

Water Use Requirements of Pistachio

Irrigation Scheduling

Regulated Deficit Irrigation

Drought Strategies

<http://ceking.s.ucdavis.edu/Agriculture/Pistachios.htm>









1982 Pistachio Irrigation Survey

<u>METHOD</u>	<u>ACRES SURVEYED</u>	<u>AVG. WATER APPLIED (ACRE FT./ACRE)</u>
FURROW	3334	2.78
SPRINKLER	5174	2.27
DRIP	13652	2.37

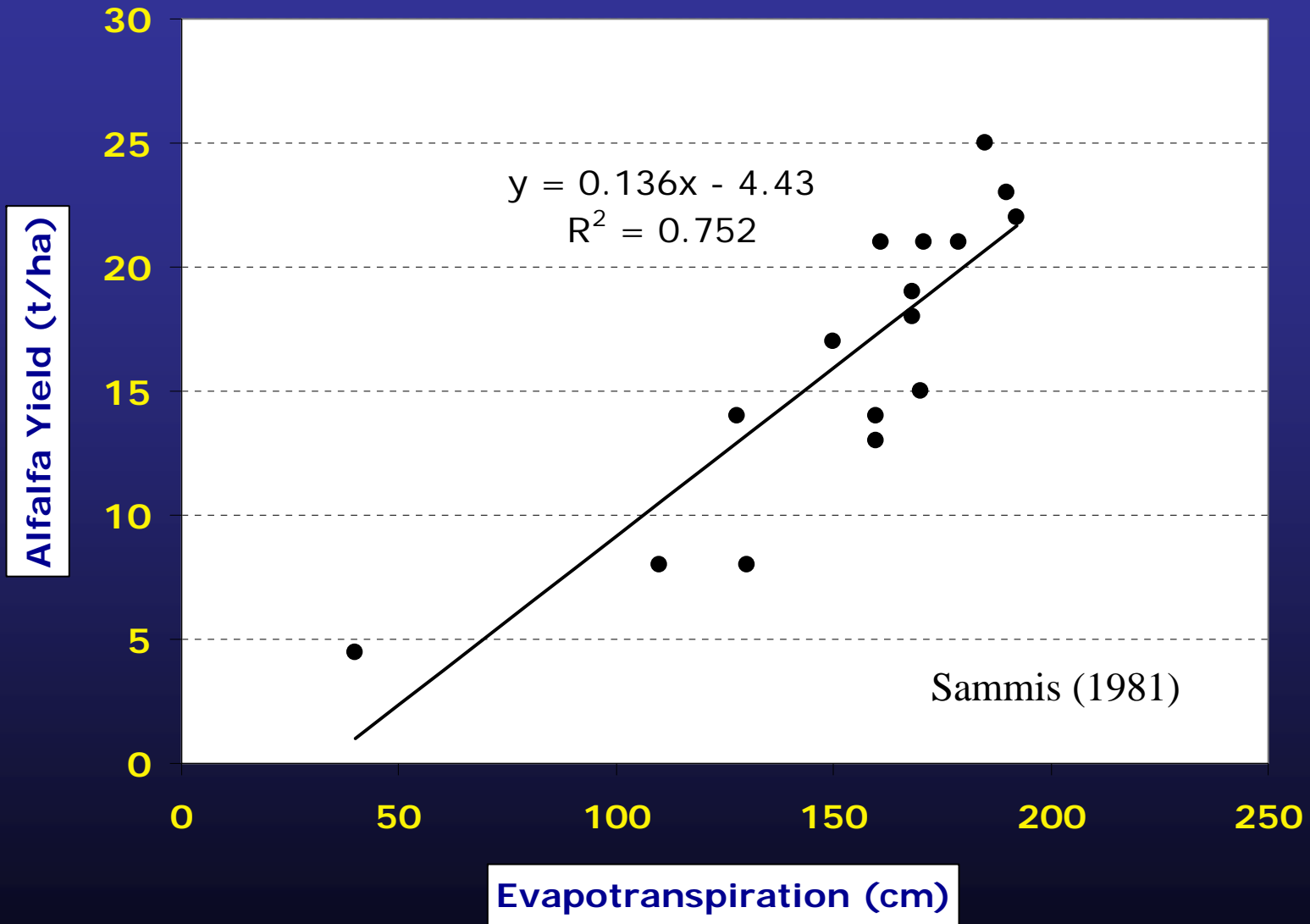
Evapotranspiration (ETc) =

Surface Evaporation

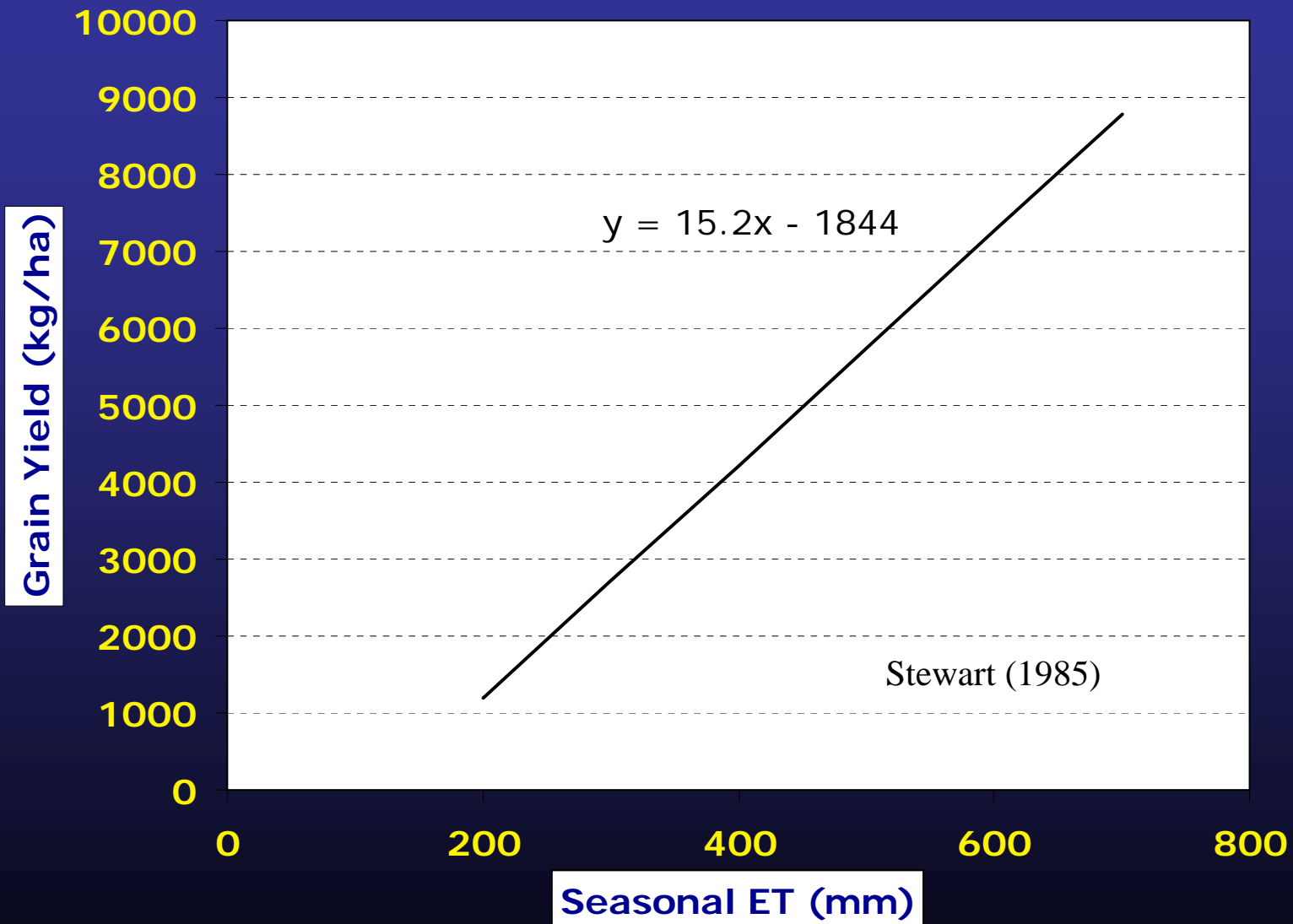
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Transpiration

Alfalfa Production Function; New Mexico



Sorghum Production Function; S. Great Plains









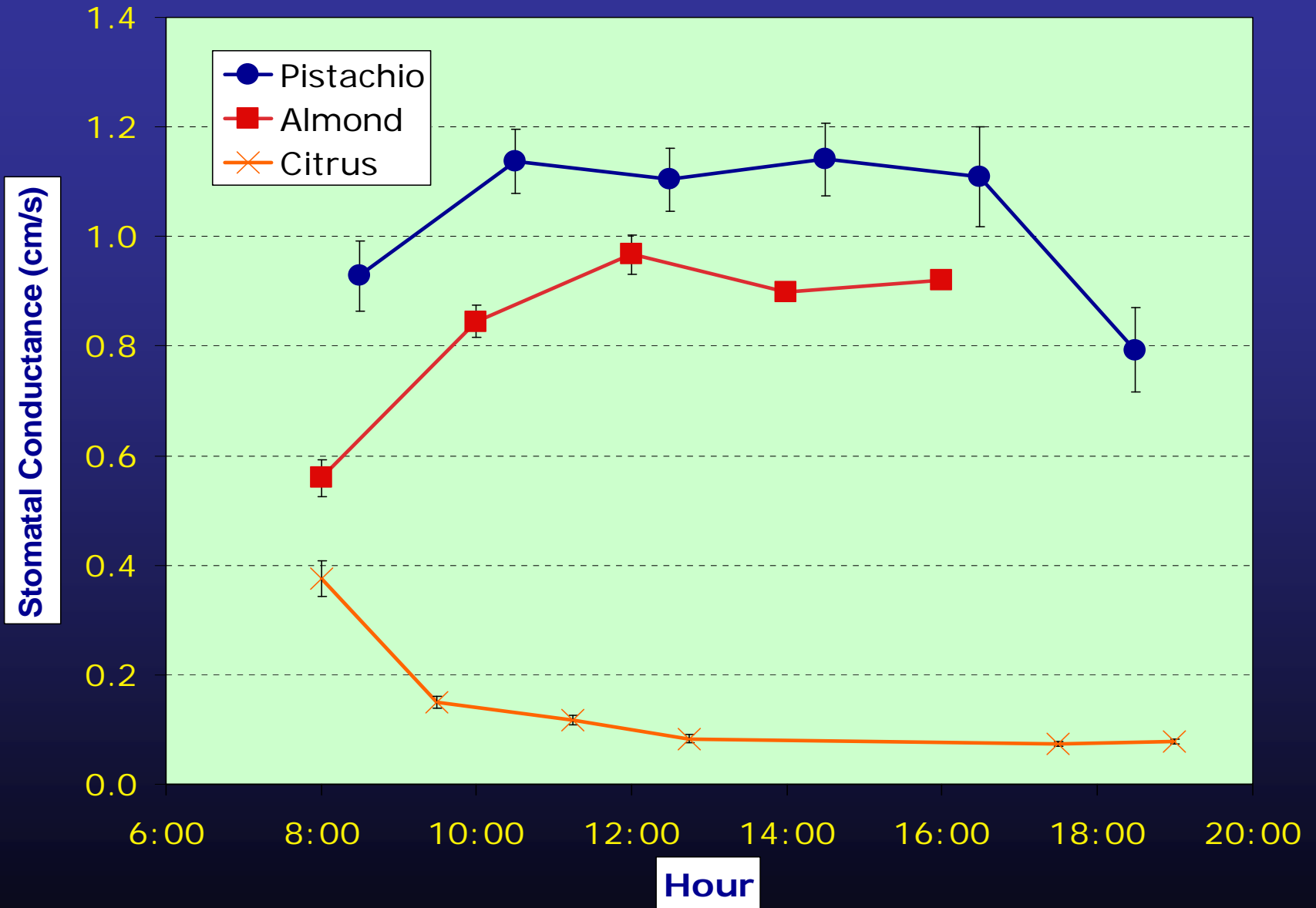
Crop Coefficient (Kc) =

Evapotranspiration (ETc)

Reference Crop Water Use (ETo)

Date	Pistachio Crop Coefficients (Kc)
Apr 1-15	0.07
Apr 16-30	0.43
May 1-15	0.68
May 16-31	0.93
Jun 1-15	1.09
Jun 16-30	1.17
Jul 1-15	1.19
Jul 16-31	1.19
Aug 1-15	1.19
Aug 16-31	1.12
Sept. 1-15	0.99
Sept. 16-30	0.87
Oct 1-15	0.67
Oct 16-31	0.50
Nov 1-15	0.35

Comparison of Diurnal Stomatal Conductance





Pistachio: high water use

Can we reduce ETc without negatively impacting production?

To reduce consumptive
use, only options are:

decrease

E and/or T

The background of the slide is a close-up photograph of water ripples, showing a pattern of light and dark blue-green waves. The text is centered over this background.

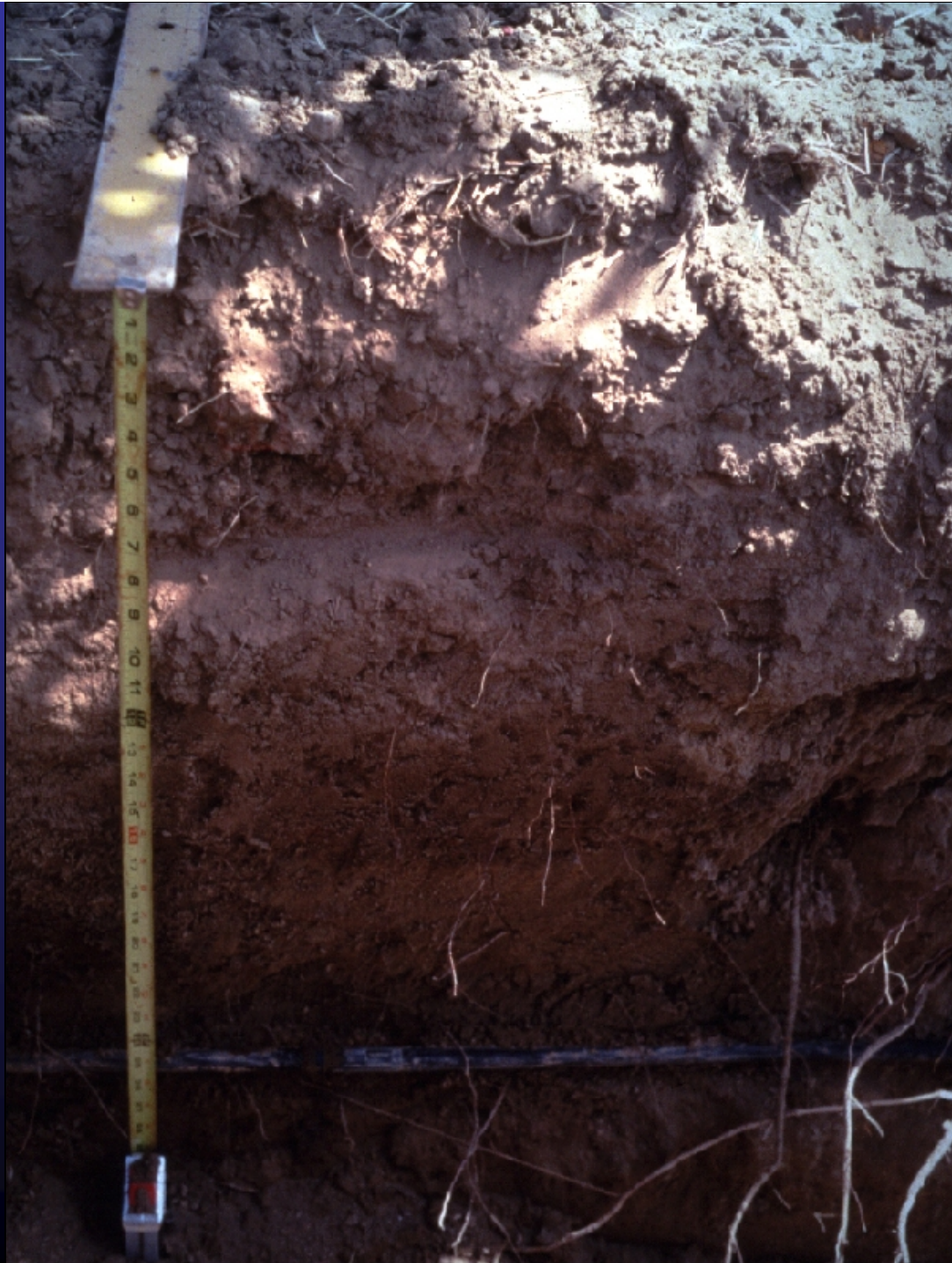
**Can we reduce
Surface Evaporation?**

Irrigation Frequency vs. Duration

Wet surface as infrequently as possible.

Insure that when you irrigate with longer duration of application, don't "overirrigate."





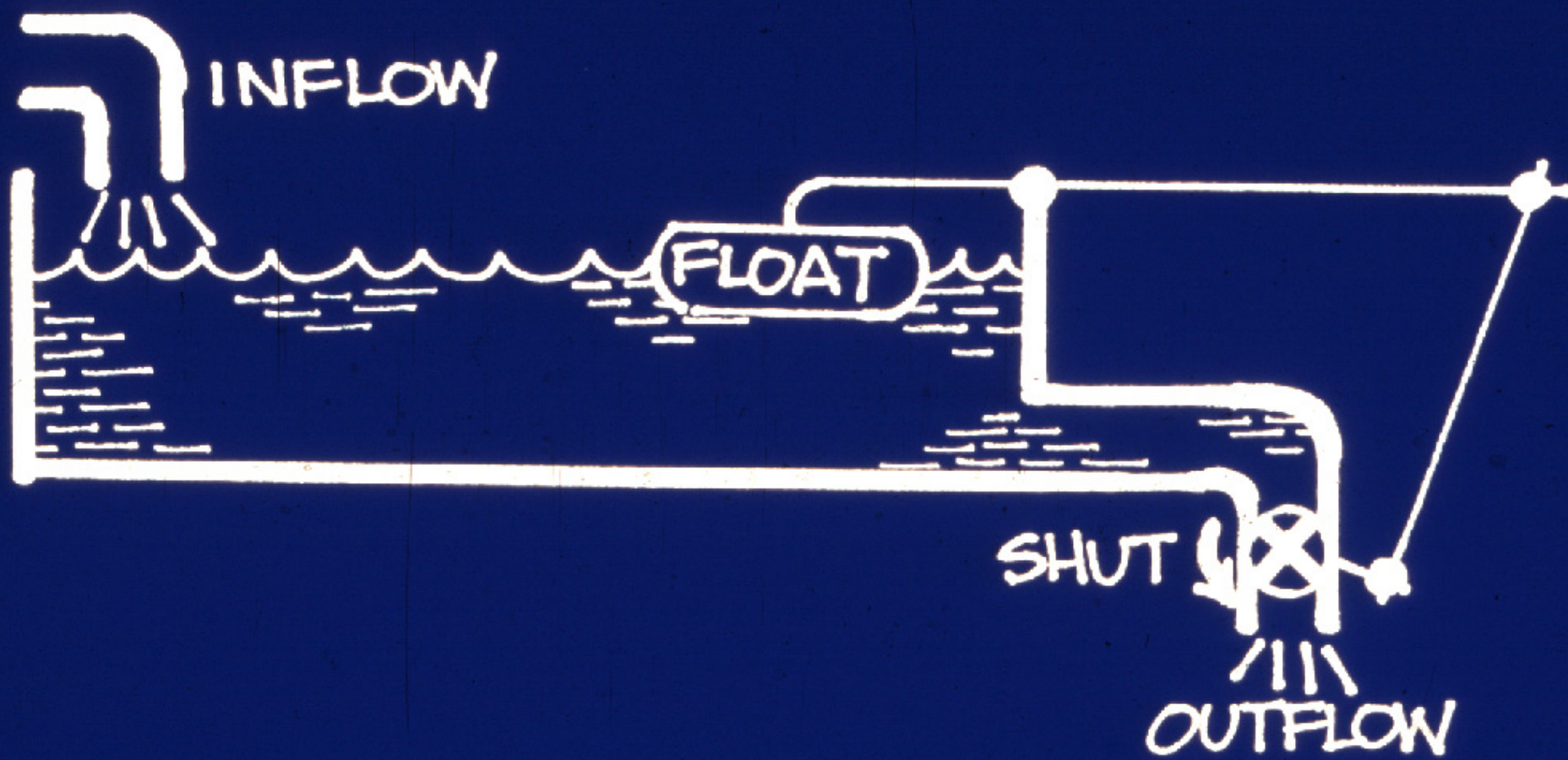


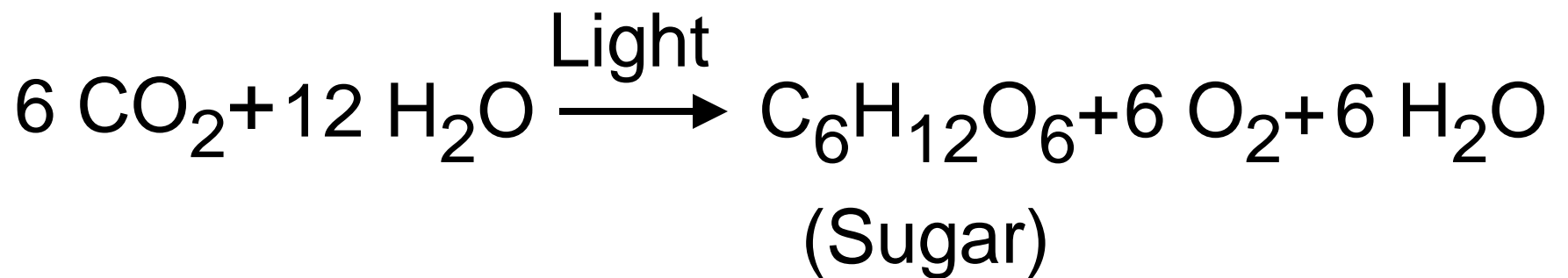
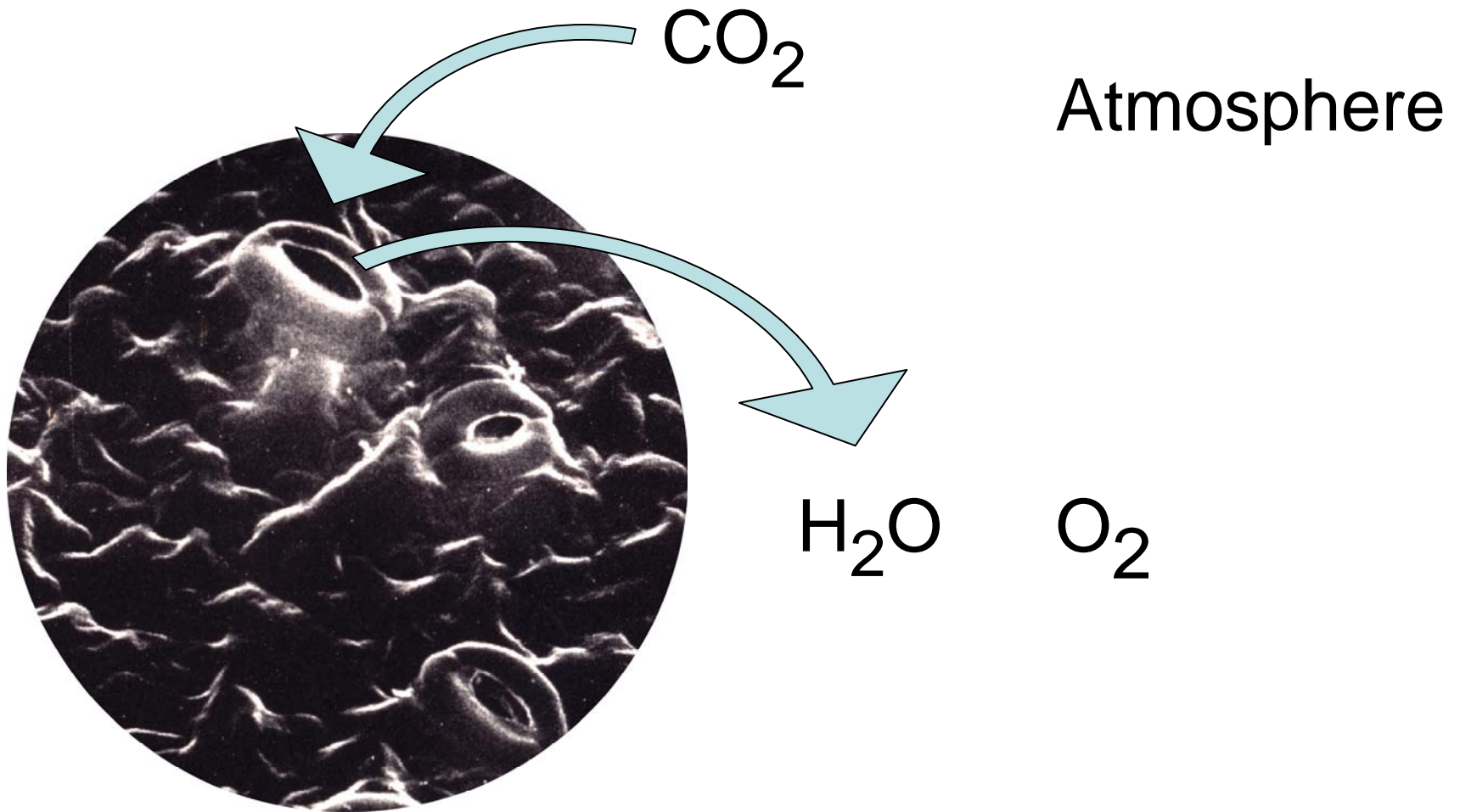




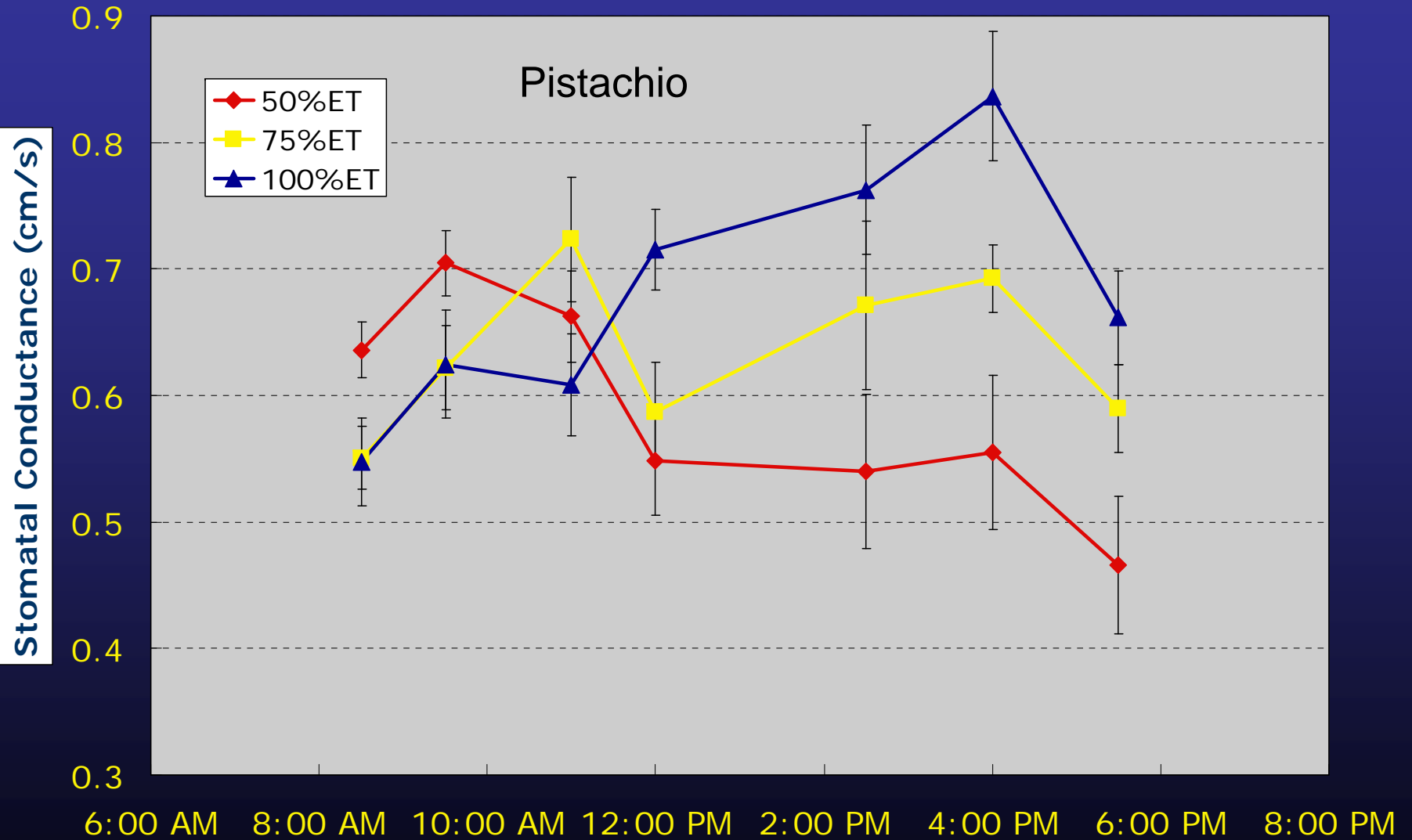


**Can we reduce
Transpiration?**

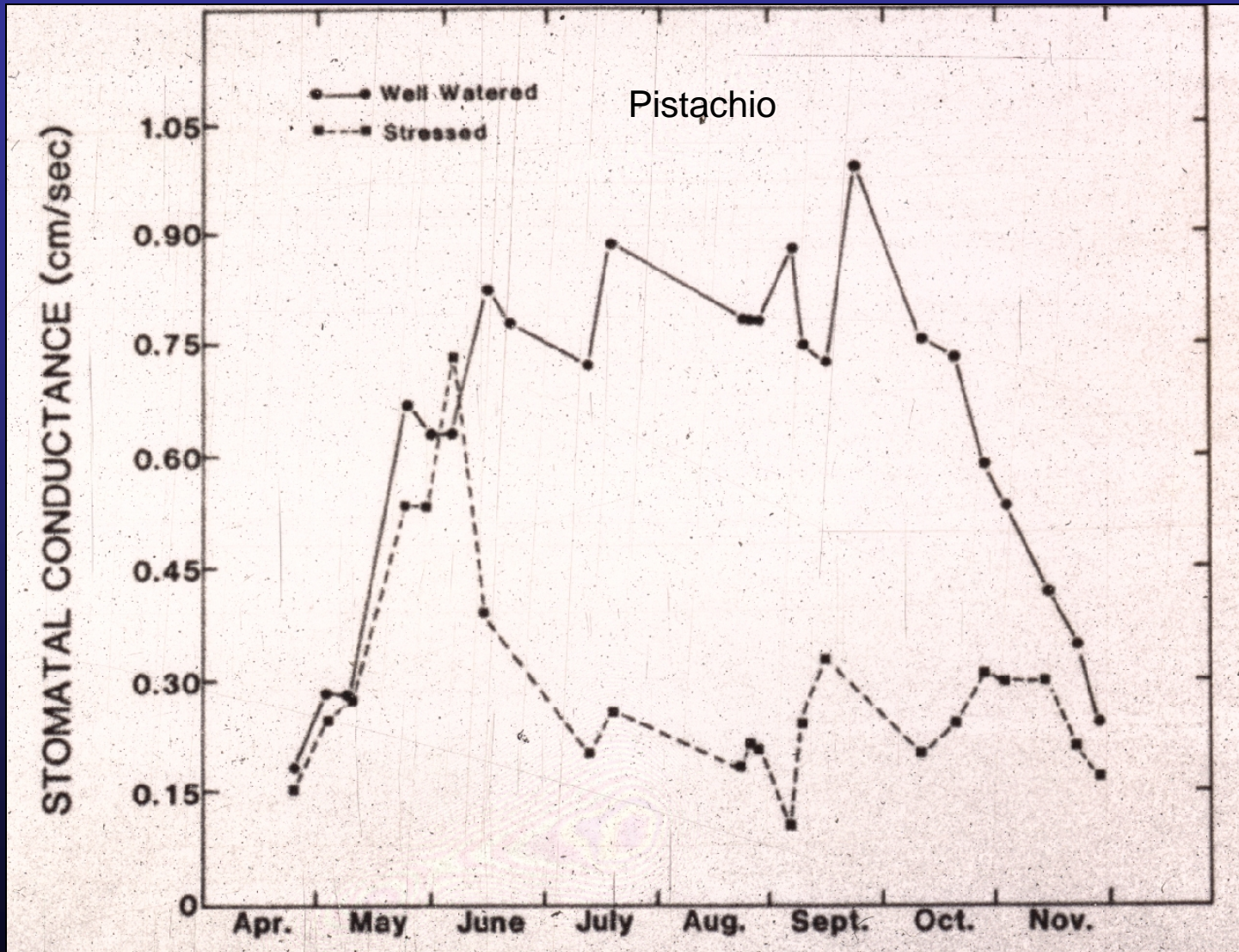




Stomatal Conductance; 3 Irrigation Levels

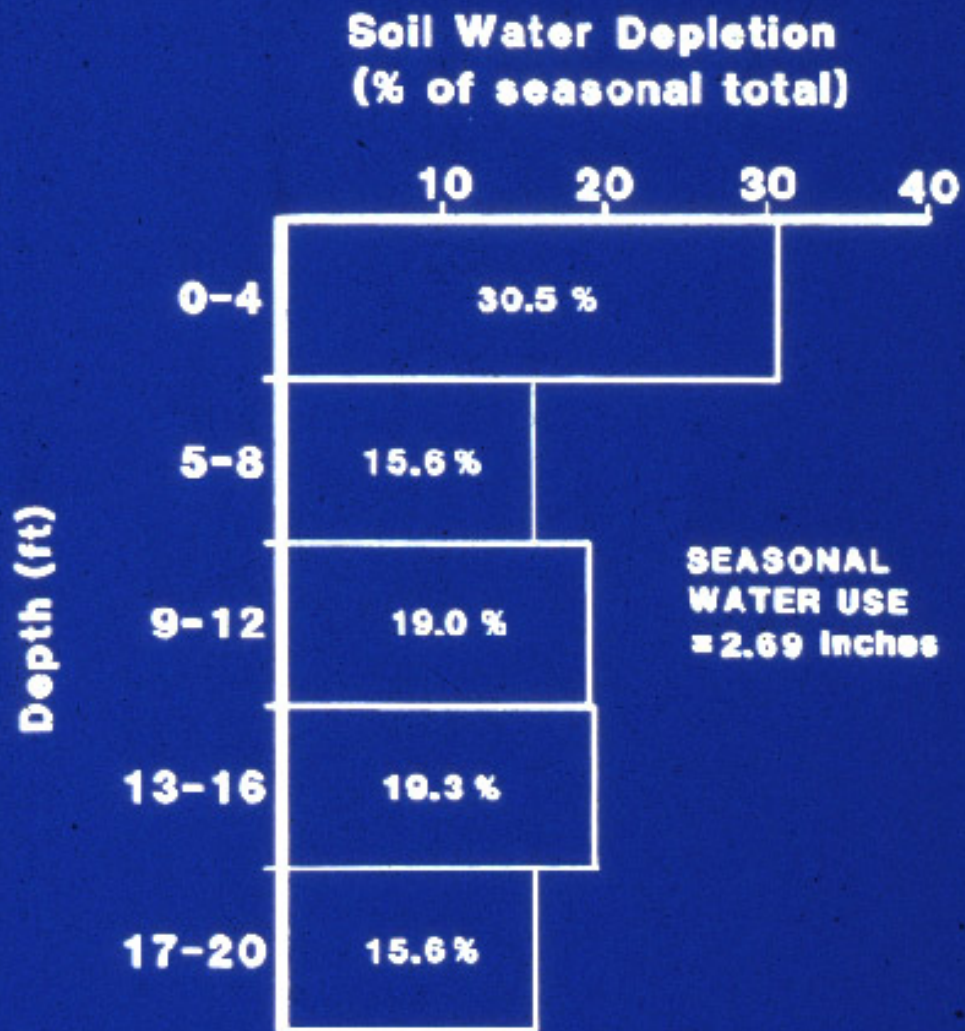


Midday Stomatal Conductance; Dryland and Full Irrigation





**SOIL WATER EXTRACTION PATTERN,
2nd YEAR STRESS Apr. 13- Nov. 1**



Drought Tolerance:

= Ability to Survive

≠ High Productivity

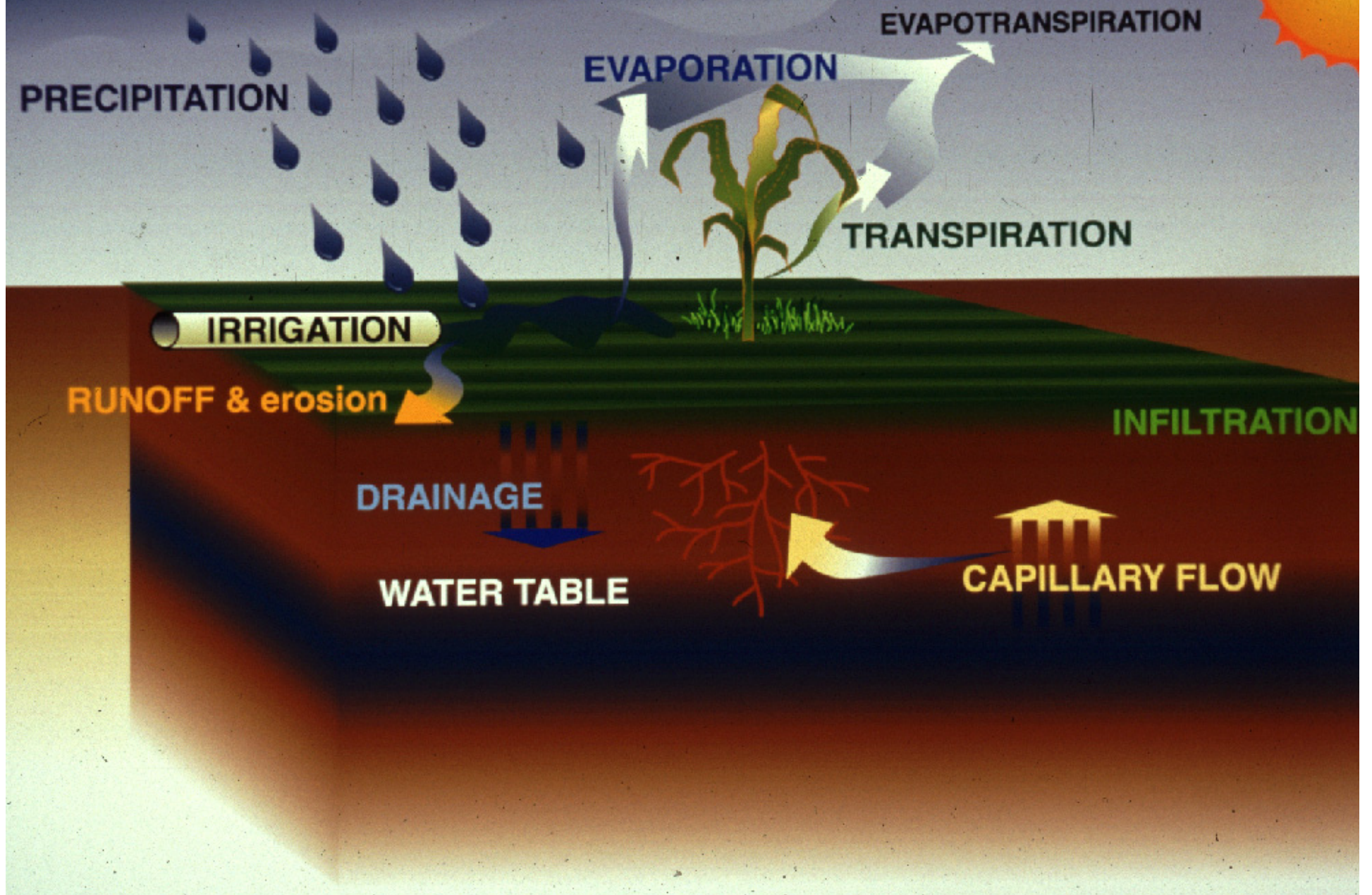
Irrigation Scheduling

- 1) When to irrigate.
- 2) How much water to apply.

Scheduling Concepts

- 1) Soil/Plant based monitoring.
- 2) Water budget.

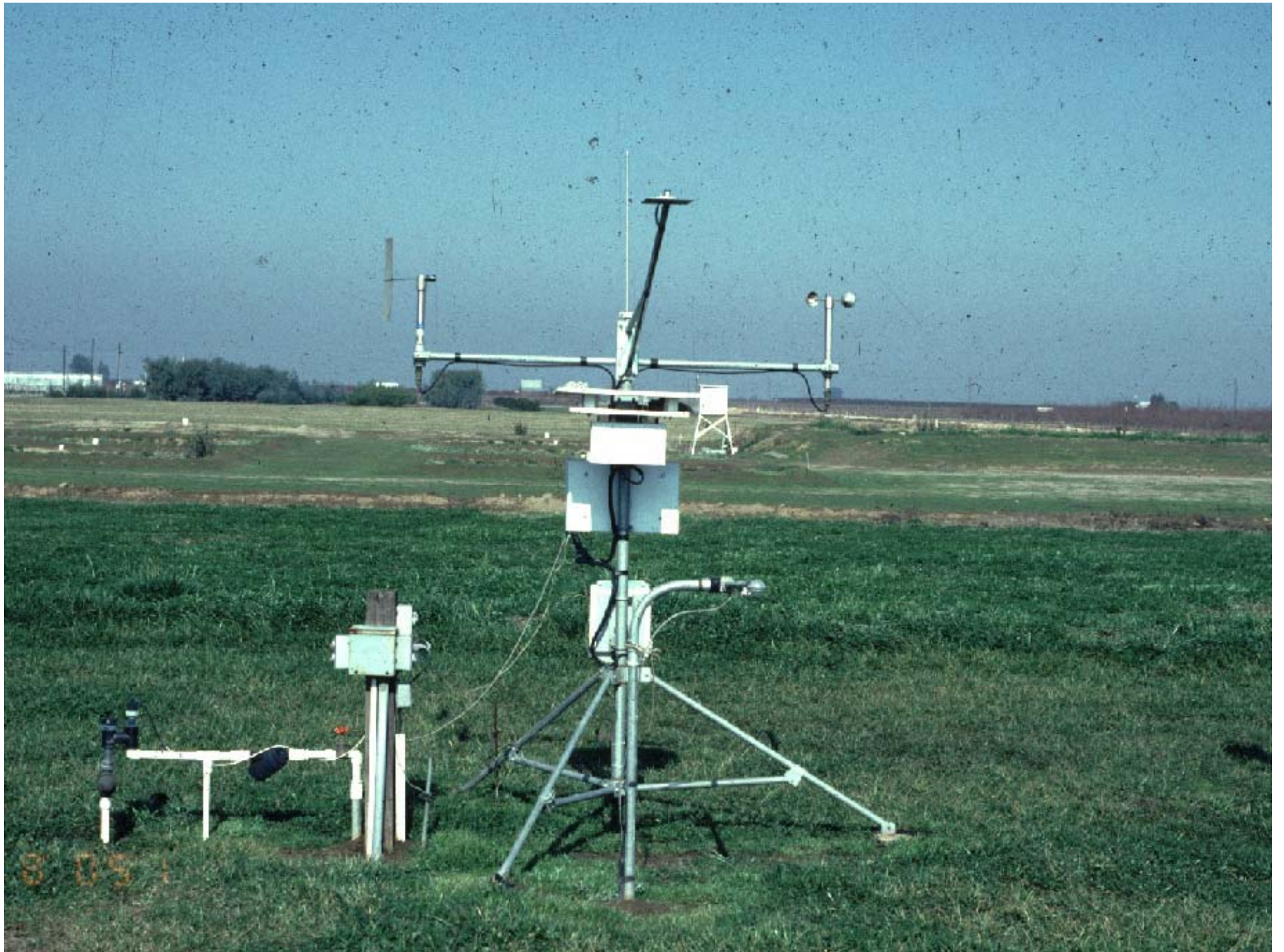
Water Balance of a Field



Water Budget

$$ET_c = K_c \times ET_o$$

Orchard Water Use = Crop Coefficient x Reference Crop Water Use



Reference Crop Water Use (ET_o)

- 1) Real time.
- 2) Long term, historical values.

California Irrigation Management Information System

Department of Water Resources

DATA REPORTS CIMIS SYSTEM IRRIGATION WEATHER STATIONS ETo

- HOME PAGE
- SYSTEM NEWS
- REGISTER
- FAQ
- DOWNLOAD
- CONTACTS
- LINKS

CIMIS (California Irrigation Management Information System)

Daily Report

Rendered in ENGLISH Units.
 February 10, 2003 - February 16, 2003
 Printed on February 17, 2003

Porterville - San Joaquin Valley - Station 169

Date	CIMIS ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap (mBars)	Max Air Temp (°F)	Min Air Temp (°F)	Avg Air Temp (°F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Pt (°F)	Avg wSpd (MPH)	Wnd Run (miles)	Avg Soil Temp (°F)
02/10/2003	0.08	0.00	304	6.2	62.2	29.3	46.1	85	32	59	32.4	3.1	73.7	50.6
02/11/2003	0.08	0.11	298	9.5	64.5	43.5	52.0	88	49	72	43.1	4.2	101.4	51.2
02/12/2003	0.00	0.66	47	11.7	55.0	44.7	50.9	94	88	92	48.7	3.5	85.4	52.3
02/13/2003	0.08	0.01	306	12.9	66.4	47.0	56.8	94	63	81	51.2	3.2	76.5	53.0
02/14/2003	0.03	0.00R	67	12.5	62.6	32.0	57.2	93	67	78	50.4	2.8	66.5	54.5
02/15/2003	0.07	0.00	279	12.3	66.8	49.6	56.9	92	58	78	49.9	2.9	70.0	55.0
02/16/2003	0.06	0.13	227	11.5	63.3	47.8	55.4	92	59	77	48.2	3.4	81.8	55.9
Total	0.40	0.91	218	10.9	63.0	42.0	53.6	91	59	77	46.3	3.3	79.3	53.2

Flag Legend

Example of Irrigation Scheduling

Crop: Pistacho

Location: Kings Co.

Tree Spacing: 17 x 17 ft.

Irrigation Method: Microsprinkler (1/tree)

Application Rate: 11 gph

Application Efficiency: 90%

Calculate Orchard Water Use Rate

July 16-31

$$\begin{aligned} \text{ETc} &= Kc \times \text{ETo} \\ &= 1.19 \times 0.27 \text{ inch/day} \\ &= 0.32 \text{ inch/day} \end{aligned}$$

Calculate Individual Tree ETc

July 16-31

$$\text{ETc (g/tree/d)} = \text{ETc (in/day)} \times \text{Tree Spacing (ft}^2\text{)} \times 0.622 \text{ (gal/in-ft}^2\text{)}$$

$$= 0.32 \text{ in/day} \times 289 \text{ ft}^2 \times 0.622 \text{ gal/inch-ft}^2$$

$$= 58 \text{ gal/tree/day}$$

Calculate Irrigation Set Time

July 16-31

$$\begin{aligned}\text{System Operating Time} &= \frac{\text{Irrigation Requirement}}{\text{Application Rate}} \\ &= \frac{64 \text{ gal/tree/day}}{11 \text{ gal/tree/hr}} \\ &= 6 \text{ hr/day} \\ &= 42 \text{ hrs/week}\end{aligned}$$

Application Efficiency

Percentage of applied water that is can be used by the tree.

Calculate Individual Tree Irrigation Requirement

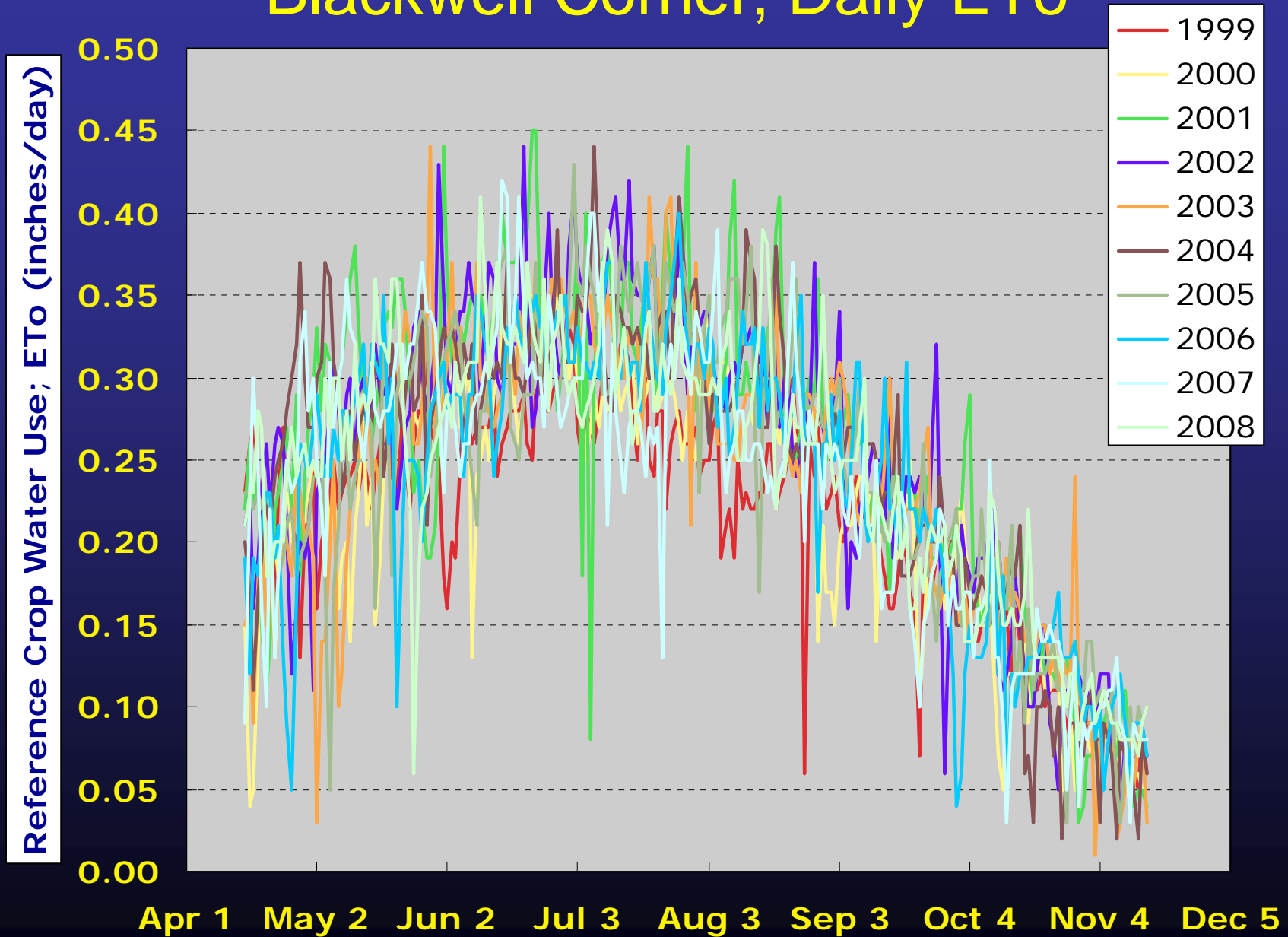
July 16-31

$$\begin{aligned}\text{Irrigation Requirement} &= \frac{ET_c}{E_a} \\ &= \frac{58 \text{ gal/tree/day}}{0.90} \\ &= 64 \text{ gal/tree/day}\end{aligned}$$

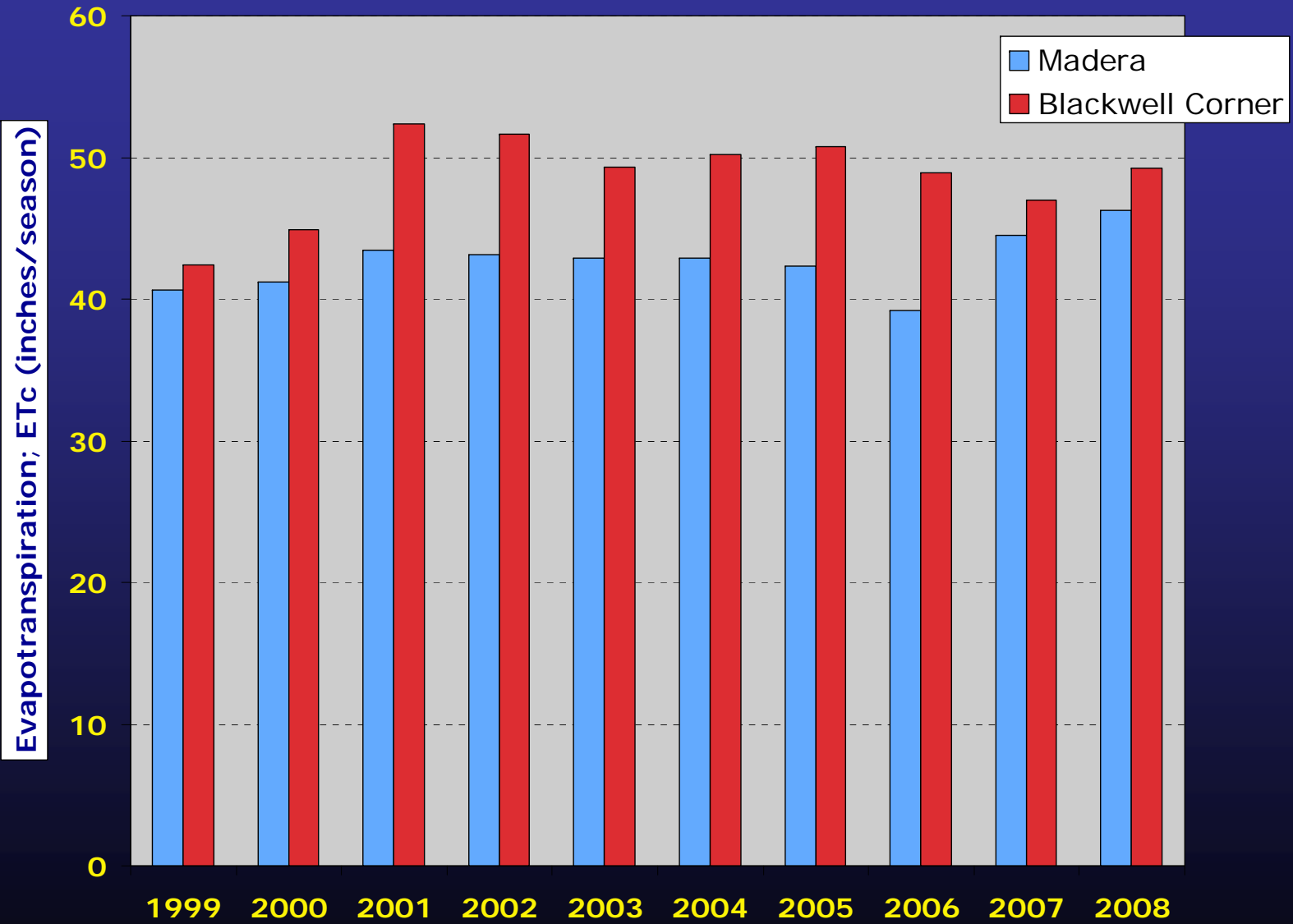
For Madera; based on 10 yr mean ETo

Date	ETo in Period (inch)	Crop Coeff. (Kc)	ETc in Period (inch)	ETc in Period (inch/dy)	ETc in Period (gal/tree/dy)	Application Amount (gal/tree/dy)	Applic. Time (hr/day)	Applic. Time (hr/wk)
Apr 16-30	2.99	0.43	1.28	0.09	15	17	1.6	10.9
May 1-15	3.43	0.68	2.33	0.16	28	31	2.8	19.8
May 16-31	3.85	0.93	3.58	0.22	40	45	4.1	28.5
Jun 1-15	4.42	1.09	4.81	0.32	58	64	5.8	40.8
Jun 16-30	4.60	1.17	5.38	0.36	64	72	6.5	45.6
Jul 1-15	4.23	1.19	5.04	0.34	60	67	6.1	42.7
Jul 16-31	4.09	1.19	4.86	0.30	55	61	5.5	38.7
Aug 1-15	4.12	1.19	4.90	0.33	59	65	5.9	41.6
Aug 16-31	3.52	1.12	3.94	0.25	44	49	4.5	31.3
Sept. 1-15	3.30	0.99	3.27	0.22	39	44	4.0	27.7
Sept. 16-30	2.54	0.87	2.21	0.15	26	29	2.7	18.7
Oct 1-15	2.08	0.67	1.39	0.09	17	19	1.7	11.8
Oct 16-31	1.47	0.50	0.74	0.05	8	9	0.8	5.9
Nov 1-15	1.11	0.35	0.39	0.03	5	5	0.5	3.3
Total			44.1					

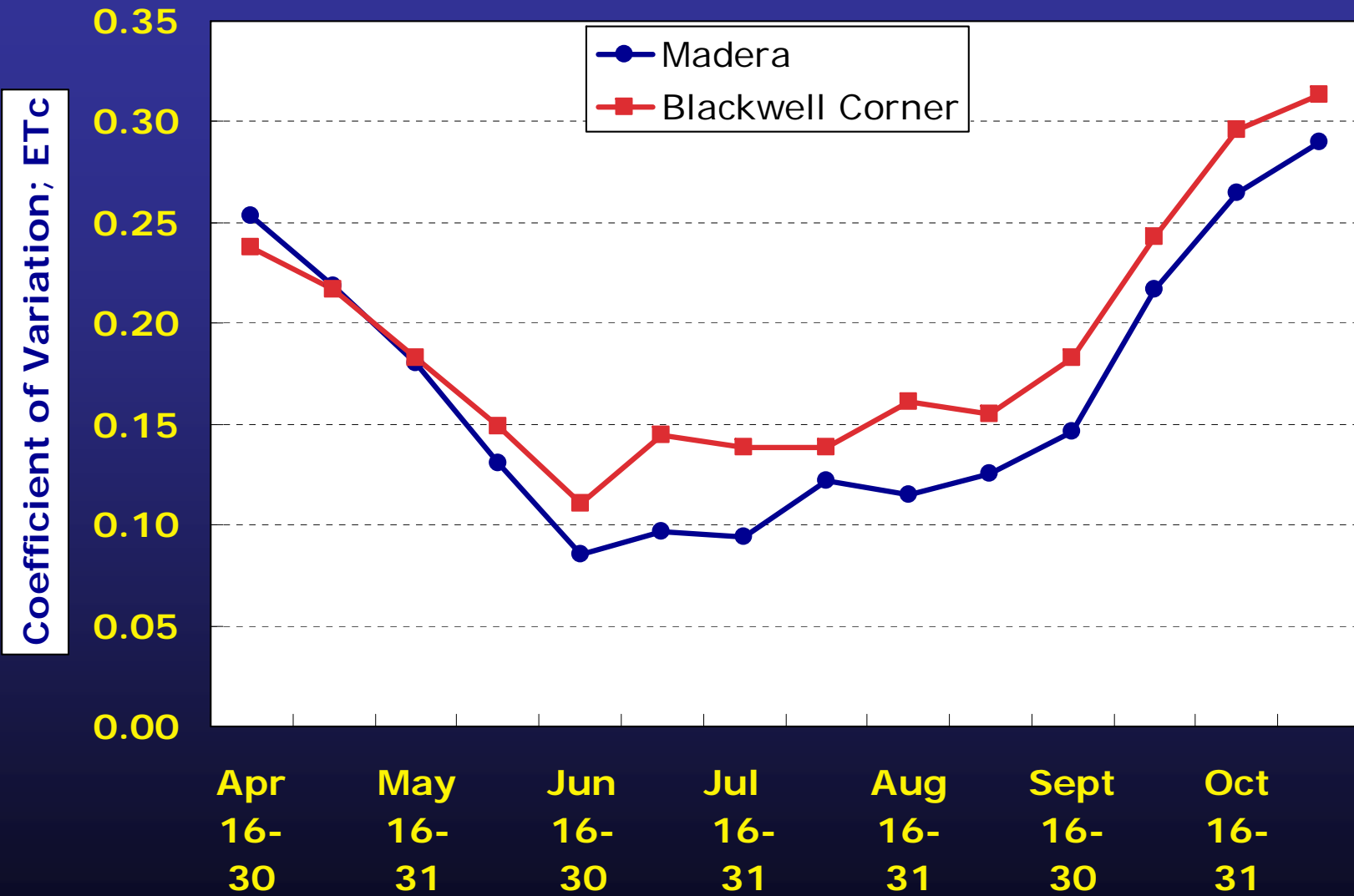
Blackwell Corner; Daily ETo

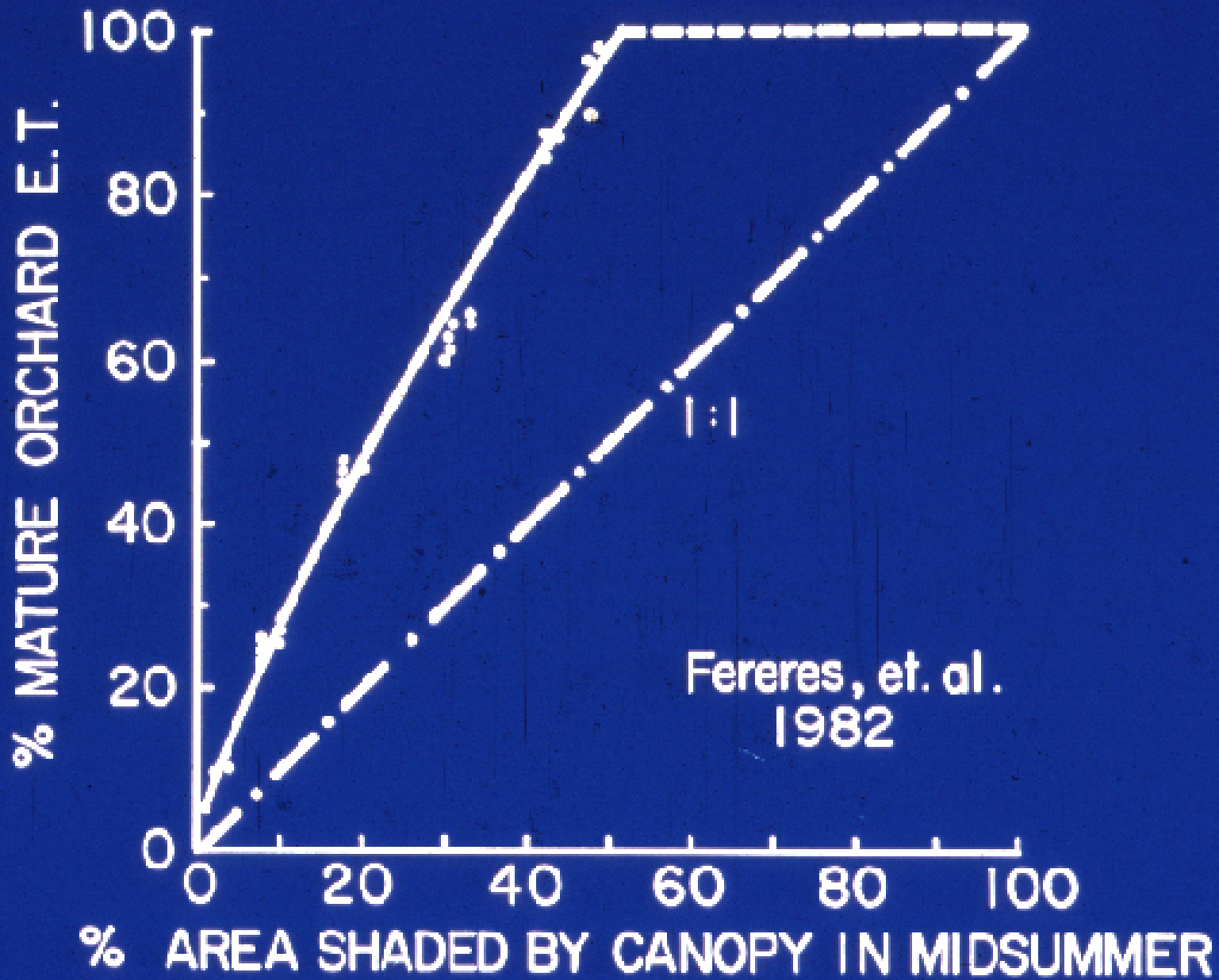


Pistachio Seasonal ETc



Coefficient of Variation; 10 Yr. ETc





Shortcomings of Water Budget

- 1) Accuracy of CIMIS ETo.
- 2) Accuracy of Kc.
- 3) Applicability of regional data to your farm.
- 4) Application efficiency estimates.
- 5) Usefulness for RDI limited.

Monitoring water status

Soil

- 1) By hand
- 2) Tensiometers
- 3) Electrical resistance/capacitance
- 4) Neutron probe

Plant

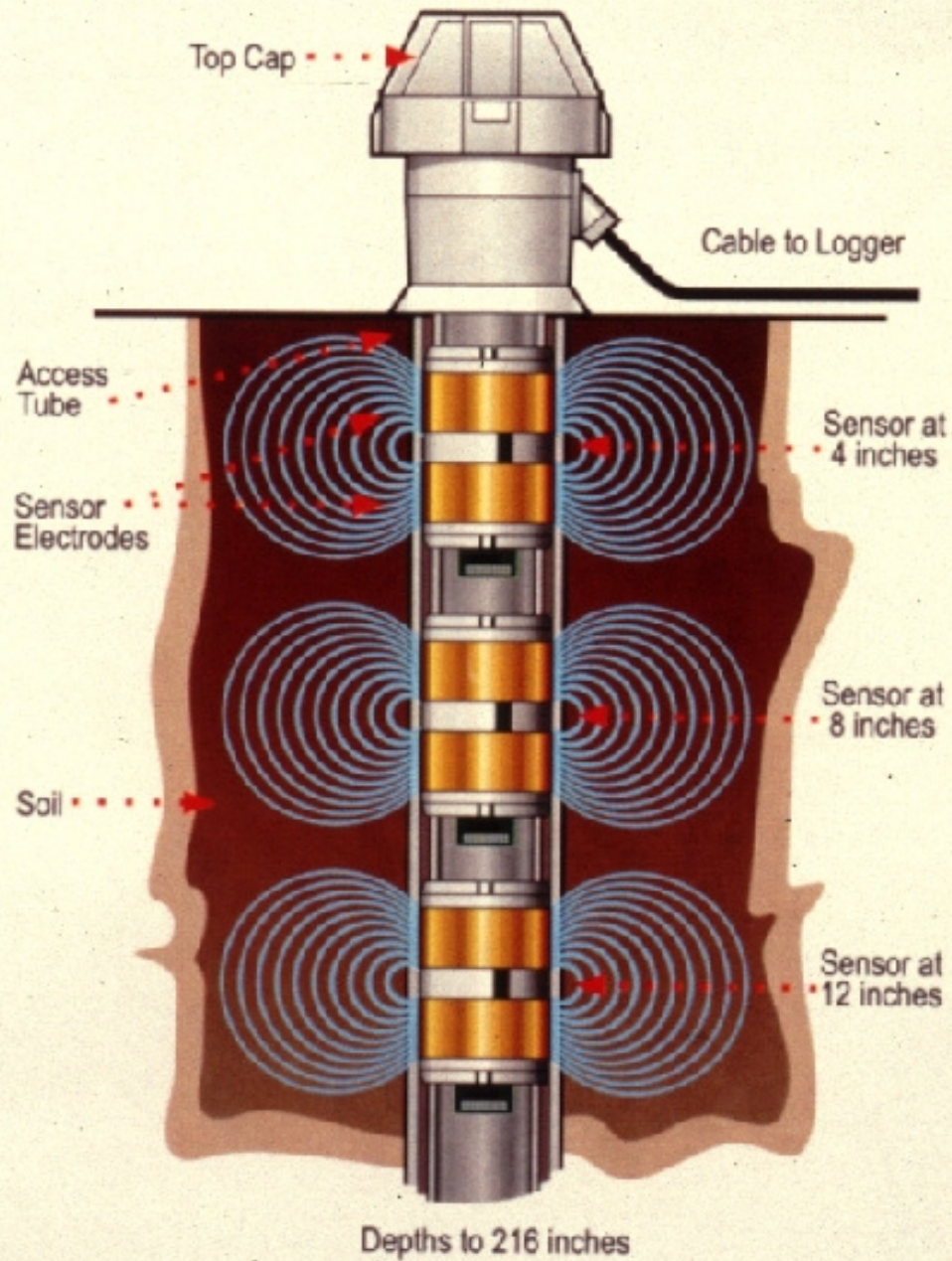
- 1) Pressure chamber
- 2) Infrared Thermometers

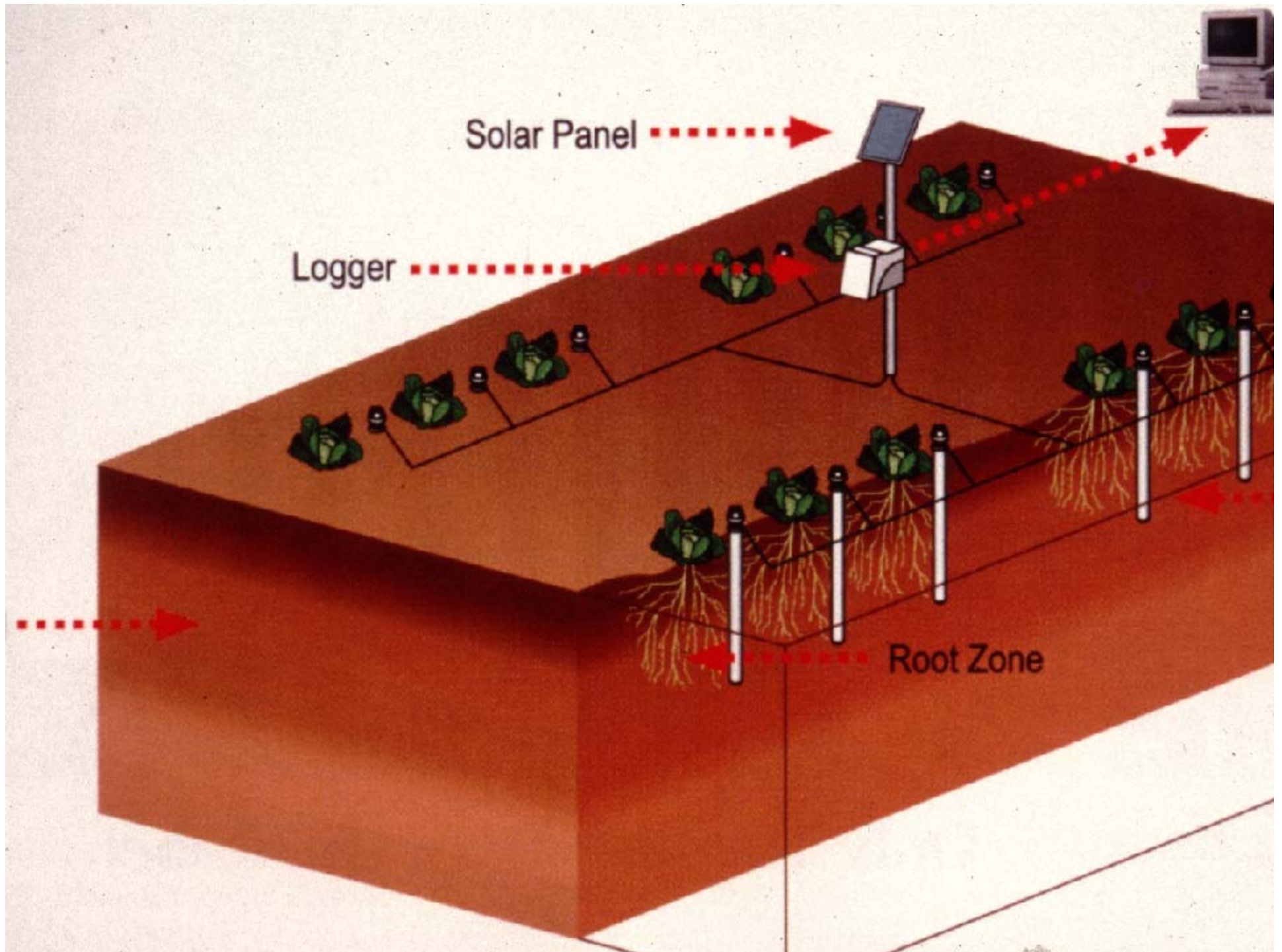




EnviroSCAN Probe

Cut-away diagram to the 12 inch sensor. Sensors are available for depths of up to 216 inches.





EnviroSCAN

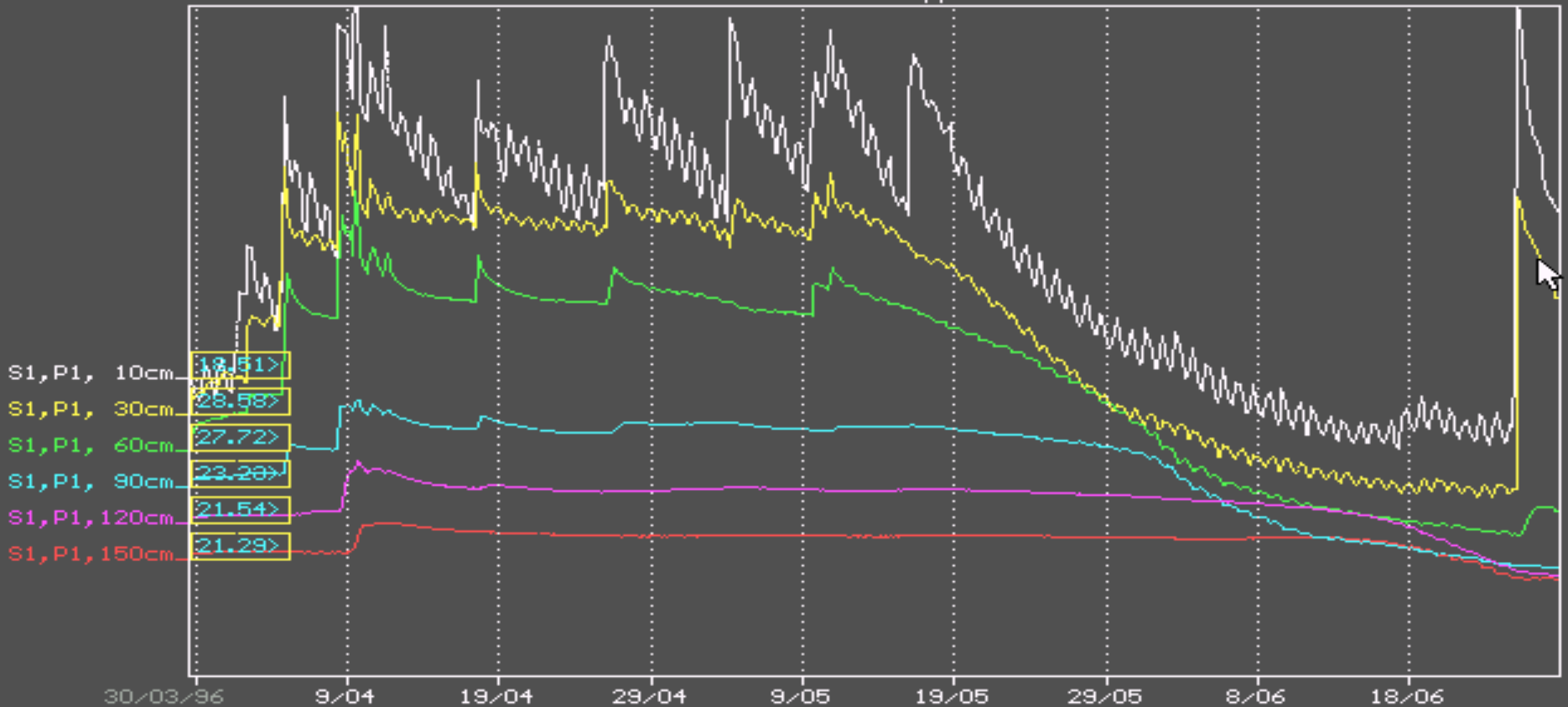
Logger Options Exit

dripper

Settings

90d

Stacked Separate Graph > Logger: gvs
Site ID's: S1=dripper



Shortcomings of Soil Monitoring

- 1) Interpretation of the data.
- 2) Accuracy of the data.
- 3) Costs.
- 4) Only a few measurements per acre possible; can't adequately characterize an entire field.

Plant-based monitoring

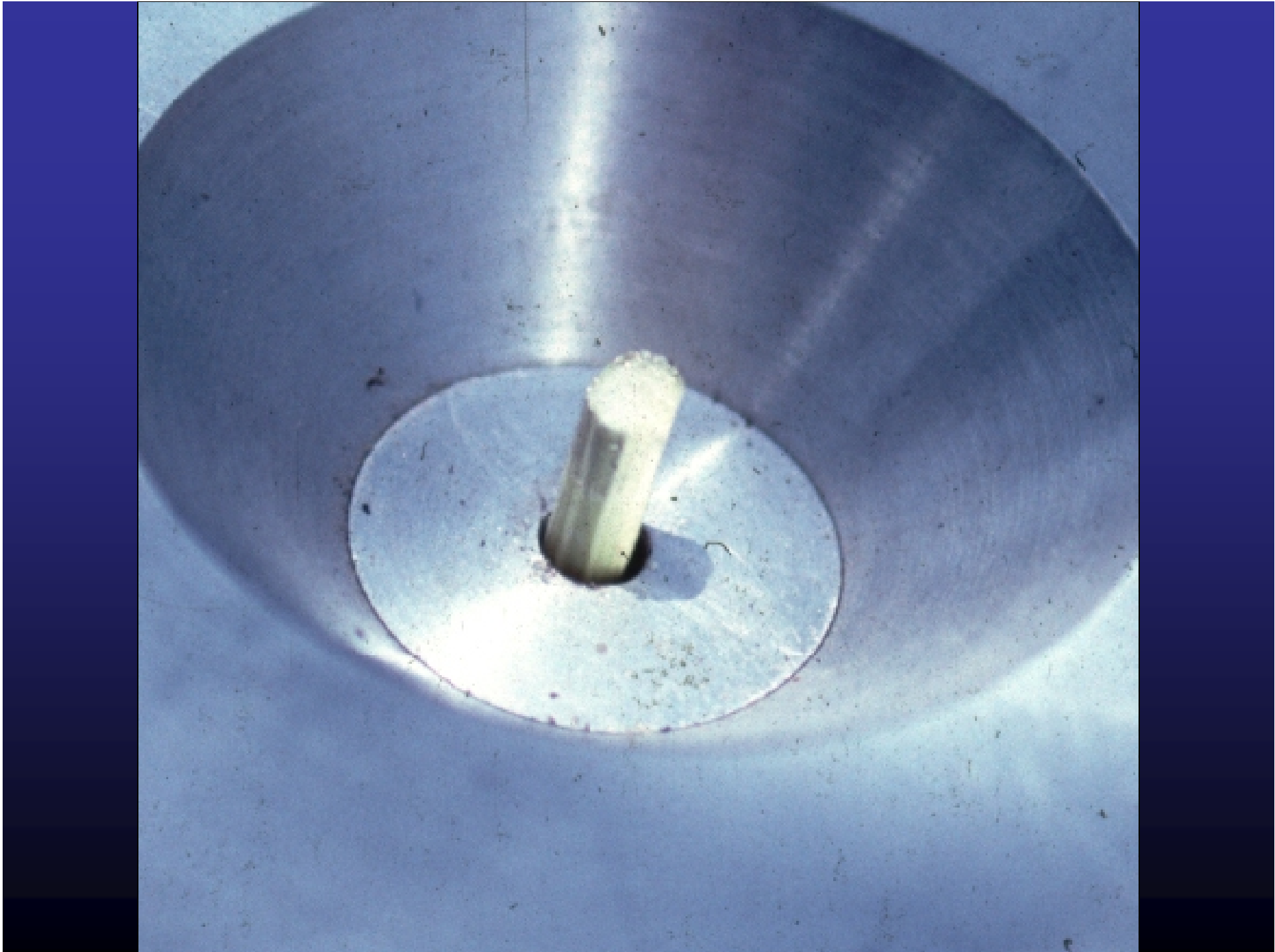
Pressure Chamber: Gives estimate of plant water status.





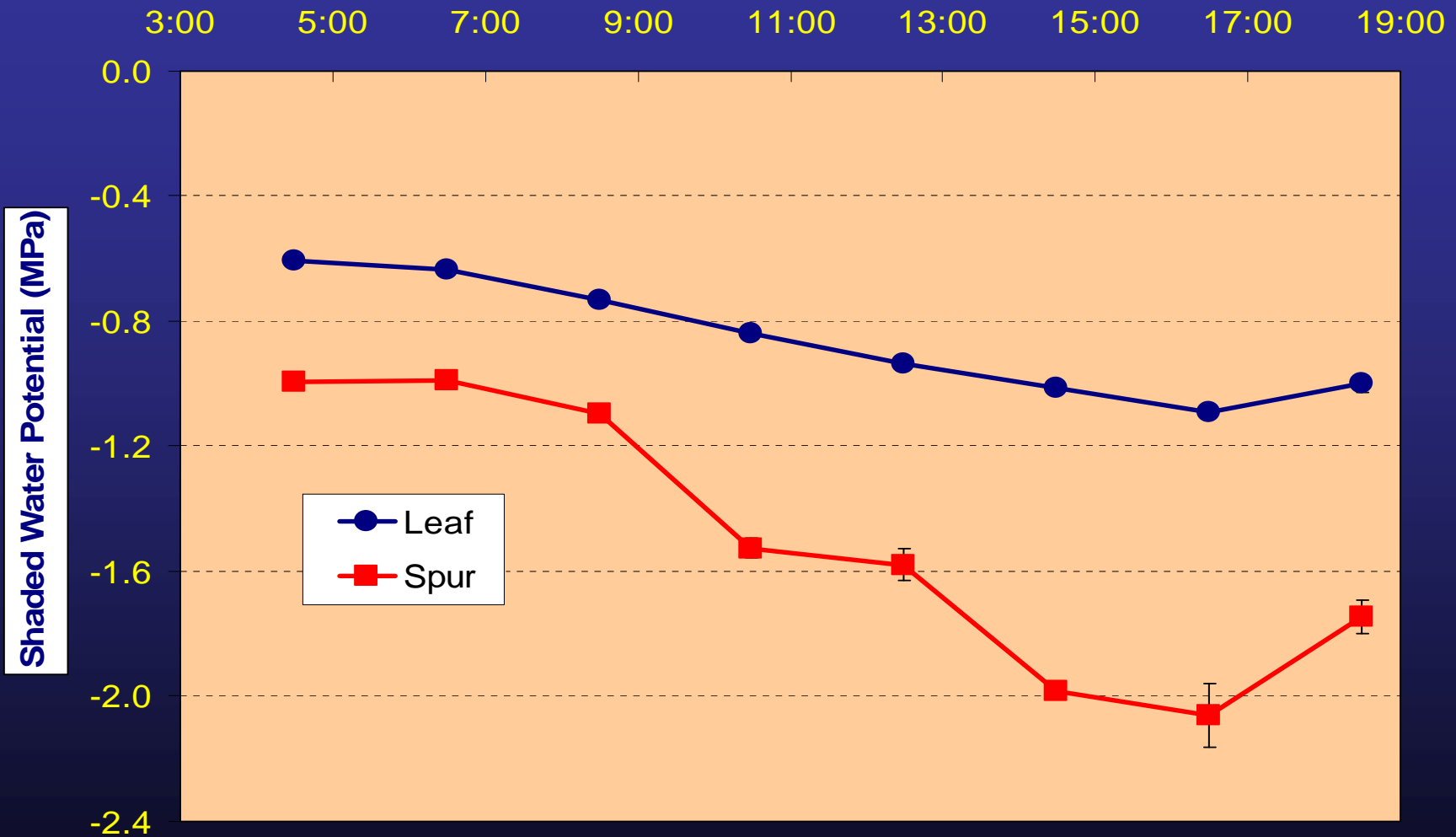




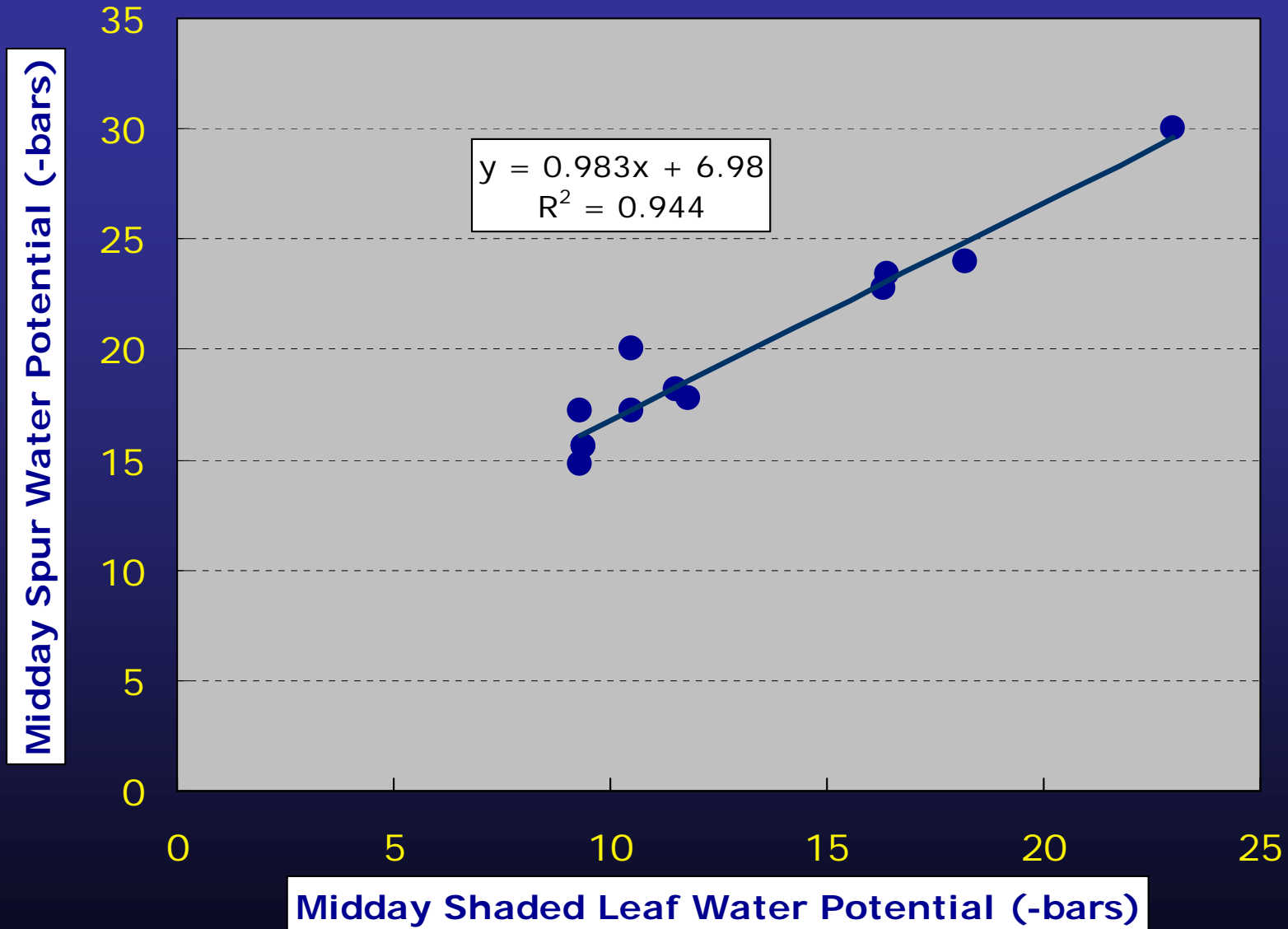




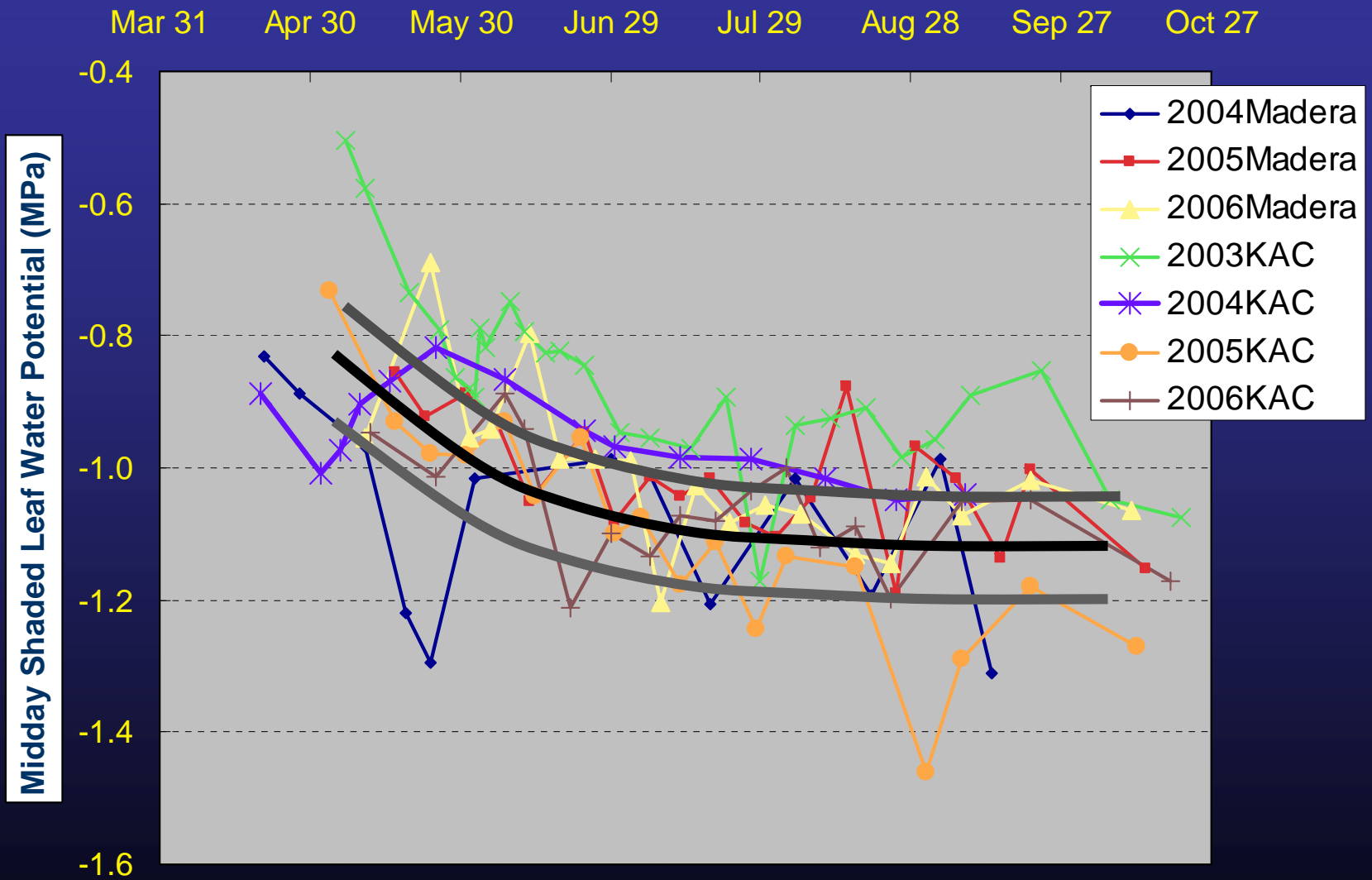
Leaf, Spur Comparison, Madera; June 17, 2004



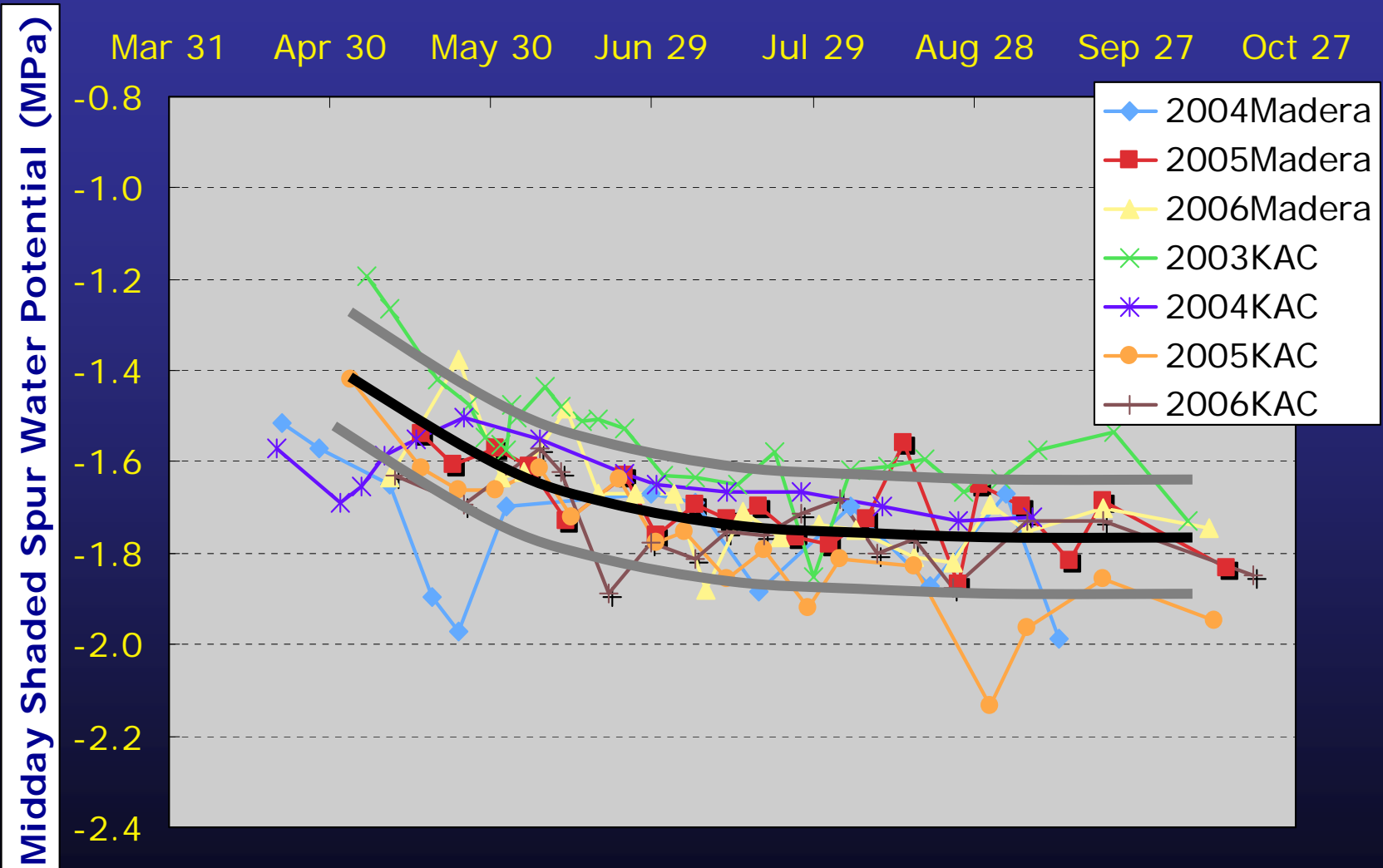
Relationship between Midday Spurs and Leaves



Fully Irrigated Midday Shaded Leaf Water Potential



Fully Irrigated Midday Spur Water Potential





Shortcomings of the Pressure Chamber

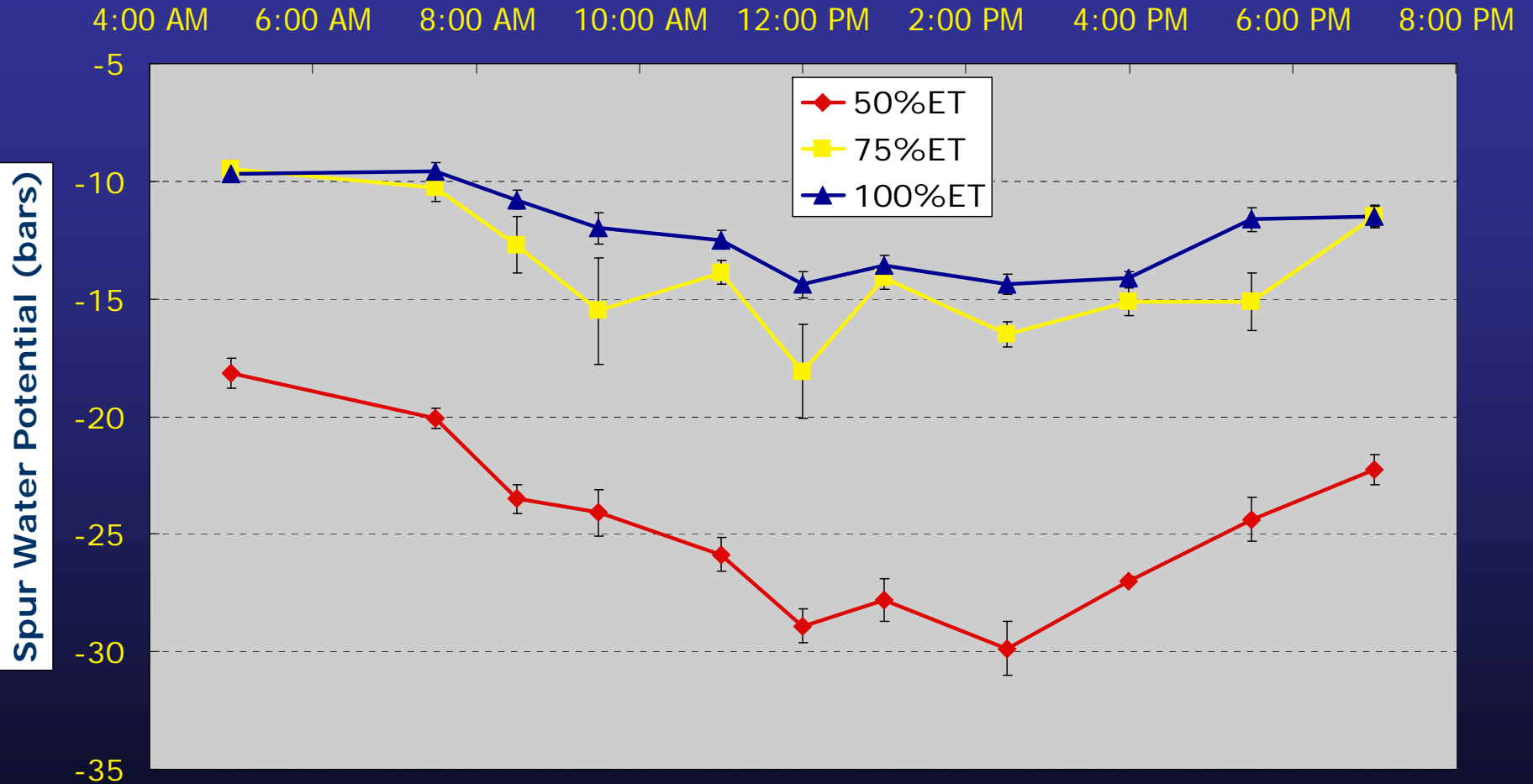
- 1) Manually taken; can't be automated.
- 2) Requires trips to the field and operator.
- 3) Limited time period to take measurements; noon-2:30 pm.

Thus, can't adequately characterize a field.

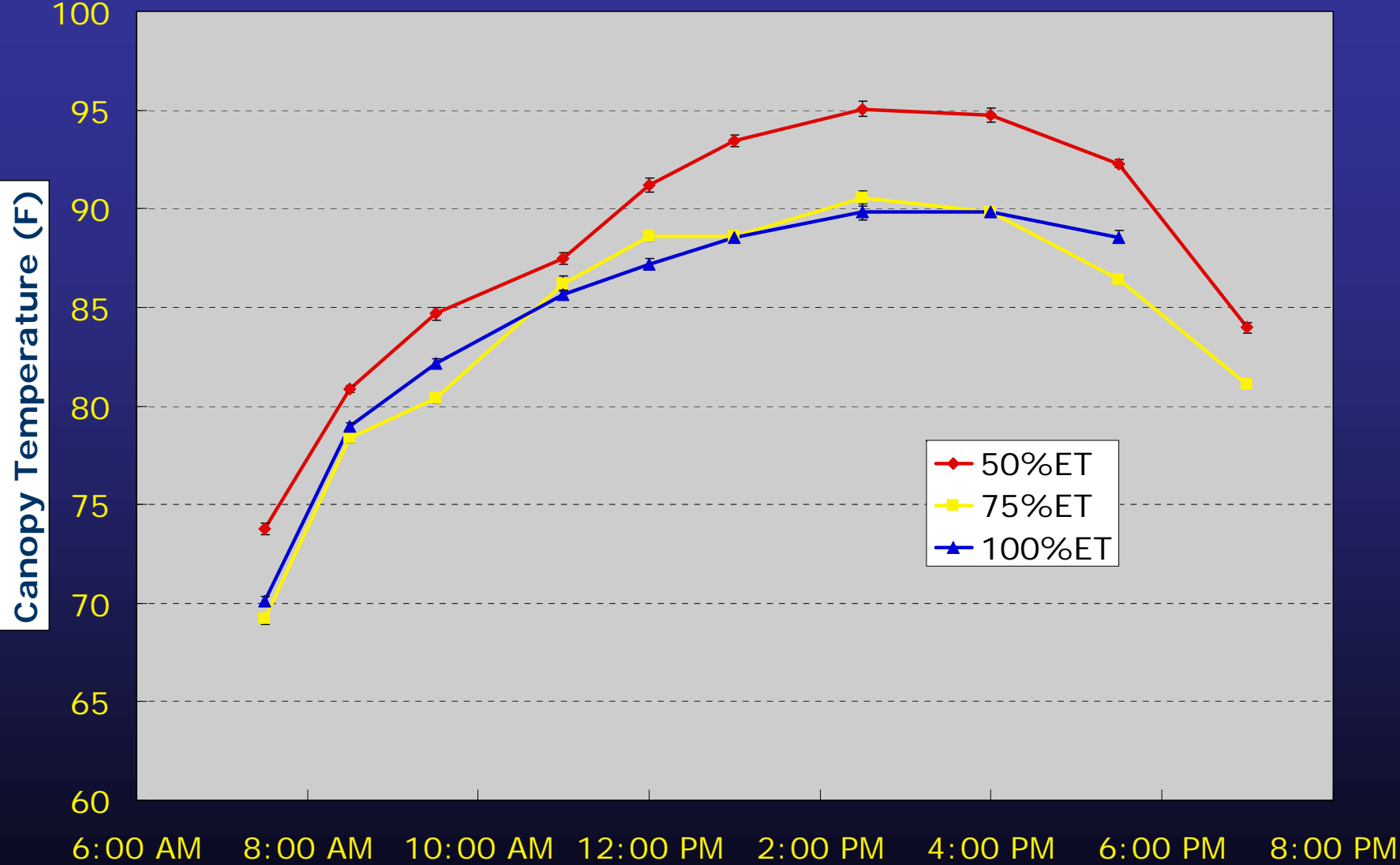
**What about hand-
held infrared
thermometers?**



Spur Water Potential; 3 Irrigation Levels



Canopy Temperature with Hand Held IRT



Irrigation Scheduling Summary

- Pistachio trees have the potential to use large amounts of water.
- Pistachio trees are extremely drought tolerant.
- Water budget approach; easy, cost effective; good starting point.