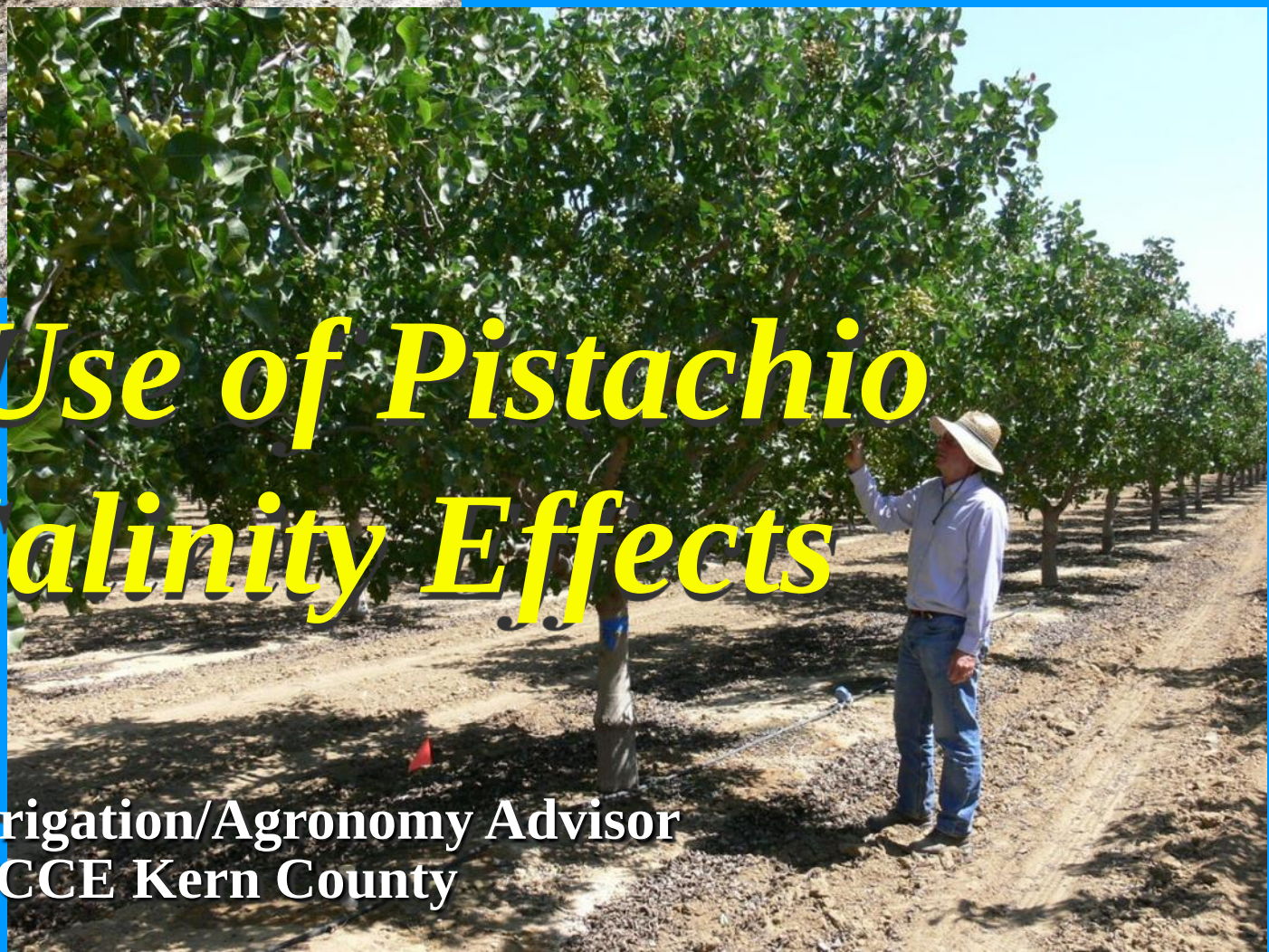
UNIVERSITY of CALIFORNIA COOPERATIVE EXTENSION

Crop Water Stress Conference

CSUFresno Center for Irrigation Technology

February 23, 2016

Water Use of Pistachio and Salinity Effects



Blake Sanden - Irrigation/Agronomy Advisor
UCCE Kern County

Approaches to water management:

- **SILVER BULLET**
  The university has the answers – just tell me how much water to use.

- **DOUBTING THOMAS**
  Nobody can figure out how much water these trees need.

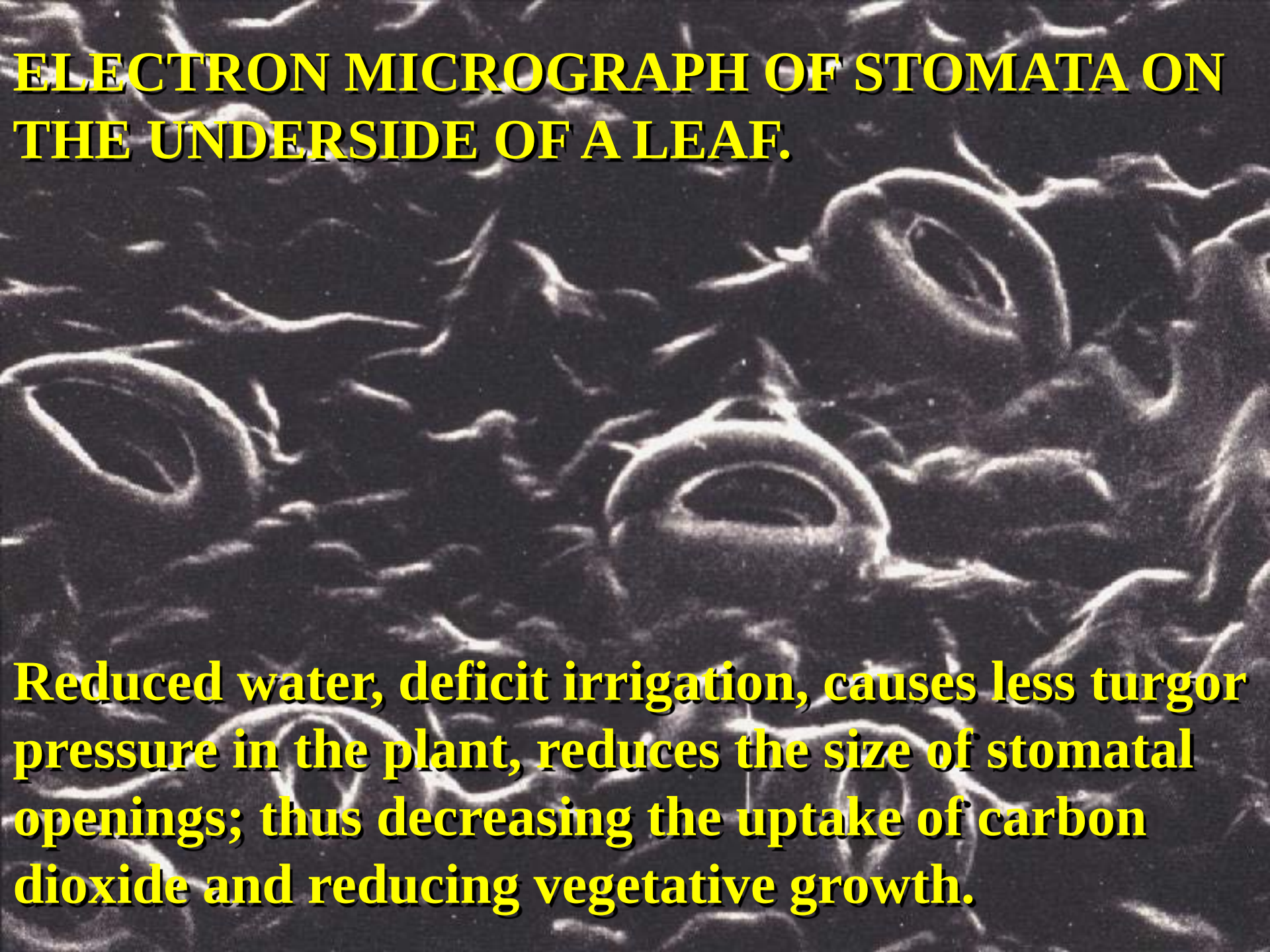
- **SELF-MADE MAN**
  My field is unique and only I know the right amount of water for this orchard.

Where do I start?

1. Pray for miracles. We need all the help we can get!
2. Get all the information you can! (That's why you're here.)
3. Get down on your knees (Similar to Step 1, but now this is work.) so you can check the soil profile, emitter flowrates, adjust pressure regulators and optimize uniformity!

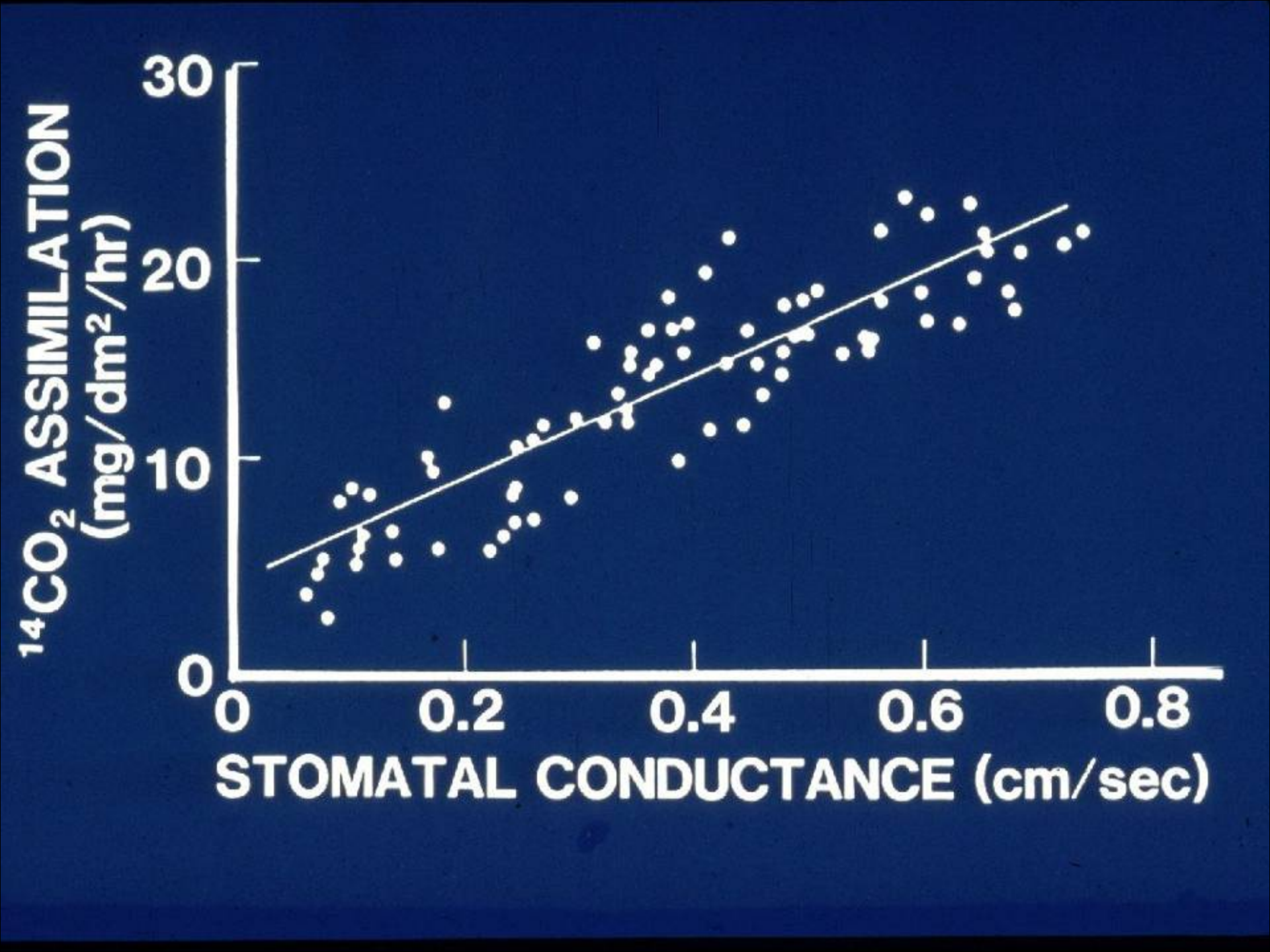
What's the critical process that keeps the crop growing?

- **Optimal photosynthesis**
- **Maximum carbon dioxide uptake**



ELECTRON MICROGRAPH OF STOMATA ON THE UNDERSIDE OF A LEAF.

Reduced water, deficit irrigation, causes less turgor pressure in the plant, reduces the size of stomatal openings; thus decreasing the uptake of carbon dioxide and reducing vegetative growth.

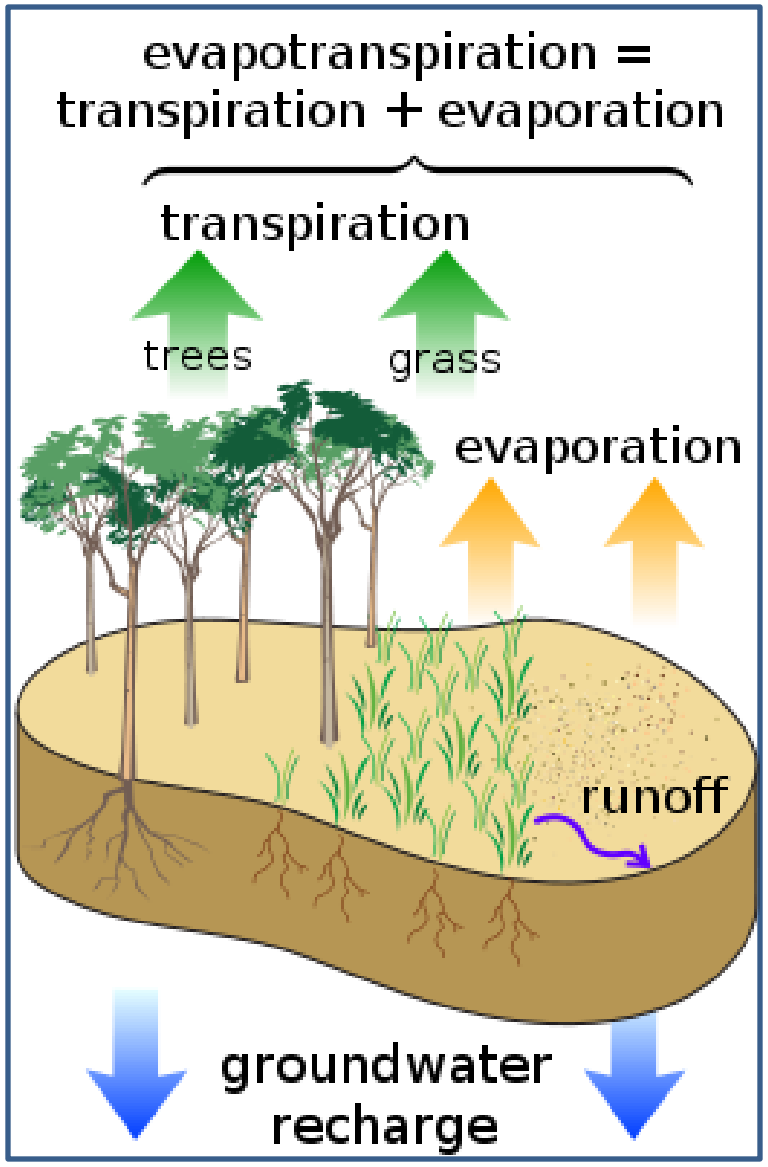

30
20
10
0
$^{14}CO_2$ ASSIMILATION
(mg/dm²/hr)
0
0.2
0.4
0.6
0.8
STOMATAL CONDUCTANCE (cm/sec)

Observation:
some orchards visibly stress and defoliate just before or after harvest…

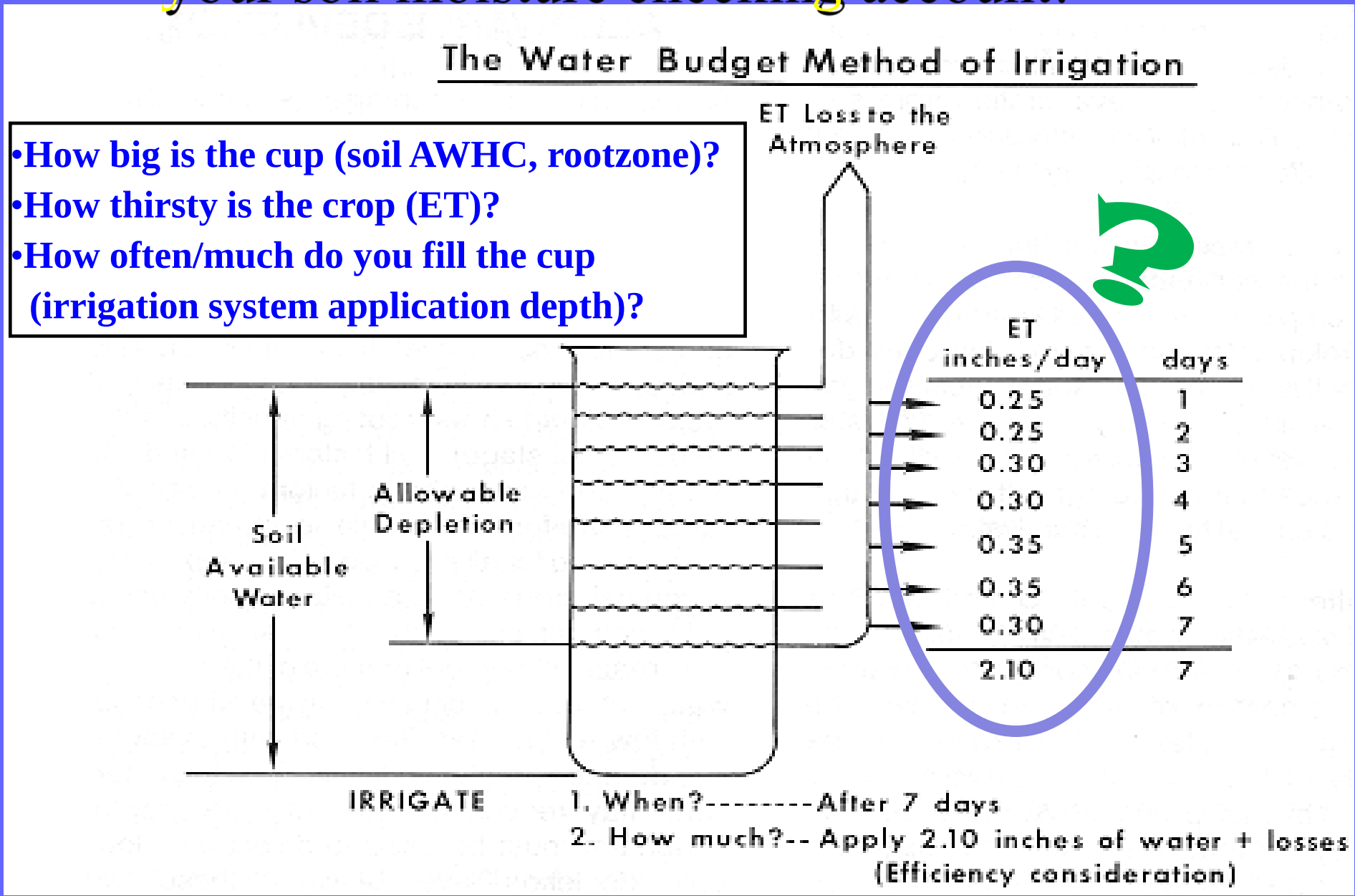
Observation: …while other orchards, even with micro systems, seem to stay wet on top, grow moss, still defoliate at harvest and have disease problems caused by saturated soil conditions

Water Use in the Orchard

- Transpiration – needed for plant growth
- Evaporation – Due to environmental conditions
- Runoff/ Deep percolation – Due to over-application



Creating the efficient field water balance – your soil moisture checking account!



How do we calculate water use to plan irrigation schedules?

Evapo-transpiration of the reference crop (non-stressed tall grass)

Known, Variable

$$ETc = ETo \times Kc$$

Evapo-transpiration of the Crop of Interest (pistachios)

Unknown

Crop Coefficient – ratio of water need of crop v/s water need of grass

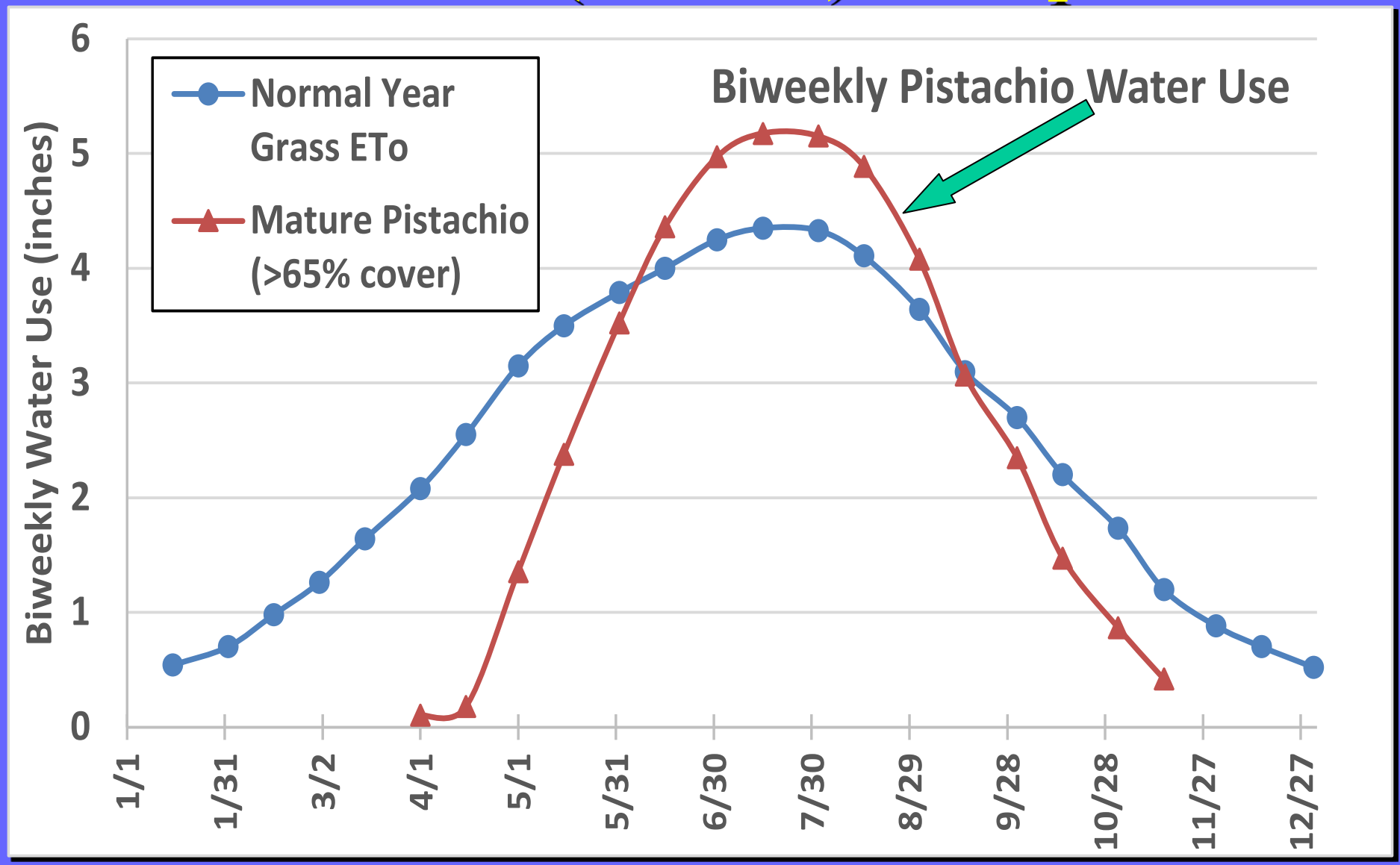
Known, Fixed Absolutely?

Pistachio Kc's, ET for the San Joaquin Valley (Goldhamer, 1992)

Growth Stage	Approx Phenology	Period	Crop Kc	ETo	ETc
Stage 1	Bloom	Apr 1-15	0.07	2.36	0.17
	Leafout	Apr 16-30	0.43	2.36	1.10
	Shell Expansion	May 1-15	0.68	3.19	2.17
Stage 2	Shell Hardening	May 16-31	0.93	3.40	3.16
		June 1-15	1.09	3.84	4.19
		June 16-30	1.17	3.84	4.49
Stage 3	Nut Fill	July 1-15	1.19	4.13	4.92
		July 16-31	1.19	4.41	5.25
	Nut Fill/Shell Split	Aug 1-15	1.19	3.54	4.21
	Shell Split	Aug 16-31	1.12	3.78	4.23
	Hull Slip	Sept 1-15	0.99	2.66	2.63
Harvest	Harvest	Sept 16-30	0.87	2.66	2.31
Post-Harvest	Postharvest	Oct 1-15	0.67	1.71	1.15
		Oct 16-31	0.50	1.83	0.91
		Nov 1-15	0.35	0.80	0.28

41.2 inches total for San Joaquin Valley

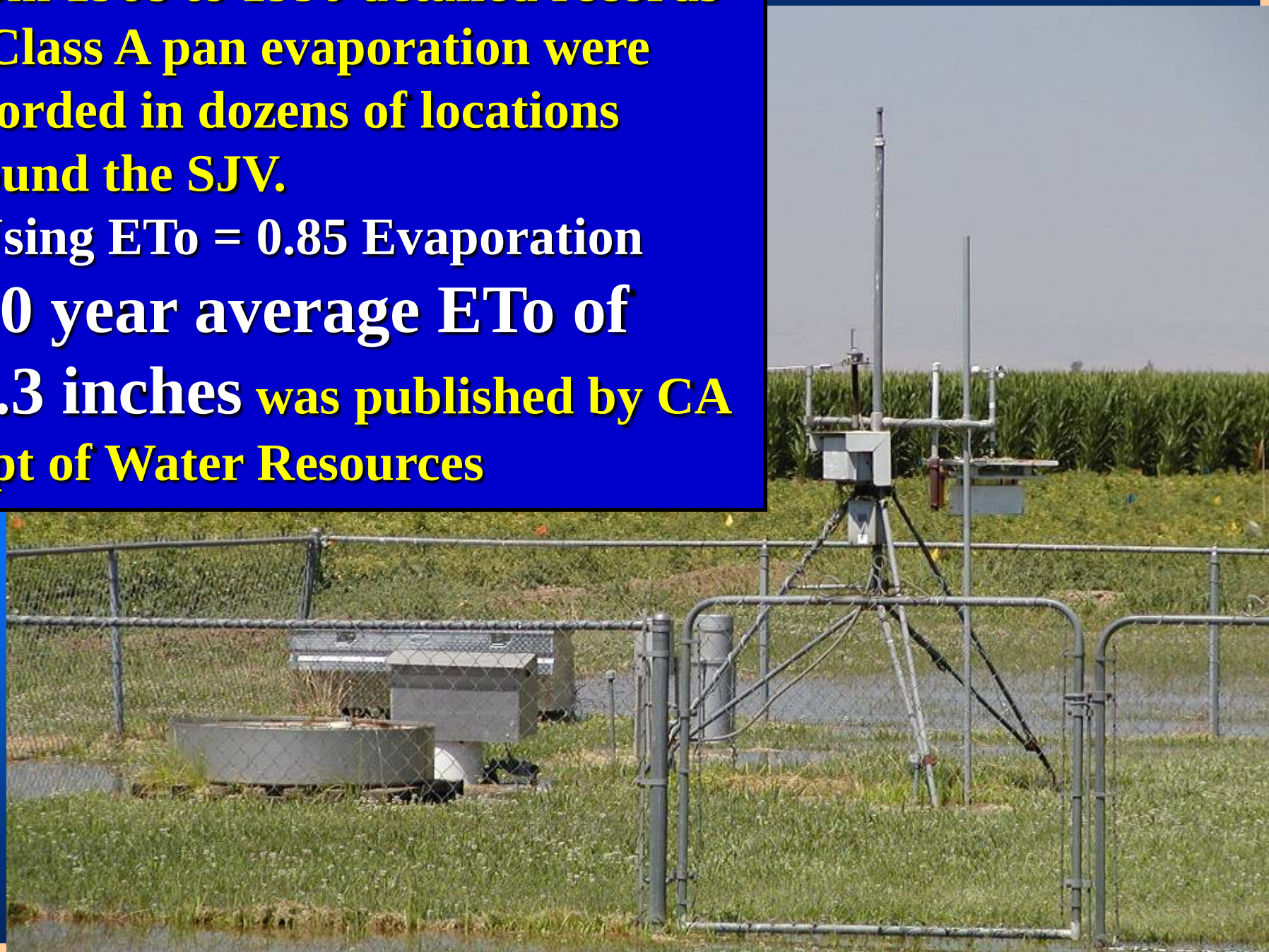
Bi-weekly Pistachio and Pasture Grass ETo (CIMIS) Compared



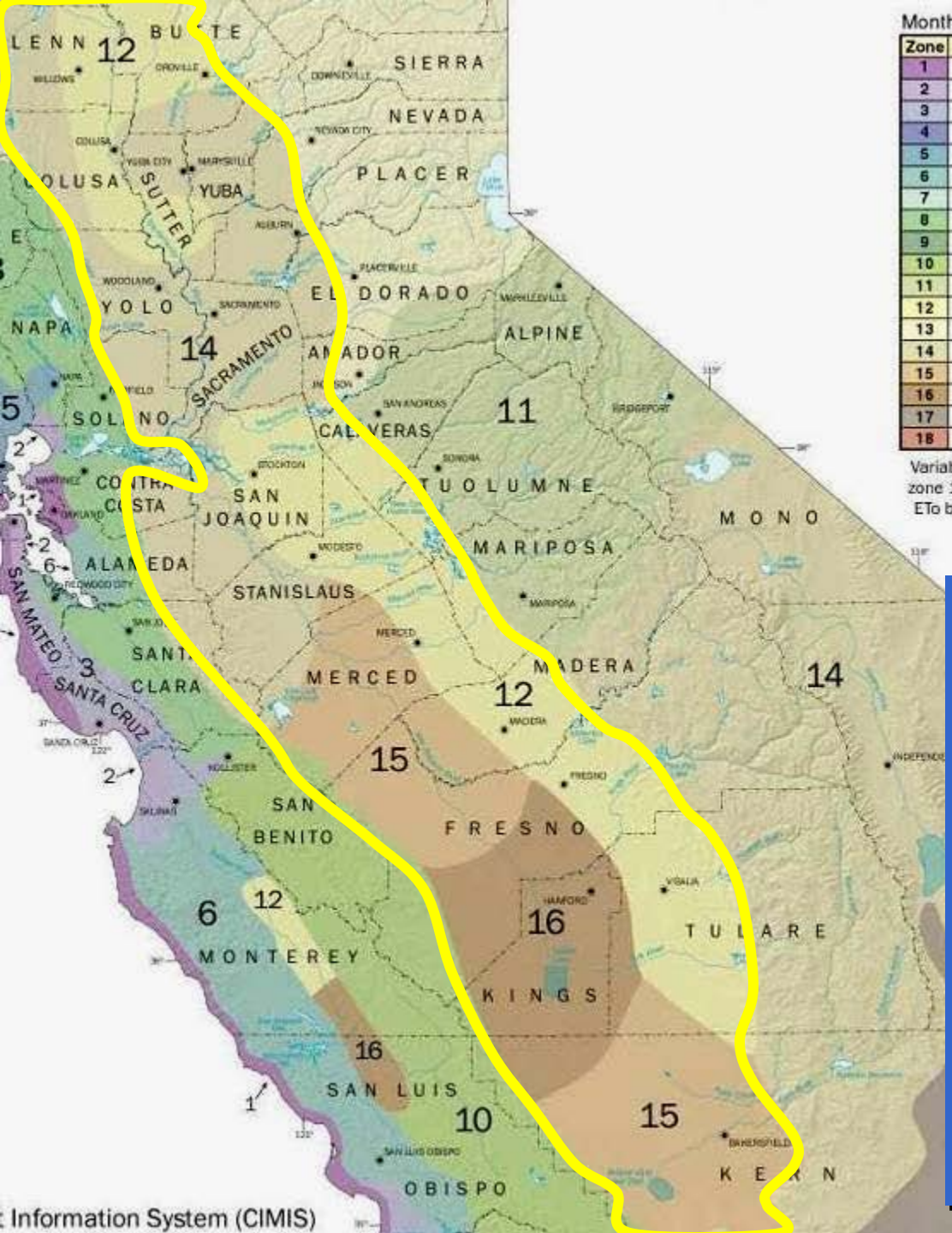
From 1968 to 1990 detailed records of Class A pan evaporation were recorded in dozens of locations around the SJV.

Using ETo = 0.85 Evaporation

a **20 year average ETo of 49.3 inches** was published by CA Dept of Water Resources



How do we figure out ETo? Access California Irrigation Management Information System



Monthly Average Reference Evapotranspiration by ETo Zone (inches/month)

Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0.93	1.40	2.48	3.30	4.03	4.50	4.65	4.03	3.30	2.48	1.20	0.62	33.0
2	1.24	1.68	3.10	3.90	4.65	5.10	4.96	4.65	3.90	2.79	1.80	1.24	39.0
3	1.86	2.24	3.72	4.80	5.27	5.70	5.58	5.27	4.20	3.41	2.40	1.86	46.3
4	1.86	2.24	3.41	4.50	5.27	5.70	5.89	5.58	4.50	3.41	2.40	1.86	46.6
5	0.93	1.68	2.79	4.20	5.58	6.30	6.51	5.89	4.50	3.10	1.50	0.93	43.9
6	1.86	2.24	3.41	4.80	5.58	6.30	6.51	6.20	4.80	3.72	2.40	1.86	49.7
7	0.62	1.40	2.48	3.90	5.27	6.30	7.44	6.51	4.80	2.79	1.20	0.62	43.4
8	1.24	1.68	3.41	4.80	6.20	6.90	7.44	6.51	5.10	3.41	1.80	0.93	49.4
9	2.17	2.80	4.03	5.10	5.89	6.60	7.44	6.82	5.70	4.03	2.70	1.86	55.1
10	0.93	1.68	3.10	4.50	5.89	7.20	8.06	7.13	5.10	3.10	1.50	0.93	49.1
11	1.55	2.24	3.10	4.50	5.89	7.20	8.06	7.44	5.70	3.72	2.10	1.55	53.0
12	1.24	1.96	3.41	5.10	6.82	7.80	8.06	7.13	5.40	3.72	1.80	0.93	53.3
13	1.24	1.96	3.10	4.80	6.51	7.80	8.99	7.75	5.70	3.72	1.80	0.93	54.3
14	1.55	2.24	3.72	5.10	6.82	7.80	8.68	7.75	5.70	4.03	2.10	1.55	57.0
15	1.24	2.24	3.72	5.70	7.44	8.10	8.68	7.75	5.70	4.03	2.10	1.24	57.9
16	1.55	2.52	4.03	5.70	7.75	8.70	9.30	8.37	6.30	4.34	2.40	1.55	62.5
17	1.86	2.80	4.65	6.00	8.06	9.00	9.92	8.68	6.60	4.34	2.70	1.86	66.5
18	2.48	3.36	5.27	6.90	8.68	9.60	9.61	8.68	6.90	4.96	3.00	2.17	71.6

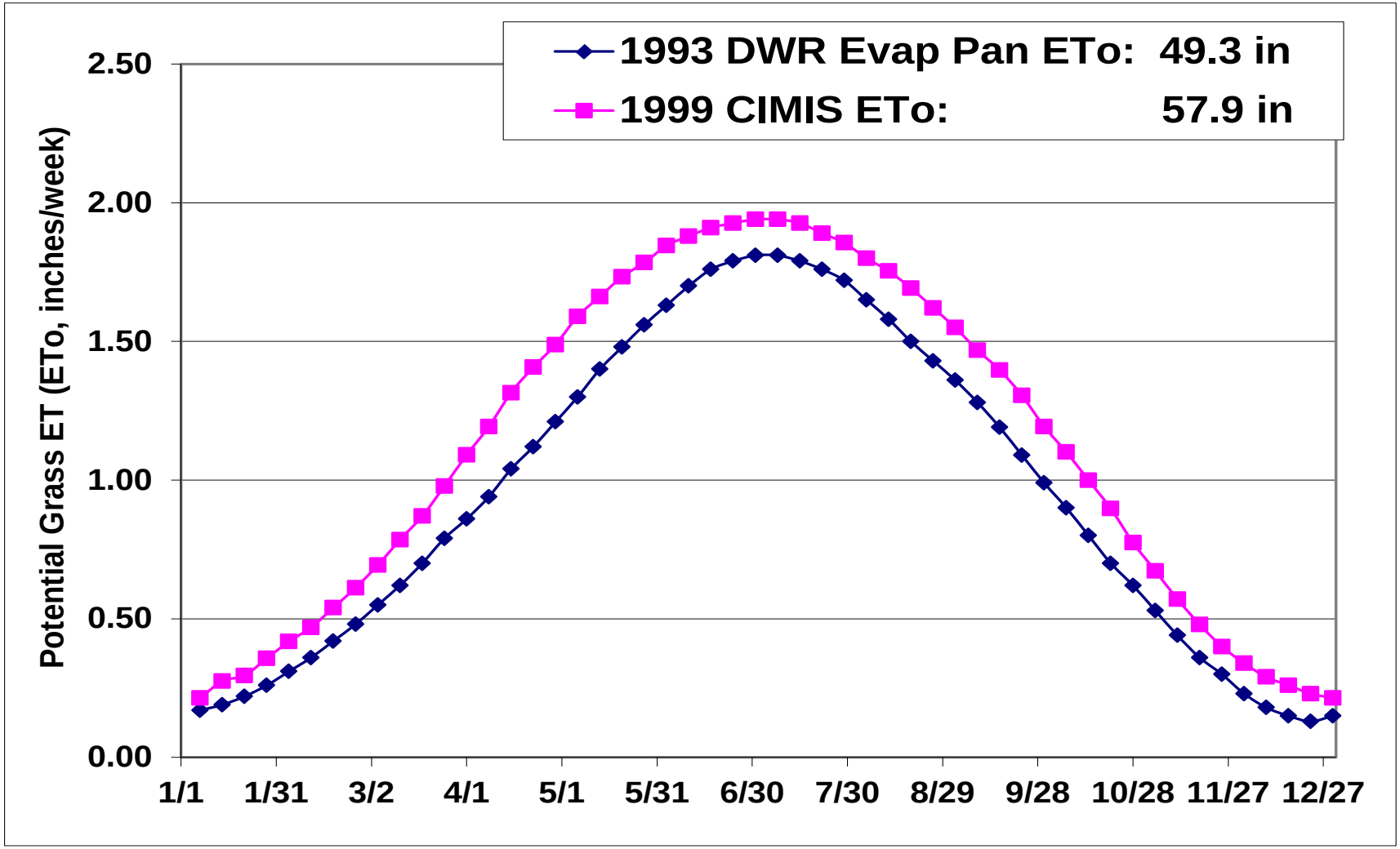
Variablity between stations within single zones is as high as 0.02 inches per day for zone 1 and during winter months in zone 13. The average standard deviation of the ETo between estimation sites within a zone for all months is about 0.01 inches per day for all 200 sites.

The whole Central Valley covers Zones 12 to 16: for an "normal year" ETo of 53.3 to 62.5 in/yr, with most area @ 53 to 58 inches.

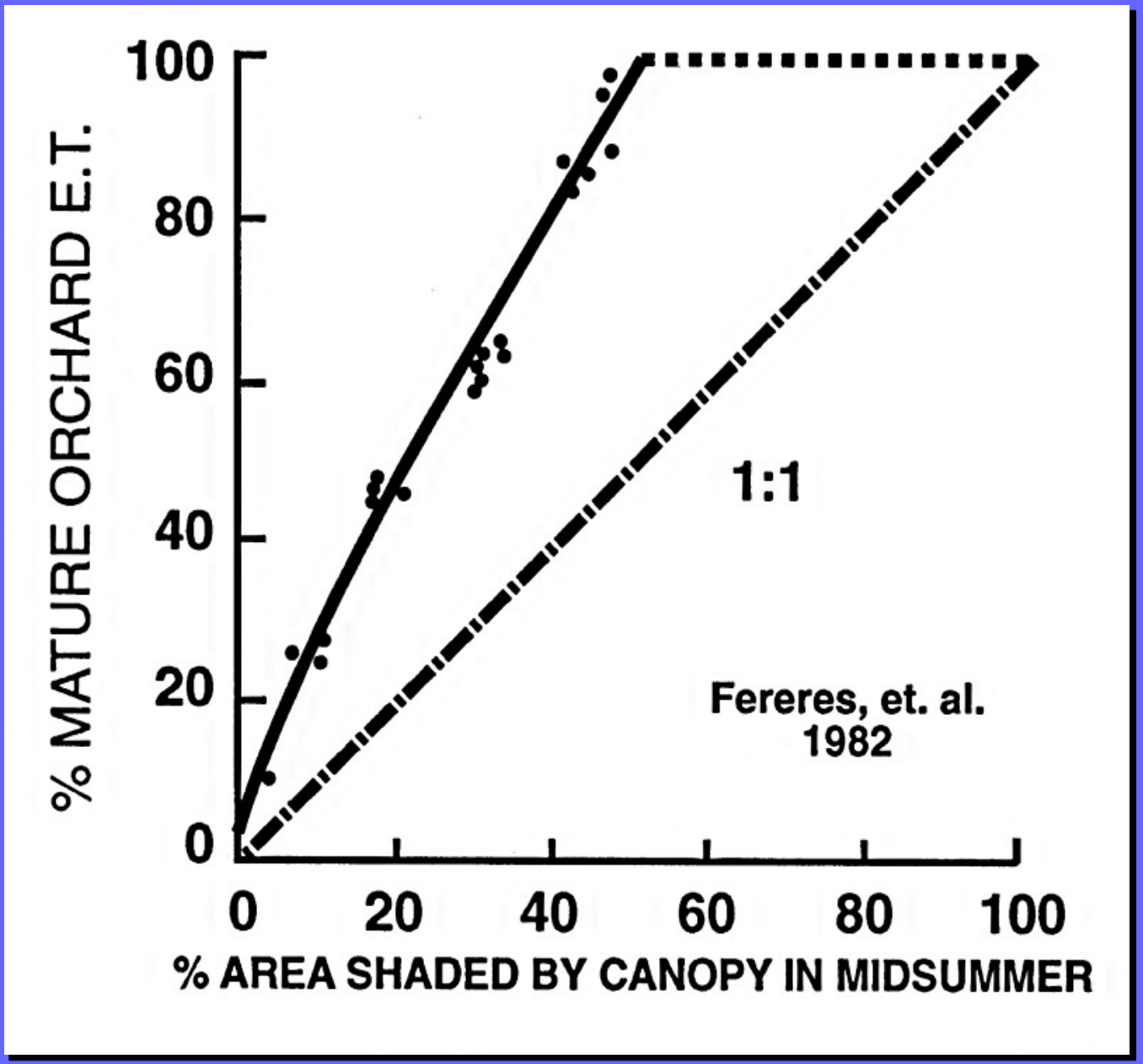
Information System (CIMIS)

Why did “normal year” ETo increase from 1993-1999?

Our understanding and accuracy of environmental and plant systems keeps improving. Then does this mean the old Kc values are always accurate?



Pistachio ET by % Shaded Area



This relation-ship for developing pistachio trees says ET is 100% with only 50% canopy cover.

NORMAL YEAR WATER USE (ET) FOR PISTACHIOS IN THE SOUTHERN SAN JOAQUIN VALLEY

(Most recent published CIMIS "normal year" ETo for the SSJV. Table by Sanden, 2002)

Week Ending	Normal Year Grass ETo	[1]Crop Coef-ficients Kc	Drip Year 1	Drip Year 2	Drip Year 3	[2]Drip Year 4 & FJ Year 1	Drip Year 5 & FJ Year 3	Drip Year 6 & FJ Year 5	Year 7	Year 8	Mature Year 9 (>65% cover)
	Adjustment Facto		**0.10**	**0.20**	**0.30**	**0.40**	**0.52**	**0.65**	**0.78**	**0.90**	**1.00**
1/15	0.54										
2/1	0.70										
2/15	0.98										
3/1	1.26										
3/15	1.64										
4/1	2.08	0.05	0.01	0.02	0.03	0.04	0.05	0.07	0.08	0.09	0.10
4/15	2.55	0.07	0.02	0.04	0.05	0.07	0.09	0.12	0.14	0.16	0.18
5/1	3.15	0.43	0.14	0.27	0.41	0.54	0.70	0.88	1.06	1.22	1.35
5/15	3.50	0.68	0.24	0.48	0.71	0.95	1.24	1.55	1.86	2.14	2.38
6/1	3.79	0.93	0.35	0.70	1.06	1.41	1.83	2.29	2.75	3.17	3.52
6/15	4.00	1.09	0.44	0.87	1.31	1.74	2.27	2.83	3.40	3.92	4.36
7/1	4.25	1.17	0.50	0.99	1.49	1.99	2.59	3.23	3.88	4.48	4.97
7/15	4.35	1.19	0.52	1.04	1.55	2.07	2.69	3.36	4.04	4.66	5.18
8/1	4.33	1.19	0.52	1.03	1.55	2.06	2.68	3.35	4.02	4.64	5.15
8/15	4.11	1.19	0.49	0.98	1.47	1.96	2.54	3.18	3.81	4.40	4.89
9/1	3.64	1.12	0.41	0.82	1.22	1.63	2.12	2.65	3.18	3.67	4.08
9/15	3.10	0.99	0.31	0.61	0.92	1.23	1.60	1.99	2.39	2.76	3.07
10/1	2.70	0.87	0.23	0.47	0.70	0.94	1.22	1.53	1.83	2.11	2.35
10/15	2.20	0.67	0.15	0.29	0.44	0.59	0.77	0.96	1.15	1.33	1.47
11/1	1.73	0.50	0.09	0.17	0.26	0.35	0.45	0.56	0.68	0.78	0.87
11/15	1.20	0.35	0.04	0.08	0.13	0.17	0.22	0.27	0.33	0.38	0.42
12/1	0.88										
12/15	0.70										
12/31	0.52										
Total	**57.90**		**4.43**	**8.87**	**13.30**	**17.74**	**23.06**	**28.83**	**34.59**	**39.91**	**44.35**

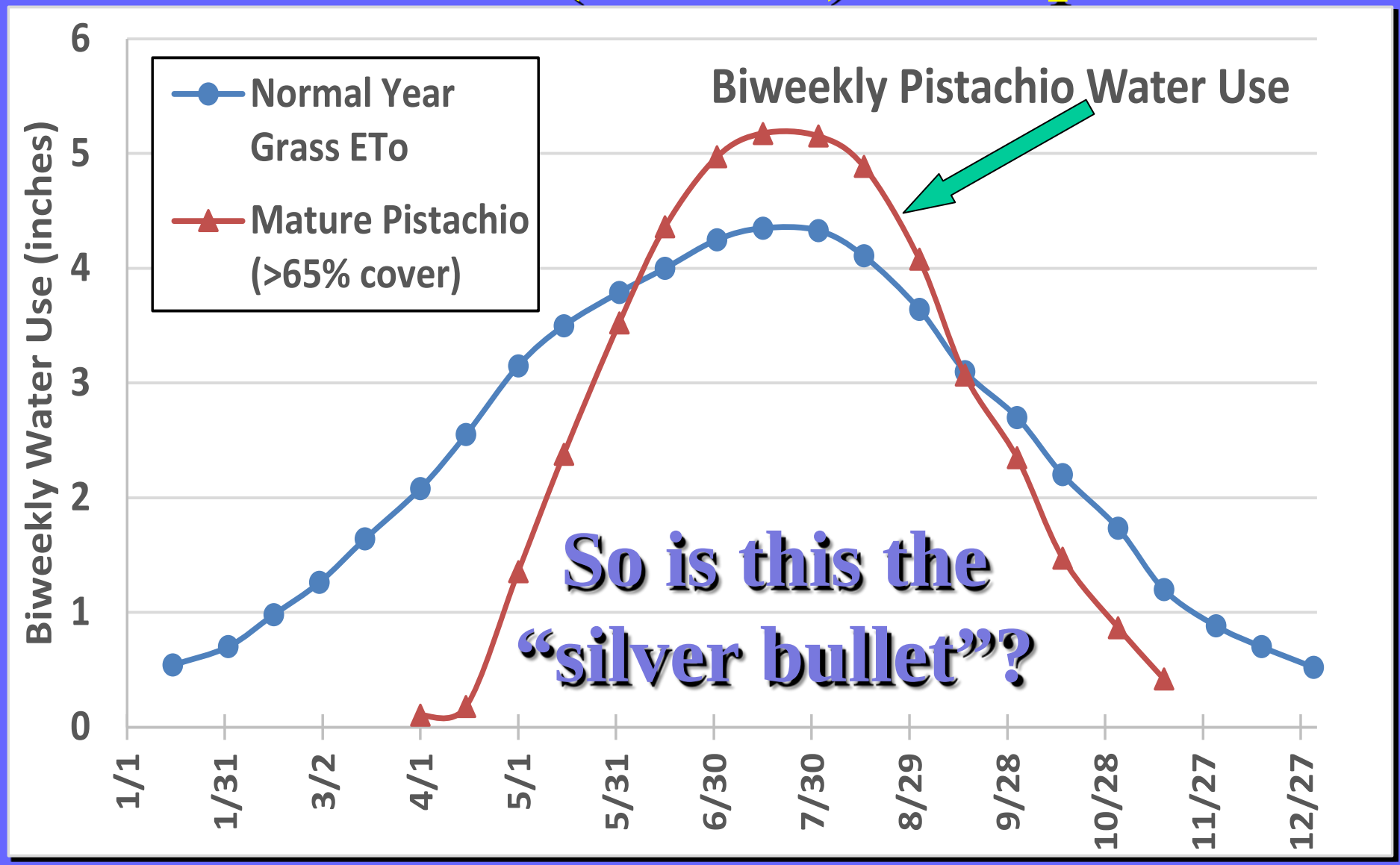
GOOGLE: cekern Pistachio ET to download weekly schedule

3.1 inches > than older Goldhamer total

[1] No weeds, bare middles. Goldhamer crop coefficients.

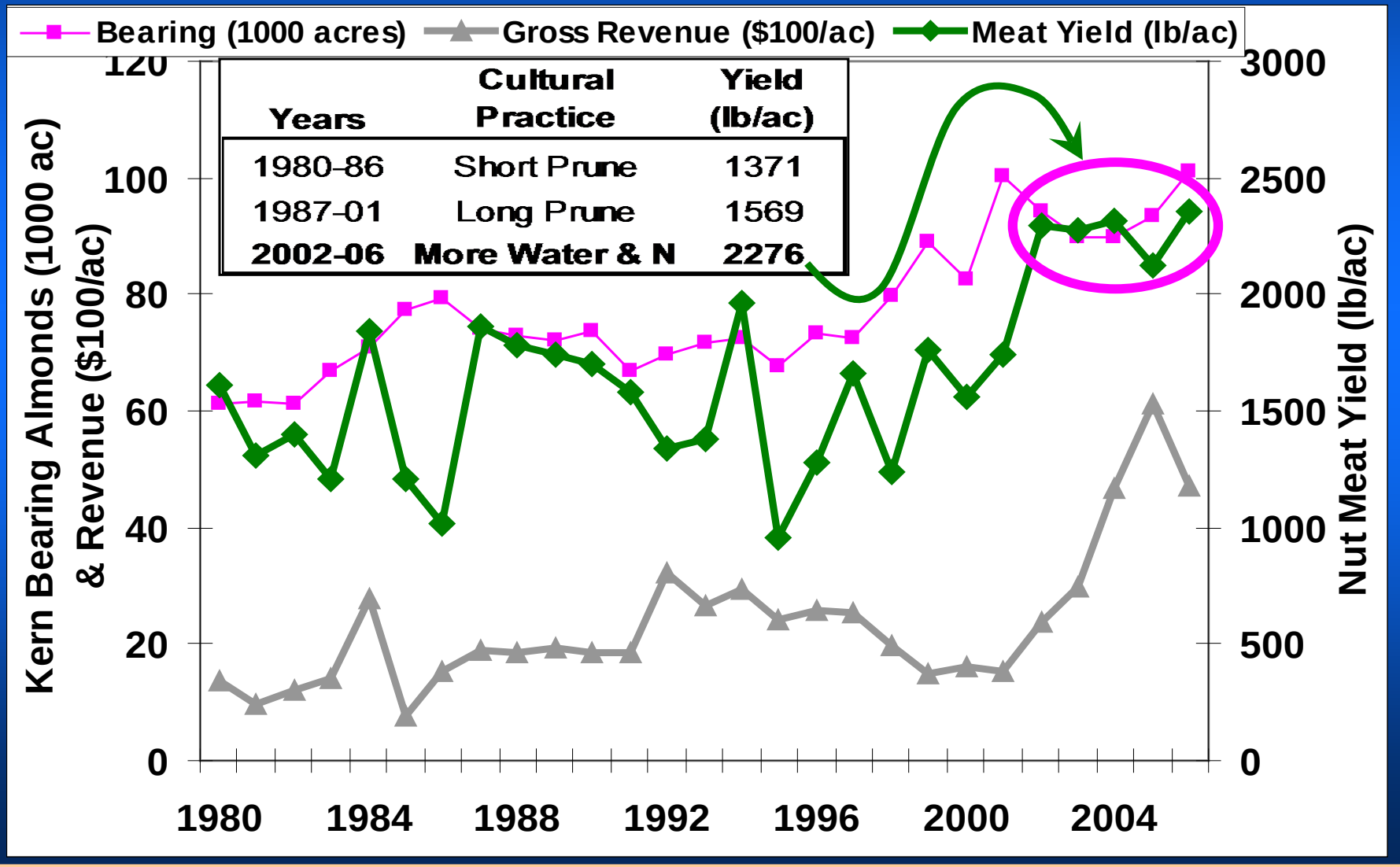
[2] FJ stands for Fanjet or any microsprinkler spraying a 10 to 15 foot diameter. Higher evaporative losses from this system create a first year water demand equal to a 4th leaf orchard on drip.

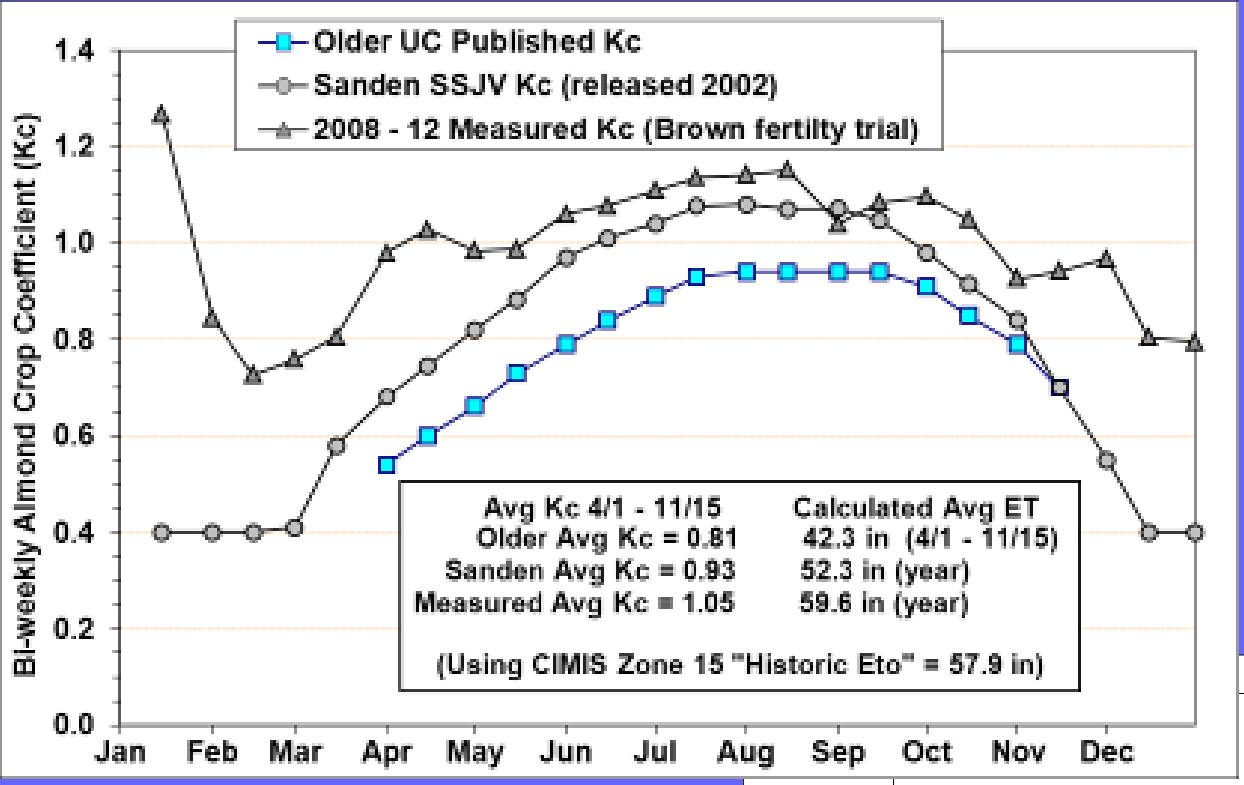
Bi-weekly Pistachio and Pasture Grass ETo (CIMIS) Compared



Observation: We still have some things to learn about crop ET…

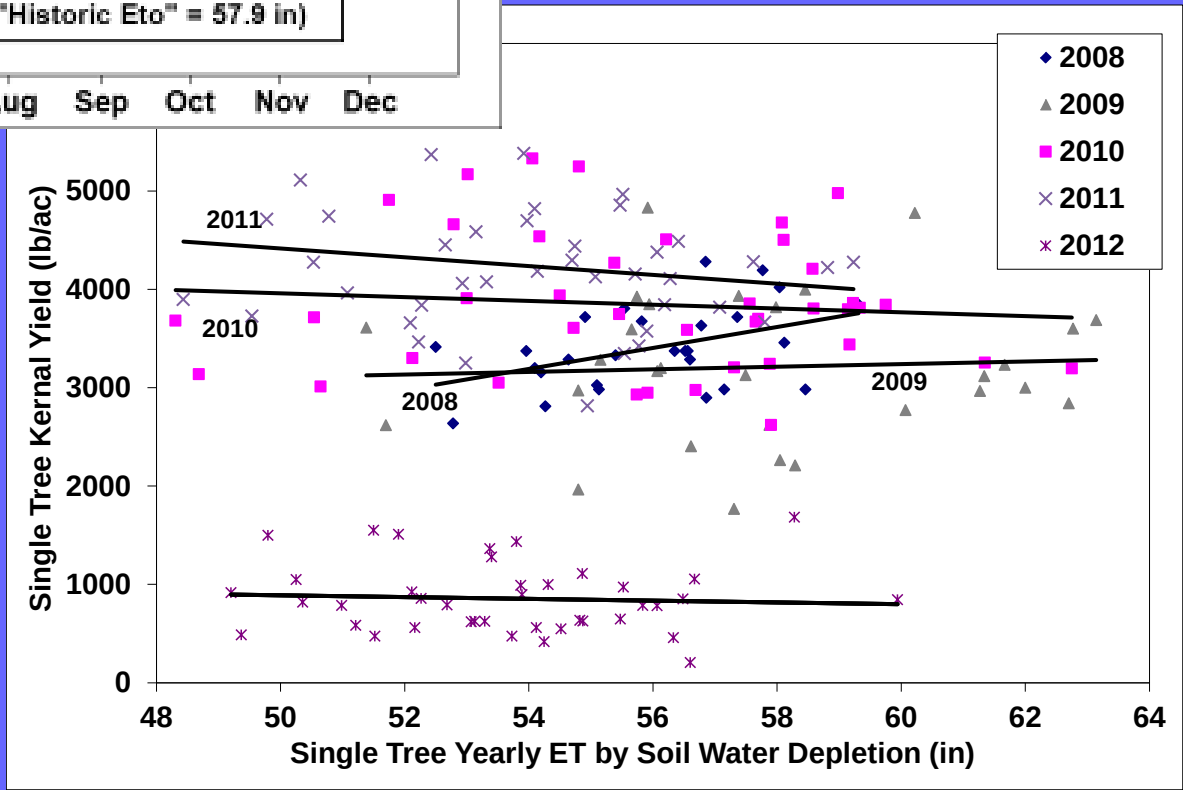
Kern County Almond Yield 1980-2006





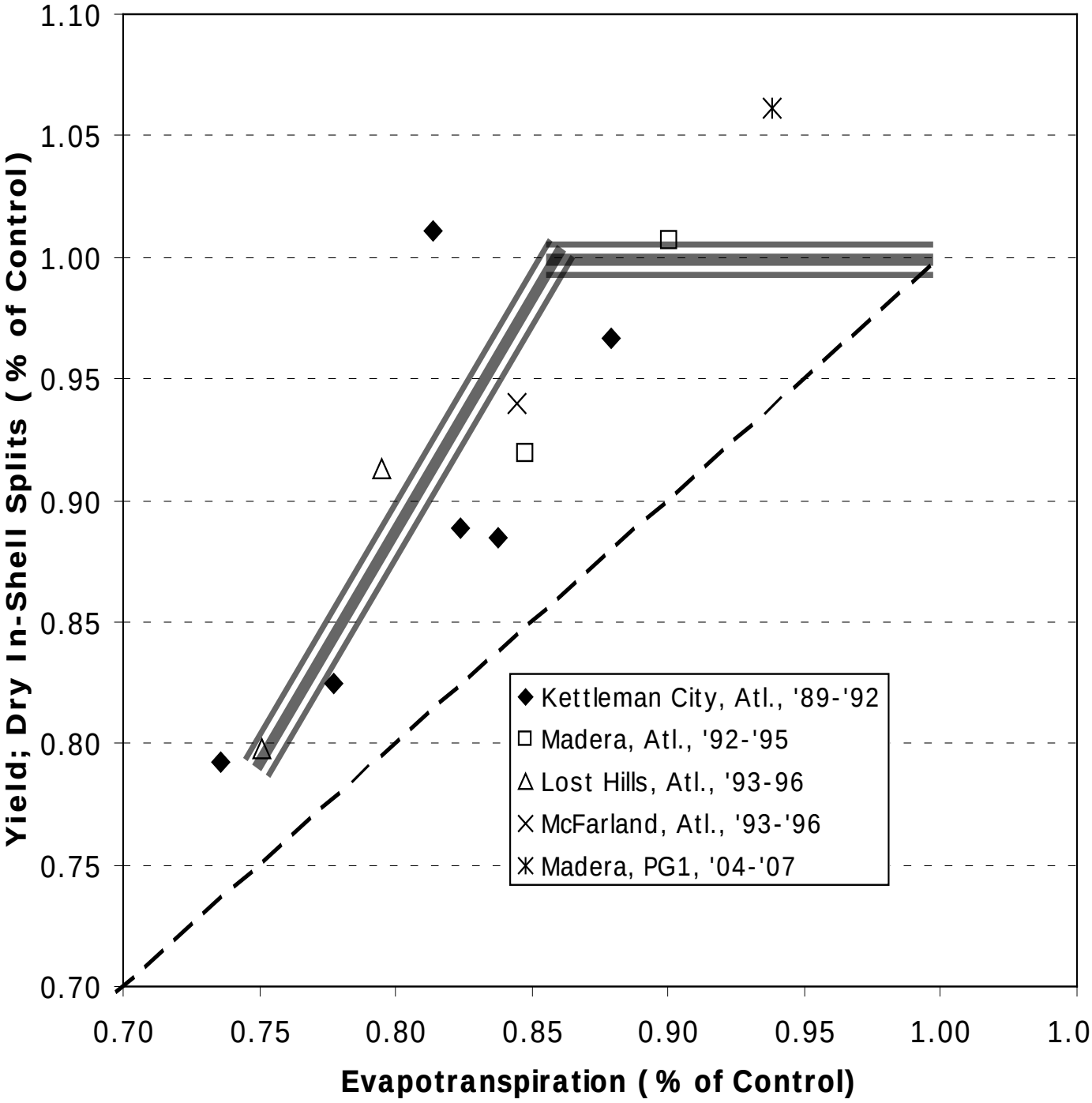
Quick review of current findings on almond ET and yield impacts in Kern County

Individual trees used as much as 60” of water but did not produce more nuts than 50” of ET.



So have the recommended UC crop coefficients (Kc) for pistachio changed?

- Not at this time.
- Reality: a few fields have used MORE water then indicated by the Goldhamer Kc values.
- Reality: most production fields are irrigated at less than Goldhamer Kc values. His research showed no yield loss using 15% less water.
- Reality: regulated deficit irrigation (RDI) during shell hardening saves water, may increase splits.
- Reality: increased osmotic resistance in saline soils and irrigation water decreases ET.



Combined pistachio ET production function

(D. Goldhamer, 2008)

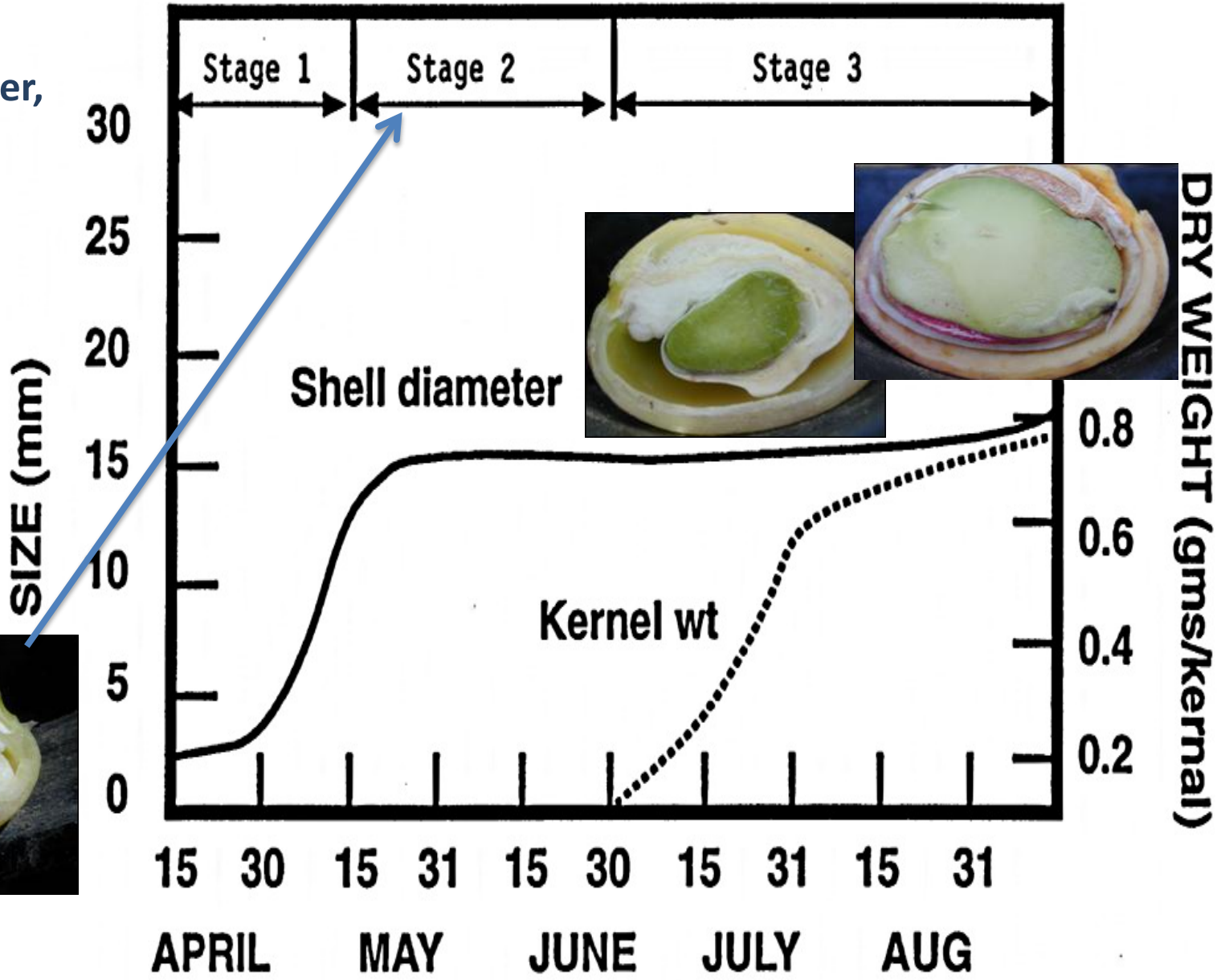
Regulated Deficit Irrigation (RDI)

Planned water deficits at specific crop developmental stages that control vegetative growth without negatively affecting production.

Goal: **Solve horticultural problems;**
Reduce water use;
Achieve higher farm profits.

Timing of Pistachio Nut Development

(Dave Goldhamer, Pistachio Production Manual 2008)

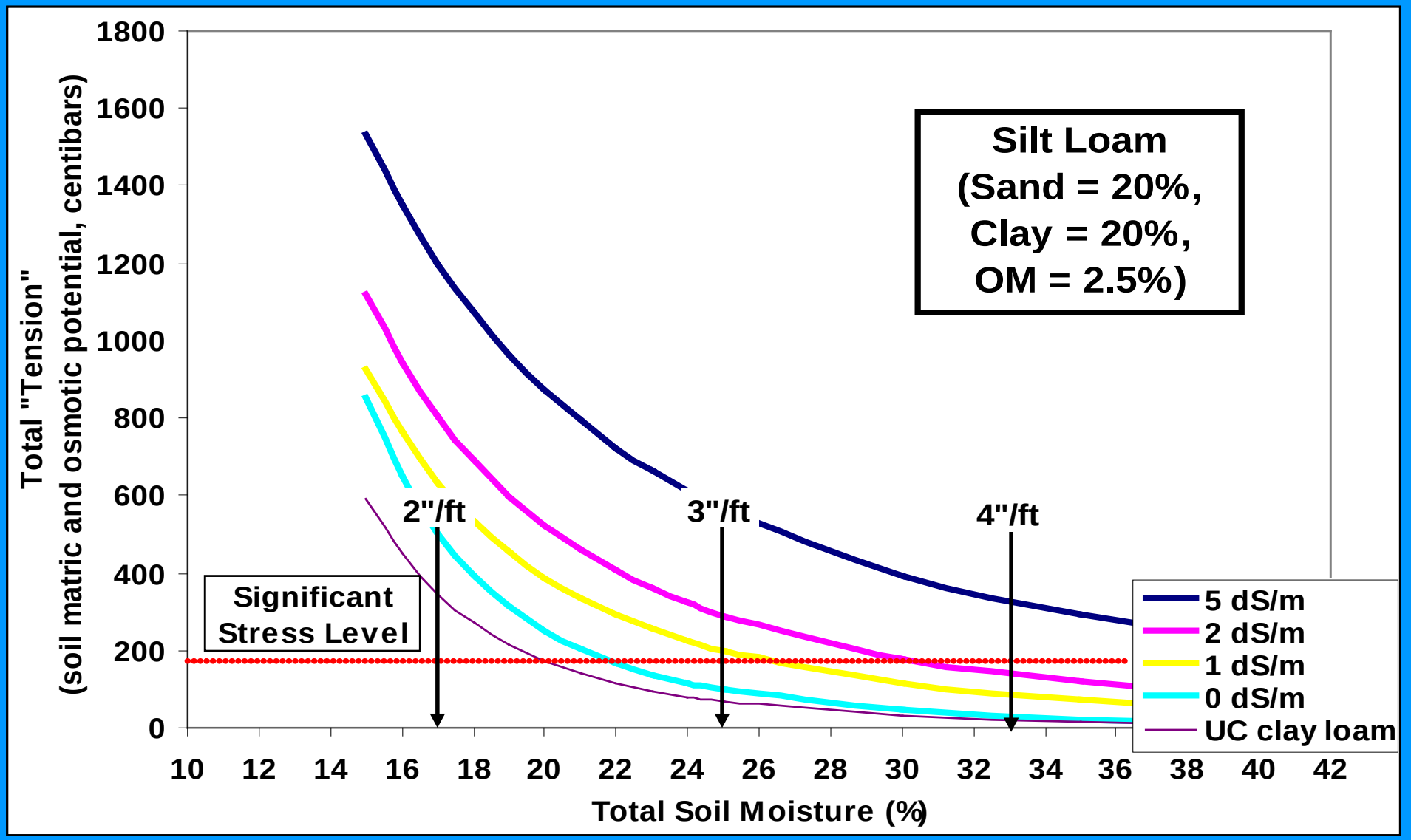


Stage 2 RDI irrigation schedule (D. Goldhamer, 2008)

Growth Stage	Phenology	Period		Refer-ence ETo (inches)	Kc	Normal ETc (inches)	RDI Level (%)	RDI ETc (inches)
	Bloom	Apr	1-15	2.36	0.07	0.17	100	0.17
Stage 1	Leafout	Apr	16-30	2.36	0.43	1.01	100	1.01
	Shell Expansion	May	1-15	3.19	0.68	2.17	100	2.17
	Shell Hardening	May	16-31	3.4	0.93	3.16	50	1.58
Stage 2	Shell Hardening	Jun	1-15	3.84	1.09	4.19	50	2.09
	Shell Hardening	Jun	16-30	3.84	1.17	4.49	50	2.25
	Nut Filling	Jul	1-15	4.13	1.19	4.92	100	4.92
	Nut Filling	Jul	16-31	4.41	1.19	5.25	100	5.25
Stage 3	Nuf Fill/Shell Split	Aug	1-15	3.54	1.19	4.21	100	4.21
	Shell Splitting	Aug	16-31	3.78	1.12	4.23	100	4.23
	Hull Slip	Sept	1-15	2.66	0.99	2.63	100	2.63
	Harvest	Sept	16-30	2.66	0.87	2.31	25	0.58
Post-harvest	Postharvest	Oct	1-15	1.71	0.67	1.15	25	0.29
	Postharvest	Oct	16-31	1.83	0.5	0.91	25	0.23
	Postharvest	Nov	1-15	0.8	0.35	0.28	25	0.07
					Totals	41.1		31.7

Plant stress can be high even with wet soil

(Effective total soil moisture tension for a silt loam soil with increasing salinity)



Salt increases osmotic potential, costing the plant energy and interfers with water uptake and limits critical processes like cell expansion for germination and shoot growth.

Pistachios in Iran
(irrigation EC 25 dS/m)

More than ½ million acres in the SJV are free of "perched water" but have poor surface soils with excessive silt and sodicity, resulting in "sealing" and poor structure not conducive to optimal root development.

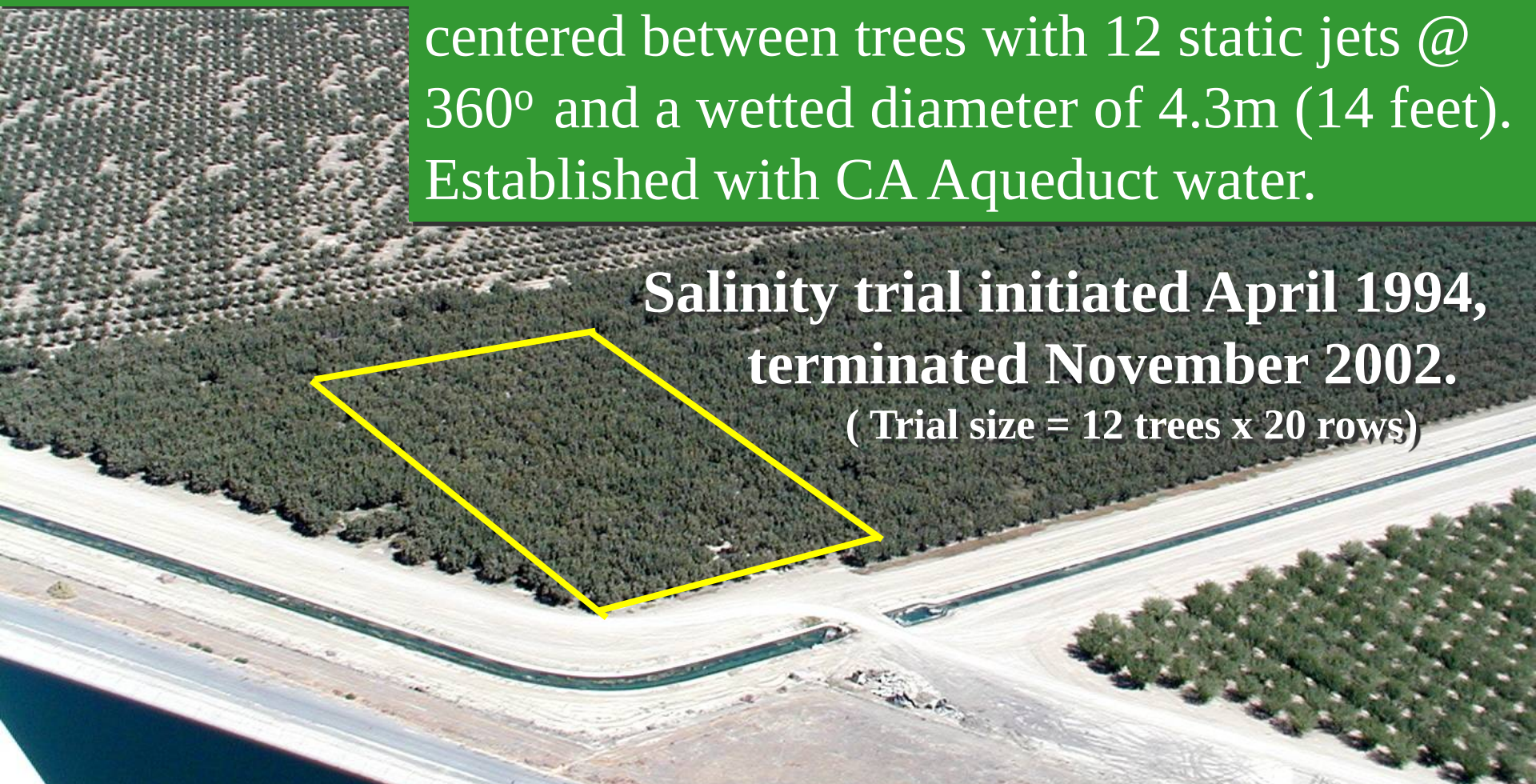
STUDY SITE – NW KERN COUNTY (Aerial 9/19/02)

40 acre pistachio orchard planted 1989

Soil: calcareous Twisselman silty clay

Spacing: 5.2 x 6.1m (17 x 20 feet)

Irrigation: One 55 lph (14.5 gph) microsprinkler/tree centered between trees with 12 static jets @ 360^{o} and a wetted diameter of 4.3m (14 feet). Established with CA Aqueduct water.

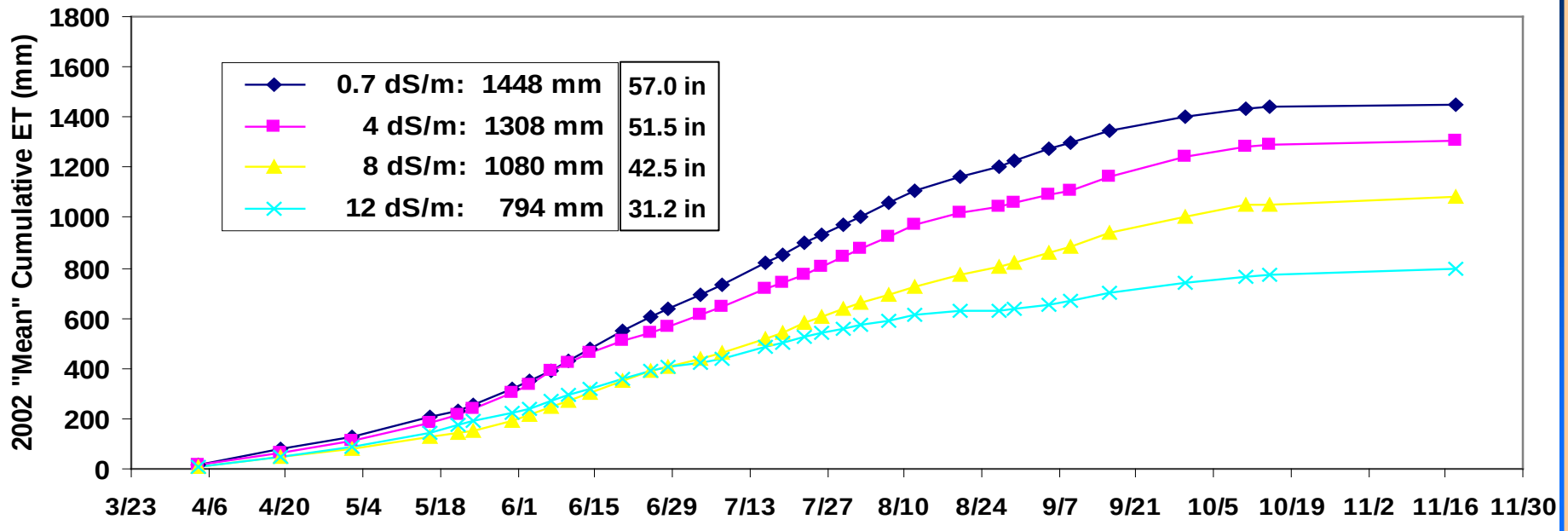


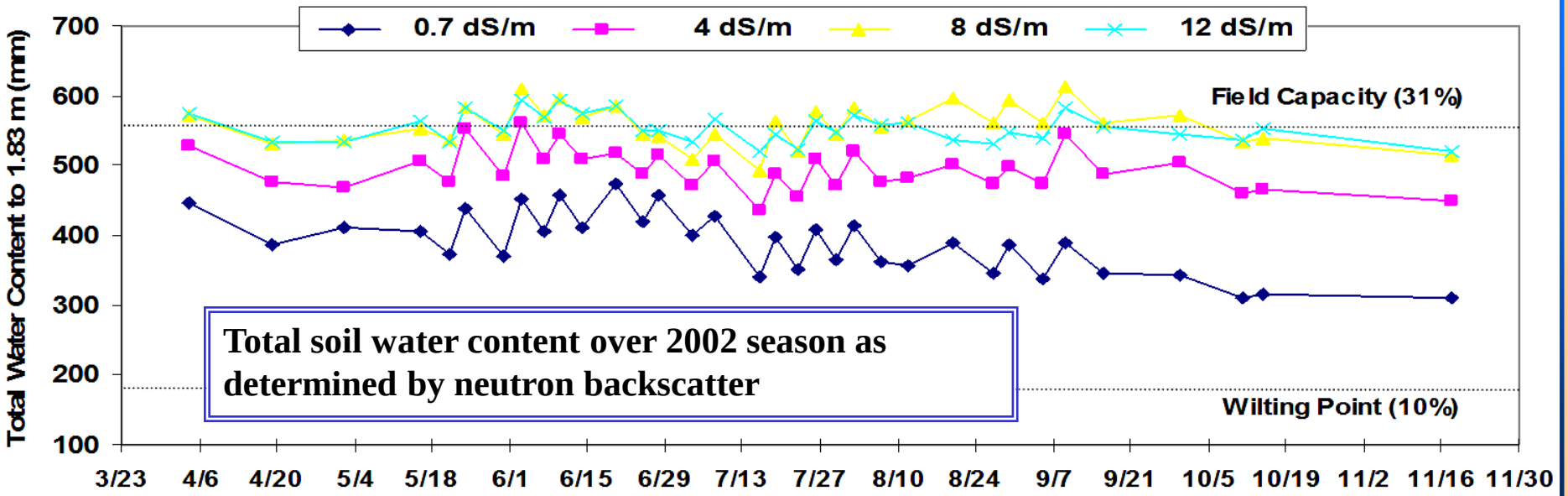
Salinity trial initiated April 1994, terminated November 2002.

(Trial size = 12 trees x 20 rows)


0.5-0.7 dS/m
4 dS/m
8 dS/m
12 dS/m

ET totals from 1994-2002 original pistachio salt tolerance trial for the San Joaquin Valley showing higher total soil moisture and lower total ET due to increasing osmotic stress.

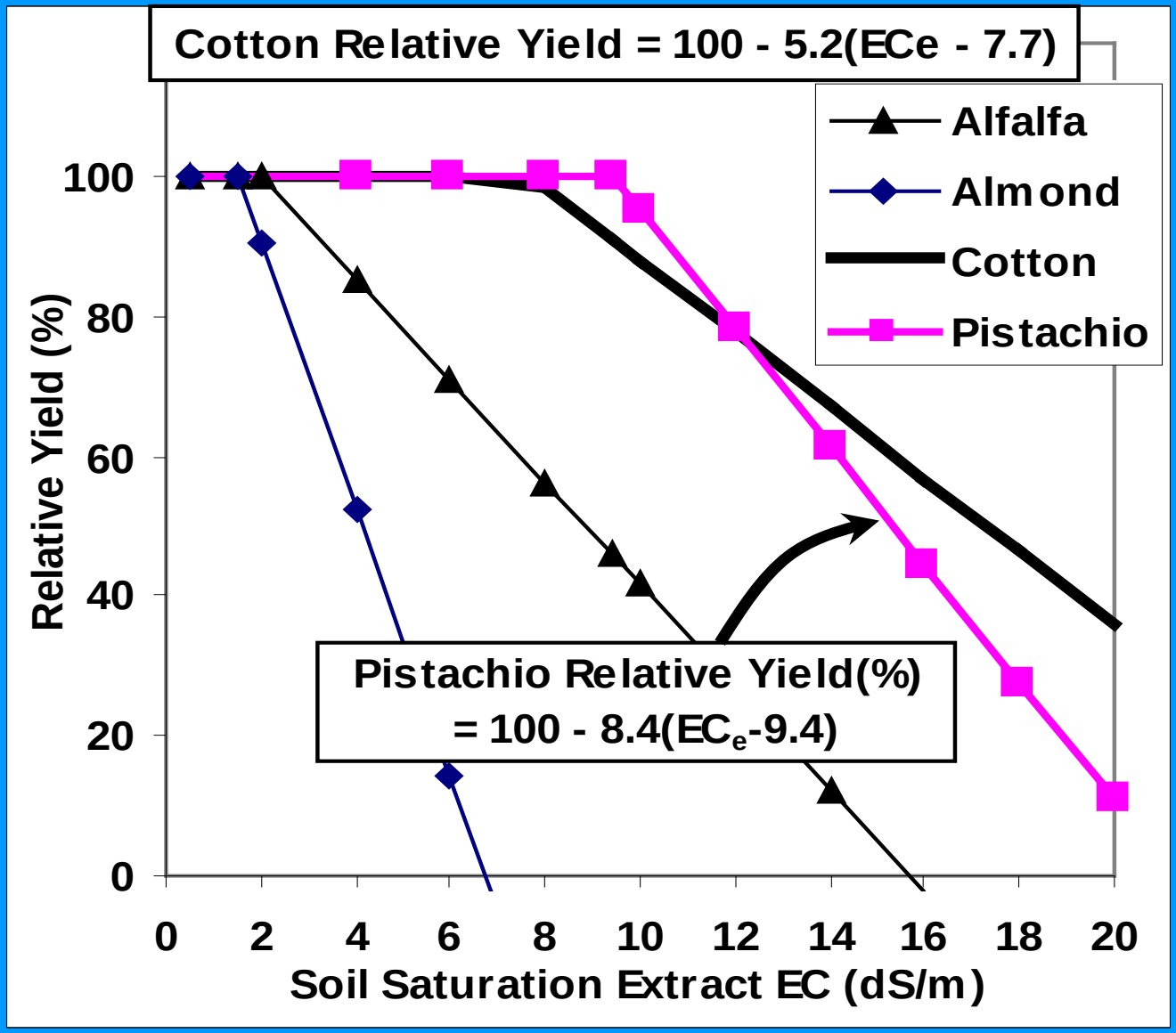




Total soil water content over 2002 season as determined by neutron backscatter

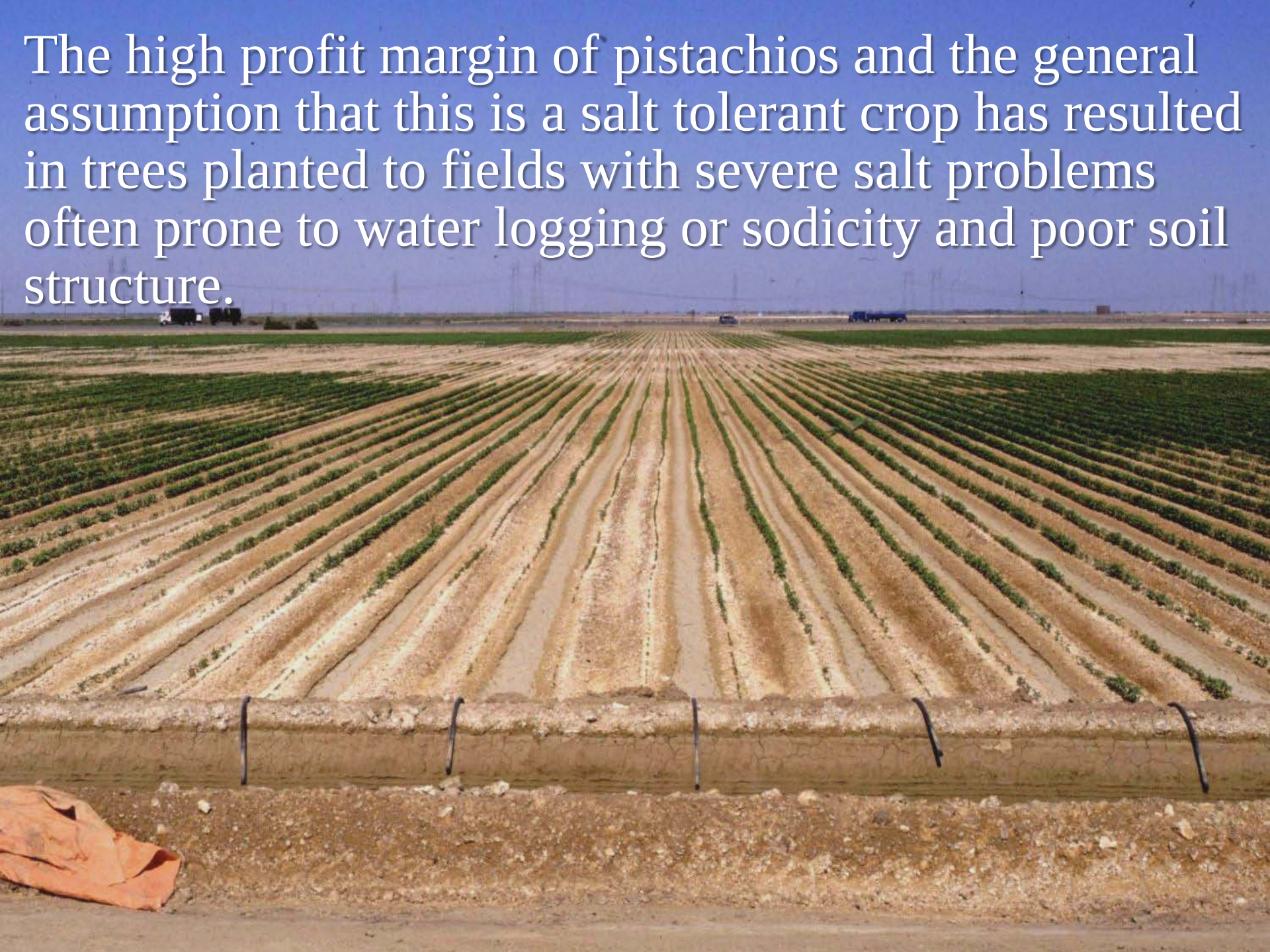
Relative yield of as a function of soil ECe

Current salinity thresholds for pistachios

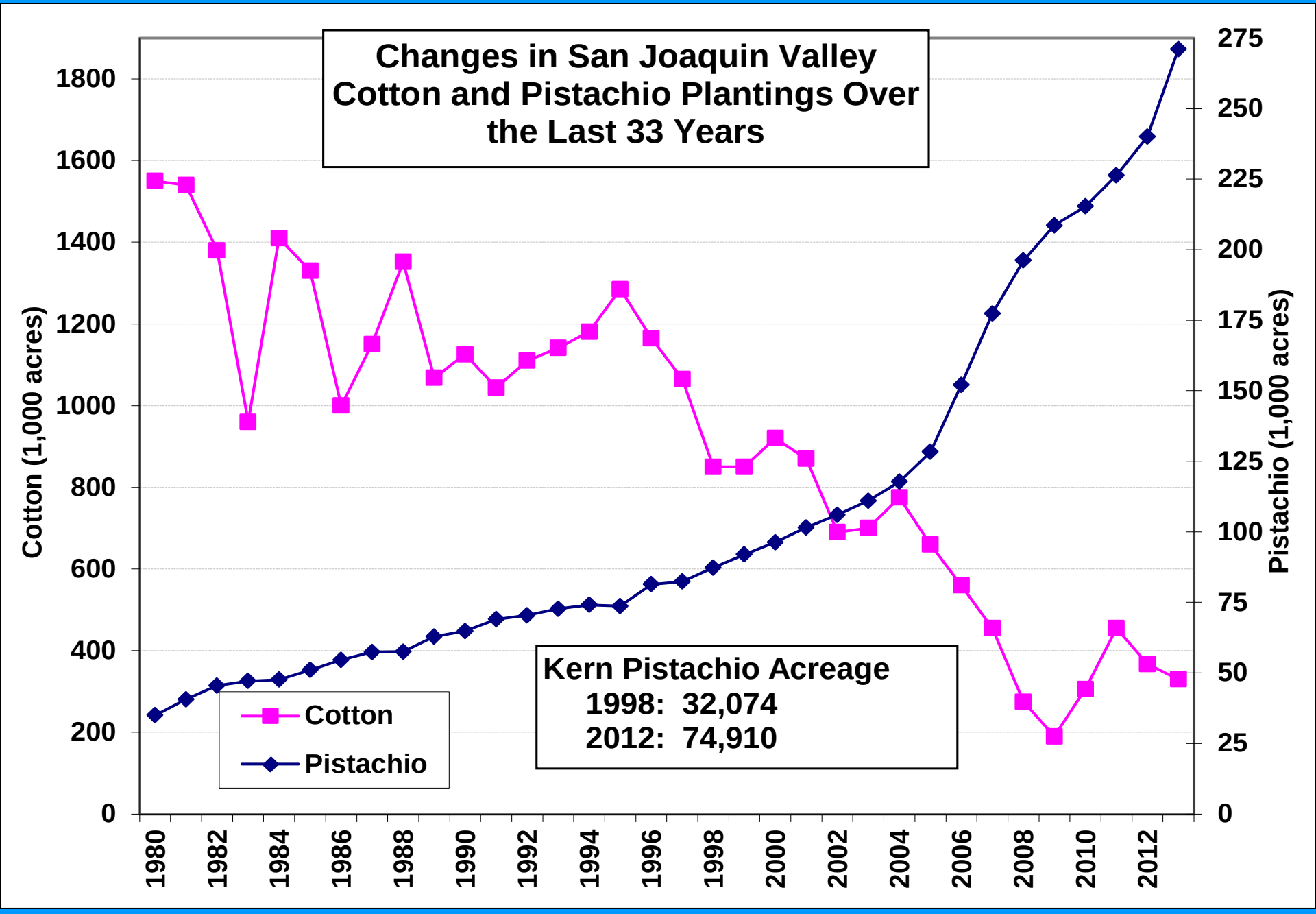


Sanden, B.L., L. Ferguson, H.C. Reyes, and S.C. Grattan. 2004. Effect of salinity on evapotranspiration and yield of San Joaquin Valley pistachios. Proceedings of the IVth International Symposium on Irrigation of Horticultural Crops, Acta Horticulturae 664:583-589.

The high profit margin of pistachios and the general assumption that this is a salt tolerant crop has resulted in trees planted to fields with severe salt problems often prone to water logging or sodicity and poor soil structure.



Pistachio acreage has more than doubled in last 10 years



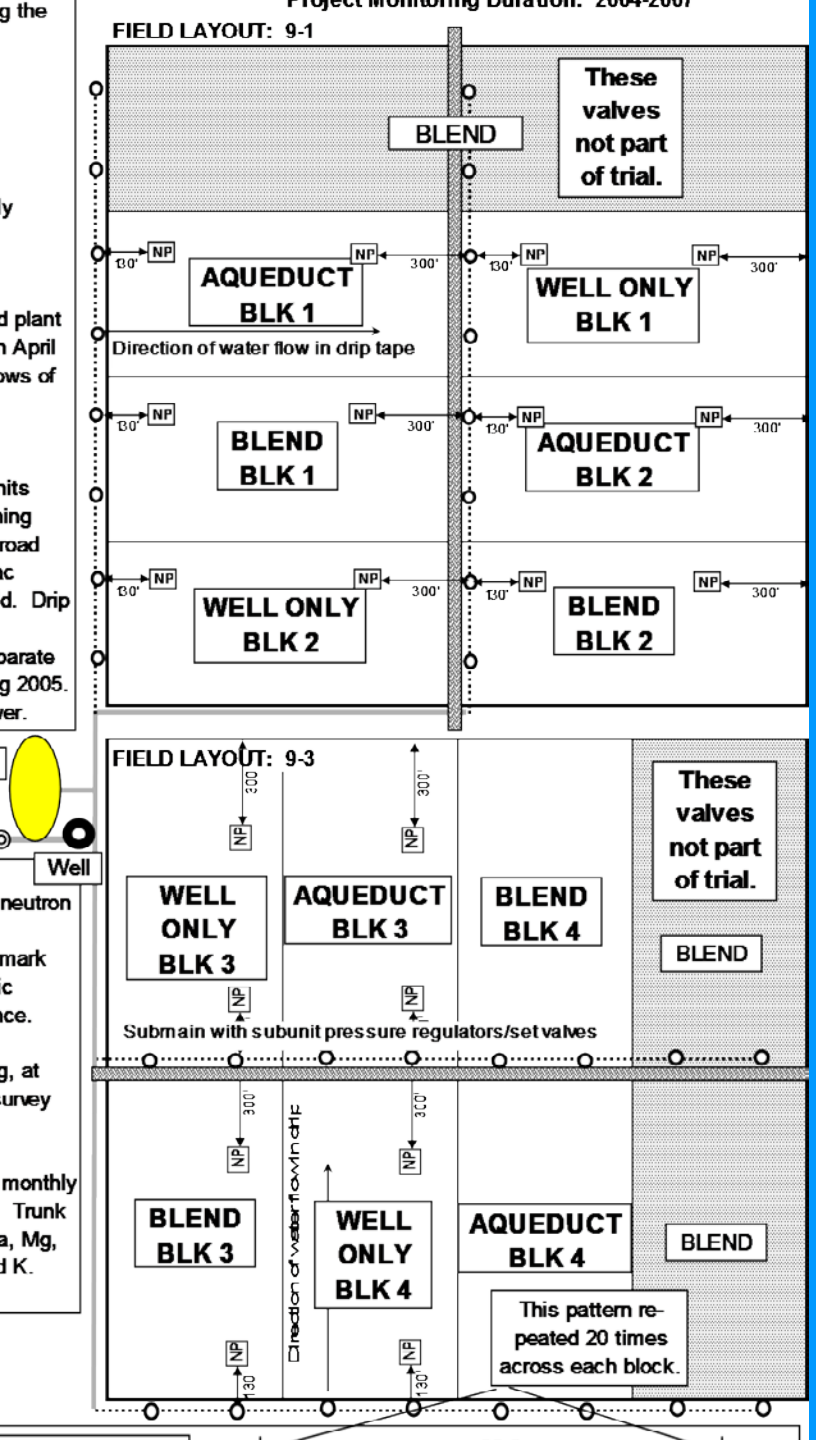

This doesn't look too salty…
or is it?


Just a little “black alkali”…

Really?

Some spots are just too hot!

WE NOW HAVE MORE LAND THEN FRESH CANAL WATER IN THE San Joaquin Valley --WHAT ABOUT DEVELOPING NEW PISTACHIO PLANTINGS USING SALINE GROUNDWATER?



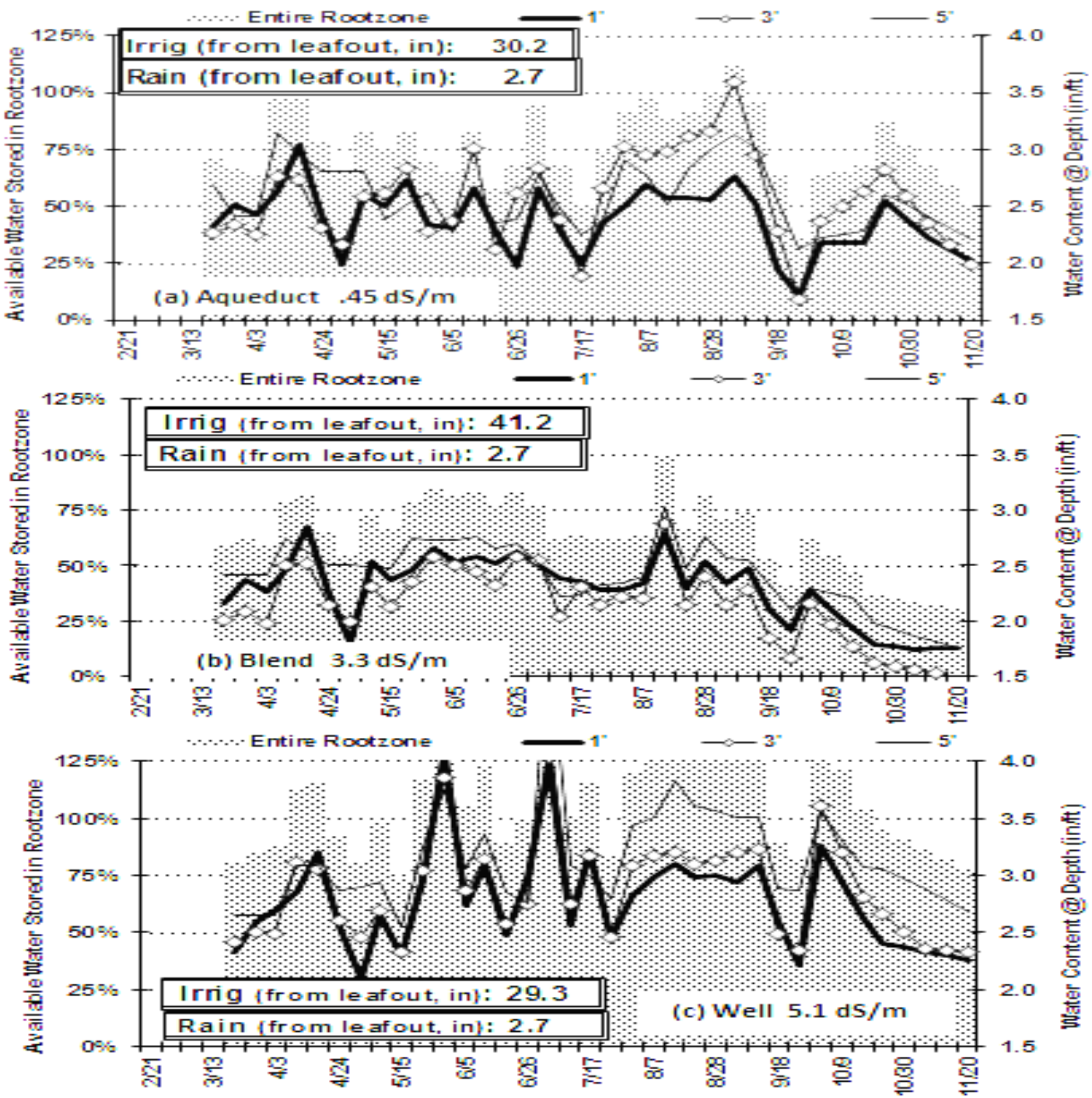
Belridge Salinity Trial

-- 2, 155 acre fields

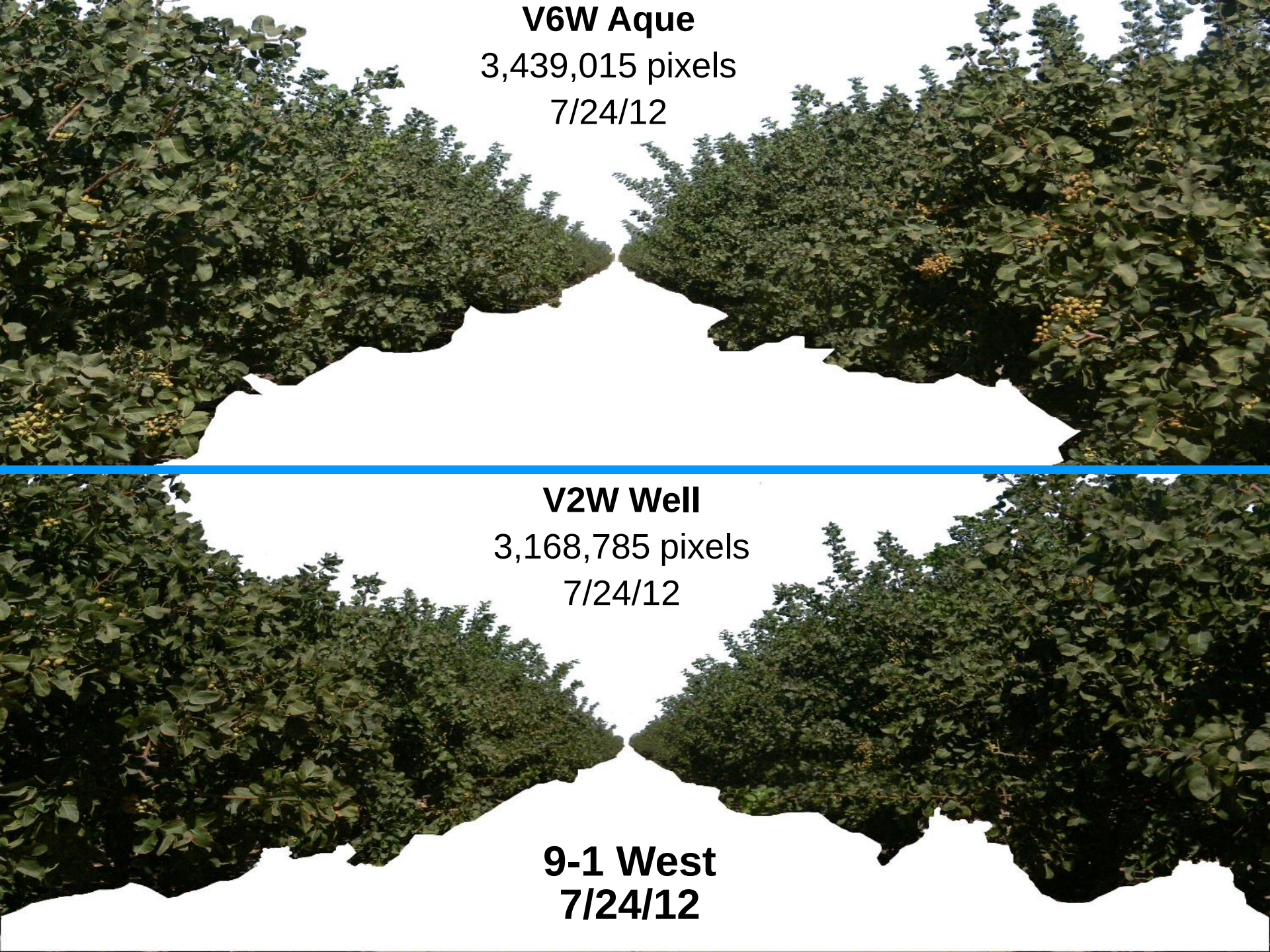
-- 12, 19.5 acre testplots

Marginal burn was seen on most leaves

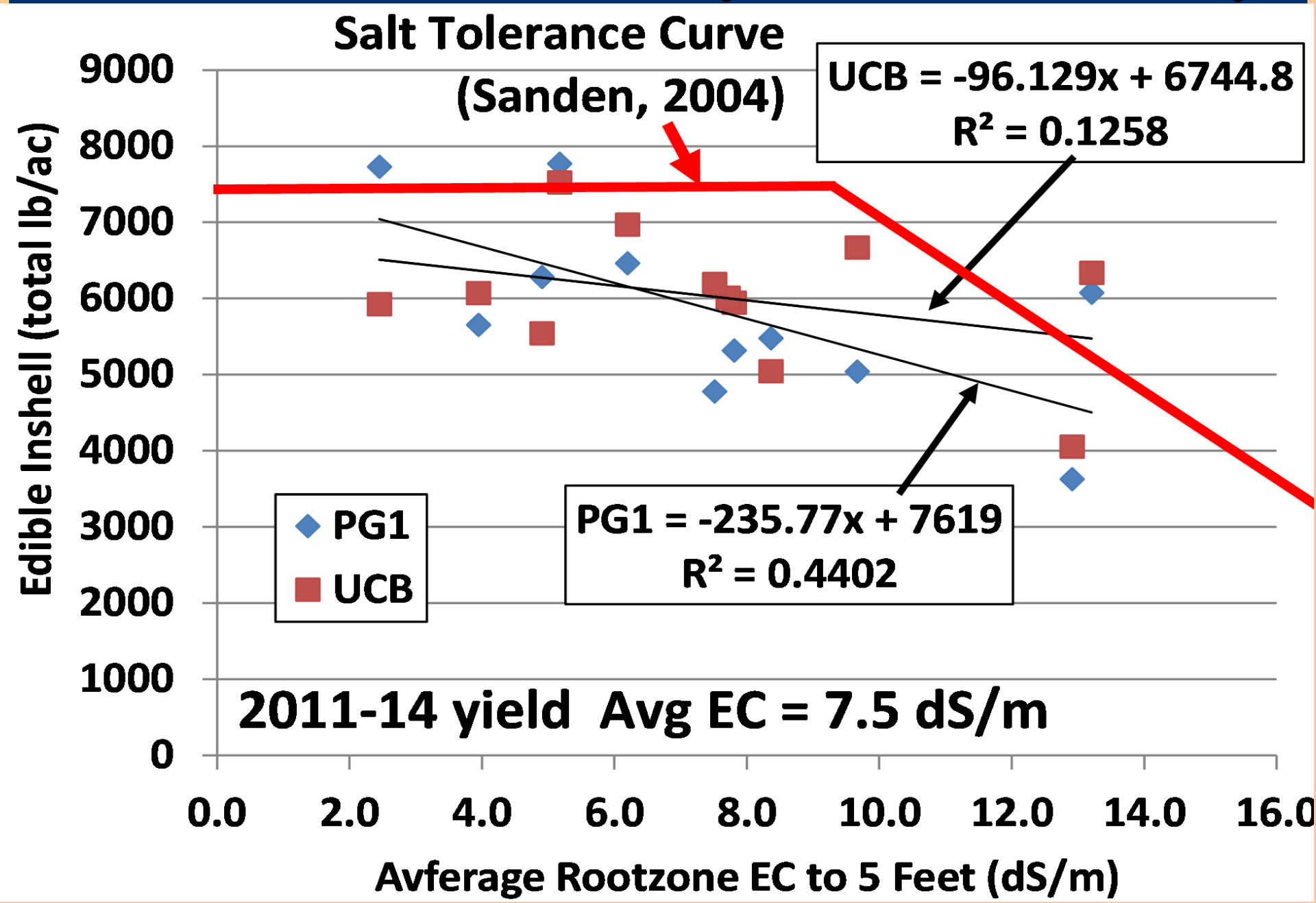
9-1 West Compare



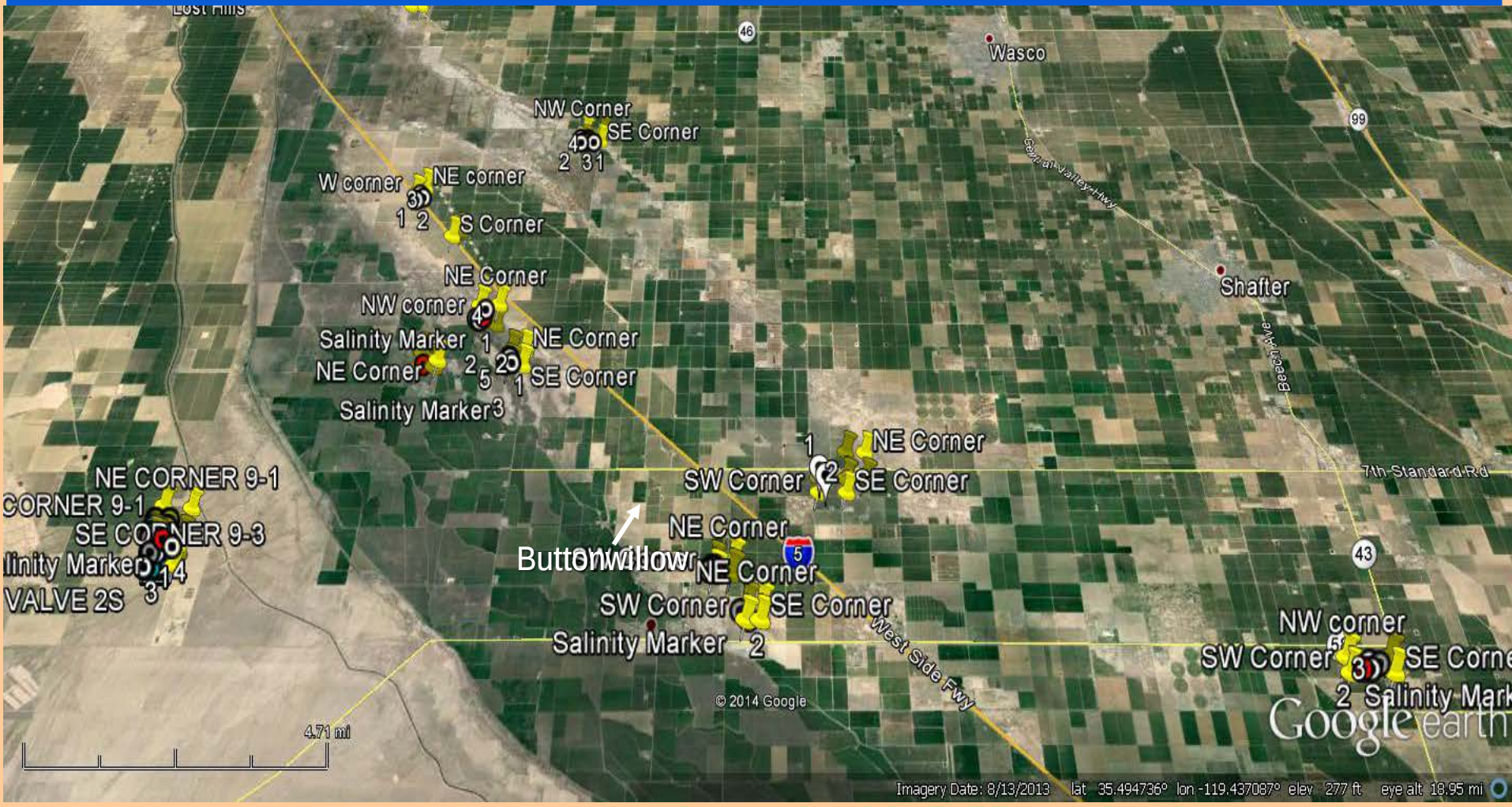
2012 neutron probe soil moisture readings showed significant leaching for the WELL treatment

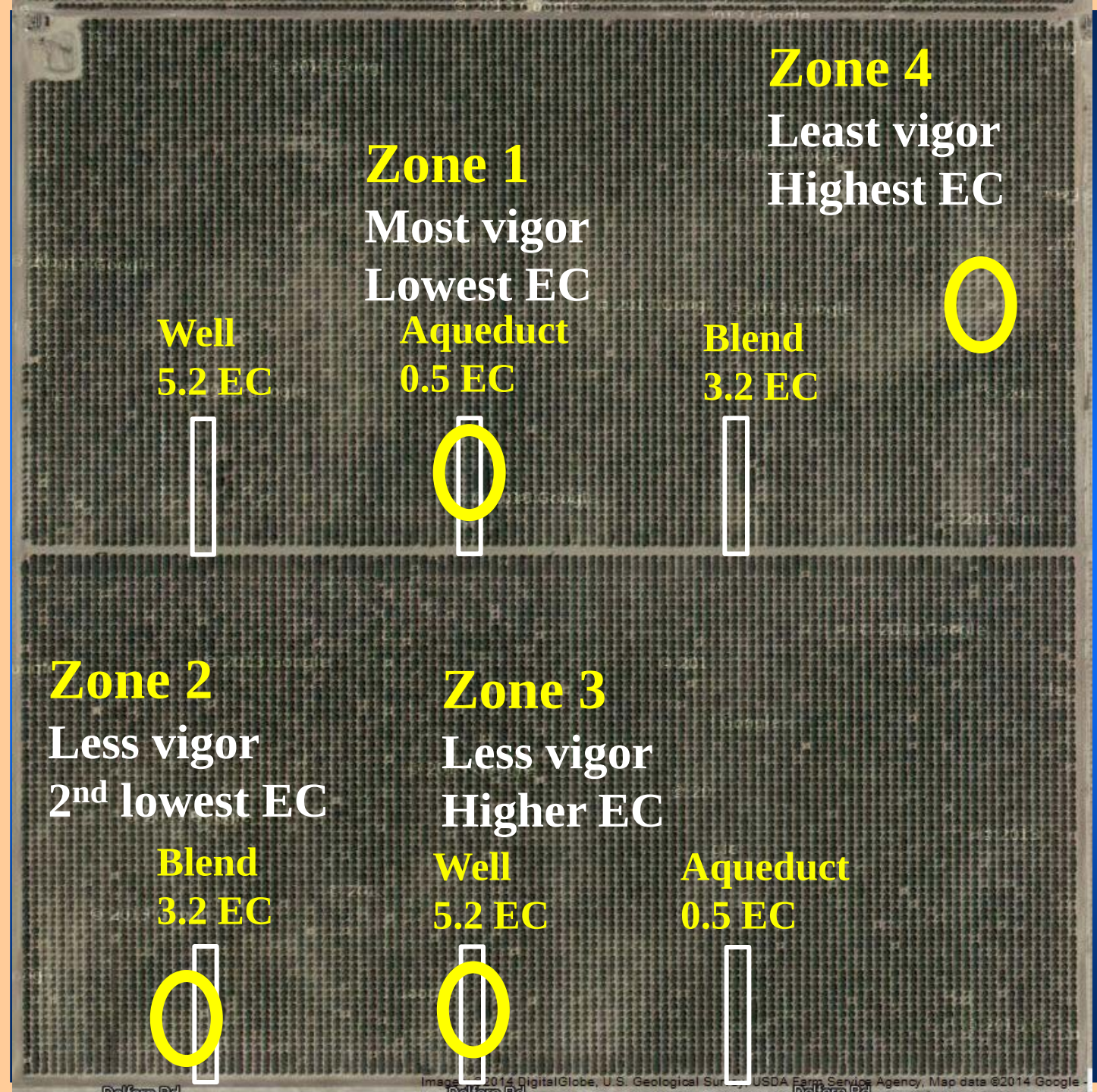

V6W Aque
3,439,015 pixels
7/24/12
V2W Well
3,168,785 pixels
7/24/12
9-1 West
7/24/12

2010-14 Yield Decline by Rootzone Salinity



2014-15 Large-Scale Utilization of Saline Groundwater for Development and Irrigation of Pistachios – Defining a 'Real World' Salt Tolerance Curve for San Joaquin Valley Pistachios (expanded survey of 10 fields, western Kern)





Use Google Earth, GEO-G2 historical NDVI and new Stanford Drone UAV infrared canopy temp images and surveys to identify 4 zones of differential crop vigor

Expanded Salinity Survey:

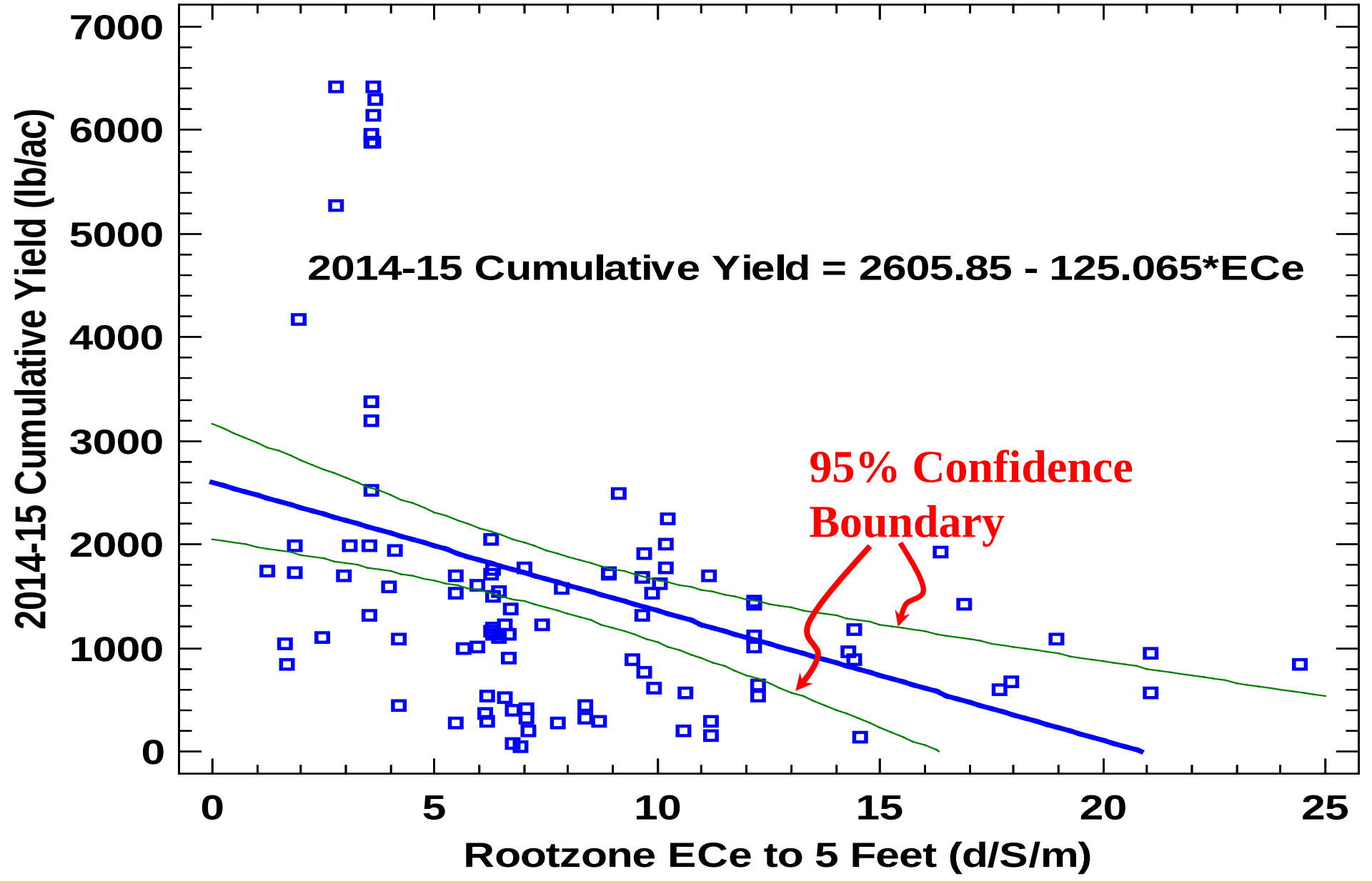
select the best (Area 1) to worst (Area 5) zone in a commercial field. Measure tree stature, rootzone salinity and yield

Area 1: Average rootzone ECe to 5 ft 9.1 dS/m (soluble B 3 ppm)

Area 5: Average rootzone ECe to 5 ft 30.0 dS/m Soluble B 27 ppm)

(6/20/2014)

2014-15 Biennial Yield Decline by Rootzone Salinity to 5 Feet (as sampled on 8/6/14)



New for 2015

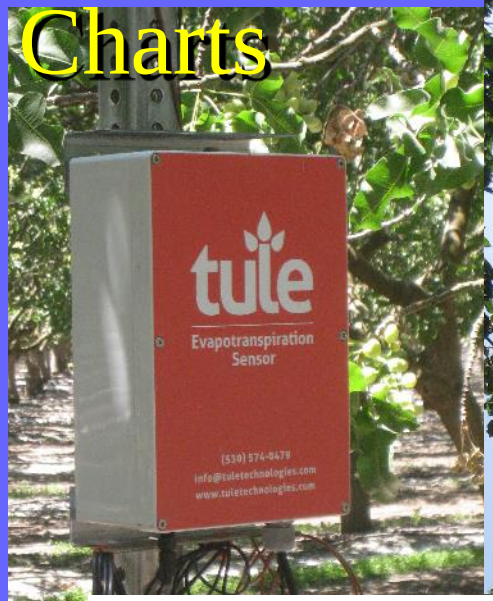
Updating Crop Water Use and Crop Coefficients of Mature Pistachio Orchards in the San Joaquin Valley

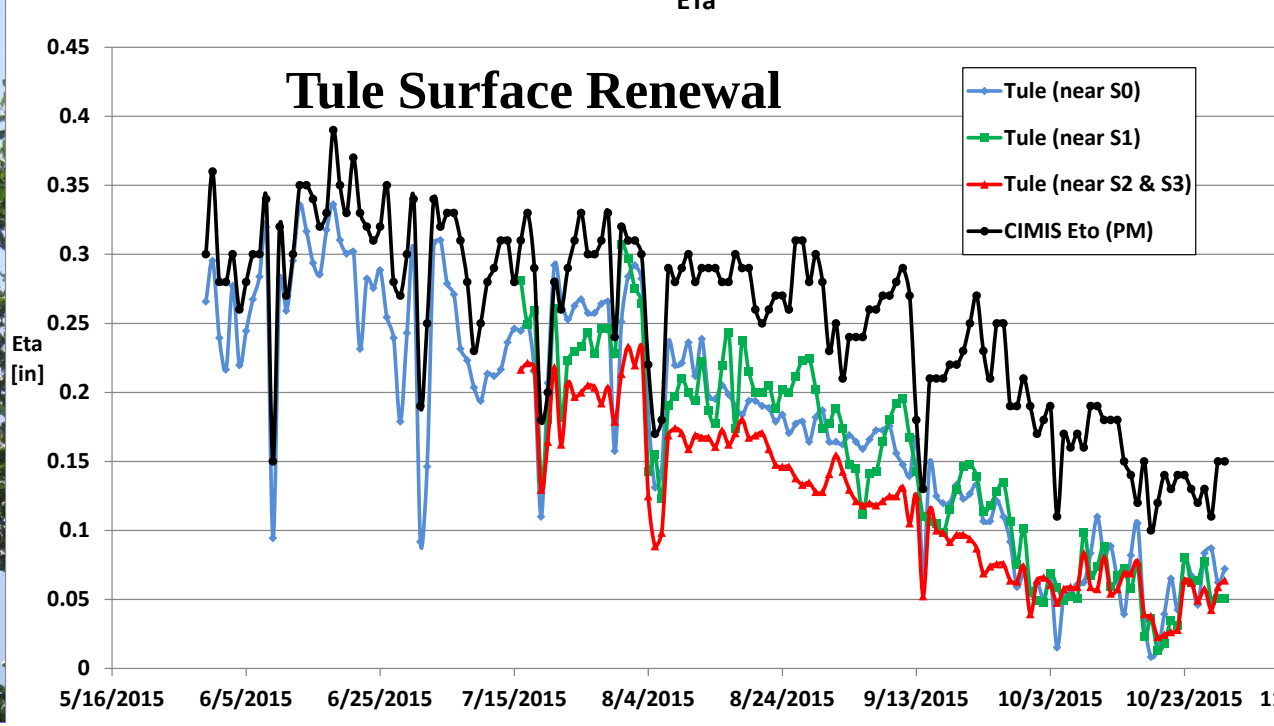
Rootzone
ECe 2.3 dS/m
Mid-valley Hanford

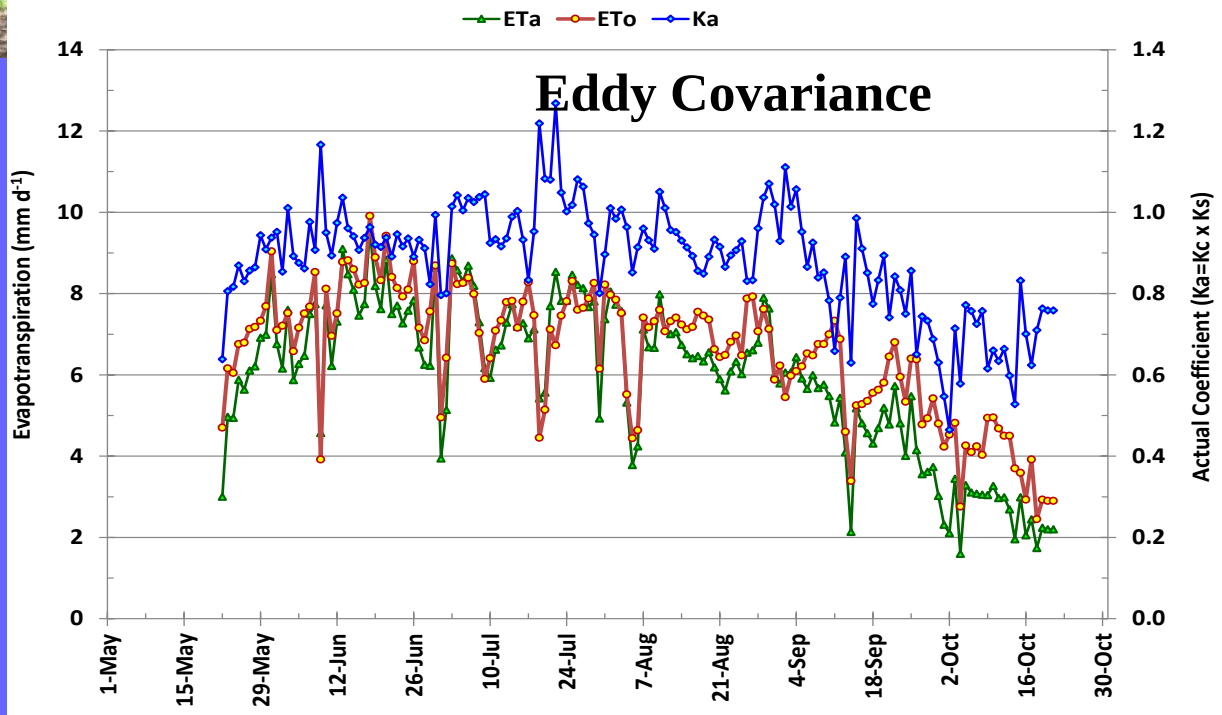
Updating pistachio Kc values for non-saline to marginally saline soils

Rootzone
ECe 5.9 dS/m
Westside Hwy 198

Daily ET Charts



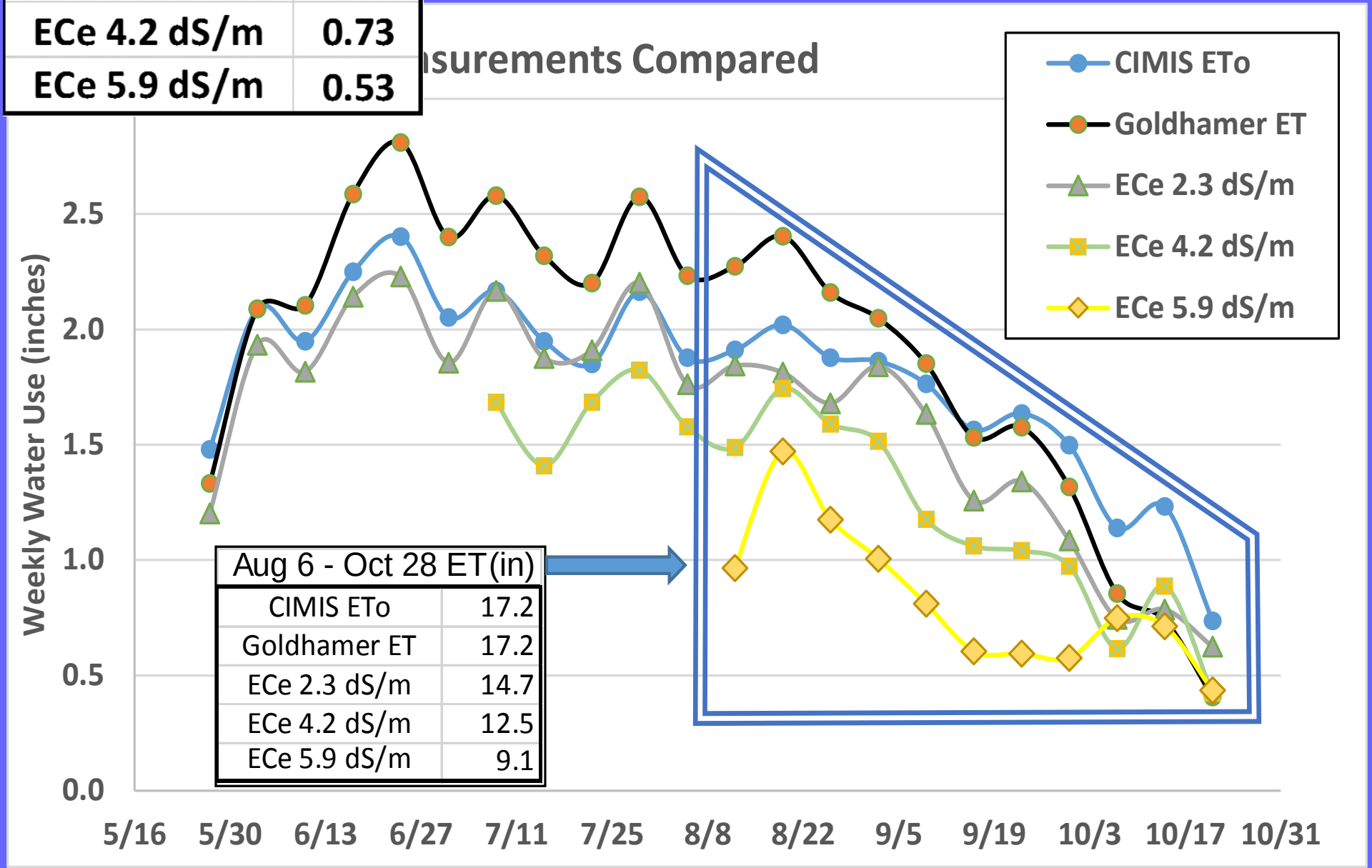




Using Tule ET stations and "eddy-covariance" energy flux to determine ET.

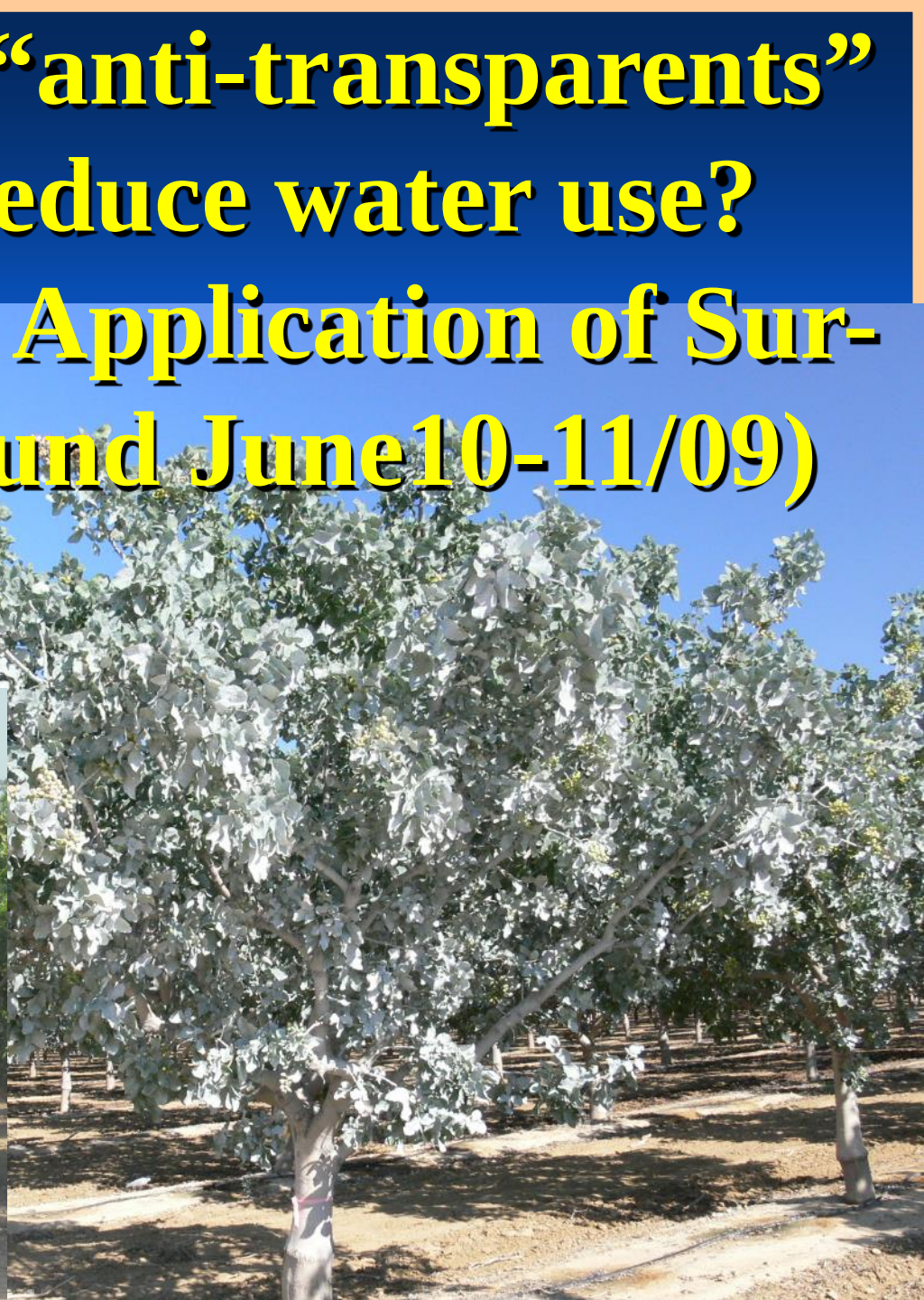
Pistachio ET measurements for 2015 compared as affected by salinity

Ratio of measured ET / Goldhamer ET	
ECe 2.3 dS/m	0.85
ECe 4.2 dS/m	0.73
ECe 5.9 dS/m	0.53

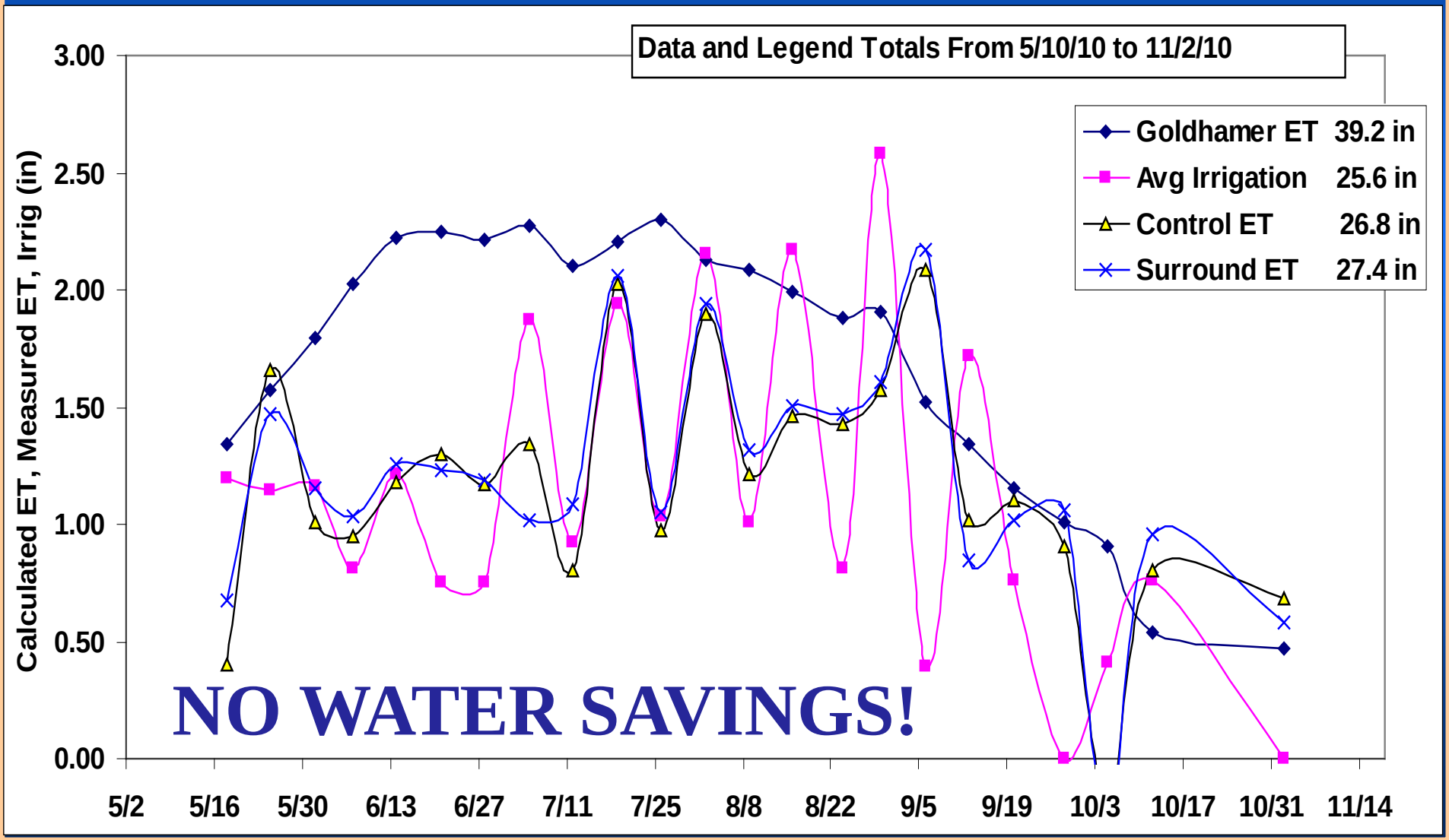


Aug 6 - Oct 28 ET(in)	
CIMIS ETo	17.2
Goldhamer ET	17.2
ECe 2.3 dS/m	14.7
ECe 4.2 dS/m	12.5
ECe 5.9 dS/m	9.1

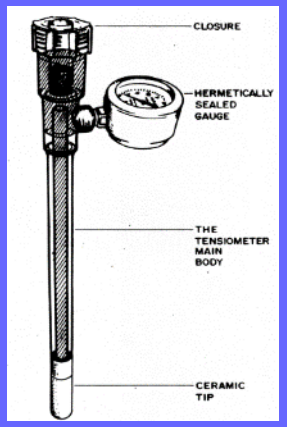
Do “anti-transparents” reduce water use? (2nd Application of Sur-round June10-11/09)

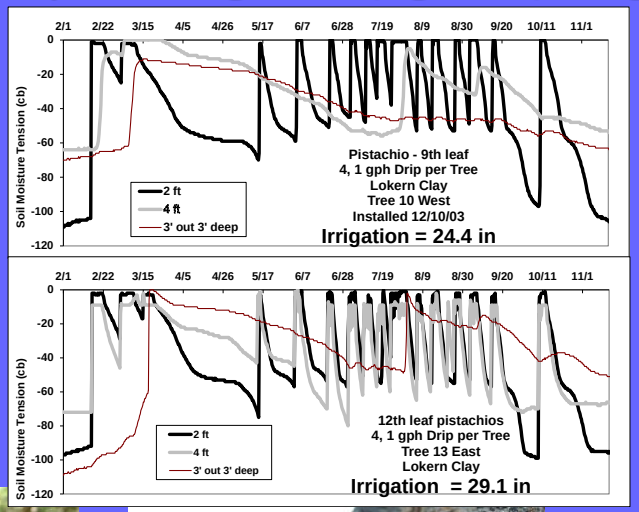


Comparison of various weekly ET calculations for 2009-2010 (Surround trial)

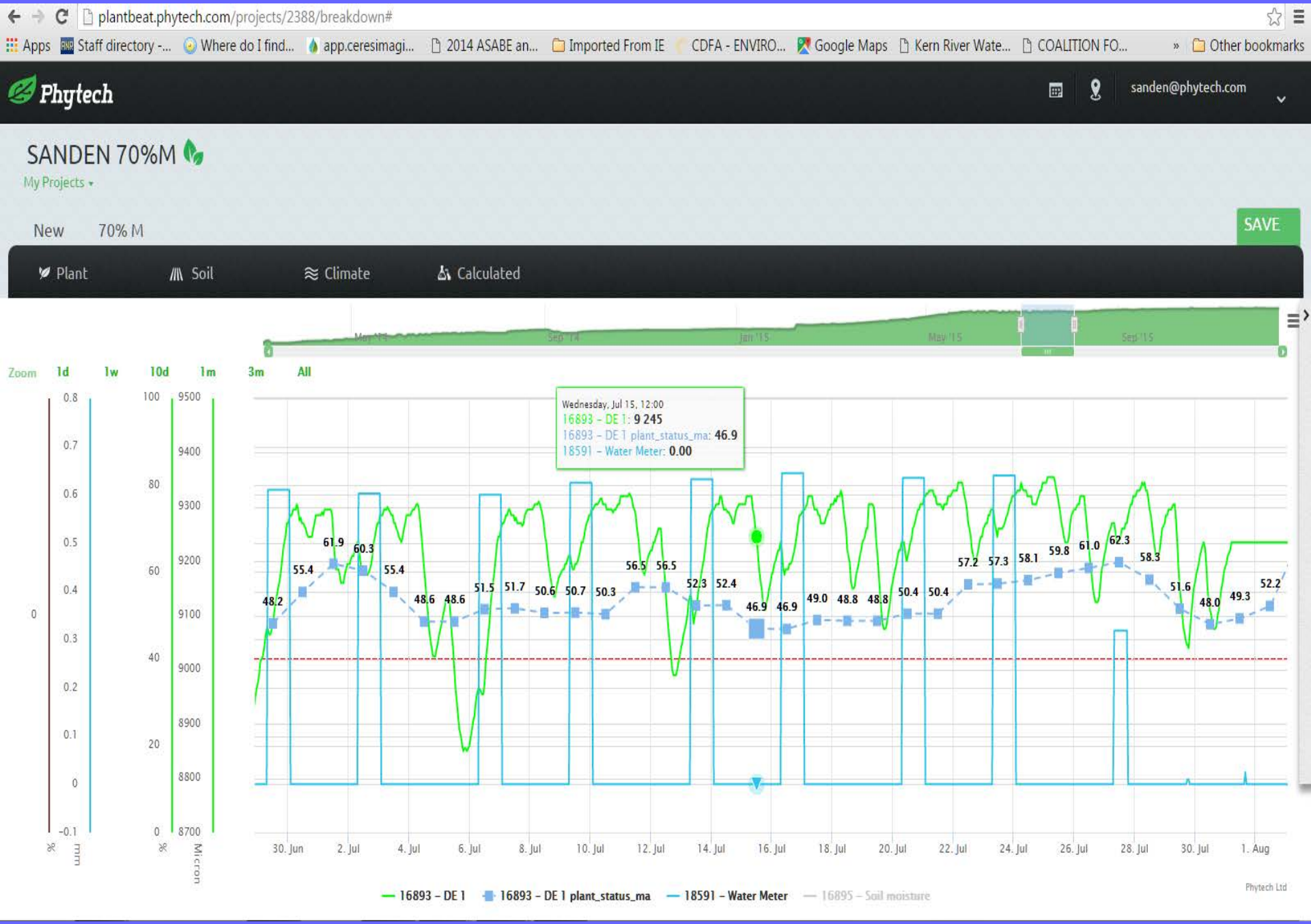


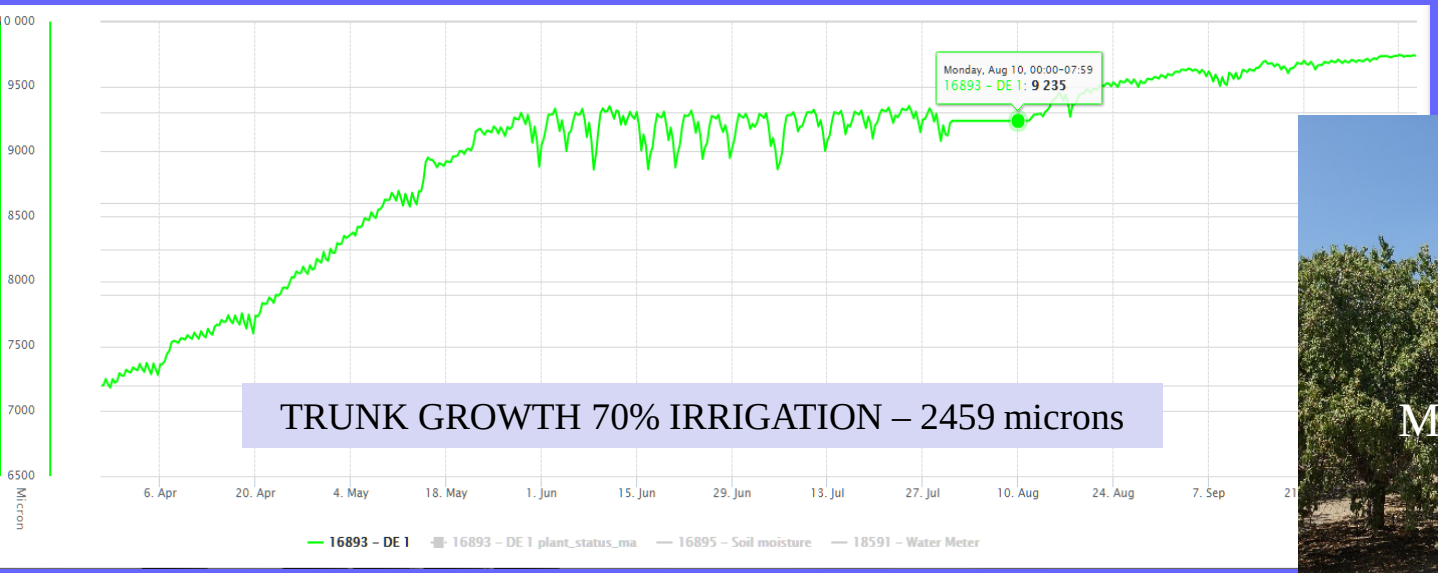
For optimal pistachio irrigation be a "self-made man"! Monitor the field.

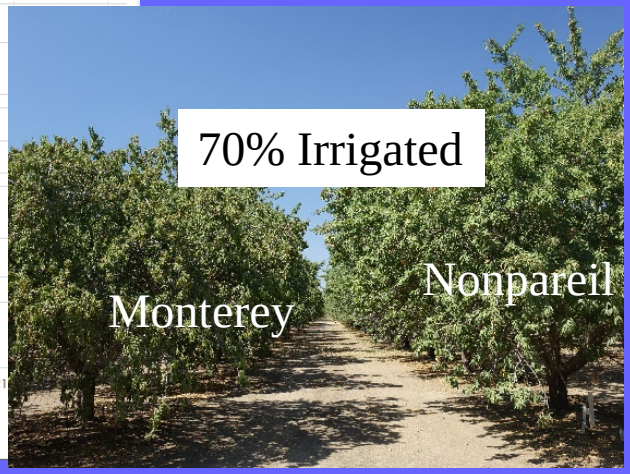




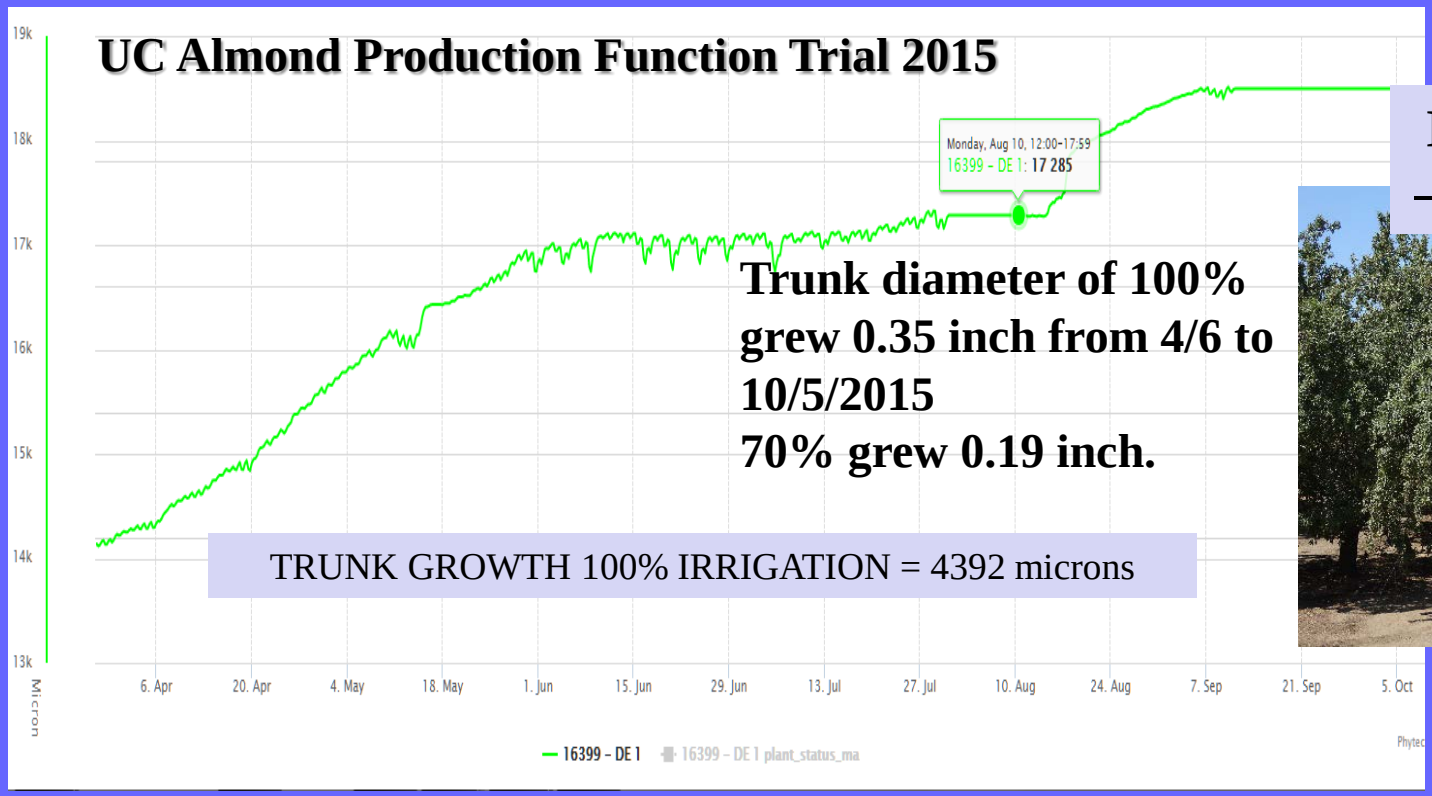
Phytech dendrometers track small changes in water stress and trunk growth


plantbeat.phytech.com/projects/2388/breakdown#
Apps
Staff directory -...
Where do I find...
app.ceresimagi...
2014 ASABE an...
Imported From IE
CDFA - ENVIRO...
Google Maps
Kern River Wate...
COALITION FO...
Other bookmarks
Phytech
sanden@phytech.com
SANDEN 70%M
My Projects
New
70% M
SAVE
Plant
Soil
Climate
Calculated
Zoom
1d
1w
10d
1m
3m
All
Wednesday, Jul 15, 12:00
16893 - DE 1: 9 245
16893 - DE 1 plant_status_ma: 46.9
18591 - Water Meter: 0.00
30. Jun
2. Jul
4. Jul
6. Jul
8. Jul
10. Jul
12. Jul
14. Jul
16. Jul
18. Jul
20. Jul
22. Jul
24. Jul
26. Jul
28. Jul
30. Jul
1. Aug
16893 - DE 1
16893 - DE 1 plant_status_ma
18591 - Water Meter
16895 - Soil moisture
Phytech Ltd



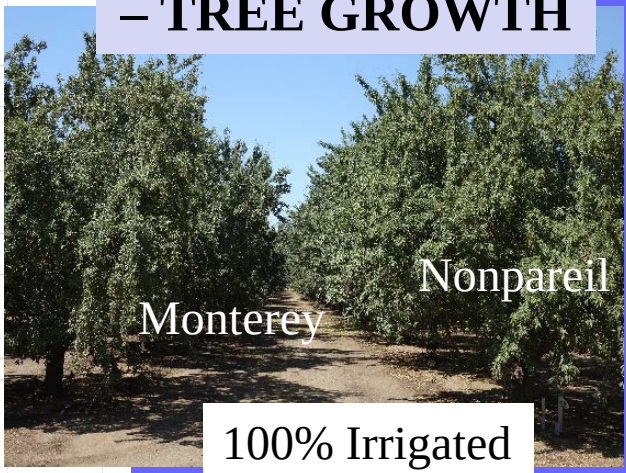


UC Almond Production Function Trial 2015

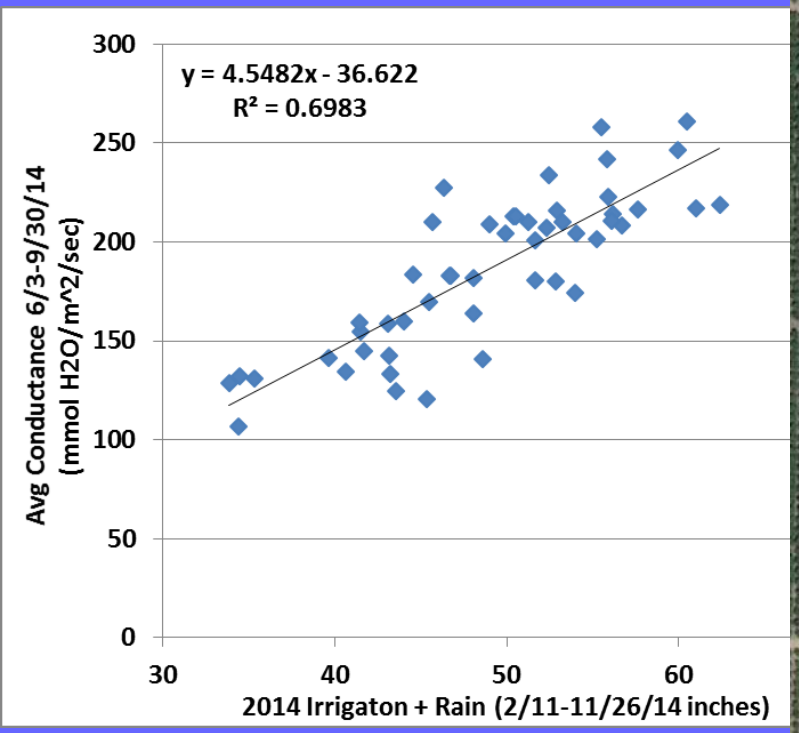


Trunk diameter of 100% grew 0.35 inch from 4/6 to 10/5/2015
70% grew 0.19 inch.

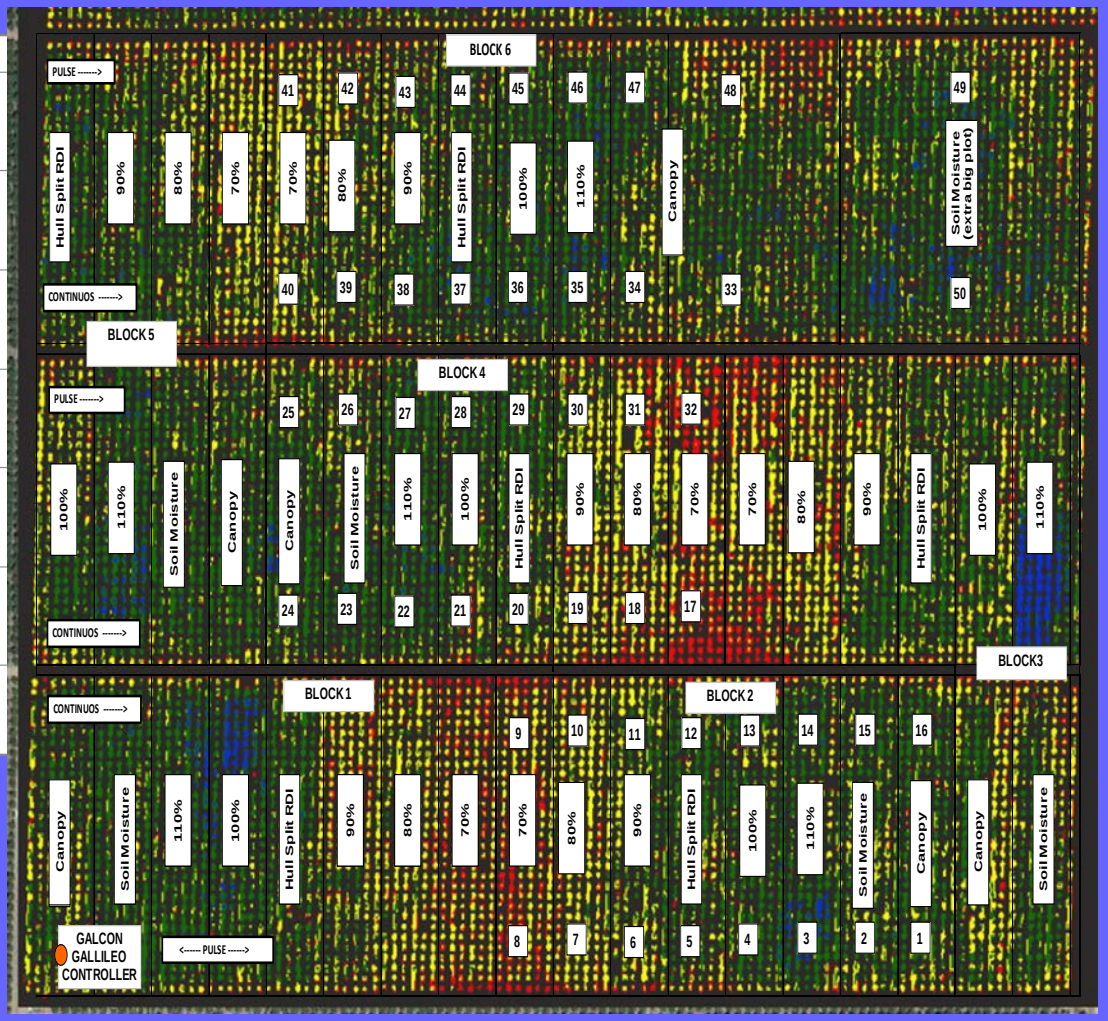
DENDROMETER – TREE GROWTH



AERIAL IMAGERY CAN IDENTIFY NON-UNIFORMITY



6/3-9/30/14 average almond plot water conductance by 2014 applied irrigation



Canopy Temp/Water Stress by Irrigation Treatment (CERES

Spectral Imaging 6-3-14,
Shackel, et al. Yield Production Function Trial)

Inspecting trees and neutron probe sites with the Chief Pistachio Nut of Kern County UC Extension – Craig Kallsen 5/15/09

Flowmeter

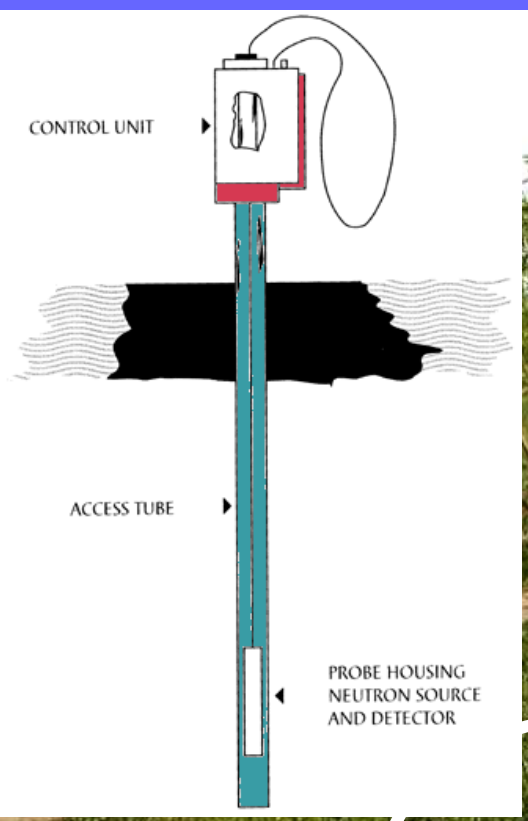
Neutron Probe tube to 9 feet

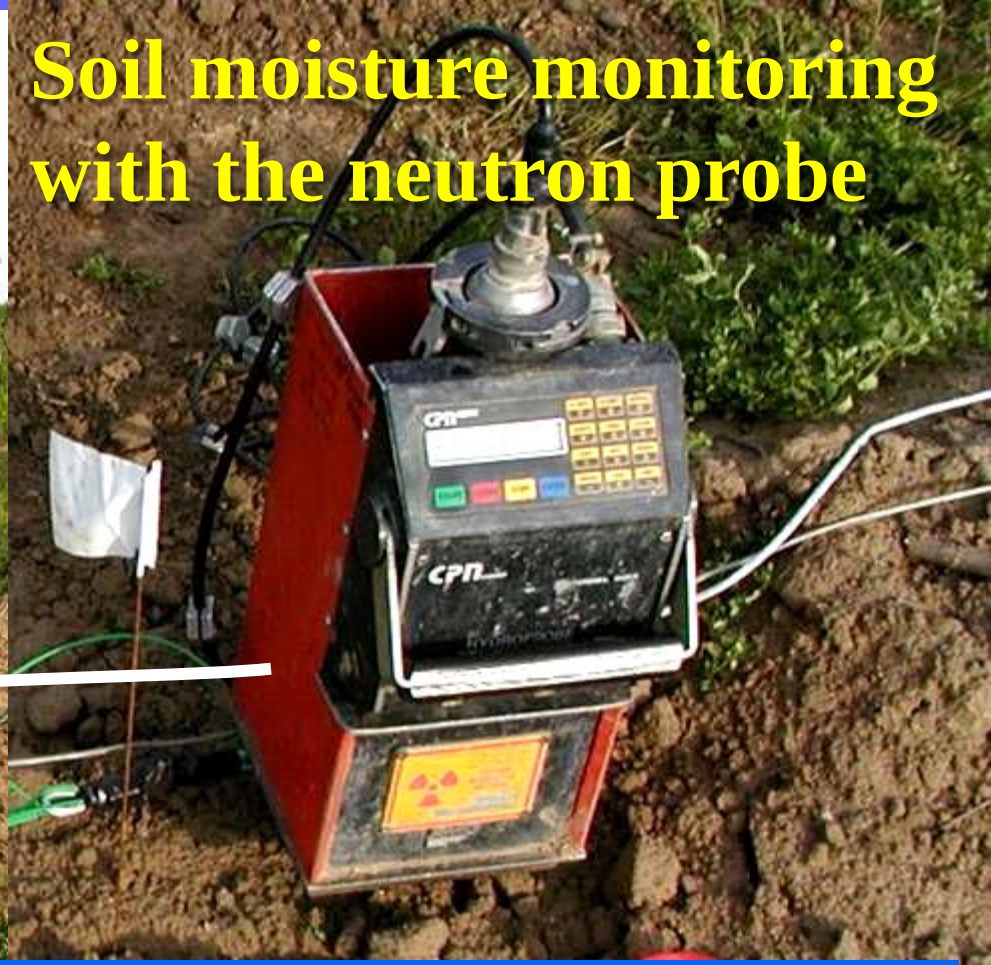
Tree spacing 17 x 20 ft
3, 1 gph PC drips/tree
(NP tube 24” from dripper)

How many sensors are enough?

What type is best for which crop?

Soil moisture monitoring with the neutron probe

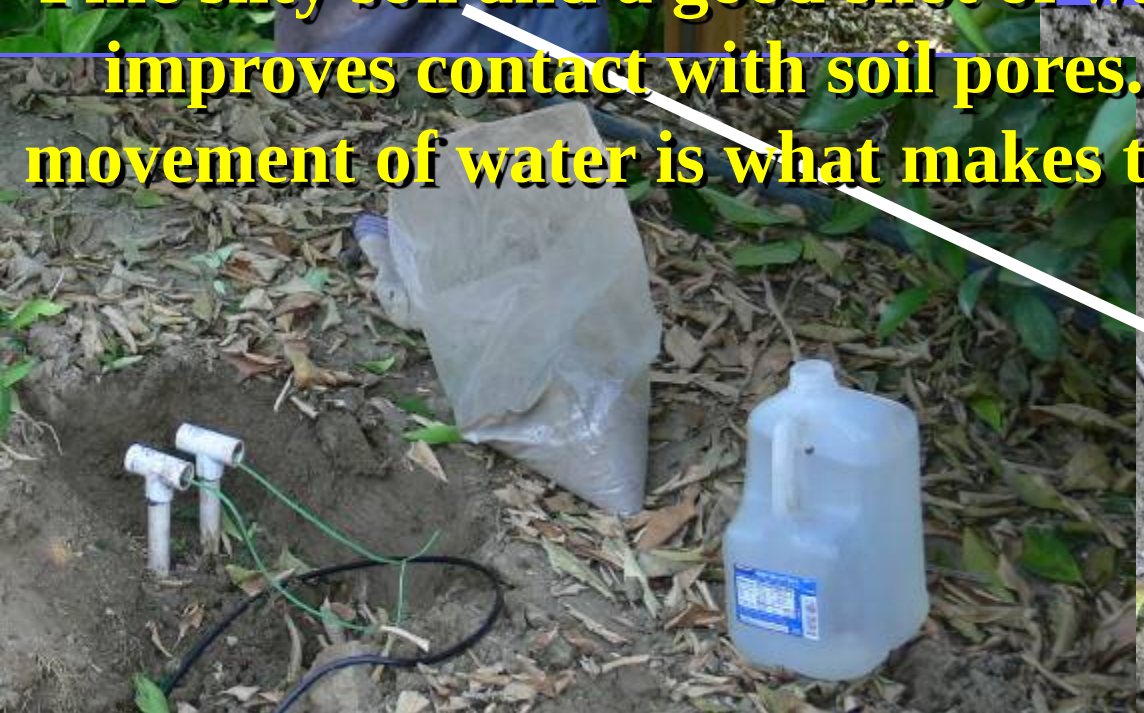




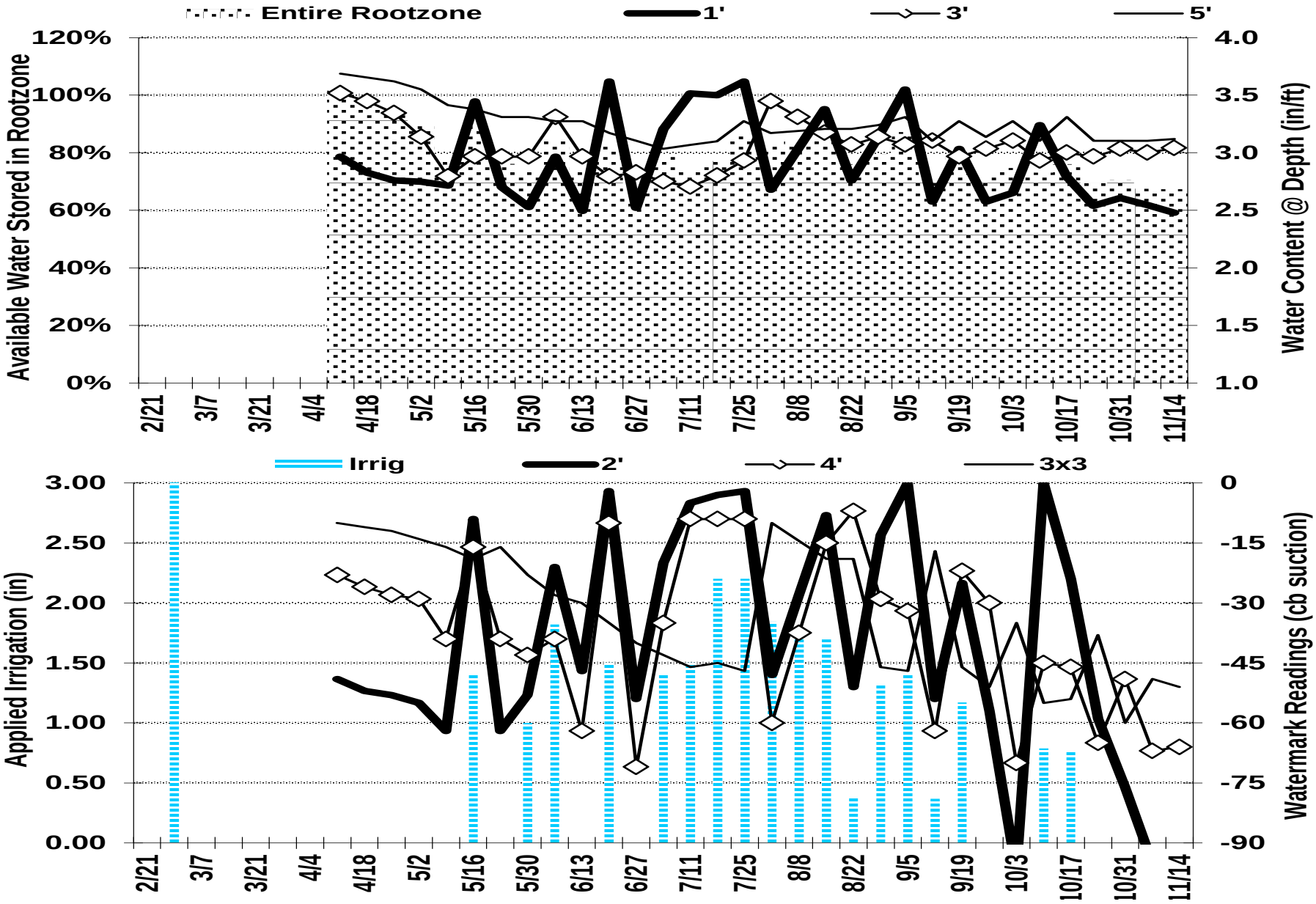
A device using low levels of radiation, the neutron probe, was developed in the 1960's for checking soil moisture. Used mostly by researchers and irrigation consultants, it is often the standard check for the accuracy of other instruments. Largest sample "volume" to estimate moisture.

Installing Watermark blocks and a Hanson AM400 logger in citrus

Fine silty soil and a good shot of water down the hole improves contact with soil pores. Good capillary movement of water is what makes these sensors work.



Weekly neutron probe/Watermark readings and applied irrigation for East Block of 12th leaf pistachios



Weekly "Checkbook" Irrigation Scheduling Using Excel

(GOOGLE: cekern irrigation http://cekern.ucdavis.edu/Irrigation_Management, click SSJV IRRIGATION CHECKBOOK SCHEDULER)

Field (no.)_____

PISTACHIO 44.3 INCHES "NORMAL YEAR" ET

VIGOR FACTOR	SOIL TYPE:	FIELD CAPACITY (in/ft):	REFILL POINT (in/ft):	ROOTING DEPTH (ft):	ROW SPACING:	IRRIG. SYSTEM:	NORMAL RUN TIME (hrs):	WETTED VOLUME (%):	Total Avail @ 100% (in):	AREA/ TREE (sq ft):	DESIGN FLOW (gph/ tree):	WET AREA APPLIC (in):	NUMBER of SETS:	TOTAL AREA APPLIC (in):	
100%	Milham/ Panoche sandy clay loam	2.6	0.9	6	18' X 22'	4, 1 gph drips	24	35%	10.2	396	6	1.67	1	0.58	
	Week Ending:	4/7	4/14	4/21	4/28	5/5	5/12	5/19	5/26	6/2	6/9	6/16	6/23	6/30	TOTAL ET
	"Normal Yr" ET:	0.08	0.26	0.42	0.74	0.95	1.16	1.39	1.61	1.85	2.00	2.18	2.25	2.25	17.16
	Block ET (in/week):	0.08	0.26	0.42	0.74	0.95	1.16	1.39	1.61	1.85	2.00	2.18	2.25	2.25	
	Run Time to Refill for Week (hrs):	3.4	10.8	17.4	30.6	39.3	47.9	57.0	66.1	75.9	82.4	89.7	92.8	92.8	TOTAL Irrig (in)
	Actual Run (hrs):			24	24	24	24	48	72	72	72	96	96	96	15.75
	Cumulative Deficit or Surplus (hrs):	-3.4	-14.3	3.7	-2.9	-22.6	-46.5	-67.8	-45.5	-40.6	-51.1	-52.5	-49.2	-55.5	
	Estimated Soil Moisture Depletion or Excess (in):	-0.24	-0.99	0.26	-0.20	-1.57	-3.23	-4.71	-3.16	-2.82	-3.55	-3.64	-3.42	-3.85	Soil Moisture Depletion (in)
	Estimated Soil Moisture (% available):	98%	90%	103%	98%	85%	68%	54%	69%	72%	65%	64%	66%	62%	-3.85
	Actual Soil Moisture (% available):		98%		95%		60%	65%	75%		60%		60%		

Pistachio Irrigation Conclusions

- Pistachio trees are extremely drought tolerant.
- % splits and individual nut weight are the most sensitive to stress.
- Depending on soil type, salinity, irrigation system and management mature pistachios can use 30 to 50 inches of water over the season. Real time soil moisture/plant stress monitoring over the season is essential to maximize yield/efficiency and minimize disease.
- During mid May thru early July and postharvest pistachios are most tolerant of stress: potentially allowing for full yield with only 85% of full ET. Successful RDI programs require full winter recharge of soil profile and understanding of soil water holding capacity and salinity.
- Keep rootzone salinity < 6 dS/m EC if possible.