THE EFFECT OF IRRIGATION DELIVERY METHOD ON LINT YIELD IN TWO YEARS WITH CONTRASTING WATER AVAILABILITY

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Introduction

Overhead (OVHD) sprinkler irrigation is the primary irrigation method used by Georgia cotton growers. Although a fairly significant number of cotton acres in the state of Georgia are also produced under dryland (rain fed) conditions, OVHD irrigation improves yield in dry years and provides security during sporadic drought events that are common during a typical cotton growing season. Despite the obvious benefits of OVHD, subsurface drip irrigation (SSDI) has been touted as a means to improve water use efficiency and increase or maintain yields in cotton production systems (Whitaker et al., 2008) relative to OVHD-irrigated cotton. Cotton irrigated with OVHD irrigation has also been shown to cause limited boll retention near the base of the plant, which can delay crop maturity (Ritchie et al., 2009). This could potentially be problematic when adversely cool fall weather limits the time frame during which normal crop maturation is allowed to occur. Furthermore, sprinkler-induced pollen rupture and associated fruit loss has been shown to limit yield in some instances (Burke, 2003), and slight yield improvements for SSDI cotton versus OVHD cotton have been observed previously (Whitaker et al., 2008). Because cotton cultivars are continuously changing, and an analysis of yield response to irrigation delivery method has not been reported in recent years for a cultivar in widespread use in Georgia, the goal was to characterize lint yield response of the cotton cultivar *Gossypium hirsutum* cv. Phytogen (PHY) 499 WRF (a widely utilized commercially available cultivar) to SSDI, OVHD, and dryland conditions during an atypically wet year (2013) and a year characterized by drought (2014).

Materials and Methods

The cotton cultivar PHY 499 WRF was planted at the CM Stripling Irrigation Research Park near Camilla, GA, on 6 May in 2013 and on 3 June in 2014 and was 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 seed per row ft. Row spacing was 36 inches. Irrigation treatments were arranged using a randomized block design. Three irrigation treatments were utilized: 1) **OVHD**: irrigation water was applied according to the University of Georgia Checkbook Method via overhead sprinkler irrigation using a center-pivot irrigation system; 2) **SSDI**: irrigation water was applied according to the University of Georgia Checkbook Method via subsurface drip tape positioned at a 12-inch depth in alternating row middles; and 3) **DRY:** No supplemental irrigation was applied beyond stand establishment. Plot sizes were six rows in width and 40 feet in length.

To characterize each year with respect to water availability, rainfall data were obtained from a weather station immediately adjacent to the research field. Table 1 provides rainfall and irrigation amounts during the irrigation treatment period for all treatments for both study years. Following defoliation, the two center rows of each plot were harvested using a two-row spindle picker and seedcotton weight was obtained on-site from each plot. Seedcotton samples were transported to the University of Georgia microgin in Tifton, where gin turnout was determined. Plot lint yield was extrapolated to lbs/acre. 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

Table 1 shows the substantial difference in rainfall between the 2013 and 2014 growing seasons. Total rainfall received during the 2013 growing season (26 inches) was 8 inches in excess of the total water required by a cotton crop in Georgia during a typical growing season (18 inches; Bednarz et al., 2002). In contrast, 2014 rainfall amounts (13.7 inches) were 4.3 inches below the 18-inch requirement to maximize lint yields.

Not surprisingly, lint yield response to irrigation treatment differed with year. For example, during 2013, there was no response to irrigation treatment due to the high rainfall amounts experienced during the season. However, for the relatively dry 2014 season, lint yield was strongly impacted by irrigation treatment (Figure 2; $P < 0.0001$). SSDI produced the highest lint yield at 1,837 lbs/acre; OVHD produced the second highest yield at 1,250 lbs per acre; DRY produced the lowest yields at 722 lbs per acre. This response to irrigation is similar to a report by Whitaker et al. (2008), although the increase in yield with SSDI compared with OVHD was much larger in the current study.

It is important to note, however, that the same plant growth regulator management strategy was used for all irrigation treatments to prevent the introduction of a confounding factor. Rank growth was observed for OVHD and SSDI-irrigated plots. Interestingly, plots irrigated via OVHD were substantially taller than those irrigated via SSDI, bolls were set at higher positions on the plant, and crop maturity was delayed (as estimated using % open boll). Poor boll retention on lower nodes and delayed crop maturity have been reported previously (Ritchie et al., 2009) for OVHD relative to SSDI.

Although the cause of these phenomena are relatively unexplored, it is interesting to speculate that sprinkler induced fruit abscission due to pollen rupture (Burke, 2003) may increase carbohydrate partitioning to vegetative growth. Thus, in the current study, the combined effects of delayed maturation, later planting date (3 June), and rank growth exhibited in OVHD irrigated cotton likely limited the time frame during which bolls at higher positions on the plant were allowed to develop.

It should be noted, however, that OVHD produced yields that were 73% higher than DRY, emphasizing the importance of irrigation, via any method, in improving yields under drought conditions and minimizing the risks associated with cotton production in Georgia.

Table 1. Cumulative Amount of Water Supplied to the Cotton Crop

Treatment	Irrigation 2013	Irrigation 2014	Rainfall 2013	Rainfall 2014	Total 2013	Total 2014
			--- Inches ---			
SSDI	6.9	11.8	26	13.7	32.9	25.5
OVHD	6.9	11.8	26	13.7	32.9	25.5
Dryland	0	0	26	13.7	26	13.7

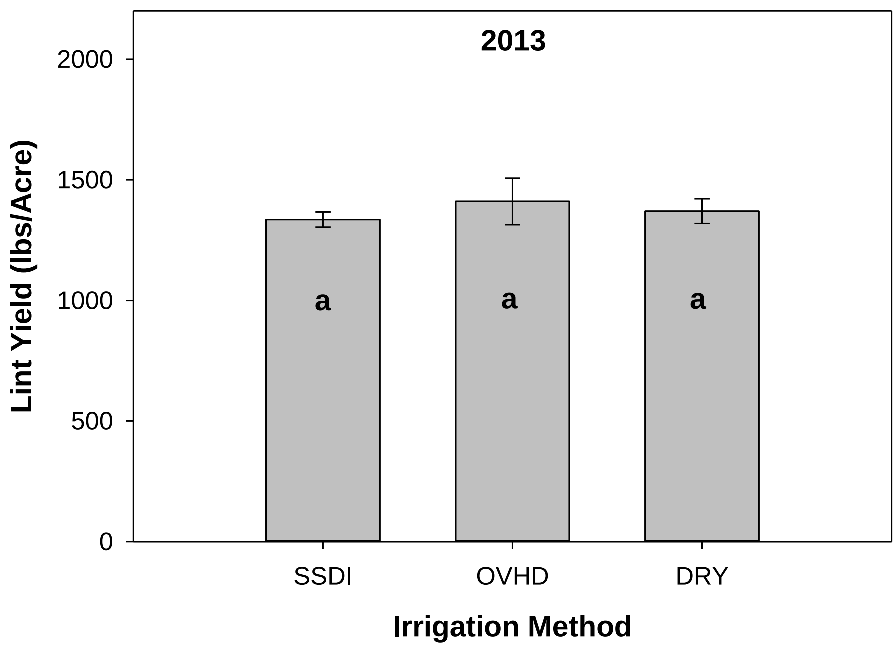

Figure 1. **Average lint yield for *Gossypium hirsutum* cv. PHY 499 WRF under three different irrigation methods during the 2013 growing season: subsurface drip irrigation (SSDI), overhead sprinkler irrigation (OVHD), and dryland (DRY). SSDI and OVHD received the same amount of water during the growing season according to the University of Georgia Cooperative Extension "Checkbook" approach. This ensured that plants in both the SSDI and OVHD treatments were well watered. Columns are means and standard errors (n = 3 for OVHD and 4 for SSDI).**

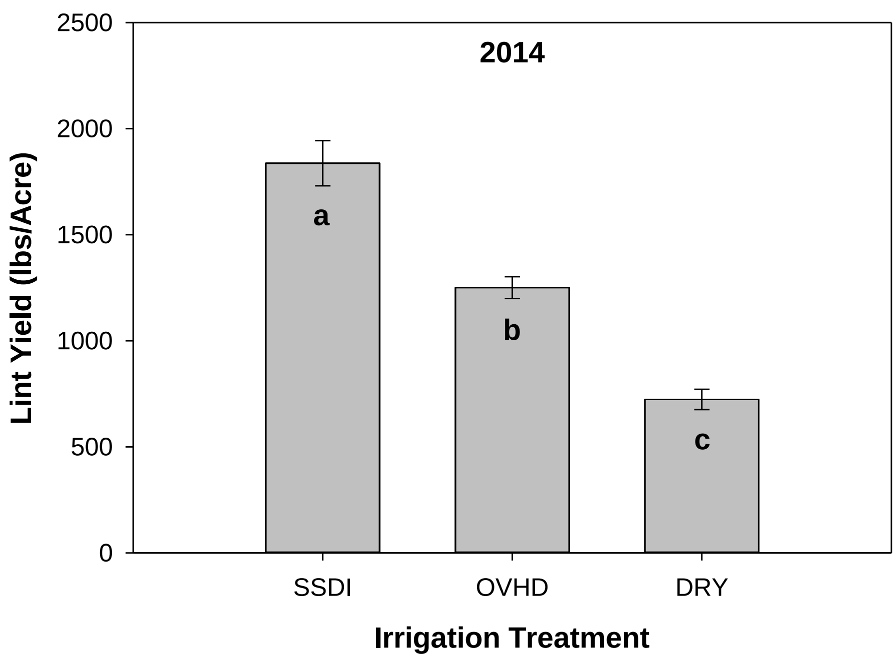

Figure 2. **Average lint yield for *Gossypium hirsutum* cv. PHY 499 WRF under three different irrigation methods during the 2014 growing season: subsurface drip irrigation (SSDI), overhead sprinkler irrigation (OVHD), and dryland (DRY). SSDI and OVHD received the same amount of water during the growing season according to the University of Georgia Cooperative Extension Service "Checkbook" approach. This ensured that plants in both the SSDI and OVHD treatments were well watered. Columns are means and standard errors (n = 3 for OVHD and 4 for SSDI)**

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References

Bednarz, C., Ritchie, G., Hook, J., Yager, R., Cromer, S., Cook, D., & Griner, I. (2002). Cotton crop water use and irrigation scheduling. In A. S. Culpepper (Ed.), *Georgia cotton research and Extension report* (pp. 61-64). Athens, GA: University of Georgia.

Burke, J. J. (2003). Sprinkler-induced flower losses and yield reductions in cotton (Gossypium hirsutum L). *Agronomy Journal, 95*(3), 709-714.

Ritchie, G. L., Whitaker, J. R., Bednarz, C. W., & Hook, J.E. (2009). Subsurface drip and overhead irrigation: A comparison of plant boll distribution in upland cotton. *Agronomy Journal, 101*(6), 1336-1334.

Whitaker, J. R., Ritchie, G. L., Bednarz, C. W., & Mills, C. L. (2008). Cotton subsurface drip and overhead irrigation efficiency, maturity, yield, and quality. *Agronomy Journal, 100*(6), 1763-1768.