Conjunctive Irrigation Water Management Practices that Reduce Water Requirements in Furrow Irrigated Soybean

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Groundwater from the Mississippi Alluvial River Valley aquifer (MARVA) is the primary irrigation source in the Delta. Over the past three decades the number of agricultural wells and withdrawals from the MARVA have increased exponentially. Currently, withdrawal from the MARVA exceeds the aquifer recharge rate causing a decline in groundwater levels. Regulators in Mississippi have responded to the overdraft on the MARVA with permitted irrigation withdrawal values and a voluntary metering programs.

Currently, the majority of the Delta's irrigated acres are planted to maturity group IV soybean, which are furrow irrigated using a conventional continuous flow delivery system. Producers in this region typically initiate irrigation on group IV soybean at the R1-R2 growth stage and, from thereafter, default to a 7 or 10 d irrigation cycle until approximately the R7 growth stage, at which point irrigation is terminated. Moreover, in the Mid-South, producers that use a conventional continuous flow delivery system do so with lay-flat polyethylene tubing which is attached to the well or riser head and then laid perpendicular to the furrows at the upper end of the field. Holes are punctured in the tubing to allow water to continuously flow down each furrow. Conventional continuous flow irrigation is the quickest methods to move water over large amounts of land, but this delivery system is only 55% efficient. Depending on soil texture, the low irrigation application efficiency with conventional continuous flow irrigation is attributed to deep percolation losses and/or tail-water runoff (Goldhamer et al. 1987; Varlev et al. 1995; Eid et al. 1999; Matter 2001). Consequently, a means to improve irrigation application timing and efficiency is required if furrow irrigation will continue in the Mid-South.

Improved irrigation application timing through the utilization of scientific irrigation scheduling tools could reduce the number and/or the amount of irrigation applied without adversely affecting soybean grain yield. For example, our small plot research program indicated that by scheduling irrigations with soil moisture sensors we would be able to reduce irrigation events by 50% without adversely affecting soybean grain yield. To date, however, the adoption of scientific irrigation scheduling tools across the Mid-South is probably less than 2%.

Computerized hole selection (CHS) and surge flow irrigation (SURGE) are two techniques that improve conventional furrow irrigation application efficiency. Computerized hole selection computes flow and pressures in lay-flat polyethylene tubing for even distribution of water from the punched holes, even for varying row lengths. Improved down-row uniformity means rows are watered more evenly, thereby reducing tail water runoff up to 17% relative to conventional. Surge irrigation is the intermittent application of water to surface irrigated furrows in a series of relatively short, on and off time periods. The intermittent application of water with surge irrigation reduces deep percolation losses, increases furrow advance time, decreases total irrigation water applied, and improves irrigation application efficiency. Until recently, no one has evaluated the use of computerized hole selection, surge irrigation, and sensor based irrigation scheduling at the production scale. The aim of this blog article is to describe the benefits of combining these three tools on soybean grain yield and irrigation water use at the production scale.

The water requirement for soybean when furrow irrigated with disposable, thin-walled, polyethylene tubing was evaluated during the 2013-2015 growing season on the production scale in the Delta region of Arkansas and Mississippi. The study consisted of 19 paired fields with the same cultivar, soil texture, planting date and management practices. One field was randomly assigned as Irrigation Water Management and the adjacent field as CONTROL. Total irrigation water applied for Irrigation Water Management fields and the CONTROL fields was determined with a flowmeter. No irrigation best management practices (BMPs) were implemented in the CONTROL fields, while irrigation application efficiency and timing were optimized in Irrigation Water Management fields. Specifically, computerized hole selection and surge irrigation were integrated into Irrigation Water Management fields to improve furrow irrigation application efficiency, and soil moisture sensors were installed to optimize irrigation timing. Additionally, we did an economic analysis on this data set to determine if the cost of the surge valve and sensor technology could be recouped by potential water savings over a range of pumping depths.

Impact of Conjunctive Irrigation Water Management on Total Water Use

Relative to the CONTROL, conjunctive Irrigation Water Management reduced irrigation water use 20%. The reduction in irrigation water applied by conjunctive Irrigation Water Management at the field scale was similar to values we observed for individual Irrigation Water Management practices in our small plot research program. For example, in our small plot program, computerized hole selection reduced irrigation water use in soybean 17%, while surge irrigation alone reduced water use by 24%. Our results indicate that conjunctive irrigation water management at the production scale will reduce water use on furrow irrigated soybean.

Conjunctive Irrigation Water Management and Soybean grain yield

The principal concept of conjunctive Irrigation Water Management is to ensure adequate moisture for optimum grain yield while improving irrigation application efficiency. Soybean grain yield pooled over all sites averaged 69 bu/acre and was not different between CONTROL and the Irrigation Water Management fields. The yield data for soybean produced under conjunctive Irrigation Water Management agree with our small plot research data which indicated that neither computerized hole selection, surge irrigation, or sensor based irrigation scheduling alone adversely affected soybean grain yield relative to the CONTROL. Mid-South producers associate Irrigation Water Management practices with reduced grain yield; however, our production scale conjunctive Irrigation Water Management data indicate that computerized hole selection, surge irrigation, and sensor based irrigation scheduling can be adopted concurrently without adversely affecting soybean grain yield.

Economic simulations

Our economic analysis for these on-farm studies indicate that there were no differences in the irrigation cost between relift-producer standard and relift-Irrigation Water Management, 140-ft well/producer standard and 140-ft well/Irrigation Water Management, 200-ft well/producer standard and 200-ft well/Irrigation Water Management, and 400 Foot/producer standard and 400-ft well/Irrigation Water Management. Our economic analysis reveal that the capital investment for surge valves and soil moisture sensor technology is compensated for with irrigation water savings and subsequent reductions in irrigation costs.

Conclusions

The objective of this study was to determine the effect of conjunctive IWM on water use, soybean grain yield, and irrigation costs at the production scale. Our data indicate that adoption of conjunctive Irrigation Water Management on soil textures ranging from very fine sandy loam to clay will have no adverse effect on furrow irrigated soybean grain yield or irrigation costs. However, conjunctive irrigation water management will reduce irrigation water use and improve soybean irrigation water use efficiency. In essence, conjunctive Irrigation Water Management can be adopted by Mid-South soybean producers without adversely affecting on-farm profitability while, concurrently, reducing the demand on groundwater resources.