Using Soil Sensor Data to Manage Your Fields More Efficiently

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Knowing Your Soil - Why is it Important?

Hard to have healthy turfgrass without understanding what's below the surface

What's your soil texture?

- Native soil field
- Sand-based field
- Amended field

Common practices we already do - Soil test

- pH level
- CEC
- Nutrient defeciences
- Etc..

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What Don't we Know?

Variables that change daily

- Temperature
- Moisture (VWC %)
- Salinity (EC)

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Anyone using soil sensors to monitor soil activity?

Technology is improving

- Maintenance equipment
- Chemicals
- Fertilizers
- Data collection
- These things can help if we use the correctly

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Soil Sensors History

- First tensiometer was developed around 1920 by Lorenzo A. Richards
  - He helped define "field capacity" and "permanent wilting point"
- Field Capacity: The amount of soil moisture or water content held in the soil after excess water has drained away and the rate of downward movement has decreased.
- Permanent Wilting Point: The minimum amount of water in the soil that the plant requires not to wilt.

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Soil Sensor Technology

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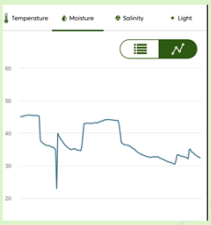
What Does a Soil Sensor Measure?

- Moisture (VWC %)
- Temperature
- Salinity (EC)
- Light (some models)



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Different Types of Sensors

- Portable Sensors
  - Pogo
  - Field Scout TDR
  - HydraGO
  - Turf-Tec Digital Sensor
- Permanent or Installed
  - SGL Turfpod
  - Spiio
  - Toro Precision Soil Sensor
- Note: These are not all the sensors on the market

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Portable Handheld Sensors

Pros

- Don't have to install in-ground – Portable
- Can check multiple spots on a field, or multiple fields
- Data can be easily recorded to app and/or gps map
- Multiple users can access and see real time data
- Easy to use

Cons

- Must be onsite – no remote data*
- Can be time consuming for multiple fields

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Portable Handheld Sensors

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Portable Handheld Sensors

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Permanent and Semi-Permanent

Pros

- Never have to move, always have data
- Monitor multiple fields at once
  - Great for multi-field facilities
- Data can be monitored and recorded off site
- Multiple users can access and see real time data

Cons

- Must dig up to move or replace
- Always monitoring same spots
- Need multiple sensors for each field
- Must remove or avoid when aerifying or re-sodding
- Cost – if buying multiple sensors

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Permanent and Semi-Permanent

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Permanent or Installed

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Depths For Measurement

- Ideally 2"-3" in soil
- 85% of moisture and salinity occur at this depth
- Depth of most root mass
- Different length rods

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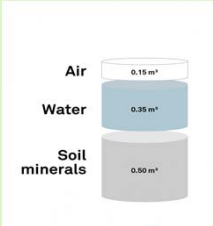
Measuring Moisture

Soil moisture sensors measure the "volumetric water content" (VWC) of the soil	Quantity of water on a volume basis compared to total volume of soil
Easier terms: the water stored in the soil profile	The VWC of this image would be 35%



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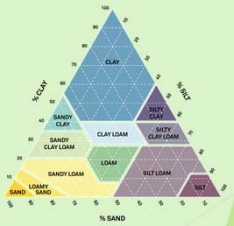
How Do We Use Moisture Data?

- Must know your soil type
- Different soil textures will have different % of field capacity and permanent wilting points
- Find "FC" and "PWP" limits to use as a baseline



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How Do We Use Moisture Data?

Field Capacity

- 15-20% in sandy soils
- 35-45% for loam soils
- 45-55% in clay soils

Permanent Wilting Point

- 5-10% sandy soils
- 10-15% in loam soils
- 15-20% in clay soils

- UNC Anderson Stadium: 20-year-old field – Silty loam soil
  - FC - 50+%
  - PWP - 10-15%
- UNC Dorrance Stadium: 3-year-old sand-based field
  - FC - 25%
  - PWP – 8%

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Irrigating Based off Data

Still need to consider all factors you normally would

- No technology can take away what a STM sees and feels
- What type of grass
- Current temperatures
  - evapotranspiration rate
  - When has it/will it rain again

Example:

- FC 25%
- PWP 8%
- Target moisture 16-17%
- When to irrigate?
  - +/- 10%
  - Figure out how much water will get you back to 16-17%

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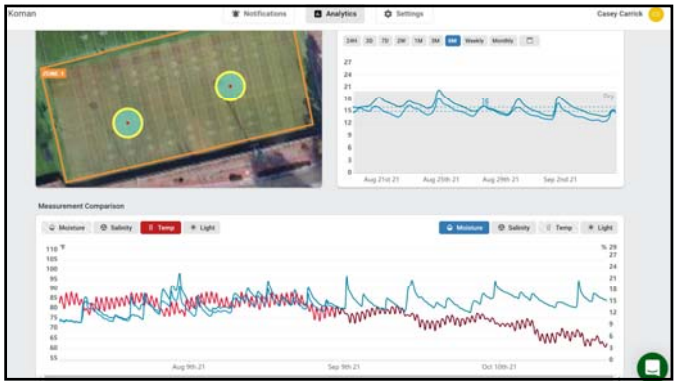

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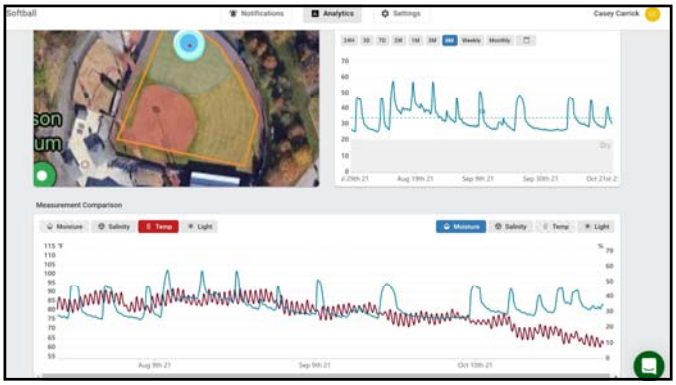

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Irrigating Based off Data

May take a few irrigation cycles and adjustments to figure out desired amount of water to apply

Monitor data after irrigation cycle or rain

How long does it take to drop back to PWP

Time to PWP will vary from field-to-field

Each field may need a different irrigation plan

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Irrigating based off Data

Cost Savings

- Irrigating more efficiently will save $$
- Most of us probably OVER WATER!
- Saving will vary from field to field
  - Cost of water
  - Potable/Reclaimed/Recaptured
- No matter the source, reducing water inputs is a good thing.

Improved Turf Quality

- Improved irrigation practices will help keep a more consistent moisture level
- Not to wet/not to dry
  - Improved playability
- Less frequent – push roots
  - Healthier plant overall

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Educating Decision makers

- Who makes decision about field playability
- Coaches, Administrators, Sports turf managers, etc…?
- Providing real time data can help influence decisions
- If its known field is too wet at 45% VWC, then sensor readings can help back up recommendations.

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Measuring Temperature

- Temperature readings may vary depending on sensor
  - Surface temps
  - In-ground temps
- Surface temp will be different than 2"-3" inches in soil
- Knowing temperature is great, but what to do with it?
- Type of grass?
  - Cool season
  - Warm season
- Chemical applications
- Fertilizer longevity

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Temperature – Cool Season Grasses

20°F Low temperature kill possible
33°F Root growth ceases
40°F Shoot growth ceases
50-65°F Optimum temperature for root growth
60-75°F Optimum temperature for shoot growth
70°F Time to seed in late summer/early fall
70°F Maximum temperature for root growth of any consequence
77°F Root growth ceases
90°F Shoot growth ceases

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Temperature – Warm Season Grasses

25°F Low temperature kill possible
50°F Initiation of dormancy occurs resulting in discoloration
50°F Chilling injury resulting in discoloration is possible
50°F Root growth begins to slow below this temperature
64°F Expected spring root decline is triggered and roots turn brown and die within 1 or 2 days
74°F Optimum time to overseed bermudagrass with ryegrass in the fall.
75-85°F Optimum root growth
80-90°F Optimum shoot growth
120°F Shoot growth ceases

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Temperature
Weed Control

- Base pre-emergent applications off soil temperature
- 53-58°F Germination of crabgrass
- 60-65°F Germination of spurge and goosegrass

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Temperature
Fungicide Applications

- Spring Dead Spot
  - Application must be done in preventatively in fall
  - Most effective when soil temperatures are between 60 and 80°F.

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Monitoring Temperature

- Important to monitor temperature under blankets
- Cool season grasses can get too hot
- Warm season grasses going dormant?
- Temps can vary +/- 10°F

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Electrical Conductivity (EC)

- Sensors have EC to help adjust moisture levels. Higher EC can give artificial moisture numbers
- EC measures salinity of the soil
- Salinity problems can be difficult to diagnose
- High soluble salts can reduce water intake by plant roots
- Soluble salts typically consist of carbonates, bicarbonates, sulfates, chlorides, and nitrates
- Does everyone need to worry about salinity?

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Electrical Conductivity (EC) Issues

- Insufficient rainfall
  - Buildup of salts
- Coastal areas
- Poor quality irrigation water
  - Reclaimed water
  - Effluent water

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Electrical Conductivity (EC) – Charts

FS	SME	FS	SME	FS	SME
0.1	1.1	1.1	3.8	2.1	6.5
0.2	1.3	1.2	4.0	2.2	6.7
0.3	1.6	1.3	4.3	2.3	7.0
0.4	1.9	1.4	4.6	2.4	7.3
0.5	2.2	1.5	4.9	2.5	7.6
0.6	2.4	1.6	5.1	2.6	7.8
0.7	2.7	1.7	5.4	2.7	8.1
0.8	3.0	1.8	5.7	2.8	8.4
0.9	3.2	1.9	5.9	2.9	8.6
1.0	3.5	2.0	6.2	3.0	8.9

Table 1: Conversion from Field Scout direct readings (**FS**) to equivalent Saturated Media Extract (**SME**) values. (Reference #3. PACE Turfgrass Research Institute. San Diego, CA)

Sensitive < 3 mS/cm	Moderately Sensitive 3 - 6 mS/cm	Moderately Tolerant 6 - 10 mS/cm	Tolerant >10 mS/cm
Annual Bluegrass	Annual Ryegrass	Bent or Seaside	Alkaligrass
Colonial Bluegrass	Chewings Fescue	Perennial Ryegrass	Bermudagrass
Kentucky Bluegrass	Creeping Bentgrass	Tall Fescue	Seashore Paspalum
Rough Bluegrass	Hard Fescue	Buffalograss	St. Augustine-grass
Centipedegrass	Bahiagrass	Zoysiagrass	

Table 2. Relative tolerance of turfgrasses to soil salinity measured by the SME Method ("Salinity in Turfgrass", Harivandi M.A, Butler J.D., Lin W. 1992).

Note: The values on this table refer to measurement of a saturated media extract (SME) . Use table 1 to convert from direct-insert readings to SME.

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Electrical Conductivity (EC)

- Flushing salts
  - Plenty of products to help flush salts and lower EC levels
  - Wetting agents
  - Calcium products
  - Pray for rain!

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Infield Skin Moisture?

- Can infield skin moisture be measured?
  - Absolutely!
- Not aware of a many sports turf managers doing it regularly
- Same variables as measuring soil moisture
  - Type of clay
  - Climate, wind, rain etc…

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Infield Skin Moisture

- Find % VWC that's too wet
- Find % VWC that infield plays the most constant at
- Use those % to help make decisions
- Every field will be different

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Key Takeaways

- Technology is always improving
  - Monitor things we couldn't in the past
  - If used correctly it can help simplify STM's jobs
  - Use data to make educated decisions
  - Save $$
  - Improve quality of our playing surfaces

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Questions?

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