Title: On-farm sub-surface drip irrigation: How does soil type impact efficiency and management

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Student's Current Status	#	Department	Was the student working for experience or towards a degree?
Undergraduate			
M.S.	1	Plant and Soil	Degree
Post Doc	1	Plant and Soil	Experience
Total			

Problem and Research Objectives:

Prior to this project there was a lack of understanding of how water moves in the soil away from subsurface drip irrigation. We generally expect that water will drain more rapidly in sandy soil with limited capillary movement to the surface from the drip tape. In contrast, drainage will be slower in clayey soils with more significant capillary movement to the surface making irrigation more effective. However, there is uncertainty about how irrigation strategy effects water movement in the soil. For example, given the flexibility of management for subsurface drip irrigation we can irrigate for a set number of concurrent hours every day or every other day or every third day and so on, with each of these strategies providing the same total amount of water distributed in time differently. It's hypothesized that larger less frequent irrigation events might increase the amount of water lost to drainage because of saturated conditions that would occur during the longer irrigation event. However, daily irrigation events do not allow for early season near surface soil drying which might limit root development.

In an effort to understand which strategy might be optimum, an on-farm project was initiated in the summer of 2016 with 2 objectives. The first objective was to better understand how producers apply water through their drip irrigation systems as well as why they choose the strategy used. The second objective was to evaluate soil water movement in a variety of production environments using subsurface drip irrigation.

Importance of Project and Findings:

The findings of this project will help to advance the efficient use of sub-surface drip irrigation in the Southern Plains. This technology is very new and there is a great need for information to understand how to optimize water use efficiency through improved irrigation strategies. As mentioned, there are many ideas and opinions on how to most effective apply water through SDI, as well as many reasons why producers use the strategies they select. However, this project provides the needed data to evaluate the actual outcome of those decisions and will provide guidance for future improvements.

Changes to the Project since Implementation:

A substantial change was made in the second growing season, when we decided to focus our efforts to evaluating soil water dynamics in a replicated experiment at the Oklahoma Panhandle Research and Extension Center. In the first year we observed some interesting results. Namely, it appeared that less frequent but larger irrigation events allow for more effective utilization of sub soil moisture which allowed for more effective maintenance of surface moisture.

Although, on-farm observations allow us to understand how soil water dynamics are affected by the producer's soil type and management, they do not allow us to compare it directly with alternative management. Secondly, we were unsuccessful in finding a diversity of soil types so that component of our project was unfruitful. For these reasons we focused on the replicated study which included grain sorghum and corn as well as irrigation strategies in which water was applied daily or on a 4 day rotation.

Methodology:

Watermark soil moisture sensors were deployed in 4 fields in the summer of 2016. They were placed in proximity to the drip irrigation tape as diagramed in figure 1. In 2017 this same configuration was used to monitor soil moisture on 16 independently irrigated plots at the Oklahoma Panhandle Research and Extension Center. Eight of these plots were growing corn and eight were growing grain sorghum. Treatments included daily and 4 day rotational irrigation. These sensors were deployed at the onset of irrigation and will remain in the field until completion. At maturity, grain will be collected for yield determination and irrigation water use efficiency will be determined for each treatment.

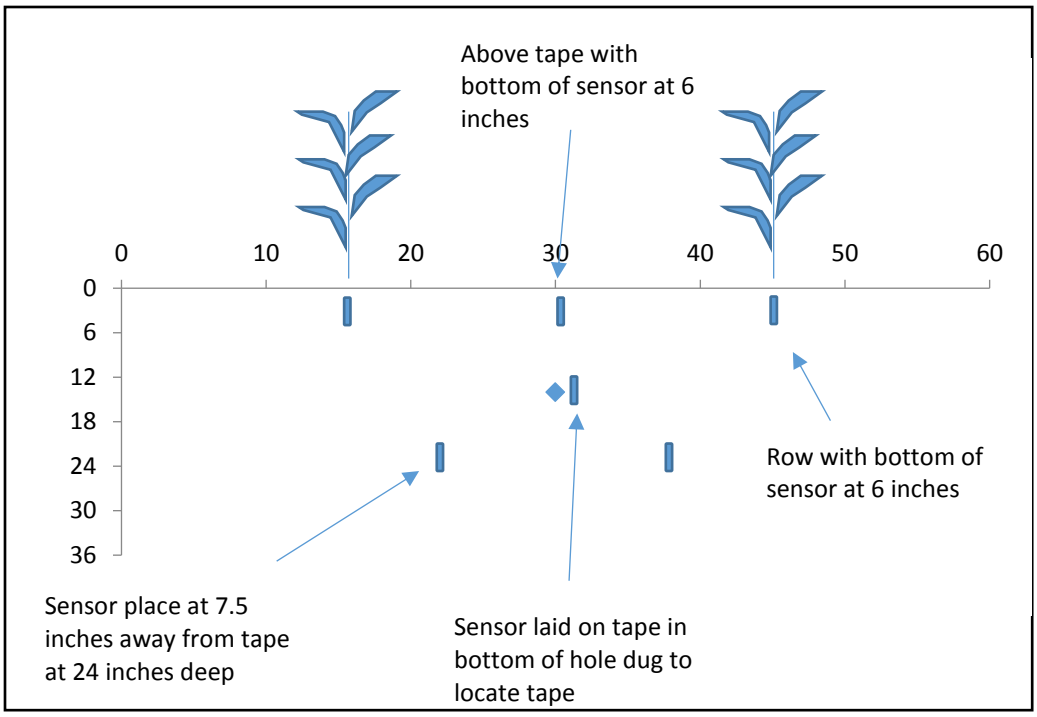

Figure 1: Location of sensors in proximity to subsurface drip irrigation tape in corn field (the cotton was planted on 40 inch rows so sensors were placed at appropriate distances for this row spacing).

Principal Findings and Significance:

This project provided a wealth of preliminary data needed to improve our understanding of how SDI is being used in Oklahoma as well as how water moves in soils. We realized that the source of irrigation water plays an important role in how water is applied. Specifically, SDI in the Lugart-Altus irrigation district is designed with large zones capably of applying thousands of gallons per minute. In contrast, the systems utilizing ground water are designed to apply hundreds of gallons per minute. Also, in the Lugart-Altus district they have less flexibility in managing the water. Specifically, when they order water they must use it despite any change in the need for water resulting from rainfall or a reduction in evapotranspiration. The two producers in the Lugart-Altus district applied water daily in continuous 8-hour applications because of the expectation that this would most effectively optimize the surface soil moisture. In contrast, the producer in the Oklahoma Panhandle applied water on a 3-day rotation with 12-hour continuous applications. He used this frequency because it matched his historic strategy of pivot irrigation. Unfortunately each of these soils were clay loams with similar hydrologic properties; therefore, we were not able to evaluate the impact of soil type on water movement.

The data collected in 2016 suggested that the producer who used a 3-day irrigation rotation was more effective at maintaining surface soil moisture without saturated the subsoil. However, the on-farm approach was not capable of properly determining the

validity of this observation; therefore, as mentioned, a side-by-side comparison of irrigation strategies for corn and grain sorghum was initiated in 2017.

In the summer of 2017, preliminary data collected supports the fact that less frequent yet larger irrigation events allow for more effective use of subsoil moisture. This is believed to occur due to improved rooting depth, stimulated by periodic drying of the surface soil, which causes roots to grow into the wetter subsoil. This is a critical advantage for two reasons. First it allows the crop to use water captured and stored in the subsoil during the fallow period. Secondly, if irrigation capacity is not sufficient to replace daily evapotranspiration during the peak of the growing season, this subsoil moisture acts as a secondary water source providing for more successful crop production. Crop yield, yet to be collected, is needed to confirm these assertions, however, visual observation of crop health support them.

Next Steps:

Fortunately, the more we learn, it seems, the more questions we have! Therefore, this line of research will continue in the Panhandle at our research station through modest support from the Sorghum Checkoff as well as funding from an USDA-AFRI grant funded to support collaborated research and extension efforts for irrigation in the Ogallala Region. We will also utilize a portion of the P.E. Harrill Endowed Professorship awarded to Jason Warren in 2017 to support continued efforts to improve subsurface irrigation management in southwest Oklahoma.

Specifically, we will continue to monitor soil water dynamics on our plots in the panhandle to confirm the reproducibility of the results. We will also collect root samples from select treatments to validate the improved rooting depth. This data will be useful in our ongoing effort calibrate and validate the Hydus model for predicting soil water movement in subsurface drip irrigation.

The ultimate goal for this effort will be to provide sound information to producers of how they might optimize the design and management of their drip irrigation systems to maximize their water use efficiency and productivity.