AGRONOMIC PERFORMANCE OF COTTON GROWN UNDER HIGH BIOMASS RYE COVER CROP

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Abstract

Environmental conditions such as unpredictable rainfall and episodic droughts, along with governmental regulations concerning agricultural water use, have heightened the focus on improving the efficiency of water used for cotton production. Although increasing the efficiency with which water is utilized is key, it also critical that water deficit or stress conditions be avoided, as these have the ability to detrimentally impact the yield of cotton (Pettigrew, 2004; Whitaker et al., 2008; Gwathmey et al., 2011). One cultural practice that shows the potential for more efficient use of water is conservation tillage, particularly the utilization of a cover crop that provides soil coverage. The use of a cover crop in a conservation tillage system has been successful in increasing soil moisture or soil water content (Mills et al., 1988; Dao, 1993; Daniel et al., 1999), as well as increasing the infiltration rate and retention of water in the soil (Dao, 1993; Bruce et al., 1995; Raper et al., 2000). Benefits have also been observed in the growth, development, and yield of cotton grown under a conservation tillage system including a cover crop compared to conventional tillage (Bordovsky et al., 1994; Raper et al., 2000; Schomberg et al., 2006; Wiatrak et al., 2006; Bauer et al., 2010). The objective of the current study was to determine the potential water savings benefits of cotton grown under in a conservation tillage system utilizing a cover crop compared to conventional tillage. Specifically, could cotton under conservation tillage match or exceed the performance of cotton grown under conventional tillage under varying irrigation regimes. The study took place at The University of Georgia's Striping Irrigation Research Park in Camilla, GA. For this study, rye (*Secale cereal*) was planted in mid-November, the year prior to cotton being planted. The rye was planted with a modified grain drill which left a 30.5 cm wide gap, every 91.5 cm, into which cotton would be planted the following spring. The rye was rolled and chemically terminated approximately two weeks prior to cotton being planted. This created a mat of rye covering the soil surface with the exception of the 30.5 cm gap left to facilitate planting and germination of cotton. This study consisted of two tillage treatments, conventional tillage which utilized a roto-tiller for land preparation and weed removal (conventional) and conservation tillage which included the rye cover crop management practices as described above and was planted with a strip tillage implement. An additional large plot on-farm location was added in 2014 in Vienna, GA a dryland site which included the same tillage treatments that were present at the Camilla location. The cultivars 'PhytoGen 499 WRF' and 'FiberMax 1944 GLB2' were included in both years at the Camilla location, while only PhtyoGen 499 WRF was planted at the Vienna location. Four irrigation treatments were also included at Camilla, and consisted of 100, 75, and 50% of The University of

Georgia Checkbook (CHBK) irrigation recommendations for high yielding cotton (Collins et al., 2015), as well as a non-irrigated (dryland) treatment. Plant height was measured every two weeks beginning at the eight leaf stage (8-Lf) and continuing until six weeks after early bloom (EB+6wk). Nodes above white flower were measured every two weeks from early bloom (EB) until EB+6wk. Lint yield was quantified at the end of the season.

There were no significant two-way or three-way interactions at any of the locations between cultivar, tillage and or irrigation (in Camilla) so only the main effects are presented. Due to the lack of significant interactions, the main effects of tillage and irrigation were pooled over cultivar at Camilla, as differences between cultivars were likely due to inherent variability of cultivar characteristics, and not the tillage or irrigation treatments. Excessive rainfall fell in several weeks during the 2013 season, resulting in the irrigation treatment targets being surpassed by rainfall alone. At Camilla in 2013, 96, 91, 86, and 77 cm of water were received by the 100% CHBK, 75% CHBK, 50% CHBK, and dryland treatments, respectively. In 2014 these totals were 66, 58, 49, and 36 cm, while 29 cm of rain fell at the Vienna 2014 location.

At the Camilla 2013 site, plant height was reduced in the conservation tillage treatment, while increases in irrigation resulted in increases in plant height, through there was typically no difference between the 100 and 75% CHBK, the two highest irrigation treatments the study. With the exception of the EB+2wk measurement, greater NAWF were present in the conventional tillage treatment. Early in the season the 100% CHBK treatment resulted in the highest NAWF, while late in the season NAWF were greatest in the dryland treatment, which may be reflective of the excessive rainfall received at this site. At the Camilla 2014 site, taller plants were present at EB in the conventional tillage treatment, while the conservation treatment resulted in taller plants at EB+4wk. Similar to the 2013 trial in Camilla, increases in irrigation typically resulted in increased plant height, though there were generally no differences between 100 and 75% CHBK treatments. In contrast to the results of the 2013 Camilla trial, the conservation tillage treatment resulted in higher NAWF season-long in Camilla 2014. The greatest amount of NAWF were present in the 100 and 75% treatments, until the last measurement at EB+6wk at which point the 100% CHBK had at least one NAWF greater than all other irrigation treatments. In Vienna, the conventional tillage treatment resulted in taller plants throughout the season and increased NAWF in two out of the four measurements. The only instance in which tillage had a significant effect on lint yield was at Camilla in 2013, when the conservation tillage system resulted in a 127 kg ha^{-1} decrease compared to conventional tillage, across all irrigation treatments. At the Camilla 2014 trial, the 75% CHBK resulted in more lint yield than the 50% CHBK and dryland treatments, through was no different than the 100% CHBK treatment. There was also a significant difference between the two lowest irrigation treatments, with a 525 kg ha^{-1} decline in lint yield from the 50% CHBK to the dryland treatment. There was no effect of tillage on lint yield at the Vienna location.

These results suggest that any potential water savings or benefits on plant growth and yield gained from the conservation tillage system evaluated in the current study are likely dependent on environmental conditions during the growing season, specifically rainfall. In years in which frequent rainfall events occur, and adequate water is supplied through participation alone, the water savings benefits of this conservation tillage system are likely minimal, while detriments may occur due to this system if multiple excessive rainfall events occur such as was the case at Camilla in 2013. However, the few instances in which benefits in plant growth and development were observed due to the conservation tillage system provide evidence that a greater positive impact could be observed if water deficit or drought conditions were present, although these conditions were not present at any location during the duration of this study. Additional work will need to be performed to further evaluate this conservation tillage system under a multitude of environmental conditions and water supply regimes to fully understand the potential benefits in regards to water savings and cotton performance.

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