Evaluation of Evapotranspiration-Based and Soil Moisture Based Irrigation Control in Turf

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Objectives

• Compare two general types of commercially available irrigation control technologies
• Compare water use and turf quality between technologies and three irrigation frequencies
• Contrast new technologies against standard controller with rain switch
“Add-on” Sensor Device (1 setpoint)

Senses soil moisture and temperature

Allows irrigation if soil moisture is below threshold value (one setpoint system)
On-Demand Sensor system

• Irrigates to maintain soil-moisture level between 2 setpoints (on/off)
• User-defined time restrictions may be added
Sprinkler precipitation rate, crop type, watering days

ET Controllers

Zone(s) run time
Can have multiple programs
Experimental Design and Plot Layout 2007-2009
Inches Applied 20 weeks, 2007

- Sensor add-on
- Sensor on-demand
- ET
- Reference ET
- Total Rain 11.43 in.
Sensor add-on

Sensor on-demand

ET

Timer

effective rainfall

Inches Applied 23 weeks, 2008

Applied Water 2008

Total Rain 24.82 in.
Inches Applied 13 weeks, 2009

Sensor add-on (missing data-lightning)

Sensor on-demand

ET

Timer

effective rainfall

Reference ET

Total Rain
9.87 in.
## Average Weekly Applied Water, inches all years (2007-2009)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Frequency</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Weekly</td>
<td>Bi-weekly</td>
</tr>
<tr>
<td>On-Demand Sensor</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Add-on Sensor</td>
<td>0.3904</td>
<td>0.5477</td>
</tr>
<tr>
<td>ET controller</td>
<td>0.7862</td>
<td>0.9803</td>
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<tr>
<td>Timer</td>
<td>0.9029</td>
<td>0.7685</td>
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<tr>
<td>Average</td>
<td>0.6931 A</td>
<td>0.7665 B</td>
</tr>
</tbody>
</table>

Values with same letter are not statistically different at 95% confidence level.

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<tr>
<td>On-Demand Sensor</td>
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<tr>
<td>Add-on Sensor</td>
<td>6.85</td>
<td>6.70</td>
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<td>ET controller</td>
<td>6.75</td>
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<tr>
<td>Timer</td>
<td>6.51</td>
<td>6.67</td>
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<tr>
<td>Average</td>
<td>6.71 A</td>
<td>6.78 A</td>
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</tbody>
</table>

Note: Does not include 2007 drought year in which turf quality differences were most variable
# Average Weekly Turf Quality, NDVI 2008-2009

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<tr>
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<td>Bi-weekly</td>
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<tr>
<td>On-Demand Sensor</td>
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<tr>
<td>Add-on Sensor</td>
<td>0.711</td>
<td>0.707</td>
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<tr>
<td>ET controller</td>
<td>0.707</td>
<td>0.711</td>
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<tr>
<td>Timer</td>
<td>0.701</td>
<td>0.707</td>
</tr>
<tr>
<td>Average</td>
<td>0.706 A</td>
<td>0.708 A</td>
</tr>
</tbody>
</table>

Note: Does not include 2007 drought year in which turf quality differences were most variable
Average Weekly Turf Quality, DGCI 2008-2009*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Weekly</th>
<th>Bi-weekly</th>
<th>Daily</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-Demand Sensor</td>
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<td>---</td>
<td>0.415 A</td>
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<tr>
<td>Add-on Sensor</td>
<td>0.410</td>
<td>0.401</td>
<td>0.366</td>
<td>0.392 B</td>
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<tr>
<td>ET controller</td>
<td>0.396</td>
<td>0.396</td>
<td>0.400</td>
<td>0.397 B</td>
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<tr>
<td>Timer</td>
<td>0.390</td>
<td>0.394</td>
<td>0.398</td>
<td>0.394 B</td>
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<tr>
<td>Average</td>
<td>0.399 A</td>
<td>0.397 A</td>
<td>0.388 A</td>
<td></td>
</tr>
</tbody>
</table>

* only 6/19 weeks of data in 2008

Note: Does not include 2007 drought year in which turf quality differences were most variable
12.81 in. (325 mm) applied
9.91 in. (252 mm) applied
Acclima RS500 Bi-weekly

9.91 in. (252 mm) applied
Acclima On-Demand

8.96 in. (228 mm) applied

2009
Estimated Water Requirements

2007  23.89 in. / 20 weeks  
2008  22.78 in. / 23 weeks  
2009  14.45 in.* / 16 weeks  

2007  26.06 in. / 20 weeks  
2008  22.70 in. / 23 weeks  
2009  17.91 in. / 16 weeks  

Atmometer

ET Weather Station
The main Research Objectives are:

- Evaluation of turf color quality, using digital image analysis under different irrigation treatments;

- Compare digital image analysis (DIA) with other techniques in evaluating turf quality;

Why digital imagery?

- Digital images can be nondestructive,
- Rapid, cost-effective,
- Reproducible,
- Objective
All images were taken by using a black light box to ensure a constant light intensity over all images and prevent any changes in light due to shadows or cloudy weather.
DIA process to evaluate the turf color quality was taken place by:

1- Acquiring digital images by appropriate digital camera in jpeg format.
2- Obtaining the RGB for all pixels using appropriate software.
3- Converting the RGB levels into Hue, saturation and brightness HSB parameters.
4- Creating a direct color index from the HSB values known as dark green color index (DCGI) (Karcher and Richardson. 2003).

Each image presents 0.55 percent of the plot area.

Five images per plot within middle region

Samples were taken once a week during a period of 15 weeks starting on 7th of May through 11th of August 2009.
The relationship between DGCI and other turf quality indicators

Turf Color Quality Results 2009

- Visual Rating: $R^2 = 0.7084$
- NDVI: $R^2 = 0.7142$
- Delta T: $R^2 = 0.0485$
2009 Visual Ratings

Acceptable >=6

Week Number
Preliminary Results

Turf quality 2009

Frequency

DGCI

Week

0.440
0.420
0.400
0.380
0.360
0.340
0.320
0.300

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

on-demand 1x 2x 7x
Outreach

Catawba River Basin Project

Irrigation Contractor Training

Town of Cary Project
Comparison of Smart-Irrigation Technologies in Warm and Cool Season Turf (2009-2011)

Garry Grabow, BAE
Daniel Bowman, Crop Science
Rodney Huffman, BAE
Grady Miller, Crop Science
Treatments

• Two Turfgrass types
  • Cool-season (Tall Fescue)
  • Warm-season (Zoysia)

• Five Technologies (both in warm and cool-season)
  • Toro Intellisense
  • Weathermatic (new to study)
  • Hunter Solar Sync (new to study)
  • Acclima RS500 SCX (add-on)
  • Acclima 3500 (on-demand)

All at twice-a-week frequency except on-demand
Experimental Design

Lake Wheeler Road

Fescue

Proposed Sensors

Zoysia

Existing Sensors

Logging Atmometer

ET weather station

shelter for irrigation control clocks and SMART controllers

1/4 circle pop-up spray head

Soil Moisture Feedback Sensor and/or Soil Moisture Sensor: (2/4 reps) both turf types

to logger or control wire

water meter

13 ft.