OPTIMIZING IRRIGATION PRACTICES FOR COTTON USING SUB-SURFACE DRIP AND OVERHEAD IRRIGATION SYSTEMS IN GEORGIA

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Abstract

Episodic or prolonged drought is commonly experienced in the Southeastern U.S. and has substantially increased the demand of groundwater resources in the state of Georgia. Cotton (*Gossypium hirsutum* L.) is a crop considered to be relatively drought tolerant due to its indeterminate growth characteristics, however episodic dry periods have been shown to adversely affect boll retention and ultimately lead to yield reductions and poorer lint quality. However, excessive rainfall and irrigation also results in increased fruit shed associated with excessive vegetative growth, potentially leading to decreases in yield. Thus, defining optimal irrigation strategies could improve yields without the adverse effects of both drought and excessive moisture. Most irrigated cotton in Georgia is irrigated with overhead sprinkler systems, however sub-surface drip irrigation (SSDI) has grown to be more popular due to its ability to improve water efficiency and its potential utility in fields that are not suitable to overhead sprinkler systems. Subsurface drip irrigation can improve efficiency of applied water compared to overhead systems by avoiding losses due to surface evaporation and droplet drift, and by applying smaller incremental amounts of water allowing for adjustments with rainfall. A series of experiments were conducted during 2011 and 2012 at Stripling Irrigation Research Park near Camilla, GA and at the Southeast Georgia Research and Education Center near Midville, GA to investigate the response of two modern cotton varieties {Deltapine 1050 B2RF® (late maturing, less sensitive to water stress) and FiberMax 1740 B2F® (early maturing, more sensitive to water stress)} to various SSDI and overhead (OVHD) irrigation management strategies. These trials were conducted using a split-block design containing four or six replications. Treatments included two varieties, OVHD irrigation triggered at Watermark® moisture potential sensors (MPS) at -40 kPa and -70 kPa, shallow (5 cm depth) SSDI triggered at -40 kPa and -70 kPa via MPS and checkbook (CHBK) irrigations of 65% and 100% of UGA recommendations checkbook (Table 1), deep (30 cm depth) SSDI triggered at -40 kPa and -70 kPa via MPS and checkbook irrigations of 65% and 100% of UGA recommendations, and a dryland control. When triggered, water was applied to SSDI treatments in the weekly amounts specified in the UGA checkbook divided over three days. When OVHD treatments were triggered via MPS, 2.54 cm of water was applied every time the trigger point was reached.

This experiment demonstrated that SSDI resulted in a 16% water savings (pooled over years and locations) compared to overhead when each were triggered at -40 kPa, primarily due to the ability of SSDI to apply small incremental amounts of water, which can be terminated if rainfall occurs. Each treatment received between 6.1 cm and 18.5 cm of irrigation in addition to 38 cm of rainfall at Camilla in 2011, between 4.1 cm and 34 cm of irrigation in addition to 19.1 cm of rainfall at Midville in 2011, and between 2.5 cm and 19.4 cm of irrigation in addition to 43.1 cm of rainfall at Camilla in 2012. Few interactions of practical significance between variety and irrigation were observed. Therefore, the effects of irrigation treatment pooled over varieties are discussed. Similar yields were observed between SSDI treatments of 100% CHBK, 65% CKBK, -40 kPa, and -70 kPa, when compared to the dryland control. However, removal of the dryland control from the analysis indicated lower yields of the -70 kPa treatment compared to others. Similar yields were observed between OVHD, SSDI shallow, and SSDI deep within each of the -40 or -70 kPa irrigation treatments, however all -40 kPa treatments yielded greater than all -70 kPa

treatments. This suggests that similar yields could be expected in SSDI and OVHD irrigation in the Southeast U.S. However, irrigation according to 100% CKBK using SSDI deep resulted in significantly lower yields than that of the SSDI shallow. Similar yields were also observed between OVHD -40 kPa, SSDI shallow -40 kPa, 100% CKBK SSDI shallow, and 65% SSDI shallow. When the OVHD irrigation treatments were removed from the analysis, the SSDI applied 100% CKBK resulted in significantly greater yields than SSDI -40 kPa, suggesting that some environments may require more water than sensor-based triggers indicate. Lastly, yield associated with SSDI shallow was significantly higher than that of SSDI deep when the -70 kPa trigger or the 100% CKBK was used. All treatments resulted in a positive yield response per total water applied across all locations, with the greatest response occurring in treatments that required the least irrigation, as expected.

In conclusion, all irrigation systems and treatments improved yields when compared to the dryland control. In some analyses, the -70cb trigger allowed for greater water deficit stress resulting in yield reductions compared to the -40 kPa trigger. Yields were generally similar in overhead and SSDI systems, suggesting that there is no yield penalty associated with SSDI in the Southeast U.S. In some situations, there was a yield penalty associated with SSDI deep compared to SSDI shallow, however factors such as necessary surface tillage practices, the need for stalk removal, and rotation with other crops would likely limit the utility of SSDI shallow in the Southeast U.S. This research shows that SSDI is a viable irrigation system for Georgia and that SSDI could improve yields if installed in fields where OVHD is impractical such as odd-shaped smaller fields. Future research should investigate SSDI practices in various soil types, evaluate new varieties irrigated using SSDI, and to evaluate the utility of SSDI beyond first open boll, when OVHD irrigation is normally terminated.

Table 1. UGA Checkbook Irrigation Recommendations.

	100% UGA Checkbook		65% UGA Checkbook	
Growth Stage	Cm Per Week	Cm/day (1/3 weekly rate) Applied on M, W, F	Cm Per Week	Cm/day (1/3 weekly rate) Applied on M, W, F
Prior to Bloom	2.54	0.85	1.65	0.55
1st week of bloom	2.54	0.85	1.65	0.55
2nd week of bloom	3.81	1.27	2.48	0.83
3rd week of bloom	5.08	1.69	3.30	1.10
4th week of bloom	5.08	1.69	3.30	1.10
5th week of bloom	3.81	1.27	2.48	0.83
6th week of bloom	3.81	1.27	2.48	0.83
7th weed of bloom	2.54	0.85	1.65	0.55
8th week of bloom	2.54	0.85	1.65	0.55
END OF BLOOM and afterwards	1.91	0.64	1.22	0.41