Rapid Detection of Drought Stress Using Field Radiometry for High Throughput Screening

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My typical role as Extension Turfgrass Pathologist
Ph.D. Focus

- Expanding the application of spectral reflectance measurements in turfgrass systems
- Hyperspectral radiometry
- Reflectance mapping
- Early onset stress detection
Relationship between vegetation indices and water availability

<table>
<thead>
<tr>
<th>Index</th>
<th>Total Chlorophyll</th>
<th>Tissue Water Content</th>
<th>Soil Water Content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
<td>Trial 2</td>
<td>Trial 1</td>
</tr>
<tr>
<td>NDVI</td>
<td>0.63</td>
<td>0.65</td>
<td>0.54</td>
</tr>
<tr>
<td>GRI</td>
<td>0.49</td>
<td>0.67</td>
<td>NS</td>
</tr>
<tr>
<td>WBI</td>
<td>0.69</td>
<td>0.85</td>
<td>0.52</td>
</tr>
</tbody>
</table>

(McCall et al., 2017)
Research Objectives

1. Determine whether vegetation indices (NDVI, GRI, and WBI) can objectively estimate moisture stress by grass species (creeping bentgrass and hybrid bermudagrass) in varying soil textures (USGA 90:10 sand, sand loam, clay) and).

2. Investigate vegetation indices as early predictors of moisture stress compared to visual symptom development of bent and bermudagrass in varying soil textures.
Experimental Design: 2x3 Factorial

Grasses
- ‘007’ creeping bentgrass
- ‘Latitude 36’ hybrid bermudagrass

Soils
- USGA 90:10 sand/peat
- Sand loam
- Clay
Greenhouse Study

- Six dry-down cycles (rep)
- Treatments Saturated
  - 2-10 min cycles of water (0.2 gal/min)
- Fan: 5-7 MPH
- Data Collection: 7am - 7pm
Volumetric Water Content (VWC)
Light Reflectance

- Spectral Evolution PSR-1100F
  - 350 - 1100 nm spectral range
  - 1.4 nm bandwidth

- Contact probe - 2.5 cm lens

- BaSO\textsuperscript{4} white reference calibration
Data collection over time

\[ R^2 = 0.67 \]
Hours after initiation (HAI) to reach inflection point (IP) using 4PL regression

P = 0.0010
Index Comparison:
WBI and Green/Red more closely related to volumetric water content than NDVI

<table>
<thead>
<tr>
<th>Vegetation Index</th>
<th>R value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBI</td>
<td>.6233</td>
</tr>
<tr>
<td>GRVI</td>
<td>.5566</td>
</tr>
<tr>
<td>NDVI</td>
<td>.4726</td>
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<tbody>
<tr>
<td>WBI</td>
<td>.80</td>
<td>81</td>
</tr>
<tr>
<td>GRVI</td>
<td>.73</td>
<td>.50</td>
</tr>
<tr>
<td>NDVI</td>
<td>.49</td>
<td>NS</td>
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</tbody>
</table>
Hours after initiation (HAI) to reach inflection point (IP) using 4PL regression
### Table

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<thead>
<tr>
<th></th>
<th>HAI</th>
<th>WBI</th>
<th>NDVI</th>
<th>GRVI</th>
<th>VWC</th>
<th>Wilt %</th>
<th>Turf quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAI</td>
<td>1.000</td>
<td>-0.7721</td>
<td>-0.7639</td>
<td>-0.7818</td>
<td>-0.7771</td>
<td>0.8310</td>
<td>-0.5897</td>
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<tr>
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<td>-0.7721</td>
<td>1.0000</td>
<td>0.8277</td>
<td>0.8907</td>
<td>0.6233</td>
<td>-0.9152</td>
<td>0.6569</td>
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<td>1.0000</td>
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<td>0.4532</td>
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<td>0.8310</td>
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<td>-0.6571</td>
<td>1.0000</td>
<td>-0.6800</td>
</tr>
</tbody>
</table>

### Graph

- **Bent Sand WBI**: $r = 0.86$
- **Bent Sand Wilt %**: $r = 0.90$
Water Band x Wilt %

0% 100%

1.034 1.009 0.98 0.958 0.906
Translation to high throughput phenotyping

- G:R Ratio shown as a good estimator
  - Cost effective
- Ground validation with few points
  - In-ground TDR
  - Field radiometry

- Collaboration with Scotts ProVista Breeding Program & TurfScout, LLC.
Line variability using the Green:Red vegetation index

June

- 1.1 - 1.2
- 1.3
- 1.4
- 1.5
- 1.5 - 1.7

September

- 0.0 - 1.3
- 1.4
- 1.5
- 1.6
- 1.7 - 1.8
Acknowledgements

Funding Sources:

Collaborators: