SUBSURFACE DRIP IRRIGATION MANAGEMENT IN SOUTHEAST CROP ROTATIONS

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Abstract

The University of Georgia has initiated a multi-year study to develop improved techniques and technologies for the use and management of subsurface drip irrigation (SSDI) in typical Southeastern row-crop rotations to maximize economic efficiency while increasing water use efficiency and water conservation. At the Stripling Irrigation Research Park, Camilla, GA, SSDI will be directly compared to overhead sprinkler irrigation and dryland. First year results from SSDI on cotton at the Stripling Park were encouraging as yields were numerically higher for SSDI as compared to overhead sprinkler irrigation or dryland production – even though the SSDI was installed 40 days after planting and only 4 irrigation applications were made with the drip. The system hardware performed well with little start-up problems. The team hopes to fully implement SSDI with continuous and pulsed water application in 2011.

Introduction

The University of Georgia has initiated a multi-year study to develop improved techniques and technologies for the use and management of subsurface drip irrigation (SSDI) in typical Southeastern row-crop rotations to maximize economic efficiency while increasing water use efficiency and water conservation. Specifically, this project will investigate several aspects key to determining the effectiveness and economic viability of SSDI including

- installation and layout/design options;
- operational / management parameters;
- crop (and pest) response; and
- water use and soil moisture status.

SSDI is still in its infancy in Georgia and much of the southeast U.S. However, in other parts of the cotton belt (such as Texas), SSDI is a very important tool for growers. One potential hindrance for more widespread adoption of SSDI in the southeast is the predominance of sandy soils in this region. The paper gives an overview of the SSDI installations and provides 2010 yield data from one location.

Materials and Methods

Study Sites

Two study sites were selected in 2010 – the Stripling Irrigation Research Park (SIRP) (Camilla GA) and the Southeast Research & Education Center (Midville GA). The Midville site is still being developed as of this writing and will not be reported on in this paper. At SIRP, SSDI will be directly compared to overhead sprinkler irrigation. Two adjacent quadrants of four center pivots were selected for this new SSDI project (Fig 1). Each pair of adjacent

quadrants was randomly selected to be either SSDI or overhead sprinkler irrigation (OVRHD). The OVRHD quadrants were divided into two equal sections and then the two sections were randomly selected to be either "full" irrigation or "deficit" irrigation. Deficit irrigation zones would receive 50% of the amount the full irrigation zones received. The SIRP field is comprised of mostly Lucy loamy sand and is relatively flat.

Within the SSDI quadrants, nine "plots" were established (Fig 2). The plots were six crop rows wide (36 inch row spacing) and approximately 260 feet long, with two crop rows between each plot serving as buffer. In each of the 8 irrigated plots, three drip tapes were installed on a 6 foot spacing, in each non-traffic "soft" middle. The drip tape was Netafim Typhoon, 18 inch emitter

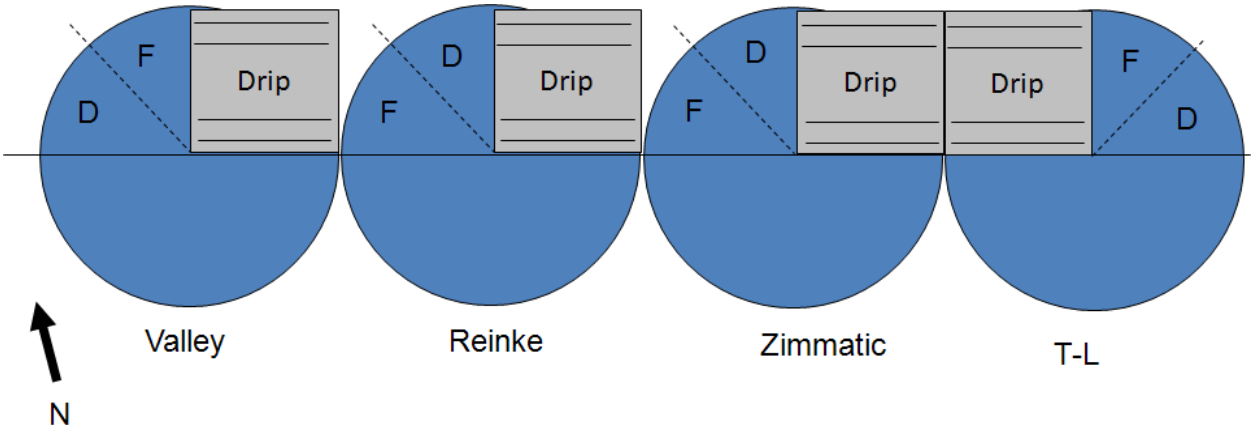

Figure 1. Layout of SSDI and OVRHD irrigation sections at the Stripling Irrigation Research Park, Camilla GA. F="full" and D="deficit".

spacing, 0.40 GPH @ 10 PSI flow rate, 15 mil wall thickness. The "dryland" plot did not have SSDI drip tape installed. In the irrigated plots, combinations of three drip irrigation treatments (drip tape depth (shallow/deep), water application amount (full/deficit), and water application method (continuous/pulsed)) plus dryland were randomized across the nine plots and re-randomized for each of the remaining 3 SSDI plot areas.

At each of the SSDI/OVRHD sections, water was supplied to the drip lines from SIRP's existing constant-pressure irrigation supply mainline (at 60 PSI) that is supplied by three deep wells with excellent water quality. After passing thru a simple screen filter, the supply water is divided into four lines (Fig 3). Each line has a Blue-White F1000 digital flowmeter and serves a pair of drip irrigated zones with the same water application amount and application method (e.g. both shallow and deep zones receiving deficit/pulsed water). Water pressure is regulated at a sub-manifold in the field near the beginning of each plot to reduce any pressure variations between the main manifold and the start of each drip line.

Within each of the SSDI plots, four cotton varieties were planted in randomly assigned areas (Fig 4). The same four varieties were randomly assigned to locations in both the full and deficit sections of the OVHD quadrants. The four varieties planted, in assigned numerical order, were DeltaPine 0912 B2RF, FiberMax 1740 B2F, DeltaPine 0949 B2RF, and DeltaPine 1050 B2RF. The varieties were re-randomized for each of the other SSDI and OVRHD quadrants. With all plot areas (SSDI and OVRHD) for all varieties, 176 plots were established.

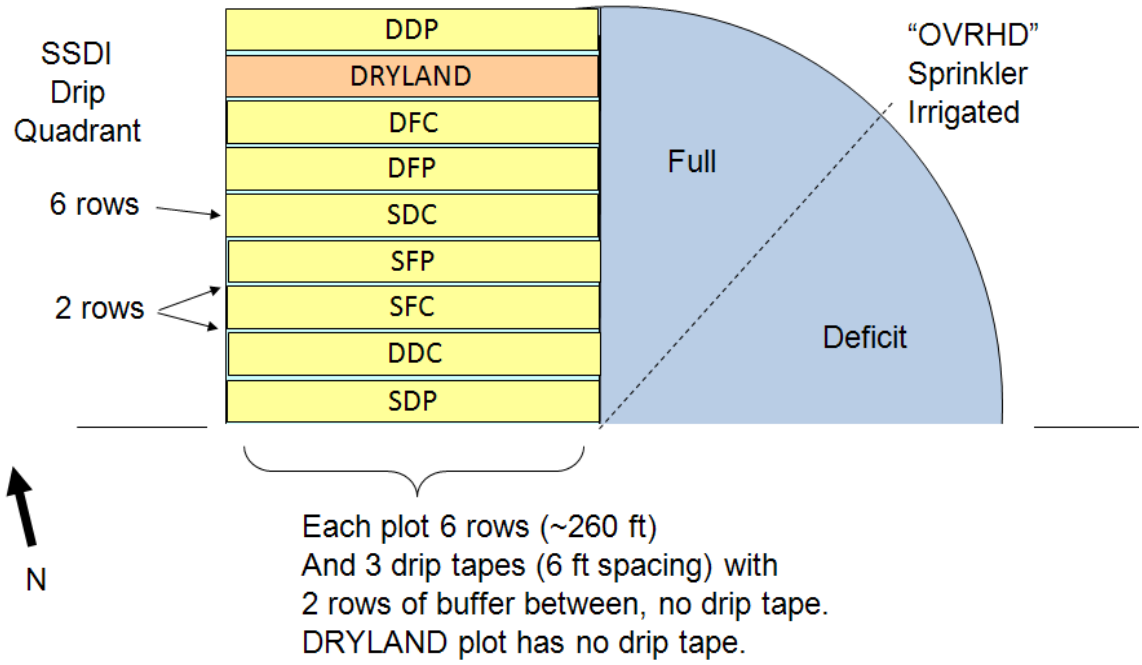

Figure 2. Illustration of SSDI plots and OVRHD sections in 1 of 4 areas at the Stripling Irrigation Research Park. Naming scheme for the plots: XYZ – X (deep/shallow), Y (full/deficit), Z (continuous/pulsed).

Figure 3. Water supply for SSDI drip irrigation.

Cotton Production

The grant funding for this project was delayed considerably and, for various reasons, the research team delayed planting until June 10-11 (early May would be a more optimal planting date). All field operations in the plot areas (SSDI and OVRHD) were the same and included a blanket dry blend fertilizer spread prior to planting followed by strip tillage (using GPS autosteer on the tractor). In a subsequent operation, seed was placed using a 2-row Monosem vacuum planter with liquid "starter" fertilizer applied behind the press wheels of the planter implement. Normal herbicides, insecticides, and side-dress fertilizer was applied to all plots.

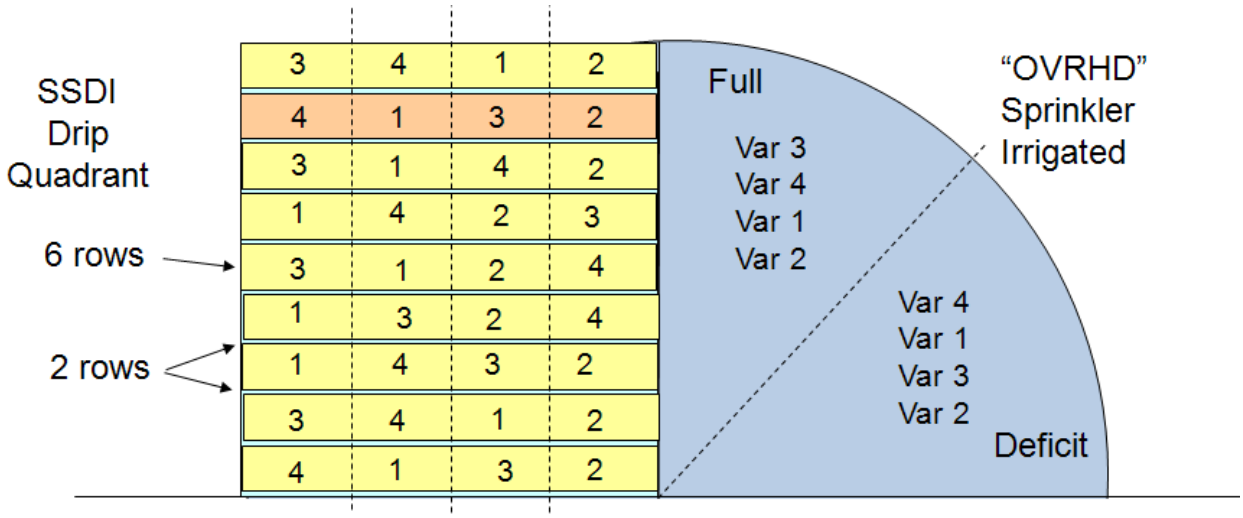

Figure 4. Layout of the 4 varieties planted in each SSDI plot. Varieties: 1 (DeltaPine 0912 B2RF), 2 (Fiber-Max 1740 B2F), 3 (DeltaPine 0949 B2RF), and 4 (DeltaPine 1050 B2RF).

Again, due to delay in receiving grant funding, the subsurface drip tape was installed 40 days after planting – July 20-21 (Fig 5), as the crop was approaching first bloom. The crop reached peak bloom period around August 20 (based on DD-60's). On November 12, defoliation products were applied and the cotton plots were harvested on December 7.

Just prior to harvest, end-of-row edge effects were eliminated by removing cotton from the ends of plots. The center two rows of each plot area were harvested with a 2-row John Deere 9930 picker modified to allow plots to be bagged. The seed cotton was weighed and a grab sample pulled for hand ginning. For this paper, a lint turnout of 38% was assumed when calculating yields.

Irrigation

The irrigation applications are shown in Table 1. Prior to drip installation, the team applied two "blanket" irrigations across all plots using the center pivot systems over all the area. After drip installation, four applications were made using both SSDI and OVRHD. The "full" irrigations with SSDI are also shown in Fig 6. The first irrigation after SSDI installation was primarily to test the system for any leaks or other problems. The latter three SSDI/OVRHD irrigations were in response to lack of rainfall during that period. No irrigation was applied during the peak bloom period (August 20) as the crop received 3.46 inches of rain between August 15 and August 28.

To apply 1 inch of irrigation to the zones, the system was operated for 15 hours. Due to time constraints resulting from the late installation, an electronic timer / controller was not installed, therefore, the "pulsed" method of water application was not implemented.

Figure 5. SSDI installation rig.

Table 1. Irrigation applied to cotton in 2010.

Date	OVRHD		SSDI	
	Full (inch)	Deficit (inch)	Full (inch)	Deficit (inch)
Before drip installation (OVRHD applied to all plots)				
05/11/2010	0.40	0.40	n/a	n/a
06/08/2010	0.50	0.50	n/a	n/a
After drip installation				
08/11/2010	1.00	0.50	1.00	0.50
09/03/2010	1.00	0.50	1.00	0.50
09/14/2010	1.50	0.75	1.50	0.75
09/23/2010	1.00	0.50	1.00	0.50

Soil Moisture Monitoring

Soil moisture status was monitored during much of the growing season (Fig 6). Decagon EC-5 sensors were installed in the crop row at 8 inch, 16 inch and 24 inch depths. These sensors indicate volumetric soil moisture in percent. Sensors were connected to Decagon EM-50 data loggers and data was recorded hourly. Sensors were installed in all variety 2 (Fiber ax) plots within the T-L and Relinked SSDI/OVRHD areas. Data collection was also delayed, beginning around August 12. Soil moisture was monitored but not used to trigger any irrigation events. This data is still being analyzed and is not presented in detail in this paper.

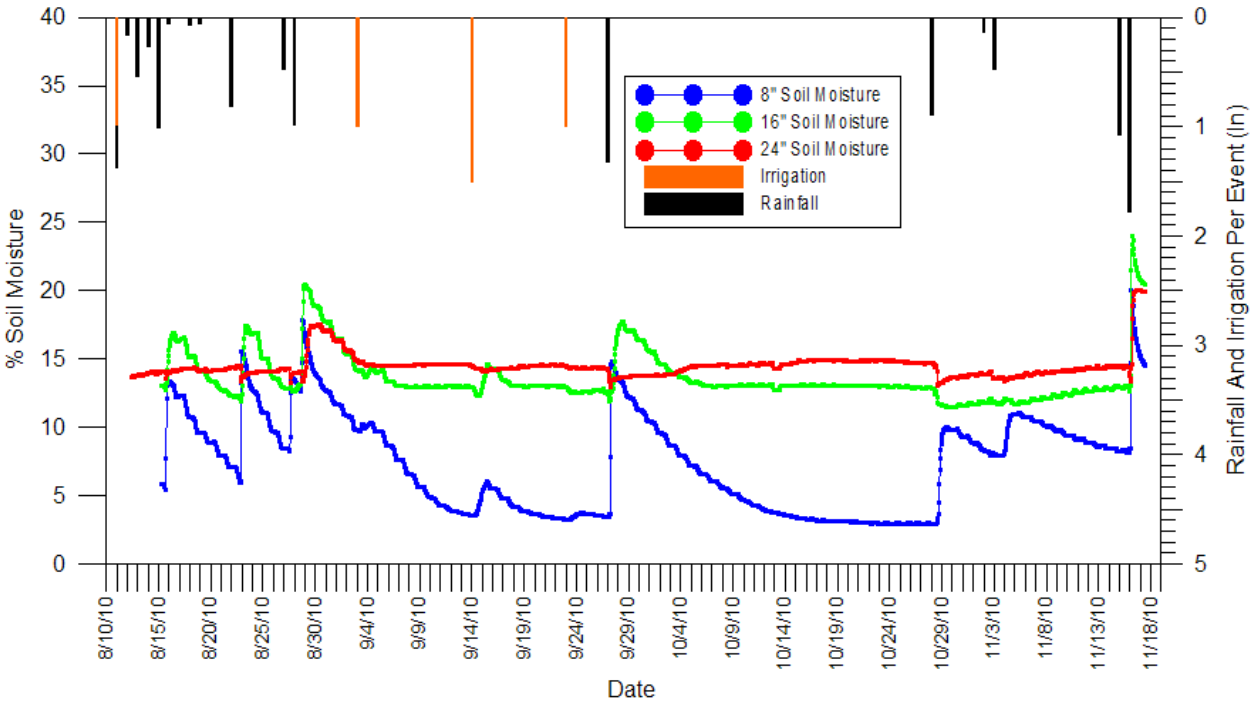

Figure 6. Soil moisture data from Decagon EC-5 sensors at 8 inch, 16 inch, and 24 inch depths. Data is from a plot with shallow drip tape, full application, and continuous irrigation method.

Statistical and Economic Analysis

Statistical and economic analyses are in-process as of this writing. The team anticipates being able to compare yields from SSDI vs. OVRHD vs. dryland. The economic analysis should provide a comparison of net returns for each irrigation method and dryland.

Results and Discussion

The SSDI system operated well after some initial problems were corrected. Most of the problems were leaks caused by drip tape not being correctly connected to supply or flush sub-mains or with plumbing components leaking due to incorrect installation of fittings. As described earlier, due to time constraints, an electronic timer was not installed and zones were irrigated manually. This allowed for "continuous" water application only – no pulsed applications were properly implemented. Reported results are from "continuous" application.

The yield results from the 2010 cotton crop are summarized in Tables 2 and 3. Table 2 provides the lint yields from the full and deficit irrigation regimes for both SSDI and OVRHD across all four varieties. This data indicates that SSDI (both deep and shallow) had numerically higher lint yields than OVRHD or dryland.

Table 3 includes the yields by variety across all irrigation regimes. This data indicates that the lint yields for the DeltaPine 0912 and FiberMax 1740 varieties well exceeded yields for the DeltaPine 0949 and DeltaPine 1050 varieties for most of the irrigation regimes with the FiberMax variety having some of the highest yields (SSDI full, deep and shallow). Lint yields for all irrigation regimes and all varieties well exceeded the dryland yields.

Table 2. Lint yields from full and deficit irrigation regimes across all 4 varieties.

Irrigation Method	Lint Yield (lb./ac)	
	Full	Deficit
SSDI Deep	1491	1340
SSDI Shallow	1548	1253
OVRHD	1387	1154
Dryland	1031	1031

Table 3. Lint yields for all 4 varieties across all irrigation regimes.

Variety Number	Variety Name	Lint Yield (lb./ac)						
		SSDI Deep		SSDI Shallow		OVRHD		Dryland
		Full	Deficit	Full	Deficit	Full	Deficit	
1	DP912	1530	1386	1585	1223	1467	1181	1146
2	FM1740	1594	1511	1595	1305	1416	1166	1144
3	DP949	1457	1168	1509	1252	1278	1097	904
4	DP1050	1382	1295	1503	1233	1389	1171	933

Conclusions

First year results from subsurface drip irrigation on cotton at the Stripling Irrigation Research Park near Camilla, GA, were encouraging as yields were numerically higher for SSDI as compared to overhead sprinkler irrigation or dryland production – even though the SSDI was installed 40 days after planting and only 4 irrigation applications were made with the drip.

The system hardware performed well with little start-up problems. The team hopes to fully implement SSDI with continuous and pulsed water application in 2011. The installation at the Midville site is expected to be completed prior to the crop season and provide additional data in a different production environment (soils, weather, tillage, etc.).