Smart Irrigation Practices to Promote Plant Defense Against Diseases

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Water stress and plant disease

• Too much water or flooding
  – Anoxic conditions
  – Disease spread
    (Phytophthora)

• Too little water
  – Greater susceptibility to disease
  – Insects view as a ‘good target’
Role of irrigation

• Add water to plants to prevent water stress
• Right amount, right time, right place
• Too much irrigation can create new problem
Components of good irrigation

• Equipment has been maintained and is regularly checked for leaks, breaks, problems
• The right system is being used (drip, micro sprinkler, lateral, etc.)
• A smart irrigation schedule is applied
Smart irrigation schedules

• “Do it myself” scheduling
• Site specific smart hardware scheduling
• Web and app scheduling tools
Do it myself style
FAWN

- Florida Automated Weather Network
- Free resource with valuable information
- Rainfall and evapotranspiration
- [http://fawn.ifas.ufl.edu/mffw/](http://fawn.ifas.ufl.edu/mffw/)
FAWN: Irrigation using ET

Visual ET for **Homestead**

This is a visual view of the last 14 days of ET calculations at Homestead.

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**Evapotranspiration (ET₀)**

- 9/13: 0.17
- 9/14: 0.19
- 9/15: 0.20
- 9/26: 0.22

**Rainfall**

- 9/13: 0.05
- 9/14: 0.05
- 9/15: 0.05
- 9/26: 0.05
How to use FAWN ET for irrigation?

1. Take average of last few days (0.11 inches), multiply by crop coefficient (Kc) (0.9) 
   \[ \text{ETc} = 0.1 \text{ in/day} \]

2. ETc is the amount of water needed per day, determine how many days you want to irrigate (3 days/wk)

3. Total irrigation for the week (7*0.1 in) divided by the number of irrigation events gives you the amount per event (0.23 in)

4. Determine the deliver rate of your system (0.25 in/hr)

5. Divide amount per event by rate (0.23/0.25*60min); 56 minutes
Smart irrigation systems
ET Controllers

2 methods of determining irrigation:
(1) Soil water balance (2) Relative to historic peak ET
ET based smart irrigation system

• **Signal based**
  – Receive weather data from remote source on daily basis to update irrigation schedule (measurement and control)
  – Annual fee for data, more real-time data used in ET estimation

• **On-site weather based or stand-alone**
  – Uses an on-site sensor to estimate ET and update irrigation schedule (measurement and control)
  – No annual fee for data, less real-time ET data used in ET estimation
ET system schematic

1. Across the U.S. each day, a vast network of weather stations transmit weather data to the NOAA satellite.

2. WeatherTRAK downloads weather data from the NOAA satellite and from other weather data sources.

3. WeatherTRAK data analysis process uses this weather data to calculate location-specific ET down to a square kilometer.

4. WeatherTRAK transmits ET data to its wireless network.

5. WeatherTRAK's wireless network broadcasts location-specific ET data to WeatherTRAK ET controllers.

6. Intelli-Sense controllers automatically adjust irrigation output as weather changes, ensuring maximum water conservation, runoff reduction and landscape health.

http://www.cisolar.com/catIrrigator2.html
Soil water based smart irrigation system

• Use some type of soil water sensor (SWS) or soil moisture sensor (SMS) to allow or bypass irrigation events (measurement and control)
• Sensor acts as a switch
• Different types exists – but generally use a sensor with TDT technology
Thresholds

- Set to a ‘lower threshold’ or lower soil water content at which irrigation is needed
Not convinced?

• Try out the virtual tool on FAWN
• Compare different irrigation technologies and see water savings in a virtual environment
• Weblink: http://irrigationtool.appspot.com
• MANY resources on this – most are linked in the tool above or are found on Dr. Duke’s website
Web tools / apps
App examples

• Currently develop a suite of irrigation apps
• Citrus, strawberry, and turf have been released
• Coming soon: cotton, avocado, tomato, cabbage, peanut
• Use real-time weather data from FAWN
Citrus app

• Irrigation system: micro sprinkler
  – Tree row distances, emitter characteristics, soil type, irrigation depth, trigger depth

• Irrigation delays for rainfall amounts (days)

• Irrigation schedule (minutes) every so many days

• User can select the day of week to receive irrigation notifications
Citrus screenshot

Results

Irrigation schedule for the next 15 days
11/06/2013 to 11/20/2013

Test

Every 5 days irrigate 4 hours and 10 minutes

Irrigation delay for when it rains

<table>
<thead>
<tr>
<th>Rain amount</th>
<th>Irrigation delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4”</td>
<td>1 day</td>
</tr>
<tr>
<td>1/4” to 1/2”</td>
<td>3 days</td>
</tr>
<tr>
<td>1/2” to 3/4”</td>
<td>5 days</td>
</tr>
<tr>
<td>3/4” to 1”</td>
<td>5 days</td>
</tr>
<tr>
<td>&gt; 1”</td>
<td>5 days</td>
</tr>
</tbody>
</table>
Strawberry app

- Irrigation system: drip
  - Between-row, planting date, harvest date, irrigation rate, efficiency
- Irrigation schedule (minutes/hrs) and degree days accumulated for everyday irrigation

<table>
<thead>
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<tbody>
<tr>
<td><strong>Irrigation schedule for the next 15 days</strong></td>
</tr>
<tr>
<td>11/06/2013 to 11/20/2013</td>
</tr>
<tr>
<td><strong>Test</strong></td>
</tr>
<tr>
<td>Irrigate 1 hour a day</td>
</tr>
<tr>
<td>Accumulated degree days: 2619</td>
</tr>
</tbody>
</table>
Urban turf app

• Irrigation system: sprinkler heads
  – Soil type, root depth
  – Micro sprinkler, spray, multi-stream spray, gear driven rotors, impacts
  – Days of week to irrigate

• Irrigation schedule in minutes considering number of irrigation events per week

• Notifications used to adjust irrigation schedules due to rainfall
Smartirrigation Turf

System 1
Soil type: Sand
Root depth: 8 in

- Edit system
- Add zone

IRRIGATION SCHEDULE

Zone A
- Irrigation time: 30 minutes

Zone B

Notifications

YESTERDAY
System 11

Zone A
Change irrigation time to 40 minutes.

MONDAY
System 11

Zone A
There is over 60% chance of rain for Zone A area in the

08/23/2013
System 1

Zone B
A rain event occurred in System 1 area. Please check

08/22/2013
ML
Cotton app

• Irrigation application rate
• Plant phenology and crop coefficient (Kc) change with accumulated heat units (GDDs)
  – User can override GDD-driven phenology
• Does not recommend irrigation amounts
  – Advises user of available soil water and stress threshold
Cotton app

- Uses real-time rain data from FAWN and GAEMN
- A daily water balance approach: allow for R to be changed and I to be input
Forecast data

- National Weather Service data: temperature, relative humidity, wind speed, probability of rain
- Current conditions
- Forecast by hour for next 11 hrs
- Forecast by day for next 5 days
Summary

• There are a variety of resources, pick the one (or more) that works best for you

• **FAWN** – good for the manual irrigation system operator that likes to be in the ‘know’ and have a say in the decision; **works for all crops**

• **Field tools** – good for those that want exact information at their field and/or want automation; **works for all crops**

• **App tool** – great for automatic irrigation systems and manual systems, does the math for you; **limited on crop**
AgroClimate Disease tools