Supplement to the article by Julia Rodriguez

"Cotton Yields Not Impacted by Decreased Irrigation during the Early Season"

written by:

Jared Whitaker, UGA Cotton Extension Agronomist,

John Snider, UGA Cotton Physiologist and

Wes Porter, UGA Extension Precision Ag and Irrigation Specialist

Cotton Folks,

A couple of days ago, an article was published by UGA Extension which was titled "Cotton Yields Not Impacted by Decreased Irrigation during the Early Season". The article was written by Julia Rodriguez and was based communication with UGA's Research Cotton Physiologist Dr. John Snider. The article discussed Dr. Snider's recent efforts to maximize cotton irrigation efficiency by potentially reducing irrigation water while maintaining yield potential. Dr. Snider and the rest of the UGA Cotton Team are continually searching for new and innovative ways to increase profitability. Irrigation is a critical tool for cotton producers in Georgia and although we are blessed to have relatively good access to irrigation it is a costly investment, both upfront and each time water is applied.

Considerable work has been done by UGA research and extension scientists to develop proper cotton irrigation strategies and methods. This work has been refined and revisited many times due to new innovations in technologies in irrigation systems increased water use efficiency of new cotton varieties and scheduling tools and the overwhelming desire of Georgia's cotton producers to sustain our natural resources for future generations.

The article, which can be found in full text at the end of this commentary, drew the attention of many of you by its title “Cotton yields not impacted by decreased irrigation during the early season” and first few sentences, and rightly so. The issue of early season or prebloom irrigation has been a widely deliberated topic among those involved with cotton in Georgia. The long and the short of this issue is related to a deficit irrigation strategy called primed acclimation. This involves withholding (or in this case reducing) irrigation early in the season (before bloom) to elicit a priming response so that drought tolerance (or water use efficiency) can be enhanced during more critical stages of development, therefore saving water, increasing water use efficiency and not negatively impacting yield.

This approach has been one widely discussed by cotton farmers when the topic of cotton irrigation scheduling is brought up. The most common way it has been described to me is “cotton needs to be stressed a little prior to bloom so that root growth becomes deep enough to withstand drought stress during bloom”. Therefore, Dr. Snider implemented a research project to examine the effect of primed acclimation irrigation in cotton (which the findings were just published in Crop Science, a scientific journal). Irrigation treatments were developed based on triggering irrigation according to soil water potential. He irrigated cotton using four soil moisture thresholds prior to bloom and with the same soil moisture threshold after bloom, all compared to a dryland check.

Table 1. Treatment descriptions and rainfall and irrigation information (in inches).

Year	Treatment	Prebloom Threshold (-kPa)	Postbloom Threshold (-kPa)	Total Season Irrigation	Total Season Rainfall	Total Water
2014	T1	−20	−35	7.2	12.6	19.8
	T2	−40	−35	6.6	12.6	19.2
	T3	−70	−35	6.0	12.6	18.6
	T4	−100	−35	6.0	12.6	18.6
	T5	Rainfed	Rainfed	0.0	12.6	12.6
2015	T1	−20	−35	5.4	24.0	29.4
	T2	−40	−35	3.9	24.0	27.9
	T3	−70	−35	3.6	24.0	27.6
	T4	−100	−35	3.3	24.0	27.3
	T5	Rainfed	Rainfed	0.0	24.0	24.0

The thresholds used prior to bloom ranged bloom ranged from very moist soil (-20 kPa) to much drier soil (-100 kPa). Dr. Snider's work revealed that all irrigated treatments produced similar yields, therefore irrigation strategies that used drier soil moisture triggers were adequate to produce maximum yields (Table 2). Specifically, compared to the -20 and -40 kPa soil moisture triggers, the -100 kPa trigger saved 1.2 and 2.1 inches or irrigation in 2014 and 2015, respectively. The 2.1 inches is where the 54,000 gallons of water savings came from the in the article.

Table 2. Irrigation water saved comparing treatments.

				Irrigation Savings	
Year	Treatment	Prebloom Threshold (-kPa)	Postbloom Threshold (-kPa)	vs. -20kPa PB Trt (T1) (inches)	vs. -40 kPa PB Trt (T2) (inches)
2014	T1	−20	−35	.	.
	T2	−40	−35	0.6	.
	T3	−70	−35	1.2	0.6
	T4	−100	−35	1.2	0.6
	T5	Rainfed	Rainfed	.	.
2015	T1	−20	−35	.	.
	T2	−40	−35	1.5	.
	T3	−70	−35	1.8	0.3
	T4	−100	−35	2.1	0.6
	T5	Rainfed	Rainfed	.	.

So, several of you have had questions after reading this article (and I'm sure many others have had questions and just not asked). Below are some questions and my thoughts.

1. **Question - So, does this mean that early season irrigation is not needed?**

   Answer - no, this does not mean that early season irrigation is not needed, there is clear evidence that irrigation may be needed prior to bloom, yet rainfall may reduce the impact of this need. Below is rainfall at the experimental sites in 2014 and 2015 (Table 3). Rainfall at these two sites was relatively plentiful prior to bloom and timely so that visual stress was not observed in any of the irrigation treatments prior to bloom. If drier conditions were observed and stress occurred, the results could be different. Which shows why soil moisture sensors are needed to adequately take advantage of water savings.

Table 3. Rainfall received (inches) at the experiment sites at the SIRP in Camilla by week prior to bloom. First bloom occurred prior to Week 9 in 2014 and Week 8 in 2015.

	Week	2014	2015
	1	1.8	1.4
	2	0.0	0.0
	3	0.4	1.3
	4	1.9	2.8
	5	0.8	1.7
	6	1.7	0.2
	7	0.7	2.5
	8	0.0	Bloom
	9	Bloom	Bloom
Entire Prebloom Period	Total	7.3	9.9
	Weekly Average	0.9	1.4
4 Weeks Prior to Bloom	Total	3.2	7.2
	Weekly Average	0.8	1.8

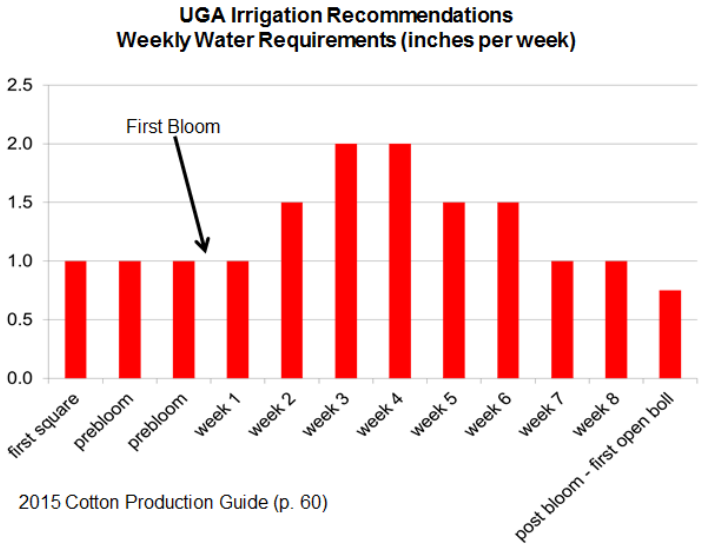
2. **Question – So, I'm overwatering prior to bloom and it could be hurting me?**

   Answer - It all depends on how you are watering prebloom, but this data does not indicate that overwatering automatically hurts yield nor does it mean that you are automatically overwatering. There are data that show that overwatering the entire season during a wet year has the potential to reduce maximum yield potential. This is often noticed by producers when higher dryland yields are recorded during years with excessive rainfall.

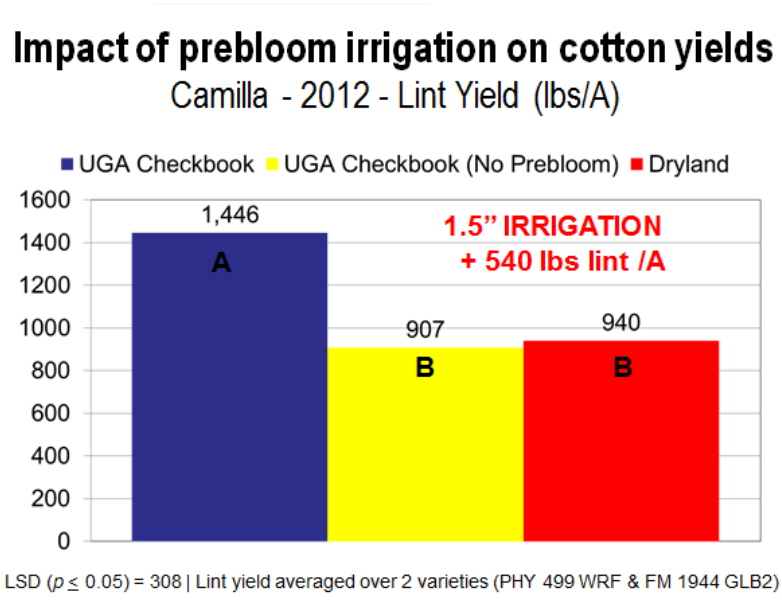
3. **Question – Jared, you have stated many times that irrigation prior to bloom is important, doesn't this disagree with you?**

   Answer - I have tried to get producers to irrigate using some sort of scheduling method, and I have relayed information which has tried to indicate that prebloom stress can significantly hurt yields and more importantly NO we are talking about two different things. I have talked about impacts from stress early season, Dr. Snider is talking about using drier soil moisture triggers to schedule irrigation. Dr. Snider's work is not looking at completely eliminating irrigation pre-bloom, the work is focused on finding the right levels of pre-bloom irrigation that will maximize root growth and development, and maximize yield at the end of the season, as referenced above, a strategy called Primed Acclimation. This strategy has a fit and may not be for everyone. It is suggested that one utilize an advanced irrigation scheduling tool such as an irrigation scheduling app or sensor to properly implement a PA strategy. This notion that we have conflicting ideas comes from work that is summarized below:

In 2011 and 2012, Dr. Guy Collins and I, implemented an irrigation study to address this issue of stressing cotton prior to bloom to improve yields (or at least maintain yields and save water). We implemented two irrigation treatments, one consisted of irrigating cotton according the "UGA Checkbook Irrigation Method". The "UGA Checkbook" irrigation treatment consisted of irrigating cotton in order to ensure that the crop received a certain amount of water per week depending upon growth stage (1" per week until bloom, then increased amounts to 2" per week during peak bloom, then decreased amounts to 1" after peak bloom). Basically, irrigation water is applied when rainfall does not fulfill the week's requirements. So, one treatment received the "UGA Checkbook" season-long and another treatment was irrigated according to the UGA Checkbook all season except during the three weeks prior to first bloom (UGA Checkbook – No Prebloom Irrigation). Both treatments received identical irrigation during entire season, expect during the three weeks prior to bloom. This trial was conducted in 2011 and 2012 in both Camilla and Midville, and in three of the four environments not watering during the three weeks prior to bloom did not impact yield. It should be noted that sufficient rainfall occurred during the three critical weeks such that no visual stress (wilting) occurred. However, in Camilla during 2012, only 1.5 inches of rainfall occurred during the three week prebloom period (yet it there was a significant period of time without rainfall which occurred early in the three week period). In this location, 1.5" of irrigation was applied during the three



week prebloom period in the season-long treatment compared to the no prebloom irrigation treatment. This 1.5" of additional irrigation kept the crop from stress and subsequently increased yields by over 540 pounds per acre. Therefore, although we actually saved water by not irrigating prior to bloom in three of the four locations, when rainfall was not enough to eliminate drought stress prior to bloom, prebloom stress resulted in substantial yield loss.



4. **Question – So, what should producers take home from this?**

   Answer – The most important is that the UGA Cotton Team is continually working to help our producers make proper decisions while making efforts to be good stewards of our environment. From an irrigation standpoint, the main point to take from this is that if a producer is not using a science-based and proven strategy they are not maximizing their investment of irrigation to begin with. There are several ways to schedule irrigation and each has benefits and drawbacks. The UGA cotton team has been on the forefront of developing strategies and continue to work to improve them. This work also shows that if producers can schedule irrigations with soil moisture sensors, then they can certainly maximize irrigation efficiency by saving water and potentially improving yields. Lastly, on the issue of whether primed acclimation is an appropriate irrigation strategy – it

depends. It depends on how well a producer can monitor crop water status and more importantly how much rainfall occurs prior to bloom. **The notion that "drought stress" during early crop development will improve yields is misguided. Stress by definition, has a negative impact on crop growth and can limit yield regardless of what stage of development it is experienced. Thus, attempting to limit early season irrigation by simply withholding water or waiting for the crop to wilt is extremely dangerous and should be avoided.**

(THE ORIGINAL ARTICLE - http://www.caes.uga.edu/newswire/story.html?storyid=6213)

Cotton yields not impacted by decreased irrigation during the early season

By Julia Rodriguez

Cotton is the most widely planted row crop in Georgia, being grow on over one million acres each year. Irrigation is used on a significant portion of the crop to provide supplemental water to help diminish stress caused by episodic drought events that occur during each growing season. We are lucky in Georgia to receive enough total rainfall during the growing season to make decent yields, yet rainfall occurs sporadically and the low water holding capacity of our soils can lead to drought stress in only a few days. The University of Georgia Cotton Team has continually worked to help producers properly use irrigation to maximize yields and limit drought stress. The team also understands the need to be good stewards of our environment and continue to find ways to conserve water resources while maintaining yields. Decreasing irrigation for cotton crops during the early season may not affect yields and could save growers more than 54,000 gallons of water per acre, according to University of Georgia researchers.

John Snider, UGA Cotton Physiologist, has conducted research trials to determine early-season, sensor-based irrigation thresholds for cotton crops. He tried to determine the minimum amount of water a young cotton plant required without affecting the crop's yield. Although current research has shown that drought stress occurring at any point of the growing season can hurt yields, there has been "old school" idea that cotton can endure stress early on and in fact may benefit from stress which occurs prior to bloom. The thought was that early season stress would encourage root growth deeper into the soil profile and allow the plant to tap into subsoil moisture and be less likely to suffer from

For two years, Snider analyzed the impact of dry early-season thresholds compared to wet early-season thresholds. The approach used to learn dry early-season thresholds produced the same yields compared to the wet early-season thresholds and reduced water used over the growing season by as much as 2 inches per acre.

“This (study) decreased irrigation water use and also minimized risks,” Snider said. “This further emphasizes the need for efficient irrigation scheduling and the effectiveness of remotely sensed, soil-moisture-based methods in limiting early-season irrigation without penalizing potential yields.”

Snider recommends that farmers use sensor-based irrigation scheduling to better monitor their irrigation applications. By limiting the amount of excess irrigation applied early in the growing season, a farmer saves water and reduces the energy costs paid to pump water to irrigate the cotton crop.

Applying too much water to a cotton crop can cause the plants to produce excess vegetative growth. The plant then applies less energy to what is needed for fruit production, Snider said. Overwatering can also negatively impact the environment by increasing nutrient runoff and reducing stream flows.

Underwatering, however, slows the plant’s cell expansion. Even mild drought stress can result in a smaller plant with smaller leaves and decreased capacity for photosynthesis, which in turn means fewer carbohydrates to fuel growth and potentially fewer fruiting sites on the plant, Snider said.

It’s a delicate balance, and soil moisture sensors let farmers know when their cotton is in drought stress and needs water.

“Without a doubt, especially during these hot, dry conditions that our cotton plants are growing in, water is a resource these plants can ill afford to do without. As the growing season moves into the summer and if the dry conditions continue, those water requirements become even more important,” Snider said. “I just want our farmers to also be mindful of the risks associated with applying too much water.”

For more information about Georgia cotton production, see www.ugacotton.com.