Deficit Irrigation and Conservation Tillage Effects on Water Use and Yield of Cotton

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ABSTRACT

Many producers in the Texas High Plains supplement growing season rainfall with irrigation using water supplied from the Ogallala aquifer. Increasing pumping costs and declining well capacities in the Southern High Plains compel producers to grow alternative drought tolerant crops and improve precipitation capture using residue retaining conservation tillage practices. Sorghum [*Sorghum bicolor* (L.) Moench] grown in rotation with wheat (*Triticum aestivum* L.) is a cropping sequence that efficiently captures and uses rain. This Wheat–Sorghum–Fallow, WSF, cropping sequence (Fig. 1) could be modified to use cotton (*Gossypium hirsutum* L.) in place of sorghum, but residue levels will be decreased. Crop residue increases infiltration of rain and reduces evaporation that, consequently, increases storage of precipitation for subsequent crop use. Reducing evaporation of irrigation water with residue cover may increase water use efficiency by increasing the portion transpired by the plant. Our objectives were to adapt cotton and wheat to a limited irrigation cropping sequence with fallow periods, and to quantify the effect of residue management practices on i) fallow precipitation storage, and ii) yield of deficit irrigated cotton.

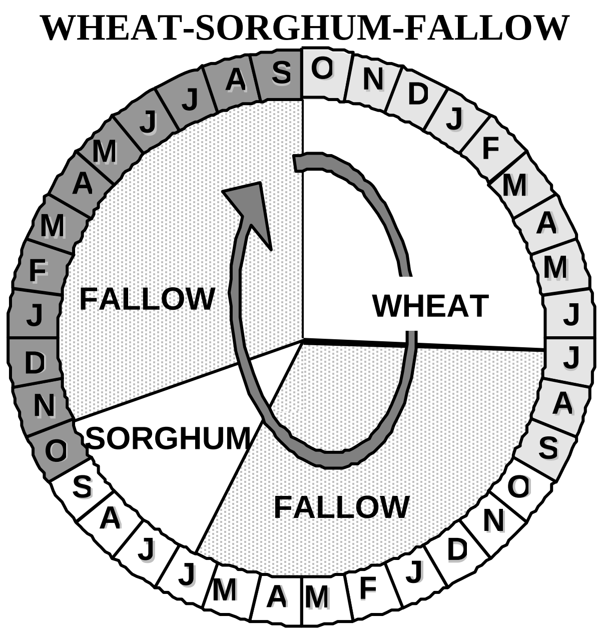

Figure 1. The three-year wheat-sorghum-fallow (WSF) rotation begins with wheat establishment in October. Wheat is harvested 10-months later in July and the soil is fallowed until June of the second year (11-months) when grain sorghum is grown using stored soil water to augment summer rain. After sorghum harvest in November of the third year the soil is again fallowed for 10-months when the sequence is repeated. The modified sequence substitutes cotton for sorghum.

All phases of a Wheat-Cotton-Fallow (WCF) cropping system were installed in 2004 on a Pullman soil (fine, mixed, superactive, thermic Torrertic Paleustoll) that was irrigated by a 300 ft long linear move mid-elevation spray irrigation system. Grain was harvested from uniformly cropped wheat that was sown at 60 lbs/ac in 10 in. rows during October. Wheat was not fertilized because ~ 50 lbs (N)/ac is typically mineralized during fallow and is usually sufficient for dryland wheat crops. Wheat residues were fallowed for ~11 months using disk, stubblemulch (sweep plow), or no –tillage residue management. Weed control in no-till fallow used a one time application of 2.5 lbs/ac a.i. atrazine [6-chloro-N-ethyl-N’-(1-methylethyl)-1,3,5-triazine-2,4-

diamine] and 1.0 lb/ac a.i. applications of glyphosate [N-(phosphonomethyl) glycine] as needed for weed escapes. After wheat fallow, 100 lbs. (N)/ac was applied through the irrigation system and cotton was planted during mid-May with unit planters in rows 30 in. apart at a population of 60,000 seed/ac. Growing season weeds were controled after tilled fallow with 1 lb/ac a.i. trifluralin [2,6-dinitro-N, N-dipropyl-4-(triflouromethyl) benzenamine] and for no-till with 1.5 lbs/ac a.i. diuron [3-(3,4-dichlorophenyl) 1,1-dimethylurea] plus 0.75 lbs/ac a.i. metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl) acetamide] with glyphosate applied to control weed escapes. Cotton was irrigated in treatment strips receiving 1 or 2 in. applications every 10 days to duplicate irrigation using 2 or 4 gpm/ac pumping capacities common for weak and good wells in this region.

Treatment combinations of irrigation levels (2) and tillage residue management practices (3) were replicated 3 times resulting in 18 plots for each rotation phase. Measurements included precipitation and gravimetric soil water content to 7.5 ft at planting and harvest for each phase of the rotation and cotton growth and yield. We compared treatment effects on cotton yield and measured soil water storage and use according to a randomized complete block split-strip plot arrangement of an analysis of variance (ANOVA).

Fallow period storage of precipitation as soil water increased as the amount of surface residue increased, but this water storage varied with precipitation amount during fallow. Following the dry 2005-2006 fallow period that received <3.5 in. precipitation, available soil water was 5 in. for no-till, 4 in. for sweep till, and 2.5 in. with disk tillage. In contrast, 11.9 in. of precipitation occurred during the 2006-2007 fallow period, resulting in soil profile storage of 8.0 in. available soil water regardless of tillage treatment. Our study shows that residue increases soil water storage during fallow for subsequent cotton use.

Cotton yields generally increased with residue retaining conservation tillage practices or increased irrigation (Table 1.). Residues decreased evaporation of irrigation water and growing season rainfall. This benefit plus differences in soil water at planting increased cotton water use and resulted in higher yields with no or sweep tillage (LSD ~ 68 lb/ac). Increasing irrigation from 1 to 2 in. every 10 d increased lint yield from 15% with disking to 30% with no-till. High initial soil water and good early season rainfall during 2007 diminished the tillage and irrigation effects on yields (LSD ~ 105 lbs/ac). That is, tillage did not affect yields when irrigated with 2 in. every 10 d and was not different from no-till cotton irrigated with 1 in. every 10 d.

Table 1. Cotton lint yield (lbs/ac) in 2006 and 2007 as affected by tillage and irrigation depth.

	2006 Irrigation / 10 d		2007 Irrigation / 10 d	
Tillage	1 in.	2 in.	1 in.	2 in.
No-till	754	1095	706	644
Sweep	654	876	521	683
Disk	487	556	519	657
Rainfall, in.	10.7		6.6	
Irrigation, in.	5.0	10.0	4.0	8.0

We conclude that residue retaining conservation tillage practices increased crop water use and yield when growing season precipitation was limited through increased fallow season soil water storage and reduced evaporation of irrigation water and rainfall.