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Tillage Intensity in a Long-Term Wheat-Sorghum-Fallow Rotation

Abstract

This study was initiated in 1991 at the Kansas State University Southwest Research- Extension Center near Tribune, KS. The purpose of the study was to identify the effects of tillage intensity on precipitation capture, soil water storage, and grain yield in a wheat-sorghum-fallow rotation. Grain yields of wheat and grain sorghum increased with decreased tillage intensity in a wheat-sorghum-fallow (WSF) rotation. In 2016, available soil water at wheat and sorghum planting was greater for reduced tillage (RT) than no-tillage (NT) and least for conventional tillage (CT). Averaged across the 16-yr study, available soil water at wheat and sorghum planting was similar for RT and NT and about 1 inch greater than CT. Averaged across the past 16 years, NT wheat yields were 4 bu/a greater than RT and 7 bu/a greater than CT. Grain sorghum yields in 2016 were 15 bu/a greater with long-term NT than short-term NT. Averaged across the past 16 years, sorghum yields with long-term NT have been 70% greater than with short-term NT (68 vs. 40 bu/a).

Keywords

no-till, conventional tillage, reduced tillage, wheat-sorghum-fallow rotation, wheat, grain sorghum

Cover Page Footnote

The U.S. Department of Agriculture, Agricultural Research Service Ogallala Aquifer Program partially supported this research project.

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Summary

This study was initiated in 1991 at the Kansas State University Southwest Research-Extension Center near Tribune, KS. The purpose of the study was to identify the effects of tillage intensity on precipitation capture, soil water storage, and grain yield in a wheat-sorghum-fallow rotation. Grain yields of wheat and grain sorghum increased with decreased tillage intensity in a wheat-sorghum-fallow (WSF) rotation. In 2016, available soil water at wheat and sorghum planting was greater for reduced tillage (RT) than no-tillage (NT) and least for conventional tillage (CT). Averaged across the 16-yr study, available soil water at wheat and sorghum planting was similar for RT and NT and about 1 inch greater than CT. Averaged across the past 16 years, NT wheat yields were 4 bu/a greater than RT and 7 bu/a greater than CT. Grain sorghum yields in 2016 were 15 bu/a greater with long-term NT than short-term NT. Averaged across the past 16 years, sorghum yields with long-term NT have been 70% greater than with short-term NT (68 vs. 40 bu/a).

Experimental Procedures

Research on different tillage intensities in a WSF rotation at the Tribune unit of the Southwest Research-Extension Center was initiated in 1991. The three tillage intensities in this study are conventional (CT), reduced (RT), and no-tillage (NT). The CT system was tilled as needed to control weed growth during the fallow period. On average, this resulted in four to five tillage operations per year, usually with a blade plow or field cultivator. The RT system originally used a combination of herbicides (one to two spray operations) and tillage (two to three tillage operations) to control weed growth during the fallow period; however, in 2001, the RT system was changed to using NT from wheat harvest through sorghum planting (short-term NT) and CT from sorghum harvest through wheat planting. The NT system exclusively used herbicides to control weed growth during the fallow period. All tillage systems used herbicides for in-crop weed control.

Results and Discussion

Soil Water

The amount of available water in the soil profile (0 to 8 ft) at wheat planting varied greatly from year to year (Figure 1). In 2016, available soil water at wheat planting was greater with RT than NT and least with CT. Averaged across the 16-yr study, available soil water at wheat planting was similar for RT and NT (about 7 inches) and about 1 inch greater than CT.

Similar to wheat, the amount of available water in the soil profile at sorghum planting varied greatly from year to year (Figure 2). In 2016, available soil water at sorghum planting was greater with RT than NT and least with CT. On average, available soil water at sorghum planting was similar for RT and NT and about 1 inch more than CT.

Grain Yields

Wheat yields in 2016 were 55 to 65 bu/a greater than the long-term average (Table 1). Since 2001, wheat yields have been depressed in 10 of 16 years, primarily because of lack of precipitation, while winterkill reduced yields in 2015. Reduced tillage and NT increased wheat yields. On average, wheat yields were 7 bu/a higher for NT (24 bu/a) than CT (17 bu/a). Wheat yields for RT were 3 bu/a greater than CT even though both systems had tillage prior to wheat. Yields of NT were significantly less than CT or RT in only 1 of the 16 years.

The yield benefit from RT was greater for grain sorghum than wheat. Grain sorghum yields for RT averaged 16 bu/a more than CT, whereas NT averaged 28 bu/a more than RT (Table 2). For sorghum, both RT and NT used herbicides for weed control during fallow, so the difference in yield could be attributed to short-term compared with long-term NT. In 2016, sorghum yields were 15 bu/a greater with long-term NT than short-term NT. This consistent yield benefit with long-term vs. short-term NT has been observed since the RT system was changed in 2001. Averaged across the past 16 years, sorghum yields with long-term NT have been 70% greater than with short-term NT (68 vs. 40 bu/a).

Acknowledgment

The U.S. Department of Agriculture, Agricultural Research Service Ogallala Aquifer Program partially supported this research project.

Table 1. Wheat response to tillage in a wheat-sorghum-fallow rotation, Tribune, KS, 2001–2016

	Tillage				ANOVA ($P > F$)		
Year	Conventional	Reduced	No-tillage	LSD (0.05)	Tillage	Year	Tillage × year
	-------------------- bu/a --------------------						
2001	17	40	31	8	0.002		
2002	0	0	0	---	---		
2003	22	15	30	7	0.007		
2004	1	2	4	2	0.001		
2005	32	32	39	12	0.360		
2006	0	2	16	6	0.001		
2007	26	36	51	15	0.017		
2008	21	19	9	14	0.142		
2009	8	10	22	9	0.018		
2010	29	35	50	8	0.002		
2011	22	20	20	7	0.649		
2012	0	1	5	1	0.001		
2013	0	0	0	---	---		
2014	10	11	18	12	0.336		
2015	10	9	9	9	0.966		
2016	72	85	82	18	0.239		
Mean	17c	20b	24a	2	0.001	0.001	0.001

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

Table 2. Grain sorghum response to tillage in a wheat-sorghum-fallow rotation, Tribune, KS, 2001–2016

	Tillage				ANOVA (*P* > *F*)		
Year	Conventional	Reduced	No-tillage	LSD (0.05)	Tillage	Year	Tillage × year
	--------------------- bu/a ---------------------						
2001	6	43	64	7	0.001		
2002	0	0	0	- - -	- - -		
2003	7	7	37	8	0.001		
2004	44	67	118	14	0.001		
2005	28	38	61	35	0.130		
2006	4	3	29	10	0.001		
2007	26	43	62	42	0.196		
2008	16	25	40	20	0.071		
2009	19	5	72	31	0.004		
2010	10	26	84	9	0.001		
2011	37	78	113	10	0.001		
2012	0	0	0	- - -	- - -		
2013	37	51	78	32	0.053		
2014	38	72	94	28	0.008		
2015	56	60	102	55	0.153		
2016	55	124	139	47	0.010		
Mean	24c	40b	68a	6	0.001	0.001	0.001

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

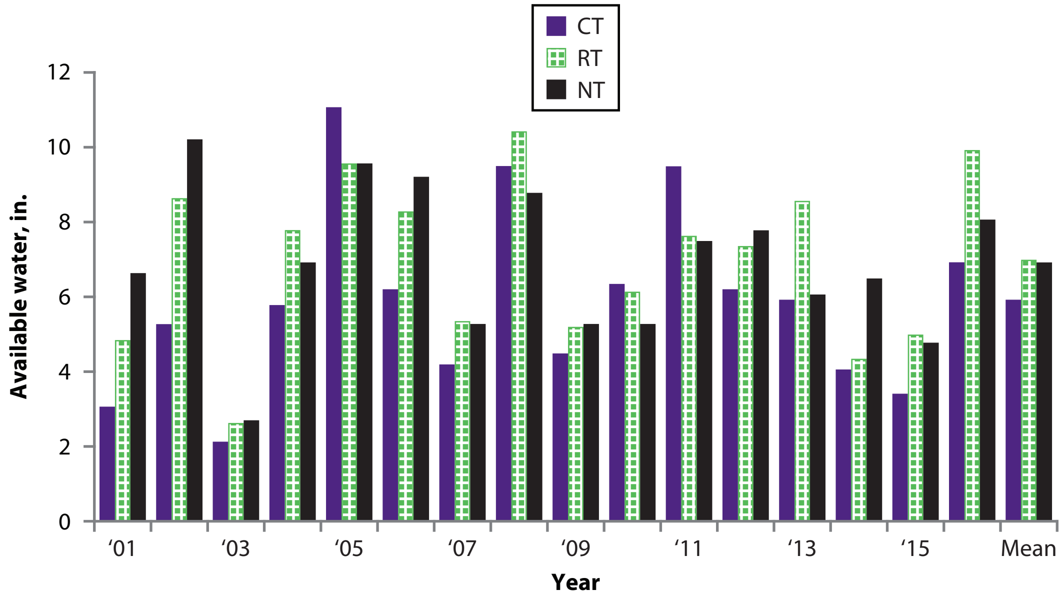

Figure 1. Available soil water in 8-ft profile at planting of wheat in a wheat-sorghum-fallow rotation as affected by tillage intensity, Tribune, KS, 2001–2016. The last set of bars (Mean) is the average across years. CT = conventional tillage, RT = reduced tillage, NT = no-tillage.

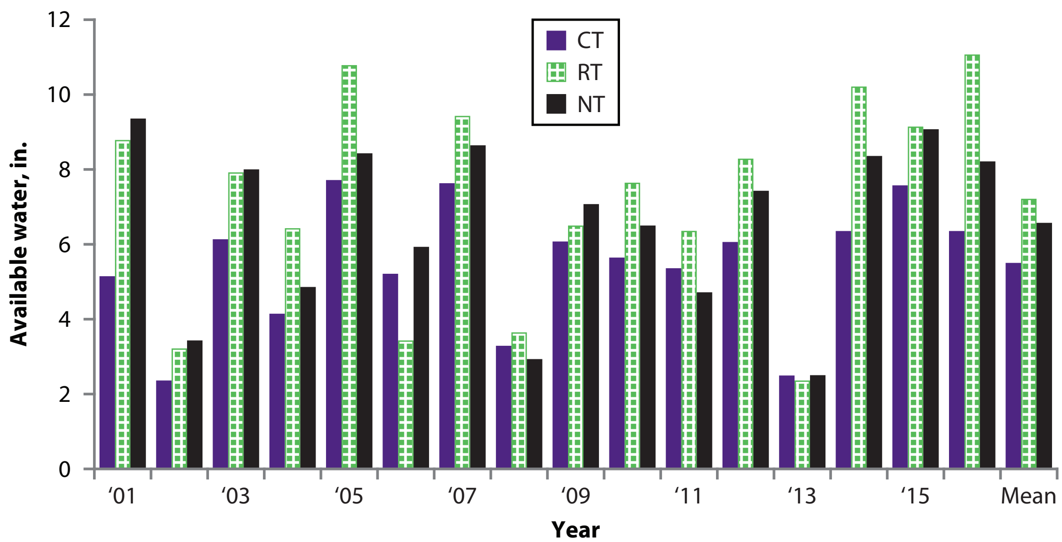

Figure 2. Available soil water in 8-ft profile at planting of grain sorghum in a wheat-sorghum-fallow rotation as affected by tillage intensity, Tribune, KS, 2001–2016. The last set of bars (Mean) is the average across years. CT = conventional tillage, RT = reduced tillage, NT = no-tillage.