IMPACT OF TILLAGE TREATMENTS ACROSS SUBSURFACE DRIP IRRIGATION LEVELS IN THE TEXAS ROLLING PLAINS

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Abstract

Identifying management practices that conserve and protect water resources are very important to a wide variety of stakeholders within semi-arid environments. The objective of this research was develop conservation tillage and water management strategies that enhance crop stand establishment, water-use efficiency, and yield in SDI cotton production in the Texas Rolling Plains. Five irrigation regimes (0, 33, 66, 100, and 133% ET replacement) and four tillage systems (conventional-till, reduced-till, no-till flat and no-till with a terminated cover crop) were evaluated. Acceptable plant stands were obtained in all tillage systems. Generally, yields increased with increasing water regimes up to 100% ET. A plateau in the amount of lint produced was seen at water regimes greater than 100% with similar yields observed between 66% and 133% ET. Data indicate that there is no preferred tillage system that will result in higher cotton yields under SDI at either deficit or full irrigation. Estimated net returns favored the no-till tillage systems.

Introduction

Groundwater is a critical water resource for Texas, providing 59% of all the water used in Texas in 2003 (Boghici, 2008). In semi-arid regions of Texas, such as the Rolling Plains, drought is an ever-present concern, which leads to pressure on water infrastructure. The Seymour Aquifer is one of nine major aquifers in Texas. Within the Rolling Plains, 90% of the water pumped from the Seymour Aquifer is used for irrigation, but serves as the source of municipal water source for several communities in the region. From 1990 to 2000, water levels in the Seymour Aquifer saw a median decline of 0.64 m with 75% of monitored wells reporting declines (Boghici, 2008). In 2006, irrigated cotton comprised only 13% of total cotton acreage, but accounted for 40% of total lint production (Texas Ag. Statistics, 2007). Irrigated crop yields can be 2 to 4 times higher than those from dryland production and much more stable from year to year. Thus, identifying management practices that conserve and protect water resources are very important to a wide variety of stakeholders in the region. The objective of this research is to develop conservation tillage and water management strategies that enhance crop stand establishment, water-use efficiency, and yield in SDI cotton production in the Texas Rolling Plains.

Materials and Methods

Stoneville 4554 B2RF cotton was planted 15 May 2008, 21 May 2009, and 20 May 2010 directly over drip lines using a GPS/RTK auto steer system at a seeding rate of 4.2 seeds per foot of row. Drip lines are 12 to 14 inches deep on 40-inch centers. Plots were eight rows wide by 150 feet long. Tillage systems included conventional-till (bedded), conventional reduced-till (flat planted), no-till, and no-till in a terminated cover crop. Irrigation regimes included: 0, 33, 66, 100, and 133% ET replacement (ET data obtained from the High Plains PET network) and adjusted weekly based on the previous 7-day moving average and rainfall. Plots were irrigated daily. Plots were machine-harvested and ginned to obtain lint yields. Treatments were replicated three times in a randomized complete block design. Data were analyzed using Proc GLM of SAS (SAS Institute, Version 9.2). Means were considered significantly different when $P < 0.05$.

Results and Discussion

Most discussion will focus on the three-year average as 2008 and 2009 data are presented in previous Beltwide Proceedings. For each year, there were no problems in obtaining acceptable plant stands (data not shown). Entering into this project, this was a concern since stand establishment had been documented as problematic under SDI in West Texas as well as the Western U.S. (Charlesworth and Muirhead, 2003; Enciso et al., 2005). In the semiarid Rolling Plains, there is usually enough rainfall in May and June to establish a crop most years and sufficient moisture was available each year of this project.

Tillage significantly affected lint yields during the first year of the project on dryland plots (Figure 1). However, tillage had no significant impact on lint yields for dryland plots in 2009 and 2010. In addition, there were no significant differences among tillage treatments for lint yields within irrigation treatments greater than 0% ET for each year (data not shown). The impact may be expected to have the rgeatest benefit for the dryland plots if moisure was indeed captured. While the three year average did show a significant tillage effect, this was probably skewed by data from the first year. It should be noted that conventional tillage was implemented for the first time starting in 2008 with a historical background of conventional tillage. Hence, the system duringthe first year was probably not stable and highly variable. This is indicated by the fact that the two highest yielding treatments were from the reduced conventional and no-till, while conventional till and no-till with a cover crop resulted in lower yields.

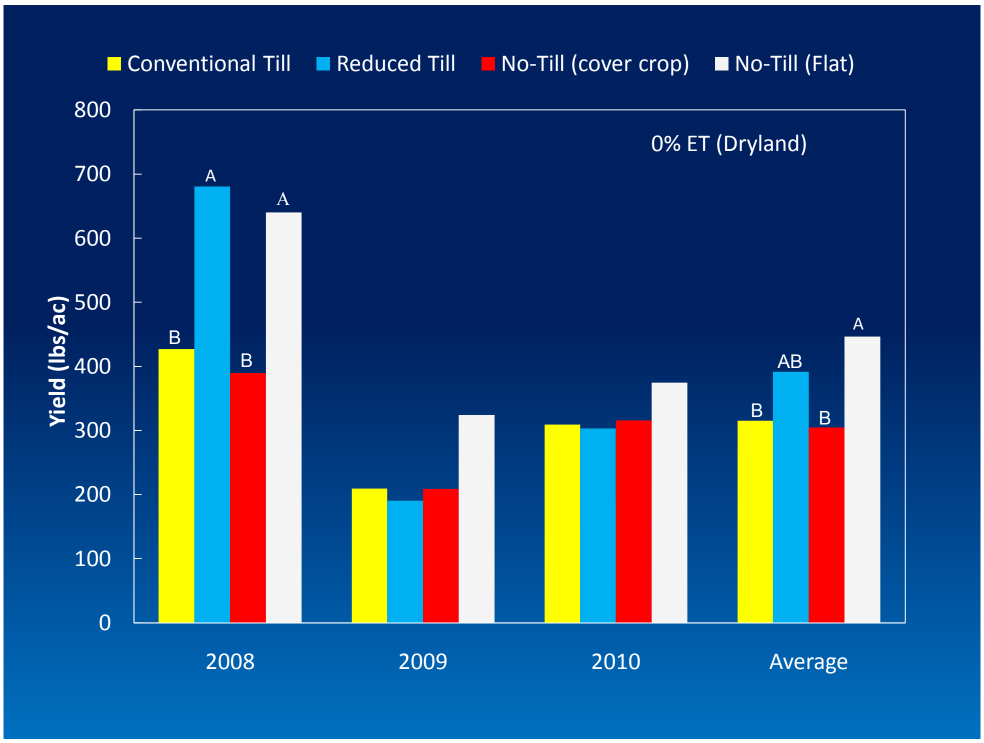

Figure 1. Effect of tillage on lint yields for dryland plots. Letters represent significant differences among tillage treatments within a year. No letters within a year represents no observed significant differences.

Rate of irrigation did have a significant impact on lint yields within tillage treatments (Figure 2). Generally, yields increased with increasing water regimes up to 100% ET. Lint yields were greatest at 100% ET replcacement for all tillage treatments. With the excpetion of the 66% no-till treatment, there were no significant differences in lint yields at ET replacement greater than 66% (Figure 2).

Averaging lint yields across all ET treatments without accounting for tillage showed that lint yields generally increased up to an ET replacement of 66% (Figure 3A). Except for 2008, lint yields at 100% ET were significantly higher than 66% (Figure 3A). However, there was not a significant difference in lint yields over the three-year average between 66% and 133% ET treatments. Figure 3B shows the average lint produced per average inch of water applied over the three-year study. A plateau in the amount of lint produced can be seen at water regimes greater than 100% with similar yields observed between 66% and 133% ET. Although other water regimes were not tested, it can probably be concluded with confidence that optimum water rates are than 100%, but greater than 66%.

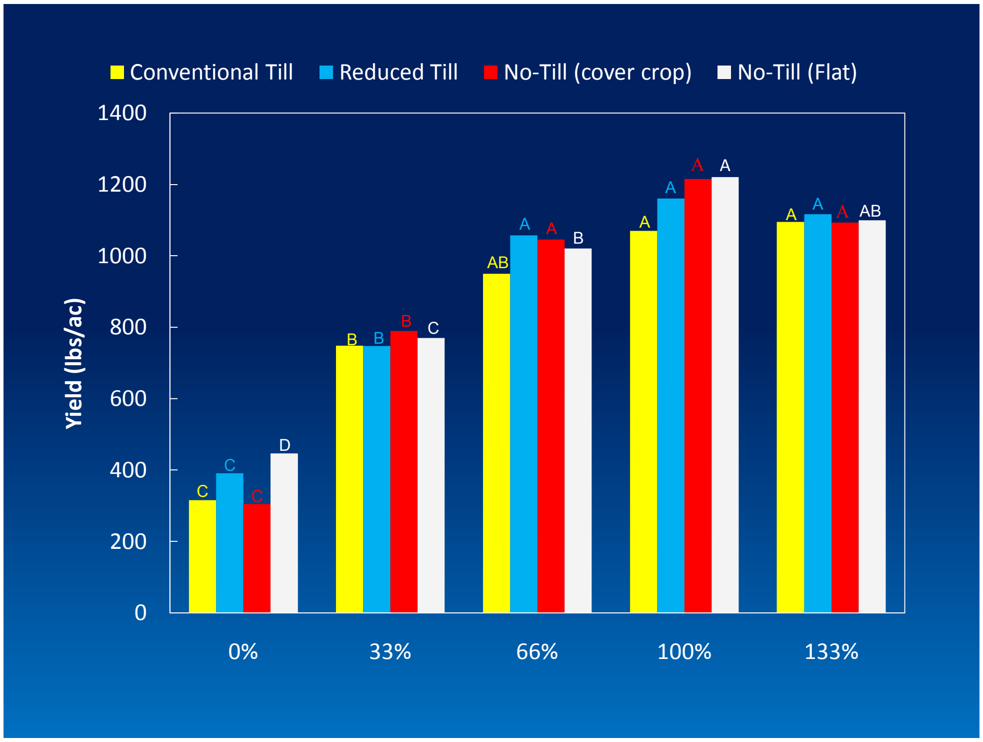

Figure 2. Effect of tillage and ET replacement on lint yield over a three-year period (2008-2010). Letters represent significant differences within a single tillage treatment across ET treatments.

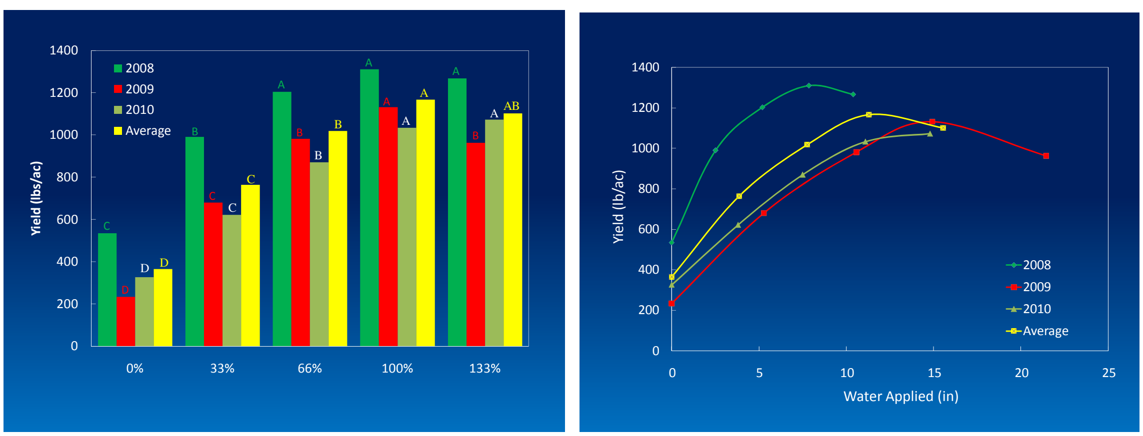

Figure 3. A) Mean lint yields for each ET treatment when grouping tillage treatments for each year and the three-year average and B) the correlation between the amount of water applied and lint yield over the three-year period.

Estimated net returns favored the no-till tillage systems (Table 1). These systems also have the least number of field operations, which enhanced net return. The greatest net return for 2009 and 2010 was from the no-till cover crop system at 100% ET replacement (Table 1). Within each ET treatment, no-till (either cover or no cover) had the greatest net return.

Summary

Four tillage systems and five subsurface irrigation regimes were evaluated for three years at the Chillicothe Research Station. Acceptable plant stands were obtained in all tillage systems. Within tillage treatments, there were no significant differences across water regimes of 66, 100, and 133% except for no-till @ 66%. Tillage treatments did not significantly differ within irrigated plots. Hence, inputs and other economic factors will probably determine the type of tillage system implemented on SDI. Highest yields were achieved under 100% ET replacement treatments. The greatest estimated net return favored the no-till system with a cover crop at 100% ET replacement. The highest net return within each irrigation ET treatment was from a no-till system.

Table 1. Estimated net returns for production years 2009 and 2010.

	ET Replacement	Conventional till	Reduced till	No-till (flat)	No-till (cover crop)
2009	66%	$233	$279	$305	$335
	100%	$362	$395	$357	$415
	133%	$320	$308	$333	$323
2010	66%	$435	$429	$438	$465
	100%	$411	$593	$581	$637
	133%	$472	$619	$592	$635

Acknowledgements

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