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Cover Page Footnote

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

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 and continuous grain sorghum) and two 2-year systems (corn-grain sorghum and corn-winter wheat). In 2020, corn yields were similar for all rotations, although averaged across the past 8 years, corn yields were greater following wheat than following corn. There were no significant differences in grain sorghum yields in 2020, which was similar to the multi-year average. Wheat yields were below 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 4, 2020, and harvested on September 29, 2020. Grain sorghum was planted on May 20, 2020, and harvested on October, 20, 2020. Wheat was planted on September 26, 2019, and harvested on July 1, 2020.

Results and Discussion

Wheat yields in 2020 (33 bu/a) were less than the long-term average (51 bu/a) (Tables 1 and 2). Precipitation was near normal from April through September (13.13 inches in 2020 vs. normal of 12.93 inches). Corn yields in 2020 were slightly below the long-term average with no differences among rotations. Grain sorghum yields were near the long-term average with no differences among rotations. On average, corn yields were 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 2020 (Table 3). Fallow accumulation prior to corn was greatest following wheat and least following sorghum, reflecting the available water at previous harvest and length of the fallow periods. Fallow efficiency prior to corn was greater following corn than sorghum, possibly because of the lower amount of available soil water at corn harvest in 2019 compared with sorghum harvest. Averaged across the 8-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) [Table 4]. For sorghum in 2020, fallow accumulation and efficiency were greater following corn than sorghum. Fallow accumulation prior to sorghum was also greater following corn than sorghum when averaged across the 8-year period. There were no differences in crop water use due to rotation for either crop in 2020 or averaged across years.

Acknowledgment

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Table 1. Grain yield of three crops under limited irrigation as affected by rotation in 2020

Rotation	Corn	Wheat	Sorghum
	---------- bu/a ----------		
Continuous corn	163	---	---
Corn-wheat	187	33	---
Corn-sorghum	180	---	132
Continuous sorghum	---	---	140
$LSD_{0.05}$	27	---	11
ANOVA (P > F)			
System	0.158	---	0.111

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

Table 2. Grain yields of three crops under limited irrigation as affected by rotation across years 2013–2020

Rotation	Corn	Wheat	Sorghum
	bu/a		
Continuous corn	175 b*	---	---
Corn-wheat	199 a	51	---
Corn-sorghum	187 ab	---	137
Continuous sorghum	---	---	135
$LSD_{0.05}$	17	---	6
ANOVA (P > F)			
System	0.041	---	0.585

LSD = least significant difference. ANOVA = analysis of variance.
* Means within a column with the same letter are not statistically different at $P = 0.05$.

Table 3. Profile available soil water, crop water use, and fallow accumulation for crop rotations under limited irrigation, Tribune, KS, 2020

		Available water					
Crop	Rotation	Previous harvest	Planting	Harvest	Crop water use	Fallow accumulation	Fallow efficiency
		inches					%
Corn	C-C	11.06	13.10	10.60	25.70	2.04 b*	40 a
	C-W	8.05	12.97	9.89	26.29	4.93 a	47 a
	C-GS	12.24	12.91	10.19	25.92	0.67 c	14 b
$LSD_{0.05}$		4.44	4.70	3.52	2.15	1.35	26
ANOVA (P > F)							
System		0.136	0.995	0.886	0.801	0.001	0.048
Wheat	C-W	9.15	9.15	9.16	14.05	---	---
ANOVA (P > F)							
System		---	---	---	---	---	---
Sorghum	C-GS	9.15 b	12.01	9.57	24.34	2.86 a	47 a
	GS-GS	11.24 a	13.01	9.57	25.33	1.77 b	31 b
$LSD_{0.05}$		1.97	2.22	0.81	2.48	0.60	10
ANOVA (P > F)							
System		0.043	0.248	0.979	0.294	0.011	0.016

Note: All crops received ~10 inches of irrigation.
In-season rainfall for corn (5/05 to 9/28) = 13.06 in.; sorghum (5/20 to 10/20) = 12.06 in.; and wheat (9/25/2019 to 6/29/2020) = 8.75 in.
C = corn. W = wheat. GS = grain sorghum. LSD = least significant difference. ANOVA = analysis of variance.
* Means within a column for a crop with the same letter are not statistically different at $P = 0.05$.

Table 4. Profile available soil water, crop water use, and fallow accumulation for crop rotations under limited irrigation across years, Tribune, KS, 2013–2020

		Available water					
Crop	Rotation	Previous harvest	Planting	Harvest	Crop water use	Fallow accumulation	Fallow efficiency
		inches					%
Corn	C-C	11.66	13.96 a*	11.88 a	26.28	2.30 b	26 ab
	C-W	10.83	13.94 a	11.59 a	26.55	3.11 a	23 b
	C-GS	11.05	12.62 b	10.49 b	26.33	1.57 c	30 a
$LSD_{0.05}$		0.76	0.63	0.72	0.58	0.41	6
ANOVA (P > F)							
System		0.089	0.001	0.001	0.613	0.001	0.048
Year		0.001	0.001	0.001	0.001	0.001	0.001
System × year		0.001	0.001	0.004	0.006	0.001	0.001
Wheat	C-W	11.48	11.48	10.73	19.21	---	---
ANOVA (P > F)							
System		---	---	---	---	---	---
Year		0.001	0.001	0.001	0.001	--	--
System × year		---	---	---	---	---	---
Sorghum	C-GS	10.06	13.42	11.54	23.56	3.36 a	31
	GS-GS	10.71	13.22	11.25	23.66	2.52 b	29
$LSD_{0.05}$		0.74	0.60	0.64	0.37	0.42	6
ANOVA (P>F)							
System		0.085	0.515	0.363	0.591	0.001	0.530
Year		0.001	0.001	0.001	0.001	0.001	0.001
System × year		0.001	0.001	0.496	0.049	0.001	0.001

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.
* Means within a column with the same letter are not statistically different at $P = 0.05$.