Grapevine Irrigation and Nitrogen Management

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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 assessment
- Soil moisture
- Plant water stress

Visual Assessment

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

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

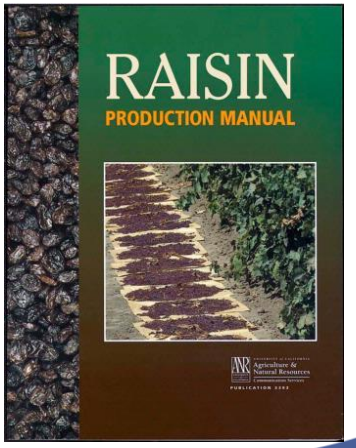
Plant Water Stress

- Pressure chamber
- Sap flow sensor
- …

Irrigation starts when midday leaf water potential reaches -10 bars

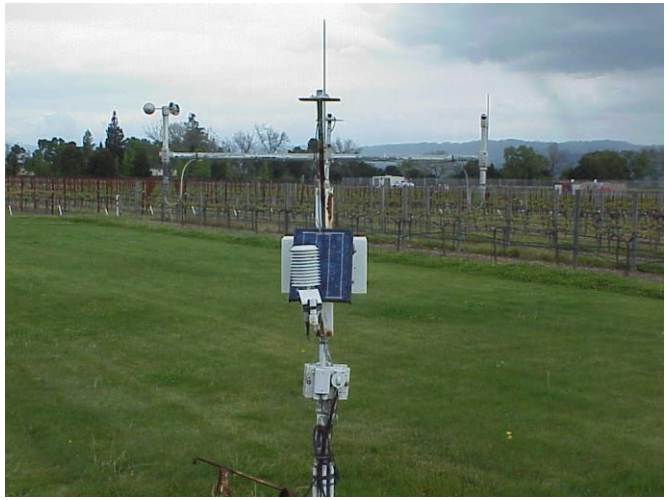
How Much to Irrigate?

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



Grapevine ET

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



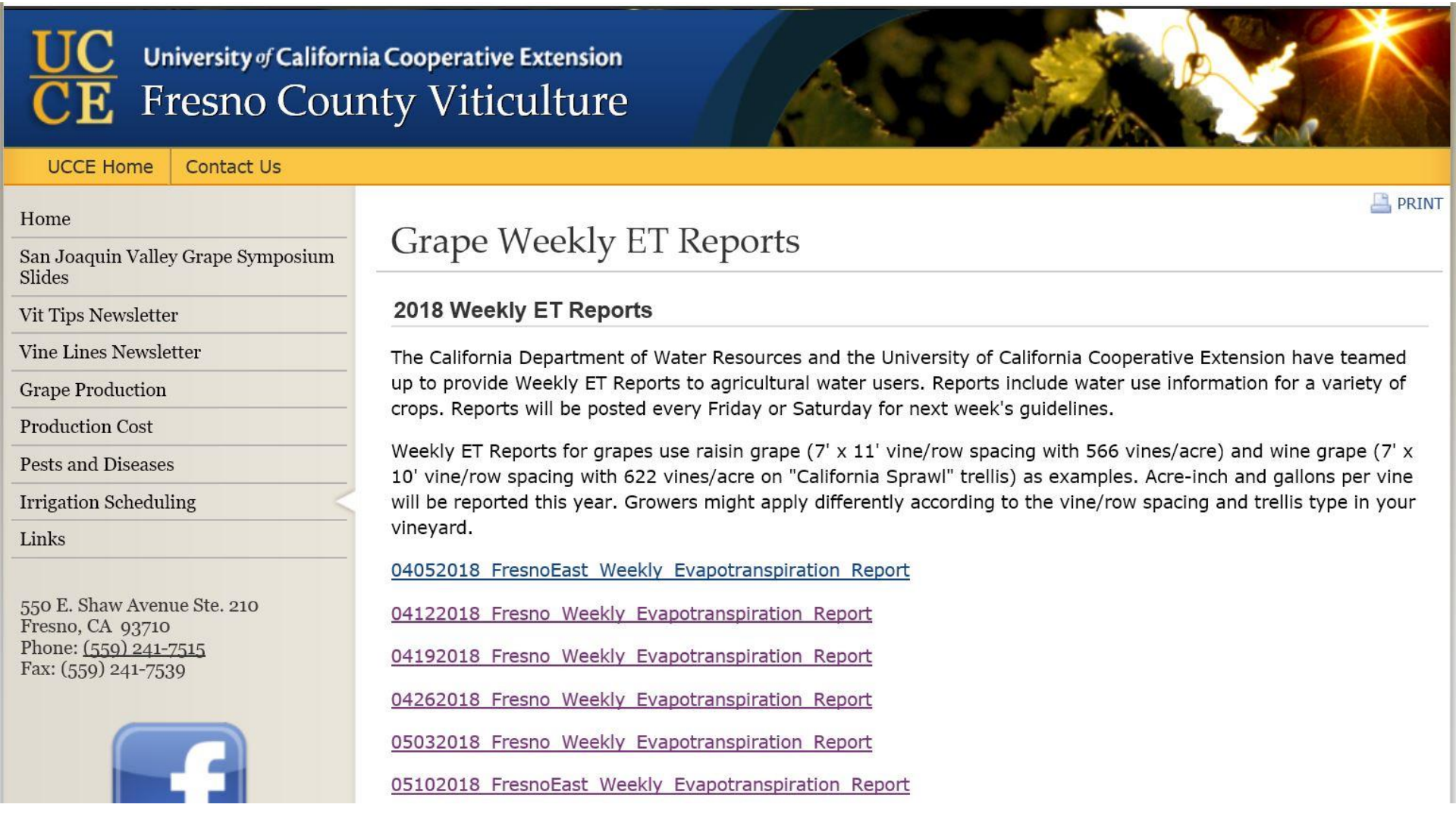
Kc=(0.017 × Shaded percentage of field)

Grapevine 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))

Too Much Work?



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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.

How to Schedule Irrigation?

- Obtain gallons/vine/week from crop ET reports, 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)

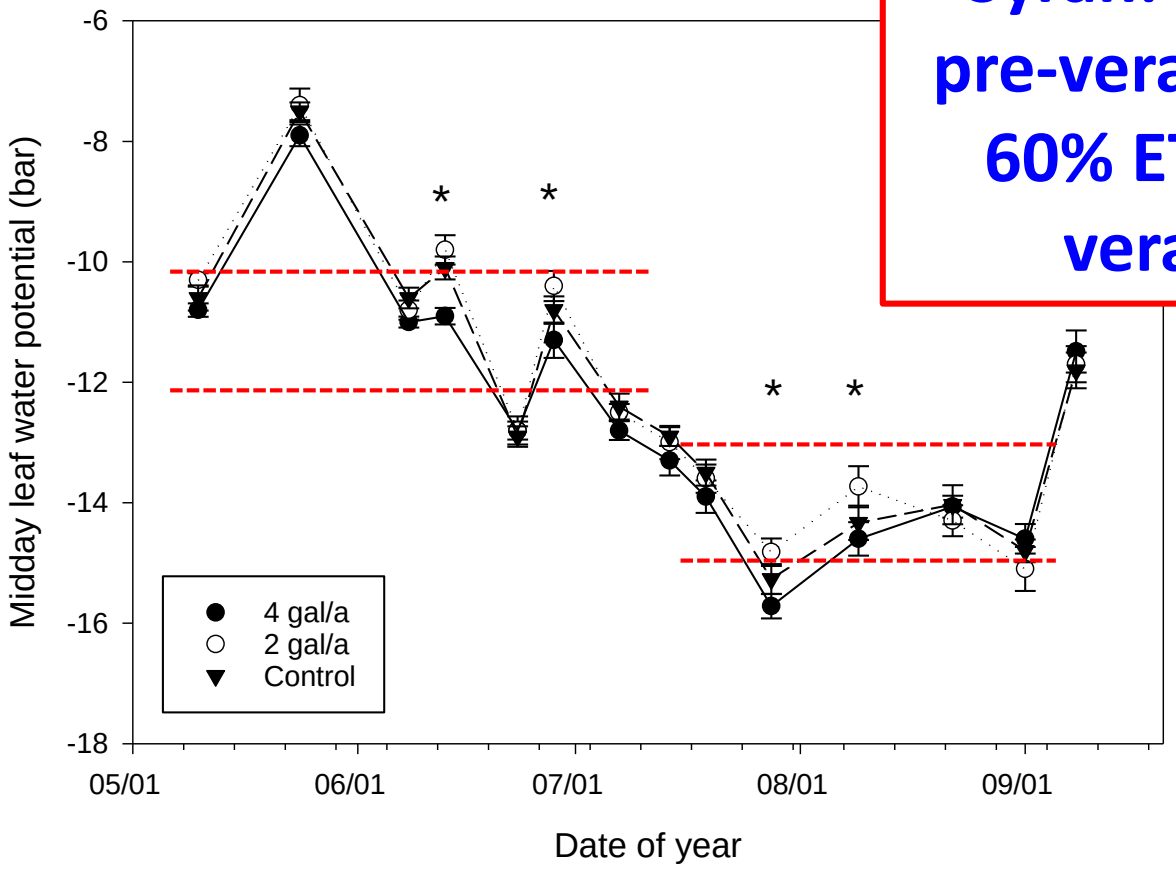
Need Deficit Irrigation?

- 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)

Use ET to Schedule Irrigation

- Midday leaf water potential well responds with ETc in San Joaquin Valley

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



Do I Need Fertilizer?

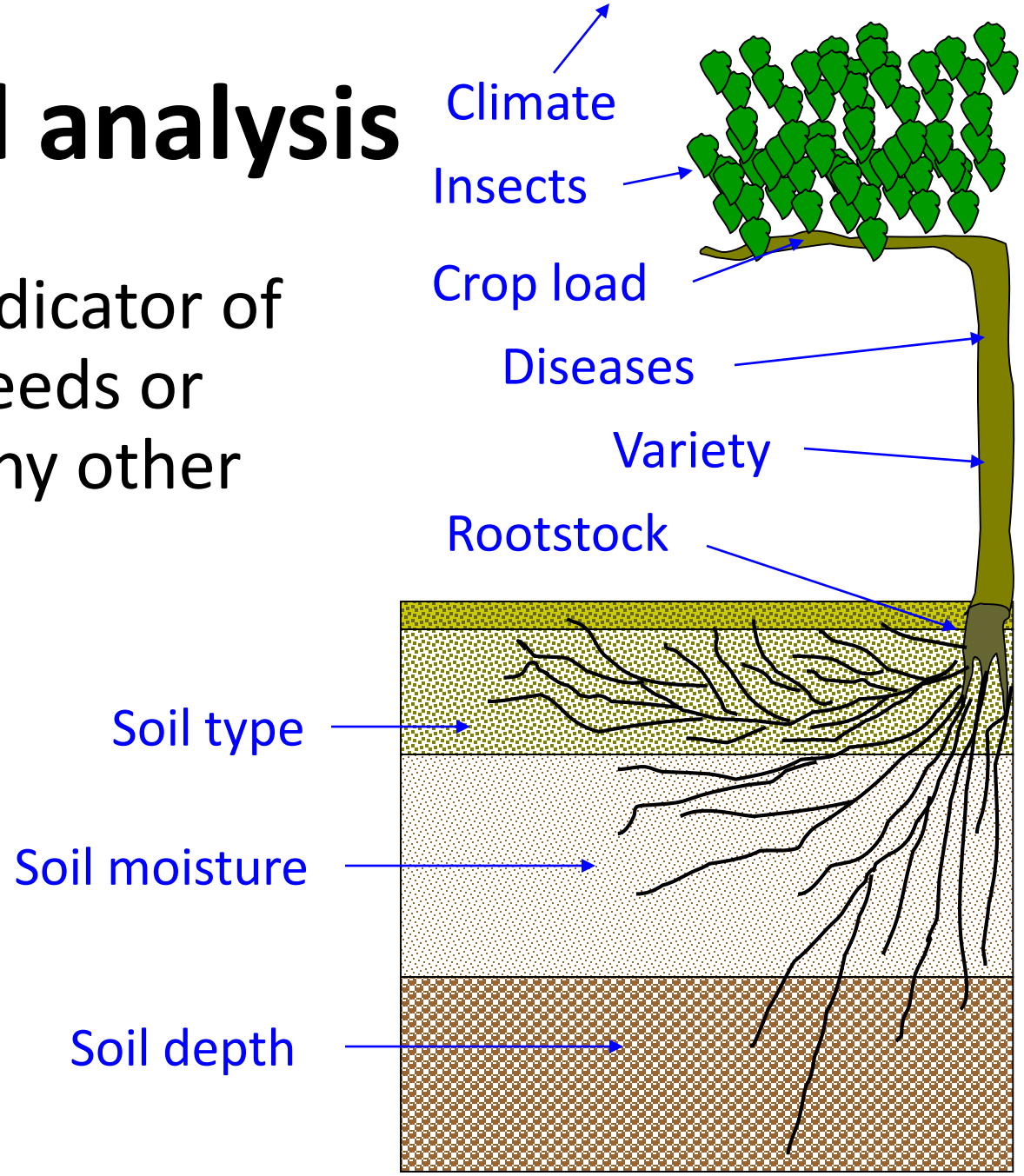
- Vine vigor
- Canopy
- Fertilizer history
- Soil and root conditions
- Laboratory analysis
  - ✓ ***Soil***
  - ✓ ***Plant tissue***: Petiole and Leaf blade
  - ✓ ***Water***

Soil Sampling

No.	Description	%	units	dS/m	meq/l	meq/l	meq/l	meq/l	%	T/ac-6"	+\-	lbs/ac-6"	mg/l	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
		SP	pH	EC	Ca	Mg	Na	Cl	ESP	GR	Lime	Lime	B	NO_3-N	PO_4-P	K	Acid K	Zn
	RL--->	0.50	1.0	0.01	0.1	0.1	0.1	0.1	0.1	0.1		500	0.1	1.0	2.0	2.0	40.0	0.1
	NAPT Methods--->	S1.00	S1.10	S1.20	S1.60	S1.60	S1.60	S1.40	Calc.			S2.50	S1.50	S3.10	S4.10	S5.10		S6.10
	Handbook 60--->									Hndbk 60-22d	Hndbk 60-23a						SSSA,p5 61 mod	
1	0-1	41	7.6	1.76	11.1	4.0	4.3	2.5	1.1		++		0.6	15	23	399		5.3
2	1-2	42	7.7	1.58	8.9	3.8	5.2	1.5	1.8		+		0.7	7	17	389		2.1
3	2-3	41	7.8	0.94	3.3	1.7	4.5	1.4	2.8		++		0.6	5	8	303		0.8
4	3-4	39	7.8	1.57	6.1	3.6	7.0	2.4	3.3		++		0.7	14	3	214		0.6

Limits of soil analysis

- Not the sole indicator of vine nutrient needs or availability; many other factors



Grapevine Tissue Sampling

- Evaluating for fertilizer needs
- Sample at full bloom (2/3 caps fallen)
- Petioles from 60–100 vines
- Sample leaf opposite a basal cluster

Bloom N Critical Values

- Bloom petiole values*

	Petiole Levels (NO_3-N, ppm)
Deficient	< 350
Questionable	350 to 500
Adequate	500 to 2,000
Excessive	> 2,000
Toxic	> 8,000

* NO_3-N critical values are based solely on Thompson Seedless on own roots

Lab #	Block/Field	Total Nitrogen (%)	Nitrate-Nitrogen (ppm)	Calcium (%)	Magnesium (%)	Phosphorus (%)	Potassium (%)	Manganese (ppm)	Zinc (ppm)	Boron (ppm)	Sodium (%)	Chloride (%)	Iron (ppm)	Copper (ppm)
3977	Block 28, Petiole Pinot Grigio		3,429	1.3	0.88	0.12	3.5	28	64	33	0.01	0.10	42	9
	Optimum Range	0.8 - 1.[illegible]	600 - 800	[illegible].0 - 2.0	0.30 - 0.80	0.15 - 0.30	1.5 - 2.5	25 - 80	25 - 50	40 - 80	0.01 - 0.30	0.01 - 0.9	35 - 150	4 - 10

Visual Assessment

- How about bloom petiole analysis under the questionable values?

N Application Timing

- Late spring or early summer
  - ✓One month after bud break
  - ✓Right after fruitset
- Post-harvest
  - ✓Intact, healthy leaf area
  - ✓> 3 weeks before leaf fall

N Application Amount

- Crop removal ≈ 30 lbs of N in 10 tons of crop which are removed from the vineyard
- Rate, lbs N/acre under ***drip irrigation***:

Rate, lbs N/acre*	Vine Vigor
0	High to excess vigor
10 – 20	High to medium
20 – 30	Medium
30 – 40	Medium to low

***Apply in increments over time**

Don’t Forget Irrigation!

- Raisin/wine grape generally requires 2-3 acre foot of water annually, and table grape requires 4 acre foot in San Joaquin Valley.
- N content in water varies based on sources: surface water ***vs.*** well water
- Consider N input from irrigation, when budgeting the vineyard N amount.

Irrigation Water Analysis

		Date Sampled	Time Sampled	EC dS/m	Ca meq/L	Mg meq/L	Na meq/L	SAR	Adj SAR	Cl meq/L	CO_3+ HCO_3 meq/L	SO_4 meq/L	B mg/L	NO_3-N mg/L	Fe mg/L	Mn mg/L	pH unit	L.I. Calc	TDS mg/L	Nitrogen agricultural use calculations lbs/AcFt	lbs/AcInch
	RL--->			0.01	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.05	0.1	0.10	0.02	1.0 to 14.0	-2.0 to 2.0	10.0		
	SM--->			2510 B				Calc	Calc		2320 B						4500H B	2330 B	2540 C		
	EPA--->				200.7	200.7	200.7			300.0		300.0	200.7	300.0	200.7	200.7					
	Analysis Date:			*9/21/18*	*9/25/18*	*9/25/18*	*9/25/18*	*9/25/18*	*9/26/18*	*9/24/18*	*9/21/18*	*9/24/18*	*9/25/18*	*9/24/18*	*9/25/18*	*9/25/18*	*9/21/18*	*9/26/18*			
	Analysis Time:			*16:55*	*11:15*	*11:15*	*11:15*	*11:15*		*13:45*	*16:55*	*13:45*	*11:15*	*13:45*	*11:15*						
1	Westlands	9/21/18	14:00	0.55	0.87	1.19	3.20	3.20	3.60	2.90	1.40	0.60	0.12	0.5	<0.10					1.4	0.1

x2.73

		Date Sampled	Time Sampled	EC dS/m	Ca meq/L	Mg meq/L	Na meq/L	SAR	Adj SAR	Cl meq/L	CO_3+ HCO_3 meq/L	SO_4 meq/L	B mg/L	NO_3-N mg/L	Fe mg/L	Mn mg/L	pH unit	L.I. Calc	TDS mg/L	Nitrogen agricultural use calculations lbs/AcFt	lbs/AcInch
	RL--->			0.01	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.05	0.1	0.10	0.02	1.0 to 14.0	-2.0 to 2.0	10.0		
	SM--->			2510 B				Calc	Calc		2320 B						4500H B	2330 B	2540 C		
	EPA--->				200.7	200.7	200.7			300.0		300.0	200.7	300.0	200.7	200.7					
	Analysis Date:			*11/6/17*	*11/6/17*	*11/6/17*	*11/6/17*	*11/6/17*	*11/14/17*	*11/4/17*	*11/6/17*	*11/4/17*	*11/6/17*	*11/4/17*	*11/6/17*	*11/6/17*	*11/6/17*	*11/14/17*			
	Analysis Time:			*13:56*	*10:58*	*10:58*	*10:58*	*10:58*		*2:13*	*13:56*	*2:13*	*10:58*	*2:13*	*10:58*	*10:58*	*13:56*				
1	Well	11/3/17	9:15	0.11	0.50	0.36	0.30	0.50	0.50	<0.1	1.10	<0.1	<0.05	0.2	<0.10	0.04	7.9	-0.6		0.5	0.0
2	Well	11/3/17	9:20	0.50	2.08	1.78	1.60	1.10	2.10	0.40	3.40	1.20	0.09	6.9	<0.10	<0.02	7.9	0.4		18.8	1.6
3	Well	11/3/17	9:25	0.66	2.83	2.32	1.40	0.80	1.70	0.50	3.60	1.60	<0.05	19.8	<0.10	<0.02	8.0	0.6		54.1	4.5

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Conclusion

- Use plant tissue analysis coupled with visual assessment to determine: do I need N fertilizer?
- Budget the vineyard N based on:
  - ✓ Yield: *3 lbs N of 1 ton of fresh fruit*
  - ✓ Irrigation: *2-3 acre foot for raisin/wine, 4 acre foot for table grape*
- Yield is maximized with applied water at 80% of estimated ETc.

Acknowledgement

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

Questions?