AVOCADO IRRIGATION SEMINAR

Timing-Scheduling
Influence of Soil and Weather Conditions
Different Irrigation Strategies
Tools Available
Field Experience Discussion

Presented by—
Andres Bascope,
Agricultural Engineer & Avocado Consultant
IRRIGATION SCHEDULING

STEP 1:
Determine Soil Properties: textural classification and Water Holding Capacity

<table>
<thead>
<tr>
<th>Soil Textures</th>
<th>inches/inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corse Sand and Gravel</td>
<td>0.02 0.06</td>
</tr>
<tr>
<td>Sands</td>
<td>0.04 0.09</td>
</tr>
<tr>
<td>Loamy Sands</td>
<td>0.06 0.12</td>
</tr>
<tr>
<td>Sandy-Loam</td>
<td>0.11 0.15</td>
</tr>
<tr>
<td>Loam and Silt Loams</td>
<td>0.17 0.23</td>
</tr>
<tr>
<td>Clay-Loam</td>
<td>0.14 0.21</td>
</tr>
<tr>
<td>Clay Loams and Silty-Clay-Loam</td>
<td>0.14 0.21</td>
</tr>
<tr>
<td>Silty Caly and Clays</td>
<td>0.13 0.18</td>
</tr>
</tbody>
</table>

Web search: Soil Water Holding Capacity
http://www.ag.ndsu.edu/pubs/ageng/irrigate/eb66w.htm#soil
## STEP 2:
Determine Weather Conditions: Crop Evapotranspiration (ETc)

### HISTORICAL MONTHLY EVAPOTRANSPIRATION
**SANTA PAULA**

<table>
<thead>
<tr>
<th>Item</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historic Avg Monthly ETo</td>
<td>1.83</td>
<td>2.2</td>
<td>3.42</td>
<td>4.49</td>
<td>5.25</td>
<td>5.67</td>
<td>5.86</td>
<td>5.61</td>
<td>4.49</td>
<td>3.42</td>
<td>2.36</td>
<td>1.83</td>
<td><strong>46.43</strong></td>
</tr>
<tr>
<td>Kc</td>
<td>0.65</td>
<td>0.65</td>
<td>0.7</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.7</td>
<td>0.65</td>
<td>0.6</td>
<td><strong>4.6</strong></td>
</tr>
<tr>
<td>Daily Avg. ETo</td>
<td>0.06</td>
<td>0.08</td>
<td>0.11</td>
<td>0.15</td>
<td>0.17</td>
<td>0.19</td>
<td>0.19</td>
<td>0.18</td>
<td>0.15</td>
<td>0.11</td>
<td>0.08</td>
<td>0.06</td>
<td><strong>0.13</strong></td>
</tr>
<tr>
<td>Weekly Avg. ETo</td>
<td>0.41</td>
<td>0.55</td>
<td>0.77</td>
<td>1.05</td>
<td>1.19</td>
<td>1.32</td>
<td>1.32</td>
<td>1.27</td>
<td>1.05</td>
<td>0.77</td>
<td>0.55</td>
<td>0.41</td>
<td><strong>0.89</strong></td>
</tr>
<tr>
<td>ETo (gal/acre)</td>
<td>49,085</td>
<td>59,009</td>
<td>91,733</td>
<td>120,433</td>
<td>140,818</td>
<td>152,083</td>
<td>157,179</td>
<td>150,474</td>
<td>120,433</td>
<td>91,733</td>
<td>63,301</td>
<td>49,085</td>
<td><strong>1,245,364</strong></td>
</tr>
<tr>
<td>ETo (AF/acre)</td>
<td>0.15</td>
<td>0.18</td>
<td>0.28</td>
<td>0.37</td>
<td>0.43</td>
<td>0.47</td>
<td>0.48</td>
<td>0.46</td>
<td>0.37</td>
<td>0.28</td>
<td>0.19</td>
<td>0.15</td>
<td><strong>3.82</strong></td>
</tr>
<tr>
<td>Irrigation (gal/acre)</td>
<td>31,905</td>
<td>38,356</td>
<td>64,213</td>
<td>90,324</td>
<td>105,613</td>
<td>114,062</td>
<td>117,884</td>
<td>112,855</td>
<td>90,324</td>
<td>64,213</td>
<td>41,146</td>
<td>29,451</td>
<td><strong>900,348</strong></td>
</tr>
<tr>
<td>Irrigation (AF/acre)</td>
<td>0.10</td>
<td>0.12</td>
<td>0.20</td>
<td>0.28</td>
<td>0.32</td>
<td>0.35</td>
<td>0.36</td>
<td>0.35</td>
<td>0.28</td>
<td>0.20</td>
<td>0.13</td>
<td>0.09</td>
<td><strong>2.76</strong></td>
</tr>
</tbody>
</table>

Source: CIMIS.  [http://www.cimis.water.ca.gov/cimis/welcome.jsp](http://www.cimis.water.ca.gov/cimis/welcome.jsp)
STEP 3:

Irrigation Calculator: Combining ETo and Soil Water Holding Capacity (WHC)

<table>
<thead>
<tr>
<th>Soil Texture Description</th>
<th>Clay-Loam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Tank Capacity (/inch)</td>
<td>0.2</td>
</tr>
<tr>
<td>Root depth (inches)</td>
<td>24</td>
</tr>
<tr>
<td>Wet area (%)</td>
<td>0.44</td>
</tr>
<tr>
<td>Real Tank Capacity (RTC)</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Real Precipitation (/hr) | 0.13 |
Irrigation Time (hrs) | 4.9 |

TRP: Maximum: 50%
Spring: 30-40%
Summer: 20-30%
EVAOPTRANSPIRATION (ET gage)

How It Works:

A ceramic evaporator at the top of the instrument responds to sun and weather as plants do. Water is drawn from a reservoir. The water level falls in the sight tube one inch for each inch used by your plants.

Replaceable green canvas covers modify the evaporation rate to simulate ET from field crops or grass.

Rain cannot get into the instrument. The rain gauge, provided with the ETgage, lets you measure rain separately.

Test Results:

Tests run in various locations since 1988 have shown good agreement with other more expensive ways of measuring ET. The graph at right shows a comparison of the ETgage and two other methods, the Penman equation (using measurements of humidity, temperature, wind, and solar radiation), and a Bowen Ratio Station (a research method that measures the flow of vapor from a crop). The test shows close agreement in a corn crop from July 4 to first freeze at the USDA experiment station in Fort Collins, Colorado. Other data available on request.
Example 11. Examining irrigation norm (Avocado, Aﬁkim, Israel, 2000)

As in above-mentioned example, two irrigation regimes were tested for avocado: the norm and 70% of the norm. Lesser-irrigated plants (green curves) had lower fruit growth rate. Behavior of the arm trend was even more differentiated between treatments (see figure to the right).

Dendrometers
Israel
Dendrometers ODN Ranch, Somis, Ventura
IRROMETER COMPANY

- Established 1951

- P.O. Box 2424
  8835 Philibin
  Riverside, California
  951.689.1701

- Tom Penning, President.
SCHEDULING IRRIGATION

• WHEN AND HOW MUCH?

• Only way to know for sure is to measure it.
WHY?

- SAVE MONEY
- SAVE WATER
- SAVE ENERGY
- SAVE LABOR
MUST KNOW

1. ROOT ZONE

2. IRRIGATION ZONE

3. SOIL ZONE
METHODS

• Direct Method – soil or plant-based
• Indirect Method – ET modeling
• Considerations
• ACCURACY
• COST
• ACTUAL VS THEORETICAL
SOIL WATER MEASUREMENT

• Site Specific
• Measure effect of irrigation
• Measure effect of rainfall
• Measure effect of evaporative loss
• Measure effect of crop water use
• Can disclose irrigation inefficiencies
MEASURING SUCTION VS. PERCENT MOISTURE

- Root system reacts to “physical force, not percent”
- Soil variability – at site and profile
- Ease of data interpretation
CONVERSION

Graph adapted from: Agronomy No.11 figure 30-2. Irrigation of Agricultural Lands.
EVALUATION OF DATA

- Rate of change
- Effect of soil type
- Effect of irrigation method: low frequency vs. high frequency
- Crop sensitivity - stage of growth
- Leaching
- Continuous data
HOW MANY SENSORS?

• One station (group) per irrigation valve.
• One station (group) per soil type.
PLACEMENT OF SENSORS

- Top of root zone
- Middle of root zone
- Bottom of root zone
- In the irrigation zone
- Be consistent with placement
Tensiometer

- Direct method
- All soil types
- Simple
- Reliable
- Manual or automatic
- MECHANICAL ROOT
E-GAUGE
WATERMARK

• Indirect method
• Most soil types
• Salinity buffered
• Manual or automatic
• Stable proven calibration
• Low cost
DATA LOGGER
WIRELESS
LONG RANGE RADIO
E-NET
SUMMARY

• SOIL MOISTURE SCHEDULING
• PRODUCES BETTER CROPS
• PROTECTS WATER RESOURCE
• SUSTAINABLE PRACTICE
• MAKE MONEY
REMEMBER. . .

CONTACT

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INNOVATIONS IN SOIL
MOISTURE MONITORING

Presented by—
Melissa Naber
888.882.7873

www.PureSense.com
Company Background

- 48 full-time employees
- Serving over 225 customers
- Over 1,300 monitored sites
- 97% renewal rate
  - Now Serving California, Arizona, Oregon, Washington, Idaho, Nebraska and Texas

Strong Roots in Agriculture

- Monitoring over 35 different crop types.
- Software developed specifically for agriculture.
- Accommodate a wide range of operation sizes.

Diverse Team

- Development team consists of 9 team members dedicated to keeping the product at the forefront of irrigation management technology.
## Major Crop Types

<table>
<thead>
<tr>
<th>Almonds</th>
<th>Oranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>Peaches</td>
</tr>
<tr>
<td>Apples</td>
<td>Pistachios</td>
</tr>
<tr>
<td>Avocado</td>
<td>Pomegranates</td>
</tr>
<tr>
<td>Blueberries</td>
<td>Potatoes</td>
</tr>
<tr>
<td>Canola</td>
<td>Raspberries</td>
</tr>
<tr>
<td>Carrots</td>
<td>Radicchio</td>
</tr>
<tr>
<td>Cherries</td>
<td>Strawberries</td>
</tr>
<tr>
<td>Corn</td>
<td>Tomatoes</td>
</tr>
<tr>
<td>Lemons</td>
<td>Walnuts</td>
</tr>
<tr>
<td>Melons</td>
<td>Wine Grapes</td>
</tr>
<tr>
<td>Nursery Crops</td>
<td>Wheat</td>
</tr>
<tr>
<td>Onions</td>
<td>Soybeans</td>
</tr>
</tbody>
</table>
Soil Moisture – What Is It?

**Soil Moisture** is the water in the pore spaces of a soil PLUS the water held by soil itself.

**Soil Moisture Characteristics**

- **Saturation** – All of the pores are filled with water.
- **Field Capacity** – Some water is in the pores, but it no longer drains freely
- **Wilt Point** – Only water held tightly by the soil is present

**Water Holding Capacity (WHC)** is the total amount of plant-available water when the soil is at field capacity
Measuring Soil Moisture

Capacitance Probes Use Volumetric Soil Moisture

1 cu ft Soil Taken from the Field

Compress the Soils to Separate the Soil, Air, and Water Components

Each Element Occupies a Percent of the 1 cu ft Volume

Water

% Air
% Water = VSM
% Soils

Volumetric Soil Moisture (VSM) is the total water content of soil by volume measured in percent.
Both WHC and VSM Vary Widely with Soil Type

- **SAND**
  - WHC% = 4%
  - Field Capacity: 9%
  - Wilt: 5%
  - Oven Dried: 0%
  - Saturation: 46%
  - Field Capacity: 27%
  - Wilt: 13%
  - Oven Dried: 0%

- **LOAM**
  - WHC% = 14%
  - Field Capacity: 13%
  - Wilt: 9%
  - Oven Dried: 0%
  - Saturation: 46%
  - Field Capacity: 27%
  - Wilt: 13%
  - Oven Dried: 0%

- **CLAY**
  - WHC% = 12%
  - Field Capacity: 15%
  - Wilt: 11%
  - Oven Dried: 0%
  - Saturation: 48%
  - Field Capacity: 42%
  - Wilt: 30%
  - Oven Dried: 0%
Target Moisture Zone

Making More Accurate Irrigation Decisions

- Saturation Point
- Full Point = Upper Boundary
- Target Moisture Zone
- Onset of Stress = Lower Boundary
- Water Holding Capacit
- Field Capacity
- Upper Safety Factor
- Lower Safety Factor
- Wilt Point

% Volumetric Soil Moisture

Time

Moisture Trend Line
Soil Moisture Response Trends: Root Activity

Stair-Step Response Shows Roots Taking Up Water During the Day and Resting at Night

Irrigation Events
How does it all work?
Hardware

- Weather station
- Solar-powered on-board field computer
- Soil probes installed down to 5 ft.
- Pressure switch or rain bucket to capture irrigation event
How It Works

Soil moisture data automatically collected every 15 minutes.

Pressure switch communicates when water is on/off.

Weather, soil and pressure switch data sent to a secure server via cell signal.

Computer

Irrigate with Confidence.

iPhone & Droid

iPad
Software

- Secure, online access. Anytime, anywhere.
- Custom alerts
- Instant readings
- Easy-to-read dashboard
- Training
- Weather reporting-GGD, Heat/Chill hours
Ease of Use
Limited water led to the grower adding gypsum in May and June resulting in improved penetration.
Soil Moisture Response Trends: Irrigation Infiltration

Infiltration Lag through the Soil Profile

Depth of Irrigation Event Infiltration Shown by Soil Moisture Response

Irrigation Events
...More than just hardware

- Support teams committed to solving your individual challenges.
- Dedicated team of developers, constantly innovating technology - with feedback from growers like you.
- Local teams to install and train you *in person*.
- Easy-to-use software helps you make intelligent irrigation decisions.

Contact us: 888.882.7873

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