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)

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 for Area of Interest		**162.4**	**100.0%**

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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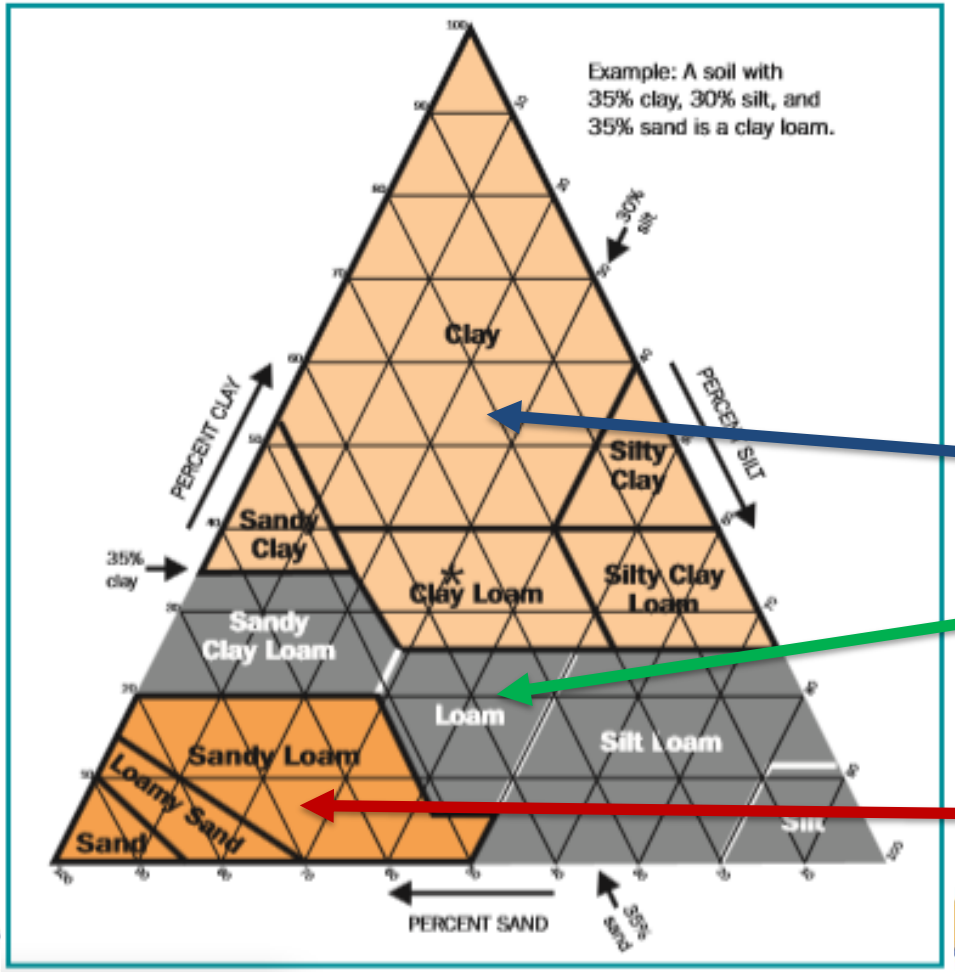


Soil type: Adjust water application rate and irrigation frequency based on soil type

Textural triangle and Water Holding Capacity (WHC)

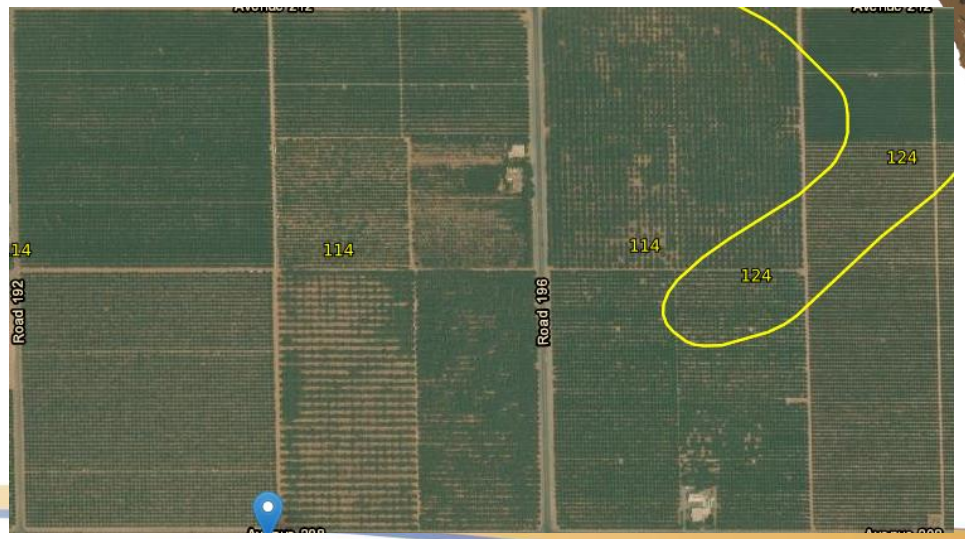
High WHC but lower infiltration rate

Medium WHC and medium infiltration rate

Low WHC but high infiltration rate

Soil Resources

- [Web Soil Survey - Home (usda.gov)]
- [California Soil Resource Lab :: Home (ucdavis.edu)]
- [ANR Catalog (ucanr.edu)]
- NRCS and RCDs



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

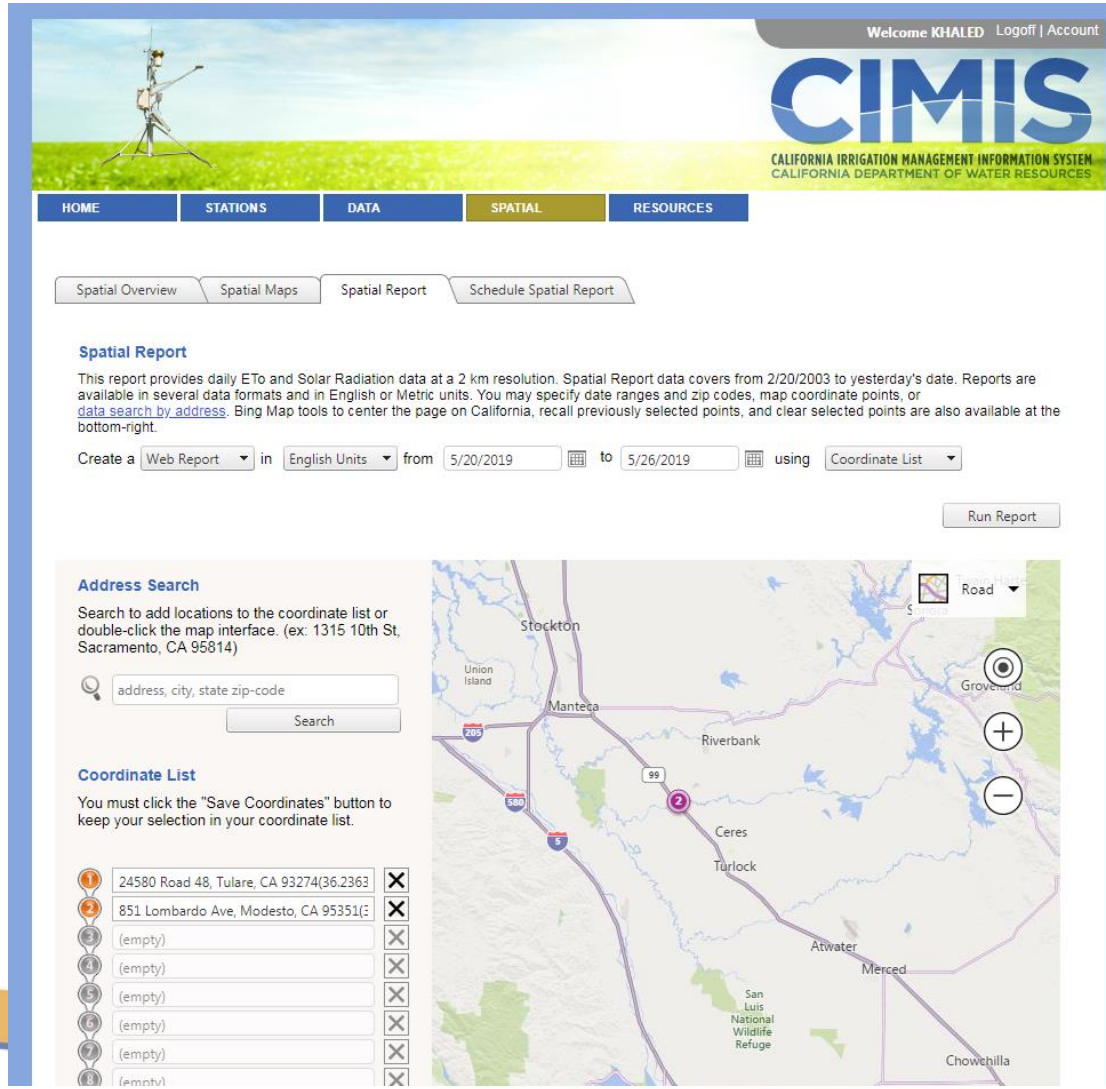
- Various irrigation vendors
- UCCE advisors and specialists
- ANR Catalog (ucanr.edu)
- Consider CDFA and other incentives to improve water use efficiency and energy savings, healthy soils, energy savings
- CDFA - OEFI - State Water Efficiency & Enhancement Program (ca.gov)
- CDFA - OEFI - Healthy Soils Program (ca.gov)
- Home Page-California Energy Commission
- Local utilities with incentives program to improve energy efficiency or reduce energy demand

Crop water requirements and irrigation scheduling

- 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

- About CIMIS Weather Stations - Fruit & Nut Research & Information Center (ucdavis.edu)

- http://ucanr.edu/sites/Nut_Crops



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 2nd quarter

20% in 3rd quarter

10% in 4th quarter

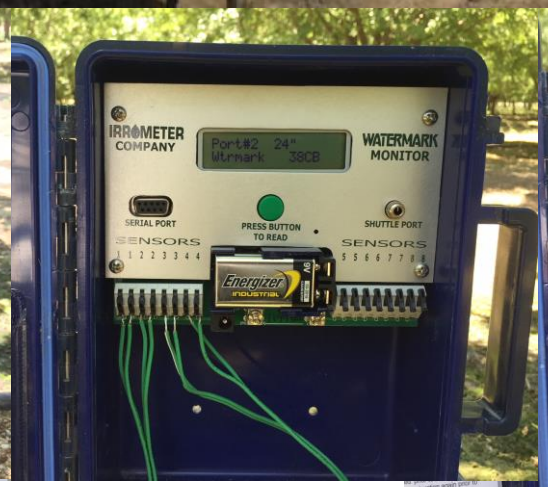
Example (**soil and crop specific, stage of growth**):

33 cb at 12” (good moisture level)

38 cb, at 24” (good)

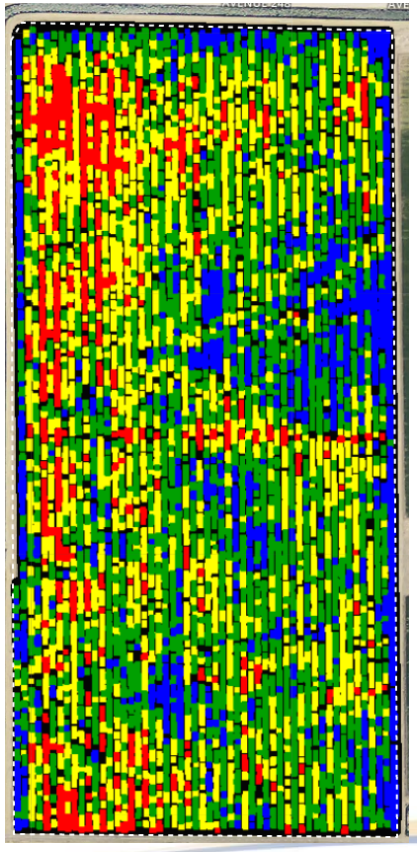
46 cb at 36” (getting dry)

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

4/10/2019



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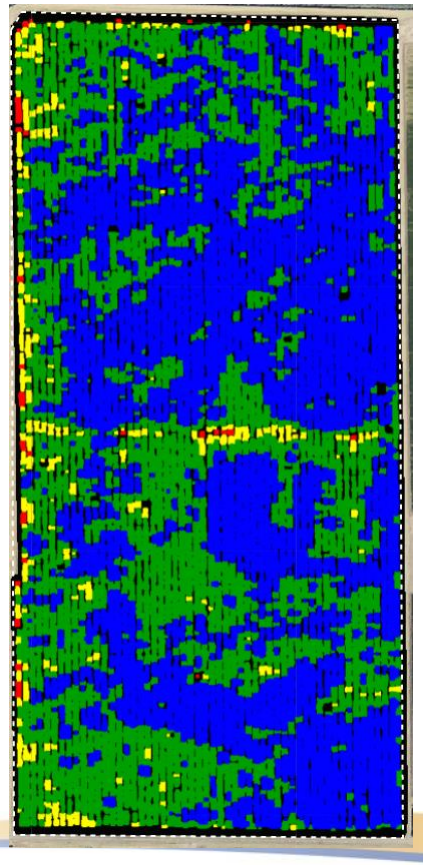

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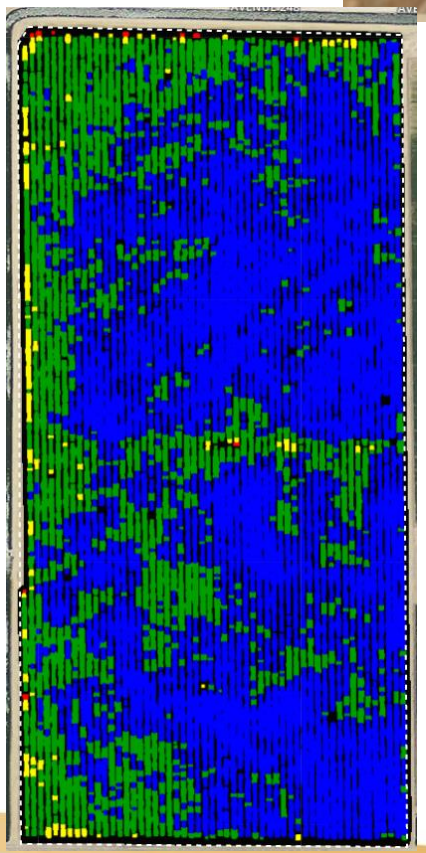

Stress related to salinity and water quality

Fine-tuning your water budget

Weekly ET Reports

http://ucanr.edu/sites/Nut_Crops

Contact Mae Culumber, UCCE Fresno

18ft*9ft

~ 270 trees/acre

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UCCE

UCCE/DWR Weekly Crop Water Use Report

WEEKLY SOIL MOISTURE LOSS IN INCHES
(Estimated Crop Evapotranspiration or ET_c)
08/27/21 through 09/02/21

Crops (Leafout Date)	#148 Merced			#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'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
Pistachio (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.

PAST WEEKLY APPLIED WATER IN INCHES, ADJUSTED FOR EFFICIENCY [1]

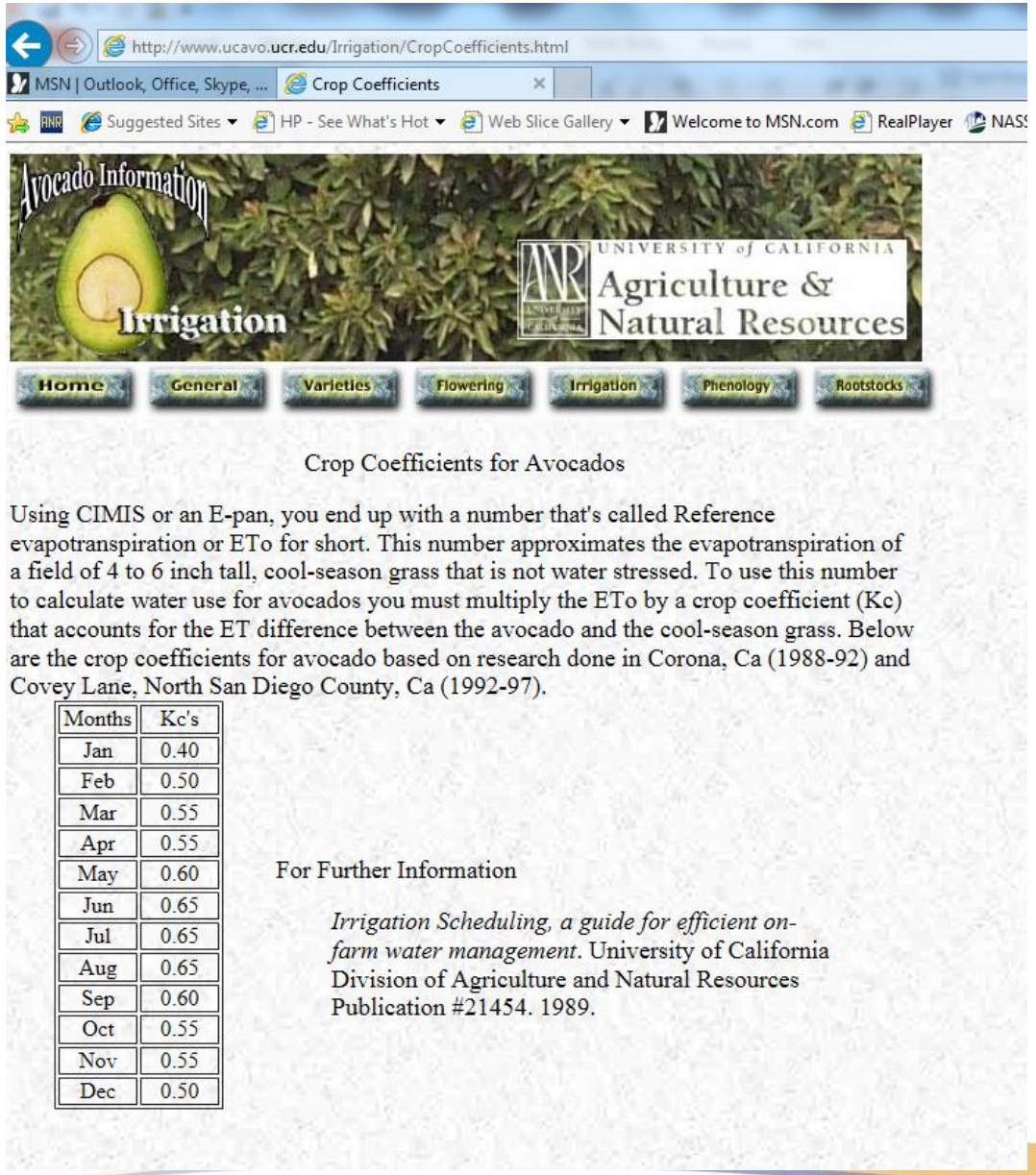
Crops	#148 Merced				#39 Parlier				#258 Lemon Cove			
System Efficiency >>	65%	75%	85%	95%	65%	75%	85%	95%	65%	75%	85%	95%
Almonds (3/5)	2.5	2.1	1.9	1.7	2.8	2.4	2.1	1.9	2.6	2.2	2.0	1.8
Pistachio (4/16)	2.5	2.2	1.9	1.7	2.8	2.4	2.1	1.9	2.6	2.3	2.0	1.8
Citrus (2/1)	1.6	1.4	1.2	1.1	1.7	1.5	1.3	1.2	1.6	1.4	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	1.5	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

1 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%.

PAST WEEKLY APPLIED WATER IN GALLON PER TREE OR VINE

Crops	#148 Merced				#39 Parlier				#258 Lemon Cove			
Almonds 115 Trees/A	590	496	449	401	661	567	496	449	614	519	472	425
Pistachio 106 Trees/A	623	548	473	424	698	598	523	473	648	573	498	448
Citrus 110 Trees/A	395	346	296	272	420	370	321	296	395	346	296	272
Raisin Grapes 366 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.



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

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

Example: Simple Crop Water Budget:

ETc = ETo x 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:

Tule Technologies Method

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

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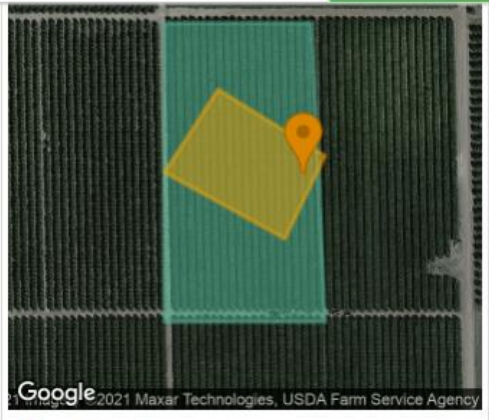
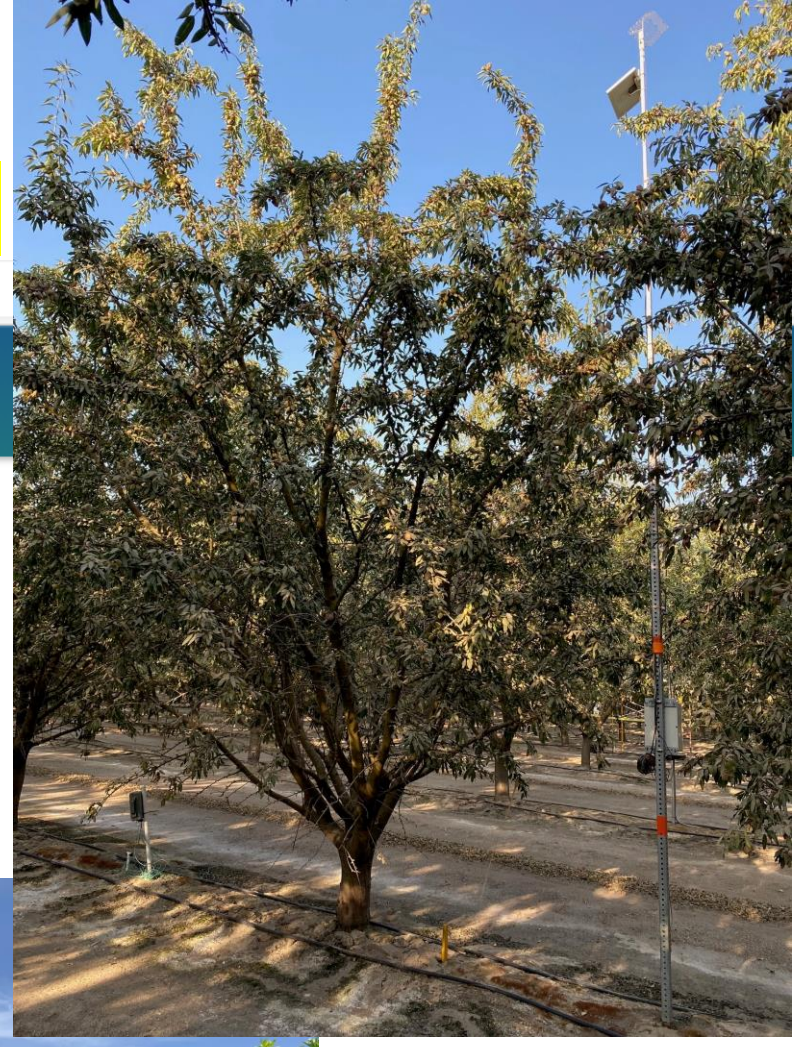
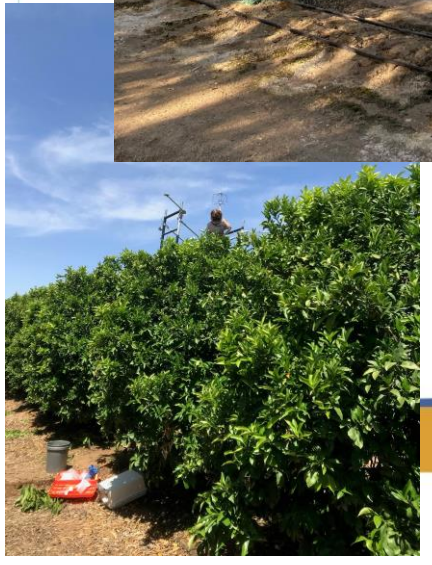
Mandarin Settings

Save Changes

Sensor Location	
Installation Date	August 16th, 2019
Similar Fields Group	Similar fields data includes measurements from 9 similar fields of 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) Edit
Crop	Citrus
Distance Between Rows (ft)	15.0
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

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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:

Tule Technologies Method

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

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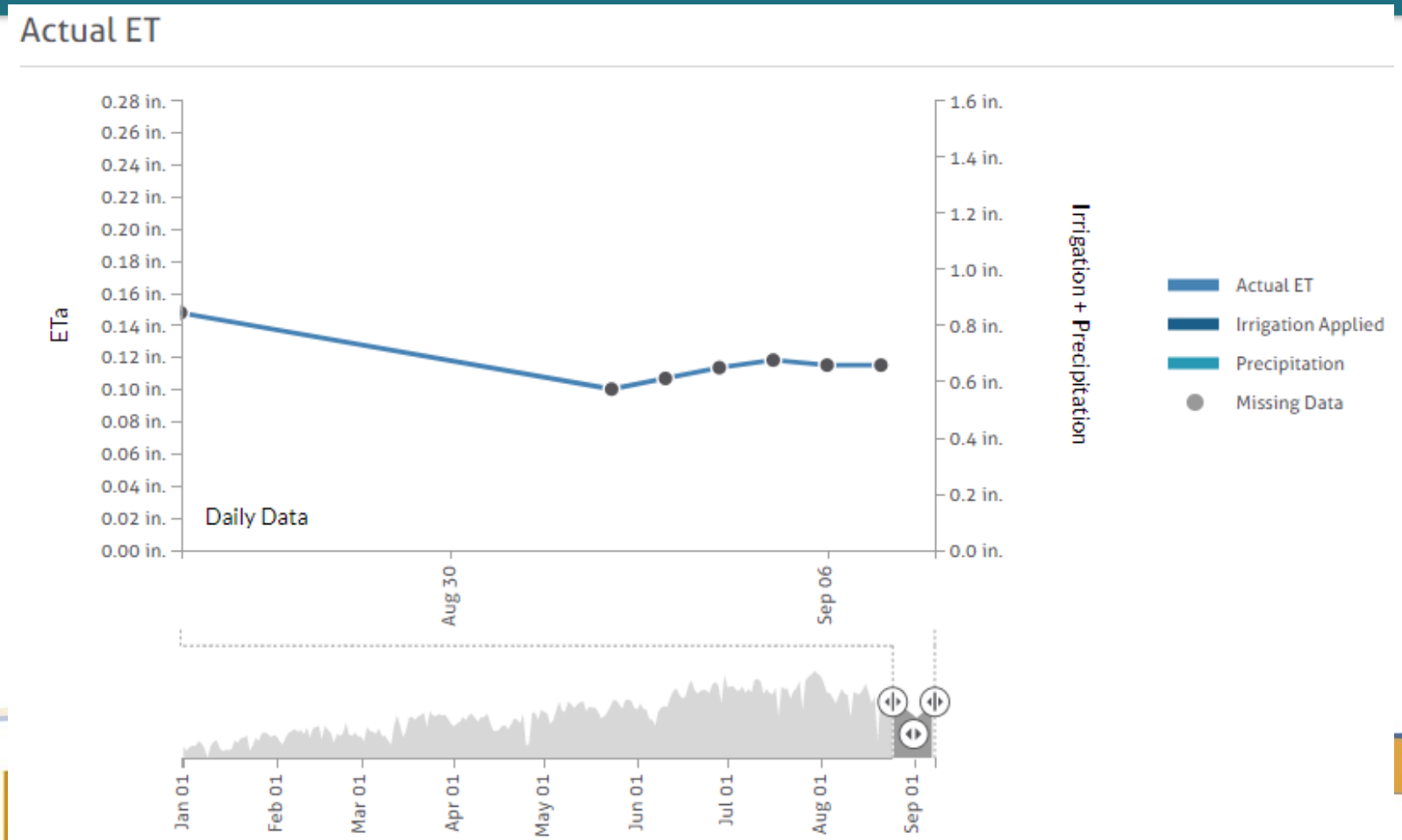
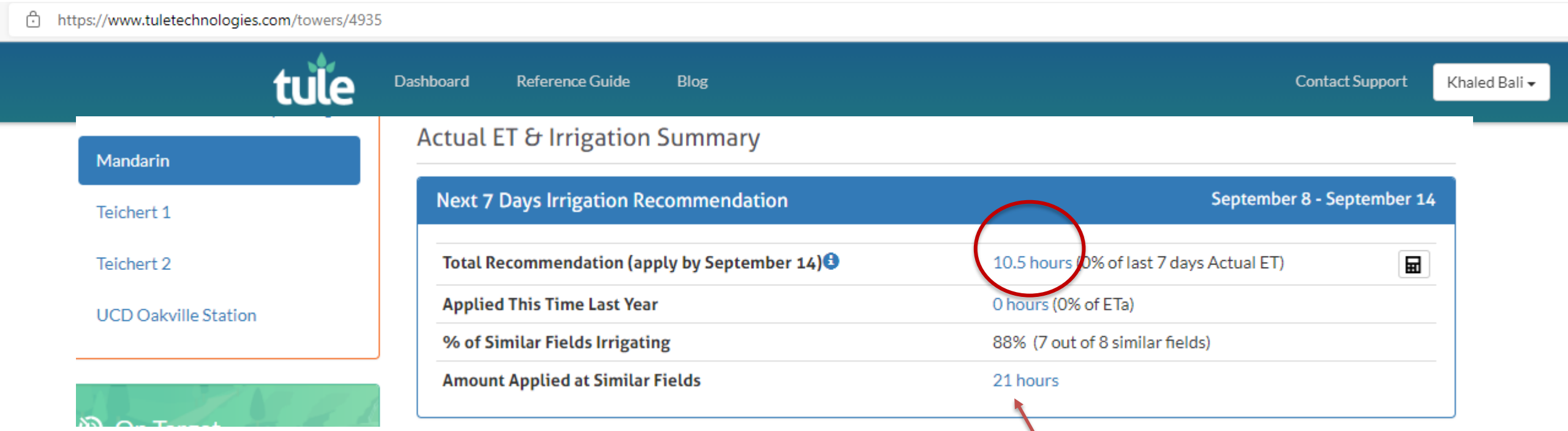


Example: Crop Water Use:

Tule Technologies Method



Example: Crop Water Use:

Tule Technologies Method

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

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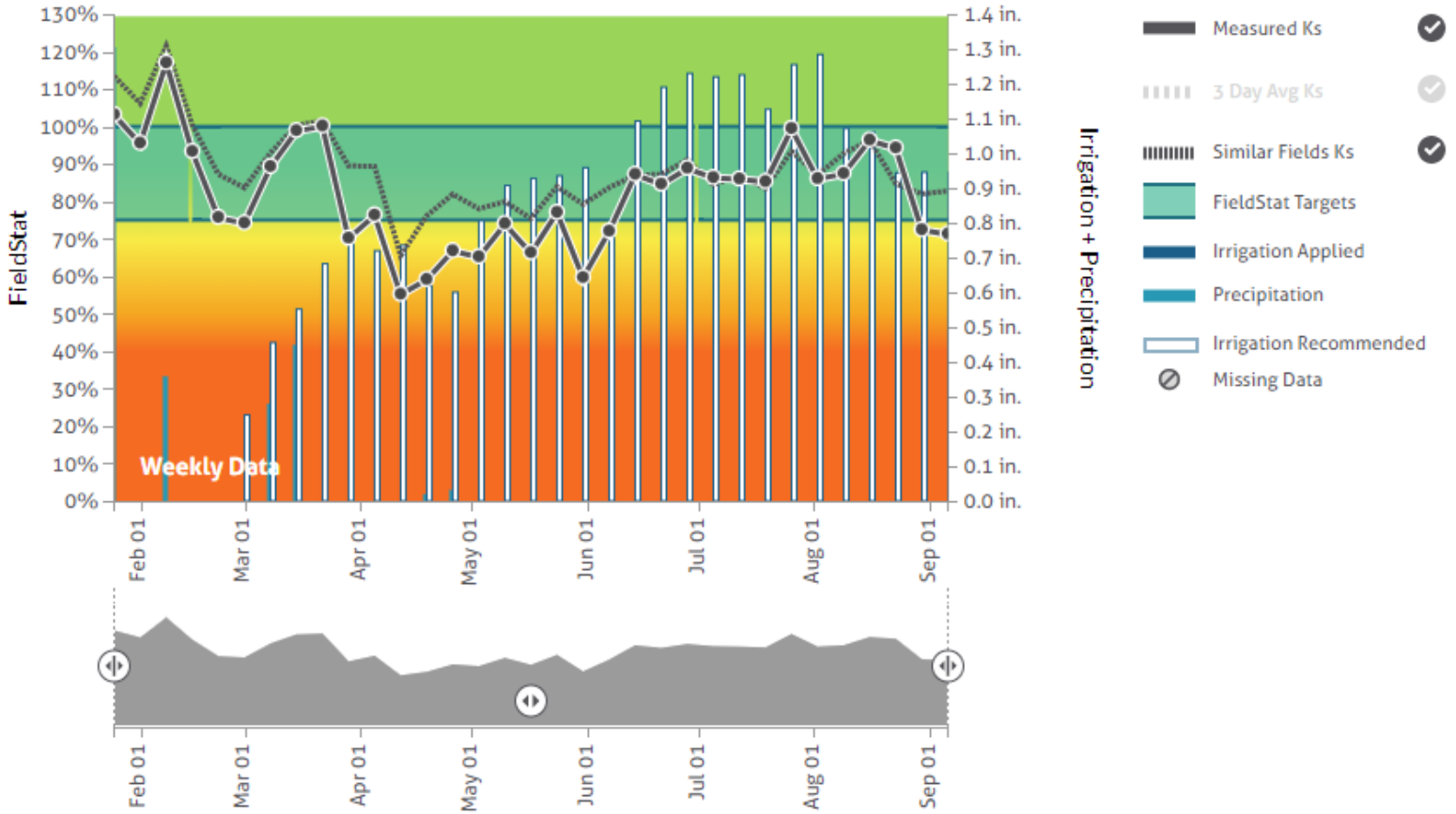
FieldStat (Crop Development) Adjust FieldStat



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