Getting the Most From Your Irrigation Water

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What Do You Do If Your Water is Limited?

- You don’t have enough water to meet tree water needs (ET).
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Looking at this list, what do we need?

1. Tree ET info.
2. Tree deficit irrigation info.
3. Irrigation efficiency info.
Tree water requirements (ET)

- Available as historical averages and as “real-time” (CIMIS)
Tree water requirements (ET)

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- California Irrigation Management Information System

Google: CIMIS
Tree water requirements (ET)

- Historical averages:

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**Understanding Your Orchard’s Water Requirements**

**LAWRENCE J. SCHWANKL**, UC Cooperative Extension Irrigation Specialist; **TERRY L. PRICHARD**, UC Cooperative Extension Water Management Specialist; **BLAINE R. HANSON**, UC Cooperative Extension Irrigation and Drainage Specialist; and **RACHEL B. ELKINS**, UC Cooperative Extension Farm Advisor, Lake County

**INTRODUCTION**

The California State Water Code requires anyone discharging waste that could affect the waters of the state to obtain a permit or coverage under a waiver. Agricultural runoff, whether from irrigation or rainfall, that leaves a property has been determined to likely contain waste (sediment, nutrients, chemicals, etc.).
Tree water requirements (ET)

- Historical averages:

HISTORICAL EVAPOTRANSPIRATION

A good initial step in estimating water use in your orchard is to use historical evapotranspiration estimates. These estimates are long-term averages developed by measuring the water use of a reference crop (well-watered pasture grass), and then converting the data for the reference crop to estimates for the orchard crop. Tables 1 through 9 show historical average evapotranspiration estimates for selected California locations during approximate 2-week periods for:

- mature almonds (table 1)
- walnuts (table 2)
- pistachios (table 3)
- stone fruit (table 4)
- olives (table 5)
- olives (table 6)
- citrus (table 7)
- apples (table 8)
- pears (table 9)
Tree water requirements (ET)

- Historical averages:

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Tree water requirements (ET)

- Real-Time ET:

\[ ET_{\text{tree}} = \text{Ref. Crop ET (ET}_o) \times \text{Crop Coefficient} \]

\[ ET_o \text{ from CIMIS} \]
Tree water requirements (ET)

- **Crop Coefficients:**

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Looking at this list, what do we need?

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3. Irrigation efficiency info.
Tree Deficit Irrigation Info.

When there is insufficient irrigation water to meet the water demands of a crop, the available irrigation water must be applied in the most efficient manner possible.

There are available strategies for maximizing irrigation water efficiency.

Agriculture

- Deficit irrigation strategies may be available to make the best use of limited water supplies. Click here for Crop Irrigation Strategies for almonds, pistachios, stone fruit, walnuts, alfalfa, olives, winegrapes, corn, and processing tomatoes.

- Quality Irrigation Scheduling can be critical to efficient irrigation water use. Evapotranspiration (ET) irrigation scheduling, soil moisture monitoring, and plant-based irrigation scheduling are all discussed.

For further California drought information, experts, and resources, please visit the California Institute for Water Resources drought pages.

http: ucmanageddrought.ucdavis.edu
Tree Deficit Irrigation Info.

Crop Irrigation Strategies

Individual Crop Deficit Irrigation Information

For some crops, primarily perennial crops, there may be growth periods when the crop can be deficit irrigated with minimal impact on yield and quality. Taking advantage of these periods, irrigation systems such as micro precise systems can apply precise irrigations to deficit irrigate without overly stressing the crop.

Click below on your crop of choice for information on irrigation strategies. Each section provides detailed information on irrigation management for crops under drought conditions, as well as a list of resources.

Almonds
Pistachios
Stone Fruit
Walnuts
Alfalfa
Olives
Winegrapes
Corn
Processing Tomatoes (New! May 1, 2014)

http: ucmanageddrought.ucdavis.edu
Tree Deficit Irrigation Info.

Almonds

Summary of University of California research on irrigation management for almond trees under drought conditions

For maximum growth, yield, crop quality and orchard longevity, almonds trees should be supplied with water to meet their full water requirement. There are some disease concerns with hull rot under full water conditions which can be addressed with moderate water stress during hull split. (Tevet et al. 2001) If water availability is limited, growers can react by applying irrigation water when trees are most sensitive to stress and by taking measures to minimize water losses that occur during irrigation events. Supplying less water than the trees can potentially use reduces soil water availability, causes tree water deficits, and reduces transpiration. Cover crops, depending on their coverage and the time of the season in which they are grown, can increase the orchard water use by up to 30%. Cover crops should be removed when water is in limited supply (Prichard et al. 1989).

Water deficits affect almond orchards not only in the year in which stress occurs, but also in the following seasons. Generally, nut size is reduced in the first season of significant water stress. Because water stress also reduces vegetative growth and potentially decreases productivity per unit canopy volume, nut load can be reduced in subsequent years (Lampinen et al. 2007). Recent research indicates some stages of almond fruit growth are more sensitive to water stress than others. Understanding these stages permits growers to withhold water while minimizing damage to trees and to current and subsequent crops.

Early season stress

Water stress affects more tree and crop development processes during the early season. [...]

http://ucmanageddrought.ucdavis.edu
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Flood Irrigation Systems:

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Flood Irrigation Systems:

- Not a lot can be done to improve them, but here are two ideas:
  - Monitor the soil moisture (and ideally the trees) to see if you can go longer between irrigations.
  - Don’t flood the entire middles. Use furrows pulled along the tree rows.
Sprinkler Irrigation Systems:

- How can we improve their performance?
Sprinkler Irrigation Systems:

- How can we improve their performance?
  - Know the application rate.
    - We provide water use information in units of “inches of water use per day (or per week………)”.
    - Need to know the system application rate (in/hr) in order to know how long to run the system.
Sprinkler Irrigation Systems:

- How can we improve their performance?
  - Know the application rate.

\[
\text{Application Rate} \left( \frac{\text{in}}{\text{hr}} \right) = \frac{96.3 \times \text{(nozzle discharge in gpm)}}{\text{Spacing along lateral (ft)} \times \text{Spacing between laterals (ft)}}
\]
# Sprinkler Application Rate:

Table 2. Sprinkler discharge rates (gpm) for various nozzle sizes (in) and pressures (psi)

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<td>9.08</td>
<td>10.66</td>
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<td>14.19</td>
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</tbody>
</table>

Note: Metric conversions: 1 gal = 3.785 l; 1 in = 2.54 cm; 1 psi = 6.89 kPa
Sprinkler Nozzle Size:
Sprinkler Application Rate

Pitot Tube & Pressure Gauge
Sprinkler Application Rate:

Table 2. Sprinkler discharge rates (gpm) for various nozzle sizes (in) and pressures (psi)

<table>
<thead>
<tr>
<th>Pressure (psi)</th>
<th>3/32</th>
<th>1/8</th>
<th>5/32</th>
<th>1/4</th>
<th>1/4</th>
<th>3/32</th>
<th>1/4</th>
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<td>7.58</td>
<td>9.08</td>
<td>10.66</td>
<td>12.32</td>
</tr>
</tbody>
</table>

Note: Metric conversions: 1 gal = 3.785 l; 1 in = 2.54 cm; 1 psi = 6.89 kPa.

Application Rate \( (\text{in/ hr}) \) = \[ \frac{96.3 \times \text{(nozzle discharge in gpm)}}{\text{Spacing along lateral (ft)} \times \text{Spacing between laterals (ft)}} \]
Sprinkler Application Rate:

**R10 Plate/Nozzle Options and Flow Performance in GPM and LPH**

<table>
<thead>
<tr>
<th>Plate Series</th>
<th>Plate Options</th>
<th>Recommended Nozzles</th>
<th>PSI 25</th>
<th>PSI 30</th>
<th>PSI 35</th>
<th>PSI 40</th>
<th>PSI 45</th>
<th>PSI 50</th>
<th>BAR 1.75</th>
<th>BAR 2</th>
<th>BAR 2.25</th>
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<th>BAR 2.75</th>
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<td>P2 9° Red</td>
<td>Lt. Blue #40</td>
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<td>—</td>
<td>.28</td>
<td>.30</td>
<td>.32</td>
<td>.34</td>
<td>—</td>
<td>61.4</td>
<td>64.7</td>
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<td>Radius 18-20'</td>
<td>Lt. Purple #45</td>
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<td>.32</td>
<td>.35</td>
<td>.37</td>
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<td>71.3</td>
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<td>80.6</td>
<td>83.9</td>
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<td>(5.5-6.1 m)</td>
<td>Dk. Green #50</td>
<td>.36</td>
<td>.39</td>
<td>.43</td>
<td>.46</td>
<td>.48</td>
<td>.51</td>
<td>82.3</td>
<td>87.2</td>
<td>93.4</td>
<td>99.4</td>
<td>104</td>
<td>108</td>
<td>112</td>
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<tr>
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<td>Stream Ht.14-23”</td>
<td>.35 10FC</td>
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<td>(36-58 cm)</td>
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<tr>
<td>P4</td>
<td>P4 9° White</td>
<td>Dk. Green #50</td>
<td>—</td>
<td>—</td>
<td>.43</td>
<td>.46</td>
<td>.48</td>
<td>.51</td>
<td>93.4</td>
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<td>(5.5-6.7 m)</td>
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<td>P4 15° Orange</td>
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<td>Radius: 23-25’</td>
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<td>(7.0-7.6 m)</td>
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<td></td>
<td>Stream Ht. 40-50”</td>
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<td>(102-127 cm)</td>
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Within the recommended pressure range of 25-50 PSI (1.75-3.25 BAR), the .35 10 FC flow control nozzle is flow regulating within a flow range of no more than 0% greater and 10% less than the nominal flow of .35 GPM (79.5 LPH).

Within the recommended pressure range of 25-50 PSI (1.75-3.25 BAR), the .50 10 FC flow control nozzle is flow regulating within a flow range of no more than 0% greater and 10% less than the nominal flow of .5 GPM (114 LPH).

**Application Rate**  
\[
\text{Application Rate} \left( \frac{\text{in}}{\text{hr}} \right) = \frac{96.3 \times (\text{nozzle discharge in gpm})}{\text{Spacing along lateral (ft)} \times \text{Spacing between laterals (ft)}}
\]
Sprinkler Application Rate

\[
\text{Application Rate} \left( \frac{\text{in}}{\text{hr}} \right) = \frac{96.3 \times \text{(nozzle discharge in gpm)}}{\text{Spacing along lateral (ft)} \times \text{Spacing between laterals (ft)}}
\]
Sprinkler Irrigation Systems:

- How can we improve their performance?
  - Know the application rate.
  - Determine and improve (if needed) the application uniformity.
Sprinkler Irrigation Systems:

- Measuring sprinkler application uniformity
  - Tells you how evenly the water is applied.
Sprinkler Irrigation Systems:

- Measuring sprinkler application uniformity

Hire Someone to Do It For You.
Soil Intake Rates and Application Rates in Sprinkler-Irrigated Orchards

INTRODUCTION
The California State Water Code requires anyone discharging waste that could affect the waters of the state to obtain a permit or coverage under a waiver. Agricultural runoff, whether from irrigation or rainfall, that leaves a property has been determined to likely contain waste (sediment, nutrients, chemicals, etc.).
Microirrigation Systems

• How can we improve them?
Microirrigation Systems

- How can we improve them?
  - Know the application rate and application uniformity.

Available at [http://ucanr.edu/schwankl](http://ucanr.edu/schwankl) along with the Powerpoint presentation
Microirrigation Systems

• Irrigation uniformity can be a problem with microirrigation systems too.

  That means all the drippers or microsprinklers aren’t discharging the same amount of water.
Microirrigation Systems

• Irrigation uniformity can be a problem with microirrigation systems too.
• Why wouldn’t it be uniform?
  • Not a good irrigation system design – pressure differences too great.
Microirrigation Systems

• Irrigation uniformity can be a problem with microirrigation systems too.

• Why wouldn’t it be uniform?
  • Not a good irrigation system design – pressure differences too great.
Microirrigation Systems

• Irrigation uniformity can be a problem with microirrigation systems too.

• Why wouldn’t it be uniform?
  • Not a good irrigation system design – pressure differences too great. PC drippers or PC micros can help.
Microirrigation Systems

• Irrigation uniformity can be a problem with microirrigation systems too.

• Why wouldn’t it be uniform?
  • Not a good irrigation system design – pressure differences too great.
  • Maintenance problems.
    • Clogging problems can lead to serious non-uniformity problems. Almost all clogging problems can be solved or prevented.
Clogging of Microirrigation Systems

Source: Physical Clogging
Clogging of Microirrigation Systems

Source: Physical Clogging - Particulates

Solution: Filtration
Filters:

- Screen, disk, and sand media filters are all available.

- They can all filter to the same degree
  BUT
  they req. different frequency of cleaning
Clogging of Microirrigation Systems

Source: Chemical Precipitates

- Lime (calcium carbonate) and iron are the most common problems.
Chemical Precipitate Clogging of Microirrigation Systems

Water quality levels of concern:

- Calcium: pH > 7.5 and 2.0 meq/l (120 ppm) of bicarbonate
- Iron: pH > 4.0 and 0.5 ppm iron
Clogging of Microirrigation Systems

Source: Lime

Solution: pH Control (Acidification) + filtration
Dealing with Iron Precipitation:

1. Precipitate iron in a pond / reservoir
Dealing with Iron Precipitation:

1. Precipitate iron in a pond / reservoir

2. Chemicals (e.g. phosphonic acid, phosphonate) may keep iron in solution
Clogging of Microirrigation Systems

Source: Biological Sources
Clogging of Microirrigation Systems

Source: Biological Sources

Solution: Filtration (usually media filters) + Biocide
Biological Clogging

Acid may deter but not eliminate biocide chlorine copper
Chlorine

- **Sources:**
  - Liquid - sodium hypochlorite.
  - Solid - calcium hypochlorite.
  - Gas chlorine.
Chlorine as a Biocide

Free Chlorine

Prevent growth 1-2 ppm
Periodic treatment 10-20 ppm
Serious clogging cleanup

Test for chlorine using a pool / spa test kit
Chlorine: Injection Rates

- Sodium hypochlorite (liquid)
  - Example: household bleach w/ 5.25% active chlorine.

\[
\text{Chlorine injection} = \text{System flow} \times \text{Desired Cl rate (gpm)} \times 0.006 \div \text{Strength of Conc. (ppm) Cl soln (%)}
\]

- Calcium hypochlorite (solid)
  - 65-70% available chlorine.
  - 12.8 lbs. of calcium hypochlorite added to 100 gallons of water forms a 1% solution.
  - Use above formula.
Flushed of Microirrigation Systems:

- Silts and clay particles pass through even the best filters.

![Image of flushing microirrigation system](image-url)
Flushing

- Silts and clay particles pass through even the best filters.
Flushed

- Silts and clay particles pass through even the best filters.
- Need to flush the system - mainlines, submains, and laterals (in that order). Flush by hand or can use self-flushing end caps.
Maintenance of Microirrigation Systems

Predicting Clogging Problems

"What should I watch for?"

Solutions to Existing Clogging Problems

"I Have a Clogging Problem and I Want to Solve It"

System evaluation for emission device clogging

"How do I determine if I have a clogging problem?"

Routine Maintenance Tasks

"What should I do to keep my microirrigation system running well?"

Microirrigation systems include microsprinklers for tree crops, drip emitters for trees, vines, and some row crops, and drip tape for row and field crops. Microirrigation systems apply water to the soil through emitters that are installed along drip lines and contain very small flow passages. Microirrigation systems can apply water and fertilizers more uniformly than other irrigation methods. This uniformity results in potentially higher yields, higher revenue, and reduced irrigation operating costs.

Uniformity, a performance characteristic of irrigation systems, is a measure of the evenness of the applied water throughout the irrigation system. Distribution uniformity (DU), sometimes called emission uniformity (EU), is an index that describes how evenly or uniformly water is applied throughout the field. A uniformity of 100% means the same amount of water was applied everywhere. Unfortunately, all irrigation systems apply water at a uniformity of less than 100%, and thus some parts of a field receive more water than others. Field evaluations have shown that microirrigation systems have the potential for higher uniformity than other irrigation methods. However, clogging reduces the uniformity of applied water in microirrigation systems, thus increasing the relative differences in applied water throughout a field.

The small flow passages in the emitters and microsprinklers make microirrigation systems highly susceptible to clogging. Clogging reduces the uniformity of the applied water and decreases the amount of applied water. Clogging also decreases the amount of salt leaching around the lateral line in saline soils.
Stay on Top of Your Maintenance
Questions???

Larry Schwankl
559-646-6500 ljschwankl@ucanr.edu

Presentation available at:  http://ucanr.edu/schwankl

Maintenance website:  http://micromaintain.ucanr.edu
Drought website:  http://ucmanageddrought.ucdavis.edu