Factors Affecting In-field Soil Moisture Variability and Its Effect on Irrigation

Final report for GS19-214

Project Type: Graduate Student
Funds awarded in 2019: $10,845.00
Projected End Date: 02/28/2021
Grant Recipient: Mississippi State University
Region: Southern
State: Mississippi
Graduate Student:

Blade Hodges

Major Professor:

Dr. Mary Love Tagert
Mississippi State University

Project Information

Summary:

There have been numerous studies on soil moisture as it pertains to irrigation in Mississippi, but more work is needed in the agricultural region known as the Blackland Prairie, located in east central Mississippi. Here, an increasing number of producers are implementing irrigation. Because it is not economical to access groundwater due to the depth of the aquifer, most producers here use surface water for irrigation. Producers have a finite amount of water to use for irrigation through the growing season, so it is critical that they conserve water and irrigate efficiently. Sprinkler irrigation is the primary application method, to accommodate the changing topography across the landscape. Soil moisture sensors conserve water while maintaining yields on irrigated fields, by better timing irrigation applications to match actual crop water needs. The goal of this project is to evaluate the correlation of plant vegetation characteristics (plant height, leaf area index) and other variables (soil texture, topography) to soil moisture in the active rooting zone, to determine if there is a good surrogate for soil moisture measurements. The Decision Support System for Agrotechnology Transfer crop model will also be used to evaluate the effects of climate on vegetative characteristics and soil moisture. The results from this project will help farmers determine the ideal number of sensor sets needed over a given area and the best placement of sensors within a field. Ultimately, producers will conserve more water by improving their use of soil moisture sensors to make better irrigation management decisions.

Project Objectives:

- Measure in-field spatial and temporal variability of soil moisture in the active

rooting zone of a soybean-corn rotation using Watermark GMS sensors.

- Evaluate the correlation of root zone soil moisture to soil texture and crop variables.
- Determine if the variability of in-field soil moisture is great enough to indicate a different irrigation schedule for different areas of the field.
- Share project results with producers and stakeholder groups.

Cooperators

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Research

Materials and methods:

Site-specific irrigation decisions require information about variations in soil moisture within the rooting depth actively being used by the crop. Producers have been using soil moisture sensors to make irrigation decisions, and it has been shown that soil moisture sensors can reduce water usage without reducing yields. There are still unanswered questions on improving efficiency with soil moisture sensors based on density and location of sensors within a field. This three-year study uses sensors to evaluate the spatio-temporal variability of soil moisture across an 18-ha production field in a corn/soybean rotation. A 55 m by 55 m grid was laid on the field, which resulted in 44 sampling points that fell either underneath the center-pivot irrigation or the end gun. At each point location, two Watermark granular matrix sensors were installed at depths of 12, and 24 in. for 2018 and 2020 and an additional 30 – in. sensor in 2019. Analysis of soil samples collected in year one of the project revealed fairly homogeneous soils across the field with silty clay loam as the major soil type and only eight percent silt loam. Plant height and leaf area index (LAI) were measured weekly at each of the 44 sampling points. Inverse distance weighted

(IDW) interpolation methods were used to predict soil tension values for locations between the known points and aid in sensor density and placement within the field. Correlations between LAI and plant height with soil matric potential were run to attempt to find surrogate methods for predicting soil tension.

Research results and discussion:

The results correlating LAI and plant height to measured soil tension show that vegetative variables alone cannot be used to predict soil moisture variability. When there are high amounts of rainfall and irrigation during the peak LAI and plant height, there is a negative relationship between soil tension and plant height and soil tension and LAI, although the correlations still have similar absolute values. Even with a homogenous soil type, there is considerable soil moisture variability. Some of this variability can be explained by the topography of the field and the six-meter difference in elevation over the field, causing water to move to the low-lying areas.

When comparing the sampling schemes, it appears that the density of the sensors is not as important as the placement of sensors within the field if uniform irrigation applications are made. The IDW results show that when uniform irrigation applications are made to the field, fewer sensors that are placed in better locations throughout the field can be as useful as a densely gridded array of sensors. If variable rate irrigation (VRI) is used, more sensors in a denser pattern may be needed to define management zones. Results showed that, while not strong, plant height had the highest correlation to soil tension.

Participation Summary

2 Farmers participating in research

Educational & Outreach Activities

9 Consultations

2 Curricula, factsheets or educational tools

2 Journal articles

3 On-farm demonstrations

1 Published press articles, newsletters

4 Webinars / talks / presentations

PARTICIPATION SUMMARY:

52 Farmers

19 Ag professionals participated

Education/outreach description:

Extension Products

Tagert, M.L. Sensors: It All Starts with Installation. *Irrigation Today*. Issue 2, Fall 2019. Pp. 6-7. http://www.modernpubsonline.com/0A406ys/ITFall2019/html/index.html?page=8&origin=reader

Video: How to Assemble and Properly Install Granular Matrix Soil Moisture Sensors. With Michaela Parker as videographer. https://youtu.be/vzlZCs3g6ac Developed July/Aug. 2019.

Understanding In-Field Soil Moisture Variability and Its Effect on Irrigation. M.L. Tagert, B. Hodges, J.O. Paz, and Q. Meng. Mississippi Soybean Promotion Board Research Round-Up. Dec. 9, 2020. Mississippi State University, Starkville, MS. (Virtual) Co-presented by M.L. Tagert and B. Hodges. (*29 participants)* Presentation was recorded and posted on the Mississippi Soybean Promotion Board YouTube page at https://www.youtube.com/watch?v=ZOXXrlCrxTA&t=34s.

North Mississippi Producer Advisory Council Meeting. Presented poster 'Evaluating In-Field Soil Moisture Variability and Factors Affecting It' authored by B.C. Hodges, M.L. Tagert, J.O. Paz, and D.B. Reginelli. Verona, MS. Feb. 20, 2020. (*42 participants*)

Extension bulletin in progress titled 'How Many Soil Moisture Sensors Are Needed in My Field?'

Thesis

Blade Hodges. Understanding In-Field Soil Moisture Variability and Associated Impact on Irrigation. November 2020.

Papers

Hodges, B., M.L. Tagert, and J.O. Paz. A Modeling Approach Using DSSAT to Evaluate In-Field Soil Moisture Variability in Irrigated Soybean. *Irrigation Science*. Submitted Jan. 2021.

Hodges, B., M.L. Tagert, J.O. Paz, and Q. Meng. Assessing In-Field Soil Moisture Variability in the Active Root Zone. *Precision Agriculture*. Submitted Dec. 2020.

Scientific Conference Presentations

Hodges, B, J.O. Paz, M.L. Tagert, Q. Meng. 2020. Assessing in-Field Soil Moisture Variability Using the Decision Support System for Agrotechnology Transfer (DSSAT) Model. 2020 ASA-CSSA-SSSA international Annual Meeting. (oral presentation; virtual meeting)

B.C. Hodges, M.L. Tagert, J.O. Paz, and Q. Meng. A geospatial analysis of in-field soil moisture. 2020 ASABE Virtual Annual International Meeting. July 12-15. (oral presentation)

Project Outcomes

2 Farmers reporting change in knowledge, attitudes, skills and/or awareness

2 Farmers changed or adopted a practice

1 Grant received that built upon this project

3 New working collaborations

Project outcomes:

This project showed that even on a small field (about 44 acres) with homogenous soils, there can still be a large range of soil moisture variability from other factors such as elevation. Results from our project highlight how farmers need to consider yield history, soil texture, and elevation when determining the number of soil moisture sensors needed and where to place those sensors. This project laid the foundation for exploring sector control variable rate irrigation (VRI), a new practice not currently being implemented in Mississippi. The farmer with whom we have been working has agreed to let us develop a VRI prescription for the field we have been studying, and we will evaluate the economic benefits of water and energy savings from the VRI prescription.

Knowledge Gained:

We became more aware of the importance of using tools and practices correctly. For example, soil moisture sensors are a great tool, and they have been shown to save water (and thus energy) through improved irrigation scheduling. However, if the sensors are not installed correctly, they will not be very helpful. In addition, we saw that a number of farmers need to be using more sensors.

Information Products

- How to Assemble and Properly Install Granular Matrix Soil Moisture Sensors (Multimedia)
- Understanding In-Field Soil Moisture Variability and Its Effect on Irrigation (Multimedia)
- Evaluating In-Field Soil Moisture Variability and Factors Affecting It (Conference/Presentation Material)
- A Geospatial Analysis of In-Field Soil Moisture (Conference/Presentation Material)
- Assessing In-Field Soil Moisture Variability Using the Decision Support System for Agrotechnology Transfer (DSSAT) Model (Conference/Presentation Material)