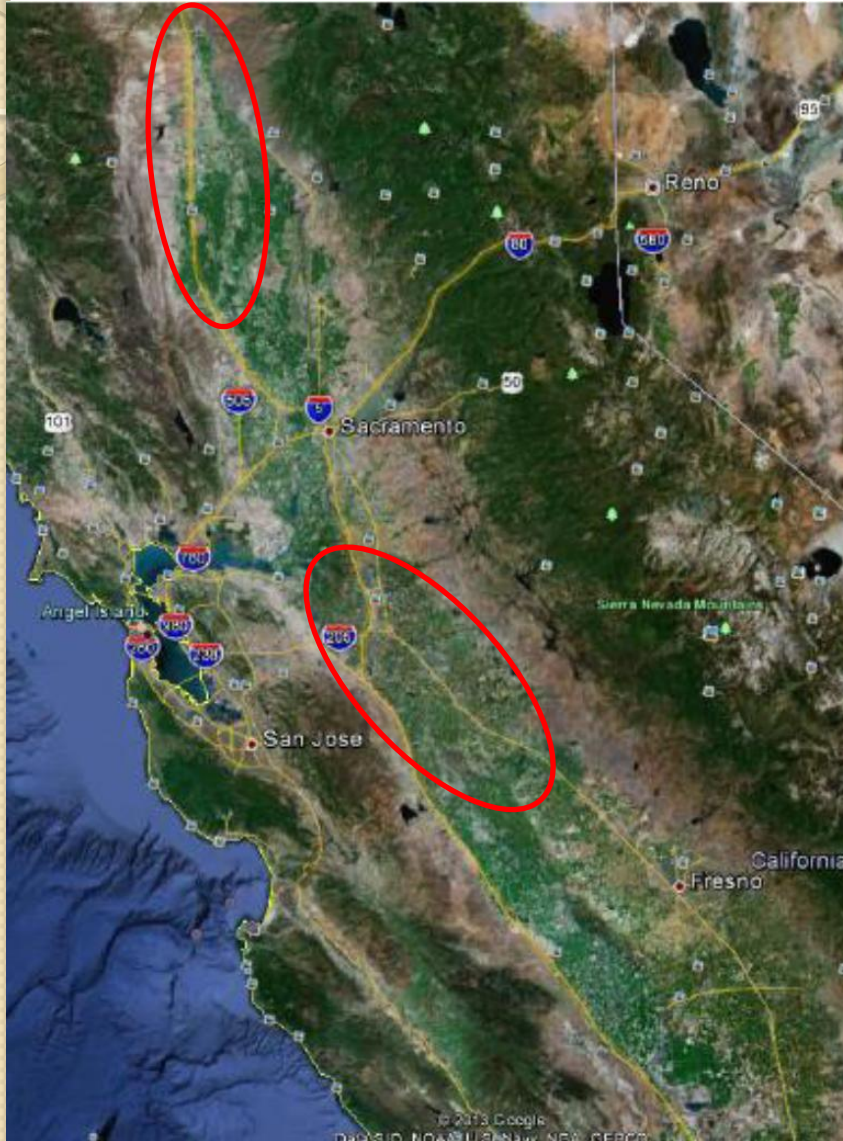




Irrigation Management Tools for Developing Orchards

Allan Fulton
UC Farm Advisor
Tehama, Glenn, Colusa,
and Shasta Counties

Growing Walnuts in the northern Sacramento Valley

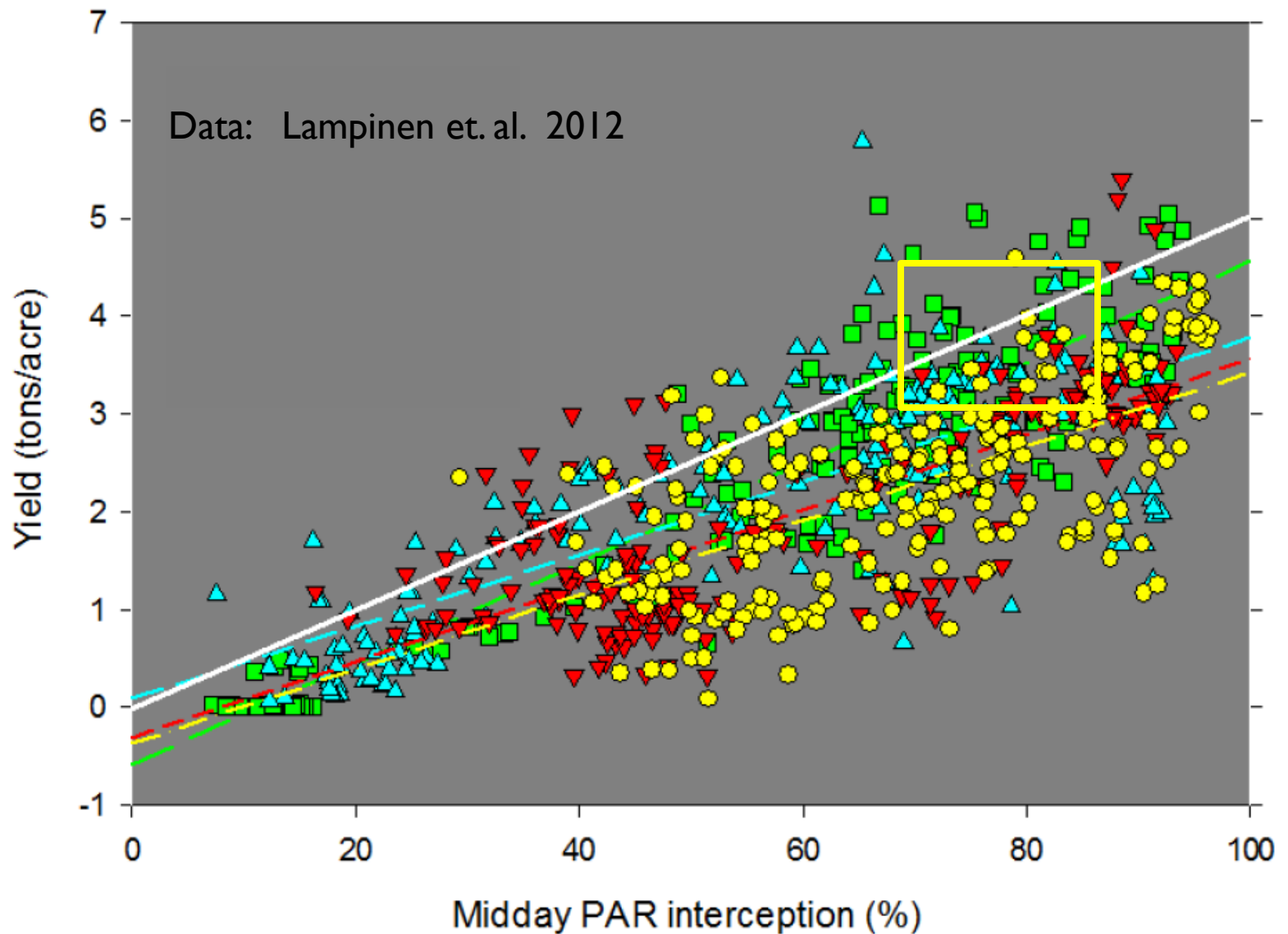


- 14 – 24 inches annual rainfall
- 3 – 6 inches of rain may fall after leafout
- Later leafing varieties (Chandler, Howard, Tulare)
- 80 percent of fruit and nut crops irrigated with rotator mini sprinklers, fan jets, drip, or buried drip methods
- Growing walnuts on soils once deemed unsuitable and more challenging

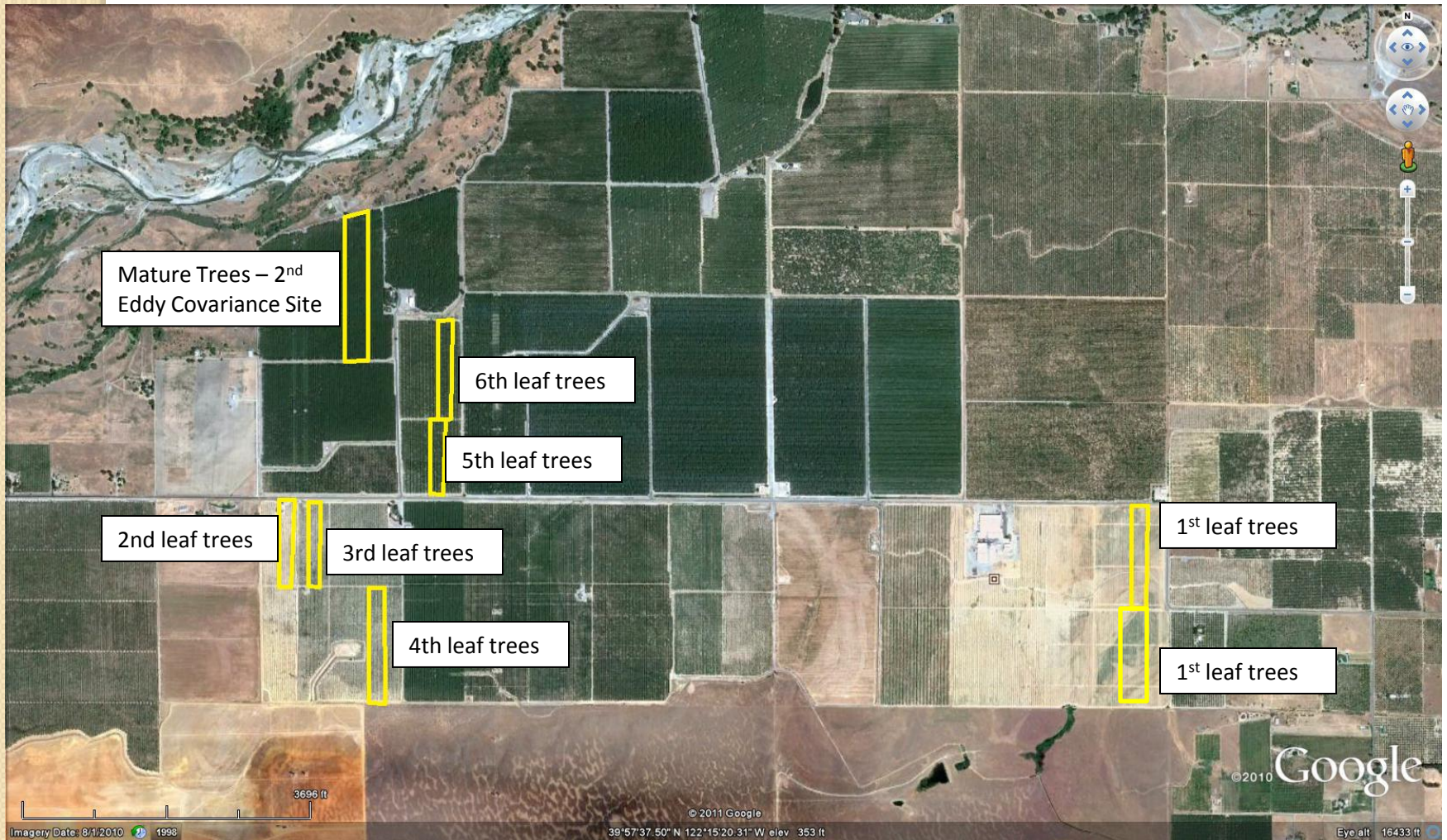
What is irrigation management?

- Making decisions about when to irrigate and how much water to apply
 - Understanding how well an irrigation system is performing and fixing it as needed
 - Attention to water placement, infiltration, and drainage
 - Choosing among different tools and applying at least one of them to help with management decisions

Why focus on developing orchards?



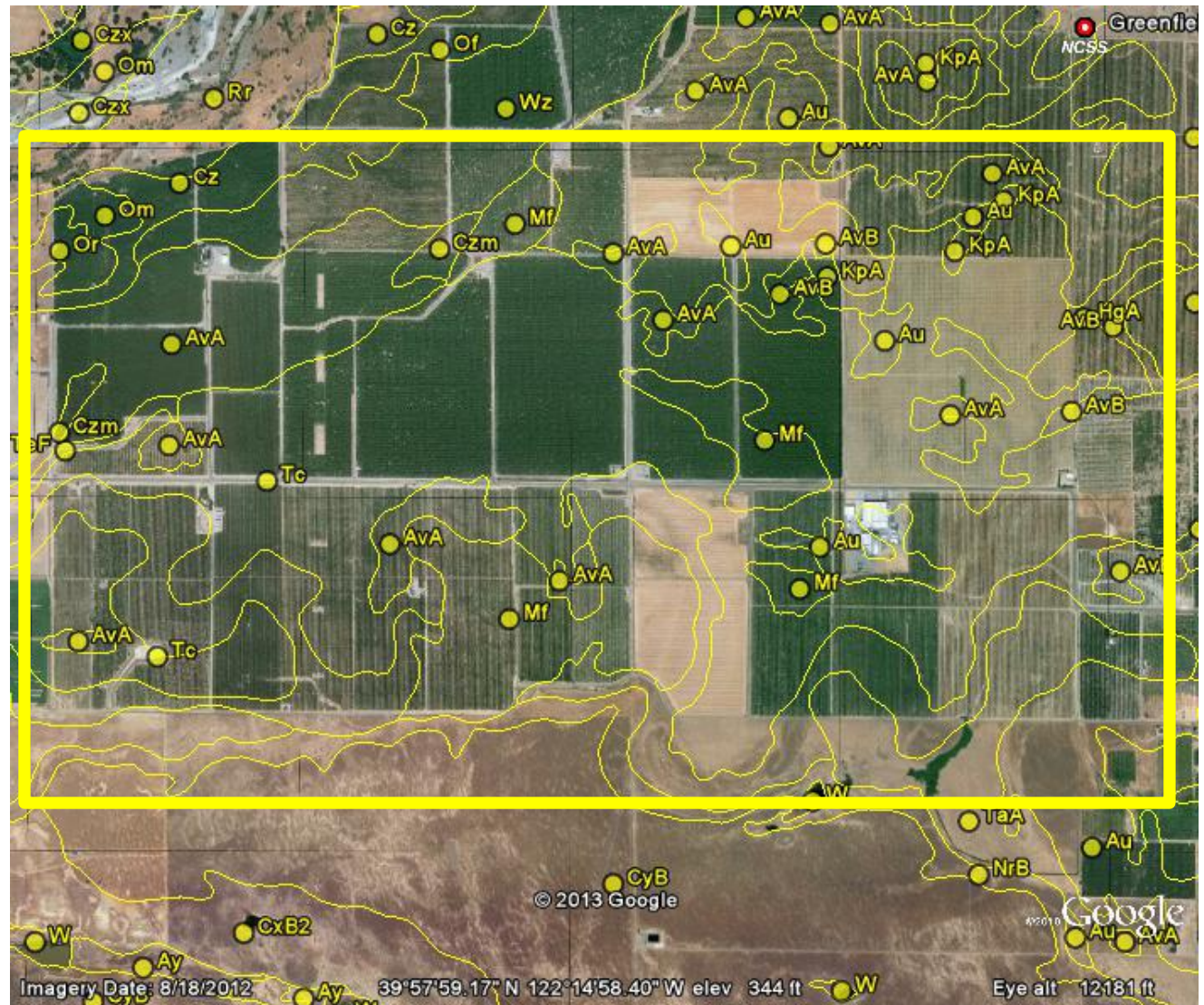
Learning Opportunity in Tehama County (2009-2012)



Opportunity to assess irrigation needs in developing orchards

- 1st leaf – 2 repetitions
- 2nd leaf – 3 repetitions
- 3rd leaf – 3 repetitions
- 4th leaf – 3 repetitions
- 5th leaf – 3 repetitions
- 6th leaf or older – 4 repetitions

Extent of soil variability





Tools used to learn about irrigation of developing orchards

Evaluating soil moisture with a soil auger

Sandier



More
Clay

Wetter



Drier



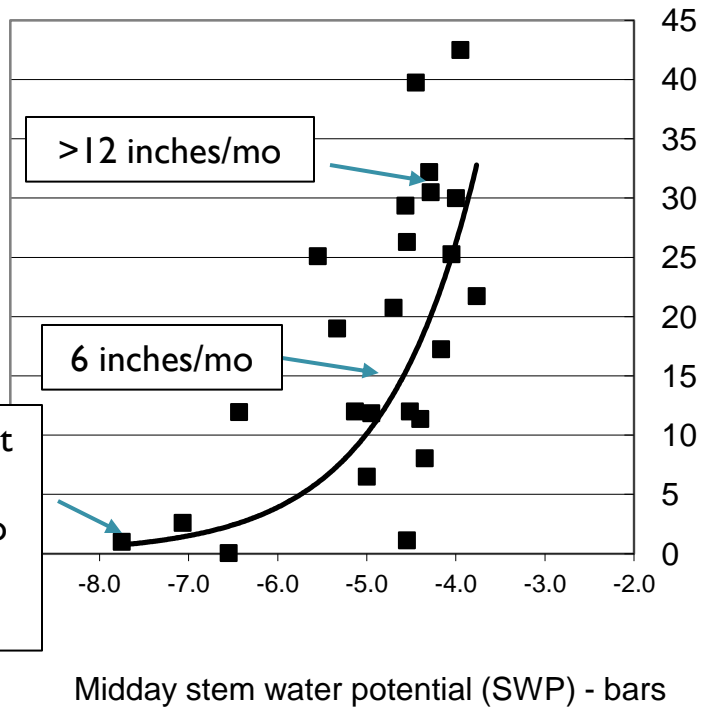
Plant camera



Weekly measurement of orchard water status (pressure chamber, midday SWP)



A working knowledge of the pressure chamber and Stem Water Potential concepts and guidelines



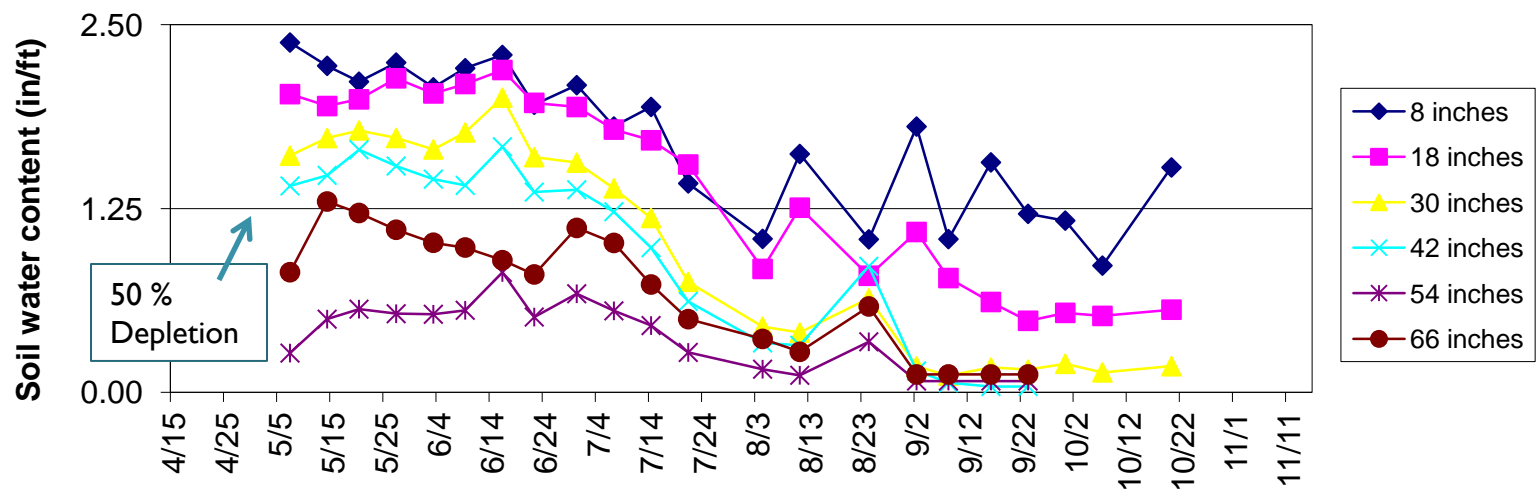
Pressure Chamber Reading (- bars)	WALNUT
0 to -2.0	Not commonly observed
-2.0 to -4.0	Fully irrigated, low stress, commonly observed when orchards are irrigated according to estimates of real-time evapotranspiration (ETc), long term root and tree health may be a concern, especially on California Black rootstock.
-4.0 to -6.0	Low to mild stress, high rate of shoot growth visible, suggested level from leaf-out until mid June when nut sizing is completed.
-6.0 to -8.0	Mild to moderate stress, shoot growth in non-bearing and bearing trees has been observed to decline. These levels do not appear to affect kernel development.
-8.0 to -10.0	Moderate to high stress, shoot growth in non-bearing trees may stop, nut sizing may be reduced in bearing trees and bud development for next season may be negatively affected.
-10.0 to -12.0	High stress, temporary wilting of leaves has been observed. New shoot growth may be sparse or absent and some defoliation may be evident. Nut size likely to be reduced.

Weekly measurement of soil moisture depletion (Neutron Probe Moisture Meter)



A working knowledge of soil moisture depletion concepts

Soil Texture	Field capacity	Wilting Point	Available Water Capacity
	(Inches/ft of soil)		
Sandy loam	2.0	0.6	1.4
Fine sandy loam	2.6	0.8	1.8
Loam	3.2	1.2	2.0
Silt loam	3.5	1.4	2.1
Clay loam	3.8	1.8	2.0
Clay	4.0	2.6	1.4



Soil moisture monitoring and young trees



Flow meters and rain gauges



Kept irrigation records (a water budget)

- **Water supplies**

- Dormant season soil storage
- In-season rainfall
- Irrigation

- **Water losses**

- Evapotranspiration (ET_c)
- Inefficiencies



Experience with the pressure chamber and 1st leaf orchards

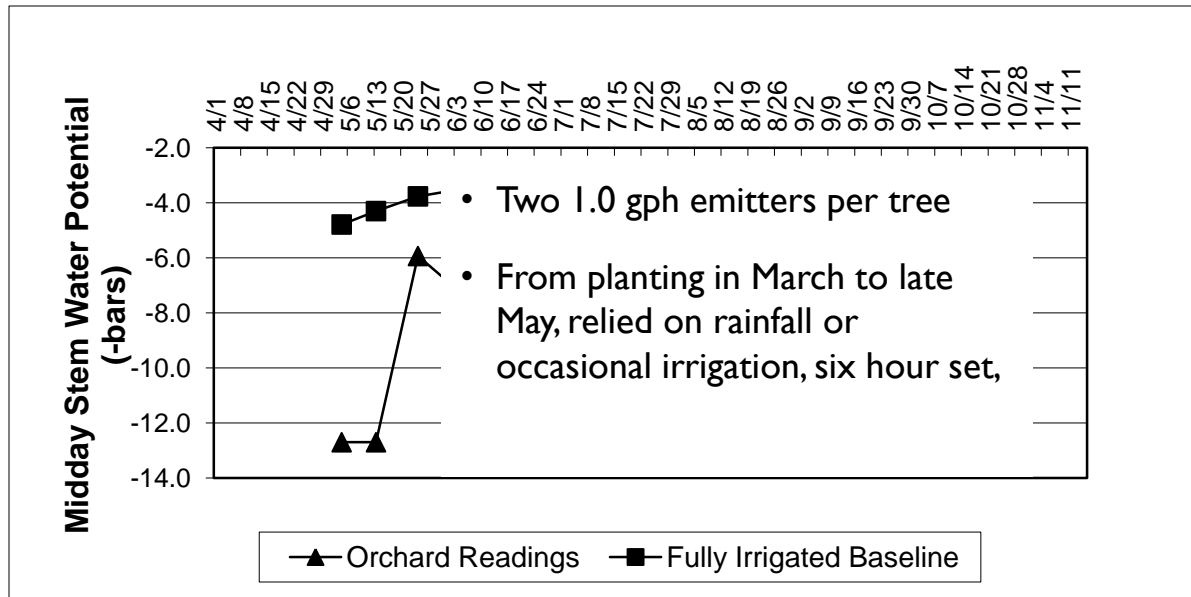
Results with 1st leaf orchards



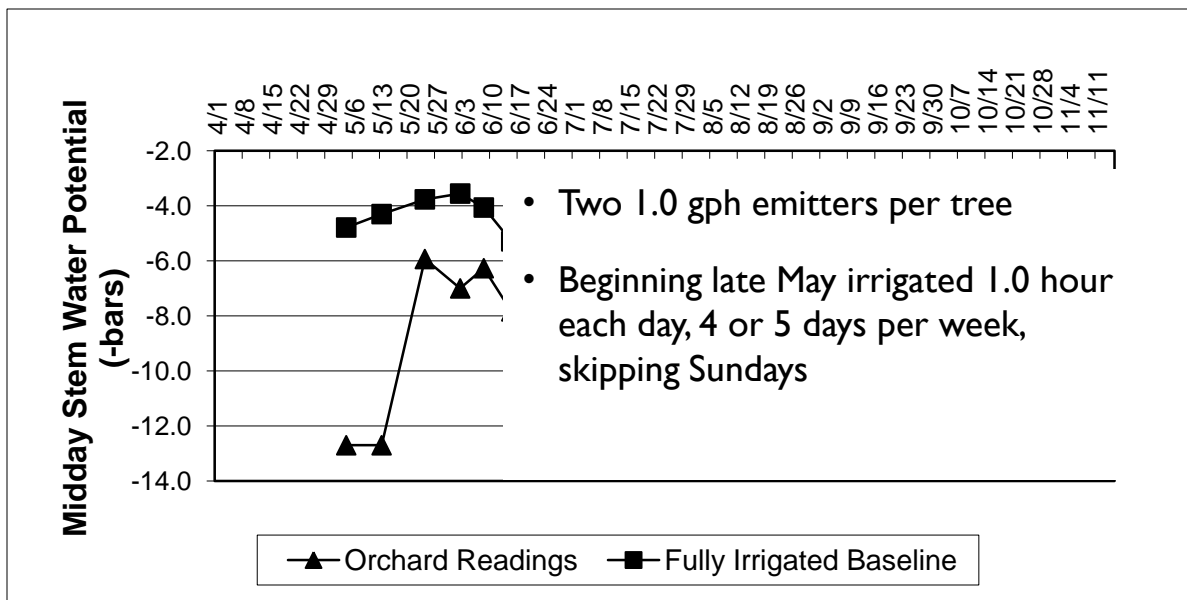
1DAY CORNING JUN.09,11 12:00 PM



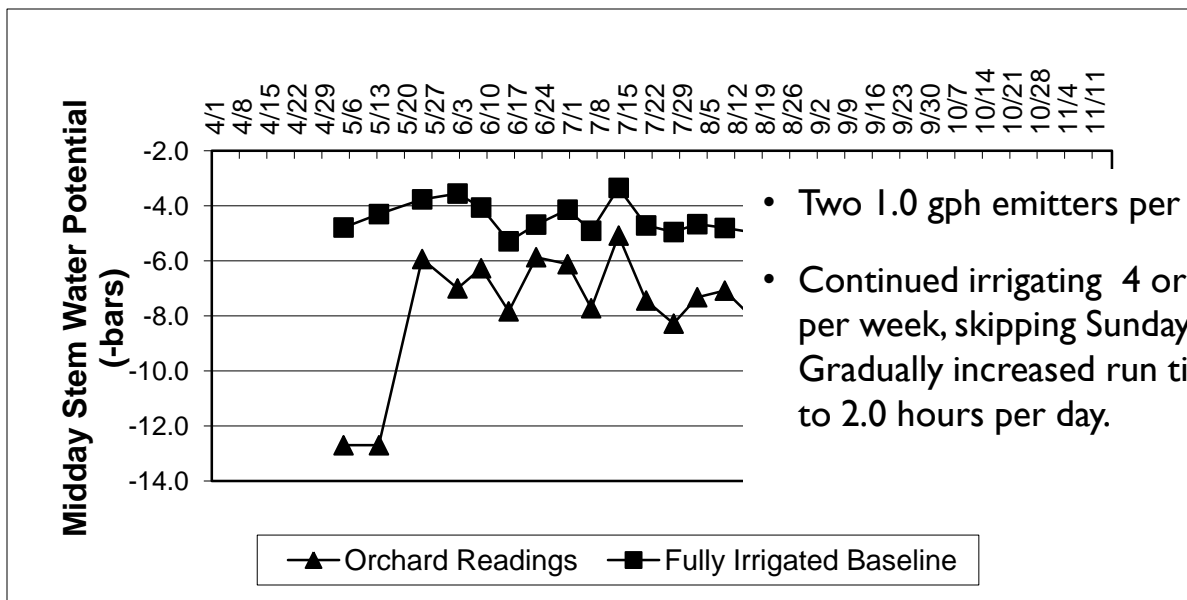
1DAY CORNING JUN.24,11 12:00 PM



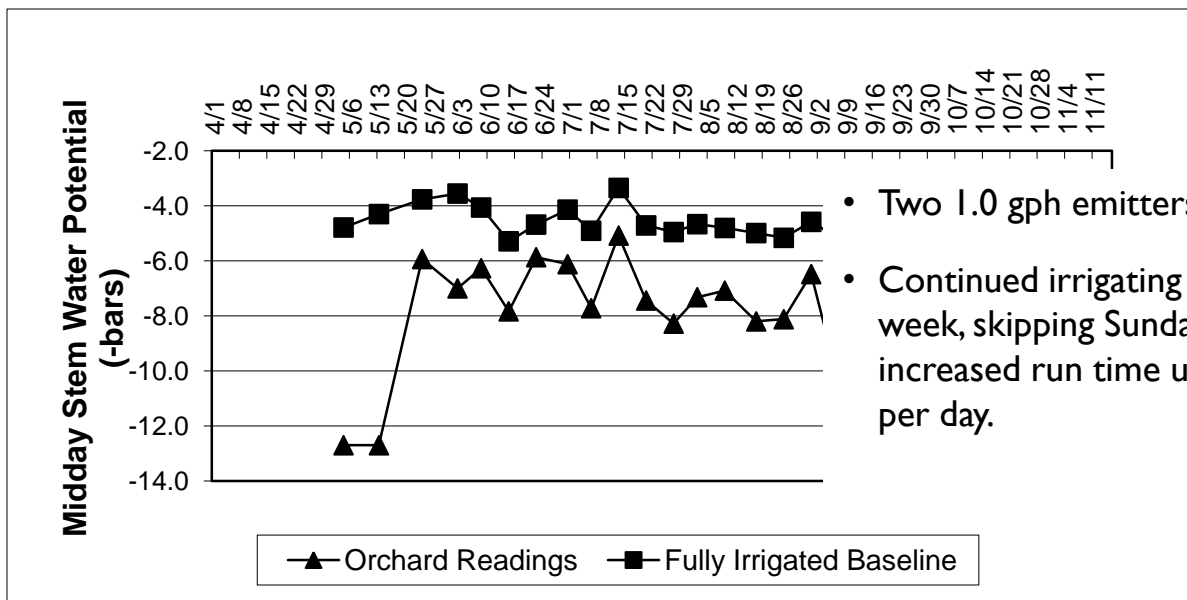
Results with the pressure chamber in 1st leaf orchards



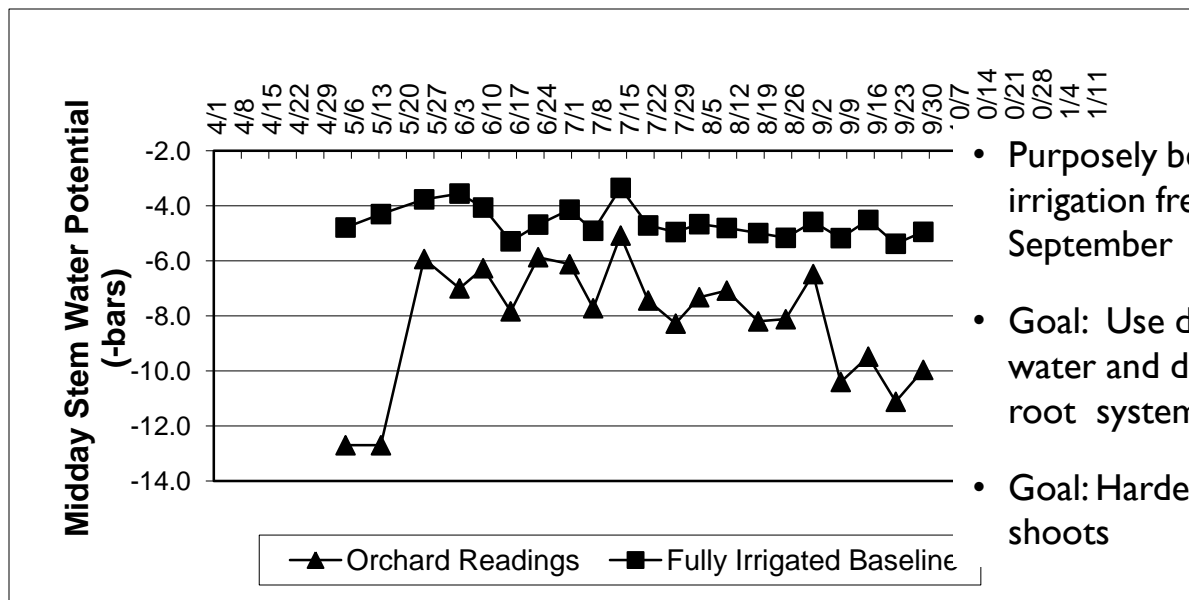
Experience with 1st leaf orchards



Experience with 1st leaf orchards



Experience with 1st leaf orchards

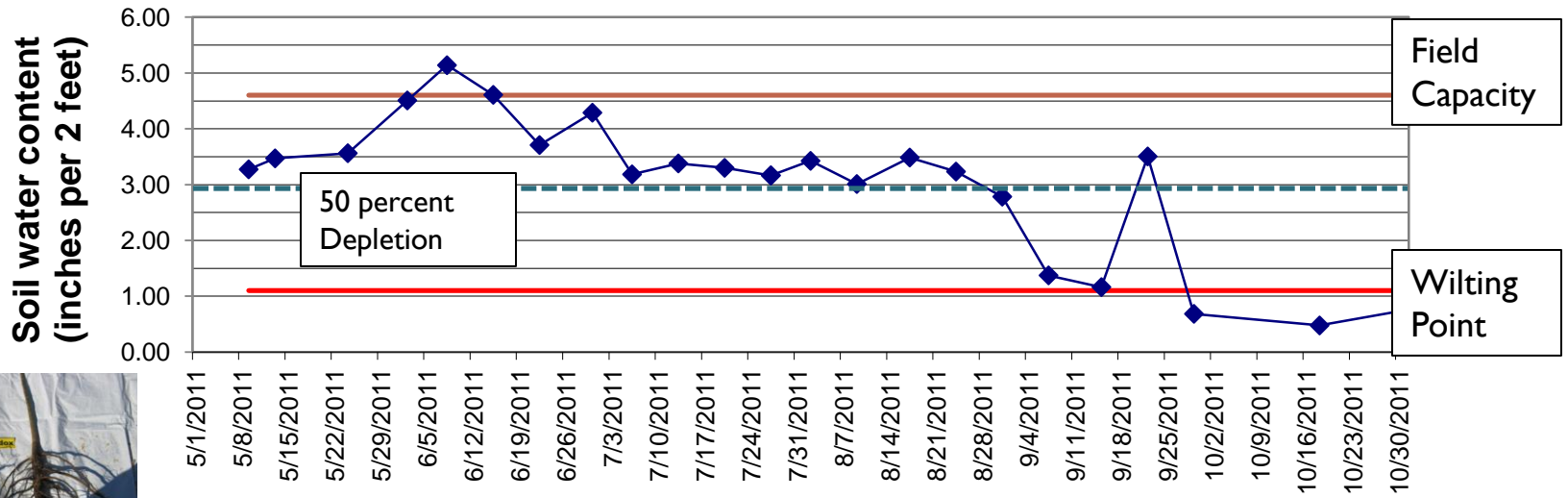


- Purposely began to reduce irrigation frequency in September
- Goal: Use deep stored water and develop deeper root system
- Goal: Harden off green shoots

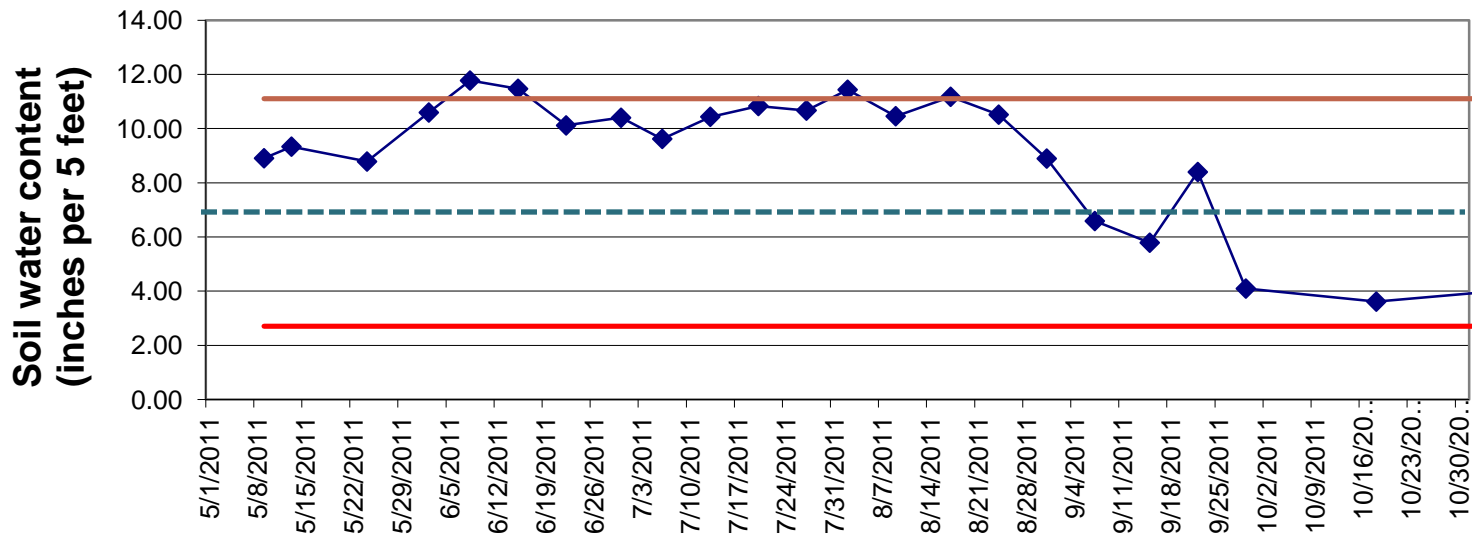


Experience with monitoring soil moisture depletion in 1st leaf orchards

Soil moisture levels in two foot soil profile



Soil moisture levels in five foot soil profile



Lessons learned with 1st leaf trees

- Terrace soils, lower quality, less forgiving
- Placement of water important when root is small
- After planting, trees more responsive to higher frequency, shorter irrigation sets
- As trees grow, root system expands
 - Better use of deeper soil moisture in latter half of season #1, placement not as critical



Progression with irrigation methods and placement of water

Estimated water use (ETc) for 1st Leaf Walnuts

Year	In-season Rainfall (in.)	Drip Irrig. (in.)	Soil Moisture Depletion (in.)	Total (in.)
2011 (Rep I)	4.3	3.3	7.5	15.1
2011 (Rep II)	4.3	3.1	7.0	14.4

Experience in 2nd to 4th leaf orchards



Experience in 2nd to 4th leaf orchards



1st Leaf ~

- 7.2 % PAR (+/- 1.8 %)
- 14 to 15 inches of water use (Not all from irrigation)
- 2 to 45 % of ET_c for a mature orchard



2nd Leaf ~

- 16-23 % PAR (+/- 2.4 %)
- 21.2 inches of water use (Not all from irrigation)
- 35 to 60 % of ET_c for a mature orchard



3rd Leaf ~

- 29 - 35 % PAR (+/- 5.0 %)
- 38.0 inches of water use (Not all from irrigation)
- 70-100 % of ET_c for a mature orchard
- Influenced by irrigation method and orchard floor vegetation



4th Leaf ~

- 48 -50 % PAR (+/- 5.0 %)
- 42.0 inches of water use (Not all from irrigation)
- Approaching 100 % of ET_c for a mature orchard
- Influenced by irrigation method and orchard floor vegetation

Approximate ETc of newly planted walnut trees. Expressed as a percentage of ETc for mature trees and as inches of ETc in two week intervals.

DATE	First Leaf %	First Leaf (inches)	First Leaf (gal/tree/day)	Second Leaf %	Second Leaf (inches)
Apr 1-15	15	0.1	1.7	35	0.3
Apr 16-30	20	0.3	4.3	40	0.6
May 1-15	25	0.5	7.8	45	0.9
May 16-31	30	1.0	14.8	45	1.5
June 1-15	30	1.0	15.2	50	1.6
June 16-30	35	1.3	19.6	50	1.9
July 1-15	40	1.8	27.7	55	2.5
July 16-31	40	2.1	31.0	60	3.1
Aug 1-15	45	1.8	27.1	60	2.4
Aug 16-31	45	1.6	24.4	60	2.2
Sept 1-15	40	1.2	17.7	55	1.6
Sept 16-30	40	0.9	14.1	55	1.3
Oct 1-15	35	0.7	10.7	50	1.0
Oct 16-31	30	0.3	4.1	45	0.4
Total	----	14.6	----	----	21.3

$$\text{Gallons/tree/day} = (((\text{ETc} \times 27,150) \div \text{trees/ac}) \div \text{days})$$

Approximate ETc of newly planted walnut trees. Expressed as a percentage of ETc for mature trees and as inches of ETc in two week intervals.

DATE	Third Leaf %	Third Leaf (inches)	Fourth Leaf %	Fourth Leaf (inches)
Apr 1-15	70	0.5	100	0.8
Apr 16-30	75	1.1	100	1.4
May 1-15	85	1.8	100	2.1
May 16-31	90	3.1	100	3.4
June 1-15	95	3.1	100	3.3
June 16-30	95	3.5	100	3.7
July 1-15	100	4.6	100	4.6
July 16-31	100	5.1	100	5.1
Aug 1-15	100	4.0	100	4.0
Aug 16-31	100	3.6	100	3.6
Sept 1-15	100	2.9	100	2.9
Sept 16-30	100	2.3	100	2.3
Oct 1-15	100	2.0	100	2.0
Oct 16-31	100	0.9	100	0.9
Total	----	38.5	----	40.1

More lessons learned

- Pressure chamber, moisture sensors, and flow meters give different insights
 - Pressure chamber – Tree response to growing conditions
 - Moisture sensors and flow meters – indicators of how management may be affecting growing conditions
 - All three tools provide a point of reference to adjust management

Benefits of irrigation management tools

Productivity

- Earlier
- Higher and more consistent
- Better crop quality and more value
- Improved orchard life span

Complements other cultural practices

Resource stewardship

Water and energy conservation?

2012 Survey of Almond Growers

- Turning to more science-based information

- 53 % Use flow meters
- 43 % Irrigation uniformity
- 44 % - Water budget (ETc)
- 49 % - Soil moisture monitoring
- 28 % - Pressure Chamber, Midday SWP



THANK YOU!

**More irrigation management information
is available at**

<http://cetehama.ucanr.edu>

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