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2009-2010 WREC Cotton Subsurface Drip Irrigation (SDI) Demonstration Report

General Description

A sub-surface drip irrigation (SDI) demonstration was installed on the Wiregrass Research Center in Headland, Alabama in late spring/early summer 2009. The site has slightly rolling topography with one or two terraces and is visible from State Highway 134. Growers will be able to visit this location throughout the year and see how subsurface drip irrigation works on the light sandy soils of Southeast Alabama. Six plots, each 950 feet long by 48 feet wide, were established for a three year irrigated and rainfed (dry land) rotation of corn, cotton, and peanuts. The six plots are grouped into three, 2-plot blocks. Each block has a 16 row rainfed (dry land) plot and a 16 row irrigated zone. Each irrigation zone has 15 mil drip tape lateral buried between every other row at 15 inches deep (eight drip laterals per irrigation zone). John Deere Auto Steer was used during installation to allow future drip tape location. With 0.26 GPH emitters spaced every 2' along tape length, design tape flow rate was 0.0022 GPM/foot. Each 1.07 acre irrigated zone requires 16.81 GPM (15.73 GPM/acre). Irrigation water is supplied by a 3-hp submersible pump with pressure tank control, installed in a farm pond approximately 1/2 mile from the site. A 2-inch time and pressure automatic cleaning filter provides clean water to the three irrigated zone control heads. An irrigation controller for zone control, a Watermark Monitor with Watermark soil moisture sensors and zone pressure monitors, and a tipping bucket rain gauge were installed. A low power field radio was connected to the Watermark Monitor to allow remote reading of received rain, soil moisture, and irrigation operation from a desktop computer located in the WREC offices about 1200 feet away. MoisMis2020, an Xcel-based irrigation scheduling program using crop growth curves, rainfall, and Watermark soil moisture feedback was to be used to schedule irrigation for the three crops.

This publication reports on rainfall, irrigation, and cotton yield results from the first two years of this WREC SDI demonstration operation.

2009

Drip tape laterals were installed April 23 but installation of manifolds, control station, main lines, and pond water pumping station occurred over the next two months. DPL 0935 cotton was planted May 14. MoisMis2020 was started with a 140 (one-forty) day *2-Bale/acre cotton crop water use* curve. Four (4) weeks into the season, field scouting verified crop growth to be 6 days behind the growth curve. MoisMis2020 "CropAdjust" was used to "lengthen" the season by these six days. System start-up problems and equipment

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delivery delays prevented installation of the tipping bucket rain gauge, system water pressure monitors, low power radio link, and soil moisture sensors until August 5 (83 DAP). The installed irrigation controller failed early June and irrigations were manually controlled based on MoisMis2020 (without soil moisture feedback until well into the season). Cotton harvest was November.

Figure 1 shows the magnitude and distribution of **54 rainfall events (**shown in **red)** totaling **24.72**". There were **7 irrigation events (**shown in **blue)** totaling **5.49"** during this same period (May 14 – October 1).

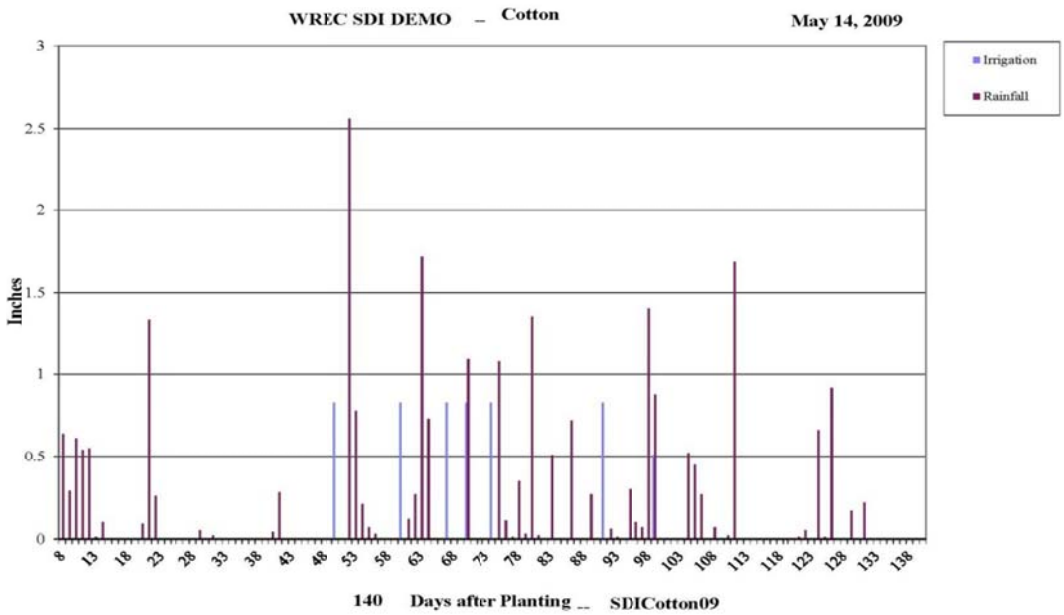

Figure 1 - 2009 Rainfall and Irrigation for WREC SDI Cotton Demo

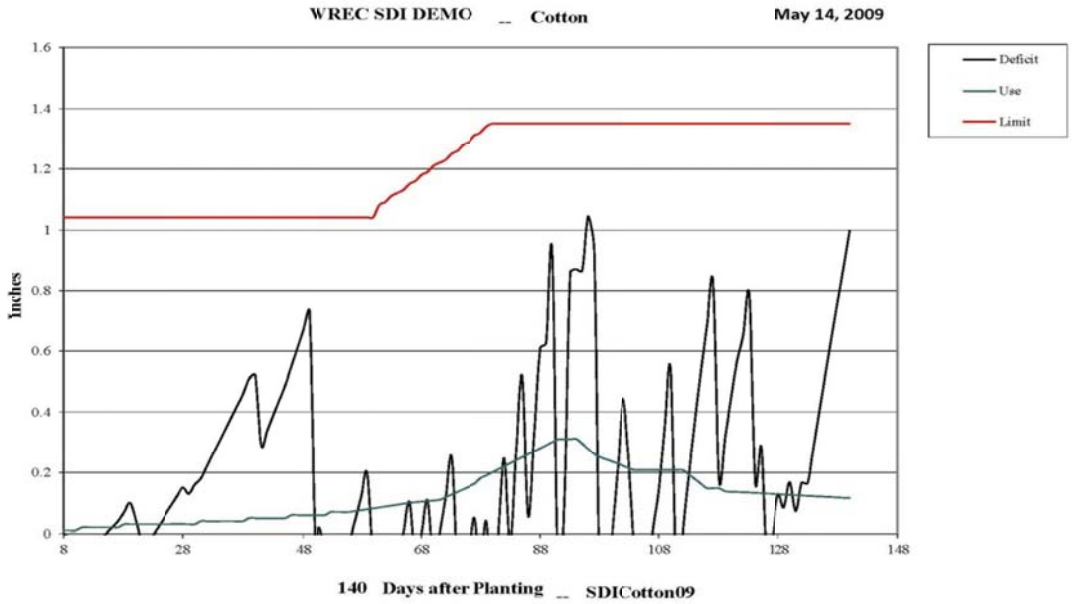

Figure 2 - 2009 SDI Cotton Demo Season Soil Moisture Deficit

The 23-51 DAP period where only .39" total rain fell slowed growth by about 6 days. First irrigation was July 3 (50 DAP). A 2.56" rain at 1stSquare (52 DAP) broke the drought and from 1st Bloom (70 DAP) thru 7WeeksAfter1st Bloom (120 DAP); 11.38" of rain fell in 28 events. Last irrigation was August 21 (99 DAP). Rainfall amount and timing kept soil moisture deficit below the MoisMis2020 50% limit of Dothan Sandy Loam throughout the season.

Figure 2 shows the soil moisture deficit for the 2009 SDI Cotton Demo and the *2-Bale/acre cotton crop water use* curve used in MoisMis2020. Red line indicates the 50% Available Water Holding Capacity of Dothan Sandy Loam used as the irrigation trigger.

2010

DPL 1050 cotton was planted April 26 but before expected seed emergence a 3.48" rain fell May 4, packing the soil enough to cause a poor stand. Cotton was replanted May 12. MoisMis2020 was started with a 140 (one-forty) day 2-Bale/acre cotton crop water use curve. A replacement controller was installed the last of May, but automatic control still failed and again, all irrigations were operated manually the remainder of the season. Soil moisture sensors were installed June 7 within 30 days after planting as recommended by MoisMis2020. Cotton harvest was October.

Figure 3 shows the magnitude and distribution of **39 rainfall events (**shown in **red)** totaling **12.85".** There were **20 irrigation events (blue)** totaling **14.88",** during this same period (May12 – September 29). The first occurred July 4 (53 DAP). Last irrigation was September 9 (120 DAP).

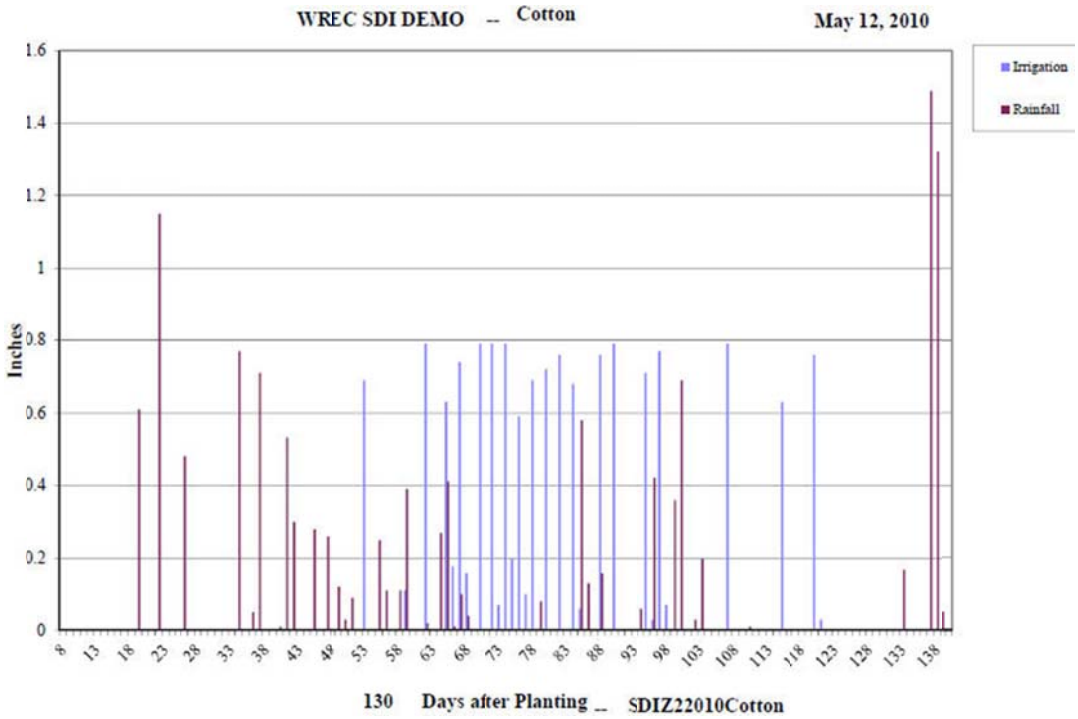

Figure 3 - 2010 Rainfall and Irrigation for WREC SDI Cotton Demo

With only 27% of total rain (3.55”) and only two rain events greater than 0.5” from 1^{S} Bloom (64 DAP) to 132 DAP (nearing defoliation), **lack of rainfall severely reduced dryland (rainfed) yield development**.

Figure 4 shows the soil moisture deficit for the 2010 SDI Cotton Demo. Red line indicates the 50% Available Water Holding Capacity (AWC) of the Dothan Sandy Loam used as the irrigation trigger in MoisMis2020. Note that accumulated daily soil moisture deficit ran higher than the irrigation trigger from 69 – 95 DAP, a period when almost 9” of irrigation water was applied.

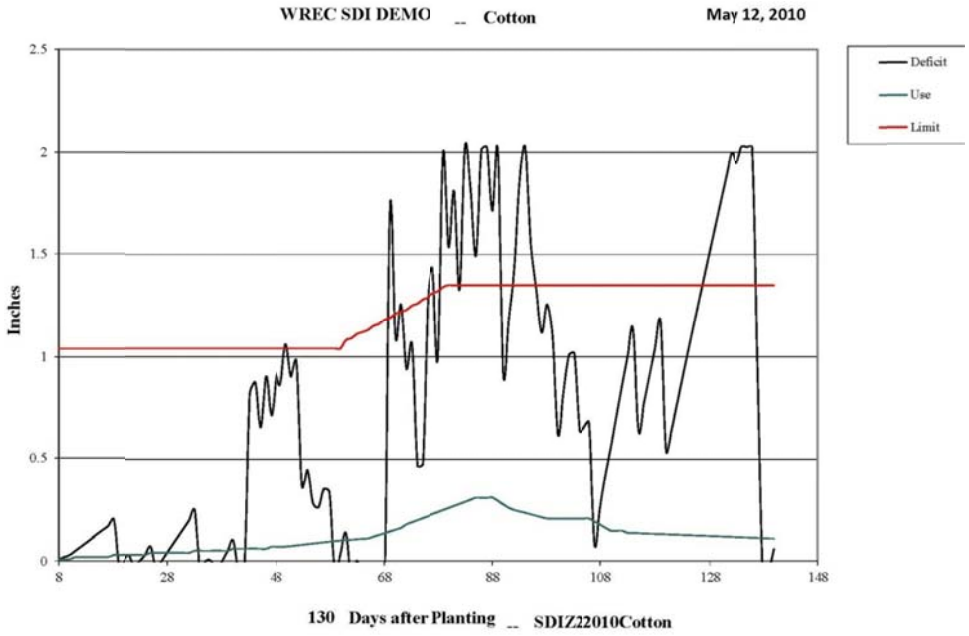

Figure 4 - 2010 SDI Cotton Season Soil Moisture Deficit

Soil Moisture deficit shown is calculated within MoisMis2020 as a running “to date” accumulation using crop water use curve values as positive and daily rainfall and irrigation as negative. Soil moisture feedback from a 9” and 18” sensor is used to calculate actual soil moisture deficit. The running total deficit is compared to actual and adjusted using internal algorithms that vary with rooting depth throughout the season. Sensors in the Dothan Sandy Loam at 9” seemed not to respond to irrigation from drip tape placed 17’ to 18” deep. This caused daily running deficits from 64 DAP to 95 DAP to show higher than the irrigation trigger even though nearly 9” of water was applied during this high water use period.

Yield Results from Rain and Irrigation

There were four checks within each treatment each year. These checks were compared and averaged to give the final rainfed (dryland) and irrigated cotton yield. Yearly irrigated yield increases are shown in red in table below.

Year	Plant Date	Rain (#) Total	Irrigation (#) Total	Yield (Lb/Acre)
2009	**May 14**	**(54) 24.72”**	**-**	**1,100**
		(54) 24.72”	**(7) 5.49”**	**1,090 (-10 IRR)**
2010	**May 12**	**(39) 12.48”**	**-**	**450**
		(39) 12.48”	**(20) 14.88”**	**1602 (+1152 IRR)**

For these two years, one with typically adequate rainfall and one with typically inadequate rainfall during the cotton season, average **rainfed yield was 775 pounds** (1.6, 480 pound bales)/acre. Average subsurface drip irrigated **(SDI) yield was 1347 pounds** (2.8, 480 pound bales)/acre. This is a **572 pound (1.2, 480 pound bale)/acre increase (75%) with SDI**.

Conclusion

Cotton yield showed response to the presence or absence of available soil water throughout the growing season. ***Greatest difference is soil moisture was observed during the critical “1stBloom thru 7WeeksAfter1stBloom” period.*** The 2-Bale/acre cotton crop water use curve in MoisMis2020 calls for 3” of rain/irrigation during the first 64 DAP. From 1st Bloom thru 7WeeksAfter1st Bloom (~64-114 DAP), curve call is 10.75”, peaking around 90 DAP. The curve calls for 2.6”-3” from 1st BollOpen (~114-124DAP) to season end. *This is a total season call of around **16.5” net** soil water with **65% (10.75”) during 1st Bloom thru 7WeeksAfter1st Bloom.***

In the 2009 season, even though a four week period with little rain occurred early, the first 64 DAP got 11.3” of rain *(365% call),* the “1stBloom thru 7WeeksAfter1stBloom” period received 11.38” rain *(105% call),* and the “boll open/defoliation” period got the remaining 2.04” *(77% call)* of the 24.72” total rainfall. **3” of SDI** (of 5.49” SDI total) brought the “1stBloom thru 7WeeksAfter1stBloom” total water to **14.38” *(133% call)*** and **added no yield** above rainfed.

With the 2010 crop, rainfall started out well. The first 64 DAP got 6.27” of rain *(216% call*), but the “1stBloom thru 7WeeksAfter1stBloom” period received only 3.55” rain *(33% call*). The “boll open/defoliation” period got the remaining 3.03” *(95% call*) of the total 12.85” 2010 rainfall. **11.87” of SDI** (of 14.88” SDI total) brought the “1stBloom thru 7WeeksAfter1stBloom” total water to **15.42” *(143% call)*** and **added 2.4 bales/acre** to the 0.94 rainfed bale yield.

The 2010 SDI yield of 1602 pound (3.34, 480 pound bale) per/acre, 1.05, 480 pound bales more than the 2009 Rainfed/SDI 1100 pound (2.29, 480 pound bale) per/acre yield, may be the result of applying 77% of “1stBloom thru 7WeeksAfter1stBloom” water with SDI in 2010 compared to only 21% during 2009. While actual rain amounts reaching the root zone are reduced by evaporation, run-off and deep percolation, SDI is reduced only by deep percolation that can be reduced by good management. For this reason, more actual applied water probably reached the active root zone in 2010 than in 2009. Production of 3 Bale cotton in this 2010 SDI demonstration with 15.42” applied during the “1stBloom thru 7WeeksAfter1stBloom” period is in

line with extension cotton irrigation recommendations offered by Curtis, et al, 1986 of 14.5" of water applied during this period.

SDI appears to work well in slightly rolling Dothan soils in the Wiregrass. These first two years of large-plot SDI irrigation at the Wiregrass Research and Education Center in Headland have demonstrated the **ability of timely applications of irrigation water using a permanently buried drip tape system to produce SDI yields almost double (175%) typical rainfed (dryland) cotton yield**. A soon-to-follow life-cycle economic analysis based on WREC SDI Demo yields and installed and operational costs should highlight accompanying economic advantages of small-field SDI irrigation in the Wiregrass.

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