Deficit Irrigation Scheduling for Quality Winegrapes

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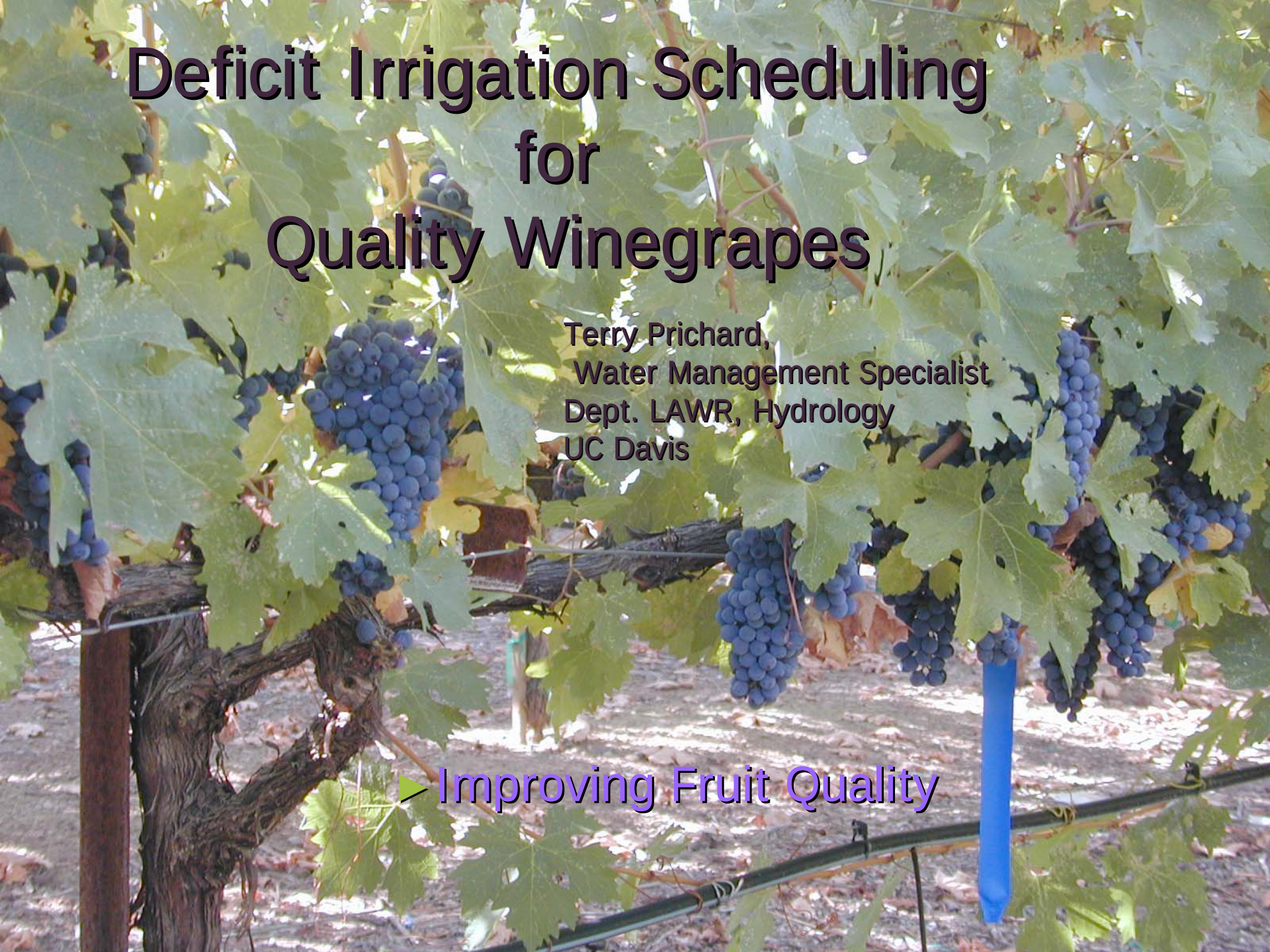


- Improving Fruit Quality

Improving Fruit Quality

- Crop Load Management
  - Pruning/Thinning
- Canopy Management
  - Trellis/Leaf Removal
- Crop Selection (drop)
- Ripeness Harvesting
- Water Deficits
  - Timing and Severity

Deficit Irrigation

Vegetative growth	-
Improved color	+
Improved characteristics	+
Yield	- / 0
Water volume/costs	+

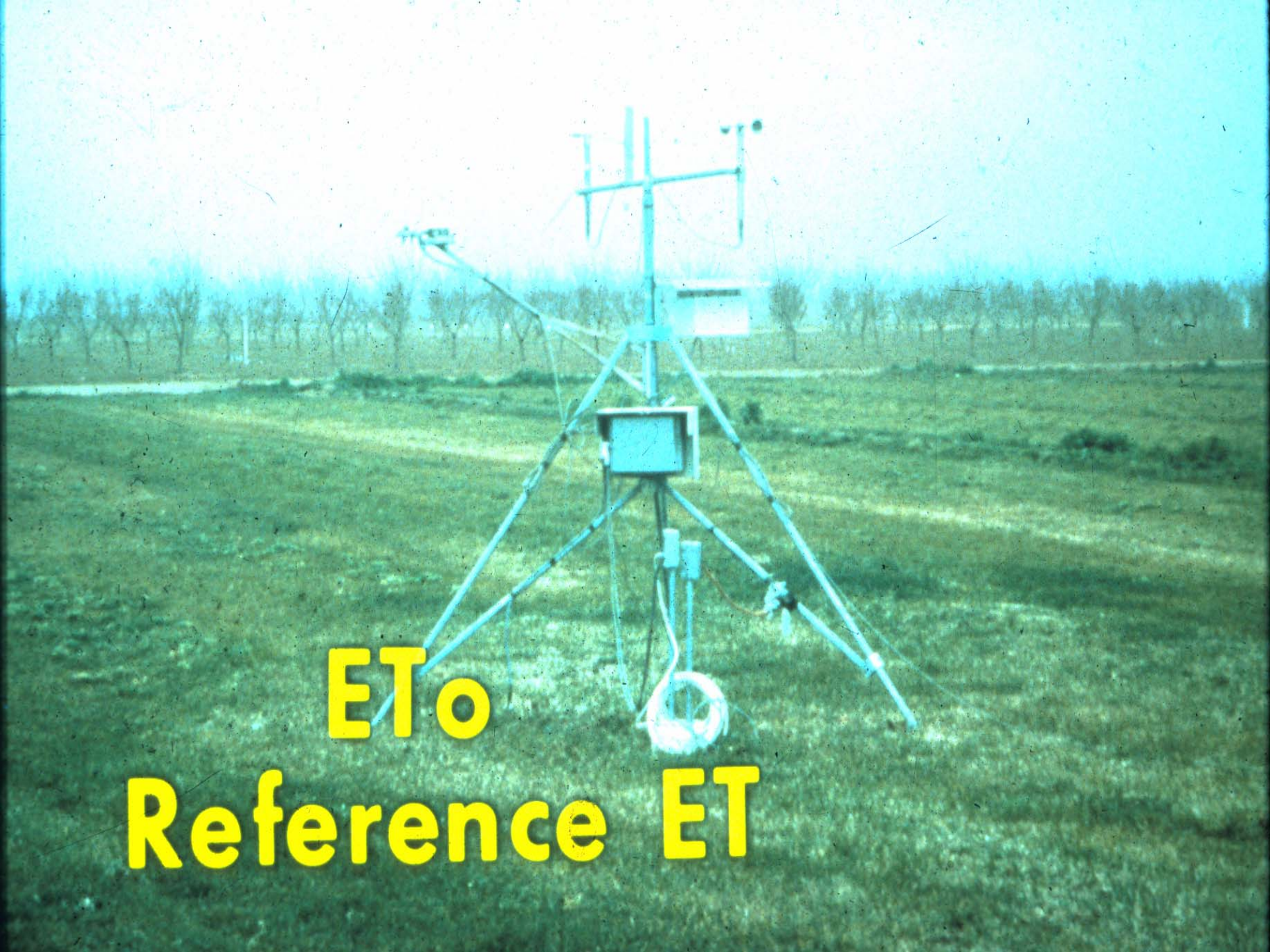
Water Use

Climate

- Evapotranspiration Reference (ETo)

Sun Interception

- Size of Canopy (Kc)
  - Time of season (canopy expansion)
  - Spacing
  - Trellis

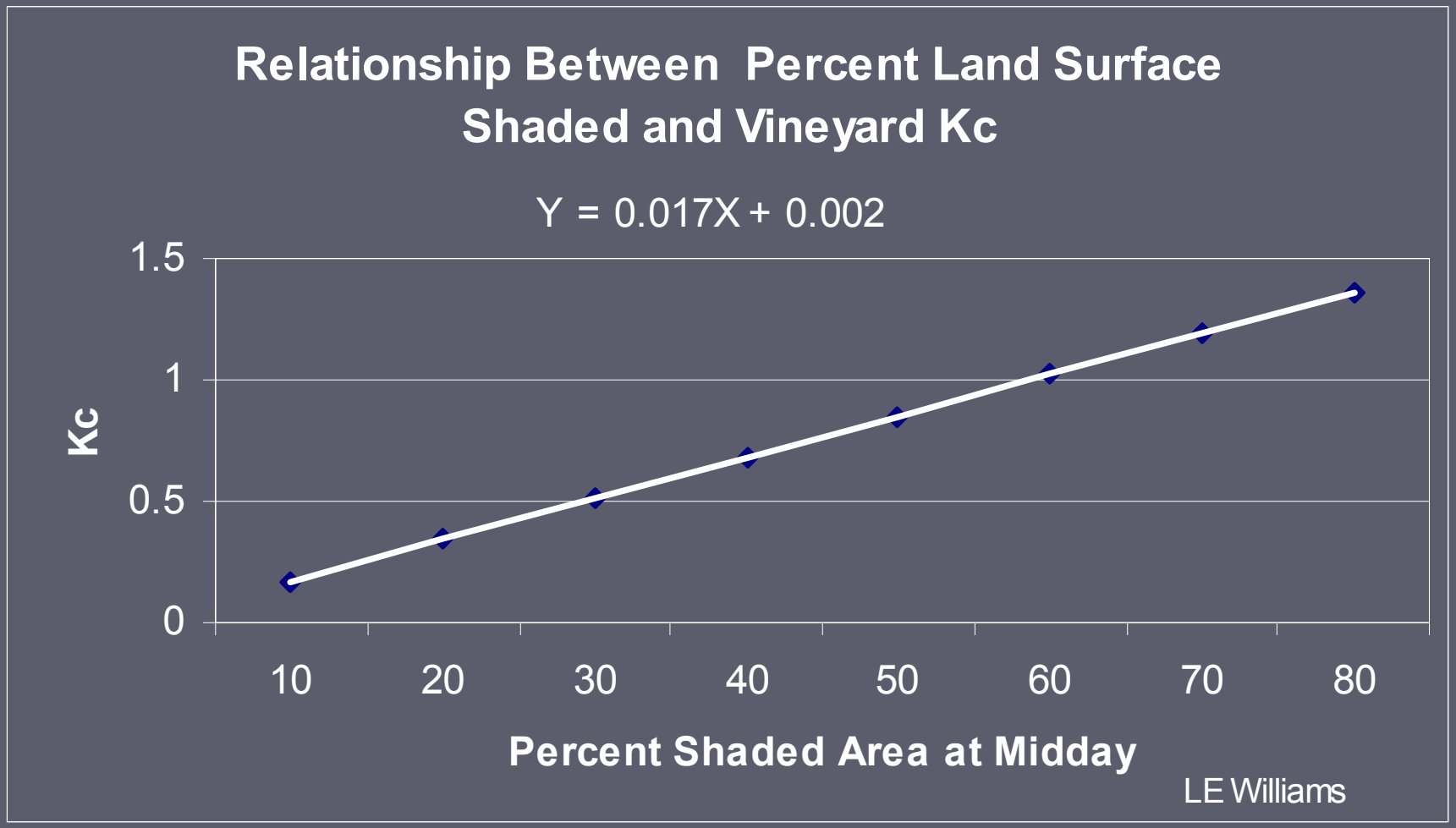

ETo
Reference ET

CIMIS

California Irrigation Management Information System

Evapotranspiration Reference (ETo) Rainfall

www.cimis.water.ca.gov



44 x 0.017 = 0.75 Kc


May 10 7:30
Quad
Vertical

Balance Vegetative/Reproductive Structure

Vineyard Development

Soil/Climate Resources

- Selection
  - Rootstock
  - Clone
  - Spacing
  - Trellis type

Irrigation Management Philosophy

Controlled water deficits

can improve fruit quality

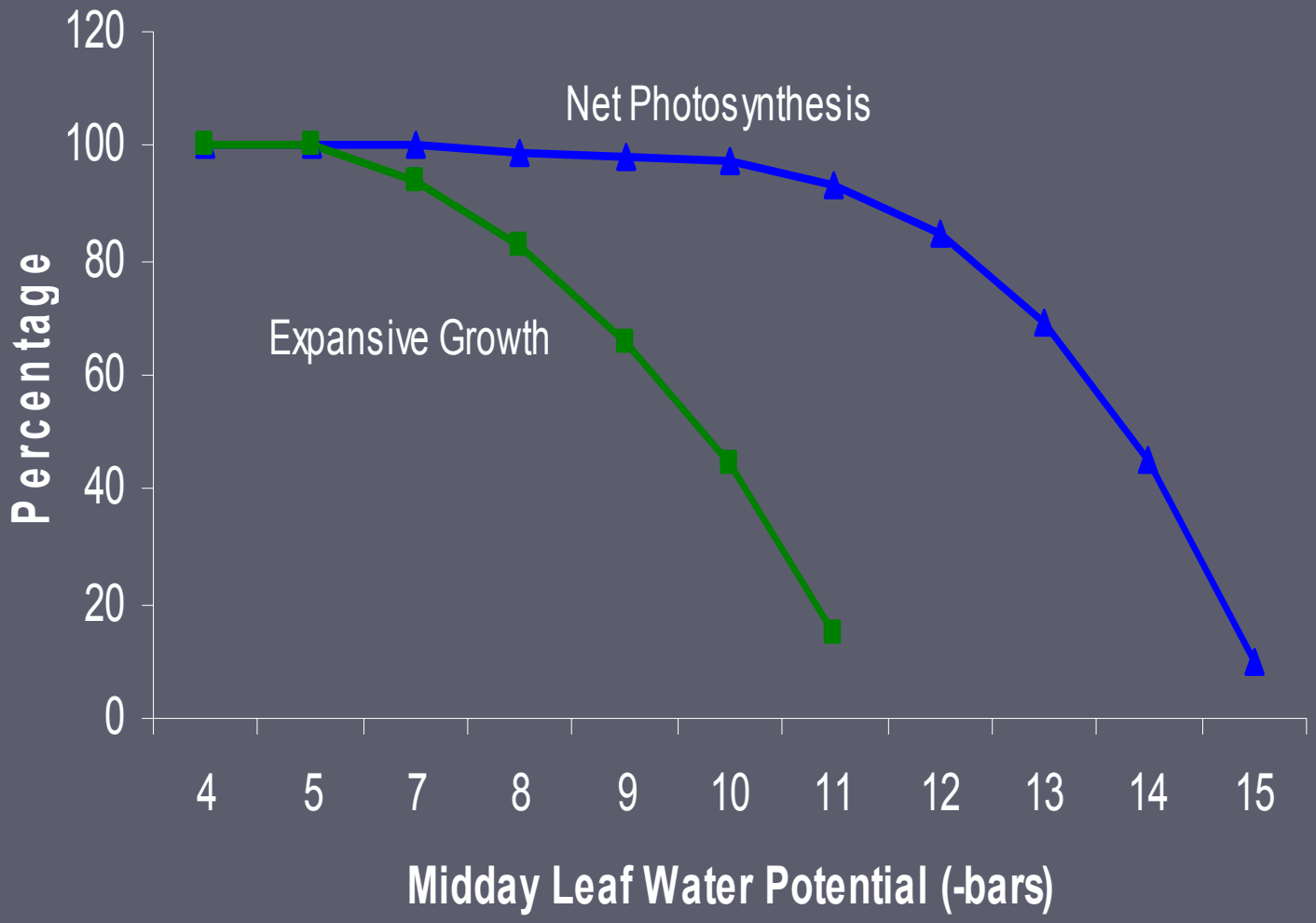
with little effect on yield

Moderate Water Deficits

- Reduce vegetative growth
  - Shoot length
  - No. of lateral shoots

Increase diffused light to fruit

Relative Rate vs. Leaf Water Potential



Quality Goals

- Titratable acidity
- Tartaric/Malic ratio
- pH
- Potassium

Extractable

- Phenolics

Extractable

- Tannins

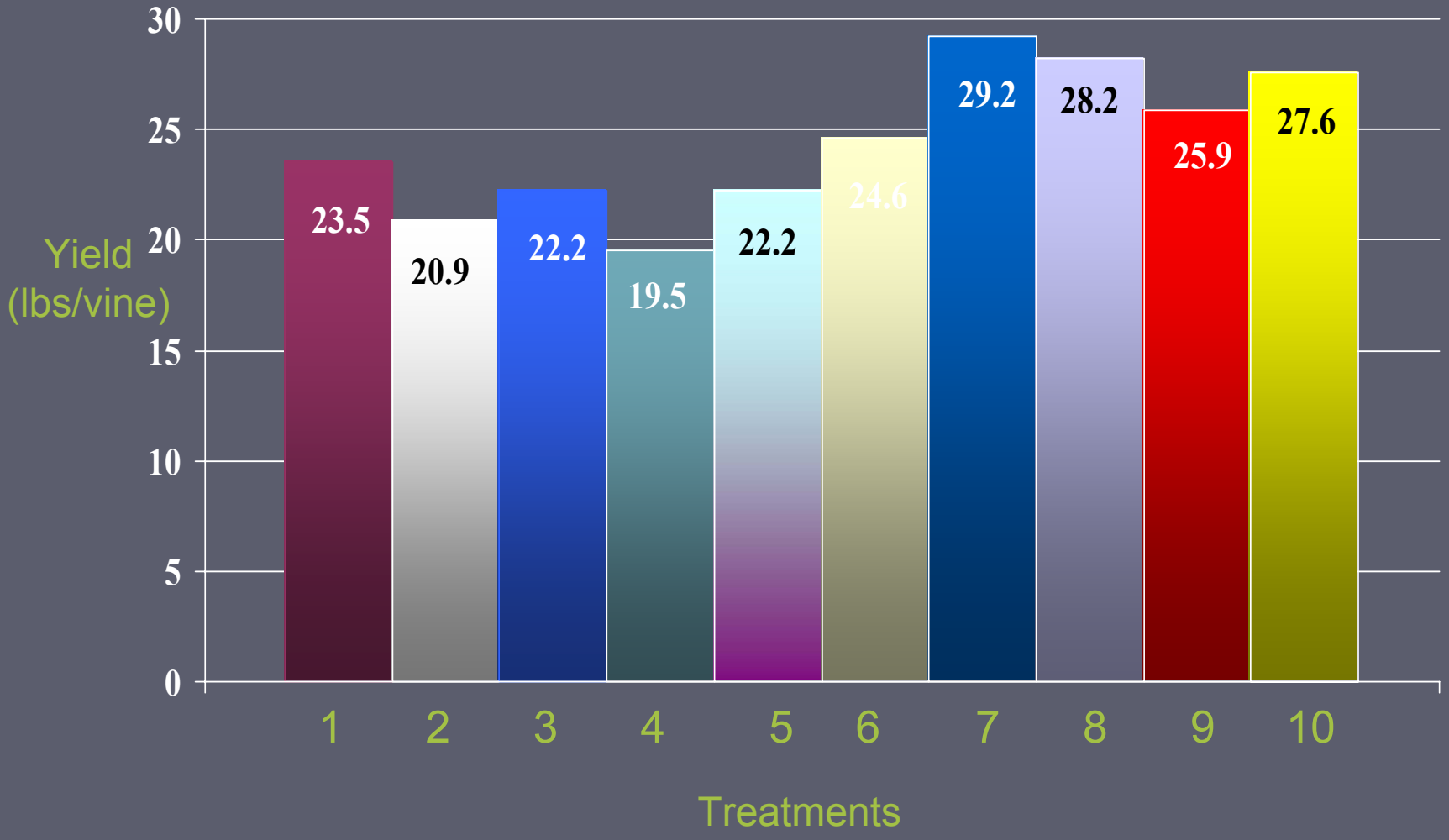
Cabernet Sauvignon, 2000

Location	Tons per acre	Yield: Prun wt	Soluble solids (°Brix)	Titratable acidity (g/L)	pH	Anthocyanins (mg g^{-1} FW)
Parlier	~9	9.1	22.8	5.4	4.2	7.9
Lodi	~8	11.3	23.4	8.1	3.7	18.2
Oakville	~6	6.5	23.9	6.7	3.9	27.5

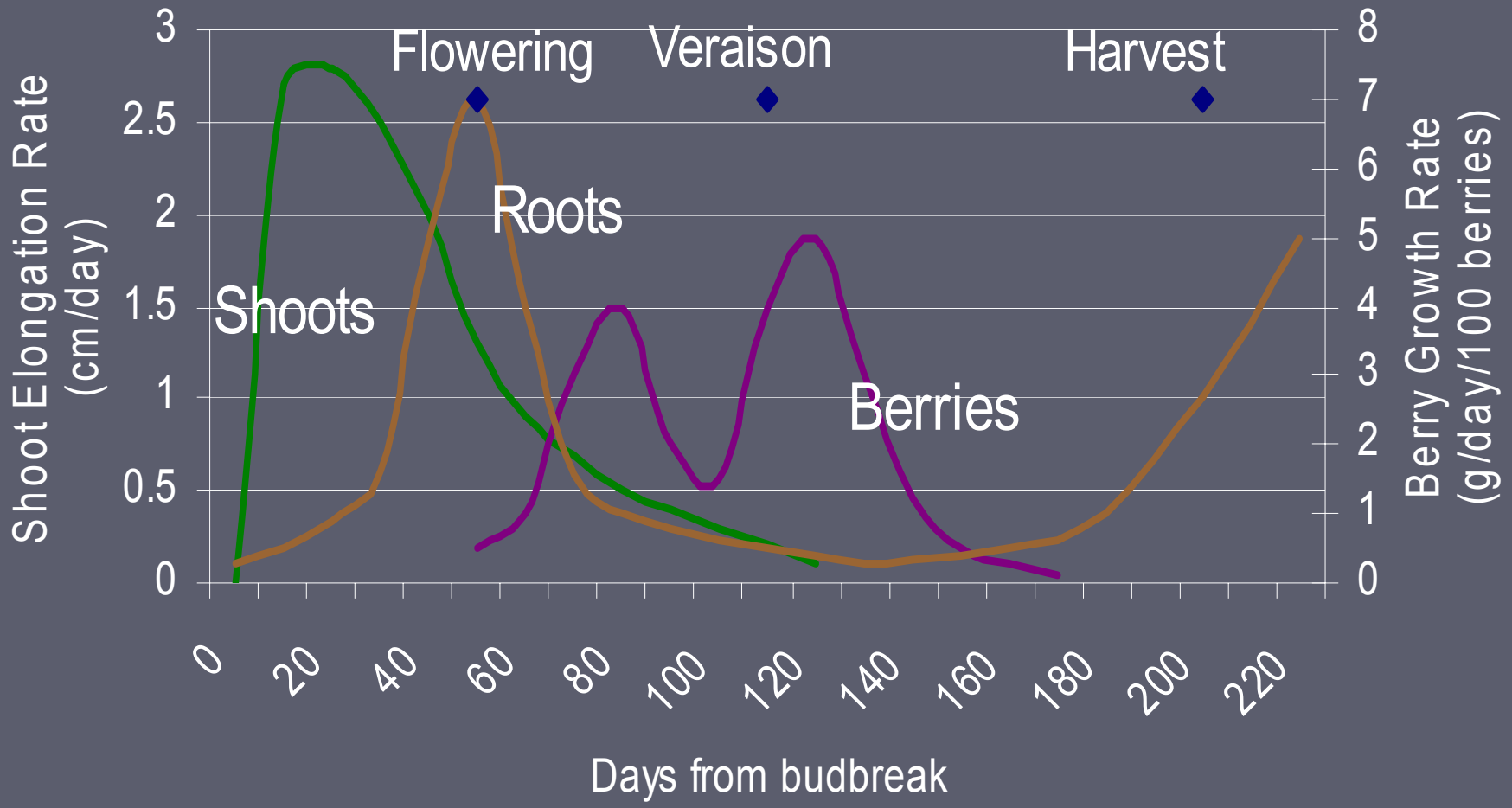
Cabernet Deficit Irrigation

	% of ETc		
Variable	50	75	100
	% of 100% Treatment		
Berry Size	80	90	100

Lodi Merlot 1998

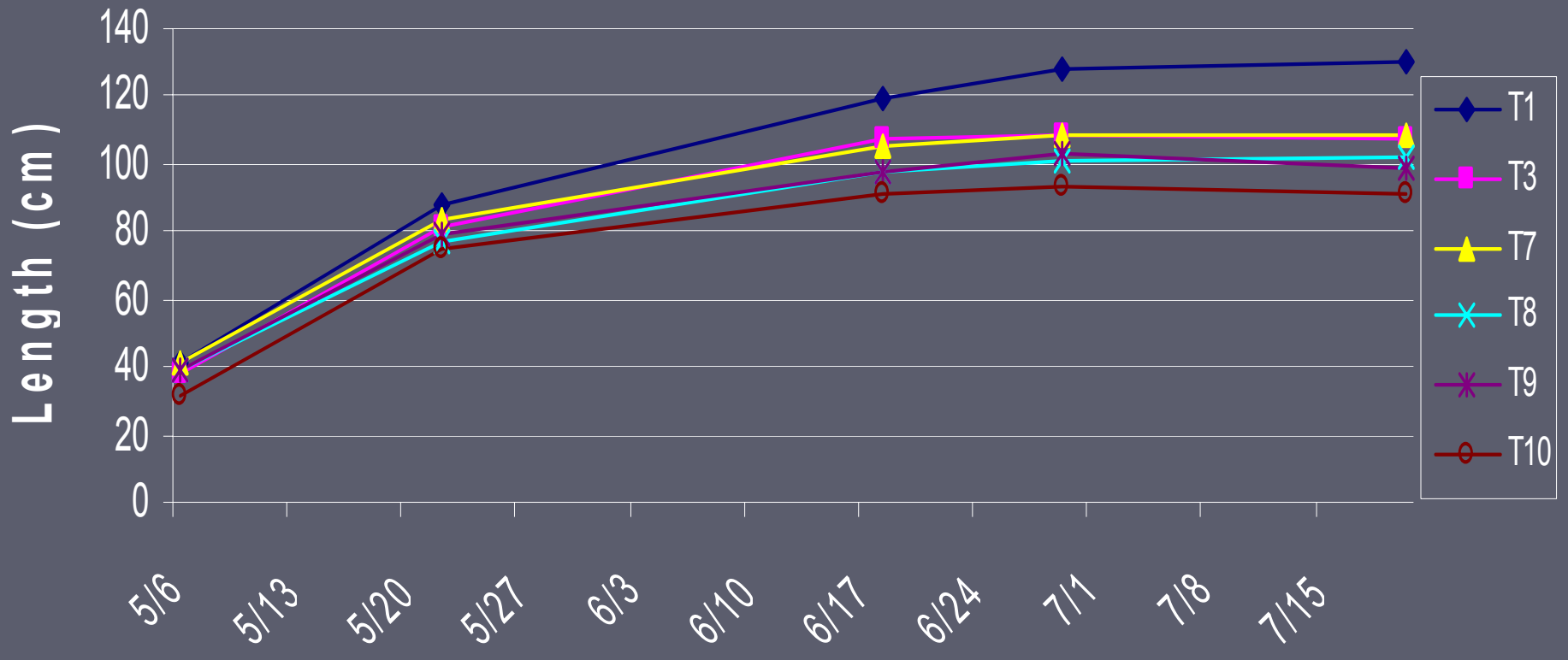


Shoot, Root, and Berry Growth Rate



Mullins, 1992

Shoot Growth, Merlot, Lodi, 1999



Irrigation of Quality Winegrapes

- Determine
  - When
  - How much
- Achieve a predictable response

Developing a Strategy

To Accomplish the Set Goal

Fruit quality/yield

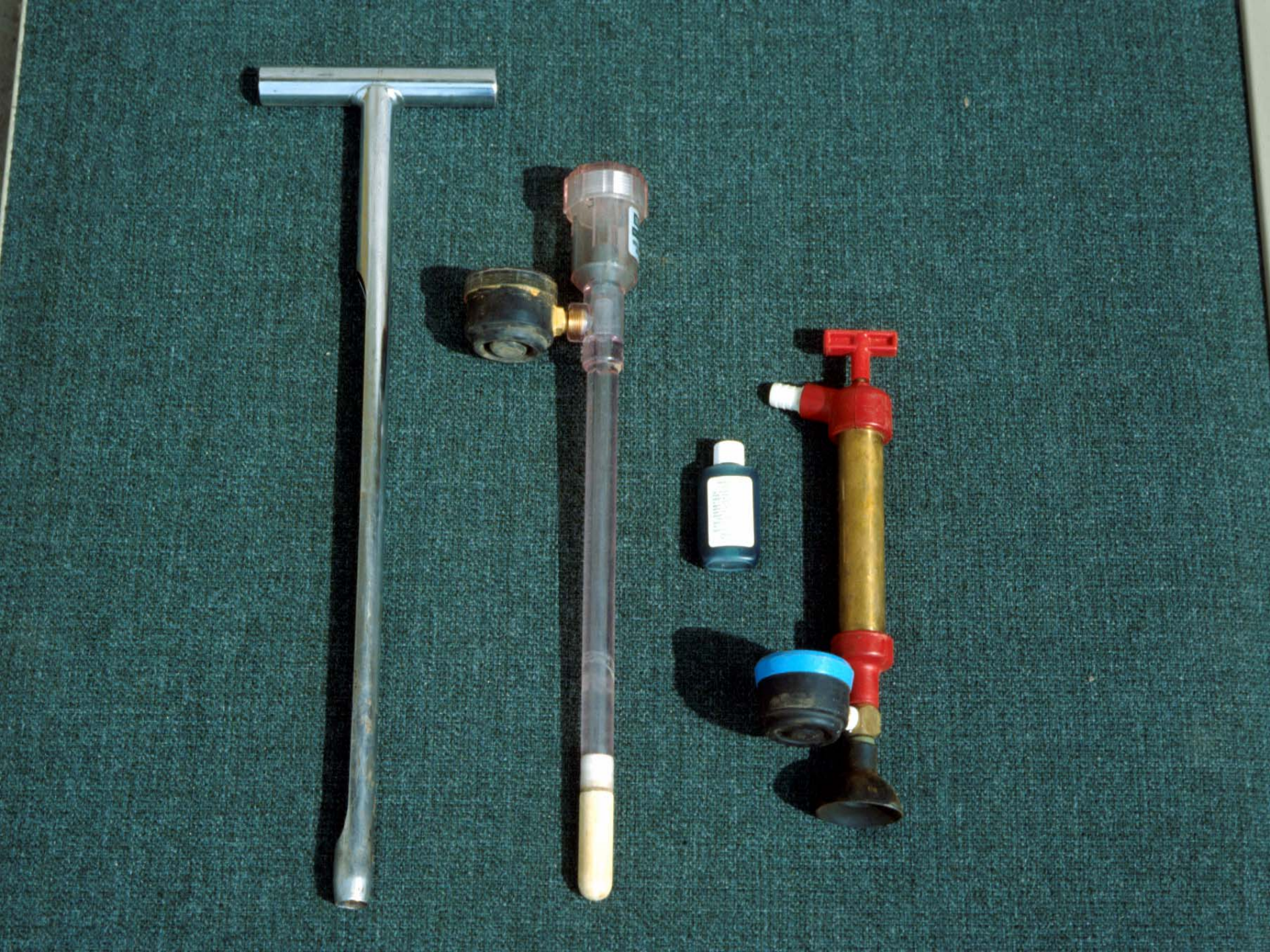
- When to Begin Irrigation
- How much to Apply

When to Begin Irrigation

- Shoot Growth
- Tip Rating
- Mid day Leaf Water Potential
- Soil Based Monitoring Decision

Soil Moisture Measurement

- Quantitative (quantity)
- Qualitative (status)

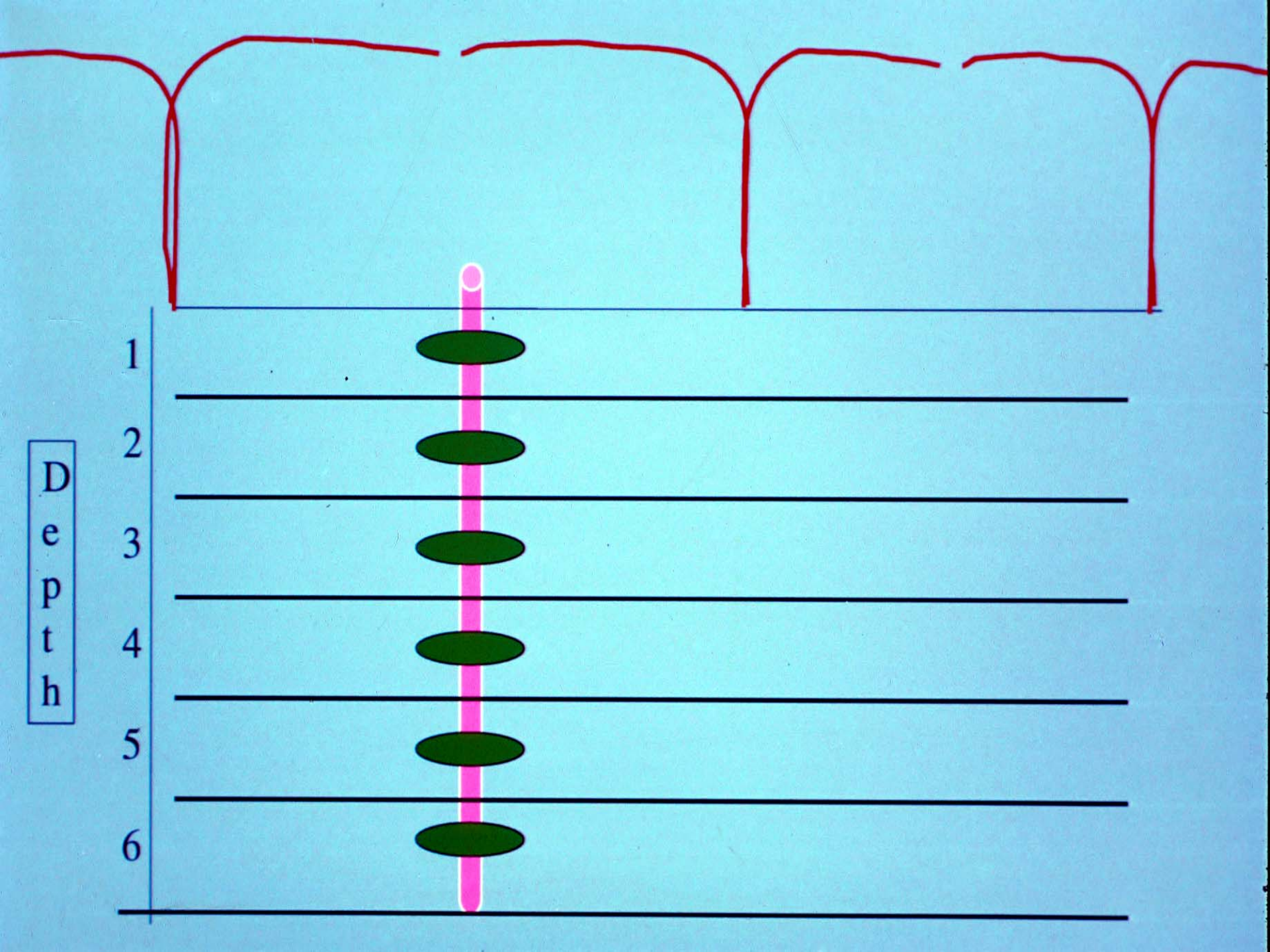


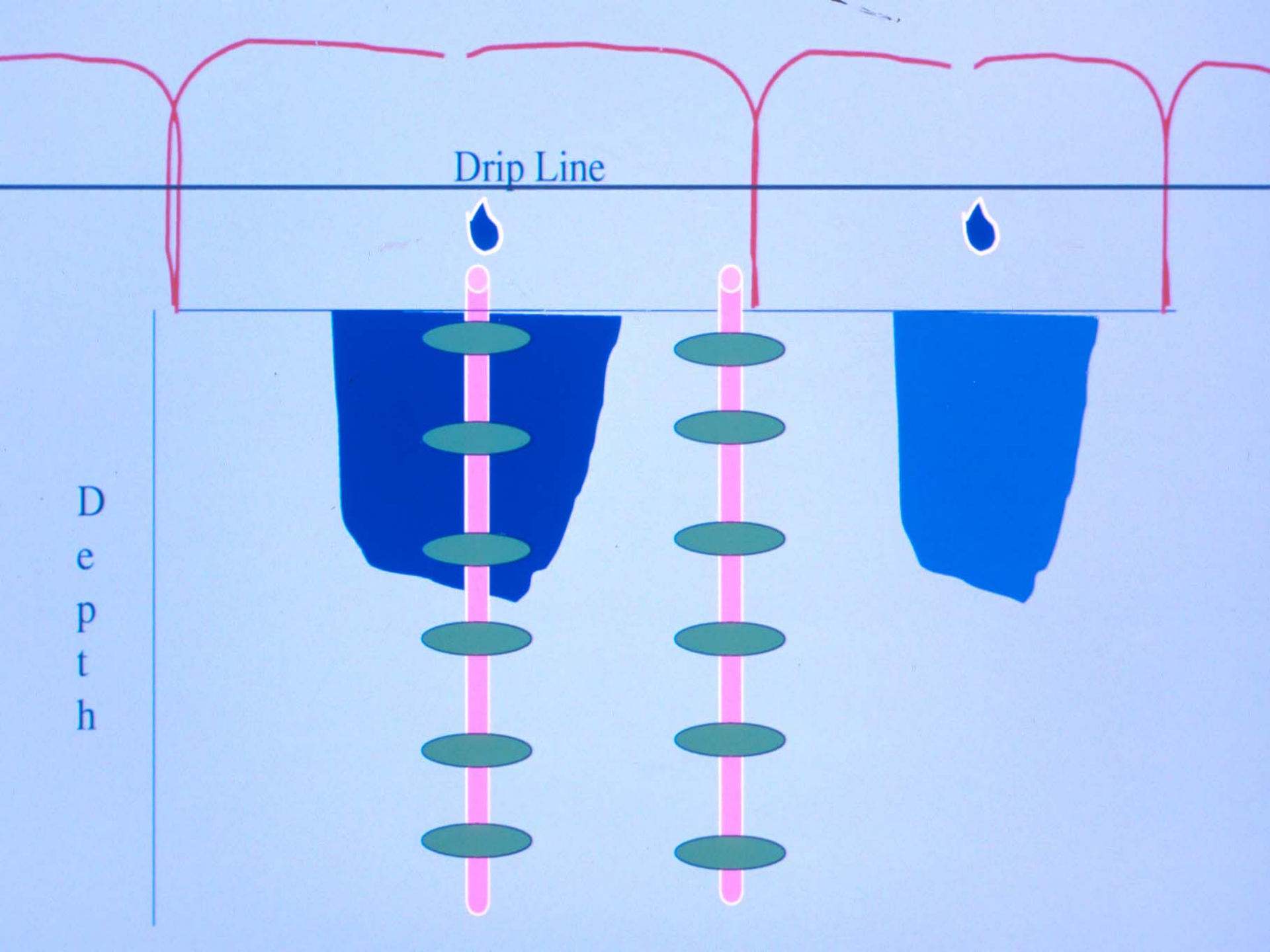

WATERMARK
Soil Moisture Meter
Moisture Reading
(Centibars/kPa)
Soil Temp. °F
21
75
27
65
85
16
32
55
95
PUSH
READ
Soil Temp. °C
For Seasonal or Area
Temperature Variations
Meter Converts Electrical
Resistance Reading of Sensor
to Centibars of Soil Suction
IRROMETER COMPANY, INC.
Riverside, California

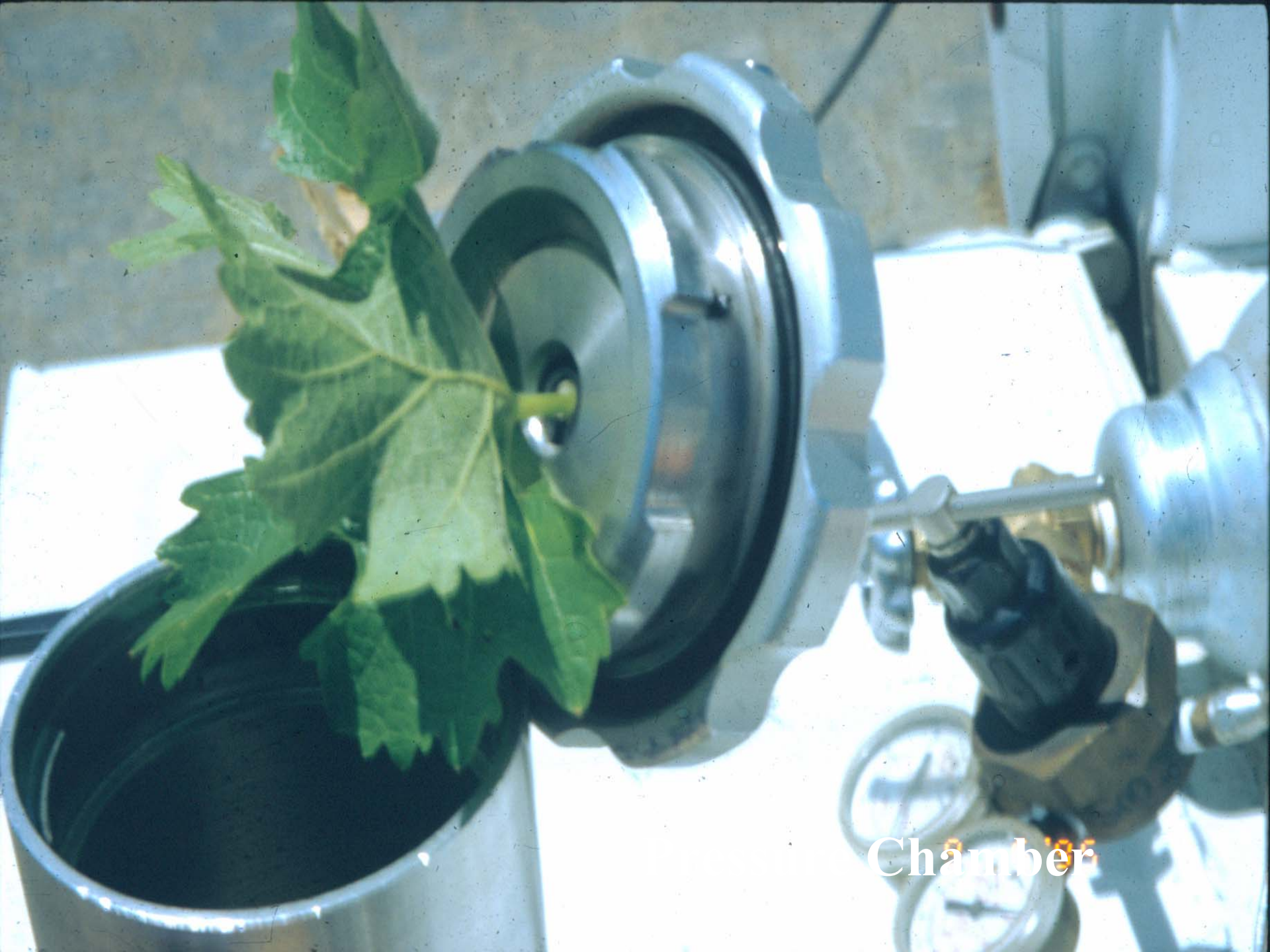
Quantitative Moisture Measurement Methods

- Gravimetric / Volumetric Soil Sampling
- Neutron Moisture Meter
- Dielectric Moisture Sensors
  - Capacitance Probes
  - Frequency Domain Reflectometry (FDR)


CPN
U.C.BERKELEY
MODEL 503


Depth
1
2
3
4
5
6

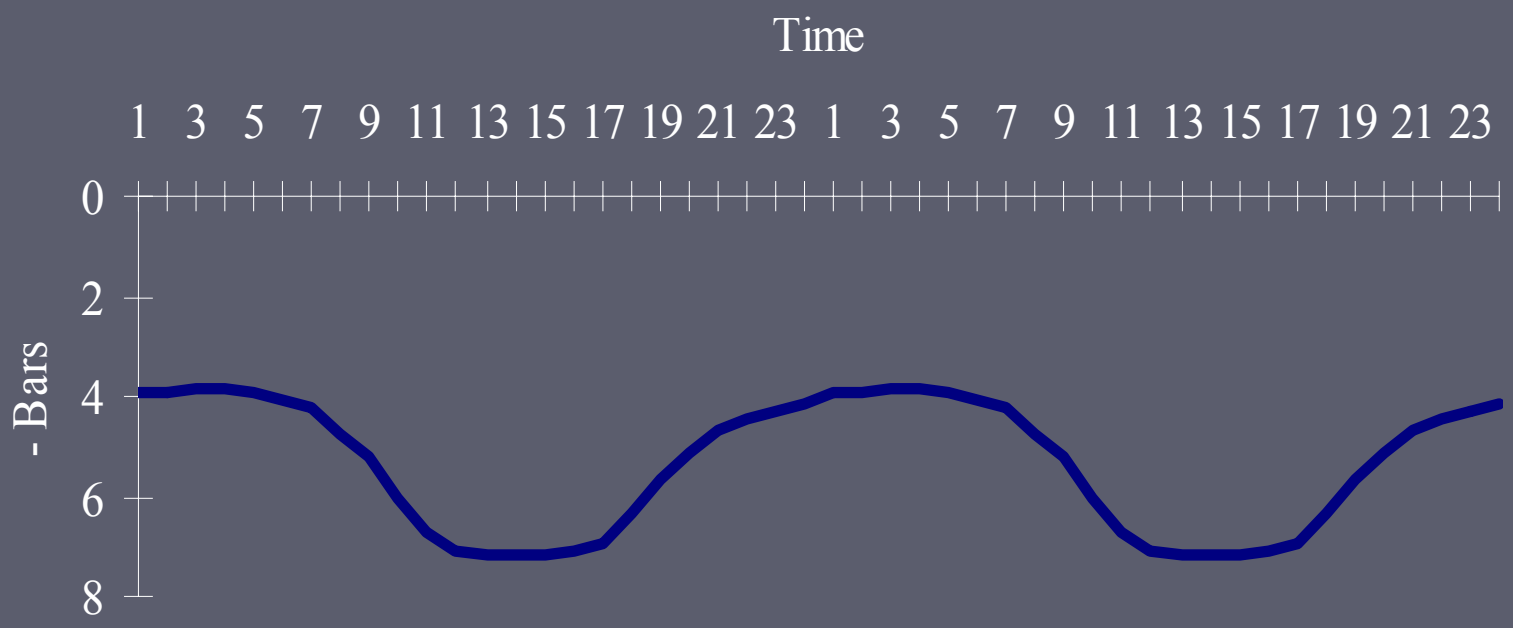

Drip Line
Depth


Chamber

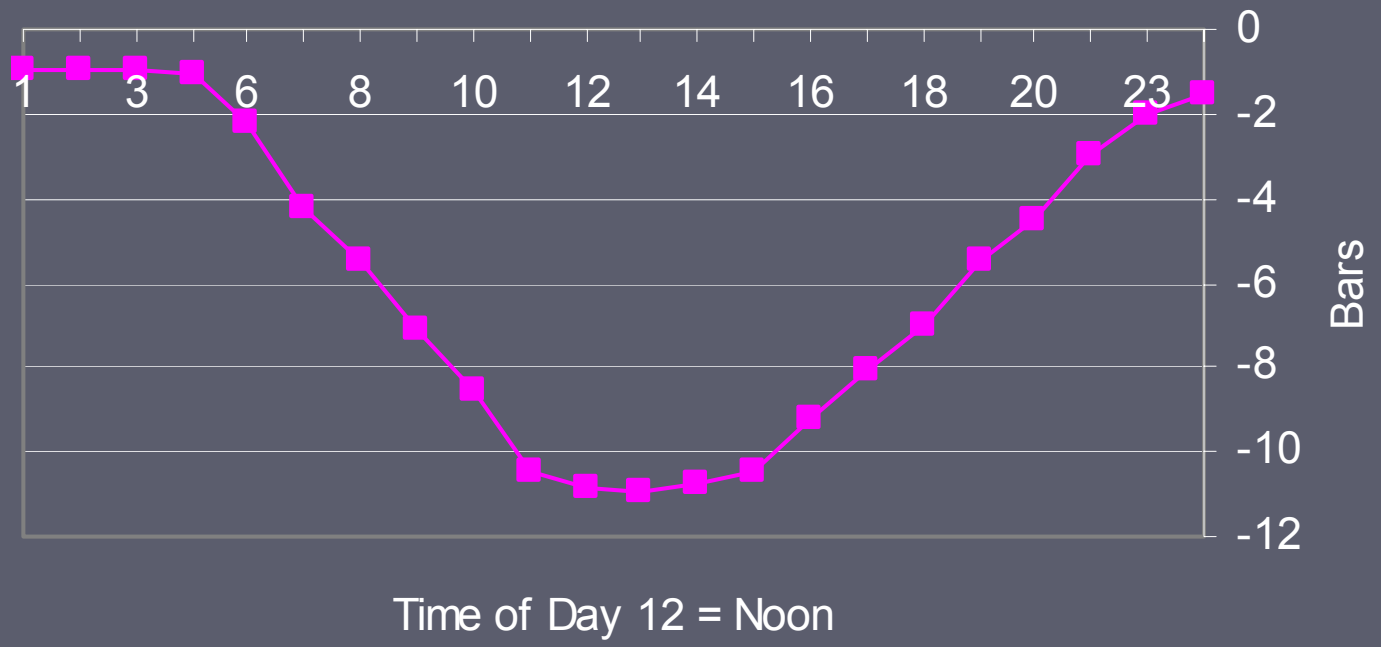

pms
INSTRUMENT CO.
CORVALLIS, OREGON, USA


8
10
12
14
16
18
20
150
100
200
50
250
300
psi
BAR
BAR

Diurnal Leaf Water Potential



Leaf Water Potential, Lodi Merlot 6/11/99



Pressure Bomb

- When to sample (solar noon +- 1.5 hr.)
- No. of vines/block (6 average vines)
- No. of leaves (2/vine)
- Leaf selection (young/fully expanded)
- Leaf bagging (before excising)
- Rate of pressure increase (3 sec/bar)
- Leaf care (breaking veins)

Deficit Threshold + RDI

- Begin irrigation at a specific leaf water potential “threshold”
- After threshold, irrigate at fraction of full water use

When to Begin Irrigation

Deficit threshold method

leaf water potential threshold

-10 to -14 bars

Leaf Water Potential

Selecting a Threshold

Enough to Stop Vegetative Growth

-12

-13

-14

-15

Variety, Wine Goal, Region

How Much Water

Deficit threshold method

After threshold, a fraction of full vine water use

Full vine water use x RDI %

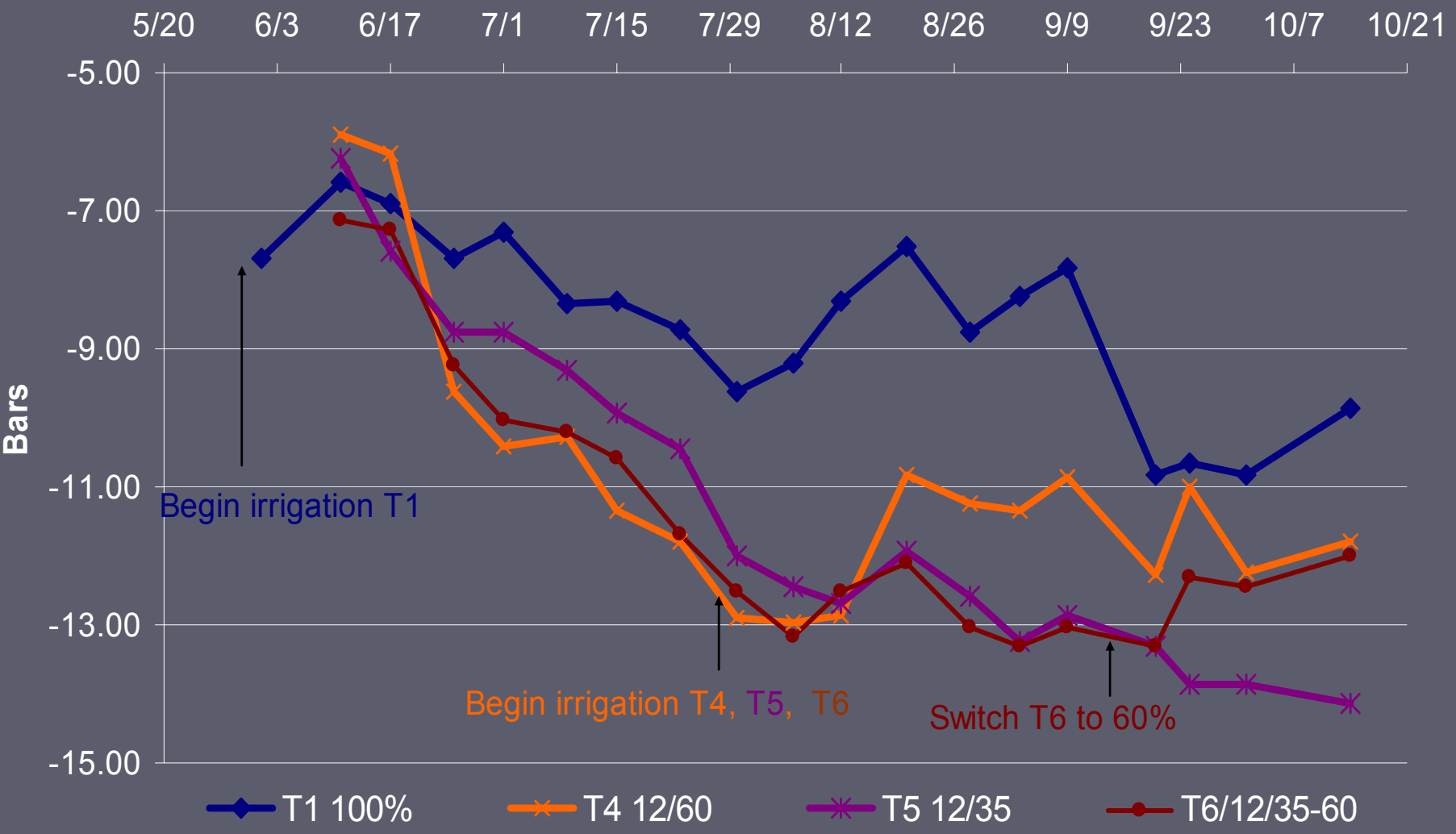
Rdi % --- 35 - 60%

How Much Water to Apply

- Volume of water to apply
  - Gallons per vine per week

- Not restart vegetative growth
- Continue Sugar accumulation (Photosynthesis)
- Protect fruit (cover)

Midday Leaf Water Potential
2000 Cabernet, Hopland



Determining the Irrigation Volume

ETo X Kc =

Full Potential Vine Water Use (Etc)

ETc X RDI% = Net Water Volume Needed

Net Irrigation X Emission Uniformity =

Gross Irrigation Volume

Madera 2002

Eto and precipitation from 2002												
Assumes that Leaf Water Potential Threshold was reached June 16												
HARVEST DATE: Septmember 15												
	A =	B =	C = A x B:	Potential Water	D =	E =	F =	G= [(C x D) - E - F]	H =	I = G/H:	J =	(I x J x 0.623)
Date	ETO	Crop Coeficient	Potential Water Use	Use Thru Harvest	RDI Coeficient	Soil Contrib.	Effective Rainfall	Net Irrigation	Emmision Uniformity	Gross Irrigation	Vine Spacing	Gallons per Vine / Period
Period	Inches/	Kc	(in)	(in)	Krdi	(in)	(in)	(in)	(%)	(in)	(sq feet)	
	Period											
Jun 16 - 30												
Jul 1 - 15												
Jul 16 - 31												
Aug 1 - 15												
Aug 16 - 31												
Sept 1 - 15												
Sept 16 - 30												
Oct. 1 -15												
Oct. 16 - 31												
Total												

Stn Id	Station	Date	Jul	CIMIS ETo (in)	Precip (in)	Biweekly	
						Eto	Ppt
145	Madera	6/16/2002	167	0.32	0		
145	Madera	6/17/2002	168	0.32	0		
145	Madera	6/18/2002	169	0.32	0		
145	Madera	6/19/2002	170	0.29	0		
145	Madera	6/20/2002	171	0.29	0		
145	Madera	6/21/2002	172	0.25	0		
145	Madera	6/22/2002	173	0.25	0		
145	Madera	6/23/2002	174	0.29	0		
145	Madera	6/24/2002	175	0.28	0		
145	Madera	6/25/2002	176	0.3	0		
145	Madera	6/26/2002	177	0.29	0		
145	Madera	6/27/2002	178	0.29	0		
145	Madera	6/28/2002	179	0.28	0		
145	Madera	6/29/2002	180	0.29	0		
145	Madera	6/30/2002	181	0.29	0	4.35	0

	A =	B =	C = A x B:	Potential Water
Period	ETO	Crop Coeficient	Potential Water Use	Use Thru Harvest
	Inches/	Kc	(in)	(in)
	Period			
Jun 16 - 30	4.35	0.75	3.26	3.26
Jul 1 - 15	4.46	0.75	3.35	3.35
Jul 16 - 31	4.28	0.75	3.21	3.21
Aug 1 - 15	3.84	0.75	2.88	2.88
Aug 16 - 31	3.71	0.75	2.78	2.78
Sept 1 - 15	3.16	0.75	2.37	2.37
Sept 16 - 3(	2.62	0.75	1.97	--
Oct. 1 -15	2.18	0.75	1.64	--
Oct. 16 - 31	1.70	0.75	1.28	--
Total	30.30		22.73	17.85

	C = A x B:	Potential Water	D =	E =	F =	G = [(C x D) - E - F]
Time	Potential Water Use	Use Thru Harvest	RDI Coeficient	Soil Contrib.	Effective Rainfall	Net Irrigation
Period	(in)	(in)	Krdi	(in)	(in)	(in)
Jun 16 - 30	3.26	3.26	0.60	0.50	0.00	1.46
Jul 1 - 15	3.35	3.35	0.60	0.50	0.00	1.51
Jul 16 - 31	3.21	3.21	0.60	0.50	0.00	1.43
Aug 1 - 15	2.88	2.88	0.60	0.50	0.00	1.23
Aug 16 - 31	2.78	2.78	0.60	0.50	0.00	1.17
Sept 1 - 15	2.37	2.37	0.60	0.50	0.00	0.92
Sept 16 - 30	1.97	--	1.00	0.00	0.00	1.97
Oct. 1 -15	1.64	--	1.00	0.00	0.00	1.64
Oct. 16 - 31	1.28	--	1.00	0.00	0.00	1.28
Total	22.73	17.85		3.00		12.59

	Madera Station 145				
	G = (C x D) - E - F]	H =	I = G / H:	J =	(I x J x 0.623)
Time	Net Irrigation	Emmision Uniformity	Gross Irrigation	Vine Spacing	Gallons per Vine / Period
Period	(in)	(%)	(in)	(sq feet)	
Jun 16 - 30	1.46	0.90	1.62	77.00	77.69
Jul 1 - 15	1.51	0.90	1.67	77.00	80.32
Jul 16 - 31	1.43	0.90	1.58	77.00	76.01
Aug 1 - 15	1.23	0.90	1.36	77.00	65.45
Aug 16 - 31	1.17	0.90	1.30	77.00	62.34
Sept 1 - 15	0.92	0.90	1.02	77.00	49.14
Sept 16 - 30	1.97	0.90	2.18	77.00	104.74
Oct. 1 -15	1.64	0.90	1.82	77.00	87.15
Oct. 16 - 31	1.28	0.90	1.42	77.00	67.96
Total	12.59		13.98		670.79
	Gallons per vine applied through harvest =				333

Madera Station 145

Eto and precipitation from 2002

Assumes that Leaf Water Potential Threshold was reached June 16

HARVEST DATE: Septmember 15

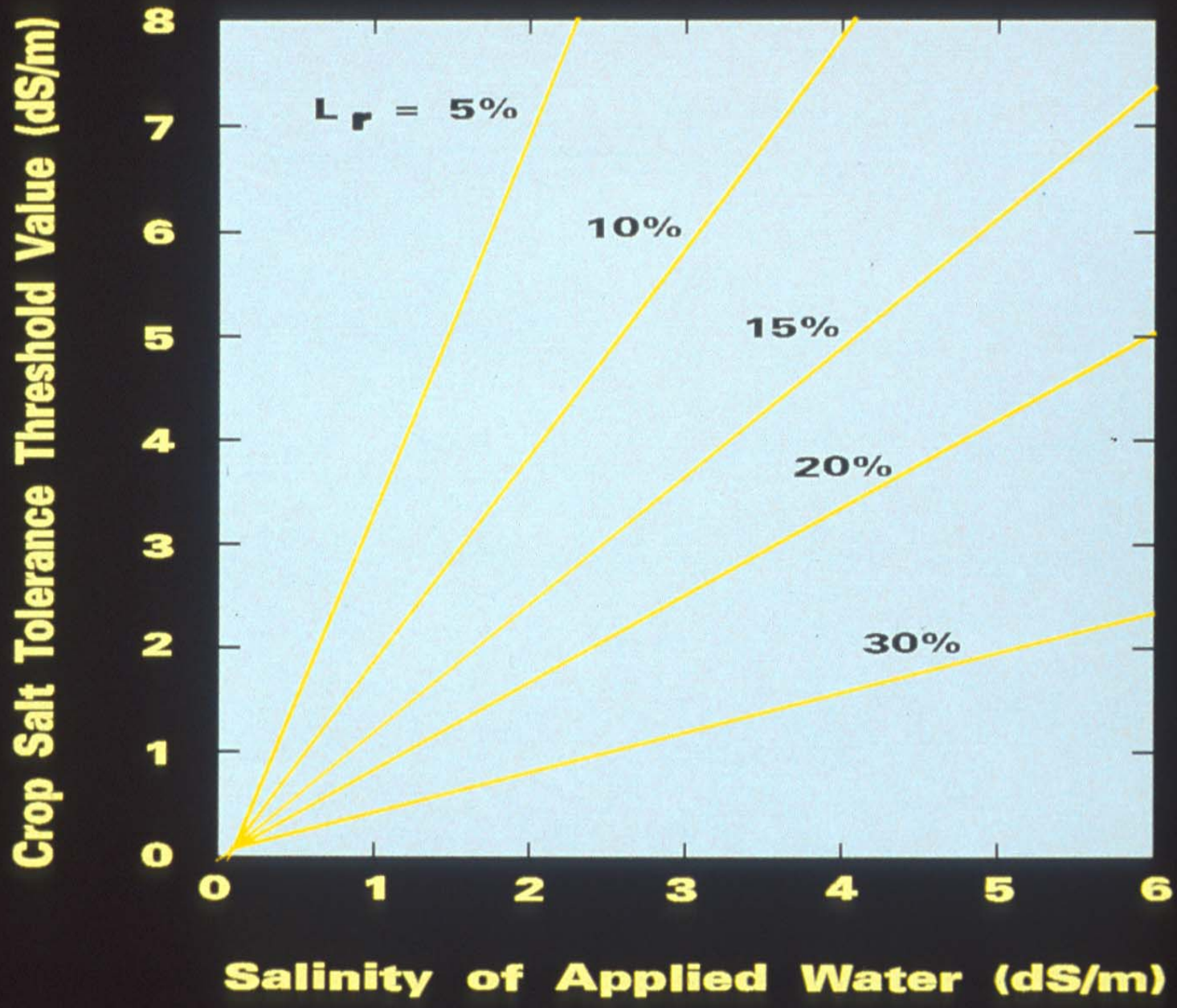
	A =	B =	C = A x B:	Potential Water	D =	E =	F =	G = [(C x D) - E - F]	H =	I = G/H:	J =	(I x J x 0.623)
Time Period	ETO Inches/ Period	Crop Coeficient Kc	Potential Water Use (in)	Use Thru Harvest (in)	RDI Coeficient Krdi	Soil Contrib. (in)	Effective Rainfall (in)	Net Irrigation (in)	Emmision Uniformity (%)	Gross Irrigation (in)	Vine Spacing (sq feet)	Gallons per Vine / Period
Mar 1 -15	1.70	0	0.00	0.00	1	0	0	0.00	0.90	0.00	77	0
Mar 16 - 31	1.98	0.15	0.30	0.30	1	0	0.6	-0.30	0.90	-0.34	77	-16
Apr 1 - 15	2.66	0.22	0.59	0.59	1	0.59	0	0.00	0.90	-0.01	77	0
Apr 16 -30	2.59	0.3	0.78	0.78	1	0.78	0	0.00	0.90	0.00	77	0
May 1 -15	3.63	0.42	1.52	1.52	0.8	1.31	0	-0.09	0.90	-0.10	77	-5
May 16 - 31	4.06	0.55	2.23	2.23	0.6	0.87	0.23	0.24	0.90	0.27	77	13
Jun 1 - 15	4.26	0.65	2.77	2.77	0.4	0.9	0	0.21	0.90	0.23	77	11
Jun 16 - 30	4.35	0.75	3.26	3.26	0.6	0.5	0	1.46	0.90	1.62	77	78
Jul 1 - 15	4.46	0.75	3.35	3.35	0.6	0.5	0	1.51	0.90	1.67	77	80
Jul 16 - 31	4.28	0.75	3.21	3.21	0.6	0.5	0	1.43	0.90	1.58	77	76
Aug 1 - 15	3.84	0.75	2.88	2.88	0.6	0.5	0	1.23	0.90	1.36	77	65
Aug 16 - 31	3.71	0.75	2.78	2.78	0.6	0.5	0	1.17	0.90	1.30	77	62
Sept 1 - 15	3.16	0.75	2.37	2.37	0.6	0.5	0	0.92	0.90	1.02	77	49
Sept 16 - 30	2.62	0.75	1.97	--	1		0	1.97	0.90	2.18	77	105
Oct. 1 -15	2.18	0.75	1.64	--	1		0	1.64	0.90	1.82	77	87
Oct. 16 - 31	1.70	0.75	1.28	--	1		0	1.28	0.90	1.42	77	68
Total	51.18		30.91	26.04		7.45	0.83	12.63		14.03		593

Gallons per vine applied through harvest = 333

Monitor Effects of Strategy

- Leaf Water Potential
- Vegetative Growth
- Yield
- Quality
- Winemaker Comments

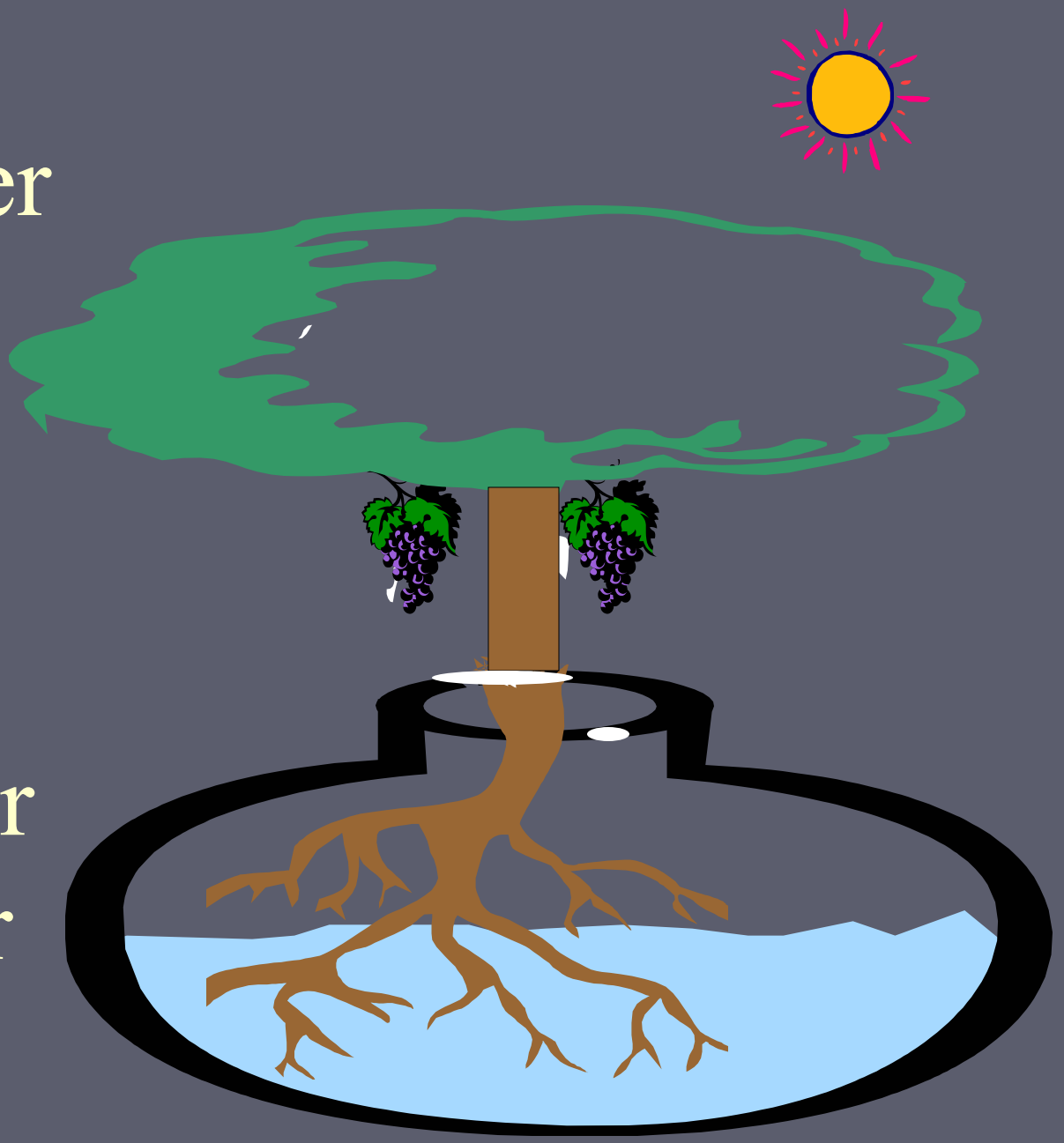

Severe Deficit
Loss of Leaf Cover


Crop Salt Tolerance Threshold Value (dS/m)
0
1
2
3
4
5
6
7
8
L_r = 5%
10%
15%
20%
30%
0
1
2
3
4
5
6
Salinity of Applied Water (dS/m)

Vine Water Use

vs.

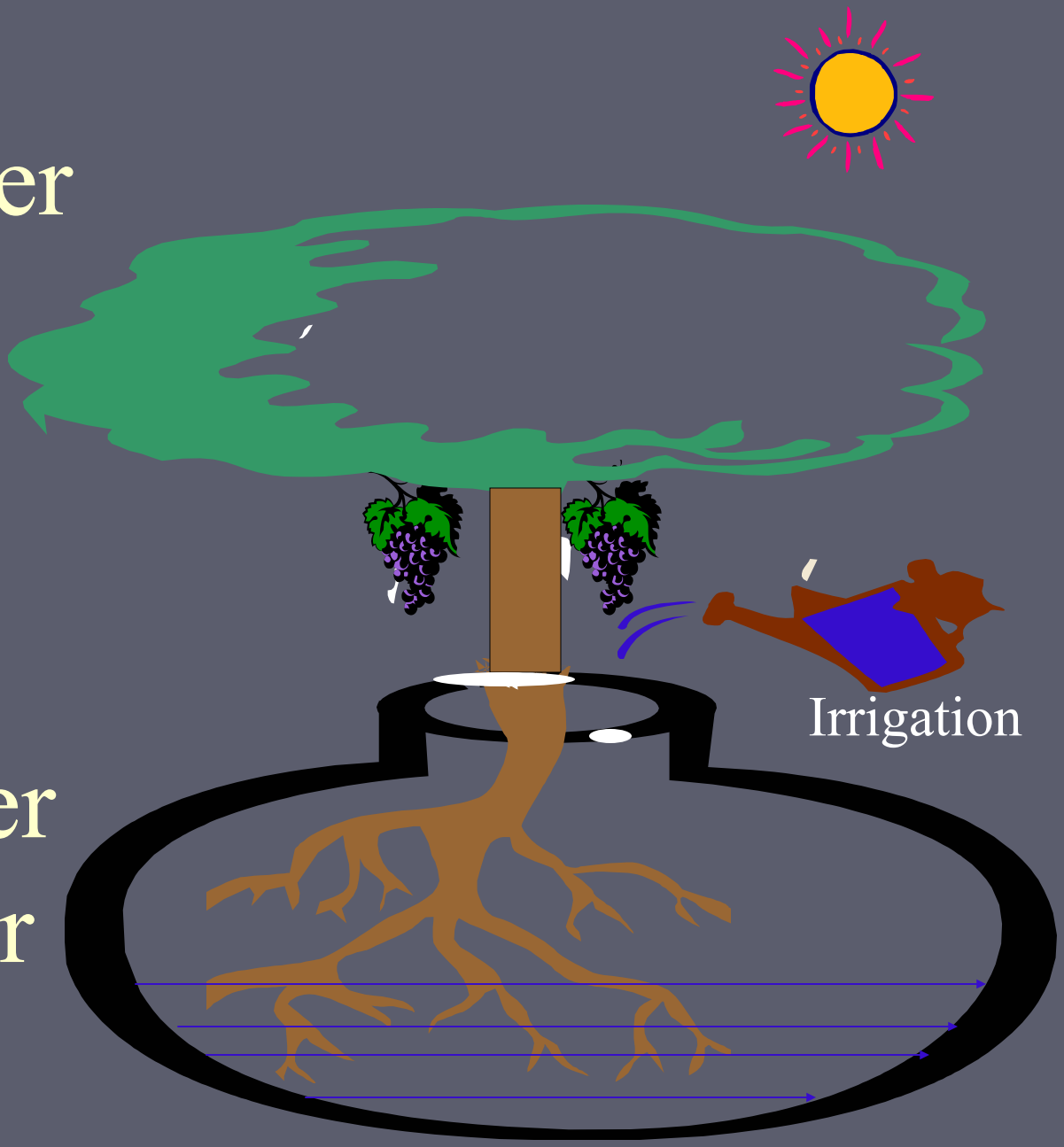
Soil Water Reservoir



Vine Water Use

vs.

Soil Water Reservoir



Irrigation of Quality Winegrapes Using

Micro-Irrigation Techniques

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Department of Land, Air and Water Resources
University of California Davis

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DRAFT

Irrigation of Quality Winegrapes Using Micro-Irrigation Techniques

http://lawr.ucdavis.edu/faculty/prichard/

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