UTILITY OF SUBSURFACE DRIP IRRIGATION FOR SOYBEAN PRODUCTION

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Water management is an important factor for high yield soybean production in Missouri. Over the past decade, subsurface drainage and integrated water management systems have increased soybean yields 9 to 14 bu/acre and corn yields 25 to 55 bu/acre on flat, poorly drained soils (Nelson et al., 2013). Synergistic soybean yield increases have been observed with integrated water management systems and fungicide applications (Nelson and Meinhardt, 2011), while cultivar (Nelson et al., 2012) and hybrid (Nelson and Smoot, 2012) selection was important in matching effective water management systems with high yield production systems. Long-term research has shown that integrated water management systems have worked effectively on flat soils with an impermeable subsoil layer, but grain yield variability has been observed above tile lines with subirrigation water compared to between the tile lines due to the wider spacing of drainage systems (Nelson et al., 2011; Nelson and Motavalli, 2013). Narrower irrigation line spacings (5 ft) have been utilized with subsurface drip irrigation to decrease production variability compared to drainage/subirrigation systems and provide irrigation opportunities on more soil types and slopes. Subsurface drip irrigation may allow farmers with irregular sized fields and varying slopes to provide effective irrigation especially in locations with limited water supply.

Subsurface drip irrigation systems have increased a farmer's ability to manage crop production, provided an opportunity for uniform application of water and nutrients, increased simplicity of operation and maintenance, increased production, reduced irrigation energy costs, and increased water use efficiency (Bucks et al., 1986). Farmers may hesitate to utilize subsurface drip irrigation because of the initial expense as well as other concerns such as rodent damage to drip lines, filtration systems, and clogging due to iron bacteria (Alam et al., 2005). Establishment of long-term research to evaluate subsurface drip irrigation will help farmers make informed decisions on the cost-effectiveness of drip irrigation systems on claypan soils where inadequate water has significantly limited yield in 4 out of the past 10 years (Nelson et al., 2013).

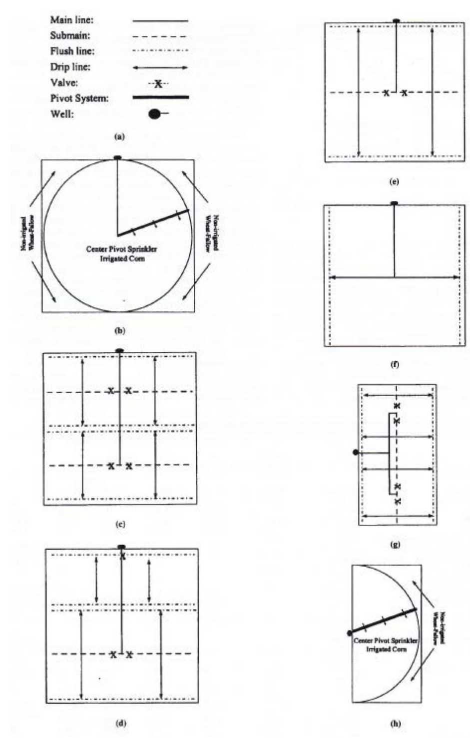

Figure 1. Subsurface drip irrigation and pivot sprinkler irrigation system designs (O'Brien et al., 1998).

Subsurface drip irrigation has been reported to be more profitable on small fields (<60 acres) (Figure 1) because of a lower investment cost per acre and pumping costs compared to center-pivot systems (Bosch et al., 1992;

O'Brien et al., 1998). Installation of drip irrigation systems on sloping soils could allow farmers to increase spacings between drip lines due to lateral water flow which may occur above the impermeable claypan layer. Installation of subsurface drip irrigation perpendicular to the slope or on the contour may allow farmers to minimize challenges with undulating fields in Missouri since application depth did not affect soybean yields (Lamm et al., 2010). On slopes up to 3%, corn and cotton yields in Georgia increased over 45% with subsurface drip irrigation on 6 ft spacings compared to a non-irrigated control (Sorensen and Lamb, 2008). Subsurface drip irrigation has reduced water use approximately 25% compared to sprinkler irrigation (Sorensen et al., 2005). With a subsurface drip irrigation system, a small amount of water can be applied quickly to avoid crop stress allowing a fast irrigation cycle to occur. In water supply limited regions of Missouri, water use efficiency is an attractive component of a subsurface drip irrigation system. There is no apparent data in Missouri on soybean response to subsurface drip irrigation on sloping soils and there is limited soybean research in the Midwest with subsurface drip irrigation (Lamm et al., 2010) . Knowledge about installation equipment, system design, pump and filtration requirements, injection system maintenance, distribution systems, and expected yield responses will help farmers make informed decisions on the success of a subsurface drip irrigation system.

In 2002-2004, corn with subsurface drip irrigation increased returns $80 to 180/acre compared with the non-irrigated control in Georgia (Sorensen and Lamb, 2008). Grain yields that double production (80 bu/acre) in a year with low overall production such as 2013 could increased returns up to $600/acre. Subsurface drainage plus subirrigation at a 20 ft spacing on flat claypan soils has increased soybean yields in dry years (2005, 2007, 2012, and 2013) up to 36 bu/acre compared to non-irrigated systems (Nelson et al., 2013). Gross returns increased over $500/acre in 2012 with this system. Results from research on subsurface drip irrigation will help farmers decide whether or not to invest in a system for soils with greater slopes. The objectives of this research are to evaluate 1) the effect of subsurface drip irrigation on soybean response in rotation with corn, and 2) the effect of subsurface drip irrigation spacing on soils with slopes greater than 3% on crop response in a claypan soil.

Procedures

Plots will be managed as high yielding no-till production systems. A pressurized water supply system from an 18 acre lake is available on-site, but supplies for a filtration device will be installed. Treatments for objective #1 will include subsurface drip irrigation with 5 ft spacing between drip lines, similar to other research (Sorensen and Lamb, 2008), overhead sprinkler irrigation using permanent sprinklers, and a non-irrigated control with at least three replications in the design. Yield data will be collected and data will be evaluated in terms of the economic benefit of subsurface drip irrigation compared to overhead irrigation and the non-irrigated control. We will evaluate overall water application and efficiency between systems. Treatments for objective #2 will include subsurface drip irrigation installed at different spacings on sloping soil. We will identify a site with greater than 3% slope and will install drip tape on the contour. Two lines will be installed at 5, 7.5, 10, and 15 ft spacings. This will be replicated at least three times. Yields will be determined above the drip line and intervals between the drip line depending on the subsurface drip line spacing. Vegetative growth differences will be quantified between water management systems relative to the location of the drip line. Grain samples for both objectives will be collected from each plot and analyzed for oil and protein concentrations (Foss 1241 NIR grain analysis system).

Water management will continue to be one of the major factors affecting crop production in Missouri. On highly erodible soils, good surface drainage reduces the impact of excessive water on crop production. However, providing adequate water in a water supply limited environment could provide tremendous returns and production stability on these soils especially where irregularly shaped fields are common. This research is important to determine the production benefits, water use benefits, and opportunities for subsurface drip irrigation.

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