Irrigation Considerations in a Dry Year

12 May 2015

CAFF-LWC Meeting

Paul Verdegaal
UC Farm Advisor
San Joaquin County

Grape Vines - Camels of Horticulture

Rainfall *Lodi*

			Rainfall Seasonal Lodi		2001-15 inches				
	Total	% Avg	OctNovDec	Jan	Feb	Mar	Apr	May	Jun
2001	16.6	100	3.6	3.7	3.7	1.9	3.7	0	0.1
2002	16.3	98	9.7	2.0	1.0	2.5	0.2	0.9	0
2003	15.2	92	8.7	0.6	4.7	1.1	0.1	0.1	0
2004	15.3	92	9.2	0.6	0.9	0.6	3.6	0.4	0
2005	23.1	139	10.4	3.2	3.3	3.5	1.4	1.3	0
2006	23.4	141	7.1	5.4	1.1	5.2	3.8	0.8	0
2007	12.1	73	4.6	0.3	4.3	0.6	2.3	T	0
2008	13.7	82	4.5	7.3	1.8	0.1	0	0	0
2009	15.1	91	4.0	1.9	5.3	1.9	0.7	1.3	0
2010	19.2	115	6.1	4.5	3.6	1.8	2.9	0.3	0
2011	26.3	158	12.1	1.4	4.1	5.8	0.2	1.4	1.3
2012	12.4	74	3.0	2.9	1.3	3.3	1.9	T	0
2013	15.8	95	11.0	1.6	0.3	2.1	0.6	0.1	0.2
2014	10.2	61	2.2	0.1	4.7	1.9	1.4	0.02	0.0
2015	13.0	78	9.2	0.0	1.9	0.3	1.6		
Average	16.6		7.0	2.4	2.8	2.2	1.6	0.5	0.1

Season Start
Chardonnay Budbreak

Lodi

Year	Date in March	Year	Date in March	Year	Date in March
1986	9	**1996**	15	**2006**	15
1987	26	**1997**	1	**2007**	14
1988	13	**1998**	14	**2008**	12
1989	17	**1999**	25	**2009**	20
1990	23	**2000**	17	**2010**	15
1991	21	**2001**	17	**2011**	17
1992	13	**2002**	13	**2012**	15
1993	22	**2003**	10	**2013**	18
1994	14	**2004**	13	**2014**	9
1995	5	**2005**	2	**2015**	28 Feb

* Budbreak = 10% of buds at ½ inch shoot length or first leaf unfolding

Average Date March 13

psv

UCCE

Varieties

- Malbec
- Cabernet Sauvignon
- Syrah
- Sauvignon blanc
- Merlot
- Petite Sirah
- Pinot noir
- Chardonnay
- Pinot grigio
- Muscat blanc

Water Use

Climate
- Evapotranspiration Reference (ETo)
- Extraneous Forces
  - Fog
  - Wind
  - Temperature

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

Soil
- Texture
- Depth

Variety/Rootstock

Competition (weeds)

Cover Crop

Rootstocks

- St. George
- Ramsey (Salt Creek)
- Dog Ridge
- 140 Ruggeri
- 110R
- Freedom
- 1103 Paulsen
- Kober 5BB
- 101-14Mgt
- 3309C
- SO4
- Teleki 5C
- 420A

Soil Water Holding Capacity WHC

Soil Texture	Available Waterholding capacity (in. of water/foot of soil)
Very coarse sands	0.4 - 0.75
Coarse sands, fine sands, loamy sands	0.75 - 1.25
Sandy loams, fine sandy loams	1.25 - 1.75
Very fine sandy loams, loams, silt loams	1.50 - 2.30
Clay loams, silty clay loams, sandy clay loams	1.75 - 2.50
Sandy clays, silty clays, clays	1.60 - 2.50

Cover Crops

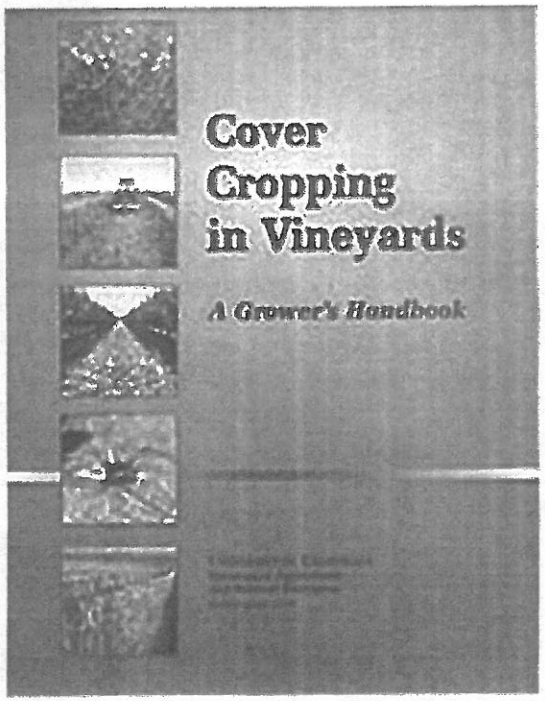
Total Water use ↑
Winter rains used
20% more irrigation

Prichard et al, 1989

Cover Crop Water Use & Effects

Annual Cover vs Perennial vs Resident
Grasses vs Broadleaf vs Mix
Every row vs Alternate
Mowing vs Incorporation
Timing
Costs
- Planting
- Nutrients
- Vertebrate Pests
- Weeds

Benefits
- Infiltration
- Access
- Erosion
- O.M.
- Beneficials
- Weed suppression

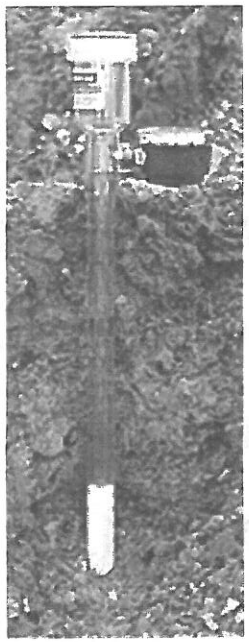


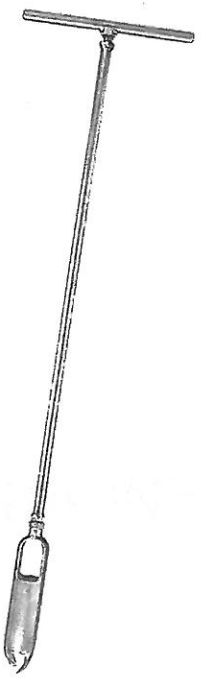
ANR Publication 3338

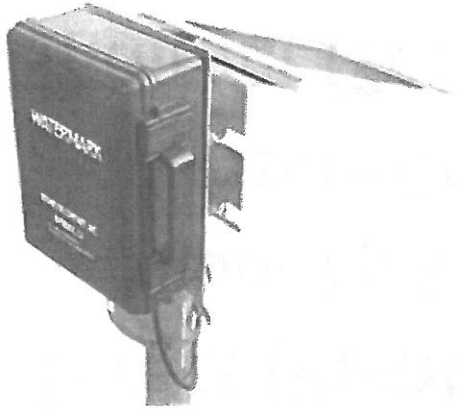
Monitoring Vine stress & Start Threshold

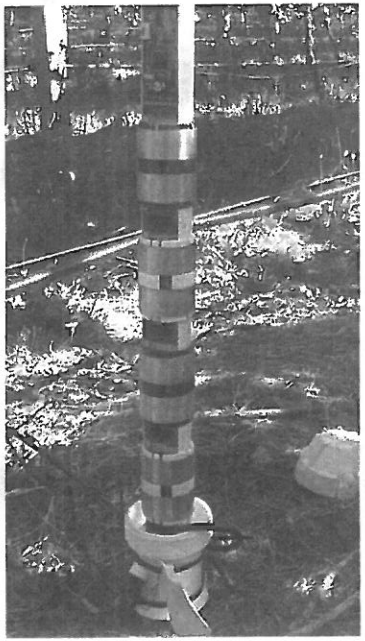
- Direct (Plant)
  - Shoot tip Rating
  - Pressure Chamber (Bomb)
- Indirect (Soil or Air)
  - Tensiometer
  - Gypsum block/Water Mark
  - Soil Capacitance
  - Neutron Probe
  - Surface Renewal

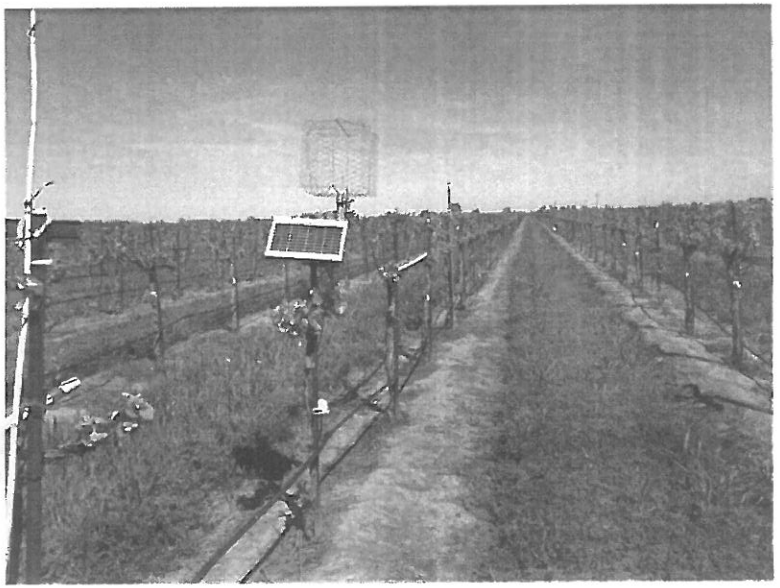
Monitoring

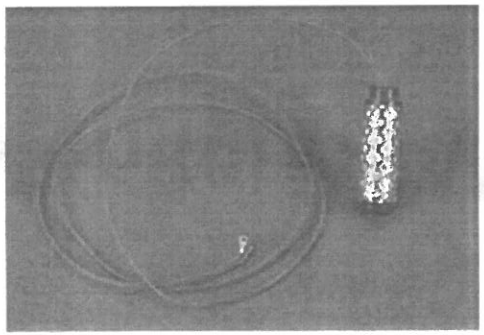






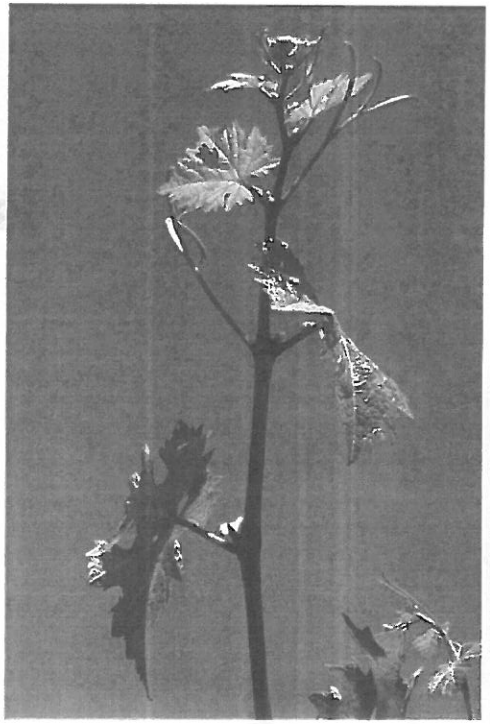






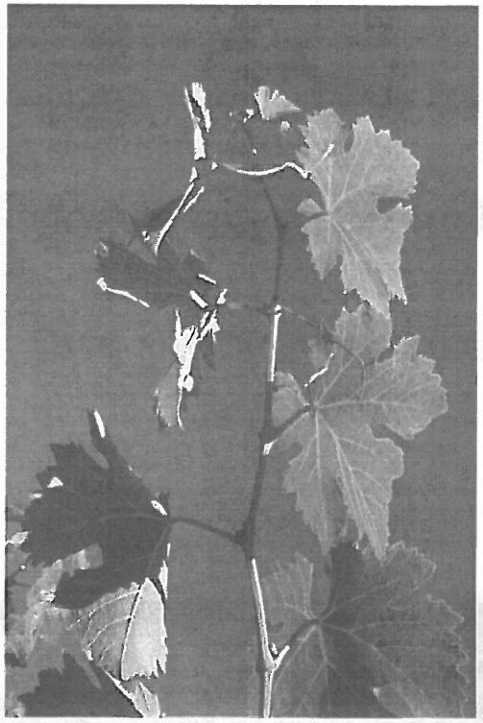
Shoot Tip Rating

No stress

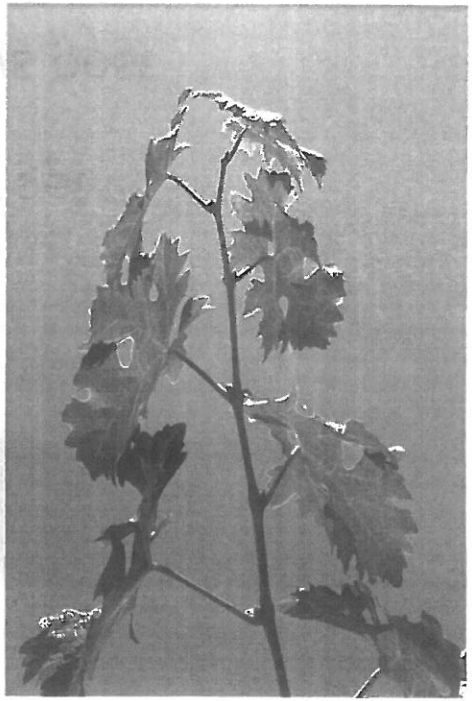


Slight stress

Moderate stress



Severe stress

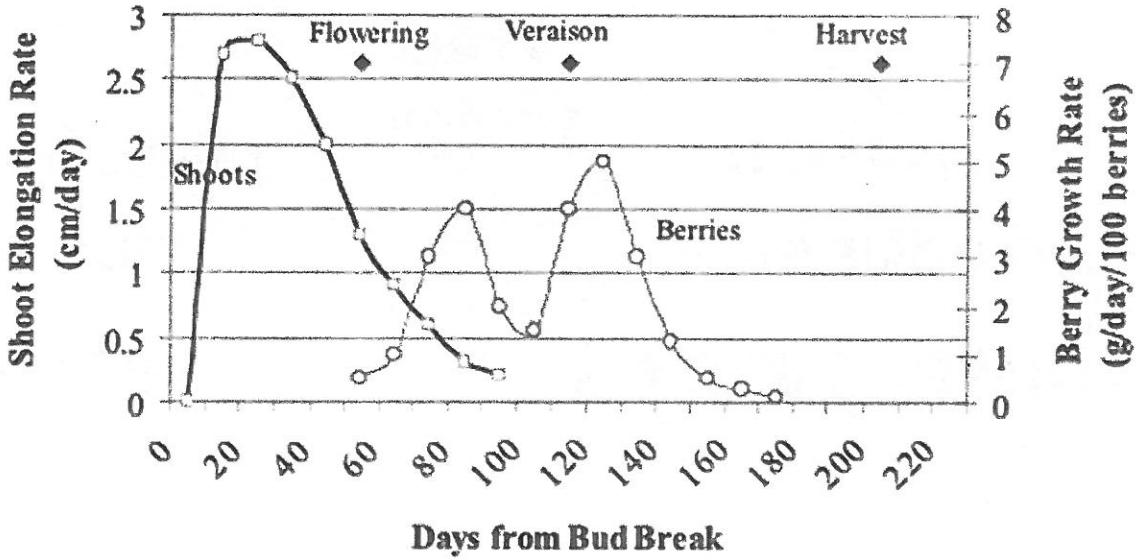


So When to Irigate?

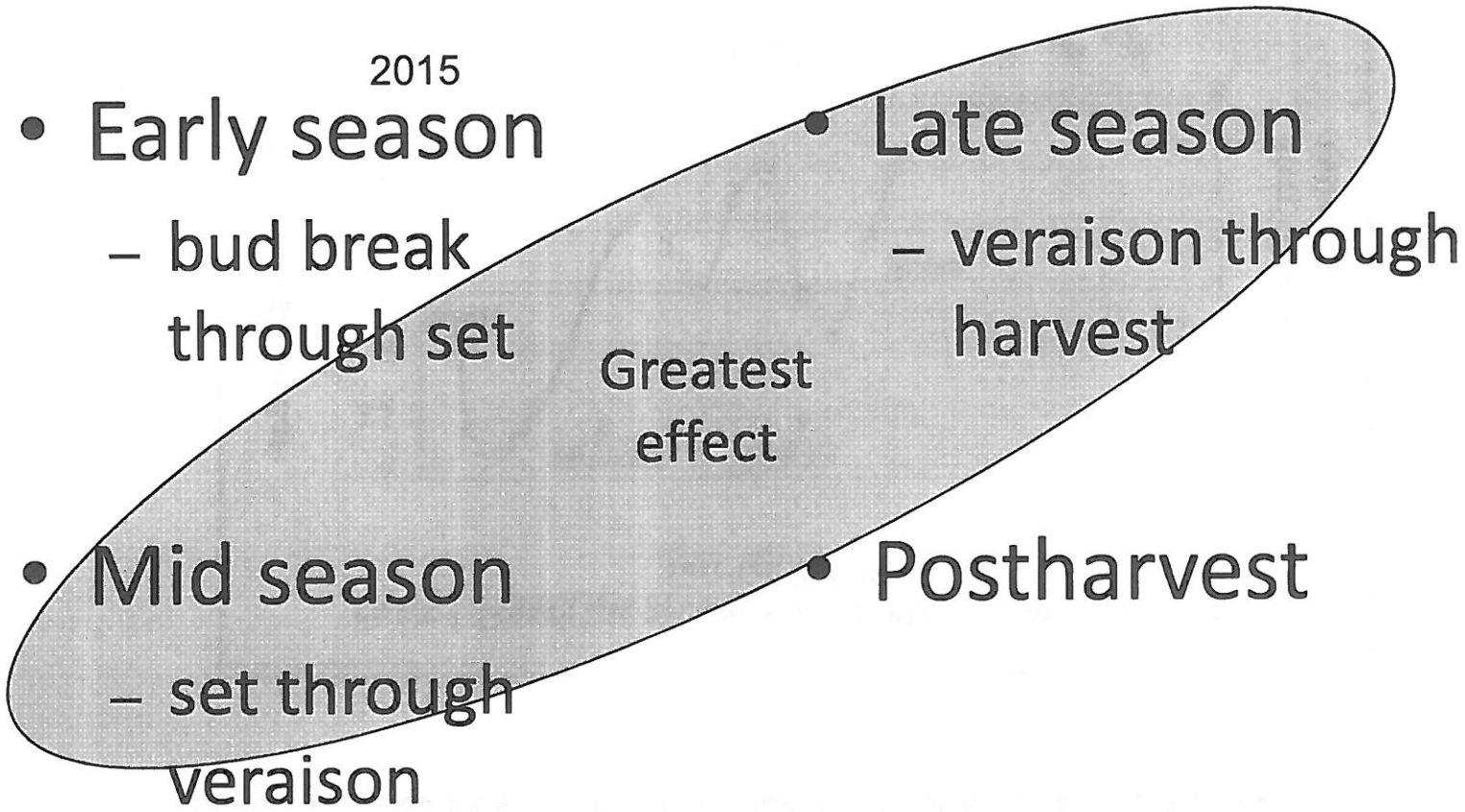
Early	***Stage I***	bud break to flower set
Mid		flower set to 30 days post
	Stage II	30-40 days post bloom
Late	***Stage III***	veraison to harvest
Postharvest		no stress

Vine and Fruit Growth Demand

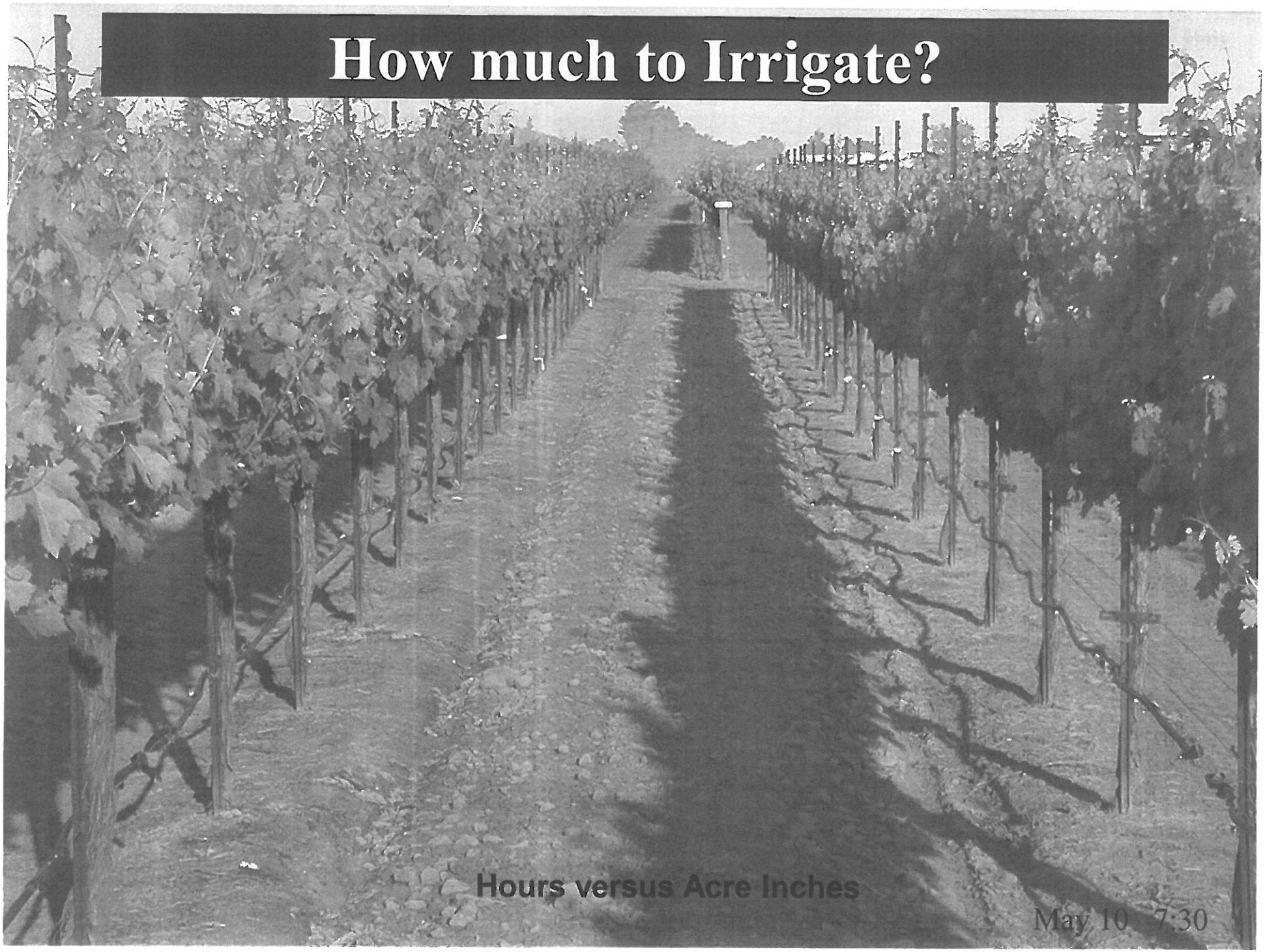
Figure 1. Growth rate of various organs of Colombard grapevines, after Van Zyl (1984)



Timing of Water Deficits



How much to Irrigate?



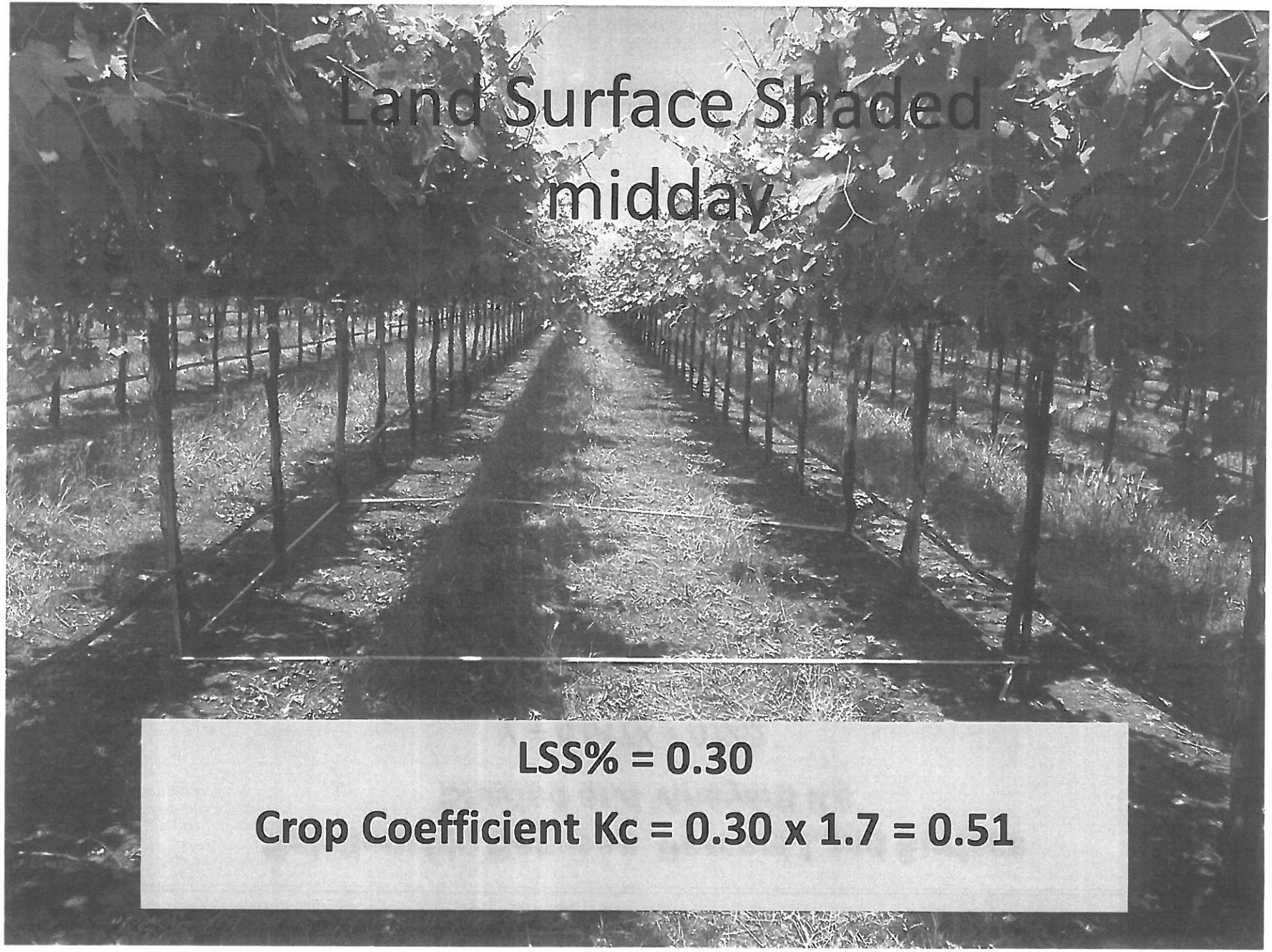
Hours versus Acre Inches

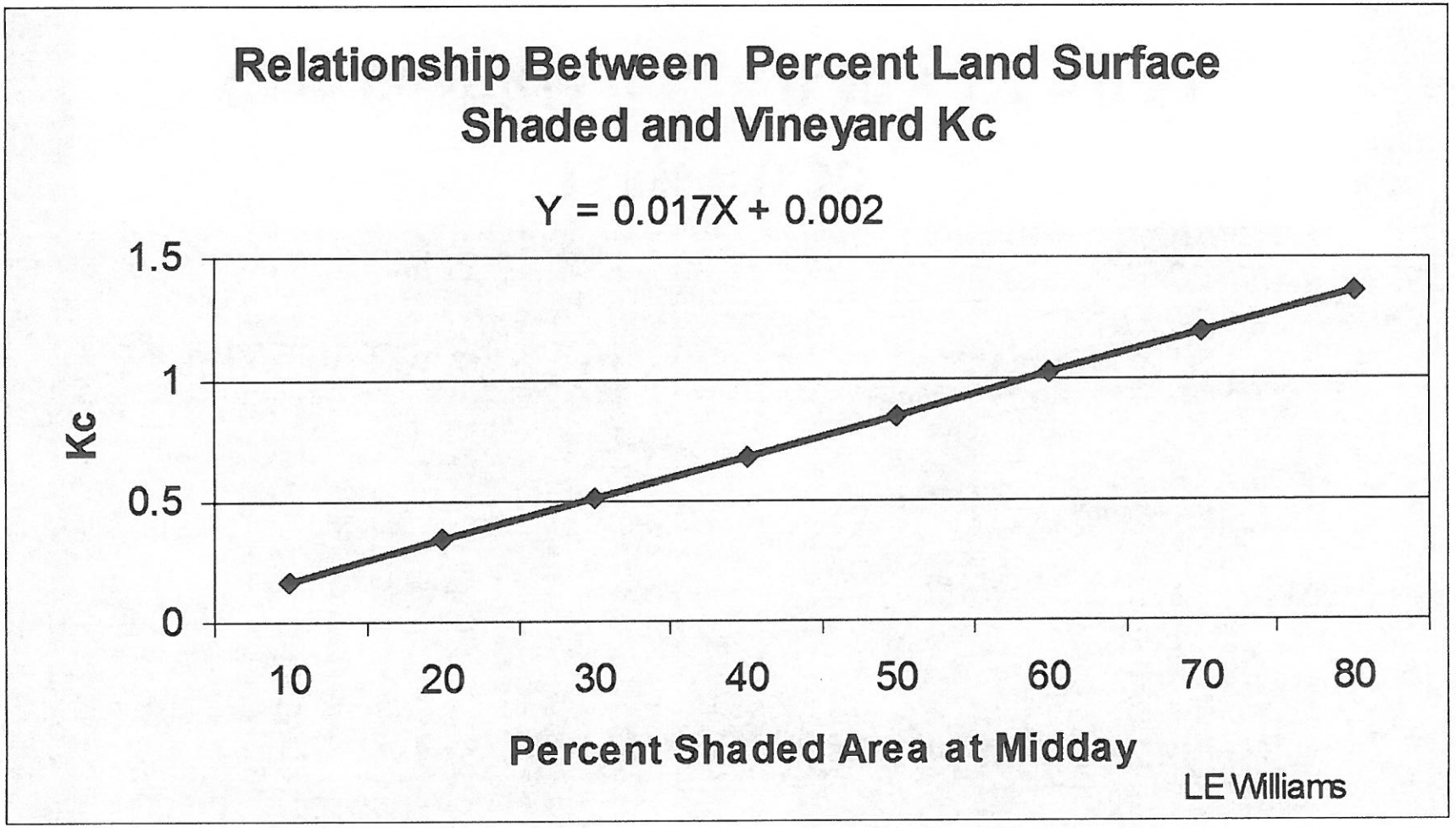
May 10 7:30

Irrigation Water Comparison Full/Deficit in Three Areas

	San Joaquin Valley	Lodi	North Coast
Full water use (in)	29	27	24
Soil storage (in)	4	9	10
Net irrigation requirement (in)	25	18	14
Irrigation efficiency (%)	90	90	90
Gross irrigation requirement (in)	27.8	20	15.6
Deficit irrigation use (in)	22	18	16
Soil storage (in)	4	9	10
Net irrigation requirement (in)	18	9	6
Irrigation efficiency (%)	90	90	90
Gross irrigation requirement (in)	20	10	6.7
Deficit/Full (%)	72	50	43

T. Prichard, 2007


Land Surface Shaded midday
LSS% = 0.30
Crop Coefficient Kc = 0.30 x 1.7 = 0.51



Example, 30 x 0.017 = .51 Kc

Begins at budbreak
Increases until bloom
Maximum at 60% cover
Cover Crop advances and increases

Rainfall March
Average 2.2 in.
2015 0.3 in.

Lodi
1983-2003

			Kc	ETo	ETc	Hours
3/12	to	3/18	0.04	0.56	0.02	
3/19	to	3/25	0.08	0.63	0.05	
3/26	to	4/2	0.12	0.61	0.07	
4/4	to	4/10	0.16	0.71	0.11	
4/11	to	4/17	0.19	0.80	0.16	
4/18	to	4/24	0.23	0.93	0.21	
4/25	to	4/31	0.26	1.10	0.29	
5/1	to	5/7	0.29	1.14	0.33	
5/8	to	5/14	0.32	1.28	0.40	
5/15	to	5/21	0.34	1.24	0.42	
5/22	to	5/28	0.36	1.43	0.52	
5/29	to	6/5	0.39	1.57	0.60	
6/6	to	6/12	0.40	1.58	0.64	
6/13	to	6/19	0.42	1.59	0.67	
6/20	to	6/26	0.43	1.67	0.73	
6/27	to	7/2	0.45	1.67	0.75	
7/3	to	7/10	0.68	1.74	1.18	
7/11	to	7/17	0.68	1.82	1.24	
7/18	to	7/24	0.68	1.85	1.26	
7/25	to	7/31	0.68	1.80	1.23	
8/1	to	8/7	0.68	1.86	1.26	
8/8	to	8/14	0.68	1.82	1.24	
8/15	to	8/21	0.68	1.72	1.17	
8/22	to	8/28	0.68	1.69	1.15	
8/29	to	9/4	0.68	1.68	1.14	
9/5	to	9/11	0.68	1.63	1.11	
9/12	to	9/18	0.68	1.56	1.06	
9/19	to	9/25	0.68	1.49	1.02	
9/26	to	9/2	0.68	1.45	0.98	
10/3	to	10/9	0.68	1.37	0.93	
10/10	to	10/16	0.68	1.23	0.83	
10/17	to	10/23	0.68	1.17	0.80	
10/24	to	10/30	0.68	1.05	0.72	
10/31	to	11/6	0.68	0.97	0.66	
11/7	to	11/13	0.68	0.88	0.60	
11/14	to	11/20	0.68	0.78	0.53	
11/21	to	11/27	0.68	0.66	0.45	
11/28	to	12/3	0.68	0.54	0.37	
					26.88	

Effective Rainfall
0.25 in. and above

Comparison of Spacings

Spacing	Vines / Acre	@10 hours	@1 acre inch
7 x 10	660	0.24 acre inch	41 gals per vine
5 x 11	792	0.30 "	34 "

vs

Irrigation Application

Gallons/vine = acre inches water x vine spacing ft x 0.623

48 gal/vine = 1.0 in x 7 x 11 x 0.623

Acre Inches = (Gallons per vine x 1.6) / vine spacing ft

1.0 acre inch = (48 x 1.6) / 7 x 11

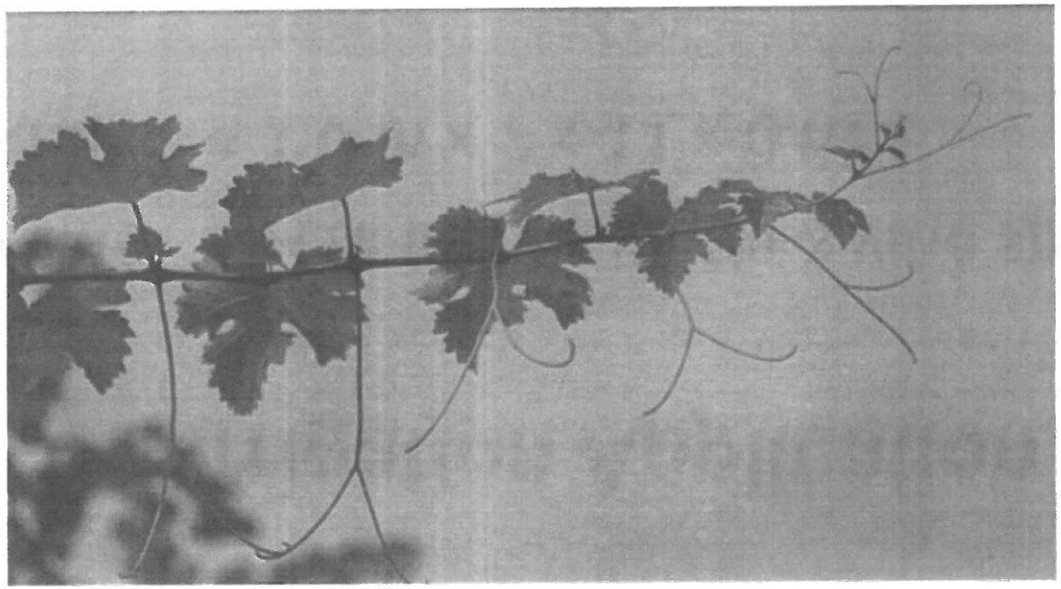
Acre Inches = (hours x gph x 1.6)/emitter spacing inches*

0.46 = 24 x 0.5 x 1.6 / 42

7 x 11 @2 emitters per vine = 42 inches

Information on Scheduling & Strategies

- http://ucmanagedrought.ucdavis.edu/
- http://cesanjoaquin.ucanr.edu/Custom_Program/
  LAWR Water Management Specialist
- http://www.lodiwine.com/lodi-winegrowers-workbook



To Do list

- Test well or water source
- Run water analysis [E.C./TDS, NO_3-N, HCO_3, pH, Na, Cl (Fe?)]
- Check system
  - Flush the laterals
  - Leaks vs plugs
  - Distribution Uniformity test
- Auger or dig down 3 feet or more
- And/Or Place soil monitoring devices
- Monitor Vines
- Begin Irrigation sooner rather than later
- Keep a record of applied water (and rainfall)

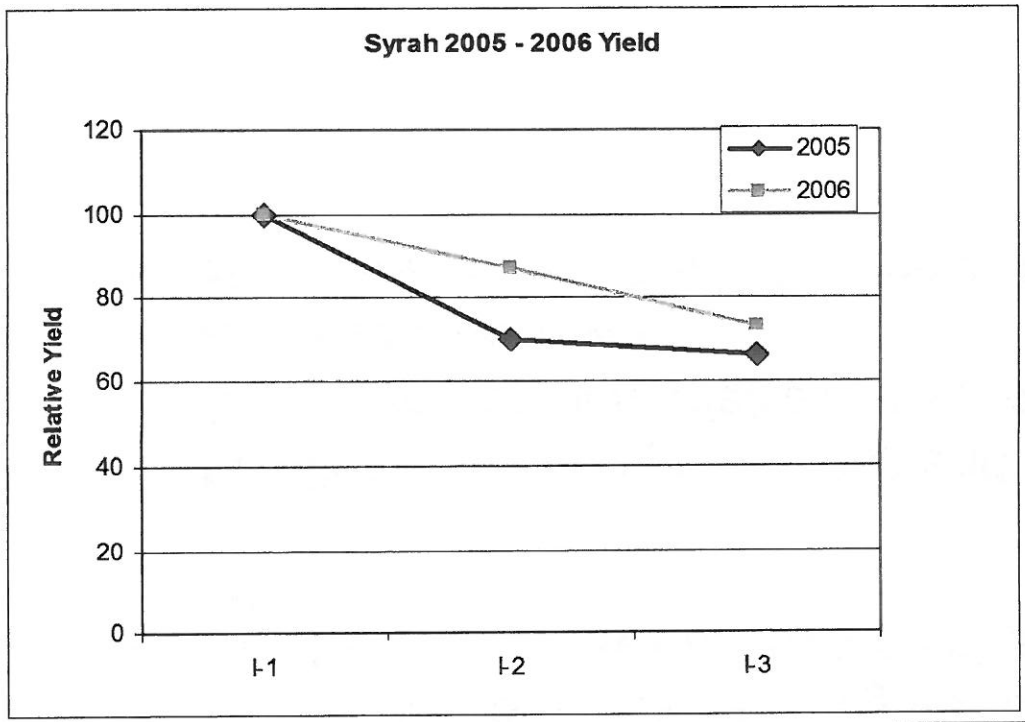
Dry Farming – Opportunity, Not The answer

- Is there a relationship between soil water content and leaf water potential?
- How often is best to irrigate?
- Does trellis design matter with water use?
- What if I have strong shoot growth?
- Does shoot thinning help reduce water use?
- Does cluster thinning reduce water use?
- Can I go too far and reduce yield or quality?
- Does continued year after year water deficits harm the vines?
- Will sever water stress advance or delay harvest date?
- Is dry farming the most sustainable strategy (a drought solution)?

Dry Farming – Opportunity, Not The answer

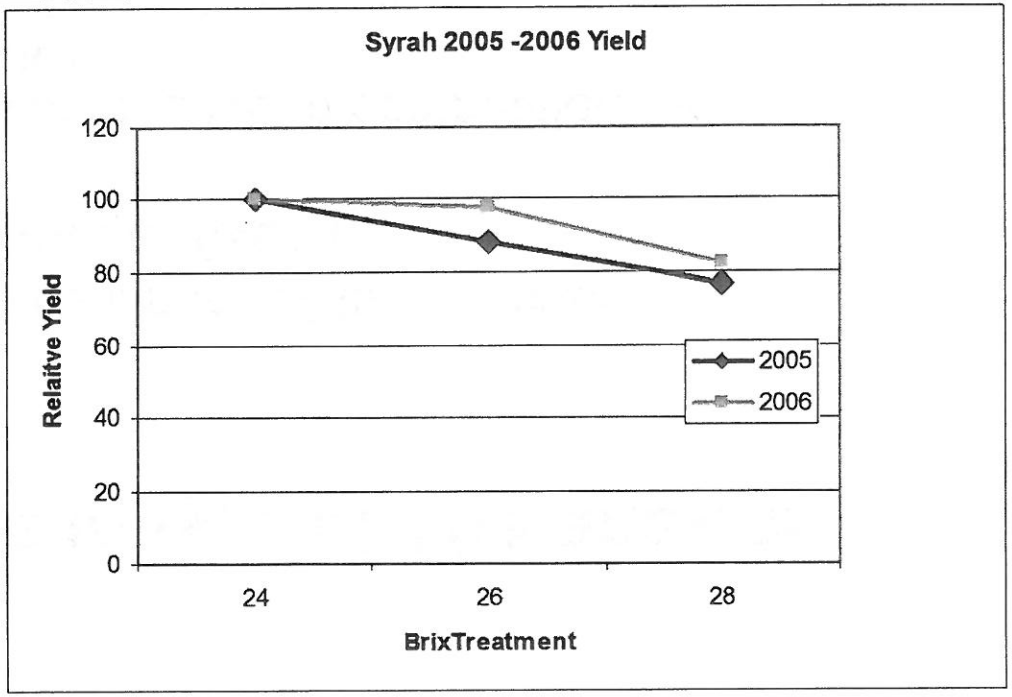
- Adequate Root zone
- *EFFECTIVE* Winter Rainfall - minimum 12 to 18 inches
- Rootstock - Strong, Healthy Drought Tolerant
- Shoot Thin - will help
- Cultivation early to reduce cover crop/weed competition (or mowing severely will help some)
- Leaf Removal - may help slightly; caution on exposure
- Cluster Thin - may help reduce stress on vine (not reduce water use)

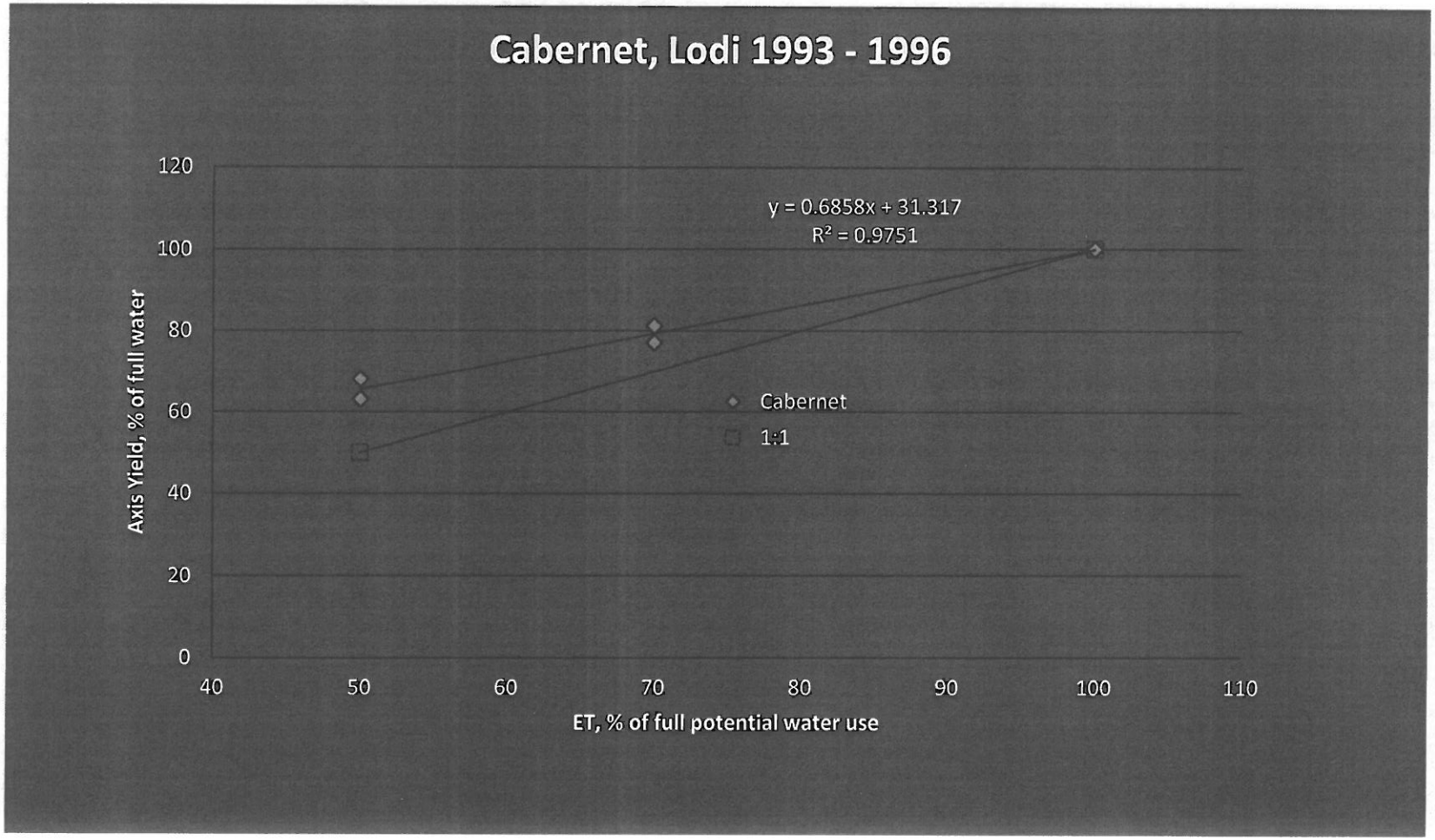
- Monitor Vines for spider mites and leafhoppers (and VMB)
- *Keep a record of rainfall events (amounts and timings)*
- *Expect much lower crop*
- *Be prepared for occasional losses to raisining some years*

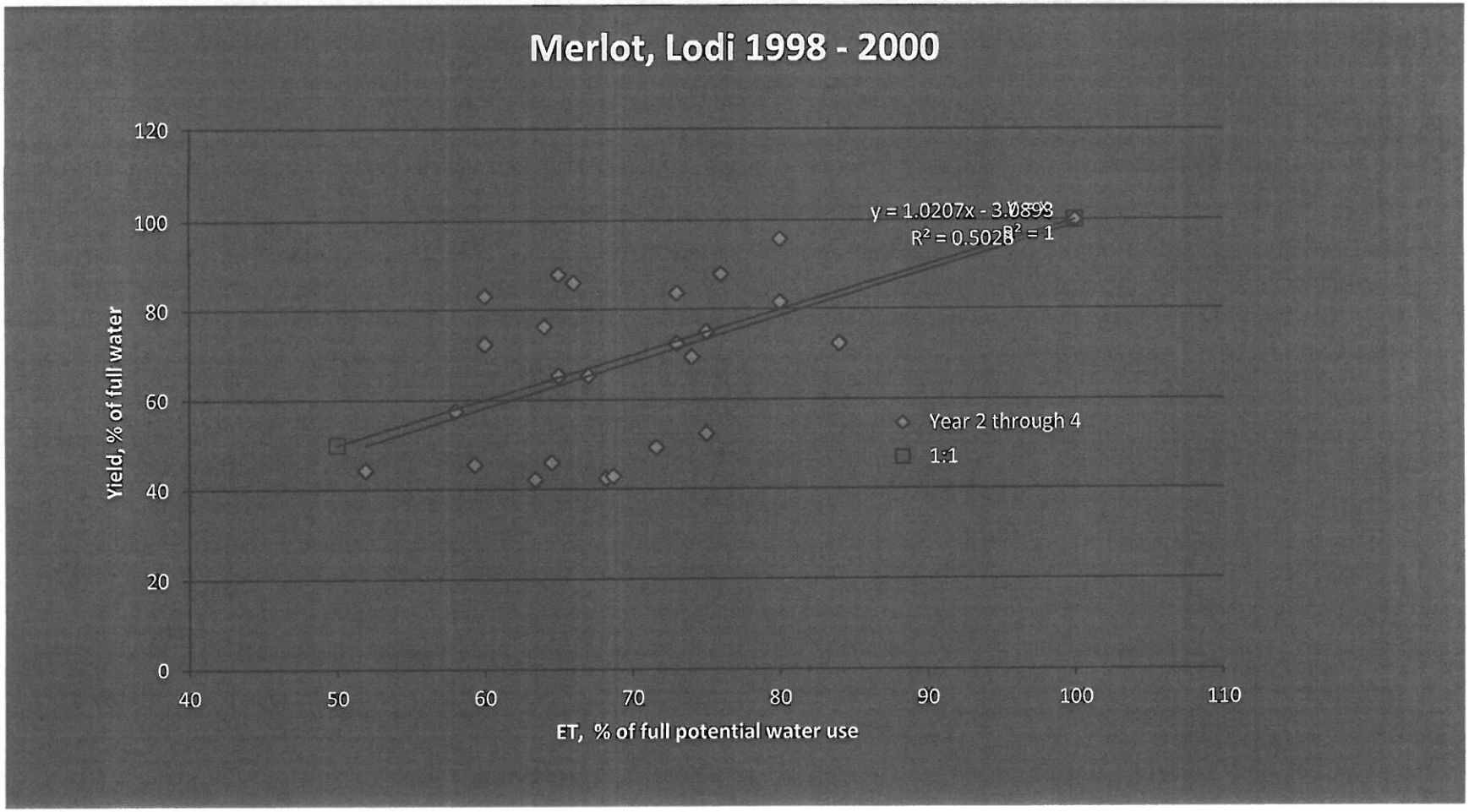


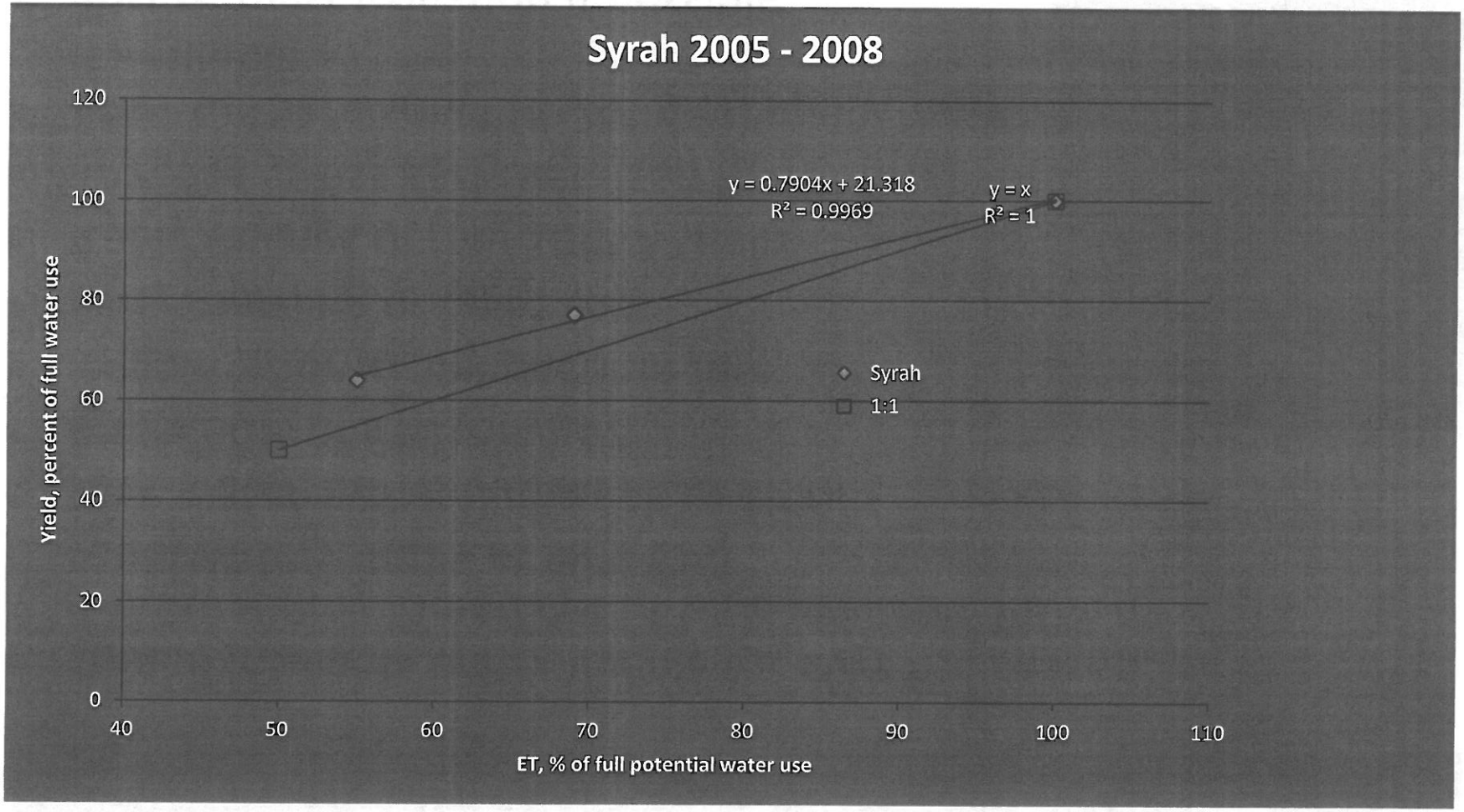
Water Stress vs "Hang Time"

I-1 = 100% ETc
I-2 = 50% Early + 100% Late
I-3 = 50% ETc



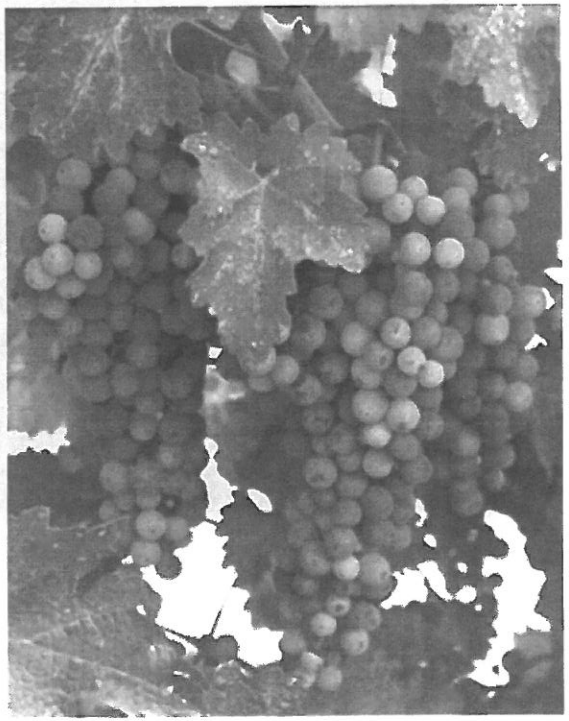

Cabernet, Lodi 1993 - 1996
y = 0.6858x + 31.317
R² = 0.9751
Cabernet
1:1
Axis Yield, % of full water
ET, % of full potential water use
120
100
80
60
40
20
0
40
50
60
70
80
90
100
110


Merlot, Lodi 1998 - 2000
120
100
80
60
40
20
0
40
50
60
70
80
90
100
110
Yield, % of full water
ET, % of full potential water use
y = 1.0207x - 3.0893
R² = 0.5028
Year 2 through 4
1:1


Syrah 2005 - 2008
120
100
80
60
40
20
0
40
50
60
70
80
90
100
110
Yield, percent of full water use
ET, % of full potential water use
y = 0.7904x + 21.318
R² = 0.9969
y = x
R² = 1
Syrah
1:1

When is it "Best" to Irrigate ?

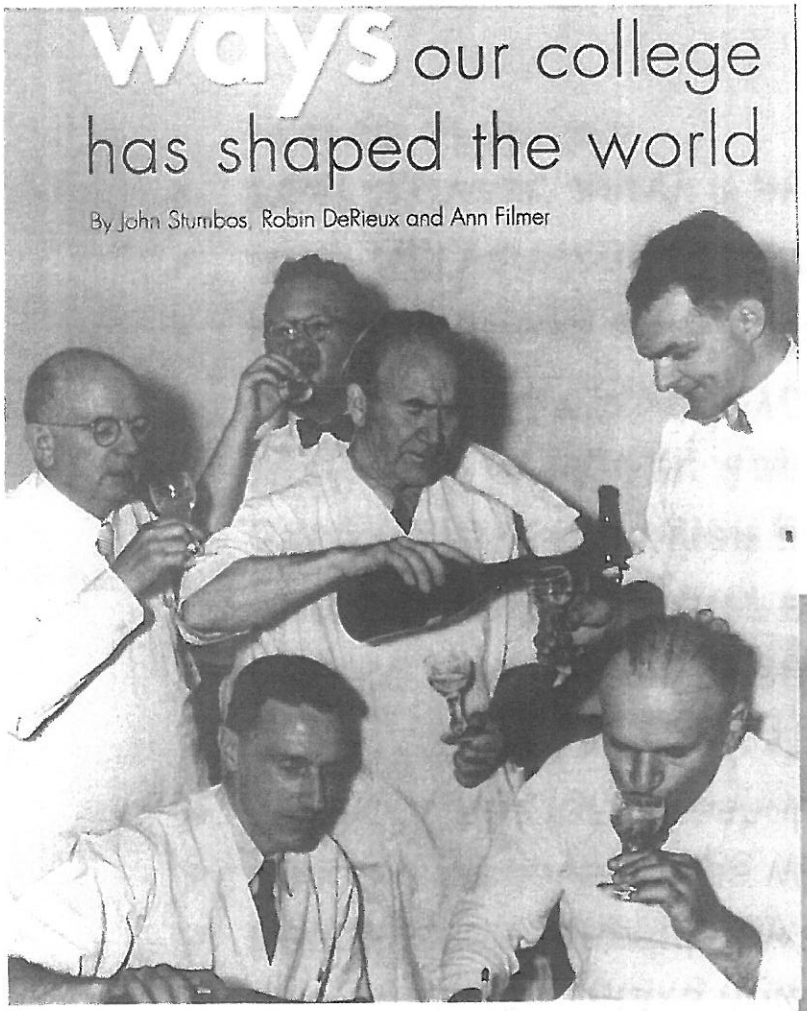
- Spread available water evenly for over the season, if short supply at percent of total available (40% of usual water; apply at 40% ETc)
- Save water early; budbreak to bloom
- Apply 50% of ETC maybe?
- Irrigate prior to any possible rain
- Early morning or night sets
- Apply savings during 100° F spells
- Increase stress early veraison (8-10° Brix)
- After full veraison(~18-20° Brix) apply more, if available
- Post Harvest Irrigation if possible



Summary

- Check out system & determine Distribution Uniformity periodically
- Evaluate soil moisture status (visual vs measured)
- Set goals for Variety & Rootstocks
- Record rainfall (make note of "effective rainfall" pattern)
- Set irrigation schedule by ETc demand (historical or real time)
- Account for cover crops water use
- Monitor vines for "threshold" of acceptable stress after budbreak

- ***Irrigate prior to any predicted rain***
- ***Spread available water evenly for the season, if in short supply***
- ***Save water early when possible***
- ***Budbreak to bloom; Apply 50% of ETC maybe?***
- ***Use "savings" during 100°F spells***
- ***Increase stress early veraison (8 to 10 ° Brix)***
- ***After full veraison (~18-20° Brix) apply more, if available***
- ***Post Harvest; apply if available until leaves senesce and/or attend church of choice***



"The object of life is not to be on the side of the majority, but to escape finding oneself in the ranks of the insane." — Marcus Aurelius