Annual Georgia Environmental Conference

11th Annual Georgia Environmental Conference
Primed Acclimation: Limited Early Season Irrigation to Maximize Water Use Efficiency.

Calvin Meeks[1], John Snider[2], Wesley M Porter[1], Gary Hawkins[1], and George Vellidis[1], (1)University of Georgia, Tifton, GA, (2)Cotton Physiology, University of Georgia, Tifton, GA

UNIVERSITY OF GEORGIA COTTON PHYSIOLOGY

Abstract/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.

FIGURE 1: UGA Smart Sensor Array

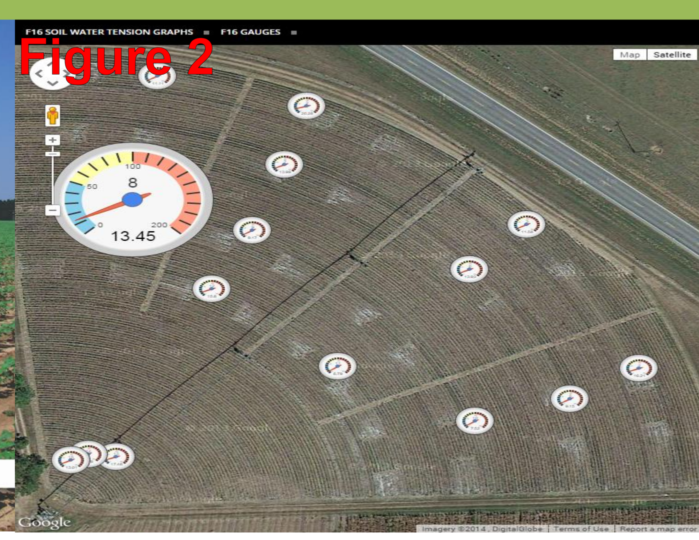


FIGURE 2: Smart Sensor Array Interface

Objectives/Materials and Methods

FIGURE 3: Aerial RGB photo of the study area

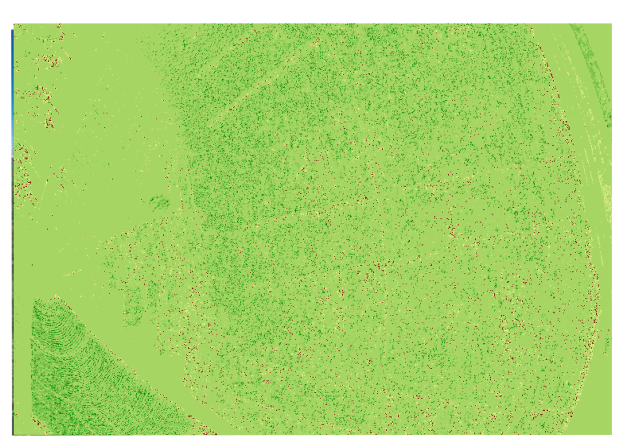


FIGURE 4: Remote sensing map of the study area.

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

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 and Agronomic Measurements were collected throughout the season
Treatment effects evaluated via 2-way ANOVA with a random blocking factor. Post-hoc analysis was done using Fisher's LSD (α=0.05).

Results

Cotton yields were not significantly different among treatments receiving irrigation (Figure 7, A-2014, B-2015).
However environmental conditions varied across the two years (Figure 5, A,C-2014, B, D-2015).
Increased irrigation thresholds decreased water usage while maintaining yields, (Figure 6)

Figure 5

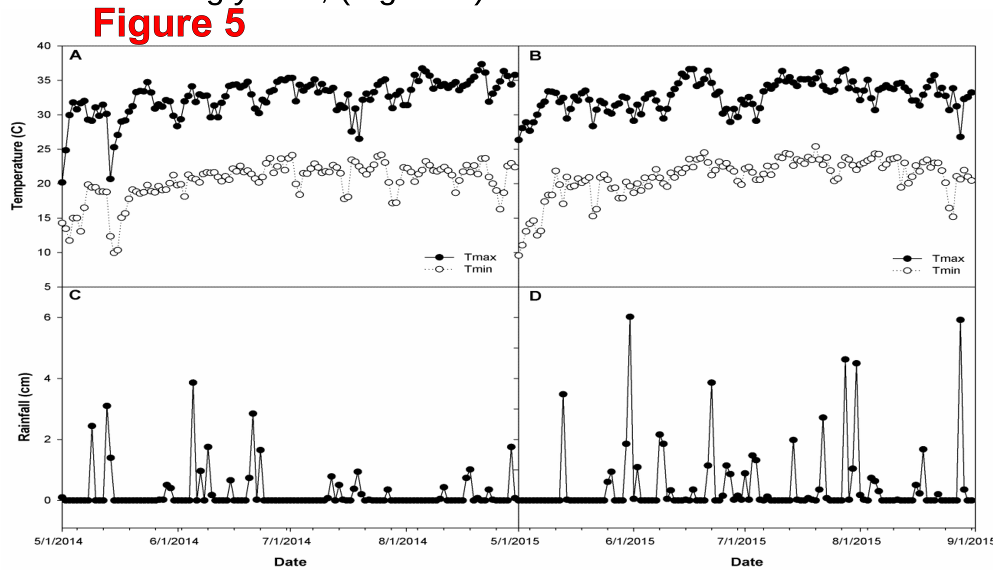
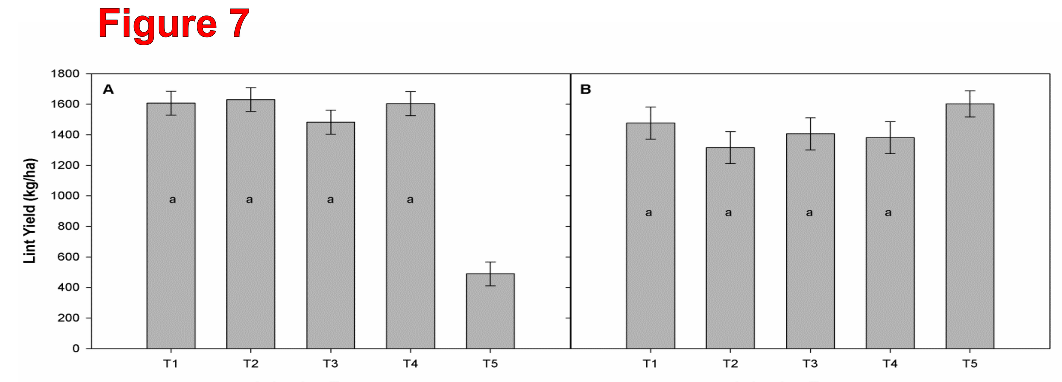


Figure 6

Year	Treatment	Pre-Bloom Threshold	Post-bloom Threshold	Irrigation (cm)	Rainfall (cm)	Total (cm)
2014	T1	-20 kPa	-35 kPa	18.3	32.0	50.3
	T2	-40 kPa	-35 kPa	16.8	32.0	48.8
	T3	-70 kPa	-35 kPa	15.2	32.0	47.2
	T4	-100 kPa	-35 kPa	15.2	32.0	47.2
	T5	Dryland	Dryland	0.0	32.0	32.0
2015	T1	-20 kPa	-35 kPa	13.7	61.0	74.7
	T2	-40 kPa	-35 kPa	9.9	61.0	70.9
	T3	-70 kPa	-35 kPa	9.1	61.0	70.1
	T4	-100 kPa	-35 kPa	8.4	61.0	69.3
	T5	Dryland	Dryland	0.0	61.0	61.0

Figure 7



Plant growth patterns were influenced by irrigation.
However, Irrigation treatments did influence boll distribution patterns.
Dryland treatments were heavily negatively affected in 2014. (Figure 8, A-T1, B-T2, C-T3, D-T4, E-T5)
Boll distribution was distributed among the most nodes and positions utilizing the highest prebloom threshold in 2014. (Figure 8, A-T1, B-T2, C-T3, D-T4, E-T5)
Dryland treatments were also negatively affected in 2015 (Figure 9, A-T1, B-T2, C-T3, D-T4, E-T5).
Boll distribution was similar regardless of applied prebloom irrigation in 2015. (Figure 9, A-T1, B-T2, C-T3, D-T4, E-T5).

Figure 8

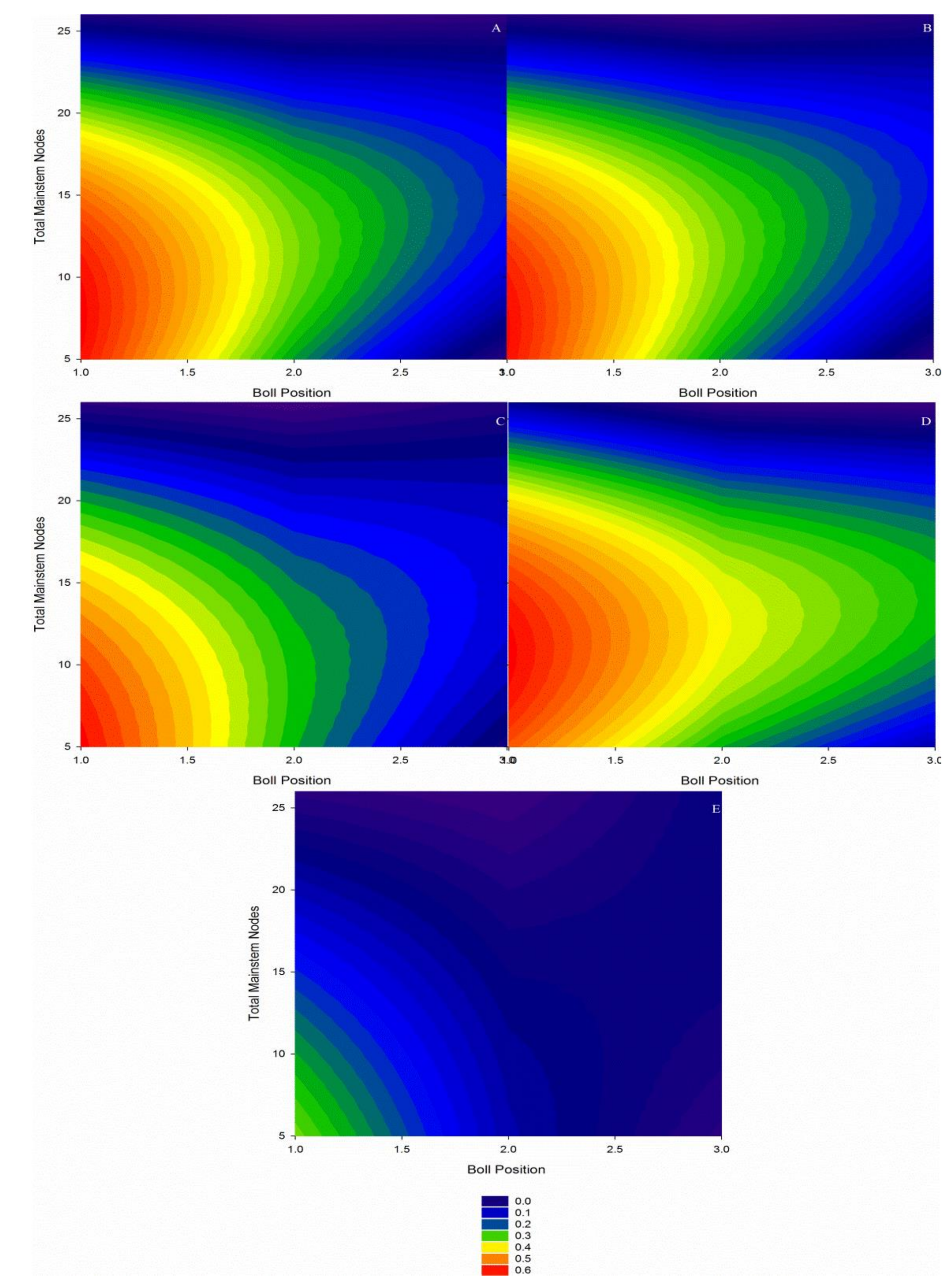


Figure 9

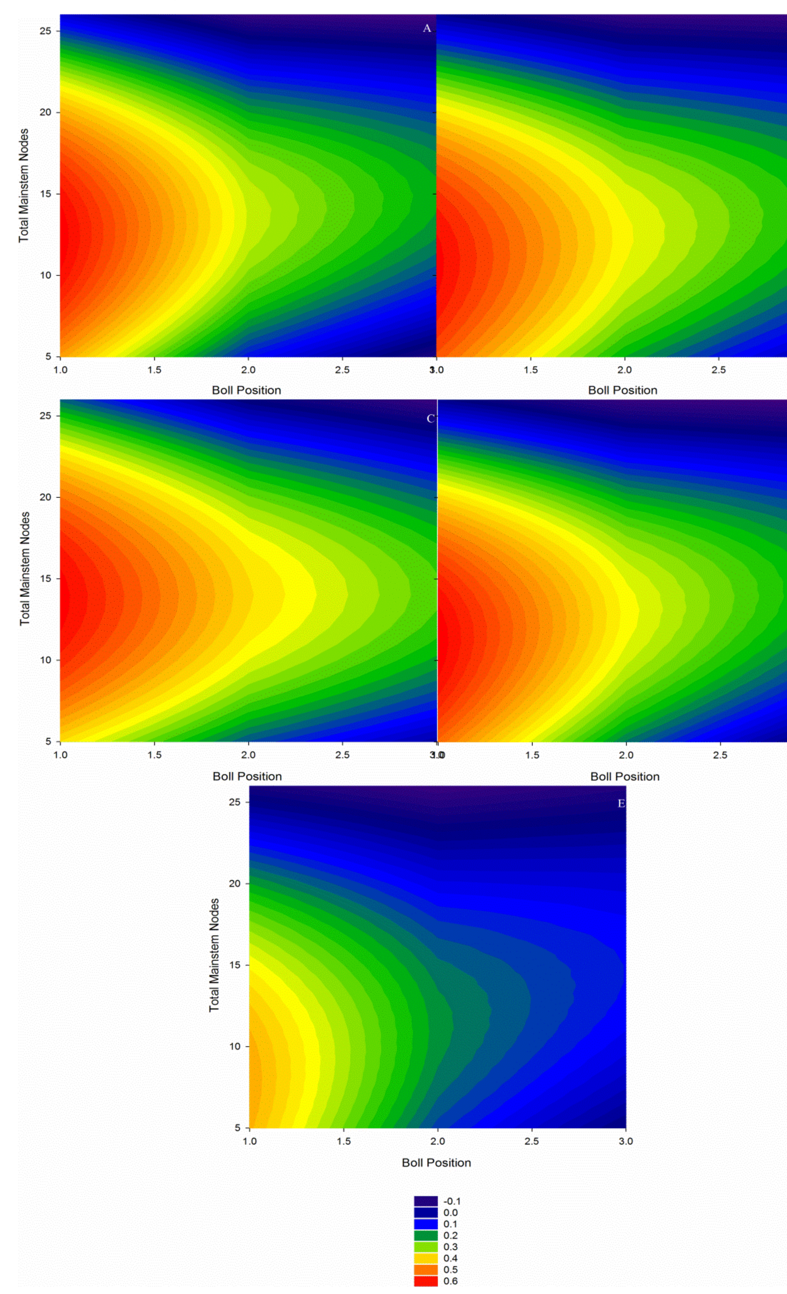
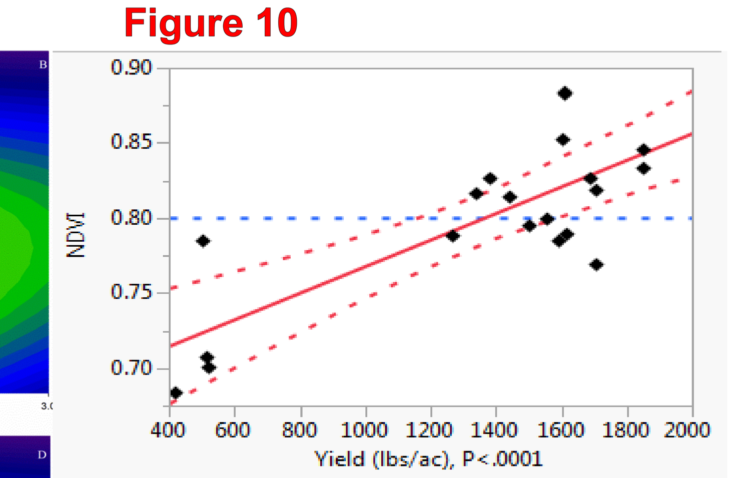
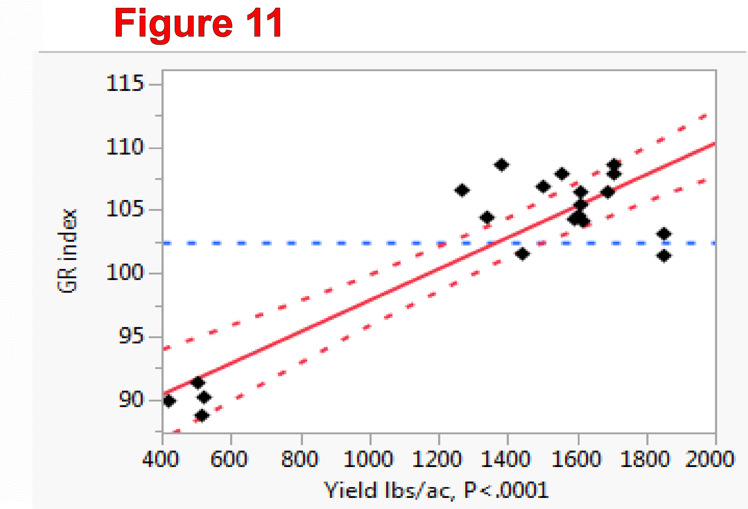


Figure 10



Remote Sensing data resulted in no observed significant differences in T1-4.
NDVI readings plotted against yield resulted in no significant differences (Figure 10).
Similar trends were observed for RGB data as well as measured by ratio of red versus green pixels (Figure 11).

Figure 11



Conclusions

- T4 and T3 irrigation treatments resulted in similar application amounts with a %17 reduction in applied irrigation compared to T1 which was fully irrigated.
- 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 3, 4, 10, & 11).
- Irrigation events triggered prebloom were four fold greater for T1 than the higher Primed Acclimation thresholds.
- Irrigation amounts and events were not significantly different even with the reduced prebloom irrigation for Primed Acclimation treatments (Figure 6).
- Lint yield was significantly higher than the dryland for all irrigation treatments in 2014, no effect was observed in 2015 due to suboptimal harvest conditions due to adverse weather (Figure 7).
- Plant mapping parameters observed indicated significant differences between irrigation treatments with respect to yield distribution (Figures 8 & 9).
- 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 allowing for higher thresholds during prebloom and higher thresholds during bloom early in the season as well.
- This research illustrates that current irrigation practices can be modified to increases efficiency and save water while maximizing the yield potential of the crop.

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 blooming (i.e., if the strategy could be implemented during the first week of bloom with no yield loss).

Thanks to Georgia Cotton Commission for all of their support as well as the cotton physiology staff: Lola Sexton, Will Vance, Keri Dixon, and Reed Flynt.

GEORGIA COTTON COMMISSION

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