Control Technologies to Reduce Residential Irrigation Water Application

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GreenTrends 2006, Gainesville, FL
Background

• Population served by public supply
  – 5.4 million 1970
  – 17 million 2004
  – 20 million 2020
• 11% U.S. new home construction in FL
• + ~1,000 people/day
• FL uses the most groundwater in the U.S.
• Most new homes in FL include irrigation
• ~60% household water use for irrigation
• High quality landscapes and low water holding capacity
Florida’s Water Crisis

Water Resource Caution Areas: places where water is either scarce or contaminated as defined by Florida’s Water Management Districts

SJRWMD Residential Irrigation Study

- Homeowners asked to volunteer at a series of workshops
- Nine cooperators recruited in each of three counties in Central Florida
- Nine homes randomly divided into three groups with three replications
T1 = Existing landscape and irrigation, only monitored
T2 = T1 landscape, reduced irrigation schedule
T3 = T2 irrigation schedule + 65% microirrigated ornamentals
Data Collection & Monitoring
Potential Uniformity Impact

Root Zone

Soil Below Root Zone

Under irrigated

Adequate irrigation

Non-uniformity (100% uniformity not practical)

Over irrigation

Adequate irrigation

Non-uniformity (100% uniformity not practical)
Microirrigation in Narrow Areas
Improper Coverage
Irrigation Water Use - Conclusions

• Despite “low uniformity”, turf quality similar across homes in most seasons

• Significant reductions in water use (20% and 40%) can be achieved by irrigation scheduling (T2) and scheduling + landscape changes (T3)
Sensor Based Irrigation

Soil moisture sensors (SMS)

Evapotranspiration (ET) based controllers
SMS Experimental Design

- 1 d/wk four brands SMS
- 2 d/wk four brands SMS
- 7 d/wk four brands SMS
SMS Experimental Design

• 1 d/wk four brands SMS
• 2 d/wk four brands SMS
• 7 d/wk four brands SMS
• Time 2 d/wk with rain sensor
SMS Experimental Design

• 1 d/wk four brands SMS
• 2 d/wk four brands SMS
• 7 d/wk four brands SMS
• Time 2 d/wk with rain sensor
• 60% of time 2 d/wk with rain sensor
SMS Experimental Design

• 1 d/wk four brands SMS
• 2 d/wk four brands SMS
• 7 d/wk four brands SMS
• Time 2 d/wk with rain sensor
• 60% of time 2 d/wk with rain sensor
• Time 2 d/wk without rain sensor
SMS Experimental Design

- 1 d/wk four brands SMS
- 2 d/wk four brands SMS
- 7 d/wk four brands SMS
- Time 2 d/wk with rain sensor
- 60% of time 2 d/wk with rain sensor
- Time 2 d/wk without rain sensor
- Non-irrigated
Soil Moisture Control Sensors

- Acclima
- Water Watcher
- Irrometer
- Rainbird

[Image of various soil moisture control sensors]
Rain sensor
Individual Plot Control
Control Panel
1: Sensor Controllers
2: Timer
## TIME vs. SMS Control

<table>
<thead>
<tr>
<th>Treatment</th>
<th>TOTAL (in)*</th>
<th>Savings compared to 2-WRS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-WRS</td>
<td>18.9</td>
<td>0</td>
</tr>
<tr>
<td>2-WORS</td>
<td>27.4</td>
<td>-45</td>
</tr>
<tr>
<td>2-DWRS</td>
<td>12.2</td>
<td>36</td>
</tr>
<tr>
<td>Sms Avg</td>
<td>8.1</td>
<td>57</td>
</tr>
</tbody>
</table>

* P<0.05  
WRS = With Rain Sensor  
DWRG = 60% Deficit With Rain Sensor  
Sms = Soil Moisture Sensors
SMS Brand Comparison

Reduction compared to 2WRS

59-88%  73-82%  34% 1-d/wk  46-81%

Mean water applied (in)

Soil Moisture Sensor Brands

A  B  C  D
4.6 c  3.9 c  16.5 a  7.4 b

P<0.05
Rainfall per Event and Cumulative Rainfall

<table>
<thead>
<tr>
<th>Date</th>
<th>Da</th>
<th>Fr</th>
<th>Je</th>
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<tbody>
<tr>
<td>20-Jul</td>
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<td>3-Aug</td>
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<td>17-Aug</td>
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<td>31-Aug</td>
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<td>14-Sep</td>
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<td>28-Sep</td>
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<td>12-Oct</td>
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<td>26-Oct</td>
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<td>9-Nov</td>
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<td>23-Nov</td>
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<tr>
<td>7-Dec</td>
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</tbody>
</table>

Total 37.2 in  T.S. Danielle 6.2 in  H. Frances 12.4 in  H. Jeanne 6.2 in  67% of total

Dates:
- 20-Jul: 0
- 3-Aug: 0
- 17-Aug: 0
- 31-Aug: 0
- 14-Sep: 0
- 28-Sep: 0
- 12-Oct: 0
- 26-Oct: 0
- 9-Nov: 0
- 23-Nov: 0
- 7-Dec: 0

Cumulative rainfall (mm):
- 40
- 37.2
- 30
- 20
- 10
- 0

Rainfall in inches (in):
- 37.2
- 6.2
- 12.4
- 6.2

Cumulative rainfall (mm)

Date

Rainfall per Event

T.S. Danielle

H. Frances

H. Jeanne

67% of total
SMS Irrigation - Conclusions

• No significant differences in turfgrass quality among treatments detected.

• WORS 45% > WRS → importance of rain sensor

• SMS savings 59-88% (excluding brand C)
Further Research

• **SMS on homes**
  - 64 homes Pinellas Co.
    • 16 SMS
    • 16 control
    • 16 rain sensors
    • 16 educational materials

• **ET controllers**

• Phase I, “Landscape” plots
• Gulf Coast REC, Hillsborough Co.
• Phase II, 40-50 homes Hillsborough Co.
Real World Application

• Majority of new homes have automatic irrigation

• SW FL landscape ordinance
  – Pasco Co.: 50% of green space can be sprinkler irrigated
  – “…compliance with the ordinances was found to be minimal…”
  – 69% green space irrigated with sprinkler
Lake Jovita

• Pasco Co. ordinance variance
• Full landscape irrigation if controlled with SMS
• ~400 homes in Lake Jovita currently
• 5 homes/month completed
• Historical water use since May 2001
• New homes since early 2006 will have SMS control
<table>
<thead>
<tr>
<th>Source</th>
<th>Irrig. Applied (mm/month)</th>
<th>Irrig. Applied (in/month)</th>
<th>Compared to Theoretical</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWWA</td>
<td>77</td>
<td>3.0</td>
<td>+60%</td>
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<tr>
<td>SJRWMD</td>
<td>Dukes, Miller, Haley, 2005</td>
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</tr>
<tr>
<td>T1</td>
<td>141</td>
<td>5.6</td>
<td>+194%</td>
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<tr>
<td>T2</td>
<td>93</td>
<td>3.7</td>
<td>+94%</td>
</tr>
<tr>
<td>T3</td>
<td>80</td>
<td>3.1</td>
<td>+67%</td>
</tr>
<tr>
<td>SWFWMD-SMS</td>
<td>Dukes, Miller Cardenas, 2005</td>
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<td></td>
</tr>
<tr>
<td>2-WORS</td>
<td>155</td>
<td>6.1</td>
<td>+223%</td>
</tr>
<tr>
<td>2-WRS</td>
<td>107</td>
<td>4.2</td>
<td>+123%</td>
</tr>
<tr>
<td>2-DWRS</td>
<td>69</td>
<td>2.7</td>
<td>+44%</td>
</tr>
<tr>
<td>SMS_{avg} (2004-05)</td>
<td>46</td>
<td>1.8</td>
<td>0%</td>
</tr>
<tr>
<td>Theoretical</td>
<td>48</td>
<td>1.9</td>
<td>0%</td>
</tr>
</tbody>
</table>
Questions?

Thank you!
SJRWMD, SWFWMD, FDACS, Hillsborough Co. Water Dept., FTGA, FNGLA

Melissa Haley, Berndardo Cardenas, Larry Miller, Danny Burch, Numerous undergrad and graduate students

www.ifas.ufl.edu
irrigation.ifas.ufl.edu