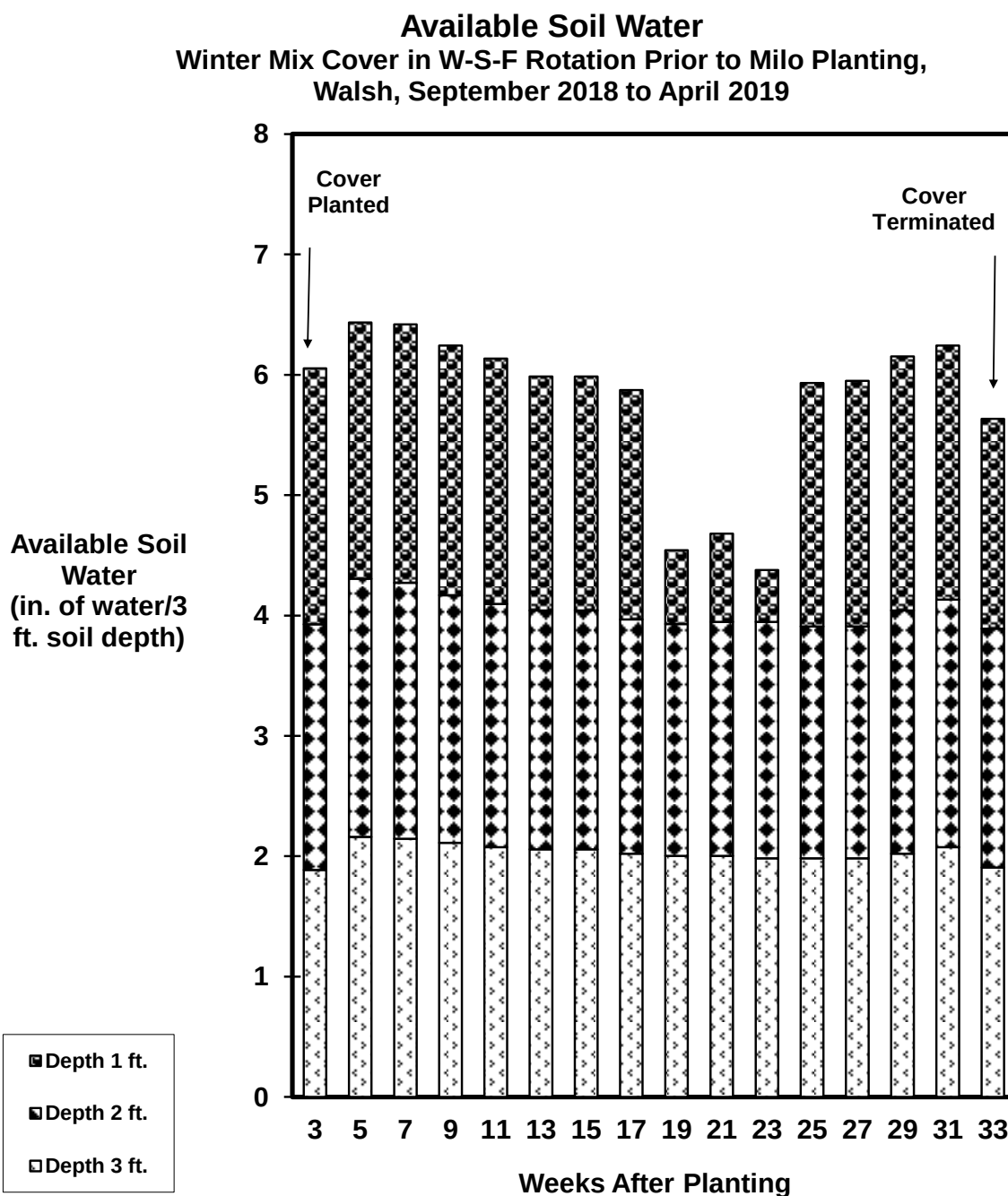
Spring cover crop seeding rate: Spring N Mix, 58 lb/a; hairy vetch, 30 lb/a; canola, 5 lb/a; oats, 60 lb/a. Spring N Mix: lentil, 10 lb/a; common vetch, 10 lb/a; spring forage pea, 15 lb/a; oats, 20 lb/a; canola, 2 lb/a; flax, 5 lb/a.

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.

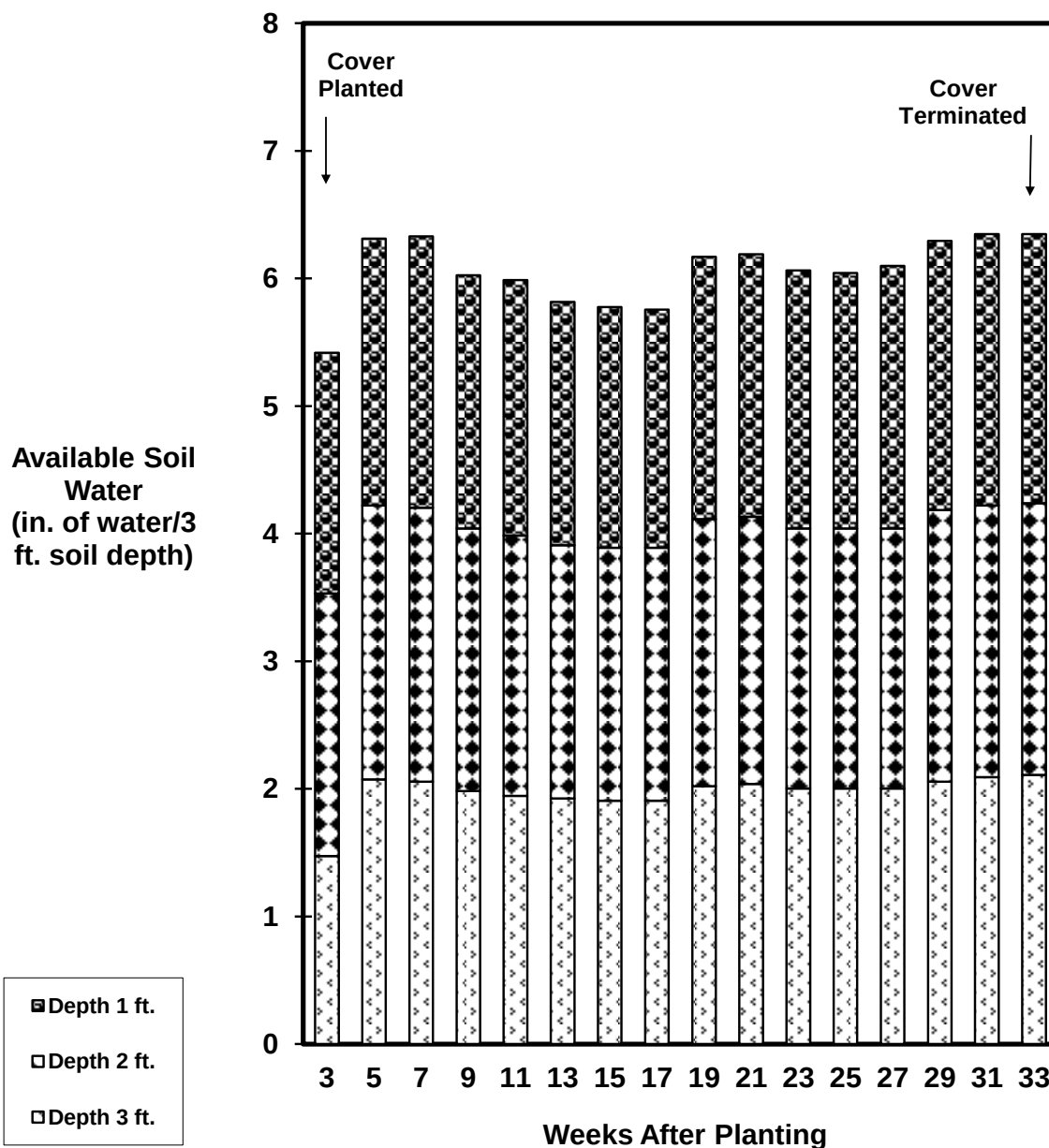
Treatment application cost: cover crop planting, \$12/a; N application, \$6.50/a.

Wheat price (Snowmass with protein premium): \$5.00/bu.



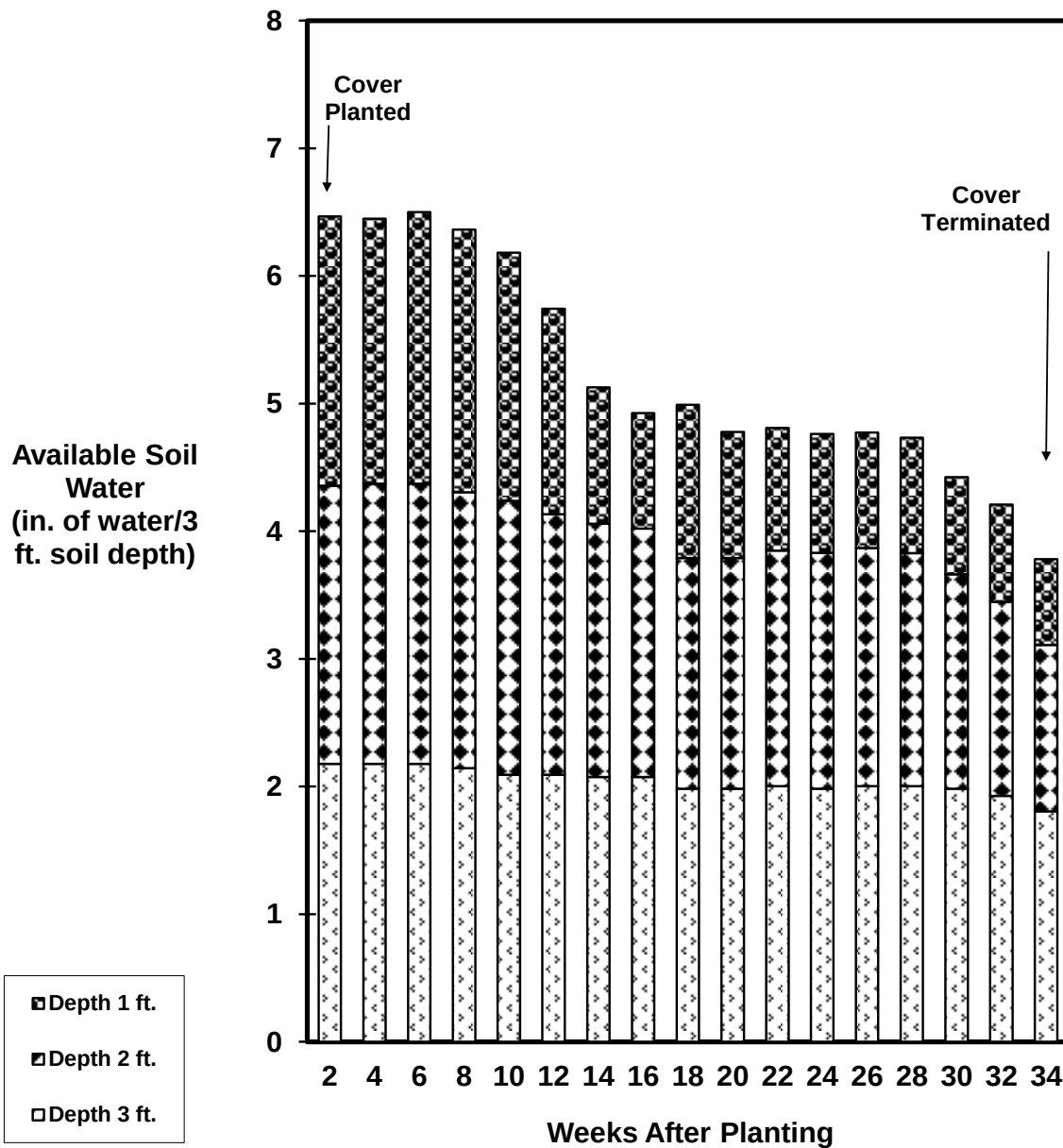
Available soil water of winter mix cover in W-S-F Rotation prior to milo planting at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 12.43 in. Any increase in available soil water between weeks is from rain.

Available Soil Water
0N (No Cover) in W-S-F Rotation Prior to Milo Planting,
Walsh, September 2018 to April 2019



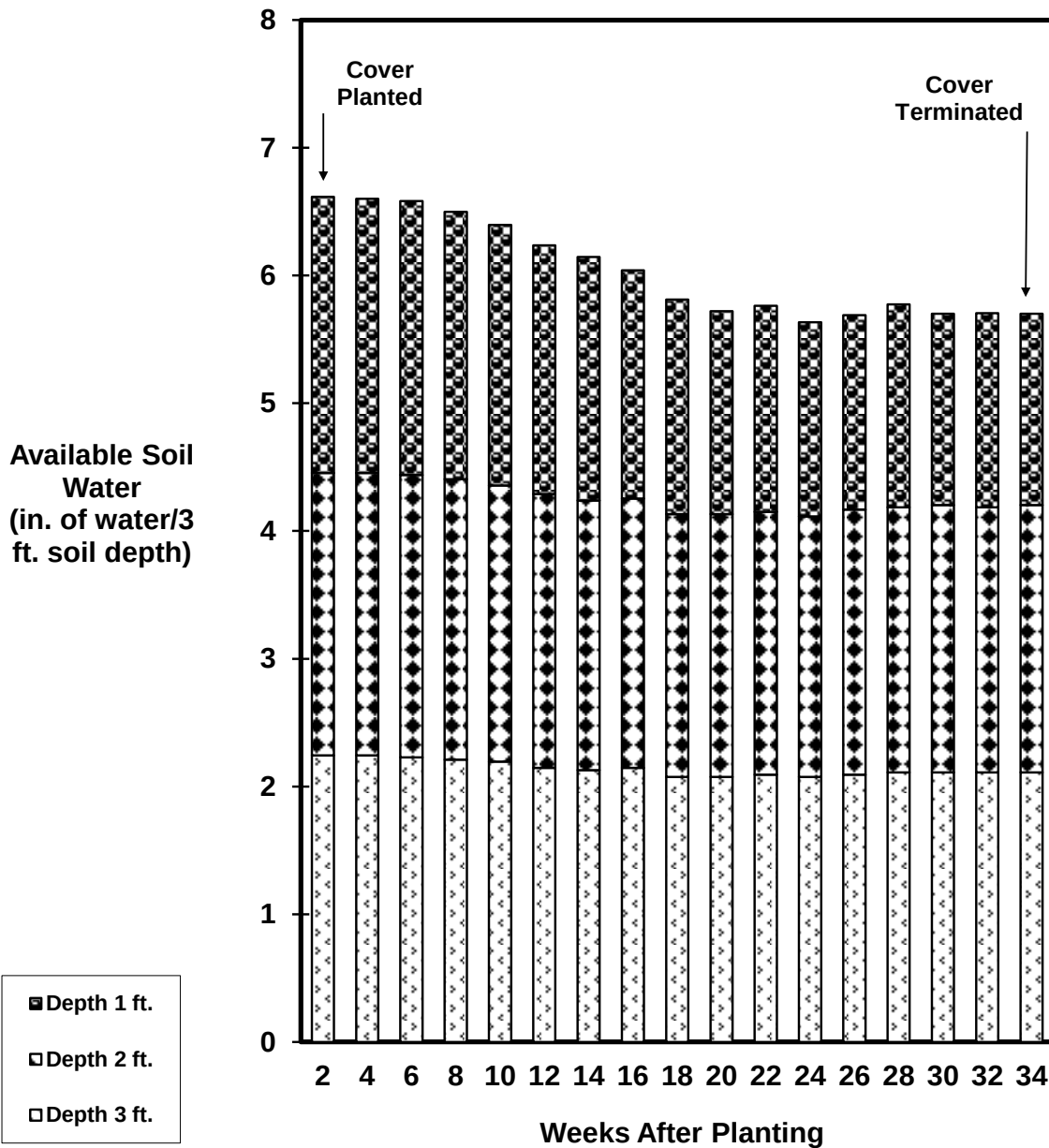
Available soil water of 0N (no cover) in W-S-F Rotation prior to milo planting at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 12.43 in. Any increase in available soil water between weeks is from rain.

Available Soil Water
Hairy Vetch Cover in W-F Rotation Prior to Wheat Planting,
Walsh, September 2017 to April 2018



Available soil water of hairy vetch cover in W-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 11.04 in. Any increase in available soil water between weeks is from rain.

Available Soil Water
0N (No Cover) in W-F Rotation Prior to Wheat Planting,
Walsh, September 2017 to April 2018



Available soil water of 0N (no cover) in W-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 11.04 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 eighth 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 four 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, Low Vol 8 oz/a, dicamba 1.5 oz/a, and Penetrant II 4 oz/a for the wheat. For N fertilization, we streamed 28-0-0 at 60 lb N/a on 20 in. spacing. We planted wheat, Avery at 50 lb/a and seedrow applied 5 gal 10-34-0/a, on September 25, 2018. For the sorghum crop, we planted Pioneer 86P20 at 34,000 seeds/a on June 7, 2019 and seedrow applied 5 gal 10-34-0/a at planting. We harvested the wheat July 13 and the grain sorghum on

November 19, 2019 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 four wheat crops have been harvested, but this is our eighth harvested grain sorghum crop. The first wheat crop, following our initial burn down or tillage to control the perennial grasses, and the 2016, 2018 and 2019 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.

In 2017, 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.

In 2018, 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.

This year, we harvested both the wheat and grain sorghum crops. This is only the fourth time that we have harvested a wheat crop in the seven years of this study. Only 1 to 2 bu/a separated the wheat yields of the chemical and tillage treatments for

both the W-F and W-S-F rotations. However, the chemical treatment produced 5.2 bu/a more grain sorghum than the tillage treatment. The greater grain sorghum yield of the chemical treatment compared to the tillage treatment is surprising because we suspended tillage in March 2015, so both chemical and tillage treatments were treated the same. For the last three years since we stopped tillage, the chemical and tillage treatments produced similar yields. We do not have an explanation for the higher grain sorghum yield of the chemical treatment this year. The grain yields were exceptional for the wheat, averaging 79 bu/a, and very good for the grain sorghum, averaging 61 bu/a. With similar yields and the same treatment costs, the maximum variable net income difference between the wheat treatments was \$9/a. The significantly higher grain sorghum yield of the chemical treatment produced \$17/a more than the tillage treatment.

Total rotational variable net income (rotational income minus CRP conversion cost and treatment maintenance cost) for the last six years of this study (2014 to 2019) produced positive incomes for the W-F rotation, \$86/a for the chemical treatment and \$120/a for the tillage treatment. This is the first time in eight years that the total rotational variable net income was positive for W-F and it was due to the exceptionally high wheat yields this year. 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 2014 to 2019, \$452/a for the chemical treatment and \$417/a for the tillage treatment. For the last six years of this CRP crop conversion study, the average annual rotational variable net income of the chemical treatment for the W-S-F rotation produced an average of \$6/a more than the tillage treatment; whereas, the tillage treatment for the W-F rotation produced an average of \$6/a more than the chemical 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>

Long Term CRP Conversion Using Tillage or Chemical, Eighth Season, Wheat-Sorghum-Fallow and Wheat-Fallow, Wheat Crop, Walsh, 2019.

CRP Conversion	Rotation	Test Weight	Wheat Yield	Gross Income	Treatment Cost	Variable Net Income
		lb/bu	bu/a	\$/a	\$/a	\$/a
Tillage	W-F	55.6	77.7	326.34	69.12	257.22
Chemical	W-F	55.5	75.5	317.10	69.12	247.98
Tillage	W-S-F	55.8	80.7	338.94	69.12	269.82
Chemical	W-S-F	55.5	81.7	343.14	69.12	274.02
Average		55.6	78.9	331.38	69.12	262.26
LSD 0.20			5.09			

Chemical: glyphosate 32 oz/a, dicamba 6 oz/a, 2,4-D 10 oz/a, AMS 2lb/a applied four times.

Chemical cost: \$7.41/a and \$6.50/a for each application.

Post chemical: Express 0.4 oz/a, Low Vol 8 oz/a, dicamba 1.5 oz/a, NIS 4 oz/a.

Post chemical cost: \$6.98/a; application cost: \$6.50 oz/a.

Tillage and no till treated the same.

N fertilizer applied at 60 lb/a as 28-0-0.

Wheat , Avery, 50 lb seeds/a, 5 gal 10-34-0/a.

seedrow applied 5 gal 10-34-0/a at planting.

Wheat planted on September 25, 2018; harvested on July 13, 2019.

wheat price: \$4.20/bu.

Variable Net Income is Gross Income minus Conversion Cost.

Long Term CRP Conversion After Using Tillage or Chemical, Eighth Season
Wheat-Sorghum-Fallow, Grain Sorghum Crop, Walsh, 2019.

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	57.7	58.5	193.05	59.83	133.22
Chemical	W-S-F	57.1	63.7	210.21	59.83	150.38
Average		57.4	61.1	201.63	59.83	141.80
LSD 0.20			3.69			

Fallow chemical: glyphosate 32 oz/a, dicamba 6 oz/a, 2,4-D 10.7 oz/a, AMS
2 lb/a applied three times.

Fallow chemical cost: \$7.41/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 60 lb/a as 28-0-0.

Grain sorghum, Pioneer 86P20, planted at 34,000 seeds/a and
seedrow applied 5 gal 10-34-0/a at planting.

Grain sorghum planted on June 7; harvested on November 19, 2019.

Grain sorghum price: \$3.30/bu.

Variable Net Income is Gross Income minus Treatment Cost.

CRP Conversion, Chemical and Tillage Comparison, Annual Rotational income,
2014 to 2019.

								2014-19	Average
Rotation & Conv. Trt	Conver- sion Cost	Variable Net Income						Total	Rotation
								Rotation	Variable
		2014	2015	2016	2017	2018	2019	Net Income	Net Income
-----\$/a-----									
<u>Chem</u>									
W-S-F	113.10	200.11	47.94	213.66	269.62	200.90	424.40	452.21	75.37
W-F	113.10	-80.80	-57.04	90.90	-66.20	36.13	247.98	85.49	14.25
<u>Tillage</u>									
W-S-F	84.00	149.63	19.63	209.91	266.02	202.41	402.84	416.81	69.47
W-F	84.00	-60.00	-40.52	113.10	-66.20	37.21	257.22	120.41	20.07
Average		52.24	-7.50	156.89	100.81	119.16	333.11	268.73	44.79

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.

Chemical and Tillage treatment have been treated the same since March 2015.

Irrigated Mid and High Oleic Sunflower Hybrid Performance Trial at Walsh, 2019

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

PURPOSE: To identify high yielding hybrids under sprinkler irrigated conditions with 3300 growing degree days in a silt loam soil.

RESULTS: Of the 5 hybrids tested, Croplan CP3732 had the highest seed yield, 1913 lb/a (715 lb/a of oil yield), significantly higher yielding than the four Dyna-Gro varieties.

PLOT: Four rows with 30 in. row spacing, at least 600 ft. long. SEEDING DENSITY: 24,000 seeds/a. PLANTED: May 28. HARVESTED: November 12.

IRRIGATION: Sprinkler irrigated: total water applied, 6.0 in/a.

PEST CONTROL: Preemergence Herbicides: Flumioxazin 2.5 oz/a, Glyphosate 32 oz/a, Spartan 2.0 oz/a. Post Emergence Herbicides: Clethodim 12 oz/a, COC 16 oz/a. CULTIVATION: None. INSECTICIDES: Ravage (Sunflower Head Moth control).

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	0.12	36	0	0	3
June	4.00	607	8	0	33
July	2.85	865	23	7	64
August	1.49	868	26	6	95
September	0.58	750	22	3	125
October	0.22	134	1	0	136
Total	9.26	3260	80	16	136

\1 Growing season from May 28 (planting) to October 11 (first freeze, 14F).

\2 GDD: Growing Degree Days for sorghum.

\3 DAP: Days After Planting.

FIELD HISTORY: Last Crop: Corn. FIELD PREPARATION: Strip-till.

COMMENTS: Planted in good soil moisture. Weed control was very good. The growing season precipitation was below average. June to July 2 was wet and July 3 to October 11 was dry. September was particularly hot and dry. Ravage was applied once at first ray petals to control head moth; however, multiple head moth flights were not controlled and moderate *Rhizopus* head damage was noted. Dectes stem borer caused approximately 40% lodging. Seed yields were only fair because of the Dectes stem borer lodging and *Rhizopus* head damage. Oil percentages were average.

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

Summary: Soil Analysis from Drip Site.

Depth	pH	Salts	OM	N	P	K	Zn	S
		mmhos/cm	%	-----ppm-----				
0-8" 8"-24"	7.7	0.7	2.1	12 10	9.1	549	1.8	15
Comment	Alka	Vlo	Hi	Mod	Med	VHi	Adeq	Adeq
Iron was adequate.								

Summary: Fertilization for Drip Site.

Fertilizer	N	P ₂ O ₅	Zn	S
	-----lb/a-----			
Recommended	40	0	0	0
Applied	150	30	0	0
Yield Goal: 2000 lb/a. Actual Yield: 1346 lb/a.				

Sprinkler Irrigated Sunflower, Mid and High Oleic Variety Trial, PRC, Walsh, 2019.

Firm	Hybrid	Mid or High Oleic	50% Flower	Plant Density	Plant Ht.	Test Wt.	Oil	Seed Yield	Oil Yield
			date	plants/a (X1000)	in	lb/bu	%	lb/a	lb/a
Croplan	CP3732	mid	7/26	21.2	49	30	37.4	1913	715
Dyna-Gro	H49NS14CL	mid	7/30	23.2	45	31	39.8	1433	570
Dyna-Gro	H45NS16CL	mid	7/27	22.8	48	31	40.6	1262	512
Dyna-Gro	H49HO19CL	high	7/31	22.4	47	30	40.4	1135	459
Dyna-Gro	H48HO15CL	high	7/31	23.0	55	30	40.3	987	398
Average			7/29	22.5	49	30	39.7	1346	531
LSD 0.20								215.2	

Planted: May 28, 2019; Harvested: November 12, 2019.

Seed Yield adjusted to 10% seed moisture content.

Total water applied was 6 in./a of sprinkler irrigation.

Dectes stem borer caused approximately 40% lodging.

Sprinkler Irrigated Sunflower, Mustang Max Seedrow Application, Walsh, 2019.

Firm	Hybrid	Mustang Max Applied	50% Flower	Plant Density	Plant Ht.	Test Wt.	Oil	Seed Yield	Oil Yield
		oz/a	date	plants/a (X1000)	in	lb/bu	%	lb/a	lb/a
Croplan	CP3732	4.0 oz	7/26	21.0	49	30	37.4	1913	715
Croplan	CP3732	0 oz	7/26	21.2	48	31	38.0	1807	687
Average			7/26	21.1	49	31	37.7	1860	701
LSD 0.20								290.9	

Planted: May 28, 2019; Harvested: November 12, 2019.

Seedrow applied 2.5 gal/a of 10-34-0 with or without Mustang Max at 4.0 oz/a.

Seed Yield adjusted to 10% seed moisture content.

Total water applied was 6 in./a of sprinkler irrigation.

Dectes stem borer caused approximately 40% lodging.

Dryland Winter Grain Legume Performance Trial at Walsh, 2019

COOPERATOR: Reza Keshavarz Afshar, Fruita Research Center; Kevin Larson, Plainsman Research Center.

PURPOSE: To identify high yielding grain legumes under dryland conditions with 4400 growing degree days (base 40F and max 85F) in silt loam soil.

RESULTS: The seed yield of the winter grain legumes averaged 1810 lb/a and ranged from 449 lb/ac for lentil 'Morton' to 3011 lb/ac for green pea 'Keystone'. The faba bean designated as "small" did not survive the winter and was not harvested for seed. Austrian winter pea 'Coop' had the highest forage yield of 16841 lb/ac and the lowest forage yield was 'Frost Master' winter pea with 7353 lb/ac.

PLOT: Four rows with 12 in. row spacing, 50 ft. long. **PLANTED:** September 12, 2018. **HARVESTED:** July 31, 2019.

PEST CONTROL: Preemergence
Herbicides: Panther 2.5 oz/ac,
glyphosate 32 oz/ac. Post Emergence
Herbicides: Clethodim 12 oz/ac.
Cultivation: None. Insecticides: None.

SOIL: Richfield silt loam.
FERTILIZATION: Preplant: N at 50
lb/ac streamed on 32-0-0.

FIELD HISTORY: Previous Crop:
Soybean. **FIELD PREPARATION:** No-
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-----		
September	0.13	418	6	0	16
October	4.00	396	1	0	47
November	0.78	106	0	0	77
December	0.85	55	0	0	108
January	0.81	147	0	0	139
February	0.92	135	0	0	167
March	2.79	242	0	0	198
April	0.26	451	0	0	228
May	4.82	553	1	0	259
June	4.00	840	9	2	289
July	2.82	1034	25	7	303
Total	22.18	4377	42	9	303

^aGrowing season from September 12, 2018 (planting) to July 31, 2019 (harvest).
^bGDD: Growing Degree Days for winter legumes.
^cDAP: Days After Planting.

COMMENTS: Planted into good soil moisture and good stand establishment. Good in-season weed control. Received abundant rains in October for stand establishment, and again in May and June for flowering and pod-filling. All the winter peas produced at least 1000 lb/ac of seed and 12000 lb/ac of forage, except 'Frost Master' winter pea. The sole lentil entry 'Morton' had low seed and forage yields. Only one faba bean variety was entered in the winter legume trial and it winterkilled.

Dryland Winter Legume Study, Plainsman Research Center, Walsh, 2019.

Variety	Legume Type	Seed Yield	Seed Moisture	Test Weight	100-Seed Weight	Plant Height	Fall Stand	Winter Survival	Vigor	Dry Forage
		lb/ac	%	lb/bu	g	in	0-100	0-100	0-100	lb/ac
Keystone	Green Pea	3011	7.5	58.7	15.7	24	84	99	86	16780
Pro 7146	Yellow Pea	2908	8.0	59.8	16.2	27	83	100	85	15329
Koyote	Yellow Pea	2885	8.0	60.9	14.5	22	94	100	73	12158
Coop Austrian	Winter Pea	2429	8.9	61.9	10.9	38	84	100	97	16841
Pro 7160	Green Pea	2208	8.5	61.2	13.0	30	87	99	74	14173
Windham	Winter Pea	2151	8.1	59.4	12.3	20	71	100	82	14305
Icicle	Winter Pea	1206	7.4	58.1	12.8	26	87	99	88	13865
Specter	Winter Pea	1075	8.6	61.5	13.0	33	87	100	100	15711
Hampton	Winter Pea	1009	7.4	60.5	20.2	23	75	63	31	12797
Frost Master	Winter Pea	584	8.6	60.8	14.2	36	72	99	76	7353
Morton	Lentil	449	--	--	--	16	91	100	83	9102
Small	Faba bean	X	X	X	X	X	65	2	0	X
Average		1810	8.1	60.3	14.3	27	82	88	73	13492
LSD 0.05		701.9					19	1.6	9.7	6973.8

Planted: September 12, 2018; Seed harvested: July 31, 2019.

Seed Yield adjusted to 13.0% moisture content.

Morton Lentil completely lodged at seed harvest.

Faba bean winterkilled and was not harvested.

Dry Forage measured at seed harvest and oven dried.

Dryland Spring Grain Legume Performance Trial at Walsh, 2019

COOPERATOR: Reza Keshavarz Afshar, Fruita Research Center; Kevin Larson, Plainsman Research Center.

PURPOSE: To identify high yielding grain legumes under dryland conditions with 3000 growing degree days (base 40F and max 85F) in silt loam soil.

RESULTS: The seed yield of the spring grain legumes averaged 200 lb/a and ranged from 30 lb/ac for '112-7127' pea to 744 lb/ac for 'Frontier' chickpea. Neither of the faba bean entered in the trial produced seed. Chickpea 'Sierra' had the highest forage yield of 4605 lb/ac and the lowest forage yield was 'Tesoro' faba bean with 840 lb/ac.

PLOT: Four rows with 12 in. row spacing, 50 ft. long. PLANTED: May 13, 2019. HARVESTED: August 23, 2019.

PEST CONTROL: Preemergence Herbicides: Panther 2.5 oz/ac, glyphosate 32 oz/ac. Post Emergence Herbicides: Clethodim 12 oz/ac, COC 16 oz/ac. Cultivation: None. Insecticides: None.

SOIL: Richfield silt loam.
FERTILIZATION: Preplant: N at 50 lb/ac streamed on 32-0-0.

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	3.06	357	1	0	18
June	4.00	840	9	2	48
July	2.85	1034	25	7	79
August	1.45	766	21	3	102
Total	11.36	2997	56	12	102
\1 Growing season from May 13 (planting) to August 23 (harvest).					
\3 GDD: Growing Degree Days for spring legumes.					
\4 DAP: Days After Planting.					

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

COMMENTS: Planted into good soil moisture and good stand establishment. Planting was delayed because trial was larger than expected. To accommodate all the entries, required terminating growing wheat border to which Express had previously been applied. Good in-season weed control. Site received abundant rains in May and June for stand and early development. From July 3 to August 23 (harvest) conditions were hot and dry. A hailstorm on August 14 after pod and seed set caused considerable pod and seed shattering. The seven chickpea varieties in this trial produced higher yields than any of the other species of spring legumes tested, averaging 511 lb/ac of seed. The chickpeas also had higher forage yields than any of the other species of spring legumes tested, except for 'Sunrise' pea. The two faba bean varieties in this spring legume trial failed to make seed and they had the lowest forage yields of any of the spring legumes tested.

Dryland Spring Legume Study, Plainsman Research Center, Walsh, 2019.

Variety	Legume Type	Seed Yield	Seed Moisture	Test Weight	100-Seed Weight	Plant Height	Stand	Vigor	Seed Shatter	Dry Forage
		lb/ac	%	lb/bu	g	in	0-10	0-10	%	lb/ac
Frontier	Chickpea	744	9.9	58.0	34.2	16	9.5	9.7	20	3434
Orion	Chickpea	702	9.5	58.0	39.2	15	9.5	9.6	33	4015
Palmer	Chickpea	582	9.5	59.0	36.8	16	9.6	9.7	33	3446
Sierra	Chickpea	524	9.0	55.0	38.9	18	9.6	9.7	9	4605
Sawyer	Chickpea	401	9.4	58.0	37.3	15	9.5	9.7	18	3415
Leader	Chickpea	345	10.2	59.0	36.3	16	9.5	9.7	40	3141
Dylan	Chickpea	281	8.9	54.5	45.2	14	8.9	9.2	17	3297
Sunrise	Pea	175	--	--	--	17	9.9	9.7	6	3439
Nette	Pea	167	--	--	--	15	9.9	9.4	3	2065
141-6258	Pea	152	--	--	--	14	10.0	9.5	6	2230
Durwood	Pea	137	--	--	--	21	9.6	9.6	5	2366
Banner	Pea	114	--	--	--	15	9.9	9.5	4	2379
143-6230	Pea	106	--	--	--	19	9.9	9.5	10	2767
Amigo	Pea	99	--	--	--	16	9.8	9.6	5	2887
133-6243	Pea	99	--	--	--	17	9.8	9.7	1	1563
Pardina	Lentil	91	--	--	--	13	9.8	9.3	2	2524
Merrit	Lentil	91	--	--	--	15	9.7	9.6	1	2407
Mason	Lentil	91	--	--	--	14	9.7	9.4	21	2336
Maxim	Lentil	84	--	--	--	17	9.9	9.5	9	2369
Brewer	Lentil	84	--	--	--	14	9.8	9.6	2	2310
Crimson	Lentil	84	--	--	--	12	9.7	9.3	3	2289
Morena	Lentil	84	--	--	--	14	9.8	9.5	1	2023
Eagle	Lentil	76	--	--	--	15	9.7	9.3	5	3051
4010	Pea	76	--	--	--	21	9.8	9.7	1	1582
Avondale	Lentil	68	--	--	--	14	9.7	9.5	5	2686
Aragon	Pea	61	--	--	--	14	9.9	9.4	1	1549
Indian Head	Lentil	53	--	--	--	14	9.7	9.4	1	1923
112-7127	Pea	30	--	--	--	13	9.9	9.4	1	2028
Pulse	Faba bean	X	X	X	X	17	9.7	9.0	X	1535
Tesoro	Faba bean	X	X	X	X	15	9.8	9.0	X	840
Average		200	9.5	57.4	38.3	16	9.7	9.5	9	2550
LSD 0.05		163.1					0.30	0.27	3.1	1202.9

Planted: May 13, 2019; Seed harvested: August 23, 2019.

Seed Yield adjusted to 13.0% moisture content.

Seed Shatter was from hailstorm damage.

Faba beans did not set pod and were not harvested.

Dry Forage measured at seed harvest and oven dried.

Dryland Cotton Variety Performance Trial at Walsh, 2019

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

PURPOSE: To identify cotton varieties that produce highest lint yields and income under dryland conditions with 2250 cotton growing degree days in a silt loam soil.

RESULTS: The 7 cotton varieties tested averaged 530 lb/a of lint. The yield ranged from 224 lb/a for Deltapine DP 1612 B2XF to 806 lb/a for Phytogen Phy 320 W3FE. All Deltapine varieties were damaged by 2,4-D sprayer contamination. The Phytogen varieties were 2,4-D tolerant.

PLOT: Four rows with 30 in. row spacing by 50 ft. long. **SEEDING DENSITY:** 35,000 seeds/a. **PLANTED:** May 14, 54°F soil temperature. **HAND-HARVESTED:** November 1.

PEST CONTROL: Preemergence Herbicides: Flumioxazin 2.5 oz/a, Glyphosate 32 oz/a, S-Metolachlor 24 oz/a; Post Herbicides: Clethodim 12 oz/a, Glyphosate 32 oz/a. **INSECTICIDE:** None. **CULTIVATION:** None.

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

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	in	in	-----no. of days-----		
May	3.06	137	1	0	17
June	4.00	388	8	0	47
July	2.85	572	23	7	78
August	1.49	572	26	6	109
September	0.58	488	22	3	139
October	0.22	79	1	0	150
Total	12.20	2236	81	16	150

\1 Growing season from May 14 (planting) to October 14 (first freeze, 11F).

\2 GDD: Growing Degree Days for sorghum.

\3 DAP: Days After Planting.

FIELD HISTORY: Previous Crop: Wheat. **FIELD PREPARATION:** Strip-tilled.

COMMENTS: Planted in good soil moisture. Delayed planting, slow emergence and poor early growth due to cold temperatures in May. Weed control was good. Sandburs were well controlled with clethodim. The growing season precipitation was average. June to July 2 was wet and July 3 to October 11 (first freeze) was dry. September was particularly hot and dry. Lint yields and lint quality were good for the 2,4-D tolerant Phytogen varieties, but poor for 2,4-D damaged Deltapine varieties.

SOIL: Silt loam for 0-8" and silt 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"-24"	7.8	0.6	1.7	10 8	9.1	556	2.4	14
Comment	Alka	VLo	Mod	Mod	Med	VHi	Adeq	Marg
Iron was adequate.								

Summary: Fertilization.				
Fertilizer	N	P ₂ O ₅	Zn	S
	-----lb/a-----			
Recommended	15	0	0	0
Applied	60	20	0	0
Yield Goal: 500 lb/a of lint. Actual Yield: 530 lb/a of lint.				

Dryland Cotton Variety Trial, Walsh, 2019

Firm	Variety	Lint Yield	Turnout	Micro- naire	Length	Staple	Strength	Uniform Length	Color Grade	Leaf Grade	Plant Density	Loan Value	Lint Value
		lb/a	%		in	1/32 in	g/tex	%			plants/a	\$/lb	\$/ac
Phytogen	PHY 320 W3FE	806	43.30	3.88	1.10	35.2	30.0	82.8	22.0	2	20.1	0.5418	436.60
Phytogen	PHY 210 W3FE	748	44.00	3.92	1.11	35.4	29.6	82.8	21.3	2	19.7	0.5488	410.41
Phytogen	PX2C14	683	42.63	3.98	1.05	33.6	29.3	81.7	21.8	1	19.5	0.5204	355.20
Phytogen	PHY 250 W3FE	623	43.46	3.96	1.09	35.0	29.7	81.6	21.8	1	13.0	0.5289	329.52
Deltapine	DP 1909 XF	330	44.18	4.23	1.14	36.6	28.6	82.0	22.0	2	16.3	0.5475	180.45
Deltapine	DP 1908 B3XF	294	42.09	4.06	1.16	37.1	29.1	82.0	21.5	2	15.2	0.5553	163.06
Deltapine	DP 1612 B2XF	224	44.18	3.92	1.14	36.3	29.9	82.7	30.5	1	17.2	0.5004	112.06
Average		530	43.41	3.99	1.11	35.59	29.43	82.21	22.96	1.52	17.3	0.53	283.90
LSD 0.05		116.0	1.607	0.179	0.050	1.71	NS	NS	3.05	NS	4.84	0.0322	70.47

Planted: May 14, 2019 at 35,000 seeds/a, 54F soil temperature; Hand Harvested: November 1, 2019.

All Deltapine varieties tested were damaged by 2,4-D sprayer contamination prior to first square.

All Phytogen varieties tested were 2,4-D tolerant.

2018-2019 National and High Plains Winter Canola Variety Trials
Plainsman Research Center, Walsh
Kevin Larson, Mike Stamm, Brett Pettinger and Perry Jones

We planted the canola trials on September 12, 2018 at the Plainsman Research Center at Walsh. We planted the canola seed at 5 lb/acre in moist soil. Unfortunately, the rains after planting caused some crusting and buried some seed too deep to emerge, which reduced plant stands, most notably in the National Winter Canola Variety Trial for both the hybrids and open-pollinated varieties. The canola trials averaged 54% plant stands for both the hybrids and open-pollinated varieties, in comparison, the High Plains Regional Trial averaged 82% plant stands. The winter was mild, therefore winter survival was high, ranging from 94% to 98%. Spring rains were plentiful for good pod filling. Yields were lower than expected, averaging only 834 lb/a for the hybrids and 1090 lb/a for the open-pollinated varieties, due in part to low stands for the National Winter Canola Trial. The High Plains Winter Canola Variety Trial average seed yield was 1411 lb/a. We harvested the National Winter Canola Variety Trial on July 25, 2019 and the High Plains Winter Canola Variety Trial on July 27, 2019.

National Winter Canola Hybrid Trial at Walsh, Colorado, 2019.

Hybrid (Line)	Stand (0-10)	Winter Survival (0-10)	Flowering Date	Plant Height in.	Seed Shattering %	Seed Yield lb/acre
Architect	6.6	9.5	23-Apr	37	0	1295
MONSD4	5.7	9.6	22-Apr	35	0	1254
Popular	4.8	9.9	22-Apr	36	0	1048
MH 15HT229	6.7	9.6	24-Apr	39	0	916
MONSD3	3.5	9.1	26-Apr	40	0	900
Advocat	6.4	9.8	23-Apr	34	0	858
Phoenix CL	5.9	9.0	23-Apr	37	0	825
MH15HT227	5.0	9.7	25-Apr	34	0	784
MH 14ES125	5.6	9.4	27-Apr	41	0	776
Plurax CL	3.8	9.7	21-Apr	34	7	716
MONSD1	3.6	9.5	23-Apr	34	0	702
MONSD2	5.8	9.4	23-Apr	36	0	685
HAMOUR	4.6	9.1	26-Apr	36	0	553
MH 15AY085	6.2	8.5	24-Apr	36	0	363
Conrad CL	6.9	9.8	X	X	X	X
Mean	5.4	9.4	23-Apr	36	1	834
LSD 0.05	2.39	0.69	1.5			676.5

Planted: September 12, 2018; Harvested: July 25, 2019

National Winter Canola Open Pollenated Trial at Walsh, Colorado, 2019.

Variety (Line)	Stand (0-10)	Winter Survival (0-10)	Flowering Date	Plant Height in.	Seed Shattering %	Seed Yield lb/acre
CP320W	6.0	9.8	23-Apr	39	0	1502
QUARTZ	7.1	9.4	24-Apr	41	7	1469
Wichita	6.0	9.9	24-Apr	41	3	1370
Riley	6.9	10.0	21-Apr	39	0	1353
Surefire	5.3	9.7	24-Apr	40	0	1345
KS4719	6.2	9.7	27-Apr	43	0	1271
Torrington	5.9	9.9	23-Apr	45	0	1263
Star 930W	5.5	9.5	23-Apr	40	8	1106
HyCLASS115W	7.4	9.2	22-Apr	40	12	1023
KS4670	4.3	9.8	22-Apr	39	0	982
KSR4767	4.8	9.5	25-Apr	40	0	916
KSR4723	4.2	9.7	25-Apr	41	0	833
Sumner	3.5	9.6	23-Apr	38	5	702
HyCLASS225W	3.3	9.6	24-Apr	42	5	693
Star 915W	3.9	8.3	25-Apr	36	0	520
Mean	5.4	9.6	23-Apr	40	3	1090
LSD 0.05	2.66	0.55	1.3			618.1

Planted: September 12, 2018; Harvested: July 25, 2019.

Great Plains Canola Variety Trial at Walsh, Colorado, 2019.

Variety (Line)	Stand (0-10)	Winter Survival (0-10)	Flowering Date	Plant Height in.	Seed Shattering %	Seed Yield lb/acre
KS4754	9.0	9.8	23-Apr	43	0	2294
KS4738	9.2	9.9	22-Apr	40	12	1832
KS4737	8.9	9.9	22-Apr	42	7	1782
Wichita	9.1	10.0	24-Apr	43	0	1765
KS4750	8.0	9.1	23-Apr	39	0	1749
KS4739	7.0	9.7	24-Apr	39	0	1667
KS4763	8.1	9.8	23-Apr	43	0	1667
KS4734	8.4	9.8	24-Apr	42	0	1650
KS4687	9.1	10.0	23-Apr	40	3	1642
Riley	8.5	9.8	22-Apr	41	0	1551
KS4685	8.3	9.6	26-Apr	44	0	1535
KS4660	7.5	9.8	25-Apr	42	0	1502
KS4721	8.8	9.9	25-Apr	43	0	1502
KS4718	9.2	9.8	25-Apr	42	0	1477
KS4714	8.8	9.7	23-Apr	43	8	1452
KS4747	8.3	9.9	26-Apr	42	0	1444
KSUR1212	7.8	9.9	24-Apr	41	0	1439
KS4628	8.2	9.9	24-Apr	42	3	1411
KS4722	8.8	9.9	22-Apr	43	3	1394
KS4707	7.9	9.5	23-Apr	40	0	1353
KS4662	7.1	9.5	24-Apr	38	0	1303
KS4748	7.8	9.6	24-Apr	41	0	1303
KS4673	8.1	9.6	24-Apr	41	5	1287
KS4677	9.0	9.8	24-Apr	40	15	1271
KS4751	8.9	10.0	24-Apr	39	13	1271
KS4716	8.6	9.9	24-Apr	40	5	1254
KS4725	6.8	9.8	25-Apr	40	3	1196
KS4713	8.8	10.0	24-Apr	43	3	1180
KS4733	8.6	9.8	23-Apr	43	0	1180
KS4720	7.9	9.6	25-Apr	44	3	1147
Sumner	6.7	9.6	23-Apr	39	3	1147
KS4789	8.6	9.9	24-Apr	39	0	1106
KS4746	8.1	9.5	25-Apr	44	0	1081
KS4749	5.3	9.7	27-Apr	42	7	1048
KS4755	8.1	9.5	23-Apr	40	0	1040
KSP4701	8.8	9.8	24-Apr	39	0	883
Mean	8.2	9.8	23-Apr	41	3	1411
LSD 0.05	2.14	0.48	1.3			756.5

Planted: September 12, 2018; Harvested: July 27 and 31, 2019.