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Alternative Cropping Systems with Limited Irrigation

Abstract

A limited irrigation study involving four cropping systems and evaluating four crop rotations was initiated at the Southwest Research-Extension Center near Tribune, KS, in 2012. The cropping systems were two annual systems (continuous corn [C-C] and continuous grain sorghum [GS-GS]) and two 2-year systems (corn- grain sorghum [C-GS]) and corn-winter wheat [C-W]). In 2017, corn yields were greatest in the corn-wheat rotation and least with continuous corn. Grain sorghum yields were greater following sorghum than following corn. The wheat was destroyed by a severe infestation of wheat streak mosaic virus and not harvested.

Keywords

alternative cropping systems, limited irrigation, southwest Kansas irrigation

Cover Page Footnote

The project was funded in part by Western Kansas Groundwater Management District No. 1.

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Alternative Cropping Systems with Limited Irrigation

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Summary

A limited irrigation study involving four cropping systems and evaluating four crop rotations was initiated at the Southwest Research-Extension Center near Tribune, KS, in 2012. The cropping systems were two annual systems (continuous corn [C-C] and continuous grain sorghum [GS-GS]) and two 2-year systems (corn- grain sorghum [C-GS]) and corn-winter wheat [C-W]). In 2017, corn yields were greatest in the corn-wheat rotation and least with continuous corn. Grain sorghum yields were greater following sorghum than following corn. The wheat was destroyed by a severe infestation of wheat streak mosaic virus and not harvested.

Experimental Procedures

A crop rotation study under sprinkler irrigation at the Kansas State University Southwest Research-Extension Center near Tribune, KS, was initiated in the spring of 2012. The study evaluates four different crop rotations with a limited irrigation allocation. The rotations include 1- and 2-year rotations. The crop rotations are 1) continuous corn; 2) corn-winter wheat; 3) corn-grain sorghum; and 4) continuous grain sorghum (a total of 6 treatments). All rotations are limited to 10 inches of irrigation water annually. All crops are grown no-till, while other cultural practices (hybrid selection, fertility practices, weed control, etc.) are selected to optimize production. All phases of each rotation are present each year and replicated four times. Irrigations are scheduled to supply water at the most critical stress periods for the specific crops and limited to 1.5 inches/week. Soil water is measured at planting, during the growing season, and at harvest in 1-ft increments to a depth of 8 ft. Grain yields are determined by machine harvest. Nitrogen fertilizer (UAN) was surface applied (stream) in March to all crops (240 lb N/a for corn, 160 lb N/a for sorghum, and 120 lb N/a for wheat). Corn was planted on April 27, 2017, and harvested on October 12, 2017. Grain sorghum was planted on June 2, 2017, and harvested on October 30, 2017. Wheat was planted on September 24, 2016, and abandoned on June 22, 2017.

Results and Discussion

Wheat yields were zero in 2017 because of a severe infestation of wheat streak mosaic virus (Table 1). Weather conditions for summer crops were good in 2017. Precipitation was above normal for April, May, July, August, and September. Corn yields in 2017 were greatest with corn-wheat (211 bu/a) and least with continuous corn (154 bu/a). Grain sorghum yields were greater following corn than following grain sorghum. De-

spite the favorable precipitation, grain sorghum yields were less in 2017 than the multi-year average (Table 2).

Available soil water at corn planting and harvest was similar for all rotations in 2017 (Table 3). Fallow efficiency was less following corn than following either wheat or grain sorghum. For wheat, available soil water at planting and harvest was greater than the 4-yr average (Table 4). The only difference observed with grain sorghum was more fallow accumulation for grain sorghum following grain sorghum than following corn. This was consistent with the average fallow accumulation for the past 4 years. Average crop water use was much greater for corn (~6 inch) in 2017 because of the greater than normal precipitation (>22 inch growing season precipitation) while grain sorghum water use was about 2 inch above the long-term average. There were no differences in crop water use due to rotation for either crop.

Acknowledgment

The project was funded in part by Western Kansas Groundwater Management District No. 1.

Table 1. Grain yield of three crops under limited irrigation as affected by rotation in 2017

Rotation	Corn	Wheat	Sorghum
	---------- bu/a ----------		
Continuous corn	154	---	---
Continuous sorghum	---	---	124
Corn-wheat	211	0	---
Corn-sorghum	173	---	108
Least significant difference$_{(0.05)}$	44	---	7

Table 2. Grain yields of three crops under limited irrigation as affected by rotation across years 2013–2017

Rotation	Corn	Wheat	Sorghum
	---------- bu/a ----------		
Continuous corn	167b	---	---
Continuous sorghum	---	---	134b
Corn-wheat	189a	51	---
Corn-sorghum	181ab	---	143a
Least significant difference$_{(0.05)}$	16	---	6

Table 3. Profile available soil water, crop water use, and fallow accumulation for crop rotations under limited irrigation, Tribune, KS, 2017

		Available water					
Crop	Rotation	Previous harvest	Planting	Harvest	Crop water use	Fallow accumulation	Fallow efficiency
		in.					%
Corn	C-C	14.85	14.66	14.42	33.08	-0.19	-4c
	C-W	12.69	14.58	13.61	33.81	1.90	16b
	C-GS	11.37	13.03	13.03	32.84	1.66	39a
$LSD_{0.05}$		3.05	2.05	1.35	0.89	1.78	20
ANOVA (P > F)							
System		0.080	0.169	0.113	0.083	0.055	0.006
Wheat	C-W	15.94	15.94	14.02	20.44	0	---
ANOVA (P > F)							
System		---	---	---	---	---	---
Sorghum	C-GS	15.27	16.16	14.50	25.89	0.89	7
	GS-GS	11.32	15.49	13.42	26.30	4.17	35
$LSD_{0.05}$		4.29	2.56	3.13	0.65	1.80	15
ANOVA (P > F)							
System		0.061	0.465	0.351	0.138	0.010	0.010

Note: All crops received ~10 inches of irrigation.
In season rainfall for corn (4/27/17–10/09/17) = 22.83 inches; sorghum (6/06/17–10/31/17) = 15.13 inches; and wheat (9/15/16–6/22/17) = 13.90 inches.
C = corn.
W = wheat.
GS = grain sorghum.
LSD = least significant difference.
ANOVA = analysis of variance.

Table 4. Profile available soil water, crop water use, and fallow accumulation for crop rotations under limited irrigation across years, Tribune, KS, 2013-2017

		Available water					
Crop	Rotation	Previous harvest	Planting	Harvest	Crop water use	Fallow accumulation	Fallow efficiency
		in.					%
Corn	C-C	11.38a	13.87a	12.50a	26.74	2.50b	28b
	C-W	10.61ab	13.89a	12.43a	26.82	3.27a	22b
	C-GS	9.64b	12.11b	10.76b	26.72	2.47b	50a
$LSD_{(0.05)}$		1.06	0.82	0.94	0.77	0.52	7
ANOVA (P > F)							
System		0.008	0.001	0.001	0.958	0.005	0.001
Year		0.001	0.001	0.001	0.001	0.001	0.001
System × year		0.001	0.006	0.016	0.001	0.001	0.001
Wheat	C-W	11.52	11.52	11.41	20.09	0	-
ANOVA (P > F)							
System		---	---	---	---	---	---
Year		0.001	0.001	0.001	0.001	---	---
System × year		---	---	---	---	---	---
Sorghum	C-GS	9.52	13.28	11.41	23.83	3.76	32
	GS-GS	9.53	12.84	11.16	23.64	3.31	37
$LSD_{(0.05)}$		0.99	0.85	0.87	0.53	0.63	9
ANOVA (P > F)							
System		0.979	0.304	0.559	0.480	0.158	0.294
Year		0.001	0.001	0.001	0.001	0.001	0.001
System × year		0.001	0.009	0.369	0.082	0.001	0.019

Note: All crops received ~10 inches of irrigation each year.
C = corn.
W = wheat.
GS = grain sorghum.
LSD = least significant difference.
ANOVA = analysis of variance.