Irrigation Technology for Turf Irrigation Water Management

Turf Drought Agent Training
25 March 2008

Garry Grabow PhD, PE
Extension Specialist
garry_grabow@ncsu.edu
Overview

• Motivation for New Technology
• Available Technology
  • “ET-based” systems
  • Soil-Sensor Feedback Systems
• How to Setup/Operate
• Costs of Technologies
• What’s being done at NC State?
• Example Setup
Motivation/Background

• Increase in irrigation of turf in North Carolina
• Increase in irrigation automation
• Good water management
  • Protects water quality
  • Can reduce costs
  • Reduce disease incidence
  • Good public relations for green industry
• Municipalities looking to offer incentives for adoption of conservation-based technologies in new construction
Motivation/Background

- Irrigation scheduling difficult in regions with spatially variable rainfall
- Takes guesswork and calculations out of scheduling irrigations (when and how much)
- Application to homeowners, commercial landscaping
Irrigation Controllers

Numerous ways to adjust controllers to schedule irrigations.....which one should be used?
Irrigation Controllers

• Daily replacement
• Fixed Day (water on set days….change run time)
• Fixed amount (fix applied depth and adjust watering days)
• Checkbook
• Historical ET (divide by no. of watering days to get amount to apply..use rain sensor)
• Monitor and Compare

From “Eight Ways to Make ET work, Brent Mecham, NCWCD
Technologies and Manufacturers

- ET controllers
  - Toro (Intelli-Sense)
  - Rain Bird (ET manager)
  - Weathermatic (Smartline)
  - Aqua-Conserve
  - Weather Track
  - Weather Reach

- Soil-Water Feedback
  - Baseline (WaterWatcher/WaterTec)
  - Acclima
  - WaterWatcher
  - Irrometer (Watermark module)
  - RainBird (MS-100)
  - H₂O Strategies
Evapotranspiration

Water lost from the surface of soil, water bodies – **Evaporation**

- Water loss through leaves of plants - **Transpiration**

- Water lost from wet soil surface and leaves (Evaporation) and plants (Transpiration) - **Evapotranspiration**
ET Controllers

- Keep a water budget, ET, rain, and irrigation
  - ET estimated from weather on-site or from nearby weather station, or historical ET, or ET gage
  - Remote data from polling from internet, satellite
  - Irrigation amount determined from run time and application rate of sprinkler system
  - May have monthly fee if accessing data from satellite or phone
ET Controllers

Enter site and irrigation system factors

Zone(s) run time
Can have multiple programs

Local weather data

Information gathered from weather stations is transmitted through satellites to the Intelli-Sense controller.
ET Controllers

Temperature, Rainfall (On-Site)
Setup – ET controller

- Site Information
  - Soil texture
  - Shading
  - Slope
  - root zone depth
  - Turf or plant type
- Location (for weather service if used)
- Irrigation System Information
  - Application rate
Operation – ET controller

• Work best if set to automatic and let it decide when to irrigate
• Schedule can be adjusted to allow for watering restrictions
• Best to consult with a sales rep. or someone setup experience
Soil Water Feedback Systems

• Concept – Soils integrates water balance - water demand, irrigation, rain, runoff, drainage
• Estimate Soil-Water content from sensors
• “Add-on” units prevent regularly scheduled irrigations if soil too wet
• Variety of sensor types
• 2-setpoint systems keeps soil-water within pre-determined range (like thermostat)
“Add-on” Devices (1 setpoint)

• “add-on” to existing controller
• Senses soil moisture
• Allows irrigation if soil moisture is below threshold value (one setpoint system)

Acclima
Closed-Loop Irrigation Systems
RS500
Soil Moisture Controller

Precision Irrigation System
Timer Upgrade Kit

NC STATE UNIVERSITY
Soil Moisture Feedback system: how 1-setpoint systems work.
2 – setpoint system

• Irrigates to maintain soil-moisture level between 2 setpoints (on/off)
• User-defined time restrictions may be added
Soil Moisture Feedback system
“on-demand” 2 setpoint system

Can cycle and soak to prevent overwatering
Setup – Soil Moisture System

• Install in turf root zone – 4-6 inches below grade
• Determine “field capacity” of soil
Operation – Sensor System

- Work best if set to irrigate daily to replace amount equal to difference between “field capacity” and “management allowed deficit”. This may be typically 0.5 inches (refer to worksheet)
- Schedule can be adjusted to allow for watering restrictions
Software
Rain Switch

- Can be set to different shutoff thresholds, e.g. \( \frac{1}{4} \), \( \frac{1}{2} \) inch of rain
- Adjustable “drying time” to delay resumption of controller operation
Rain Switch

- Florida study showed 45% savings from using rain switch
- NCSU study, saved about 15% in 2007 (April 22 – Sept 8)
Costs

- **ET Controllers**
  - $300 – $500 generally
  - Most expensive $4,000 (flow monitoring, software, etc.)

- **Soil-Moisture Based**
  - Add-on systems start at $150
  - On-demand $2,500 (plus zone-adapters if retrofit)
Evaluation of Evapotranspiration-Based and Soil Moisture Based Irrigation Control in Turf

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

- Irrigation control based upon estimates of evapotranspiration and water balance (ET)
- Irrigation control based upon feedback from soil moisture sensors (SM)
- Standard calendar based turf irrigation (standard clock)

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Intellisense (ET)</th>
<th>Acclima-1 (SM)</th>
<th>Acclima-2 (SM)</th>
<th>Standard Clock</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 appl. per week</td>
<td>(dictated by system)</td>
<td>Avg. weekly NIR (^1)</td>
<td>1/2 avg. weekly NIR</td>
<td>Avg. weekly NIR</td>
</tr>
<tr>
<td>2 appl. per week</td>
<td>(dictated by system)</td>
<td>1/2 avg. weekly NIR</td>
<td>Approx. 0.5 in., as needed</td>
<td>1/2 avg. weekly NIR</td>
</tr>
<tr>
<td>7 appl. per week</td>
<td>(dictated by system)</td>
<td>Avg. daily NIR</td>
<td>Avg. daily NIR</td>
<td>Avg. daily NIR</td>
</tr>
</tbody>
</table>

\(^1\)NIR – net irrigation requirement = (crop ET – effective precipitation)
## Total applied water (in inches)
April 22\textsuperscript{nd} – September 8\textsuperscript{th} 2007 (20 weeks)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Once per week</td>
</tr>
<tr>
<td>AC1</td>
<td>8.56</td>
</tr>
<tr>
<td>ET</td>
<td>16.27</td>
</tr>
<tr>
<td>Tim</td>
<td>16.88</td>
</tr>
<tr>
<td>AC2</td>
<td>On demand system</td>
</tr>
</tbody>
</table>
Turf quality of plots in the lower terrace at the end of the experimental period (Photo taken September 11, 2007)
Acclima water on-demand system

17.64 inches applied
Acclima add-on 2 x week

12.81 inches applied
ET – 2 x week

24.54 inches applied

Volumetric Water Content

Rain
Irr

Rain and Irrigation, in.

May
Jun
Jul 2007
Aug
Sep
Estimated Water Requirements

- 23.89 in. / 20 weeks
- 26.06 in. / 20 weeks

Atmometer

ET Weather Station
Questions? / Worksheet