

Alternative Cropping Systems with Limited Irrigation

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Summary

A limited irrigation study involving six cropping systems 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 four 2-year systems (corn-sorghum [C-GS]), corn-sunflower [C-SF], corn-winter wheat [C-W], and corn-wheat/double sunflower [C-W/SF]). In 2015, corn yields were lower following corn than other crops while wheat and grain sorghum yields were similar for all rotations. This tended to agree with the 3-year average yields except for average sorghum yields being higher following corn than sorghum. Sunflowers were destroyed by rodents and no yields were obtained.

Procedures

A crop rotation study under sprinkler irrigation at the Southwest Research-Extension Center near Tribune was initiated in the spring of 2012. The study evaluates six 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-wheat/double-crop sunflower; 4) corn-sunflower; 5) corn-sorghum; and 6) continuous sorghum (a total of 10 treatments). All rotations are limited to 10 inches of irrigation water annually. When double crop sunflower is grown after wheat, the 10-inch irrigation allocation is split between the two crops. 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 sunflower, and 120 lb N/a for wheat). Corn was planted on May 18 and harvested on September 22. Grain sorghum was planted on June 8 and harvested on November 4. Sunflower was planted on June 9 and replanted on July 6 of 2015 along with double crop sunflowers. The sunflowers were destroyed by ground squirrels and jackrabbits both times, so there was no harvest. Wheat was planted on September 27, 2014, and harvested on July 2, 2015.

Results and Discussion

Weather conditions in 2015 were variable. Precipitation was above normal for May and June and near normal or below normal the rest of the summer. Corn yields in 2015 ranged from 155 to 197 bu/a. Corn following wheat/sunflower produced the highest yield and continuous corn the lowest yield (Table 1). Wheat yields tended to be higher (but not significantly so) in the corn-wheat rotation than in the corn-wheat/sunflower rotation. Grain sorghum yields were similar following corn or sorghum. This tended to agree with the 3-year average yields except for average sorghum yields being higher following corn than sorghum (Table 2). Rodents (ground squirrels and jackrabbits) destroyed the sunflowers in both rotations in 2015.

Available soil water at corn planting was lower following double crop sunflower than other crops (Table 3). This effect carried through to corn harvest. Water use for corn was lower following double crop sunflower primarily because of the lower amount of available water at planting. Fallow accumulation prior to corn ranged from 3.7 to 5.3 inches with fallow efficiencies of 33 to 62%. Fallow precipitation from row crop harvest to corn planting was greater than 8 inches, while corn following wheat had 16 inches of fallow precipitation. For wheat, available soil water and crop water use tended to be greater when in C-W rotation than in a C-W/SF rotation. The only difference observed with grain sorghum was more fallow accumulation for sorghum following corn than following sorghum. When averaged across 3 years, available soil water at corn planting and crop water use was less for corn, following double crop sunflower than following other crops (Table 4). Available water at wheat planting and harvest along with water use was greater for wheat in C-W rotation than C-W/SF. Soil water and water use were similar for grain sorghum following corn or sorghum.

Acknowledgment

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Table 1. Grain yield of four crops as affected by rotation in 2015.

Rotation	Corn	Wheat	Sorghum	Sunflower
	----- bu/a -----			lb/bu
Continuous corn	155	--	--	--
Continuous sorghum	--	--	158	--
Corn-wheat	177	58	--	--
Corn-sorghum	170	--	163	--
Corn-sunflower	187	--	--	--
Corn-wheat/sunflower	197	50	--	--
LSD _{0.05}	32	21	23	--

Table 2. Grain yields of four crops under limited irrigation as affected by rotation across years 2013 - 2015.

Rotation	Corn	Wheat	Sorghum	Sunflower
	----- bu/a -----			lb/bu
Continuous corn	169	--	--	--
Continuous sorghum	--	--	133b	--
Corn-wheat	185	58	--	--
Corn-sorghum	182	--	144a	--
Corn-sunflower	182	--	--	1603a
Corn-wheat/sunflower	190	52	--	987b
LSD _{0.05}	14	7	9	149

Table 3. Profile available soil water, crop water use, and fallow accumulation for crop rotations under limited irrigation, Tribune, KS, 2015.

Crop	Rotation	Available water			Crop water use	Fallow accumulation	Fallow efficiency
		Previous harvest	Planting	Harvest			
		----- inches -----					
Corn	C-C	10.35a	15.52a	10.03	25.85a	5.17a	47b
	C-W	10.59a	15.88a	9.58	26.66a	5.29a	33c
	C-GS	10.92a	14.65a	7.69	27.32a	3.74b	44b
	C-SF	11.41a	15.43a	9.21	26.58a	4.01b	48b
	C-W/SF	4.05b	9.28b	5.78	23.86b	5.23a	62a
LSD _{0.05}		3.26	2.80	3.99	1.57	1.01	9
<u>ANOVA (P>F)</u>							
System		0.002	0.001	0.194	0.004	0.011	0.001
Wheat	C-W	10.61	10.61	10.74	22.49	0	-
	C-W/SF	7.31	7.31	6.97	19.91	0	-
LSD _{0.05}		3.63	3.63	7.54	5.61	-	-
<u>ANOVA (P>F)</u>							
System		0.063	0.063	0.210	0.239	-	-
Sorghum	C-GS	8.49	15.67	10.28	24.10	7.19a	46
	GS-GS	11.01	16.13	10.57	24.26	5.12b	39
LSD _{0.05}		4.11	2.73	3.67	2.00	1.49	10
<u>ANOVA (P>F)</u>							
System		0.146	0.628	0.813	0.812	0.022	0.107
Sunflower	C-SF	6.71	12.68a	13.17	8.84	5.97a	36
	C-W/SF	6.97	6.97b	9.99	9.58	0.00b	-
LSD _{0.05}		3.50	5.13	4.11	3.29	2.45	-
<u>ANOVA (P>F)</u>							
System		0.828	0.038	0.091	0.525	0.005	-

Note: All crops received ~10 inches of irrigation, except W/SF where each crop received ~5 inches. In season rainfall for corn (5/18/15 – 9/29/15) = 10.57 inches, sorghum (6/09/15 – 11/04/15) = 8.86 inches, sunflower (7/01/15 – 11/04/15) = 7.92 inches, and wheat (9/24/14 – 7/01/15) = 16.65 inches.

Table 4. Profile available soil water, crop water use, and fallow accumulation for crop rotations under limited irrigation across years, Tribune, KS, 2013-2015.

Crop	Rotation	Available water			Crop water use	Fallow accumulation	Fallow efficiency
		Previous harvest	Planting	Harvest			
		----- inches -----				inch	%
Corn	C-C	11.59a	12.85a	11.07a	23.97b	2.60bc	24
	C-W	9.81a	13.19a	10.86a	24.52ab	4.86a	31
	C-GS	10.46a	10.82b	8.51b	24.50ab	1.94c	25
	C-SF	10.29a	12.65a	9.54ab	25.30a	2.06c	26
	C-W/SF	4.88b	8.39c	7.96b	22.63c	2.87b	44
LSD _{0.05}		3.00	1.71	1.93	1.14	0.79	19
<u>ANOVA (P>F)</u>							
System		0.002	0.001	0.007	0.001	0.001	0.239
Year		0.734	0.001	0.001	0.001	0.001	0.001
System*Year		0.001	0.001	0.001	0.001	0.001	0.009
Wheat	C-W	10.69a	10.69a	10.12a	20.15a	0	-
	C-W/SF	8.12b	8.12b	6.26b	18.44b	0	-
LSD _{0.05}		2.09	2.09	2.43	1.01	-	-
<u>ANOVA (P>F)</u>							
System		0.020	0.020	0.005	0.003	-	-
Year		0.001	0.001	0.067	0.001	-	-
System*Year		0.324	0.324	0.167	0.023	-	-
Sorghum	C-GS	8.21	11.57	10.40	22.91	3.36a	34
	GS-GS	8.59	11.06	10.36	22.43	2.47b	36
LSD _{0.05}		1.43	1.24	1.24	0.83	0.86	13
<u>ANOVA (P>F)</u>							
System		0.577	0.386	0.945	0.238	0.043	0.760
Year		0.001	0.001	0.015	0.001	0.001	0.001
System*Year		0.001	0.012	0.599	0.113	0.021	0.468

continued

Table 4. Profile available soil water, crop water use, and fallow accumulation for crop rotations under limited irrigation across years, Tribune, KS, 2013-2015.

Crop	Rotation	Available water			Crop water use	Fallow accumulation	Fallow efficiency
		Previous harvest	Planting	Harvest			
		----- inches -----				inch	%
Sunflower	C-SF	8.50	11.98a	11.25a	15.67a	3.48a	31
	C-W/SF	6.26	6.26b	6.59b	13.11b	0.00b	-
LSD _{0.05}		2.71	2.45	2.49	1.01	0.64	-
<u>ANOVA (P>F)</u>							
System		0.097	0.001	0.002	0.001	0.001	-
Year		0.001	0.001	0.001	0.001	0.001	0.032
System*Year		0.001	0.001	0.001	0.001	0.001	-

Note: All crops received ~10" of irrigation, except W/SF – each crop received ~5 inches.

*Corn - PH, FA, and FE use only 2014 and 2015 values due to missing sunflower harvest soil moisture data for 2012.