EFFECT OF IRRIGATION TIMING ON COTTON PRODUCTION UNDER VARIOUS TILLAGE STRATEGIES

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Abstract

Water is the limiting factor for crop production within the Texas Rolling Plains and has become a critical resource for multiple stakeholders. Hence, efficient irrigation is paramount to conserve water resources. We evaluated three irrigation strategies: 1) continuous irrigation starting at planting 0.25 inch/day (high); 2) continuous irrigation starting at flowering 0.25 inch/day (low); and 3) continuous irrigation starting at flowering at 0.30-0.35 inch/day (medium) conducted on conventional, strip-till, no-till and no-till with a cover crop plots. Results obtained from Chillicothe Research Station showed that irrigation strategy did not have a significant impact on lint yields over a two year period. No-till treatments resulted in numerically higher lint yields at lower irrigation levels, indicating high water use efficiency than conventional and strip-tillage.

Introduction

Water is a critical resource in for multiple stakeholders within semi-arid environments, which has been exacerbated by exceptional drought conditions since 2010 within the Texas Rolling Plains. Due to critically low lake levels, demands for groundwater use by municipalities and industries have increased. Hence, cropping systems that conserve water resources are as important as ever. Prior to the start of the current drought in 2010, 16% of planted acres within the Texas Rolling Plains was irrigated and accounted for 41% of harvested cotton (USDA, 2010). Bordovsky et al. (2014) reported that irrigating in excess early in the season to build soil water in the profile reduces irrigation water value compared to applying irrigation water at critical growth stages later in the year. Texas A&M AgriLife Research at Vernon has found that conservation tillage in cotton systems has no impact on yield and can result in higher stored soil moisture entering the cropping system. However, the synergy between conservation tillage and irrigation timing has not been evaluated. We initiated a pilot study in 2013 at Chillicothe Research Station to evaluate the impact of irrigation timing on cotton yields.

Materials and Methods

Research was conducted at the Texas A&M AgriLife Chillicothe Research Station (CRS) in the Texas Rolling Plains. Three irrigation management strategies were evaluated under subsurface drip irrigation: 1) continuous irrigation starting at planting 0.25 inch/day (high); 2) continuous irrigation starting at flowering 0.25 inch/day (low); and 3) continuous irrigation starting at flowering 0.32 inch/day in 2014 and 0.33 inch/day in 2014 (medium). For irrigation strategies starting at flowering, irrigation began once flowering was visually observed in the field. In addition, during the first year, irrigation (1.9") was applied to the low and medium treatments prior to flowering due to exceptional drought conditions. Each irrigation strategy was conducted on four different tillage systems: 1) conventional till; 2) strip-till; 3) no-till; and 4) no-till with a terminated wheat cover crop. The wheat cover crop is planted after harvest each year at 30 lb/ac and terminated at 50% heading with glyphosate in the spring. The plots have been in no-till since 2008 and strip-till since 2011. Each plot is 150 ft long and 8 rows wide and each treatment combination was replicated three times. Cotton (NG 1511) was on 40 inch row spacing June 12, 2013 and June 13, 2014. Cotton was harvested using a four row stripper and lint yield and quality were measured. Irrigation water use efficiency (IWUE) was calculated as lb of lint produced per inch of irrigation water applied. Statistical analysis was conducted using the Proc Mixed procedure in SAS. For this paper, year was considered a random effect.

Results and Discussion

Precipitation and Irrigation

Precipitation for the months of May to August is presented in Table 1. The region had been under exceptional drought conditions for a significant time since Fall 2010. Conditions were extremely dry entering the 2013 season, a significant rain event occurred the first week of June 2013. However, irrigation was applied to all treatments to ensure plant establishment in 2013. For each year, near the time of flowering, significant rainfall events were recorded each year.

Over 4 inches of rain were recorded the last two weeks of July each year. For the high water rate, irrigation was initiated on June 14, 2013 and June 20, 2014. The low and medium irrigation treatments were initiated on August 5, 2013 and August 8, 2014. Resulting irrigation amounts applied in 2013 were 9.9 inches for the low treatment, 12.14 inches for the medium treatment, and 15.75" for the high treatment. In 2014, total irrigation amounts were 5.0 inches for the low treatment, 6.6 inches for the medium treatment, and 9.75 inches for the high treatment. Over the two year period, average irrigation applied were 7.45 inches for the low treatment, 9.37 inches for the medium treatment, and 12.75 inches for the high treatment.

Table 1. Recorded precipitation at Chillicothe Research Station in 2013 and 2014.

Month	Precipitation	
	2013	2014
May	0.80	6.95
June	3.65	3.80
July	4.35	6.30
August	0.94	1.69

Lint Yield

Statistical analyses indicated that tillage (P=0.1408) and irrigation (P=0.1546) did not significantly affect lint yields. Lint yields are presented in Figure 1. Based on these data, reducing irrigation amounts did not impact lint yields, showing that application of irrigation water at critical growth periods can be a best management practice to conserve water resources. For these two years, early application of irrigation water did not provide yield benefits. Hence, "banking" water early in the season for later crop use was not productive. Of course, heavy precipitation was received each year just as the plant was entering a critical growth period, which could explain the lack of response to early season irrigation. However, Bordovsky et al. (2014) also reported that irrigating in excess early in the season reduced irrigation water value compared to applying irrigation water at critical growth stages later in the year.

Irrigation Water Use Efficiency

As observed with lint yields, IWUE was not significantly impacted by irrigation (P=0.1407) or tillage (P=0.1198). Although not significant, IWUE tended to decrease with increasing irrigation rates (Figure 2). This would be expected as there were no differences in yield among the irrigation treatments. As Bordovsky et al. (2014) concluded, early excess irrigation did not result in enhanced efficiency or water value. For the low and medium irrigation treatments, IWUE were numerically higher for the no-till treatments compared to the conventional and strip-till treatments. This could possibly be attributed to enhanced water capture and retention for no-till systems, which perhaps may be more beneficial in deficit irrigated systems.

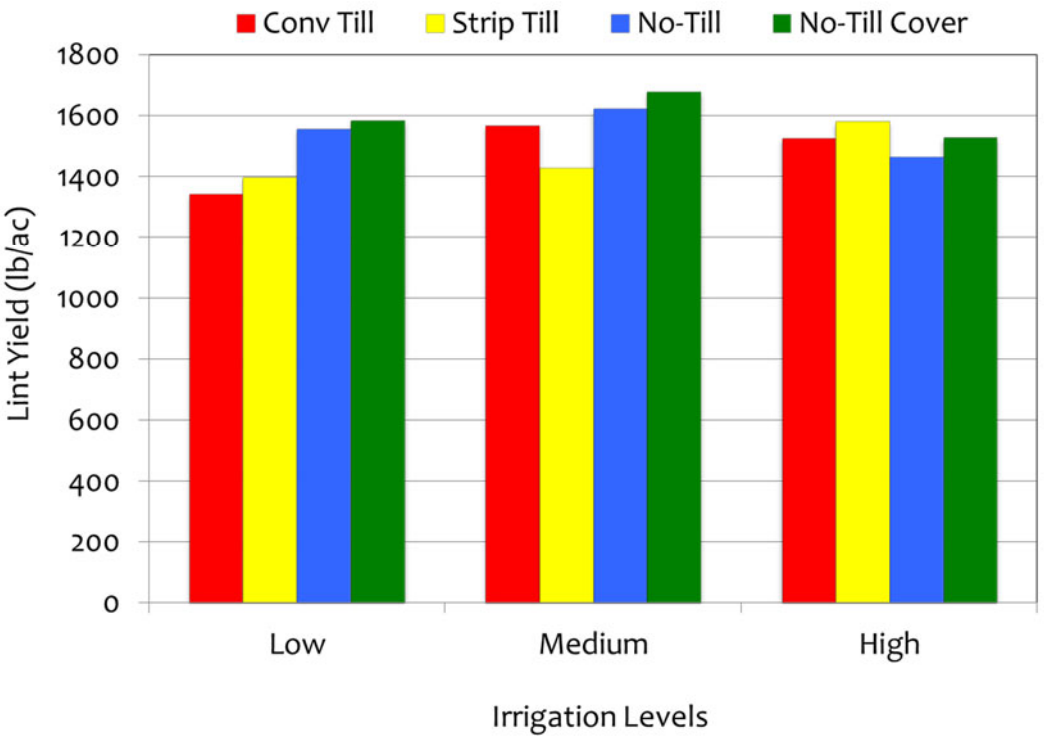

Figure 1. Lint yields over a two year period as affected by irrigation timing and tillage at Chillicothe Research Station 2013-2014.

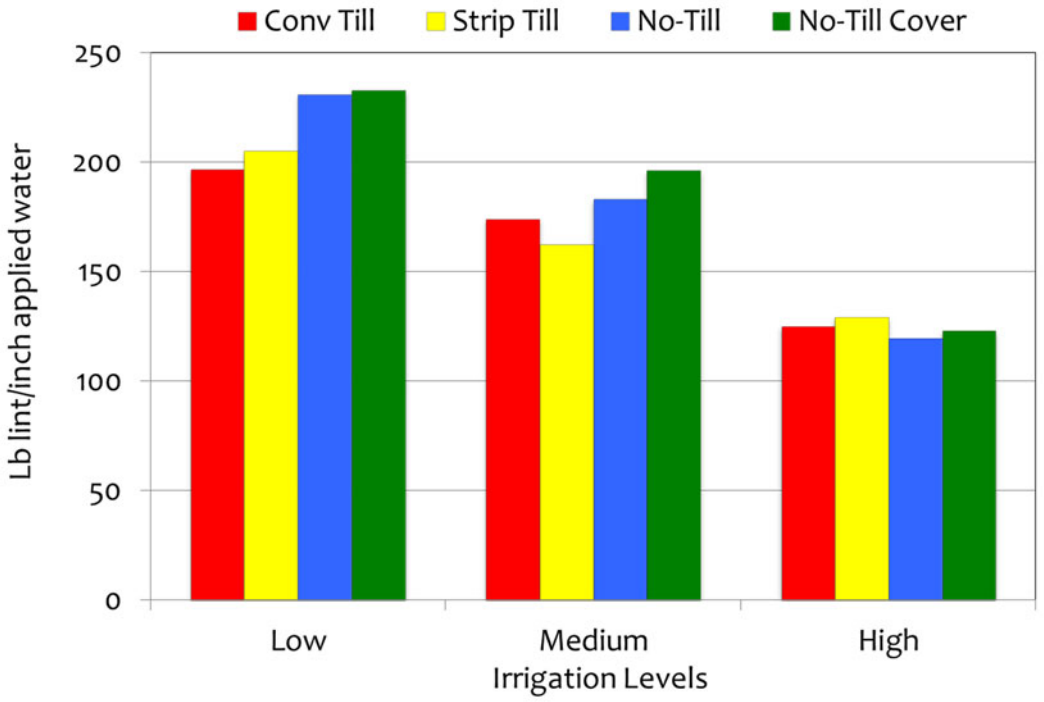

Figure 2. Irrigation water use efficiency as affected by irrigation timing and tillage at Chillicothe Research Station 2013-2014.

Summary

Over a two year trial period, irrigation timing or tillage did not significantly affect lint yields or IWUE. In this study, irrigation rates were reduced by 27 to 42% without affecting lint yield. Applying excess water early in the growing season was not beneficial and did not prove to be a best management practice in regard to water conservation. However, significant precipitation fell during critical growth periods each year that may have offset any deficits incurred due to delaying irrigation until critical growth stages. If well capacity is a concern and irrigation water is limited, then applying irrigation at critical growth stages could provide the greatest irrigation water value and more efficiently conserve water.

Acknowledgements

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