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USING SOIL MOISTURE SENSORS TO SCHEDULE IRRIGATION

Water withdrawal for irrigation from the Mississippi River Valley Alluvial Aquifer (MRVAA) is occurring at a rate that is depleting the aquifer–i.e., it is not sustainable. Therefore, methods to increase the efficiency of irrigation water application to crops, especially soybeans, are required to curb this over-withdrawal.

Soil moisture sensor readings can be used to trigger irrigation during vegetative and reproductive developmental stages of soybeans. Results from MSPB-funded research indicate that soybean grain yield, net returns above irrigation costs, and IWUE are optimized using a season-long, static 85 centibar threshold. Moreover, research conducted at the farm scale encompassing approximately 23,000 km^2 showed that 85 to 100 centibar thresholds utilized season-long did not adversely affect irrigated soybean grain yield or net returns above irrigation costs on soil textures ranging from silt loam to clay. Thus, in general, sensor readings of 80-90 centibars should be the trigger for applying irrigation at any time during the growing season.

Watermark soil moisture sensors are marketed by the Irrometer Corp. The company website provides specificatons and installation instructions for these sensors, as well as a brochure that provides and describes monitoring options.

Publication EC783 published by Univ. of Nebraska Extension provides a thorough treatment of the principles and operational characteristics of Watermark Soil Moisture Sensors. It is arguably the best reference for information that may be needed when installing and using Watermark Sensors to schedule irrigation. Pertinent topics in that publication follow.

- Definition of soil water potential (SWP) as a measure of the energy required to extract water from soil, and how soil moisture sensor readings relate to SWP;
- Proper pre-installation requirements and procedures for Watermark sensors;
- Preferred locations and depth of placement of soil moisture sensors in a field to be irrigated;
- How soil texture and associated SWP will affect amount of soil water available to plants;
- How to accomplish downloading and interpretation of soil moisture sensor data for use in irrigation scheduling; and
- Examples of how to use soil moisture sensor readings to schedule irrigation

MSU Extension and YMD personnel have published articles that provide detailed information about how soil moisture sensors work and how they can be used to schedule irrigation in the Midsouth. Those articles have been compiled into one file that contains the following articles.

- In "Utilizing Moisture Sensors to Increase Irrigation Efficiency" (MCS blog May 24, 2016), authors Krutz and Roach provide a brief summary of how to use soil moisture sensors to 1) determine soil water content/availability in the crop's active rooting zone, and 2) determine how to use sensor readings from different depths to estimate water availability in the crop's active rooting zone.
- In "Corn and Soybean Irrigation Guidelines" (MCS blog May 27, 2016), authors Krutz and Roach provide sensor readings that can be used to trigger irrigation of soybeans and corn based on crop growth stage.
- In "Irrigation Scheduling with Soil Moisture Sensors–Soybeans/Corn" (YMD), sensor readings that can be used to trigger irrigation of soybeans and corn based on crop growth stage are presented along with narrative and pictorial descriptions of those growth stages in both crops.

In a Feb. 23, 2018 MCS blog article titled "It's time to check those irrigation sensors", Dan Roach, Extension Associate at MSU's DREC, provides details about the necessary pre-installation preparation of Watermark Soil Moisture Sensors that will be used for irrigation scheduling. The following highlights are worth noting.

- Watermark sensors have a useful life of about 5 years. Sensors older than this should be discarded and replaced with new sensors.

- Watermark sensors should be pre-conditioned before installation to ensure the quickest response to changes in soil moisture after installation. The procedure for pre-installation conditioning is provided.
- Sensors must be installed wet.

The most critical factor when using soil moisture sensors to schedule irrigation is ensuring they are placed in the most representative area or areas of each field to be irrigated. If only one sensor site is used, it should represent the soil texture that is the majority of the field. However, multiple sensor sites may be needed or preferred in fields with variable soil textures.

A research report titled "Irrigation Water Management Practices that Reduce Water Requirements for Mid-South Furrow-Irrigated Soybean" (CFTM, Aug. 3, 2017) provides results from Midsouth studies that show how use of soil moisture sensors can be combined with surge irrigation and computerized hole selection to improve irrigation water use efficiency (IWUE) of soybeans in the Midsouth. A summary of those results follows.

- The objectives of the research reported in the article were to determine the effect of Irrigation Water Management (IWM) practices that included computerized hole selection (CHS–Pipe Planner), SURGE delivery, and sensor-based irrigation scheduling on water use, soybean seed yield, IWUE, and net returns above irrigation costs on a production scale.
- Studies were conducted during the 2013 through 2015 growing seasons on 20 paired fields in the Prairie region of Arkansas and the Delta region of Arkansas and Mississippi. Each set of paired fields (IWM practices and conventional–CONV) received the same management practices. Paired irrigation sets ranged in size from 6 to 80 acres.
- Irrigation was applied to IWM fields when the weighted average of soil water potential in the 0- to 24-in. soil zone was between -85 and -100 centibars. Irrigation for IWM fields was terminated when soybean reached the R6.5 stage.
- Enterprise budgets for each site were developed using the Mississippi State Budget Generator. A baseline diesel price of \$2.83/gal. and a commodity price of \$11.11/bu were used to develop all budgets across the 3 years. To test the sensitivity of the IWM and CONV technologies, minimum (\$1.60/gal.) and maximum (\$3.70/gal.) diesel prices were used.
- Irrigation water applied to CONV and IWM fields was 11.5 and 9.1 in., respectively, or a reduction of 21% applied to IWM fields.
- Soybean seed yields of 69.3 bu/acre from CONV fields and 68.6 bu/acre from IWM fields were statistically similar.
- IWUE of 9.8 bu/acre-in. of water in IWM fields was 36% greater than the 7.2 bu/acre-in. in CONV fields.
- Net returns above irrigation costs were not different between CONV and IWM for either of the specified paramaters (four water lifting depths and 3 diesel prices) used in the study.

The results reported in the above article show that IWM that includes soil moisture sensor scheduling can be implemented without adversely affecting soybean yield or on-farm profitability from irrigated soybean production. However, IWM will reduce irrigation water use and improve soybean IWUE, thus prolonging MRVAA sustainability and furrow irrigation capability of soybeans in the Midsouth.

Composed by Larry G. Heatherly, Nov. 2018, larryh91746@gmail.com