Irrigation Management of Young Pistachios

Young Orchard Irrigation and Nutrient Management Workshop

Tobias Oker

Farm Advisor – Soils & Irrigation, Kern County

teoker@ucanr.edu

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UC CE UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources Cooperative Extension

Contents

1. How much water young pistachio trees need?
2. How do you apply the water the trees need?
3. What other factors to consider?

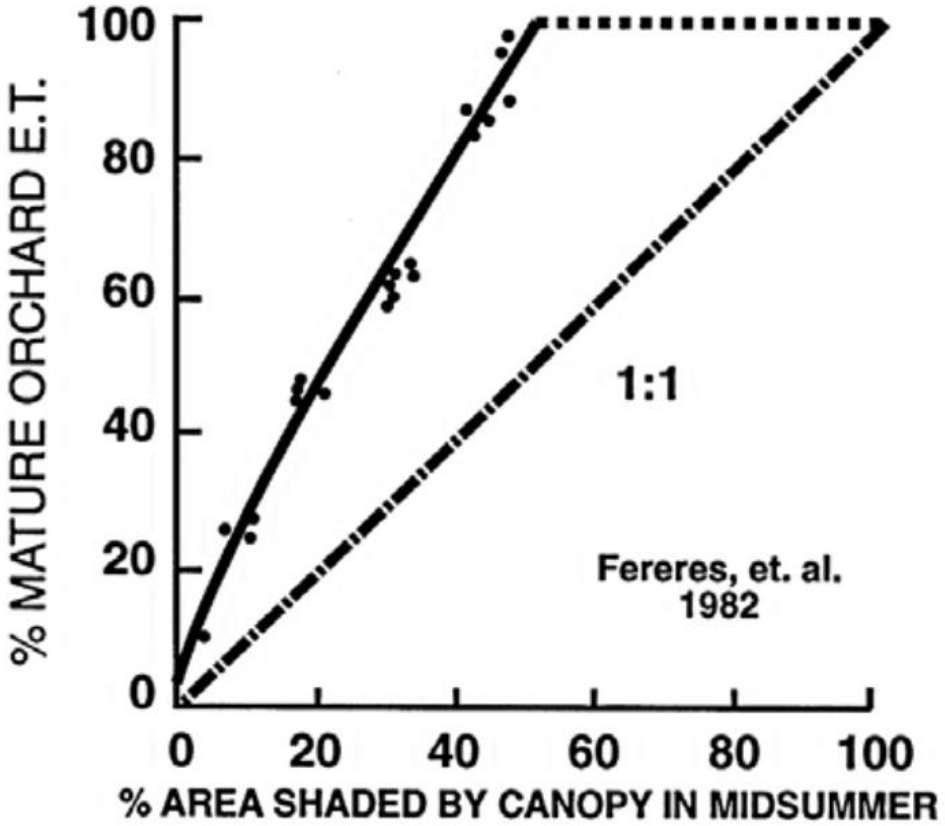
Pistachio production in California

- Acreage steadily increasing in California
- New plantings southern San Joaquin Valley
- Acreage (Administrative Committee for Pistachios, 2023)
  - Current bearing ≈ 605,442 acres
  - Non-bearing ≈ 144,000 acres
  - New yearly plantings (5-year average) ≈ 29,000 acres
- Young pistachio trees are those that of non-bearing age

1. How much water do young pistachios need?

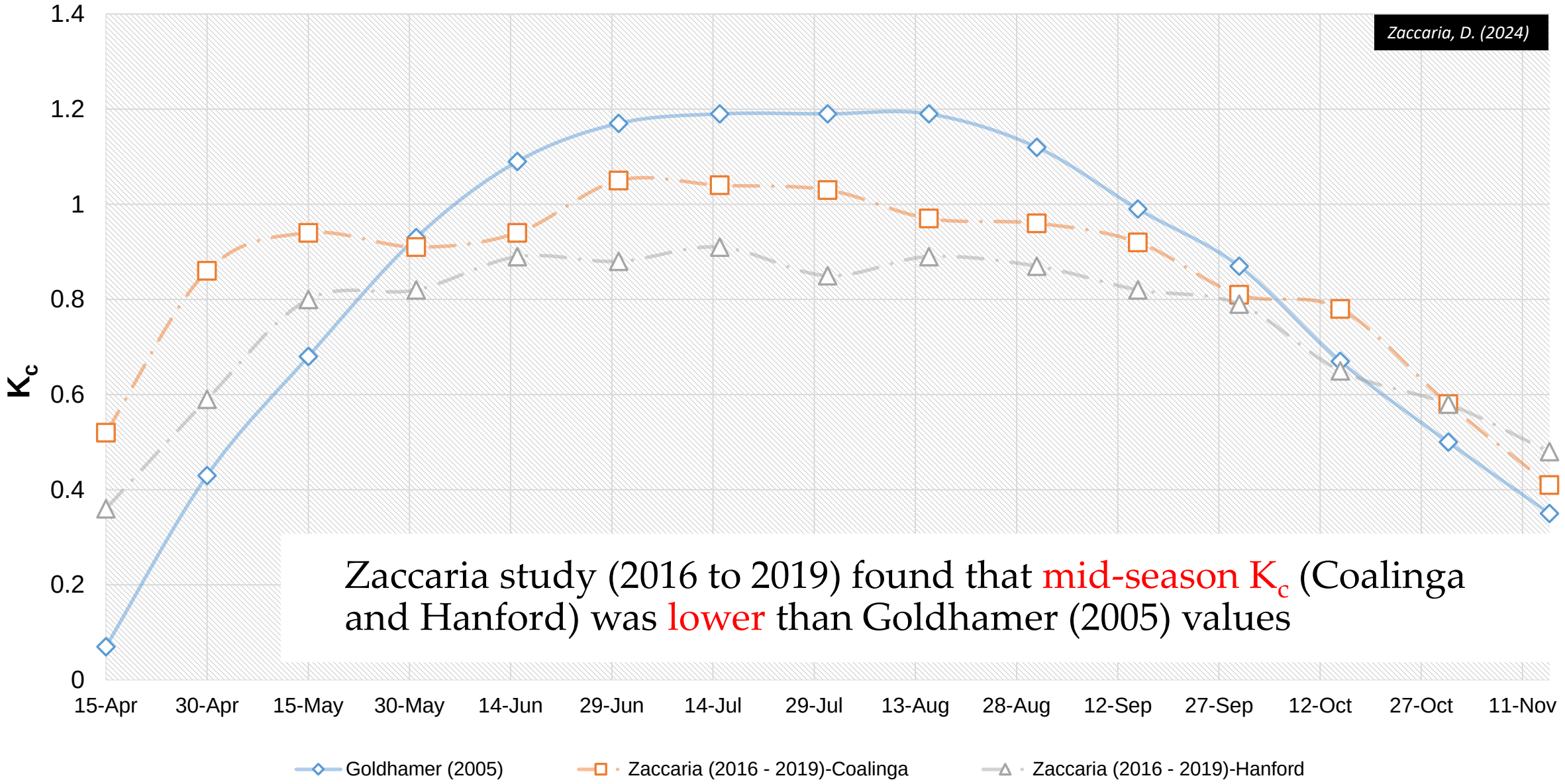
Spacing and tree water requirements

- There is currently no crop coefficient curve for young pistachio
- Mature pistachio crop coefficients: Goldhamer D. (2005), Zaccaria D. (2024)
- Spacing: Row = 20 to 22 ft; Tree = 15 x 20 ft.
  - Area/tree = 300 to 440 ft^2/tree
- Tree grows to cover most of this space by the time it reaches maturity
- Strong linear relation between canopy shading and ET
  - Small canopy in young trees
- Mature pistachio ≈ ET 46 in/season in SSJV
  - Peak daily ≈ 0.34 inches/day (July)
- Max ET when canopy shade is about 50 and 60%.
- ET **adjustment factor** for young pistachios



Goldhamer D. (2005)

Pistachio crop coefficients (K_c)



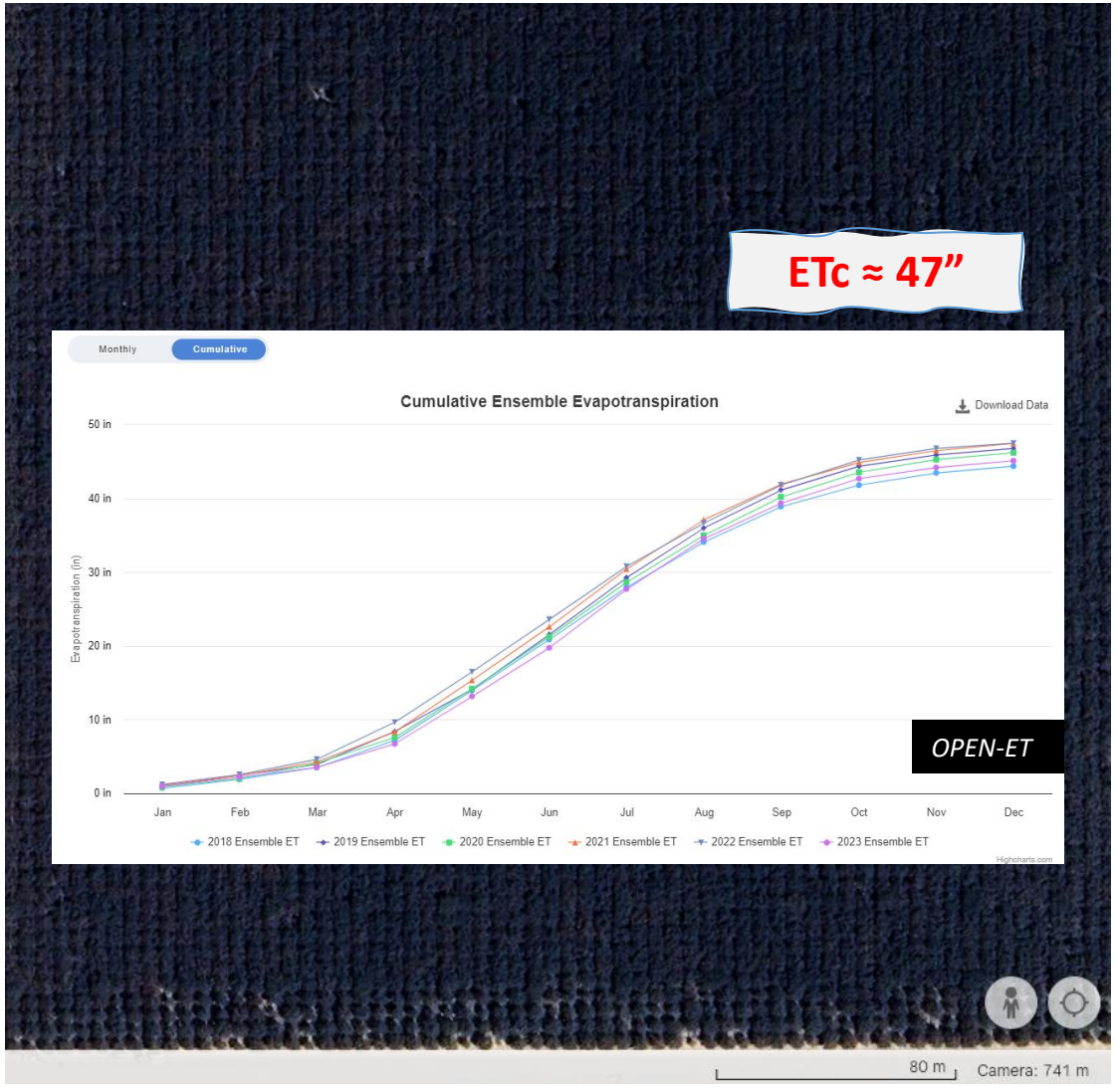
Zaccaria study (2016 to 2019) found that mid-season K_c (Coalinga and Hanford) was lower than Goldhamer (2005) values

Pistachio crop coefficients -California

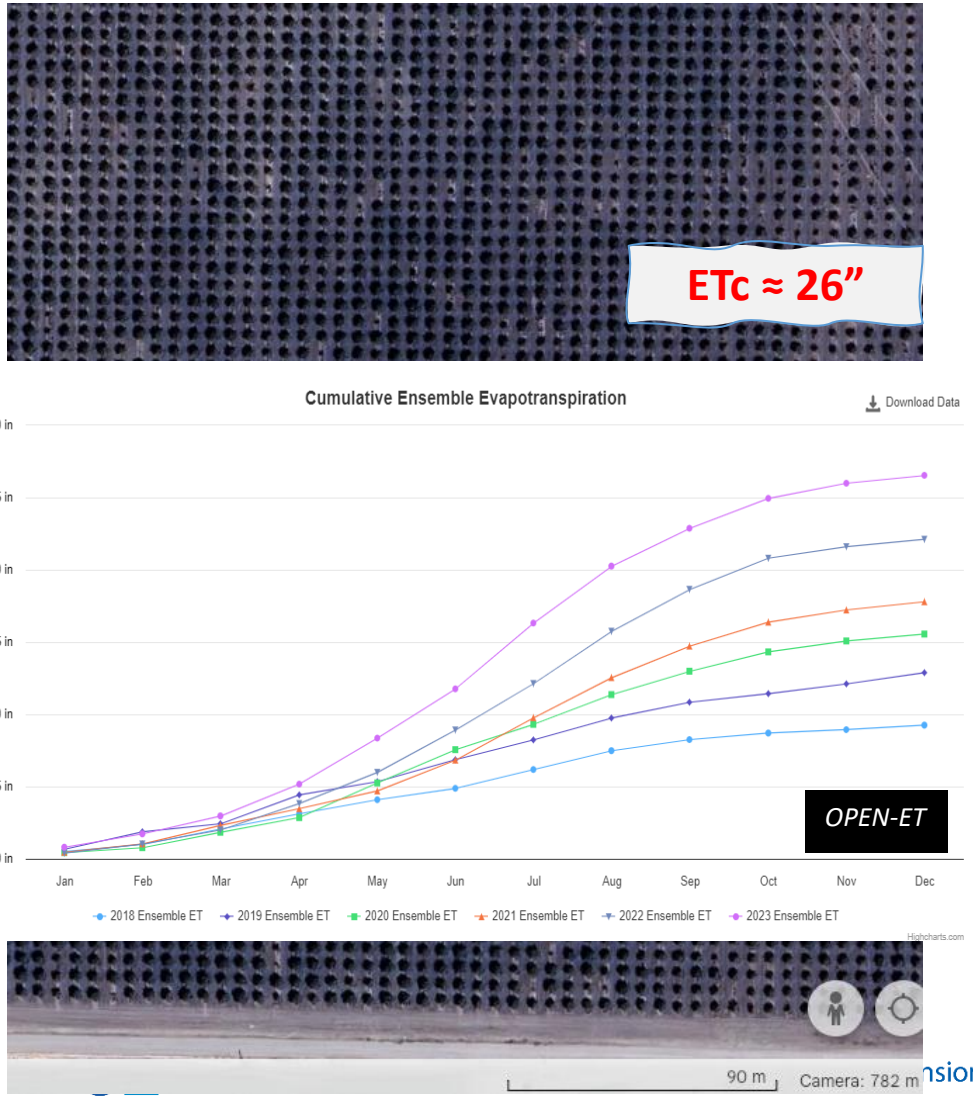
Date	Goldhamer (2005)	Zaccaria (2016 - 2019)-Coalinga	Zaccaria (2016 - 2019)-Hanford
15-Apr	0.07	0.52	0.36
30-Apr	0.43	0.86	0.59
15-May	0.68	0.94	0.8
31-May	0.93	0.91	0.82
15-Jun	1.09	0.94	0.89
30-Jun	1.17	1.05	0.88
15-Jul	1.19	1.04	0.91
31-Jul	1.19	1.03	0.85
15-Aug	1.19	0.97	0.89
31-Aug	1.12	0.96	0.87
15-Sep	0.99	0.92	0.82
30-Sep	0.87	0.81	0.79
15-Oct	0.67	0.78	0.65
31-Oct	0.5	0.58	0.58
15-Nov	0.35	0.41	0.48

Pistachio spacing and water requirements

Canopy of mature pistachio orchard with full



Canopy of 10-year pistachio in highly saline-sodic soil



ET adjustment factors for young pistachios

Normal Year Grass ETo	[1]Pistachio Crop Coefficients Kc	Drip Year 1	Drip Year 2	Drip Year 3	[2]Drip Year 4 & FJ Year 1	Drip Year 5 & FJ Year 3	Drip Year 6 & FJ Year 5	Year 7	Year 8	Year 9 (>65% cover)
Adjustment Factor		**0.10**	**0.20**	**0.30**	**0.40**	**0.52**	**0.65**	**0.78**	**0.90**	**1.00**
0.21										
0.28										
0.30										
0.36										
0.42										
0.47										
0.54										
0.61										
0.69										

Note: the below numbers are a guide only. There are some areas of Kern County where elevated soil/water salinity reduces pistachio ET by as much as 15 to 25%. There are other locations where adjacent canals and sand layers allow shallow groundwater to move out under fields and be taken up by pistachio roots -- reducing the need for surface applied irrigation water. Augering/probing for current soil moisture levels in the orchard rootzone is the only way to insure that you are not deficit or overirrigating.

4,000 lb/ac pistachios have been grown in Kern County with as little as 30 inches to as much as 48 inches of water.

Sanden B. (2006)

Example:

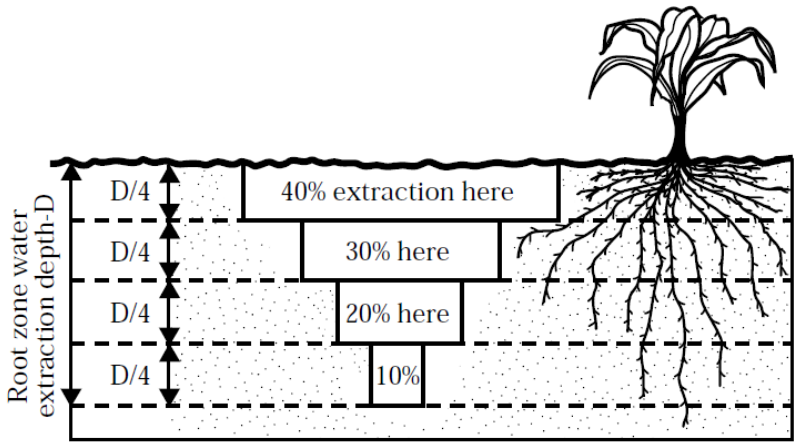
- If weekly ET for mature tree is 2.4 in.
- ET for drip irrigated 2nd - leaf tree = 0.2 x 2.4 = 0.48 in/week

Adjustment factor

2. How do you apply the water the trees need?

Pistachio root systems

Figure 3–2 Typical water extraction pattern in uniform soil profile



Note: Approximately 70 percent of water used by plants is removed from the upper half of the plant root zone. Optimum crop yields result when soil-water tensions in this area are kept below 5 atmospheres. Very thin tillage pans can restrict root development in an otherwise homogenous soil. **Never assume a plant root zone.** Observe root development of present or former crops.

USDA/NRCS

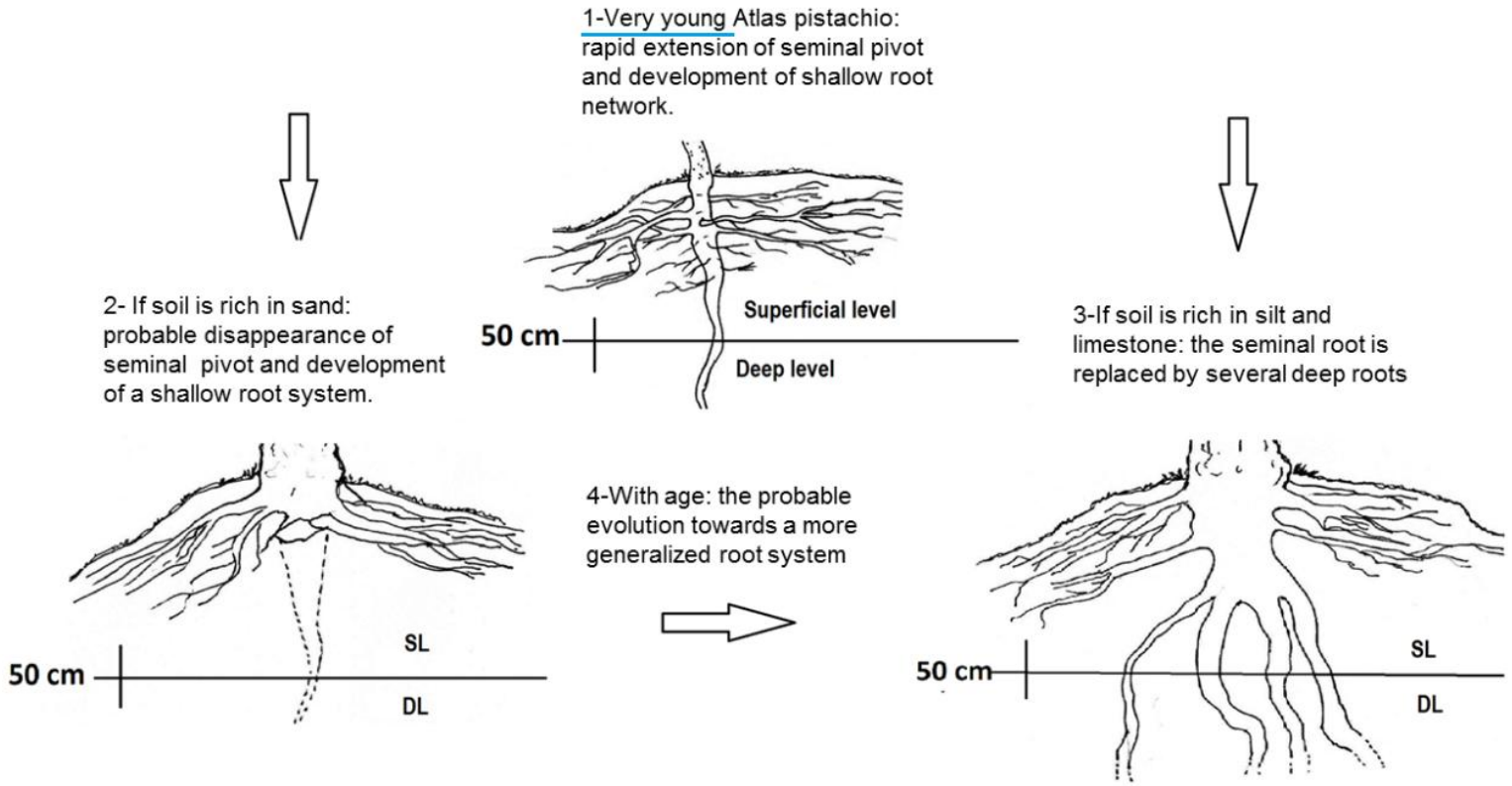


Figure 3. Evolution of Atlas pistachio root system in relation to underlying soils in the El-Mergueb National Reserve, M'sila, Algeria.

- **Pistachios are phreatophytes (deep rooted)**
  - Roots up to 20 ft (6 m) – mature Atlas pistachio trees

Pistachio irrigation using Microirrigation

- Microirrigation is very efficient (≥ 90%)

Mature pistachio irrigation using microsprinklers in Kern County

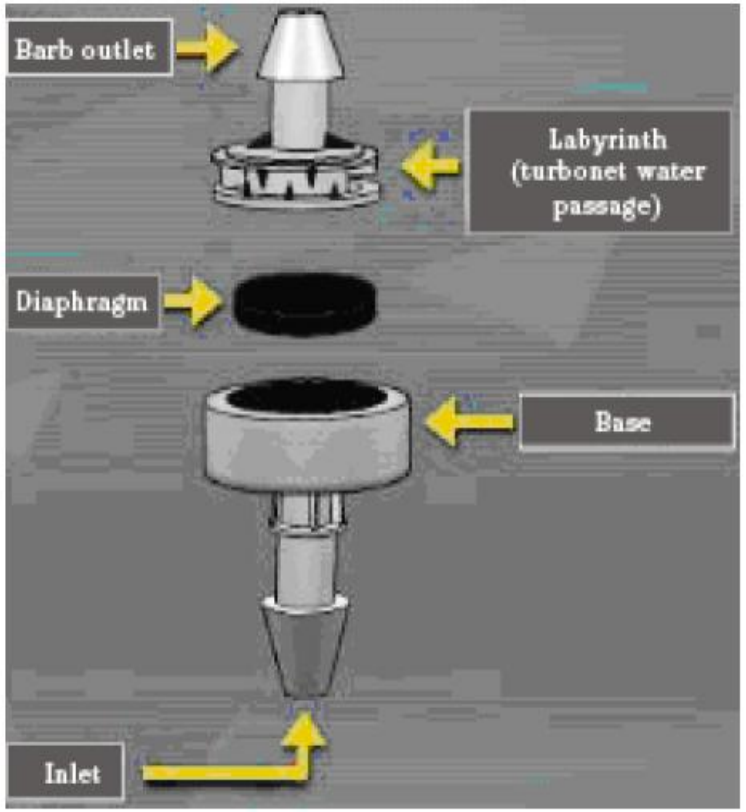
What microirrigation device to use for young pistachios?

- Emitters that apply water close to young tree
- Button drippers
  - Low flow rates (0.13 to 4 GPH)
  - Pressure range ≈ 7 to 60 PSI
- Easily installed close to young tree
- Pressure compensated drippers recommended
  - Relatively uniform flow across orchard

Hydrobuilder

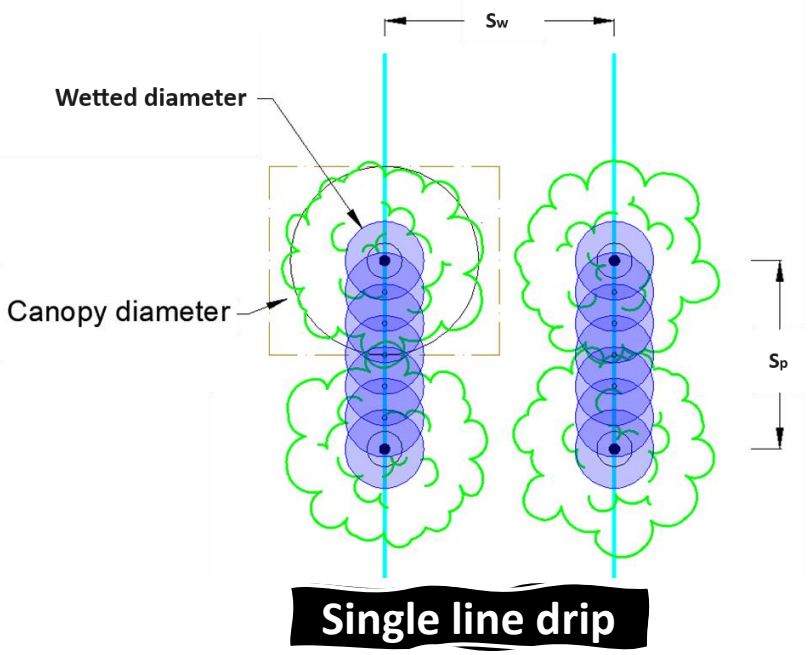
Orchard Valley Supply

Figure 7–60 Schematic of a pressure compensated, turbulent flow button emitter *(courtesy Netafim USA)*



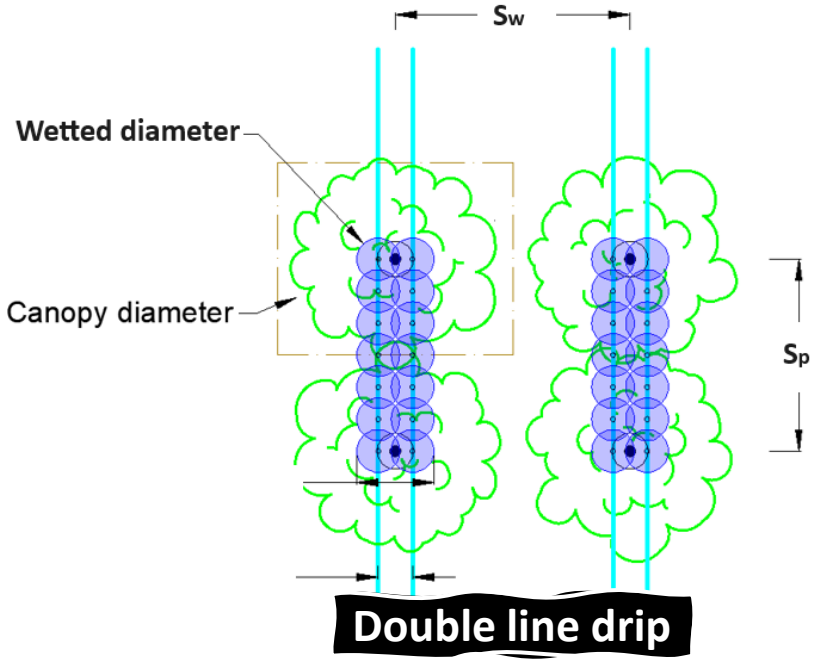
USDA/ NRCS

Positioning emitters and wetted surface area



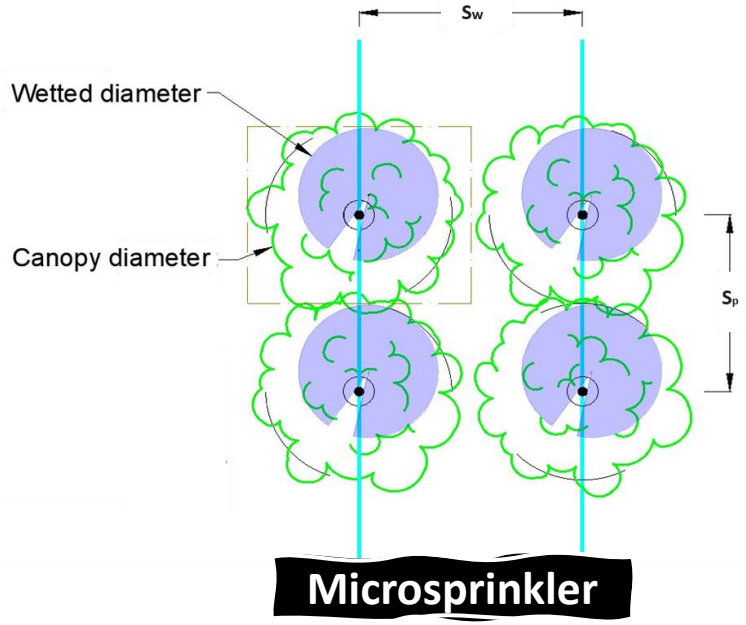
Single line drip

$$P_w = \frac{e \cdot S_e \cdot S_w}{S_p \cdot S_r} \times 100$$



Double line drip

$$P_w = \frac{e \cdot S'_e(S'_e + S_w)}{2(S_p \cdot S_r)} \times 100$$

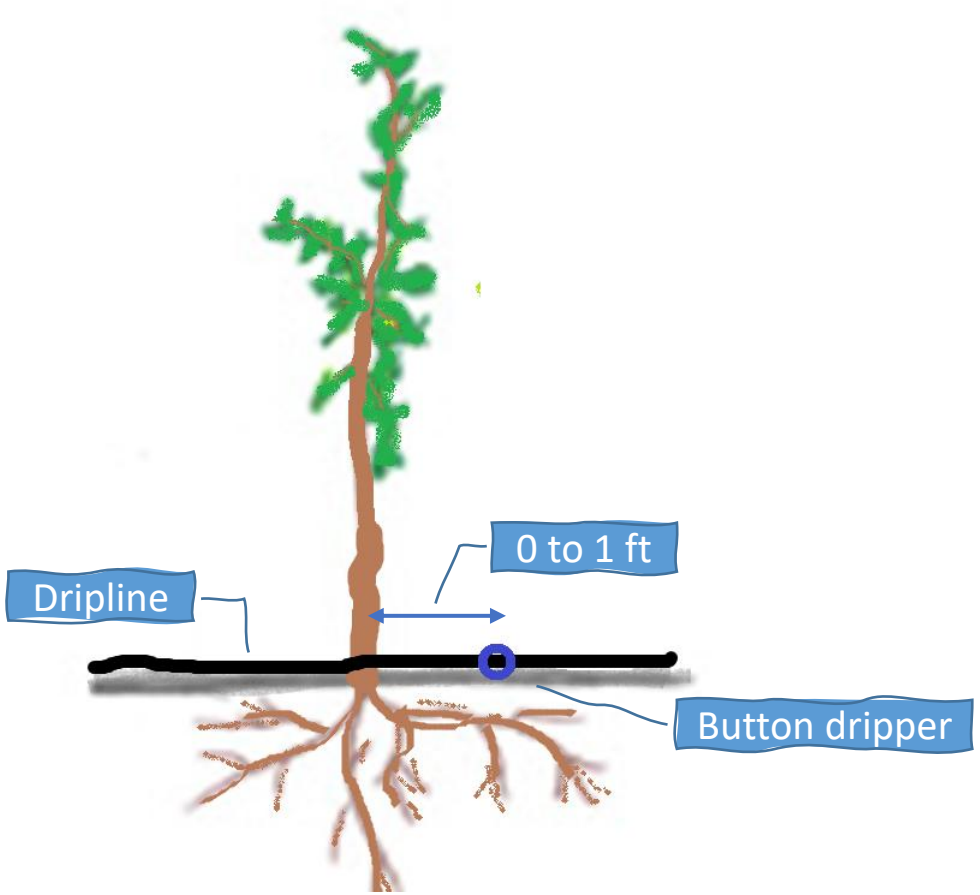


Microsprinkler

$$P_w = \frac{e[A_s + (S'_e \times P_s)]}{S_p \cdot S_r} \times 100$$

- Ideal wetting ≈ 50 to 60% for mature orchards
  - Or one-third to half of horizontal cross-sectional area
- Much smaller wetting for young trees

Positioning emitters



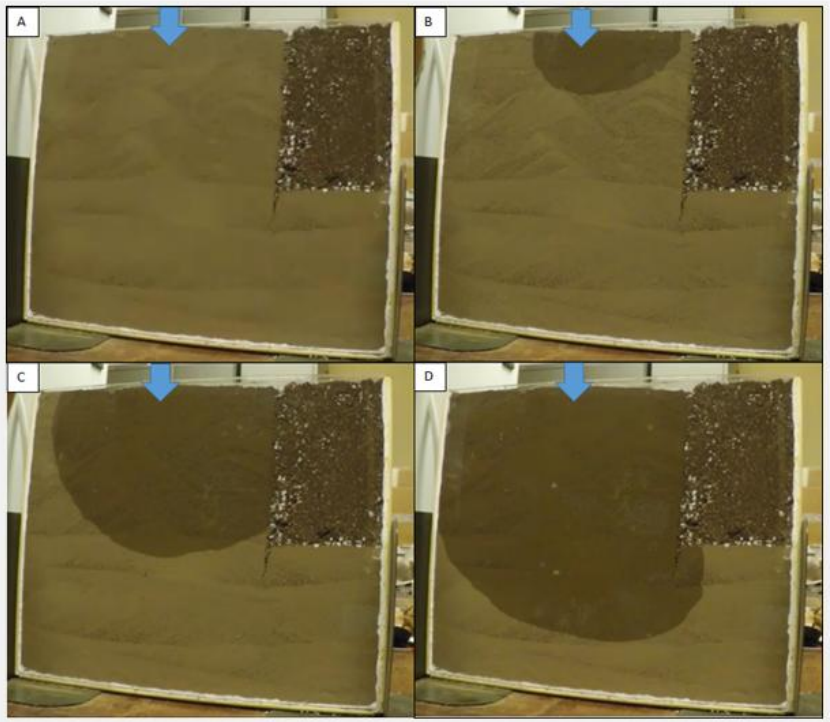


Figure 1. This sequence of photos shows the movement of water applied to Tehama series silty-loam soil. Water was applied at the blue arrow, approximately 4 inches from the potting soil. Total elapsed time was 51 minutes. Water moved downwards and laterally but did not cross the boundary into the potting soil. More details HERE (photos by D. Lightle).

Niederholzer, F.

- Initially, position dripper to apply water directly to root ball of newly planted trees
- Takes about 30 days to roots to grow into soil mass (Niederholzer, F. (2022))

Wetted surface area

Table 7–14 Estimates of area (A_w) [1/] wetted in various soils

Soil or root depth and soil texture [3/]	Kind of soil layers [2/]: Homogeneous		Varying layers, generally low density		Varying layers, generally medium density [4/]	
	$S'_e \times S_w = A_w$ (ft^2)	(cm^2)	$S'_e \times S_w = A_w$ (ft^2)	(cm^2)	$S'_e \times S_w = A_w$ (ft^2)	(cm^2)
Depth	2.5 ft	76 cm	2.5 ft	76 cm	2.5 ft	76 cm
Coarse	1.2 × 1.5 = 1.8	37 × 46 = 1,702	2.0 × 2.5 = 5.0	61 × 276 = 4,645	2.8 × 3.5 = 9.8	85 × 107 = 9104
Medium	2.4 × 3.0 = 7.2	73 × 91 = 6643	3.2 × 4.0 = 12.8	98 × 122 = 11,892	4.0 × 5.0 = 20.0	122 × 152 = 18,581
Fine	2.8 × 3.5 = 9.8	85 × 107 = 9,104	4.0 × 5.0 = 20.0	122 × 152 = 18,581	4.8 × 6.0 = 28.8	146 × 183 = 26,756
Depth	5 ft	152 cm	5 ft	152 cm	5 ft	152 cm
Coarse	2.0 × 2.5 = 5.0	61 × 76 = 4,695	3.6 × 4.5 = 16.2	110 × 137 = 15,050	4.8 × 6.0 = 28.8	146 × 183 = 26,756
Medium	3.2 × 4.0 = 12.8	98 × 122 = 11,892	5.6 × 7.2 = 39.2	171 × 219 = 37,459	7.2 × 9.0 = 64.8	219 × 274 = 60,201
Fine	4.0 × 5.0 = 20.0	122 × 152 = 18,591	5.2 × 6.2 = 33.8	158 × 198 = 31,401	6.4 × 8.0 = 51.2	195 × 244 = 47,566

1 Based on an emitter flow rate of 1 gallon per hour (3.785 L), the estimated A_w is given as a rectangle with the wetted width (S_w) equal to the maximum expected diameter of the wetted circle and the optimum emitter spacing (S_e) equal to 80 percent of that diameter.

2 Most soils are layered. As used here, "varying layers of low density" refers to relatively uniform texture but with some particle orientation, some compaction layering, or both that gives higher horizontal than vertical permeability; "varying layers of medium density" refers to changes in texture with depth as well as particle orientation and moderate compaction.

3 Coarse includes coarse to medium sands, medium includes loamy sands to loams, and fine includes sandy clay loam to clays (if clays are cracked, treat as coarse to medium soils).

4 For soils with varying layers and high density, the A_w may be larger than the values shown.

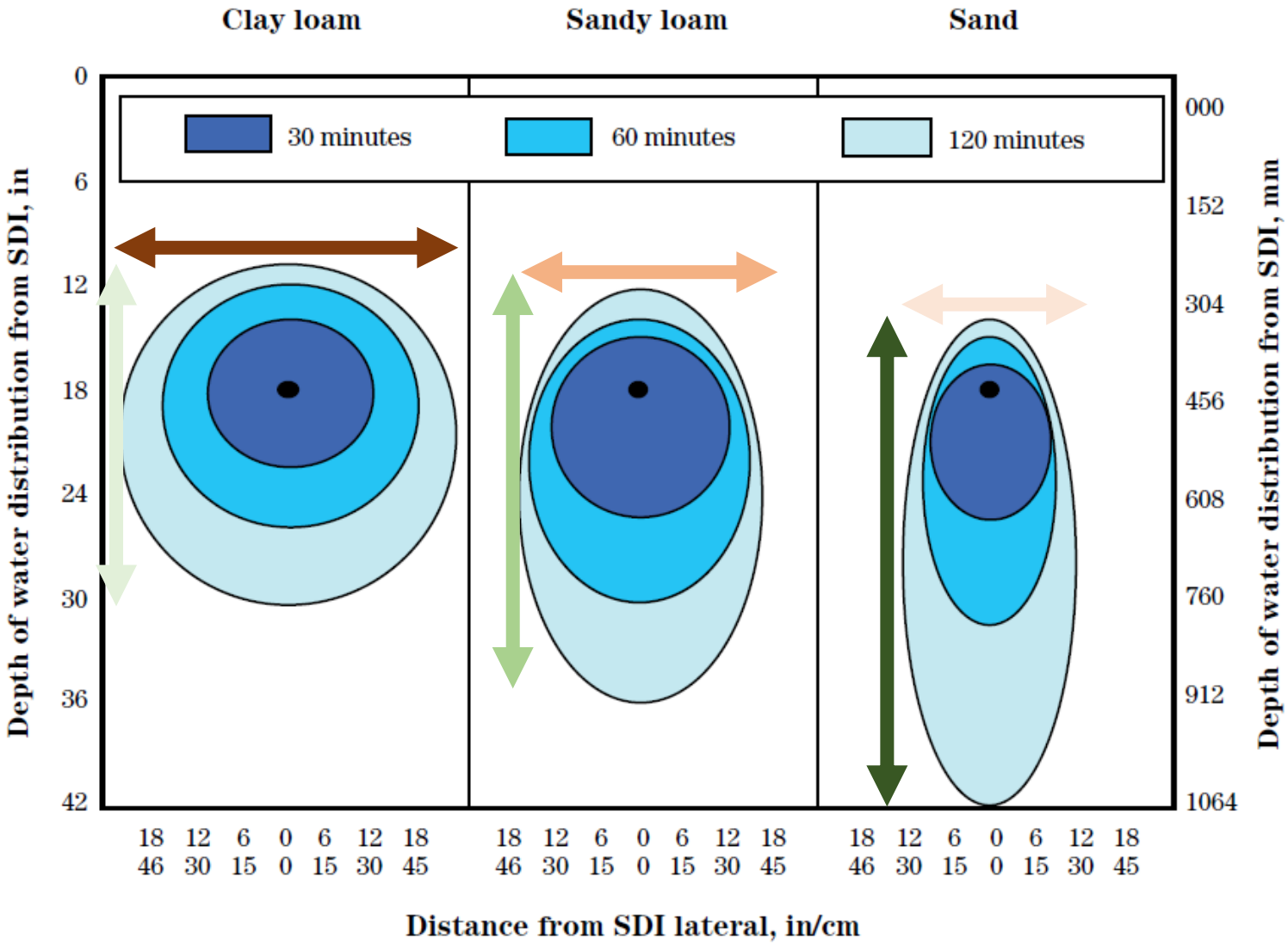
USDA/ NRCS

Wetted surface area and soil water storage

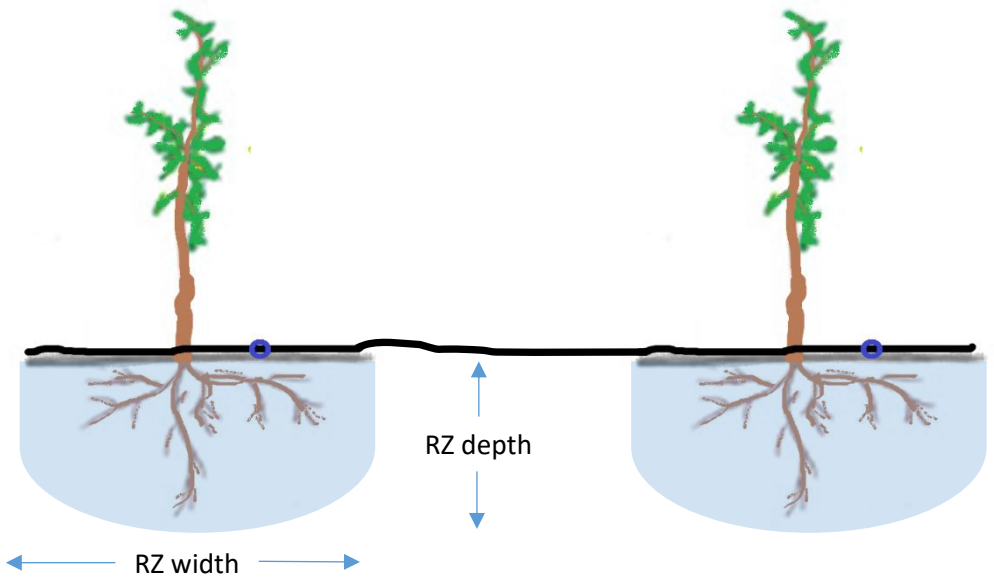
- Run irrigation system for duration needed per irrigation event
- Use measuring tape to estimate wetted diameter
- Vertical water movement within wetted circle
- Why is it important vis-à-vis young trees?
  - Storage volume of root zone

Soil water storage capacity

Figure 7–67 Idealized patterns of soil water distribution from a subsurface point source in a homogeneous soil, as affected by irrigation duration and soil textures

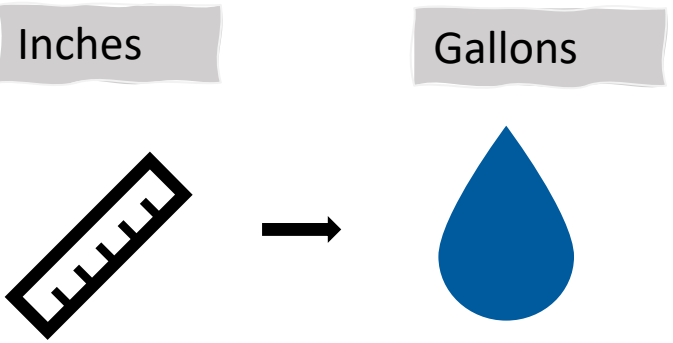


Positioning emitters



- How much water the young tree needs each week?
  - in./week/tree
  - Excel file of pistachio weekly ET by age in SSJV
- Determine water storage capacity of root zone
  - Depth and width
  - Available Water Capacity (AWC) of soil material
- Balance tree water demand vs. storage capacity

Translating storage inches to gallons



Conversion factor

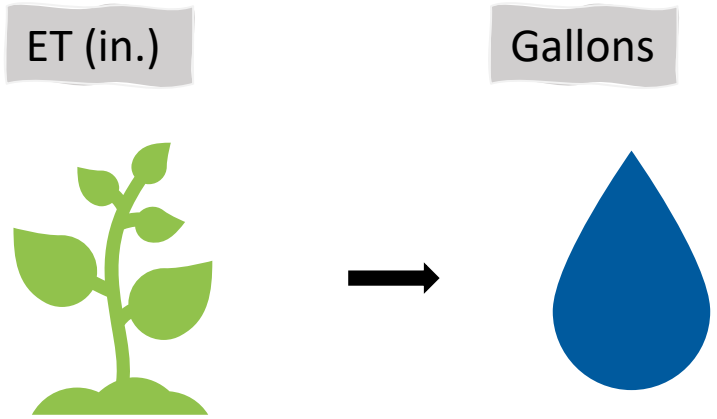
Storage (gal.) = 0.623 x Storage depth (in.) x Total wetted area (ft^2)

- Example:
  - Assume: storage depth = 3 in.; wetted diameter = 4 ft.; one emitter
  - Storage (gal.) = 0.623 x depth (in.) x wetted area (ft^2)

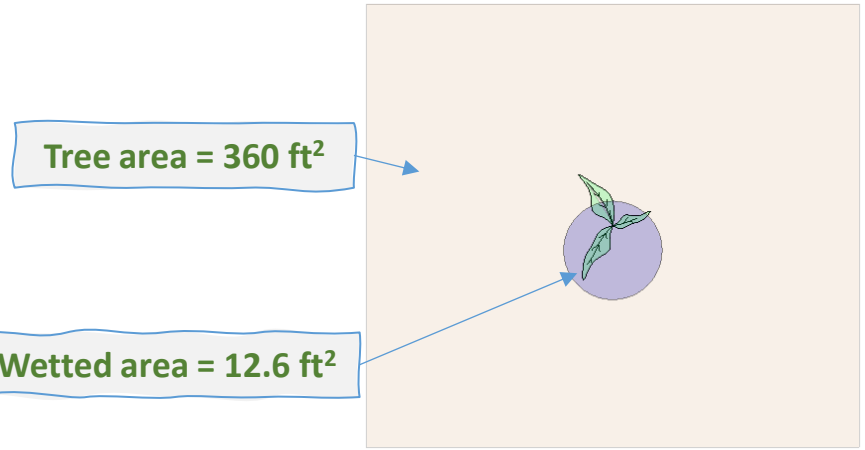
    = 0.623 x 3 in. x 12.6 ft^2 = 23.5 gal

Estimated storage capacity of root zone

Pistachio ET inches to gallons



$$ET\ (gal.) = 0.623 \times ET\ (in.) \times Tree\ area\ (ft^2)$$



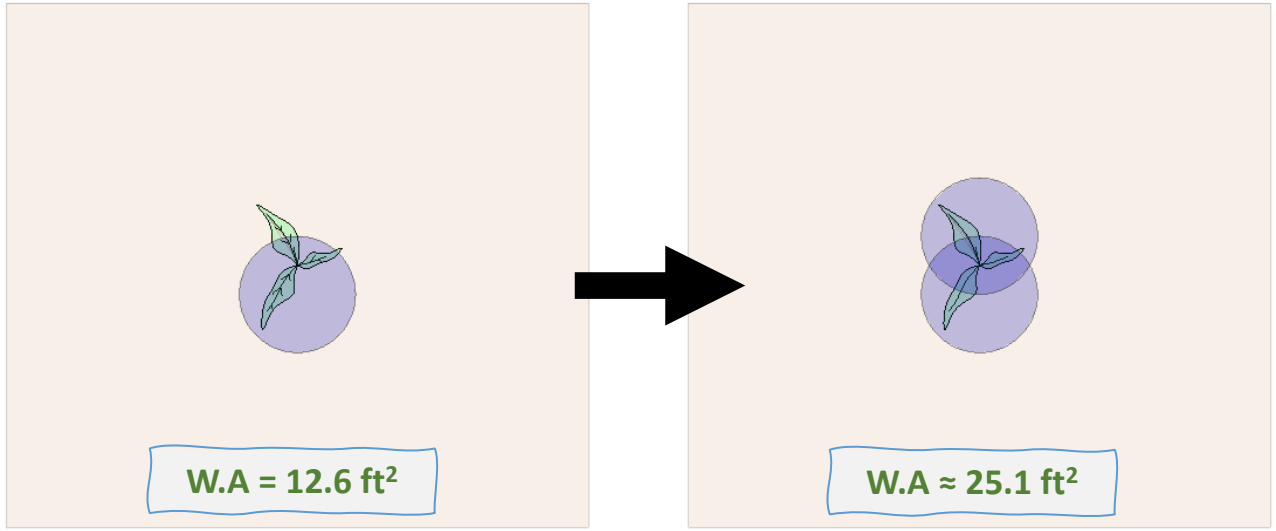
- Example:
  - Assume: 2nd – leaf with peak ET of 0.48 in/week; planted at 20 x 18 ft

    Gal./tree/wk = 0.623 x 0.48 in./wk x 360 ft² = 107.7 gal/wk.

    = 15.4 gal./day
  - To reduce runtime, add:
    - More emitters
    - Use emitter with more flow (GPH)
  - *Caution: Addition of emitters may expand storage beyond root zone*

Runtime vs. storage area vs. water access

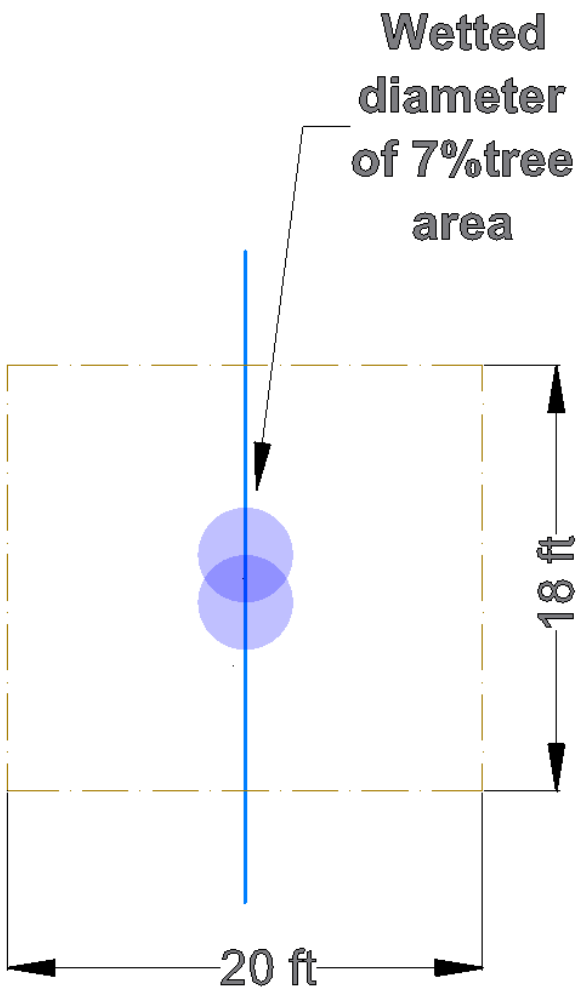
What if you increased the number of emitters to cut runtime?



- Storage (gal.) = 0.623 x 3 in. x 12.6 ft^2 x 2 ≈ 47 gal
- Shorter runtime but <u>larger wetted area</u>
- Is water beyond expanded storage easily accessible?
  - Redistribution?
  - Potential water loss
  - Important to know grow growth (spread and depth)

How frequently do you irrigate young trees?

Young tree



- Based on a **Management Allowable Depletion (MAD)**
- Young tree MAD maybe 40%?

Irrigation (in.) = MAD x WHC x RZD x % wetted area

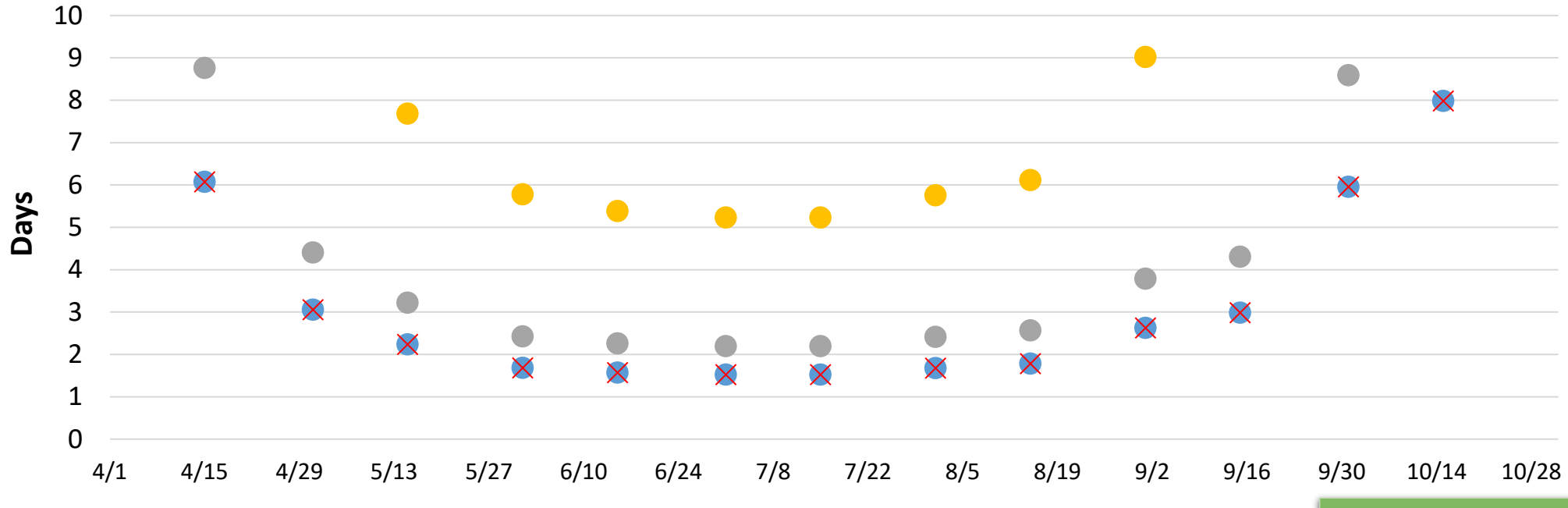
- Example:
  - Assume: Water depth fraction of 1.5 in./ft and RZD of 2 ft.; 7% of potential storage of 20 ft. x 18 ft. area is used; peak ET of 0.48 in./week

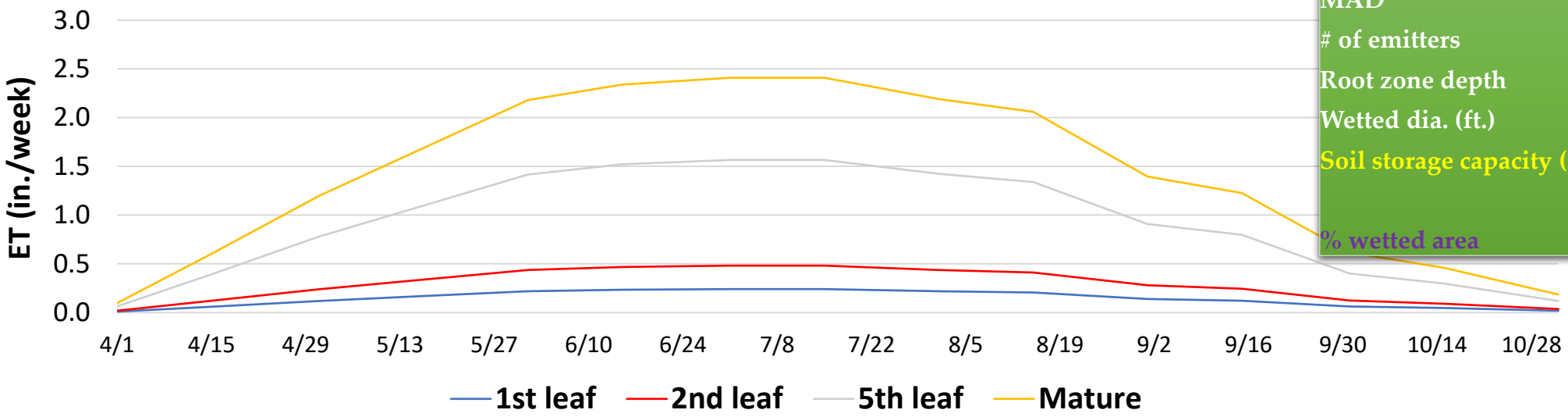
Irrigation (in.) = 0.4 x 1.5 (in./ft/) x 2 (ft.) X 0.07 = 0.08 in.

- How often to irrigate if tree ET if 0.48 in./week?

$$\text{Irrigation interval} = \frac{0.08 \text{ in.}}{0.48 \text{ in./week}} = 0.2 \text{ weeks} \approx 1.2 \text{ days}$$

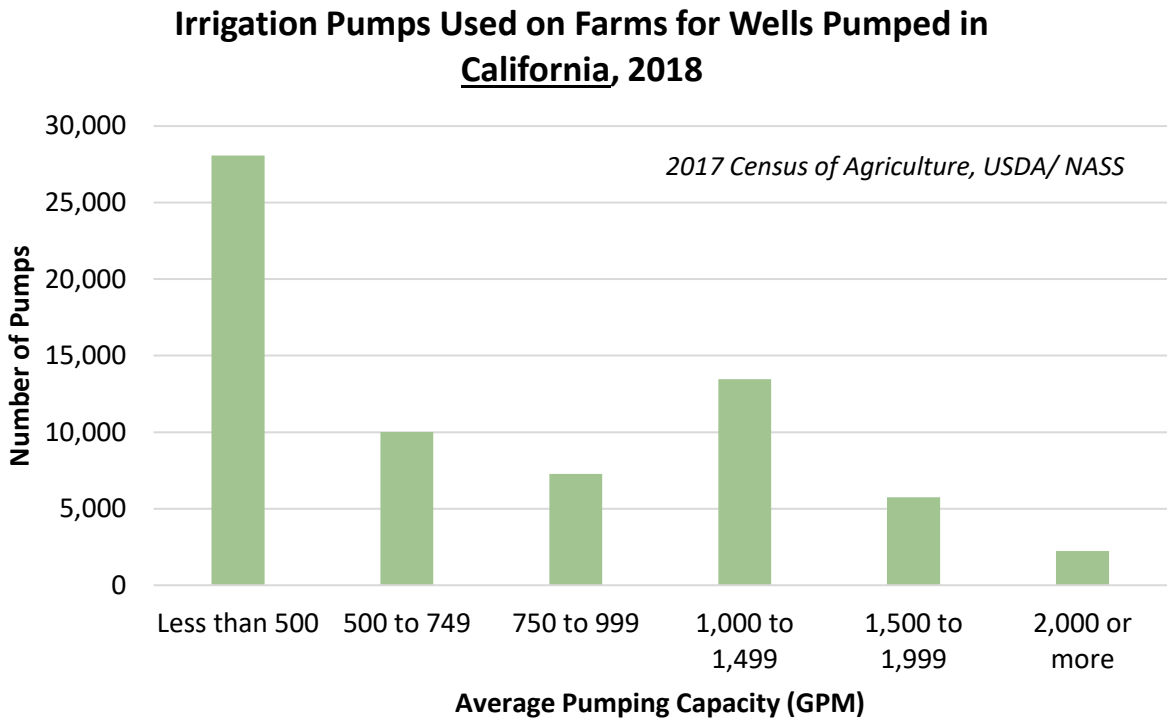
Irrigation interval for pistachio on a sandy loam



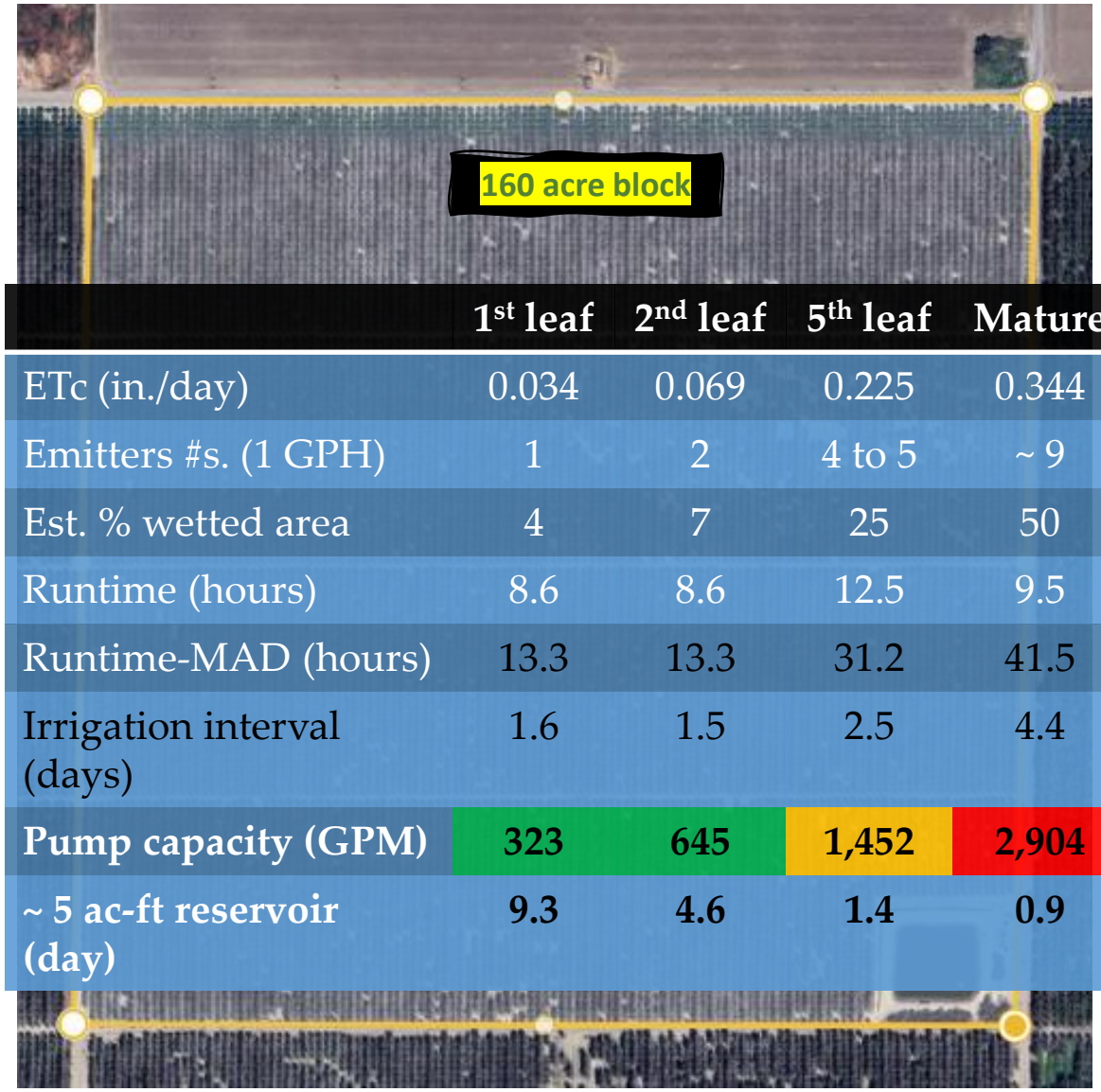


	1st leaf	2nd leaf	5th leaf	Mature
MAD	0.5	0.5	0.5	0.4
# of emitters	1	2	4	9
Root zone depth	2	2	3	4
Wetted dia. (ft.)	4	4	5	5
Soil storage capacity (ft^3)	3.1	6.3	29.5	90.0
	24	47	220	673
% wetted area	3%	7%	22%	50%

System capacity and water availability



- 68% of farms have a pumping capacity of less than 1,000 GPM
- 20% have a pumping capacity between 1,000 to 1,499 GPM



	1st leaf	2nd leaf	5th leaf	Mature
ETc (in./day)	0.034	0.069	0.225	0.344
Emitters #s. (1 GPH)	1	2	4 to 5	~ 9
Est. % wetted area	4	7	25	50
Runtime (hours)	8.6	8.6	12.5	9.5
Runtime-MAD (hours)	13.3	13.3	31.2	41.5
Irrigation interval (days)	1.6	1.5	2.5	4.4
Pump capacity (GPM)	**323**	**645**	**1,452**	**2,904**
~ 5 ac-ft reservoir (day)	**9.3**	**4.6**	**1.4**	**0.9**

Thank you

Tobias E. Oker

Soils and Irrigation Advisor, Kern County

1031 South Mount Vernon Avenue

Bakersfield, CA 93307

Office: (661) 868-6218

teoker@ucanr.edu