EFFECT OF IRRIGATION TIMING AND CONSERVATION TILLAGE ON COTTON PRODUCTION

Paul DeLaune
Partson Mubvumba
Texas A&M AgriLife Research
Vernon, TX
Emi Kimura
Texas A&M AgriLife Extension Service
Vernon, TX
Srinivasulu Ale
Texas A&M AgriLife Research
Vernon, TX

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 over the 2015-2017 growing seasons: 1) continuous irrigation starting after emergence at 0.2 inch/day (high); 2) continuous irrigation starting at flowering at 0.2 inch/day (low); and 3) continuous irrigation starting at flowering at 0.25 inch/day (medium) conducted on conventional, strip-till, no-till and no-till with a terminated wheat cover crop plots. Lint yields were not significantly different between the high and low water treatments. No-till systems, with and without cover crops, resulted in significantly higher lint yields than the conventional and strip-till treatments over a five-year average. Low irrigation treatments resulted in greater IWUE while no-till with a terminated wheat cover crop yielded higher IWUE than strip-till and conventional tillage. Irrigating at critical growth stages along with no-till can significantly improve irrigation water value and lint yields.

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. 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 (DeLaune and Mubvumba, 2016). The synergy between conservation tillage and irrigation timing has not been evaluated. Our objective was to determine the effect of irrigation timing and capacity on cotton production in conservation tillage systems of the Texas Rolling Plains.

Materials and Methods

Research was conducted at the Texas A&M AgriLife Chillicothe Research Station (CRS) in the Texas Rolling Plains on a clay loam soil under subsurface drip irrigation. Cotton (NG 1511) was planted on 40 inch row spacing at 3 seeds/ft each year of the study until 2017 when PHY 490 WFE was planted. Three irrigation management strategies were evaluated under subsurface drip irrigation: 1) continuous irrigation starting after stand establishment at 0.2 inch/day (high); 2) continuous irrigation starting at flowering 0.20 inch/day (low); and 3) continuous irrigation starting at flowering 0.25 inch/day. Irrigation strategies starting at flowering began once flowering was visually observed in the field. 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 tillage treatments were implemented in Fall 2007, with the exception of strip-tillage that was implemented in Spring 2011. The wheat cover crop was planted at 30 lb/ac and terminated using glyphosate each year. Each plot is 150 ft long and 8 rows wide and each treatment combination was replicated three times. 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.

Results and Discussion

Lint Yield

For 2015-2017, average irrigation applications were 5.6 inches for the low treatment, 7.1 inches for the medium treatment, and 9.7 inches for the high treatment. Irrigation treatment was significant at P<0.01. There were no observed significant difference in lint yield between the low water treatment and high water treatment (Figure 1). The high water treatment resulted in significantly higher lint yields compared to the medium water treatment over the three-year average (Figure 1). Compared to the high irrigation treatment, the low irrigation treatment received 42% less water while reducing lint yield by 14%. Tillage or tillage*irrigation interaction were not significant. While tillage was not significant for the three-year average, no-till systems (with and without cover crop) did result in significantly higher lint yields than conventional and strip-tillage systems over a five-year average (Figure 2).

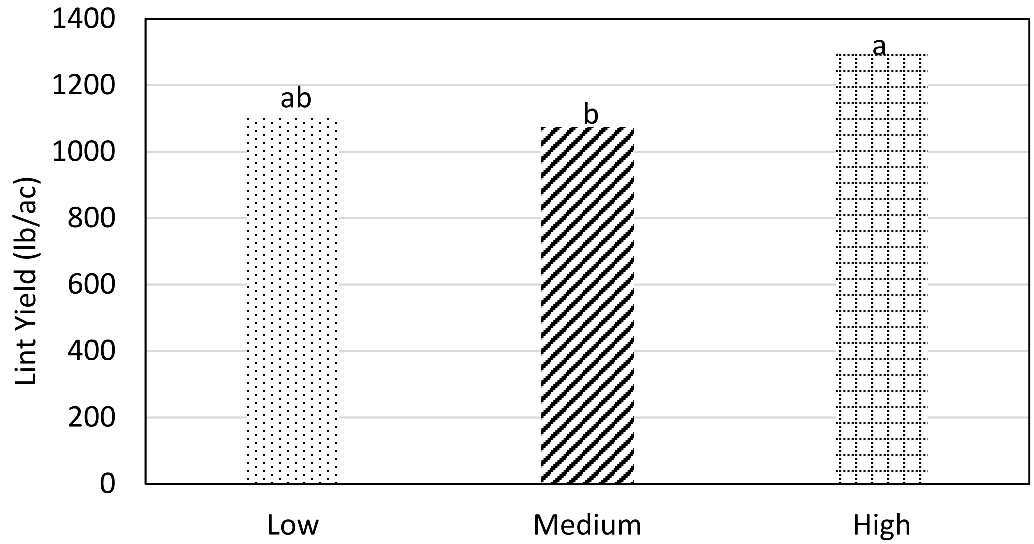

Figure 1. Average lint yield (2015-2017) as affected by irrigation treatment level. Different letters signify significant differences at $P<0.1$.

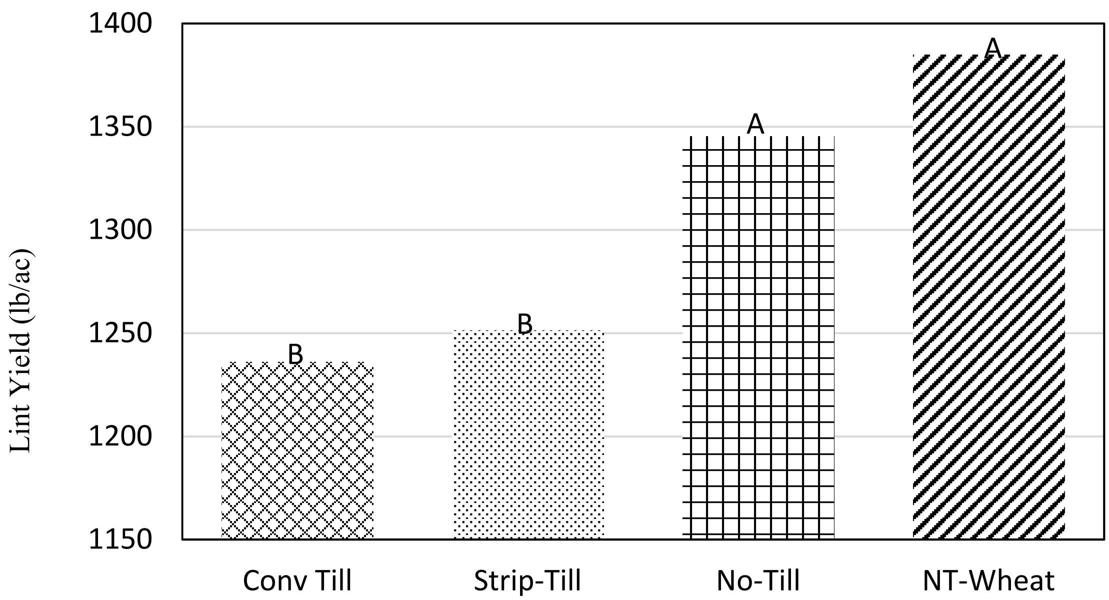

Figure 2. Average lint yield (2013-2017) as affected by tillage treatment level. Different letters signify significant differences at $P<0.05$.

Irrigation Water Use Efficiency

Irrigation (P<.05) and tillage (P<0.1) treatments were significant over the 2015-2017 seasons. The low irrigation treatment resulted in significantly higher IWUE than both the medium and high irrigation treatments (Figure 3). When comparing the low and high irrigation treatments, IWUE was 32% higher for the low irrigation treatment although lint yields were 14% lower. No-till, with and without a cover crop, resulted in significantly higher IWUE than conventional and strip-tillage systems (Figure 4). No-till with a terminated wheat cover crop improved IWUE 14% over the conventional tillage system. These data indicate that both irrigation strategy and conservation tillage can improve IWUE.

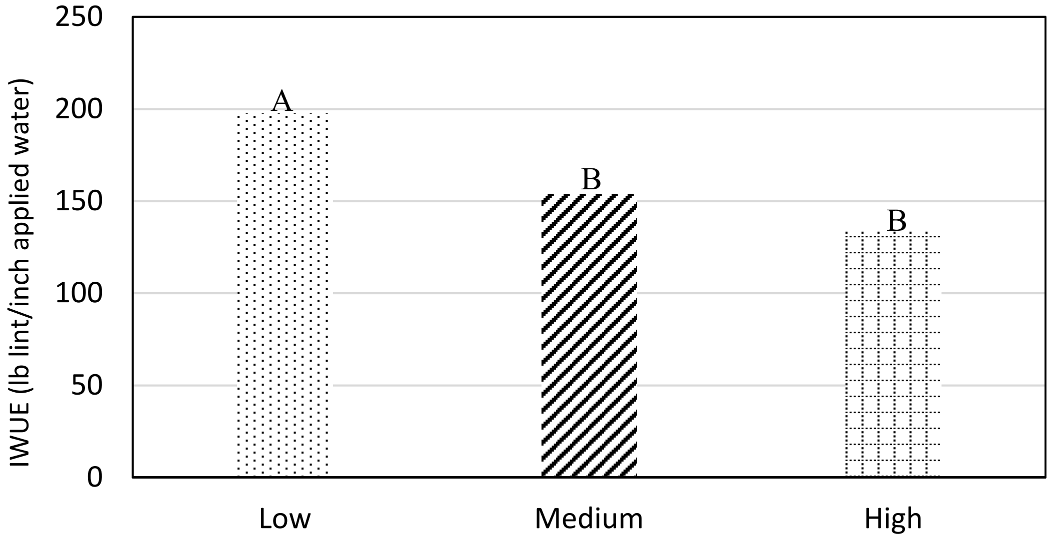

Figure 3. Average irrigation water use efficiency (2015-2017) as affected by irrigation treatment level. Different letters signify significant differences at P<0.05.

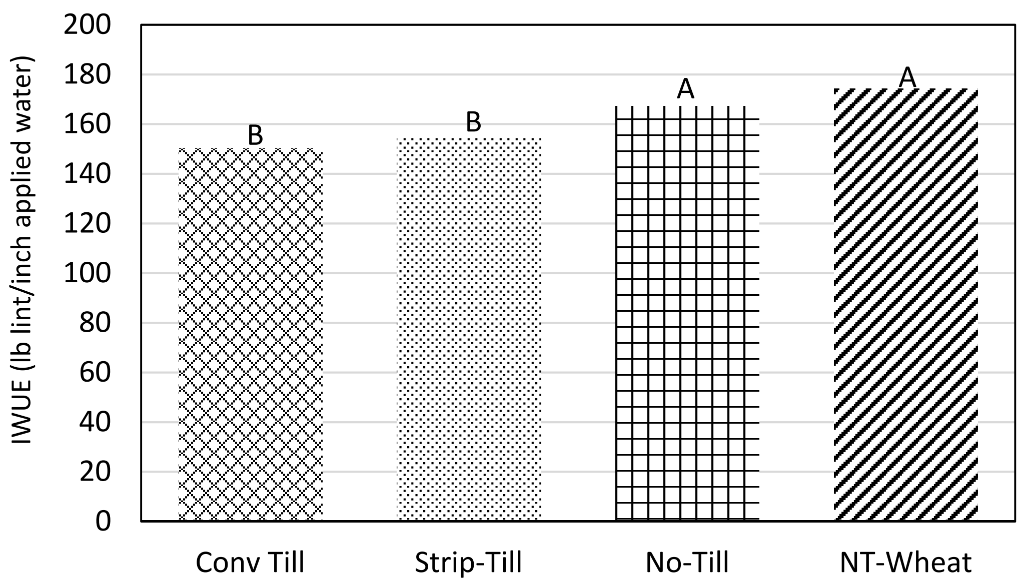

Figure 4. Average irrigation water use efficiency (2015-2017) as affected by tillage treatment level. Different letters signify significant differences at P<0.1.

Summary

Strategic irrigation timing can provide markedly lower irrigation rates while not significantly affecting lint yields. Early season irrigation did not result in improved lint yields and decreased the value of irrigation water. Delaying irrigation until critical growth stages resulted in 42% lower irrigation rates, 14% lower lint yields, and 32% higher IWUE compared to the high irrigation treatment. Irrigation strategies coupled with conservation tillage systems can further enhance water use efficiencies. No-till systems resulted in significantly higher lint yields over a five year period and significantly higher IWUE over a three year period.

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