Soil Moisture Sensor Data Interpretation and Applications

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Soil Moisture Sensor Placement


Placement and Interpretation of Soil Moisture Sensors for Irrigated Cotton Production in Humid Regions

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RSMM

• Remote Soil Moisture Monitoring

Soil Moisture Status Sensors

Volumetric Measurement

Tensiometric Measurement
Capacitance Sensors

- Oscillator applies frequency between 50 – 150 MHz to electrodes
- Causes resonant frequency in surrounding soil
  - Frequency is function of dielectric constant
  - High soil moisture = low frequency
  - Low soil moisture = high frequency
- Calibration equation
Calibration

Proper calibration required

http://www.sentek.com.au
Capacitance Sensors

- Adcon
- AquaCheck
- Aqua Spy
- Decagon
- Dynamax
- Sentek
- Etc.
Capacitance Sensors

Advantages
• Accurate after calibration
• Respond quickly
• Wide range (wet to very dry)
• Can be used in high salinity environments
• Many choices on the market

Disadvantages
• Soil-specific calibration
• Small sensing distance (0.5 to 0.8 inches)
• Cost compared to tensiometric sensors
• Energy requirements
Tensiometer

- Plastic tube filled with water.
- Ceramic cup at bottom allows tension in water column to equilibrate with soil water tension.
- Water column tension read by gage or pressure sensor.
- Requires regular maintenance.
Granular Matrix Sensors

- Electrodes embedded in granular matrix
- Soil water in soil equilibrates with granular matrix
- Embedded electrodes measure resistance change
  - Wet = low resistance
  - Dry = high resistance
Tensiometric Sensors

Irrometer
- Watermark
- Tensiometers

Decagon
- MPS-2 Dielectric Water Potential
- Tensiometers
Tensiometric (Granular Matrix) Sensors

Advantages
• Simple and inexpensive
• Up to 4 inch sensing distance
• Minimal energy requirements

Disadvantages
• Slower response time
  – Not a factor in irrigation scheduling for agronomic crops
• Less accurate in very wet or very dry soils
• May require temperature compensation
Data Collection – Telemetry

- Manual
- Bluetooth
- Radio link
- Cell modem
- Satellite uplink
Problems with RSMM

• Interpretation of sensor data
  – Setting the correct thresholds for each crop
  – Properly weighting sensor depths correctly

• Acquisition of data
  – Manual (infrequent)
  – Telemetry (usually high cost)

• Overall System Cost

• Intensive management required

• Support of systems
  – Installations/Uninstallations
  – Data
Preparation and Installation

• Tensiometers and Watermarks should be soaked in clean water for approximately 24 hours prior to installation.

• Installation can be completed by a few options:
  – Soil probe or a ½” piece of metal pipe driven into the ground to the proper depth.
  – ⅓” or greater diameter auger
Preparation and Installation

Hazelhurst, GA

Prattville, AL

Florence, SC
Sensor Placement

Legend
ELEVATION
Meters
- 44 - 47
- 48 - 50
- 51 - 52
- 53 - 55

Zone 1: steepest slope and shallowest soil
Zone 2: deep soil well drained
Zone 3: poor drainage in low area & seepage at tow slope

Sensor Sites
Sensor Placement

Legend
FLOW ACCUMULATION
- 0 - 258
- 259 - 1,187
- 1,188 - 3,018
- 3,019 - 6,578
Sensor Placement

ZONES ACCORDING TO MANAGEMENT ZONE ANALYST

Legend
ZONES
- 0 - 1
- 2
- 3
- 4
Soil Moisture Sensor Placement

- The more layers of field data that are available the better.
- Local knowledge of the field helps.
- Higher numbers of sensors and more VRI zones will require higher the level of management.
- Higher resolution on a VRI system and more sensors in the field cost more money.
What to Do With the Data

- There are a few options of how to proceed with soil moisture data (SWT data):
  - Schedule Irrigation
  - Monitor responses to irrigation and rainfall
  - Determine irrigation trigger levels
  - Variable Rate Irrigation

- How do you determine trigger levels
  - Soil type
  - Weighted Averages
  - IrrigatorPro
What to Do With the Data

What to Do With the Data

• Weighted Averages
  – Sensor Depths
  • Crops
    – Cotton
      » 4-6”, 8-12”, 16-24”
    – Corn
      » 8”, 16”, 24”
    – Soybeans
      » 6”, 12”, 18”
    – Peanuts
      » 4”, 8”, 16”
What to Do With the Data

• Weighted Averages
  – Crop maturity and root development

  These are only meant as a guide, you should apply local knowledge to your specific crops.

  – Late Season
    • $0.40 \cdot D_1 + 0.30 \cdot D_2 + 0.30 \cdot D_3$
Soil Moisture Sensor Data Interpretation

[Graph showing soil moisture levels over time with markers for bloom and cracked boll stages.]

<table>
<thead>
<tr>
<th>Soil Type/Texture</th>
<th>Loamy Sand</th>
<th>Sandy Loam</th>
<th>Loam</th>
<th>Silt Loam</th>
<th>Clay Loam</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Saturation</strong></td>
<td>0 to -5</td>
<td>0 to -5</td>
<td>0 to -7.5</td>
<td>0 to -10</td>
<td>0 to -10</td>
</tr>
<tr>
<td>(kPa or cbar)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Field Capacity</strong></td>
<td>-10</td>
<td>-15</td>
<td>-20</td>
<td>-20</td>
<td>-25</td>
</tr>
<tr>
<td>(kPa or cbar)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Irrigation Threshold</strong></td>
<td>-25 to -30</td>
<td>-30 to -40</td>
<td>-35 to -50</td>
<td>-40 to -60</td>
<td>-60 to -80</td>
</tr>
</tbody>
</table>
Soil Moisture Sensor Data Interpretation

1. Events used to determine Field Capacity at 29%
2. Irrigation Threshold determined by subtracting 50% of AWHC from Field Capacity (29% - 10% = 19% for a silt loam soil)
3. Deeper sensors starting to show depletion when irrigation is initiated
4. Rate of Crop Water Use starting to decline
5. Crop Water Use equals irrigation and Rainfall (WFC stabilizes)

Bloom

Ave Sensors • Field Capacity • Irrigate Low • Rain • Irrigation


Cracked Bell
Data Interpretation

- Select upper and lower thresholds of PAW
  - Either through soil testing or in-season observations
Questions??
Irrigation Timing and Frequency

Node 3 - Camilla Lat UGA SSA

Irrigation (I) or Rainfall (R)
Irrigation Timing and Frequency

Node 17 - Camilla Lat UGA Dryland

Irrigation (I) or Rainfall (R)
Irrigation Timing and Frequency

Node 17 - Camilla Lat UGA Dryland

Irrigation (I) or Rainfall (R)

Soil Water Tension (kPa)

UGA extension | extension.uga.edu | 1-800-ASK-UGA1
Irrigation Timing and Frequency

Node 7 - Camilla Lat UF peanut Farm

Soil Water Tension (kPa)

Irrigation (I) or Rainfall (R)

UGA extension
extension.uga.edu | 1-800-ASK-UGA1
Sensor Based Irrigation Management

Node 1 - Suziblue

Soil Water Tension (kPa)

08 May 15 May 22 May 29 May 05 Jun 12 Jun 19 Jun 26 Jun

Sensor at 4in
Sensor at 8in
Sensor at 12in

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extension.uga.edu  1-800-ASK-UGA1
Sensor Based Irrigation Management

Node 4 - Suziblue

Soil Water Tension (kPa)

- Sensor at 4in
- Sensor at 8in
- Sensor at 12in

29 May | 05 Jun | 12 Jun | 19 Jun | 26 Jun | 03 Jul | 10 Jul | 17 Jul
Sensor Based Irrigation Management

Node 7 - SuziBlue

Soil Water Tension (kPa)

01 May  08 May  15 May  22 May  29 May  06 Jun  12 Jun  19 Jun  26 Jun  03 Jul

- Sensor at 4in
- Sensor at 8in
- Sensor at 12in
Sensor Based Irrigation Management

Was the sensor used to schedule irrigation in this case?

Node 9

- Sensor at 8in
- Sensor at 16in
- Sensor at 24in

Soil Water Tension (kPa)

UGA extension

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