## Water Budgeting: Where to Find the Relevant Information & How it All Works Together

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## Water Budgeting Things to consider:

- Soil type (texture and its impact on water holding capacity, infiltration rate, irrigation frequency, and possibly leaching if needed)
- Irrigation system (drip or other systems, efficiency, application rate, flow rate, irrigation frequency, variable rate irrigation)
- Irrigation water quality
- Crop water requirements and irrigation scheduling (ETo, Kc, ETa, CIMIS, Tule, plant-based technologies, and soil moisture)
- Fine-tuning your water budget (additional factors to consider)





Soil type (texture and its impact on water holding capacity, infiltration rate, irrigation frequency, and possibly leaching if needed)

- Soil texture: get to know your soil (several sources), start with the soil map but backhoe or at least a shovel is a must
- Check for soil variability (may need to have variable rate irrigation, slopes, rooting depth)
- What is your water holding capacity (WHC)?
- Effective rootzone depth (flood vs drip)
- If considering new irrigation system, consider soil variability in the new design (management zones)
- Consider soil type in leaching (if needed)

Map Unit Legend

Tulare County, Western Part, California (CA659)

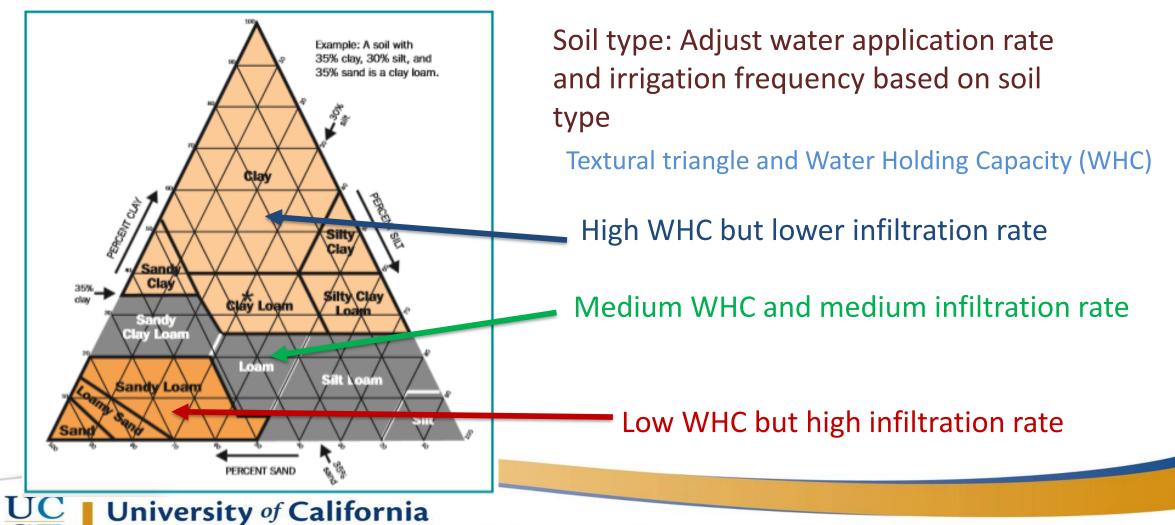
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
114	Exeter loam, 0 to 2 percent slopes	162.4	100.0%
Totals fo Interest	or Area of	162.4	100.0%



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### Soil type and irrigation system

- Even within the same texture classification, you may have variations in soil physical properties that may impact irrigation scheduling (compacted soil with low infiltration rate, slope)



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## **Soil Resources**

- Web Soil Survey Home (usda.gov)
- <u>California Soil Resource Lab :: Home (ucdavis.edu)</u>
- ANR Catalog (ucanr.edu)
- NRCS and RCDs



Resources Conservation

Natural

Soil Colors of

California

## **Irrigation system**

- Existing irrigation system:
  - Current system design (check application rate, flow meter, and other system components)
  - Check system efficiency (DU) at least once a year
  - Determine system DU (distribution uniformity, >85% good)
  - What can be done to improve efficiency (infiltration rate, emitters, fixing leaks, etc)
  - Remember Application Rate= Crop water needs/DU
  - Consider water and energy costs (lower DU=higher operating costs)
  - Check flow rate vs design application rate
  - Irrigation frequency based on soil texture
- New irrigation system:
  - Consider energy rates and time of use in design (4 pm- 9 pm)
  - Old system design: irrigation day up to 18-20 hrs
  - New system design: 14-20 hrs with high energy costs (except for heat waves)



## **Irrigation System Resources**

- Various irrigation vendors
- UCCE advisors and specialists
- ANR Catalog (ucanr.edu)
- Consider CDFA and other incentives to improve water use efficiency and energy savings, healthy soils, energy savings
- **CDFA OEFI State Water Efficiency & Enhancement Program** (ca.gov)
- <u>CDFA OEFI Healthy Soils Program (ca.gov)</u>

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- Home Page-California Energy Commission
- Local utilities with incentives program to improve energy efficiency or reduce energy demand





## **Crop water requirements and irrigation scheduling**

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- ETo: Spatial CIMIS
- Kc: Crop coefficient (various sources but use as a guide, need to adjust to your farm)
- ETa: Tule technologies, Arable Mark, other sources
- Soil moisture sensors: various vendors
- <u>About CIMIS Weather Stations Fruit & Nut</u>
   <u>Research & Information Center (ucdavis.edu)</u>

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http://ucanr.edu/sites/Nut\_Crops

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Soil moisture sensors (Example: rootzone 4') Most of water/nutrient uptake from the top 50% of the rootzone (2-3 ft)

Typical root distribution 40% of roots in first quarter 30% in 2<sup>nd</sup> quarter 20% in 3<sup>rd</sup> quarter 10% in 4<sup>th</sup> quarter

Example (soil and crop specific, stage of growth): 33 cb at 12" (good moisture level) 38 cb, at 24" (good) 46 cb at 36" (getting dry) 79 cb at 48" (dry potential stress???)



Example of stress related to variable soil physical properties (same soil texture based on soil maps)-almond. Hanford, CA. Bali and Culumber 2019



lighest stress

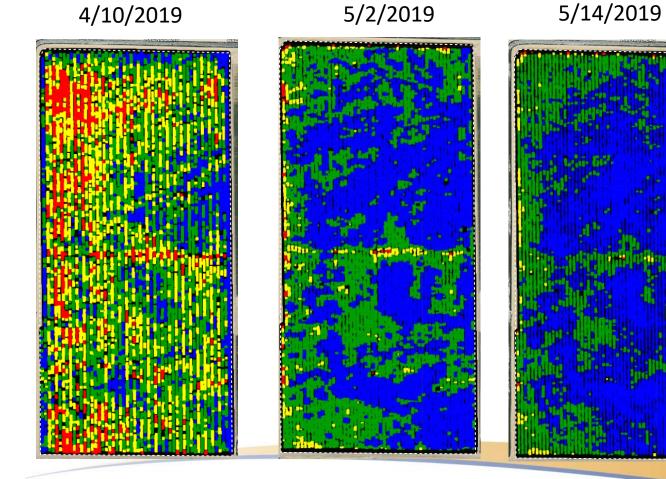
oderate stress

Lowest stress

Unstressed



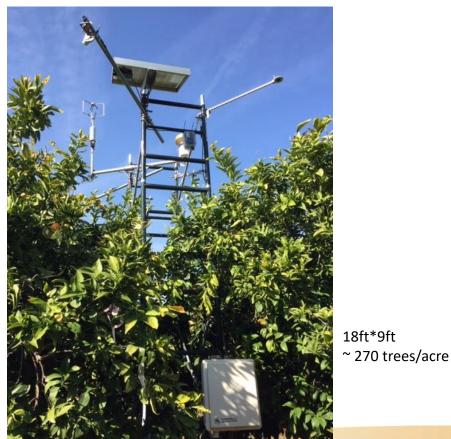




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## Fine-tuning your water budget

### Weekly ET Reports http://ucanr.edu/sites/Nut Crops Contact Mae Culumber, UCCE Fresno



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UCCE/DWR Weekly Crop Water Use

Report

### WEEKLY SOIL MOISTURE LOSS IN INCHES (Estimated Crop Evapotranspiration or ET<sub>c</sub>) 08/27/21 through 09/02/21

Crops (Leafout Date)		#148 Merced	1	#39 Parlier			#258 Lemon Cove		
	8/27 - 9/2 Water Use	Accum'd Seasonal Water Use	9/3 - 9/9 Estimated ETc	8/27 - 9/2 Water Use	Accum <sup>*</sup> d Seasonal Water Use	9/3 - 9/9 Estimated ETc	8/27 - 9/2 Water Use	Accum'd Seasonal Water Use	9/3 - 9/9 Estimated ETc
Almonds (3/5) *	1.61	38.52	1.54	1.80	41.19	1.44	1.67	38.29	1.46
Distachie (4/16) * **	1.65	33.00	1.56	1.82	35.59	1.47	1.69	32.78	1.49
Citrus (2/1)	1.02	29.70	1.05	1.12	31.50	1.01	1.06	29.39	1.02
Raisin Grapes (3/12) (11 ft. row spacing)	1.27	26.17	1.24	1.38	28.28	1.16	1.29	26.04	1.18
Winegrapes (3/12) (10 ft. spacing on California Sprawl Trellis) ***	1.44	28.72	1.39	1.59	31.04	1.30	1.48	28.55	1.32
Walnuts (4/5)	1.53	35.11	1.39	1.68	37.70	1.30	1.57	34.86	1.32
Stone Fruit (3/10)	1.65	31.55	1.60	1.82	34.05	1.51	1.69	31.37	1.53
Past 7 days precipitation (inches)		0.00			0.00			0.00	
Accumulated precipitation (inches) (1/1/2021)		5.54			3.66			3.90	

Dates in parentheses above, indicate leaf out or starting date for ET accumulation for the specific crop

\* Estimates are for orchard floor conditions where vegetation is managed by some combination of strip applications of herbicides, frequent mowing or tillage, and by mid and late season shading and water stress. Weekly estimates of soil moisture loss can be as much as 25 percent higher in orchards where cover crops are planted and managed more intensively for maximum growth.

\*\* Very vigorous, non-salt affected peak season pistachio Kc can be as high as 1.19 - resulting in about 8% greater water use than shown in these tables.

PA	ST WEEK	LY APPLI	ED WATEF	R IN INCHI	S, ADJUST	FED FOR F	FFICIENC	<b>Y</b> <sup>1</sup>				
Crops	#148 Merced				#39 Parlier				#258 Lemon Cove			
System Efficiency >>	65%	75%	85%	95%	65%	75%	85%	95%	65%	75%	85%	95%
Almonds (3/5)	2.5	2.1	1.9	1.7	2.8	2.4	2.1	1.9	2.6	2.2	2.0	1.8
Pistachio (4/16)	2.5	2.2	1.9	1.7	2.8	2.4	2.1	1.9	2.6	2.3	20	1.8
Citrus (2/1)	1.6	1.4	1.2	1.1	1.7	1.5	1.3	1.2	1.6	1.4	1.2	1.1
Raisin Grapes (3/12) (11 ft. row spacing)***	2.0	1.7	1.5	1.3	2.1	1.8	1.6	1.5	2.0	1.7	1.2	1.4
Winegrapes (3/12) (10 ft. spacing on California Sprawl Trellis) ***	2.2	1.9	1.7	1.5	2.4	2.1	1.9	1.7	2.3	2.0	1.7	1.6
Walnuts (4/5)	2.4	2.0	1.8	1.6	2.6	2.2	2.0	1.8	2.4	2.1	1.8	1.7
Stone Fruit (3/10)	2.5	2.2	1.9	1.7	2.8	2.4	2.1	1.9	2.6	2.3	2.0	1.8

The amount of water required by a specific irrigation system to satisfy evapotranspiration. Typical ranges in irrigation system efficiency are: Drip, 80%-95%; Micro-sprinkler, 80%-90%; Sprinkler, 70%-85%; and Border-furrow, 50%-75%.

Crops	10.0	#148 Merc	ed			#39 Parlier			1 I	#258 Lemo	on Cove	
Almonds 115 Trees/A	590	496	449	401	661	567	496	449	614	519	472	425
Pistochio 106 Trees/A	623	548	473	424	698	598	523	473	648	573	198	448
Citrus 110 Trees/A	395	346	296	272	420	370	321	296	395	346	296	272
Raisin Grapes 566 Vines/A	96	82	72	62	101	86	77	72	96	82	72	67
Winegrapes 622 Vines/A	96	83	74	65	105	92	83	74	100	87	74	70
Walnuts 76 Trees/A	857	715	643	572	929	786	715	643	857	750	643	607
Stonefruit 172 Trees/A	395	347	300	268	442	379	332	300	410	363	316	284

For further information concerning all counties receiving this report, contact the Fresno Co. Farm Advisor's office at (559) 241-7526.





# Home General Varieties Flowering Irrigation Phenology Re

### Crop Coefficients for Avocados

Using CIMIS or an E-pan, you end up with a number that's called Reference evapotranspiration or ETo for short. This number approximates the evapotranspiration of a field of 4 to 6 inch tall, cool-season grass that is not water stressed. To use this number to calculate water use for avocados you must multiply the ETo by a crop coefficient (Kc) that accounts for the ET difference between the avocado and the cool-season grass. Below are the crop coefficients for avocado based on research done in Corona, Ca (1988-92) and Covey Lane, North San Diego County, Ca (1992-97).

Months	Kc's
Jan	0.40
Feb	0.50
Mar	0.55
Apr	0.55
May	0.60
Jun	0.65
Jul	0.65
Aug	0.65
Sep	0.60
Oct	0.55
Nov	0.55
Dec	0.50

For Further Information

Irrigation Scheduling, a guide for efficient onfarm water management. University of California Division of Agriculture and Natural Resources Publication #21454. 1989.

# ETc = ETo x Kc

Example: KC in September is 0.60

Comments about crop coefficients for Hass Avocado on Mexican Seedling Rootstocks. January 10, 2007 J.D. Oster and M.L. Arpaia University of California Riverside, CA. James.oster@ucr.edu

The comments begin with the cover page and abstract of a paper accepted on January 9, 2007 for publication by the J. Amer. Soc. Hort. Sci. Kc~0.86\* fraction of shaded area

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Table 1 Recommended irrigation crop coefficients (Kc) for avocado production in the South-West and northern Perth in Western Australia based on month and growth stage

Approximate grwoth stage	Crop coefficient South-West	Crop coefficient northern Perth
Fruit Growth	0.4 (Jul)	0.5 (Jun)
Fruit Growth	0.4 (Aug)	0.5 (Jul)
Flower development	0.7 (Sep)	0.7 (Aug)
Flowering, vegetative flush	0.8 (Oct)	0.9 (Sep)
Flowering, vegetative flush	0.8 (Nov)	0.9 (Oct)
Initial fruit drop, vegetative flush	0.7 (Dec)	0.8 (Nov)
Vegetative flush, root flush	0.7 (Jan)	0.8 (Dec)
Vegetative flush, root flush, summer fruit drop	0.8 (Feb)	1.0 (Jan)
Root flush, fruit growth	0.8 (Mar)	1.0 (Feb)
Root flush, fruit growth	0.7 (Apr)	0.9 (Mar)
Root flush, fruit growth	0.4 (May)	0.9 (Apr)
Root flush, fruit growth	0.4 (Jun)	0.7 (May)

 Table 1. source: Growing avocados – annual water requirements

 Department of Primary Industries and Regional Development (DPIRD)

 Government of Western Australia

 https://www.agric.wa.gov.au/water-management/growing-avocados-%E2%80%93-annual-water-requirements

### **Cooperative Extension**

# Example: Simple Crop Water Budget:

 $ETc = ETo \times Kc$ 

ETo=1 in/week, Kc=0.6

ETc is 1\*0.6=0.6 inches/week

Irrigation system DU:85%

Irrigation requirements: 0.6/0.85 = 0.71 inches

Last 7 days precipitation: 0 inches

No need to irrigate if precipitation is higher than ETa (but check soil moisture, slope and runoff)



If precipitation is **zero**, we need to apply 0.71"/week If irrigation system application rate is 0.09 in/hr, need to irrigate for 0.71/0.09=7.9 hrs



## Example: Crop Water Use: Gallons per tree method Look at gallons needed/tree (130 gallons/tree/week)\*150 trees/ac\*area (10 ac) =195,000 gallons

Look at the flow meter reading (gpm) example 410 gpm

Run time in minutes= 195,000 gal/410 gpm=475 minutes Or 475/60= 7.9 hrs/week

Other considerations:

Trees/ac and gallons/tree (130\*?? Based on ETa)

If relatively dry year, check your soil profile to determine soil moisture status



# Example: Crop Water Use: <u>Tule Technologies Method</u>

Reference Guide

Blog

https://www.tuletechnologies.com/towers/4935

tule

Dashboard

Mandarin Settings Save Changes Sensor Location Installation Date August 16th, 2019 Similar fields data includes measurements from 9 similar fields of Similar Fields Gro mature citrus trees in the East San Joaquin Valley on soils with high water holding capacity. Soil Water Holding Capacity 6.24 inches (provided by NRCS) Crop Citrus Google<sub>2021</sub> Sensor Location Distance Between Rows (ft) 15.0 O Measurement Area Block Boundary Distance Between Plants within Row (ft) 12.0 Harvest Method Hand Harvest \* **Planting date** 2019-07-01



# Example: Crop Water Use: Tule Technologies Method

https://www.tuletechnologies.com/towers/4935

	tule	Dashboard	Reference Guide	Blog	Contact Support	Khaled Bali 🗸
Irrigation System						

The total flow rate for the block is calculated using the row/bed spacing, plant spacing, emitter spacing, and flow rate information provided to Tule during the initial setup of this site. If the total flow rate shown is incorrect, please enter the correct values in the fields below. The total flow rate will be recalculated after the changes are saved. This new flow rate will be used for calculating all future irrigation events. Please contact Tule Support if previously applied irrigation amounts should also be updated based on the flow rate changes.

Total Flow Rate	0.0891 inches per hour	
Irrigation Type	Micro sprinkler 🗸	]
Distance Between Emitters (inches)	72	]
Flow Rate per Emitter	5.0 Gallons per hour	
More than 1 irrigation line?	Yes 🗸	]

# Example: Crop Water Use: <u>Tule Technologies Method</u>

https://www.tuletechnologies.com/towers/4935



# Example: Crop Water Use: Tule Technologies Method

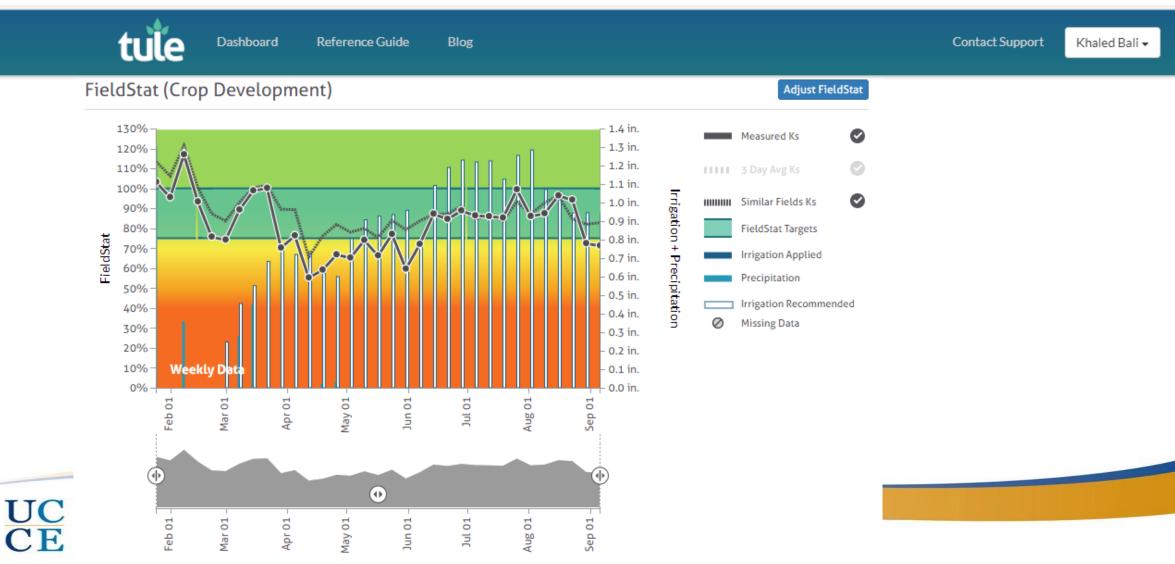
https://www.tuletechnologies.com/towers/4935

tule	Dashboard Reference Guide Blog	Contact Support Khaled
Mandarin	Actual ET & Irrigation Summary	
Teichert 1	Next 7 Days Irrigation Recommendation	September 8 - September 14
Teichert 2	Total Recommendation (apply by September 14)	10.5 hours (0% of last 7 days Actual ET)
UCD Oakville Station	Applied This Time Last Year	0 hours (0% of ETa)
	% of Similar Fields Irrigating	88% (7 out of 8 similar fields)
	Amount Applied at Similar Fields	21 hours



# Example: Crop Water Use: <u>Tule Technologies Method</u>

https://www.tuletechnologies.com/towers/4935



## **Summary**

- Start with soil type (texture and its impact on water holding capacity, irrigation frequency, salinity)
- Consider irrigation water quality (salinity, leaching, etc,)
- Irrigation system (drip or other system, efficiency, application rate, flow rate, irrigation frequency, variable zone irrigation)
- Energy cost and irrigation efficiency
- Crop water requirements and irrigation scheduling (ETo, Kc, ETa, CIMIS, Tule, plant-based technologies, and soil moisture)
- Fine-tuning your water budget (FRET, soil moisture, other technologies)



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# Thank You



