Alternative Cropping Systems with Limited Irrigation

A. Schlegel and D. Bond

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 2018, corn yields were similar for all rotations, although averaged across the past 6 years, corn yields were greater following wheat than following corn. There were no significant differences in grain sorghum yields in 2018, which was similar to the multi-year average. Wheat yields were near the multi-year average.

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 per 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 May 3, 2018, and harvested on September 25, 2018. Grain sorghum was planted on June 4, 2018, and harvested on November 28, 2018. Wheat was planted on October 13, 2017, and harvested on July 6, 2018.

Results and Discussion

Wheat yields in 2018 (45 bu/a) were slightly less than the long-term average (50 bu/a) (Tables 1 and 2). Precipitation was near normal from April through September followed by a wet October that delayed sorghum harvest. Corn yields in 2018 were above the long-term average with no differences among rotations. In contrast to previous years, grain sorghum yields were greater following sorghum than corn, but because of

extreme variability the difference was not significant. The delayed harvest caused by above-normal late fall precipitation caused the grain sorghum to lodge, which may have reduced overall yields and increased variability. On average, corn yields are greatest following wheat and least following corn, with little difference in grain sorghum yields following corn or sorghum (Table 2).

Available soil water at corn and sorghum planting and harvest was similar for all rotations in 2018 (Table 3). Fallow efficiency was near zero or often negative because of wet soils at harvest in 2017. For wheat, available soil water at planting and harvest was greater than the 6-year average (Table 4). Averaged across the 6-year period, fallow accumulation prior to corn was greater following wheat than following sorghum or corn; however, fallow efficiency was greatest following sorghum (shortest fallow period). There were no differences in fallow accumulation or efficiency for grain sorghum following corn or sorghum. There were no differences in crop water use due to rotation for either crop.

Acknowledgement

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Table 1. Grain yield of three crops under limited irrigation as affected by rotation in 2018

Rotation	Corn	Wheat	Sorghum
	---------- bu/a ----------		
Continuous corn	214	---	---
Corn-wheat	232	45	---
Corn-sorghum	222	---	122
Continuous sorghum	---	---	142
$LSD_{0.05}$	19	---	43
ANOVA (P > F)			
System	0.141	--	0.235

LSD = least significant difference.
ANOVA = analysis of variance.

Table 2. Grain yields of three crops under limited irrigation as affected by rotation across years 2013–2018

Rotation	Corn	Wheat	Sorghum
	---------- bu/a ----------		
Continuous corn	175 b	---	---
Corn-wheat	196 a	50	---
Corn-sorghum	188 ab	---	139
Continuous sorghum	---	---	136
$LSD_{0.05}$	15	---	11
ANOVA (P > F)			
System	0.034	--	0.371

LSD = least significant difference.
ANOVA = analysis of variance.

Table 3. Profile available soil water, crop water use, and fallow accumulation for crop rotations under limited irrigation, Tribune, KS, 2018

		Available water					
Crop	Rotation	Previous harvest	Planting	Harvest	Crop water use	Fallow accumulation	Fallow efficiency
		inches					%
Corn	C-C	14.42	14.18	10.90	24.51	-0.24 b	-10
	C-W	14.02	14.81	11.53	24.51	0.79 a	5
	C-GS	14.50	13.94	10.74	24.43	-0.56 b	-24
$LSD_{0.05}$		2.90	2.89	3.87	1.38	0.79	24
ANOVA (P > F)							
System		0.909	0.760	0.873	0.987	0.014	0.064
Wheat	C-W	13.61	13.61	11.54	17.15	---	---
ANOVA (P > F)							
System		---	---	---	---	---	---
Sorghum	C-GS	13.03	13.18	13.46	23.61	0.15	4
	GS-GS	13.42	13.40	13.35	23.95	-0.01	0
$LSD_{0.05}$		1.53	1.85	1.61	0.77	0.75	18
ANOVA (P > F)							
System		0.480	0.723	0.842	0.259	0.544	0.544

Note: All crops received ~10 inches of irrigation.
In season rainfall for corn (5/01 - 9/19) = 11.06 inches; sorghum (6/04 - 11/07) = 13.73 inches; and wheat (10/09/17 - 7/06/18) = 7.52 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, 2013–2018

		Available water					
Crop	Rotation	Previous harvest	Planting	Harvest	Crop water use	Fallow accumulation	Fallow efficiency
		inches					%
Corn	C-C	11.88 a	13.92 a	12.23 a	26.37	2.04 b	21 b
	C-W	11.18 ab	14.04 a	12.28 a	26.44	2.86 a	19 b
	C-GS	10.45 b	12.42 b	10.76 b	26.34	1.97 b	38 a
$LSD_{(0.05)}$		0.96	0.72	0.85	0.66	0.52	7
ANOVA (P > F)							
System		0.016	0.001	0.001	0.951	0.002	0.001
Year		0.001	0.001	0.001	0.001	0.001	0.001
System × year		0.001	0.001	0.012	0.001	0.001	0.001
Wheat	C-W	11.87	11.87	11.43	19.60	---	---
ANOVA (P > F)							
System		---	---	---	---	---	---
Year		0.001	0.001	0.001	0.001	---	---
System × year		---	---	---	---	---	---
Sorghum	C-GS	10.10	13.26	11.75	23.79	3.16	28
	GS-GS	10.18	12.94	11.53	23.69	2.76	31
$LSD_{(0.05)}$		0.90	0.76	0.78	0.44	0.53	7
ANOVA (P>F)							
System		0.865	0.391	0.558	0.653	0.135	0.395
Year		0.001	0.001	0.001	0.001	0.001	0.001
System × year		0.001	0.005	0.467	0.064	0.001	0.017

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.