Vineyard Irrigation in San Joaquin Valley of California

George Zhuang
Viticulture Farm Advisor
UC Cooperative Extension - Fresno County

UC CE University of California Agriculture and Natural Resources Cooperative Extension

Vineyard Irrigation and Sustainability – Dr. Larry Williams, UC Davis

- Maintain productivity over time
- Maximize fruit quality
- Increase vineyard ***water use efficiency*** or decrease ***water footprint*** (*in general, if the vineyard is irrigated any reduction in applied water will increase WUE, decrease water footprint*).
- Minimize/maximize soil water depletion (function of soil type and rooting depth, cover crop management)
- Some of the above factors will be a function of location in California and price of grapes

How to Make Irrigation Decisions?
- Dr. Larry Williams, UC Davis

- *When should one initiate irrigations at the beginning of the season?*
- *How much water should one apply?*
- How does the design of your irrigation system affect the ability to irrigate your vineyards?
- Are there deficit irrigation practices to minimize production loss and maximize fruit quality?

When to Start?

- Visual estimation
- Soil moisture
- Plant water stress

Visual Estimation

- Budbreak
- Shoot tip
- Leaf
- Tendril
- Inflorescence/berry

Visual Estimation

Soil Moisture

- Tensiometer (centibar)– measures the attraction of soil to its water. Soil-water suction or tension is a measure of the *soil's matric potential*.
- Gravimetric (%) – taking a known volume of soil and weighing it first and then taking its dry weight.
- Neutron probe, capacitance sensors, TDR – are used to measure soil volumetric water content (θ_v) .

Soil Moisture

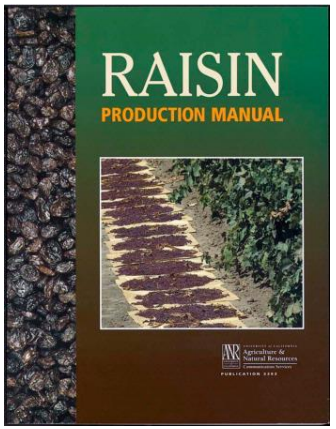
Plant Water Stress

- Pressure chamber
- Sap flow sensor
- …

Irrigation starts when midday leaf water potential reaches -10 bars

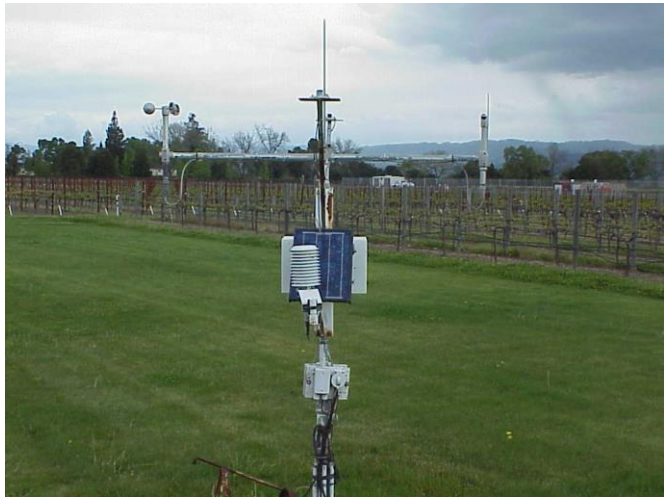
How Much to Irrigate?

- Evapotranspiration (ET)
  - Historical ET
  - Crop ET (ETc): ETc = ETo × Kc, Dr. Larry Williams, UC Davis
  - Actual Crop ET (ETa): surface renewal method, e.g., Tule Technology



Crop ET

- ETc = ETo × Kc
- ETo from CIMIS Stations
- Kc
  - *Measuring canopy cover*
  - Estimate Kc by using GDD



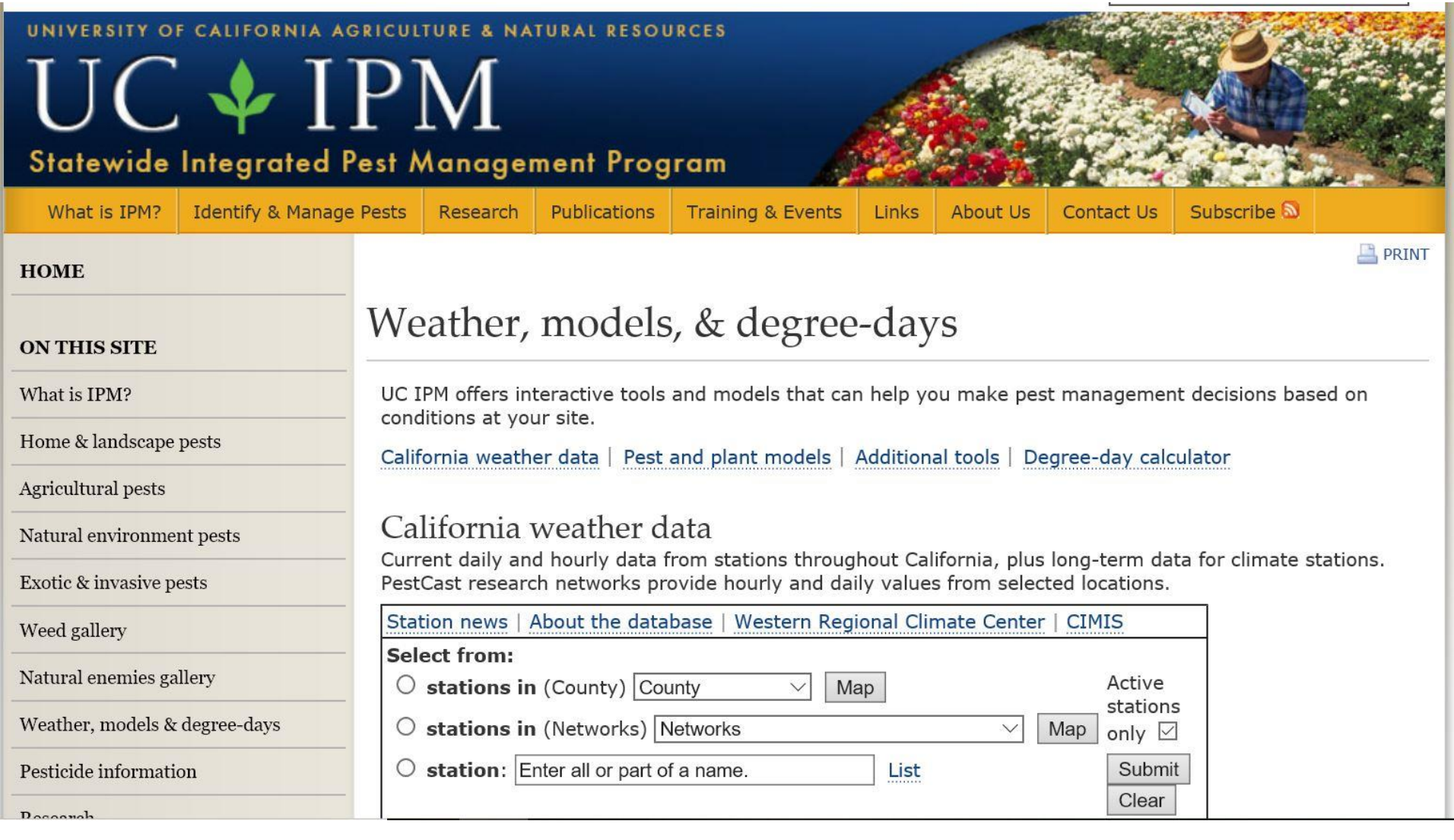
Kc=(0.017 × Shaded percentage of field) – 0.008

Crop Coefficient (Kc)

- Estimate Kc by using GDD (Dr. Larry Williams, UC Davis)

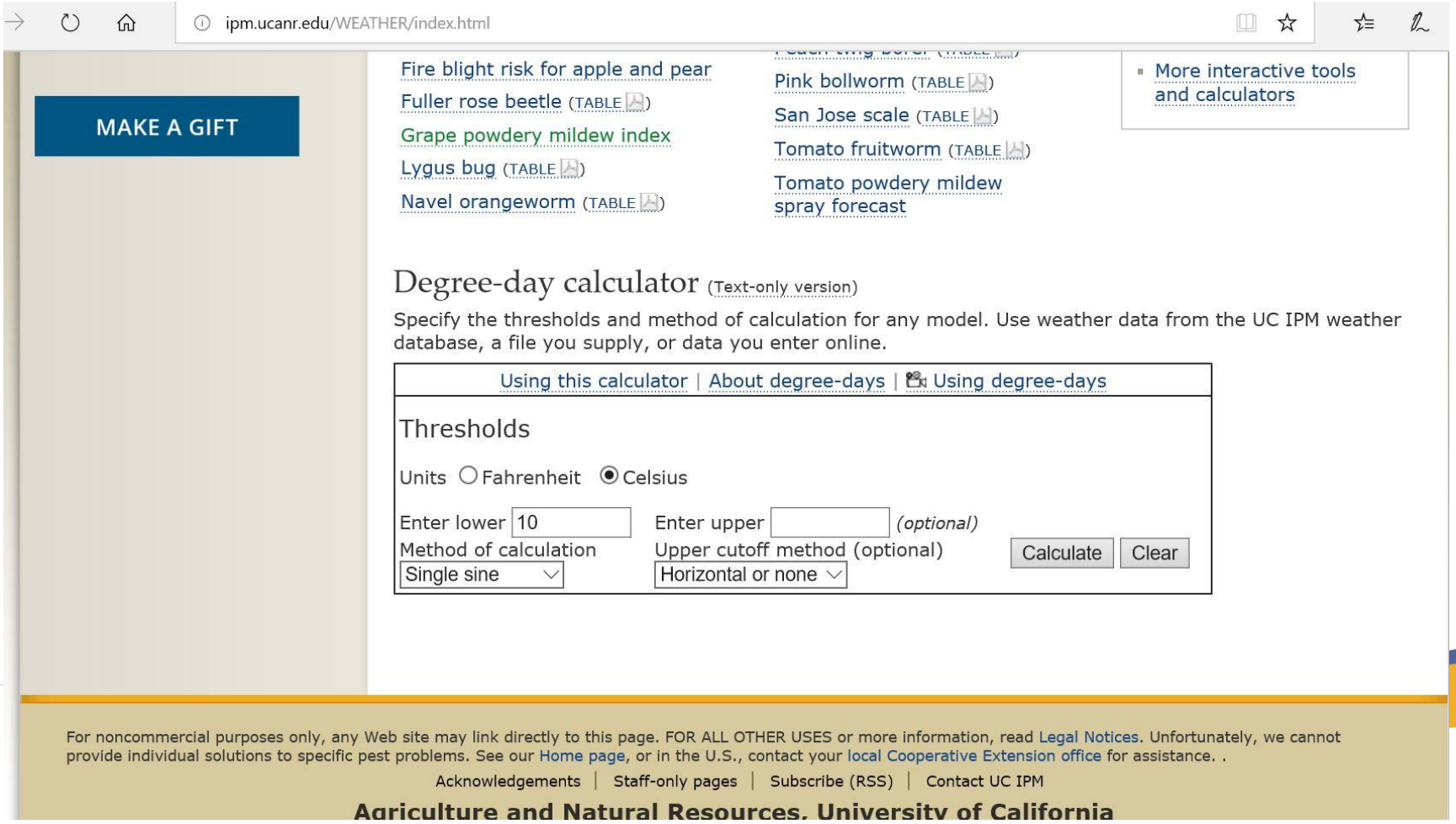
Trellis/Canopy type	Row Spacing (ft)	Kc Equation
VSP	7	Kc=0.74/(1+e^(-(**x**-525)/301))
	8	Kc=0.65/(1+e^(-(**x**-525)/301))
CA Sprawl	10	Kc=0.84/(1+e^(-(**x**-325)/105))
	11	Kc=0.76/(1+e^(-(**x**-325)/105))
Quad-cordons	11	Kc=0.93/(1+e^(-(**x**-300)/175))
	12	Kc=0.85/(1+e^(-(**x**-300)/175))

How to Calculate Kc?



How to Calculate Kc?

- GDD is based on 10 °C



How to Calculate Kc?

UNIVERSITY OF CALIFORNIA AGRICULTURE & NATURAL RESOURCES

UC IPM

Statewide Integrated Pest Management Program

How to Manage Pests

Degree-Days: Custom Calculation

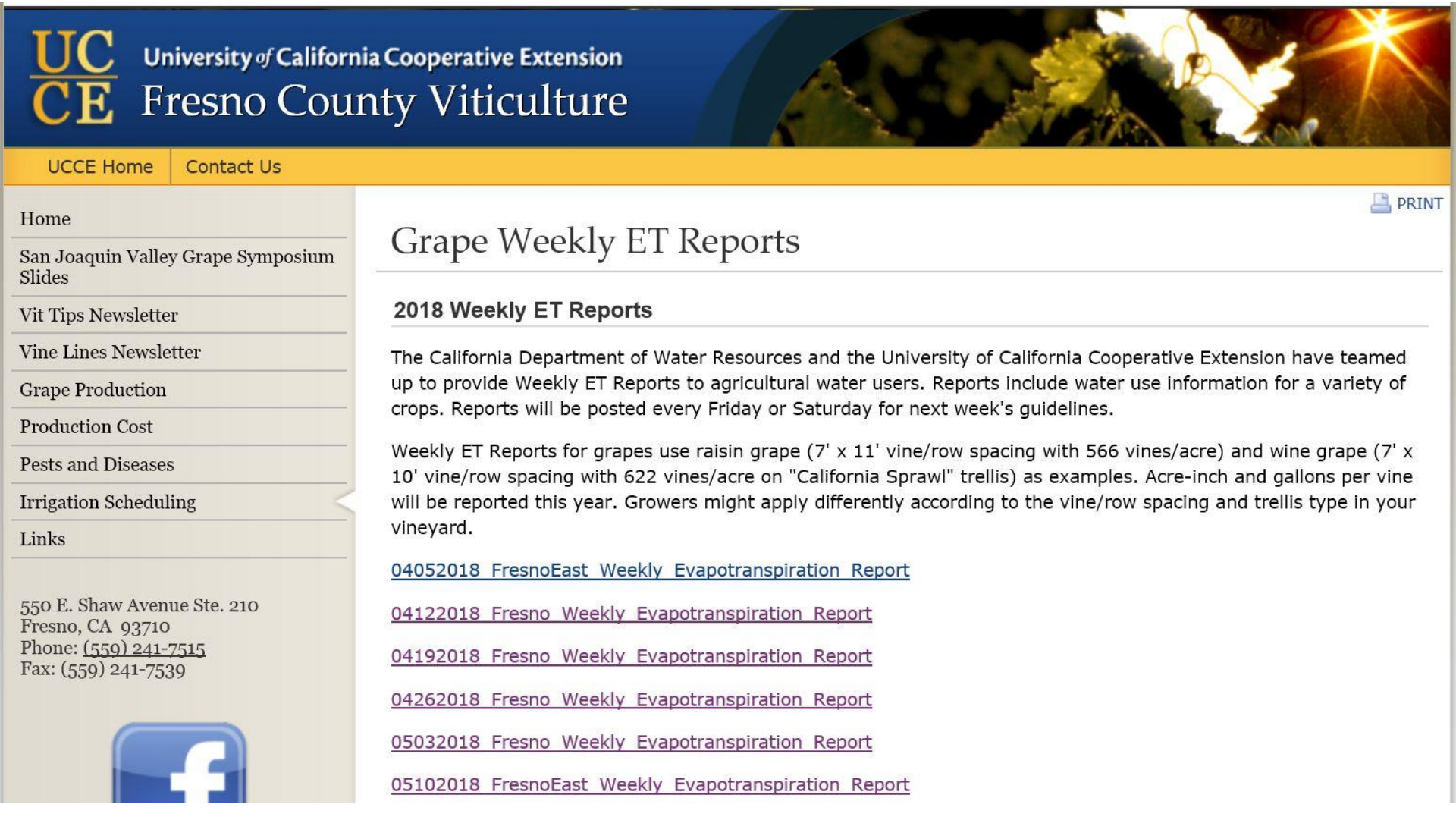
| Degree-day menu | Change county or date | Change station | Change backups | About degree-days |

Lower threshold: 10°C
Calculation: single sine/horizontal

Weather station: PARLIER.A (CIMIS #39, Parlier)
Time period: March 15, 2018 to July 11, 2018, retrieved on July 12, 2018 (119 days).
Note: Only 99% of requested data were available from station PARLIER.A. See retrieval table.

Date	Air temperatures (°C)		Degree-days		Notes
	Min *	Max *	Daily	Accumulated	
Mar 15 2018	5.6	16.7	2.38	2.38	
Mar 16 2018	5.0	14.4	1.35	3.73	
Mar 17 2018	2.2	15.0	1.39	5.11	
Mar 18 2018	1.7	15.0	1.36	6.47	
Mar 19 2018	2.8	20.0	3.47	9.95	
Mar 20 2018	8.9	17.8	3.52	13.46	
Mar 21 2018	11.1	17.2	4.15	17.61	
Mar 22 2018	9.4	18.9	4.21	21.83	
Mar 23 2018	6.1	17.2	2.67	24.50	
Mar 24 2018	5.6	17.8	2.87	27.36	

Too Much Work?



University of California
Agriculture and Natural Resources
Making a Difference for California

UCCE

UCCE/DWR Weekly Crop Water Use Report

WEEKLY SOIL MOISTURE LOSS IN INCHES

(Estimated Crop Evapotranspiration or ET_c)
06/29/18 through 07/05/18

Crops (Leafout Date)	#188 Madera II ***			#39 Parlier			#86 Lindcove		
	6/29- 7/5 Water Use	Accum'd Seasonal Water Use	7/6- 7/12 Estimated ETc	6/29- 7/5 Water Use	Accum'd Seasonal Water Use	7/6- 7/12 Estimated ETc	6/29- 7/5 Water Use	Accum'd Seasonal Water Use	7/6- 7/12 Estimated ETc
Almonds (3/16) *	1.97	20.45	1.90	2.07	20.64	1.89	2.03	19.88	1.89
Pistachio (4/21) * **	2.08	10.68	2.04	2.18	10.85	2.03	2.14	10.62	2.03
Citrus (2/1)	1.26	18.71	1.20	1.30	18.78	1.19	1.27	18.12	1.19
Raisin Grapes (3/16) (11 ft. row spacing)	1.62	13.86	1.55	1.69	13.94	1.54	1.66	13.46	1.54
Winegrapes (3/16) (10 ft. spacing on California Sprawl Trellis)	1.80	14.50	1.76	1.88	14.60	1.75	1.85	14.17	1.75
Walnuts (4/4)	1.82	15.75	1.83	1.92	15.91	1.82	1.88	15.37	1.82
Stone Fruit (3/16)	1.72	14.74	1.69	1.82	14.86	1.68	1.78	14.40	1.68
Past 7 days precipitation (inches)		0.00			0.00			0.00	
Accumulated precipitation (inches) (1/1/2018)		6.33			4.96			3.32	

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.
*** CIMIS station #188 Madera II has been taken out of service due to a conversion of the pasture to permanent crops. For the remainder of 2018 irrigation season Historical Average ETo will be used for the weekly report.

PAST WEEKLY APPLIED WATER IN INCHES, ADJUSTED FOR EFFICIENCY

Crops	#188 Madera II				#39 Parlier				#86 Lindcove			
System Efficiency >>	65%	75%	85%	95%	65%	75%	85%	95%	65%	75%	85%	95%
Almonds (3/16)	3.0	2.6	2.3	2.1	3.2	2.8	2.4	2.2	3.1	2.7	2.4	2.1
Pistachio (4/21)	3.2	2.8	2.4	2.2	3.4	2.9	2.6	2.3	3.3	2.9	2.5	2.3
Citrus (2/1)	1.9	1.7	1.5	1.3	2.0	1.7	1.5	1.4	2.0	1.7	1.5	1.3
Raisin Grapes (3/16) (11 ft. row spacing)	2.5	2.2	1.9	1.7	2.6	2.3	2.0	1.8	2.6	2.2	2.0	1.7
Winegrapes (3/16) (10 ft. spacing on California Sprawl Trellis)	2.8	2.4	2.1	1.9	2.9	2.5	2.2	2.0	2.8	2.5	2.2	1.9
Walnuts (4/4)	2.8	2.4	2.1	1.9	3.0	2.6	2.3	2.0	2.9	2.5	2.2	2.0
Stone Fruit (3/16)	2.6	2.3	2.0	1.8	2.8	2.4	2.1	1.9	2.7	2.4	2.1	1.9

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	#188 Madera II				#39 Parlier				#86 Lindcove			
Almonds 115 Trees/A	708	614	543	496	756	661	567	519	732	638	567	496
Pistachio 106 Trees/A	797	698	598	548	847	722	648	573	822	722	623	573
Citrus 110 Trees/A	469	420	370	321	494	420	370	346	494	420	370	321
Raisin Grapes 566 Vines/A	120	106	91	82	125	110	96	86	125	106	96	82
Winegrapes 622 Vines/A	122	105	92	83	127	109	96	87	122	109	96	83
Walnuts 76 Trees/A	1000	857	750	679	1072	929	822	715	1036	893	786	715
Stonefruit 172 Trees/A	410	363	316	284	442	379	332	300	426	379	332	300

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

Actual Grape ET

- Surface Renewal, e.g., Tule Technology: provide daily actual ET, e.g., gallons/vine/day

How to Schedule Irrigation?

- Obtain gallons/vine/week from crop ET reports, Tule, historical ET…
- Number of emitters per vine, e.g., 2 emitters/vine
- Flow rate per emitter, e.g., 0.5 gallon/hour
- Hours/week = (gallons/vine/week)/(number of emitters/vine × flow rate)

Double Check Flow Rate!

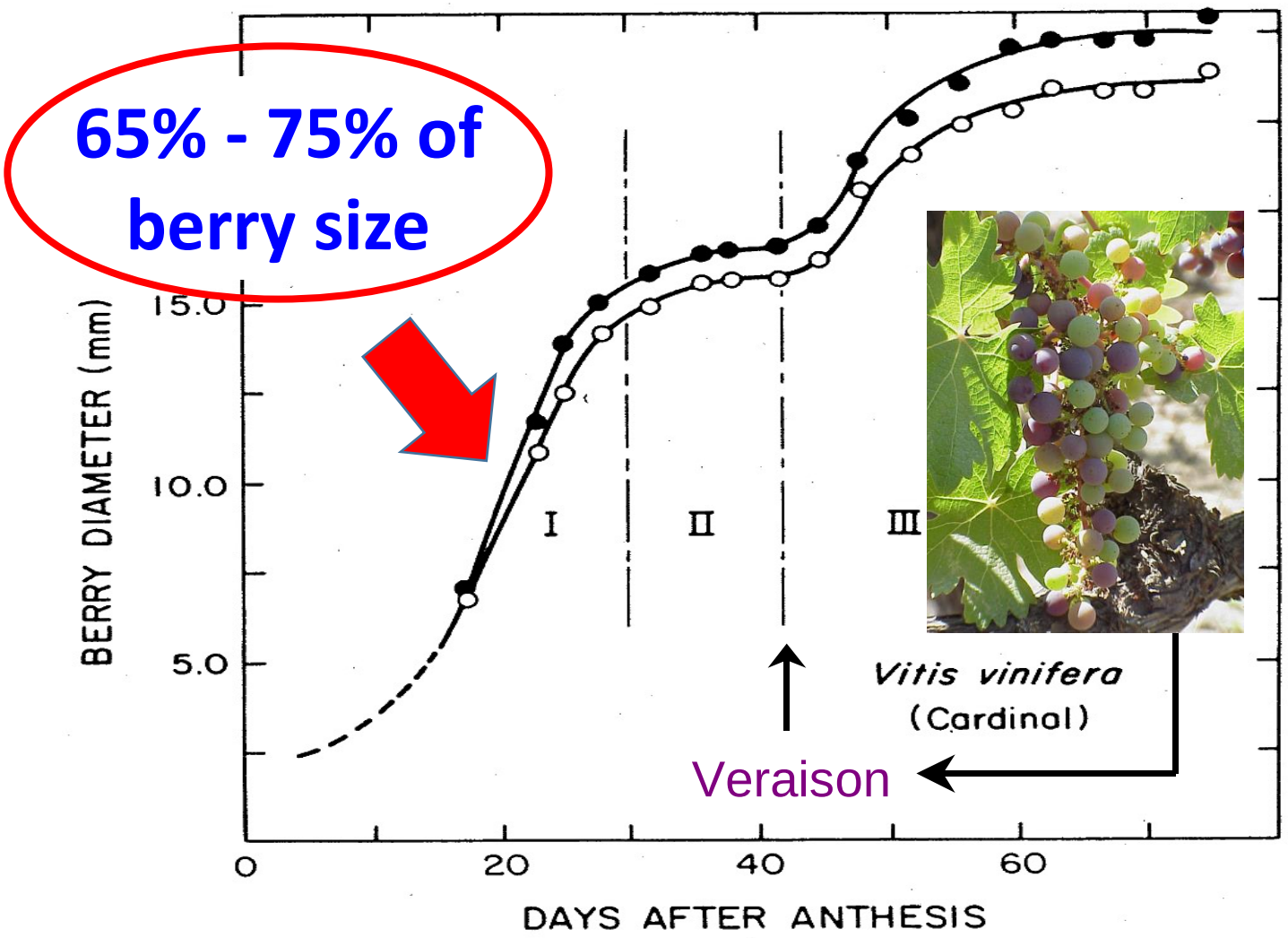
How to Deficit Irrigation?

- It depends on your production goal:
  - Yield
  - Quality
- Overall, berry size/yield is maximized with applied water at **80%** of ETc (Dr. Larry Williams, UC Davis)

How to Deficit Irrigation?

- Pre-veraison water deficit
  - Significant impact on berry size/yield, and generally beneficial for quality: *smaller berry with higher skin/pulp ratio*
- Post-version water deficit
  - Minimal impact on berry size/yield, and still beneficial for quality: *plant growth regulator, e.g., ABA?*

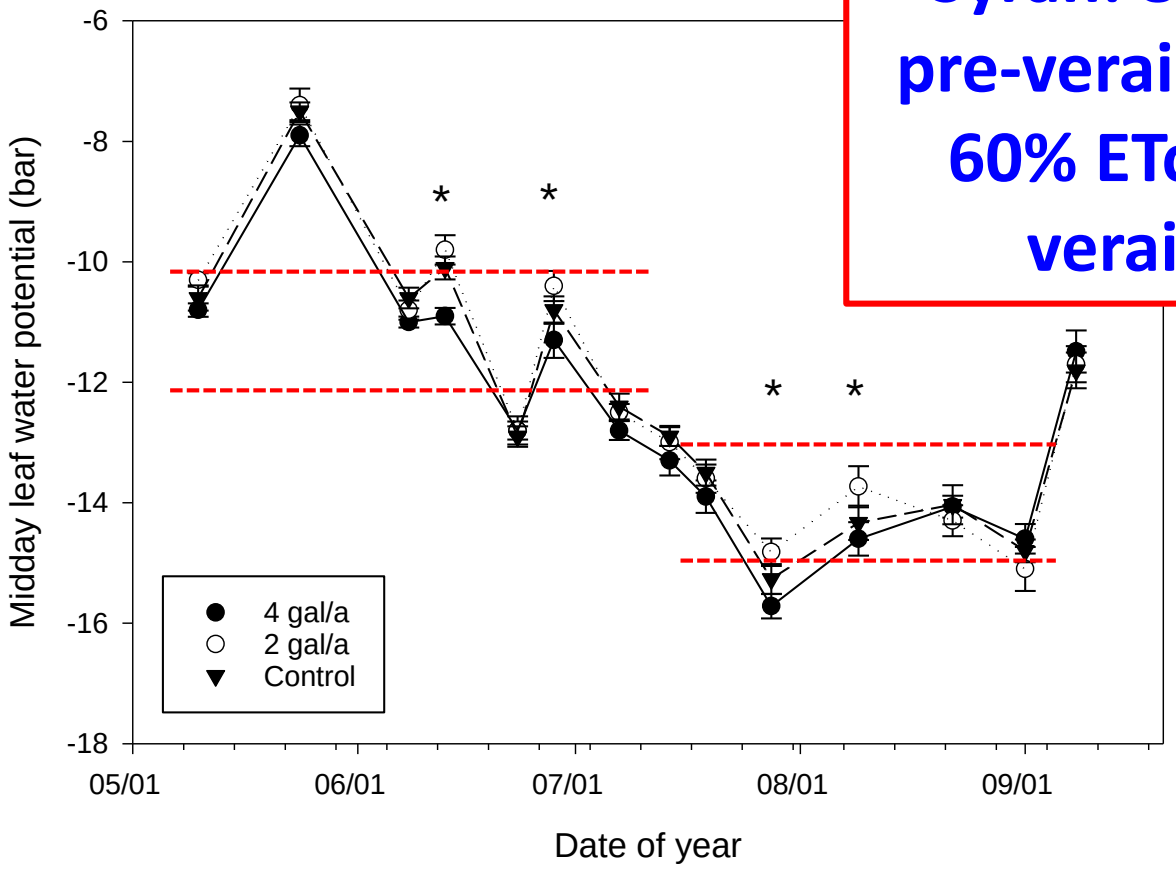
Water Deficit on Berry Size



Irrigation Scheduling

- Midday leaf water potential well responds with ET in the SJV

Syrah: 80% ETc pre-veraison and 60% ETc post-veraison



Conclusion

- Deficit irrigation (at applied water amounts ~ **80%** of estimated ET_c) had only minimal effects on berry size.
- Overall, yield is maximized with applied water at **80%** of estimated ETc.
- Water deficit can be applied at different phenological stages to achieve the production goal.

Acknowledgement

- Gaia Nafziger, UCCE Fresno County
- Dr. Larry Williams, UC Davis
- SJV wine growers and wineries

Questions?