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WITH UP-TO-DATE SOYBEAN PRODUCTION INFORMATION

MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO. 10-2018 (YEAR 1)
2018 ANNUAL REPORT

Title: Understanding in-field soil moisture variability and its effect on irrigation

Project Leader: Mary Love Tagert--Email: mltagert@abe.msstate.edu
Cooperators: Joel O. Paz, Dennis Reginelli, and William Burdine

BACKGROUND AND OBJECTIVES

There has been considerable research using different methods and technologies to measure soil moisture, but much of this work has been done to estimate surface soil moisture in the near surface soil layer. It is important to consider soil moisture in the active rooting zone when making irrigation decisions, and using granular soil moisture sensors has been shown to accomplish the conservation of both water and money while maintaining soybean yields because they can be used to schedule irrigation events based on crop water needs. However, questions still remain on the proper placement of sensors within a field and the density of sensors needed for making irrigation decisions.

This project evaluates the spatio-temporal variability of rooting zone soil moisture over an approximate 18-hectare field using Watermark granular soil moisture sensors placed at 12- and 24-inch depths on a 55- x 55-m grid, resulting in roughly 44 sampling points. The project is being carried out over three years at a pivot-irrigated site in Noxubee County growing primarily soybeans and corn to evaluate rooting zone soil moisture variability over time under different climatic conditions.

Because soils are commonly heterogeneous, and soil texture affects soil moisture, it is assumed that there will be some variability in soil moisture throughout the field. This project will determine the level of in-field variability of the rooting zone soil moisture of a soybean crop throughout the growing season, as well as the influence of soil texture and soybean vegetative characteristics on rooting zone soil moisture variability. The results of this project will help develop guidelines for sensor placement and density of sensors needed within a field. This project will increase the knowledge of North Mississippi producers on the use of sensors and thus increase the adoption of sensors for triggering irrigation applications in North Mississippi.

The specific objectives are as follows:
1. Measure in-field spatial and temporal variability of soil moisture in the active rooting zone of soybeans using Watermark GMS sensors.
2. Evaluate the correlation of root zone soil moisture to soil texture and soybean vegetative variables.
3. Determine if the variability of in-field soil moisture is great enough to indicate a different irrigation schedule for different areas of the field.
4. Share project results with producers and stakeholder groups.

REPORT OF PROGRESS/ACTIVITY

1. Measure in-field spatial and temporal variability of soil moisture in the active rooting zone of soybeans using Watermark GMS sensors.
    - We placed soil moisture sensors at 12- and 24-inch depths on a 55- x 55-meter grid, resulting in 44 soil sensor locations, and connected the sensors to a data logger at each location which was set to log hourly throughout the course of the growing season. The data were downloaded weekly from the data loggers to analyze the soil moisture content over that time period.

2. Evaluate the correlation of root zone soil moisture to soil texture and soybean vegetative variables.
    - Soil samples were collected in September to a depth of 24 inches, the same depth to which sensors were installed. Samples were analyzed. The soil texture was quite homogeneous across the field, with the primary soil type being silty clay loam, while five out of 44 sample points were determined to be silt loam. We are still analyzing soil moisture, soil texture, LAI, plant height, and NDVI data to evaluate correlations.
    - Based on the soil texture results, it is unlikely that any variability in soil moisture would be attributed to changes in soil texture, since the field is mostly homogenous. Also, we have preliminary data that show a higher correlation between soil moisture and plant height. Topography also plays a big role in the soil moisture based on the digital elevation model and our soil moisture maps.

3. Determine if the variability of in-field soil moisture is great enough to indicate a different irrigation schedule for different areas of the field.
    - More analysis is needed to determine if patterns are consistent and whether there is enough variability to indicate a different irrigation schedule for different areas of the field. We have started to delineate possible site specific management zones that could use different treatments.

4. Share project results with producers and stakeholder groups.
    - Multiple presentations and posters have been created and given to present the preliminary findings of this project and will be listed in the End Products section.

All data are still preliminary, and no final conclusions have been drawn.

IMPACTS AND BENEFITS TO MISSISSIPPI SOYBEAN PRODUCERS

Once this project is finished, it should provide major benefits to Mississippi soybean producers, particularly in Northeast MS. This project will help producers have a better understanding of how sensors can be utilized under pivots and in the rolling terrain of Northeast MS. Also, it will hopefully make producers more profitable and more efficient with their water usage for irrigation.

END PRODUCTS–COMPLETED OR FORTHCOMING

Completed Oral Presentations:

Blade Hodges: Factors Affecting In-Field Soil Moisture; Mississippi Water Resources Conference April 3, 2019

Mary Love Tagert: Irrigation Sensors Research in Noxubee County; Multi-County Precision Agriculture Meeting February 5, 2019

Future Oral Presentations:

Mary Love Tagert will give an oral presentation at the 2019 ASABE conference in Boston, MA in July 2019.

Completed Poster Presentations:

Blade Hodges: Understanding In-Field Soil Moisture Variability; Mississippi State Undergraduate Research Symposium, August 1, 2018
Blade Hodges: Understanding In-Field Soil Moisture Variability; 2019 Farm and Gin Show

Future Poster Presentations:

Blade Hodges will present another poster on updated findings at the Mississippi State Undergraduate Research Symposium April 19, 2019.

Graphics/Tables

Attached is a power point of our study to date with multiple graphics that represent methods and findings through Year 1.

Factors Affecting In-Field Soil Moisture

Blade Hodges, Mary Love Tagert, Joel Paz, and Dennis Reginelli

Mississippi Water Resources Conference

April 2, 2019

Jackson, MS

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Department of Agricultural and Biological Engineering

Overview

- Background
- Objectives
- Methods
- Results
- Future Work

Background

- Irrigation in southeastern states has been increasing from 1997-2013, with Mississippi having the fourth largest increase of all Mid-South and Southeastern states.
- Less rainfall during the growing season; periodic drought

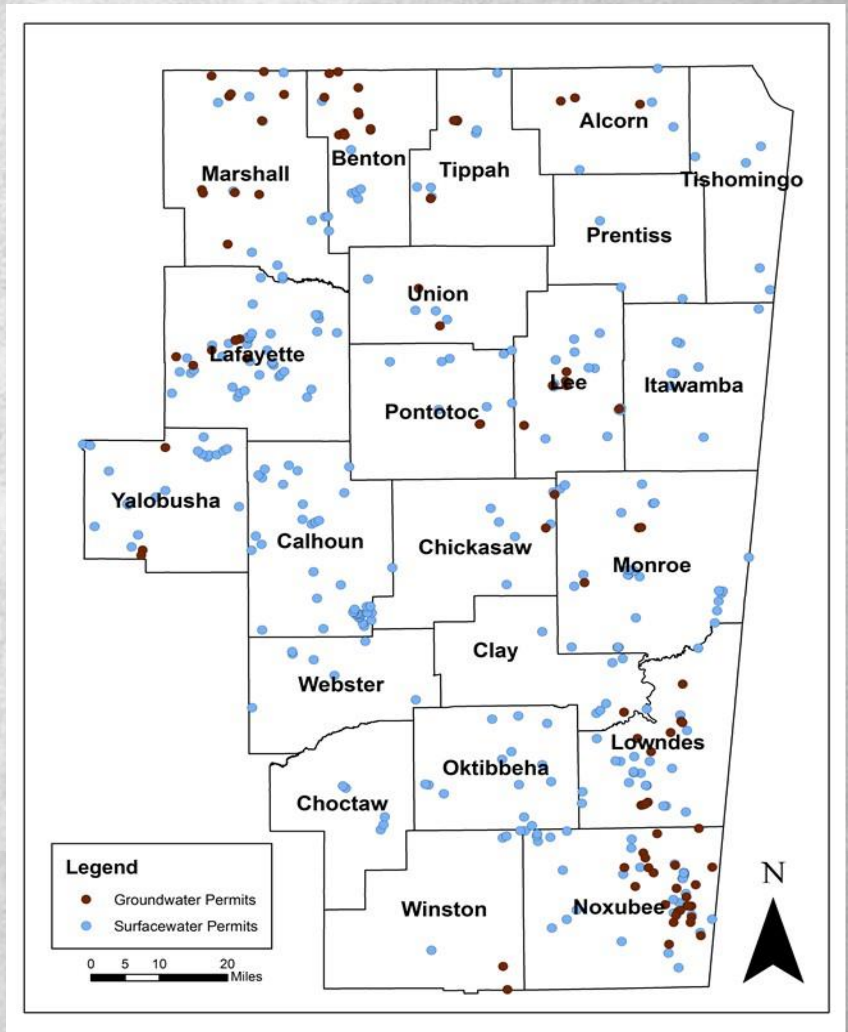
Top States in Irrigation (millions of acres)

Nebraska	8.3
California	7.5
Arkansas	5.0
Texas	4.5
Idaho	3.5
Kansas	2.9
Colorado	2.3
Montana	1.9
Mississippi	1.7
Washington	1.6

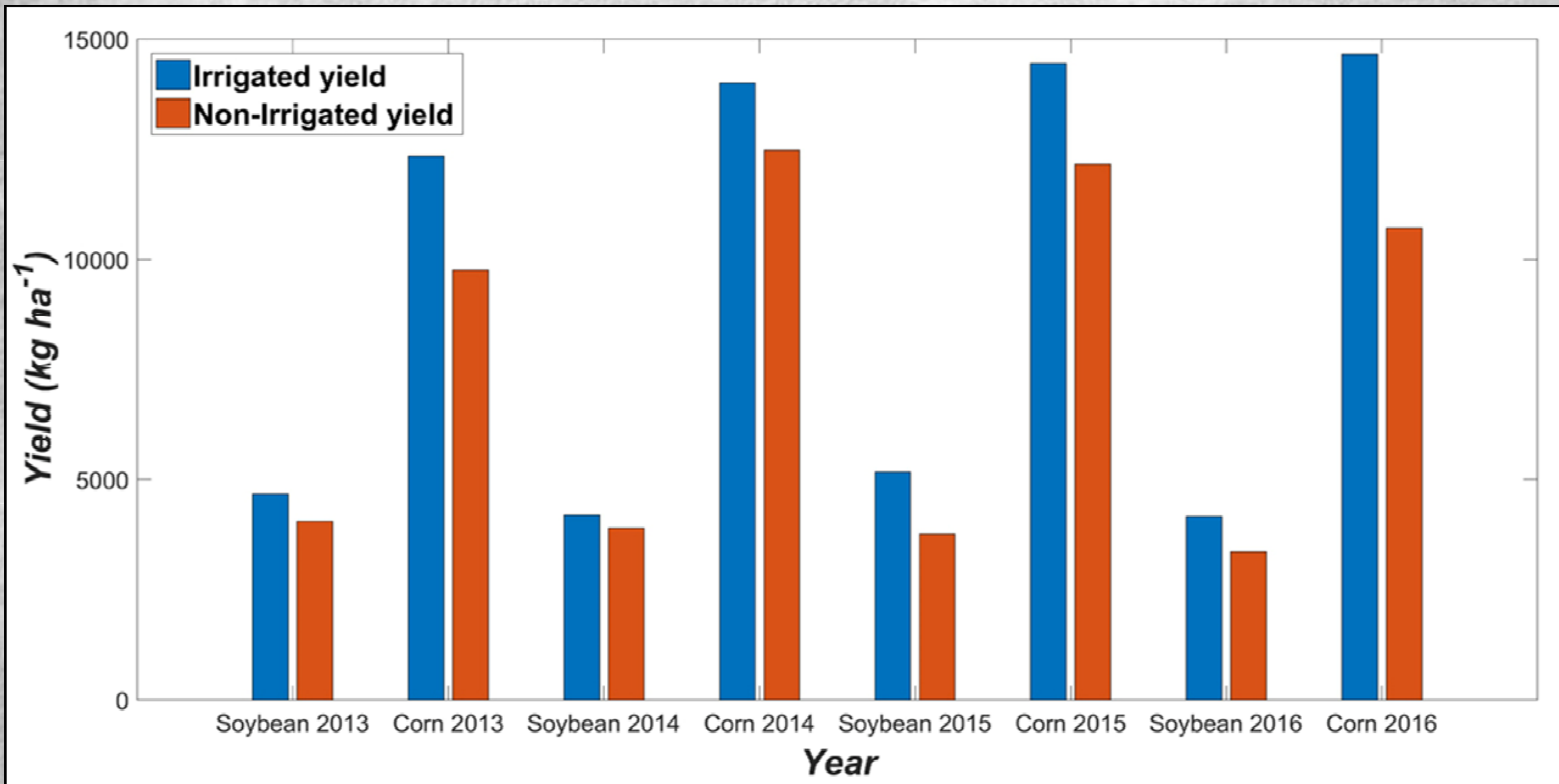
Source: USDA NASS, 2013 Farm and Ranch Irrigation Survey (2012 Census of Agriculture).

Background

- Mississippi receives an average 56 (1,422 mm) inches rainfall annually (70% in winter and spring).
- East Mississippi – historically dryland production due to high cost of drilling wells (depth to reach water). However, more producers irrigating using surface water and center pivots.



Background



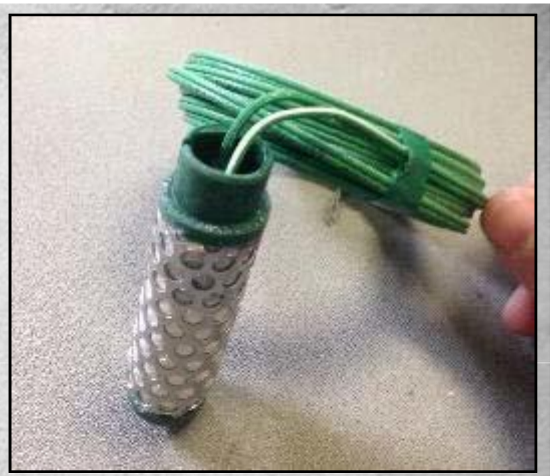
- Irrigated corn yield higher by an average of **39, 24, 36, and 63 bushels per acre,** in 2013, 2014, 2015, and 2016, respectively.
- Irrigated soybean yield higher by an average of **9, 5, 21, and 12 bushels per acre** in 2013, 2014, 2015, and 2016, respectively.

Background

- When irrigating with surface water, the producer has a somewhat finite amount of water at the beginning of the season and must ensure it lasts the entire growing season.
- Even if using groundwater, it is important to use only the water the crop needs, to ensure there is enough water for everyone as more producers implement irrigation.

Background

- Soil moisture sensors are a relatively inexpensive tool that can help determine when to irrigate, based on crop water needs.
- Soil moisture sensors can be used to help schedule irrigation applications and conserve water.
- Measure soil tension, or soil water potential, from 0 cb (saturated) to 200 cb (crops are scorched) through resistance of electrical current between two electrodes.



Background

- Install when crop is young, roughly 6 inches in height. This reduces damage to plants and gives sensors more time to acclimate to soil conditions.

Background

Recommended irrigation trigger points for soybeans under center pivot irrigation:

Soybean Growth Stage	Rooting Depth Avg. Sensor Reading
V1-R3	60-70
R3-R6	55
R6	Irrigation if needed to supply moisture needs to R6.5
R6.5	Terminate Irrigation

References: www.mssoy.org, Dr. Jason Krutz and Dan Roach (http://www.mississippi-crops.com/2016/05/27/corn-and-soybean-irrigation-guidelines/, and the Yazoo Mississippi Delta Joint Water Management District.

Background

Calculating weighted average sensor reading:

Sensor	Sensor Depth	Sensor Reading (cb)	% Rooting Zone	Weighted Reading
1	12 in	70	50	35
2	24 in	40	50	20
3	30 in	7	0	0
				55 cb

Weighted Average

References: www.mssoy.org, Dr. Jason Krutz and Dan Roach (http://www.mississippi-crops.com/2016/05/27/corn-and-soybean-irrigation-guidelines/, and the Yazoo Mississippi Delta Joint Water Management District.

Objectives

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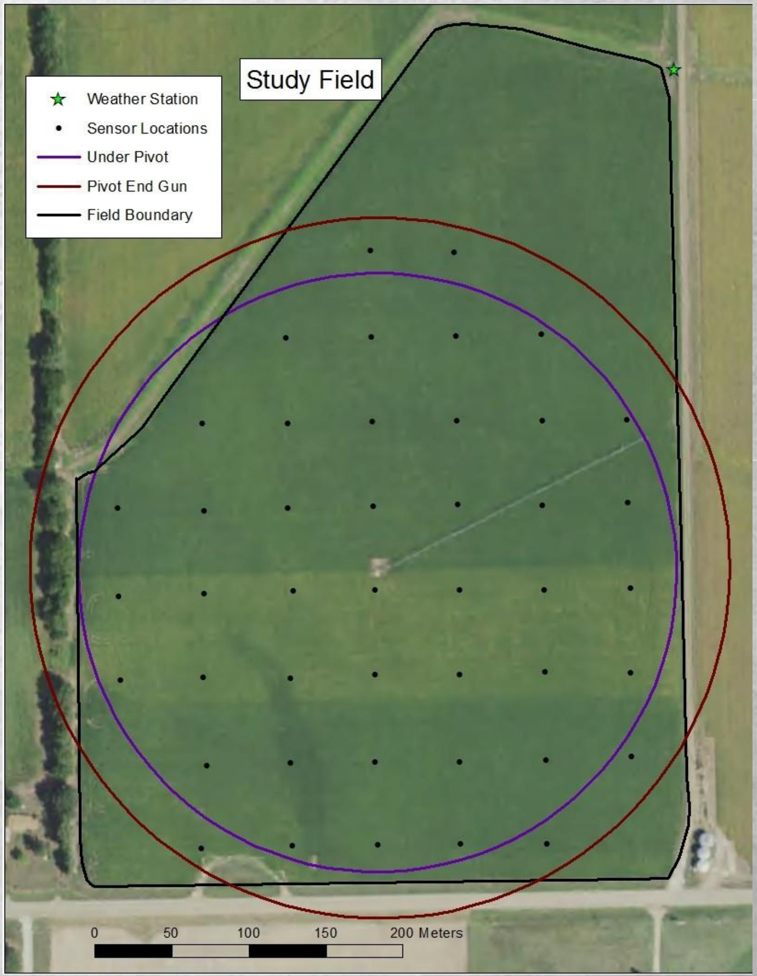
Study Area

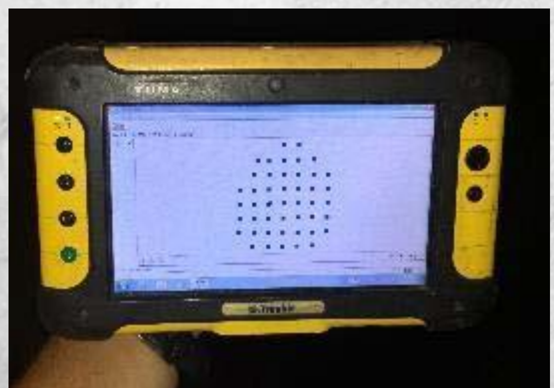
Methods

- A 55-m grid was created in ArcGIS over a 18 ha soybean field, planted on May 3, 2018.
- Resulted in 44 grid points under the pivot.
- Field monitored with Campbell Scientific weather station in NE corner.



Methods

- Trimble Yuma was used to navigate to points, 2- to 4-m accuracy.
- Pivot has Lindsey Growsmart IM3000 magnetic flowmeter to monitor irrigation events.



Methods

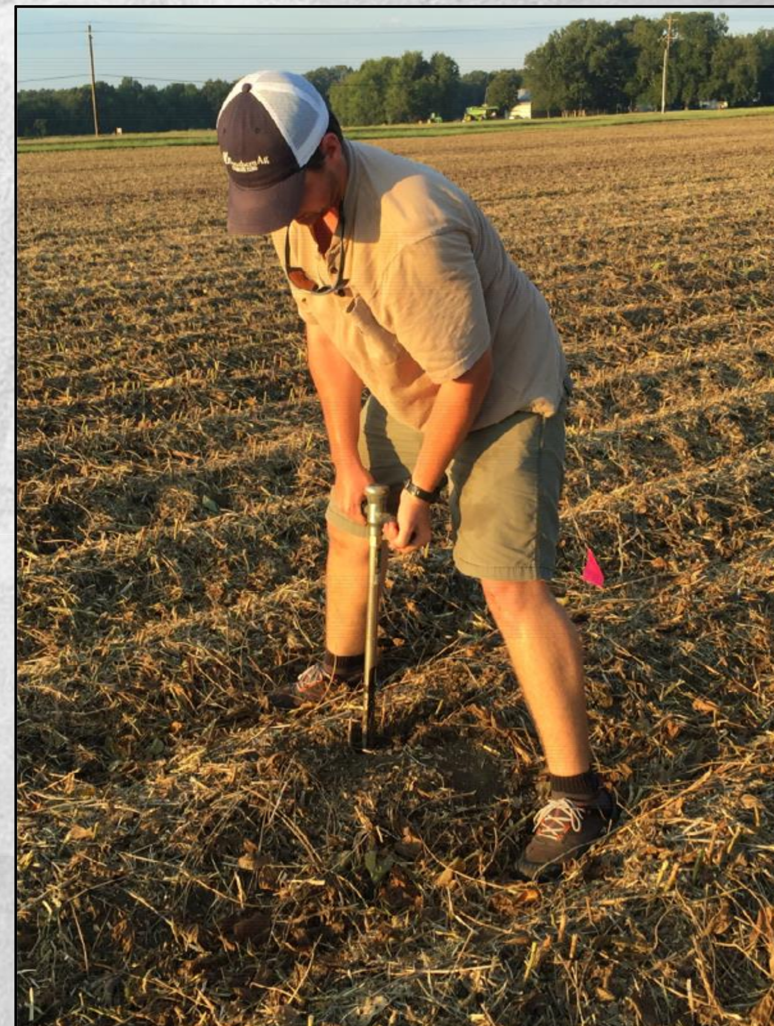
At each point, Watermark 200SS GMS sensors were installed at 12 and 24 inches and connected to a 900M Watermark data logger. Sensors were cycled and installed wet with good soil/sensor contact.

Methods

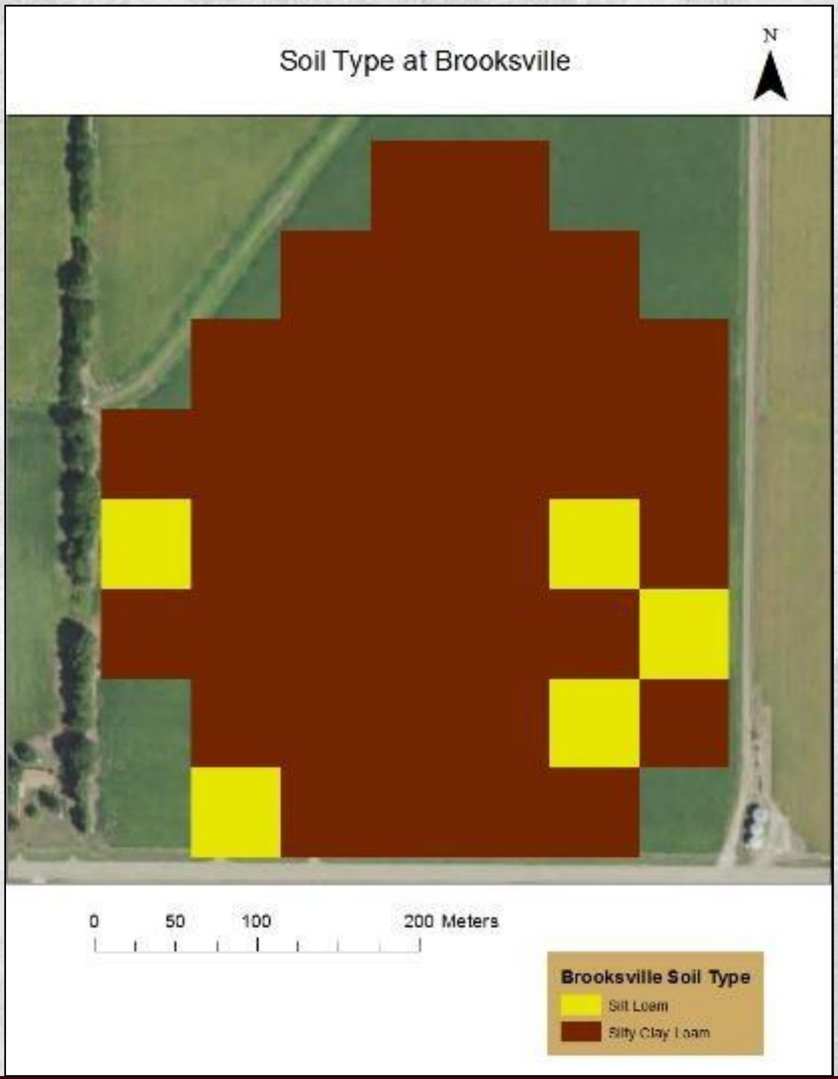
- LAI and plant height measurements were taken weekly from June 14 – August 17 using a Li-Cor LAI-2000 Plant Canopy Analyzer

Methods – Soil Texture

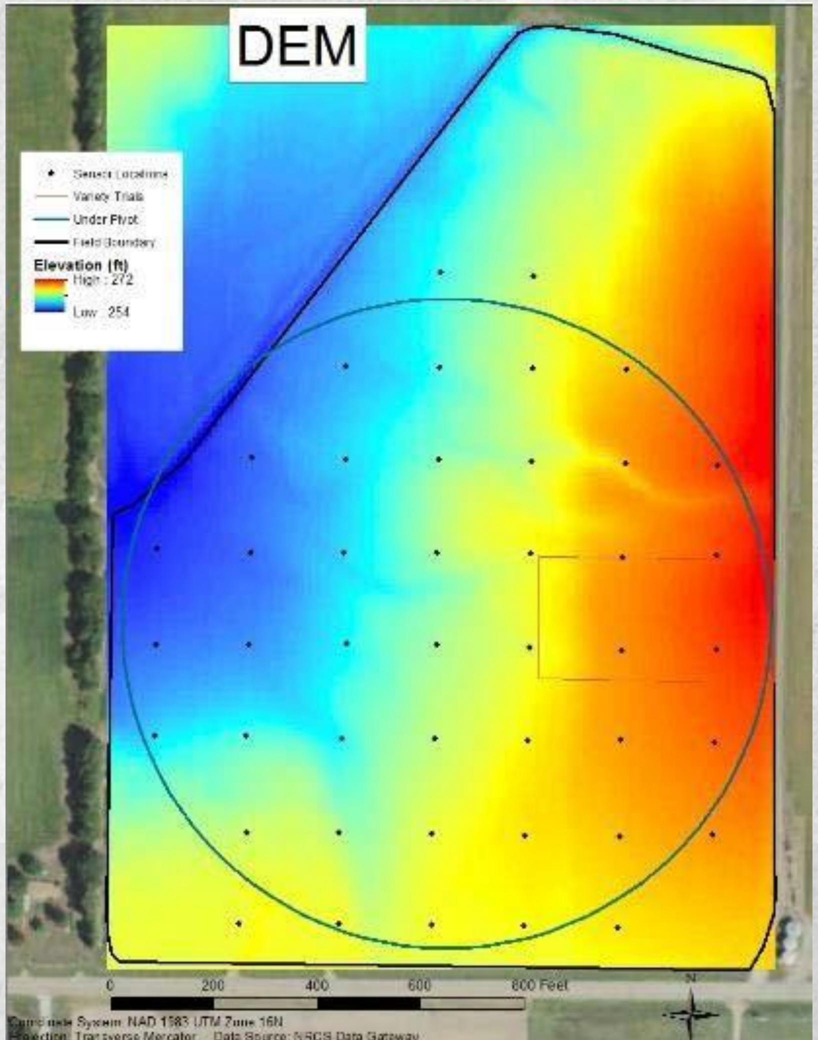
- Field was harvested on Sept. 19, and soil samples were pulled on Sept. 20
- 2-3 pulls per grid point until enough soil was collected
- Soil samples were pulled at a depth of 24 inches.



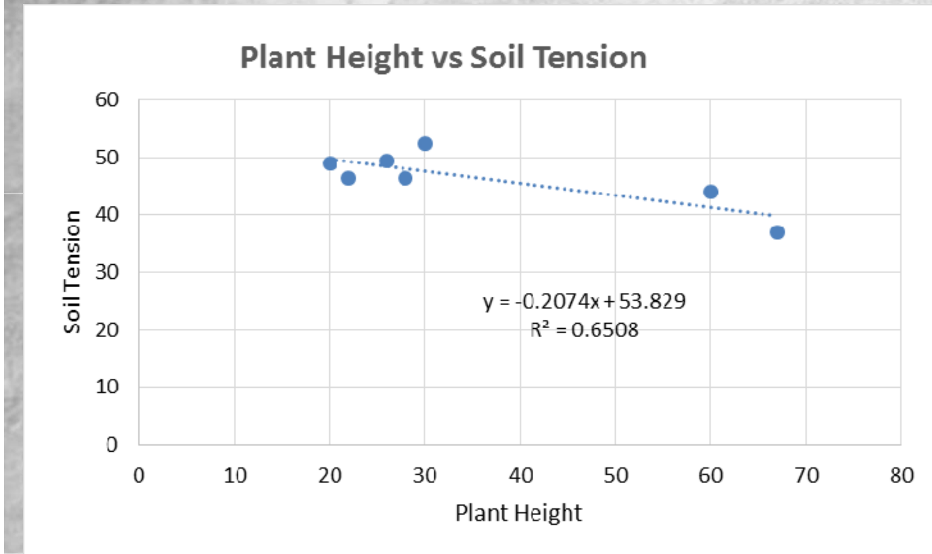
Results – Soil Texture

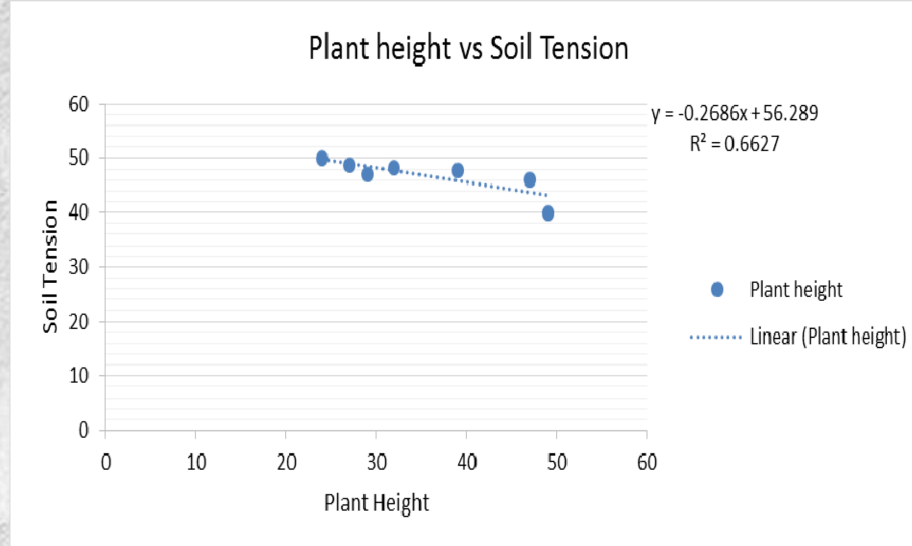


Results – Digital Elevation Model



Results



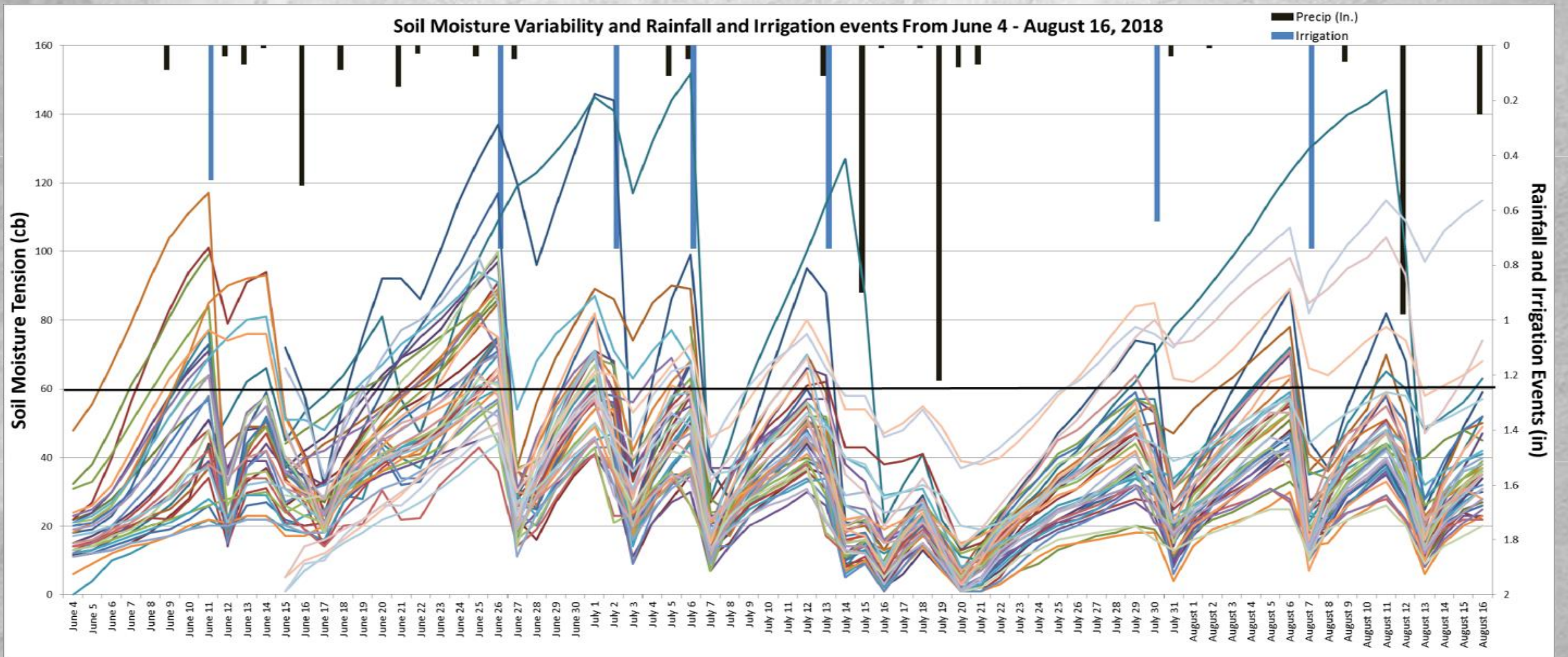


Point 9

Point 40

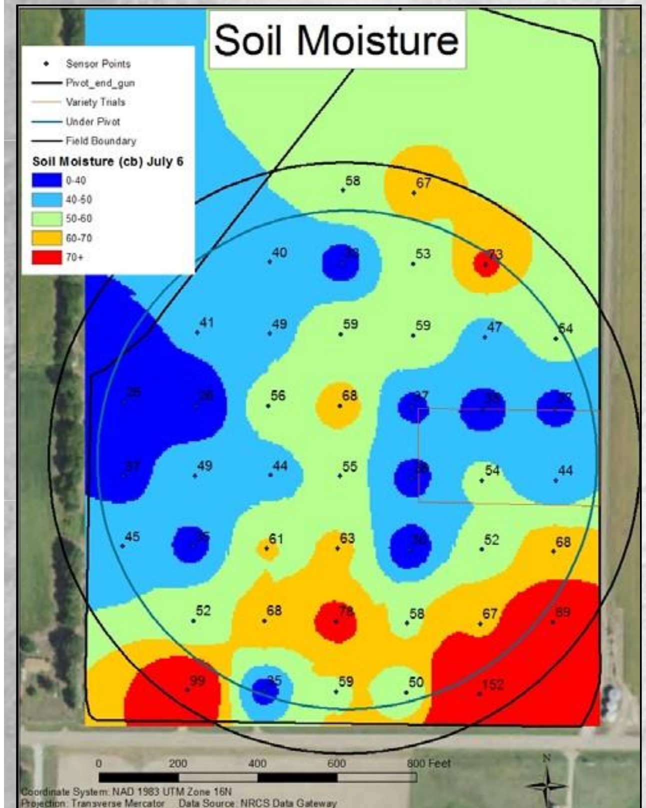
- Preliminary Data shows that Plant Height has the highest correlation to Soil Water Tension when analyzed at different points in the field for days that data for plant height is available.

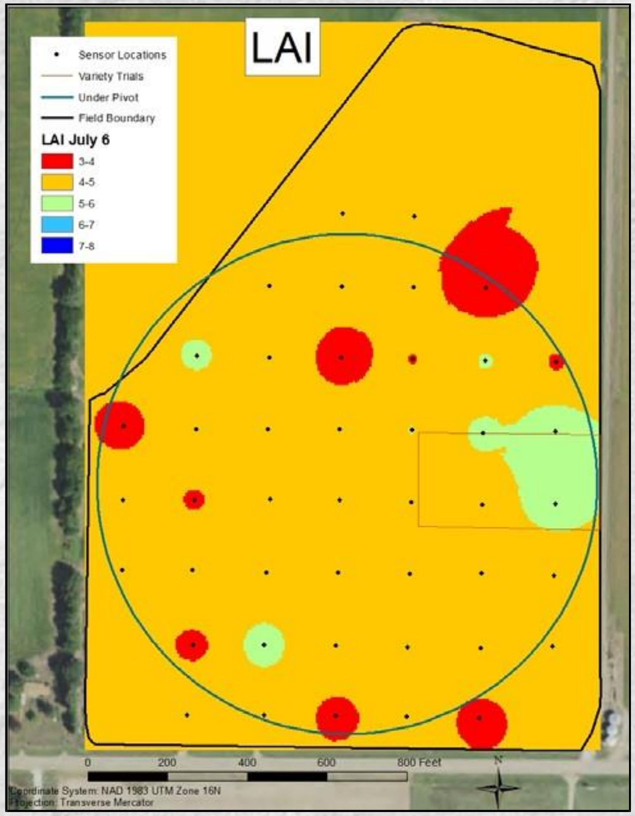
Results

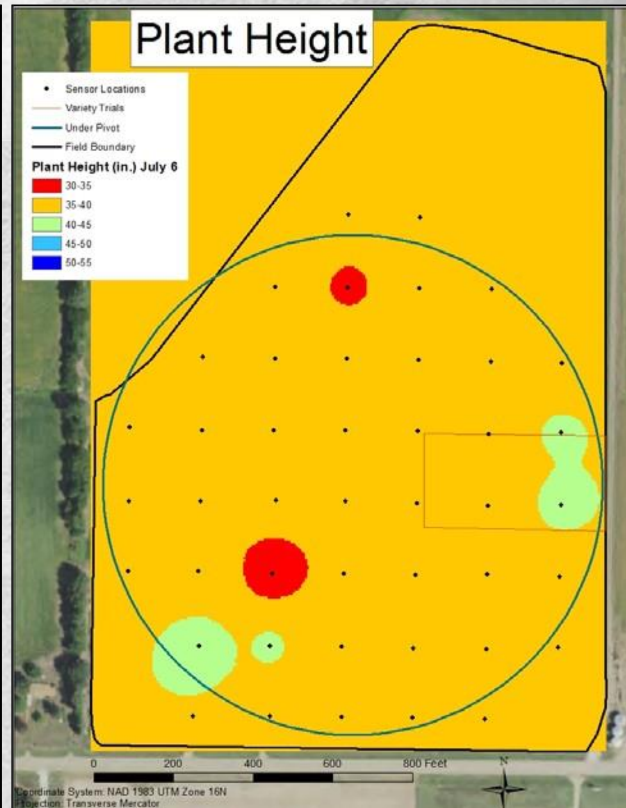


- **Started averaging the 12 and 24 inch sensors on June 15.**
- **July 6 has the largest range/variability across the field. (126 cb)**
- **Applied a season total of 4.83 inches of irrigation and received a total of 10 inches of rain from May 3 to September 19 (Plant date to harvest).**

Results – July 6

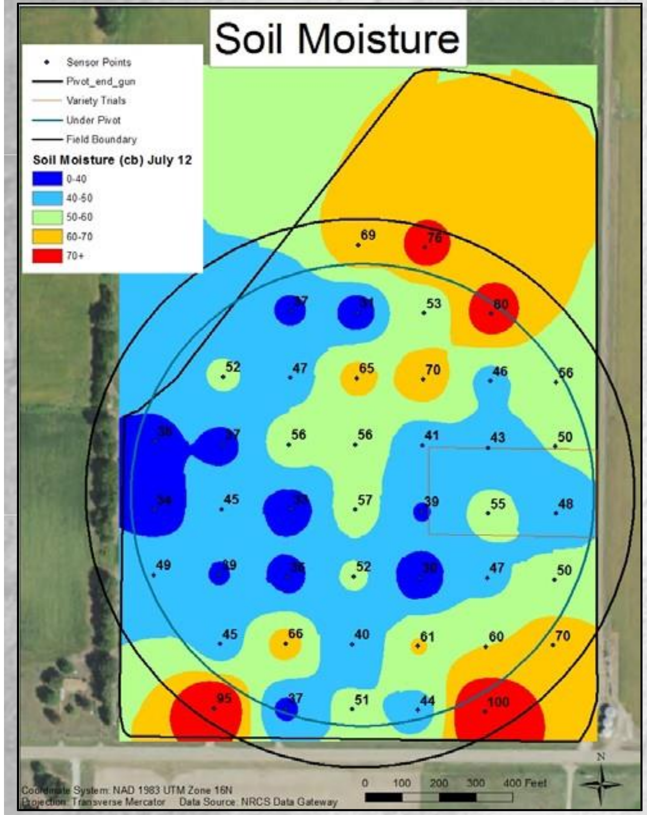


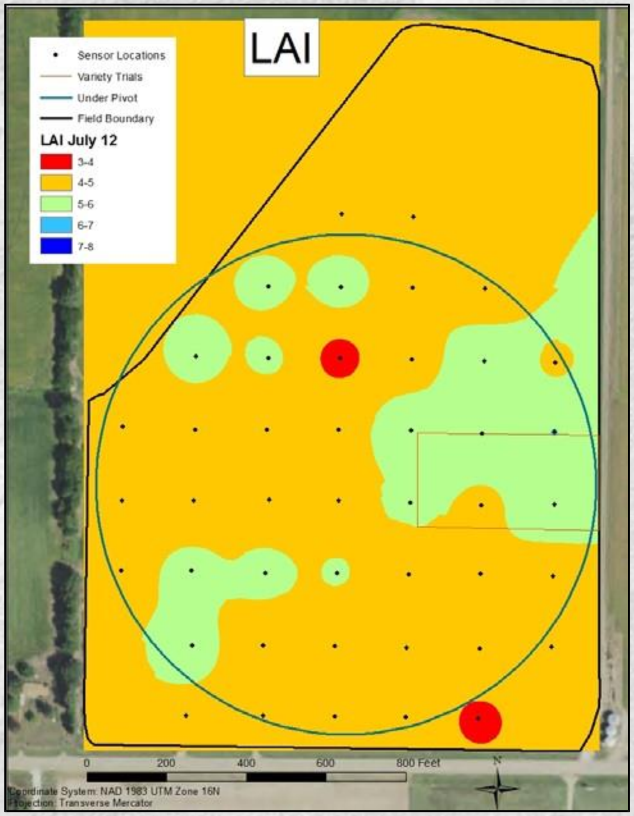


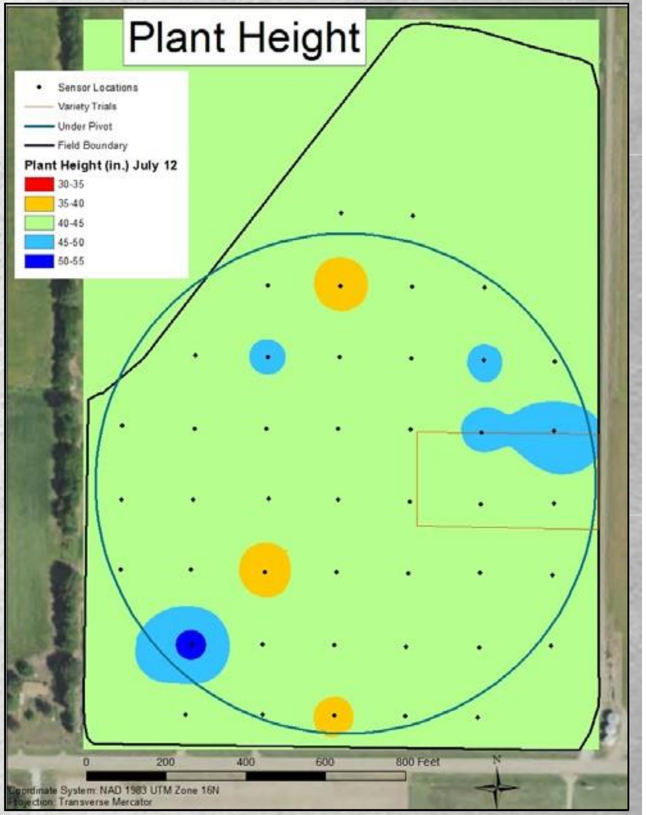


These maps were made using IDW interpolation methods from the data at all 44 point locations.

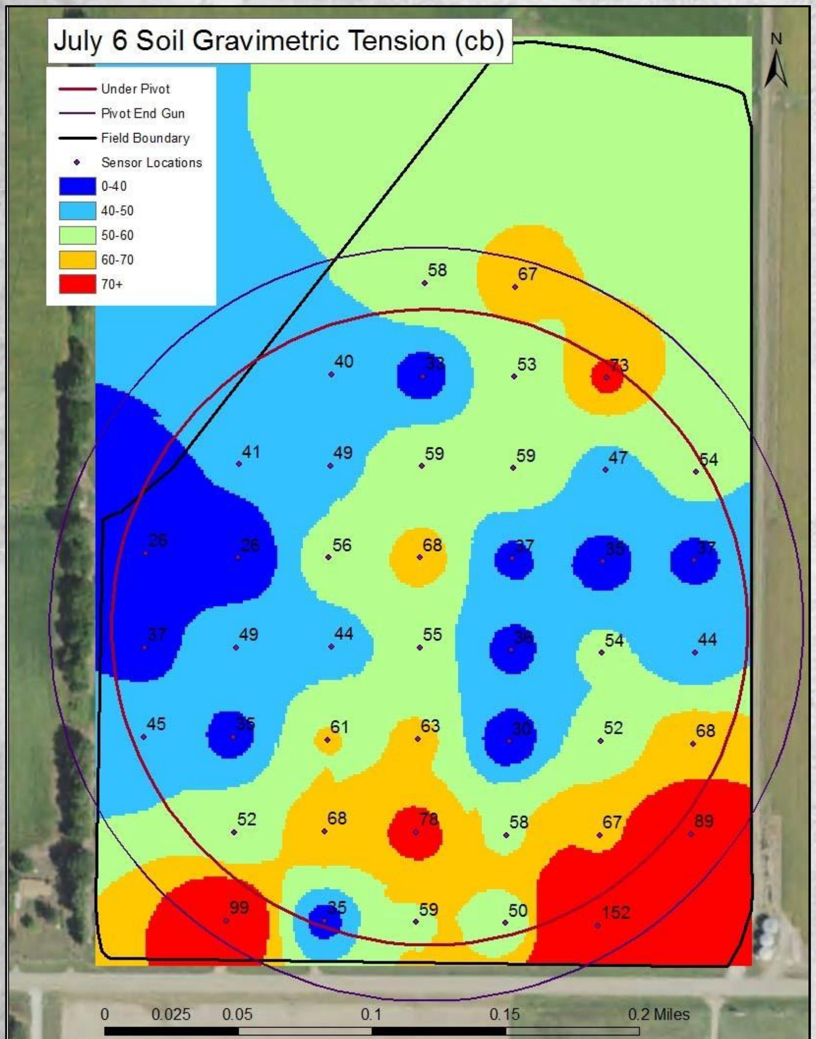
Results – July 12

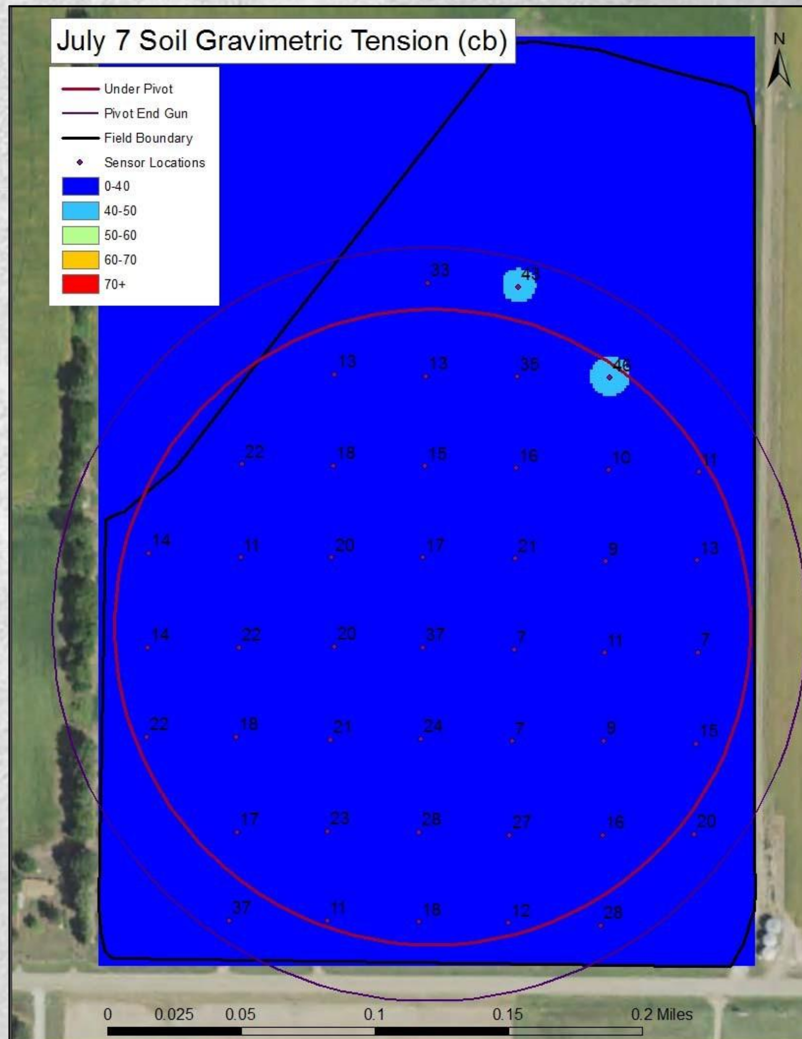






Results - Before and after Irrigation Event on July 6





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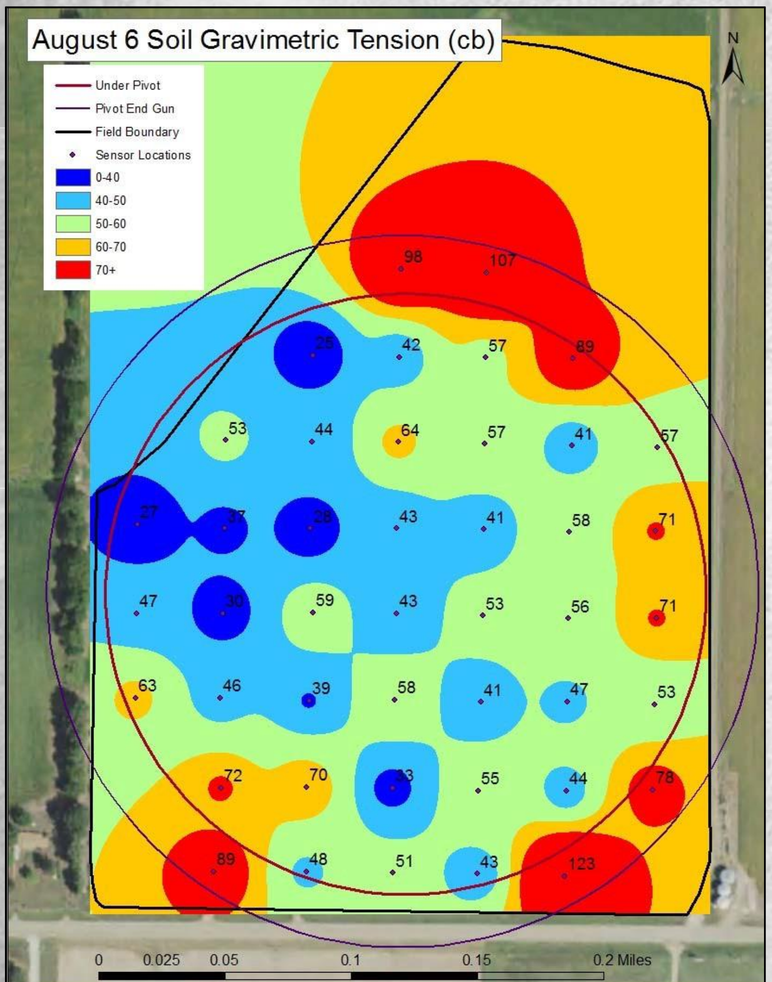
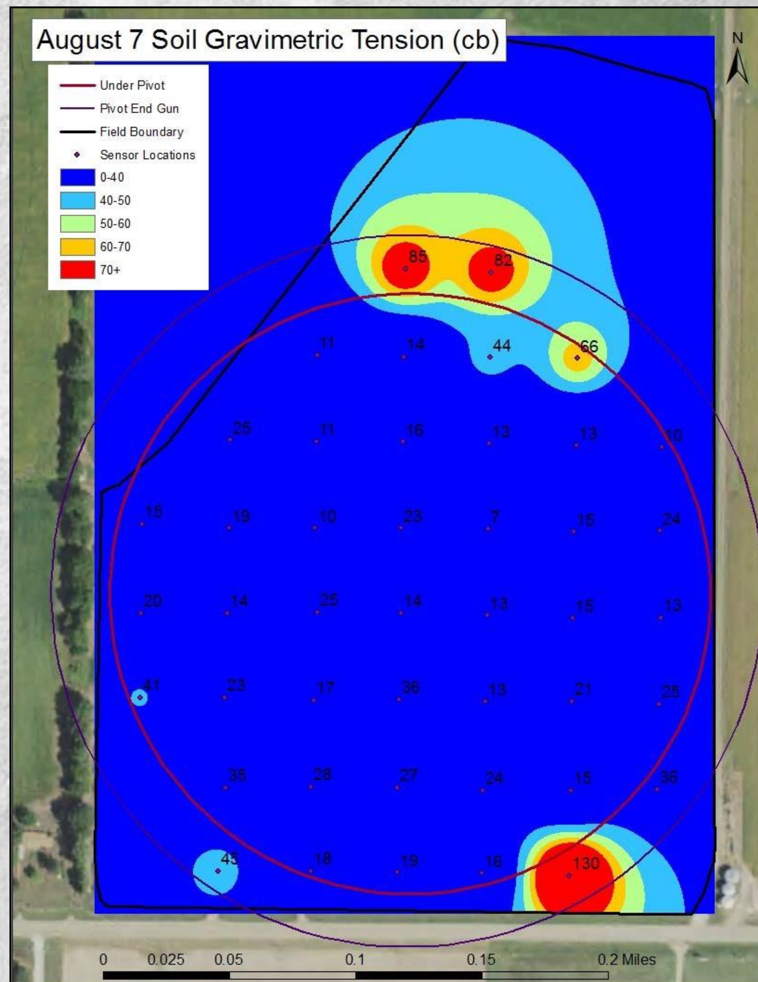
Results – Before and after Irrigation Event on August 6. The average reading across the field is 53 cb.





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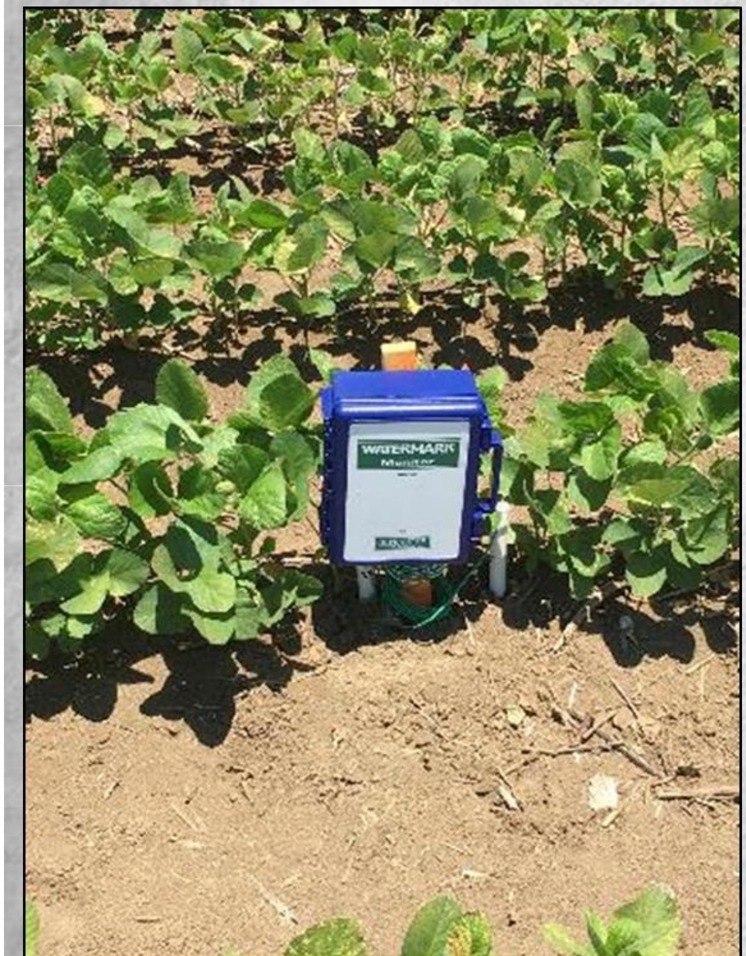
Conclusions

- Of the variables we have measured, preliminary data for year one indicates plant height has the strongest correlation to soil moisture.
- Variability across the field is highest when the field is driest.
- Year one data presents a case for creating site specific management zones and/or implementing precision irrigation.
- Soil moisture variability can occur despite a homogeneous soil type across the field.

Future Work

- Continue monitoring soil moisture
- Correlation of soil moisture with UAV imagery and other variables
- Statistical analysis
- Incorporate DSSAT crop model

Questions?



SIP
Sustainable Irrigation Project

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