Assessing the Utility of Primed Acclimation for Improving Water Use Efficiency in a Sensor-Based Irrigation Scheduling System

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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 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. Consequently, the UGA Smart Sensor Array (SSA) was used to trigger irrigation events at predetermined soil water potential readings prebloom with all irrigation events triggered at -35 cb following the first week of bloom. Infield physiological data such as plant height and total nodes was collected biweekly, while remote sensing data were collected weekly and included Normalized Difference Vegetation Index (NDVI), and aerial RGB photography.

Objectives

- To demonstrate the potential usage of the UGA SSA to apply the Primed Acclimation irrigation strategy.
- To evaluate multiple **irrigation thresholds** pre-bloom to maximize Water Use Efficiency (WUE).

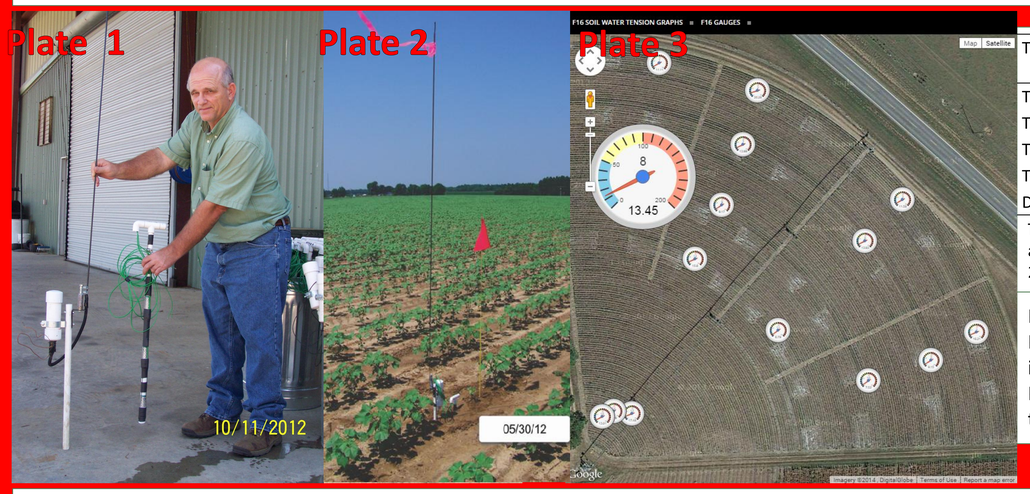
Hypotheses

- Current irrigation practices can be modified, using higher soil moisture potential readings prebloom to increase irrigation efficiency.
- Prebloom irrigation would not significantly affect yield.

Materials and Methods

- Field experiments were conducted in Camilla, GA during 2014 and 2015.
- The experiment was conducted using a Split-Block Design with 4 replications.
- Treatments:
- 1 Cotton Cultivar- FiberMax 1944GLB2
- **T5**: a dryland check (This treatment could not be randomized with the other treatments due to irrigation system limitations).
- 4 prebloom irrigation triggers- **T1** (-20 cb pre bloom), **T2** (-40 cb pre bloom), **T3** (-70 cb pre bloom), and **T4** (-100 cb pre bloom
- 1 trigger at first bloom- (-35 cb)
- Remote sensing measurements included NDVI collected via GreenSeeker® and RGB photography was collect via a 3DR X8 Unmanned Aerial Vehicle with a gimbal mounted Go Pro camera.
- Agronomic Measurements
- Height, Total Nodes and Nodes Above White Flower measurements were collected throughout the season
- Post defoliation in field Plant mapping was done to determine yield distribution
- Seedcotton and lint yield, harvested from two 40 ft rows.
- Treatment effects evaluated via 2-way ANOVA with a random blocking factor. Post-hoc analysis was done using Fisher's LSD (α=0.05).

Materials and Methods



Treatment	Irrigation (in)	Rainfall (in)	Total Water (in)
T1	7.2	12.6	19.8
T2	6.6	12.6	19.2
T3	6	12.6	18.6
T4	6	12.6	18.6
Dryland	0	12.6	12.6

Table 1. Irrigation, Rainfall, and total water applied to five irrigation treatments for cotton in 2014.

Plate 1, left. UGA SSA
Plate 2, left. UGA SSA actually installed in field
Plate 3, left. Graphical user interface of the UGA SSA portal.

Results

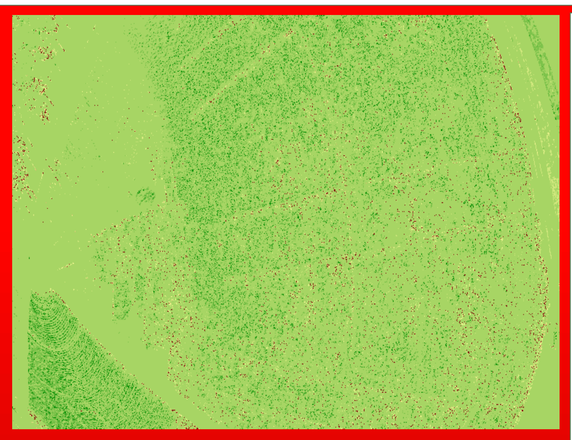
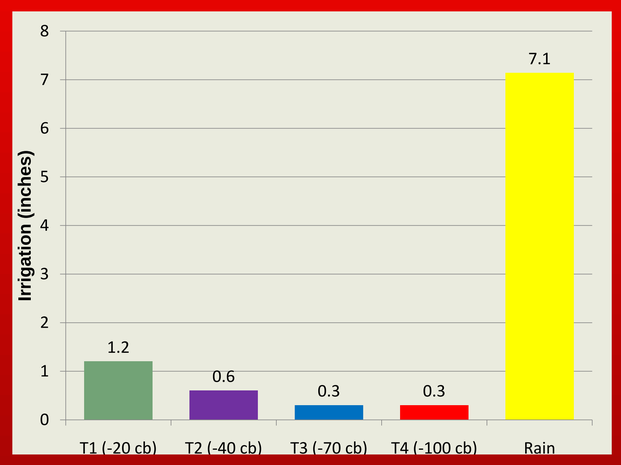


Figure 1, left top. An example of aerial RGB photograph over the experiment area.

Figure 2, right top. An example of RGB photography converted into a red/green index image with applications similar to NDVI

No significant difference between irrigation treatments were detected using this technology nor using conventional NDVI measures



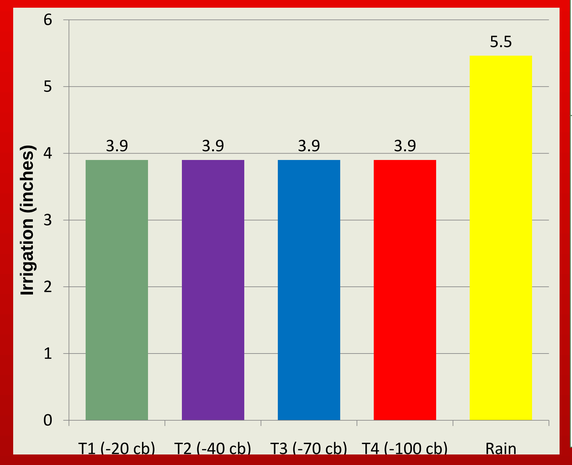
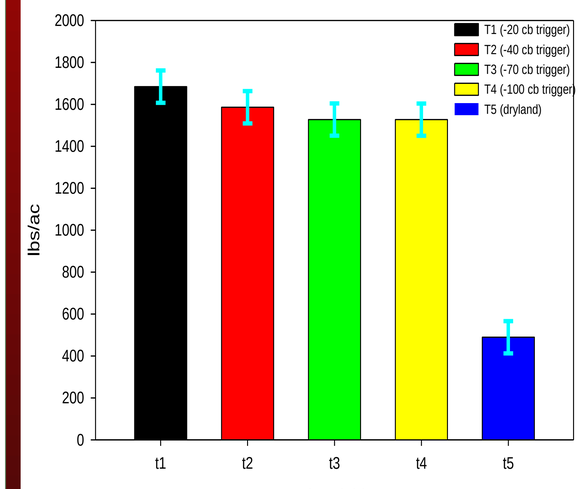


Figure 3, left center. Irrigation was applied upon triggering during the Primed Acclimation period prebloom 0.3in per trigger.
Figure 4, right center. Post bloom irrigation, applications were made for all treatments at -35 cb.

Figure 5. Lint yield was higher for all irrigation treatments when compared to the dryland check. However, yield response was similar across all irrigated treatments.

Figure 5



Future Research

In 2015, this project was repeated, at the Stripling Irrigation Research park in Camilla, Ga, however end of season data is not yet available. Future research should be under taken to determine if Primed Acclimation irrigation strategies could utilize higher trigger points than the -100 cb trigger for higher water savings. Experiments should also have been under taken to observe if this irrigation strategy can be implemented while the cotton crop is its first bloom stage. (ie., the first week of bloom with no yield loss).

Citations

- Rowland, D.L., Faircloth, W.H., Payton, P., Tissue, D., Jason, T., Ferrell, A. , Sorensen, R.B. and Butts, C.L. (2012) Primed Acclimation of Cultivated Peanut (Arachis hypogaea L.) through the Use of Deficit Irrigation Timed to Crop Developmental Periods. Agricultural Water Management, 113, 85-95.
- Vellidis, G., M. Tucker, C. Perry, C. Kvien, and C. Bednarz. 2008. A real-time wireless smart sensor array for scheduling irrigation. *Computers and Electronics in Agriculture* 61(1):44-50

Discussion

- T4 and T3 irrigation treatments resulted in similar application amounts with a %17 reduction in applied irrigation compared to T1 which was fully irrigated (Table 1).
- Sensor-based primed acclimation irrigation strategies exhibited water savings without a yield penalty.
- NDVI as well as RGB imagery parameters demonstrated no significant differences between irrigated treatments (Figure 1 & 2).
- Irrigation events triggered prebloom were four fold greater for T1 than the higher Primed Acclimation thresholds (Figure 3).
- Irrigation amounts and events were not significantly different even with the reduced prebloom irrigation for Primed Acclimation treatments (Figure 4).
- Lint yield was significantly higher than the dryland for all irrigation treatments. However, no significant differences were observed between irrigated treatments for lint yield and WUE(Figure 5).
- Plant mapping parameters observed indicated no significant differences between irrigation treatments with respect to yield distribution (Data Not Shown).
- Observations thus far indicate that Primed Acclimation irrigation strategies could potentially be successfully implemented in cotton production although additional data will be needed to verify these findings.
- Current trigger points may need to be modified to fully take advantage of this irrigation strategy.

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