THE EFFECT OF PRIMED ACCLIMATION IRRIGATION STRATEGIES ON COTTON WATER USE EFFICIENCIES

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Introduction

Important steps for producers after establishing a good plant stand are to promote healthy root development and canopy growth. A type of irrigation management strategy called primed acclimation (PA) aims to limit water availability early in the growing season to promote root development, which potentially helps prepare plants for episodic drought in years with limited water. Recent advances in continuous and remote soil moisture monitoring will allow for a more definitive assessment of 1) the utility of the primed acclimation strategy and 2) the thresholds needed to achieve the maximum benefit from this strategy.

Rowland et al. (2012) have demonstrated this system to be highly effective in peanut production. Guinn et al. (1981) demonstrated water savings without negative impacts on cotton yield (relative to treatments receiving irrigation at the start of squaring) by delaying the first irrigation until two weeks after the first visible square was observed.

To our knowledge, there are no studies currently available that assess the utility of PA in cotton by using variation in early-season soil water potential-based irrigation scheduling thresholds. Plants produced under PA conditions have demonstrated improvement in their water use efficiency (WUE), as well as photosynthesis when compared to non-acclimated plants under drought stress (Flexas et al., 2006; Rowland et al., 2012). Physiological alterations resulting from prior exposure to stresses (one example being histone modification) are often retained by plants the entire growing season (Bruce et al., 2007). The key to the PA approach is to clearly define early-season irrigation thresholds such that the cotton crop is not exposed to yield-limiting drought stress (Perry et al., 2012).

Materials and Methods

Field experiments were conducted at the CM Stripling Irrigation Research Park near Camilla, GA, during 2014. The experiment was a split-block design with four replications. A single commercial cotton cultivar, FiberMax 1944 GLB2, was planted on 19 May in 2014 and managed according to practices outlined by University of Georgia Cooperative Extension with respect to fertility, plant growth regulator application, weed control, and insect control. Seed were planted at a 1 inch depth at a rate of three and a half seed per row ft. with row spacing of 36 inches. Five treatments were utilized including four pre-bloom irrigation triggers:

T5 A dryland check with no irrigation applied beyond what was needed for stand establishment. This treatment could not be randomized with the other treatments due to irrigation system limitations.

T1 -20cb pre-bloom

T2 -40cb pre-bloom

T3 -70cb pre-bloom

T4 -100cb pre-bloom

The UGA Smart Sensor Array (SSA) utilizing Watermark soil water potential sensors was used to trigger irrigation with these predetermined pre-bloom soil moisture triggers. Upon initiation of flowering, all irrigated treatments were triggered at -35 cb for the remainder of the season. Irrigation was applied via overhead sprinkler irrigation using a variable rate center-pivot irrigation system. Plot sizes were a minimum of eight rows in width and 40 feet in length.

Rainfall data were obtained from a weather station in the vicinity of the experimental area. Table 1 shows rainfall and irrigation amounts during the irrigation treatment period for all treatments in 2014. Following defoliation, rows four and five of each eight-row plot were harvested using a two-row spindle picker. Seedcotton weight was obtained on-site. Seedcotton samples were then sent to the University of Georgia microgin in Tifton for ginning, and lint yield was determined. The effect of irrigation treatment on lint yield was analyzed using a mixed effects ANOVA where block was a random effect and irrigation treatment was a fixed effect. Post-hoc analysis was conducted using Fisher's LSD ($\alpha = 0.05$).

Results and Discussion

Using the higher thresholds of -70 cb or -100 cb saved 0.9 inches of applied irrigation water compared to the lower threshold of -20 cb (Table 1). Irrigation triggered prebloom for T1 was four times greater than the other PA thresholds. All four irrigated treatments resulted in the same irrigation applied postbloom (Figure 1). Even with varying amounts of irrigation water applied pre-bloom, irrigation triggered and applied postbloom were the same (Figure 2).

Rainfall in 2014 (12.6 inches) was 5.4 inches less than the 18-inch amount reported by Bednarz et al. (2002) as needed to maximize lint yields. Irrigation amounts and events were not substantially different applied postbloom even with the reduced prebloom irrigation for PA treatments. Total water received (irrigation plus rainfall) was 17.7 inches for T1 and 17.1 inches for T2.

Lint yields were not significantly different for any of the prebloom triggers (Figure 3). Yields were substantially higher in all irrigation treatments compared to the dryland treatment. Plant mapping parameters indicated no significant differences between irrigated treatments with respect to yield distribution (data not shown).

Observations thus far indicate that PA irrigation strategies could potentially be successfully implemented in cotton production, although additional data is needed to verify these findings.

Table 1. Cumulative Amount of Water Supplied to the Cotton Crop During the 2014 Growing Season From Irrigation Treatment Initiation Until Irrigation Termination (in Inches)

Treatment	Pre-bloom Irrigation	Post-bloom Irrigation	Rainfall	Total
T1 -20cb	1.2	3.9	12.6	17.7
T2 -40cb	0.6	3.9	12.6	17.1
T3 -70cb	0.3	3.9	12.6	16.8
T4 -100 cb	0.3	3.9	12.6	16.8
T5 Dryland	0.0	0.0	12.6	12.6

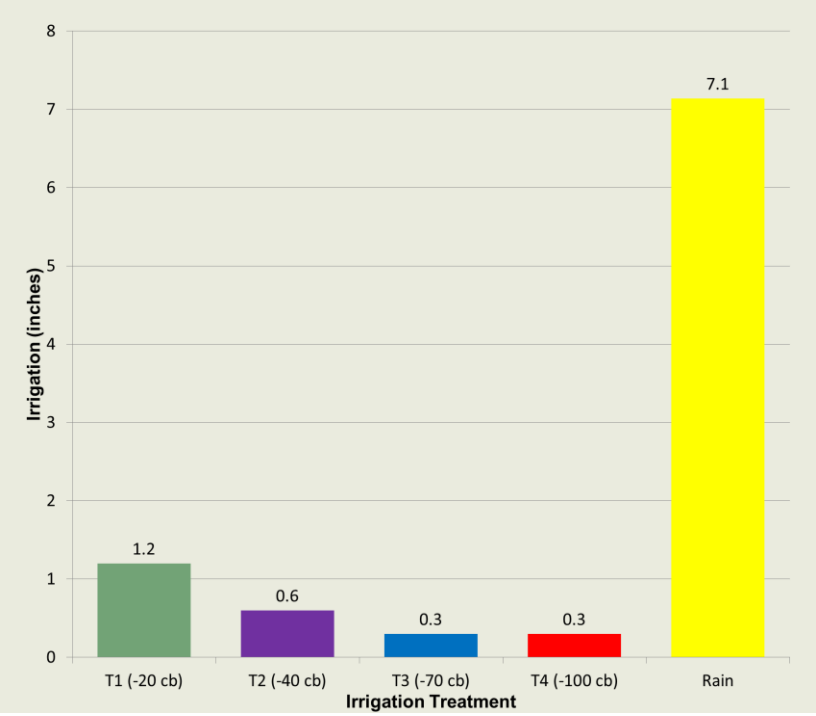

Figure 1. Applied prebloom irrigation for *Gossypium hirsutum* cv. FiberMax 1944 GLB2 under four different irrigation triggers during the 2014 growing season.

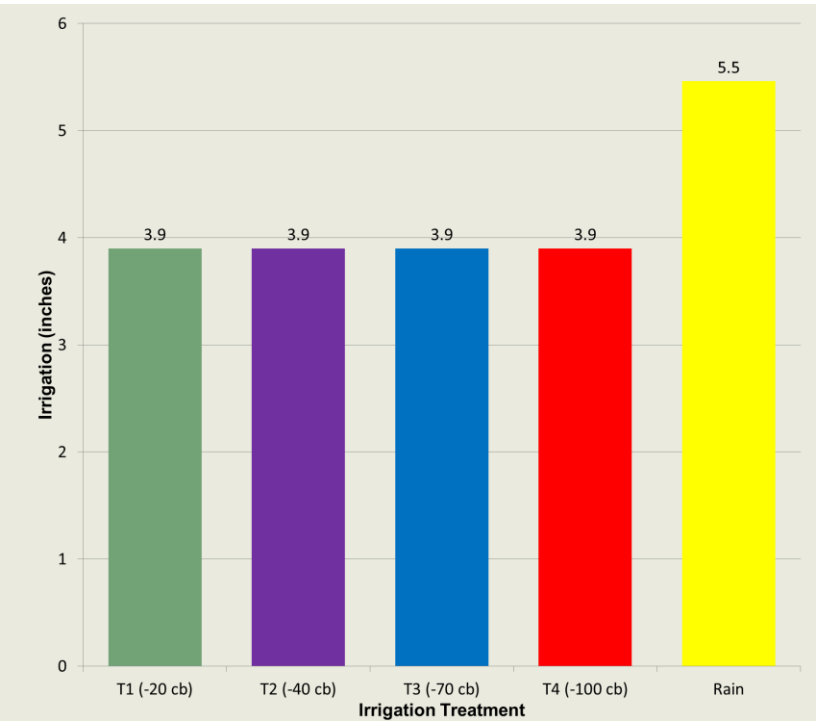

Figure 2. Applied postbloom irrigation for *Gossypium hirsutum* cv. FiberMax 1944 GLB2 under four different irrigation triggers during the 2014 growing season.

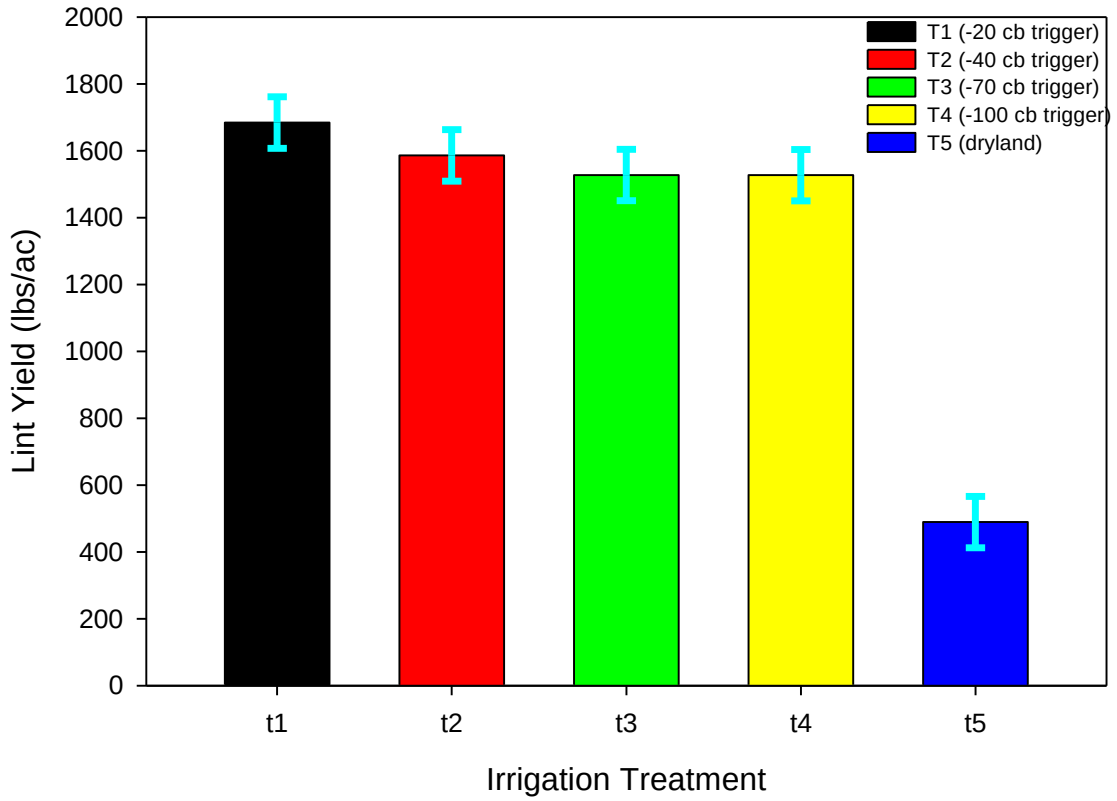

Figure 3. Average lint yield for *Gossypium hirsutum* cv. FiberMax 1944 GLB2 under five different irrigation triggers during the 2014 growing season. Columns are means and standard errors.

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