Irrigation strategies for dry times:

getting the most from every drop

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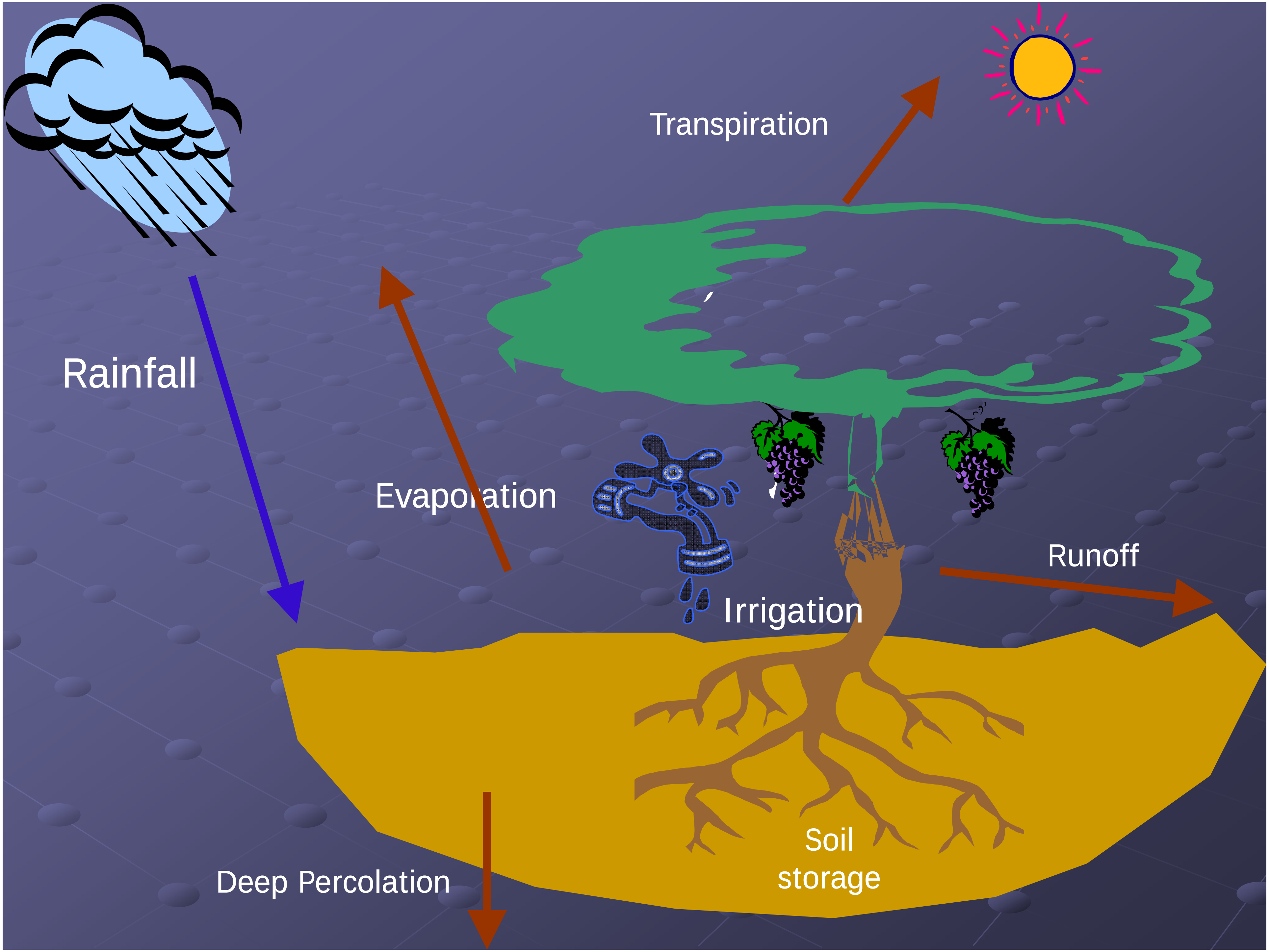
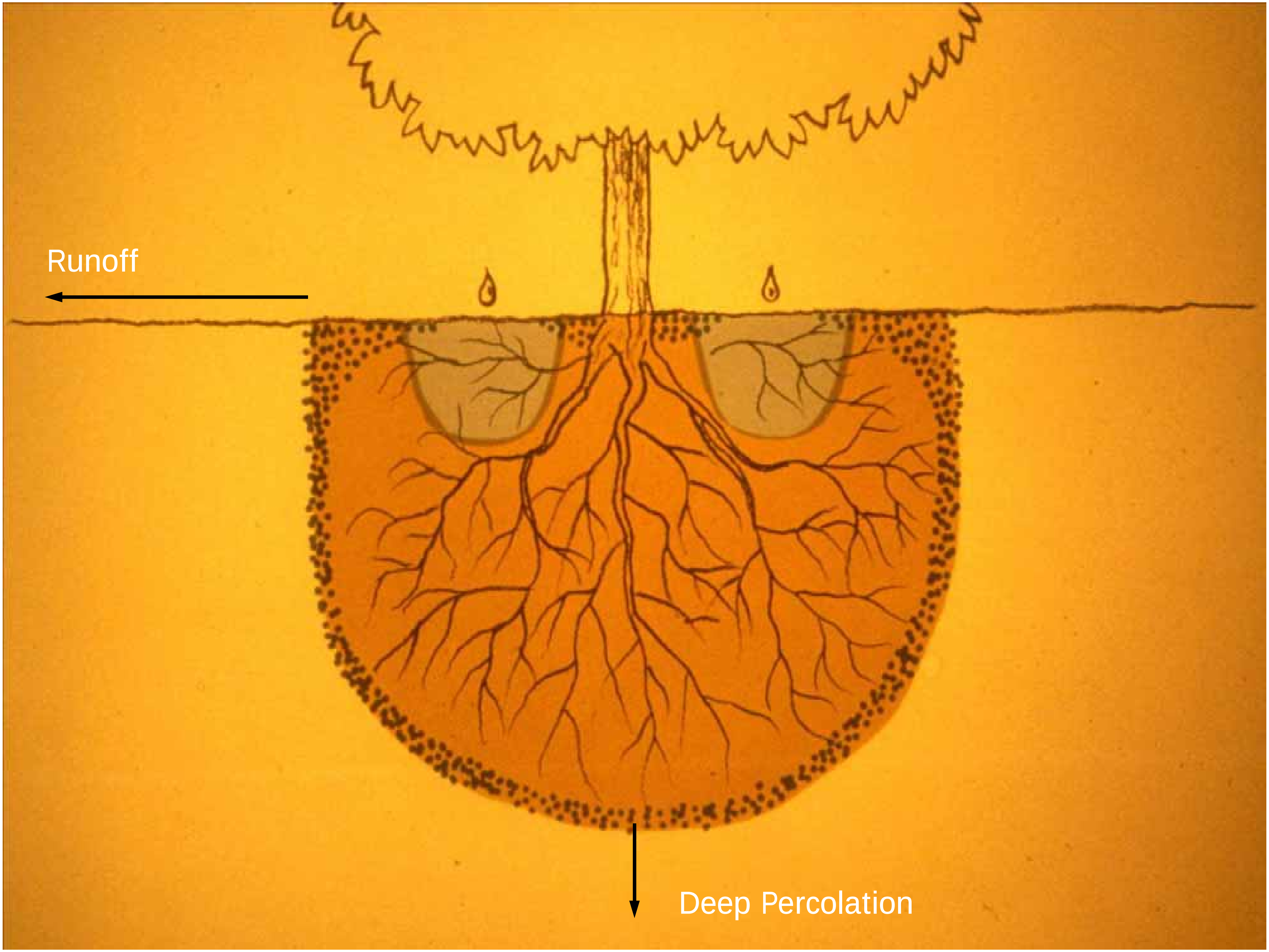
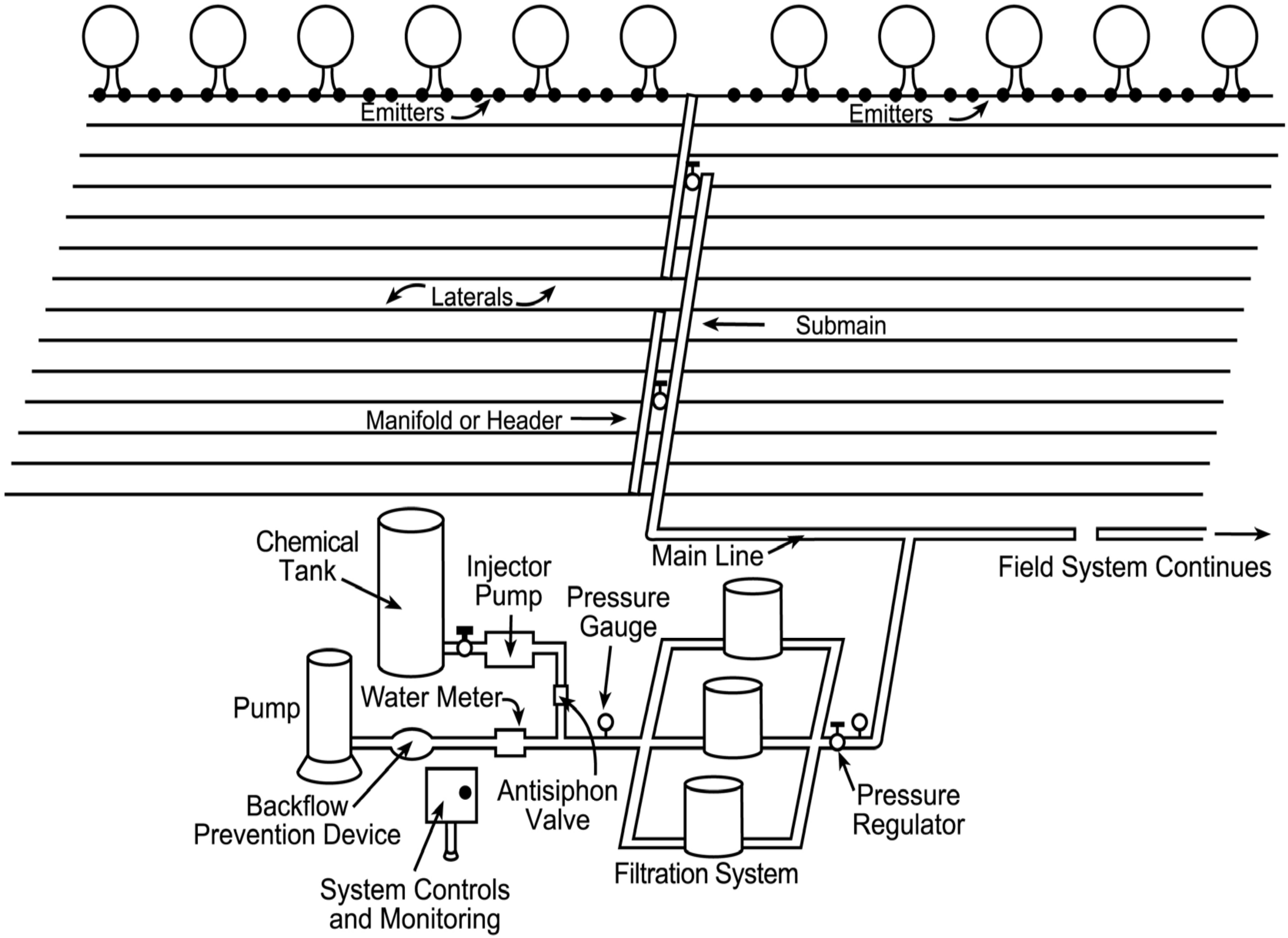

Transpiration
Rainfall
Evaporation
Runoff
Irrigation
Soil
storage
Deep Percolation

Cutting Back

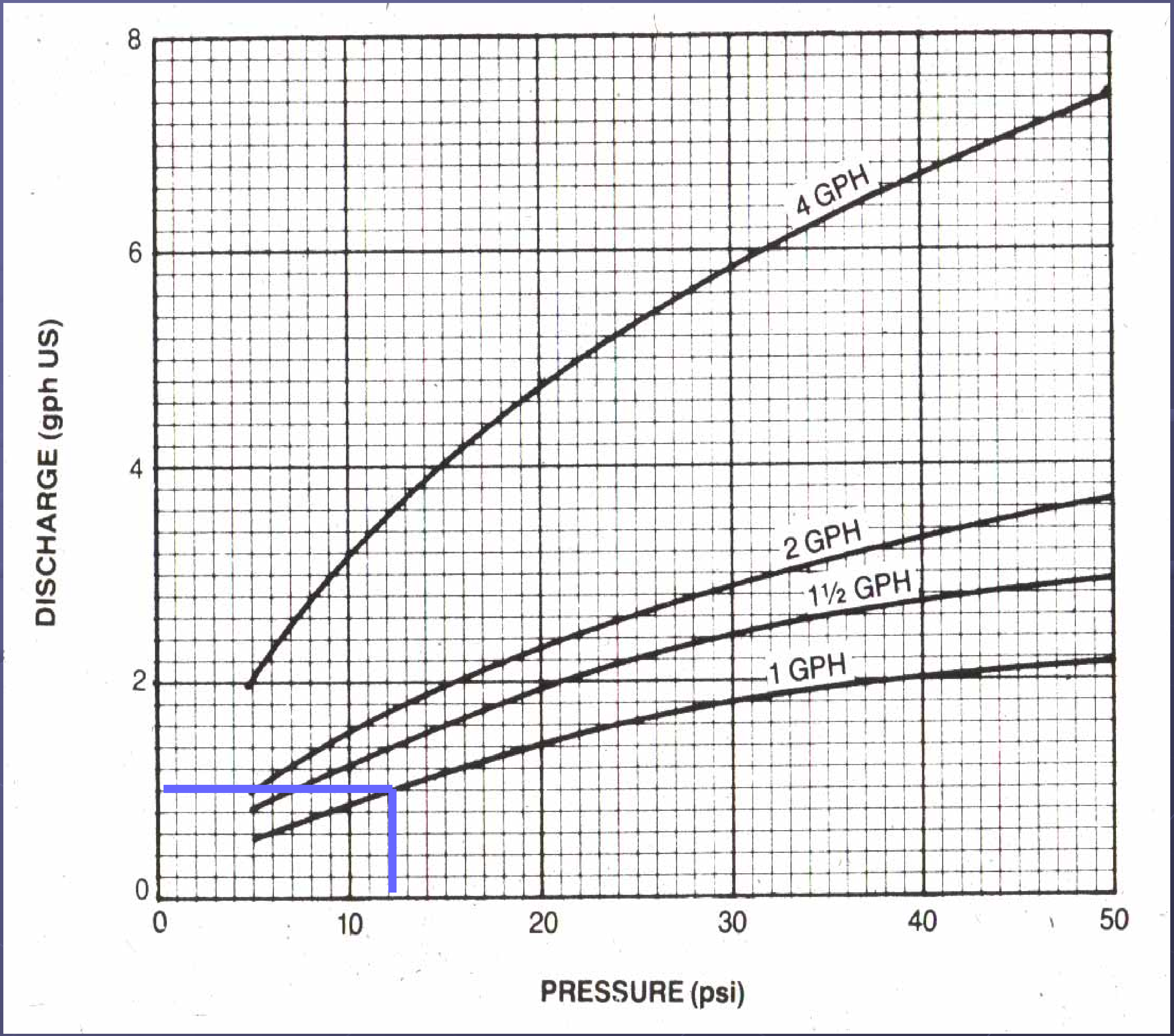
- Eliminate Water Losses
  - Runoff
  - Deep Percolation
  - Middles Use
  - Evaporation
- Maximize Distribution Uniformity
- Reduce Transpiration


Runoff
Deep Percolation

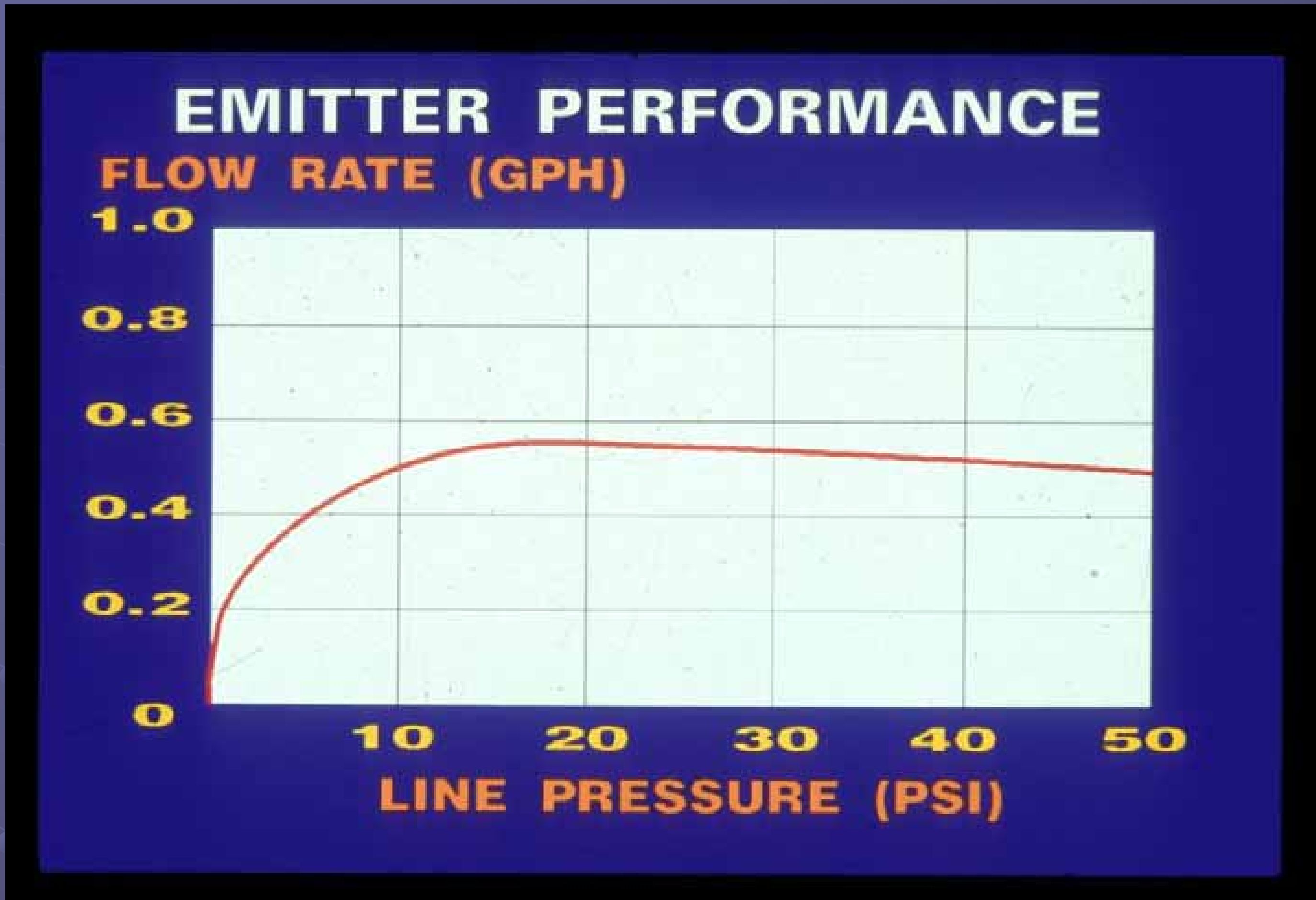
Distribution Uniformity

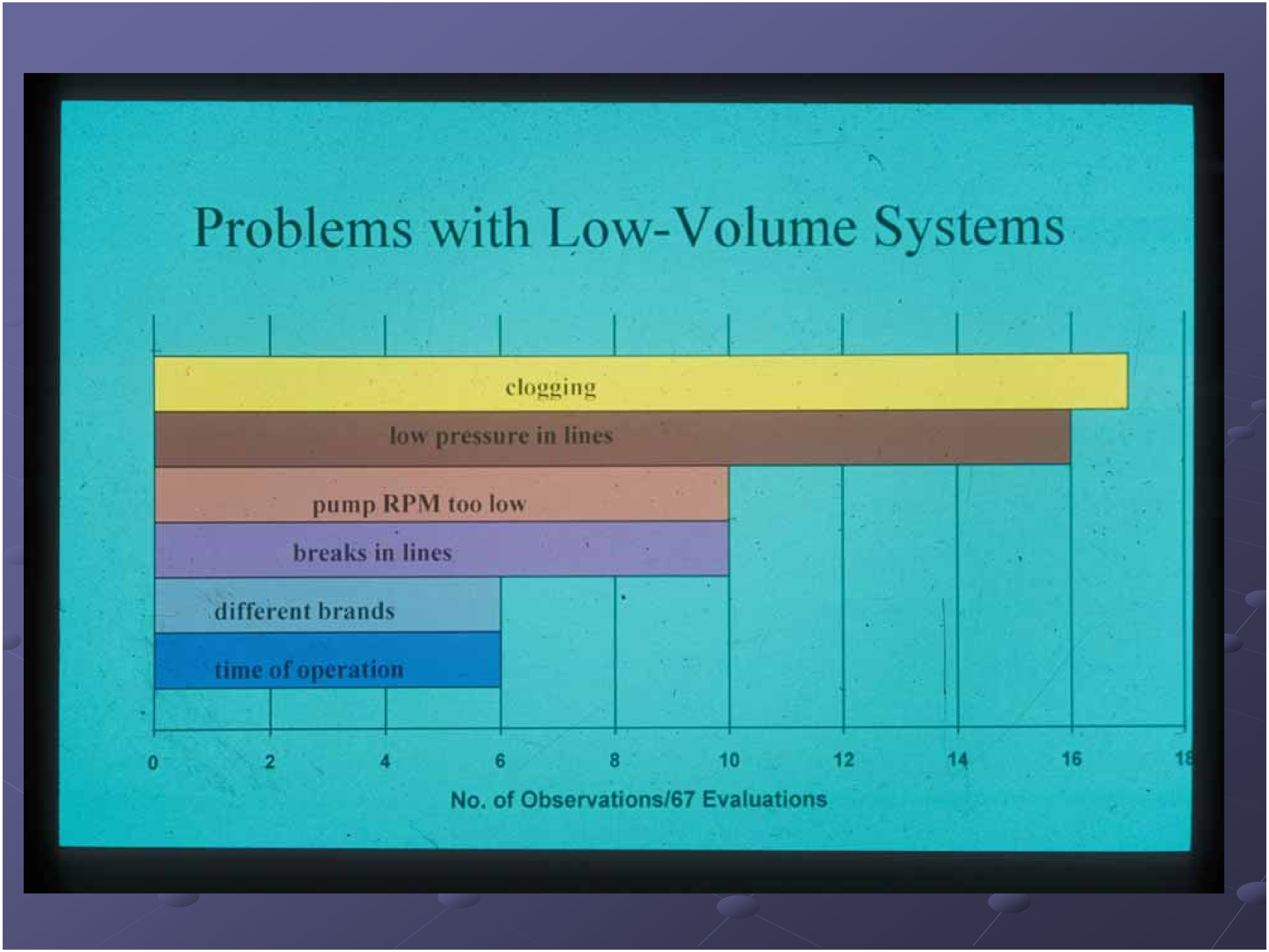


Emitters
Emitters
Laterals
Submain
Manifold or Header
Chemical Tank
Injector Pump
Pressure Gauge
Main Line
Field System Continues
Pump
Water Meter
Antisiphon Valve
Backflow Prevention Device
System Controls and Monitoring
Filtration System
Pressure Regulator



DISCHARGE (gph US)
8
6
4
2
0
0
10
20
30
40
50
PRESSURE (psi)
4 GPH
2 GPH
1½ GPH
1 GPH


EMITTER PERFORMANCE
FLOW RATE (GPH)
1.0
0.8
0.6
0.4
0.2
0
10
20
30
40
50
LINE PRESSURE (PSI)



Problems with Low-Volume Systems
clogging
low pressure in lines
pump RPM too low
breaks in lines
different brands
time of operation
0
2
4
6
8
10
12
14
16
18
No. of Observations/67 Evaluations


4 18 '91

Reducing Transpiration

- Reduce the water supply to less than full water use

    Remove Vineyard floor vegetation

    Deficit Irrigation

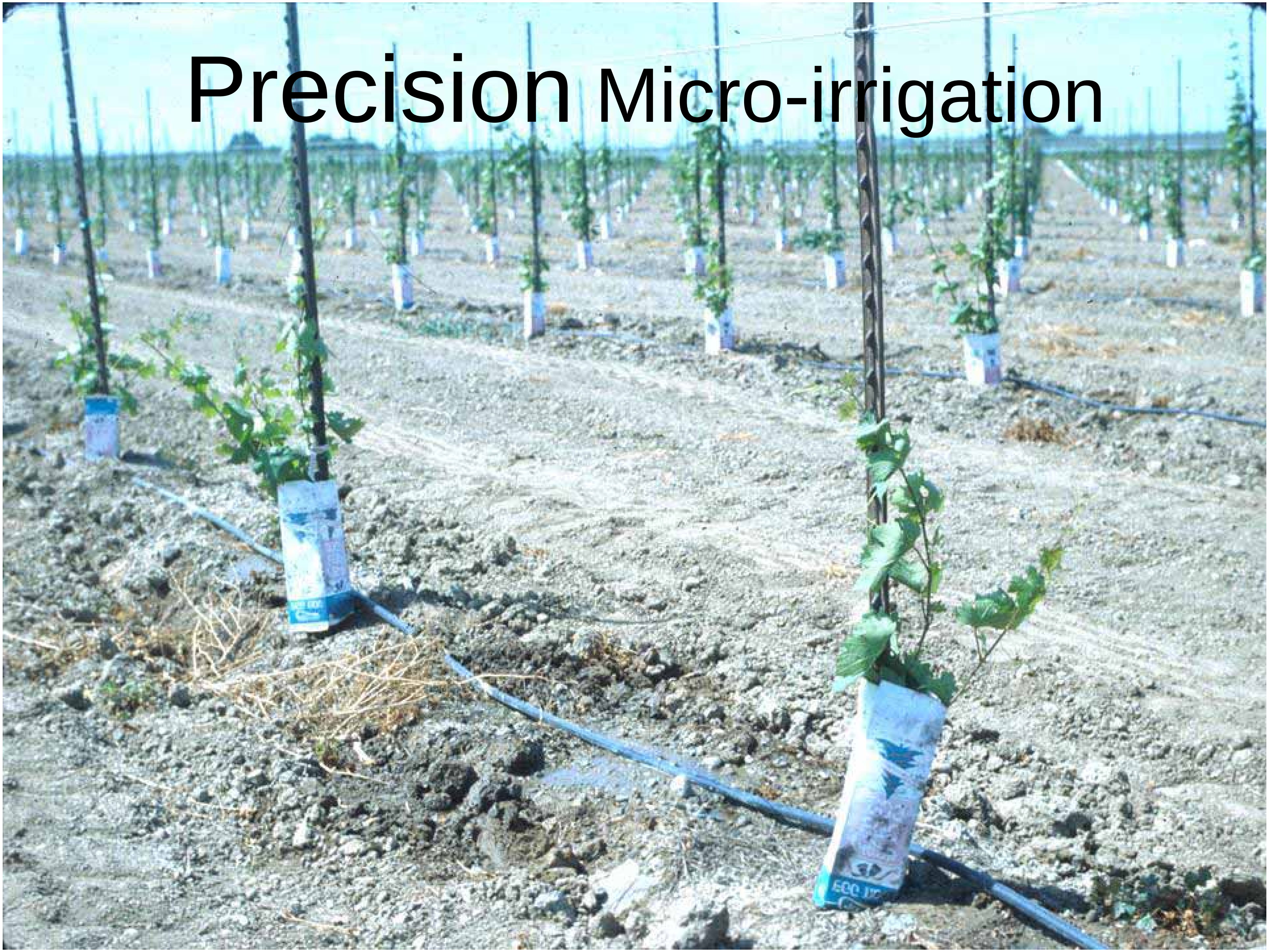

22 3 '96

Deficit Irrigation

- Supplying vines with less irrigation water than they can use.
- Causing reduced soil moisture availability
- Causing vine water stress

Purpose: Produce Quality Fruit

Precision Micro-irrigation



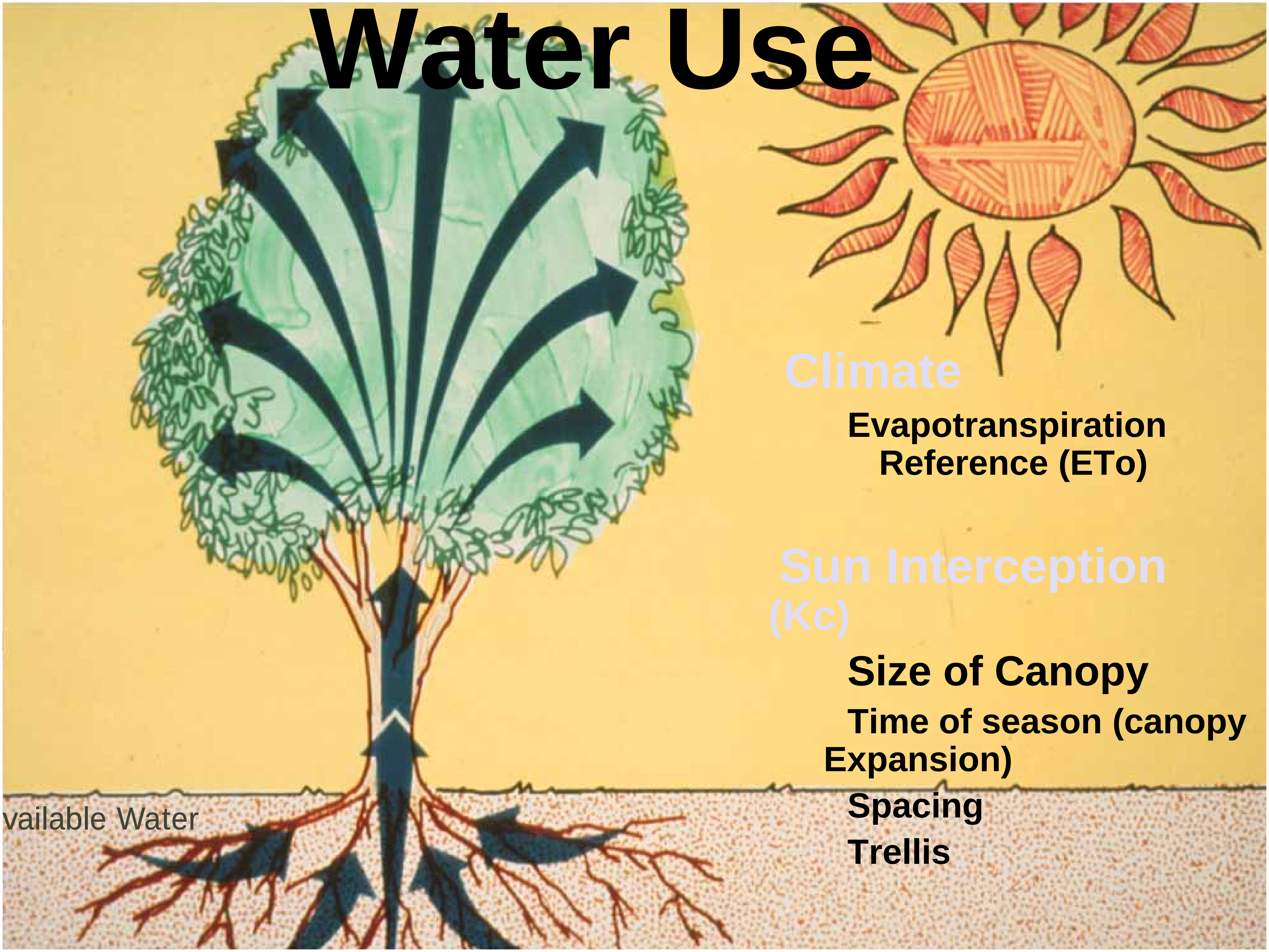
Most strategies to improve fruit quality involve some level of:

Vine Water Deficits Created by Withholding Irrigation

Low Water Source Availability

How to parcel out available supply

Water Use



Climate

- Evapotranspiration Reference (ETo)

Sun Interception (Kc)

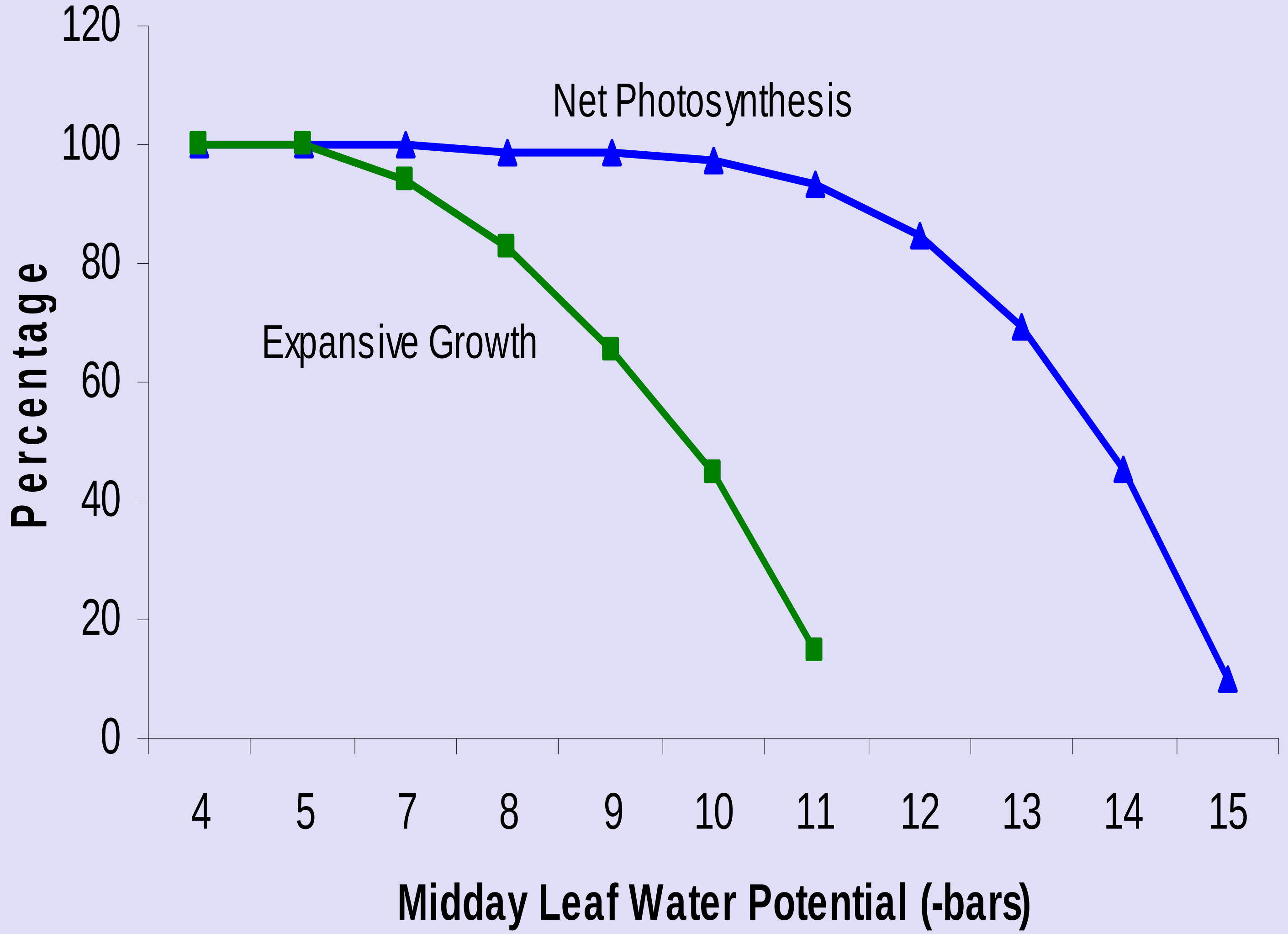
- Size of Canopy
- Time of season (canopy Expansion)
- Spacing
- Trellis


Moderate Water Deficits

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

Increase light in canopy

Relative Rate vs. Leaf Water Potential



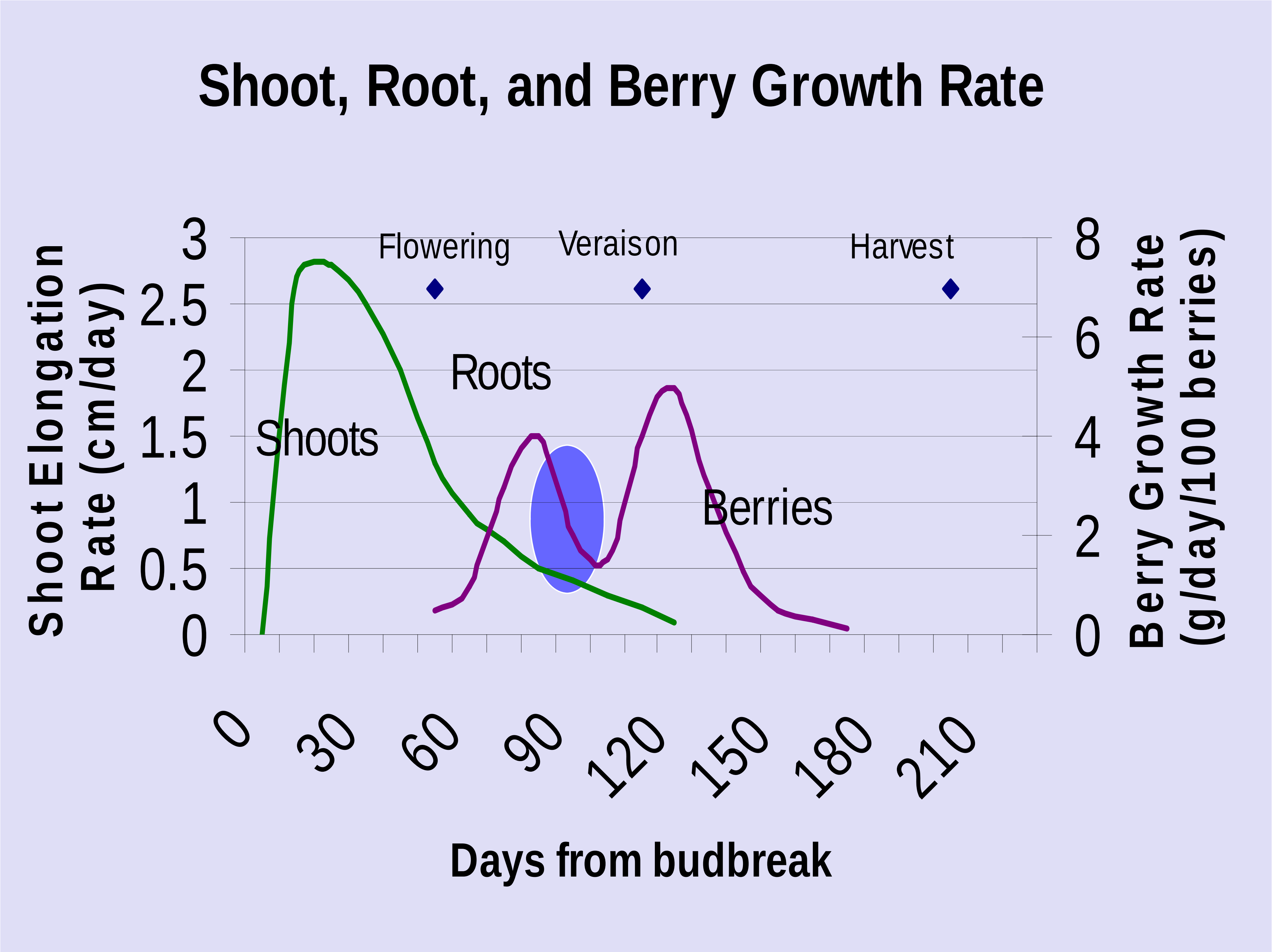
Syrah Deficit Irrigation

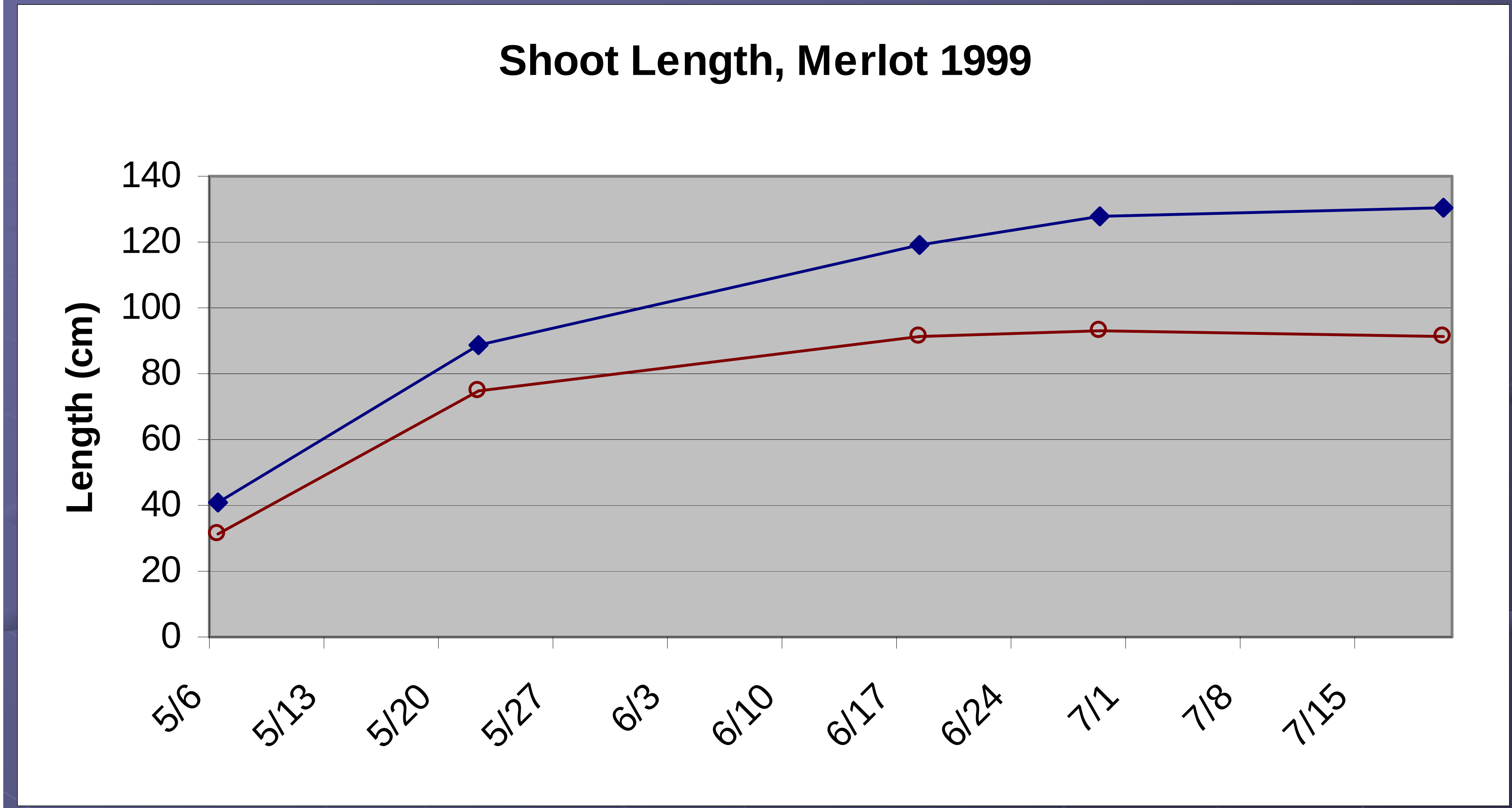
Variable	% of ETc		
	55	69	100
	% of 100% treatment		
Berry size	79	85	100
Fruit load	82	91	100
Yield	64	77	100

From TLP

Timing of Water Deficits

- Early season
  - bud break through set
- Mid season
  - set through veraison
- Late season
  - veraison through harvest
- Postharvest


Shoot, Root, and Berry Growth Rate
Shoot Elongation Rate (cm/day)
Berry Growth Rate (g/day/100 berries)
Days from budbreak
Flowering
Veraison
Harvest
Roots
Shoots
Berries
0
0.5
1
1.5
2
2.5
3
0
2
4
6
8
0
30
60
90
120
150
180
210


Shoot Length, Merlot 1999
Length (cm)
0
20
40
60
80
100
120
140
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
7/8
7/15

Stress Threshold
Regulated Deficit Irrigation

- Measure plant stress
- Ability to estimate full potential vine water Use
- Micro-irrigation System

Select, Bag, and Cut the Petiole

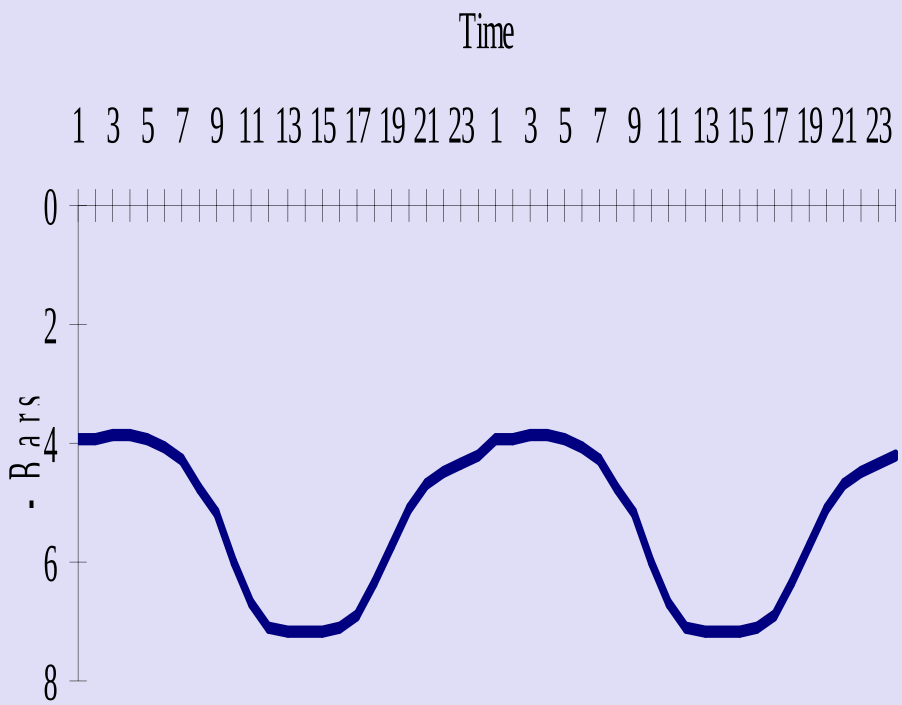
Place leaf in bag in chamber

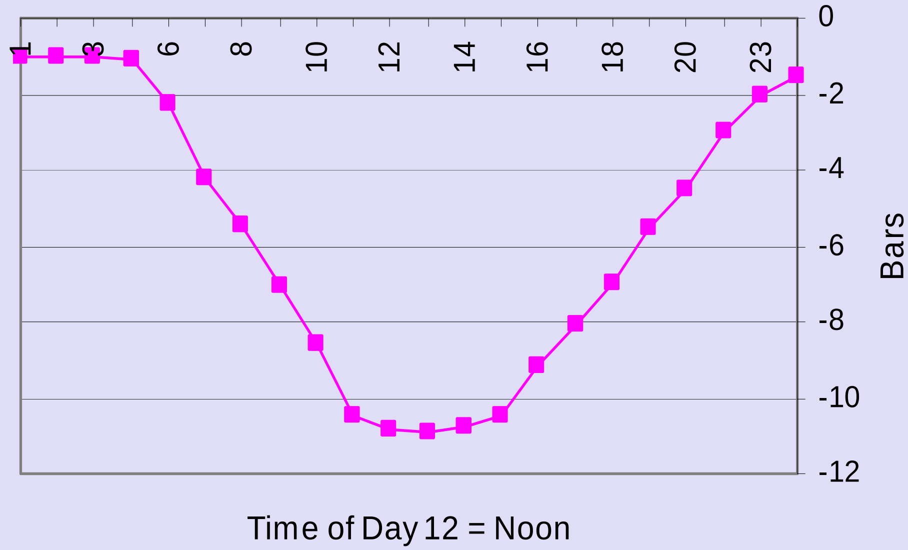

pms


pms


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

Diurnal Leaf Water Potential





Pressure Bomb

Factors which Influence Readings

- When to sample (Solar Noon +- 1.5)
- No. of Vines
- No. of Leaves (2/vine)
- Leaf Selection (young/fully expanded)
- Leaf bagging (before excising)
- Rate of Pressure Increase (3sec/bar)
- Leaf Care (breaking veins)

Table F-2. Levels of winegrape water deficits measured by mid-day leaf water potential		
1	less than -10 Bars	no stress
2	-10 to -12 Bars	mild stress
3	-12 to -14 Bars	moderate stress
4	-14 to -16 Bars	high stress
5	above -16 Bars	severe stress

Stress Threshold + RDI

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

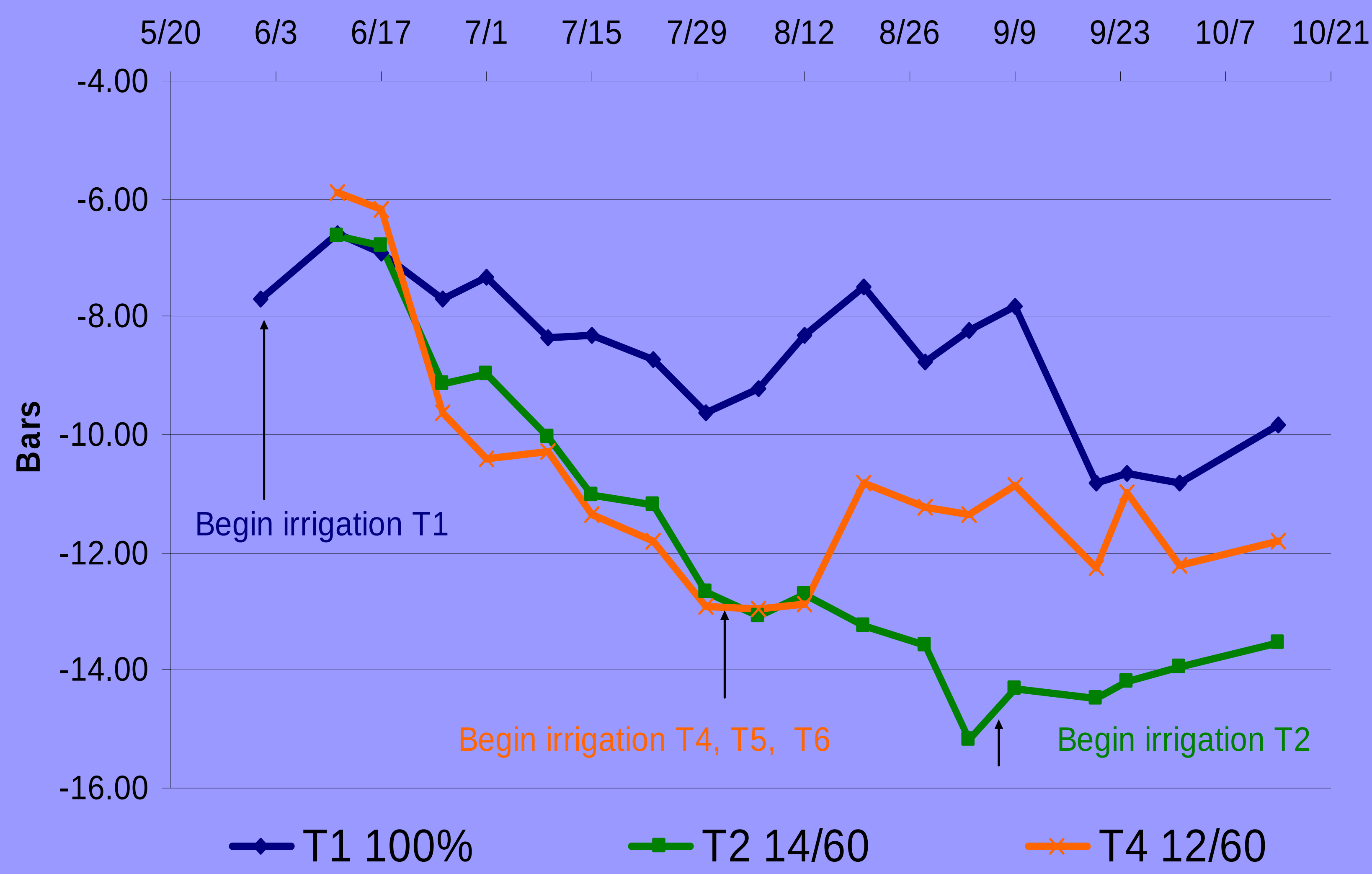
When to begin Irrigation

Stress Threshold Method

leaf water potential threshold

-12 to -14 bars

Mid-day Leaf Water Potential Hopland Cabernet 2000



Tip Ratings

1 Tendrils longer than tip

2 Tendrils even with tip

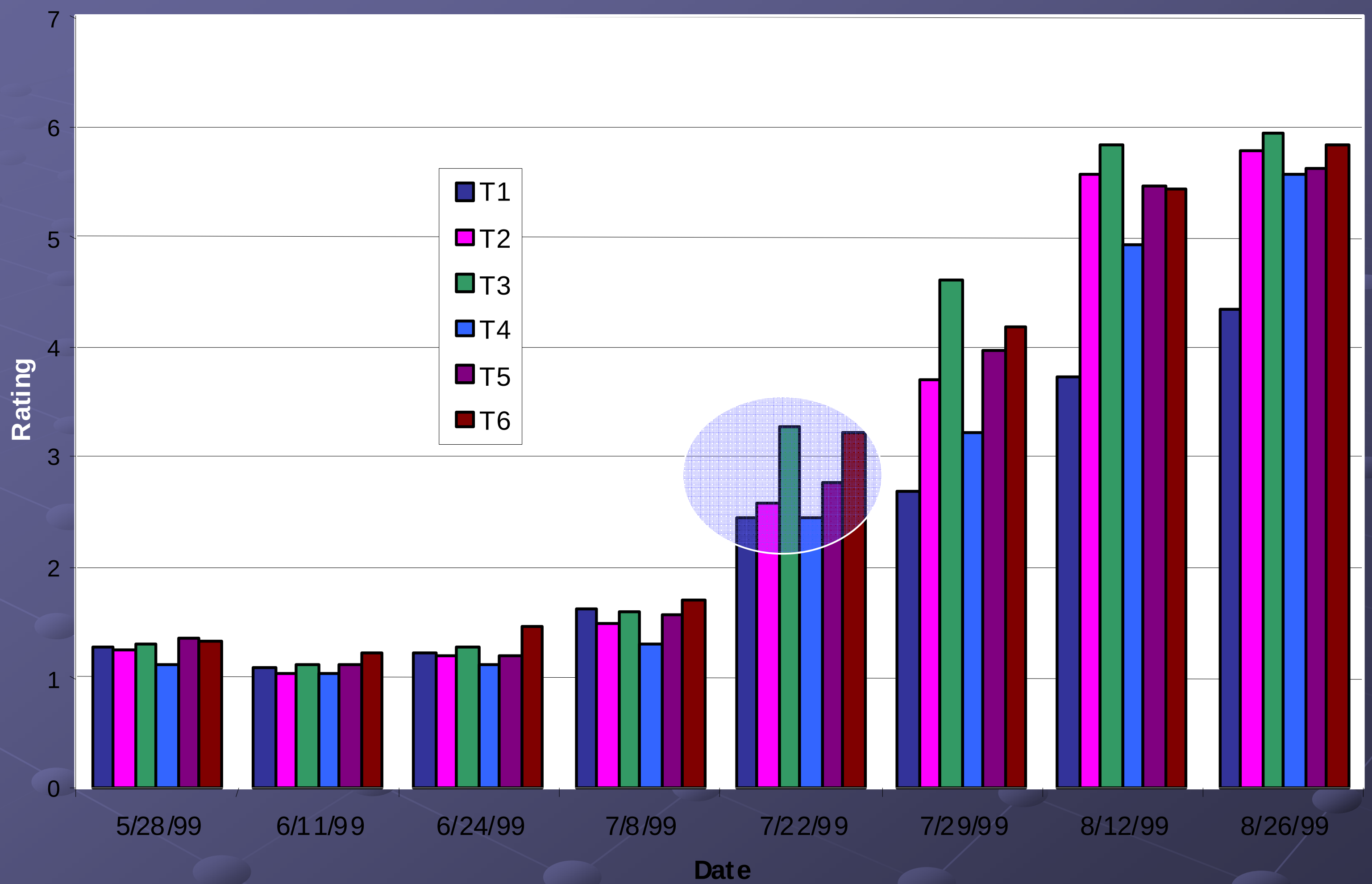
3 Tendrils behind tip

4 Tendrils yellow/withering

5 Tendrils gone

6 Tip dead

Shoot tip ratings, Cabernet Sauvignon, 1999 Hopland



When to Begin irrigation

- Soil water depletion level
- Specific soil water content

Year	Water content (Inches in soil profile)	MDLWP
98	3.4	-12
99	3.8	-12
2000	2.4	-12

How Much Water

Regulated Deficit

After threshold a fraction of full vine water use

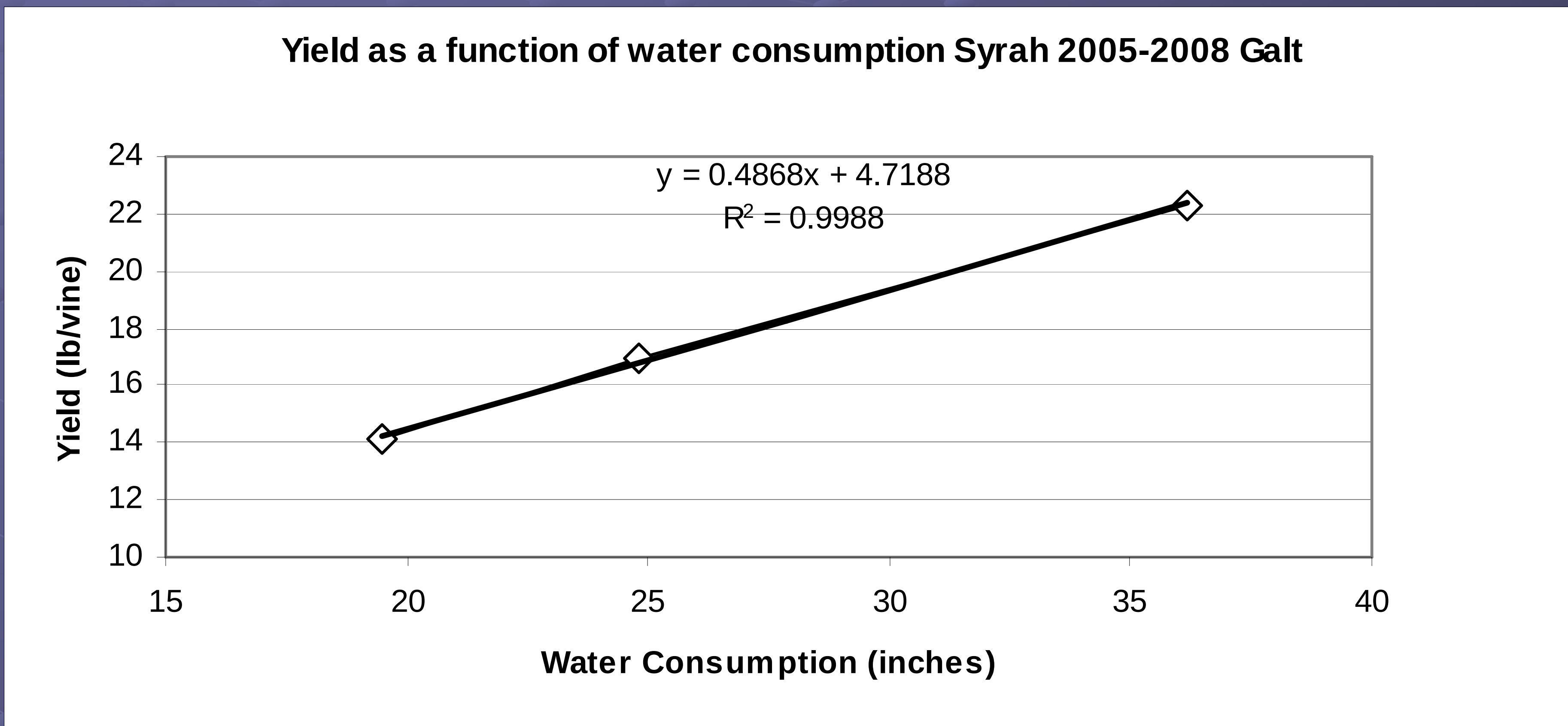
Full vine water use x RDI %

RDI % --- 35 - 60%

Post Threshold RDI %

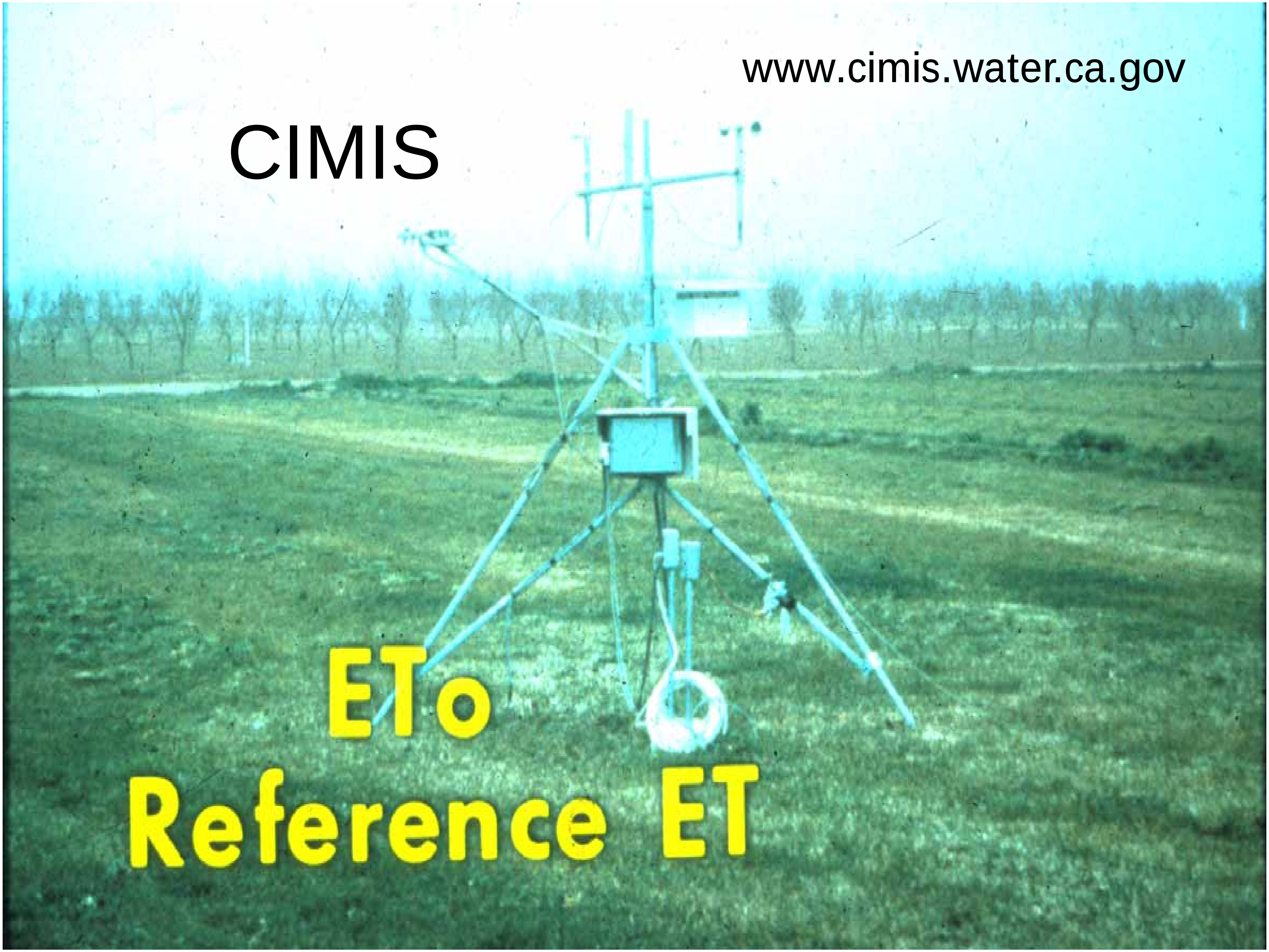
- Prevent new vegetative growth
- Provide fruit cover
- Continued photosynthesis

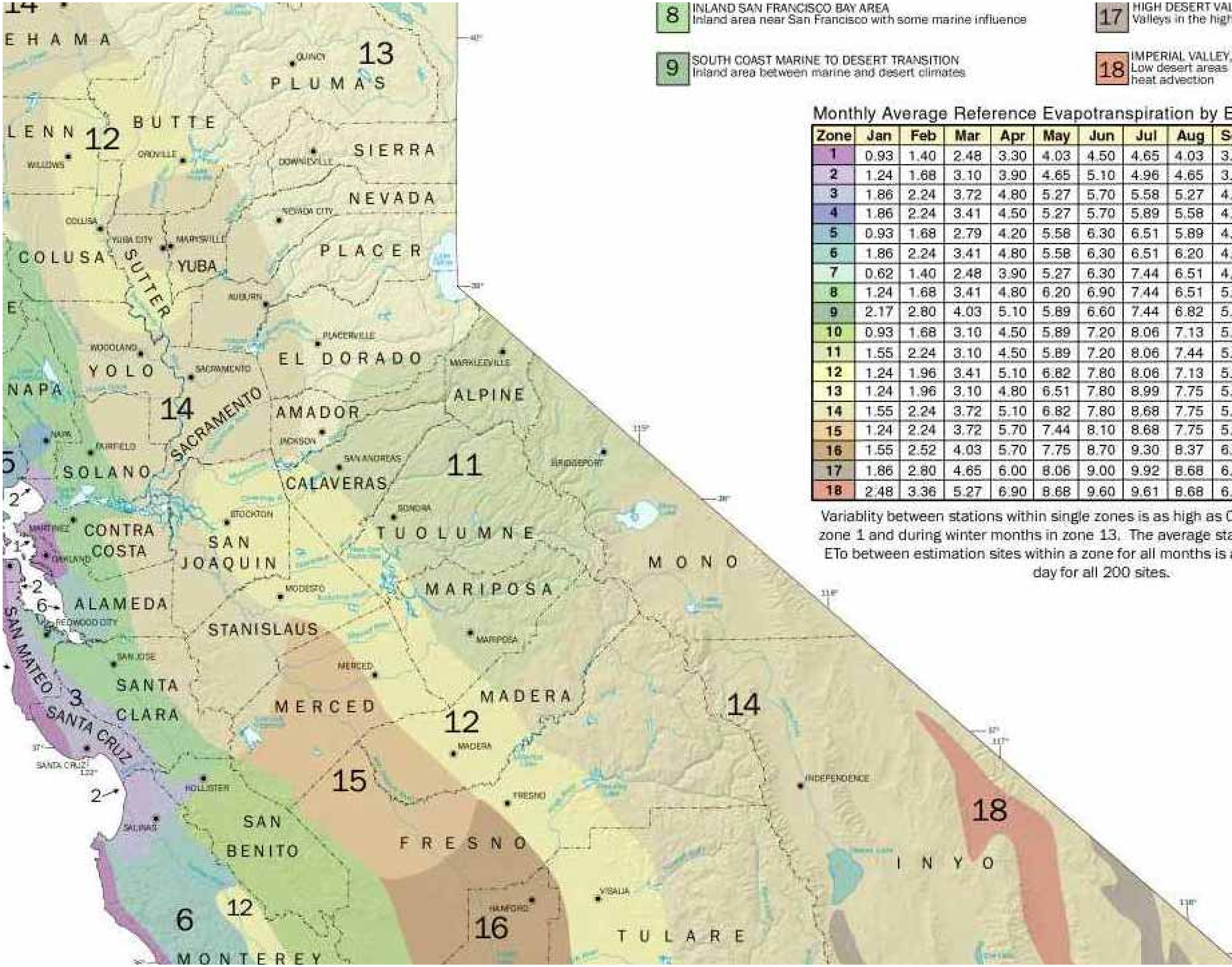
Response to increased irrigation is linear



How Much To Apply

- Full Potential Water Use X RDI%
- ETo X Kc = Full potential Water Use


www.cimis.water.ca.gov
CIMIS
ETo
Reference ET



8 INLAND SAN FRANCISCO BAY AREA
Inland area near San Francisco with some marine influence

9 SOUTH COAST MARINE TO DESERT TRANSITION
Inland area between marine and desert climates

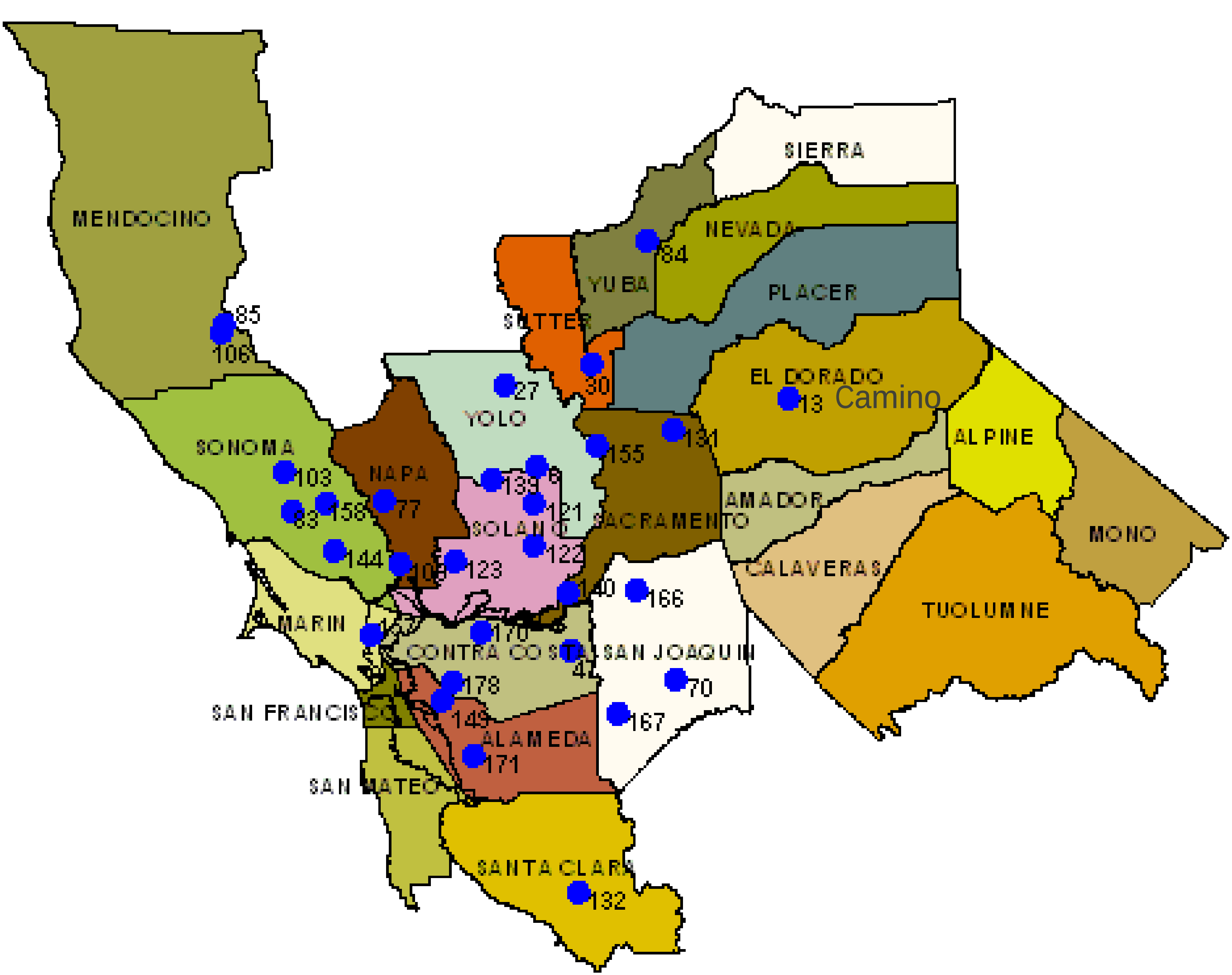
17 HIGH DESERT VALLEYS
Valleys in the high desert n

18 IMPERIAL VALLEY, DEATH V
Low desert areas with high
heat advection

Monthly Average Reference Evapotranspiration by ETo Zo

Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oc
1	0.93	1.40	2.48	3.30	4.03	4.50	4.65	4.03	3.30	2.4
2	1.24	1.68	3.10	3.90	4.65	5.10	4.96	4.65	3.90	2.7
3	1.86	2.24	3.72	4.80	5.27	5.70	5.58	5.27	4.20	3.4
4	1.86	2.24	3.41	4.50	5.27	5.70	5.89	5.58	4.50	3.4
5	0.93	1.68	2.79	4.20	5.58	6.30	6.51	5.89	4.50	3.1
6	1.86	2.24	3.41	4.80	5.58	6.30	6.51	6.20	4.80	3.7
7	0.62	1.40	2.48	3.90	5.27	6.30	7.44	6.51	4.80	2.7
8	1.24	1.68	3.41	4.80	6.20	6.90	7.44	6.51	5.10	3.4
9	2.17	2.80	4.03	5.10	5.89	6.60	7.44	6.82	5.70	4.0
10	0.93	1.68	3.10	4.50	5.89	7.20	8.06	7.13	5.10	3.1
11	1.55	2.24	3.10	4.50	5.89	7.20	8.06	7.44	5.70	3.7
12	1.24	1.96	3.41	5.10	6.82	7.80	8.06	7.13	5.40	3.7
13	1.24	1.96	3.10	4.80	6.51	7.80	8.99	7.75	5.70	3.7
14	1.55	2.24	3.72	5.10	6.82	7.80	8.68	7.75	5.70	4.0
15	1.24	2.24	3.72	5.70	7.44	8.10	8.68	7.75	5.70	4.0
16	1.55	2.52	4.03	5.70	7.75	8.70	9.30	8.37	6.30	4.3
17	1.86	2.80	4.65	6.00	8.06	9.00	9.92	8.68	6.60	4.3
18	2.48	3.36	5.27	6.90	8.68	9.60	9.61	8.68	6.90	4.9

Variablity between stations within single zones is as high as 0.02 inc
zone 1 and during winter months in zone 13. The average standard
ETo between estimation sites within a zone for all months is about 0.
day for all 200 sites.



MENDOCINO
85
106
SONOMA
103
83
158
77
144
NAPA
YOLO
27
SUTTER
30
YUBA
84
NEVADA
SIERRA
PLACER
EL DORADO
13
Camino
131
155
ALPINE
139
6
121
SOLANO
123
122
SACRAMENTO
AMADOR
MONO
CALAVERAS
166
TUOLUMNE
MARIN
170
CONTRA COSTA
47
SAN JOAQUIN
70
178
SAN FRANCISCO
149
ALAMEDA
171
167
SAN MATEO
SANTA CLARA
132

CIMIS Weather Station Data

windsor	sta103				Bi Weekly	
Station	Date	J Date	ETo	Ppt	ETo	Ppt
13	7/16/2001	196	0.22	0		
13	7/17/2001	197	0.21	0		
13	7/18/2001	198	0.24	0		
13	7/19/2001	199	0.2	0		
13	7/20/2001	200	0.21	0		
13	7/21/2001	201	0.21	0		
13	7/22/2001	202	0.25	0		
13	7/23/2001	203	0.21	0		
13	7/24/2001	204	0.2	0		
13	7/25/2001	205	0.19	0		
13	7/26/2001	206	0.17	0		
13	7/27/2001	207	0.2	0		
13	7/28/2001	208	0.21	0		
13	7/29/2001	209	0.22	0		
13	7/30/2001	210	0.21	0		
13	7/31/2001	211	0.2	0	3.35	0


Land surface
shaded midday
LSS% = 0.30
Kc = 0.30 x 1.7 = 0.51

Windsor Station 103
2001

Date Period	Eto Inches/ Period	Crop Coefficient Kc	Potential Water Use (in)	Through Harvest (in)
June 1 - 15				
June 15 - 30				
July 1 - 15				
July 16 - 31	3.35	0.51	1.71	1.71
Aug 1 - 15	3.03	0.51	1.55	1.55
Aug 16 - 31	3.29	0.51	1.68	1.68
Sept 1 - 15	2.64	0.51	1.35	1.35
Sept 16 - 30	2.03	0.51	1.04	1.04
Oct. 1 -15	2.04	0.51	1.04	
Oct. 16 - 31	1.29	0.51	0.66	
Total			9.01	7.31

Threshold of July 16th and Harvest October 1st. Shaded Area = 30%

Windsor Station 103
2001

Date Period	Potential Water Use (in)	RDI Coefficient	Soil (in)	Effective (in)	Net (in)
July 16 - 31	**1.71**	**0.6**	**0.5**	**0**	**0.73**
Aug 1 - 15	**1.55**	**0.6**	**0.5**	**0**	**0.63**
Aug 16 - 31	**1.68**	**0.6**	**0.5**	**0**	**0.71**
Sept 1 - 15	**1.35**	**0.6**	**0.5**	**0**	**0.51**
Sept 16 - 30	**1.04**	**0.6**	**0.5**	**0**	**0.32**
Oct. 1 -15	**1.04**	**1**		**0**	**1.04**
Oct. 16 - 31	**0.66**	**1**		**1.24**	**-0.58**
Total	**9.01**		**2.5**	**1.24**	**3.93**

Irrigation of Quality Winegrapes Using

Micro-Irrigation Techniques

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Supported in part by: Lodi-Woodbridge Wine Commission

DRAFT

Irrigation of Quality Winegrapes Using Micro-Irrigation Techniques

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go to :alternative professional page

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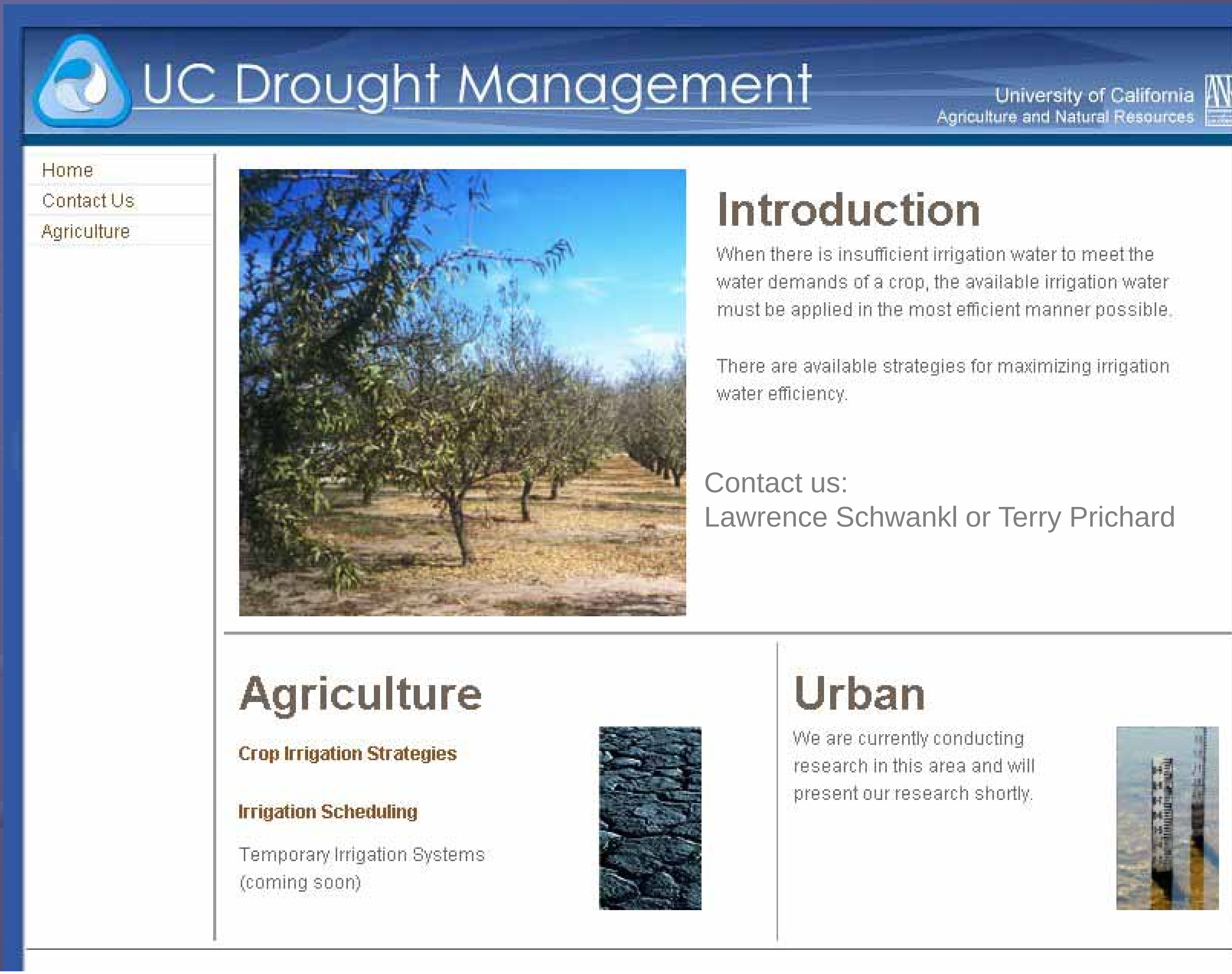

Contact us:
Lawrence Schwankl or Terry Prichard

Irrigation Application

Gallons/vine

= inches water x vine spacing x 0.623

50 gal/vine = 1.0 in x 7x11x 0.623