MANAGEMENT OF COTTON GROWN UNDER SUB-SURFACE DRIP AND FURROW IRRIGATION WITH DIFFERING PLANT DENSITIES

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Abstract

Crop management practices such as irrigation and plant density may impact final lint yield in cotton. A two-year field trial was conducted in 2010 and 2011 using four planting densities ranging from 6.5 to 16.1 plants m^{-2} on two irrigation schemes, sub-surface drip and furrow irrigation. This trial was conducted to identify potential growth and developmental changes related to cotton grown at differing plant densities and irrigation schemes. Irrigation was shown to have significant effects on yield and fiber quality. Plants grown on sub-surface drip irrigation had higher yield/A in. of water than plants grown on furrow irrigation and used less water in both 2010 and 2011. In the 2010 season, a plant density of 9.7 m^{-2} had the highest yields while in the 2011 season, the plant density of 12.9 plants m^{-2} had the highest yields. Utilizing a Smart Field™ system for monitoring crop stress and determining irrigation timings and adding a dryland treatment would be beneficial to this trial in the future.

Introduction

Urban water demand in Texas has grown rapidly in recent years causing water resources to become limited. Water designated for agriculture use is one of the main consumers of the water supply. Reducing agricultural water use while maintaining crop yields is one way to solve this problem. Sub-surface drip irrigation (SDI) is becoming more widely used as a way to decrease water use and to maintain or in some cases, increase crop yields. Also, due to the rise in planting seed costs, a proper plant density has the capacity to maximize cotton yield and fiber quality for a given level of available water. Planting to an optimum stand is one method of reducing cost and helping to insure satisfactory yield, since cotton yields are directly influenced by the number of plants obtained at planting (Bridge et al. 1973).

The objectives for this trial are to compare yield and fiber quality of cotton produced under sub-surface drip and furrow irrigation under differing planting densities, to examine the phenology and growth characteristics of a cotton crop under these differing irrigation strategies, to compare irrigation applied through SDI and furrow applied methods for their impact on water use efficiency relative to unit of yield produced, and to compare time of maturity based upon population densities over irrigation models.

Materials and Methods

A trial was conducted at the Texas AgriLife Research Farm in Burleson County on a Weswood silt loam. All treatments were arranged on a split plot design with one variety, Stoneville ST 5458 Bollgard 2 Roundup Flex® cotton. Irrigation schemes used were sub-surface drip irrigation (SDI), with replacement of 85% ET and conventional furrow irrigation. Treatments consisted of four population densities: 6.5 plants m^{-2}, 9.7 plants m^{-2}, 12.9 plants m^{-2}, and 16.1 plants m^{-2}. Each treatment was replicated four times. The trial was fertilized uniformly with 134 Kg of 32-0-0 liquid N per hectare. Biomass and light interception readings was done at pinhead square (49 DAP), peak bloom (80 DAP), and mature boll (110 DAP). Canopy temperature readings, lint yield, and fiber quality were all evaluated. All treatments were harvested with a John Deere 9910 two-row, high drum spindle picker. Fiber quality measurements were determined by sending samples to The Fiber and Biopolymer Research Institute in Lubbock, Texas.

Table 1. Water Inputs (cm)

	2010		2011	
	Drip	Furrow	Drip	Furrow
Irrigation	30.48	50.8	29.46	48.26
Precipitation	35.56	35.56	17.78	17.78
Total	66.04	86.36	47.24	66.04

Results and Discussion

Significant interactions can be seen between irrigation and seed cotton lbs. /A, percent turnout, and lint cotton lbs. /A. Irrigation also significantly impacted micronaire, length, uniformity, strength, and elongation (Table 2). However, no significant interactions were shown between planting density and yield and fiber quality. Plants grown on sub-surface drip irrigation had a higher amount of canopy closure at peak bloom and mature boll than plants grown on furrow irrigation. Plants grown during the 2010 season had a higher amount of canopy closure than plants in the 2011 growing season. Yield/A in. of water was higher for plants grown on sub-surface drip than furrow irrigation in 2010 and 2011. Plants grown on sub-surface drip irrigation had higher yield/A in. of water than plants grown on furrow irrigation and used less water in both 2010 and 2011 (Fig. 1). In the 2010 season, a plant density of 9.7 m^{-2} had the highest yields while in the 2011 season, the plant density of 12.9 plants m^{-2} had the highest yields.

Table 2. Effects of irrigation on yield and fiber quality

Source	Seed Cotton Lbs/A	% Turnout	Lint Cotton Lbs/A	Mic.	Length	Uniform.	Strength	Elong.
SDI	2172.2 A	0.42 A	902.12 A	4.93 A	1.04 B	80.14 B	28.01 B	7.45 A
Furrow	1871.15 B	0.41 B	766.10 B	4.62 B	1.14 A	81.44 A	28.70 A	5.74 B

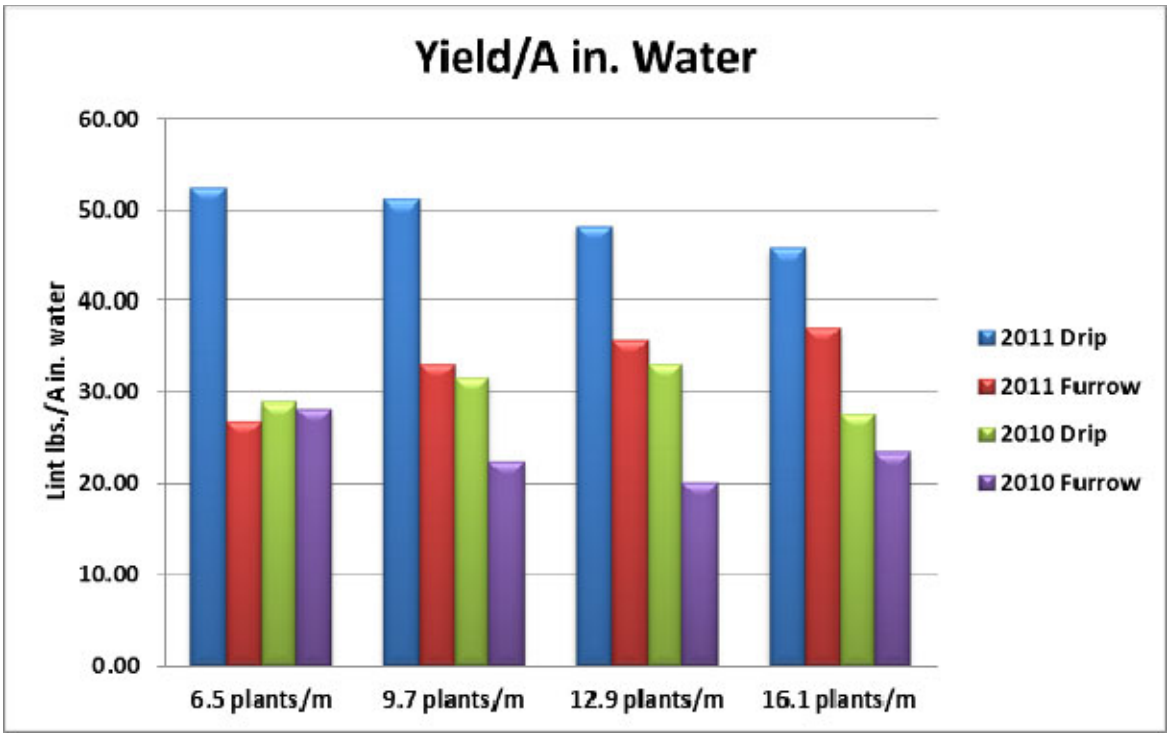

Figure 2. Lint yield/A in. water (lbs. /A)

Summary

Irrigation significantly impacted the yield and fiber quality of cotton grown during both the 2010 and 2011 growing seasons. However, no significant interactions were shown between planting density and yield and fiber quality. Plants grown on sub-surface drip irrigation had a higher amount of canopy closure at peak bloom and mature boll than plants grown on furrow irrigation however, during pinhead square plants that were furrow irrigated had a higher amount of canopy closure. A lower amount of canopy closure in the sub-surface drip irrigated plots at pinhead square may be due to the young root system of the plants and their inability to reach the water applied through the drip irrigation. Plants grown during the 2010 season had a higher amount of canopy closure than plants in the 2011 growing season which can be attributed to the higher amount of rainfall experienced in the 2010 growing season, resulting in more vegetative growth. Plants grown on sub-surface drip irrigation had higher yield/A in. of water than plants grown on furrow irrigation and used less water in both 2010 and 2011. This data shows that with irrigation applied directly to the root system of cotton plants, higher yields can be achieved while using less water due to a reduction of evapotranspiration.

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References

Bednarz, C.W., D.C. Bridges, and S.M. Brown. 2000. Analysis of cotton yield stability across population densities. Agron. J. 92:128-135

Bridge, R.R., W.R. Meredith, and J.F. Chism. 1973. Influence of planting method and plant population on cotton (*Gossypium hirsutum*). Agron. J. 65:104-110.

Feng, L., et al. 2010. Effects of irrigation and plant density on cotton within-boll yield components. Agron. J. 102:1032-1036