Avocado Irrigation

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Subtropical Horticulture

Special Challenges in Avocado Irrigation

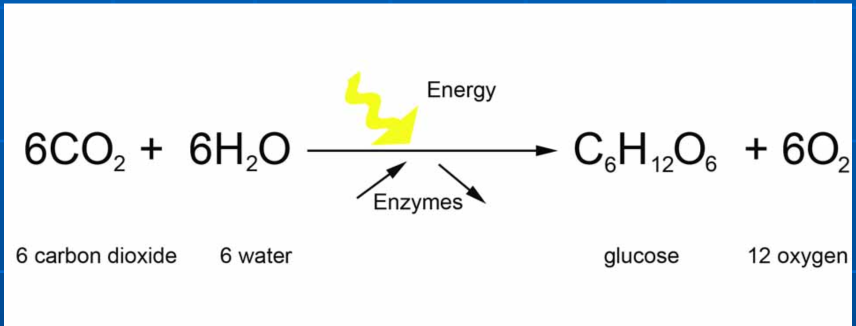
- 80-90% of the feeder root length is located in the upper 8 inches of the soil profile
- Inefficient at absorbing water (few root hairs)
- Many of the groves are located on steep hillsides with decomposed granite soil, this drains rapidly but doesn’t store water well
- Avocados are heavy water users, water is expensive, most people irrigate less than is required for optimum yields

Special Challenges in Avocado Irrigation

- There must be some over-irrigation periodically to leach salts out of the soil
- If leaching is not done, chloride-caused tip-burn will result, eventually reducing yields

Reasons for Watering

- Photosynthesis to create carbohydrates
- All secondary reactions
- Transportation medium for fertilizer salts
- Fills the plant and maintains plant stucture
- Cooling
- Leaching of salts in the soil



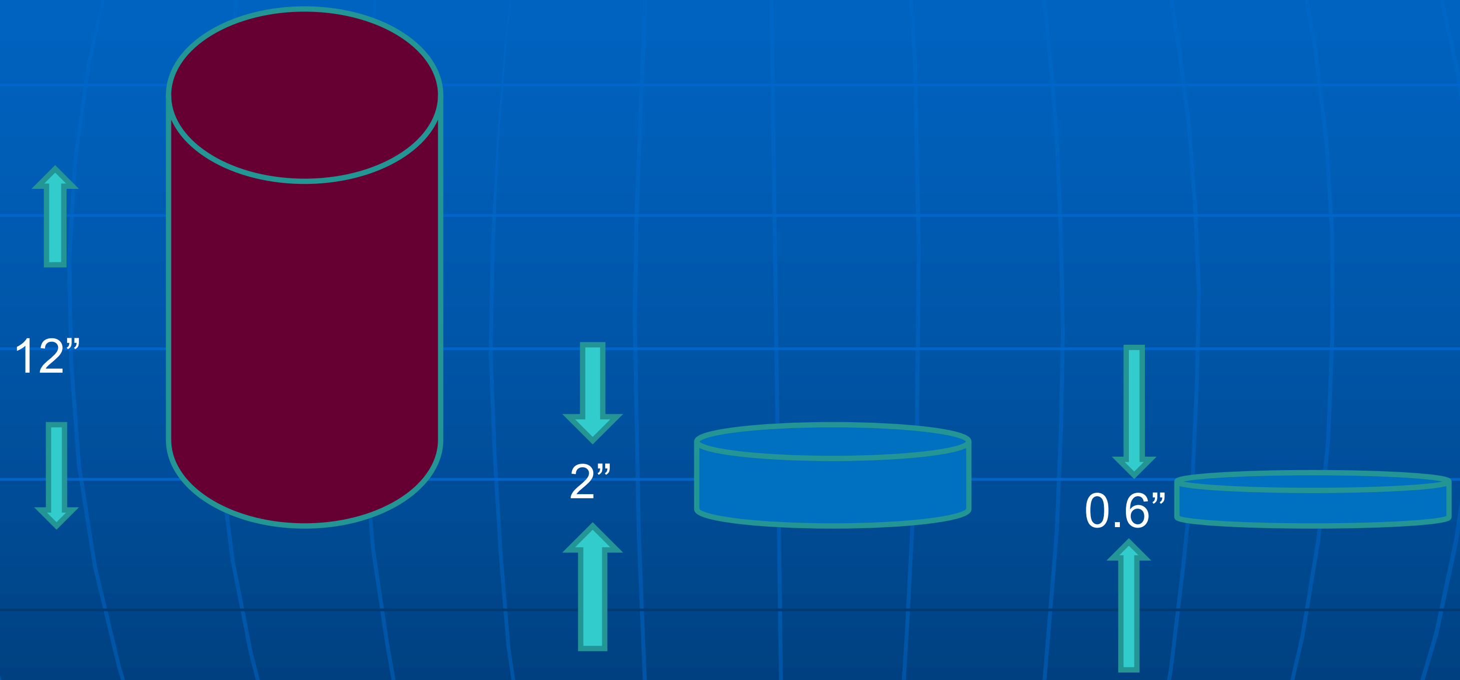
Irrigation Scheduling

- The most important cultural operation in the grove
- Need to know both ***frequency*** of irrigation and ***how much*** water to apply during an irrigation event

Frequency

- Irrigate when 30% of soil moisture is lost (decomposed granite soils) or when 50% of soil moisture is lost (clay soils)
- Therefore, you must check soil moisture content
  - Shovel
  - Tensiometer 30% moisture depletion = 20 cb reading on the instrument (in coarse soils)
  - Gypsum blocks (WaterMarks) (do not read well from 0-10 cb)
  - Portable electrical meters (some work well, but the tips are sensitive to cracking and breaking in rocky soils

Loam soil, 2” water per 1’ of soil



Tensiometers

- Must be within the wetted area of the mini-sprinkler or dripper
- Should be placed 2-3 feet away from the sprinkler on the contour of the hill
- Set one tensiometer 8” below the soil surface (in d.g. soils)
- Set another tensiometer 20” deep (this helps to know when to turn off the water usually at 10cb, or to irrigate for a longer period of time if it remains too dry)

Tensiometers

- Maintain them on a regular basis
  - Fill with water
  - Pump out air bubbles
  - Replace cork once a year
- Protect them from the pickers
- If the soil gets too dry (tensiometer reads 80), the clay cup breaks tension from the soil and you need to pull it out, fill it and re-pump it

Measuring Soil Moisture – Simple and Cheap Methods

- Tensiometers
  - Labor intensive to collect data
  - Requires regular maintenance
  - Can be inaccurate in extremely wet or dry soils
  - Not accurate in very sandy soils
  - Indicates when to apply, not how much to apply

Simple

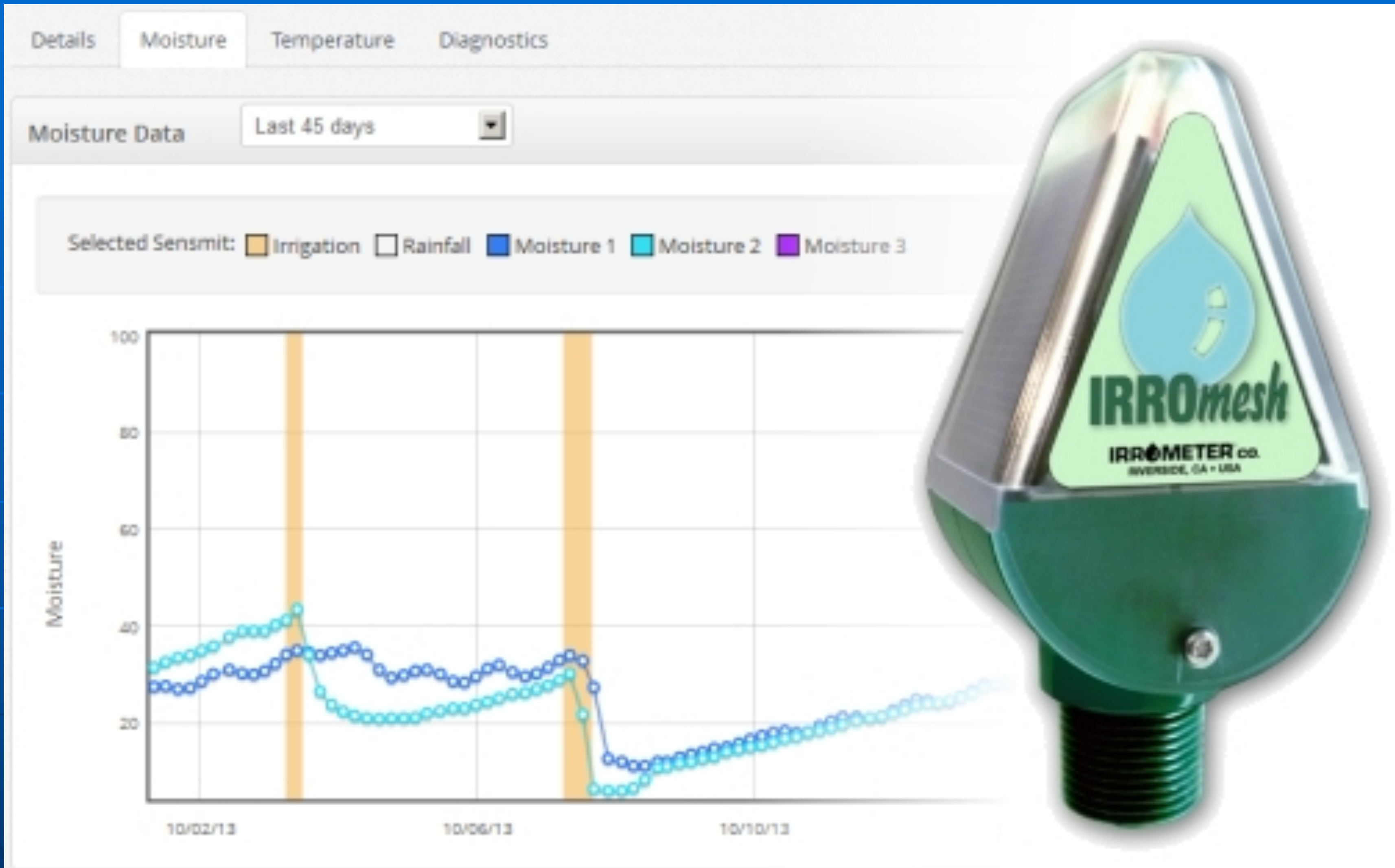
(and relatively cheap devices)

- Gyspsum blocks (Water Marks®)
  - Labor intensive to collect data
  - Needs a digital meter
  - Can be inaccurate in extremely wet or dry soils
  - Indicates when to irrigate, not how much
  - Older models only lasted 18 months due to breakdown of gypsum, newer versions are supposed to last five years

Watermark Soil Moisture sensor (Item 6450)

More Expensive Methods

- Capacitance probes
  - Measure change in dielectric constant in the soil
- Neutron probes
  - Used only by researchers and irrigation consultants


Details
Moisture
Temperature
Diagnostics
Moisture Data
Last 45 days
Selected Sensmit:
Irrigation
Rainfall
Moisture 1
Moisture 2
Moisture 3
100
80
60
40
20
Moisture
10/02/13
10/06/13
10/10/13
IRROmesh
IRROMETER co.
RIVERSIDE, CA • USA

An Example: the Irromesh System

Irrometer Company, Riverside,CA

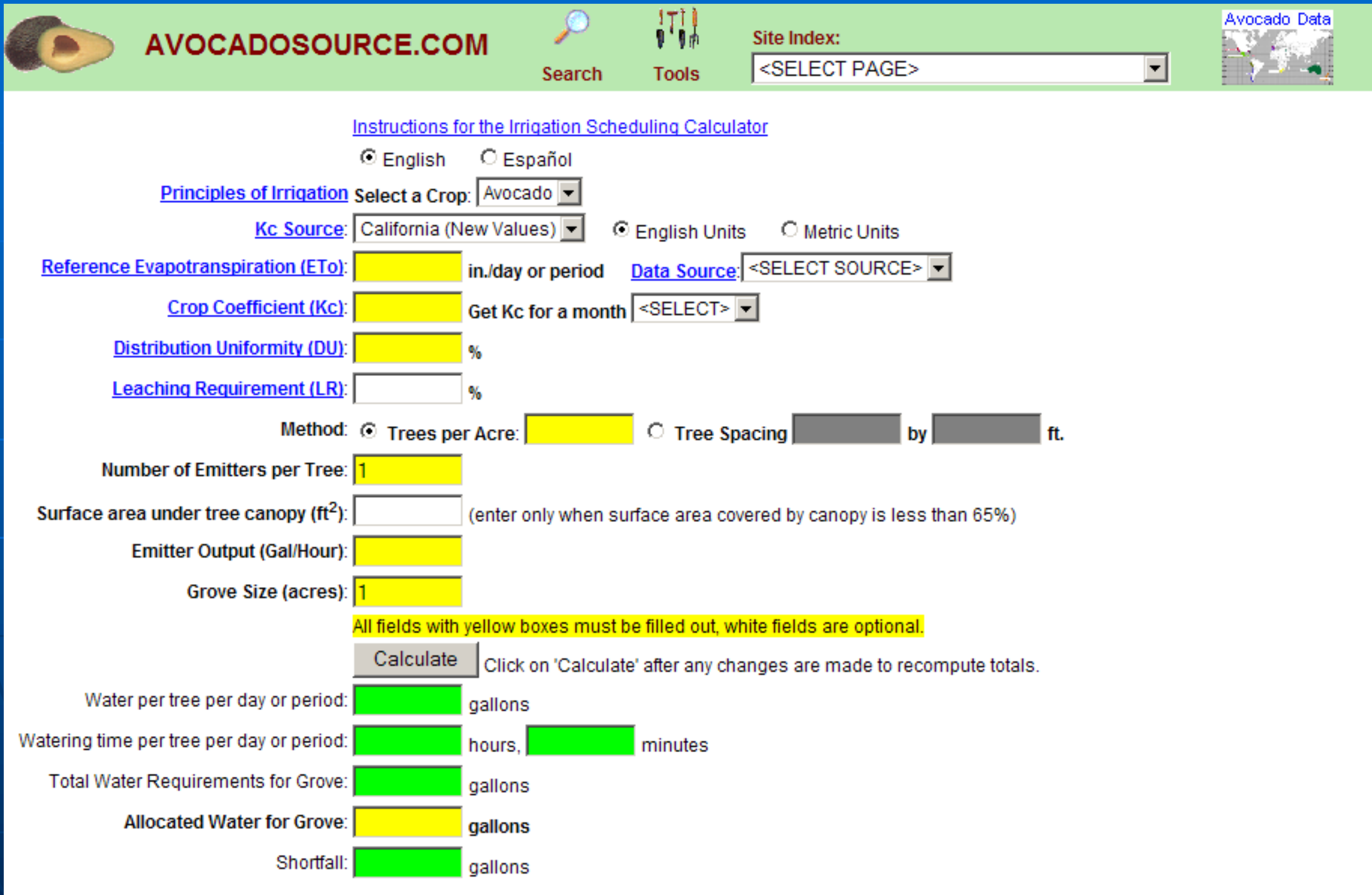
"IRROmesh is a compact, solar-powered, wireless system for in-field measurement of soil moisture, temperature, and other parameters. Sensor data from each node is routed through an interactive mesh network back to a central point where it can be uploaded to the web and made accessible to anyone with an Internet enabled PC or smart device, or stored locally for collection. Each node is capable of reading three soil moisture sensors and a soil temperature sensor, along with inputs for recording irrigation events and rain gauge data."

Utilizing the proven and economical WATERMARK soil moisture sensors, IRROmesh allows growers to collect real-time data from sensors all over the farm/vineyard and instantly review it to make informed irrigation scheduling decisions. Each IRROmesh radio node automatically relays messages forward, enabling economical data collection over large areas."

How Much to Irrigate

- Use CIMIS to determine how much water a tree is using on a daily basis
- Eto x Kc = Etc
  - Divide this by the distribution uniformity (du)
  - If du is 1, that means you have every sprinkler putting out the exact same amount of water
  - Average du is 0.8
- When it is time to irrigate (as indicated by your tensiometer) apply the amount per day times the days between irrigations
- Add 10% amount for leaching of salts

Irrigation and Water Use Efficiency



Irrigation Scheduling Calculator

Instructions for the Irrigation Scheduling Calculator

(•) English ( ) Español

Principles of Irrigation **Select a Crop**: Avocado

Kc Source: California (New Values) (•) English Units ( ) Metric Units

Reference Evapotranspiration (ETo): 1.18 **in./day or period** **Data Source**: <SELECT SOURCE>

Crop Coefficient (Kc): .86 **Get Kc for a month** August

Distribution Uniformity (DU): 85 %

Leaching Requirement (LR): %

Method: (•) **Trees per Acre**: 100 ( ) **Tree Spacing** by ft.

Number of Emitters per Tree: 1

Surface area under tree canopy (ft^2): (enter only when surface area covered by canopy is less than 65%)

Emitter Output (Gal/Hour): 17

Grove Size (acres): 1

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: 324 gallons

Watering time per tree per day or period: 19 hours, 4 minutes

Total Water Requirements for Grove: 32418 gallons

Allocated Water for Grove: **gallons**

Shortfall: 32418 gallons

The expanded irrigation calculator:
The irrigation calculator has been expanded to provide the user more variables to consider when scheduling water usage. These include:
The ability to vary the DU to examine how improving irrigation uniformity can conserve water
The ability to designate canopy coverage (i.e. young trees, tree removal or stumped trees)
The ability to designate both the number of emitters per tree and their output to account for multiple emitters per tree

Background:
The water allocation for farmers in the MWD-supplied water districts of southern CA will be cut by 30% beginning Jan 1, 2008. Most avocado groves affected by the cuts are planted on hillsides with shallow decomposed granite soils with low holding water capacity. The avocado requires approximately 3-4 acre feet per year. Additionally, avocado is the most salt sensitive tree crop and requires careful water and leaching management to avoid yield decline due to the effect of salts.
Irrigation management on hillsides is difficult. A key factor in irrigation efficiency is the DU (distribution uniformity). It is not unusual to find groves with DU of 65% or less. The main reasons for the low DU are poor pressure regulation and inadequate infrastructure design (often due to conversion from low volume drip to greater output micro emitters).

Created by Reuben Hofshi and Shanti Hofshi

This calculator is a revision of the CIMIS calculator by R. Hofshi, S. Hofshi and B. Faber (www.avocado.org).

Things to Remember

- Avocados use water all year long. If it rains in the winter, calculate "effective" rainfall, extra rain is lost by gravity and run-off
- Water use changes constantly according to temperature, light, humidity, and wind. Setting a timeclock is dangerous because it encourages you not to re-set it each week

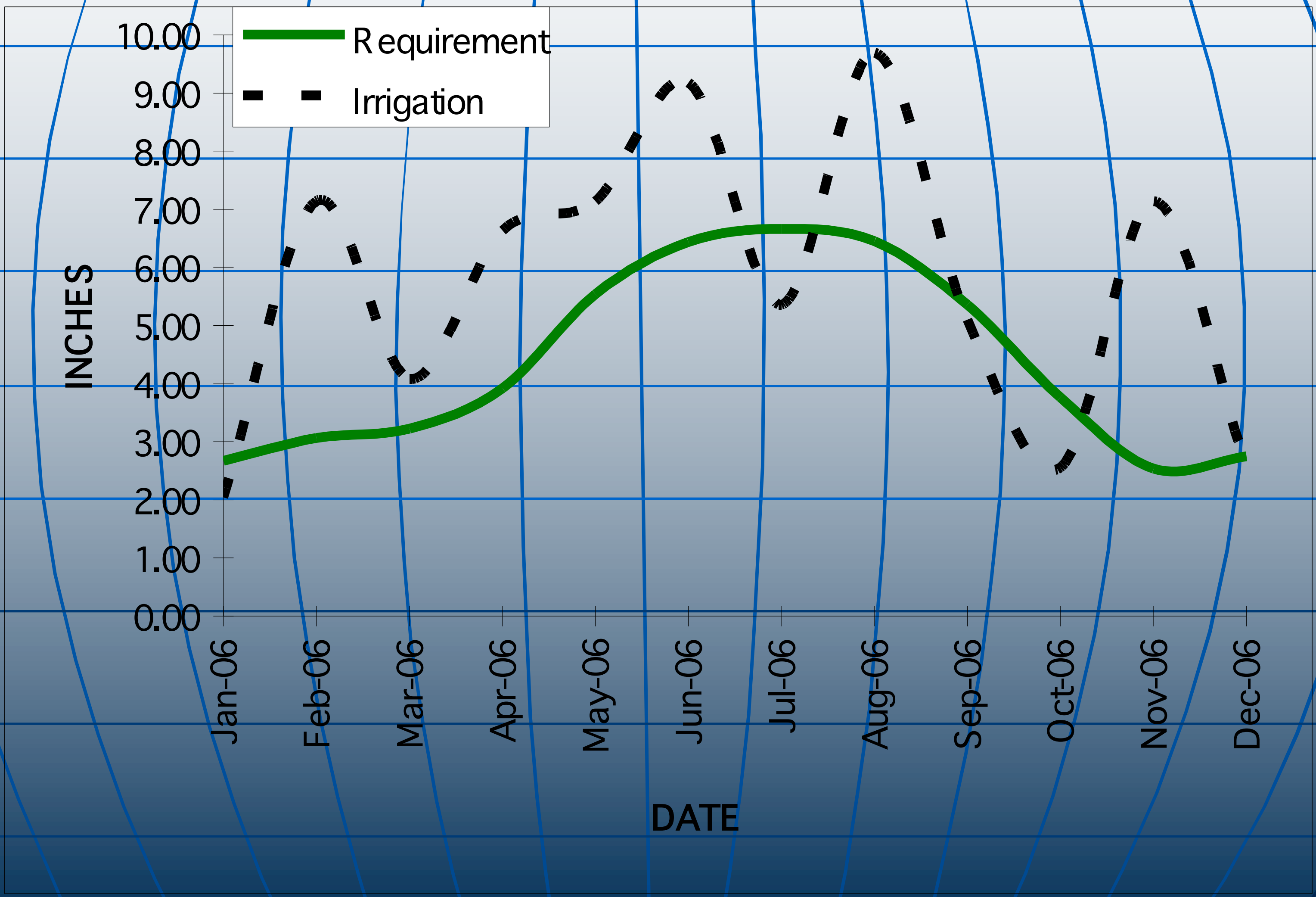
Things to Remember

- Water use changes according to the number of leaves
- Control weeds – they also use water
- Historical water tables are somewhat useful, but dangerous. (the weather changes a lot!)

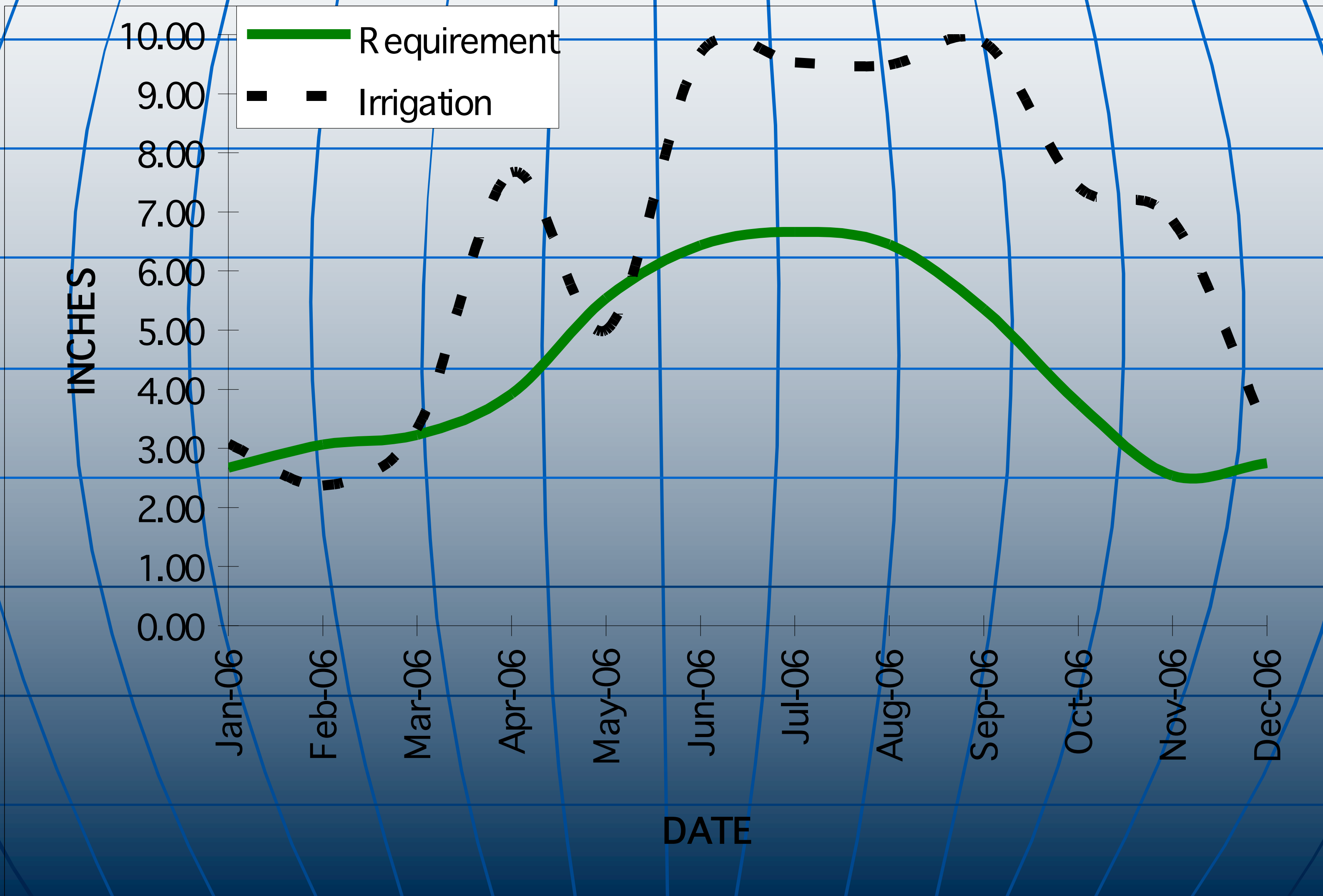
The “Guessing” Method of Irrigation Scheduling

- It can work if you are a darn good guesser!
- But most of us aren’t (see next two slides)

Year Totals	6725	46.2	52.4	68.6	131
Acre Feet =	15.4	irrigated acreage does not include outbuildings, roads, or landscaping			
Gallons =	5030300			Irrigated Acres =	2.7



Year Totals	7602	46.2	52.4	77.6	148
Acre Feet =	17.5	irrigated acreage does not include outbuildings, roads, or landscaping			
Gallons =	5686296			Irrigated Acres =	2.7



Soils and Irrigation

- Irrigation water requirement is driven by the weather, not the soil type. Soil is important, however, because soil stores the water.
- Sandy soils (coarse soils) hold less water than clay soils. Thus trees on sandy soils need to by irrigated more often.

Parts of an Irrigation System

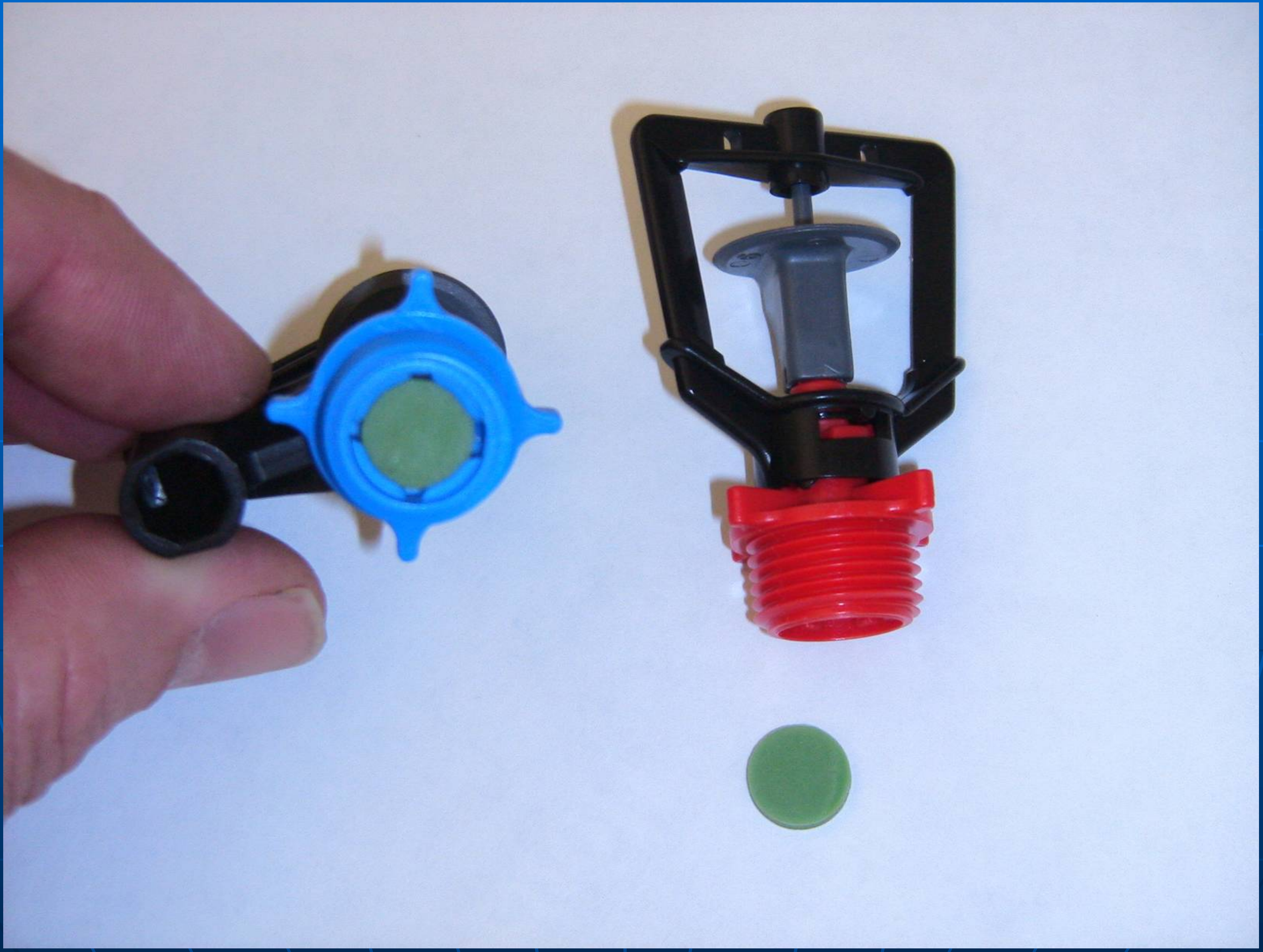
1. Pump and motor (if you have a well)
2. Water meter (if you are on district water) See Table 7 for water meter capacity
3. Reduced pressure (RP) backflow device
4. Main valve
5. Bermad valve or electrically operated valve
6. Flowmeter and pressure gauges
7. Air-vacuum relief valves
8. Injection equipment
9. Filter
10. Sub-main valves to various parts of the grove
11. Pressure regulators (usually pre-set) on each lateral line
12. Emitters
13. Your feet in the grove to "walk the lines"

Water Meter Capacity

Meter size	Capacity in GPM (1)	Suggested acreage served (2)	Acres at 5.4 GPM/acre (3)	Acres at 8.4 GPM/acre	Connection fees for FPUD and SCWA Combined (4)
¾ inch	16 - 24	0 - 1	3.7	2.4	$ 9,492
1 inch	40	1 - 3.5	7.4	4.8	$ 15,188
1 ½ inches	80	3.5 – 8	14.8	9.5	$ 28,476
2 inches	145	8 – 15	26.9	17.3	$ 49,358
3 inches	265	15 – 35	49.1	31.5	$ 91,124
4 inches	440	35 – 80	81.5	52.4	$ 155,168
6 inches	840	80 +	155.6	100.0	$284,760

Common Design Problems

Lack of Pressure Regulation



Pressure Regulators

Common Design Problems

Lack of Pressure Regulation

Common Design Problems

This is what you need!

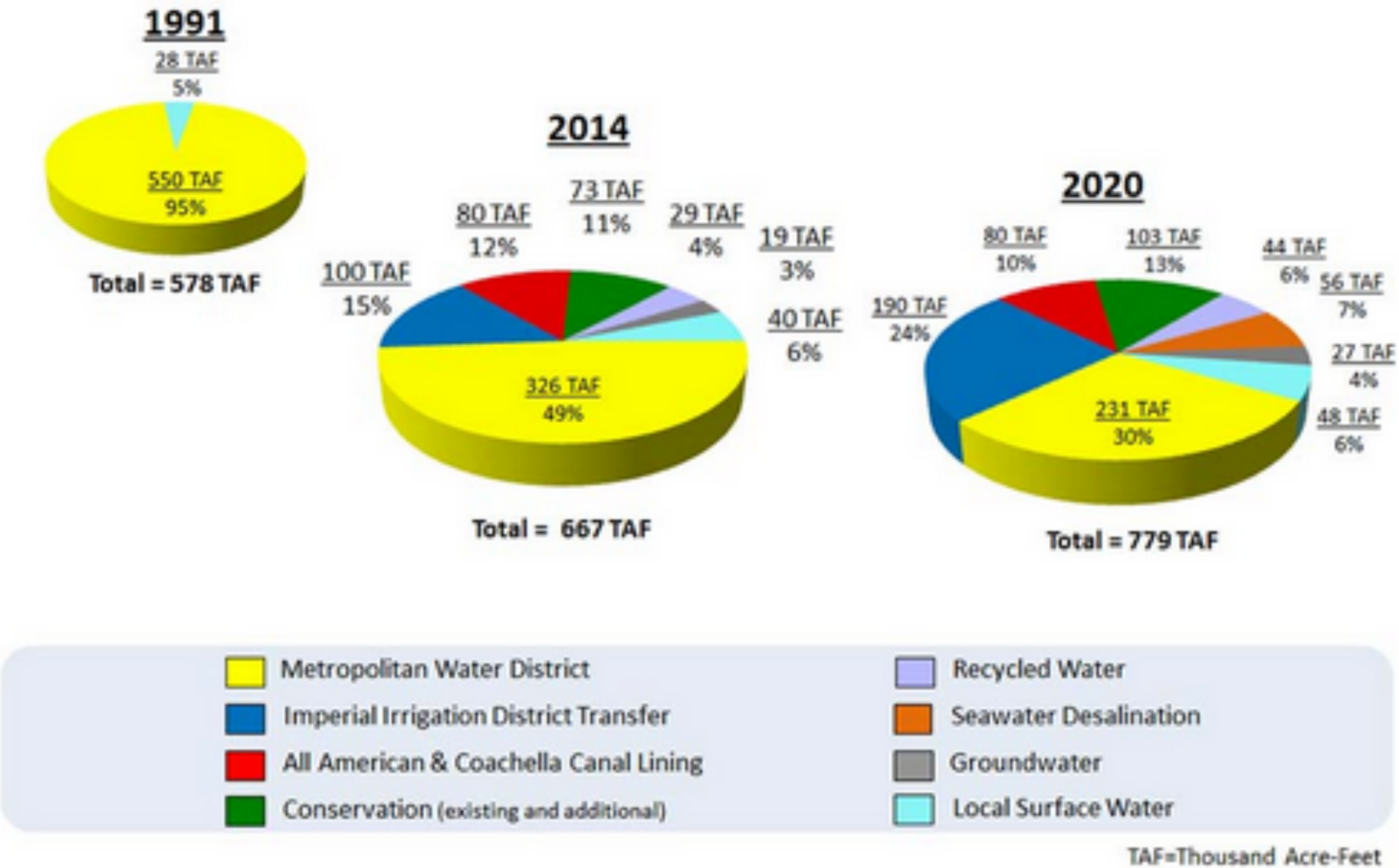
Irrigation System Maintenance

- Check poly hose systems
- Flush lateral lines
- Clean filters
- Repair sprinklers

Water Supply

- Avocado is the most sensitive tree crop to salts in water (of all the commercially grown varieties of fruits and nuts in California)
- What about the EC of water?
  - no loss in yield = EC 0.9
  - 10% loss in yield = EC 1.2
  - 25% loss in yield = EC 1.7
  - 50% loss in yield = EC 2.4
    - *From R. S. Ayers, Journal of Irrigation and Drainage, ASCE Vol. 103, June 1977*

Increasing San Diego County's Water Supply Reliability through Supply Diversification



Reclaimed Water?

- In one five year trial in Escondido, reclaimed water (EC=1.5) reduced yield by 40% compared to district water (EC=0.7)
- Many wells in San Diego have EC of 1.2-1.7)

Your Lab Report

- EC means electrical conductivity of water, the higher the number = easier for electricity to travel through water = more salt in the water
- EC of water

  1.0 dS/m = 640 ppm total dissolved solids (salts)

  Some labs report the EC in mmhos/cm, which makes the EC number 1000 times higher

Chloride Tip Burn on Avocado

What does Salinity do to Avocado?

1. Osmotic potential in soil increases, making it difficult for roots to extract water from soil.
    1. Water may leave the roots, even during an irrigation
    2. This would happen at an EC = 4
2. Sodium may accumulate in soil replacing calcium and magnesium, destroying soil structure.
3. Chloride uptake causes “tip-burn” in leaves. These leaves must drop and be replaced. Tree focuses energy on leaf replacement and not flowering and fruiting

What can you do about salinity?

- Leach!

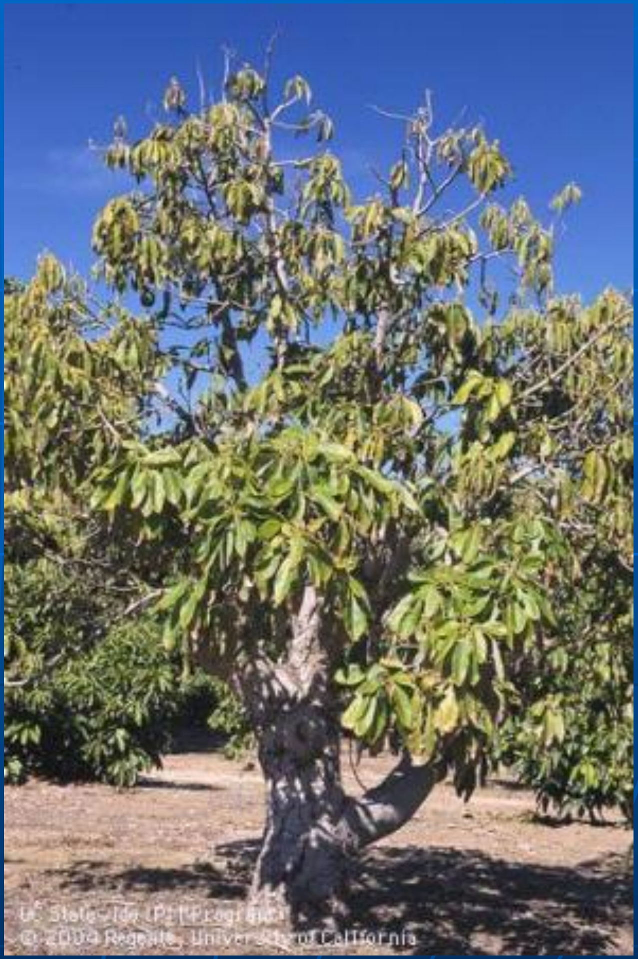
Creating less salty water by doing reverse osmosis works, but what do you do with the brine? (without getting in trouble?)

➡ There are no “magic” solutions that work!

- there is no evidence that a device can “inactivate” salts

What if you don't have enough water?
Root Rot Infected Trees

- Do a critical evaluation of the crop
  - No crop?
    cap your sprinklers

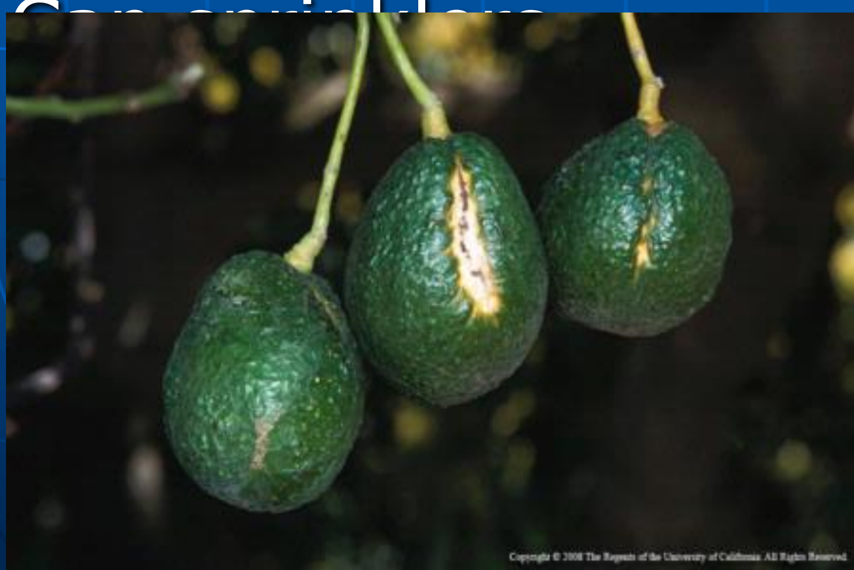


Mulch

- Concentrate on most productive areas

Sunblotch infected trees

- Deep grooving in fruit
- Rough bark on lower trunk
- Remove trees
- Can sprinklers



Trees in wind-prone areas

- Windbreak trees that lose fruit every year
- Cap sprinklers

Tall tre

- Stump to 4-5 ft
- Whitewash to protect bark
- Cap sprinklers for about 2 months
- Gradually increase watering

Thin the grove

- Remove every other tree and cap sprinklers
- Increase water to remaining trees
  - Roots will have been growing into neighboring trees
  - Change sprinklers to wider pattern

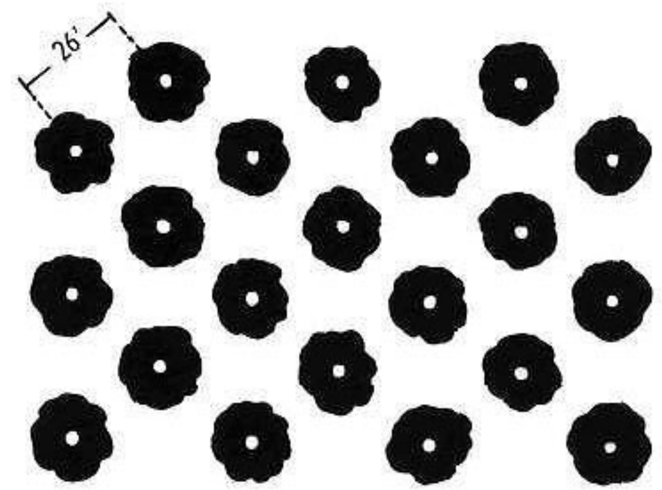
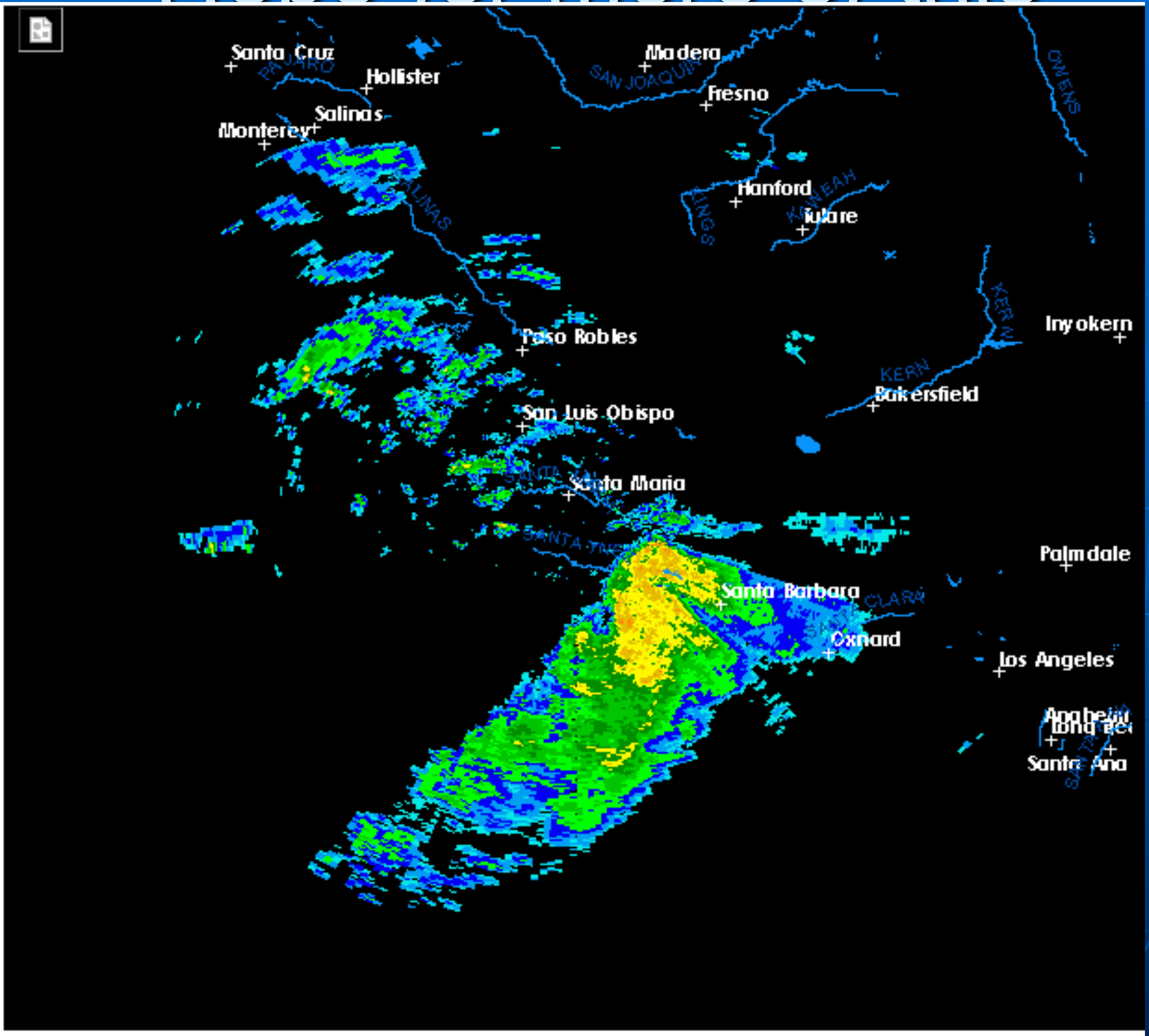


FIGURE 5. Orchard after first thinning—68 trees per acre.

Prune

- Removing half the foliage doesn't reduce water use by half
- Estimates would be 20-30% reduction
  - Increased light within canopy
  - Increased air flow

Hope for more of this



Difficulty:
Which part of the grove uses more water?

Lastly, Don't do This!
Furrow Irrigation of Avocados in Riverside
(a thing of the past!)