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The Almond Conference

Research Updates: Speed Dating

Bob Curtis, ABC (Moderator)

Gurreet Brar, UCCE-Fresno, Madera Counties

Matthew Gilbert, UC Davis

Ken Shakel, UC Davis

Baris Kutman, UC Davis

Daniel Schellenberg, UC Davis

Jan Hopmans, UC Davis

Astrid Volder, UC Davis

Ted Dejong, UC Davis

Sonja Brodt, UC Davis

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Gurreet Brar
UCCE-Fresno, Madera Counties

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Can Spring Foliar N+K Sprays Increase Almond Yield in the Sacramento Valley?

Franz Niederholzer
UC Farm Advisor, Colusa/Sutter/Yuba

Stan Cutter
Nickels Soil Lab, Arbuckle, CA

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Why foliar N in the Spring – Especially in the Sacramento Valley?

- Early season tree N use is fed by reserves stored over winter in the woody tissue.
- Soil can be cool/wet. Root activity maybe limited, especially in the Sac Valley.
- Fertigation is delayed in wet springs. No need for water. Irrigating = higher blowover risk.
- Can spring foliar feeds bridge the gap between storage N and “new” N from fertigation once the skies clear?

Overall Study Details

- Nonpareil, Aldrich, Fritz planting
- 7th leaf
- Nonpareil on Krymsk 86
- 20’ x 12’
- Sprayed by backpack airblast sprayer
- Randomized complete block design, blocked by tree size (trunk diameter)

Treatment/spray	Feb 5*	Feb 18**	Mar 13	April 9
7.8 lb N & 4 lb K_2O/a			X	X
7.5 lb N/a			X	X
4 lb K_2O/a			X	X
Seaweed (2 qt/a)	X	X	X	X
Seaweed (2 qt/a) + 7.5 lb N/a	X	X	X	X
Seaweed (2 qt/a) + 7.5 lb N/a			X	X

Treatment/spray	Yield (lbs/tree)	% Leaf N	% K
Control	23.9 a	2.50 a	2.17 a
7.8 lb N & 4 lb K_2O/a	22.1 a	2.49 a	2.20 a
7.5 lb N/a	23.2 a	2.48 a	2.34 a
4 lb K_2O/a	22.0 a	2.53 a	2.14 a
Seaweed (2 qt/a)	22.2 a	2.54 a	2.11 a
Seaweed (2 qt/a) + 7.5 lb N/a	22.2 a	2.52 a	2.09 a
Seaweed (2 qt/a) + 7.5 lb N/a	23.5 a	2.49 a	2.26 a

Efficacy Trials of Registered and Developmental Insecticides for Navel Orangeworm

Brent A. Holtz, Ph.D.
UCCE Farm Advisor,
San Joaquin County (SJC)

Cooperating Personnel:
Stephen Colbert, Ph.D., DuPont
Alistair McKay, Ph.D., Dow
Cheryl Gartner, UCCE SJC

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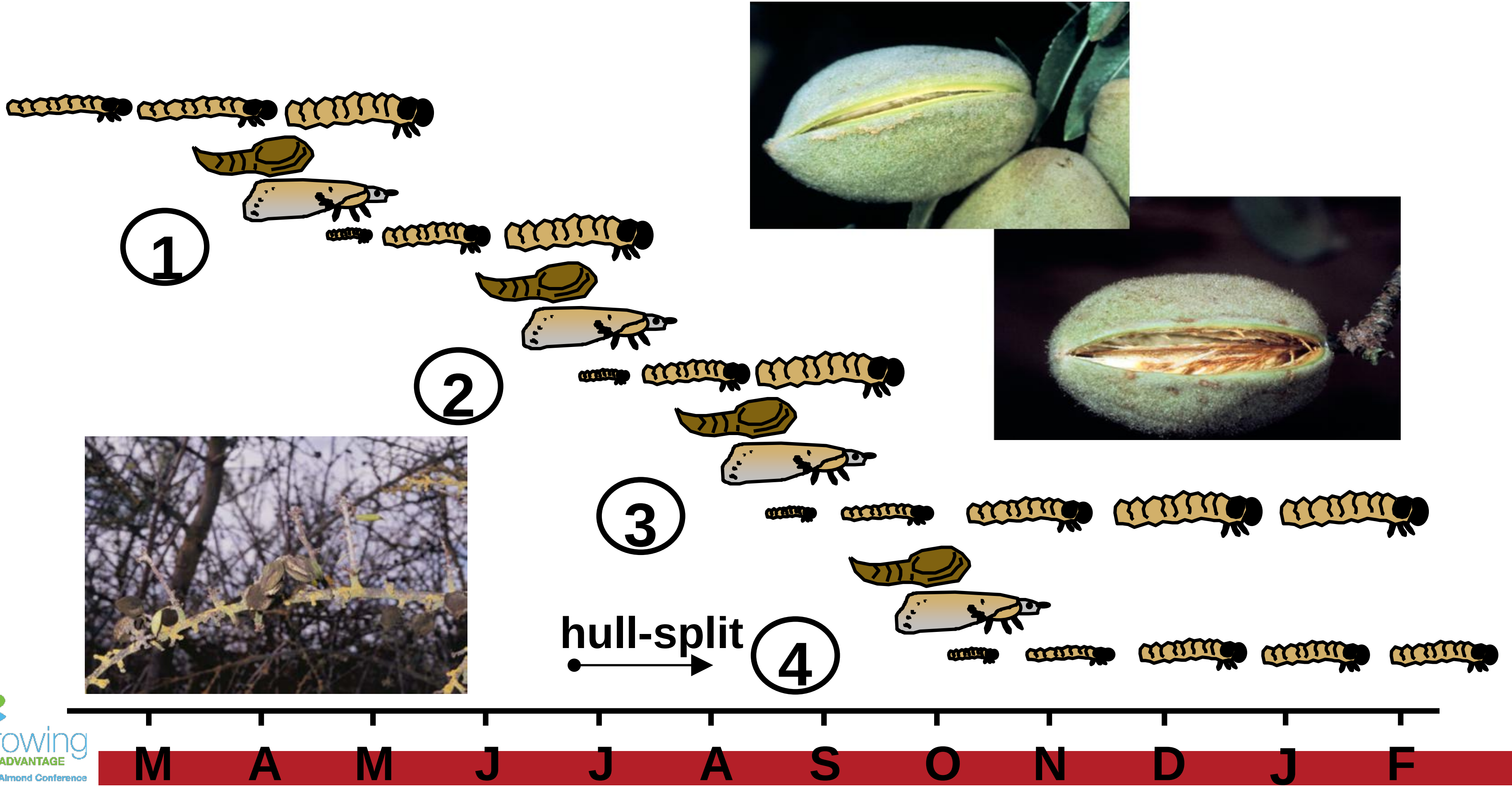
Navel Orangeworm – Pest of a Variety of Nut Crops




In-season, NOW is in “stick-tights” until “hull-split”



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Navel Orangeworm Efficacy Trial

Nonpareil Variety-August Harvest

2013 Treatments	% NOW[a]	data transformed[b]	
16 Belt SC 4 floz + Hort oil 1 gal	0.0	0.0	a
11 Proclaim + Dyne-Amic, 4.5 oz + 0.25%	0.0	0.0	a
15 Hero EW 11.3 floz + Hort oil 1 gal	0.0	0.0	a
13 Gladiator 19.0 floz + Hort oil 1 gal	0.0	0.0	a
7 Intrepid 16.0 floz + Vigilant	0.0	0.0	a
12 Athena 19.2 fl oz + Hort oil 1 gal	0.0	0.0	a
10 Intrepid/Delegate Mix 12.0 floz + Vigilant	0.1	0.0141539	ab
8 Asana 12.8 floz + Vigilant	0.1	0.0141539	ab
9 Intrepid/Delegate Mix 10.0 floz + Vigilant	0.1	0.0141539	ab
3 DuPont Exp 35.0 g + Vigilant	0.2	0.0283079	abc
6 Altacor® (Rynaxypyr) 4.0 oz/ac + Vigilant	0.2	0.0283079	abc
5 Cyazypyr (HGW86) 20.5 floz + Vigilant	0.2	0.0283079	abc
14 Brigade WSB 18 oz + Hort oil 1 gal	0.5	0.0425334	abc
2 DuPont Exp 23.3 g + Vigilant	0.5	0.0425334	abc
1 DuPont Exp 11.6 g + Vigilant	0.6	0.0483414	bc
4 DuPont Exp 46.54 g + Vigilant	0.7	0.0625668	c
18 Untreated	1.2	0.109214	d
17 Untreated	1.3	0.110534	d

[a]200 nuts were cracked out of each rep, 5 replications, 1000 nuts per treatment. Percent worm damage was determined per 1000 nuts. Data was transformed (ArcSin(sqrt(x)) [b] for analysis (one way anova).

Nematicide Trials in a First Leaf Orchard Infested with Plant Parasitic Nematodes

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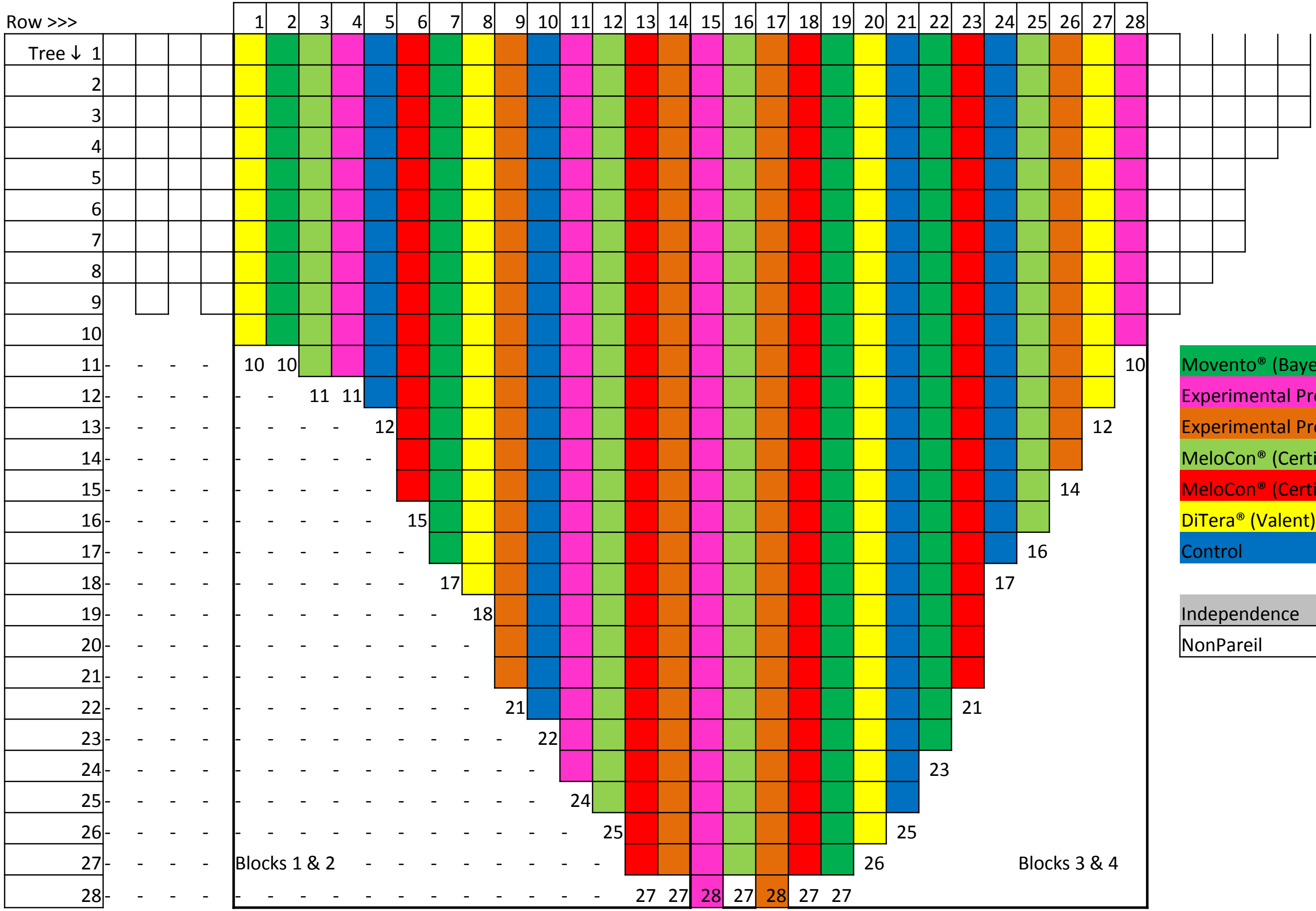
David Doll
UC Farm Advisor, Merced County

Methods:

Product/ Timing #	Application Method	First Application	Second Application	Third Application
Movento® (Bayer)	Foliar	May 12th	September 15th	-
Experimental Product (Bayer)/#1	Injection	May 12th	June 16th	-
Experimental Product (Bayer)/#2	Injection	May 12th	September 15th	-
MeloCon® (Certis)/#1	Injection	May 12th	June 16th	September 15th
MeloCon® (Certis)/#2	Injection	May 12th	September 15th	-
DiTera® (Valent)	Injection	May 12th	June 16th	September 15th
Control	N/A	-	-	-

- Injections of products at the riser into the double line drip irrigation line
- Movento® sprayed onto leaves with an adjuvant
- Trunk measurements taken at knee height before and after growing season
- Annual Nematode monitoring

Layout



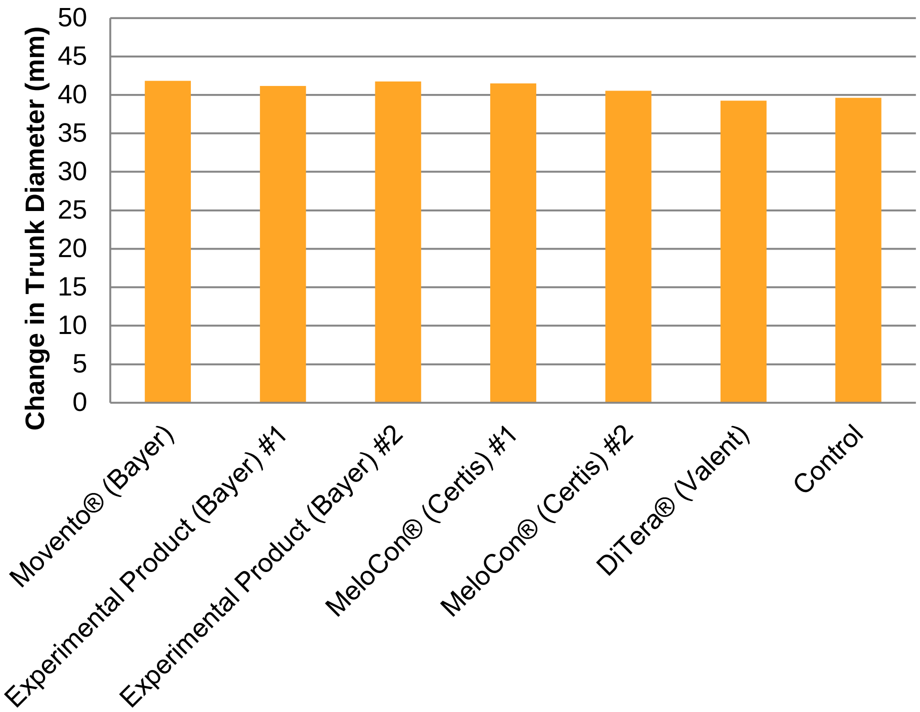
- Movento® (Bayer)
- Experimental Product (Bayer) #1
- Experimental Product (Bayer) #2
- MeloCon® (Certis) #1
- MeloCon® (Certis) #2
- DiTera® (Valent)
- Control

- Independence
- NonPareil

Nematode counts

SAMPLE	Ring	Spiral	Spiral
Rows	CX	HP	HD
1. 2+3	0	0	0
2. 4+5	8	0	0
3. 6+7	14	0	0
4. 8+9	112	0	0
5. 10+11	18	0	0
6. 12+13	0	0	2
7. 14+15	140	0	0
8. 16+17	0	0	0
9. 18+19	0	0	0
10. 20+21	0	0	0
11. 22+23	0	8	0
12. 24+25	0	0	52
13. 26+27	0	0	4
14. 28+29	18	0	0
15. 30+31	0	8	0
16. 32+33	0	14	12

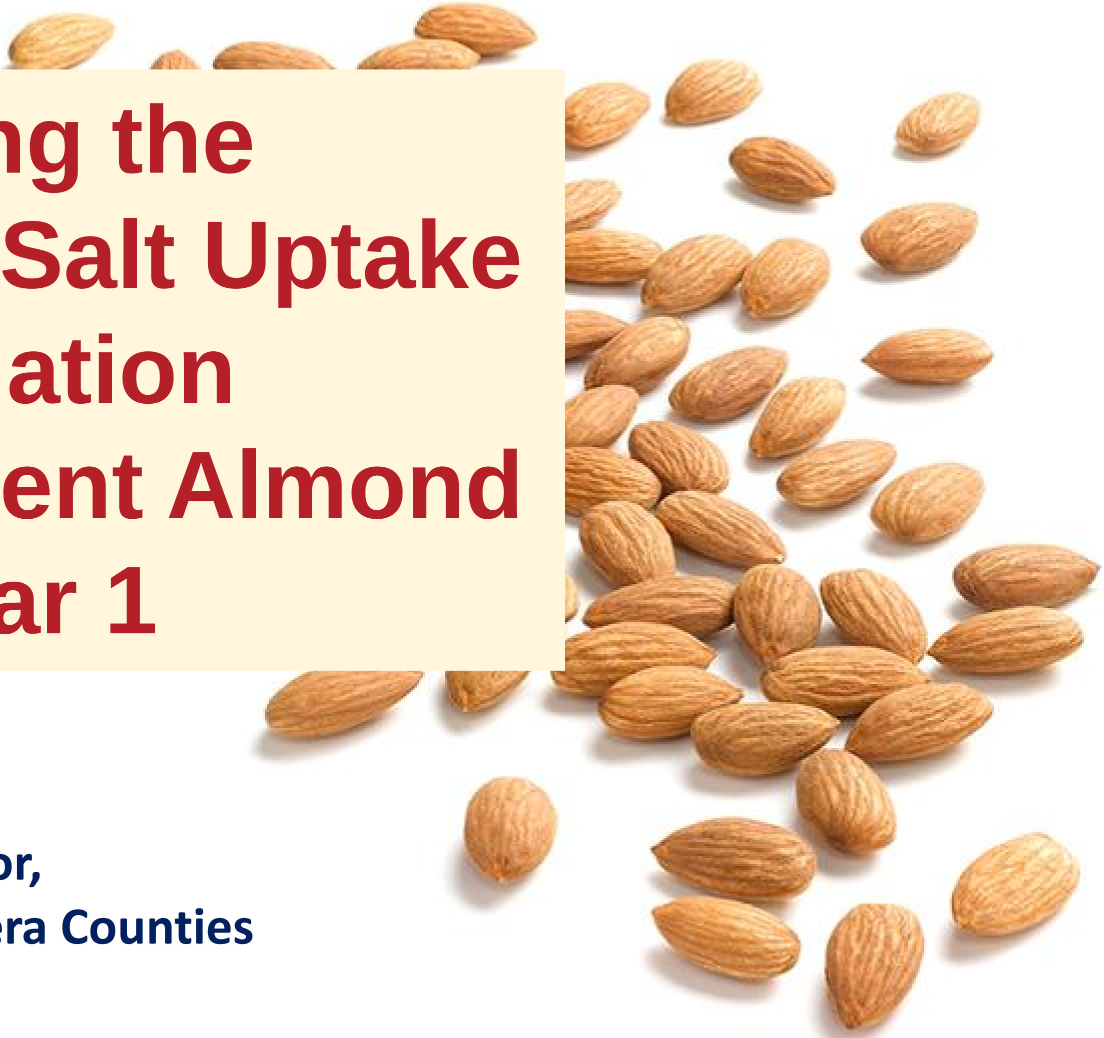
Trunk dia. (mm)



Conclusions after first year:

- Ring nematodes have been found throughout the test plot;
- No difference in growth among treatments yet, experiment is planned to be continued for the next three years.

Understanding the Variability in Salt Uptake and Accumulation among Different Almond Cultivars- Year 1



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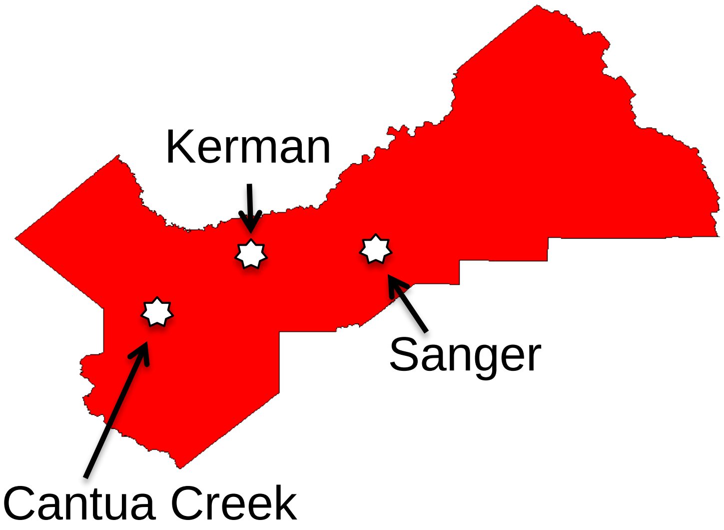
Gurreet Brar
UC Farm Advisor,
Fresno & Madera Counties

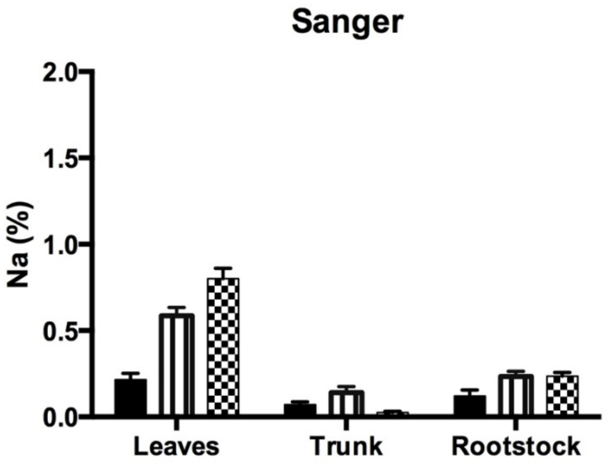
Methods:

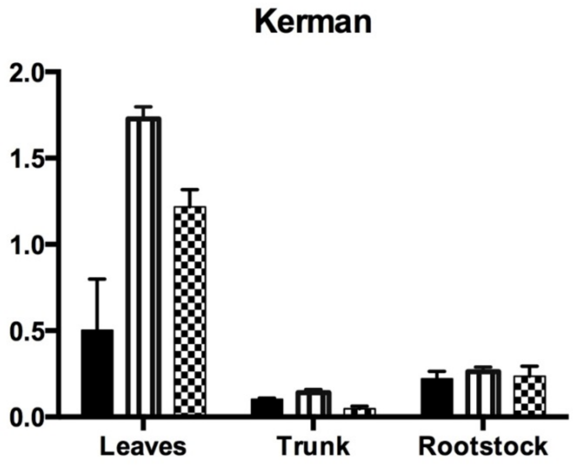


- Trees sampled from 3 locations
- 3 varieties- Nonpareil, Aldrich & Monterey
- 3 trees sampled randomly in each cv
- 3 samples: Leaves, Trunk & Rootstock
- All trees on Nemaguard

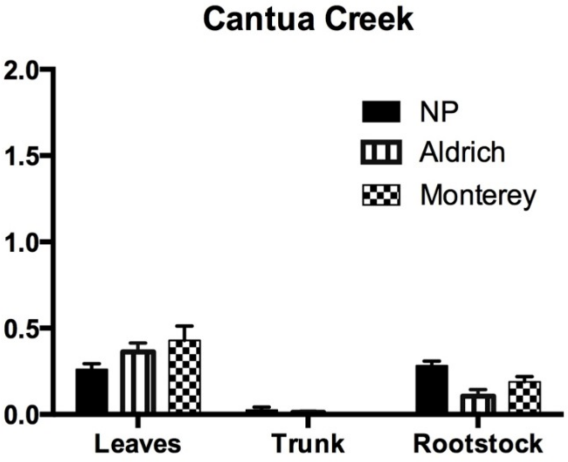
Trunk & Rootstock samples taken by drilling 1” holes in the trees

Sodium %





- Leaf Na conc. in Aldrich & Monterey was significantly higher than NP
- In Cantua Creek samples, NP sequestered more Na in the rootstock



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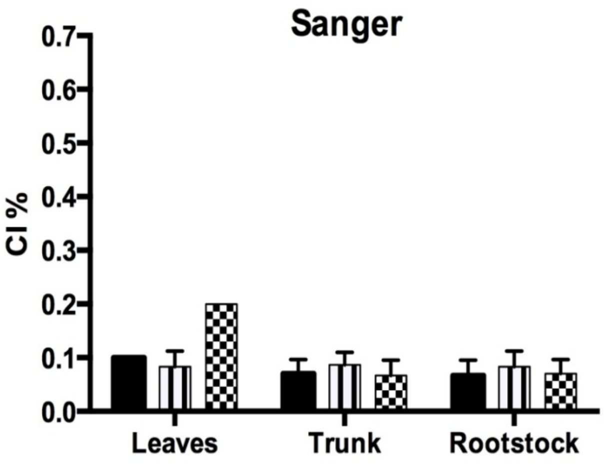
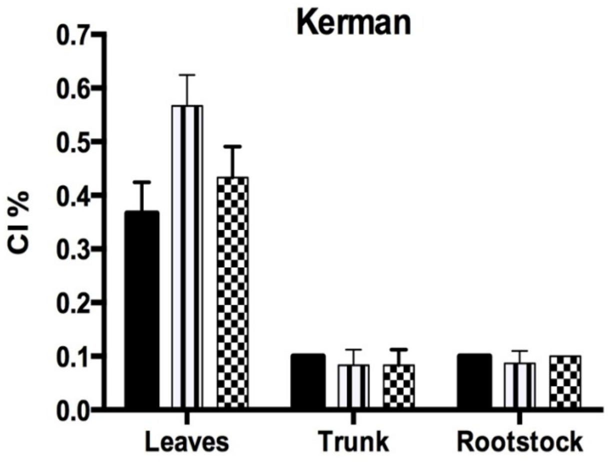
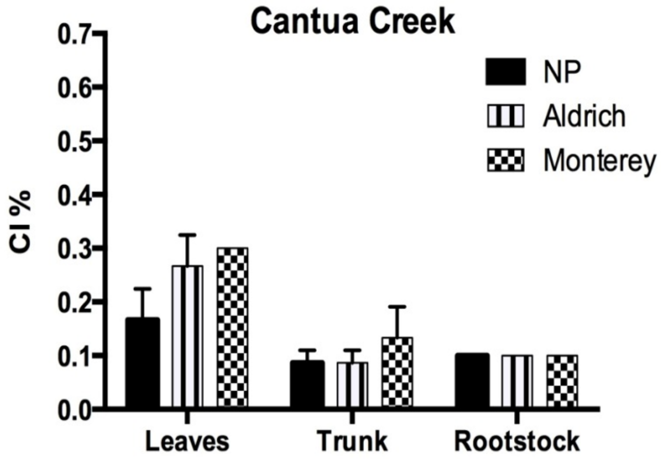
Chloride %





- Rootstock samples were similar across all varieties
- NP leaf tissue had significantly less Cl at 2 locations
- Trunk tissue showed significant Cl accumulations



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Thank you!

Matthew Gilbert, UC Davis

Evaluation of Leaf Heat Tolerance of Germplasm in the UC Davis Almond Breeding Program

Matthew E. Gilbert, UC Davis
megilbert@ucdavis.edu

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Heat Tolerance: Physiologists Helping Breeders Screen Varieties

- Overview of project
  - Improvement of heat tolerance screening method (to date)
  - Evaluation of when photosynthetic stress occurs in orchards (to date)
  - Determine if there are any tradeoffs (May-July 2015)
  - Evaluation of 100 genotypes/species of potential use for breeding program (May-July 2015)

Larry Williams

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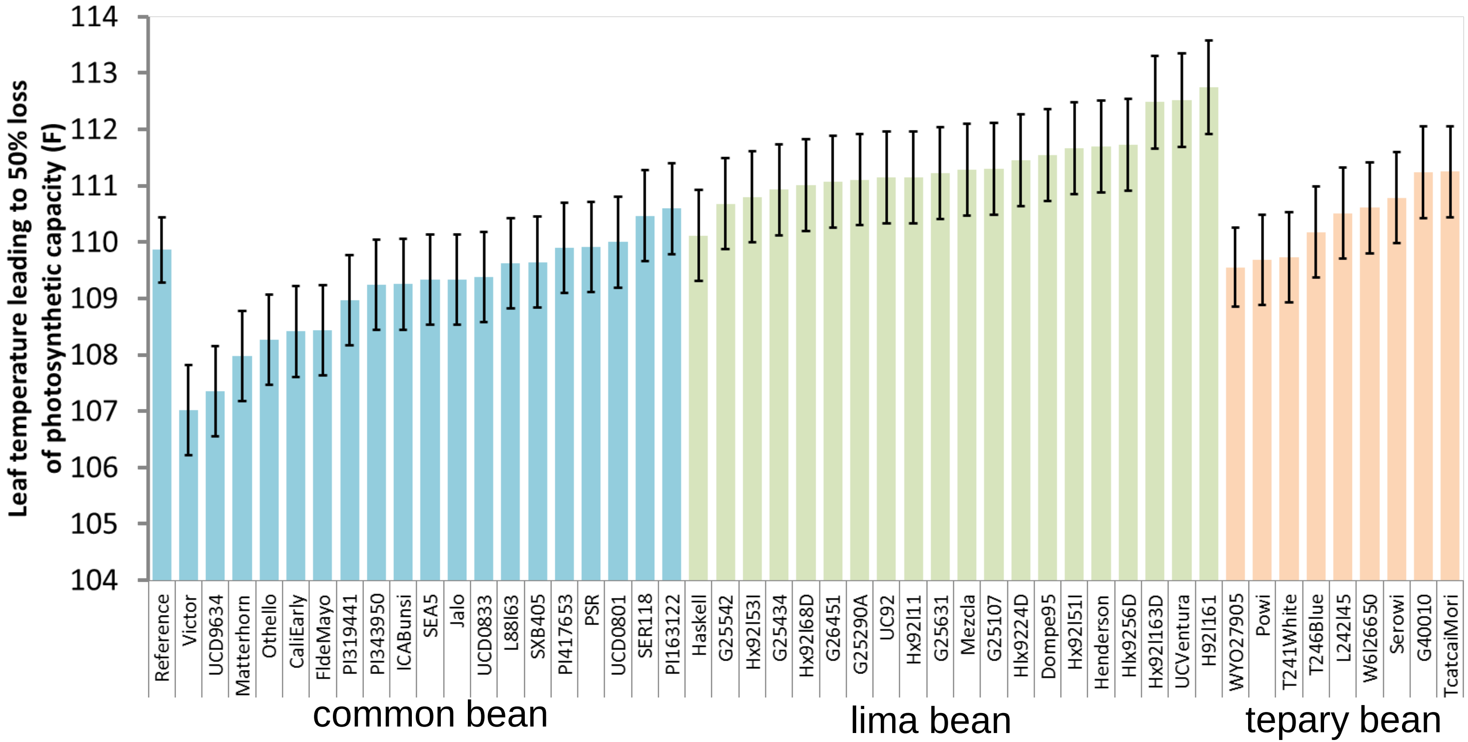
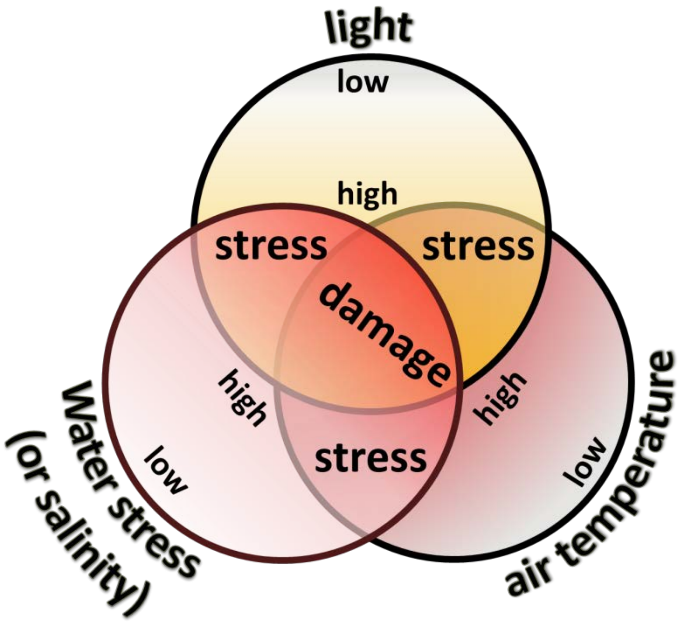
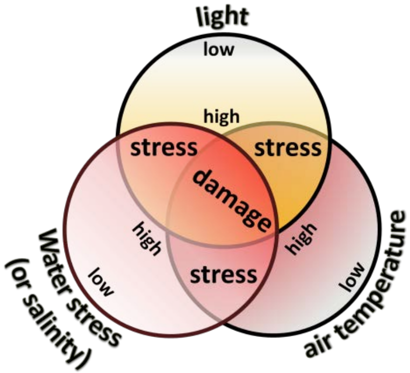
Heat Tolerance: an Example from ***Beans*** of What is Possible for Almonds



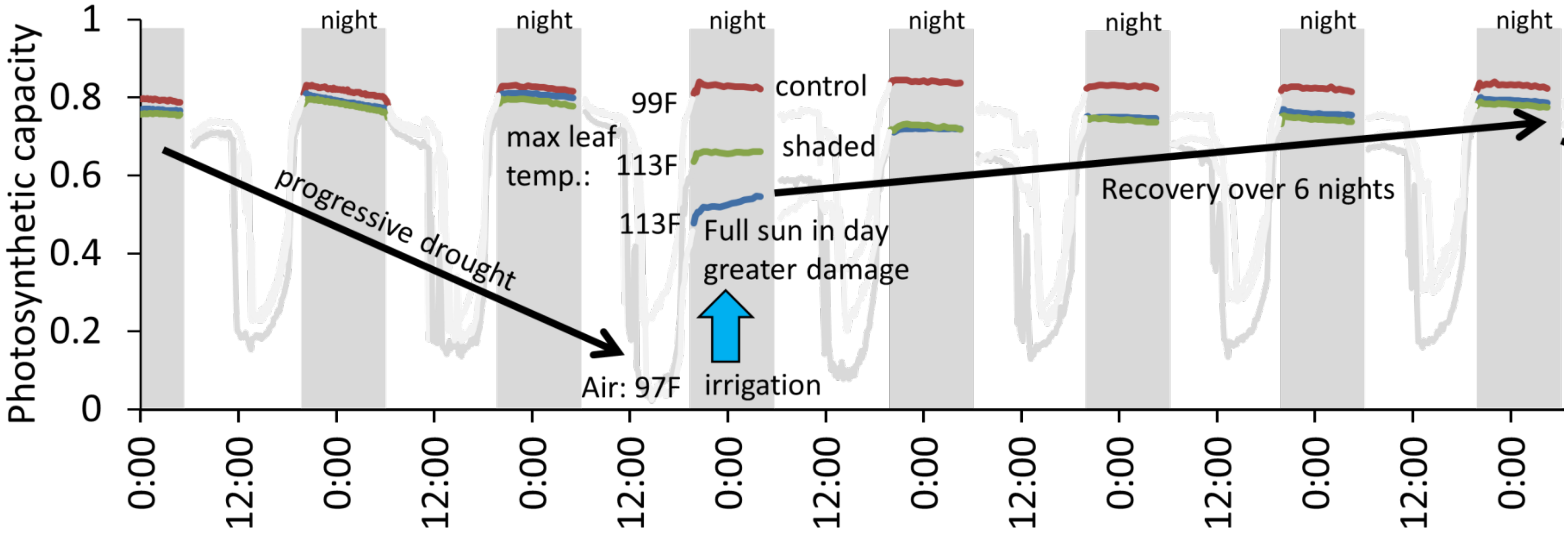
Heat Tolerance: When does Heat Stress Occur?



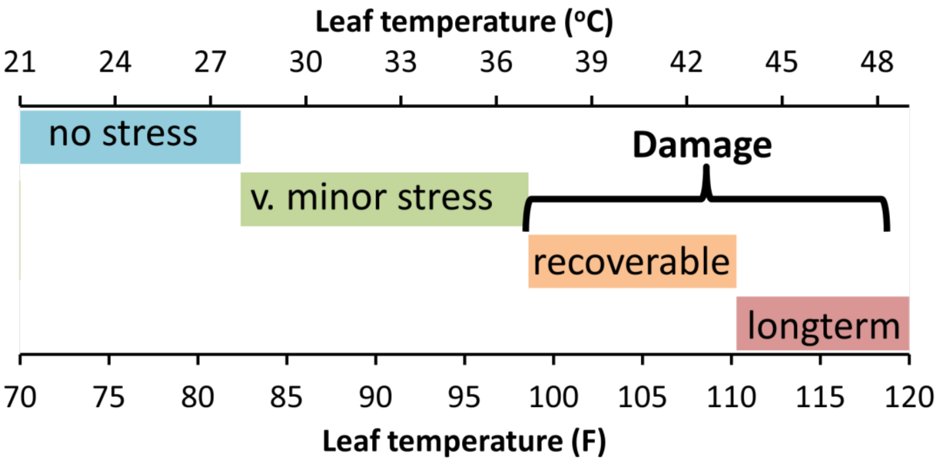
Heat Tolerance: When does Heat Stress Occur?



- Take home message:
  - combination of water stress, high temperatures, and high light lead to damage

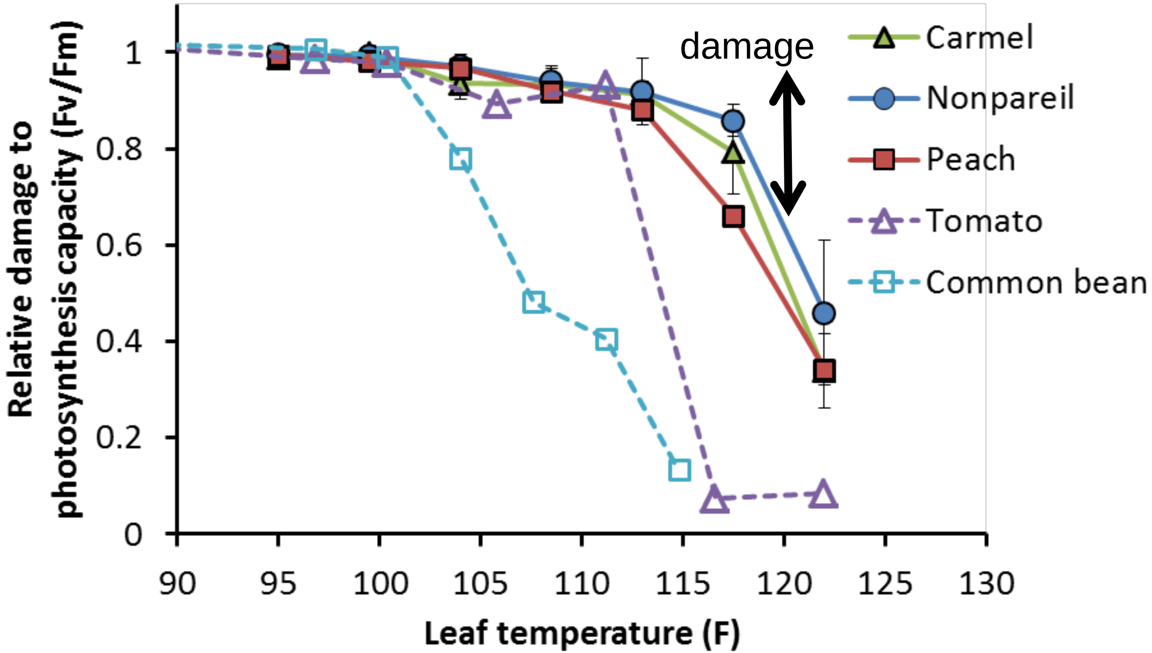


Heat Tolerance: Damage can be Recoverable or Not

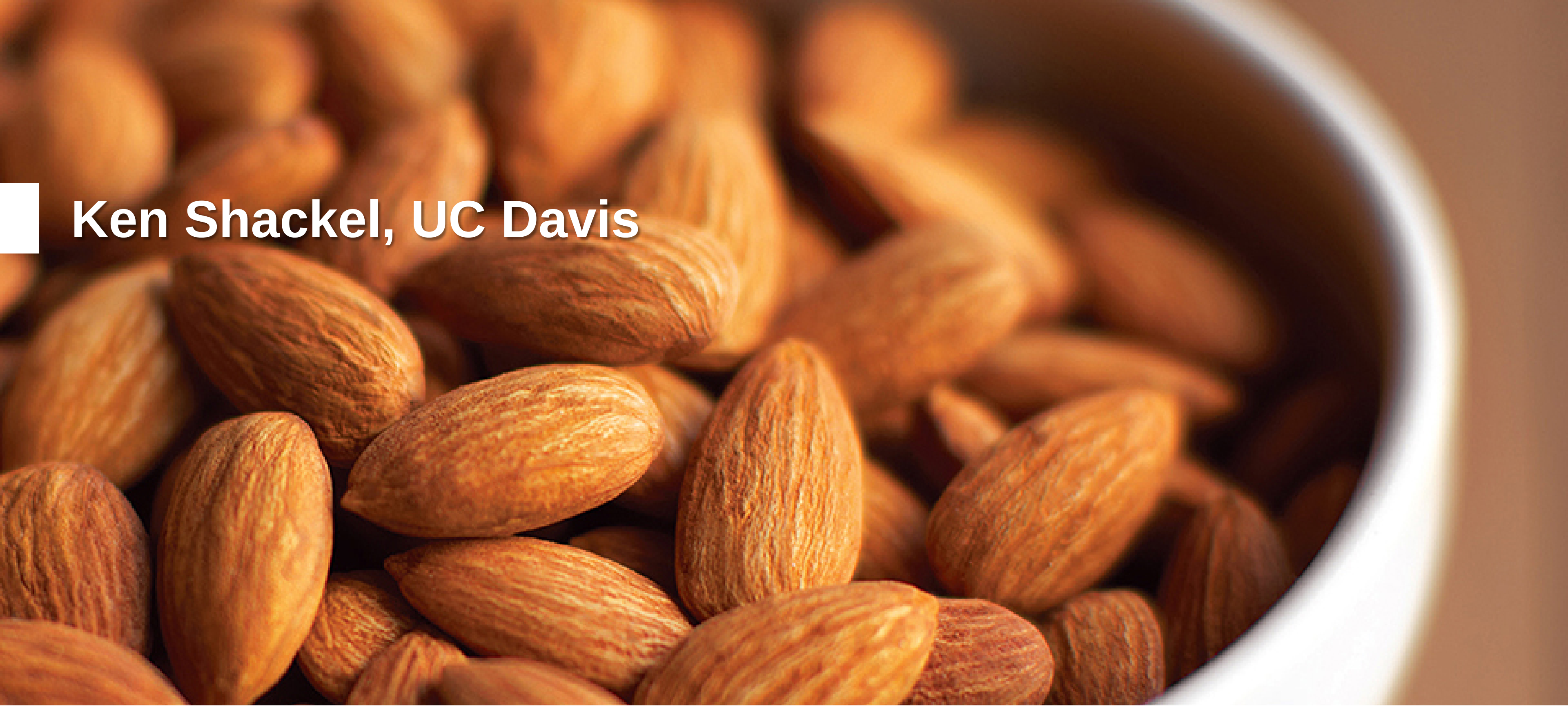


Heat Tolerance: How do Almonds Rank?

- Preliminary results:
  - Almonds are incredibly tolerant



Ken Shackel, UC Davis



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Whole Tree ET/Lysimeter

Ken Shackel (UC-Davis)
Gurreet Brar (UCCE-Fresno)
Bruce Lampinen (UCCE-Davis)

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Three acre lysimeter plot at Kearny Ag. Center, Fresno, CA, has been prepared and will be planted Jan/Feb, 2015

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Water Production Function

Ken Shackel (UC-Davis)
Dave Doll (UCCE-Merced)
Allan Fulton (UCCE-Tehema)
Bruce Lampinen (UCCE-Davis)
Blake Sanden (UCCE-Kern)

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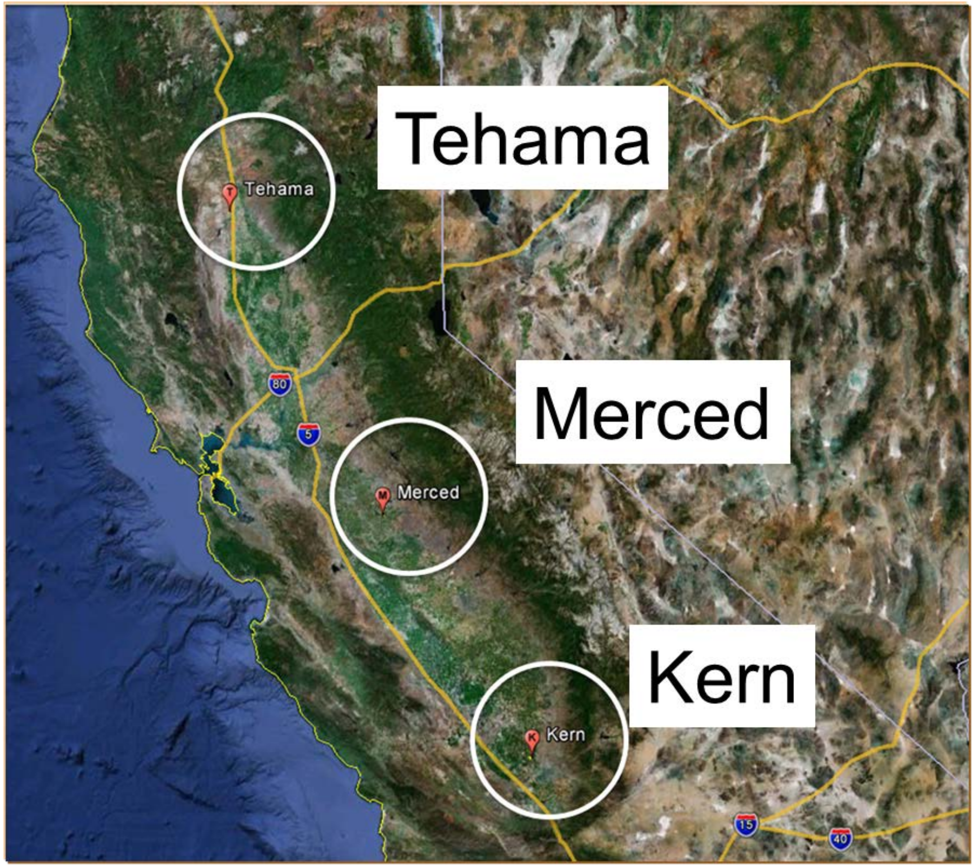
Overall Objective

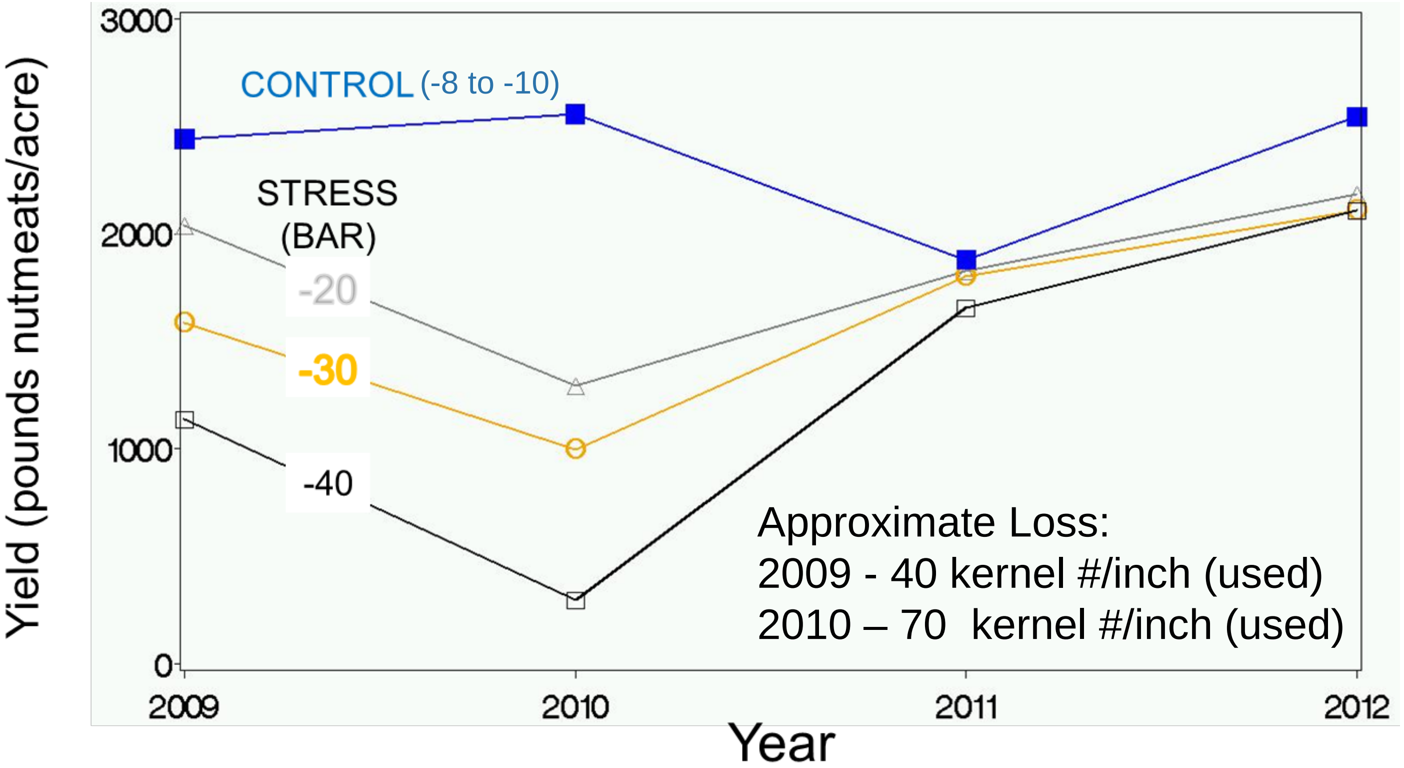
Develop a water production function (WPF) for almonds grown in California that will relate potential yield to water applied, accounting for the site-specific effects of orchard cover, soils, varieties, and physiological level of stress experienced by the tree.



Growers irrigation systems were modified to apply a range of ET levels (70 – 110%) at each site

Site	# of blocks	Treatment targets (% ET)
Kern	6	70, 80, 90, 100, 110
Merced	3	70, 80, 90, 100, 110
Tehama	6	74, 86, 100, 116

Background, 2009 drought study: Largest yield reduction occurred in the year following the stress (i.e. carryover effect)



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WPF 2013 (year 1)
Expected trend of SWP, no difference in PAR, unclear yield trends

Site	Yield (Lbs nutmeats/ac)		% PAR		SWP (Bar)	
	Treatment	Mean	Treatment	Mean	Treatment	Mean
Kern	90	3450a	110	70	110	-15.3a
	110	3340ab	80	69	100	-16.2b
	100	3320ab	100	69	90	-17.1c
	80	3140ab	70	68	80	-17.3c
	70	2840 b	90	68	70	-18.6d
Merced	100	3240	100	63	110	-13.4a
	110	3040	110	61	100	-13.6a
	70	2900	70	59	80	-14.3a
	80	2720	80	55	90	-14.4a
	90	2620	90	55	70	-17.2b
Tehama	86	2310	113	67	116	-10.7a
	74	2210	74	66	100	-12.6b
	100	2150	100	65	86	-13.0b
	116	2140	86	64	74	-13.7b

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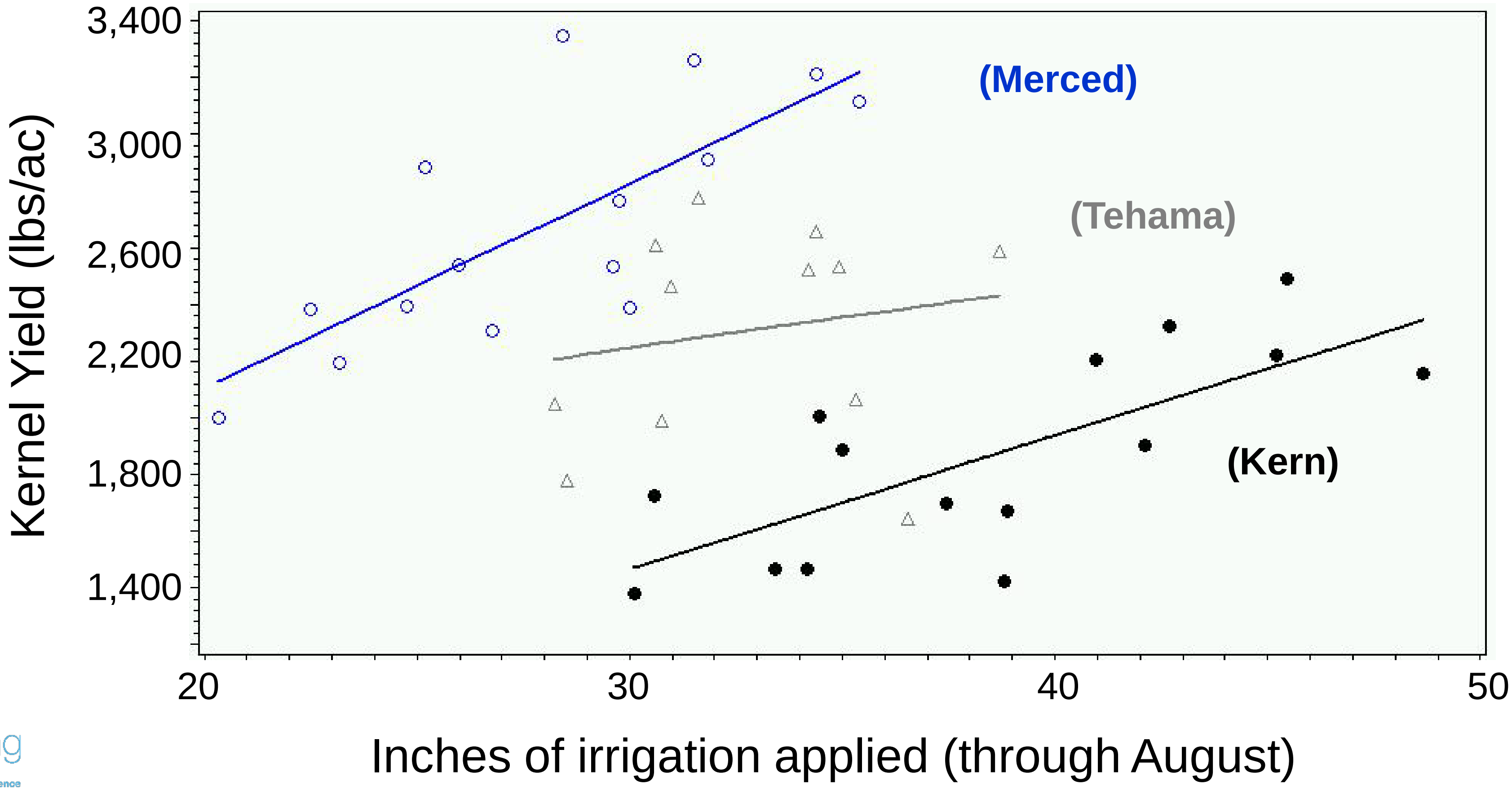
WPF 2014 (year 2)

From 20 to 70 kernel pounds per inch of applied water, depending on the site.



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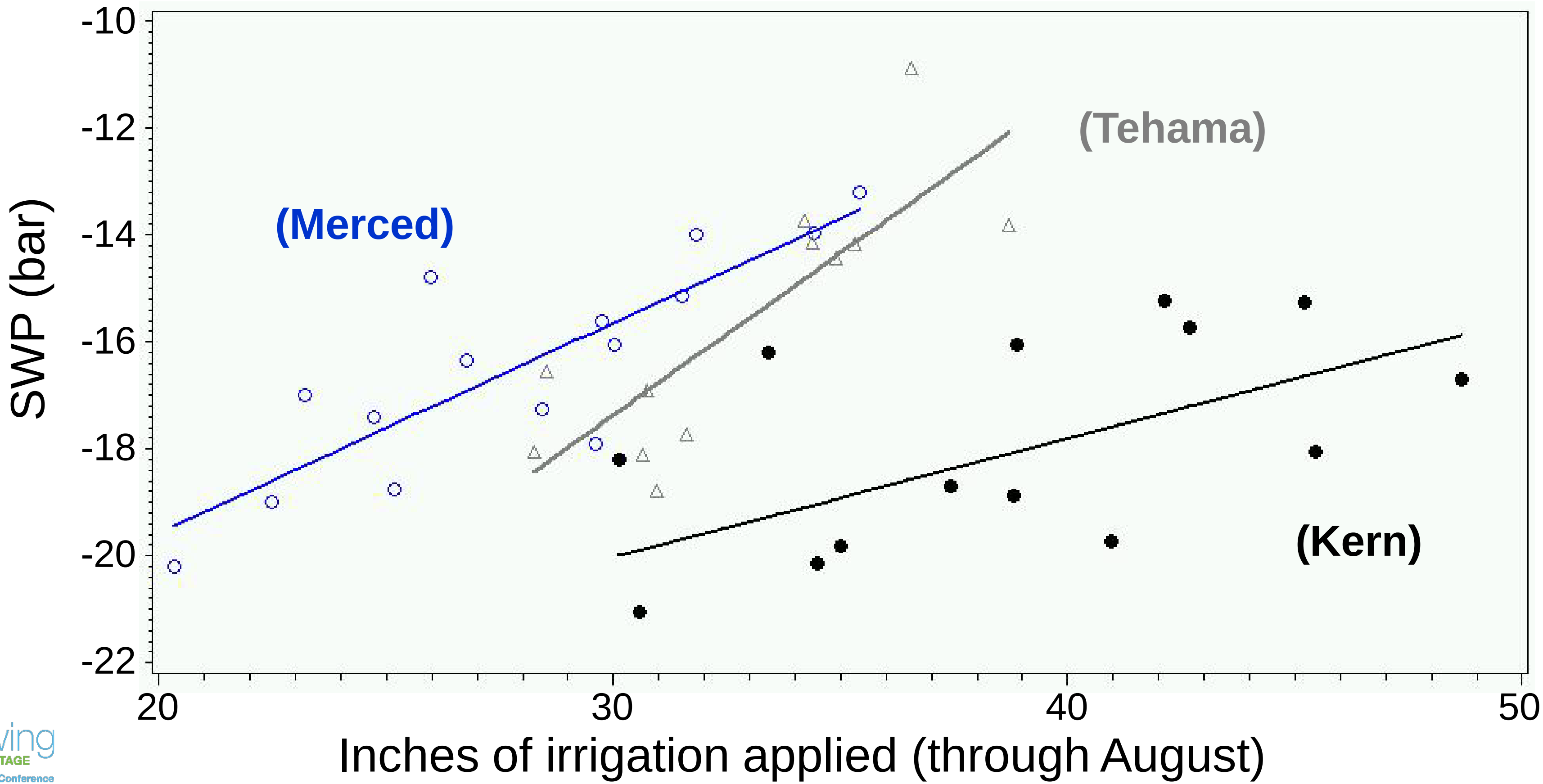
WPF 2014 (year 2)
Parallel differences in SWP



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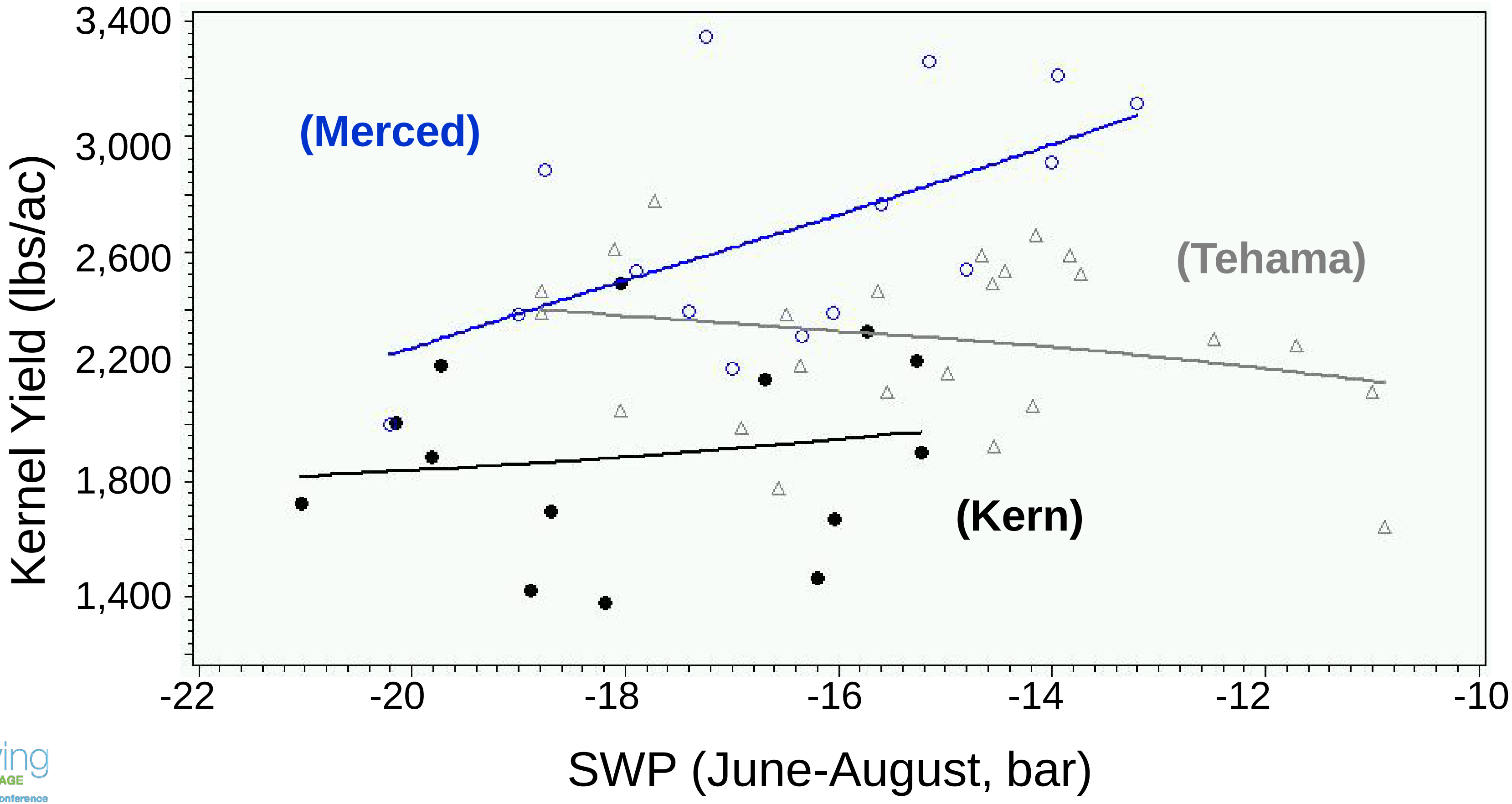
WPF 2014 (year 2)

More consistent relation of yield to SWP than to applied water, but not perfect.



Take home points

1) First whole tree lysimeter (ET) data will be in 2015.
2) Site differences in the WPF project are consistent with earlier studies that **different** amounts of water (%ET) may be required to achieve the **same** SWP on different soils.
3) Estimates of loss in yield per reduction in applied water (20 to 70 kernel pounds per inch) are very preliminary. Site and block differences are important and need deeper examination.

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Thanks for your attention and support

Baris Kutman
UC Davis

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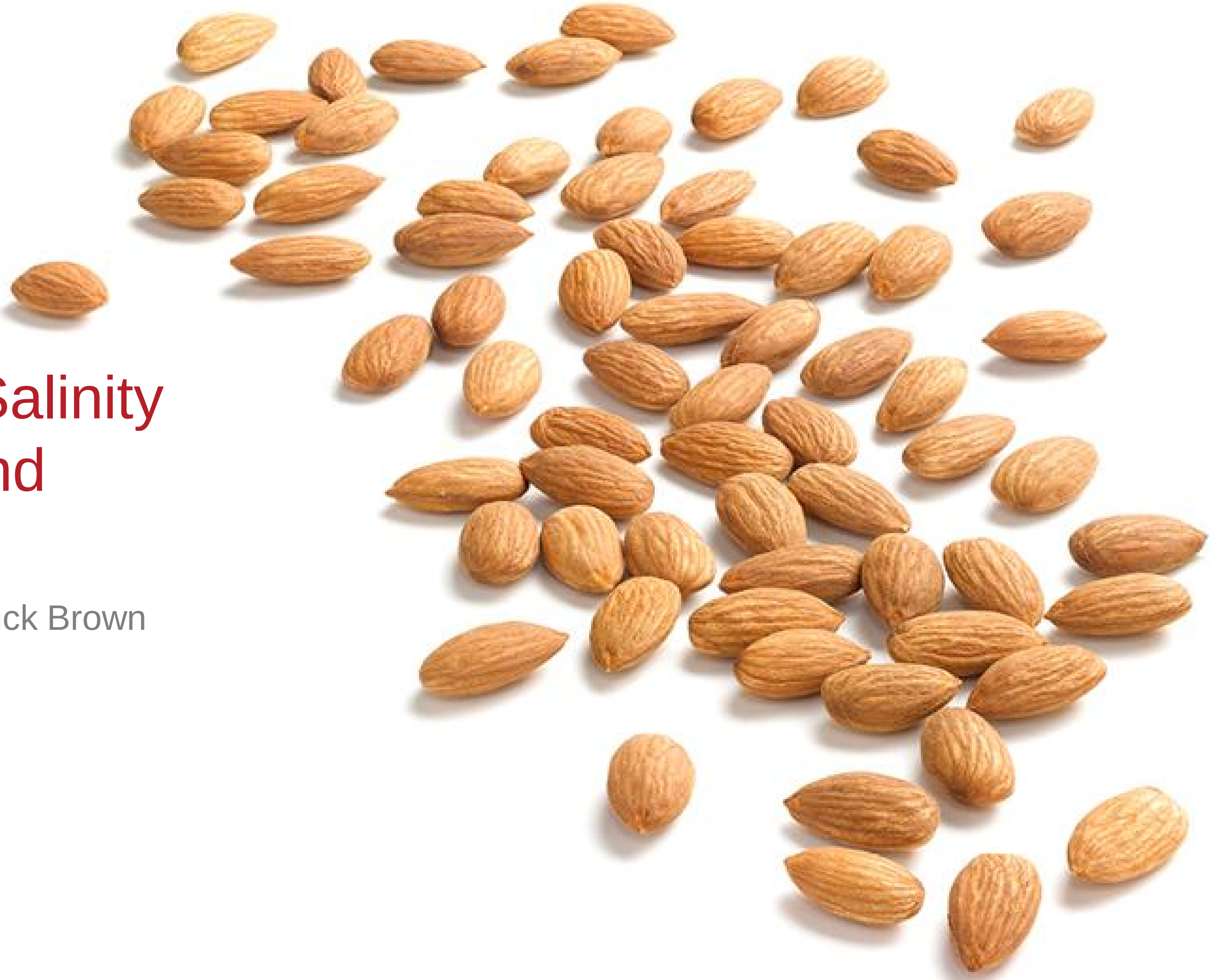

Physiology of Salinity Stress in Almond

Umit Baris Kutman & Patrick Brown
Plant Sciences, UC Davis

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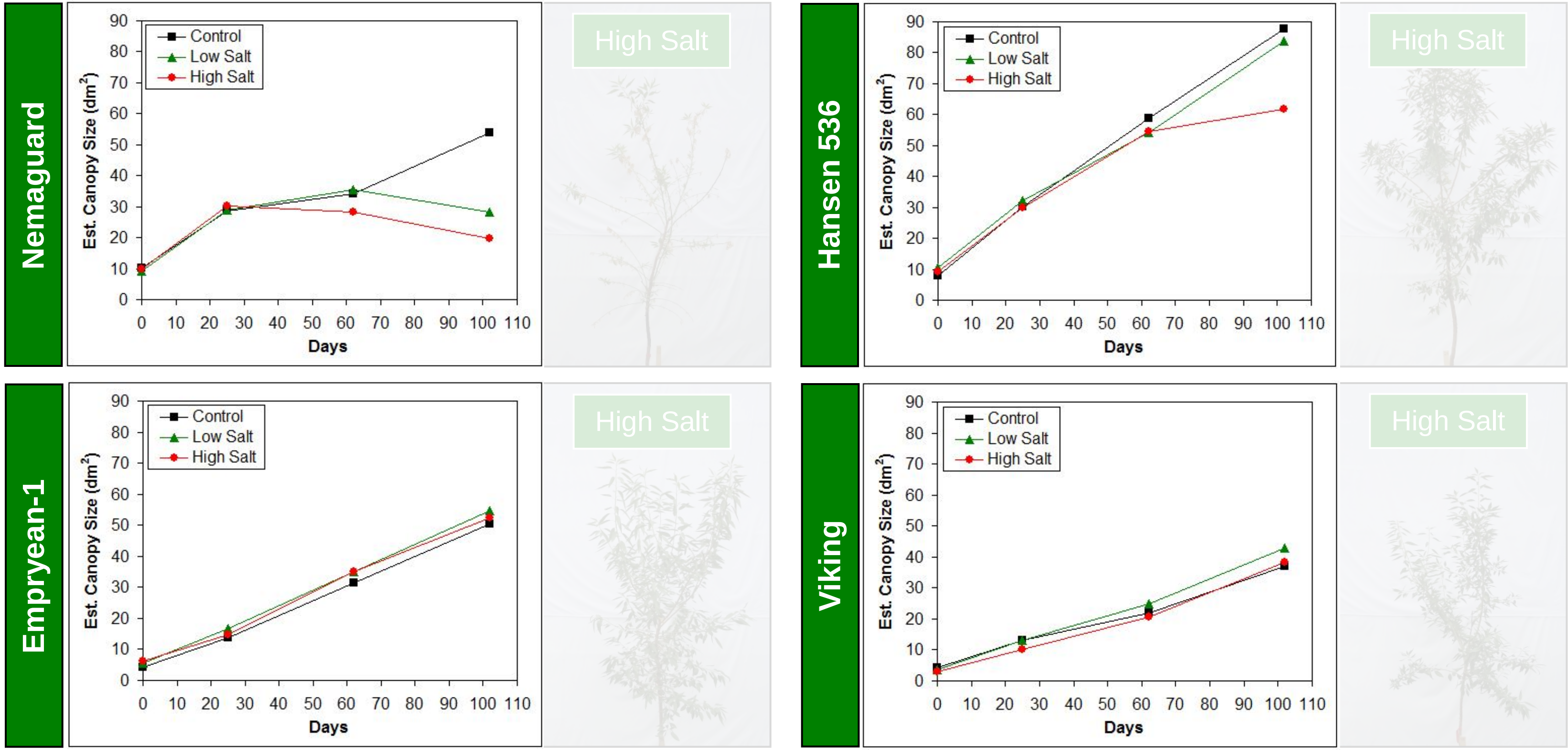
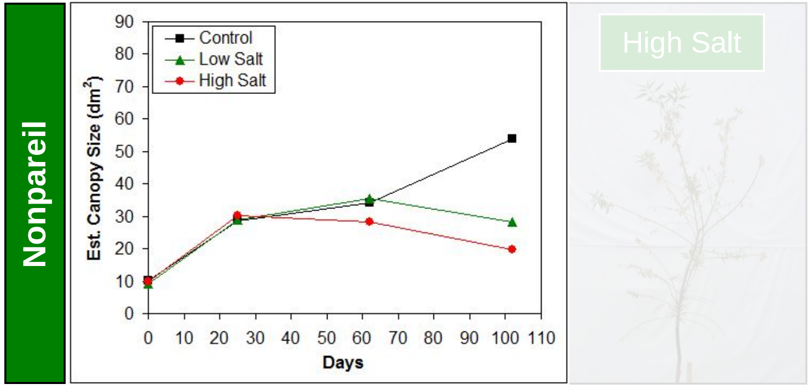
Information about the Experiment

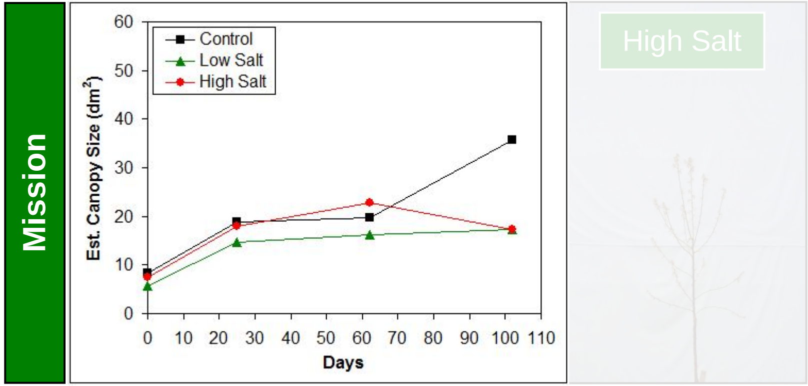
- Young grafted almond trees planted in 7-gal pots filled with Turface, a calcined clay substrate
- 4-replicate experiment conducted in open field conditions
- 4 rootstocks
  - Nemaguard, Hansen536, Empyrean-1, Viking
- 4 cultivars
  - Nonpareil, Mission, Monterey, Fritz
- Nutrients and salts applied with each irrigation
  - 3 salt levels: control (~1 dS/m background); low salinity (additional 2 dS/m); high salinity (additional 4 dS/m)
  - NaCl used as the main salinizing agent
  - KCl and Na_2SO_4 also tested as alternatives
- Salinity levels maintained by free leaching

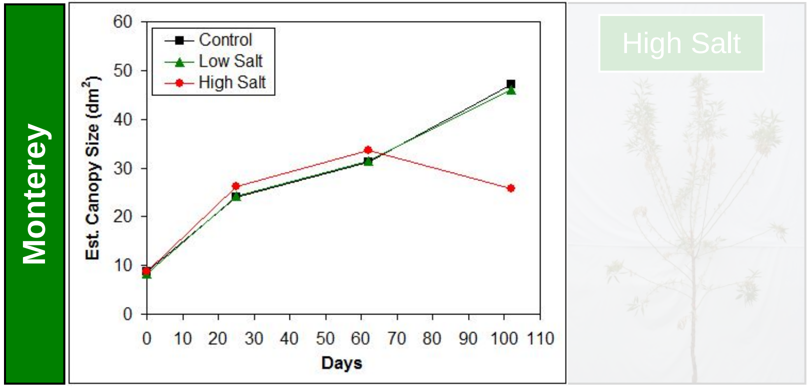
Growth and Salt Tolerance of Nonpareil on Different Rootstocks

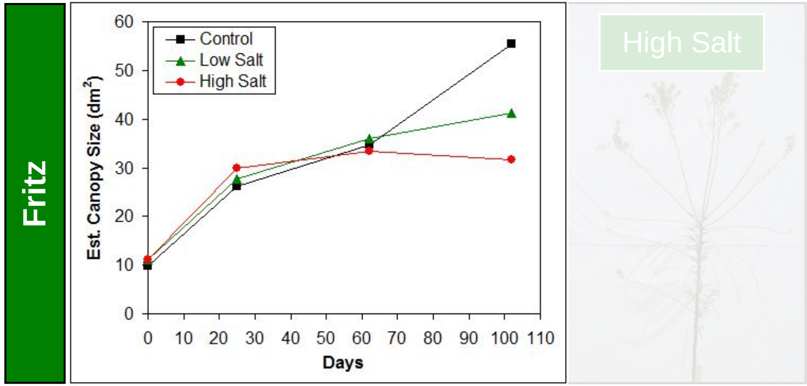


Growth and Salt Tolerance of Different Cultivars on Nemaguard









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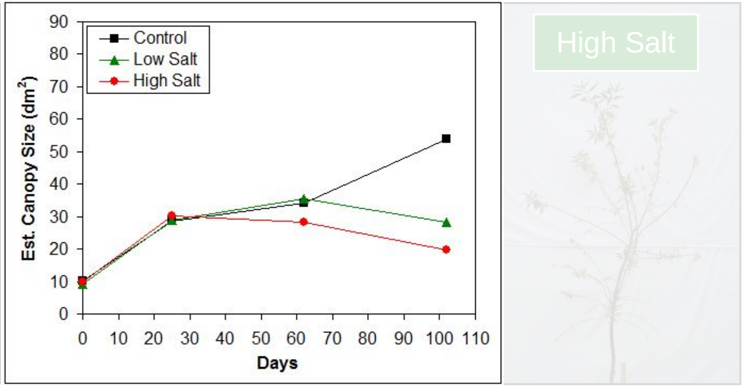
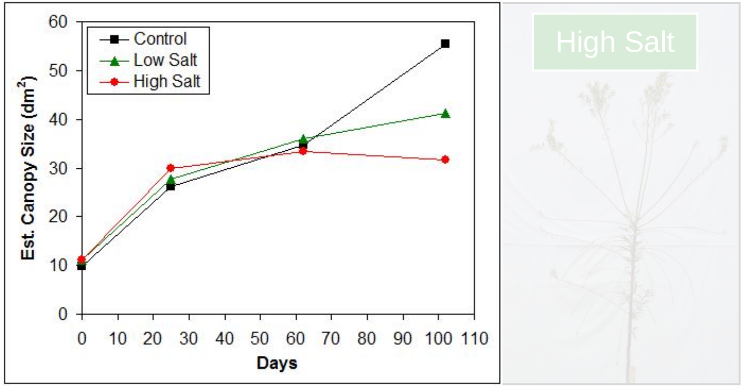
Salt Tolerance of Nonpareil vs. Fritz on Nemaguard vs. Hansen 536

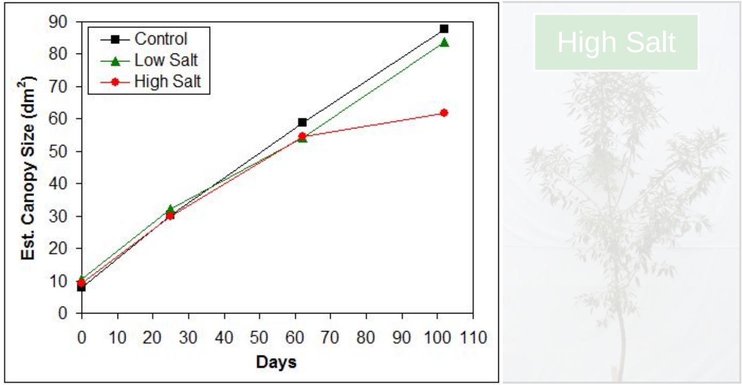
Nonpareil / Nemaguard



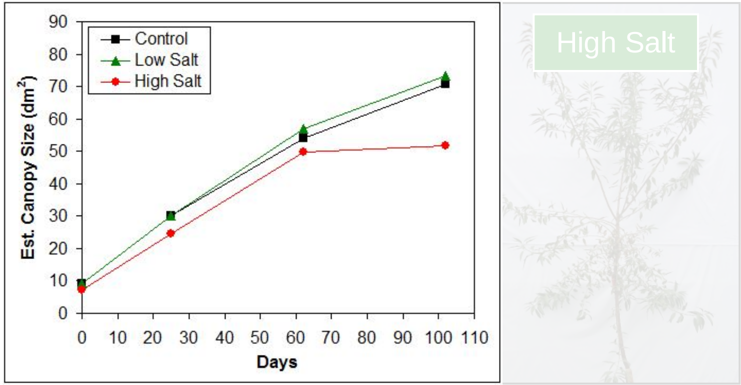
Fritz / Nemaguard



Nonpareil / Hansen

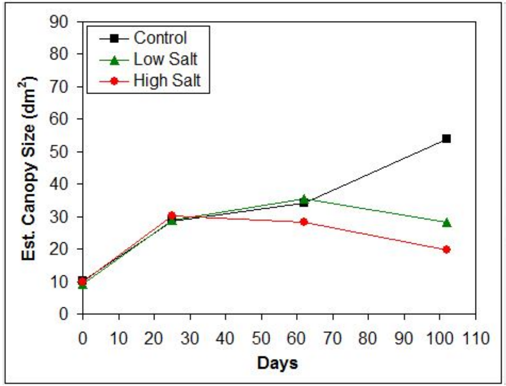


Fritz / Hansen

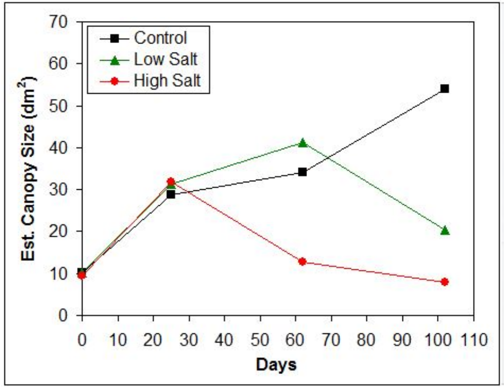


Effect of Salt Type on Growth of Nonpareil on Nemaguard

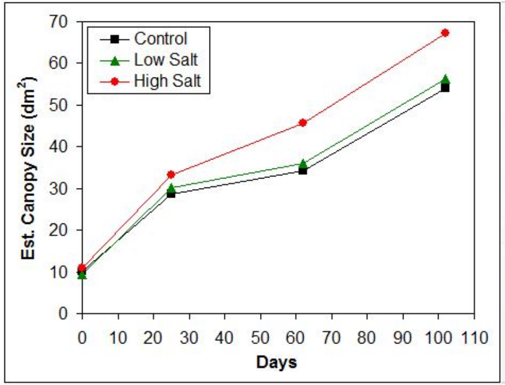
NaCl



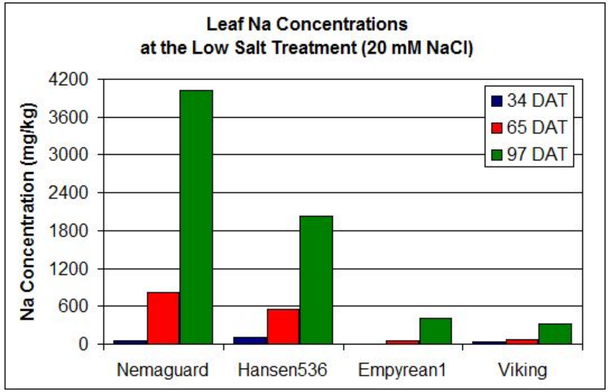
KCl

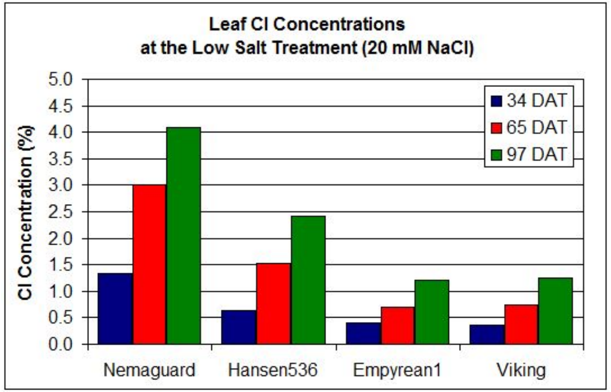


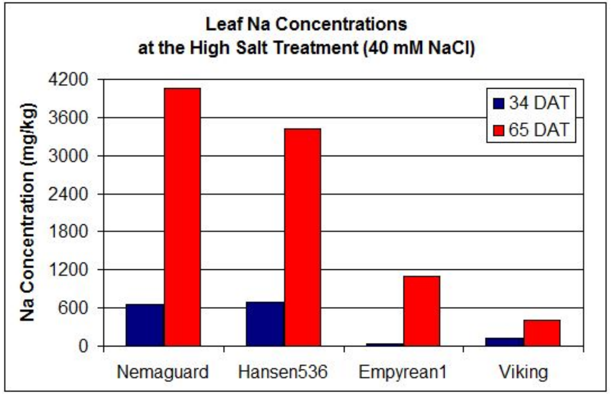
Na_2SO_4

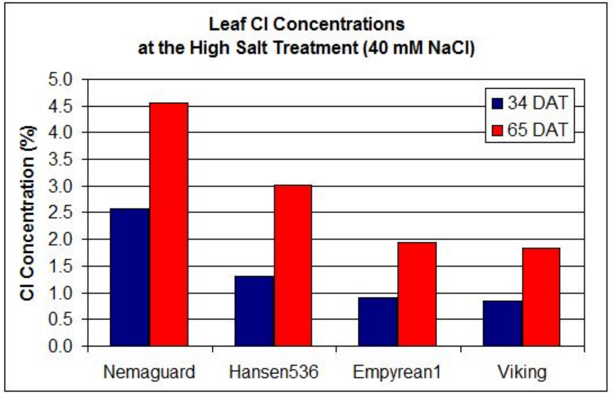


Leaf Na and Cl Concentrations of Nonpareil on Different Rootstocks

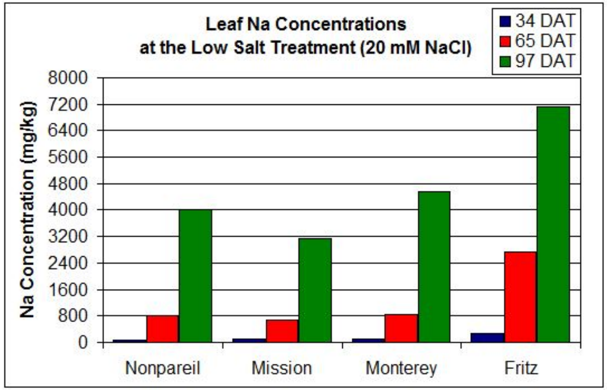


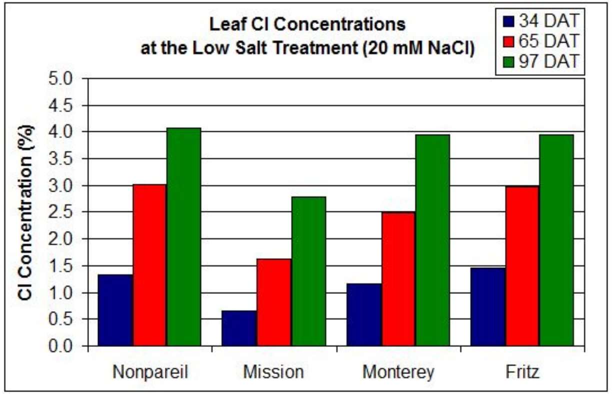


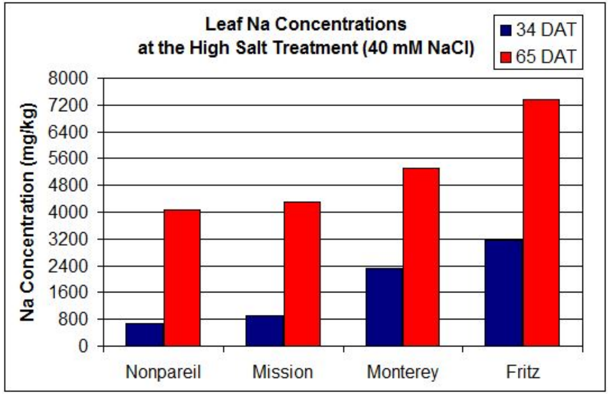


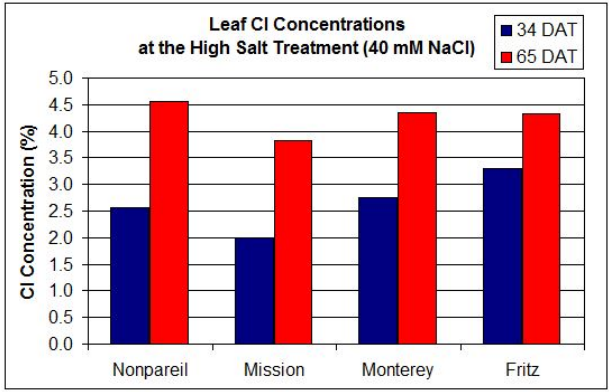


Leaf Na and Cl Concentrations of Different Cultivars on Nemaguard

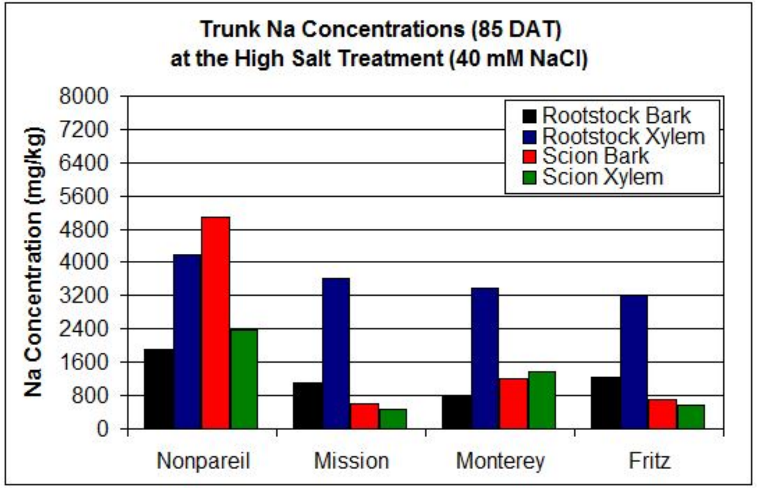


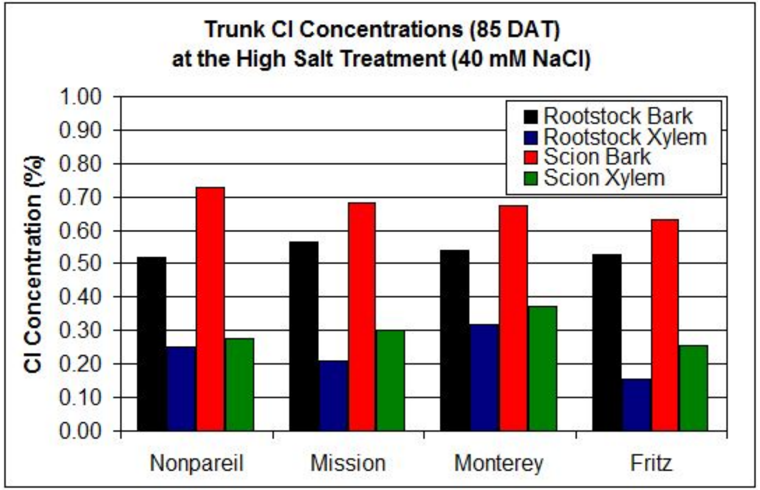




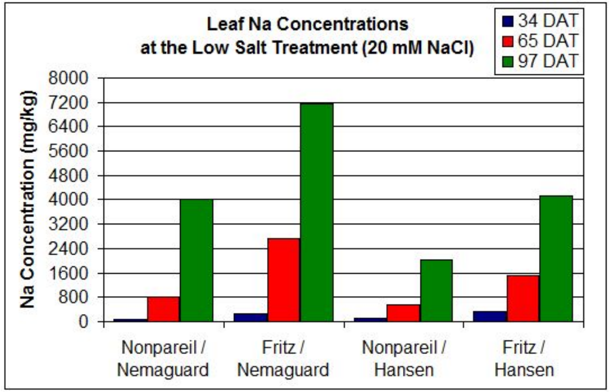


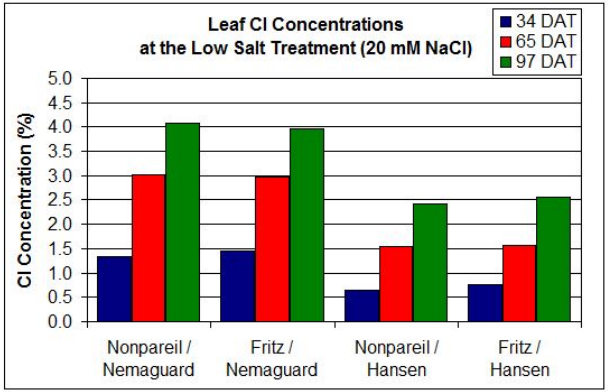
Trunk Na and Cl Concentrations of Different Cultivars on Nemaguard

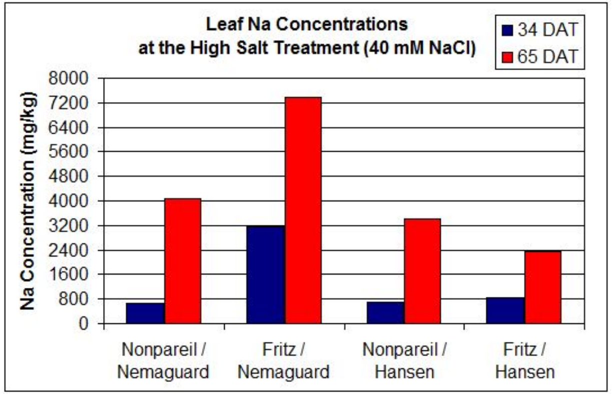


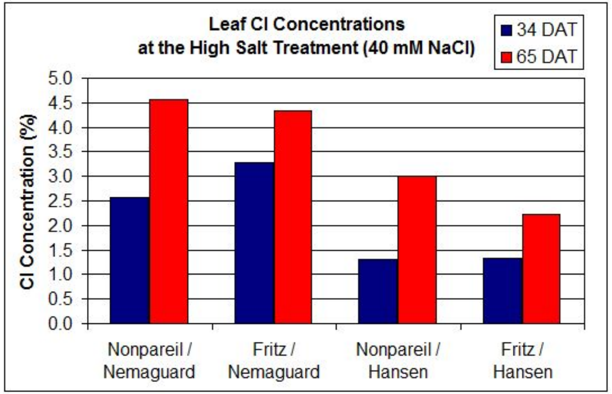


Leaf Na and Cl of Nonpareil vs. Fritz on Nemaguard vs. Hansen 536

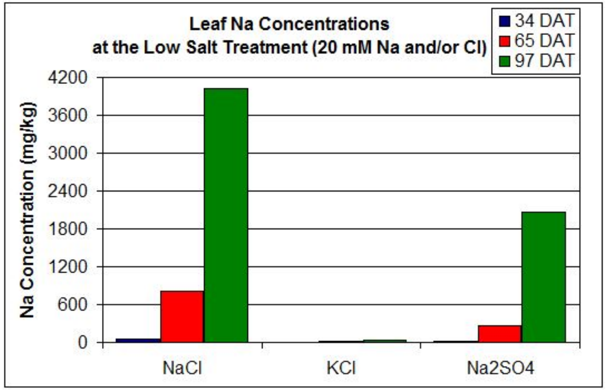


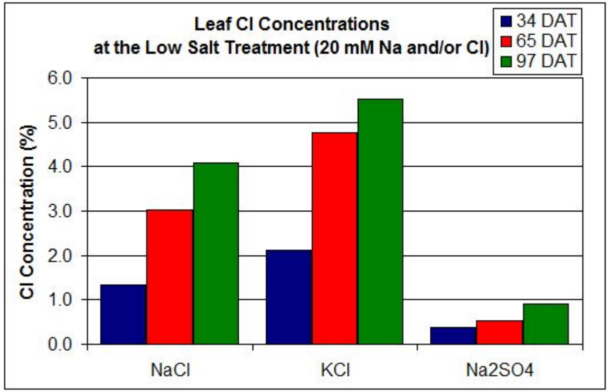


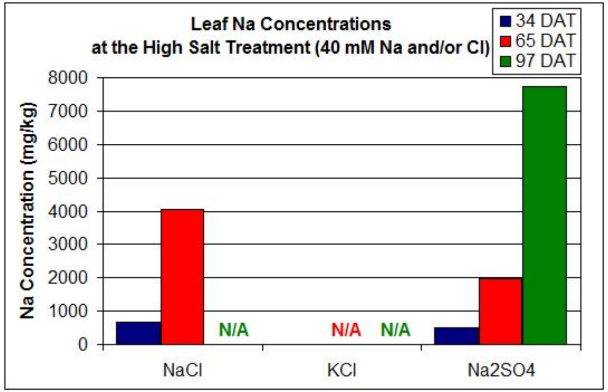


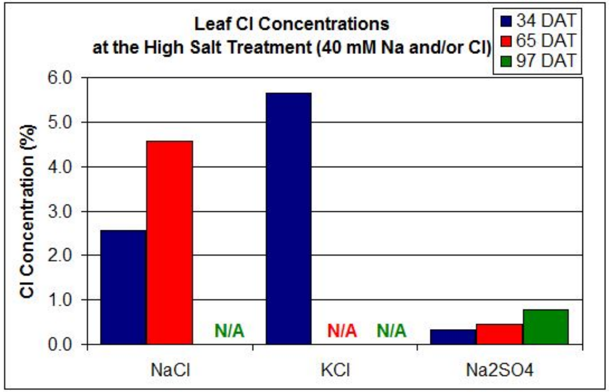


Effect of Salt Type on Leaf Na and Cl of Nonpareil on Nemaguard









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Summary of Findings & Poster Information

- There is a great degree of variation in salinity tolerance of rootstocks:
  - Viking = Empyrean-1 > Hansen536 > Nemaguard
- There is also considerable variation in salt accumulation characterics of different almond cultivars.
  - Trunk accumulation of Na appears to be a critical tolerance mechanism.
  - Nonpareil is very efficient whereas Fritz and Mission lack this ability.
- If Na and Cl are found at comparable levels in the soil, Cl accumulates much faster than Na in the leaves and acts as the dominant toxic ion.
- Salinity tolerance in almond is very well correlated with exclusion of toxic ions from leaves.
  - Growth of efficient excluders is not affected by salinity.
  - Salt-induced water stress may not be significant at practically relevant salt levels.
- For further information and discussion, please visit Poster 58.

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Grower Ratings of Organic Matter Amendments - Benefits, Concerns and Access

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Department of Plant Sciences
University of California Davis

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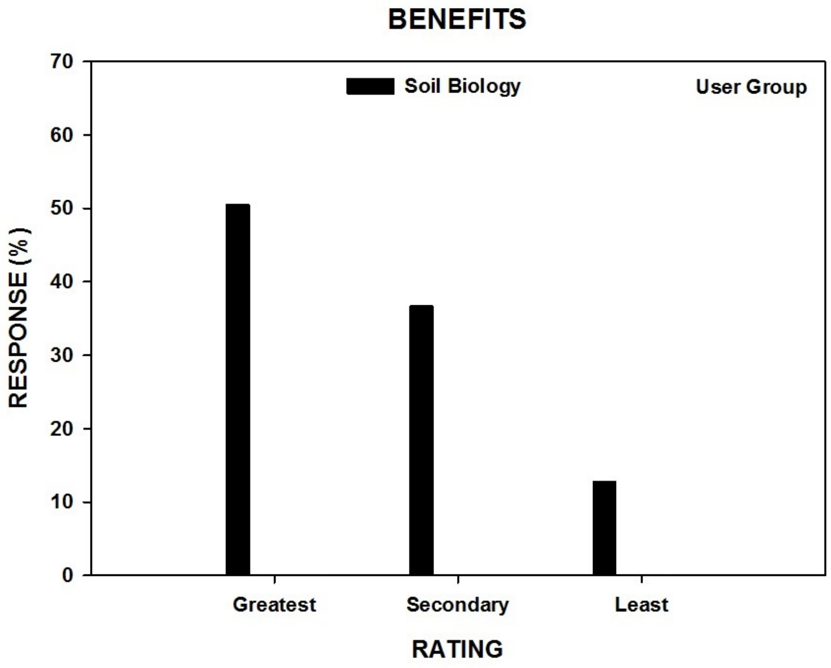
Survey Overview

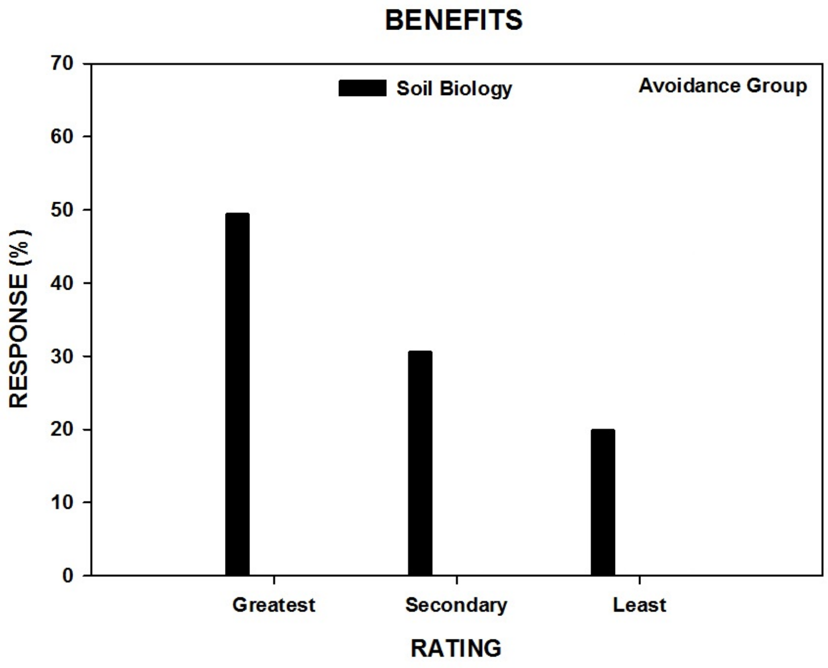
- 1657 replies out of 6237 unique addresses
- 26.6% response rate
- 989 surveys completed
- 398 opt outs
- 300,000+ acres

Survey Structure

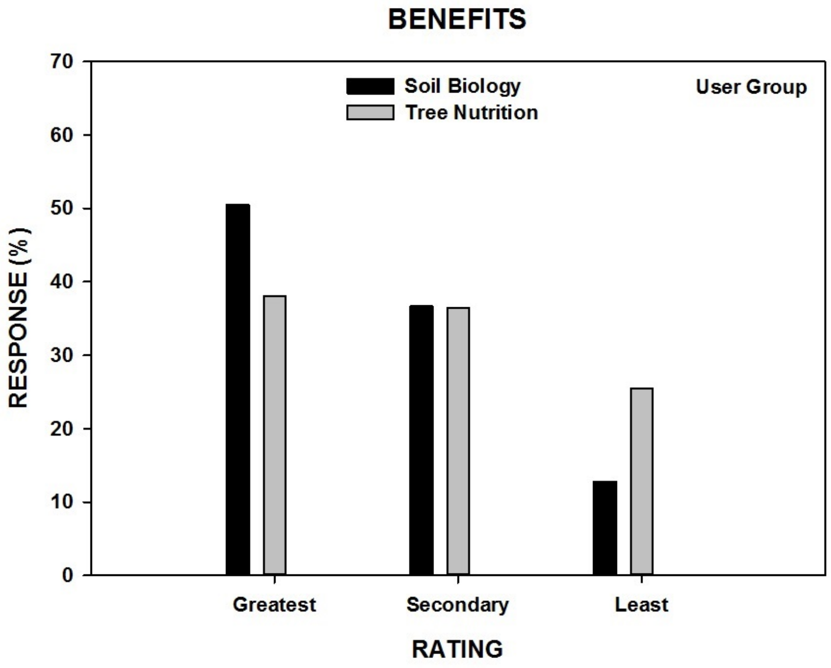
- Opinion of Benefits
- Issues of Concerns
- Quality of Access
- Grouped Responses
  - User Group
  - Avoidance Group

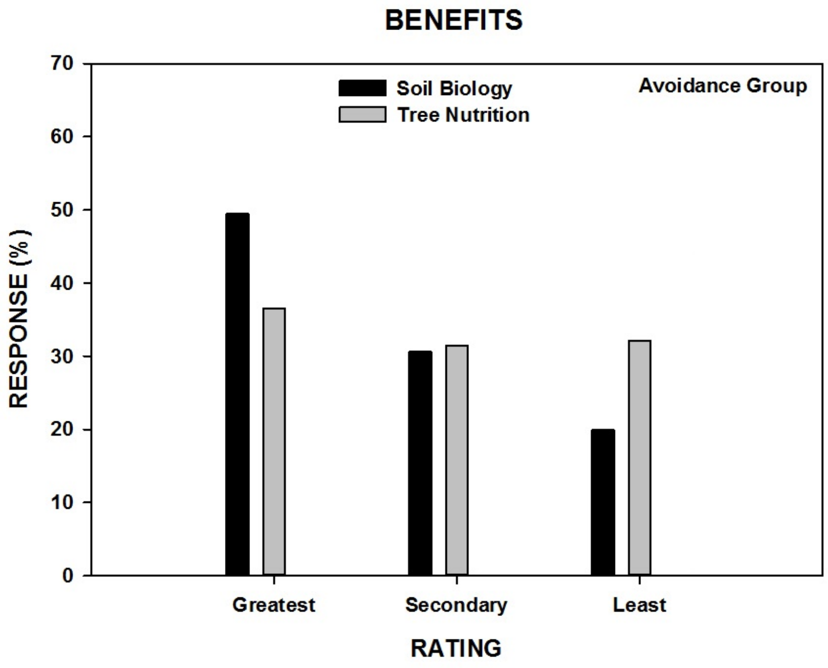
Rating Benefits



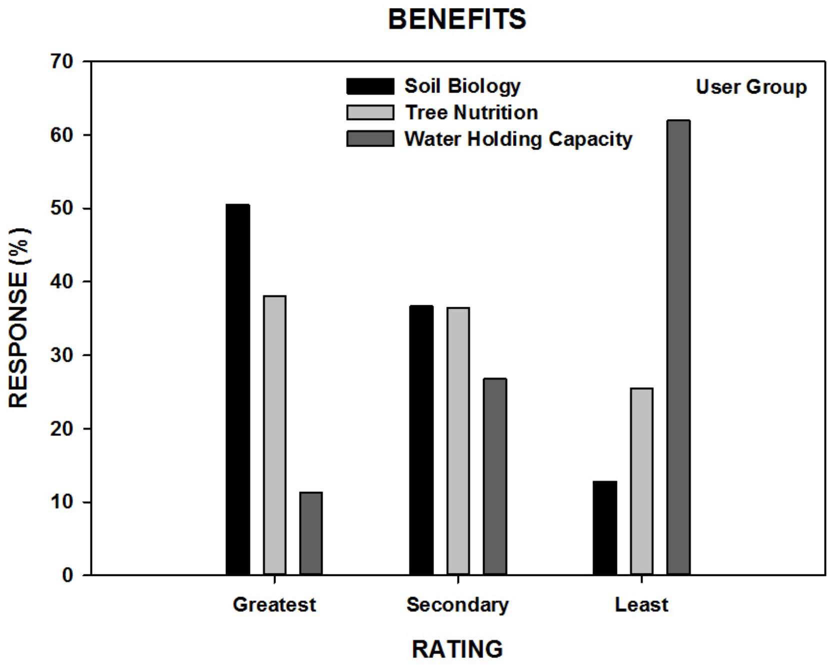


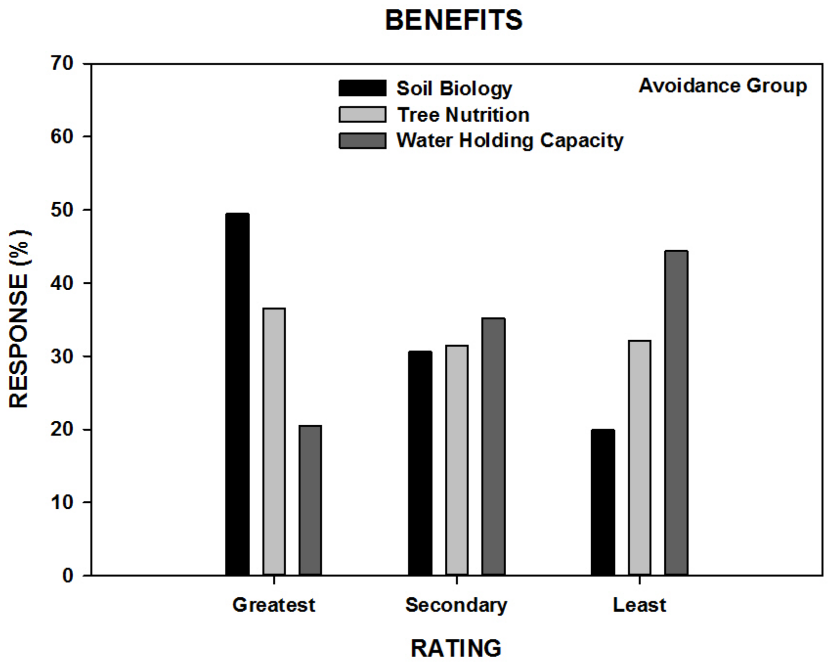
Rating Benefits



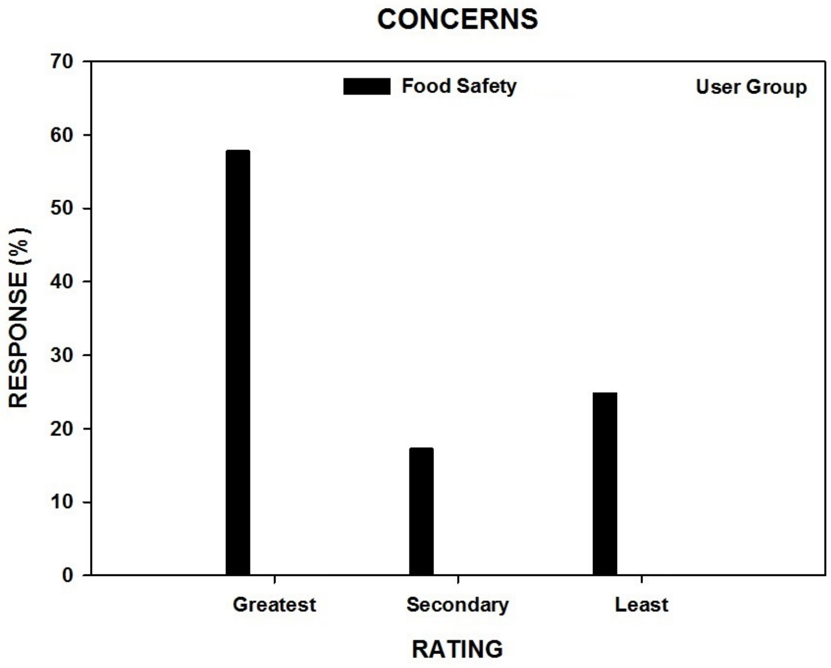


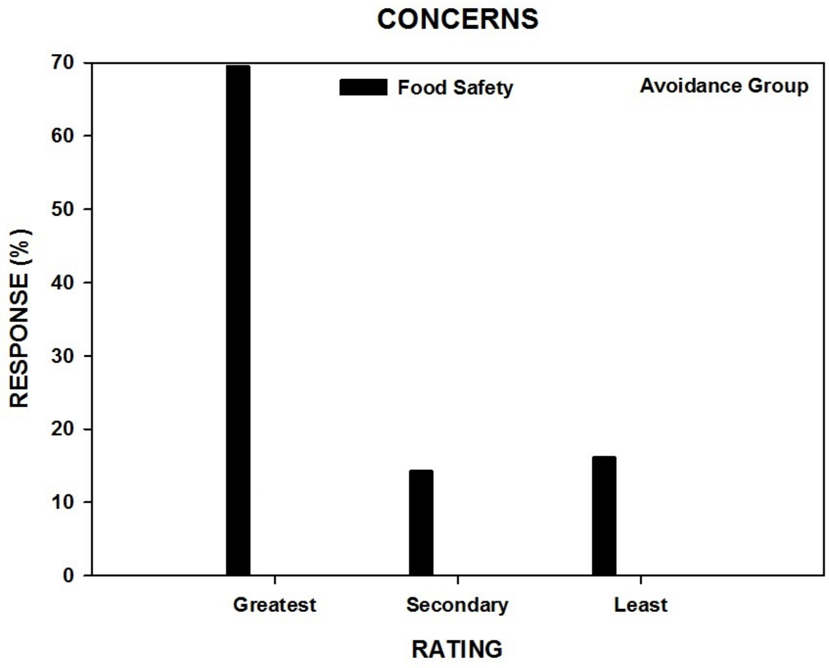
Rating Benefits





Rating Concerns





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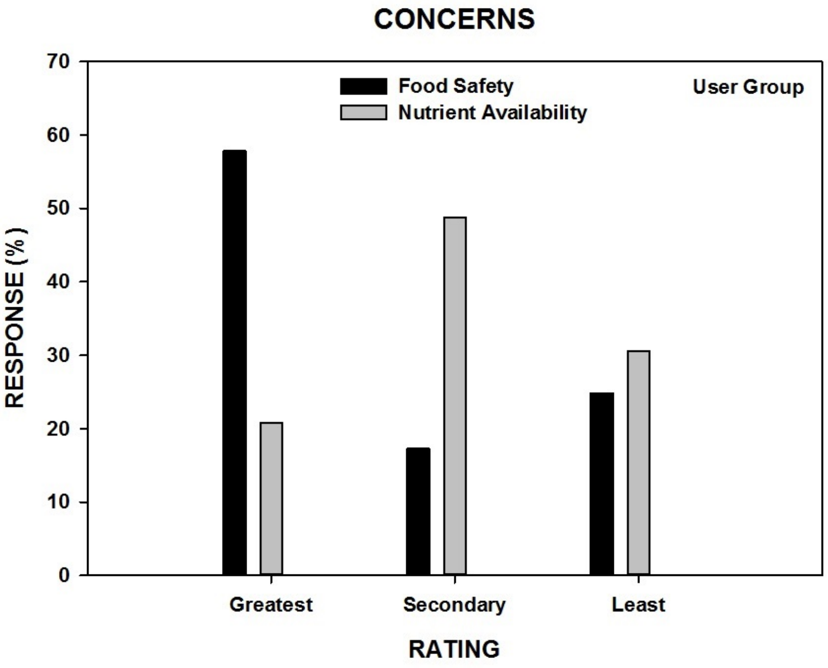

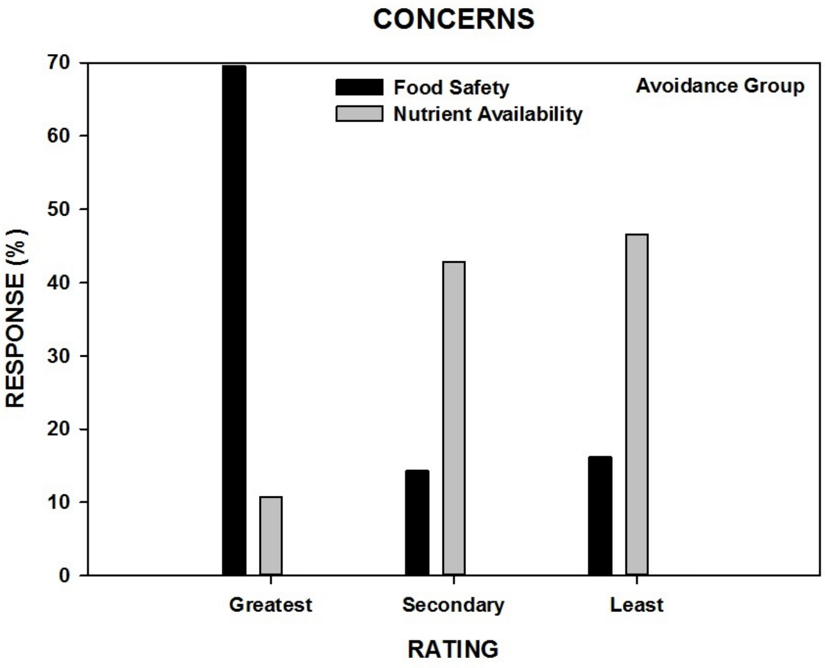

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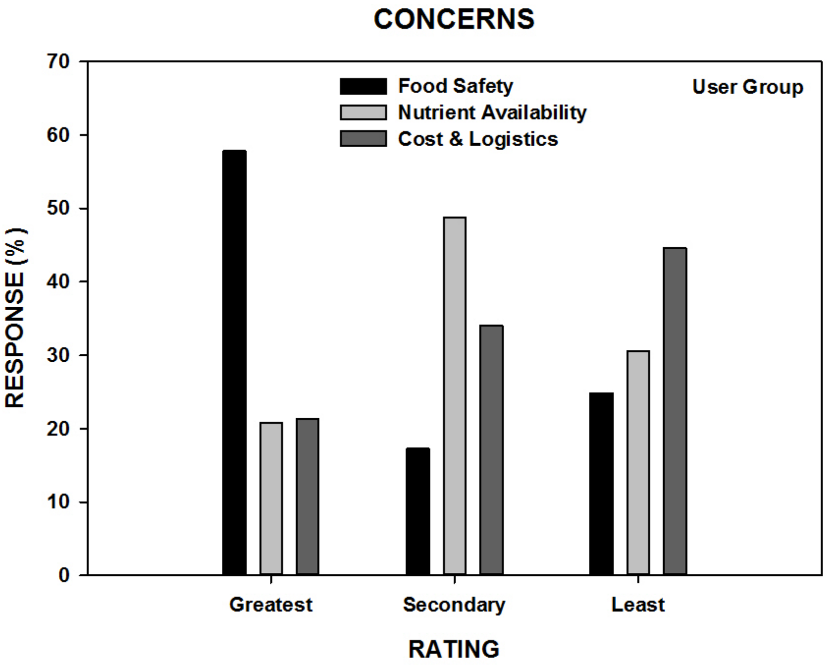
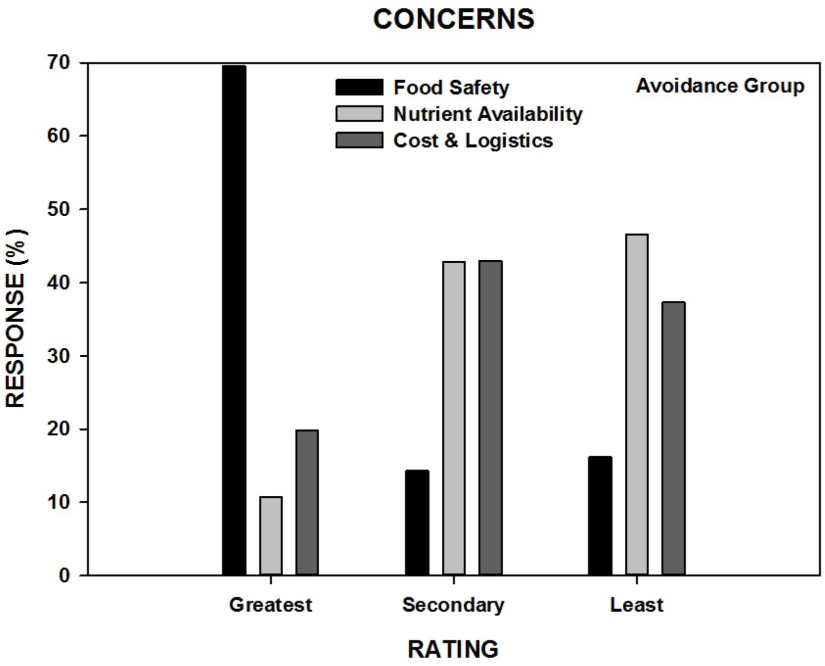
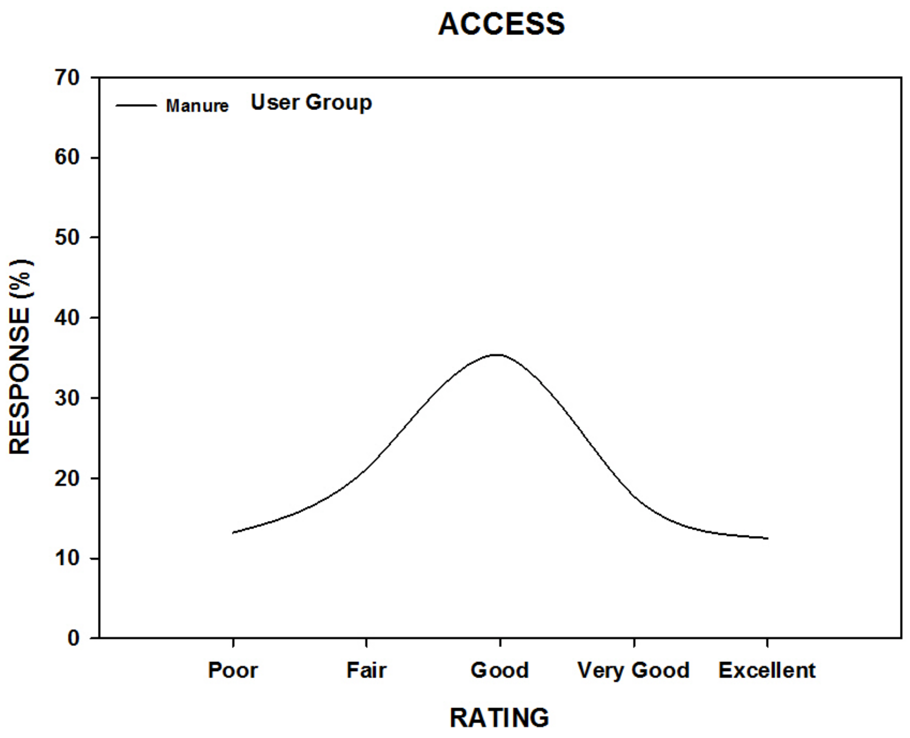




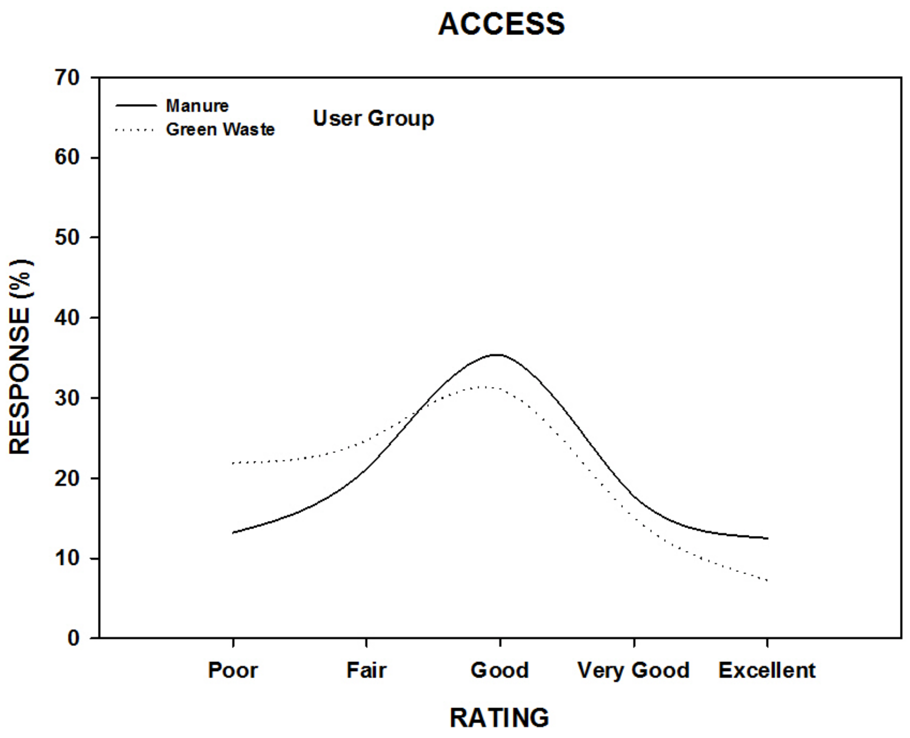
Rating Access



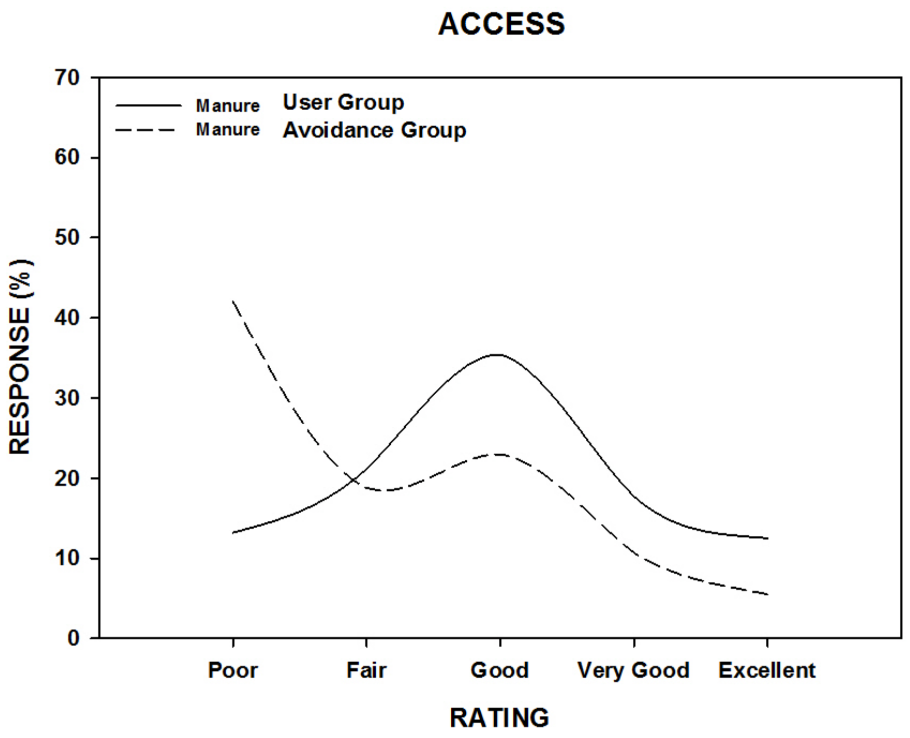
More Results & Future Work

- Agronomics of User Group
  - Planting vs. Non-bearing vs. Bearing
  - Sources & Forms
  - Timing
  - Placement
- Grower vs. Acreage Response
- Response by County with Maps
- Future Work with On-Farm trials
- Take the Survey

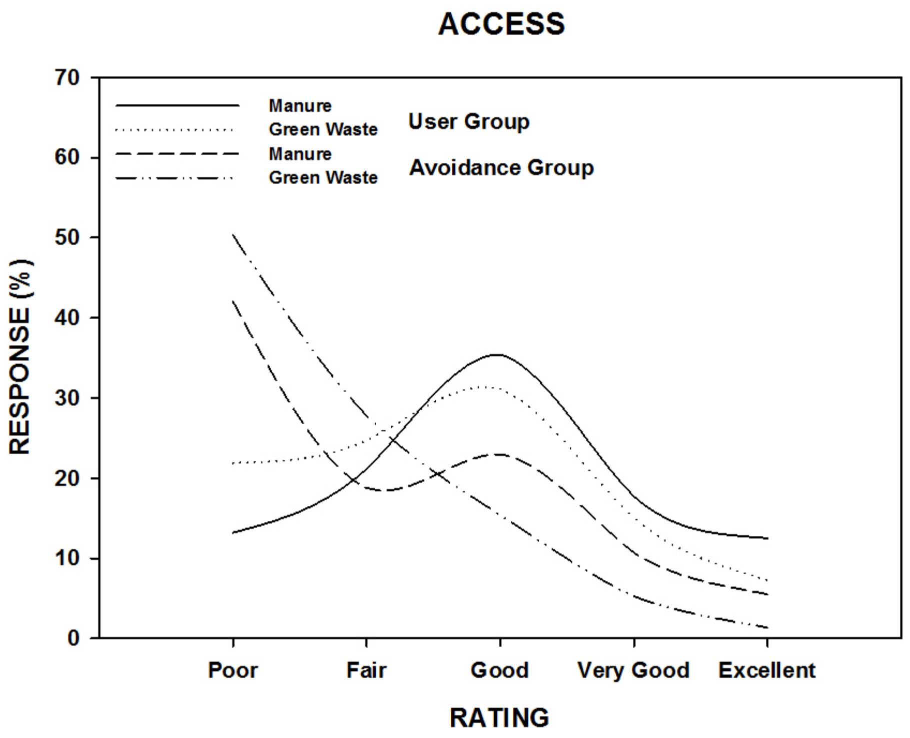
Rating Access



Rating Access



Rating Access



Conclusions

- User & Avoidance Groups - Soil Biology > Tree Nutrition > Water Holding Capacity
- User Group - Food Safety > Nutrient Availability > Cost & Logistics
- Avoidance Group – Food Safety >> Cost & Logistics > Nutrient Availability
- User Group Greater Access than Avoidance Group
- Manure Greater Access than Green Waste

Jan Hopmans,
Land, Air and Water Resources, UC Davis

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Efficient irrigation and fertigation practices across California

UC DAVIS
UNIVERSITY OF CALIFORNIA

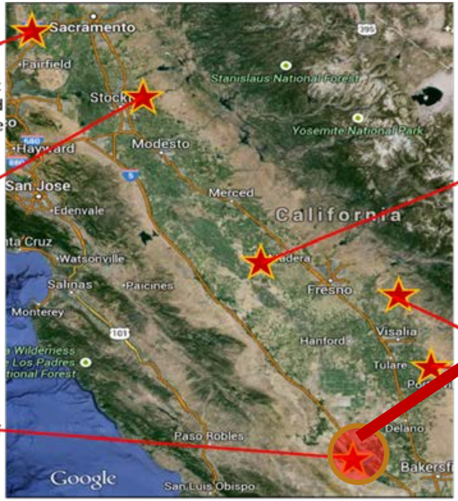
Objectives:

- Develop improved irrigation water & nitrate management guidelines in **almonds**
- Focus on reduced leaching practices
- Establish field-scale soil water monitoring protocol

Tomato field: Effect of winter fallow and cover crop in nitrate leaching under drip irrigation

Walnut orchard: Plant nutrition and nitrate leaching under sprinkler irrigation

Almond orchard: Nitrate leaching under fanjet and drip irrigation



Almond orchard: Nitrate leaching under fanjet irrigation, pump and fertigate

Citrus orchards: Irrigation efficiency and nitrate leaching in oranges and mandarin orchards under fanjet ation

Paramount Farms, Lost Hills

Wireless Sensor Networks

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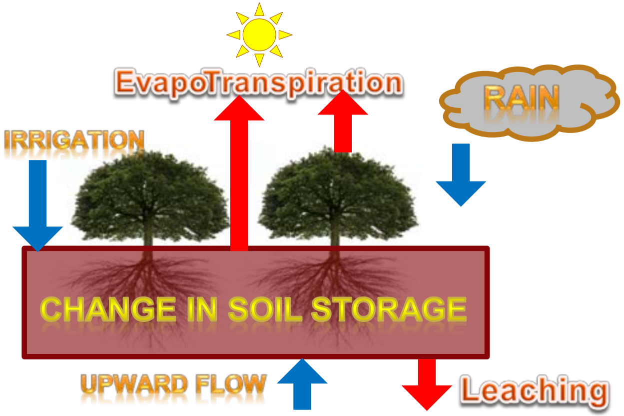
WATER BALANCE (INCHES)

	2009	2010	2011	2012	2013	2014
Rainfall	3.88	9.28	4.71	3.43	1.61	0.33
ET_o	58.75	54.87	52.39	57.12	59	59.91
ET_c	63.78	54.33	54.33	55.91		
Irrigation	55.12	51.57	50	50	~48	*
Change in Soil Storage	0.28	1.79	3.13	-5.71		
Leaching	-1.57	3.54	-2.95	2.20		

* Applied Irrigation Water Reduced by approximately 50%

Drought has reduced irrigation and minimized leaching, as inferred from deep soil water content and tensiometer measurements

Mass balance approach



Leaching (L) = Irrigation + Rainfall - ET - Change in soil water storage

Field scale

ET and precipitation monitoring:

CIMIS stations, ET_o

Eddy Covariance Tower, ET_{crop}

Irrigation monitoring:
Flowmeters

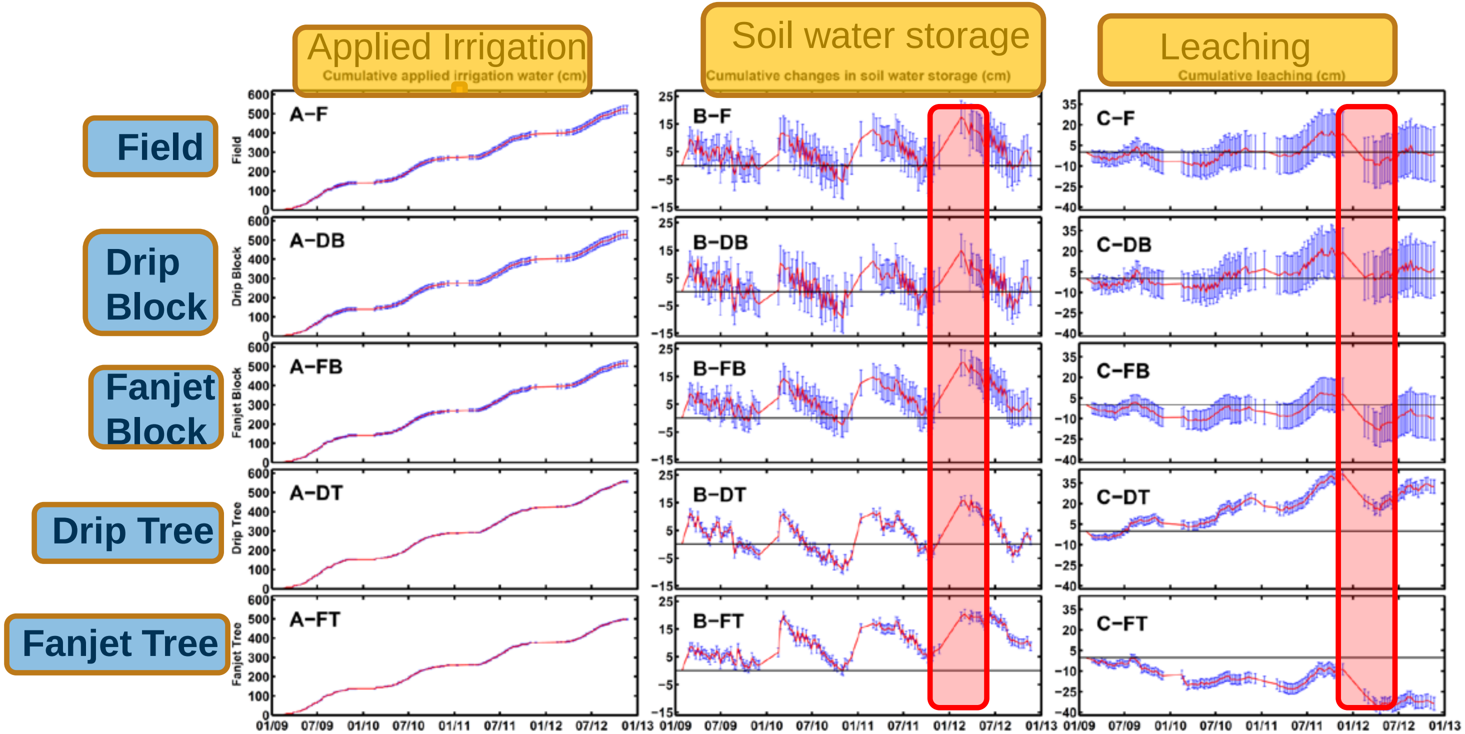
Field scale

Local

Field and Local scale

Soil storage monitoring:
Neutron probe

Uncertainty in leaching estimation



Decrease in leaching is likely caused by over-estimation of winter ET from evaporation of fog condensation.(~ 1mm/day for warm winters)

High uncertainties in leaching estimation from single tree to field scale (inches).

Data are cumulative from 2009-2013

	Field scale P (in)	Field scale* ET (in)	Local IW (in)	Local ΔS (in)	Local L (in)
Field	22.5 (±0.5)	228 (±1.2)	206 (±7.5)	0.5 (±1.97)	-0.5 (±7.75)
Drip block			209 (±7.8)	0.04 (±1.97)	2.8 (±7.68)
Fanjet block			203 (±5.83)	1 (±1.85)	-3.8 (±6.3)
Drip tree			219 (±1.26)	0.7 (±0.63)	12.6 (±1.93)
Fanjet tree			196 (±1.14)	3.6 (±0.63)	-13.5 (±1.85)

* Variation is assumed to be 10% of daily ET, but in reality likely to be much larger

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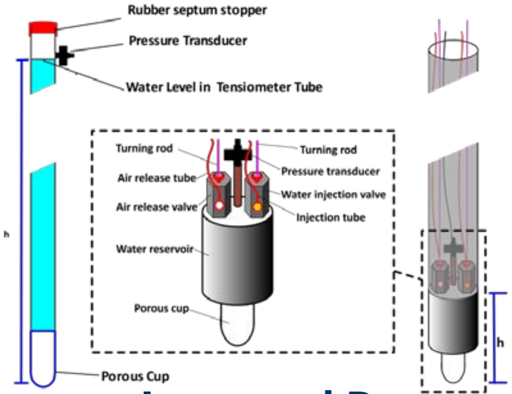
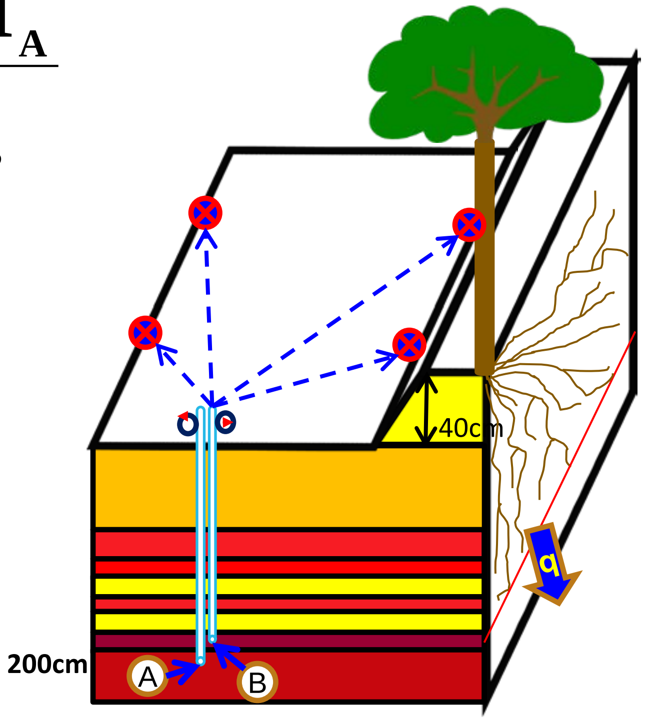
Darcy Flow Approach : Tensiometers below root zone

Tree plot scale

$$q_{A-B} = -K(\theta)\frac{H_B - H_A}{\Delta z_{A-B}}$$

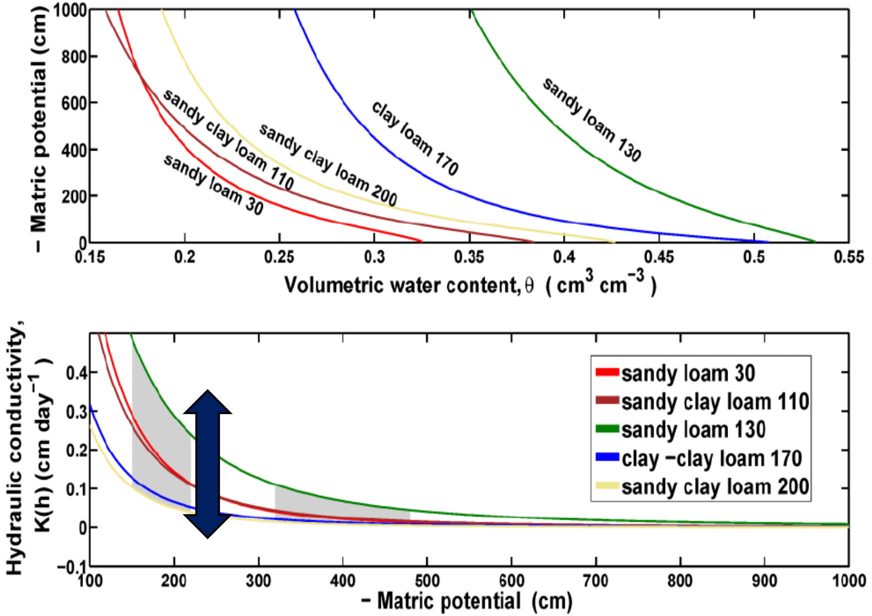


Improved Deep Tensiometer

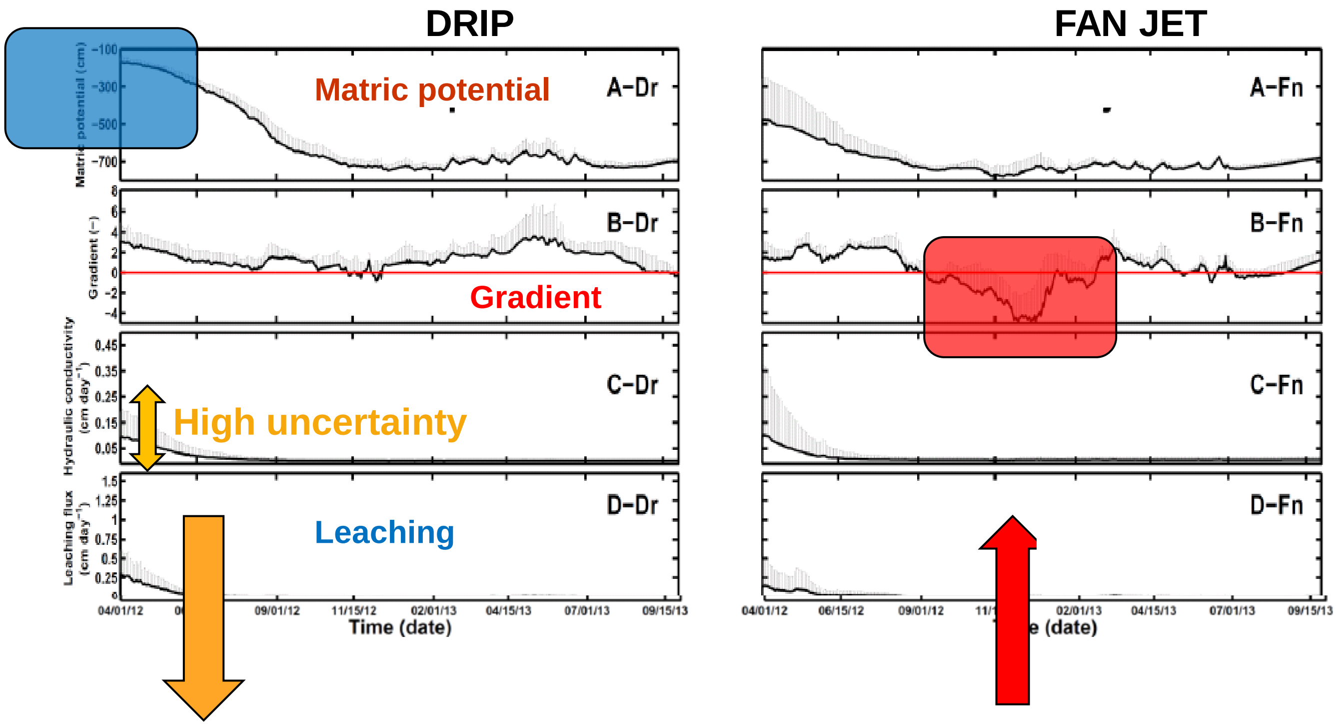


ENORMOUS DEPTH VARIATION IN SOIL TEXTURE/LAYERING, SOIL WATER RETENTION, WITH CORRESPONDING UNSATURATED HYDRAULIC CONDUCTIVITY FUNCTIONS

Fan Jet	Clay (%)	Silt (%)	Sand (%)	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Drip
Sandy clay loam	21	18	61	10	73	12	15	Sandy loam
				20				
				30				
	27	26	47	40	75	13	12	
				50				
				60				
	21	26	53	70	72	15	13	
				80				
				90				
Loam	28	27	45	100				
				110	37	32	31	Clay loam
				120				
Clay	54	27	19	130	43	38	19	loam
				140				
Sandy loam	19	25	56	150				
				160	48	27	25	Sandy clay loam
loam	23	32	45	170				
Sandy loam	14	12	74	180				
				190	21	37	42	Clay
Silt clay	44	47	6	200				
				210				
Clay loam	29	37	34	220	37	29	34	Clay loam
				230				
				240				
				250	62	19	19	Sandy loam
				260				
				270				



LEACHING RATES COMPUTED FROM TENSIOMETERS



Leaching only significant when deep soil is wet, with possible upwards capillary flow in the late summer

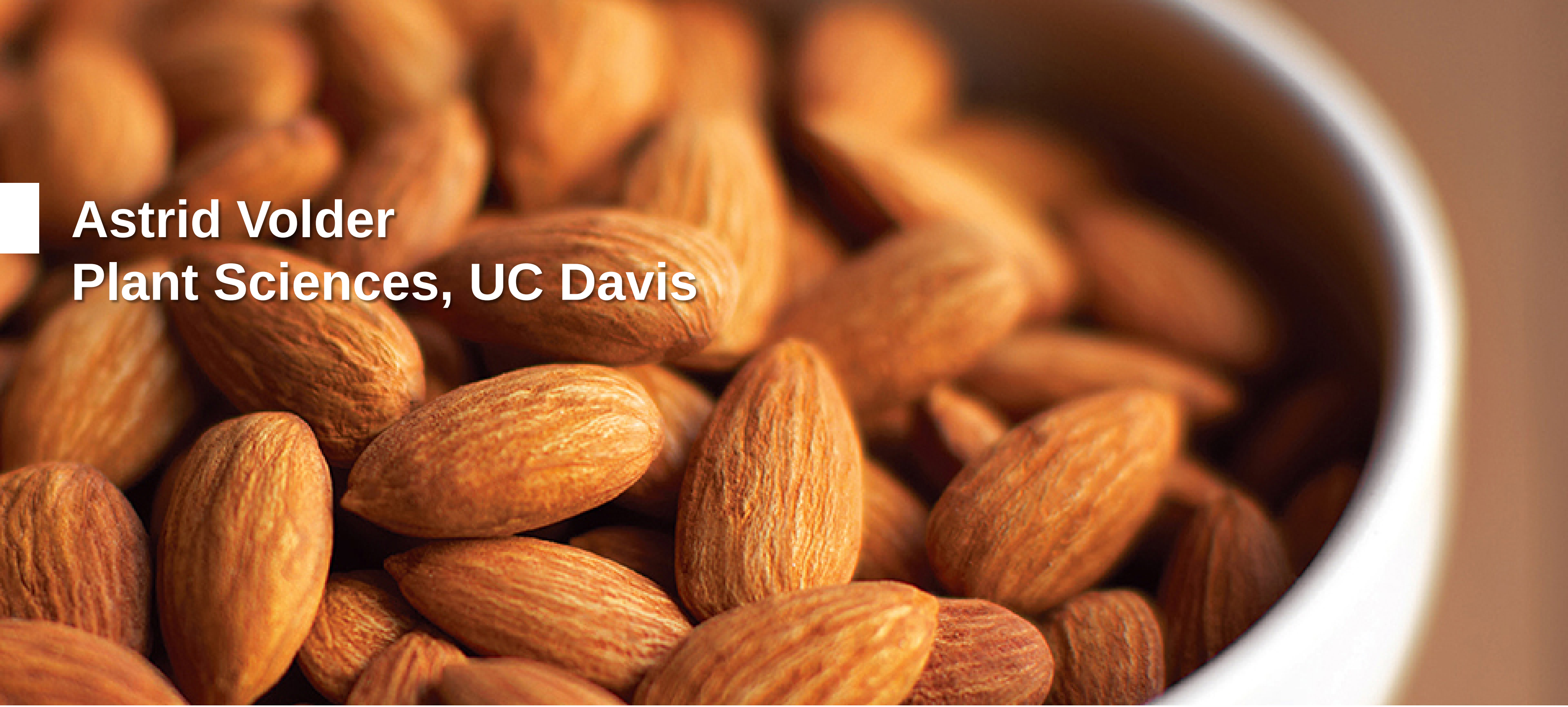
GENERAL RESULTS

- <u>Field-scale</u> applied irrigation water is about equal (or less in drought years) to crop ET.
- Therefore, the field-scale irrigation management practices are done as best as one can wish for with the current technologies.

However, the large uncertainty in tree-scale irrigation water application and ET estimates, as determined from flow meter and flux tower measurements, prohibit spatial variations in leaching calculations across the field <u>that are quite large</u>.

In addition, the large field soil spatial variability swamps leaching estimates and its variations across the field.

Improvement would require extensive monitoring at the tree-plot scale across fields.



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Impact of Drought Stress on Roots

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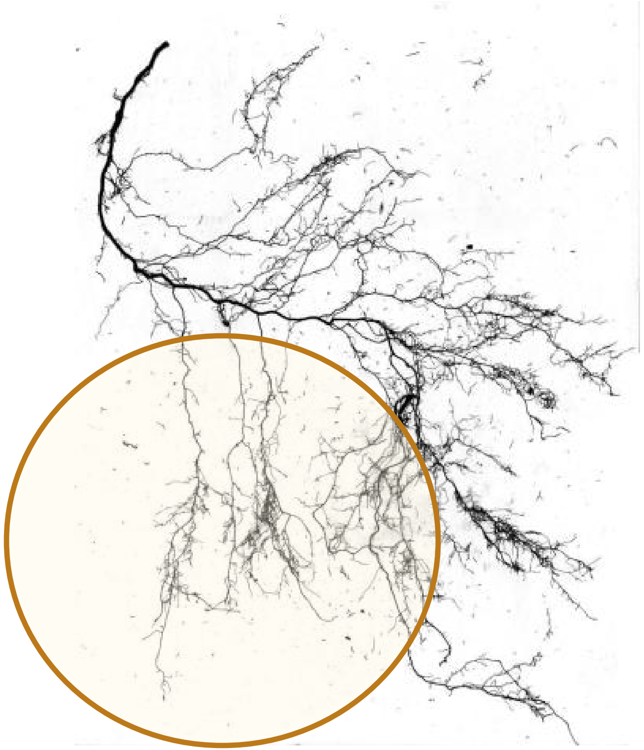
Fine Roots

- Vast majority of absorptive surface are fine roots (<0.5 mm diameter)
- Lack of suberization and small diameter may leave fine roots vulnerable to drought
- Different types of drought may differentially impact fine roots
  - Severe drought may kill fine roots
  - Chronic mild drought (deficit irrigation) may alter root traits (diameter distribution, suberization)
- Suberized and/or larger diameter roots have reduced absorptive capacity

Root Classification

Most external roots = absorptive roots



Step 1 – Survey fine root traits in existing irrigation trials

- Samples collected in Merced in July and November
- More trials will be added

Step 2 – Impact of irrigation on the ability of roots to acquire water & nutrients

- Establish controlled test site at UC Davis
- Three irrigation regimes
- Measure production and physiology of different root size classes
  - Minirhizotron observation (appearance/disappearance of roots)
  - Respiration
  - Nutrient uptake rates

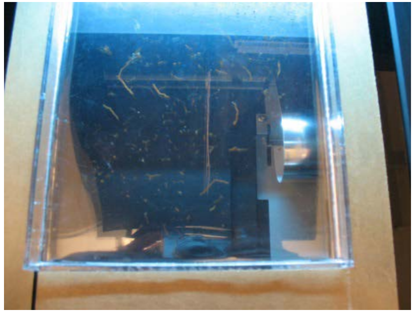
Merced Irrigation Trial

- 5 levels of irrigation
- Soil cores collected July 2014 at 5 target depths
  - 0 – 10 cm (0-4”)
  - 10 - 20 cm (4-8”)
  - 20 - 30 cm (8-12”)
  - 30 - 40 cm (12-16”)
  - 40 - 50 cm (16-20”)

Collecting Soil Cores

Manual Root Washing

Down to the finest roots…..then scan for length and diameter distribution



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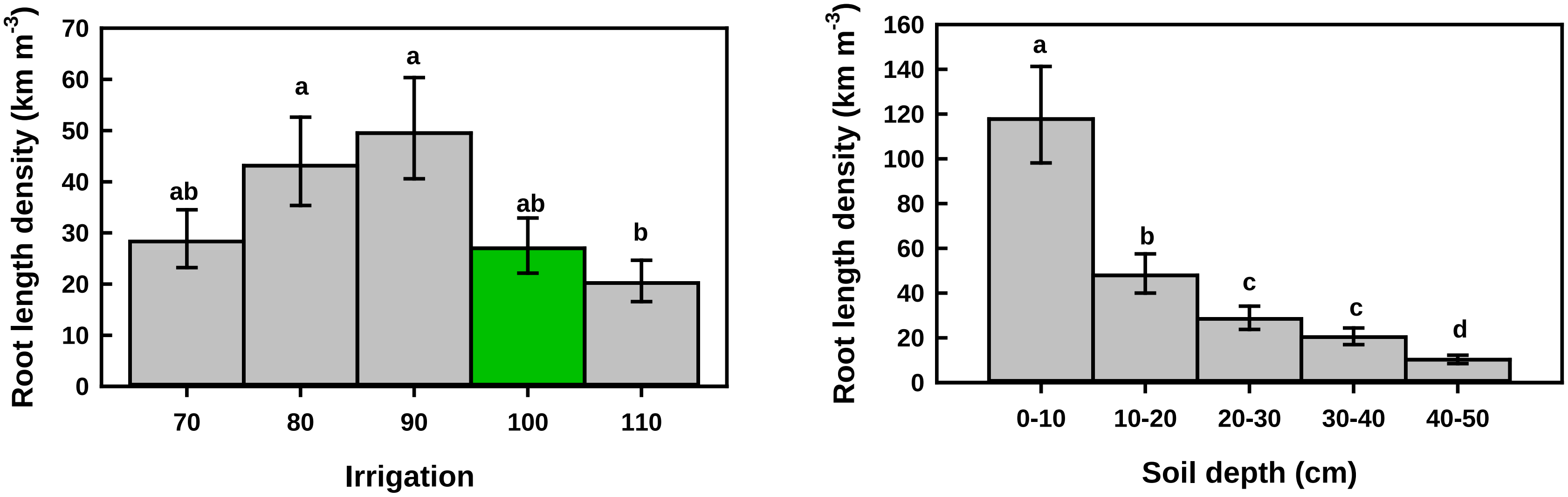
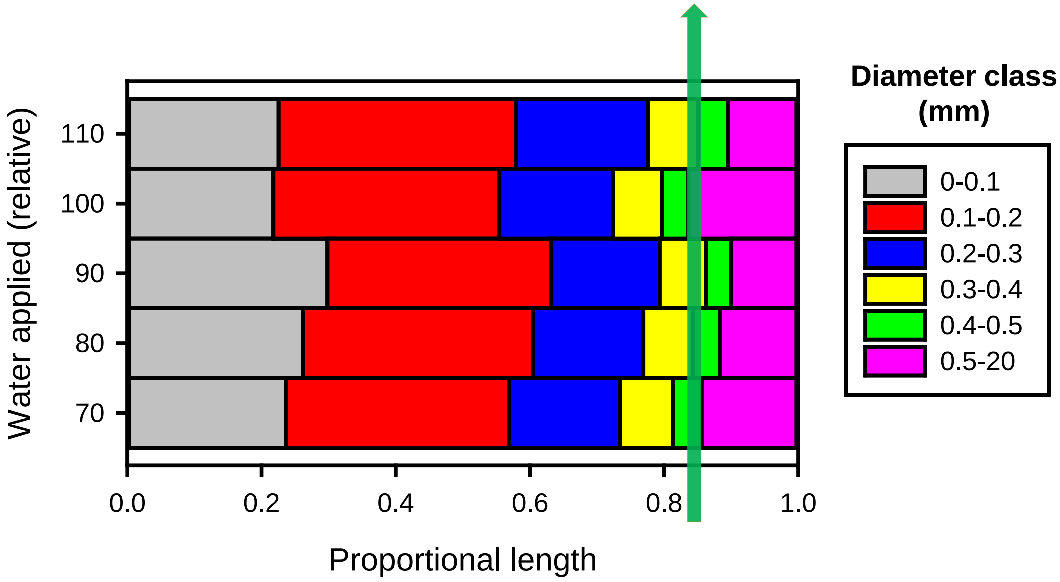
Increased Water Applied Decreased Standing Root Length in July



Root length density decreased strongly with increasing soil depth

No Treatment Effect on Root Diameter Distribution



Note – at least 85% of root length was < 0.5 mm in diameter

Next Steps

- Further characterization of fine roots in existing irrigation trials
  - Seasonality
  - Different soils / climates
- Install a new experiment with 3 patterns of irrigation
  - Measure impact on root traits (production pattern, rooting depth, diameter distribution, suberization, lifespan, anatomy)
  - Measure impact on root physiology (nitrogen uptake, water uptake, hydraulic conductivity)

Potential Use of These Data

- Develop a management strategy aimed at maintaining most effective root system (not necessary highest root density)
  - – Water management
  - – Nutrient management
- Breeding implications?

Questions?

Acknowledgements:

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Rebecca Scott

University of California
Agriculture and Natural Resources

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Ted DeJong

Plant Sciences, UC Davis

Developing a Carbon Budget, Physiology, Growth and Yield Potential Model for Almond Trees

TM DeJong, BD Lampinen,
C. Negron, K. Pope, E. Marvinney,
D. Da Silva, S. Metcalf
Plant Sciences Dept. UC Davis

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Almond Tree Modeling

This project has two main goals: developing an integrated computer simulation model of almond tree physiology, growth, carbon budget and yield potential, and to develop methods to estimate standing biomass of almond orchards.

Since time is limited I will only address the first goal.

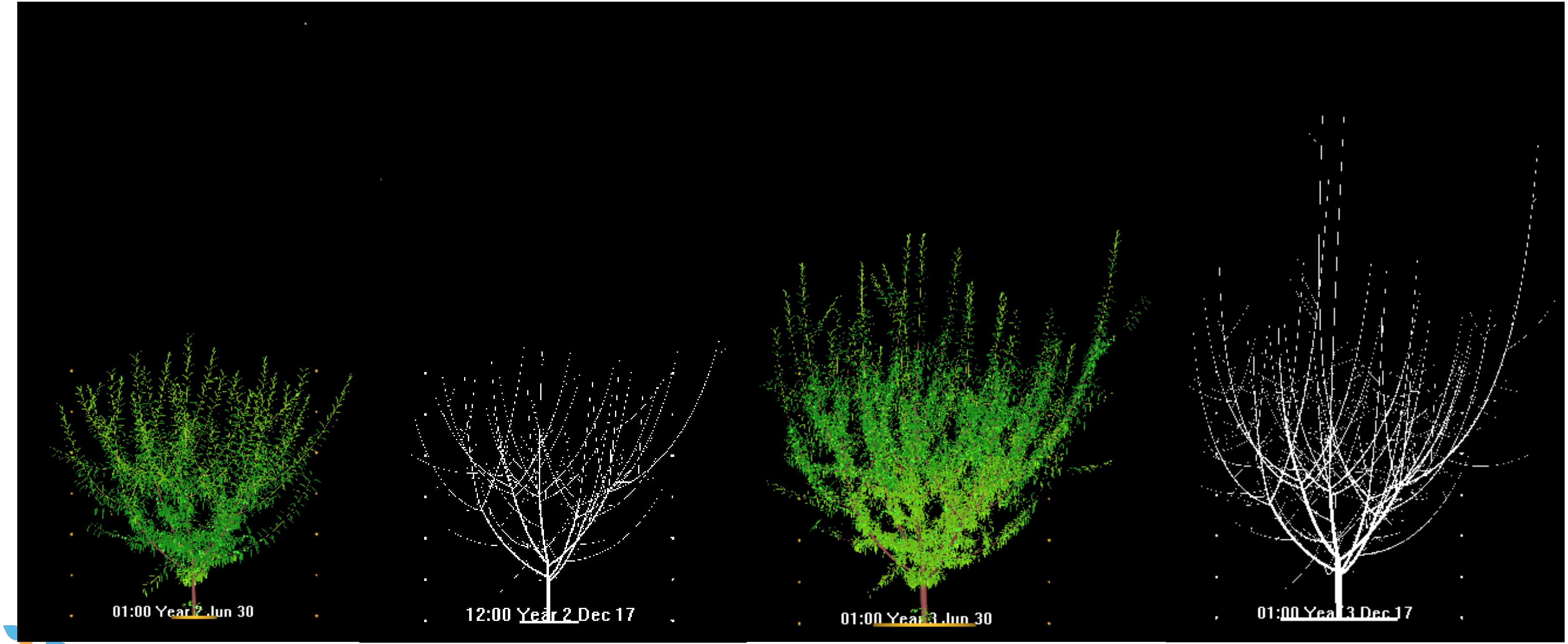
Our approach to developing an almond tree model was to adapt the previous L-Peach simulation model to almond trees.

To do this we had to complete detailed studies of almond tree fruit and shoot growth.

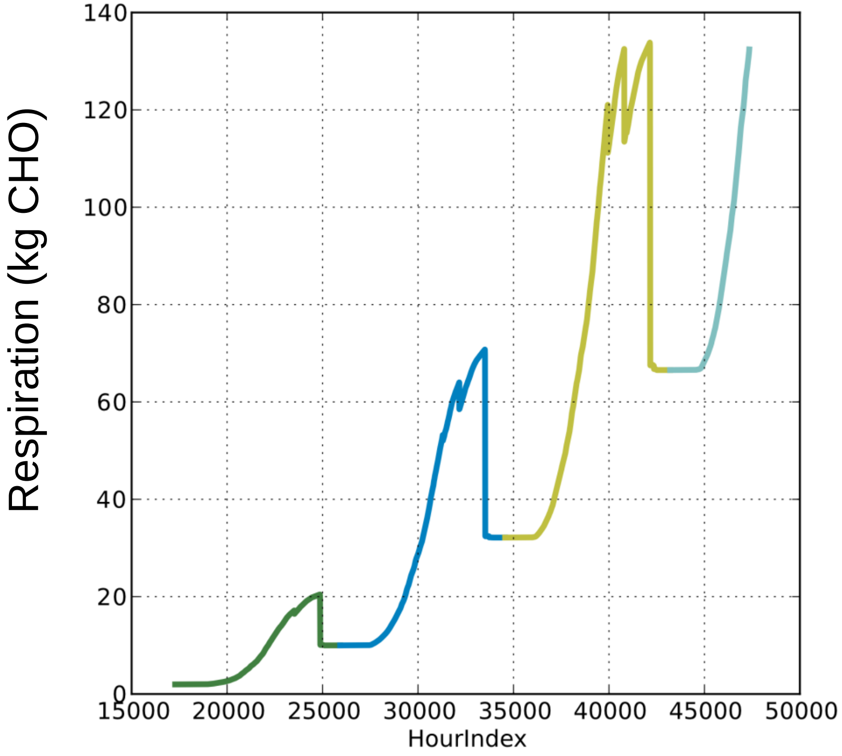
More problematic was developing a method to simulate tree growth without pruning and this required developing a method to simulate shoot/spur death in the shaded areas of the canopy.

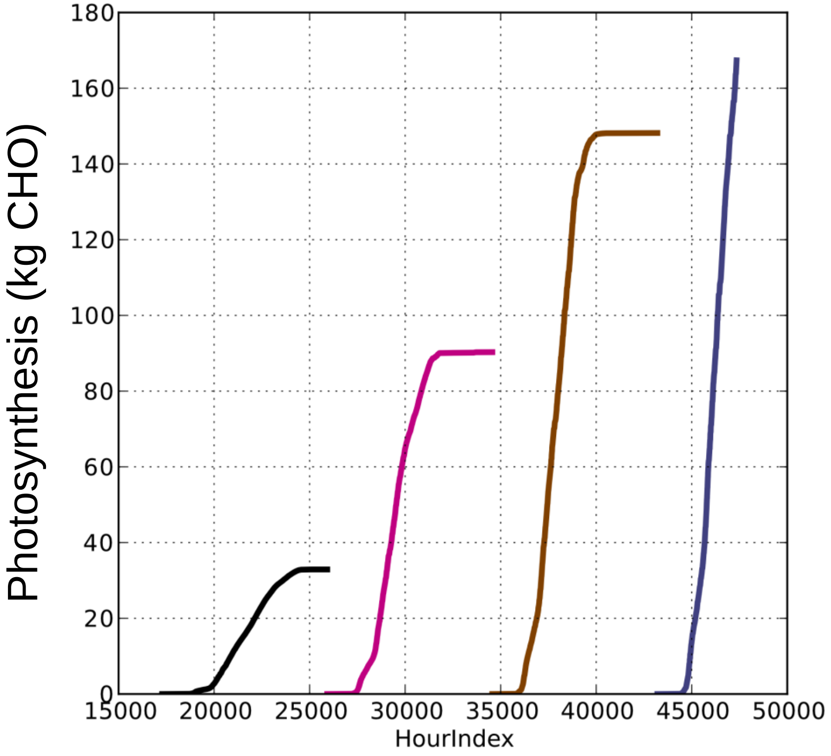
We now have model that simulates tree growth, physiology and cropping of almond trees through several years of growth and are in the process of model validation.

Simulated almond trees in years 2 and 3 after planting in orchard

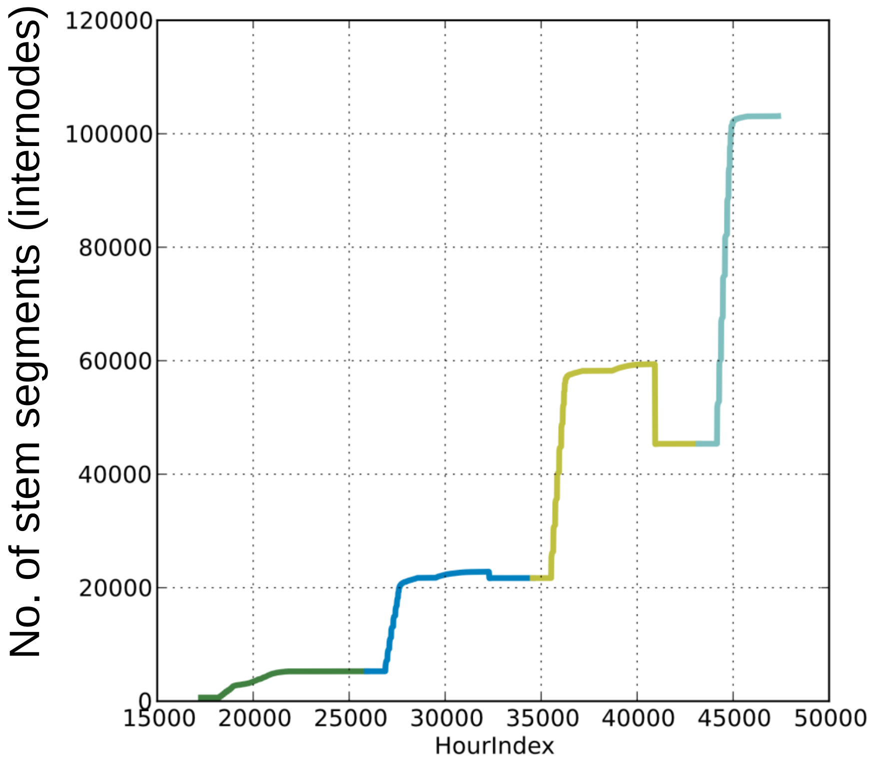


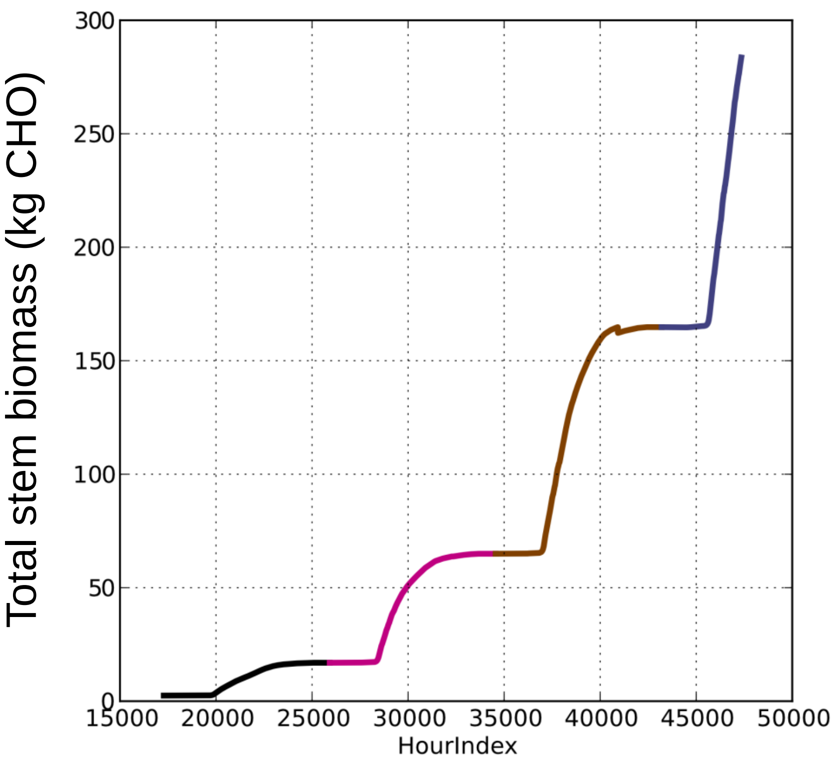
Simulated whole tree respiration and photosynthesis for years 2 – 4.5 of tree growth



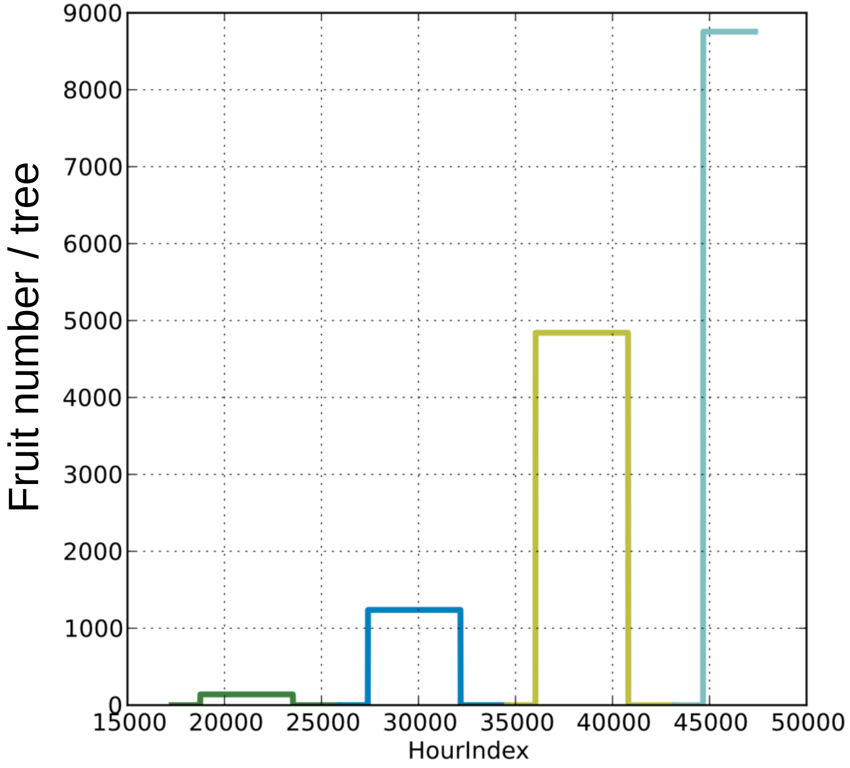


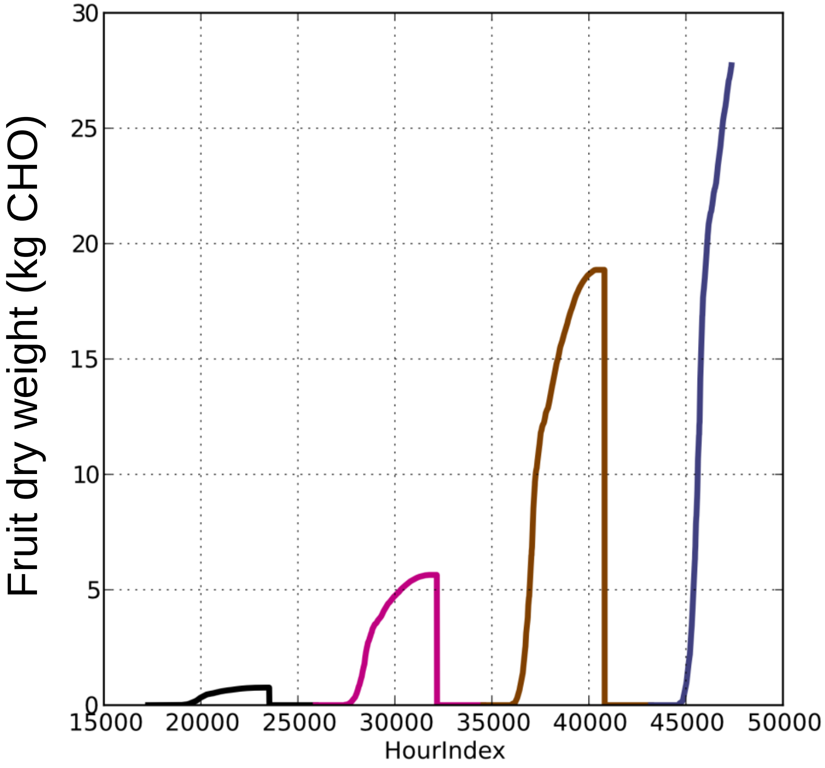
Simulated number of stems segments (internodes) and stem biomass for years 2 – 4.5 of tree growth





Simulated number of fruits and total fruit dry weight for years 2 – 4.5 of tree growth





We have a model. **So What?**

- This is truly an example of when **the journey is more important than the destination**.
- The process of model building has forced us to look at all the things we thought we knew about how almond trees work, test them and discover many things we did not know or details that have been overlooked.
- Such as:
  - Seasonal dynamics of CHO storage and remobilization
  - Critical periods of potential CHO limitation
  - Spurs population dynamics
  - Shoot architecture and its role in determining cropping potential
  - Hypotheses regarding tree yield declines after 11 -13 years

Publications related to this research

- Spur behaviour in almond trees: relationships between previous year spur leaf area, fruit bearing and mortality. Bruce D. Lampinen, Sergio Tombesi, Samuel Metcalf and Theodore M. DeJong. *Tree Physiology* (2011) 31: 700-706
- Relationships between spur- and orchard-level fruit bearing in almond (*Prunus dulcis*) Sergio Tombesi, Bruce D. Lampinen, Samuel Metcalf and Theodore M. DeJong. *Tree Physiology* (2011) 31: 1413-1421
- Relationships between spur flowering, fruit set, fruit load and leaf area in almond trees. Sergio Tombesi, Bruce D. Lampinen, Samuel Metcalf and Theodore M. DeJong *(submitted for publication)*
- Systematic Analysis of Branching Patterns of Three Almond Cultivars with Different Tree Architectures. Claudia Negron, Loreto Contador, Bruce D. Lampinen, Samuel G. Metcalf, Yann Guedon, Evelyne Costes and Theodore M. DeJong. *J. Amer. Soc. Hort. Sci.* (2013) 138(6):407–415. 2013.
- Differences in proleptic and epicormic shoot structures in relation to water deficit and growth rate in almond trees (*Prunus dulcis*). Claudia Negron, Loreto Contador, Bruce D. Lampinen, Samuel G.Metcalf, Yann Guedon, Evelyne Costes and Theodore M. DeJong. *Annals of Botany* (2013) 113:545-554.
- How different pruning severities alter shoot architecture: A modelling approach in young 'Nonpareil' almond trees. Claudia Negron, Loreto Contador, Bruce D. Lampinen, Samuel G.Metcalf, Yann Guedon, Evelyne Costes and Theodore M. DeJong. Functional Plant Biology (2014) (*in press*)

Sonja Brodt,
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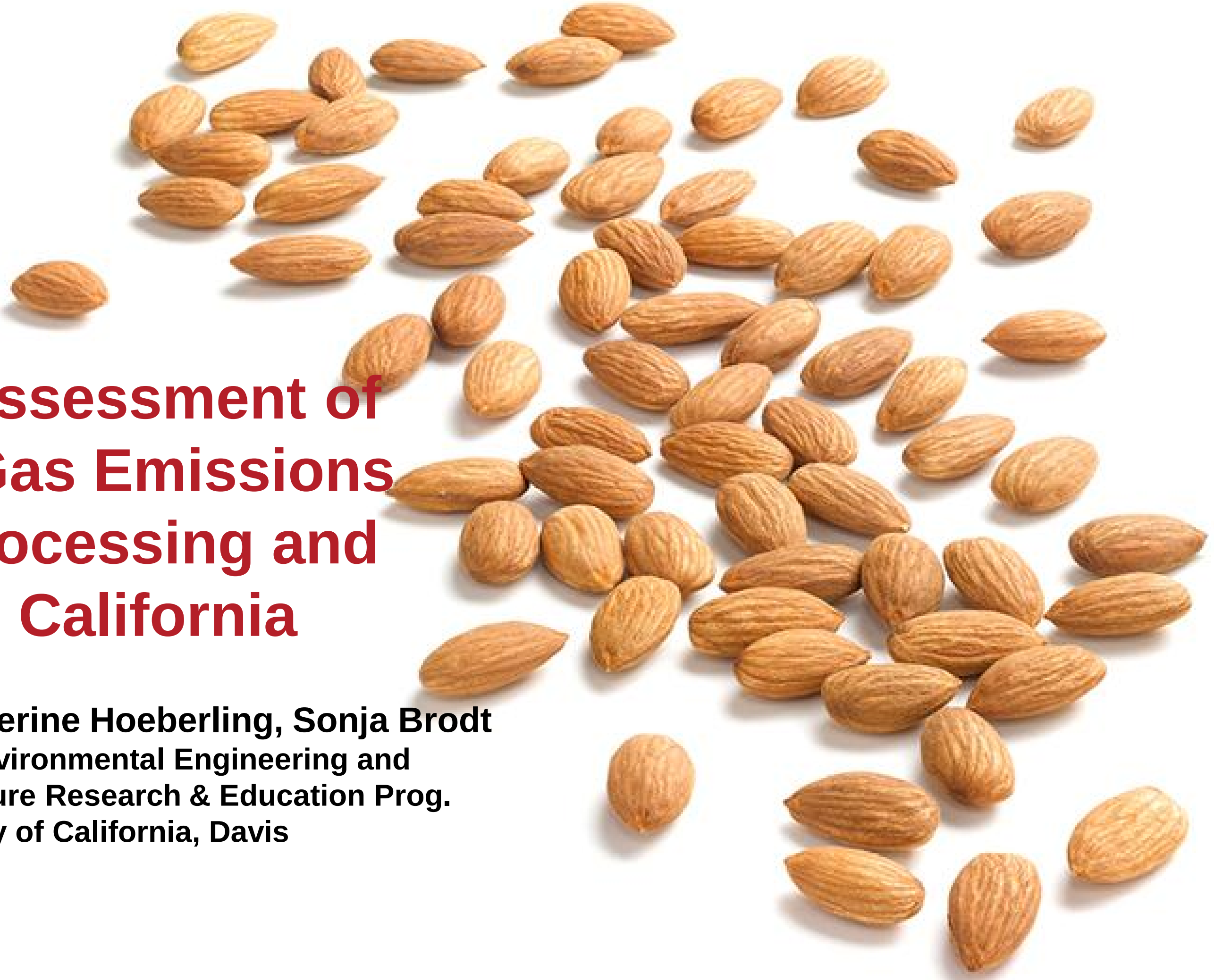

A Life Cycle Assessment of Greenhouse Gas Emissions for Almond Processing and Distribution in California

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Background

- California almonds are consumed across the U.S. and around the world, with 70% being shipped to foreign markets.
- Global consumers and corporate food buyers are increasingly interested in understanding the full greenhouse gas footprint, or “carbon footprint”, of their food purchases.

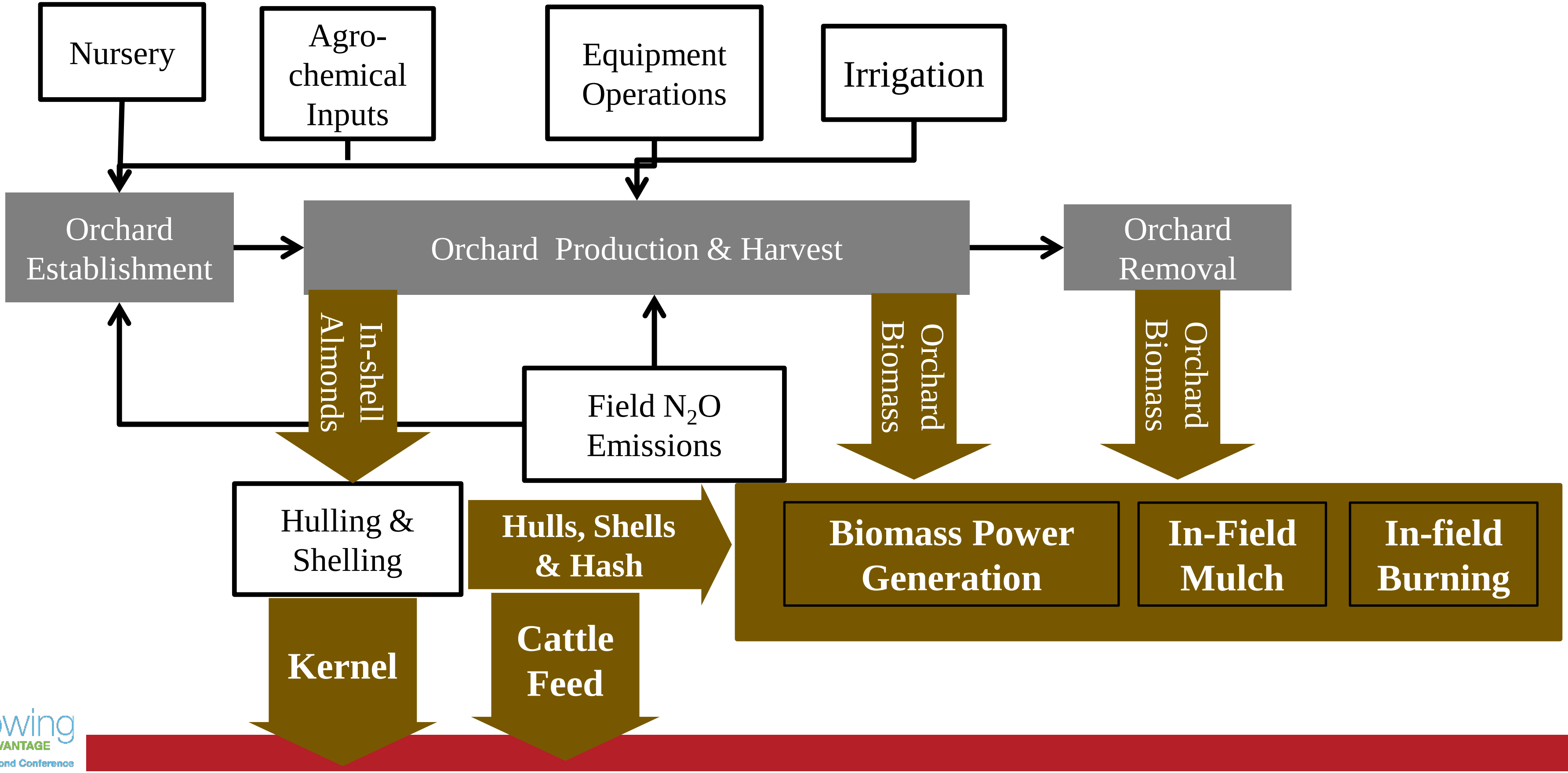
Project Objective

- To model and calculate representative energy, greenhouse gas, and air pollutant footprints for basic **processing** of raw almonds and **transport to major distribution points** in domestic and foreign markets

Methods

- **Life cycle assessment** – a “cradle-to-grave” accounting model that counts emissions in all phases of a product’s production, including emissions associate with all upstream inputs into the production system.

Previous Work



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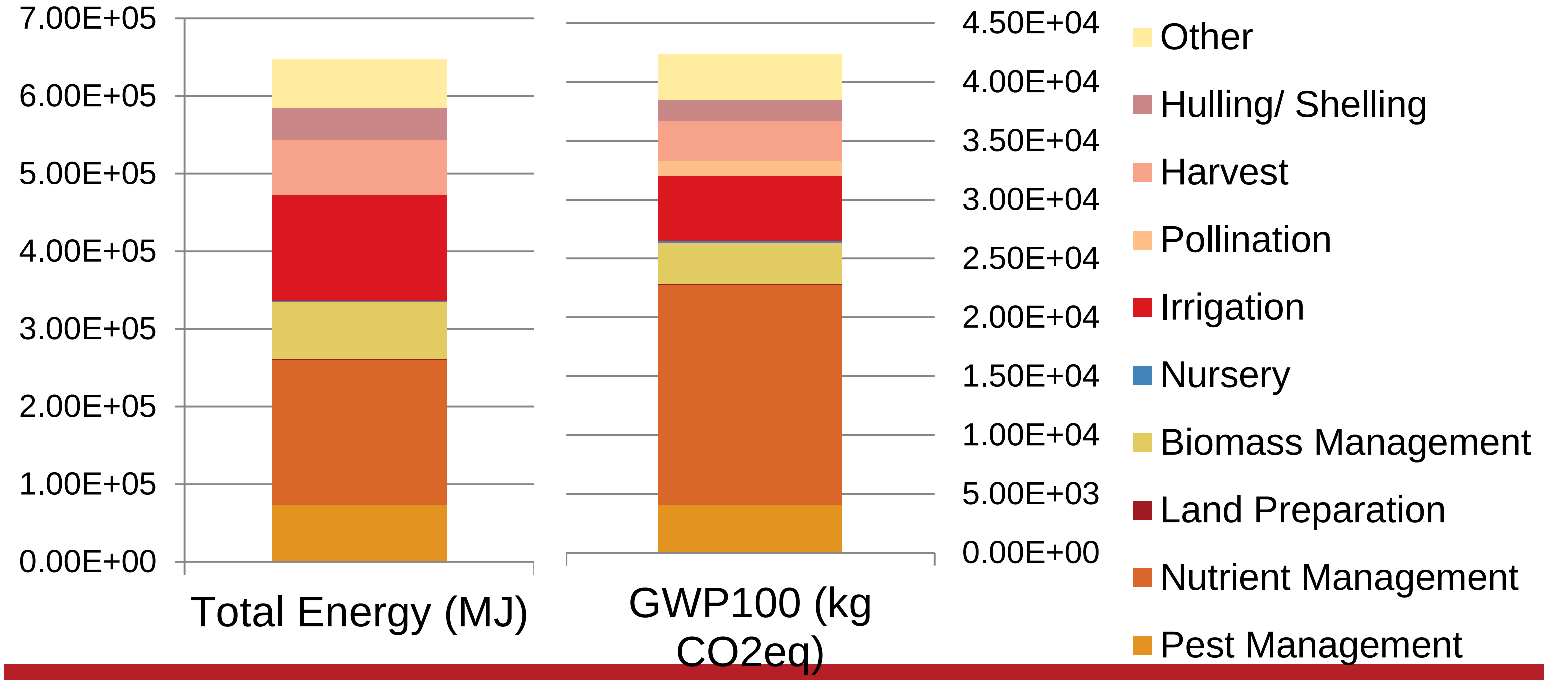
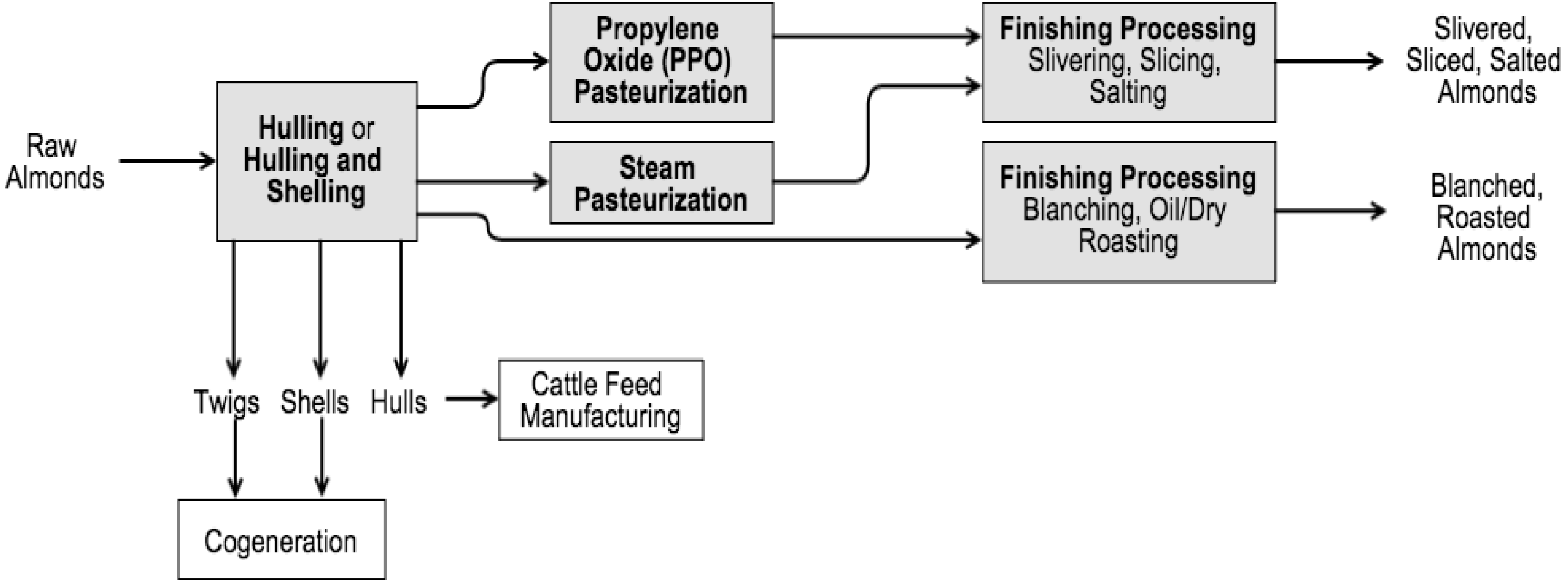
Key Results from Previous Work

- **Nutrient management and irrigation** contribute the most emissions.
- Use of tree biomass for **bioenergy production** is critical to improving the GHG and energy performance of orchard production systems.



Current Work: Scoping



Expected Outcomes from this Project

- Energy, greenhouse gas, and air pollutant footprints associated with a range of processed almond products and shipping destinations.

  For example:
  - Sliced almonds arriving in Shanghai, China
  - Salted, roasted almonds in New York City
  - Blanched almonds purchased in Hamburg, Germany
- A model that will enable the almond industry to identify the production processes and practices that contribute the most (and least) to energy use, GHG emissions, and air pollution



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