An Overview: Merging of Subsurface Drip Irrigation (SDI) and Auto-Guidance for Cotton Production in Alabama

John P. Fulton[1], Joey N. Shaw[2], Mark Dougherty[1], and Randy L. Raper[3]
[1]Biosystems Engineering Department, Auburn University, Auburn, AL
[2]Department of Agronomy and Soils, Auburn University, Auburn, AL
[3]USDA-ARS National Soil Dynamic Laboratory, Auburn, AL
fultojp@auburn.edu

Abstract

This investigation was initiated to evaluate the integration of pressure compensated subsurface drip irrigation (SDI) installed on rolling terrain via tractor auto-guidance systems for cotton production in the Tennessee Valley of Alabama. One of many goals is to demonstrate the usefulness of these new technologies in conjunction with one another so farmers can determine how these technologies can be implemented into their management strategy. The objective of this paper is to provide an overview of this ongoing project which was employed in a 15-acre field located in northern Alabama. The experimental design is a randomized block design with two irrigation treatments (dry versus wet) and two cover crop treatments (cover versus no cover) with four replications. The cover crop treatment is being evaluated to determine its ability to increase water infiltration, provide soil protection during winter months, and reduce soil compaction at shallow depths. The pressure compensated SDI tape was installed using a real-time kinematic (RTK) autoguidance system to accurately place tape parallel on 80-in spacing at 1200-ft length. AB lines were established and archived for using the autoguidance system to properly locate cotton and cover crops in relation to SDI tape runs. Cotton is planted on 40-in row spacing placing SDI tape at the center of every other row of cotton. The 2005 cropping season represents the first year of operation for this new SDI system.

Summary

Cotton is a vital component of the row crop agricultural economy in Alabama. Production systems using conservation tillage have been widely adapted with resulting benefits for both soil and water conservation. However, drought continues to negatively affect yields with considerable yield variability within and between years depending on the timing and adequacy of rainfall. New precision agricultural technologies offer the opportunity to integrate precision farming techniques with precision irrigation technology to maximize yield each year while optimizing the use of production inputs such as fertilizer, agricultural chemicals, and seed.

Currently, SDI products are designed and recommended for fields that are flat or that have a minimum, uniform slope, but a new product (pressure compensated SDI) is now available, providing potential for many Alabama producers. A majority of the terrain supporting cotton production in Alabama is rolling, thus traditional SDI products are not a viable option. Pressure compensated SDI offers a method to apply water, subsurface, uniformly on rolling terrain by compensating water flow for varying ground pressure. This type of technology negates the effect of gravity, which causes more water to be distributed down slope with traditional SDI products. System design and management is a major factor in determining application uniformity. Therefore the objectives of this investigation are to 1) evaluate cotton production on rolling terrain irrigated with SDI in conjunction with cover crops, 2) evaluate spatial yield variability as related to SDI and topography, and 3) evaluate the performance of a new SDI product developed for use on rolling terrain.

A 15-acre field located at the Tennessee Valley Research and Extension Center (TVREC) in Belle Mina, Alabama was selected for this investigation. The field consists of Decatur silt loam and Decatur silt clay soils with slopes ranging from 1% up to 6%. A detailed topographical map was developed using a total station with sub-centimeter accuracy. Additional data collection before installation included mapping soil electrical conductivity (EC) and grid soil samples. The soil EC measurements were collected using a Veris equipped with a Differential Global Positioning System (DGPS) to develop field EC variability based on 1-foot and 3-foot soil depths. Grid soil samples were collected at two depths; 0-10 in. and 11-16 in. The deeper soil cores were collected to look at subsoil acidity providing background data prior to SDI usage. Future plans include re-sampling the same soil core sites to assess fertility and acidity changes.

Implementation of this research required the establishment of an AB line (the initial guidance pass) prior to inserting the tape. This AB line was archived to use for all subsequent field operations using equipment with autoguidance capabilities; primarily planting of cotton and cover crops. SDI tape was installed on 80-in spacing between every other plant row average depth using precision guidance equipment. All treatments have rows 1200 ft. in length over rolling terrain. This placement of cotton rows in relation to the SDI tape allows each run of tape to feed two cotton rows. Cotton variety selection and soil fertility management will be conducted according to Alabama Cooperative Extension System guidelines and program used at TVREC.

Sand media and disc filters were installed to remove suspended particles from irrigation water in order to reduce drip emitter clogs. Routine flushing and chemical treatment will alleviate any evidence of clogging as a result of back siphonage. Totalizing water meters are used to monitor water flow volumes during irrigation events. Decreases in total water volume applied would suggest emitter clogging. Irrigation scheduling has been established at 60% evaporation of pan. This level was selected based on 6 years of prior irrigation research at the same research facility investigating the appropriate percent of pan evaporation for determining SDI timing.

The experimental design is a randomized block design with two irrigation treatments and two cover crop treatments with four replications. No irrigation versus SDI irrigation comprises the two irrigation treatments. Cover crops are being investigated to examine their ability to supply soil protection over the winter months while also increasing infiltration from frequent winter and spring rains. Organic matter is added to the soil, but may come at the price of increased moisture use by the cover crops. The presence of SDI would eliminate this problem by allowing irrigation to compensate for any moisture use by cover crops. Research has illustrated that Alabama soils can be improved by cover crops as they increase infiltration and eliminate compaction occurring at shallow depths.

Since the 2004 cropping season was the first season of operation, it was used to complete hardware installation and troubleshoot the system during irrigation events. A cotton crop was planted but minimal irrigation was scheduled due to the above average rainfall for the year. The irrigation events were used to diagnose and mend problems with the system, ensuring proper functioning for the 2005 growing season. The entire system was operated during any irrigation event meaning no analyses were performed. Moisture sensors were placed at five locations across the test plot at depths of 6, 13, and 30 inches to monitor soil moisture variability during the growing season within the various treatments. A wireless communication system was also installed to relay all flow and moisture data back to a central computer for automatic archiving.

A winter wheat cover crop was planted after the fall 2004 harvest and burned down prior to planting in spring of 2005. Cover crops were only established on those treatments requiring one. Future data collection includes site-specific cone index and soil moisture measurements on a yearly basis using a multiple-probe soil cone penetrometer system. Cone penetrometer measurements will be used to determine the development of compacted soil layers through the soil profile over the duration of the study. A cotton picker equipped with a yield monitoring system will be used to provide spatial crop performance. Yield data produced by the monitor system will be segregated by treatment to assess yield variability within and among each treatment. Total harvested yield will also be collected for each treatment using a weigh cart. Summed yield will be used for treatment comparisons and correction of yield monitor data so it reflects the actual magnitude of yield for each treatment.

In conclusion, 2005 represents the first year for comparisons between the different treatments. While it has taken over a year to ensure proper system operation, the implementation of this investigation has helped make pressure compensated SDI tape available to farmers in northern Alabama. It is currently estimated that approximately close to 1000 acres has been installed in northern Alabama with installation potentially occurring on another 3000 acres in the near future based on interests from farmers who already have experience with SDI or are looking at it as an irrigation alternative. These technologies along with current management practices, tillage, cover crops, etc., could provide a site-specific methodology of managing water resources and increasing profitability. Our goal is to demonstrate the usefulness of these new technologies in conjunction with one another and develop proper management strategies for them.