Soil/Water/Plant/Atmosphere Continuum

Or

Why Water?

ceventura.ucdavis.edu/avocado
A plant must lose water in order to grow.
CO2 + H2O + energy $\leftrightarrow$ sugar + O2
Stomata - openings on leaves

open

closed
Water lost through stomata is called TRANSPIRATION.
Which is the same process as EVAPORATION
Water lost from a landscape or crop is called **EVAPOTRANSPIRATION**
The stomata must be open for transpiration to occur!!!! Otherwise the plant heats up, and sunburn occurs.

RADIATIVE COOLING

And cools the plant
When water stops moving through the plant, nutrients stop moving through the plant

N deficiency
Evapotranspiration is driven by:

- Sun – day length, clouds
- Wind
- Humidity
- Temperature
And there must be leaves
if water is lost through transpiration
NO Leaves, No transpiration !!!!
400 sq. ft.  

250 gallons  

one inch in each equals  

43,560 sq. ft.  

27,154 gallons  

one acre-inch
### Table 12

**Average Daily Evapotranspiration (ET) Rates by Location in California**

<table>
<thead>
<tr>
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<td>0.12</td>
<td>0.16</td>
<td>0.19</td>
<td>0.26</td>
<td>0.23</td>
<td>0.16</td>
<td>0.09</td>
<td>0.03</td>
<td>0.02</td>
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<td>0.02</td>
<td>0.04</td>
<td>0.06</td>
<td>0.08</td>
<td>0.11</td>
<td>0.12</td>
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<td>0.06</td>
<td>0.04</td>
<td>0.02</td>
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<tr>
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<td>0.04</td>
<td>0.08</td>
<td>0.11</td>
<td>0.16</td>
<td>0.20</td>
<td>0.23</td>
<td>0.20</td>
<td>0.15</td>
<td>0.09</td>
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<td>0.25</td>
<td>0.21</td>
<td>0.16</td>
<td>0.11</td>
<td>0.05</td>
<td>0.02</td>
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<td>0.13</td>
<td>0.15</td>
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<td>0.14</td>
<td>0.18</td>
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<td>0.22</td>
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<td>0.12</td>
<td>0.08</td>
<td>0.05</td>
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<tr>
<td>Sierra (Tahoe Basin)</td>
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<td>--</td>
<td>0.10</td>
<td>0.13</td>
<td>0.16</td>
<td>0.20</td>
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<td>Southern California Deserts</td>
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<td>0.06</td>
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</table>

*Source: California Department of Water Resources and University of California (UC), as printed in UC Division of Agriculture and Natural Resources Leaflet #2976. Each of the 11 locations listed is considered a climate zone within the state.*
Different Plant Deal with Water Differently
Fig. 3. Relationship between the percent ground area shaded by tree canopy in midsummer and ETc of drip-irrigated young trees as a percent of ETc of mature orchards (estimated from figure 8 in UC Leaflet 21259).
CIMIS weather station – data and complex equations are used to calculate a reference crop ET

Crop ET = crop coefficient × reference crop ET
ETo x kc = ET plant
ETavocado = 0.65 in/week
27,154 gals/ac-in X 0.65 =
  17,650 gals
17,650 gals /100 emitters/10gph=
  17.7 hrs of irrigation
to replace water lost
In California, we plant avocados on slopes and irrigate all the trees with the same irrigation system and schedule.
9 atmometers
4 quadrants
3 positions
toe
mid-slope
top
The Water Budget Method of Irrigation

ET Loss To The Atmosphere

<table>
<thead>
<tr>
<th>ET Inches/Day</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>1</td>
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<tr>
<td>0.25</td>
<td>2</td>
</tr>
<tr>
<td>0.30</td>
<td>3</td>
</tr>
<tr>
<td>0.30</td>
<td>4</td>
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<tr>
<td>0.35</td>
<td>5</td>
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<tr>
<td>0.35</td>
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</tr>
<tr>
<td>0.30</td>
<td>7</td>
</tr>
<tr>
<td>2.10</td>
<td>7</td>
</tr>
</tbody>
</table>

Soil Available Water

Allowable Depletion

Irrigate

1. When? ——— After 7 Days

2. How Much? ——— Apply 2.10 Inches of Water + Losses (Efficiency Consideration)
THE ROOT PATTERNS OF VARIOUS FRUIT TREES

A

B

C

D

Meters

4

3

2

1

0

1

2

3

4

4

3

2

1

0

1

2

3

4
Avocado roots are shallow, but dense
The soil is a reservoir
approximately 50% pores
and 50% solids
*saturation*-when all pores
are full
*field capacity*-water held
after draining
*wilting point*-water content
  when plant won’t revive
*available water*-between

F.C
and
W.P.
Soil is a reservoir for water

Saturated soil

Field capacity

Water-filled pores

Curved films of water in partially emptied pores

Air spaces
The amount of water in the soil between dry and field capacity is called AVAILABLE WATER.
More water is held in a clay soil than a sandy soil with the same volume of soil.

sand  clay
The speed that water moves in the soil is largely controlled by soil texture – how much sand or clay is in the soil.

Clay has many small pores for carrying air and water.

Sand has bigger, but fewer pores so water moves faster.
Plants need more water in a sandy soil than they do in a clay soil.
Evapotranspiration is driven by:

Sun – day length, clouds
Wind
Humidity
Temperature
Sandy soils need more frequent, small irrigations than a clay soil.

Putting the same amount of water on a sandy soil as a clay soil will push the water deeper in the sandy soil.
Don’t apply water at a greater rate than it can be infiltrated !!!!!!!!
Soil texture affects the wetted pattern
DRIP IRRIGATION WET SPOTS MERGE BELOW THE SURFACE

Zone of continuous moisture
Water Movement

Water

Soil A

Soil B
Water Movement

Water
Roots need air just like we do.
When soil is saturated there is no air for the roots
When soil is dry
Plants wilt
Water movement is controlled by:
1. gravity - down
2. concentration - wet to dry
3. salinity – less salty to more
4. surfaces – toward a surface
Assess Irrigation System Efficiency
Utilize Irrigation Mobile Lab Programs
Resource Conservation District (RCD)

Good Uniformity

Low Uniformity
With poor Distribution Uniformity (DU) also called Emission U

Some plants get too much water and others don’t get enough

Perfect conditions for disease and DEATH
Distribution Uniformity (DU)

- A good DU for groves – 85%
  - 15% more water to meet needs of all the trees
- Poor DU
  - Plugged sprinklers and lines
  - Breaks and leaks
  - Poor pressure regulation
Trees need 128 gallons of water. Leaching fraction of 10% adds another 12 gals.
What causes poor DU?
Irrigation System Maintenance

- Check poly hose systems
- Flush lateral lines
- Clean filters
- Repair sprinklers
Salt Accumulation in Tree Crop Orchards Using Micro-Spray Irrigation

CDWR 2003
Emitters

All companies use different colors

In-Line Dripper

dripper

microsprinkler

fan jet
Total Dissolved Solids (TDS) <1000 ppm

Specific Ions
Chloride <100 ppm
Sodium <100 ppm
Boron <1 ppm
The Problem with Total Dissolved Salt:
High Salt Inhibits Plant Water Uptake

For avocado, this occurs at EC = 4 dS/m

From D. Crowley, UCR, 2013
Avocado Yield Function for Irrigation Water Salinity


From D. Crowley, UCR, 2013
Salt flush at beginning of each irrigation set. EC range between leaching is \(.75\) to \(2.9\) dS/m.

Soil water potential (plant available water) decreases from 0 to \(-427\) cbars between irrigation sets.

Soil volumetric water content at saturation is \(37\%\) decreasing to \(22\%\) as soil water potential reaches wilting point. Total available water \(~40\%\).

Irrigation timer indicates that trees are being watered every 3 weeks.

From D. Crowley, UCR, 2013
One acre-foot of water (average house uses $\frac{1}{4}$ that)
With a TDS of 640 ppm
Has nearly a ton of salt
Soil water quality can be no better than the initial quality of the applied water.

So need to Leach

**LEACHING REQUIREMENT**

- Most irrigation water contains dissolved salts.
- Evaporation removes pure water, leaving a concentration of salt in the soil.
- Salt concentration may reach a level that is detrimental to the growth of the crop and should be controlled. The only practical way of achieving this is by leaching.

*Leaching requirement* is an extra water needed to pass through the root zone in addition to the normal requirement to ensure that salts are placed below the root zone.
Schedule Irrigations Properly

• Proper Scheduling of Irrigations in Avocado Production

How much to put on, when?
Irrigation and Water Use Efficiency

Instructions for the Irrigation Scheduling Calculator

- English
- Español

Principles of Irrigation

Select a Crop: Avocado

Kc Source: California (New Values)

Reference Evapotranspiration (ETo): in./day or period

Crop Coefficient (Kc):

Distribution Uniformity (DU):

Leaching Requirement (LR):

Method:
- Trees per Acre:
- Tree Spacing

Number of Emitters per Tree:

Surface area under tree canopy (ft²):

Emitter Output (Gal/Hour):

Grove Size (acres):

Data Source: <SELECT SOURCE>

All fields with yellow boxes must be filled out, white fields are optional.

Calculate

Click on 'Calculate' after any changes are made to recompute totals.

Water per tree per day or period: gallons

Watering time per tree per day or period: hours, minutes

Total Water Requirements for Grove: gallons

Allocated Water for Grove: gallons

Shortfall: gallons

English Units

Metric Units
Irrigation Check List

Where are the roots?
Where is the water?
What is the water quality?
How evenly is it applied?
How fast is the water disappearing?
How soon does it need to be replaced?
How much extra water needs to be applied to compensate for poor DU?
How much needs to be applied to leach salts?
How much maintenance is required?
Hope for more of this