What Lies Beneath: Soil Moisture Tools for Measuring and Managing

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WHY THIS MATTERS

- In many cropping systems, water is the most yield limiting factor.
- Good water management will maximize yields and minimize the potential for pollution.
- Cascading effects of poor water management on N management.
STUFF YOU NEED TO KNOW

- All agronomy is site specific!
- Saturation
- Field Capacity
- Permanent Wilting Point
- Relationship between soil water tension and volumetric water content
SITE SPECIFIC?

Credit: Colorado State Extension
SATURATION, FIELD CAPACITY & VWC

- Saturated soil is subject to gravitational drainage
- Field Capacity is when gravitational drainage stops
- VWC varies according to pore size

TENSION AND VWC

Different soils have different characteristic curves

Brady and Weil, 2002
WHAT DOES VWC REALLY MEAN?

- Tension is a measure of how hard the plant has to work to extract water from soil.
- VWC is a % so it’s the same for Metric and SAE.
- .07 inch $H_2O$/inch soil = 2.52 inches water in 36 inch soil profile.
IN MN SOILS?

Plant available water between FC and PWP to 3ft:
- Hubbard: 3.58in
- Barnes: 8.64in
- Forman: 8.82in

Irrigation typically starts at 50% depletion
Ok. The book learning is over. Now its time to talk about the practical implications.
ASK THE APPROPRIATE QUESTION

- What are you using soil moisture data for?
- When do I need to turn the irrigation system on?
- When do I stop irrigation?
- Do I need to raise or lower stop logs?
Menahga Profile

<table>
<thead>
<tr>
<th>Texture</th>
<th>AWHC (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loamy Sand</td>
<td>0.54</td>
</tr>
<tr>
<td>Sand</td>
<td>0.42</td>
</tr>
<tr>
<td>Coarse Sand</td>
<td>0.49</td>
</tr>
<tr>
<td>Coarse Sand</td>
<td>0.28</td>
</tr>
<tr>
<td>Coarse Sand</td>
<td>0.16</td>
</tr>
</tbody>
</table>

18 in AWHC = 1.4 in
30 in AWHC = 1.9 in
ROOTS ARE NOT DISTRIBUTED EVENLY

% Seasonal Water Use

Soil Depth

- 0-6"  47
- 6-12"  24
- 12-18" 13
- 18-24"  7
- 24-30"  6
- 30-36"  3

Stone and Gordon, 1985
You Do Not Understand Something Until You Can Explain It Mathematically
PICKING A SENSOR

- As cost increases, so does accuracy and power.
- The more water you can store in the soil, the more accuracy and power matters.
SOIL WATER TENSION SENSORS

Watermark correlates electrical resistance to matric potential. $40

Tensiometer physically measure matric potential. $70
TDR AND CAPACITANCE SENSORS

- Both correlate with volumetric water content.
- Both are going to be expensive $300-3000 depending on configuration.
IF IT DON’T FIT TIGHT.....

- ....It don’t fit right.
- This is true for every soil moisture sensor.
- Oversize bore holes are to be avoided
- Slurry installations should only be used when you have very uniform soil profiles
TELEMETRY AND SOIL MOISTURE

- This is the future
- You can purchase systems outright or lease.
- Don’t miss the opportunity to bring in weather data.
How many sensors do I need?

HOW MANY CAN YOU AFFORD?
UNDERSTAND VARIABILITY BEFORE INSTALLATION

- Web Soil Survey
- Electromagnetic Induction mapping
- Yield Maps
- A shovel

Anderson Kriged EM38 Data
SOIL WATER AND YIELD

\[ y = 1.4307x^2 + 47.885x - 133.71 \]

\[ R^2 = 0.5979 \]
Is this right?

SOME PAST EXPERIENCES AND TIPS FOR SUCCESS
LOGGED DATA VS OBSERVATIONS

- Logged data lets you see trend lines as the data is collected over time.
- Allows troubleshooting
- Better ability to monitor crop developments
- Cost ~ $0.50-20/acre

- Extremely Flexible, great way to add value to the services
- You need a site specific calibration.
- Extremely low per acre cost, but this takes time and money to travel to sites.
- Cost ~ Time
SITE CALIBRATION FOR OBSERVATIONS

- Completely saturate area and then allow it to drain.
- Sand ~ 24 hours
- Loam ~ 3-4 days
- FC reading can then be used to calculate % depletion
MONITOR AT LEAST 2 DEPTHS

- 6 and 18 inches if nothing else
- Do not expect to see the deep sensor move much until late in the season
SOIL MOISTURE DATA IS UGLY
STRAIGHT LINES ARE BAD
HABITS ARE HARD TO BREAK
USE ALL YOUR RESOURCES!

- Local weather data
- Rain Gauge
- Keep up a soil water balance
Questions?