Technical Report TR23-2 January 2023

Colorado State University

Agricultural Experiment Station

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

Plainsman Research Center 2022 Research Reports

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

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in cooperation with the Plainsman Agri-Search Foundation

This Plainsman Research Center booklet is dedicated to:

The Neill Foundation Board:

James Hume, Corwin Brown, Randy Hutches, Pat Cooper, Dawn Rodarmel, and Todd Rose

The grant from the Neill Foundation will provide efficient transport of Plainsman's grain crops from both our research and bulk fields. In addition, this grant will allow us to check our crops, even in inclement weather, without excessively scarring our roads and fields. 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, 2022 Research Reports

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2022 Climatological Summary
Plainsman Research Center

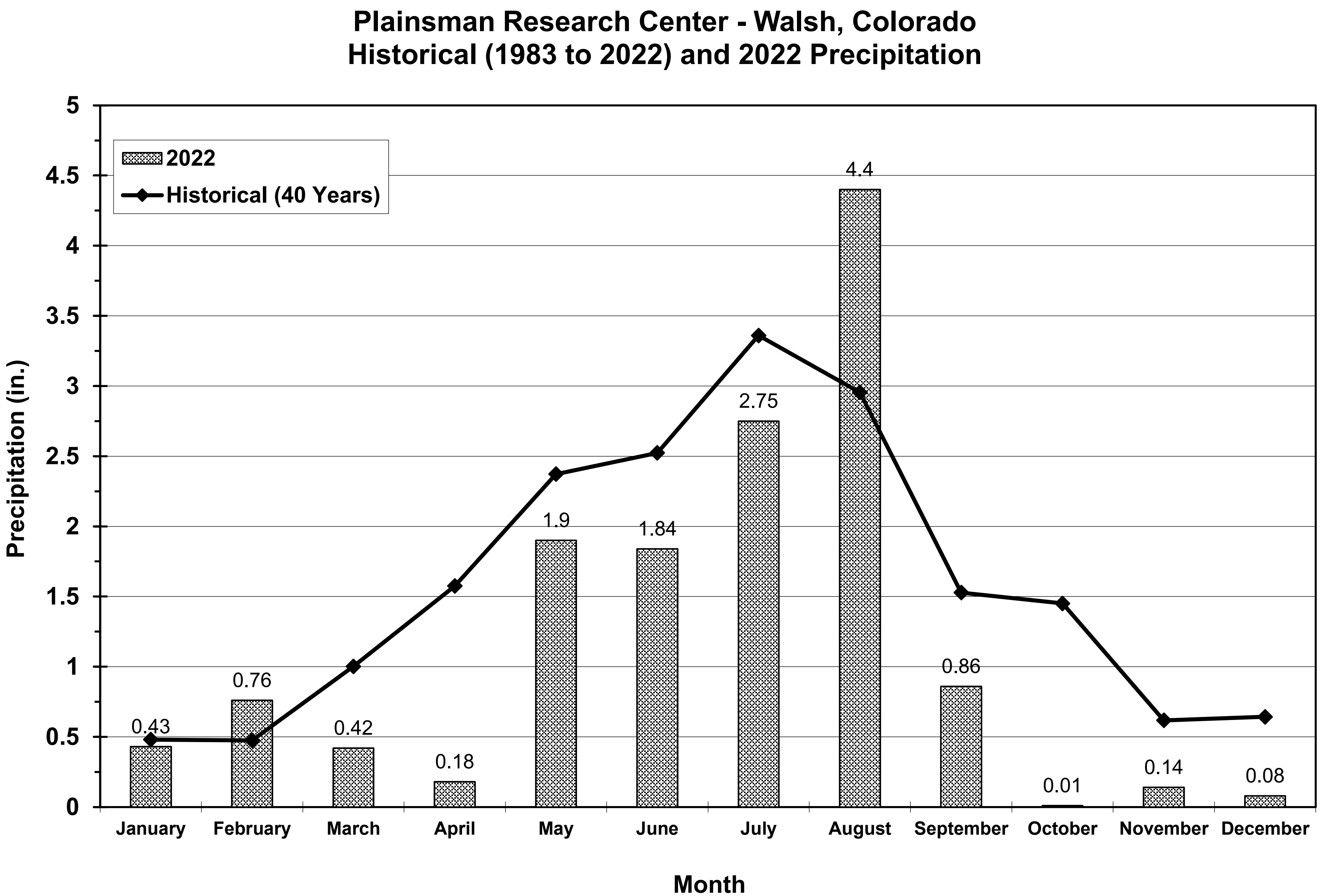
Month	Temperature Max. F	Min. F	Max. Mean F	Min. Mean F	Precip. In.	Greatest Day of Precip-atation	Snow-Fall In.	Greatest Snow Depth In.	Average Soil Temp.	Evapor-ation In.
Jan.	62	-2	46.9	17.1	0.43	0.30	5.50	3.00	34.40	
Feb.	72	-8	46.8	15.7	0.76	0.45	7.90	3.90	33.60	
Mar.	86	9	59.7	26.5	0.42	0.12	6.50	2.00	43.00	
Apr.	90	17	72.6	36.4	0.18	0.15	T	T	54.80	6.98
May	99	32	81.5	47.0	1.90	0.57	0.00	0.00	64.20	13.55
Jun.	107	48	88.9	59.8	1.84	0.53	0.00	0.00	73.10	13.31
Jul.	109	61	97.7	65.7	2.75	0.54	0.00	0.00	81.10	14.72
Aug.	102	54	91.8	61.1	4.40	4.36	0.00	0.00	78.00	11.82
Sept.	98	42	86.4	54.1	0.86	0.70	0.00	0.00	71.90	9.46
Oct.	88	23	72.7	40.5	0.01	0.01	0.00	0.00	61.50	3.91
Nov.	77	8	53.5	25.3	0.14	0.05	2.40	1.00	44.30	
Dec.	72	-8	48.8	18.7	0.08	0.07	1.20	1.00	35.80	
Total			**70.6**	**38.99**	**13.77**		**23.50**			**73.75**

*** 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.

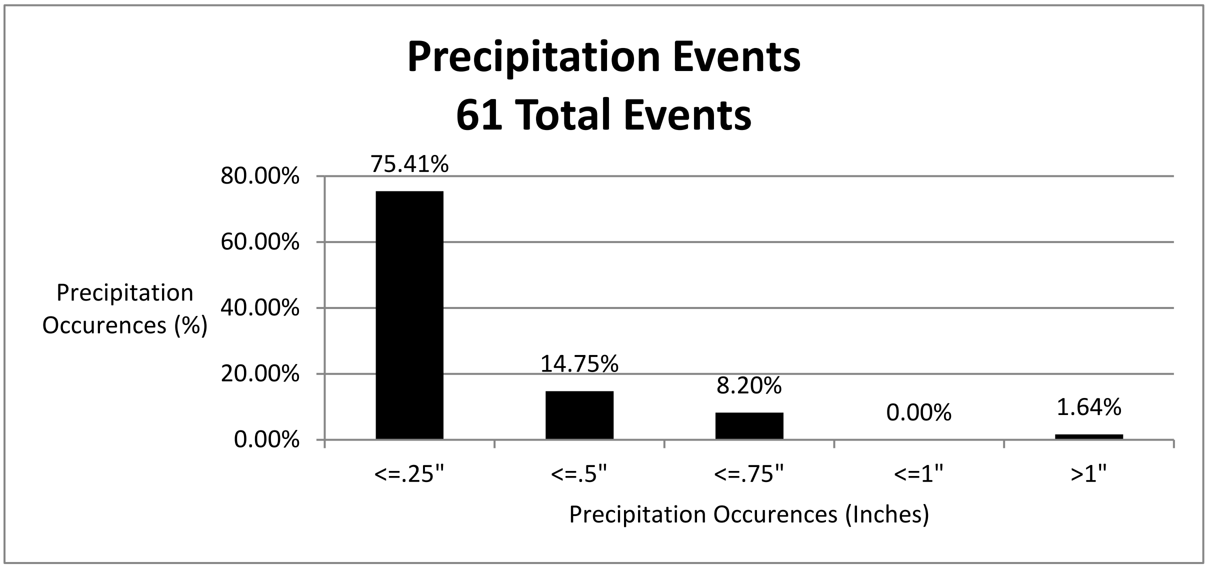
	2022	2021
Highest Temperature:	109 on July 17th	108 on June 24th
Lowest Temperature:	-9 F Feb. 4, Dec. 22, 23	-24 F on Feb. 15th
Last freeze in spring:	32 F on May 1st	32 F on April 24th
First freeze in fall:	30 F on Oct. 17th	32 F on Oct. 15th
Frost free season:	169 frost free days	174 frost free days
Avg. Precip for 40 yrs:	18.98	

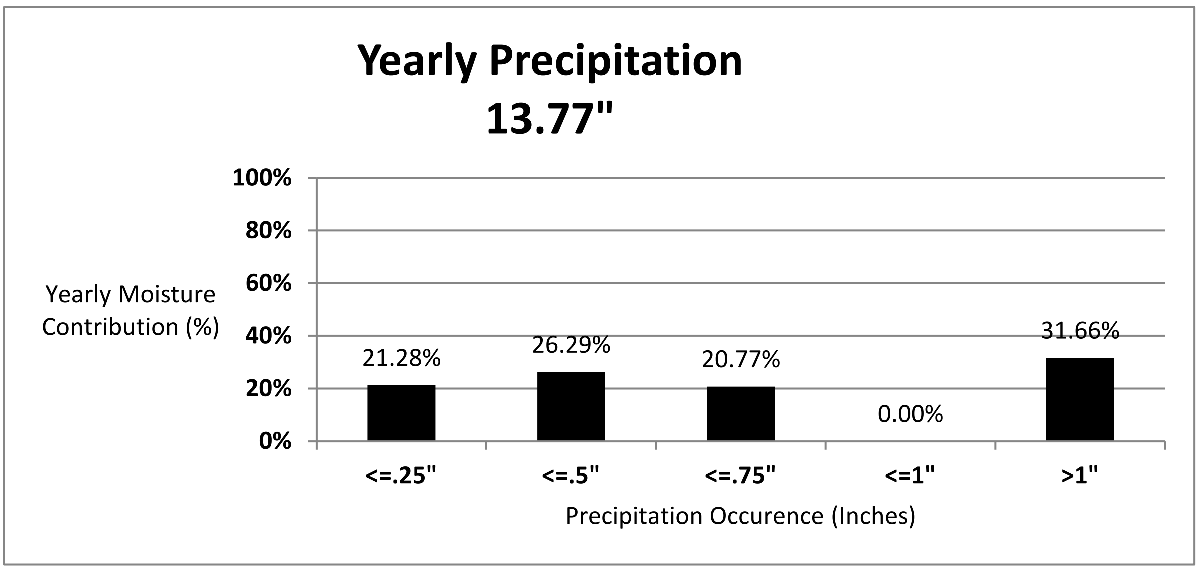
Maximum Wind:

Jan.	49 mph on 15th	July.	44 mph on 1st
Feb.	40 mph on 20th	Aug.	28 mph on 6th, 7th
Mar.	60 mph on 5th	Sept.	32 mph on 1st, 15th
Apr.	56 mph on 23rd	Oct.	48 mph on 24th
May	50 mph on 11th	Nov.	42 mph on 4th
Jun.	43 mph on 8th	Dec.	43 mph on 22nd



Plainsman Research Center - Walsh, Colorado
Historical (1983 to 2022) and 2022 Precipitation
2022
Historical (40 Years)
Precipitation (in.)
Month
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0.43
0.76
0.42
0.18
1.9
1.84
2.75
4.4
0.86
0.01
0.14
0.08
January
February
March
April
May
June
July
August
September
October
November
December


Precipitation Events
61 Total Events
80.00%
60.00%
40.00%
20.00%
0.00%
Precipitation
Occurences (%)
75.41%
14.75%
8.20%
0.00%
1.64%
<=.25"
<=.5"
<=.75"
<=1"
>1"
Precipitation Occurences (Inches)


Yearly Precipitation
13.77"
100%
80%
60%
40%
20%
0%
Yearly Moisture
Contribution (%)
21.28%
26.29%
20.77%
0.00%
31.66%
<=.25"
<=.5"
<=.75"
<=1"
>1"
Precipitation Occurence (Inches)

Overview of 2021-2022 Eastern Colorado Winter Wheat Trials

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. Our work in Colorado is possible due to the support and cooperation of the entire Colorado wheat industry, the Colorado Wheat Administrative Committee, the Colorado Wheat Research Foundation, seed companies who enter varieties, and Colorado farmers who donate their resources and time to host wheat variety trials. We test under a broad range of environmental conditions to best determine expected performance of new varieties. We have a regional uniform variety testing program, meaning that dryland varieties entered in our northeast region are tested across our six test locations in northeast Colorado, and varieties entered in our southeast region are tested across our five tests in southeast Colorado. All irrigated varieties are tested in all three irrigated trials across northeast Colorado. There were 41 varieties including experimental lines across the two regions of the 11 total dryland trials. The three irrigated trials each had 22 varieties. The variety trials included a combination of public and private varieties and experimental lines. Seed companies with entries in the variety trials included AgriPro Syngenta, CROPLAN, and Meridian Seeds. There were entries from the Colorado marketing organization PlainsGold, the Kansas Wheat Alliance, Montana State University, Oklahoma Genetics, Inc., and Crop Research Foundation of Wyoming. 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 0.20 to 1.5 acres per variety in side-by-side strips with seeding rates conforming to the seeding rate used by the collaborating farmer. Yield is corrected to 12% moisture. Variety trial plot weight, test weight, and grain moisture content information were obtained from a Harvest Master H2 weighing system on a plot combine. General Conditions Affecting the 2022 Colorado Wheat Crop Fall 2021 was drier than normal in east-central and southeast Colorado, but scattered rainfall received in September allowed for most wheat to be planted into moisture. Soil moisture conditions quickly deteriorated throughout eastern Colorado, especially in Baca County in the southeast and Washington County in the northeast. Temperatures in the fall were above average. The entirety of eastern Colorado was under moderate to extreme drought conditions from December 2021 through harvest in July 2022. Little precipitation was received during the winter months and warmer than average temperatures and windy conditions occurred in the spring. 5 Many wheat acres were chiseled or abandoned in the spring due to severe wind erosion and/or poor emergence due to the lack of moisture. The northeast and east-central parts of Colorado experienced a hard, late freeze in mid-April that caused mainly cosmetic damage to the leaves of the wheat plants. Scattered rainfall in May and June helped the remaining wheat, but some severe storms with hail occurred later in the season which caused more losses, especially in southeast Colorado. Stripe rust disease was not an issue this season due to hot and dry conditions. Brown wheat mites were observed at very low levels in east-central and northeast Colorado, and higher levels that required chemical control were noted in parts of southeast Colorado. Wheat Stem Sawfly (WSS) was devastating and widespread across many northeast Colorado counties, with some producers swathing wheat to avoid lodging and to decrease harvest losses. WSS appeared at higher levels than seen in prior years in east-central Colorado including Lincoln and Kit Carson counties.

2022 Dryland Winter Wheat Variety Performance Trial at Sheridan Lake

Variety	Brand/Source	Market Class	Grain Yield[a]	Test Weight
			bu/ac	lb/bu
CO18SFD009W	Colorado State University exp.	**HWW**	39.5	59
CO16D402W	Colorado State University exp.	**HWW**	38.5	60
Whistler	PlainsGold	HRW	37.5	60
Breck	PlainsGold	**HWW**	36.5	62
CP7017AX	CROPLAN	HRW	36.0	62
CO18D007W	Colorado State University exp.	**HWW**	34.5	61
CO13D1479	Colorado State University exp.	**HWW**	34.0	61
Snowmass 2.0	PlainsGold	**HWW**	34.0	61
Sunshine	PlainsGold	**HWW**	33.0	59
CO18D297R	Colorado State University exp.	HRW	32.0	61
KS Dallas	Kansas Wheat Alliance	HRW	31.5	60
CO17449R	Colorado State University exp.	HRW	31.0	61
KS Hamilton	Kansas Wheat Alliance	HRW	30.5	60
CO18042RA	Colorado State University exp.	HRW	29.0	59
MS Maverick	Meridian Seeds	HRW	29.0	59
Kivari AX	PlainsGold	HRW	28.5	59
Byrd	PlainsGold	HRW	28.0	59
CO16SF032	Colorado State University exp.	HRW	27.0	61
Monarch	PlainsGold	**HWW**	27.0	60
Breakthrough	Oklahoma Genetics, Inc.	HRW	25.5	60
Amplify SF	PlainsGold	HRW	25.0	60
Langin	PlainsGold	HRW	25.0	58
Canvas	PlainsGold	HRW	24.5	61
CO18D076W	Colorado State University exp.	**HWW**	24.5	60
Steamboat	Crop Research Foundation of Wyoming, Inc.	HRW	24.0	60
Avery	PlainsGold	HRW	23.5	60
Guardian	PlainsGold	HRW	23.0	60
CO18035RA	Colorado State University exp.	HRW	22.0	59
Ray	PlainsGold	HRW	22.0	57
Byrd CL Plus	PlainsGold	HRW	21.0	60
Hatcher	PlainsGold	HRW	21.0	60
Brawl CL Plus	PlainsGold	HRW	20.0	60
AP Roadrunner	AgriPro	HRW	19.5	60
Crescent AX	PlainsGold	HRW	19.5	59
CO16SF067	Colorado State University exp.	HRW	19.0	61
KS Silverado	Kansas Wheat Alliance	**HWW**	17.0	60
Fortify SF	PlainsGold	HRW	12.0	58
CP7266AX	CROPLAN	HRW	9.5	59
	Average		**26.5**	**60**

†This trial could not be interpreted due to plot variation caused by very dry growing conditions. Average yields reported above are only trends and averages should not be considered different from each other. Yield results should not be used by farmers for selecting superior varieties for planting.

Site Information

Collaborator: Scherler Farms
Harvest date: June 30, 2022
Planting date: September 8, 2021
Soil Type: Olney sandy loam
GPS Coordinates: 38.53838, -102.47213
Trial Comments: Planted 1.5” deep into moisture and corn residue. Volunteer corn present at planting, but was controlled by spring. Stands were average with some thin spots and normal fall growth. By mid-April, the varieties were just jointing and the top 4" of soil was dry. Radar estimates showed the trial received 4.9" of precipitation and 3446 growing degree-days (GDD) (base 32°F) from Jan. 1st through June 30th, which was 2.9" below and 83 GDD below the 10-year average, respectively.

Summary of 2-Year (2021-2022) Dryland Winter Wheat Variety Performance Results

			2-Year Average[a]					
Variety[b]	Brand/Source	Market Class[c]	Yield	Yield	Test Weight	Test Weight	Plant Height	Protein
			bu/ac	% trial average	lb/bu	% trial average	in	percent
KS Silverado	Kansas Wheat Alliance	**HWW**	53.2	107%	59	104%	28	13.6
Langin	PlainsGold	HRW	52.9	107%	57	100%	29	13.3
CO16D402W	Colorado State University exp.	**HWW**	51.8	105%	56	99%	28	13.3
Snowmass 2.0	PlainsGold	**HWW**	51.6	104%	57	100%	28	13.4
CO18D007W	Colorado State University exp.	**HWW**	51.3	104%	57	100%	29	13.7
Byrd	PlainsGold	HRW	51.1	103%	57	101%	30	12.9
Monarch	PlainsGold	**HWW**	51.0	103%	57	100%	28	12.4
CO18D297R	Colorado State University exp.	HRW	50.9	103%	57	101%	30	13.6
KS Dallas	Kansas Wheat Alliance	HRW	50.7	103%	57	100%	29	13.7
KS Hamilton	Kansas Wheat Alliance	HRW	50.7	102%	56	99%	28	13.4
Canvas	PlainsGold	HRW	50.6	102%	56	99%	29	13.5
Crescent AX	PlainsGold	HRW	50.6	102%	57	100%	31	13.7
Kivari AX	PlainsGold	HRW	50.5	102%	56	98%	30	13.1
Avery	PlainsGold	HRW	50.3	102%	56	99%	31	13.1
AP Solid	AgriPro	HRW	49.7	100%	58	102%	28	13.2
CP7017AX	CROPLAN	HRW	49.3	100%	57	100%	29	13.2
Amplify SF	PlainsGold	HRW	49.1	99%	57	101%	32	13.1
CO16SF032	Colorado State University exp.	HRW	49.0	99%	57	101%	32	12.9
CO18D076W	Colorado State University exp.	**HWW**	48.7	98%	57	99%	30	13.5
Breck	PlainsGold	**HWW**	48.5	98%	58	102%	31	14.1
AP Roadrunner	AgriPro	HRW	48.2	97%	55	97%	29	14.0
Whistler	PlainsGold	HRW	48.1	97%	55	97%	31	13.3
Fortify SF	PlainsGold	HRW	48.0	97%	58	102%	31	13.2
Byrd CL Plus	PlainsGold	HRW	47.9	97%	56	99%	31	13.7
Brawl CL Plus	PlainsGold	HRW	47.1	95%	58	102%	31	13.7
Guardian	PlainsGold	HRW	45.8	93%	57	100%	31	13.8
Hatcher	PlainsGold	HRW	45.5	92%	55	98%	29	12.9
CO16SF067	Colorado State University exp.	HRW	43.9	89%	57	100%	31	14.2
		Average	**49.5**	**100%**	**57**	**100%**	**30**	**13.4**

[a]Two-year average yield and test weights are based on 12 trials (three in 2022 and nine in 2021 trials). Plant heights are based on 11 trials (three in 2022 and eight in 2021 trials). Protein is based on 9 trials (three in 2022 and six in 2021 trials).
[b]Varieties ranked according to average 2-year yield.

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

Summary of 3-Year (2020-2022) Dryland Winter Wheat Variety Performance Results

Variety[b]	Brand/Source	Market Class[c]	3-Year Average[a] Yield	Yield	Test Weight	Test Weight	Plant Height
			bu/ac	% trial average	lb/bu	% trial average	in
Langin	PlainsGold	HRW	52.9	108%	57	100%	28
Snowmass 2.0	PlainsGold	**HWW**	52.4	107%	57	100%	28
KS Silverado	Kansas Wheat Alliance	**HWW**	51.6	106%	59	103%	27
Avery	PlainsGold	HRW	50.5	103%	56	99%	30
Byrd	PlainsGold	HRW	50.3	103%	57	100%	30
Monarch	PlainsGold	**HWW**	50.3	103%	57	100%	27
KS Dallas	Kansas Wheat Alliance	HRW	50.0	102%	57	100%	28
Kivari AX	PlainsGold	HRW	50.0	102%	56	98%	30
CP7017AX	CROPLAN	HRW	49.7	102%	57	100%	27
Whistler	PlainsGold	HRW	49.7	102%	55	97%	31
Canvas	PlainsGold	HRW	49.1	101%	56	99%	28
Breck	PlainsGold	**HWW**	48.5	99%	58	102%	30
Crescent AX	PlainsGold	HRW	48.3	99%	57	100%	29
Byrd CL Plus	PlainsGold	HRW	48.2	99%	56	99%	30
Brawl CL Plus	PlainsGold	HRW	47.7	98%	58	102%	30
Fortify SF	PlainsGold	HRW	47.6	97%	58	102%	29
CO16SF032	Colorado State University exp.	HRW	47.1	96%	57	101%	31
Guardian	PlainsGold	HRW	47.0	96%	57	101%	30
Amplify SF	PlainsGold	HRW	46.6	95%	57	100%	30
Hatcher	PlainsGold	HRW	44.9	92%	56	98%	27
CO16SF067	Colorado State University exp.	HRW	43.0	88%	57	100%	30
		Average	**48.8**	**100%**	**57**	**100%**	**29**

[a]The 3-year average yield and test weight are based on 21 trials (three 2022, nine 2021, and nine 2020 trials). Plant heights are based on 19 trials (three 2022, eight 2021, and eight 2020 trials).

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

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

2022 Dryland Grain Sorghum Hybrid Performance Trial at Sheridan Lake

Brand	Hybrid	Grain Yield[a]	Yield	3-Year Average Yield	Test Weight	Moisture	Emerged Plant Population	Harvest Population[b]	Tillering[c]	50% Bloom	Maturity Group[d]	Grain Color
		bu/ac	% of test average	bu/ac	lb/bu	percent	plants/ac	heads/ac	tillers/plant	days after planting		
Dyna-Gro Seed	GX22916	**66.0**	136%	-	56	22	39,300	43,100	0.1	71	ME	Bronze
Dekalb	DKS29-95	59.7	123%	55	58	17	40,000	47,500	0.2	68	E	Dark Red
Dyna-Gro Seed	GX22923	58.5	120%	-	55	21	40,100	51,000	0.3	70	E	Cream
Dyna-Gro Seed	M60GB88	54.3	112%	56	58	18	40,700	45,100	0.1	70	ME	Bronze
Dyna-Gro Seed	M59GB94	53.7	110%	59	56	21	40,700	45,700	0.1	66	E	Bronze
Dekalb	DKS38-16	52.8	109%	-	58	21	40,500	49,900	0.2	68	ME	Bronze
Dekalb	DKS36-07	51.9	107%	-	56	22	43,800	44,900	0.0	70	ME	Bronze
Dyna-Gro Seed	M63GB78	51.9	107%	-	57	23	39,400	47,200	0.2	74	ME	Bronze
Sorghum Partners	SP 31A15	51.9	107%	54	57	16	42,300	45,000	0.1	67	ME	Bronze
Hoegemeyer Seed	H6037	51.0	105%	57	59	16	44,700	51,000	0.1	65	ME	Red
Sorghum Partners	SP 43M80	50.7	104%	56	58	20	45,000	45,200	0.0	67	ME	Bronze
Dyna-Gro Seed	M57GC29	50.1	103%	-	57	19	40,600	46,800	0.1	66	E	Cream
Dyna-Gro Seed	GX21991	49.5	102%	-	55	21	41,300	39,400	0.0	65	ME	Bronze
Hoegemeyer Seed	H6020	49.5	102%	61	58	20	37,500	42,900	0.1	63	ME	Red
Dyna-Gro Seed	M54GR24	48.6	100%	57	59	18	39,400	43,000	0.1	65	E	Red
Dyna-Gro Seed	M60GB31	48.6	100%	53	56	25	39,100	34,300	0.0	75	ME	Bronze
Sorghum Partners	SP 30A30 DT	48.6	100%	-	56	22	38,200	46,900	0.2	67	ME	Bronze
Dekalb	DKS28-05	48.0	99%	57	58	18	44,000	58,400	0.3	59	E	Bronze
Dekalb	DKS28-07	47.7	98%	-	57	18	44,300	51,400	0.2	63	E	Bronze
Dekalb	DKS29-28	45.6	94%	53	58	19	45,100	50,400	0.1	64	E	Bronze
Hoegemeyer Seed	H6041	45.6	94%	57	58	16	39,400	52,500	0.3	65	ME	Cream
Golden Acres	GA 2620C	45.3	93%	56	58	18	42,900	52,300	0.2	66	ME	Cream
Alta Seed	AG1201	44.7	92%	-	57	20	40,400	43,800	0.1	69	E	Red
Sorghum Partners	SP 45A45 DT	43.5	89%	-	57	22	42,800	56,500	0.3	67	ME	Bronze
Golden Acres	GA 2730B	42.9	88%	54	57	20	41,200	55,600	0.4	65	ME	Bronze
Dyna-Gro Seed	M59GB57	42.3	87%	53	57	19	41,000	46,400	0.1	62	E	Bronze
Golden Acres	GA 1510C	38.7	80%	53	56	23	41,000	46,300	0.1	69	E	Cream
Alta Seed	ADV G1120IG	20.7	43%	-	52	27	38,500	19,000	0.0	96	ME	Red
	Average	**48.7**	**100%**	**56**	**57**	**20**	**41,200**	**46,500**	**0.2**	**68**		
	[e]LSD (.30)	5										
	[e]LSD (.05)	10										

[a]Yields adjusted to 14% moisture and hybrids ranked by yield. Yields in bold are in the top LSD group (.30) and are not significantly different from one another.

[b]Harvest population is the total number of grain-producing heads/panicles counted at harvest that were mature, including tillers.

[c]Average number of productive (grain containing and mature) tiller heads per plant. Does not include main plant head.

[d]Maturity group: E=early; ME=medium-early. Maturity groups are provided by the company and may not align with the observed flowering dates in the trial due to the latitude and relatively high elevation of the trial site (3,990 feet).

[e]Farmers selecting a hybrid based on yield should use the LSD (.30) to protect themselves from false negative conclusions (concluding hybrids are the same when they are actually different). Companies or researchers may be interested in the LSD (.05) to avoid false positive conclusions (concluding hybrids are different when they are actually the same). Yield differences less than the LSD value are considered the same.

Site Information

Collaborator:	Scherler Farms
Planting Date:	May 31, 2022
Harvest Date:	October 12, 2022
Fertilizer:	Pre-plant: N at 50 lb/ac
Herbicide:	Pre-plant (spring): s-metolachlor at 22 oz/ac and 2,4-D at labeled rate
Previous Crop:	Failed winter wheat
Soil Type:	Fort Collins sandy loam
GPS Coordinates:	38.53702, -102.43399
Trial Comments:	Planted into good moisture and heavy wheat residue. Very good stands and emergence. Most plots flowered by the week of August 15th. Sandbur in the trial was sprayed on July 14th with a hooded sprayer. Moderate to heavy sandbur pressure was still present within crop rows, and especially in plots where plants did not canopy well. Hail damage caused minor leaf shredding in July. Trial was harvested before fall freeze, so grain moisture was higher than what is typical. Weather station estimates showed the trial received about 11 inches of rain from planting to harvest, and 14.3 inches since January 1st, which is 96% of the ten-year average (year-to-date).

2022 Dryland Grain Sorghum Hybrid Performance Trial at Walsh

Brand	Hybrid	Grain Yield[a]	Yield	2-Year Average Yield	Test Weight	Plant Lodging	Emerged Plant Population	Plant Height	50% Bloom	GDD[b]	50% Mature	Maturity Group[c]	Grain Color
		bu/ac	% of test average	bu/ac	lb/bu	percent	plants/ac	in	days after planting		days after planting		
Dekalb	DKS36-07	**93.4**	117	73	61	10	28,700	48	76	2199	124	ME	Bronze
Dyna-Gro Seed	GX21991	**90.1**	112	--	61	1	24,000	45	81	2302	129	M/ME	Bronze
Dyna-Gro Seed	M63GB78	**87.8**	110	61	60	4	25,600	48	82	2321	130	M/ME	Bronze
Dyna-Gro Seed	GX22923	**87.7**	109	--	61	7	21,700	46	77	2217	127	ME/E	Cream
Dekalb	DKS38-16	**83.7**	104	--	62	4	24,800	48	76	2199	124	ME	Bronze
Sorghum Partners	SPSD352	81.4	102	--	62	4	24,400	46	78	2240	127	ME/M	Bronze
Dyna-Gro Seed	GX22916	81.2	101	--	60	14	20,500	47	83	2342	134	M/ME	Bronze
Dyna-Gro Seed	M59GB94	80.8	101	68	61	7	25,600	47	77	2217	128	ME/E	Bronze
Dyna-Gro Seed	M54GR24	80.2	100	58	61	2	25,200	47	76	2199	125	ME/E	Red
Dekalb	DKS28-07	80.0	100	--	61	2	20,900	44	72	2078	123	E	Bronze
Sorghum Partners	SP 43M80	79.8	100	65	62	3	28,700	48	75	2175	124	ME	Bronze
Dyna-Gro Seed	M60GB88	78.5	98	60	61	4	30,800	48	75	2175	124	ME	Bronze
Dyna-Gro Seed	M60GB31	78.3	98	57	61	6	20,900	47	83	2342	129	M/ME	Bronze
Dyna-Gro Seed	M57GC29	78.3	98	--	61	0	21,700	40	72	2078	121	E	Cream
Dekalb	DKS29-95	78.3	98	59	61	1	21,700	43	71	2048	119	E	Dark Red
Sorghum Partners	SP 68M57	77.0	96	--	61	4	22,500	47	76	2199	125	ME/M	Bronze
Dekalb	DKS29-05	76.3	95	58	61	10	22,500	46	71	2048	120	E	Bronze
Dekalb	DKS29-28	74.8	93	58	61	1	27,100	41	69	1995	119	E	Bronze
Sorghum Partners	SPSD353	67.6	84	--	61	1	19,800	47	82	2321	130	M	Bronze
Dyna-Gro Seed	M59GB57	67.3	84	54	62	4	25,600	41	71	2048	120	E	Bronze
Average		**80.1**		**61**	**61**	**4**	**24,100**	**46**	**76**	**2187**	**125**	**ME**	
[d]LSD (P<0.20)		10.5				2							
[d]LSD (P<0.05)		20.2											

[a]Yields adjusted to 14% moisture and hybrids ranked by yield. Yields in bold are in the top LSD (.20) group and are not significantly different from one another.

[b]GDD: Sorghum growing degree days to 50% bloom date.

[c]Maturity Group: E=early; ME=medium-early; M=medium; ML=medium late; L=late. Maturity groupings with two classes are trial observation/seed company description.

[d]Farmers selecting a hybrid based on yield should use the LSD (.20) to protect themselves from false negative conclusions (concluding hybrids are the same when they are actually different). Companies or researchers may be interested in the LSD (.05) to avoid false positive conclusions (concluding hybrids are different when they are actually the same). Yield differences less than the LSD value are considered the same.

Site Information

Collaborator:	Plainsman Research Center (Kevin Larson & Brett Pettinger)
Planting Date:	June 2, 2022 at 43,500 seeds/ac, planting depth 1.5 in.
Harvest Date:	November 16, 2022 with a harvest area of 10 ft. by 44 ft. per plot.
Previous Crop:	Wheat
Herbicide:	Preemergence: Flumioxazin at 3.0 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 15 oz/ac, Atrazine at 0.5 lb/ac, and AMS at 1.0 lb/ac.
Fertilizer:	Anhydrous N at 60 lb/ac and 10-34-0 at 5 gal/ac (20 lb P2O5/ac, 6 lb N/ac) was strip till applied.
Soil Type:	Richfield silt loam
Comments:	Planted into strip tilled wheat stubble. Slow emergence and adequate stands. Total rainfall for the growing season was nearly average. August was wet with 4.40 in. (4.36 in. in one rain event). September and October were dry. Weed control was good. Some, mostly minor, lodging noted at harvest.

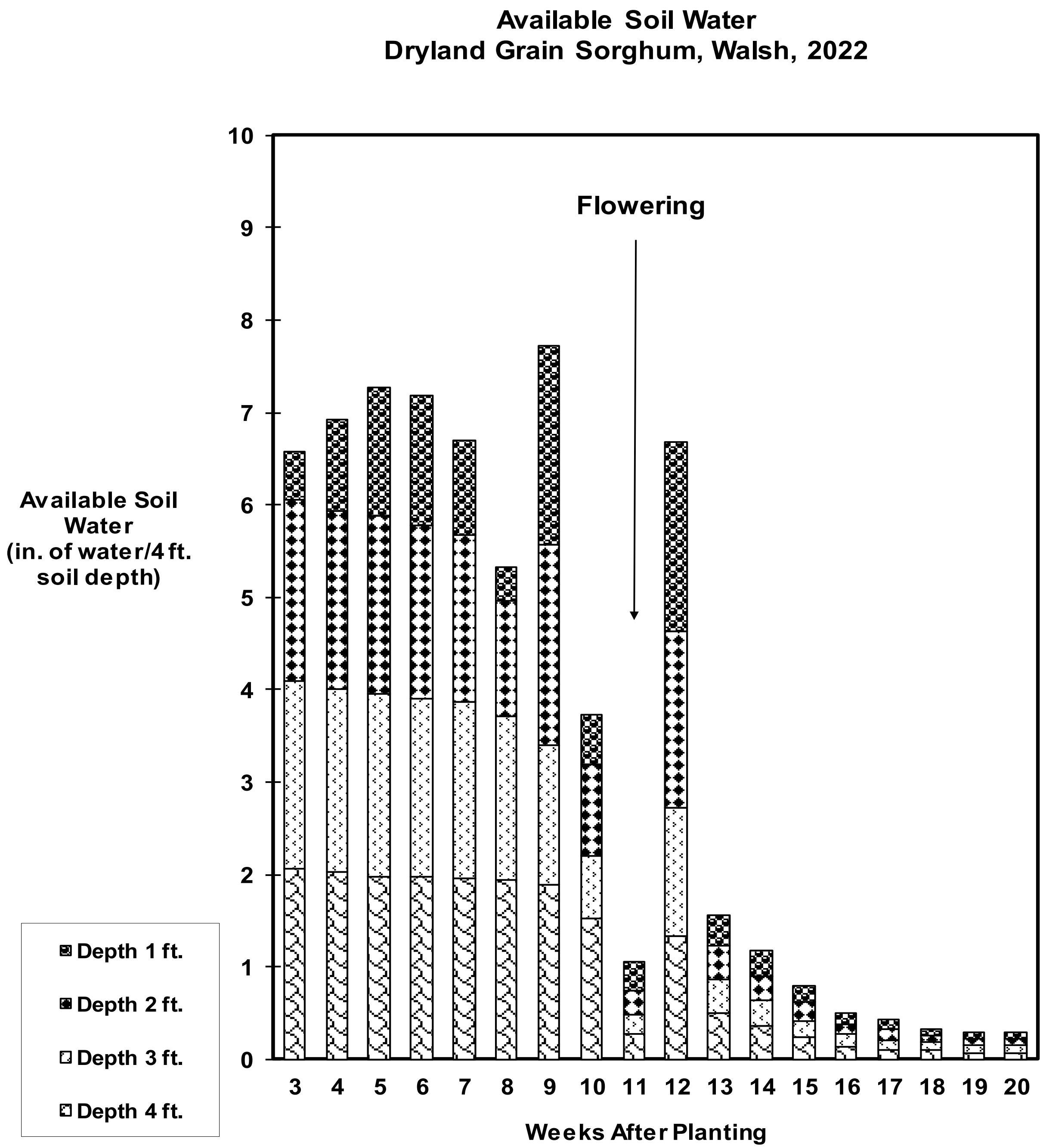


Fig. . Available soil water in dryland grain sorghum at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to first freeze (October 18) was 9.86 in. Any increase in available soil water between weeks is from rain.

2022 Sprinkler Irrigated Grain Sorghum Hybrid Performance Trial at Walsh

Brand	Hybrid	Grain Yield[a]	Yield	Test Weight	Plant Lodging	Emerged Plant Population[b]	Plant Height	50% Bloom	GDD[c]	50% Mature	Maturity Group[d]	Grain Color
		bu/ac	% of test average	lb/bu	percent	plants/ac	in	days after planting		days after planting[e]		
Dyna-Gro Seed	M60GB31	**111.2**	116	63.5	0	35,300	53	79	2107	127	M/ME	Bronze
Alta Seed	AG1201	**109.2**	114	61.3	0	30,400	47	82	2192	129	M/E	Bronze
Sorghum Partners	SPSD353	**105.1**	110	62.9	0	27,200	54	85	2275	131	ML/M	Bronze
Dyna-Gro Seed	M63GB78	**104.6**	109	61.9	9	30,800	52	80	2141	130	M/ME	Bronze
Alta Seed	ADV XG272	102.2	107	63.0	0	22,800	54	86	2306	132	ML/ME	Bronze
Dyna-Gro Seed	M60GB88	99.8	104	62.2	0	40,500	52	74	1947	123	ME	Bronze
Sorghum Partners	SPSD352	99.2	104	64.0	0	40,000	51	77	2040	126	M	Bronze
Dyna-Gro Seed	M59GB94	94.7	99	62.8	7	26,800	50	74	1947	122	ME/E	Bronze
Sorghum Partners	SP 68M57	93.1	97	62.7	0	26,400	51	73	1916	122	ME/M	Bronze
Dyna-Gro Seed	M54GR24	91.0	95	61.9	4	33,300	47	70	1846	118	E	Red
Dyna-Gro Seed	M59GB57	89.6	94	62.2	0	33,300	47	70	1846	119	E	Bronze
Alta Seed	ADV G1329	87.8	92	60.8	0	23,200	43	72	1889	121	E	Cream
Alta Seed	ADV G1120IG	86.7	91	62.6	5	26,800	54	81	2164	128	M/ME	Red
Dyna-Gro Seed	M57GC29	81.7	85	60.8	0	26,800	43	71	1865	120	E	Cream
Sorghum Partners	SP 43M80	81.2	85	63.3	8	36,900	51	73	1916	122	ME	Bronze
Average		**95.8**		**62.4**	**2**	**30,700**	**50**	**76**	**2026**	**125**	**M**	
[f]LSD (P<0.20)		8.9			0.8							
[f]LSD (P<0.05)		14.1										

[a]Yields adjusted to 14% moisture and hybrids ranked by yield. Yields in bold are in the top LSD (.20) group and are not significantly different from one another.

[b]Plant population taken after final stand. Main plants only, does not include tillers.

[c]GDD: Sorghum growing degree days to 50% bloom date.

[d]Maturity Group: E=early; ME=medium-early; M=medium; ML=medium late. Maturity groupings with two classes are trial observation/seed company description.

[e]Days after planting or seed maturation.

[d]Farmers selecting a hybrid based on yield should use the LSD (.20) to protect themselves from false negative conclusions (concluding hybrids are the same when they are actually different). Companies or researchers may be interested in the LSD (.05) to avoid false positive conclusions (concluding hybrids are different when they are actually the same). Yield differences less than the LSD value are considered the same.

Site Information

Collaborator:	Plainsman Research Center (Kevin Larson & Brett Pettinger)
Planting Date:	May 20, 2022 at 50,000 seeds/ac.
Harvest Date:	November 30, 2022, harvest area was 10 ft. by 800 ft. (average).
Previous Crop:	Corn
Herbicide:	Preemergence: Flumioxazin at 3.0 oz/ac; Atrazine at 1.0 lb/ac, Mesotrione at 6.4 oz/ac; and Metolachlor at 1.33 pts/ac; Post emergence: Bromoxynil at 1.5 pts/ac and Fluroxypyr at 6.4 oz/ac.
Fertilizer:	Anhydrous N at 150 lb/ac and 10-34-0 at 7.5 gal/ac was strip till applied and 10-34-0 at 5 gal/ac at planting.
Irrigation:	Sprinkler irrigated with 16.0 in./ac of total applied irrigation.
Soil Type:	Wiley loam
Comments:	Planted into strip tilled corn stalks. Slow emergence caused reduced stand counts. Near normal precipitation for the growing season with a wet August (mostly from a single 4.36 in. rain event) and dry for the months of September and October. Weed control was fair and required cultivation. Five hybrids had 9% or less lodging, most hybrids had no lodging at harvest.

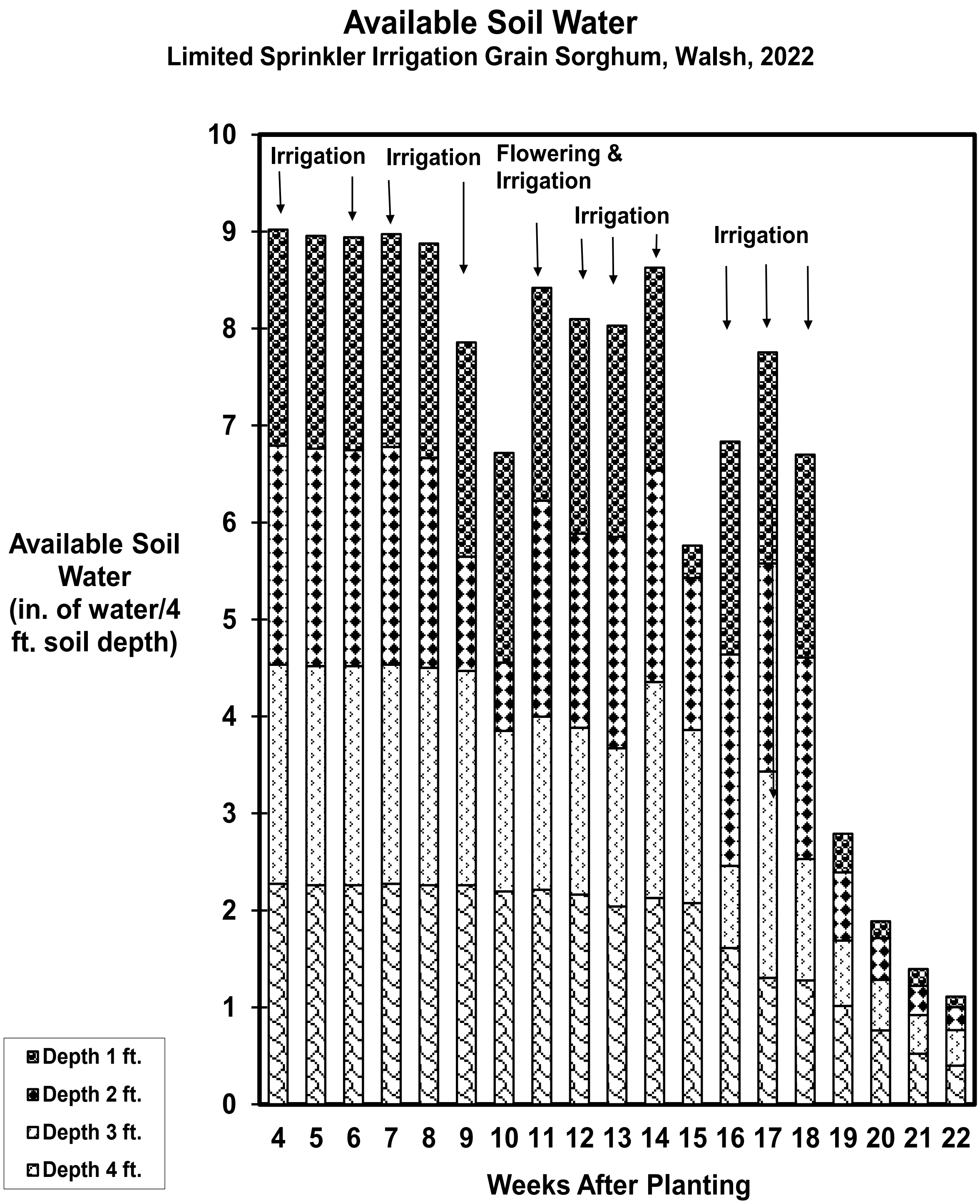


Fig. . Available soil water in dryland grain sorghum at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to first freeze was 9.86 in. Any increase in available soil water between weeks not attributed to applied irrigation is from rain.

2022 Dryland Hybrid Forage Sorghum Performance Trial at Walsh

Brand	Hybrid	Forage Yield[a]	Yield	Brix	Emerged Plant Population	Plant Height	Lodging	Days to Flowering	Relative Maturity[b]	Forage Type[c]	Traits[d]	RFQ[e]
		tons/ac	% of test average	%	plants/ac	in	%	days after planting				
Dyna-Gro Seed	Sweet Ton MS	**19.3**	138	20.5	35,200	98	0	82	E/ML	FS	SCA,MS	142
Dyna-Gro Seed	Fullgraze II BMR	**18.9**	135	18.8	20,500	119	0	112	ML	SS	BMR	123
Dyna-Gro Seed	Super Sile 30	**17.5**	125	19.2	21,500	104	0	108	ML/ME	FS	-	117
Dyna-Gro Seed	Danny Boy II BMR	16.0	115	14.8	32,500	100	0	Veg	PPS	SS	BMR	128
Dyna-Gro Seed	Super Sile 20	15.4	110	15.3	35,200	97	0	109	ML	FS	-	106
Dyna-Gro Seed	Fullgraze II	15.0	107	19.6	34,100	114	10	109	ML	SS	-	126
Dyna-Gro Seed	Dynagraze II BMR	15.0	107	16.4	23,900	88	0	83	E/ME	SS	BMR	97
Warner Seeds	2-Way AT	14.9	107	16.2	26,700	77	0	107	ML	FS	SCA	123
Dyna-Gro Seed	5FS Star	14.9	107	10.1	30,600	89	0	97	M/E	FS	-	129
Dyna-Gro Seed	Super Sweet 10	14.1	101	12.5	22,500	99	0	83	E/M	SS	-	132
Sorghum Partners	SP2774 BMR	14.0	100	13.4	27,100	97	0	84	E	FS	BMR	136
Sorghum Partners	SPBD702	14.0	100	13.6	32,900	64	0	100	M	FS	-	151
MOJO Seed	PEARL	14.0	100	6.6	22,900	82	2	96	M	FS	SCA	167
Sorghum Partners	SP1792 MS	13.9	100	10.2	35,200	84	8	96	M	FS	MS	132
Sorghum Partners	SS405	13.7	98	17.7	23,600	105	0	112	ML	FS	-	118
Dyna-Gro Seed	F72FS05	13.6	97	19.7	29,000	64	0	110	ML/ME	FS	-	152
Dyna-Gro Seed	F71FS72 BMR	13.6	97	6.3	29,400	73	0	89	ME/E	FS	BMR	109
Sorghum Partners	SPBD703	13.5	97	10.3	29,000	76	8	99	M	FS	-	136
Warner Seeds	W7706-W	13.3	95	6.5	29,000	69	0	95	M/ME	GS	SCA	169
Sorghum Partners	SP1727 MS BMR	13.3	95	15.5	29,400	90	0	96	M	FS	MS/BMR	151
Sorghum Partners	F74FS23 BMR	13.2	95	11.6	26,700	86	4	105	M	FS	BMR,BD	140
Dyna-Gro Seed	F75FS13	13.0	93	16.6	21,700	79	0	89	ME/M	FS	-	136
KWS	Freya	12.8	92	13.3	31,800	120	2	83	E/VE	SS	-	122
Dyna-Gro Seed	F72FS72 BMR	11.3	81	12.9	43,400	63	0	108	ML/M	FS	BMR	123
Dyna-Gro Seed	F72FS25 BMR	11.3	81	9.8	34,500	63	0	107	ML/M	FS	BMR	130
KWS	Kallisto	10.9	78	DS	32,900	116	4	79	E/VE	SS	-	107
Dyna-Gro Seed	Dynagraze II	10.5	75	15.0	44,500	105	0	78	E/ME	SS	-	111
Sorghum Partners	NK300	10.2	73	15.2	22,900	62	0	107	ML	FS	-	133
Average		**14.0**		**14.0**	**29,593**	**89**	**1**	**97**				**130**
[f]LSD (P<0.20)		2.6										
[f]LSD (P<0.05)		4.0										

[a]Yields are adjusted to 65% moisture content based on oven-dried samples. Yields in bold are in the top LSD (.20) group and are not significantly different from one another.

[b]Relative Maturity: E=early; ME=medium-early; M=medium; ML=medium-late; L=late; PPS=photoperiod sensitive.

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

[d]Traits: BD=brachytic dwarf; BMR=brown mid-rib; MS=male sterile; SCA=Sugar Cane Aphid.

[e]Forage quality analyses based on oven-dried weight, RFQ=relative forage quality.

[e]Farmers selecting a hybrid based on yield should use the LSD (.20) to protect themselves from false negative conclusions (concluding hybrids are the same when they are actually different). Companies or researchers may be interested in the LSD (.05) to avoid false positive conclusions (concluding hybrids are different when they are actually the same). Yield differences less than the LSD value are considered the same.

Site Information

Collaborator:	Plainsman Research Center (Kevin Larson & Brett Pettinger)
Planting Date:	June 2, 2022 at 69,700 seeds/ac, planting depth 1.5 in.
Harvest Date:	October 14, 2022 with a harvest area of 5 ft. by 44 ft per plot.
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 60 lb/ac and 10-34-0 at 5 gal/ac (20 lb P_2O_5/ac, 6 lb N/ac) was strip till applied.
Soil Type:	Richfield silt loam
Comments:	Planted into strip tilled wheat stubble. Slow emergence and adequate stands. Precipitation for the growing season was nearly average. August was wet with 4.40 in. (4.36 in. came from one rain event). September and October were dry. Weed control was good. Only a few hybrids had minor lodging at harvest.

2022 Dryland Forage Sorghum Hybrid Performance Trial Feed Quality at Walsh

Brand	Hybrid	Forage Yield[b]	Forage Quality[a]													
			RFQ	CP	aNDFom	Lignin	WSC Sugar	Starch	Fat	Ash	NDFD 30hr	NDFD 240hr	TDN	NEL	Milk/Ton	Beef/Ton
		tons/ac		percent										Mcal/cwt	lb/ton	lb/ton
Dyna-Gro Seed	Sweet Ton MS	**19.3**	142	7.8	40	3.0	14.9	18	3	7	41	60	68	71	3,218	152
Dyna-Gro Seed	Fullgraze II BMR	**18.9**	123	7.4	55	4.6	11.2	4	2	7	59	75	66	65	2,980	170
Dyna-Gro Seed	Super Sile 30	**17.5**	117	8.3	55	3.7	11.3	4	3	8	57	72	66	63	2,839	147
Dyna-Gro Seed	Danny Boy II BMR	16.0	128	8.3	55	4.3	10.1	2	2	9	62	75	66	63	2,875	165
Dyna-Gro Seed	Super Sile 20	15.4	106	8.2	54	5.2	8.4	10	2	7	51	70	65	63	2,801	121
Dyna-Gro Seed	Dynagraze II BMR	15.0	126	7.4	55	5.5	10.5	10	2	6	58	72	66	67	3,083	171
Dyna-Gro Seed	Fullgraze II	15.0	97	6.4	61	5.2	8.9	5	2	5	53	70	65	63	2,765	112
Warner Seeds	2-Way AT	14.9	123	8.1	49	3.8	12.4	9	3	7	51	70	67	66	2,988	158
Dyna-Gro Seed	5FS Star	14.9	129	7.3	48	4.2	11.1	17	2	6	51	69	67	68	3,132	167
Dyna-Gro Seed	Super Sweet 10	14.1	132	8.3	42	5.6	10.3	28	2	5	41	59	67	74	3,358	158
Sorghum Partners	SP2774 BMR	14.0	136	7.9	51	5.2	9.0	19	2	6	58	72	67	69	3,239	191
Sorghum Partners	SPBD702	14.0	151	9.0	47	4.1	9.9	25	3	6	57	68	68	71	3,349	205
MOJO Seed	PEARL	14.0	167	9.1	37	3.8	10.7	34	3	6	46	62	69	75	3,484	186
Sorghum Partners	SP1792 MS	13.9	132	7.4	45	4.1	12.6	16	3	5	47	65	67	71	3,263	172
Sorghum Partners	SS405	13.7	118	6.5	48	4.0	13.9	9	2	5	47	68	67	68	3,087	154
Dyna-Gro Seed	F71FS72 BMR	13.6	152	8.5	43	5.3	10.4	28	3	6	52	66	68	72	3,371	188
Dyna-Gro Seed	F72FS05	13.6	109	8.0	57	5.9	6.9	11	2	7	55	73	65	63	2,849	136
Sorghum Partners	SPBD703	13.5	136	7.9	50	4.5	8.4	19	2	8	58	71	66	67	3,080	169
Warner Seeds	W7706-W	13.3	169	8.8	38	4.4	10.5	35	3	5	47	64	69	76	3,591	206
Sorghum Partners	SP1727 MS BMR	13.3	151	8.2	41	4.1	13.8	16	3	5	47	64	68	73	3,389	187
Sorghum Partners	F74FS23 BMR	13.2	140	7.8	47	4.0	10.6	15	3	8	56	71	67	67	3,086	178
Dyna-Gro Seed	F75FS13	13.0	136	6.7	45	3.4	14.1	17	3	6	48	67	68	70	3,214	172
KWS	Freya	12.8	122	7.6	52	6.1	8.3	21	2	4	51	67	66	70	3,209	162
Dyna-Gro Seed	F72FS72 BMR	11.3	123	7.8	52	5.5	8.1	14	2	9	57	72	66	63	2,861	144
Dyna-Gro Seed	F72FS25 BMR	11.3	130	9.9	51	4.9	9.6	9	3	10	59	73	66	64	2,903	164
KWS	Kallisto	10.9	107	7.7	52	5.7	8.9	19	2	5	45	63	66	67	3,003	123
Dyna-Gro Seed	Dynagraze II	10.5	111	7.0	51	5.4	9.8	15	2	6	48	65	65	66	2,941	122
Sorghum Partners	NK300	10.2	133	7.1	43	3.8	13.1	17	2	8	48	66	68	69	3,157	153
	Average	**14.0**	**130**	**7.9**	**49**	**4.6**	**10.6**	**16**	**2**	**7**	**52**	**68**	**67**	**68**	**3,111**	**162**
	[c]LSD (0.20)	2.6														
	[c]LSD (0.05)	4.0														

[a]All forage quality analyses results are dry basis values. CP=crude protein; aNDFom=ash free neutral detergent fiber; NDFD=neutral detergent fiber digestibility; TDN=total digestable nutrients; NEL=net energy for lactation; Milk/ton= predicted amount of milk produced per ton of silage dry matter calculated using MILK2013.

[b]Yields are adjusted to 65% moisture content based on oven-dried samples. Yields in bold are in the top LSD (.20) group and are not significantly different from one another.

[c]Farmers selecting a hybrid based on yield should use the LSD (.20) to protect themselves from false negative conclusions (concluding hybrids are the same when they are actually different). Companies or researchers may be interested in the LSD (.05) to avoid false positive conclusions (concluding hybrids are different when they are actually the same). Yield differences less than the LSD value are considered the same.

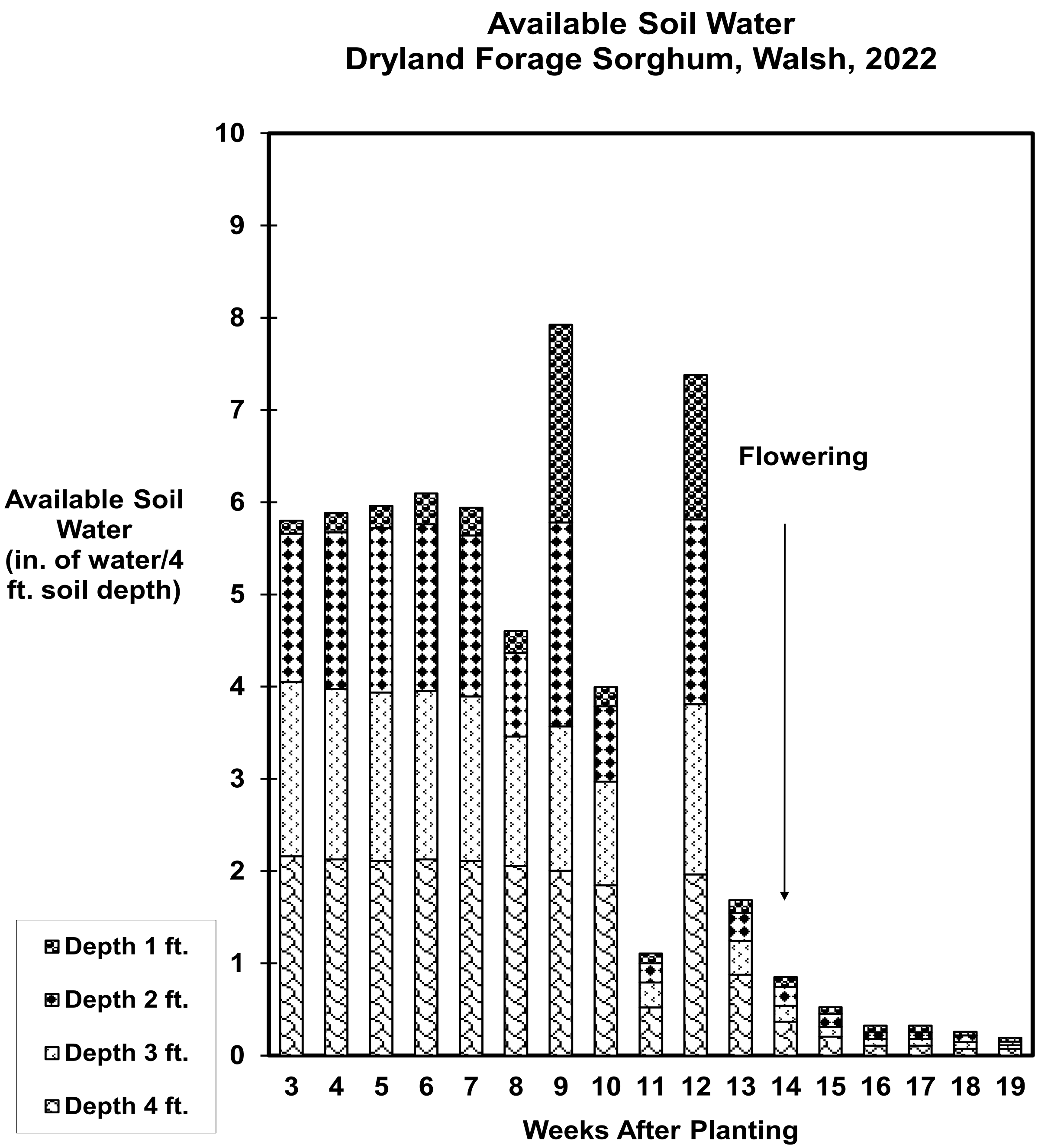


Fig. . Available soil water in dryland grain sorghum at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to harvest was 9.86 in. Any increase in available soil water between weeks is from rain.

Sprinkler Irrigation Corn Hybrid Study at Walsh, 2022

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

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

RESULTS: The average yield for all eight hybrids tested was 182 bu/a. Grain yield ranged from 152 bu/a for Channel Seed 211-97R (non Bt check) to 203 bu/a for both Golden Harvest G13N18-3111 and Dyna-Gro D57tC29.

PLOT: Eight rows with 30” row spacing, at least 400’ long. SEEDING DENSITY: 28,000 seeds/a. PLANTED: April 28. HARVESTED: November 9.

PEST CONTROL: Preemergence Herbicides: Flumioxazin 3.0 oz/a, Atrazine 1lb/a, S-Metolachlor 24 oz/a, Mesotrione 6.4 oz/a; Post Herbicides: Glyphosate 32 oz/a, Status 5 oz/a. CULTIVATION: None. INSECTICIDE: Capture LFR 16 oz/a with seedrow 10-34-0 fertilizer.

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--------			
April	0.03	1.45	54	0	0	3
May	1.90	1.45	523	12	0	34
June	1.84	2.90	723	18	5	64
July	2.75	4.35	983	27	15	95
August	4.40	4.35	820	17	7	126
September	0.86	4.35	622	14	0	156
October	0.01	0.00	181	0	0	174
Total	11.79	18.85	3906	88	27	174

\1 Growing season from April 28 (planting) to October 18 (freeze, 28F).
\2 Total in-season water from irrigation and precipitation was 30.64 in/a.
\3 GDD: Growing Degree Days for sorghum.
\4 DAP: Days After Planting.

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

COMMENTS: Planted into strip-tilled grain sorghum stalks. Only fair soil moisture, so irrigated for seed germination and stand establishment. Weed control was good. The growing season precipitation was nearly average with a wet August (mostly from a single 4.36 in. rain event) and dry for the months of September and October. Grain yields and test weights were very good. We applied 19 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”	7.9	0.8	2.2	15	3	680	0.5	34.6
8”-24”				5				
Comment	Alka	VLo	Hi	Mod	VLo	VHi	Lo	Adeq

Iron was adequate.

Summary: Fertilization.

Fertilizer	N	P_2O_5	Zn	S
	--------------------lb/a------------------			
Recommended	75	0	0	0
Applied	175	50	0.3	0

Yield Goal: 150 bu/a.
Actual Yield: 182 bu/a.

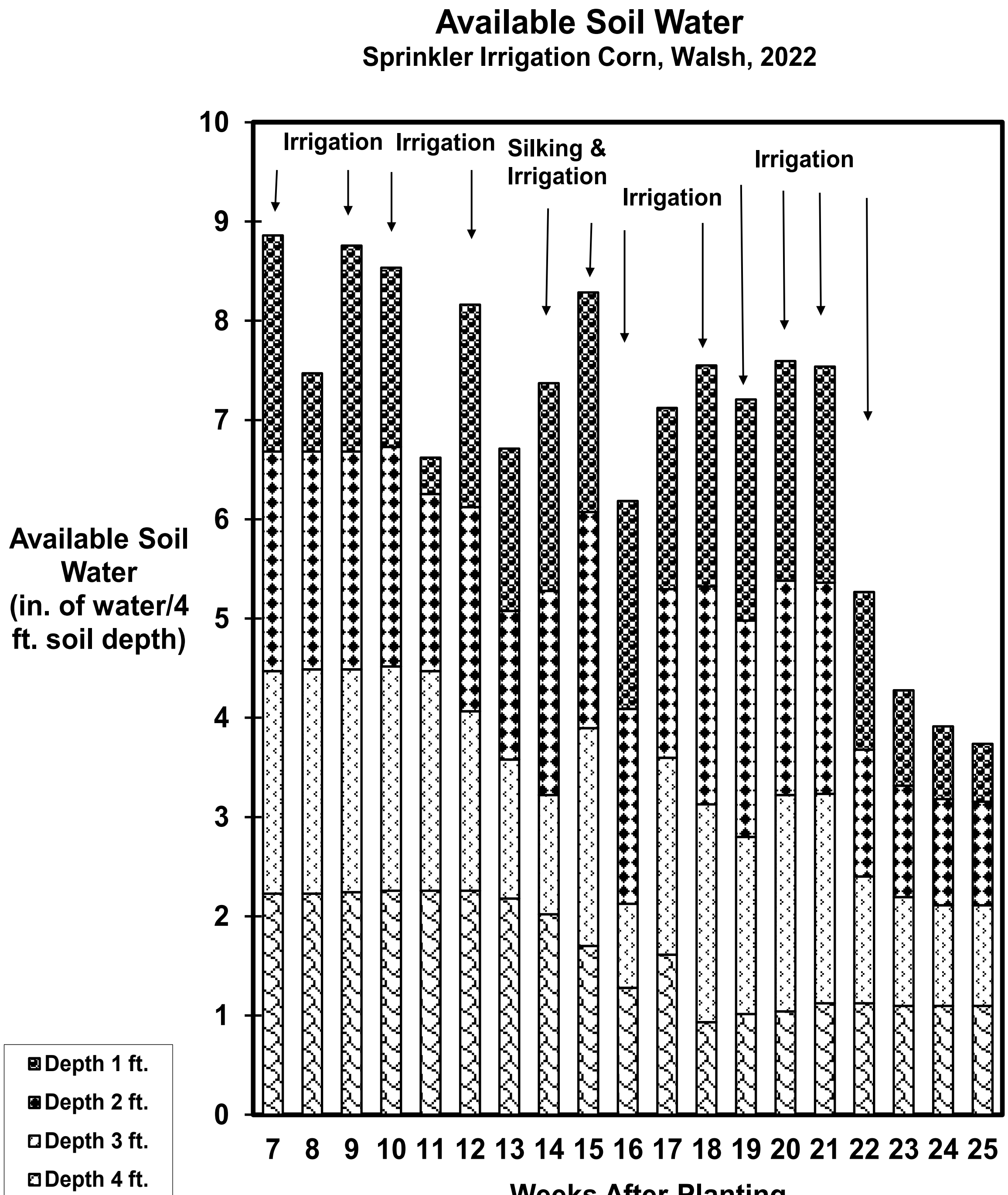


Fig. . Available soil water in limited sprinkler irrigation corn at Walsh. Gypsum block measurements taken to 4 ft. with 1 ft. increments. Total rainfall at Walsh from planting to first freeze was 11.79 in. Total applied sprinkler irrigation was 18.85 in. Any increase in available soil water between weeks not attributed to applied irrigation is from rain.

Sprinkler Irrigated Corn, Plainsman Research Center, Walsh, 2022.

Brand	Hybrid	Grain Yield	Seed Moisture	Test Weight	Plant Density	50% Silking Date
		bu/a	%	lb/bu	plants/a (X 1000)	
Golden Harvest	G13N18-3111	203	15.0	58.1	27.6	25-Jul
Dyna-Gro Seed	D57TC29	203	14.6	61.0	26.8	26-Jul
Dyna-Gro Seed	D54VC14	188	15.9	62.4	27.6	25-Jul
NC+	14-88 VT2PRIB	187	12.9	62.3	27.0	24-Jul
NC+	16-29 VT2PRIB	181	15.1	61.4	26.6	26-Jul
Dyna-Gro Seed	D52DC82	180	14.7	58.2	26.4	24-Jul
Dyna-Gro Seed	D51VC67	165	13.6	58.5	28.0	23-Jul
Channel Seed	211-97R (non Bt)	152	12.9	61.0	26.4	23-Jul
Average		182	14.3	60.4	27.1	25-Jul
LSD 0.20		7.1				

Planted: April 28; Harvested: November 9, 2022.
Grain Yield adjusted to 15.5% moisture content.
This corn trial received a total of 19 acre-in./acre of irrigation.

Corn Borer Resistant and Nonresistant Hybrid Comparisons, Walsh, 2022

Kevin Larson, Brett Pettinger and Perry Jones

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

Results: There were no first-generation corn borer shot holes on any of the hybrids. There were no second-generation corn borer stalk holes, nor second-generation corn borer lodging on any of the hybrids. Grain yields were good despite the late-season dry conditions. The corn hybrids averaged 182 bu/a.

Discussion: This is the third consecutive year that there was no first-generation and no second-generation corn borer damage. First-generation corn borer damage has been quite low for years and this is the third year that there was no damage recorded with no corn borer controlling insecticides applied (We did a seedrow application of Capture LFR at planting to control Corn Rootworm but Capture LFR is not effective in controlling Southwestern Corn Borer when applied at planting). Unlike most 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. We believe that the absence of first-generation and second-generation corn borer damage was due to negligible corn borer numbers. Since there was no corn borer damage to any of the hybrids, corn borer resistance could not be measured. As in previous years, we attribute the low, or no, level of corn borer damage to our region’s extensive use of corn borer resistant hybrids. Even though we could not evaluate corn borer damage, we still advocate the use of corn borer resistant hybrids. 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.

Dryland Corn Hybrid Trial, Plainsman Research Center at Walsh, 2022

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

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

RESULTS: The average yield for the seven corn hybrids tested was 86 bu/a. Dyna-Gro D45TC55 produced the highest yield of 98 bu/a and Dyna-Gro D40VC41 produced the lowest yield, 71 bu/a, of the seven hybrids tested.

PLOT: Four rows with 30 in. row spacing, 1265 ft. long. SEEDING DENSITY: 12,500 seeds/a. PLANTED: May 13. HARVESTED: October 28.

PEST CONTROL: Preemergence Herbicides: Flumioxazin 3.0 oz/a, S-Metolachlor 24 oz/a, Atrazine 1.0 lb/a, Mesotrione 6.4 oz. Post Herbicides: Glyphosate 32 oz/a. CULTIVATION: None. INSECTICIDE: None.

FIELD HISTORY: Previous Crop: Failed wheat. FIELD PREPARATION: Strip till.

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

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	in		--------no. of days--------		
May	1.77	299	7	0	18
June	1.84	732	18	5	48
July	2.75	983	27	15	79
August	4.40	820	17	7	110
September	0.86	622	14	0	140
October	0.01	181	0	0	153
Total	11.63	2583	76	27	153

\1 Growing season from May 13 (planting) to October 13 (harvest).
\3 GDD: Growing Degree Days for sorghum.
\4 DAP: Days After Planting.

SOIL: Richfield silt loam.

FERTILIZATION: N at 60 lb/a, P_2O_5 at 40 lb/a, Zn (chelate) at 0.38 lb/a.

COMMENTS: Planted in fair soil moisture, 8 in. off the side of strip till zone, which resulted in good seed germination and stand establishment. Weed control was very good. The growing season precipitation was nearly average. August was wet; September and October were dry. Grain yields and test weights were very good. A rare 4.36 in. rain event in the middle of August made it possible for later maturing hybrids to perform well this year.

Dryland Corn Hybrid Trial, Plainsman Research Center, Walsh, 2022.

Brand	Hybrid	Grain Yield	Seed Moisture	Test Wt.	Ear Position/ Set	50% Silking Date
		bu/ac	%	lb/bu		
Dyna-Gro Seed	D45TC55	98.2	11.7	61.5	Low/2Fair	1-Aug
NC+	EX0822VT2PRIB	95.5	13.6	60.2	High/1Good	6-Aug
Dyna-Gro Seed	D52DC82	86.7	13.3	59.6	Mid/2Fair	6-Aug
Dyna-Gro Seed	D48QZ22	86.6	11.1	58.9	Mid/1Tillering	4-Aug
NC+	01-01 VT2PRIB	82.5	11.0	60.2	Mid/1Good	1-Aug
Golden Harvest	G09Y24-5222A	81.0	12.5	58.9	Mid/2Fair	5-Aug
Dyna-Gro Seed	D40VC41	70.6	10.4	59.6	Mid/1Tillering	30-Jul
Average		85.9	11.9	59.8		3-Aug
LSD 0.20		5.5				

Planted: May 13 at 12,500 seeds/acre; Harvested: October 28, 2022.
Grain Yield adjusted to 15.5% moisture content.
Plant density was good for all hybrids, ranging from 11,800 to 12,800 plants/acre.

Dryland Corn Hybrid Trial, Thunderbird Farms at Towner, 2022

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 thirteen corn hybrids tested was 65 bu/a. NC+ 01-01 VT2PRIB produced the highest yield of 82 bu/a and Dyna-Gro D45TC55 produced the lowest yield, 42 bu/a, of the 13 hybrids tested.

PLOT: Twelve rows with 30 in. row spacing, 2630 ft. long. SEEDING DENSITY: 11,000 seeds/a. PLANTED: May 30. HARVESTED: October 7.

PEST CONTROL: Preemergence Herbicides: Flumioxazin 3.0 oz/a, Acetochlor 1.3 lb/a, Atrazine 0.8+1 lb/a, Dicamba 14 oz/a, Post Herbicides: Glyphosate 1.0 lb/a. CULTIVATION: None. INSECTICIDE: None.

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

SOIL: Richfield silt loam.

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	28	0	0	2
June	0.81	582	17	3	32
July	5.79	723	23	11	63
August	0.16	653	21	1	94
September	0.00	505	15	1	124
October	0.00	92	0	0	131
Total	6.76	2583	76	15	138

\1 Growing season from May 30 (planting) to October 7 (harvest).
\3 GDD: Growing Degree Days for corn.
\4 DAP: Days After Planting.

FERTILIZATION: N at 74 lb/a, P_2O_5 at 59 lb/a, S at 22 lb/a, Zn at 7 lb/a (applied dry). XRN at 1.5 gal/a, and Fertigard at 1 gal/a were foliar applied.

COMMENTS: Planted in good soil moisture, which resulted in good seed germination and stand establishment. Weed control was very good. The growing season precipitation was nearly average. July was very wet; August and September were dry. Grain yields and test weights were good. A rare 5 in. rain event in the end of July made it possible for later maturing hybrids to perform well this year.

Dryland Corn Hybrid Trial, Thunderbird Farms, Towner, 2022.

Brand	Hybrid	Grain Yield	Seed Moisture	Test Wt.	Ear Position/ Set	50% Silking Date
		bu/ac	%	lb/bu		
NC+	01-01 VT2PRIB	81.6	16.5	57.7	Mid/1Good	4-Aug
NC+	EX0822VT2P	75.5	20.3	54.6	High/2Good	10-Aug
Dyna-Gro Seed	D52DC82	74.8	21.5	55.1	High/1Good	10-Aug
FBN	F2F1G-011	72.7	17.3	54.9	Mid/1Good	3-Aug
FBN	GF-P019-GTA	69.7	15.6	56.4	Mid/1Good	2-Aug
Golden Harvest	G09Y24-5222A	68.3	20.2	53.5	Mid/2Fair	10-Aug
FBN	MBZ-P920-3220	65.8	14.9	57.2	Mid/1Fair	3-Aug
Dyna-Gro Seed	D40VC41	65.0	17.5	56.9	Mid/1Tillering	3-Aug
FBN	MBZ-R962-3120	64.9	13.3	56.8	Mid/2Fair	3-Aug
FBN	MBZ-F950-3220	62.1	15.7	56.7	Mid/2Fair	3-Aug
FBN	MBZ-C939-3220A	61.8	16.7	55.8	Mid/1Tillering	3-Aug
Dyna-Gro Seed	D48QZ22	44.7	19.1	53.6	Mid/1Tillering	8-Aug
Dyna-Gro Seed	D45TC55	42.0	14.2	56.7	Low/2Small	6-Aug
Average		65.3	17.1	55.8		5-Aug

Planted: May 30 at 11,000 seeds/acre; Harvested: October 7, 2022.
Grain Yield adjusted to 15.5% moisture content.
Plant density was good for all hybrids, ranging from 10,200 to 11,800 plants/acre.

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

Brett Pettinger, Perry Jones, and Kevin Larson

This twin row and conventional row spacing comparison for W-S-F production study had its origin in a dryland wheat row spacing study. For the dryland wheat row spacing study, we tested five row spacing arrangements: 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 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 bottom of 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 dryland wheat row spacing study aligned with 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. John Deere 1590 single 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 fourth year that we harvested grain crops from established rotations for complete row-spacing interactions. We planted wheat, Avery, at 50 lb/a on October 7, 2021 for the single, 10 in. treatment and October 11, 2021 for the twin, 7.5 in. treatment.

The wheat for all three treatments was planted in dry soil and did not emerge, therefore, no wheat was harvested. We planted grain sorghum, Pioneer 86P20, at 34,000 seeds/a on May 27 for both single, 30 in. and twin, 7.5 in. treatments. We applied 60 lb/a of N to the study site. To control glyphosate-resistant kochia, we applied flumioxazin 3.0 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. Since the wheat never emerged, we did not apply any in-season weed control in the wheat. 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. There was no wheat crop to harvest, but we harvested the grain sorghum crop on November 22 with a self-propelled combine equipped with an HarvestMaster H2 automated grain weighing system. For the grain sorghum crop, we used 14% moisture-adjusted grain yield for comparisons. We recorded cost of production and yields to determine treatment revenues.

Results and Discussion

The wheat crop did not emerge because of inadequate planting moisture due to drought. No wheat was harvested. Grain sorghum yields were very good, averaging 64 bu/a for all row arrangements. The grain sorghum was planted in marginal soil moisture, and emergence was slow, but stands were relatively uniform. Growing season precipitation was nearly average, with a wet August with 4.40 in. (4.36 in. from a single rain event in mid-August). September and October were dry. Total precipitation from May 27 (planting) to October 18 (the first freeze) was 8.86 in. This year, there was no wheat only grain sorghum crop production and the annual rotation row spacing productions of the W-S-F rotation had a 125 lb/a range, 1148 lb/a for Twin W:Single GS to 1273 lb/a for Twin W:Twin GS. The Twin W:Twin GS treatment produced 6.7 bu/a more than the Twin W:Single GS treatment and 6.3 bu/a more grain sorghum than the Single W:Single GS treatment. This year, since the twin row grain sorghum treatment produced more yield than either of the conventional row spacing grain sorghum treatments, there was a yield advantage for the twin row grain sorghum treatment.

When comparing the income of the conventional Single W:Single GS to the other two row arrangements, the Twin W:Twin GS was $45/a more and the Twin W:Single GS was $3/a less than the Single W:Single GS treatment. 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 only the grain sorghum crops and the total rotation production difference was 375 lb/a between the highest and lowest yielding row arrangement treatments. The 2022 total production for the Twin W:Twin GS in the W-S-F rotation was 3819 lb/a. The yields from the crop rotational phases were: wheat, 0 lb/a; grain sorghum, 3819 lb/a; and, of course, no production for fallow. The annual rotation production was 1273 lb/a, which is one-third the total production because the W-S-F rotation takes three years to complete one rotation cycle.

This year is the fourth year of complete rotational cycles; however, there was no wheat production this year. This is the first year that the Twin W:Twin GS produce higher yield and income than the conventional row spacing treatment.

In 2019, the first year of complete rotational cycles, 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.

In 2020, the income difference between the Single W:Single GS was $49.98 more than the Twin W:Twin GS and $32.55 more than the Twin W:Single GS treatments. We harvested both wheat and grain sorghum crops and the total rotation production difference was 544 lb/a between the highest and lowest yielding row arrangement treatments.

Because of the dry wheat growing conditions in 2021, the wheat yields were poor and only 3.3 bu/a separated the treatment yields with single, 10 in. treatment producing more than twin, 7.5 in. treatment. For grain sorghum, the yields were much higher than the wheat and some of the yield separations were higher as well. The Single W:Single GS treatment produced 2.7 bu/a more than the Twin W:Single GS treatment and 8.8 bu/a more grain sorghum than the Twin W:Twin GS treatment. When comparing the income of the conventional Single W:Single GS to the other two row arrangements, the Twin W:Twin GS was $30.62 less and the Twin W:Single GS was $14.93 less than the Single W:Single GS treatment.

For the past four years with complete rotational cycles, the conventional row spacing treatment produced higher income than the twin row treatments. In total gross income, the conventional Single W:Single GS treatment provided $101/a more than Twin W:Twin GS treatment and $129/a more than the Twin W:Single GS treatment after four years of complete rotational cycles. However, this is still a relatively new row spacing arrangement comparison study and we are still establishing the rotational treatments effects, therefore only limited long-term rotational outcomes can be evaluated at present.

Twin Row and Convention Row Spacing for W-S-F, Crop Production, 2022.

Crop	Row Arrangement & Spacing	-------2022 Crop------- Wheat	Grain Sorghum	Fallow	2022 Total Rotation Production	Annual Rotation Production
		lb/ac (bu/ac)	lb/ac (bu/ac)	-------------lb/ac------------		
1 Wheat:	Twin, 7.5 in.	0 (0.0)		--	3819	1273
1 Grain Sorghum	Twin, 7.5 in.		3819 (68.2)			
2 Wheat:	Twin, 7.5 in	0 (0.0)		--	3444	1148
2 Grain Sorghum	Single, 30 in.		3444 (61.5)			
3 Wheat:	Single, 10 in.	0 (0.0)		--	3466	1155
3 Grain Sorghum	Single, 30 in.		3466 (61.9)			
Average		0 (0.0)	3576 (63.9)	--	3576	1192
LSD 0.20			613 (10.9)			

Annual Rotation Production is Total Rotation Production divided by the number of years to complete one rotation cycle.
This is the fourth year that crops are planted in the correct row arrangements.
Wheat planted October 7, 2021 for single, 10 in.drill treatment.
Wheat planted October 11, 2021 for twin, 7.5 in. drill treatment.
Grain sorghum planted May 27, 2022 for single, 30 in. planter treatment.
Grain sorghum planted May 27, 2022 for twin, 7.5 in. planter treatment.
All wheat failed due to drought.

Twin Row and Conventional Row Spacing in W-S-F Rotation, Income Comparison, Walsh, 2022.

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.		0	0.00	
Grain Sorghum	Twin Row 7.5 in.	60.4	68.2	486.27	
Treatment Total				486.27	44.92
Wheat	Twin Row 7.5 in.		0	0.00	
Grain Sorghum	Single Row 30 in.	59.4	61.5	438.50	
Treatment Total				438.50	-2.85
Wheat	Single Row 10 in.		0	0.00	
Grain Sorghum	Single Row 30 in.	59.6	61.9	441.35	
Treatment Total				441.35	--
Average Wheat		0.0	0.0	0.00	
Average Grain Sorghum		59.8	63.9	455.37	
Wheat LSD 0.20			2.48		
Grain Sorghum LSD 0.20			8.65		

Wheat planted: October 7 for Single Row, October 11, 2021 for Twin Row.
No wheat harvested due to drought.
Grain Sorghum planted: May 27, 2022; Harvested: November 22, 2022.
Both wheat and grain sorghum planted in correct row arragement stubble.
Wheat crop price: no wheat harvested.
Grain Sorghum price: $7.13/bu.

Twin Row and Conventional Row Spacing in W-S-F Rotation, Income Comparison, Walsh, 2019-2022.

Crop	Row Spacing Arrangement	2019 Gross Income	2019 Gross Income Diff.	2020 Gross Income	2020 Gross Income Diff.	2021 Gross Income	2021 Gross Income Diff.	2022 Gross Income	2022 Gross Income Diff.	Total Income Compared to Conventional Spacing
		$/ac	$/ac	$/ac	$/ac	$/ac	$/ac	$/ac	$/ac	$/ac
Wheat	Twin Row 7.5 in.	267.50		10.32		88.85		0.00		
Grain Sorghum	Twin Row 7.5 in.	191.40		191.48		341.01		486.27		
Treatment Total		458.90		201.80		429.86		486.27		
Conventional Spacing Comparison			**-65.01**		**-49.98**		**-30.62**		**44.92**	**-100.69**
Wheat	Twin Row 7.5 in.	256.00		0.00		101.66		0.00		
Grain Sorghum	Single Row 30 in.	188.76		219.23		343.89		438.50		
Treatment Total		444.76		219.23		445.55		438.50		
Conventional Spacing Comparison			**-79.15**		**-32.55**		**-14.93**		**-2.85**	**-129.48**
Wheat	Single Row 10 in.	333.50		19.78		113.70		0.00		
Grain Sorghum	Single Row 30 in.	190.41		231.99		346.78		441.35		
Treatment Total		523.91		251.77		460.48		441.35		
Conventional Spacing Comparison			**--**		**--**		**--**		**--**	**--**
Average Wheat		285.6667		10.03		101.40		0.00		
Average Grain Sorghum		190.19		214.23		343.89		455.37		

Since 2019 both wheat and grain sorghum planted in correct row arragement stubble.
No wheat emerged for the Twin W/Single GS treatment in 2020.
Wheat failed in all treatments in 2022 because of drought in the fall through spring of 2021-2022.

Narrow Row Drill and Conventional Row Vacuum Planter Comparison for Grain Sorghum Production

Perry Jones, Kevin Larson, and Brett Pettinger

Currently there are two major planting systems for seeding grain sorghum in our area: air drill 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 planting acreage increases 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 for this dryland grain sorghum planting study. We compared a 24-row, John Deere 1590 drill 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 November 8, 2021. For phosphate fertilization, we seedrow applied 10-34-0 at 5 gal/a at planting for both the vacuum planter and the drill. We planted Sorghum Partners 24C20DT on June 13 at 40,000 seeds/a for the vacuum planter and we planted at least 69,000 seeds/a for the drill on June 14. For pre-emergence weed control, we applied flumioxazin at 3.0 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: FirstAct at 10 oz/a (we planted a quizalofop tolerant sorghum hybrid) and later we applied Huskie at 15 oz/a and atrazine at 0.5 lb/a. We harvested the 60 ft. wide by 1200 ft. long grain sorghum plots on November 30 for the vacuum planter treatment using a modified corn head with ARRO conversions, and on November 31 for the drill treatment using a 20 ft. Case 1020 flex platform with a Case-IH 1660 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

Only 0.3 bu/a separated the dryland grain sorghum planted with the vacuum planter on 30 in. row spacing and the drill with 10 in. row spacing. Even though there was no significant yield difference between the conventional 30 in. row spacing and the 10 in. drill treatments, the test weight of the drilled treatment was 2.0 lb/bu higher than the conventional planter treatment. The reason for the similar yields of the wide (30 in. rows) vacuum planter treatment and the narrow (10 in. rows) drill treatment is unclear; however, it undoubtedly relates to the 4.36 in. rainfall event in the middle of August, which provided abundant water for plant and grain development despite the wide difference in plant populations between the two treatments (19,800 plants/a for 30 in. row planter and 56,100 plants/a for 10 in. row drill).

In 2020, the dryland grain sorghum planted with the vacuum planter on 30 in. row spacing produced 21 bu/a more than the drill with 10 in. row spacing. The 30 in. row vacuum planter also had 6 lb/bu higher test weight than the 10 in. row drill. This year, the reason the 30 in. row vacuum planter produced significantly higher yield than the 10 in. drill was because of water runoff from an adjacent field that covered the vacuum planter replications more than the drill replications.

In 2019, we suggested two plausible reasons that contributed to the vacuum planter yielded more than the air drill. First, we noticed that the stand of the air drill 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 drill produced significantly more yield than the vacuum planter, and the narrow row air drill also suppressed weeds. In fact, the air drill suppressed sandburs so well that last year we used the air drill to plant grain sorghum seed in some of Plainsman's sandbur infested fields, and it worked well.

For two of the four harvest years that we have conducted this dryland study, the vacuum planter produced higher grain sorghum yields and net incomes than the drill treatment. Only in 2017 did the drill treatment produce higher yields and variable net incomes than the vacuum planter. This year there was no yield difference between the vacuum planter and drill treatments. In 2020, the vacuum planter had an unfair advantage with the water runoff targeting its replications, therefore, there are only three harvest years of equitable comparison: one year where the 30 in. row vacuum planter had the highest yield, one year where the 10 in. row drill had the highest yield, and this year where there was no yield difference between the 30 in. row planter and 10 in. row drill treatments.

Narrow Row Drill and Conventional Row Vacuum Planter Comparison for Grain Sorghum Production, Walsh, 2022.

Planter Type	Row Spacing Arragement	Grain Sorghum Yield	Test Weight	Moisture Content	Plant Population	Flowering Date
		bu/ac	lb/bu	%	plants/ac	
Vacuum Planter	30 in. double disc	64.6	56.0	12.2	19,800	11-Aug
Drill	10 in. single disc	64.3	58.0	11.9	56,100	12-Aug
Average		64.5	57.0	12.1	37,950	12-Aug
LSD (0.20)		3.80				

Planted: vacuum planter on June 13 and drill June 14, 2022.
Sorghum Partners 24C20DT, at 40,000 seeds/acre for vacuum planter and at 69,000 seeds/ac for drill.
Harvested vacuum planted on November 30 and drilled on November 31.
Planters: John Deere 1590 drill; John Deere 7300 Vacuum Planter.

Strip Till Zone Planting Proximity, Planting On and Off Strip Till Zone

Kevin Larson, Brett Pettinger, and Perry Jones

Higher N fertilizer costs have growers searching for ways to lower fertilizer expense. Anhydrous ammonia is the least expensive form of N fertilizer. Strip till is a zone tillage and fertilizer placement method which allows the use of anhydrous N. Strip till employs chisel shanks to till zones and inject anhydrous N into the soil. Strip tilling subjects the soil in the tillage zones to drying. Under dry planting conditions, planting on the strip till zone may be too dry for adequate seed germination, whereas there may be enough planting moisture for seed germination by planting beside the strip till zone. We conducted this study to compare planting sorghum on and off the strip till zone for their effect on plant densities and grain yields.

Materials and Methods

We performed 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. around November 4, 2021. We planted Pioneer 86P20 at 34,000 seeds/a on June 10, 2022 with a John Deere vacuum planter with eight, 30 in. rows on the strip till zone (On Zone treatment) and 8 in. beside the strip till zone (Off Zone treatment). For pre-emergence weed control we applied Flumioxazin 3.0 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 Brox at 24 oz/a and Stare Down at 6.4 oz. We harvested the 20 ft. wide by 1200 ft. long grain sorghum plots on November 7 with a Case-IH 1660 combine using a modified corn head with ARRO conversions 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 Off Zone planting produced 16.8 bu/a more grain yield than the On Zone planting. The yield increase undoubtedly was the result of the higher emerged plant population of 11,300 plants/a achieved by Off Zone planting compared to On Zone planting. Because of the dry winter and spring, there was only marginal soil moisture at planting. Soil water was lost by strip tilling and only partially replaced by winter and spring precipitation. Therefore, planting on the strip till zone, where planting moisture was lacking, reduced seedling stands compared to planting 8 in. off the strip till zone, where soil moisture remained and was not lost to strip tilling. We will continue this strip till zone planting proximity study in both dry and wet years to discover if off zone planting is an important strategy not only for dry years, but wet years as well.

Planting On and Off Strip Till Zone Comparison for Grain Sorghum Production, Walsh, 2022.

Planted Strip Till Zone Placement	Distance From Strip Till Zone	Grain Sorghum Yield	Test Weight	Moisture Content	Plant Population	Flowering Date
		bu/ac	lb/bu	%	plants/ac	
Off	8 in. Off Zone	81.9	59.5	10.5	30,200	12-Aug
On	On Zone	65.1	58.7	11.0	18,900	14-Aug
Average		73.5	59.1	10.8	24,550	13-Aug
LSD (0.20)		12.2				

Planted: June 6, 2022 at 34,000 seeds/ac on or 8 in. beside strip till zone.
Strip tilled: November 4, 2021 at 60 lb N/ac and 10-34-0 at 5 gal/ac to 8 in. depth.
Harvested: November 7, 2022.

Strip Till and No Till N Fertilization Comparison for Dryland Grain Sorghum Production

Kevin Larson, Perry Jones, and Brett Pettinger

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 expense 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 November 4, 2021. For the no till treatment, we surface applied liquid 28-0-0 in streams 20 in. apart at 60 lb N/a on November 8, 2022 and seedrow applied 10-34-0 at 5 gal/a at planting. We planted Sorghum Partners 24C20DT at 40,000 seeds/a on June 14, 2022 with a John Deere vacuum planter with eight, 30 in. rows. For pre-emergence weed control we applied Flumioxazin 3.0 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: FirstAct at 10 oz/a (we planted a quizalofop tolerant sorghum hybrid) and later we applied Huskie at 15 oz/a and atrazine at 0.5 lb/a. We harvested the 60 ft. wide by 1200 ft. long grain sorghum plots on November 30 with a Case-IH 1660 combine using a modified corn head with ARRO conversions 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 35.1 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 $9.60/a less expensive for strip till using anhydrous N than for no till using liquid N (anhydrous cost was $1160/ton and liquid 28-0-0 cost was $480/ton). 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). The cost of 10-34-0 increased $130/ton from the strip till fall application to the planter applied spring application ($700/ton in November 2021 to $830/ton in May 2022). 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. Total N and P variable treatment cost was $4.95 more for the no till treatment compared to the strip till treatment. The variable net income of no till was $245.31/a more than strip till, due to the higher grain yield of no till (35.1 bu/a @ $7.13/bu). This is the second year that the production cost of dryland grain sorghum using typical N fertilizer rates was more expensive for no till compared to strip till. For four of the six years of this study, production costs with typical N fertilizer rates were the same or nearly equivalent for strip till and no till. 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 five of the six 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 no till produced higher yield and income than strip till because the plant population of strip till was low and non-uniform compared to no till. The low plant population of strip till was due to marginal planting moisture, particularly in the strip till zone. In an adjacent study, we found that with dry planting conditions seedling emergence was much better when planting 8 in. off the strip till zone. In 2020, no till produced significantly higher yields than strip till because of water runoff from an adjacent field that covered the no till replications more than the strip till replications. Therefore, only five years of this study had equitable comparisons: four years no till had higher yields and income, and one year strip till had higher yield and income.

No Till and Strip Till N Fertilizer Comparison on Dryland Grain Sorghum at Walsh, 2022.

Tillage Treatment	Grain Yield	Test Wt.	Plant Population	N Fertilizer	N Fertilizer Cost	N Application Cost	Total N & P Variable Treatment Cost	Variable Net Income
	bu/ac	lb/bu		type	$/60 lb N	$/ac	$/ac	$/ac
No Till	64.6	56.0	19,800	Liquid (28-0-0)	51.60	6.50	82.55	378.05
Strip Till	29.5	56.0	9,000	Anhydrous (82-0-0)	42.00	15.00	77.60	132.74
Average	47.1	56.0	14,400		46.80	10.75	80.08	255.39
LSD (0.20)	3.80							

Strip till: anhydrous N applied November 4, 2021 on 30 in. row spacing at a depth of 8 in.
No till: surface applied liquid 28-0-0 on November 8, 2021 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: $1160/ton; 28-0-0 cost $480/ton.
P as 10-34-0 cost: $700/ton in November and $830/ton in May.
Grain sorghum price: $7.13/bu.
Planted: Sorghum Partners 24C20DT at 40,000 seeds/ac on June 14, 2022.
Harvested: November 30, 2022

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 only grow where there is 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 and income.

Materials and Methods

We strip tilled anhydrous N at 60 lb N/ac at 8 in. deep around November 4, 2021 into standing wheat stubble for all treatments for this dryland grain sorghum P placement and rate study. We compared: 1) No P, no applied P; 2) Planter P, seedrow P placement with a vacuum planter with 30 in. spacing at 5 gal/ac of 10-34-0; 3) Strip Till P, deep P placement with a strip tiller at 5 gal/ac of 10-34-0; and 3) Strip Till P/Planter P, both strip till P and planter P at 5 gal/ac 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 20 ft. John Deere 7300 vacuum planter with eight 30 in. rows. We planted Pioneer 86P20 on May 27, 2022 at 34,000 seeds/ac. For pre-emergence weed control, we applied flumioxazin at 3.0 oz/ac, S-metolachlor at 24 oz/ac, mesotrione at 6.4 oz/ac and atrazine at 1.0 lb/ac, and no post emergence herbicides were applied. We harvested the 20 ft. wide by 900 ft. long grain sorghum plots on October 20, 2022 with a Case-IH 1660 combine using a modified corn head with ARRO conversions 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 strip till P treatment had the highest yield and it was significantly higher than all other P treatments. There was no significant difference between the no P check and the planter P or the strip till/planter P combination. This year, the strip till P treatment made at least $21/ac more variable net income than any of the other P treatments. For the previous two years of this study, there was no significant yield difference between strip till P and planter P. A single application of 5 gal/ac of 10-34-0 (20 lb P_2O_5/ac, 6 lb N/ac) applied at strip tilling or at planting appeared to be enough P fertilizer for grain sorghum production under our dryland conditions and yield goals. However, this year the strip till P treatment made significantly more yield and income than the planter P treatment. In fact, after three years, the strip till P treatment is the only P fertilizer treatment to have a positive total variable net income (and it was only $2.56/a higher) than the no P check.

Strip Till and Planter Applied P Comparison for Grain Sorghum Production, Walsh, 2022.

Application Method	10-34-0 Rate	Grain Sorghum Yield	Test Weight	Moisture Content	10-34-0 Cost	Variable Net Income
		bu/ac	lb/bu	%	$/ac	$/ac
1 Strip Till P	5 gal/a	88.9	58.8	14.1	20.62	613.24
2 No P	0	83.1	58.9	14.2	0.00	592.50
3 Strip Till P 3 Planter P	5 gal/a 5 gal/a	81.6	58.5	14.8	45.06	536.75
4 Planter P	5 gal/a	80.2	58.6	14.6	24.44	547.39
Average		80.9	58.6	14.7		542.07
Dunnett's LSD (0.10)		4.54				
(DLSD Comparison to No P)						

Planted: Pioneer 86P20 on May 27, 2022 at 34,000 seeds/a with John Deere 7300 vacuum planter on 30 in. spacing.
All plots strip tilled on November 4, 2021 applied 60 lb N/a.
Strip till P: 10-34-0 at 5 gal/a applied with strip tiller on November 4, 2022.
Planter P: 10-34-0 at 5 gal/a applied seedrow with planter on May 27, 2022.
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/Plant P was 10 gal/a.
P as 10-34-0 cost: $700/ton in November 2021 and $830/ton in May 2022.
Grain sorghum price: $7.13/bu.
Variable Net Income is Yield X $7.13/bu -P cost.

Strip Till and Planter Applied P Three Years Comparison for Grain Sorghum Production, Walsh 2020 to 2022.

Application Method	10-34-0 Rate	2020 Grain Sorghum Yield	2020 Variable Net Income	2021 Grain Sorghum Yield	2021 Variable Net Income	2022 Grain Sorghum Yield	2022 Variable Net Income	2020-2022 Total Grain Yield	2020-2022 Total Variable Net Income	2020-2022 Comparison to No P Net Income
		bu/ac	$/ac	bu/ac	$/ac	bu/ac	$/ac	bu/ac	$/ac	$/ac
1 No P	0	30.7	170.39	60.6	349.66	83.1	592.50	174.4	1112.55	0.00
2 Strip Till P	5 gal/a	29.3	150.42	64.0	351.46	88.9	613.24	182.2	1115.11	2.56
3 Planter P	5 gal/a	29.5	151.53	66.6	366.46	80.2	547.39	176.3	1065.37	-47.18
4 Strip Till P/ 4 Planter P	5 gal/a 5 gal/a	27.2	126.56	67.0	350.95	81.6	536.75	175.8	1014.26	-98.29
Average		29.2	149.72	67.0	350.31	83.5	572.47	177.2	1076.82	-35.73
LSD (0.20)		1.02		3.86		2.56				
DLSD (0.10) Comparison to No P						4.54				

Planted: Late May to early June at 34,000 seeds/a with John Deere 7300 vacuum planter on 30 in. spacing.
All plots strip tilled on September to November applied 60 lb N/a.
P as 10-34-0 cost: $415/ton, 2020; $605/ton, 2021; $700/ton, November 2021 and $830 /ton, May 2022.
Grain sorghum price: $5.55/bu, 2020; $5.77/bu, 2021; $7.13/bu, 2022.
Variable Net Income is Yield X grain price/bu -P cost.

In-Furrow Microbiologicals for Dryland Grain Sorghum Production at Walsh, 2022

COOPERATORS: Kevin Larson and Brett Pettinger, Plainsman Research Center; Sally Jones-Diamond, CSU Crop Testing Program Director.

PURPOSE: To identify microbiological products applied in-furrow that produce highest yields under dryland conditions for grain sorghum production.

RESULTS: None of the in-furrow applied microbiological products produced more yield than the control treatment.

PLOT: Four rows with 30 in. row spacing, 200 ft. long. SEEDING DENSITY: 43,500 seeds/a. PLANTED: June 3. HARVESTED: November 17.

MICROBIOLOGICAL APPLICATION: In-furrow, 30 in. rows, 3.8 gal/ac of product and water solution at planting.

PEST CONTROL: Preemergence Herbicides: Flumioxazin 3.0 oz/a, S-Metolachlor 24 oz/a, Atrazine 1.0 lb/a, Mesotrione 6.4 oz/a; Post Herbicides: Huskie 15 oz/a, Atrazine 0.5 lb/a. CULTIVATION: None. INSECTICIDE: None.

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

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	in		-------no. of days--------		
June	1.84	697	18	5	27
July	2.75	983	27	15	58
August	4.40	820	17	7	89
September	0.86	622	14	0	119
October	0.01	232	0	0	137
Total	9.86	3354	76	27	137

\1 Growing season from June 3 (planting) to October 18 (freeze, 28F).
\3 GDD: Growing Degree Days for sorghum.
\4 DAP: Days After Planting.

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

SOIL: Richfield silt 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 (20 lb P_2O_5/ac, 6lb N/ac).

COMMENTS: Planted into strip tilled wheat stubble. Slow emergence but good plant stands. Total rainfall for the growing season was nearly average. August was wet with 4.40 in. (4.36 in. from one rain event). September and October were dry. Weed control was good. Some minor lodging noted at harvest. Grain yields and test weights were good for all products tested. The lack of response from the microbiological products may be due to the site being fully fertilized for dryland grain sorghum production prior to the application of products.

In-Furrow Microbiological Products Comparison for Dryland Grain Sorghum Production at Walsh, 2022.

Microbiological Brand	Microbiological Product	Product Rate	Application Method	Grain Sorghum Yield	Test Weight	Moisture Content	Plant Population	Plant Lodging
		*/ac		bu/ac	lb/bu	%	plants/ac thousand	%
Control				65.0	60.4	13.1	23.6	5
Valent	MycoApply EndoPrime SC	2 oz	In-Furrow	64.1	60.3	12.9	24.2	4
PivotBio	ReturN	12.8 oz	In-Furrow	64.9	59.9	13.1	24.8	5
N-TEXX	Edge	32 oz	In-Furrow	66.8	60.4	13.0	22.2	5
Average				65.2	60.3	13.0	23.7	5
DLSD (0.10) Comparison to Control				15.9				

Planted: Pioneer 86P20 on June 3, 2022 at 43,500 seeds/ac with a 4-row distributor planter with AcraPlant row units on 30 in. spacings.

Site was strip tilled on November 4, 2021 at 60 lb N/ac and 5 gal 10-34-0/ac (20 lb P_2O_5/ac, 6 lb N/ac).

Biologic products applied June 3 after mixing with water and applied in-furrow at 3.8 gal/ac.

Soil: Richfield silt loam. Available N (lb/ac, top 2 ft.) = 52, OM% = 2.0.

Dryland Grain Sorghum In-Furrow Microbiological Product Trials in 2021 & 2022

Sally Jones-Diamond and Kevin Larson

Introduction

Plant microbiological products represent a growing part of the agriculture market and include seed treatments and soil and/or foliar applied products to help improve plant growth. Many of these products contain naturally occurring microbes using endophytes (bacteria or fungi that live inside the plant without causing harm) to help create a symbiotic relationship between the plant and the microbiological product being applied. These products are reported to increase root and plant structures, increase yield, and improve plant nutrient uptake.

A grain sorghum microbiological product trial was conducted at three locations in 2021 and four locations in 2022 in eastern Colorado. The trial consisted of three product treatments plus an untreated control in the first year, and five products plus an untreated control in the second year. Treatments included a mycorrhizal fungal product, multiple bacterial products, and a micronutrient, bacterial, and humic acid blend product. The purpose of the study was to determine if/how the various products affected the grain yield compared to the untreated control. Data collected and summarized included soil test results, field management, grain yield, and grain test weight.

Approach

The trial was planted in farmer or research station fields at Akron, Seibert, and Sheridan Lake, Colorado under dryland production for two years, and Walsh, CO in 2021. Up to five combinations of products were tested on grain sorghum, using commercially available hybrids (DKS28-05 (Akron, Seibert, and Sheridan Lake) and M59GB57 (Walsh) in 2021, and 5C35 (Akron, Seibert, and Sheridan Lake) and M59GB57 (Walsh) in 2022.
In 2021 the treatments were 1) Valent® MycoApply® EndoPrime SC in-furrow applied at 2 fluid oz/ac; 2) PivotBio® ReturN in-furrow applied at 12.8 fluid oz/ac; and 3) Royal-Grow® Enzyme Max® and Ultra Sweet at 16 oz/ac each. There were three total products plus an untreated check tested in 2021. In 2022, treatments one and two (Valent® and PivotBio®) from the year prior were tested again, treatment three (Royal-Grow®) was dropped, and the following treatments were added: 1) Indigo Ag BioTrinsic™ M33 FP and M34 FP products seed applied at 16.2 grams/cwt each; 2) Indigo Ag BioTrinsic™ W10 FP seed applied at 16.2 grams/cwt; and 3) Indigo Ag BioTrinsic™ W12 FP seed applied at 16.2 grams/cwt. There were five total products tested in 2022 along with an untreated check.

The treatments were replicated a minimum of four times in 2021 and a minimum of six times in 2022. Plots were planted in 4-rows that were 10 feet wide by 31 feet long (harvested area). Plots were planted using 30" row spacing, and the sorghum was seeded at a rate of 43,000 seeds/acre. No starter fertilizer was applied but all sites had nitrogen applied pre-plant. Plot seed weight, moisture, and test weight were collected using a Harvest Master H2 grain weighing system on a modified plot combine. Seed yield was adjusted to 14% moisture content. Soil samples were pulled at planting (0-12" and 12-24" depth) and were analyzed at American Agricultural

Laboratory, Inc. in McCook, Nebraska. Treatment yield results were analyzed using the mixed model procedure in SAS 9.4. Significant differences were determined using an alpha level of 0.05, which protects against false positives (concluding treatments are different when they are actually the same).

Results

2021

The average yield across the four sites was 64.9 bu/ac, and test weight was 59 lb/bu. There were no significant differences among the four treatment yields, and no significant difference was found when comparing each of the product treatments to the untreated control within any of the four locations. When data was combined across locations, there was not a location by treatment interaction. Test weight was not significantly different among the treatments or across locations.

2022

The average yield across the three sites was 37.1 bu/ac, and test weight was 57 lb/bu. There were no significant differences among the six treatment yields, and no significant difference was found when comparing each of the product treatments to the untreated control within any of the three locations. When data was combined across locations, there was not a location by treatment interaction. Test weight was not significantly different among the treatments or across locations.

A bar graph for each year comparing each product treatment to the untreated control has been provided. Error bars were added to the graph to help visualize treatment differences (or lack thereof). When the error bars overlap between the two treatments being compared, it indicates that those treatments were not significantly different from one another. Tables for each year with single location yield and yield averaged across sites have also been provided, with the untreated control treatment being repeated to allow direct comparison to each of the product treatments.

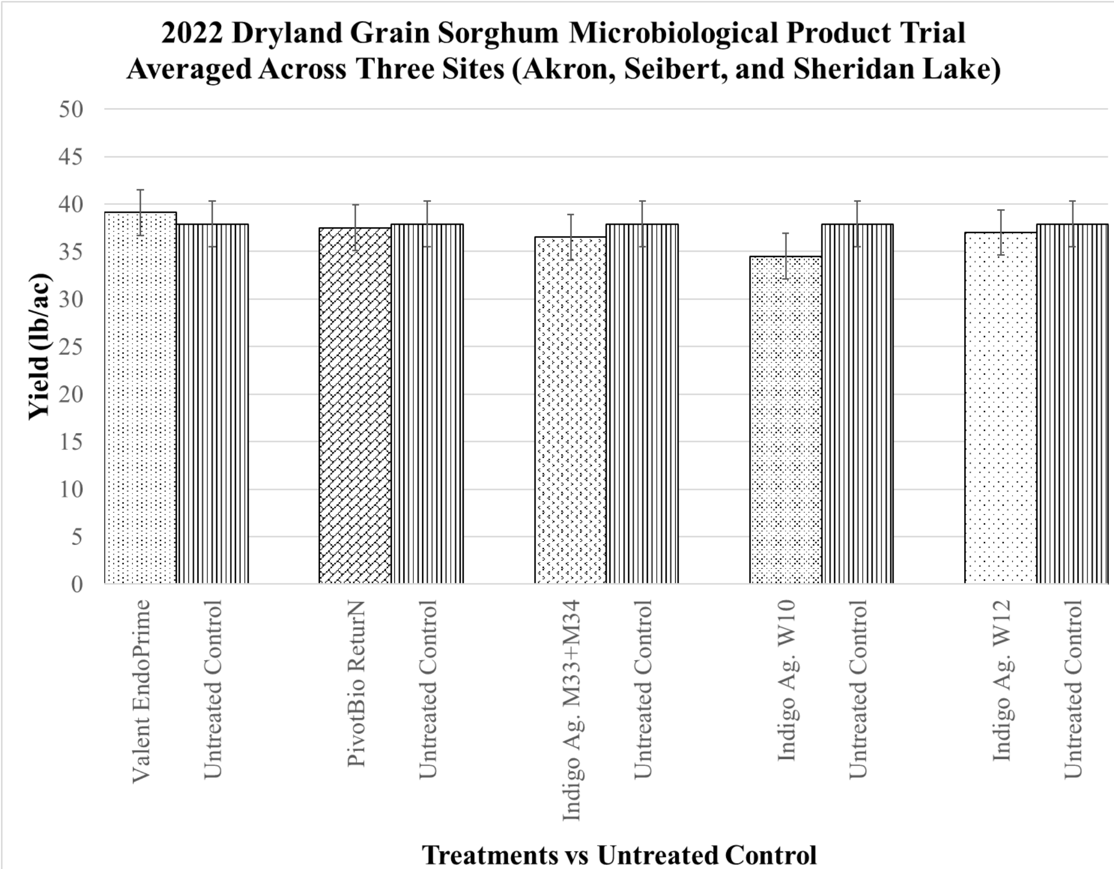
Discussion

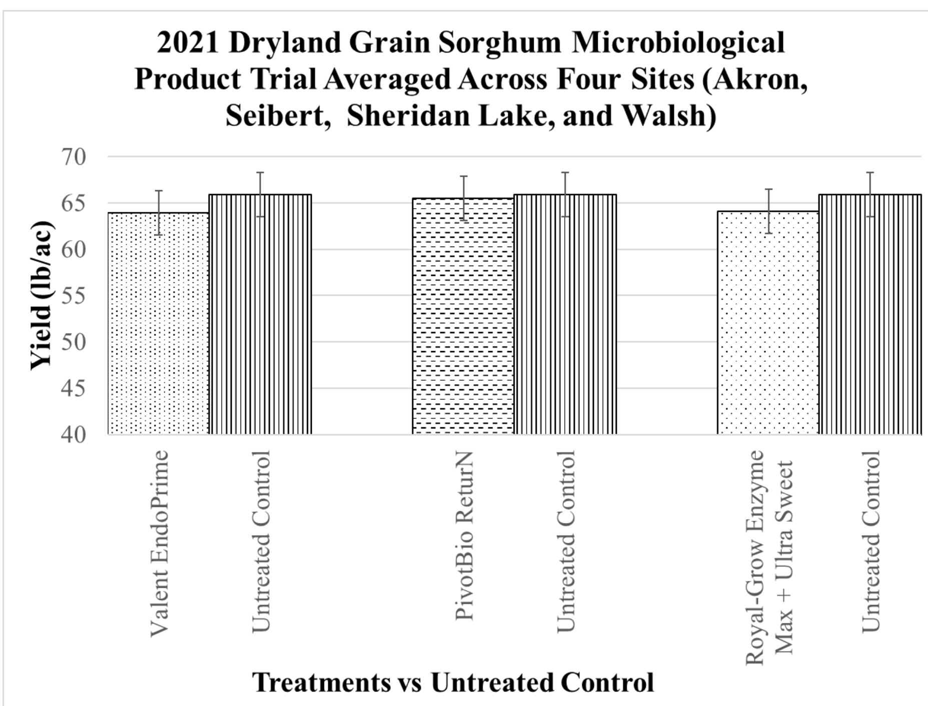
Across the seven site-years, no significant yield increase was observed when sorghum had seed or in-furrow applications of these products. The main benefit/purpose of these products is to increase the plant’s ability to obtain important nutrients such as nitrogen and phosphorus, along with water from the soil due to the symbiotic relationship with the bacteria and/or fungi that colonize in the soil and plant roots. Studies have been conducted in both the lab and field and have showed varied plant responses to these products depending on the crop, management practices such as tillage and fertilization, and the general growing environment.

In our study, the amount of available nutrients in the form of nitrogen varied widely among site-years (see tables on following pages). The presence or lack of sufficient nitrogen in the soil did not influence grain yield in our study, possibly due to the more yield-limiting lack of water. In 2022, our grain yield was below 50 bu/ac across all treatments and sites due to drought conditions across eastern Colorado. Grain yield was higher in 2021, ranging from 45 to 76 bu/ac across the sites, but no differences in grain yield, test weight, or visual plant vigor were observed among the treatments.

More research across more environments is needed to parse out potential differences in yield, and in the future we will likely conduct the study under irrigation to see if more plant available water will allow us to detect yield improvements to the plants when these products are applied.

Results Graphs and Tables





COLORADO STATE UNIVERSITY
EXTENSION

2022 Dryland Grain Sorghum Microbiological Product Trial at Three Sites

Crops Testing
www.csucrops.com

Company	Treatments	Avg. Yield	Test Weight	Akron	Seibert	Sheridan Lake
		bu/ac	lb/bu		bu/ac	
None	*Untreated Control*	*37.9*	*56*	*36*	*44*	*34*
Valent Biosciences	EndoPrime SC	39.1	57	37	43	37
None	*Untreated Control*	*37.9*	*56*	*36*	*44*	*34*
Pivot Bio	ReturN	37.5	57	36	45	31
None	*Untreated Control*	*37.9*	*56*	*36*	*44*	*34*
Indigo Ag	W12	37.0	56	34	41	36
None	*Untreated Control*	*37.9*	*56*	*36*	*44*	*34*
Indigo Ag	M33 and M34	36.5	57	35	38	36
None	*Untreated Control*	*37.9*	*56*	*36*	*44*	*34*
Indigo Ag	W10	34.5	56	31	41	31
	Average	**37.1**	**57**	**35**	**42**	**34**
	[b]LSD (0.05)	NS	NS	NS	NS	NS
	Available Nitrate-N (lb/ac top 2 feet):			46	77	73
	Organic Matter Content (%):			1.6	1.3	1.2
	Soil pH in top foot:			6.6	6.8	8.2
	Soil Type:			Keith-Kuma complex	Ascalon sandy loam	Keith-Richfield silt loam

[a]Yields corrected to 14% moisture.

[b]An LSD (alpha 0.05) has been used to minimize the risk of false positive results, or concluding there is a difference when one doesn't exist.

COLORADO STATE UNIVERSITY EXTENSION

2021 Dryland Grain Sorghum Microbiological Product Trial at Four Sites

Crops Testing www.csucrops.com

Company	Treatments	Avg. Yield	Test Weight	Akron	Seibert	Sheridan Lake	Walsh
		bu/ac	lb/bu	bu/ac			
None	*Untreated Control*	*65.9*	*59*	*72*	*68*	*73*	*51*
Valent Biosciences	EndoPrime SC	63.9	59	72	65	73	47
None	*Untreated Control*	*65.9*	*59*	*72*	*68*	*73*	*51*
Pivot Bio	ReturN	65.5	59	76	74	67	45
None	*Untreated Control*	*65.9*	*59*	*72*	*68*	*73*	*51*
Royal-Grow	Enzyme Max + Ultra Sweet	64.1	59	67	71	72	46
	Average	**64.9**	**59**	**72**	**69**	**71**	**47**
	[b]LSD (0.05)	NS	NS	NS	NS	NS	NS
	Available Nitrate-N (lb/ac top 2 feet):			56	32	66	124
	Organic Matter Content (%):			1.4	1.1	1.0	1.7
	Soil pH in top foot:			7.3	7.3	8.3	7.7
	Soil Type:			Weld silt loam	Ascalon sandy loam	Olney sandy loam	Richfield silt loam

[a]Yields corrected to 14% moisture.
[b]An LSD (alpha 0.05) has been used to minimize the risk of false positive results, or concluding there is a difference when one doesn't exist.

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 2022 were: 1) Panther (flumioxazin) 3.0 oz/a; 2) mesotrione 6 oz/a and atrazine 0.75 lb/a; 3) dicamba 16 oz/a and atrazine 0.75 lb/a; and 4) dicamba 16 oz/a and atrazine 0.75 lb/a plus a single sweep plow tillage operation. The application date for the herbicide treatments prior to grain sorghum in 2022 was March 25, 2022, and the sweep plow tillage portion of treatment was performed May 30, 2022. The kochia-controlling treatments prior to wheat in 2022 were: 1) Panther 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 date for the treatments before wheat in 2022 was March 16, 2021 for the herbicide treatments, and May 28, 2021 for the sweep plow treatment. We applied a pre-plant application to the grain sorghum of metolachlor 24 oz/a and glyphosate 32 oz/a. We planted wheat, Avery, at 50 lb seed/a on October 7, 2021. We planted grain sorghum, Pioneer 86P20, at 34,000 seeds/a on June 1, 2022. A post emergence application of Stare Down 6.4 oz/a and Brox 2EC 24 oz/a was applied to all grain sorghum treatments in mid-July. Since no wheat emerged because of drought conditions, we did not apply any post emergence herbicides to the wheat. 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. No wheat was harvested. We harvested the 20 ft. wide by 1000 ft. long grain plots of grain sorghum on November 21, 2022 with a modified Gleaner F3 combine equipped with a HarvestMaster H2 weighing system. Grain yields were adjusted to 14.0% seed moisture content for grain sorghum.

Results and Discussion

We did not harvest any wheat due to drought conditions from October 2021 (wheat planting) through May 2022. The wheat growing season was dry and no wheat was harvest, but the grain sorghum growing season was nearly average. August was wet with 4.40 in. of rainfall (mostly from one rain event of 4.36 in. in mid-August). September and October were dry.

Since no wheat was harvested, the wheat phase of the W-S-F rotation was just expenses of herbicide and application costs. Flumioxazin at 3.0 oz/a had the highest grain sorghum yield of 33 bu/a. The flumioxazin treatment yielded significantly more than the dicamba/atrazine and dicamba/atrazine/tillage treatments, but there was no significant yield difference between the flumioxazin treatment and the mesotrione/ atrazine treatment. With the highest grain sorghum yield and the lowest treatment cost, the flumioxazin treatment had the highest total rotational variable net income of $210/a. The total rotational variable net income of the flumioxazin treatment was $83/a higher than the second highest treatment, mesotrione/atrazine. All treatments had negative variable net incomes for wheat and positive variable net incomes for grain sorghum. Even with the negative variable net incomes of the wheat phase, all the W-S-F rotational variable net incomes for all the treatments were positive. The flumioxazin treatment had the highest rotational variable net income and provided $155/a more return than the lowest treatment, the dicamba/atrazine/tillage treatment.

Herbicide and Single Tillage Control of Kochia in W-S-F Rotation, Wheat Crop, Walsh, 2022.

Treatment	Product Dosage	Dosage Unit	Application Date	Seed Moisture %	Test Weight lb/bu	Grain Yield bu/a	Treatment Cost $/a	Variable Net Income $/a
1 Flumioxazin	2.5	oz/a	3/16/2021	0.0	0.0	0.0	12.93	-12.93
2 Scoparia	2.5	oz/a	3/16/2021	0.0	0.0	0.0	19.20	-19.20
3 Dicamba	16	oz/a	3/16/2021	0.0	0.0	0.0	11.46	-11.46
4 Tillage (sweep plow)			5/28/2021	0.0	0.0	0.0	22.46	-22.46
4 Dicamba	16	oz/a	3/16/2021					
Average				0.0	0.0	0.0	16.51	-16.51
LSD 0.20								

Planted: October 7, 2021, wheat variety: Avery at 50 lb seed/a.
Herbicide treatments applied: 3/16/21 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 $11/a.
No in-season weed control.
There was no wheat harvested because of the drought in the fall and spring.
Variable Net Income: gross income (grain yield x $8.33/bu) minus treatment cost.
Wheat price: $8.33/bu.

Herbicide and Single Tillage Control of Kochia in W-S-F Rotation, Grain Sorghum Crop, Walsh, 2022.

Treatment	Product Dosage	Dosage Unit	Application Date	Seed Moisture %	Test Weight lb/bu	Grain Yield bu/a	Treatment Cost $/a	Variable Net Income $/a
1 Flumioxazin	3	oz/a	3/25/2022	10.9	59.4	33.1	12.68	223.32
2 Mesotrione	6	oz/a	3/25/2022	10.9	59.4	22.7	15.58	146.27
2 Atrazine	0.75	lb/a	"					
3 Dicamba	16	oz/a	3/25/2022	10.5	58.6	15.6	17.20	94.03
3 Atrazine	0.75	lb/a	"					
4 Tillage (sweep plow)			5/30/2022	11.2	59.4	14.9	28.20	78.04
4 Dicamba	16	oz/a	3/25/2022					
4 Atrazine	0.75	lb/a	"					
Average				10.9	59.2	21.6	18.42	135.41
LSD 0.20						14.25		

Planted: June 1, 2022, grain sorghum hybrid: Pioneer 86P20 at 34,000 seeds/a.
Herbicide treatments applied: March 25, 2022, 20' by 1000', 2 replications, prior to kochia emergence.
Pre-planted application: atrazine 1.0 lb/a, metolachlor 24 oz/a, glyphasate 32 oz/a.
In-season weed control applied to all treatments July 14, 2021: 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 $11/a.
Variable Net Income: gross income (grain yield x $7.13/bu) minus treatment cost.
Grain sorghum price: $7.13/bu.

Table .--Herbicide and Single Tillage Control of Kochia for W-S-F Rotation, Walsh, 2022.

Treatment	Product Dosage	Dosage Unit	Application Date	Test Weight lb/bu	Grain Yield bu/a	Treatment Cost $/a	Variable Net Income $/a	Total Rotational Variable Net Income $/a
1 Flumioxazin (Wheat)	2.5	oz/a	3/16/2021	0.0	0.0	12.93	-12.93	210.39
1 Flumioxazin (Milo)	3	oz/a	3/25/2022	59.4	33.1	12.68	223.32	
2 Scoparia (Wheat)	2.5	oz/a	3/16/2021	0.0	0.0	19.20	-19.20	127.07
2 Mesotrine (Milo)	6	oz/a	3/25/2022	59.4	22.7	15.58	146.27	
2 Atrazine (Milo)	0.75	lb/a	"					
3 Dicamba (Wheat)	16	oz/a	3/16/2021	0.0	0.0	11.46	-11.46	82.57
3 Dicamba (Milo)	16	oz/a	3/25/2022	58.6	15.6	17.20	94.03	
3 Atrazine (Milo)	0.75	lb/a	"					
4 Tillage (Wheat)			5/28/2021	0.0	0.0	22.46	-22.46	55.58
4 Dicamba (Wheat)	16	oz/a	3/16/2021					
4 Tillage (Milo)			5/30/2022	59.4	14.9	28.00	78.04	
4 Dicamba (Milo)	16	oz/a	3/25/2022					
4 Atrazine (Milo)	0.75	lb/a	"					
Wheat Average				0.0	0.0	16.51	-16.51	
LSD 0.20 (Wheat)								
Milo Average				59.2	21.6	18.37	135.42	
LSD 0.20 (Milo)					14.25			

Wheat planted: 10-7-21, Avery at 50 lb seed/a. Milo planted: 6-1-22, Pioneer 86P20 at 34,000 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 $11/a.
Variable Net Income: gross income (grain yield x $8.33/bu for wheat; $7.13/bu for milo) minus treatment cost.

ImiFlex, Zest, and FirstAct Herbicide Comparison for Sandbur and Puncturevine Control in Fallow, Pre and Post Emergence, Plainsman Research Center, Walsh, 2022

Cooperators: Ryan Bryant, UPL LTD Technical Services Manager, and Kevin Larson, Research Scientist, CSU Plainsman Research Center.

Purpose: To evaluate pre (ImiFlex) and post emergence herbicides (ImiFlex, Zest, and FirstAct) for sandbur and puncturevine control in fallow.

Results: For the preemergence application, all treatments (except Untreated Check) received Moccasin II Plus (metolachlor), only treatment 2 included ImiFlex (ImiFlex, Moccasin II Plus). Two and four weeks after the preemergence ImiFlex treatment sandbur control was very poor, 17% sandbur control two weeks after application and dropped to 13% sandbur control four weeks after application. The preemergence ImiFlex treatment was only marginally better than the Moccasin II Plus treatments alone, which averaged 8% sandbur control two weeks after application and 7% sandbur control four weeks after application. The preemergence ImiFlex treatment 2 provided good puncturevine control with 75% two weeks after application and 88% four weeks after application. The preemergence puncturevine control of the Moccasin II Plus treatments was poor to fair, averaging 36% two weeks after application and 56% four weeks after application. For sandbur control with post emergence applications, FirstAct (Assure II applied) provided the highest sandbur control, 70% two weeks after application, 83% four weeks after application, and 74% six weeks after application. Post applied ImiFlex gave the second highest sandbur control, but was 7% lower control at two weeks, 19% lower control at four weeks, and 13% lower control at six weeks after post application compared to the FirstAct treatment. Of the three post applied treatments, Zest (Accent Q applied) provided the least sandbur control, dropping from 53% at two weeks, 43% at four weeks, and 38% at six weeks after application. For post application puncturevine control, ImiFlex gave consistently fair control, averaging 50% throughout the six-week rating period. Post application Zest provided fair to poor puncturevine control, beginning at 55% and ending with 34% for the six-week rating period after post application. FirstAct had no activity on puncturevine throughout the six-week rating period.

Discussion and Comments: The addition of ImiFlex with metolachlor preemergence herbicide did not significantly improve sandbur control. The preemergence addition of ImiFlex to metolachlor provided good puncturevine control for the 10 weeks duration of the study. Post application of FirstAct (Assure II applied) produced the highest and only good sandbur control six weeks after application of the three herbicides studied. Post application ImiFlex gave fair and consistent sandbur control for the six-week rating period after post application. Zest (Accent Q applied) ranged from fair to poor sandbur control for the six weeks of ratings after post application. Puncturevine control from post applications was fair for ImiFlex and fair to poor for Zest for the six-week period after post application. There was no puncturevine control with post applied FirstAct. This suggests that post emergence application of FirstAct with preemergence application of metolachlor provided good sandbur control, but no puncturevine control. ImiFlex applied with preemergence metolachlor gave good puncturevine control when applied preemergence, and fair sandbur control when applied post emergence. Zest applied post application with preemergence metolachlor resulted in poor sandbur and puncturevine control six weeks after post application.

ImiFlex Herbicide, Preemergence Application, Sandbur Control, Plainsman Research Center, Walsh, 2022.

Treatment	Rate	Application Timing	Sandbur Control 6/14	6/28
	*/ac		---------%--------	
1 Untreated Check			0	0
2 ImiFlex	9 oz	Pre	17	13
2 Moccasin II Plus	1.33 pt	Pre		
3 Moccasin II Plus	1.33 pt	Pre	7	3
4 Moccasin II Plus	1.33 pt	Pre	6	9
5 Moccasin II Plus	1.33 pt	Pre	11	9
Average			8	7
LSD 0.05			27.1	17.0

Preemergence treatments applied June 1.
Sandbur control was rated 14 and 28 days after preemergence application based on sandbur coverage of untreated check as zero control.

ImiFlex Herbicide, Preemergence Application, Puncturevine Control, Plainsman Research Center, Walsh, 2022.

Treatment	Rate	Application Timing	Puncturevine Control 6/14	Puncturevine Control 6/28
	*/ac		--------%-------	
1 Untreated Check			0	0
2 ImiFlex	9 oz	Pre	75	88
2 Moccasin II Plus	1.33 pt	Pre		
3 Moccasin II Plus	1.33 pt	Pre	29	35
4 Moccasin II Plus	1.33 pt	Pre	47	72
5 Moccasin II Plus	1.33 pt	Pre	32	61
Average			37	51
LSD 0.05			50.8	40.4

Preemergence treatments applied June 1.
Puncturevine control was rated 14 and 28 days after preemergence application based on puncturevine coverage of untreated check as zero control.

ImiFlex, Zest, and FirstAct Herbicide Comparison, Post Emergence Application, Sandbur Control, Plainsman Research Center, Walsh, 2022.

		Application	Sandbur Control		
Treatment	Rate	Timing	7/15	7/26	8/10
	*/ac		------------%-------------		
1 Untreated Check			0	0	0
2 ImiFlex	9 oz	Pre	29	33	38
2 Moccasin II Plus	1.33 pt	Pre			
3 Moccasin II Plus	1.33 pt	Pre	63	64	61
3 ImiFlex	6 oz	Post			
3 COC	1% v/v	Post			
3 UAN	2.5% v/v	Post			
4 Moccasin II Plus	1.33 pt	Pre	53	43	38
4 Zest (Accent Q applied)	0.67 oz	Post			
4 COC	1% v/v	Post			
4 UAN	2.5% v/v	Post			
5 Moccasin II Plus	1.33 pt	Pre	70	83	74
5 FirstAct (Assure II applied)	10 oz	Post			
5 COC	1% v/v	Post			
Average			43	45	42
LSD 0.05			8.7	13.0	14.6

Preemergence treatments applied June 3. Post emergence treatments applied June 28.
Sandbur control was rated 17, 28 and 43 days after post emergence application based on sandbur coverage of untreated check as zero control.

ImiFlex, Zest, and FirstAct Herbicide Comparison, Post Emergence Application, Puncturevine Control, Plainsman Research Center, Walsh, 2022.

Treatment	Rate	Application Timing	Puncturevine Control 7/15	7/26	8/10
	*/ac		------------%-------------		
1 Untreated Check			0	0	0
2 ImiFlex	9 oz	Pre	75	75	85
2 Moccasin II Plus	1.33 pt	Pre			
3 Moccasin II Plus	1.33 pt	Pre	50	50	51
3 ImiFlex	6 oz	Post			
3 COC	1% v/v	Post			
3 UAN	2,5% v/v	Post			
4 Moccasin II Plus	1.33 pt	Pre	55	54	34
4 Zest (Accent Q applied)	0.67 oz	Post			
4 COC	1% v/v	Post			
4 UAN	2.5% v/v	Post			
5 Moccasin II Plus	1.33 pt	Pre	0	0	0
5 FirstAct (Assure II applied)	10 oz	Post			
5 COC	1% v/v	Post			
Average			36	36	34
LSD 0.05			40.1	41.7	26.6

Preemergence treatments applied June 3. Post emergence treatments applied June 28.
Puncturevine control was rated 17, 28 and 43 days after post emergence application based on sandbur coverage of untreated check as zero control.

Double Team Sorghum Partners Grain Sorghum Hybrid Sprinkler Irrigation Trial at Walsh, 2022

COOPERATORS: Brett Pettinger, Perry Jones, and Kevin Larson Plainsman Research Center; Rick Kochenower, Agronomist, S & W Seed Company.

PURPOSE: To identify Sorghum Partners DT grain sorghum hybrids that produce highest yields with the Double Team system to control sandburs and volunteer sorghum.

RESULTS: After post emergence application of First Act to control sandburs, the medium-early hybrid, SP 45A45DT, produced the highest yield of the Sorghum Partners Double Team hybrids tested. The FirstAct application had poor control of sandburs.

PLOT: Four rows with 30 in. row spacing, 800 ft. long. SEEDING DENSITY: 50,000 seeds/a. PLANTED: June 2. HARVESTED: November 28.

SANDBUR CONTROL: First Act 10 oz/a, COC 1% v/v on July 5 when sorghum was 10 in. tall.

PEST CONTROL: Preemergence Herbicides: Flumioxazin 3.0 oz/a, S-Metolachlor 24 oz/a, Atrazine 1.0 lb/a, Mesotrione 6.4 oz/a; Post Herbicides: Brox 24 oz/a, Stare Down 6.4 oz/a. CULTIVATION: None. INSECTICIDE: None.

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

Month	Rainfall	GDD \2	>90 F	>100 F	DAP \3
	in		-------no. of days--------		
June	1.84	710	18	5	28
July	2.75	983	27	15	59
August	4.40	820	17	7	90
September	0.86	622	14	0	120
October	0.01	181	0	0	138
Total	9.86	3316	76	27	138

\1 Growing season from June 2 (planting) to October 18 (freeze, 28F).
\3 GDD: Growing Degree Days for sorghum.
\4 DAP: Days After Planting.

FIELD HISTORY: Previous Crop: Sorghum. FIELD PREPARATION: Strip-tilled.

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

FERTILIZATION: Strip tilled N at 125 lb/a, 10-34-0 at 7.5 gal/a (30 lb P_2O_5/ac, 9 lb N/ac) and 10-34-0 at 5 gal/a (20 lb P_2O_5/ac, 6 lb N/ac) at planting.

COMMENTS: Planted in marginal soil moisture, so irrigated for seed germination, but stands were still nonuniform. Competition from sandbur and volunteer sorghum was evident. The post emergence application of FirstAct to the Double Team hybrids provided poor control of sandbur but good control of volunteer sorghum. The lack of sandbur control was possibly due to year-old FirstAct that froze. The growing season precipitation was nearly average. August was wet with 4.40 in. (4.36 in. from one rain event). September and October were dry. Grain yields were low and test weights were good. We applied 4.35 in. of irrigation.

Double Team Sorghum Partners Grain Sorghum Hybrid Trial at Walsh, 2022,

Brand	Hybrid	Grain Yield	Seed Moisture	Test Weight	Plant Height
		bu/a	%	lb/bu	in
Sorghum Partners	SP 45A45DT	57.0	11.4	61.5	41
Sorghum Partners	SP 58M85DT	49.8	11.9	62.1	42
Sorghum Partners	SP 30A30DT	49.0	11.9	62.0	39
Sorghum Partners	SP 24C20DT	45.8	11.6	62.0	41
Sorghum Partners	SP 31C06DT	44.0	11.9	61.8	40
Average		49.1	11.7	61.9	41
LSD 0.20		6.20			

Planted: June 2 at 50,000 seeds/ac; Harvested: November 28, 2022.
Sandbur control: First Act 10 oz/a and COC 1% v/v on July 5, 2022.
Grain Yield adjusted to 14% moisture content.

Dryland Millet and Wheat Rotation Study

Kevin Larson, Brett Pettinger and Perry Jones

This was the sixteenth 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 fifteenth 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, Avery, at 50 lb/a on October 1, 2021 and Proso millet, Huntsman, at 10 lb/a on June 16, 2022. We applied 60 lb N/a to the study site. Before planting, we sprayed two applications of glyphosate at 32 oz/a, dicamba 8 oz/a, Low Vol 0.5 lb/a and applied Stare Down 6.4 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, the wheat failed to emerge because of drought and no in-season herbicides were applied; millet, Stare Down 6.4 oz/a and 2,4-D ester 8 oz/a; and fallow, glyphosate 32 oz/a, dicamba 8 oz/a and Low Vol 0.5 lb/a two times. The M-M rotation was sprayed out because it was severely infested with sandburs. In the M-M rotation, we applied glyphosate 32 oz/a as a cleanup. The wheat failed to emerge due to drought and no wheat was harvested. We harvested the millet on October 11 using a modified Gleaner F3 combine equipped with HarvestMaster H2 grain weighing system. Grain yields were adjusted to 14% moisture content 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. In 2020, no millet was harvested in any of the rotations because of poor stand and sandbur infestations. In 2021, it was too dry after wheat harvest to plant millet in the W/M-F rotation. This year, no wheat was harvested because it failed to emerge dur to drought, and the millet was sprayed out in M-M rotation because it was severely infested with sandburs.

Results and Discussion

The wheat did not emerge due to fall and spring drought and was not harvested. The millet also struggled to establish a uniform stand due to spring drought. When the rains did come in August, it was too late for the millet, which was reflected in the average yield of only 133 lb/a. The M-M rotation was sprayed out because it was infested with sandburs.

This year, because there was no wheat harvested and poor millet yields, all rotations produced negative variable net incomes. The W/M-F rotation had the highest millet yield, but it still a negative variable net income of -$10/a.

We have conducted this study for sixteen years. We have had multiple crop failures and missed plantings, therefore rotational affects are, at best, difficult to generalize and quantify. This year because of drought, the wheat failed and the millet crop was poor. Over the past seven harvest years, the continuous wheat (W-W) rotation provided the highest average annual rotational variable net return of $60/a. For the past seven harvest years, and acknowledging crop failures and missed plantings, W-W produced $13/a more than W/M-F, the second highest rotation. Aside from the continuous wheat and the W/M-F rotations, the remaining rotations containing wheat, W-M-F, M/W-F, and W-F, were separated by $8/a or less.

In 2021, wheat yields were low due to the dry wheat growing season, but millet yields were good due to timely summer rains, and perhaps, from the elimination of flumioxazin from the spray mix that may have caused injury to millet in past years. In 2020, the wheat crop was very poor because it was dry from planting to harvest. Millet crops were not harvested because of poor stands and heavy infestation of sandburs. In 2019, 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 little 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 an average annual rotation variable net incomes 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, 2022.

Rotation	-----------2022 Crop----------- Wheat	Millet	Fallow	2022 Total Rotation Production	Annual Rotation Production
	-----------------------------lb/a (bu/a)-----------------------------				
W/M-F	0	331 (5.9)	0	331	166
M/W-F	0	149 (2.7)	0	149	75
W-M-F	0	53 (1.0)	0	53	18
M-M		0 (0.0)		0	0
W-F	0		0	0	0
W-W	0			0	0
Average	0	133 (2.4)		89	43
LSD 0.20		180.5 (3.2)			

Annual Rotation Production is Total Rotation Production divided by the number of years to complete one rotation cycle.
The wheat failed because of drought.
The M-M rotation was sprayed out because of sandbur infestation.

Dryland Millet and Wheat Rotation Study, Walsh, 2022.

Crop Rotation	Seeding Density	Seed Cost	Weed Control Cost	Yield	Crop Price	Gross Income	Variable Net Income
	lb/a	$/a	$/a	bu/a	$/bu	$/a	$/a
Wheat							
W-W	50	12.50	0.00	0.0	8.33	0.00	-12.50
M/W-F	50	12.50	0.00	0.0	8.33	0.00	-12.50
W/M-F	50	12.50	0.00	0.0	8.33	0.00	-12.50
W-M-F	50	12.50	0.00	0.0	8.33	0.00	-12.50
W-F	50	12.50	0.00	0.0	8.33	0.00	-12.50
Wheat Average	**50**	**12.50**	**0.00**	**0.0**	**8.33**	**0.00**	**-12.50**
Millet							
W/M-F	10	3.00	15.38	5.9	10.08	59.47	44.09
M/W-F	10	3.00	15.38	2.7	10.08	27.22	8.84
W-M-F	10	3.00	15.38	1.0	10.08	10.08	-8.30
M-M	10	3.00	15.89	0.0	10.08	0.00	-18.89
Millet Average	**10**	**3.00**	**15.51**	**2.4**	**10.08**	**24.19**	**6.43**
Fallow	---	---	52.04	---	---	-52.04	-52.04
Average		8.28	11.41			4.47	-8.88

Planted: Millet, Huntsman at 10 lb/a on June 16; Wheat, Avery at 50 lb/a on October 1, 2021.
Harvested: Millet on October 11. No wheat was harvested.
Wheat herbicides: No in-season herbicides were applied to the failed wheat.
Millet herbicides: Staredown 6.4 oz/a, 2,4-D ester 8 oz/a; Glyphosate 32 oz/a for M-M cleanup.
Millet herbicide cost: $8.88/a; Glyphosate cost: $9.39/a
Fallow herbicides: glyphosate 32 oz/a, 2,4-D 0.5 lb/a, dicamba 8 oz/a;
Fallow herbicide cost: $16.48/a per application (two applications, $6.50/a per application)
Applied Stare Down 6.4 oz/a to control kochia. Kochia control cost: $6.08/a.
Weed control cost is herbicide cost and $6.50/a application cost for each application.

Dryland Millet-Wheat Rotation, Variable Net Income, 2022.

Rotation	Wheat	Millet	Fallow	2022 Total Crop Net Income	Annual Rotation Variable Net Income
	-----------2022 Crop----------				
	--------------------------$/a----------------------------				
W/M-F	-12.50	44.09	-52.04	-20.45	-10.23
W-W	-12.50			-12.50	-12.50
M-M		-18.89		-18.89	-18.89
W-M-F	-12.50	-8.30	-52.04	-72.84	-24.28
M/W-F	-12.50	8.84	-52.04	-55.70	-27.85
W-F	-12.50		-52.04	-64.54	-32.27
Average	-12.50	6.44	-52.04	-40.82	-21.00

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.
No wheat was harvested because of drought.
Millet in M-M was sprayed out due to sandbur infestation.

Millet-Wheat Rotation, Annual Rotation Income, 2016 to 2022.

Rotation	2016	2017	2018	2019	2020	2021	2022	Total Annual Rotation Variable Net Income	Average Annual Rotation Variable Net Income
	Annual Rotation Variable Net Income								
	$/a								
W-W	56.06	-16.46	126.11	234.19	-16.97	46.13	-12.50	416.56	59.51
M/W-F	26.80	45.74	9.88	134.99	-31.11	166.44	-27.85	324.89	46.41
W/M-F	61.89	54.96	25.14	122.05	-27.88	33.91	-10.23	259.82	37.12
W-M-F	34.04	31.50	29.15	97.84	-19.16	90.52	-24.28	239.62	34.23
M-M	-12.02	102.90	-28.68	-12.08	-13.30	201.91	-18.89	219.84	31.41
W-F	57.92	-20.95	54.84	116.39	-22.31	49.94	-32.27	203.55	29.08
Average	37.45	32.95	36.07	115.56	-21.79	98.14	-21.00	277.38	39.63

No millet was harvested in 2018 and 2020 (poor stands).
No wheat was harvested in 2017 and 2022 (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.

Dryland Crop Rotation Study

Kevin Larson, Brett Pettinger and Perry Jones

This is the eighteenth 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 sixteenth 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, Avery, at 50 lb/a on October 1, 2021; proso millet, Huntsman, at 10 lb/a on June 16; grain sorghum, Pioneer 86P20, at 34,000 seeds/a on May 27; and corn, Golden Harvest G09Y24, at 12,500 seeds/a on May 13, 2022. 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 8 oz/a. For in-season weed control, we chose short-residual herbicides that should not interfere with crop rotations: no in-season herbicides were applied to the wheat because the wheat failed to emerge due to drought; millet, Stare Down 6.4 oz/a, Low Vol 8 oz/a; 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 8 oz/a, Low Vol 10.7 oz/a two times, and to one of these applications we included Stare Down 6.4 oz/a to all the fallow plots to control glyphosate-resistant kochia. The S-M rotation had a severe infestation of sandbur in both its millet and grain sorghum crops. To control sandbur in the S-M rotation, we sprayed glyphosate at 32 oz/a to both the millet and sorghum phases of its rotation, which killed both the sandbur and the crops. We harvested the crops with a modified Gleaner F3 combine equipped with a HarvestMaster H2 weighing system: millet October 11; grain sorghum, November 22; corn, October 22; wheat was no harvested due to drought, and no crops were harvested in the S-M rotation because they were sprayed out due to sandbur infestation. The seed moisture contents were adjusted to 12.0% for wheat; 14% for grain sorghum; 15.5% for corn, and 14% for millet. We recorded cost of production and yields to determine rotation revenues.

Results and Discussion

This year the wheat was not harvested because it did not emerge due to drought. In the S-M rotation, both the millet and grain sorghum crops were sprayed out because they were severely infested with sandburs. Since no wheat was harvested from any of the rotations, all rotations were reliant on their summer crops for their entire grain production. Corn in W-C-F had the highest production of 64.3 bu/a, followed by grain sorghum in W-S-F with 48.2 bu/a, and millet in M/W-F trailed well behind with 2.6 bu/a. Therefore, the W-C-F rotation produced the highest total rotation production of 3595 lb/a. The W-C-F rotation made 296 lb/a more total rotation production than the W-S-F rotation, the second highest rotation. 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 2022 total production for the W-S-F rotation was 2705 lb/a. The crop rotational phases were: wheat, 0 lb/a; grain sorghum, 2705 lb/a; and, of course, no production for fallow. The annual rotation production was 902 lb/a, which is one-third the total production because the W-S-F rotation takes three years to complete one rotation cycle.

With no wheat harvested in any of the rotations, the W-C-F rotation had the highest annual rotation variable net income of $123/a due entirely from the corn phase of its rotation. Since both crop phases in the S-M rotation were sprayed out because of sandbur infestations, the S-M rotation had no income just expenses. This year, the S-M rotation had the lowest annual rotation variable net income of -$37/a.

After the last seven harvest years, the W-S-F rotation had the highest long-term annual rotation income of $84/a; however, the income of the W-S-F rotation was only $4/a more than the income of the W-C-F rotation. The W-S-F and W-C-F rotations have extended fallow periods with a summer fallow preceding the wheat and a long winter fallow before sorghum or corn. During the dry years, the extended fallow periods of the W-S-F and W-C-F rotations have contributed to their higher production and income. The S-M rotation has typical winter fallow periods between the summer crops, which are sufficient fallow periods under average winter moisture conditions. However, this year the loss of all crop income from sandbur infestations for the S-M rotation dropped its long-term annual rotation income from second to the bottom of the dryland rotations tested.

In past years, winter wheat performed better than the spring crops in both yield and income. However recently, the wheat crops were failed in six of the last ten years: one year it was lost because of drought, two years it was lost to hail, one year it winterkilled, and two years 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 good corn, good grain sorghum crops and high prices, and no wheat and low millet crops, rotations containing grain sorghum and corn had higher incomes. This suggests with the frequent failure of wheat, particularly during fall and early spring droughts, that rotations should concentrate on adapted spring crops that may take advantage of the higher rainfall patterns during the summer months.

Dryland Crop Rotation Study, Crop Production, 2022.

	Crop Production						
	--------------------------2022 Crop--------------------------					2022 Total	Annual
Rotation	Wheat	Grain Sorghum	Millet	Corn	Fallow	Rotation Production	Rotation Production
	------------------------------------lb/a (bu)------------------------------------						
W-C-F	0			3595 (64)	0	3595	1198
W-S-F	0	2705 (48)			0	2705	902
M/W-F	0		290 (5)		0	290	145
S-M		0	0			0	0
Average	0	2705 (48)	290 (5)	3595 (64)	0	1648	561
LSD 0.20							

Annual Rotation Production is Total Rotation Production divided by the number of years to complete one rotation cycle.
No wheat was harvested. Wheat failed to emerge in all rotations because of drought.
Millet and sorghum were sprayed out in S-M rotation due to infestation of sandbur.

Dryland Crop Rotation Study, Variable Net Income, 2022.

	-------------------------2022 Crop-------------------------					2022 Total Crop	Annual Rotation Variable
Rotation	Wheat	Grain Sorghum	Millet	Corn	Fallow	Net Income	Net Income
	--$/a--						
W-C-F	-12.50			434.69	-52.08	370.11	123.37
W-S-F	-12.50	306.18			-52.08	241.60	80.53
M/W-F	-12.50		34.04		-52.08	-30.54	-15.27
S-M		-54.08	-18.89			-72.97	-36.49
Average	-12.50	126.05	7.58	434.69	-52.08	127.05	38.04

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 wheat in all rotations did not emerge and was not harvested because of drought.
In S-M, both crops (millet and sorghum) were sprayed out due to sandbur infestation.

Dryland Crop Rotation Study, Walsh, 2022.

Crop Rotation	Seeding Density	Seed Cost	Weed Control Cost	Yield	Crop Price	Gross Income	Variable Net Income
		------------------------------------	----------------	$/a	----------------	------------------------------------	
Wheat	50 lb	12.50	0.00	0 bu	8.33/bu	0.00	-12.50
M/W-F			0.00	0.0	8.33	0.00	-12.50
W-C-F			0.00	0.0	8.33	0.00	-12.50
W-S-F			0.00	0.0	8.33	0.00	-12.50
Millet	10 lb	3.00	15.64	2.6 bu	10.08/bu	26.21	7.57
S-M			15.89	0.0	10.08	0.00	-18.89
M/W-F			15.38	5.2	10.08	52.42	34.04
Grain Sorghum	34,000 seeds	9.44	36.71	48.3 bu	7.13/bu	172.19	126.04
S-M			44.65	0.0	7.13	0.00	-54.09
W-S-F			28.76	48.3	7.13	344.38	306.18
Corn	12,500 seeds	44.53	44.65	64.2 bu	8.16/bu	523.87	434.69
W-C-F			44.65	64.2	8.16	523.87	434.69
Fallow	---	---	52.08	---	---	-52.08	-52.08
Average			59.68			134.04	100.74

Planted: Grain Sorghum, Pioneer 86P20 at 34,000 seeds/a on May 27; Millet, Huntsman at 10 lb/a on June 16; and Corn, Golden Harvest G09Y24 at 12,500 seeds/a on May 13; Wheat, Avery at 50 lb/a on October 1, 2021.
No wheat was harvested. The wheat did not emerge because of drought.
In the S-M rotation, no millet and no sorghum were harvested due to infestation of sandbur.
Harvested: Millet, October 11; Grain Sorghum, November 11; Corn, October 27.
Weed control cost is herbicide cost and $6.50/a application cost for each application.

Table .-Dryland Crop Rotation Study, Annual Rotation Income, 2016 to 2022.

Rotation	2016	2017	2018	2019	2020	2021	2022	Total Annual Rotation Variable Net Income	Average Annual Rotation Variable Net Income
	Annual Rotation Variable Net Income								
	$/a								
W-S-F	89.46	91.11	49.89	142.92	22.89	108.55	80.53	585.35	83.62
W-C-F	81.16	44.73	54.33	127.09	-24.00	155.60	123.37	562.27	80.32
M/W-F	53.43	30.61	19.24	103.87	107.31	73.13	-15.27	372.31	53.19
S-M	50.52	93.93	64.19	58.34	-26.42	160.87	-36.49	364.94	52.13
Average	68.64	65.09	46.91	108.06	19.94	124.54	38.04	471.22	67.32

No crops were harvested in 2008 and 2011 because of drought.
The 2012 (hail), 2014 (winterkill), 2015 (hail), 2017 (too dry, no emergence), and 2022 (too dry, no emergence) wheat crops were not harvested.
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.

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

Kevin Larson, Brett Pettinger and Perry Jones

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

This is the sixth 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 sixth 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 10 lb/a on June 16; grain sorghum, Pioneer 86P20, at 34,000 seeds/a on May 27; and corn, Golden Harvest G09Y24, at 12,500 seeds/a on May 13, 2022. We planted wheat, Avery, at 50 lb/a on October 1, 2021. 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 8 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; no in-season weed control was applied to the wheat because it did not emerge due to drought. For fallow, we applied glyphosate 32 oz/a, dicamba 8 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 modified Gleaner F3 combine equipped with a HarvestMaster H2 weighing system: wheat was not harvested due to drought; millet, October 12; grain sorghum, November 22; and corn, October 22. We 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 higher total rotation production, 1125 lb/a more than the W-C-M-F rotation because there were no wheat crop yields for both rotations and grain sorghum production in the W-S-F rotation was much higher than corn and millet production combined in the W-C-M-F. 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 $67/a. The higher income of the W-S-F rotation, $99/a, compared to the W-C-M-F rotation, $31/a, was due to the high yielding grain sorghum 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 2022 total production for the W-C-M-F rotation was 2005 lb/a. The crop rotational phases were: wheat, 0 lb/a; millet, 163 lb/a; corn, 1842 lb/a; and, of course, no production for fallow. The annual rotation production was 501 lb/a, which is one-fourth the total production because the W-C-M-F rotation takes four years to complete one rotation cycle.

This is the sixth cropping year and only the fourth year that the crops followed the correct cropping sequence. After four years of following the correct cropping sequence, the W-S-F rotation generated $31/a more in annual rotation variable net income than the W-C-M-F rotation. However, since this is only the sixth 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, 2022.

Crop Rotation	Seeding Density	Seed Cost	Weed Control Cost	Yield	Crop Price	Gross Income	Variable Net Income
		---------------------	----------	$/a	----------	---------------------	
Wheat	50 lb	12.50	0.00	0.0 bu	8.33/bu	0.00	-12.50
W-C-M-F				0.0	8.33	0.00	-12.50
W-S-F				0.0	8.33	0.00	-12.50
Corn	12,500 seeds	44.53	44.65	32.9 bu	8.16/bu	268.46	179.28
W-C-M-F				32.9	8.16	268.46	179.28
Millet	10 lb	3.00	15.38	2.9 bu	10.08/bu	29.23	10.85
W-C-M-F				2.9	10.08	29.23	10.85
Grain Sorghum	34,000 seeds	9.44	28.76	55.9 bu	7.13/bu	398.57	360.37
W-S-F				55.9	7.13	398.57	360.37
Fallow	---	---	52.08	---	---	-52.08	-52.08
Average			28.17			128.84	97.18

Planted: Grain Sorghum, Pioneer 86P20 at 34,000 seeds/a on May 27; Millet, Huntsman at 10 lb/a on June 16; and Corn, Golden Harvest G09Y24 at 12,500 seeds/a on May 13; Wheat, Avery at 50 lb/a on October 1, 2021.
No wheat was harvested. The wheat did not emerge because of drought.
Harvested: Grain Sorghum, November 22; Corn, October 22; Millet, October 12.
Weed control cost is herbicide cost and $6.50/a application cost for each application.

Dryland WCMF and WSF Rotation Comparison Study, Crop Production, 2022.

Rotation	Wheat	Grain Sorghum	Millet	Corn	Fallow	2022 Total Rotation Production	Annual Rotation Production
	Crop Production						
	2022 Crop						
	lb/a						
W-C-M-F	0		163 (3)	1842 (33)	0	2005	501
W-S-F	0	3130 (56)			0	3130	1043
Average	0	3130 (56)	163 (3)	1842 (33)	0	2568	772

Annual Rotation Production is Total Rotation Production divided by the number of years to complete one rotation cycle.
Wheat in both rotations did not emerge and was not harvested because of drought.
This is the sixth cropping year of this rotational study.

Dryland WCMF and WSF Rotation Comparison Study, Variable Net Income, 2022.

Rotation	Wheat	Grain Sorghum	Millet	Corn	Fallow	2022 Total Crop Net Income	Annual Rotation Variable Net Income
	2022 Crop						
	$/a						
W-C-M-F	-12.50		10.85	179.28	-52.08	125.55	31.39
W-S-F	-12.50	360.37			-52.08	295.79	98.60
Average	-12.50	360.37	10.85	179.28	-52.08	210.67	64.99

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.
No wheat was harvested. The wheat did not emerge due to drought.

WCMF and WSF Rotation, Annual Rotation Income, 2019 to 2022.

Rotation	Annual Rotation Variable Net Income 2019	2020	2021	2022	Total Annual Rotation Variable Net Income	Average Annual Rotation Variable Net Income
	-----------------------------$/a-----------------------------					
WSF	59.72	136.98	90.89	98.60	386.19	96.55
WCMF	23.83	97.64	110.58	31.39	263.44	65.86
Average	41.77	117.31	100.74	65.00	324.81	81.20

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.
In 2022, no wheat was harvested due to drought.

Dryland Corn Production, With and Without Fallow, and Cover Crops in Fallow

Kevin Larson, Perry Jones, and Brett Pettinger

At the 2020 Plainsman Agri-Search Foundation research advisory meeting, a couple of board members proposed a new research study for Plainsman. They had read an online AgWeb article about wide row spacings in corn seeded to cover crops (Bennet, 2019). They were excited about the prospect of raising corn on 60-inch row spacings with cover crops in between the rows that had, according to the article, little or no yield drag compared to conventional 30-inch row corn. Since we lacked the necessary equipment for the row arrangement logistics for 60-inch rows, and still maintain comparative treatments of corn, fallow, and cover crops, we used the width of our 8-row planter (20 ft.) as the width of our treatment strips. These 20 ft. wide corn, fallow, and cover crops strips would allow us to plant, spray, and harvest them without damaging adjacent strip treatments.

Materials and Methods

We tested three dryland corn, fallow, and cover crop rotational strips: 1) Corn-Fallow, 2) Corn-Cover Crops (in fallow), and 3) Corn-Corn (continuous corn). We planted a Spring N Mix from Green Cover Seed in Bladen, Nebraska at 58 lb/a on March 9, 2021. The Spring N Mix consisted of lentil at 10 lb/a, common vetch at 10 lb/a, spring forage pea at 15 lb/a, oats at 20 lb/a, canola at 2 lb/a, and flax at 5 lb/a. All cover crop seeds were from Green Cover Seed in Bladen, Nebraska. Before emergence of cover crops, we sprayed Sharpen at 0.75 oz/a, glyphosate at 32 oz/a, MSO at 16 oz/a, and AMS at 2.5 lb/a. Cover crop planting conditions were dry, but adequate for seed germination and stand establishment. On June 12, 2021, we terminated the spring cover crops and controlled weeds in the fallow plots with an application of glyphosate 32 oz/a, 2,4-D ester 12 oz/a, StareDown 6.4 oz/a, AMS 2.5 lb/a, and flumioxazin 2.5 oz/a. For the fallow and cover crops in fallow treatments, we applied an additional application of glyphosate 32 oz/a, 2,4-D ester 12 oz/a, StareDown 6.4 oz/a, and AMS 2.5 lb/a during the fallow period. We applied N at 60 lb/a to all treatments. For weed control prior to corn planting, we applied a mix of atrazine 1.0 lb/a, mesotrione 6.4 oz/a, metolachlor 24 oz/a; and glyphosate 32 oz/a. We planted the corn strips on May 13, 2022, to Golden Harvest G09Y24 at 12,500 seeds/a and seedrow applied 10-34-0 at 5 gal/a and Zn chelate at 0.38 lb/a. For in-season weed control in the corn crop, we applied a tank mix of glyphosate 32 oz/a, atrazine 0.75 lb/a, and Brox 2EC 24 oz/a. After establishing the rotations, all phases of each rotation were present each year. We harvested the corn on October 26, 2022 with a modified Gleaner F3 combine equipped with a HarvestMaster H2 weighing system. Corn yields were adjusted to 15.5% seed moisture content.

Results and Discussion

This is the second year that all phases of the Corn-Fallow (C-F), Corn-Cover Crops in fallow (C-CC), and Corn-Corn (C-C) rotations followed their correct sequences. Unlike the 2020 spring cover crops which failed to emerge, the 2021 spring cover crops made a fair amount of forage. The C-F rotation produced the highest yield of 59 bu/a, but it was not significantly higher than the C-CC, which averaged 46 bu/a ($p<0,20$).

Both the C-F and C-CC rotations produced significantly more yield than the C-C rotation. After three crop harvests, it was evident from the low yield of the C-C (continuous corn) rotation that it struggled with the drier conditions this year. Along with producing the highest yield, the C-F rotation also provided the highest total variable net income of $423/a per corn crop, $172/a more than the C-CC and $284/a more than the C-C rotations. The C-F and C-CC rotations produce a corn crop (income) once every two years, while the C-C rotation produces a corn crop (income) every year. Despite having a corn crop (income) once in two years, the C-F rotation provided the highest annual rotation variable net income of $212/a, even though its variable net income was halved because it takes two years to complete its rotation cycle. The C-C rotation produced $14/a more annual rotation variable net income than the C-CC rotation because of the high cost of cover crop production in fallow and its variable net income is halved because it takes two years to complete its rotation cycle.

This is the third cropping year and only the second year that the crops followed the correct cropping sequence. Moreover, in 2020 the cover crops in the C-CC rotation failed, so there were only cover crop expenses and no benefits from their inclusion. In 2021, the cover crops produced some forage, therefore the C-CC rotation effects were more fully realized. Since this was only the second year of following the correct cropping sequence, and only one year in which cover crop rotational effects were established, no long-term rotational effects can be fully evaluated.

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Corn Production, With & Without Fallow, and Cover Crops in Fallow, Walsh, 2022.

Treatment	Corn Yield	Test Wt.	Cover Dry Matter	Cover N	Fixed N	Variable Treatment Cost	Fixed N Income	Variable Net Income
	bu/a	lb/bu	lb/a	lb/a	lb/a	$/a (per corn crop)	$/a	$/a
Corn-Fallow	59	58.5				58.97		423.29
Corn-Cover Crops	46	58.6	2811	101.7	0.0	126.55	0.00	251.26
Corn-Corn	17	56.9						139.54
Average	41	58.0				61.84		271.36
LSD 0.20	24.8							

Cover crops planted: March 9, 2021 on 12-in. row spacings.
Cover crops pre-emergence weed control: Sharpen 0.75/a lb, glyphosate 32 oz/a, MSO 16 oz/a, AMS 2.5 lb/a. Herbicide cost: $19.43/a.
Sampled and terminated spring cover crops: June 12, 2021.
Cover crops termination and fallow weed control with two applications of glyphosate 32 oz/a, Staredown 6.4 oz/a, Low Vol 12 oz/a, AMS 2.5 lb/a. Herbicide cost: $20.41/application, plus flumioxazin 2.5 oz/a was added to the first application, cost: $5.15/a.
Corn strips planted: May 13, 2022, to Golden Harvest G09Y24 at 12,500 seeds/a.
Corn harvested: October 26, 2022. Grain yields were adjusted to 15.5% moisture.
Spring cover crop seeding rate: Spring N Mix, 58 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.
Treatment application cost: cover crop planting, $12/a: sprayer application,$6.5/a.

Corn Production, With and Without Fallow, and Cover Crops in Fallow, Variable Net Income, Walsh, 2022.

Rotation	Corn Yield	Corn Gross Income	Fallow Cost	Cover Crop Fallow Cost	Total Crop Variable Net Income	Annual Rotation Variable Net Income
	bu/a	-----------------------------$/a-----------------------------				
Corn-Fallow	59	482.26	58.97		423.29	211.64
Corn-Cover	46	377.81		126.55	251.26	125.63
Corn-Corn	17	139.54			139.54	139.54
Average	41	333.20	29.49	126.55	271.36	158.94

Variable Net Income is gross income minus fallow and cover crop costs.
Annual Rotation Variable Net Income is Total Crop Net Income divided by the number of years to complete one rotation cycle.
Cover crops planted: March 9, 2021 on 12-in. row spacings.
Sampled and terminated spring cover crops: June 12, 2021.
The cover crops made 2811 lb/a.
Corn price: $8.16/bu.

Corn Production, With & Without Fallow, and Cover Crops in Fallow, Annual Rotation Variable Net Income, 2021-2022.

Rotation	Annual Rotation Variable Net Income 2021	 2022	Total Annual Rotation Varible Net Income	Average Annual Rotation Variable Net Income
	--------------------------------$/a			----------------------------------
Corn-Fallow	315.20	211.64	526.84	263.42
Corn-Cover	273.95	125.63	399.58	199.79
Corn-Corn	546.27	139.54	685.81	342.90
Average	378.47	158.94	537.41	268.70

Variable Net Income is gross income minus fallow and cover crop costs.
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.

We planted the W-F winter cover crops on August 1, 2020 after wheat harvest. We planted the cover crops in good soil moisture, and there was enough moisture at planting and throughout the season for seedling emergence and growth for good cover crop forage. The cover crops were terminated April 24, 2021 with a mix of glyphosate 32 oz/a, flumioxazin 2.5 oz/a, Stare Down 6.4 oz/a, Sharpen 2.0 oz/a, MSO 16 oz/a, and AMS 2 lb/a. For the wheat phase of the W-S-F rotation, we planted the spring cover crops in the W-S-F rotation on March 9, 2021 during the fallow period after sorghum harvest. There was enough moisture at planting and throughout the season for seedling emergence and plant stands. The spring cover crops produced good forage, except for the rapeseed cover crop which did not emerge. We terminated the spring cover crops on June 12, 2021 and controlled weeds in the N plots with an application of glyphosate 32 oz/a, 2,4-D ester 12 oz/a, flumioxazin 2.5 oz/a, StareDown 6.4 oz/a, NIS 8 oz/a, and AMS 1.0 lb/a. We planted both the W-S-F and the W-F wheat on October 7, 2021 with Avery at 50 lb/a and seedrow applied 10-34-0 at 5 gal/a at planting. It was too dry at wheat planting for seedling emergence and the drought continued throughout the wheat growing season, so no wheat was harvest in 2022 for either the W-F or W-S-F rotations. Since it was too dry for the wheat to emerge, no in-season weed control was used on the wheat. We planted the winter cover crops prior to sorghum planting in the W-S-F rotation on September 27, 2021, into wheat stubble in dry soil moisture, and we sprayed a tank mix of glyphosate 32 oz/a, Sharpen 0.75 oz/a, NIS 12 oz/a, and AMS 2.0 lb/a prior to planting cover crops and to control weeds in the N plots. Because of droughty conditions, the cover crops failed to emerge and grow. Prior to grain sorghum planting, we sprayed a mix of glyphosate 32 oz/a, StareDown 6.4 oz/a, flumioxazin 2.5 oz/a, MSO 16 oz/a, and AMS 2 lb/a. We planted Pioneer 86P20 at 34,000 seeds/a on May 27, 2022 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 atrazine 0.75 lb/a and Brox 2EC 24 oz/a.

No wheat was harvested in the W-F and W-S-F rotations because of drought. We harvested the W-S-F grain sorghum on November 23, 2022, with a modified Gleaner F3 combine equipped with a HarvestMaster H2 weighing system. Grain yields were adjusted to 14.0% seed moisture content for grain sorghum.

Results and Discussion

This year, we were able to harvest the grain sorghum crop in the W-S-F rotation, but the wheat crops in both the W-S-F and the W-F rotations failed to emerge because of drought conditions from wheat planting throughout the wheat growing season. Grain sorghum yields were good for all the cover crops and N treatments. The winter cover crops preceding wheat planting for the W-F rotation and the spring cover crops preceding wheat planting for the W-S-F rotation survived, but the winter cover crops failed to emerge prior to grain sorghum planting for the W-S-F rotation. Thus far, 2020, 2019 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, including this year, either the cover crops did not survive, or the wheat crop was lost to hail, drought, or was winterkilled.

Grain Sorghum Phase, W-S-F Rotation

Precipitation from planting to termination of the winter cover crops (eight months, September 2021 through April 2022) for the grain sorghum phase of the W-S-F rotation was 3.30 in. The eight months of the cover crop growing season was too dry for cover crop growth prior to sorghum planting. No soil water was used by the cover crops since they did not grow; therefore, the cost of planting the cover crops (seed and drilling) was expenses without benefits.

The treatment with the highest grain sorghum yield was the hairy vetch treatment with 48.6 bu/a, which was significantly higher than the lowest yielding treatment, wheat cover, 31.7 bu/a. There were no significant yield differences between any of the other cover crops or N treatments.

The 25N treatment produced the highest variable net income, $300/a, because it had the second highest grain yield and much less treatment cost than hairy vetch. The hairy vetch treatment was second in variable net income, averaging $278/a, because it had the high grain sorghum yield, which more than compensated for its highest treatment cost. The lowest variable net income of $204/a was from wheat cover, which had the lowest yield and the third lowest treatment cost.

After six cropping years of grain sorghum harvest, the highest average annual variable net income was the 0N treatment with $144/a, which was only $7/a higher than the 25N treatment, the second highest treatment. All the N treatments had higher average annual variable net incomes than all the cover crop treatments. The cover crop treatment with the highest average annual variable net income was rapeseed with $103/a. The average annual income of the rapeseed cover crop was $11/a better than any of the other cover crops.

Wheat, W-F Rotation

Precipitation from planting to termination of the winter cover crops (eight months, September 2020 through April 2021) for the W-F rotation was 5.75 in. After eight months of growth, the average dry matter production of the cover crops was 2730 lb/a. The cover crops forage yields ranged from 1843 lb/a for hairy vetch cover to 3577 lb/a for wheat cover. Wheat cover had significantly higher forage yield than rapeseed, Winter N Mix, and hairy vetch at the 0.20 alpha level.

When terminated after eight months of growth, the cover crops preceding the wheat had these changes in available soil water (at termination minus at planting): -0.60 in. for wheat, -0.61 in. for rapeseed, -0.53 in. for hairy vetch, and +0.24 in. for Winter N Mix of soil water to a depth of three feet. The fallow 0N check (at termination minus at planting) gained +0.27 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 gained during no-till fallow equals the water use cost of cover crops. The water use cost to a soil water depth of three feet was: 0.87 in. for wheat, 0.88 in. for rapeseed, 0.80 in. for hairy vetch, and 0.03 in. for Winter N Mix. Water use by the cover crops was around 0.8 in. or higher for three of the four cover crops tested.

No wheat in the W-F rotation was harvested in any of the cover crops or N treatments because of drought from wheat planting through the wheat growing season.

All treatments had negative incomes because all cover crops had seed and planting expenses, and the N treatments had N fertilizer expenses, except the 0N check which had no variable costs.

After six cropping years, encompassing three years of wheat crop failures, the 0N treatment of the W-F rotation had the highest average annual variable net income of $94/a, which was $10/a better than the second highest treatment, the 25N treatment. The average annual income of the rapeseed cover crop was $18/a better than any of the other cover crops, and only $4/a less than the 25N treatment.

Wheat Phase, W-S-F Rotation

Precipitation from planting to termination of the spring cover crops (three-and-one-half months, March 2021 through mid-June 2021) for the wheat phase of the W-S-F rotation was 8.50 in. Conditions were wet for cover crop planting and cover crop growth. The spring cover crops made very good forage yields, especially considering their growth period was only three-and-one-half months long. After three-and-one-half months of growth, the average dry matter production of the spring cover crops was 2086 lb/a. The rapeseed cover did not emerge and did not produce forage. The lack of rapeseed emergence may have been due to old, low germinating seed, or to residual herbicides that affected its germination. Of the treatments that produced forage, cover crop forage yields ranged from 1725 lb/a for hairy vetch cover to 3501 lb/a for Spring N Mix. Spring N Mix cover had significantly higher forage yield than oats and hairy vetch at the 0.20 alpha level.

When terminated after three-and-one-half months of growth, the cover crops preceding wheat had these changes in available soil water (at termination minus at planting): -0.85 in. for oats, -1.17 in. for hairy vetch, and -1.94 in. for Spring N Mix of soil water to a depth of three feet. Since the rapeseed cover did not emerge and had no forage growth, the rapeseed cover had a gain of +0.35 in. The fallow 0N check (at termination minus at planting) gained +0.39 in. of soil water to a depth of three feet during the same three-and-one-half months. Therefore, subtracting soil water used by cover crops from soil water gained 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: 1.24 in. for oats, 1.56 in. for hairy vetch, 2.33 in. for Winter N Mix, and 0.04 in. for rapeseed. Water use by the cover crops averaged 1.7 in. for the three cover crops that had forage growth.

The wheat failed in all cover crops and N treatments because of drought conditions from wheat planting throughout the wheat growing season. All treatments had negative incomes because all cover crops had seed and planting expenses, and the N treatments had N fertilizer expenses, except the 0N check which had no variable costs.

After six cropping years of the wheat phase of the W-S-F rotation, that spanned three years of wheat crop failures, the highest average annual variable net income was the 0N treatment with $79/a, which was only $7/a higher than 25 N, second highest treatment. The cover crop treatment with the highest average annual variable net income was rapeseed with $61/a. The average annual income of the rapeseed cover crop was only $3/a better than the oats cover crop, and $3/a better than the 50 N treatment.

Conclusion

The 0N treatment had the highest average annual variable net income after six cropping years for both the wheat and grain sorghum crops of both the W-F and W-S-F crop rotations compared to all the winter and spring cover crops and N treatments. The 25 N treatment had the second highest average annual variable net income for both crops and both rotations. The cover crop with the highest average annual variable net income was rapeseed, and the rapeseed treatment income from wheat was a few dollars higher than the 50N treatment. The overall trend of increasing average annual variable net income after six cropping years is that the lowest cost treatments have the highest incomes. This increasing income trend with low-cost treatments is especially evident for crop failure and low crop production years.

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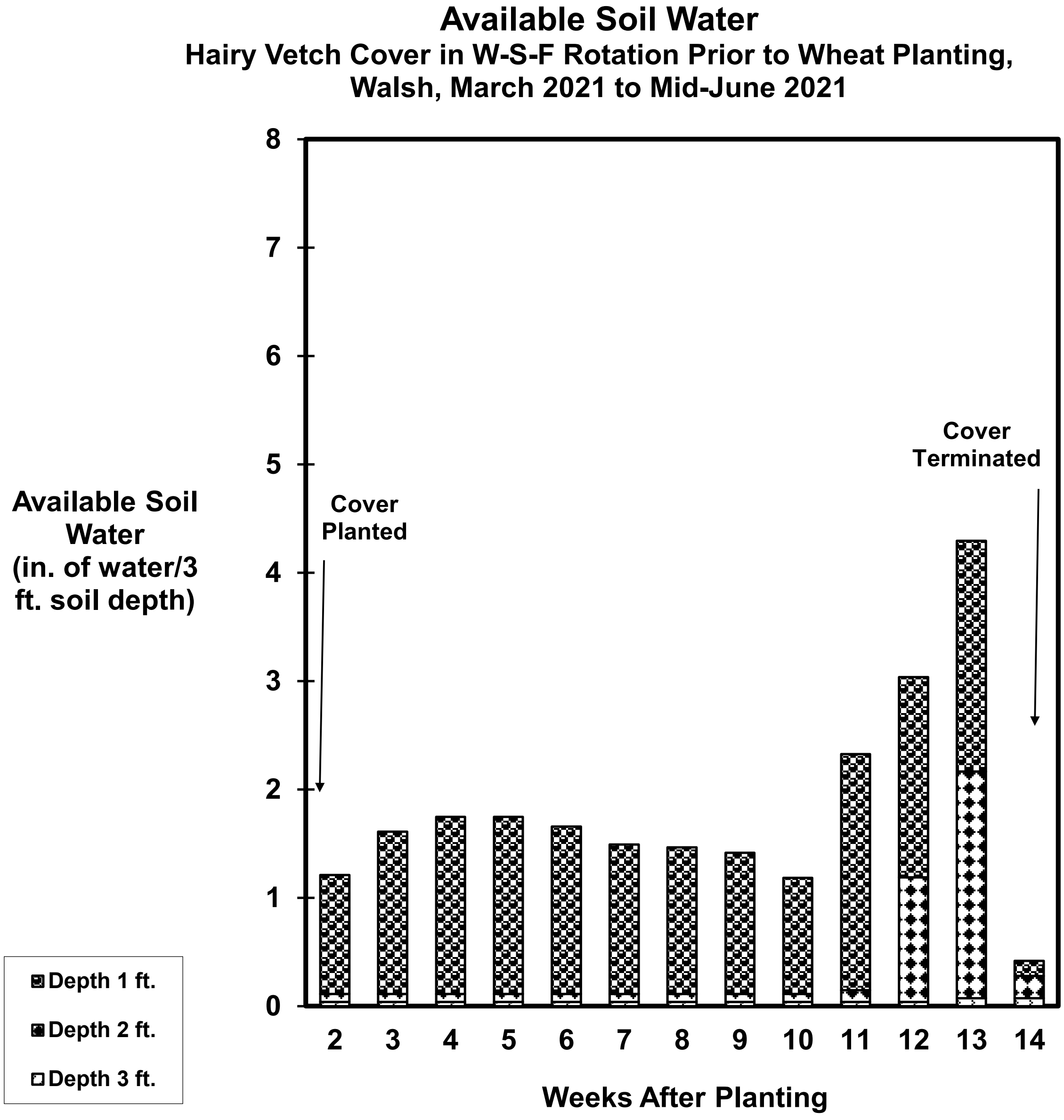
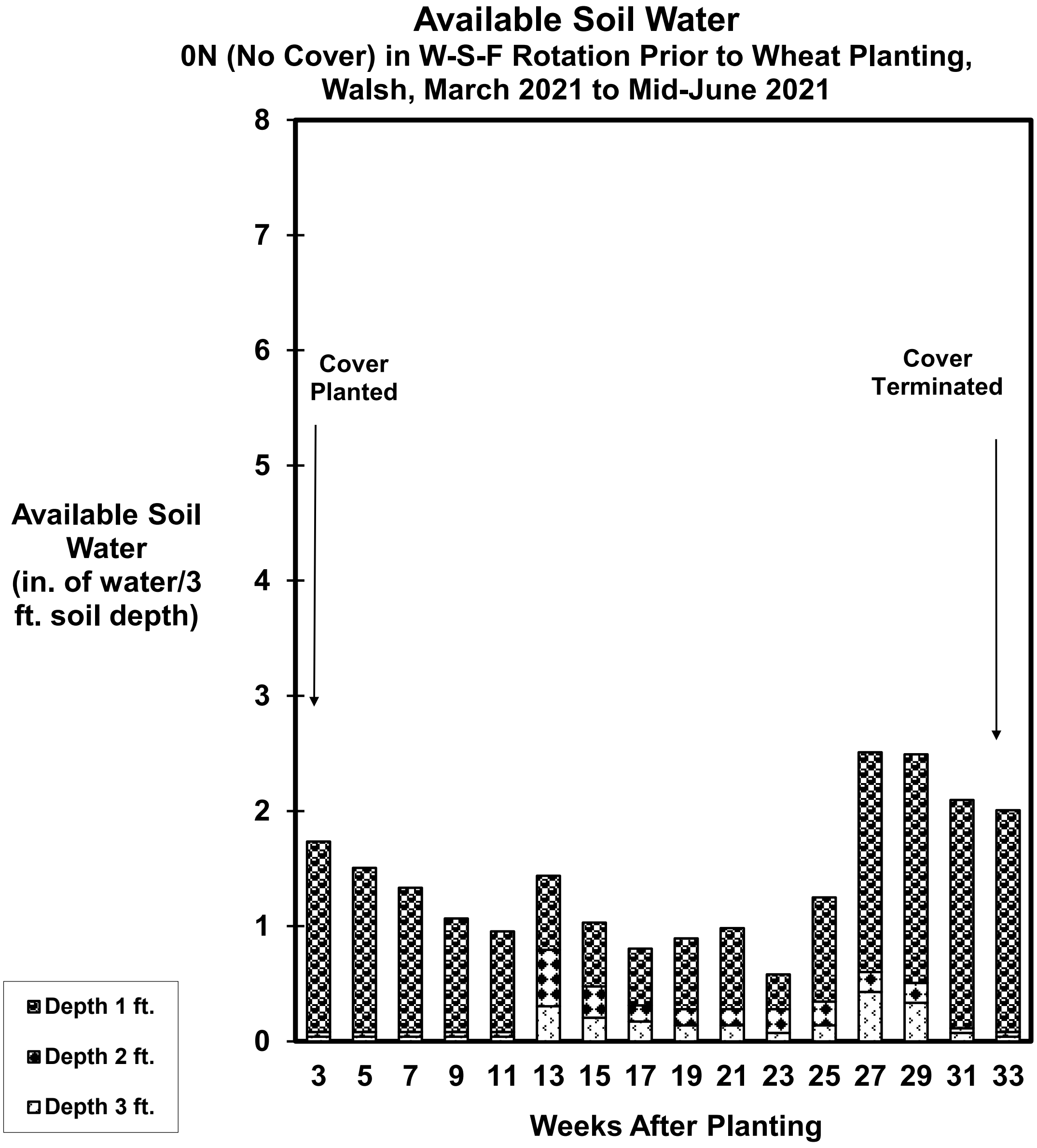
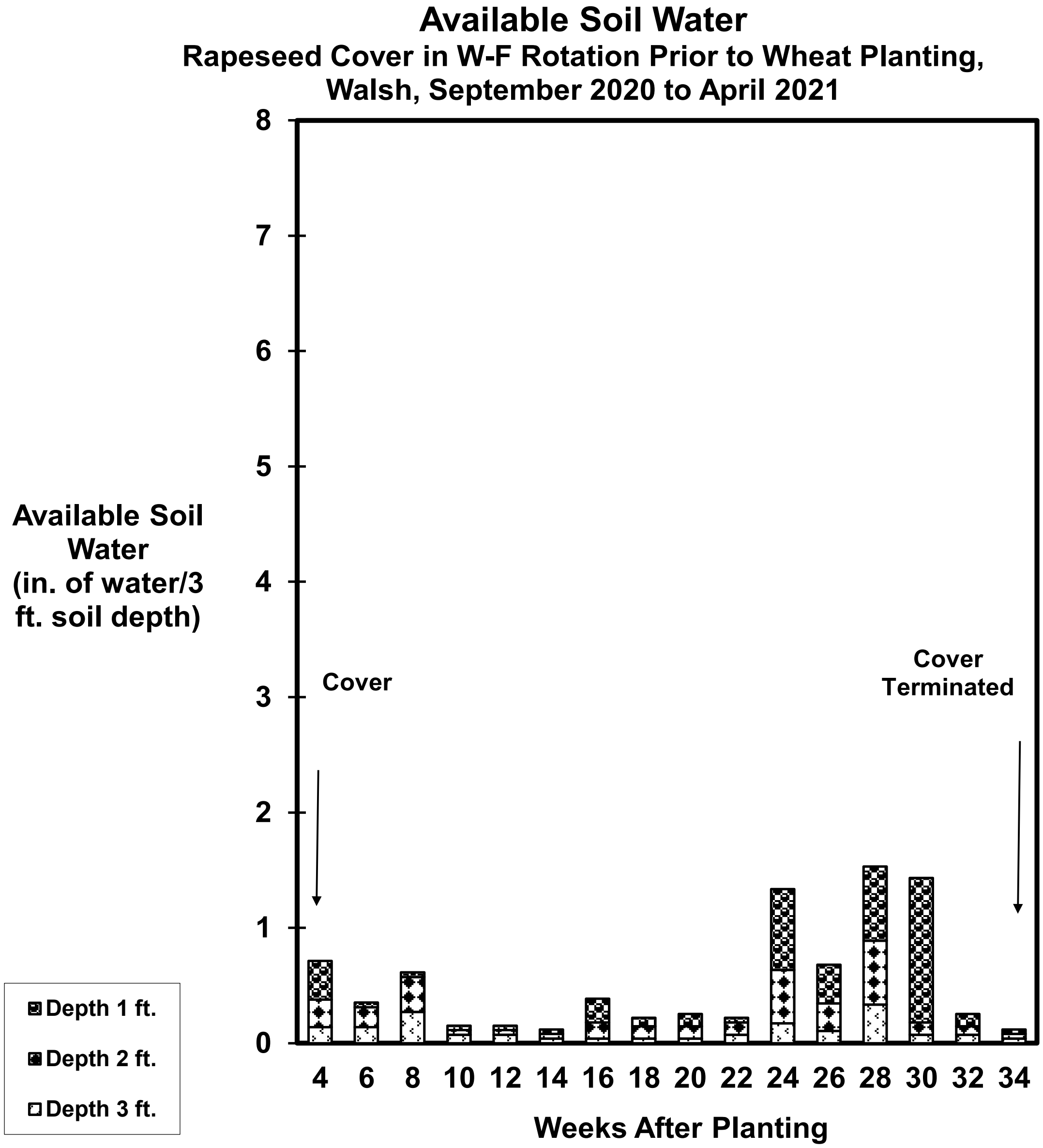


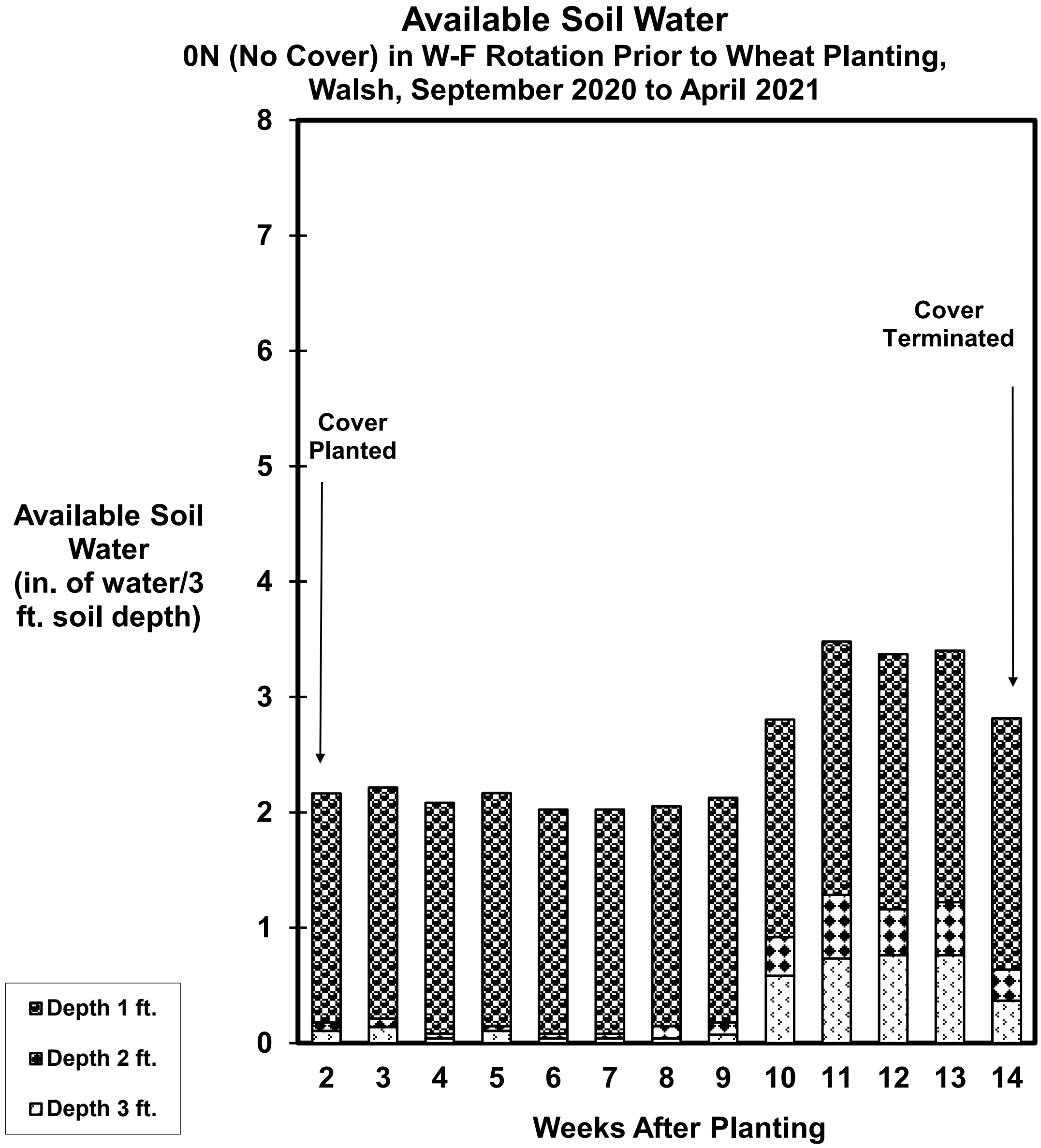
Available soil water of hairy vetch cover in W-S-F Rotation prior to wheat planting at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 8.50 in. Any increase in available soil water between weeks is from rain.



Available soil water of 0N (no cover) in W-S-F Rotation prior to wheat planting at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 8.50 in. Any increase in available soil water between weeks is from rain.



Available soil water of rapeseed 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 5.75 in. Any increase in available soil water between weeks is from rain.



Available soil water of 0N (no cover) in W-S-F Rotation prior to wheat planting at Walsh. Gypsum block measurements taken to 3 ft. with 1 ft. increments. Total rainfall at Walsh from cover crop planting to cover crop termination was 8.50 in. Any increase in available soil water between weeks is from rain.

Cover Crop Study, Grain Sorghum (W-S-F) after Winter Cover Crop, Walsh, 2022.

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
Hairy Vetch	48.6	60.3	0	0.0	0.0	69.00	0.00	277.52
Rapeseed	35.1	59.8	0	0.0		16.75		233.51
Winter N Mix	35.2	59.7	0	0.0	0.0	46.25	0.00	204.73
Wheat	31.7	60.2	0	0.0		22.42		203.60
0 N	36.6	60.0				0.00		260.96
25 N	45.3	60.5				22.50		300.49
50 N	40.4	60.5				38.50		249.55
Average	39.0	60.1	0	0.0		30.77		247.19
LSD 0.20	16.89		0					

Cover crops planted: September 27, 2021.
Cover crops did not emerge. It was too dry.
Grain sorghum planted: May 27, 2022; Harvested: November 23, 2022.
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; wheat, 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, $10.42/a.
N fertilizer cost: 28-0-0, $0.64/lb.
Treatment application cost: cover crop planting, $12/a; N application, $6.50/a.
Grain sorghum price: $7.13/a.

Cover Crop Study, Wheat (W-S-F) after Spring Cover Crop, Walsh, 2022.

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
Rapeseed	0	0	0	0.0		16.75		-16.75
Oats	0	0	3116	117.5		20.33		-20.33
Spring N Mix	0	0	3501	126.7	9.2	46.25	5.89	-40.36
Hairy Vetch	0	0	1725	63.5	0.0	69.00	0.00	-69.00
0 N	0	0				0.00		0.00
25 N	0	0				22.50		-22.50
50 N	0	0				38.50		-38.50
Average	0	0	2086	76.9		30.48		-29.63
LSD 0.20	0.0		349.6					

Cover crops planted: March 9, 2021.
Cover crops hand-sampled and terminated: June 12, 2021
Wheat planted: October 7, 2021, Avery at 50 lb seed/a, 5 gal/a of 10-34-0.
Wheat was not harvested. It was too dry to emerge.
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, $0.64/lb.
Treatment application cost: cover crop planting, $12/a; N application, $6.50/a.
Wheat price: $8.33/bu.

Cover Crop Study, Wheat (W-F) after Winter Cover Crop, Walsh, 2022.

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
Rapeseed	0	0	2812	74.6		16.75		-16.75
Wheat	0	0	3577	124.8		22.42		-22.42
Winter N Mix	0	0	2689	94.1	0.0	46.25	0.00	-46.25
Hairy Vetch	0	0	1843	65.2	0.0	69.00	0.00	-69.00
		0						
0 N	0	0				0.00		0.00
25 N	0	0				22.50		-22.50
50 N	0	0				38.50		-38.50
Average	0	0	2730	89.7		30.77		-30.77
LSD 0.20	0		571.2					

Cover crops planted: September 1, 2020.
Cover crops terminated April 24, 2021.
Wheat planted: October 7, 2021, Avery 50 lb/a and 5 gal/a of 10-34-0.
Wheat was not harvested. It was too dry to emerge.
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, $10.42/a.
N fertilizer cost: 28-0-0, $0.64/lb.
Treatment application cost: cover crop planting, $12/a; N application, $6.50/a.
Wheat price: $8.33/bu.

Cover Crop Study, Grain Sorghum (W-S-F) after Winter Cover Crop, Annual Variable Net Income, Walsh, 2017 to 2022.

Treatment	2017	2018	2019	2020	2021	2022	Total Annual Variable Net Income	Average Annual Variable Net Income
	Annual Variable Net Income							
	$/a							
Rapeseed	231.00	97.98	117.56	4.34	166.74	233.51	617.61	102.94
Hairy Vetch	248.67	93.10	77.30	-35.50	170.46	277.52	554.02	92.34
Wheat	189.25	45.07	73.72	13.80	219.96	203.60	541.79	90.30
Winter N Mix	210.50	50.19	108.83	-24.55	150.51	204.73	495.47	82.58
0 N	281.25	109.53	123.09	26.64	325.43	260.96	865.93	144.32
25 N	282.25	115.10	126.05	13.25	286.77	300.49	823.42	137.24
50 N	260.25	92.73	102.51	4.70	263.85	249.55	724.03	120.67
Average	243.31	86.24	104.15	0.38	226.24	247.19	660.33	110.05

Rapeseed cover crop was canola or rapeseed.
Wheat cover crop was wheat or triticale.
Variable Net Income is gross income minus cover crop and N treatment costs.
Annual Variable Net Income is Total Crop Variable Net Income divided by years in study.

Cover Crop Study, Wheat (W-S-F) after Spring Cover Crop, Annual Variable Net Income, Walsh, 2017 to 2022.

Treatment	Annual Variable Net Income 2017	2018	2019	2020	2021	2022	Total Annual Variable Net Income	Average Annual Variable Net Income
	---------------$/a---------------							
Rapeseed	-16.75	51.16	280.75	-13.31	63.82	-16.75	365.68	60.95
Oats	-24.60	44.89	298.17	-16.03	48.19	-20.33	350.62	58.44
Spring N Mix	-41.65	40.85	269.75	-32.70	23.78	-40.36	260.03	43.34
Hairy Vetch	-69.00	3.77	236.50	-64.70	21.36	-69.00	127.93	21.32
0 N	0.00	67.91	308.50	12.47	83.58	0.00	472.47	78.74
25 N	-18.50	64.43	321.50	-1.17	66.82	-22.50	433.08	72.18
50 N	-31.00	36.72	312.00	-8.31	37.74	-38.50	347.15	57.86
Average	-28.79	44.25	289.60	-17.68	49.33	-29.63	336.71	56.12

Rapeseed cover crop was canola or rapeseed.
Variable Net Income is gross income minus cover crop and N treatment costs.
Annual Variable Net Income is Total Crop Variable Net Income
divided by years in study.

Cover Crop Study, Wheat (W-F) after Winter Cover Crop, Annual Variable Net Income, Walsh, 2017 to 2022.

Treatment	2017	2018	2019	2020	2021	2022	Total Annual Variable Net Income	Average Annual Variable Net Income
	Annual Variable Net Income							
	$/a							
Rapeseed	-16.75	52.78	321.25	6.04	131.59	-16.75	478.16	79.69
Hairy Vetch	-69.00	22.09	353.67	-11.03	140.89	-69.00	367.62	61.27
Winter N Mix	-46.25	44.30	295.75	-14.00	105.86	-46.25	339.41	56.57
Wheat	-28.80	55.67	273.50	-46.06	92.49	-22.42	324.38	54.06
0 N	0.00	62.52	331.50	13.76	153.61	0.00	561.40	93.57
25 N	-18.50	39.63	316.50	1.41	160.95	-22.50	499.99	83.33
50 N	-31.00	39.95	319.50	-1.86	124.34	-38.50	450.93	75.15
Average	-30.04	45.28	315.95	-7.39	129.96	-30.77	431.70	71.95

Rapeseed cover crop was canola or rapeseed.
Wheat cover crop was wheat or triticale.
Variable Net Income is gross income minus cover crop and N treatment costs.
Annual Variable Net Income is Total Crop Variable Net Income
divided by years in study.

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 identify 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 eleventh 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 8 oz/a, 2,4-D 12 oz/a, AMS 2 lb/a two times prior to the wheat and grain sorghum crops for the W-S-F rotation and three times for the W-F rotation. To the first fallow chemical application, we added flumioxazin 3.0 oz/a. No wheat emerged because of drought, so no in-season weed control was applied to the wheat. For pre-emergence weed control, we applied atrazine 1 lb/a, mesotrione 6.4 oz/a, and Medal 24 oz/a for the grain sorghum. 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 October 1, 2021. For the sorghum crop, we planted Pioneer 86P20 at 34,000 seeds/a on May 27, 2021 and seedrow applied 5 gal 10-34-0/a at planting. No wheat was harvested because of droughty conditions from fall planting through the spring. We harvested the grain sorghum on November 17, 2022, using a modified Gleaner F3 combine equipped with a HarvestMaster H2 weighing system. Seed moisture content for the yields were adjusted to 12% for wheat and 14% for grain sorghum. We recorded cost of production and yields to determine conversion and rotation revenues.

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 five wheat crops have been harvested, but this is our eleventh harvested grain sorghum crop. The first wheat crop, following our initial burn down or tillage to control the perennial grasses, and the 2016, 2018, 2019, and 2021 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.

In 2019, we harvested both the wheat and grain sorghum crops. This was 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.

In 2020, we harvested only the grain sorghum crop. The wheat crop failed because conditions were too dry throughout the wheat growing season. The chemical and tillage treatments were treated the same since we suspended the tillage operations in March of 2015. Grain sorghum yields were low averaging 10.2 bu/a and only 0.7 bu/a separated the chemical and old tillage treatments. With similar yields and the same treatment cost, there was only $3.88 difference between the treatments in variable net income. These minor yield and income differences is not surprising since we treated the chemical and tillage treatments the same.

In 2021, we harvested both the grain sorghum and wheat crops. However, the wheat crop was poor, averaging less than 2 bu/a, because conditions were very dry throughout the wheat growing season. This was only the fifth time that we have harvested a wheat crop in the ten years of this study. The chemical and tillage treatments were treated the same since we suspended the tillage operations in March of 2015. Grain sorghum yields were exceptionally high, averaging 94.5 bu/a, and only 0.1 bu/a separated the chemical and old tillage treatments. With similar yields and the same treatment cost (both tillage and chemical were treated the same), there was only $0.58 difference between the treatments in variable net income.

This year, the wheat did not emerge because of drought conditions at planting and throughout the wheat growing season. The no wheat harvest has been a common theme throughout this CRP conversion study. The tillage treatment grain sorghum yield was 6.3 bu/a higher than the chemical treatment. This significant yield difference between tillage and chemical treatments is surprising because the tillage and chemical treatments have been treated the same since March 2015. We have no explanation for the significant yield difference between tillage and chemical treatments. In 2019, a similar occurrence happened where the grain sorghum yield of the tillage treatment was significantly higher than the chemical treatment. In 2019, like this year, we had no explanation for the yield difference, especially considering that tillage and chemical treatments were treated the same.

Average annual rotational variable net income for the last six years of this study (2017 to 2022) produced positive incomes for the W-F rotation, $4/a for the chemical treatment and $6/a for the tillage treatment. This is the fourth time in ten years that the total rotational variable net income was positive for W-F and it was due to the exceptionally high wheat yields in 2019, especially since there were negative wheat incomes this year and in 2021, because there were no wheat yields this year and poor wheat yields in 2021. By 2013, after the second grain sorghum crop, the W-S-F rotation was producing positive rotational variable net incomes. Grain sorghum production of the W-S-F rotations accounted for most of their average annual rotational variable net incomes from 2017 to 2022, $233/a for the chemical treatment and $238/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 tillage treatment for the W-S-F rotation produced an average of $5/a more than the chemical treatment; moreover, the tillage treatment for the W-F rotation produced an average of $2/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, Eleventh Season, Wheat-Sorghum-Fallow and Wheat-Fallow, Wheat Crop, Walsh, 2022.

CRP Conversion	Rotation	Test Weight	Wheat Yield	Gross Income	Treatment Cost	Variable Net Income
		lb/bu	bu/a	$/a	$/a	$/a
Tillage	W-F		0	0.00	79.35	-79.35
Chemical	W-F		0	0.00	79.35	-79.35
Tillage	W-S-F		0	0.00	79.35	-79.35
Chemical	W-S-F		0.0	0.00	79.35	-79.35
Average		0.0	0.0	0.00	79.35	-79.35
LSD 0.20						

Chemical: glyphosate 32 oz/a, dicamba 8 oz/a, 2,4-D 12 oz/a, AMS 2 lb/a applied three times. Flumioxazin 2.5 oz/a was included with first application.
Chemical cost: $17.89/a (3X), $6.18/a (1X) and $6.50/a (3X) application cost.
No wheat emergence due to drought, so no post chemical application cost.
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 at planting.
Wheat planted on October 1, 2021; Harvested: July 28, 2021.
wheat price: $8.33/bu.
Variable Net Income is Gross Income minus Treatment Cost.

Long Term CRP Conversion After Using Tillage or Chemical, Eleventh Season
Wheat-Sorghum-Fallow, Grain Sorghum Crop, Walsh, 2022.

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	58.6	47.0	335.11	54.96	280.15
Chemical	W-S-F	58.0	40.7	290.19	54.96	235.23
Average		58.3	43.9	312.65	54.96	257.69
LSD 0.20			2.16			

Fallow chemical: glyphosate 32 oz/a, dicamba 8 oz/a, 2,4-D 12 oz/a, AMS
2 lb/a applied two times. Flumioxazin 3.0 oz/a included with first application.
Chemical cost: $17.89/a (2X), $6.18/a (1X), and $6.50/a (2X) application cost.
Pre-emergence chemical: Atrazine 1 lb/a, Mesotrione 6.4 oz/a, Medal 24 oz/a.
Pre-emergence chemical cost: $22.26/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 May 27; harvested on November 17, 2022.
Grain sorghum price: $7.13/bu.
Variable Net Income is Gross Income minus Treatment Cost.

CRP Conversion, Chemical and Tillage Comparison, Annual Rotational income, 2017 to 2022.

Rotation and Conversion Treatment	Annual Rotation Variable Net Income 2017	2018	2019	2020	2021	2022	Total Annual Rotation Variable Net Income	Average Annual Rotation Variable Net Income
	$/a							
Chem								
W-S-F	269.62	200.90	424.40	-77.66	426.89	155.88	1400.03	233.34
W-F	-66.20	36.13	247.98	-69.03	-47.36	-79.35	22.17	3.70
Tillage								
W-S-F	266.02	202.41	402.84	-73.51	428.98	200.80	1427.54	237.92
W-F	-66.20	37.21	257.22	-69.03	-43.89	-79.35	35.96	5.99
Average	100.81	119.16	333.11	-72.31	191.16	49.50	721.43	120.24

The first wheat crop was 2013. There was no wheat harvested in 2014 (winterkill); 2015 (hail); 2017, 2020, and 2022 (too dry, poor emergence).
Variable Net Income is gross income minus 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.