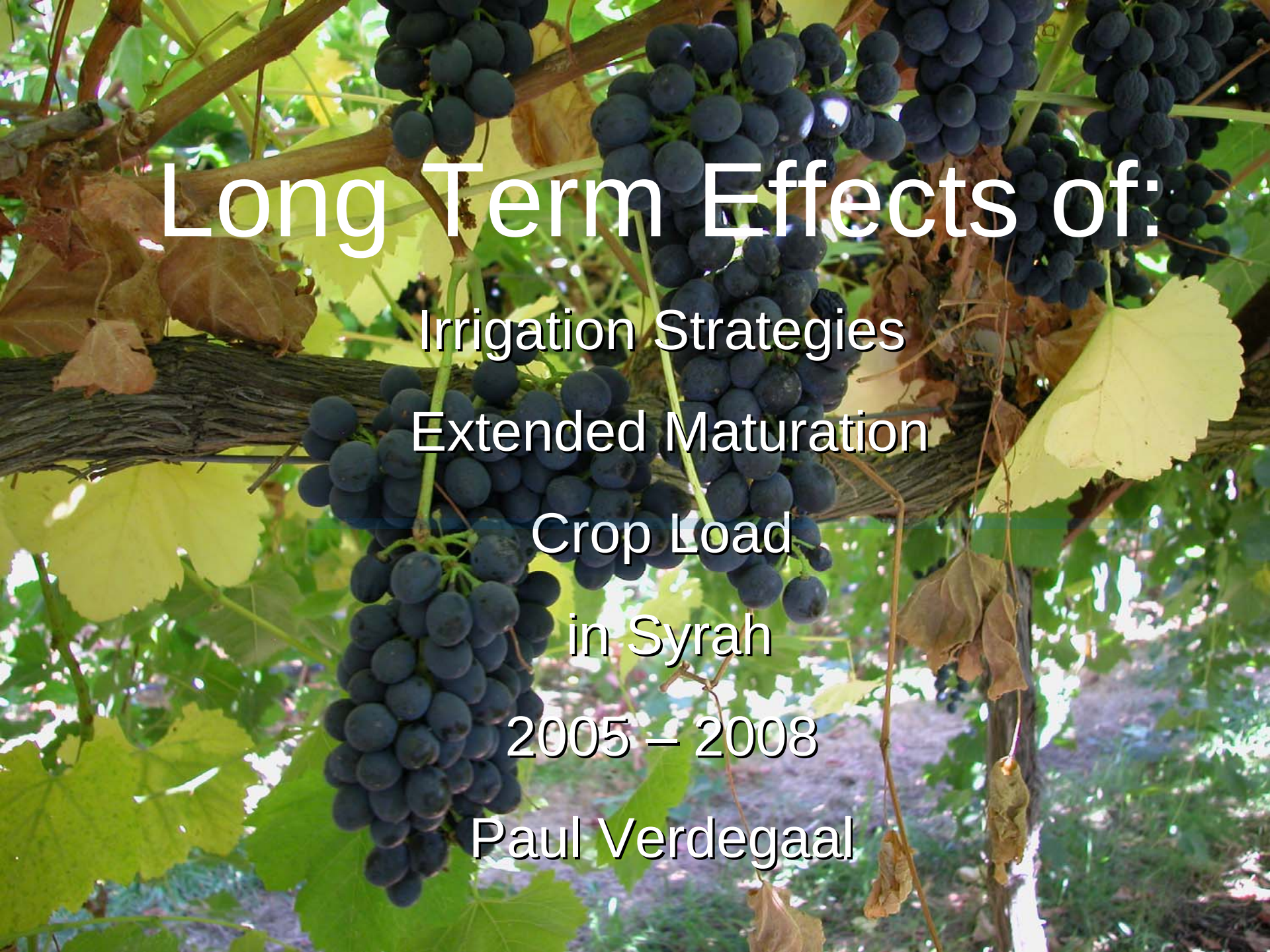


Long Term Effects of:

Irrigation Strategies

Extended Maturation

Crop Load

in Syrah

2005 – 2008

Paul Verdegaal

Cooperators and Funding

- UC: Paul Verdegaal Chuck Ingles Terry Prichard
- E J Gallo Winery: Nick Dokoozilian and Research Team
- Pacific Agrilands: Ernie Dosio and Carl Maggio

California Department of Water Resources

Proposition 50 Funds

- CAWG

Galt, CA
1998 Syrah clone 6 on SO4

Irrigation, Trellis, Shoot removal

Irrigation Treatments

Imposed 2004 through 2008

Weekly Irrigations

- I-1 Full Irrigation, 100% ETc
- I-3 Begin irrigation @ -14 bars then 50% ETc
- 1-2 Begin irrigation @ -14 bars then 50% ETc
  Followed by 100% ETc at 19º Brix

Select, Bag, and Cut the Petiole

Place leaf in bag in chamber

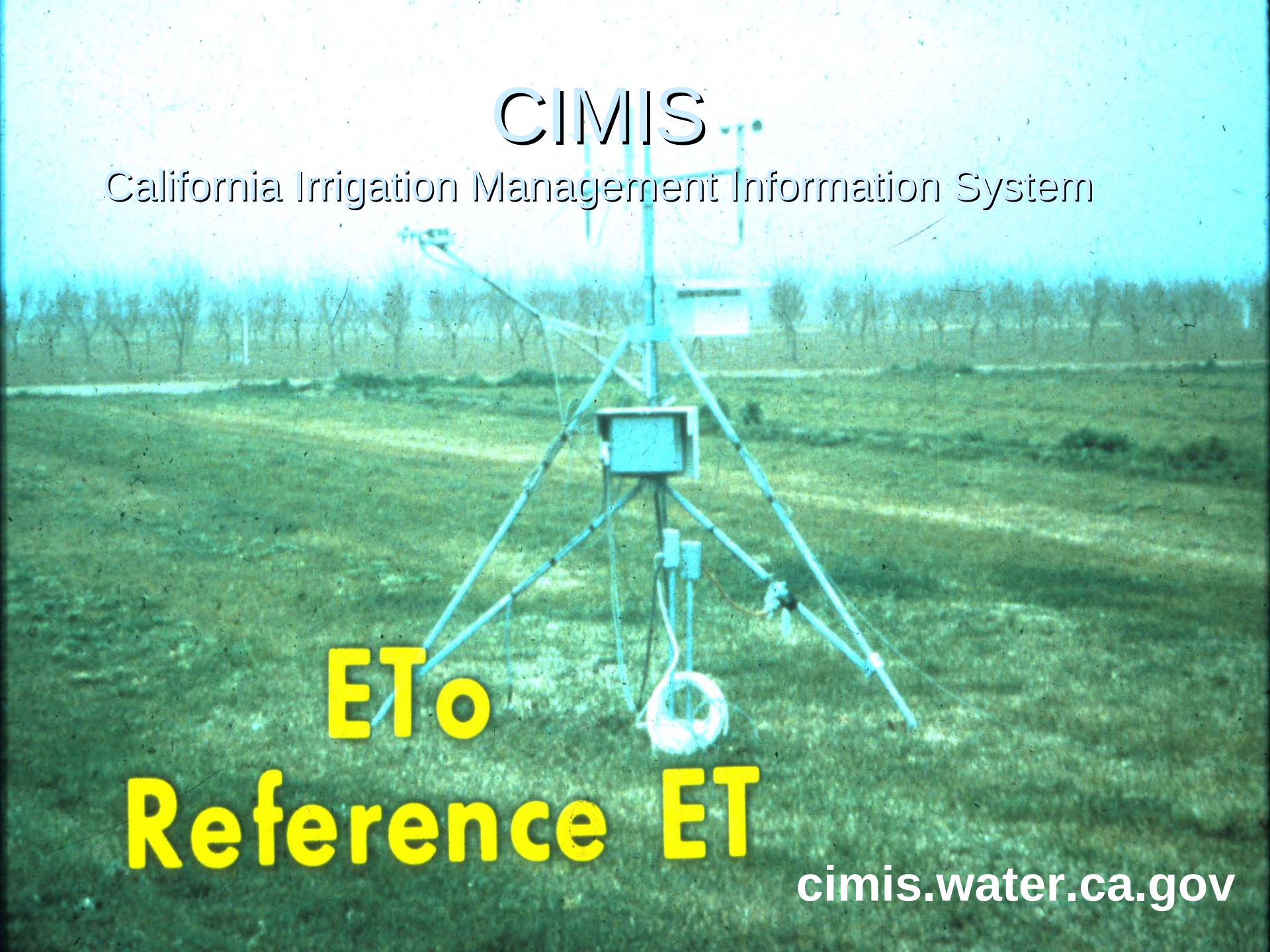

I-1 no stress
-8 then irrigate
I-2 and I-3
-14 Bar Irrigation
Threshold
Late June-
Mid July
pms

Irrigation volume determined by calculating full vine water use

Then

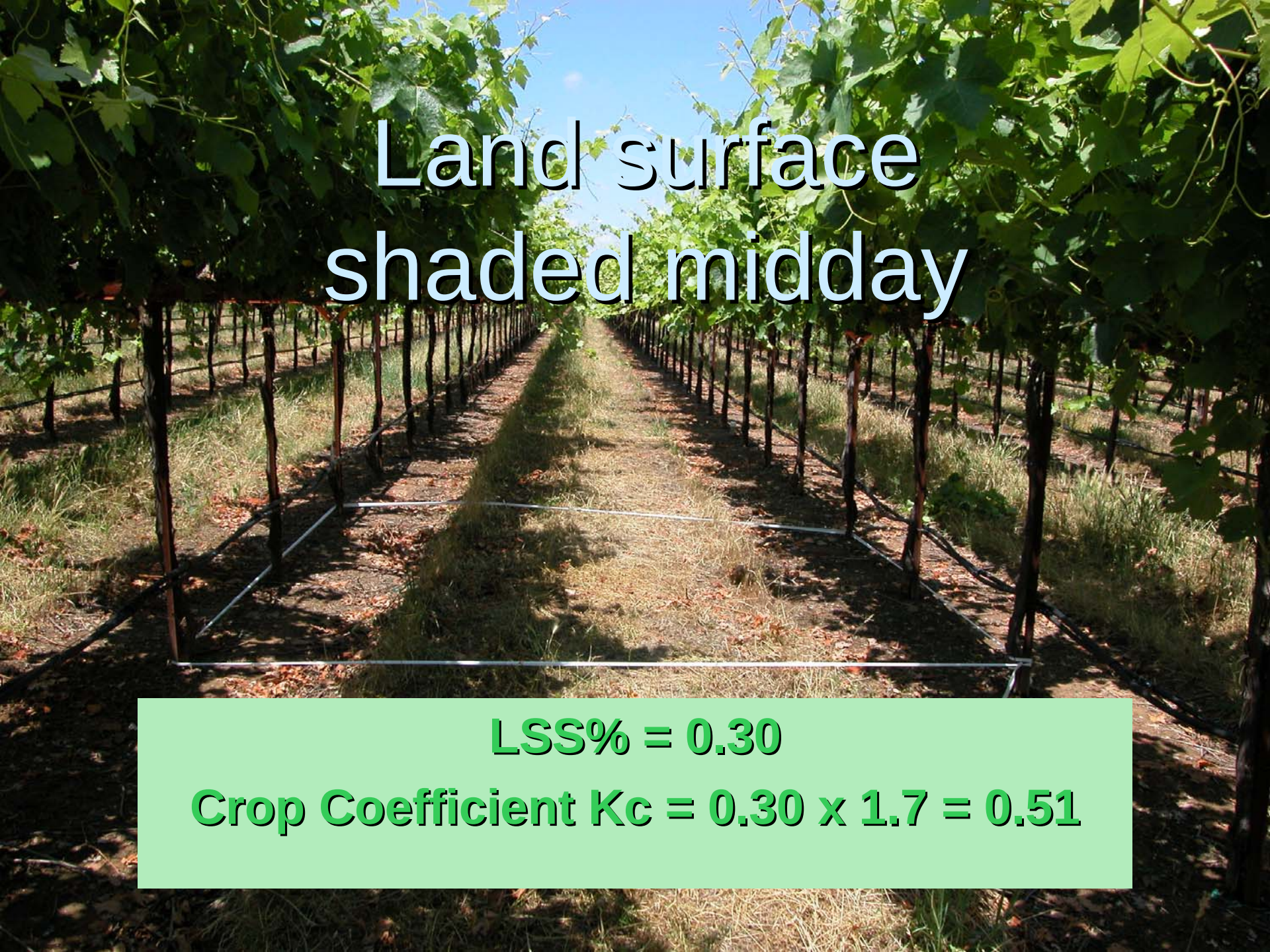
Appling the RDI%

- Treatment ETc = ETo x Kc x RDI%


CIMIS
California Irrigation Management Information System
ETo
Reference ET
cimis.water.ca.gov

Full Irrigation

Deficit Irrigation


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

Weekly Irrigation Volume
Treatment 3 in August

- ETo x Kc x RDI% = Treatment ETc
- 1.67 X (0.40 X 1.7) X 50% = 0.57 in or 19 gal/vine
- Gals/Vine = 0.623 X vine spacing feet X ETc

Maturity Treatments

Split in each irrigation treatment

Irrigation Treatment	Brix Treatment	Leaf Water Potential Trigger at Which Irrigation Will Occur	Criteria for Subsequent Irrigation
1	24	no trigger	supply full water
1	26	no trigger	supply full water
1	28	no trigger	supply full water
2	24	-14 bars	50% / 100%
2	26	-14 bars	50% / 100%
2	28	-14 bars	50% / 100%
3	24	-14 bars	50%
3	26	-14 bars	50%
3	28	-14 bars	50%

Crop Load Treatments

Split in each irrigation treatment

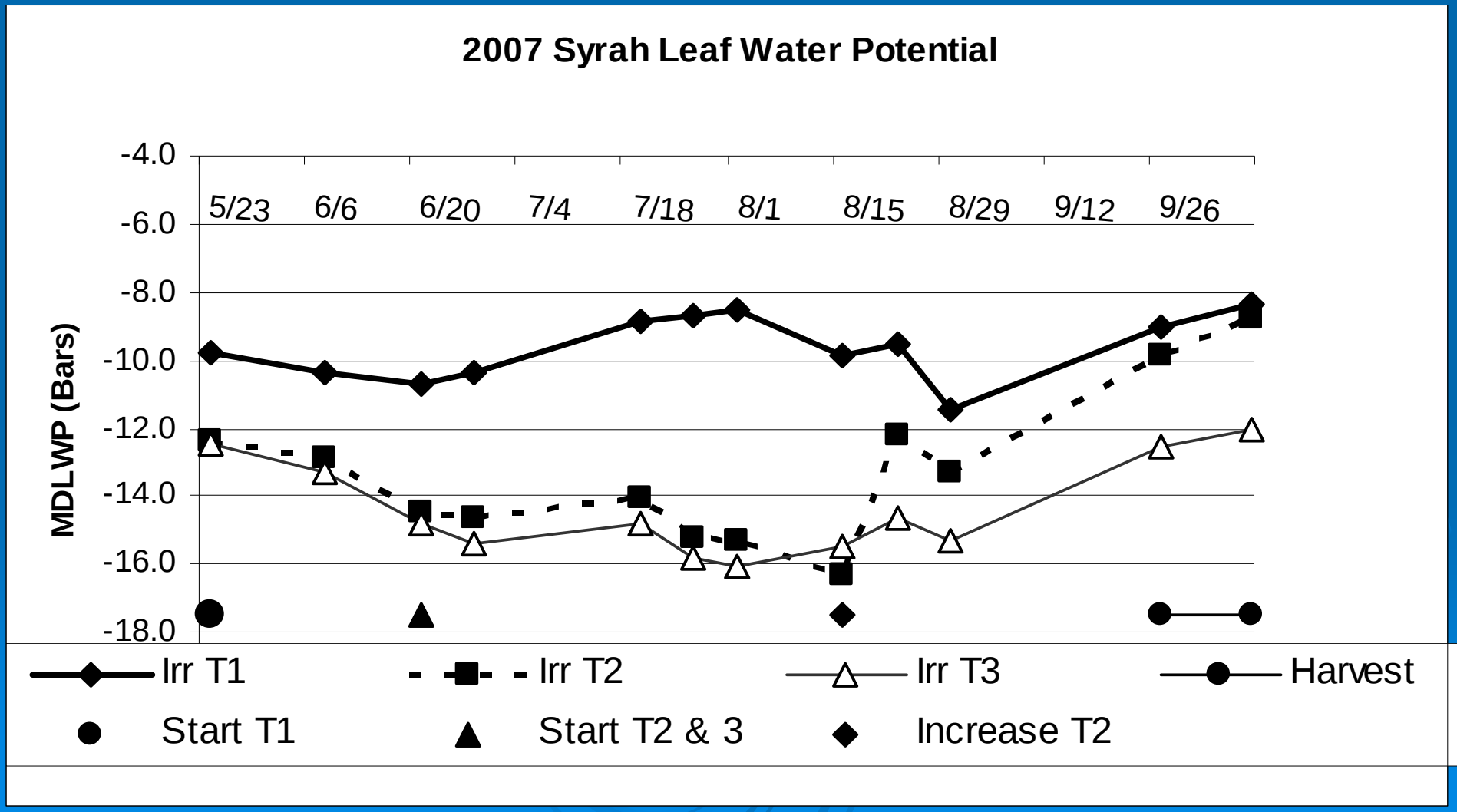
- 14 2-bud spurs / vine
  - 5.6 buds/ft of row
  - 0.51 buds/ft^2
- 18 2-bud spurs / vine
  - 7.2 buds/ft of row
  - 0.65 buds/ft^2

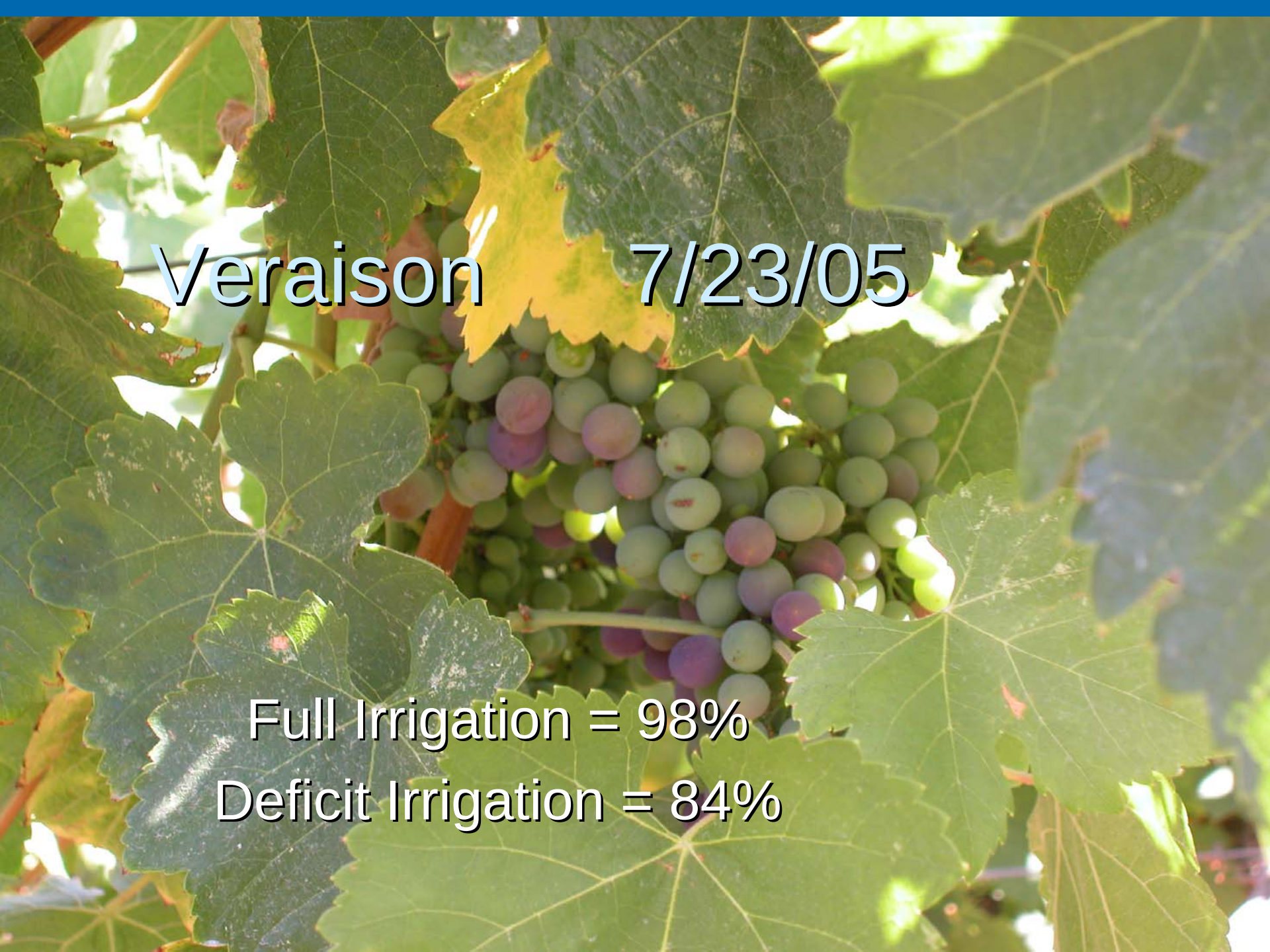
Water Applied and Consumed Average 2005-2008

Irrigation Strategy	Water Applied (in)		Soil Use (in)	Effective In-Season Rainfall (in)	Total Water Consumed (in)		% of Irrigation Strategy 1	
	Pre harvest	Post harvest			Pre harvest	Inc. Post Harvest	Pre Harvest	Seasonal
1	28.8	2.1	4.8	1.1	34.7	36.7	100	100
2	13.3	2.1	8.3	1.1	22.7	24.8	68	69
3	9.3	1.9	7.2	1.1	17.6	19.5	53	55

Vine Water Status

Significant differences due to treatment




Veraison 7/23/05
Full Irrigation = 98%
Deficit Irrigation = 84%

Canopy

I-3 June 7 2006


I-2 June 7 2006


I-1 June 7 2006


Deficit Irrigation


Full Irrigation

Canopy Measurements

	Shoot Length (cm)	Land Surface Shaded
Irrigation		
I-1	74.2 a[a]	62a
I-2	69.7 ab	48 b
I-3	64.1 b	52 b
P =	0.0148	0.0480
Brix		
24	72.8 a	
26	64.2 b	
28	71.1 a	
P =	0.0301	
Spurs		
14	70.3	
18	68.4	
P=	0.4847	
Interactions	NS	

Harvest Dates

Late August - October

- Earlier
  - Deficit I-3
- Mid
  - Deficit I-2
- Later
  - Full Irrigation I-1
- Generally No Difference
  - Crop Load

Yield

	Yield (lb/vine)	Relative Yield (%)	Berry Size (g)	Relative Berry Size (%)	Fruit Load (berry/vine)	Relative Fruit Load (%)
Irrigation						
I-1	22.1 a[a]	100	1.52 a	100	6342 a	100
I-2	17.0 b	77	1.29 b	85	5779 b	91
I-3	14.1 c	64	1.20 c	79	5209 c	82
P =	0.0000		0.0000		0.0000	
Brix						
24	19.6 a	100	1.43 a	100	5839	100
26	17.7 b	90	1.35 b	94	5774	99
28	16.1 c	82	1.24 c	87	5719	98
P =	0.0000		0.0000		0.8396	
Spurs						
14	16.3 b	84	1.34	100	5461 b	90
18	19.3 a	100	1.33	99	6093 a	100
P=	0.0001		0.4969		0.0002	
Year						
2005	13.8 c	63	1.51 a	100	3954 d	56
2006	22.0 a	100	1.43 b	95	7027 a	100
2007	16.5 b	75	1.15 d	76	6416 b	91
2008	16.2 b	74	1.28 c	85	5712 c	81
P=	0.0000		0.0000		0.0000	
Interactions	NS		NS		NS	

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I-2	17.0 b	77	1.29 b	85	5779 b	91
I-3	14.1 c	64	1.20 c	79	5209 c	82
P =	0.0000		0.0000		0.0000	
Brix						
24	19.6 a	100	1.43 a	100	5839	100
26	17.7 b	90	1.35 b	94	5774	99
28	16.1 c	82	1.24 c	87	5719	98
P =	0.0000		0.0000		0.8396	
Spurs						
14	16.3 b	84	1.34	100	5461 b	90
18	19.3 a	100	1.33	99	6093 a	100
P=	0.0001		0.4969		0.0002	
Year						
2005	13.8 c	63	1.51 a	100	3954 d	56
2006	22.0 a	100	1.43 b	95	7027 a	100
2007	16.5 b	75	1.15 d	76	6416 b	91
2008	16.2 b	74	1.28 c	85	5712 c	81
P=	0.0000		0.0000		0.0000	
Interactions	NS		NS		NS	

Treatment	Cluster Number (clusters/vine)	Relative Cluster No. (%)	Cluster Size (lbs/cluster)	Relative Cluster Size (%)
Irrigation				
I-1	57.5 a[a]	100	0.37 a	100
I-2	53.4 b	93	0.30 b	81
I-3	47.4 c	82	0.29 b	78
P =	0.0000		0.0000	
Brix				
24	52.3	98	0.35 a	100
26	52.8	99	0.32 b	91
28	53.2	100	0.29 c	83
P =	0.7935		0.0000	
Spurs				
14	48.9 b	86	0.33 a	100
18	56.6 a	100	0.31 b	94
P=	0.0000		0.0500	
Year				
2005	48.7 b	87	0.28 c	70
2006	54.6 a	98	0.40 a	100
2007	56.0 a	100	0.29 c	73
2008	51.6 b	92	0.31 b	78
P=	0.0001		0.0000	
Interactions	NS		NS	

Yield Component Analysis

- Factors which are responsible for yield increase or decrease over all treatments
  - Fruit Load (berries per vine) 74.4%
  - Berry Size 20.1%
- Irrigation – Cluster number
- Maturity --- Berry Size
- Crop Load – Cluster number

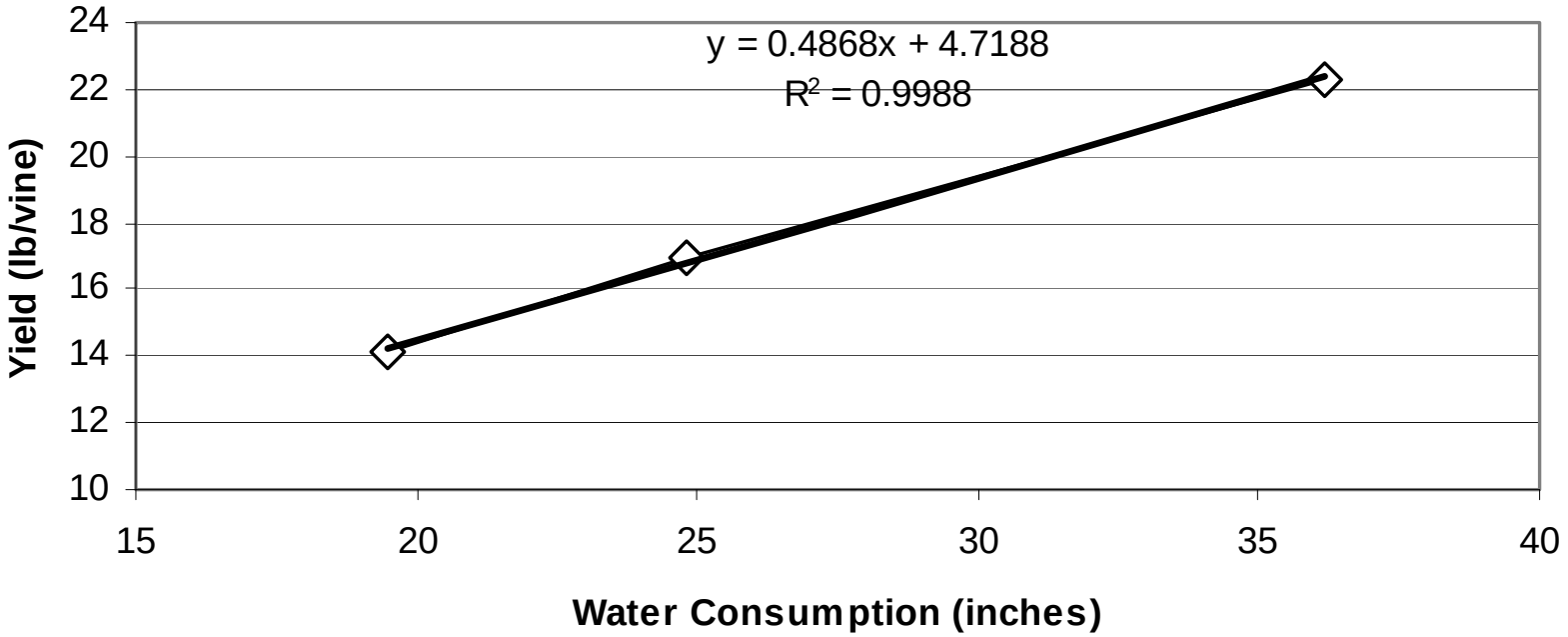
Fruit Condition / Yield

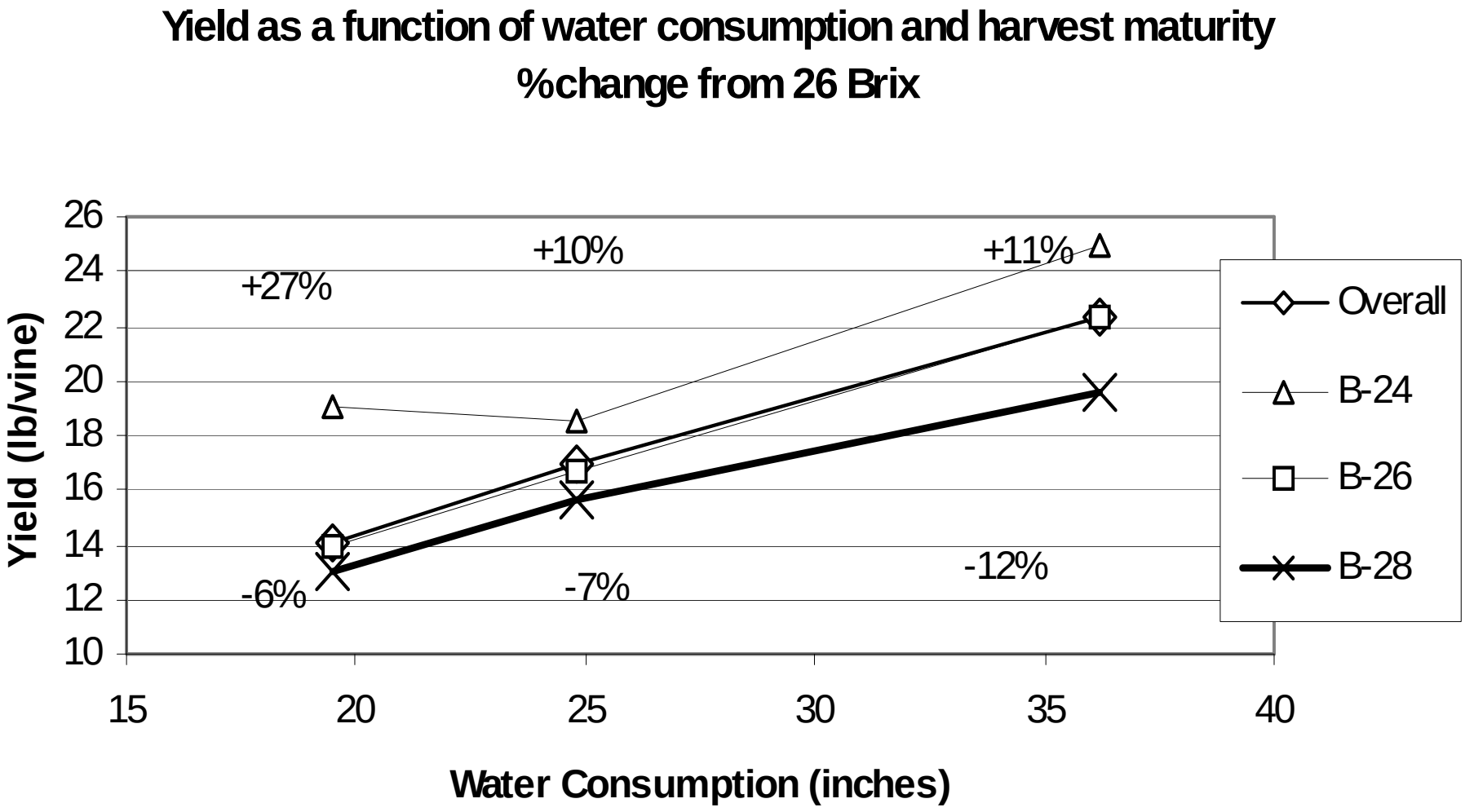
Fruit Analysis

Treatment	º Brix	pH	Potassium (mg/L)	Titratable Acid (g/L)
Irrigation				
I-1	25.2 c[a]	3.85 b	2044 a	0.42 a
I-2	25.7 b	3.85 b	1915 b	0.36 b
I-3	26.1 a	3.91 a	2050 a	0.36 b
P =	0.0000	0.0254	0.0039	0.0000
Brix				
24	24.2 c	3.68 c	1598 c	0.42 a
26	25.6 b	3.83 b	2004 b	0.37 b
28	27.3 a	4.11 a	2408 a	0.35 c
P =	0.0000	0.0000	0.0000	0.0000
Spurs				
14	25.6	3.87	2004	0.38
18	25.8	3.87	2002	0.38
P =	0.2818	0.8246	0.9641	0.7033
Years				
2005	26.2 a	3.78 b	1930	0.46 a
2006	25.3 b	3.78 b	2009	0.39 c
2007	25.9 a	3.98 a	2080	0.26 d
2008	25.4 b	3.94 a	1994	0.41 b
P =	0.0000	0.0000	0.0739	0.0000

Treatment	Tartaric Acid (mg/L)	Malic Acid (mg/L)	Tartaric:Malic Ratio	Anthocyanins (mg/g)	Phenolics (mg/g)
Irrigation					
I-1	4663	2949 a[a]	1.66 b	1.11 b	1.37 b
I-2	4768	2206 b	2.41 a	1.16 ab	1.44 ab
I-3	4893	2207 b	2.47 a	1.20 a	1.47 a
P =	0.1998	0.0000	0.0000	0.0014	0.0454
Brix					
24	4514 b	2533	1.91 b	1.08 b	1.33 b
26	4513 b	2455	2.26 a	1.20 a	1.46 a
28	5297 a	2375	2.38 a	1.19 a	1.50 a
P =	0.0000	0.1805		0.0000	0.0001
Spurs					
14	4759	2451	2.15	1.14 b	1.41
18	4790	2457	2.21	1.18 a	1.43
P =	0.7668	0.9399	0.5153	0.0650	0.3393
Years					
2005		2883		1.11 b	1.43
2006	5167 a	2731 a	2.11 b	1.18 a	1.44
2007	4362 c	1824 c	2.67 a	1.21 a	
2008	4795 b	2778 a	1.76 c	1.12 b	
P =	0.0000	0.0000	0.0000	0.0143	0.7496

Response to increased irrigation is linear




Yield as a function of water consumption and harvest maturity
%change from 26 Brix
Yield (lb/vine)
26
24
22
20
18
16
14
12
10
15
20
25
30
35
40
Water Consumption (inches)
+27%
+10%
+11%
-6%
-7%
-12%
Overall
B-24
B-26
B-28

Conclusions

- Deficit irrigation techniques and extended maturation strategies each reduce yield over time.

  - Deficit Irrigation
    - decreased fruit load from fewer clusters and smaller berries
  - Extended Maturation
    - decreases berry size

Conclusions

- Deficit irrigation treatment I-2
  - Preserved yield by having larger berries
  - Generally was equal in fruit quality to I-3
    - At a yield increase of about 20 %

Conclusions

- Increasing fruit load by pruning to 30% more primary buds

  - resulted in a 16% average yield boost

  - while vine balance seems not to have been affected;
  - no significant delay in harvest was found;
  - changes in Juice components were not significant.

Utilizing water deficits, extended maturity harvest, and pruning each has a distinct effect on yield and fruit quality.

- Any combination of these strategies should be carefully considered and compared to the quality changes and always compared to the value of the crop