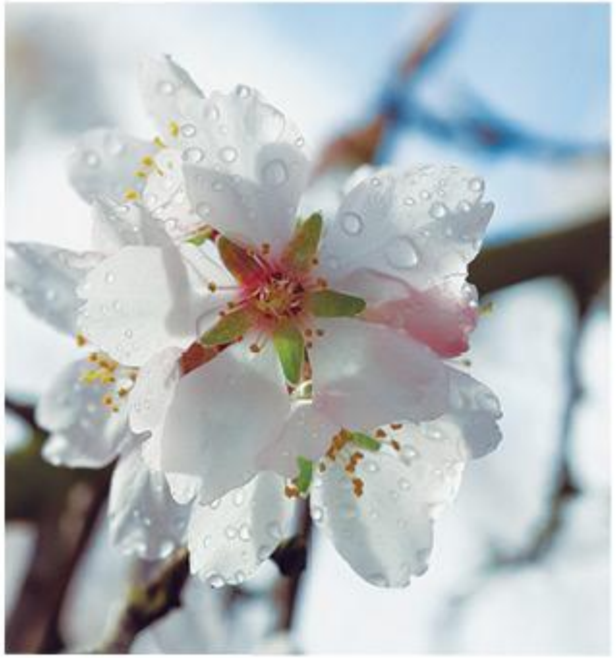
Research Updates



growing
ADVANTAGE
The Almond Conference

Almond Culture and Orchard Management Studies

Brent Holtz

David Doll

Roger Duncan

Elizabeth Fichtner

Franz Niederholzer

Fertilizing First Leaf Almond Trees

David Doll,

Farm Advisor, Merced County

University of California
Agriculture and Natural Resources

Cooperating personnel:

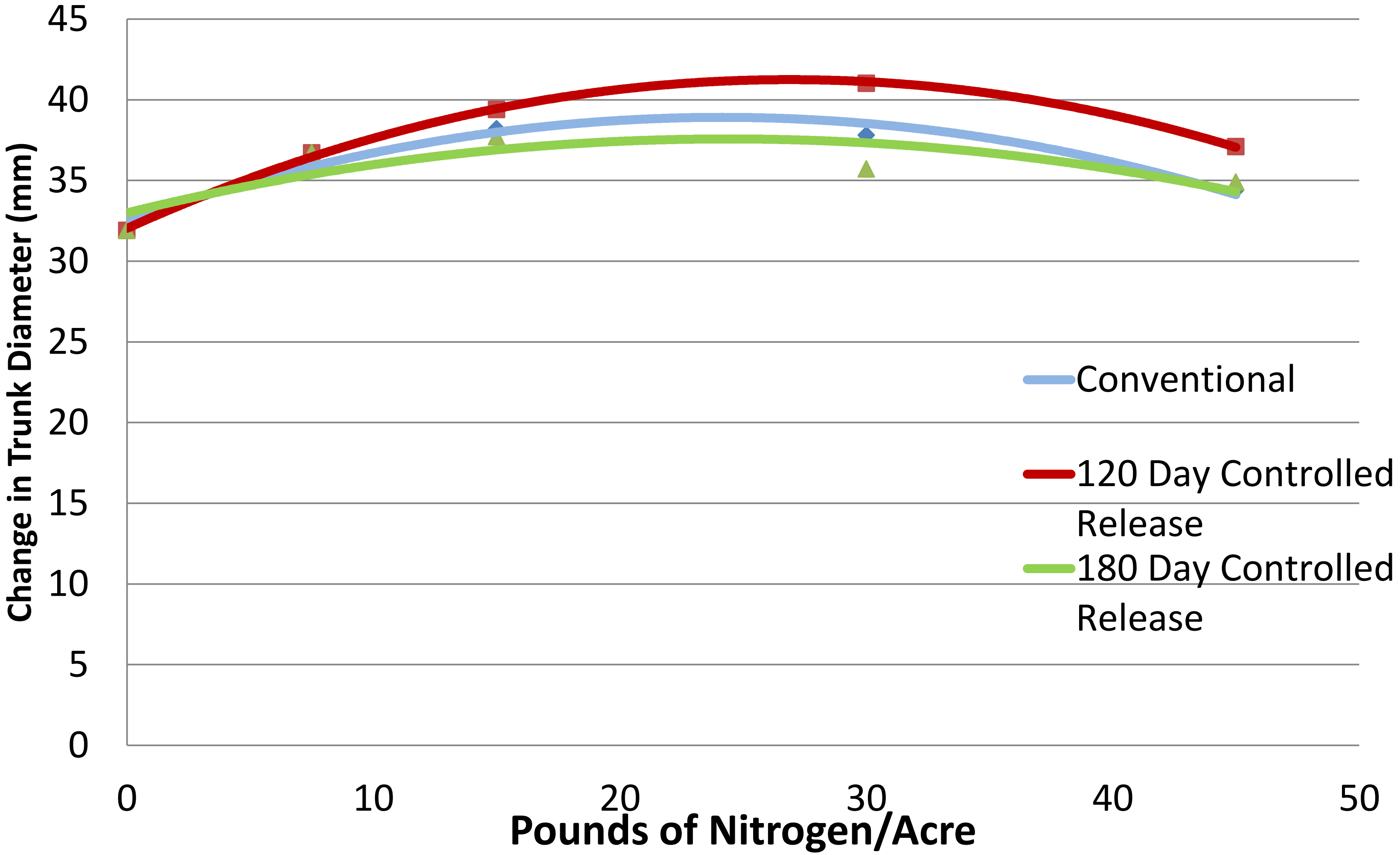
Randy Taylor

Andrew Littlejohn

Nitrogen Rates for Young Almond Trees – David Doll (UCCE Merced)

- Trial Located on sandy soil, irrigated with solid set sprinklers
- Applied 7.5, 15, 30, and 45 pounds of N/acre using conventional fertilizer, 120 day and 180 day controlled release
- Conventional fertilizer was applied monthly for 6 months, starting in early April. Controlled release fertilizer was applied once, early April.

Nitrogen Rates for Young Almond Trees



Conclusions:1. 20-30 lbs/N delivered optimal growth – Needs to be repeated

2. 120 Day Controlled Release performed as well as conventional fertilizer

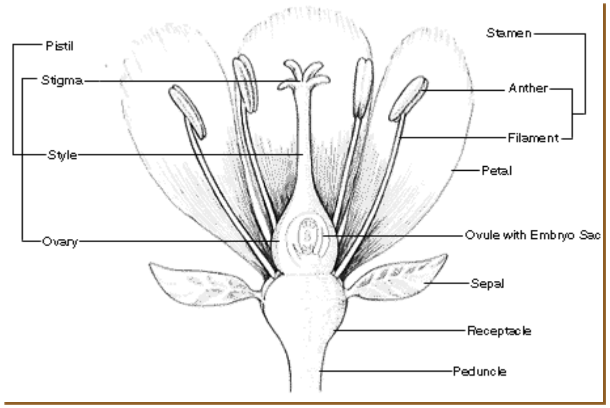
Do Self-Fertile Almond Varieties Benefit from the Addition of Honey Bees?

Roger Duncan
UC Cooperative Extension
Stanislaus County

University of California
Agriculture and Natural Resources

Background

- The pollen of self-compatible almond varieties can fertilize the ovule of the same flower.
- However, pollen must still be transferred from anthers to the stigma.
- Questions remain about whether the addition of honeybees might increase the transfer of pollen, improve fertilization and increase yield.



Methods

- In a commercial, 3rd-leaf ‘Independence’ orchard, six trees were enclosed in screen structures to exclude honeybees.

Methods

- Percent set was calculated by counting flowers on tagged shoots and later comparing to nut counts.
- Nuts were collected at harvest to determine kernel quality and yield.

Results

The Effect of Honeybees on Nut Set, Yield & Kernel Quality of 'Independence' Self-Fertile Almond

	% Nut Set	Yield (lb. / acre)	Kernel Size (g)	% Kernel Shrivel
Screened until 100% petal fall	10.5 c	364 b	1.32 a	10.3 a
Screened until 40-50% petal fall	18.3 b	672 a	1.25 a	4.0 a
Trees outside of screen structures	28.1 a	743 a	1.02 b	6.8 a

Conclusions

- Trees in screen enclosures through petal fall had 63% lower nut set and 51% lower yield than trees exposed to honeybees.
- It is unclear if the reduction in set and yield of the enclosed trees was due to the absence of honeybees or if the screen structures presented unnatural conditions (i.e., reduction in light and/or wind) unfavorable to pollination, fertilization and/or nut set.
- A new trial will be established in 2013 to address these questions.

Factors affecting prevalence and activity of Tenlined June Beetle in Tulare County Orhcards

Elizabeth Fichtner, UCCE Tulare County

University of California Agriculture and Natural Resources

Factors affecting prevalence and activity of Tenlined June Beetle in Tulare County orchards

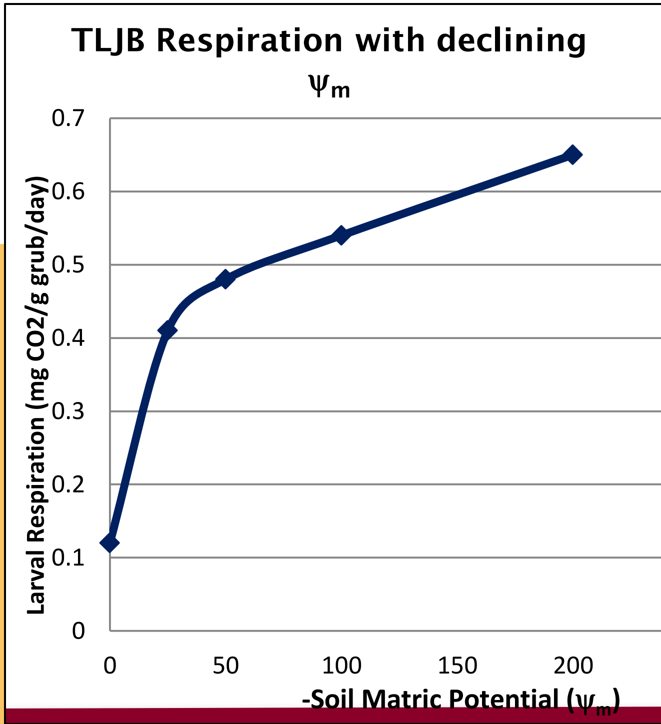
Hypothesis

1. Because damage by TLJB is more prevalent in sandy soils or sand streaks, we hypothesize that TLJB activity will be inhibited at higher soil matric potentials (Ψ_m).

Damage

Root predation-

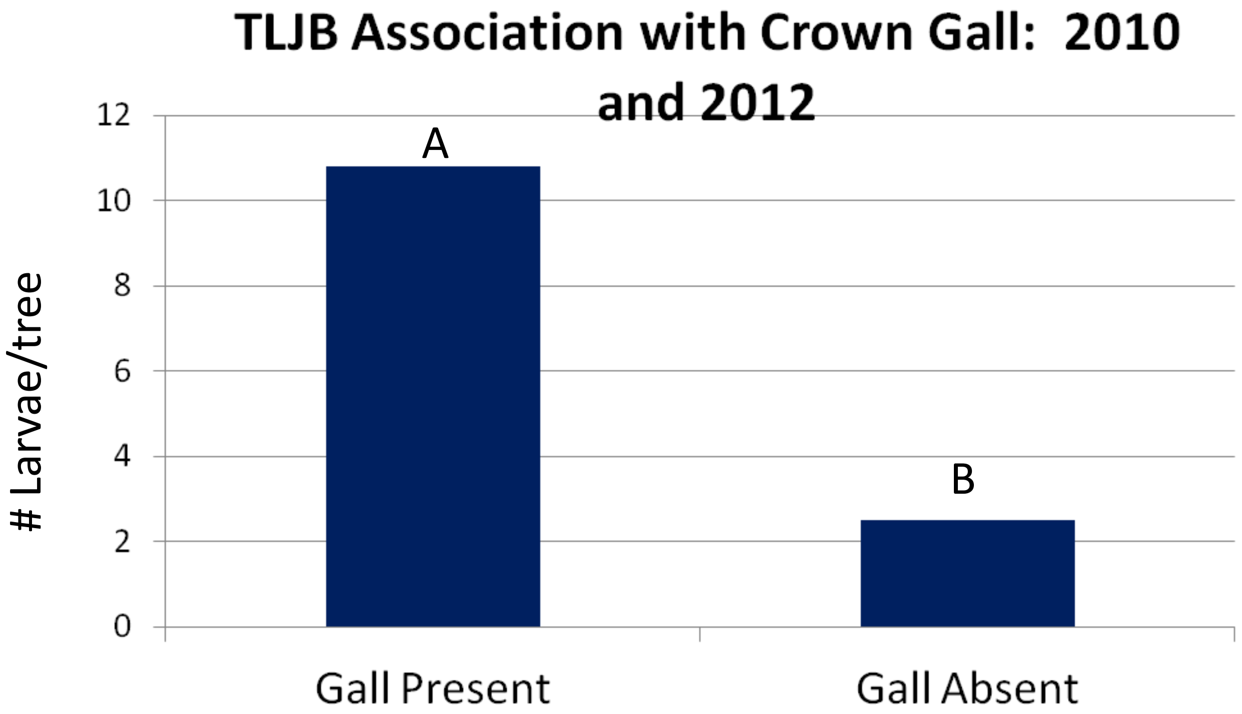
- susceptibility to wind damage
- root gouging
- increased susceptibility to soilborne disease?



Hypothesis

2. We hypothesize that infection with *Agrobacterium tumefaciens* (cause of crown gall) may enhance populations of TLJB larvae on roots.

Larvae embedded in gall tissue



TLJB Association with Crown Gall: 2010 and 2012

Results

TLJB larvae are more prevalent on trees with crown gall than on asymptomatic trees, suggesting that either the larvae preferentially feed on gall tissue or enhance spread/incidence of galls in orchards. Crown gall and TLJB may concurrently (or synergistically) inhibit tree growth and productivity.

- Walnuts used as model system. Seeking almond orchard with both crown gall and TLJB for future survey!

Increasing almond tree boron levels in Sutter County – how long can it last?

Franz Niederholzer, Farm Advisor,
UCCE Sutter/Yuba Counties

University of California
Agriculture and Natural Resources

Cooperating Personnel: Jed Walton, PCA, Big Valley Ag Service, Gridley, CA

Boron Fertilization: How long does it last?

- How long does soil applied boron (B) fertilizer affect tree B levels?
- Tested in mature almond block in Sutter Co.
- Two rates (20 or 40 lb Solubor/acre) in October, 2008 or May, 2009. Additional treatment = 50 lb Granubor/acre in May, 2009
- Flowers and hulls sampled annually and tested for B concentration.
- How long will one “shot” of B last?

Boron fertilization: How long does it last?

Treatment	Flower Boron (ppm B) 2009	Flower Boron (ppm B) 2010	Flower Boron (ppm B) 2011	Flower Boron (ppm B) 2012
Untreated	30 a	47 a	28 a	25 a
20 lb/acre Solubor® October, 2008	36 a	52 a	39 ab	34 bc
40 lb/acre Solubor® October, 2008	38 a	69 b	48 bc	39 cd
20 lb/acre Solubor® May, 2009		60 ab	46 bc	29 ab
40 lb/acre Solubor® May, 2009		86 c	59 c	37 c
50 lb/acre Granubor® May, 2009		90 c	56 c	43 d

Boron fertilization: How long does it last?

Treatment	Hull Boron (ppm) 2009	Hull Boron (ppm) 2010	Hull Boron (ppm) 2011
Untreated	35 41 44	50 a	37 a
20 lb/acre Solubor® October, 2008	40 65 84	59 a	46 b
40 lb/acre Solubor® October, 2008	72 104 153	108 bc	65 c
20 lb/acre Solubor® May, 2009	47 54 61	80 ab	48 b
40 lb/acre Solubor® May, 2009	45 59 78	114 cd	63 c
50 lb/acre Granubor® May, 2009	60 77 94	138 d	78 d

Boron Fertilization: How long does it last?

- Soil applied boron (B) fertilizer didn’t change flower levels the next spring.
- High soil-applied B fertilizer rates (8 lbs B/acre) did increase hull B from 30-40 ppm B to > 100 ppm B, but only for one or two years. The year after treatment produced the highest hull B levels across treatments.
- Regular soil-applied B fertilizer use may be necessary to maintain hull B >100 ppm in low B soils in the Sacramento Valley where significant winter rains occur.

Efficacy Trials of Registered and Developmental Insecticides for Navel Orangeworm

Brent A. Holtz,

UCCE Farm Advisor, San Joaquin County

University of California
Agriculture and Natural Resources

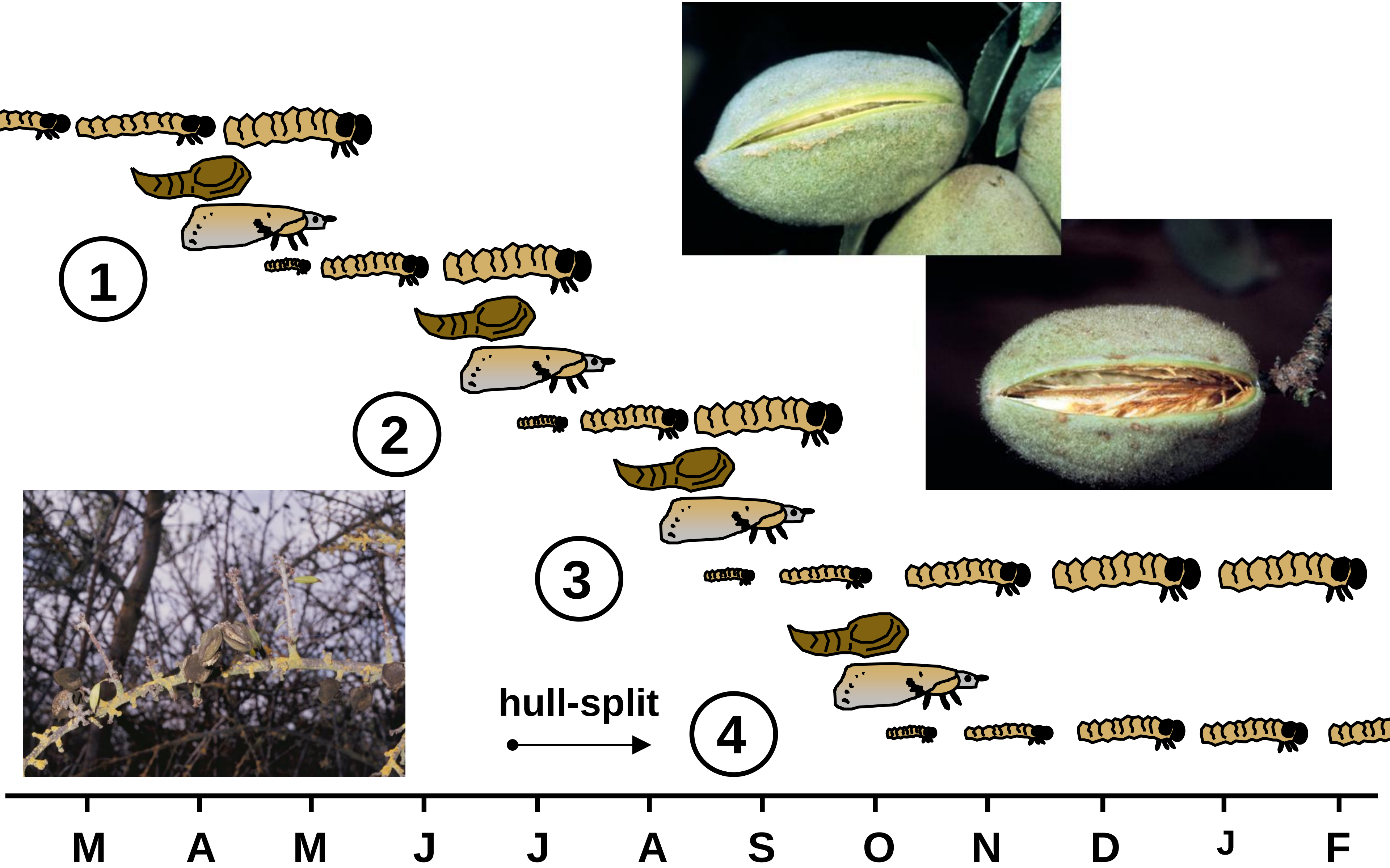
Cooperating Personnel:

Walt Bentley, UC IPM Emeritus

Stephen Colbert, DuPont Inc.

Navel Orangeworm – pest of a variety of nut crops

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



Hull split spray

NOW efficacy Trial

Nonpareil Variety

2011 Treatment	% NOW[a]
5 Cyazypyr (HGW86) 13.5 floz	0.0 a
3 Altacor®+Asana® XL 3.0 oz+ 9.6 floz	0.1 ab
6 Proclaim + Dyne-Amic 4.5 oz + 0.25%v/v	0.2 abc
11 Belt 4 floz	0.3 abcd
7 Intrepid+ Delegate 12.8 floz + 3.2 oz	0.4 abcd
4 Altacor® + Bifenthrin 3.0 oz +16.0 oz	0.5 abcd
12 Asana 12.8 floz	0.6 abcd
1 Altacor® (Rynaxypyr) 3.5 oz/ac	0.9 abcd
9 Athena 19.2 fl oz	0.9 bcd
10 Hero EW 11.2 floz	1.0 bcd
8 Brigade WSB 18 oz	1.0 cd
2 Altacor® 4.0 oz	1.1 d
13 Untreated	3.3 e

[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 for analysis.

Thank You!

THE UNIVERSITY OF CALIFORNIA

LET THERE BE LIGHT

1868

Nickels Soil Lab projects & Concealed Damage

Franz Niederholzer
U.C. Farm Advisor
Colusa/Sutter/Yuba Counties

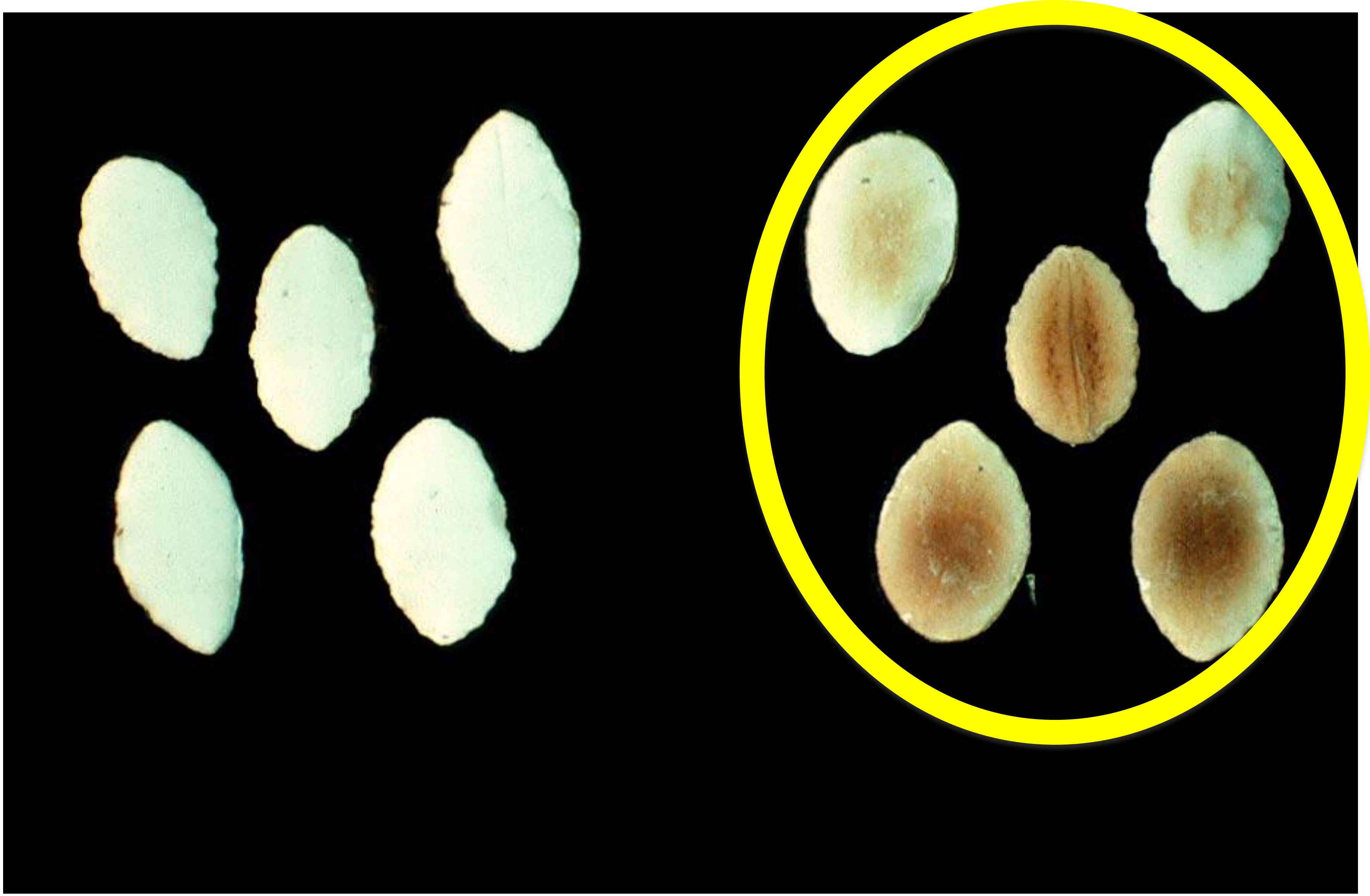
Project Collaborators

- **Nickels Soil Lab**
  - John Edstrom
  - Bill Krueger
  - Stan Cutter
  - Ubaldo Salud
  - Roberto Reyes
- **Concealed Damage**
  - Bruce Lampinen, UC Davis Plant Sciences Department
  - Stan Cutter, Nickels Soil Lab
  - Gabriela Ritokova, UC/ABC Intern, 2011
  - Andrew “Bobby” Johnson, UC/ABC Intern, 2012
  - Alyson Mitchell, Food Science Department, UC Davis.

Nickels Soil Lab Projects

- Pruning trial
  - 15th leaf, no differences in yield between the four treatments. Annual pruning vs. no annual pruning, etc.
- Organic block
  - Organic production continues to be roughly one-third of conventional.
  - Aggressive sulfur in season improved rust control in organic treatments.
  - Organic production costs are significantly higher than conventional costs.

Concealed Damage



Concealed Damage field work

- What conditions in the field affect concealed damage development in almond?
- What field practices could minimize concealed damage development in almond?

Concealed Damage field work

Monterey variety

Nickels Soil Lab

Samples to Mitchell lab at UC Davis for analysis

2011

- “Rain” on conditioned or unconditioned windrows.
- Wet nuts in “stockpiles”.

2012

- “Rain” on conditioned or unconditioned windrows. Condition or not after rain.

Concealed Damage field work

Concealed Damage field work

Treatments	% Moisture, on Oct 28	% Moisture one week	% Discoloration	% Moisture, four weeks	% Discoloration
Dry, conditioned nuts,	11.9	5.4 ± 0.4	1.7 ± 2.9	.7 ± 0.2	2.3 ± 4.2
Wet nuts, conditioned	12.9	5.6 ± 0.3	5.0 ± 5.8	.4 ± 0.2	1.9 ± 4.2
Dry, unconditioned nuts,	17.1	6.4 ± 0.2	10.8 ± 7.9	.2 ± 0.3	4.2 ± 3.4
Wet nuts, unconditioned	19.8	9.6 ± 0.8	23.8 ± 10.6	---*	---*

Concealed Damage Field Work

- Conditioning reduced concealed damage in 2011 trial.
- Wet, unconditioned nuts showed the most concealed damage in 2011 trial.
- Conditioning nuts before and after the “rain” in 2012 produced the most rapid drying.
- Differences in weather before “rain” affected windrow qualities that influenced damage in 2011 vs. 2012. BMPs for Concealed Damage may have to reflect this.

A) Drought Survival Strategies for Established Almond Orchards

B) Defining an Almond ET/Yield Production Function

Ken Shackel

Plant Sciences/Pomology Professor

UC Davis

With: David Doll, Allan Fulton, Blake Sanden, Bruce Lampinen.

Drought Survival Strategies

Questions:

1) How much water does it take for an almond tree to survive?

2) Under non-irrigated (rain and stored soil moisture only) conditions, will survival be improved by 50% canopy reduction and/or kaolin (surround) spray?

3) Will application of small amounts of water (5", 10") over the season help?

4) Is there a critical level of tree water stress that is necessary to cause tree death or dieback?

Drought Survival Strategies

Location: Nickels soils lab, Arbuckle, CA

- Single line drip irrigation system (restricted root zone expected)
- Gravel soil, WHC about 1”/foot
- Previously demonstrated root water uptake only to about 3’

Should be a good place to cause water stress!

Drought Survival Strategies

Treatments applied, 2009:

Irrigation Treatment	Canopy modification
0 (rain fed)	None
	50% reduction once SWP reaches -15 bars
	50% reduction + Kaolin spray
5" in-season	None
	Kaolin spray
10" in-season	None
	Kaolin spray
Control (100% ETc, 40”?)	None

Q: How much water does it take to survive?

An extensive system of neutron soil moisture monitoring sites were installed to track soil water depletion. Nine sites per tree (1/4 of root zone), eight to a depth of 6’, one to a depth of 10’.

Water uptake at 10’ was detected in all deficit treatments!

Drought Survival Strategies

Contribution of irrigation, rain, and stored soil water to observed tree water use

Treatment	Irrigation	Rain	Soil	Total	%ETc
0”	0”	2.1”	5.5”	7.6”	21%
5”	3.6”	2.1”	6.7”	12.4”	35%
10”	7.2”	2.1”	5.9”	15.2”	42%
Control	30.8”	2.1”	(?)	(32.9”)	(92%)

Q: How much water to stay alive?
A: 7.6” can be enough!

Drought Survival Strategies

Measuring tree stress with the pressure chamber (a.k.a. 'bomb')

July 21, 2009

Control tree

- 9.8 bars SWP

July 21, 2009

10” tree

- 25 bars SWP

July 21, 2009

0” tree

- 39 bars SWP

July 21, 2009

0” tree

- 54 bars SWP

This tree had reached -63 bars (913 psi) on July 14, 2009, and by July 28 was completely defoliated.

This tree had reached -63 bars (913 psi) on July 14, 2009, and by July 28 was completely defoliated. However, ALL trees have survived as of 2012.

TENTATIVE GUIDELINES FOR INTERPRETING PRESSURE CHAMBER READINGS (MIDDAY STEM WATER POTENTIAL-SWP) IN WALNUT, ALMOND, AND DRIED PLUM. UPDATED MAY 2007.

Allan Fulton and Richard Buchner, UCCE Farm Advisors, Tehama County, Joe Grant, Farm Advisor, San Joaquin County, Terry Prichard, Bruce Lampinen, Larry Schwankl, Extension Specialists, UC Davis, and Ken Shackel, Professor UC Davis.

Pressure Chamber Reading (- bars)	WALNUT	ALMOND	PRUNES
0 to –2.0	Not commonly observed	Not commonly observed	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.	Low stress, indicator of fully irrigated conditions, ideal conditions for shoot growth. Suggest maintaining these levels from leaf-out through mid June.	Low stress, common from March to mid April under fully irrigated conditions. Ideal for maximum shoot growth.
-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.	↓	Suggested levels in late April through mid June. Low stress levels enabling shoot growth and fruit sizing.
-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.	Mild to moderate stress, these levels of stress may be appropriate during the phase of growth just before the onset of hull split (late June).	Suggested mild levels of stress during late June and July. Shoot growth slowed but fruit sizing unaffected.
-12.0 to –14.0	Relative high levels of stress, moderate to severe defoliation, should be avoided.	↓	Mild to moderate stress suggested for August to achieve desirable sugar content in fruit and to reduce "dry-away" (drying costs).
-14.0 to –18.0	Severe defoliation, trees are likely dying.	Moderate stress in almond. Suggested stress level during hull split, Help control diseases such as hull rot and alternaria, if diseases are present. Hull split occurs more rapidly	Moderate stress acceptable in September.
-18.0 to –20.0	Crop stress levels in English walnut not observed at these levels.	Transitioning from moderate to higher crop stress levels	Moderate to high stress levels. Most commonly observed after harvest. Generally undesirable during any stage of tree or fruit growth. Most appropriately managed with post-harvest irrigation
-20 to -30	↓	High stress, wilting observed, some defoliation	
Less than – 30		Extensive defoliation has been observed	High stress, extensive defoliation

* These guidelines are tentative and subject to change as research and development with the pressure chamber and midday stem water potential progress. This table should not be duplicated without prior consent by the authors.

Around -60

Complete defoliation

Drought Survival Strategies

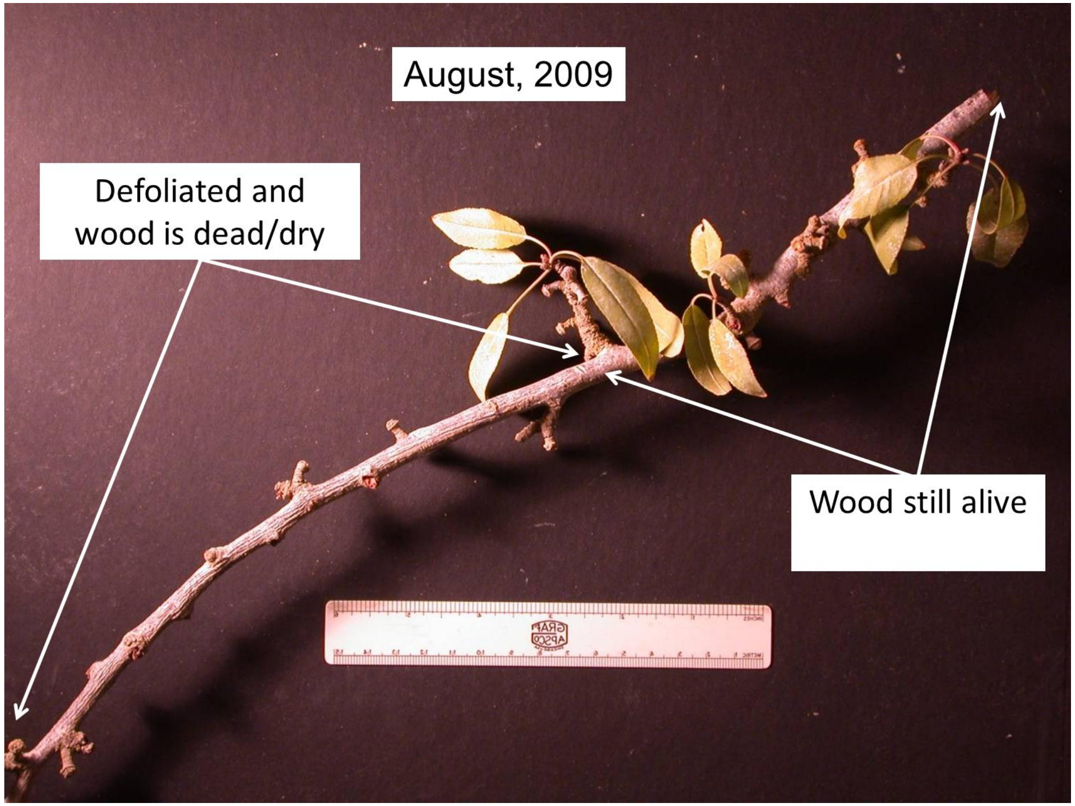
Canopy modification (pruning, spraying) under rain fed conditions – did it do any good?

Year	Yield (pounds nutmeats/acre)	
	Non-modified	Pruned or P+S
2009	1030	730
2010	320	600
2011	1450	1170
2012	1540	1610
Average	**1080**	**1030**

Answer: No.

Drought Survival Strategies

Dieback: minimal twig dieback was observed in 2009



And in the worst case was 20% of the canopy affected in 2011

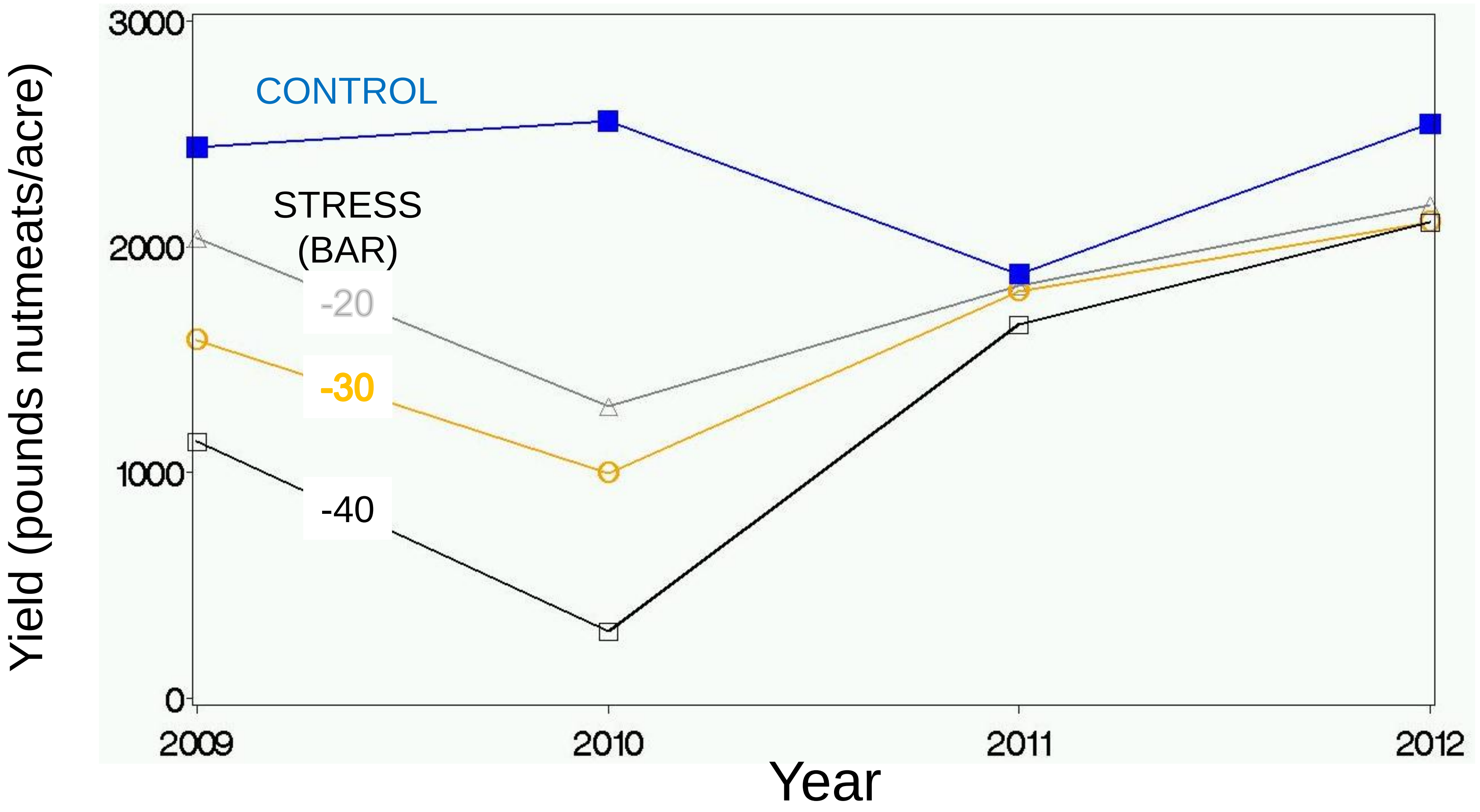
Drought Survival Strategies

Other "interesting" symptoms of severe stress

- Re-sprouting in the fall when given some postharvest irrigation (by mistake).
- About 3 days of delay in full bloom the following spring.

Drought Survival Strategies

Yield: The biggest reduction occurred in the year following the stress (i.e. carryover effect)



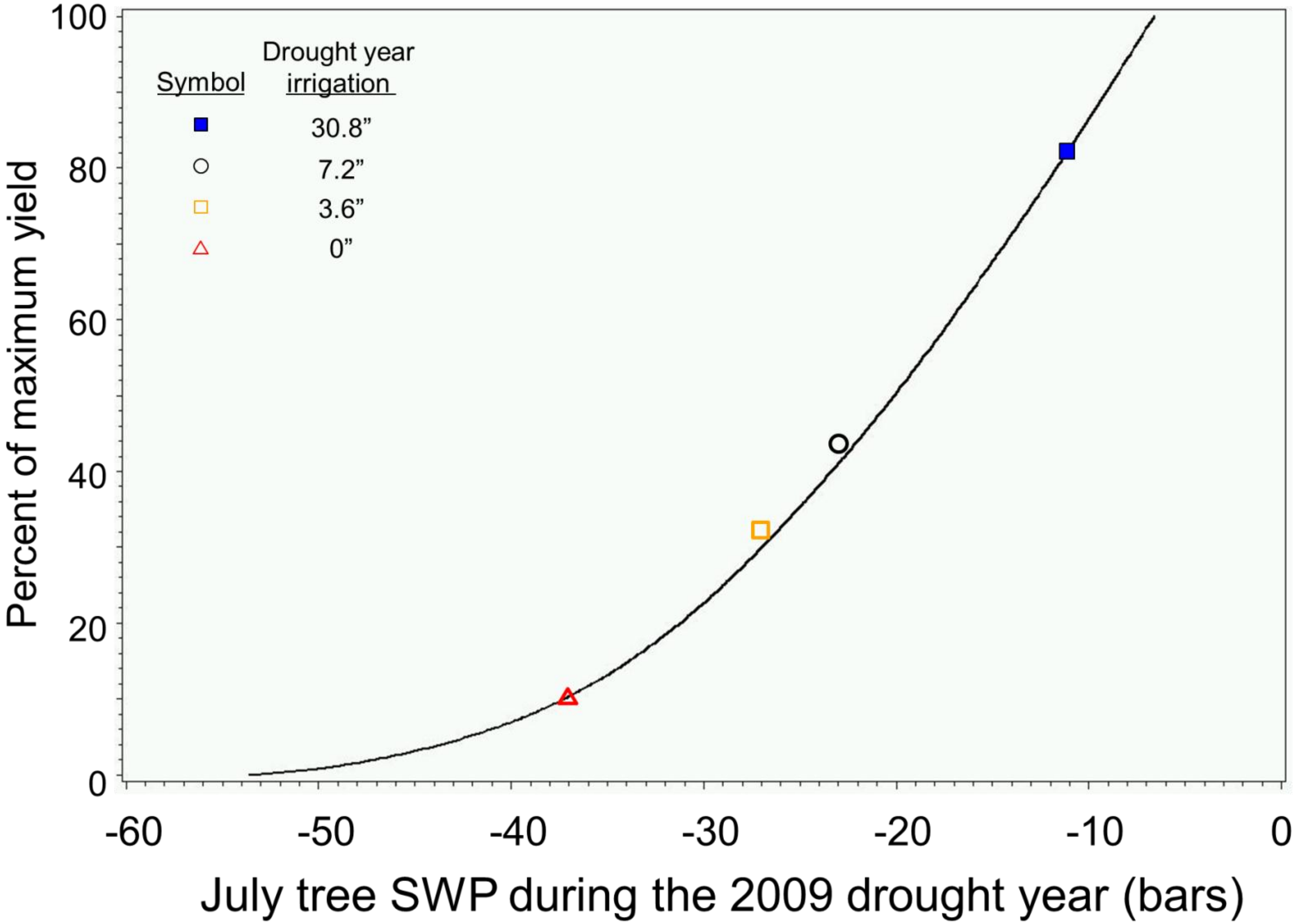
Drought Survival Strategies

Carryover effects were seen on both return bloom and % set

Stress level (bar)	Flowering		Set	
	Number per branch area	(% of control)	%	(% of control)
-10 (control)	0.518	100	34.5	100
-20	0.445	86	22.1	64
-30	0.370	71	20.0	58
-40	0.185	36	12.8	37

Drought Survival Strategies

Carryover effects of drought in 2009 on yield in 2010



Drought Survival Strategies

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Questions:

1) How m tree to survive?

As little as 7.5” may be enough!

2) Under non-irrigated (ra nd stored soil moisture only) conditions, will su al be improved by 50% canopy reduction and/or kaolin (surround) spray?

No

3) Will application of sma ounts of water (5”, 10”) over the season help?

Yes

4) I r

We found no “threshold,” but about 20% dieback was associated with very stressed conditions (-50 bar)

Drought Survival Strategies

Thanks for your support.
More details are available at the poster

Almond ET/Yield Production Function

Question:

Will yield increase if I increase irrigation?

The almond
"Water Production Function"

Almond ET/Yield Production Function

Example: How much labor would you invest under the following conditions?

Labor invested (h)	0	2	4	6	8	10
Return #1	$0	$20	$190	$600	$1,220	$2,000

Maximum return at 10h

Almond ET/Yield Production Function

Example: How much labor would you invest under the following conditions?

Labor invested (h)	0	2	4	6	8	10
Return #2	$0	$1,300	$1,700	$1,880	$1,920	$2,000

Maximum return at 2h

Almond ET/Yield Production Function

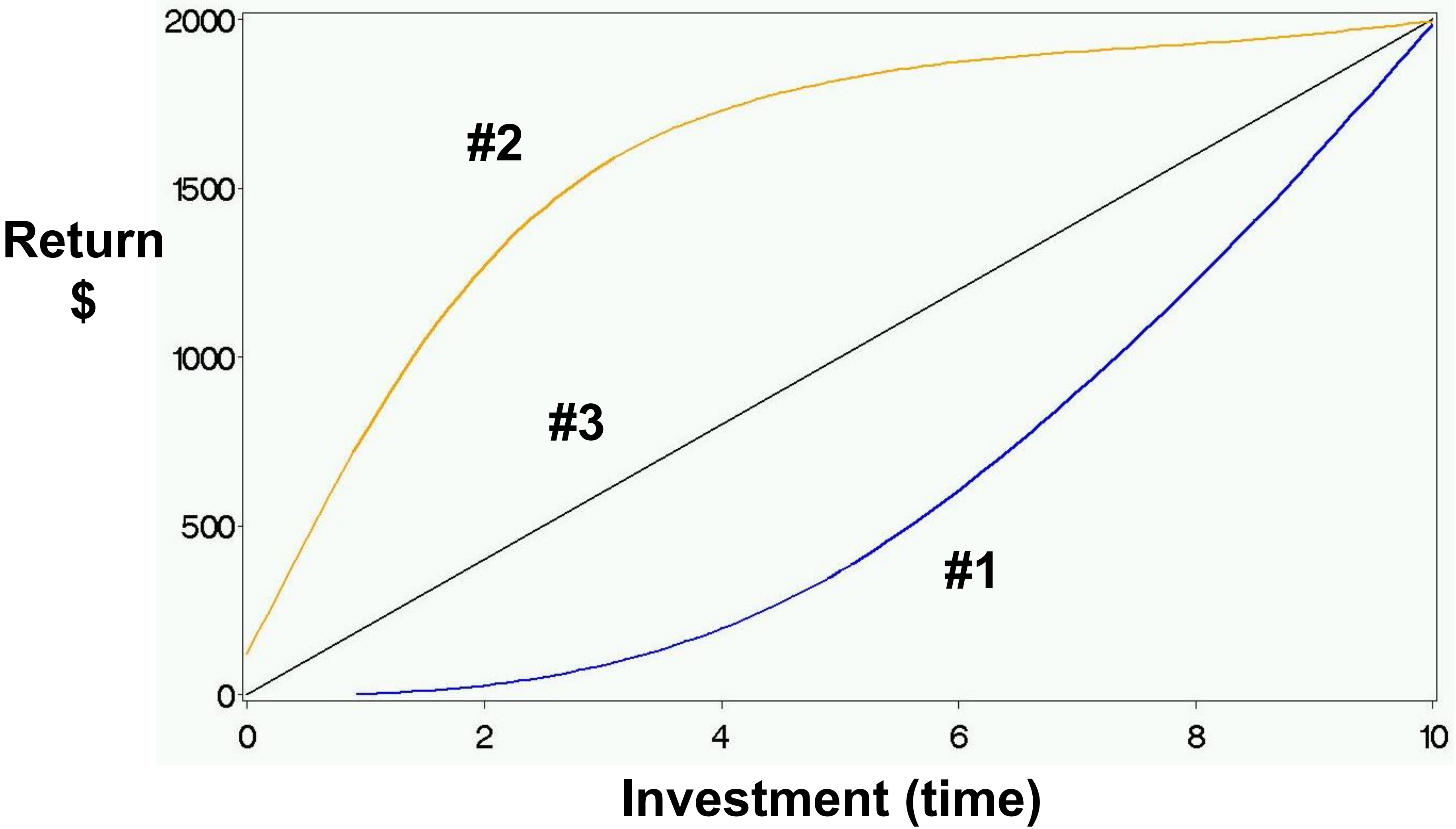
Example: How much labor would you invest under the following conditions?

Labor invested (h)	0	2	4	6	8	10
Return #3	$0	$400	$800	$1,200	$1,600	$2,000

Same return throughout

Almond ET/Yield Production Function

Your investment decision depends on the return scenario



Almond ET/Yield Production Function

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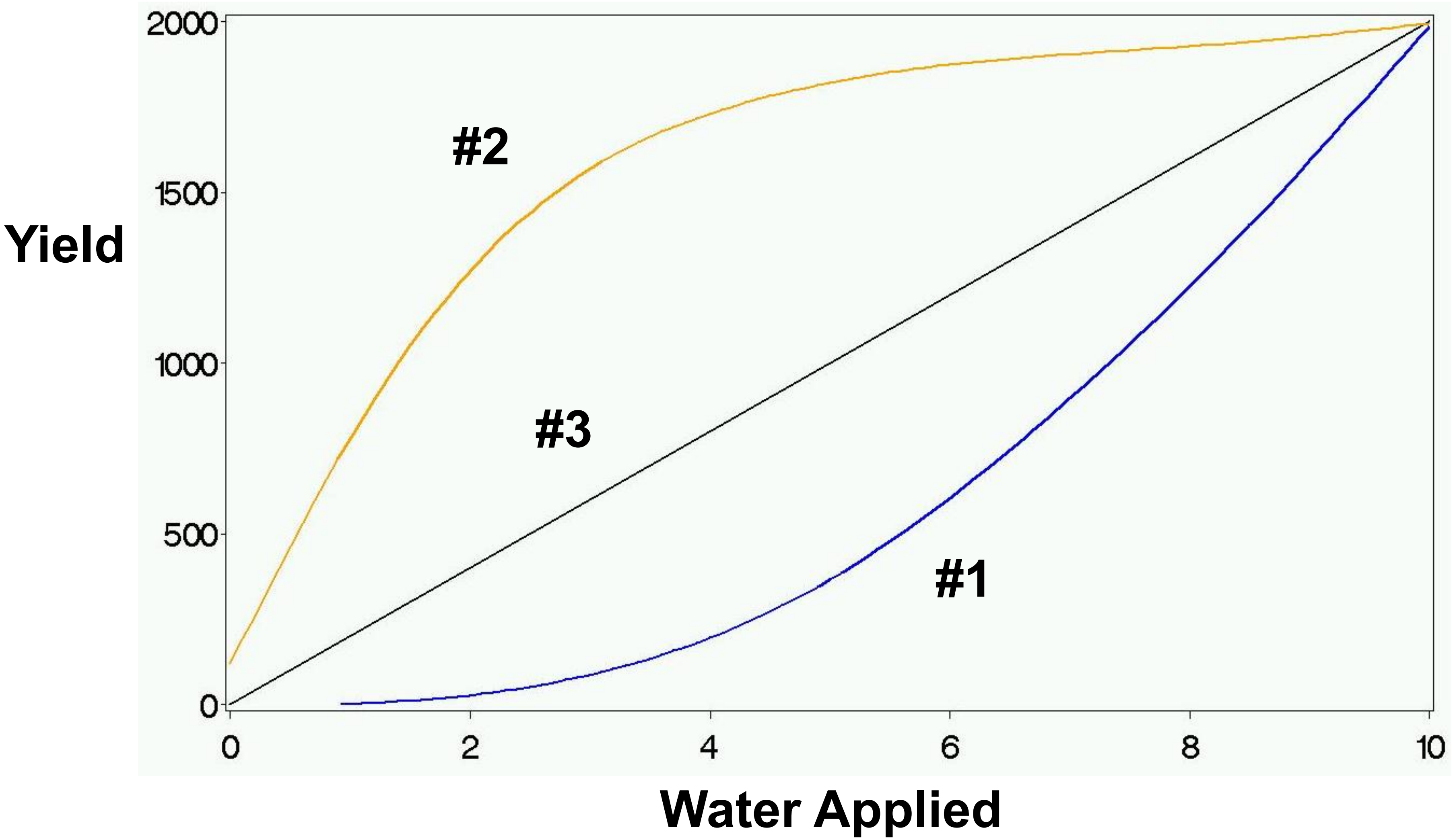
Your irrigation decision should depend on the yield response



Almond ET/Yield Production Function

Almond ET/Yield Production Function

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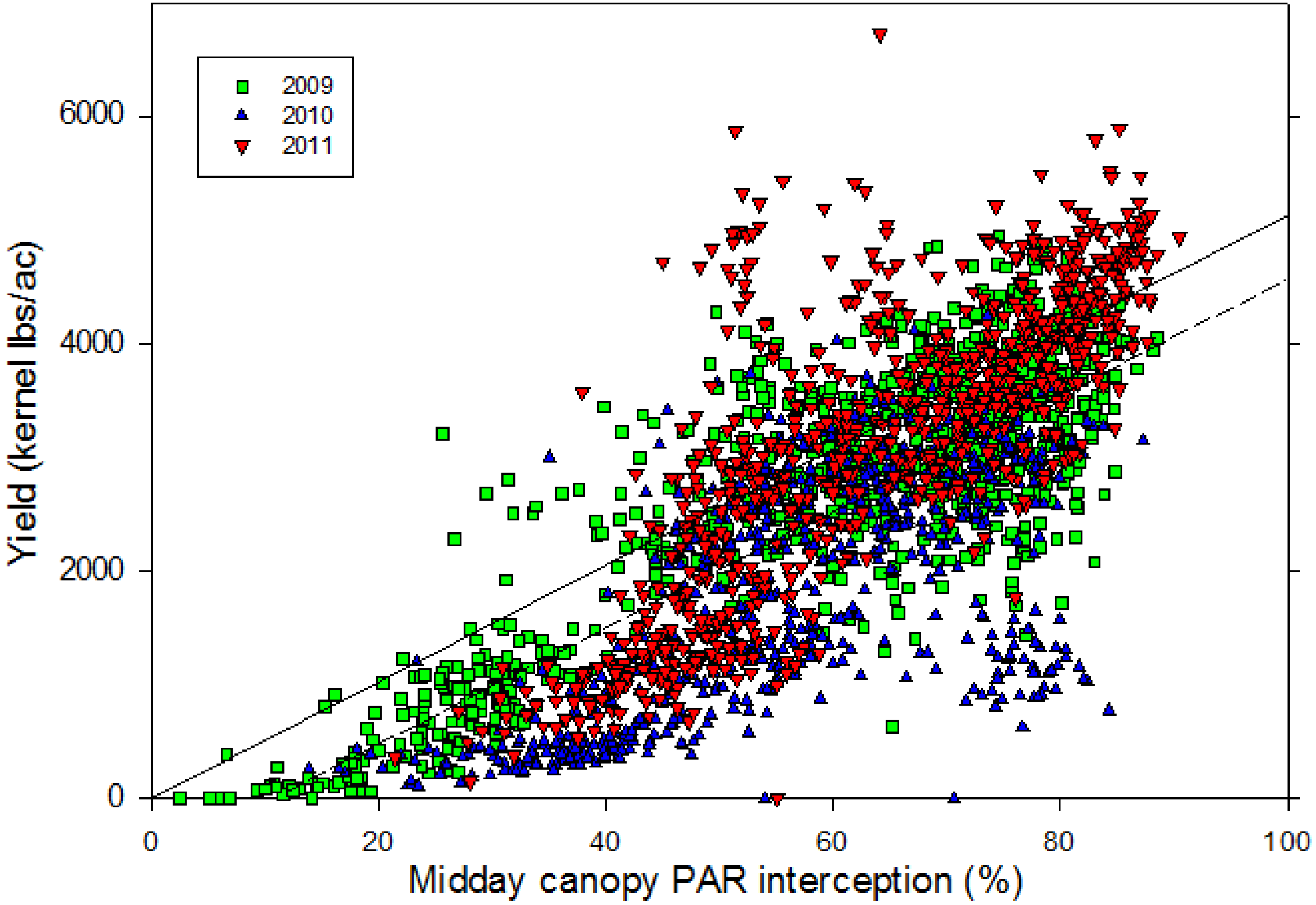
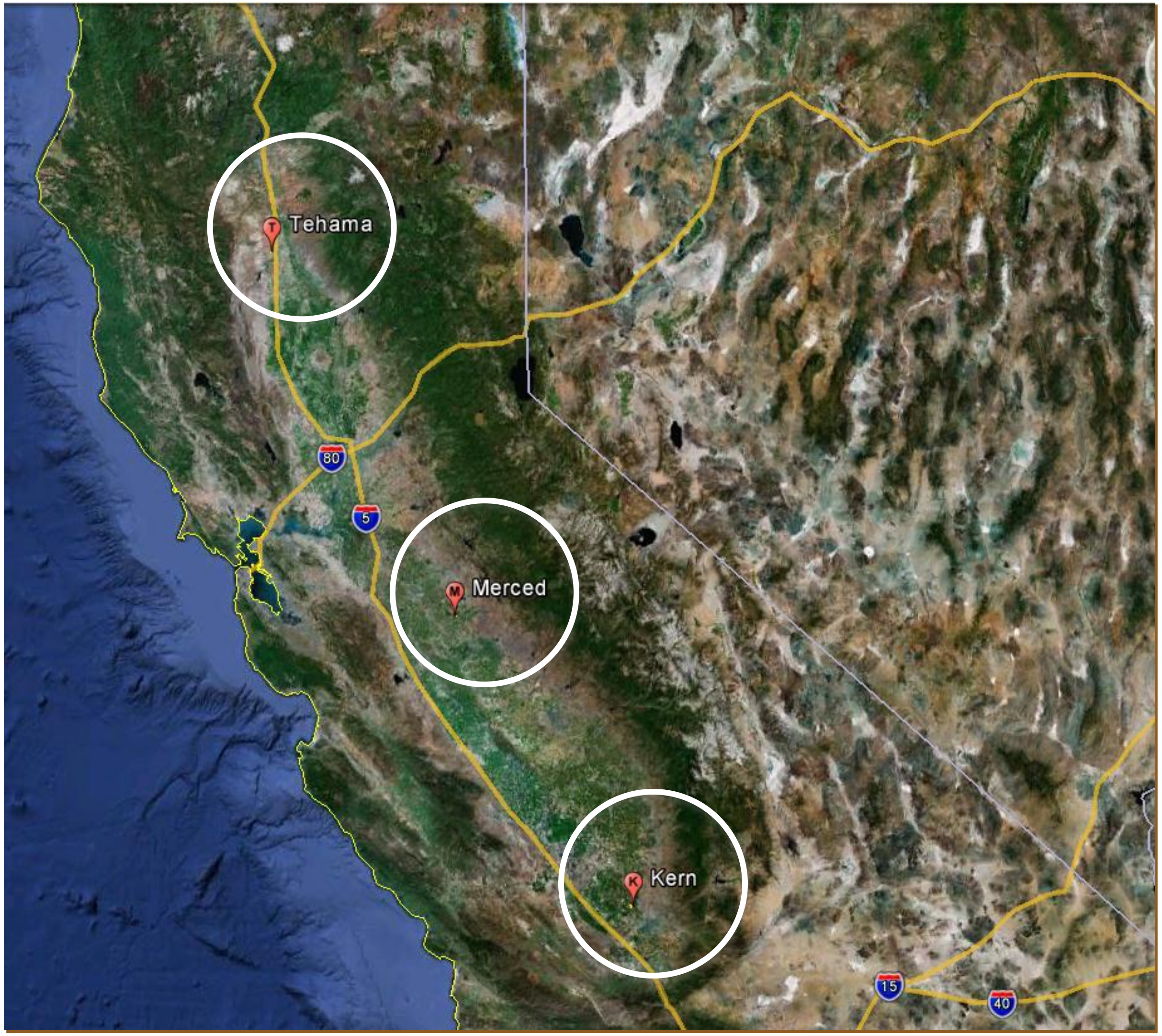
Yield increases as canopy light interception increases



Almond ET/Yield Production Function

Study sites: North, Central and South locations



Tehama county

Merced county

Kern county

Almond ET/Yield Production Function

Data collection <u>before</u> applying treatments:
Site differences in ET, rainfall, and irrigation

Site	March 1 – November 23, 2012				
	ETc	Rain	Irrigation	Total	%ETc
North (Tehama)	45.8”	7.7”	35.6”	43.3”	94%
Central (Merced)	49.4”	5.6”	31.6”	37.2”	75%
South (Kern)	51.0”	2.2”	50.5”	52.7”	103%

Almond ET/Yield Production Function

Site differences in tree water stress and midday canopy PAR interception

Site	Stem water potential (bar)		% Interception Average (& range)
	Baseline	Tree water stress Average (& range)	
North (Tehama)	-8.4	-15.9 (13-18)	52% (25-75)
Central (Merced)	-8.3	-12.6 (9-15)	61% (53-67)
South (Kern)	-8.1	-13.2 (11-16)	68% (61-78)

Almond ET/Yield Production Function

Examples of within-orchard variability in % light interception (Tehama)

38%

68%

Almond ET/Yield Production Function

Examples of within-orchard variability in % light interception (Merced)

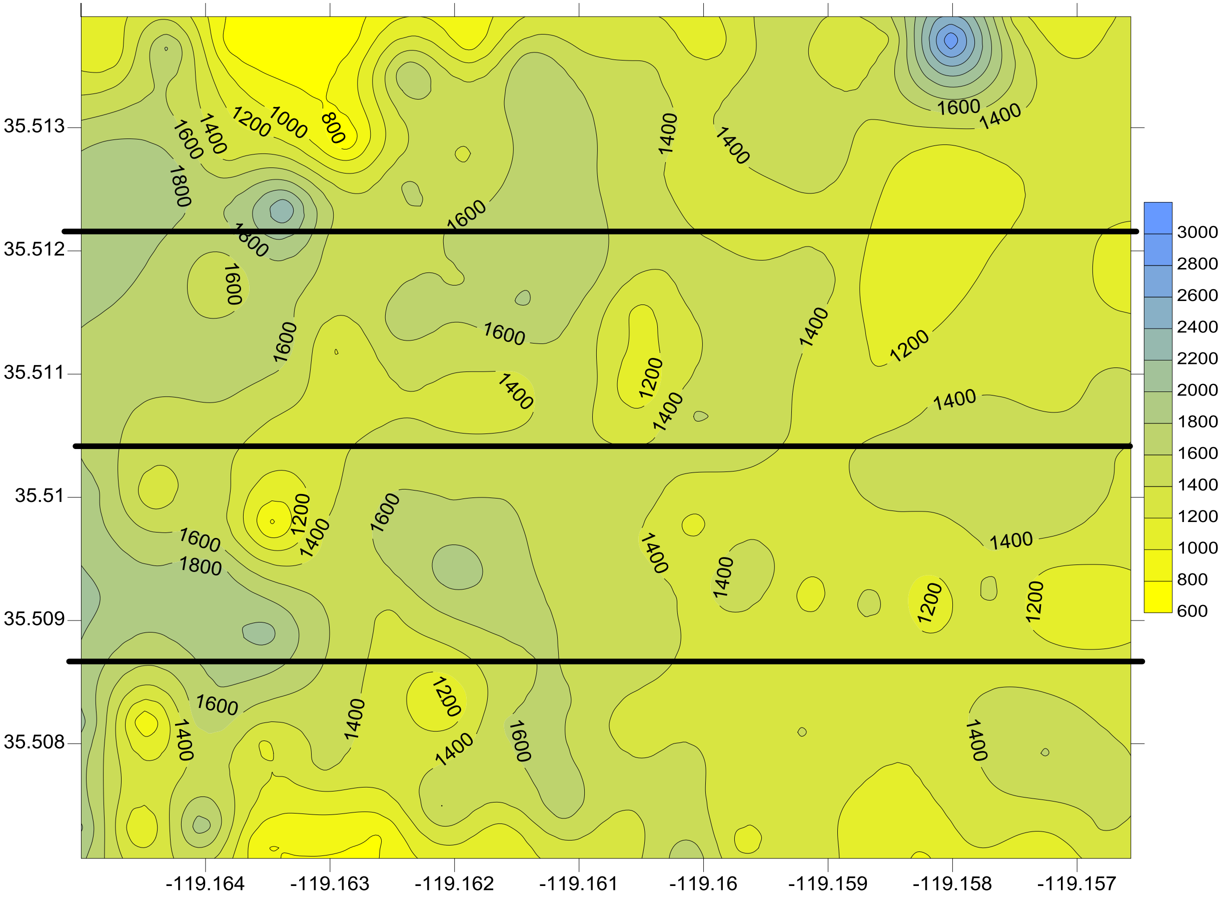
50%

73%

Almond ET/Yield Production Function

Using soils and other information to determine an almond water production function that can be used across the state.

Yield map from the Kern Co. site



Almond ET/Yield Production Function

On behalf of Allan Fulton, David Doll, Blake Sanden, and Bruce Lampinen, thanks for your support.

More details are available at the poster

Real-Time Weather Monitoring for Frost Protection with Sprinklers

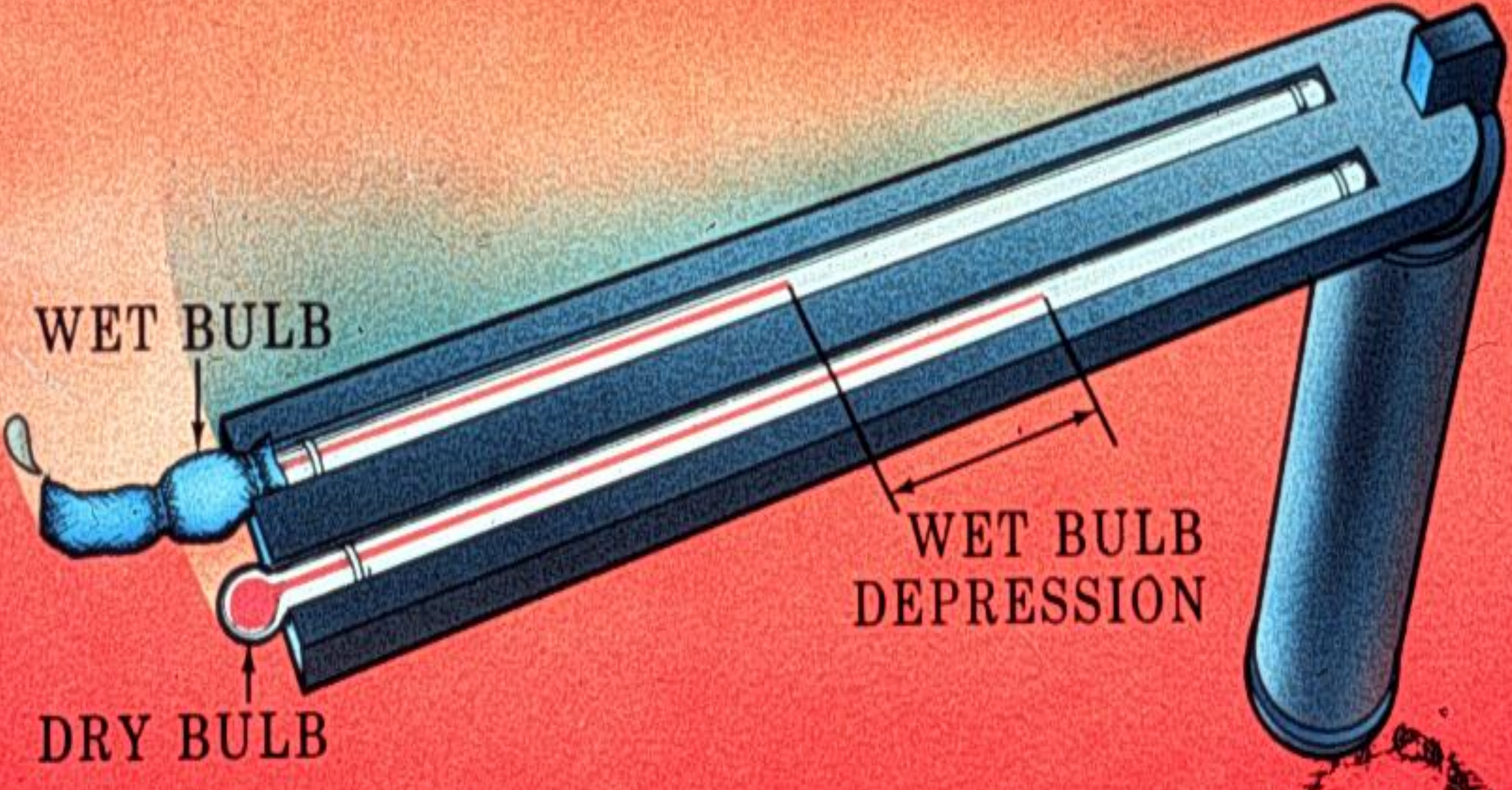
Richard L. Snyder
Biometeorologist
University of California, Davis

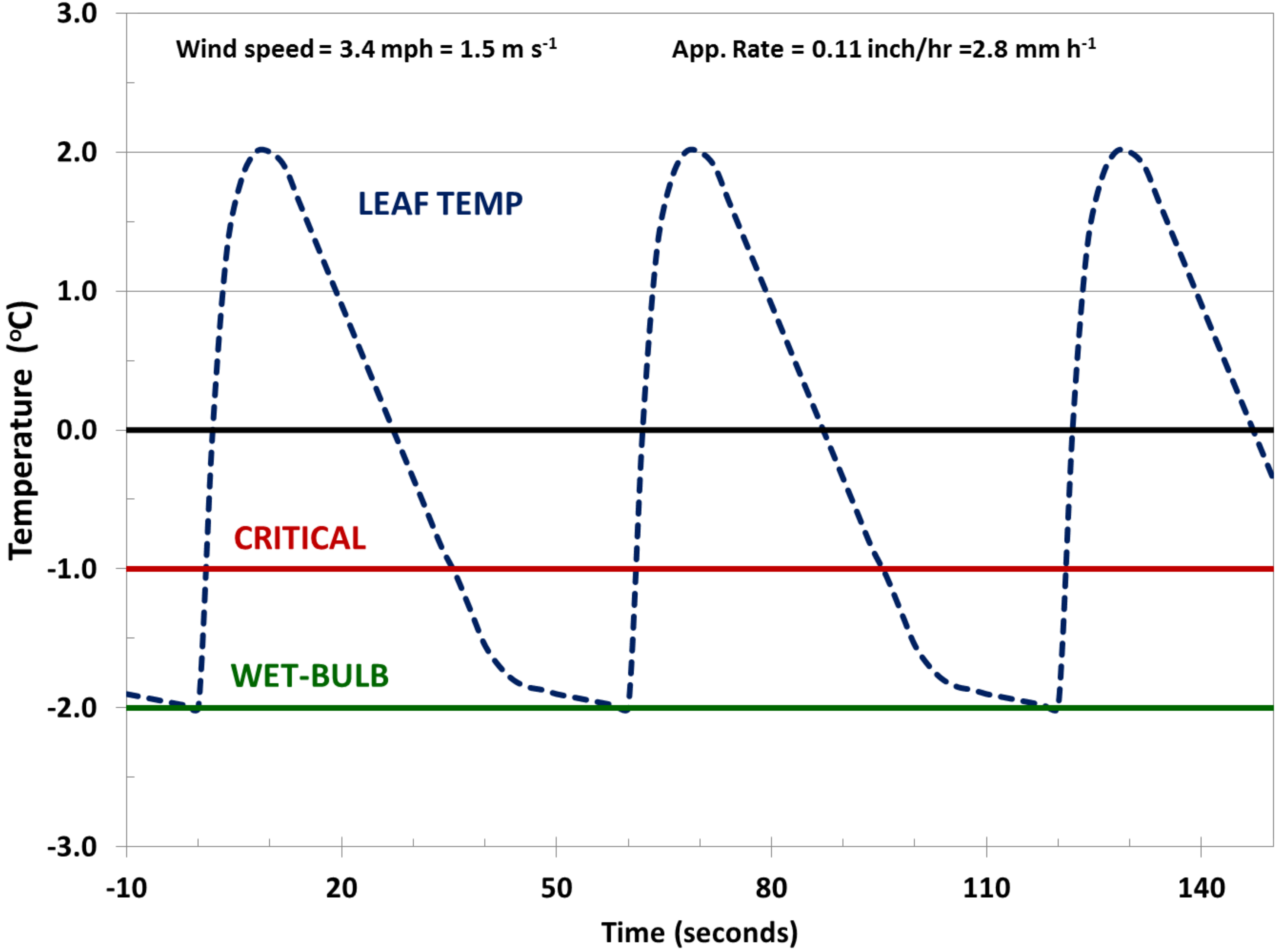
Joseph Connell
Farm Advisor
UCCE Butte County

STARTING AND STOPPING

1. Air temperature initially drops to the wet-bulb temperature
2. If sprinklers stop, soil surface temperature drops to the wet-bulb
3. Between wetting, wet plant tissue cools to the wet-bulb

SLING PSYCHROMETER METHOD OF MEASURING RELATIVE HUMIDITY



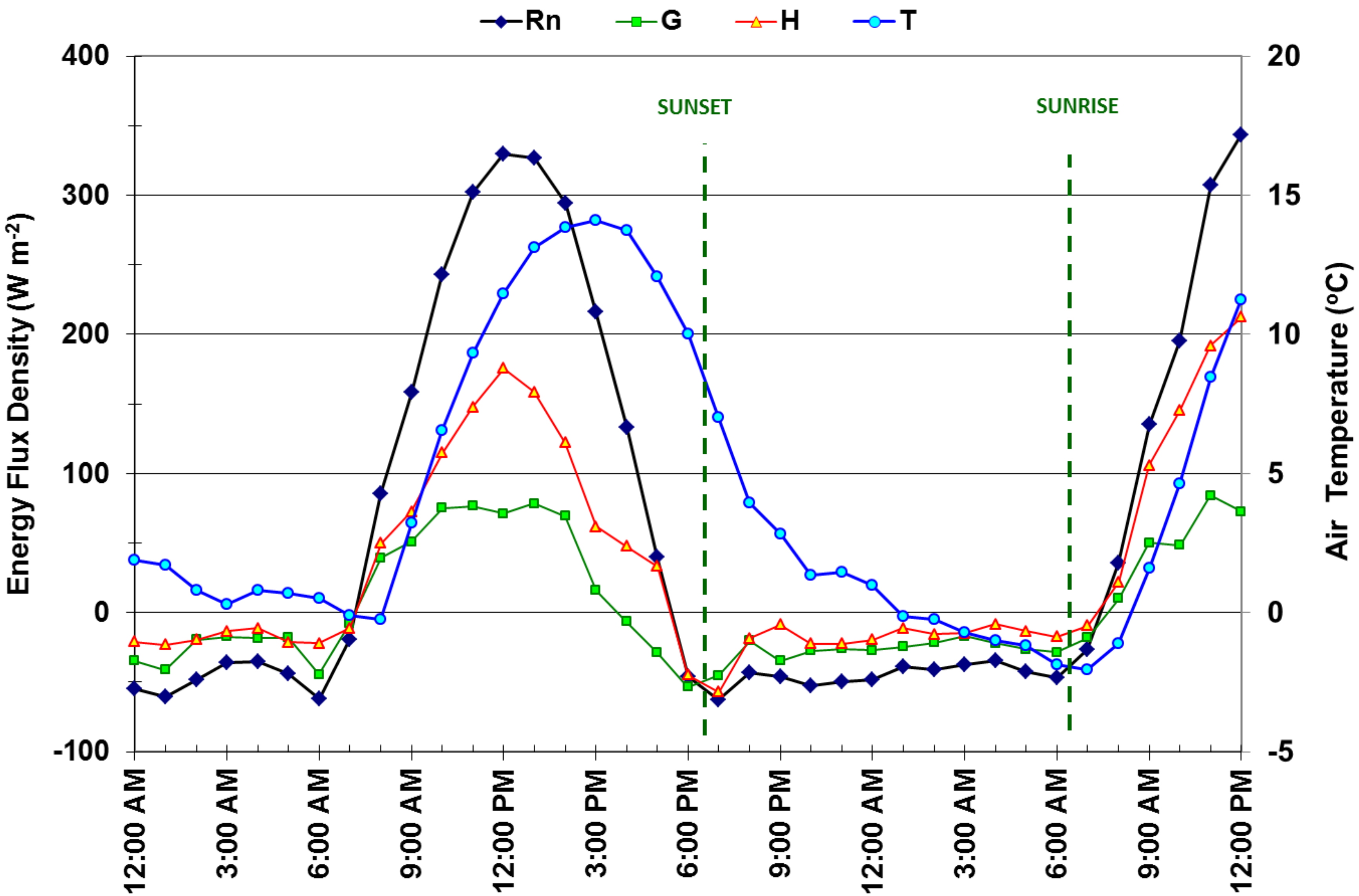

3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
Temperature (°C)
-10
20
50
80
110
140
Time (seconds)
Wind speed = 3.4 mph = 1.5 m s-1
App. Rate = 0.11 inch/hr =2.8 mm h-1
LEAF TEMP
CRITICAL
WET-BULB

Real-Time Weather Monitoring for Frost Protection with Sprinklers

OBJECTIVES:

1. Develop an automated computer-based model to monitor real-time weather conditions in orchards as a basis for managing sprinkler operations for frost protection.

2. Develop guidelines for using the model to manage sprinkler operations on radiation frost nights.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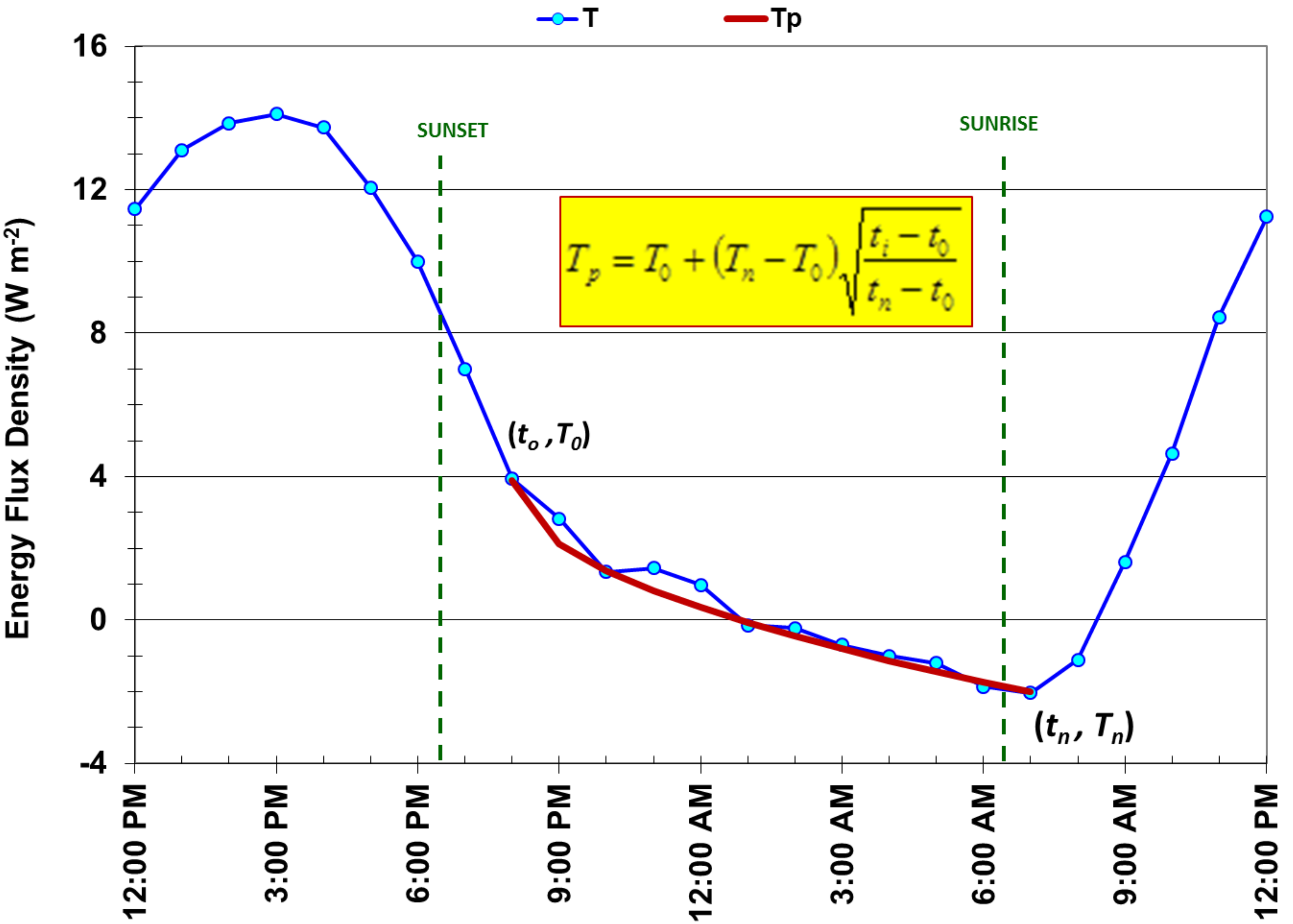
H
T
Energy Flux Density (W m-2)
400
300
200
100
0
-100
Air Temperature (ºC)
20
15
10
5
0
-5
SUNSET
SUNRISE
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM



$$T_p = T_0 + (T_n - T_0)\sqrt{\frac{t_i - t_0}{t_n - t_0}}$$

Calculate vapor pressure (e) from T_d

$$e = 0.6108\,exp\left(\frac{17.27T_d}{T_d + 237.3}\right)$$

Calculate barometric pressure (p_a)

$$p_a \approx 101.3\left(\frac{293 - 0.0065E_L}{293}\right)^{5.26}$$

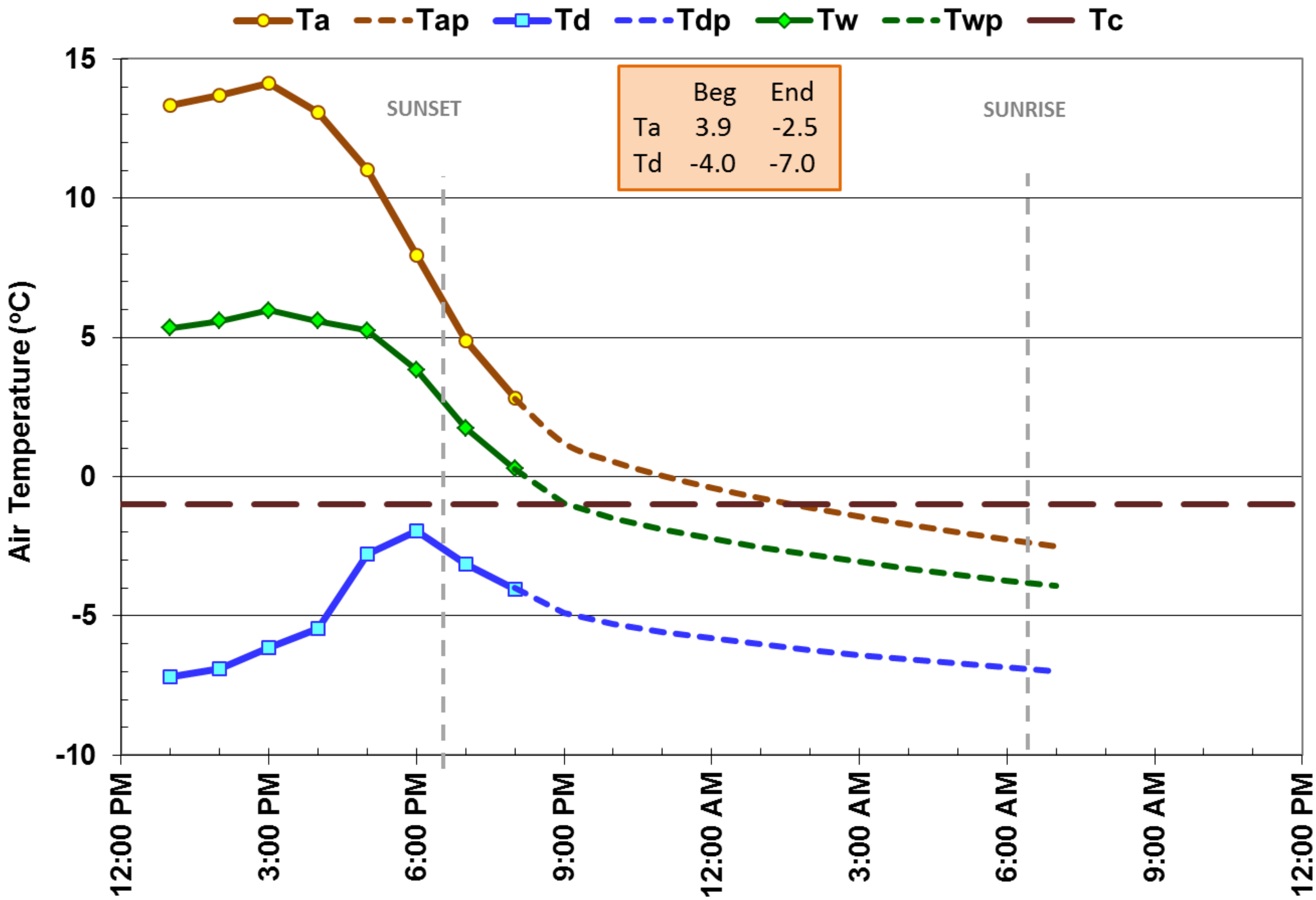
Iterate T_w until e′= e

$$e' = e_w - 0.00115T_w\left(T - T_w\right)p_a$$

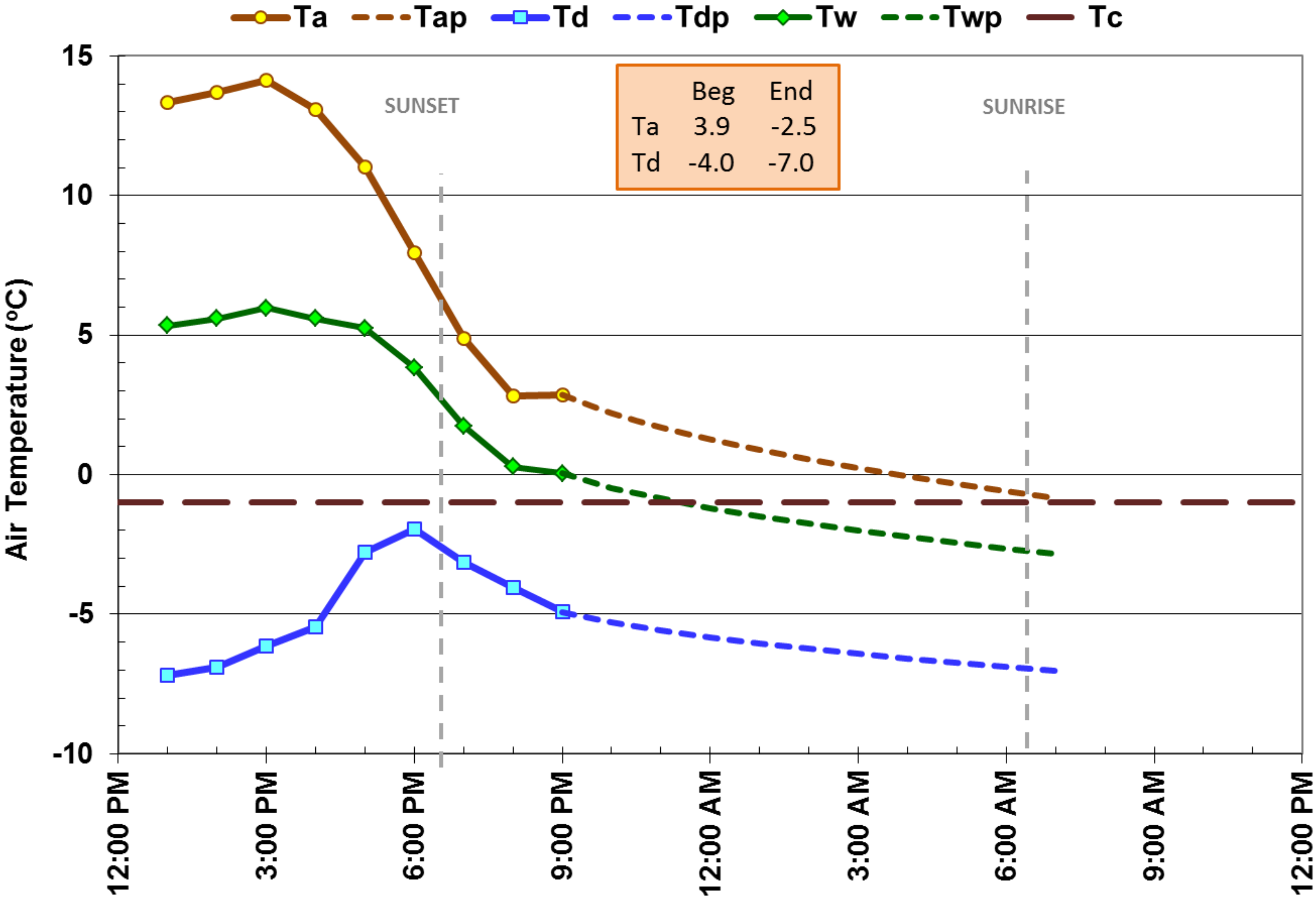
Calculate e_w from T_w

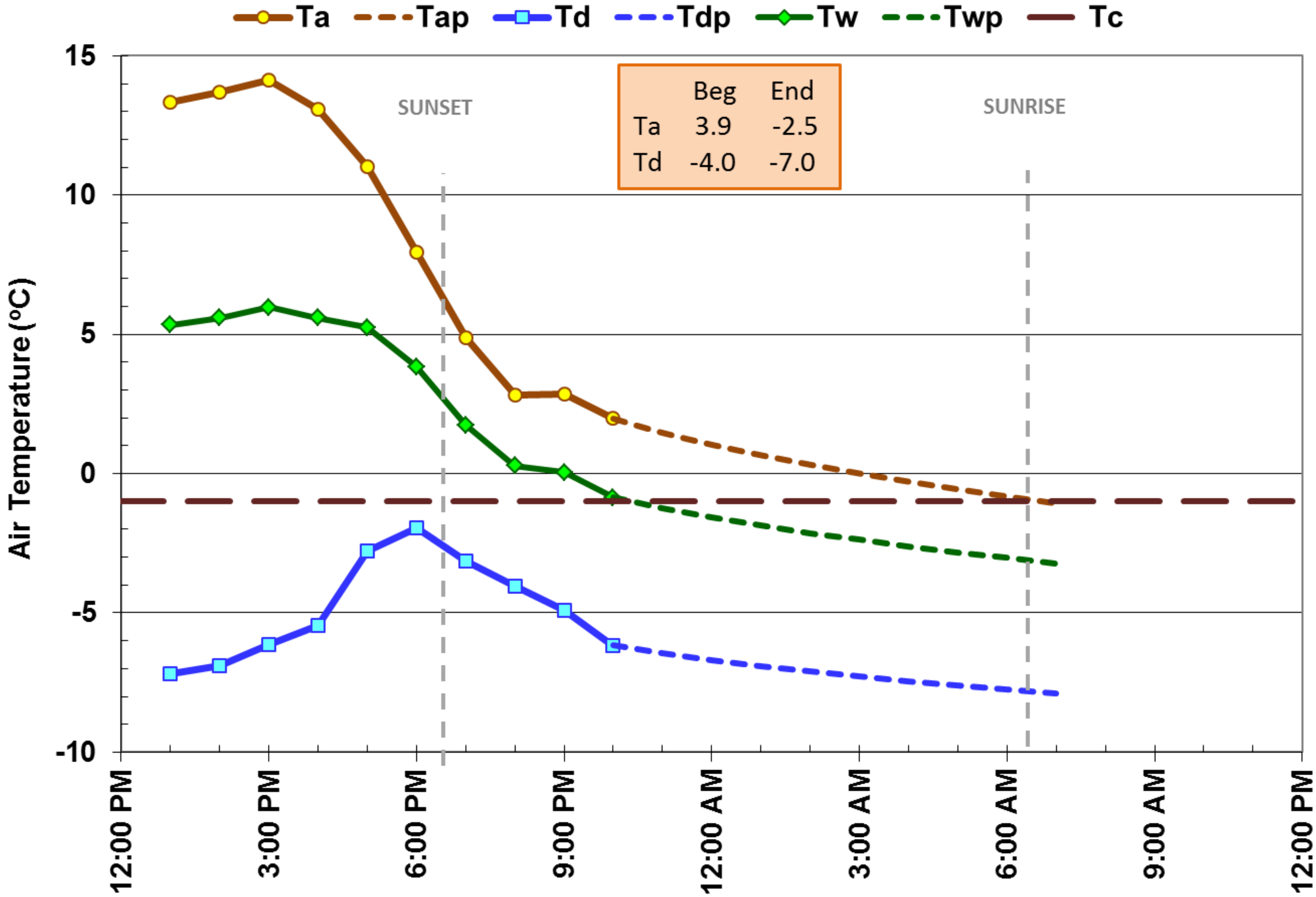
$$e_w = 0.6108\,exp\left(\frac{17.27T_w}{T_w + 237.3}\right)$$

	T (°C)	e_s (kPa)	e (kPa)
T	12.0	1.402564	
Td	1.0	0.656709	0.656709
Tw	6.9	0.997724	0.656708
Tw1	6.5	0.967977	0.597509
Tw2	9.25	1.167595	0.981779
Tw3	7.875	1.06367	0.785383
Tw4	7.1875	1.014831	0.690417
Tw5	6.84375	0.99116	0.64371
Tw6	7.015625	1.002934	0.667
Tw7	6.929688	0.997032	0.655339
Tw8	6.972656	0.999979	0.661166
Tw9	6.951172	0.998504	0.658251
Tw10	6.94043	0.997768	0.656795
Tw11	6.935059	0.9974	0.656067
Tw12	6.937744	0.997584	0.656431
Tw13	6.939087	0.997676	0.656613
Tw14	6.939758	0.997722	0.656704
Tw15	6.940094	0.997745	0.65675
Tw16	6.939926	0.997733	0.656727
Tw17	6.939842	0.997727	0.656715
Tw18	6.9398	0.997725	0.65671
Tw19	6.939779	0.997723	0.656707
Tw20	6.93979	0.997724	0.656708

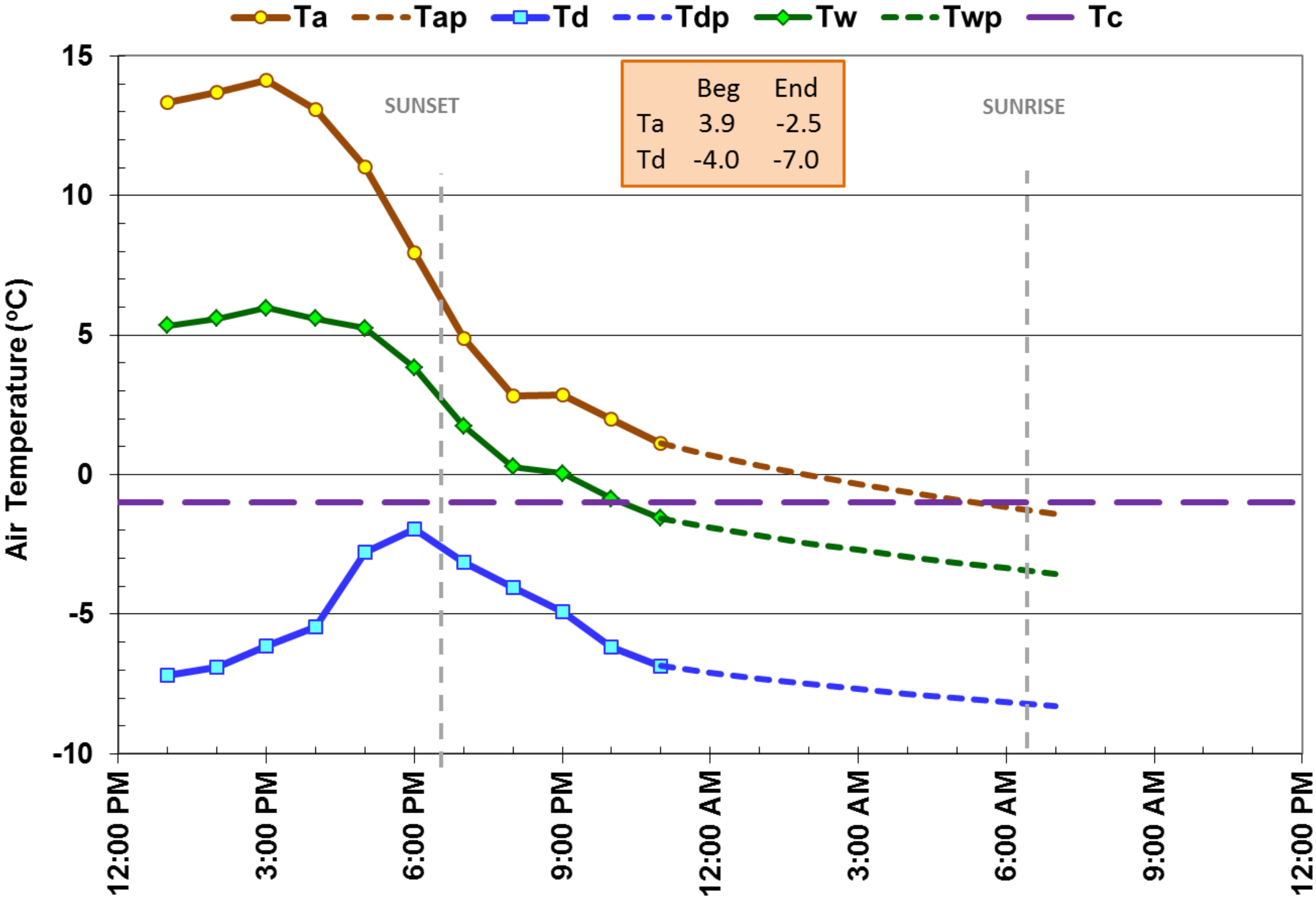


	Beg	End
Ta	3.9	-2.5
Td	-4.0	-7.0

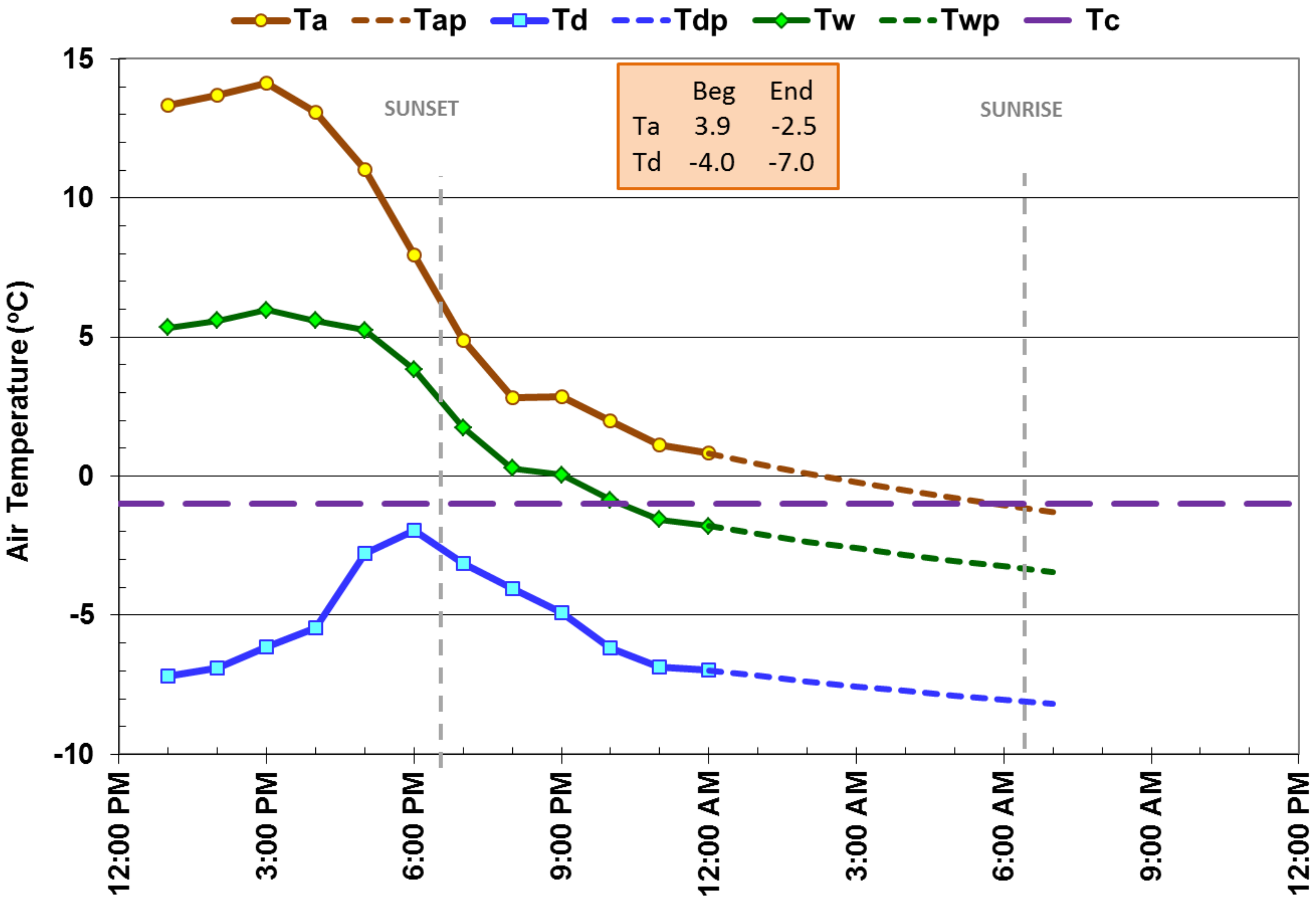

Ta
Tap
Td
Tdp
Tw
Twp
Tc
Beg
End
Ta 3.9 -2.5
Td -4.0 -7.0
SUNSET
SUNRISE
Air Temperature (ºC)
15
10
5
0
-5
-10
12:00 PM
3:00 PM
6:00 PM
9:00 PM
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM



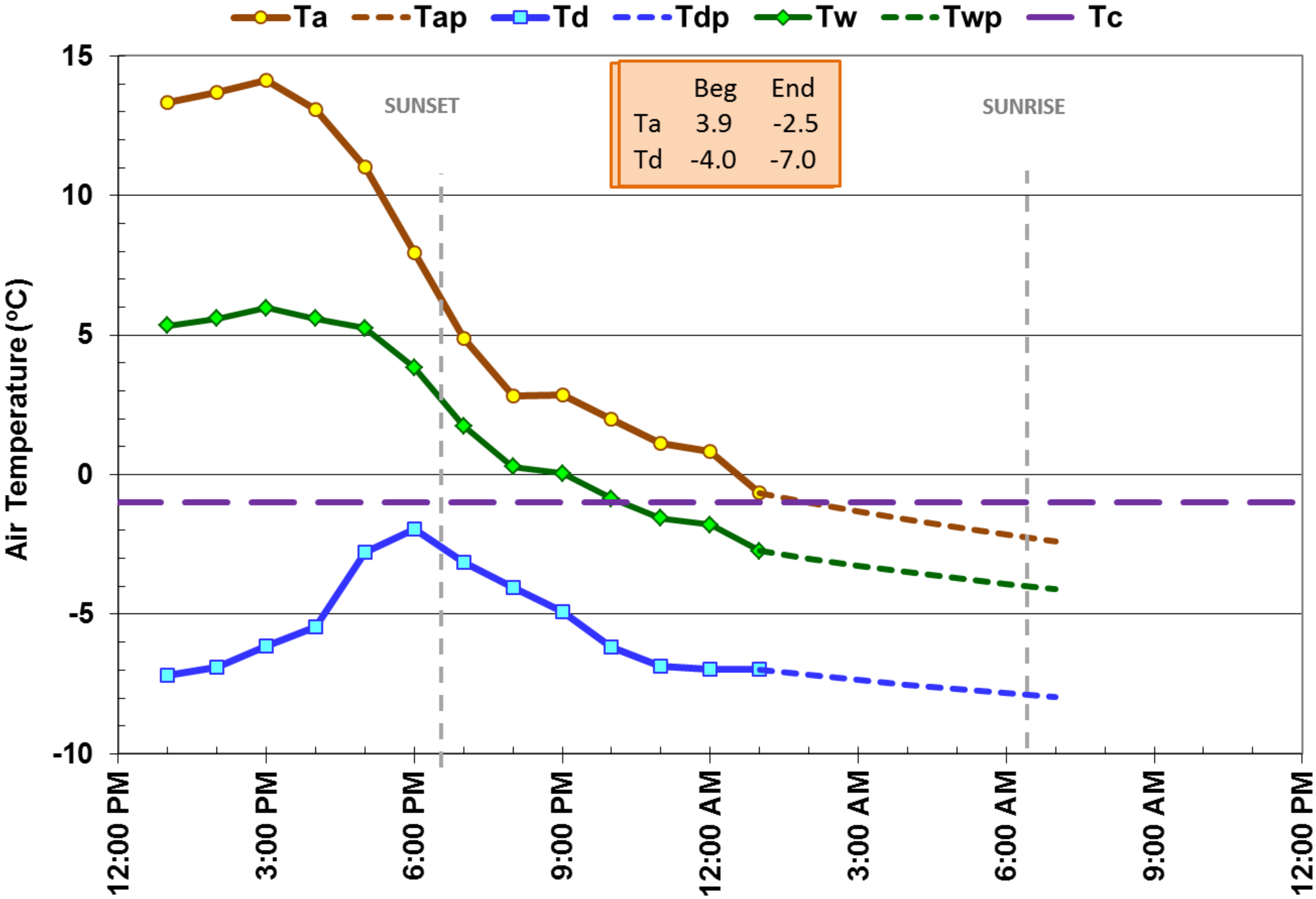
	Beg	End
Ta	3.9	-2.5
Td	-4.0	-7.0



	Beg	End
Ta	3.9	-2.5
Td	-4.0	-7.0



	Beg	End
Ta	3.9	-2.5
Td	-4.0	-7.0


Ta
Tap
Td
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Tw
Twp
Tc
Beg End
Ta 3.9 -2.5
Td -4.0 -7.0
SUNSET
SUNRISE
Air Temperature (°C)
15
10
5
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12:00 PM
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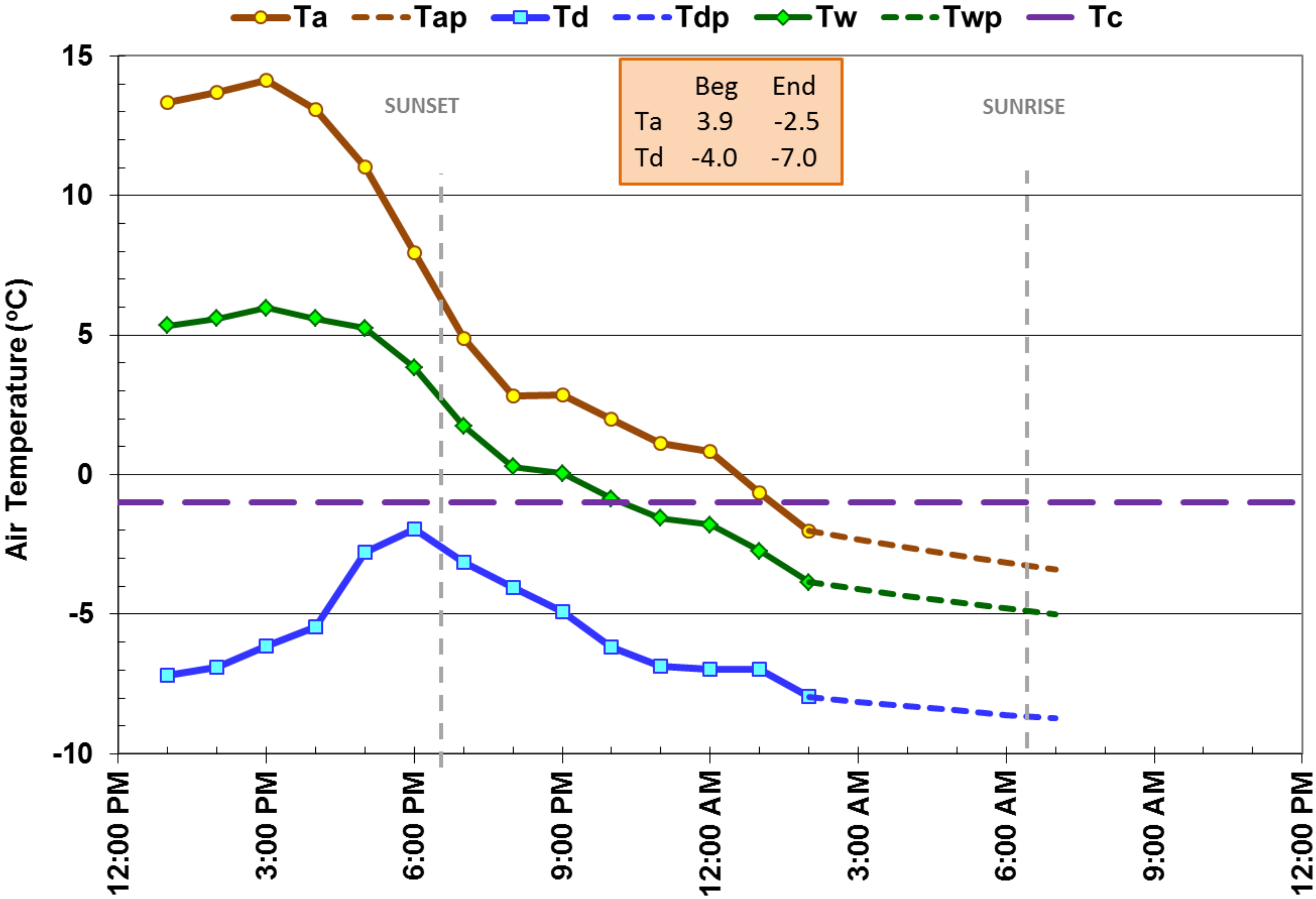
12:00 AM
3:00 AM
6:00 AM
9:00 AM
12:00 PM


Ta
Tap
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Tdp
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Tc
Beg End
Ta 3.9 -2.5
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15
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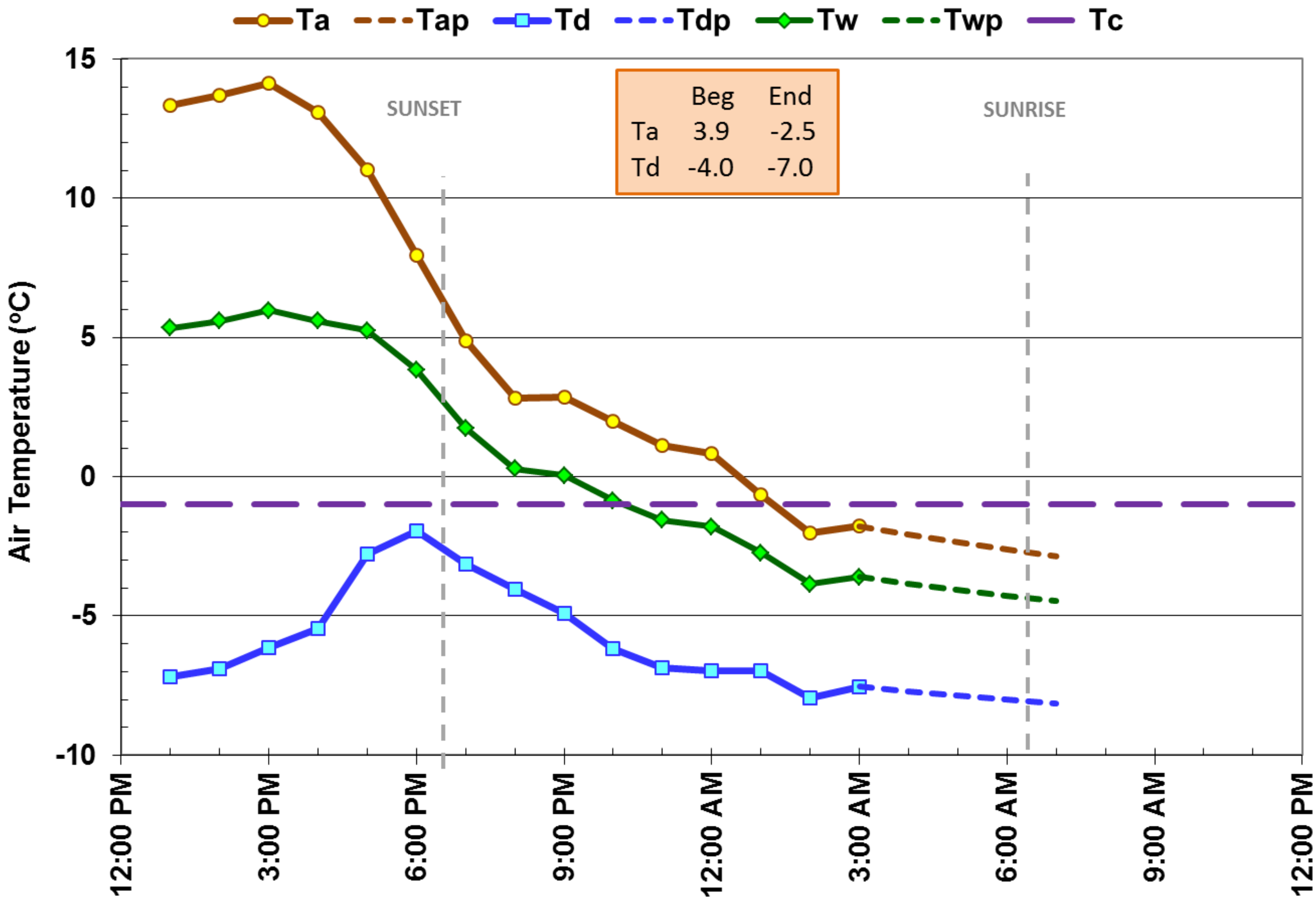
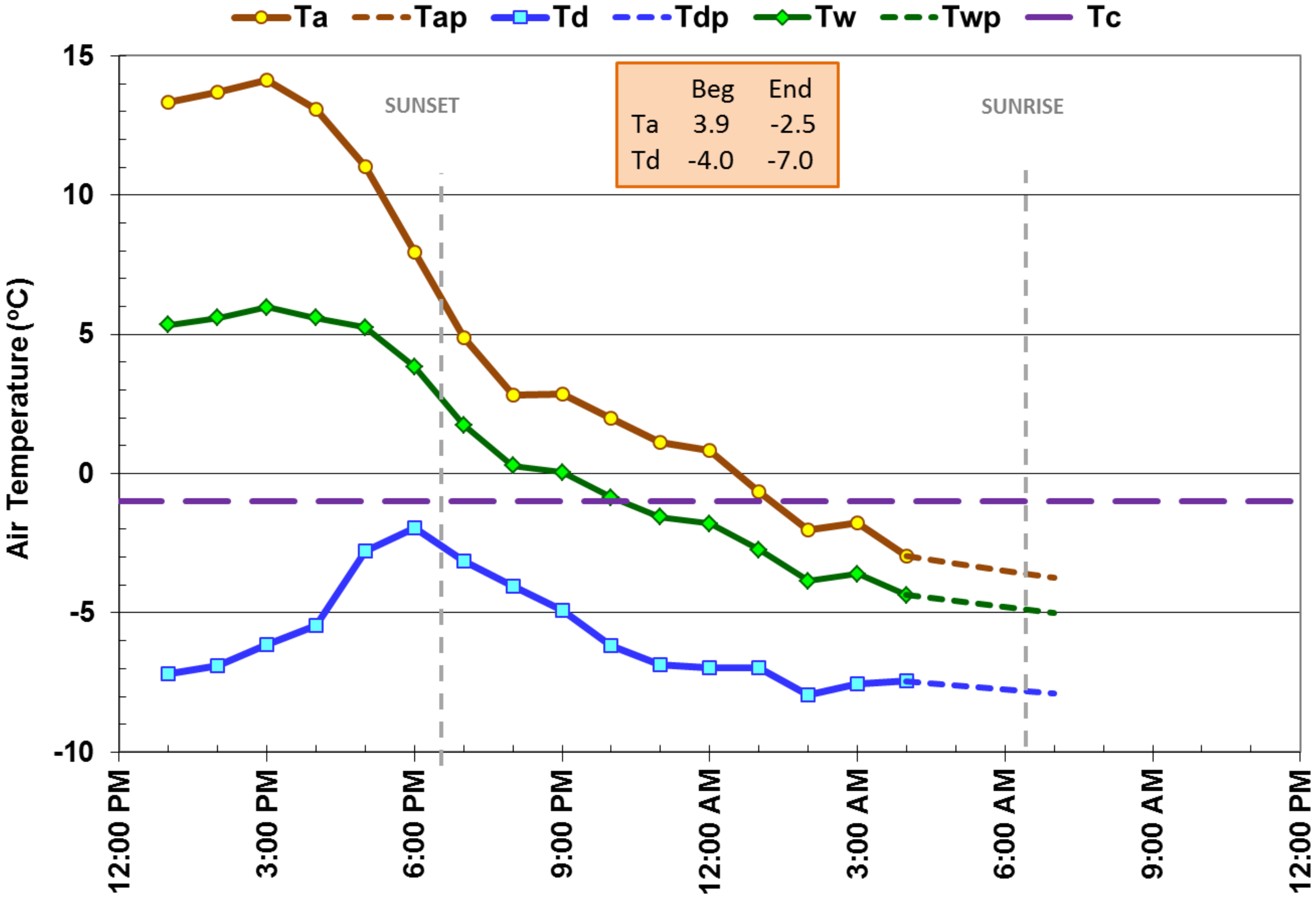
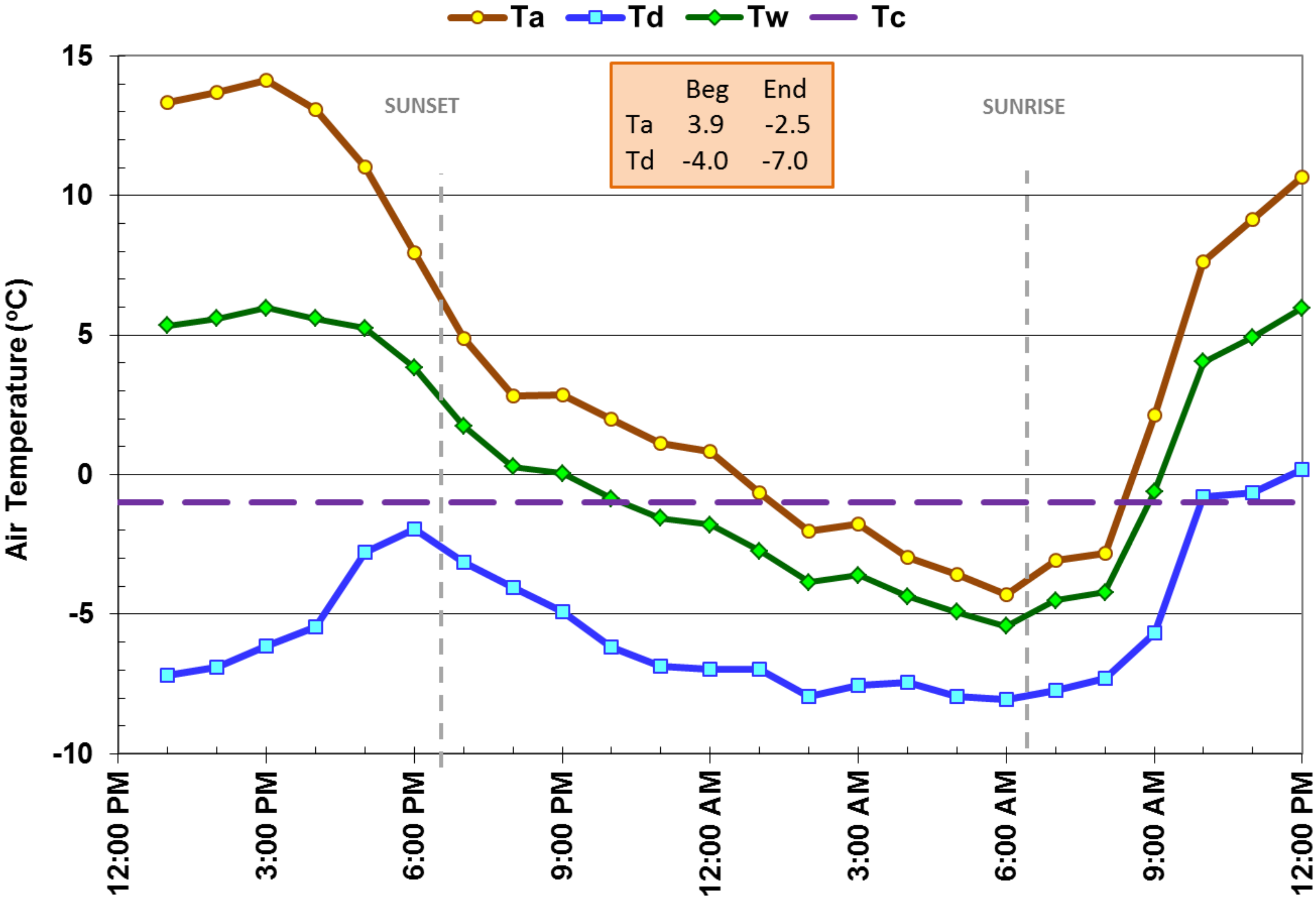
6:00 AM
9:00 AM
12:00 PM



	Beg	End
Ta	3.9	-2.5
Td	-4.0	-7.0



	Beg	End
Ta	3.9	-2.5
Td	-4.0	-7.0



	Beg	End
Ta	3.9	-2.5
Td	-4.0	-7.0

Guidelines

1. For a dry crop and $T_a < T_c$ more than half and hour during the night, start when $T_w > T_c$
2. For wet crop and $T_w < 0^oC$ during the night, start when $T_w > 0^oC$
3. Stop when $T_w > 0^oC$

Future Plans

1. Work with weather station vendors to add model to their station packages
2. Finish document on how to interpret data and use the model
3. Provide information on critical temperatures for almond varieties

Thanks!

http://biomet.ucdavis.edu

Precision canopy and water management with sensor technology

Bruce Lampinen, Integrated Orchard Management Specialist, UC Davis Plant Sciences

Cooperators

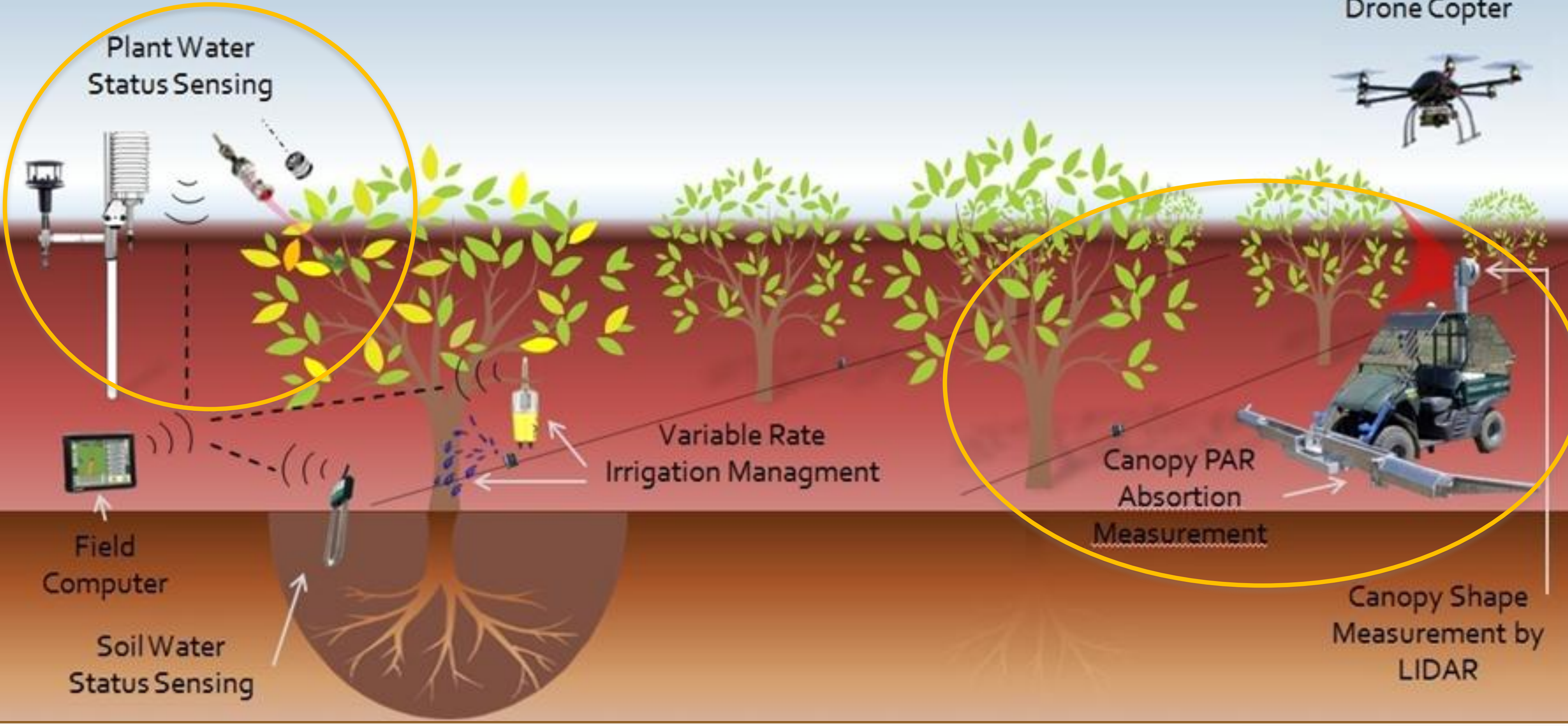
<u>Cooperating campus personnel</u>- Shrini Upadhyaya, Vasu Udompetaikul, Greg Browne, David Slaughter, Bill Stewart, Loreto Contador, Sam Metcalf, Ignacio Porris Gómez and Jed Roach

<u>Cooperating farm advisors</u>- Carolyn DeBuse, David Doll, John Edstrom, Allan Fulton, Brent Holtz, Bill Krueger and Blake Sanden

Precision Canopy and Water Management of Specialty Crops through Sensor-Based Decision Making

(SCRI-USDA-NIFA No. 2012-01213)

- Goal

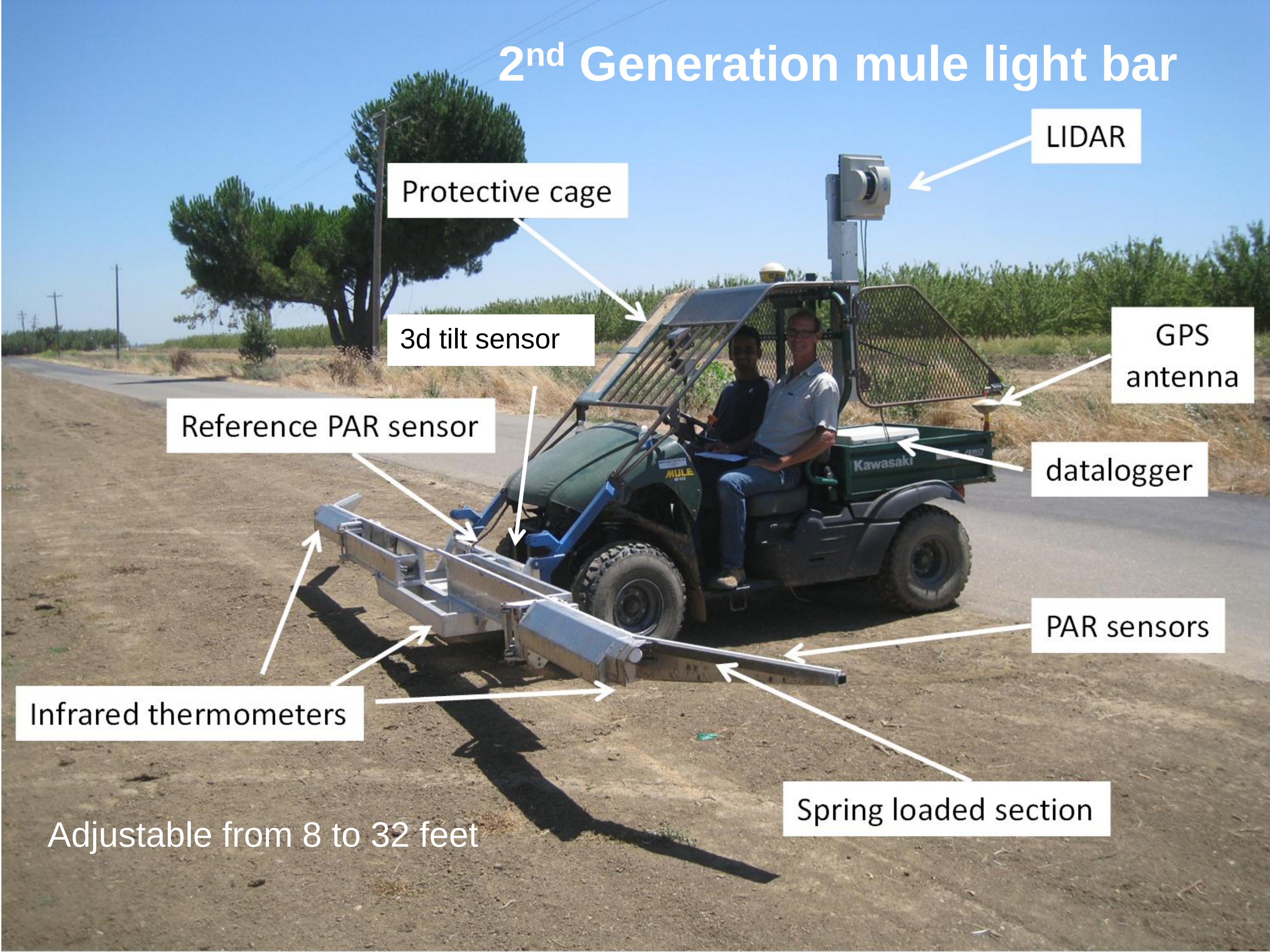


Objectives 2012

Objective 1- Continue refining the light interception and yield data relationship.

Objective 2- Continue developing data from the plant water stress sensor suite

2nd Generation mule light bar



LIDAR

Protective cage

3d tilt sensor

GPS antenna

Reference PAR sensor

datalogger

PAR sensors

Infrared thermometers

Spring loaded section

Adjustable from 8 to 32 feet

Orchards mapped with Mule Lightbar

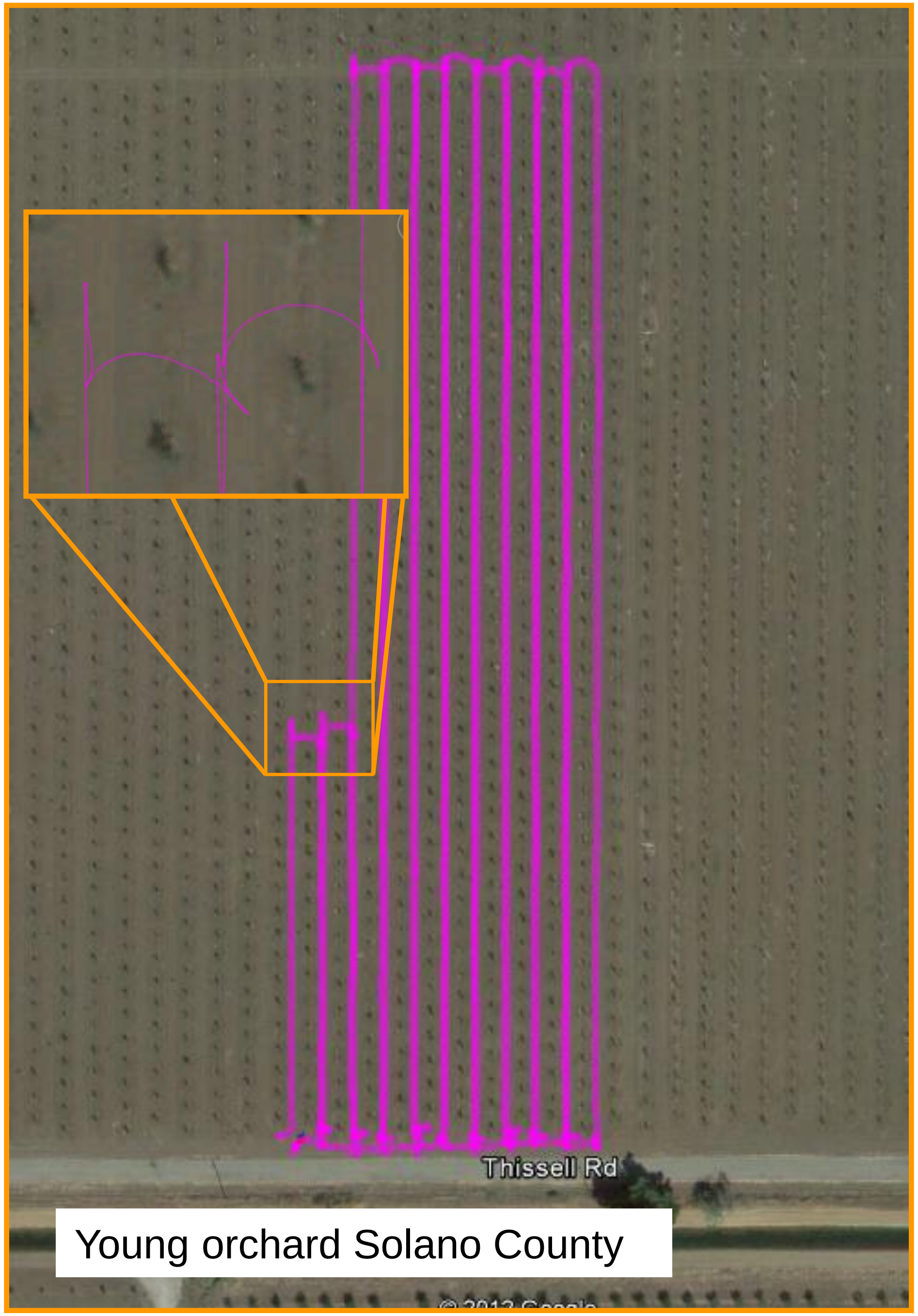
2009
- 19 almond
- 13 walnut
- 1 olive
- 1 peach
- 1 pear
- 1 pistachio
- 1 prune
- 1 olive
- 1 vineyard

2010
- 20 almond
- 13 walnut
- 1 olive
- 1 peach
- 1 pear
- 1 pistachio
- 1 prune
- 1 olive

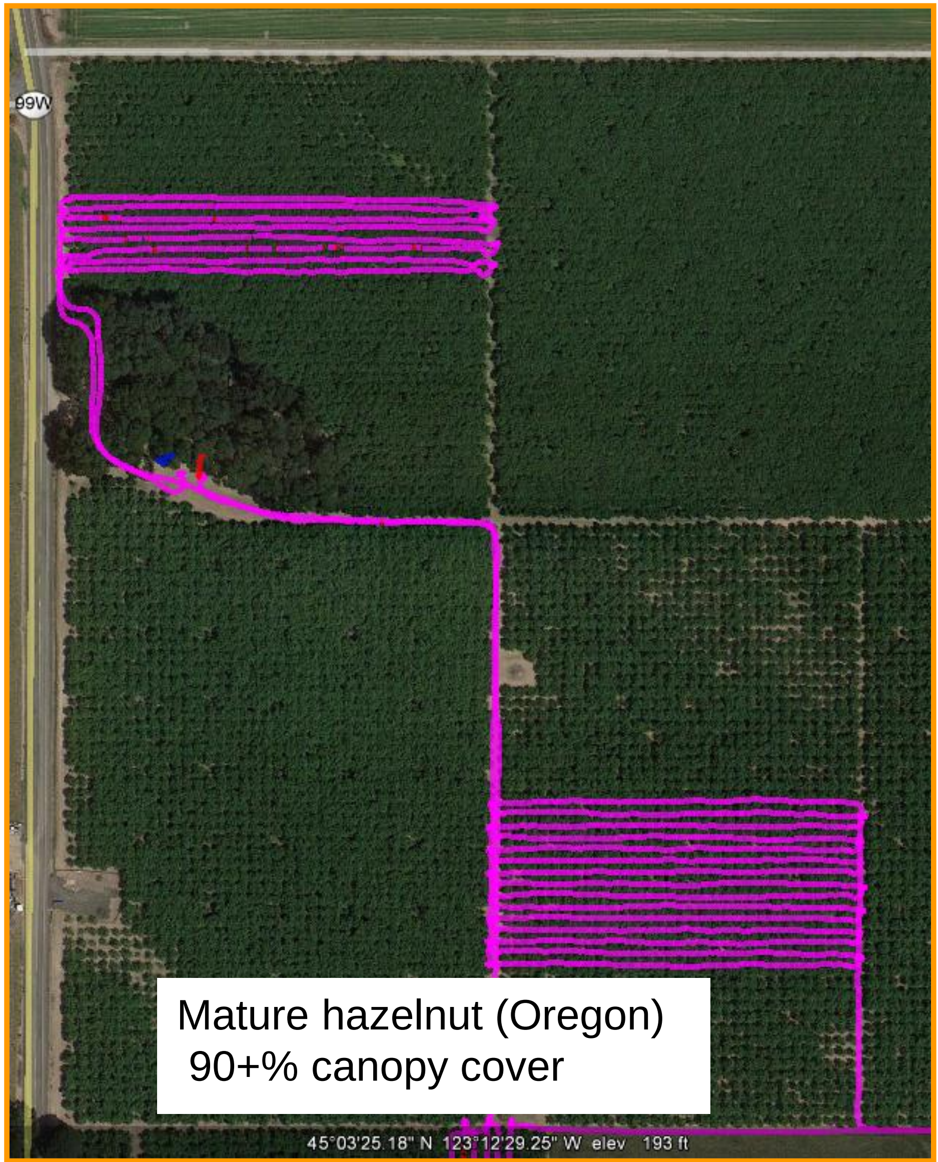
2011
- 20 almond
- 15 walnut
- 4 hazelnut
- 3 olive
- 1 peach
- 2 pear
- 1 pistachio
- 1 prune

2012
- 21 almond
- 16 walnut
- 4 hazelnut
- 3 olive
- 1 peach
- 2 pear
- 1 pistachio
- 1 vineyard

Experimental GPS from Trimble is working well in orchards including high canopy cover



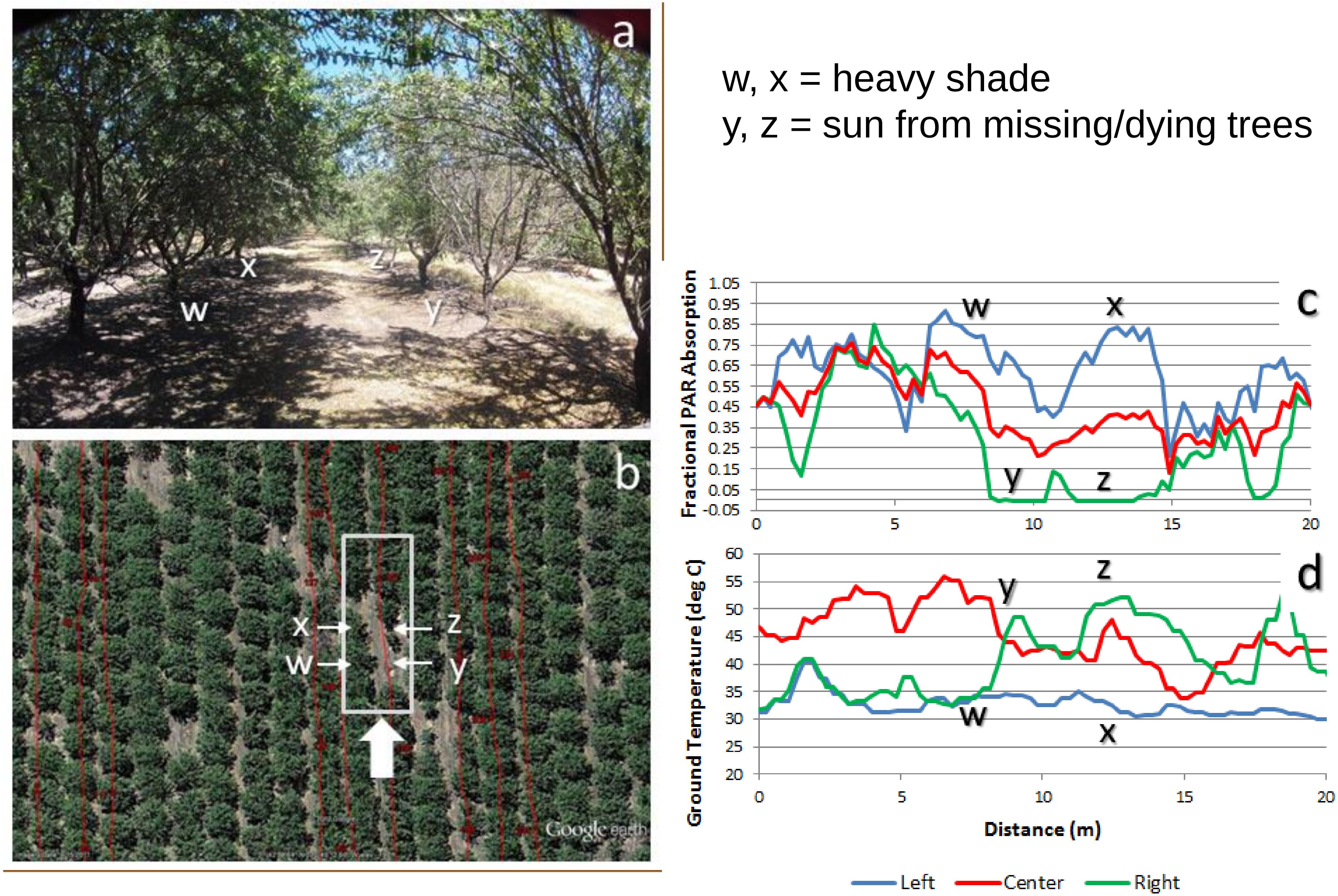
Young orchard Solano County



Mature hazelnut (Oregon)
90+% canopy cover


Autonomous
DGNSS
SBAS
RTK - Float
RTK - Fixed
WA RTK - Float
WA RTK - Fixed
VBS
HP
XP
HP+XP
HP+G2
G2
N
© 2012 Google
Google earth
magery Date: 9/15/2011
1998
37°42'13.51" N 120°45'33.28" W elev 259 ft
Eye alt 2694 ft

w, x = heavy shade
y, z = sun from missing/dying trees



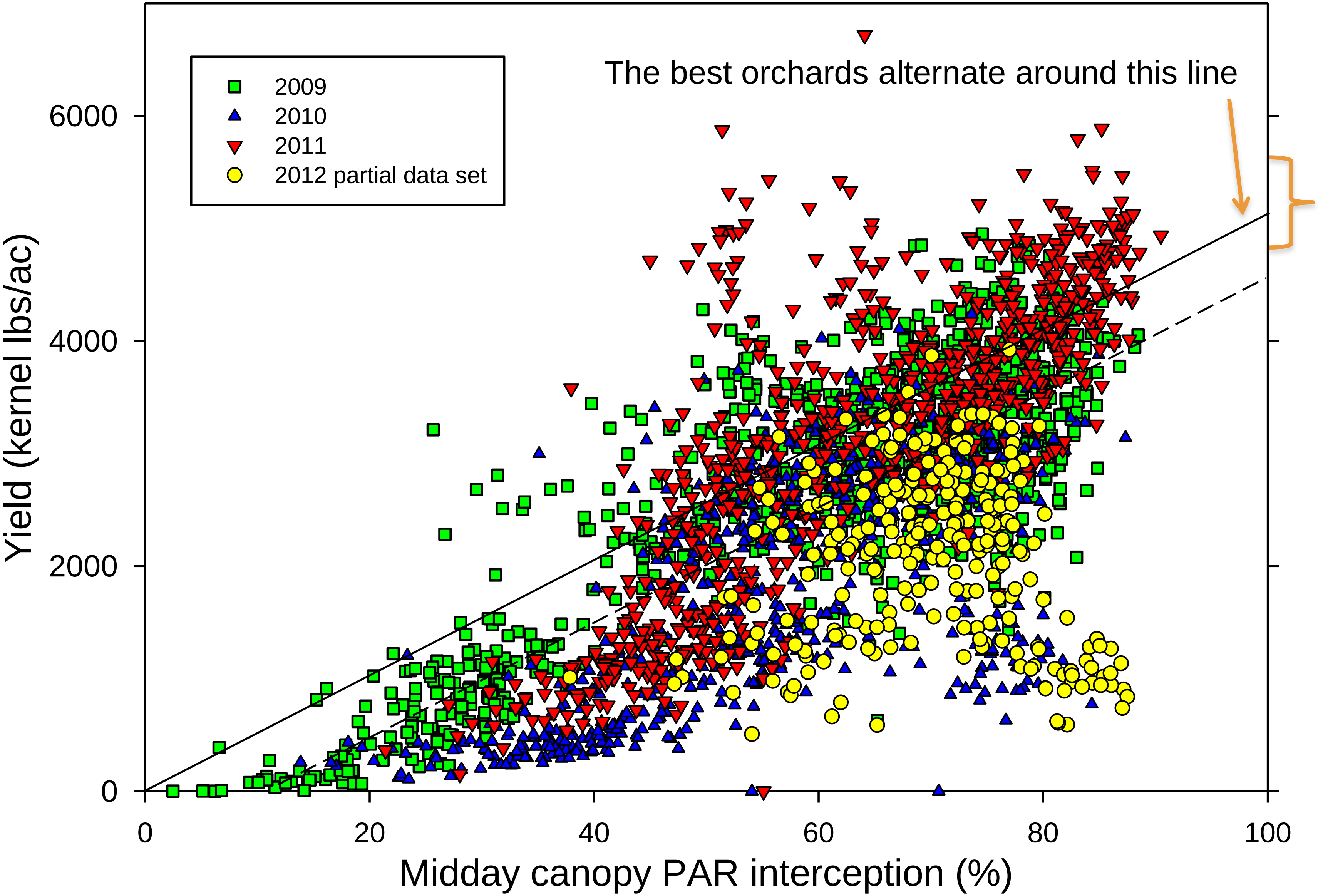
Self contained hydraulic system for operating augers, autosampler and elevator

Trimble GPS acts as datalogger to collect continuous yield data

Front skirt to prevent nuts from overflowing as cart fills

Wireless controller for hydraulically operated auto sampler

All almond light bar sites 2009, 2010, 2011 and partial 2012 data

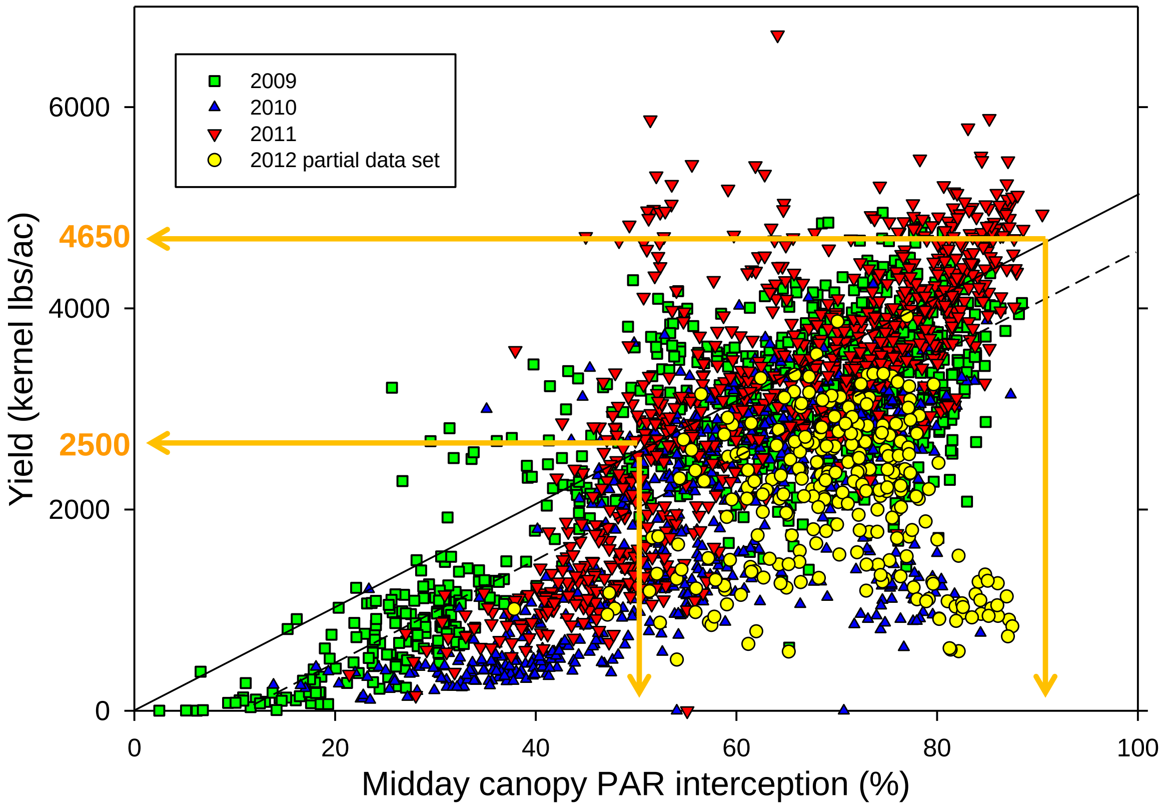


The best orchards alternate around this line

Summary of PAR/yield relationship

For almond:

Potential production = %PAR interception x 50 kernel lbs/ac



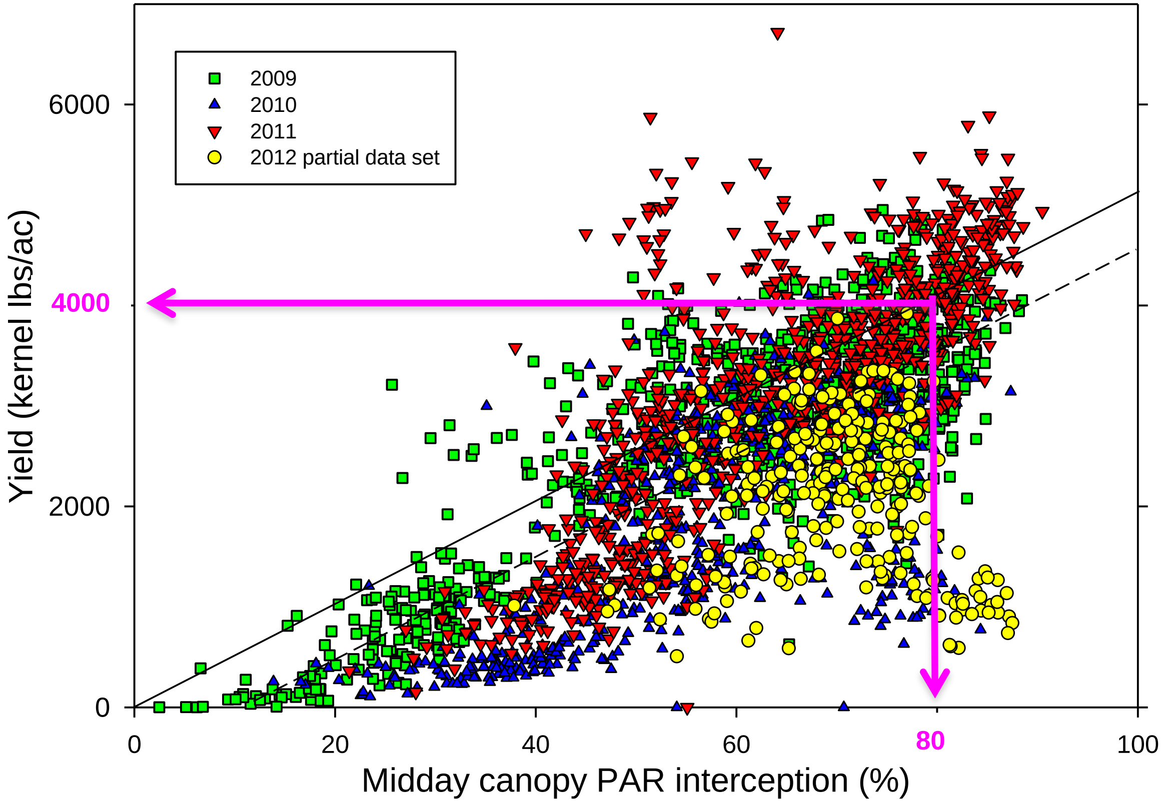
93% PAR int. = 4650 kernel lbs/ac

50% PAR int. = 2500 kernel lbs/ac

Summary of PAR/yield relationship

For almond:

Potential production = 80 x 50 = 4000 kernel lbs/ac



~~93% PAR int. = 4650 kernel lbs/ac~~

Maximum recommended is 80% canopy cover due to food safety risk

80% PAR int. = 4000 kernel lbs per acre yield potential

Having this information allows us to analyze experimental results and orchard growth in new ways

- Variety trials- is a new variety more productive or does it just grow faster?
- Pruning trials- pruning effects on yield efficiency (expressed as yield per unit PAR intercepted)
- Orchard age- is a given orchard at level of PAR interception/yield we would expect for age
  - -If not, what is limitation
- Orchard value assessment- can predict yield and hence income potential for an orchard relative to others
- Food safety risk- we know that orchard above ~75% PAR interception have much lower orchard floor temperatures more conducive to Salmonella survival

Objective 2- stress sensing

Continue utilizing and analyzing data from the plant water stress sensor suite

Figure 2. Mobile sensor suite and pressure chamber during data collection in an almond orchard.

The sensor suite consist of an infrared thermometer, PAR sensor, ambient temperature, ambient humidity, and wind speed sensors.

Shaded leaves appear to give better results than sunlit leaves making possibility of moving stress sensing to mobile platform easier than it would be using sunlit leaves where leaf angle needs to be included

Harvest and stockpile management to reduce aflatoxin potential

Bruce Lampinen, Integrated Orchard Management Specialist, UC Davis Plant Sciences

Collaborators

Themis Michailides, Jim Thompson, Sam Metcalf, William Stewart, David Morgan, Heraclio Reyes, Y. Luo and B. Kabak

Several aspects to this workOrchard microclimate can influence food safety risk

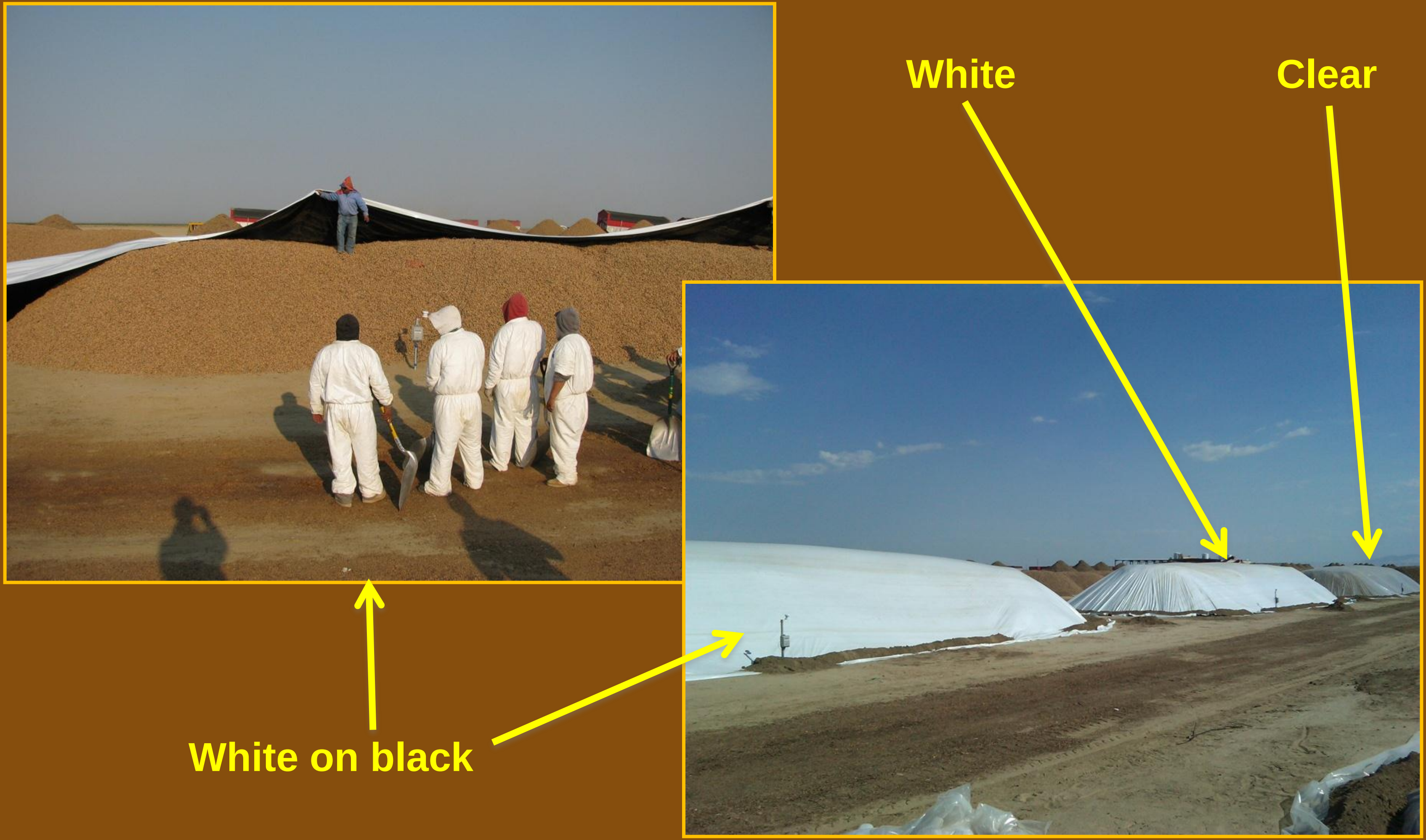
Stockpiling

- Tarp types
  - Clear, white, white on black
- Stockpile orientation
  - North south versus east west facing
- Moisture content- water activity versus moisture content

Orchard microclimate influence on food safety risk

- Midday canopy light interception versus orchard floor temperature
- Nut drying on orchard floor- left in place versus conditioned and windrowed

Impact of different tarp materials on stockpile conditions



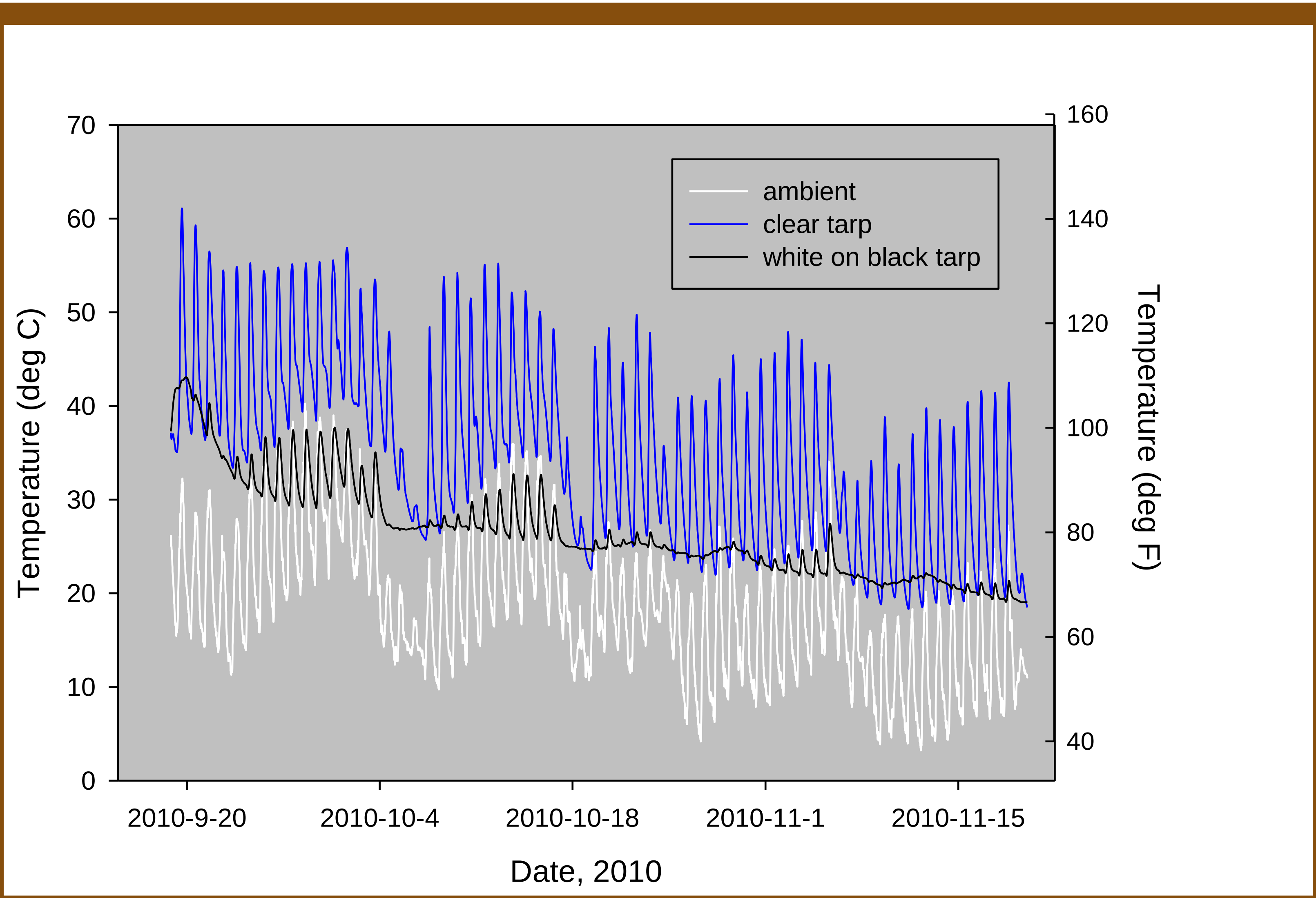
White

Clear

White on black

Temperature and relative humidity sensor placement in stockpiles

Impact of different tarp materials on stockpile conditions

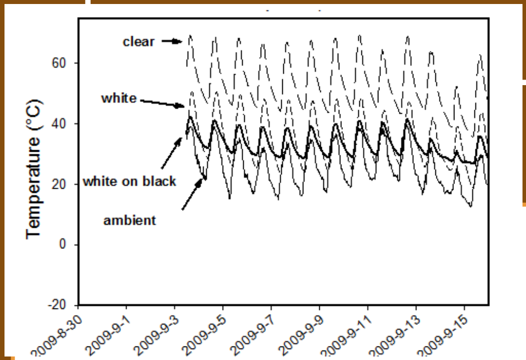


White on black tarp ran up to 40 deg F cooler than commonly used clear tarp and had much smaller day to night temperature fluctuations

Large humps on top of piles leads to valleys where condensed water can collect and contact nuts leading to mold growth

Flattening tops of piles leads to less concentration of condensate. Orienting piles with long axis in north/south direction is also beneficial

Impact of different tarp materials on stockpile conditions



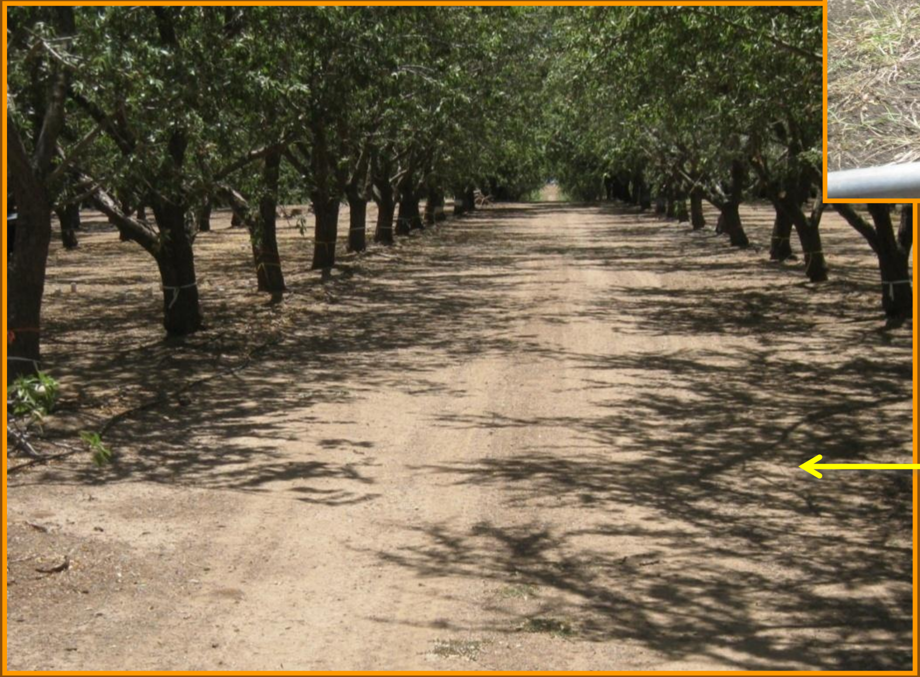
Clear tarp north end

White on black tarp north end

Smaller temperature fluctuations under white on black tarp led to less condensation problems and correspondingly less mold growth- problems worse on north end of pile so minimize this with east/west orientation of long axis of piles

Canopy density as well as canopy size can have large impact on light interception/yield potential as well as food safety risk

Dense canopy letting very little light reach orchard floor under tree (higher yield, cooler temperatures)



Sparse canopy letting much more light reach orchard floor under tree (lower yield, warmer temperatures)

Hedgerow
(mechanical pruning)

More traditional spacing
(hand pruning)

If your orchard is producing above 3500 kernel pounds per acre (above 70% light interception), you should pay particular attention to food safety risk.


92%


4600 lbs/ac

Sampling nuts from orchard floor before harvest

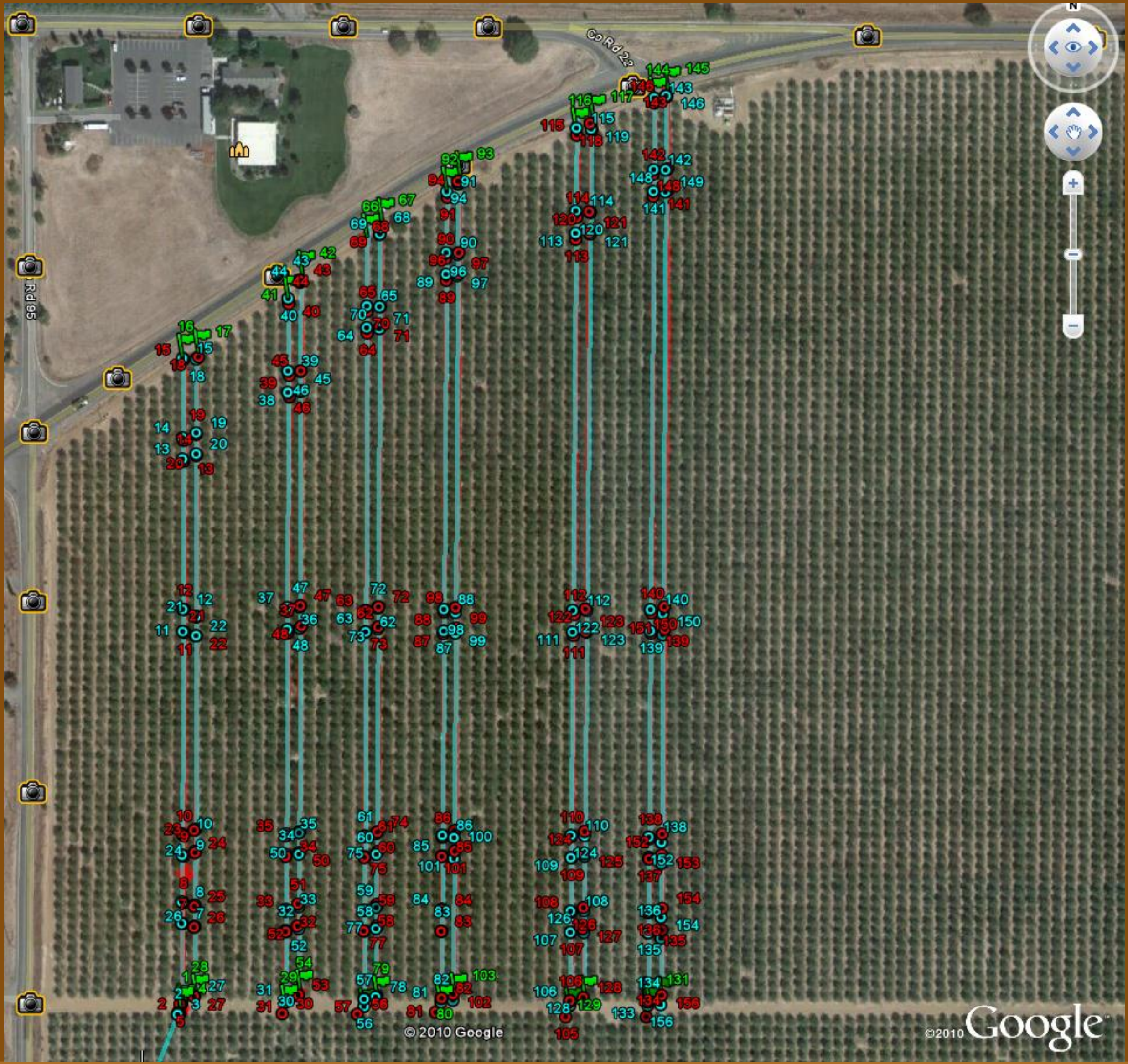
Nuts left to dry under tree after shaking

From across orchard floor in orchard where they are left to dry as shaken

Nuts dried in windrow

From top to bottom of windrow in orchard where nuts are dried in windrow

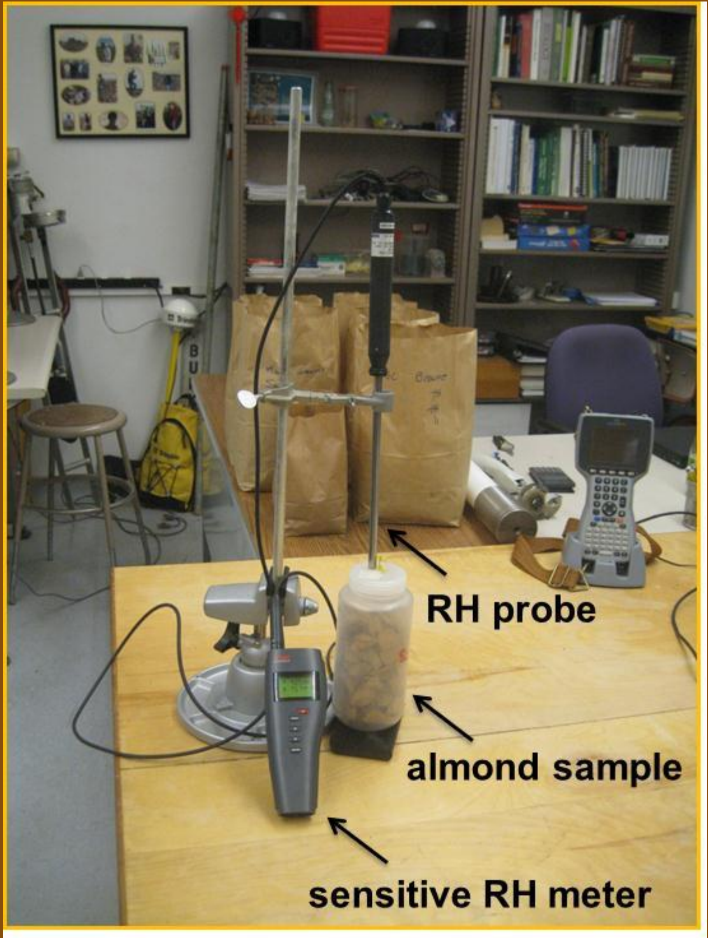
Nut drying on orchard floor can vary depending on canopy size- be sure to sample across canopy size gradients



Water activity definition

Water activity - a measure of the availability of water in the food product which is available for bacterial or fungal growth

- It is water activity rather than water content that determines the potential for bacterial or fungal growth
- For almonds, a water activity of less than 0.7 is best
- A water activity of 0.7 is equivalent to a relative humidity of 70%



Stockpiling Guidelines

Do not stockpile if either the hull moisture content exceeds 13% or the kernel moisture content exceeds 6%

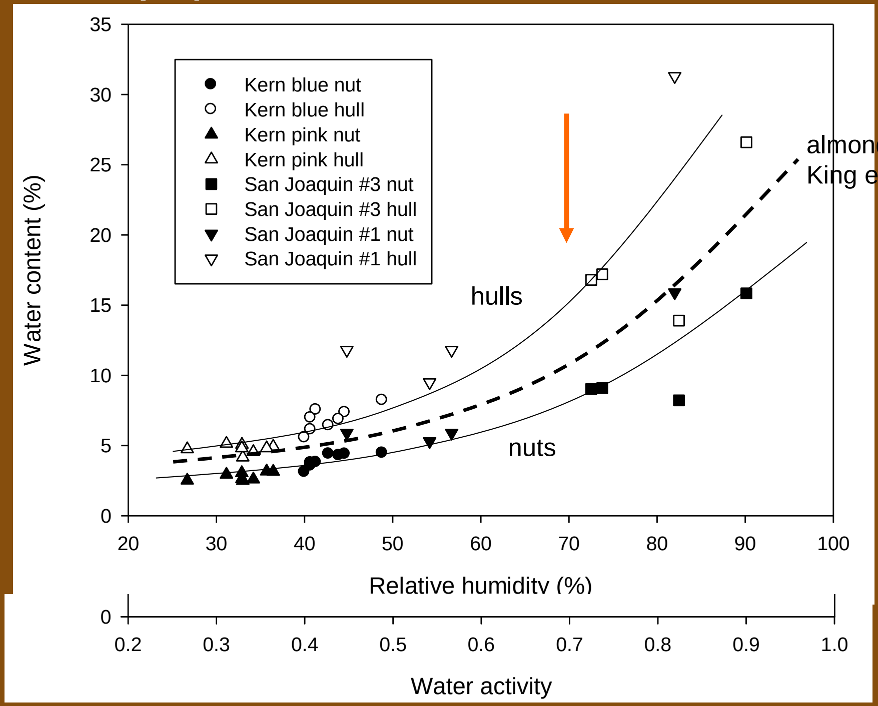
This is equivalent to a sample water activity of 0.7 or a relative humidity of 70% (at room temperature)

Hull moisture content

11-12%	Acceptable (the hull snaps)
>13%	Too high

Kernel moisture content

4-5%	Excellent
< 6%	Acceptable
> 6%	Too high



almond from King et.al, 1983

Relationship between RH, water activity (at room temperature), and water content (kernels and hulls, hulls, and kernels)

		water content		
Relative humidity	Water activity	kernels+hulls	hulls	kernels
30	0.30	3.80	4.43	2.73
31	0.31	3.89	4.59	2.79
32	0.32	4.00	4.76	2.85
33	0.33	4.11	4.94	2.92
34	0.34	4.22	5.12	2.99
35	0.35	4.34	5.31	3.06
36	0.36	4.47	5.50	3.14
37	0.37	4.61	5.71	3.22
38	0.38	4.75	5.92	3.31
39	0.39	4.89	6.13	3.40
40	0.40	5.05	6.36	3.50
41	0.41	5.20	6.59	3.60
42	0.42	5.37	6.83	3.71
43	0.43	5.54	7.07	3.82
44	0.44	5.72	7.32	3.94
45	0.45	5.90	7.58	4.06
46	0.46	6.09	7.85	4.18
47	0.47	6.29	8.12	4.31
48	0.48	6.49	8.40	4.45
49	0.49	6.70	8.69	4.59
50	0.50	6.92	8.98	4.73
51	0.51	7.14	9.28	4.88
52	0.52	7.37	9.59	5.03
53	0.53	7.60	9.90	5.19
54	0.54	7.84	10.22	5.35
55	0.55	8.09	10.55	5.51
56	0.56	8.34	10.89	5.69
57	0.57	8.60	11.23	5.86
58	0.58	8.87	11.58	6.04
59	0.59	9.14	11.94	6.23
60	0.60	9.42	12.30	6.42
61	0.61	9.70	12.67	6.61
62	0.62	9.99	13.05	6.81
63	0.63	10.29	13.43	7.01
64	0.64	10.59	13.82	7.22
65	0.65	10.90	14.22	7.43
66	0.66	11.22	14.62	7.65
67	0.67	11.54	15.04	7.87
68	0.68	11.87	15.45	8.10
69	0.69	12.20	15.88	8.33
70	0.70	12.55	16.31	8.56
71	0.71	12.89	16.75	8.80
72	0.72	13.25	17.20	9.05
73	0.73	13.61	17.65	9.30
74	0.74	13.97	18.11	9.55
75	0.75	14.34	18.58	9.81
76	0.76	14.72	19.06	10.07
77	0.77	15.11	19.54	10.34
78	0.78	15.50	20.03	10.61
79	0.79	15.89	20.52	10.89
80	0.80	16.30	21.02	11.17
81	0.81	16.71	21.53	11.45
82	0.82	17.12	22.05	11.75
83	0.83	17.55	22.57	12.04
84	0.84	17.97	23.10	12.34
85	0.85	18.41	23.64	12.64
86	0.86	18.85	24.18	12.95
87	0.87	19.30	24.74	13.27
88	0.88	19.75	25.29	13.59
89	0.89	20.21	25.86	13.91
90	0.90	20.68	26.43	14.24
91	0.91	21.15	27.01	14.57
92	0.92	21.63	27.60	14.90
93	0.93	22.11	28.19	15.25
94	0.94	22.60	28.79	15.59
95	0.95	23.10	29.39	15.94
96	0.96	23.60	30.01	16.30
97	0.97	24.11	30.63	16.66
98	0.98	24.63	31.26	17.02
99	0.99	25.15	31.89	17.39
100	1.00	25.68	32.53	17.76

Conclusions

Food safety risk should be assessed in relation to orchard planting design and canopy structure

- Hedgerow planting → more dense shade under tree row may increase food safety risk
- More conventional tree spacing → more varied light/temperature patterns across orchard floor
- Any orchard producing above 3500 kernel pounds per acre likely has increased potential for food safety related problems

Food safety risk during harvest/stockpiling:

- Make sure nuts are adequately dry before stockpiling
  - Sample nut moisture content (ideally water activity) in a systematic way across orchard before beginning harvest operation
- Choose appropriate tarp materials to minimize condensation potential

Biocontrol of *Aspergillus* and Aflatoxin in Almonds

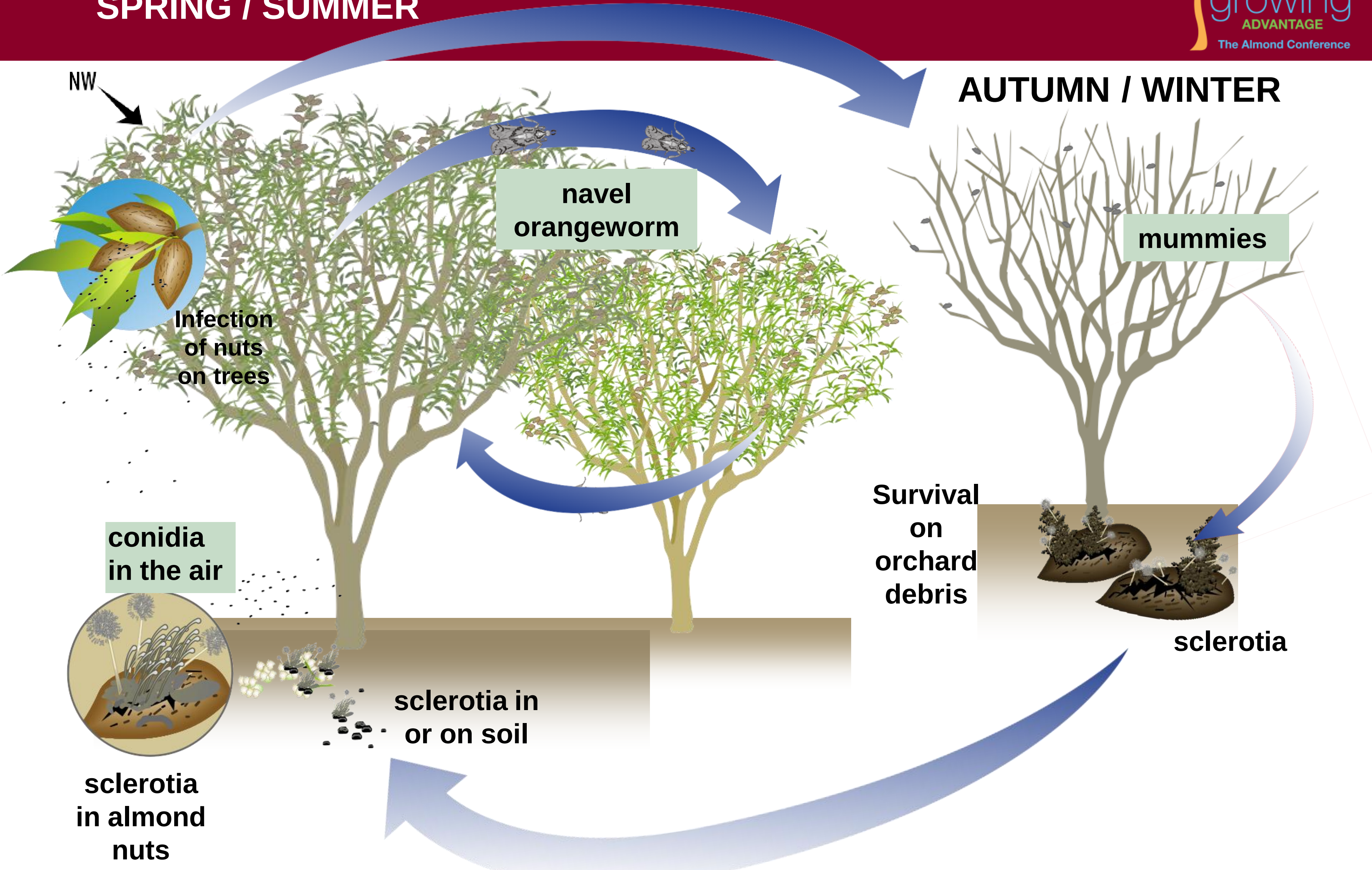
Themis J. Michailides
Plant Pathologist

University of California
Kearney Agric Research & Extension Center

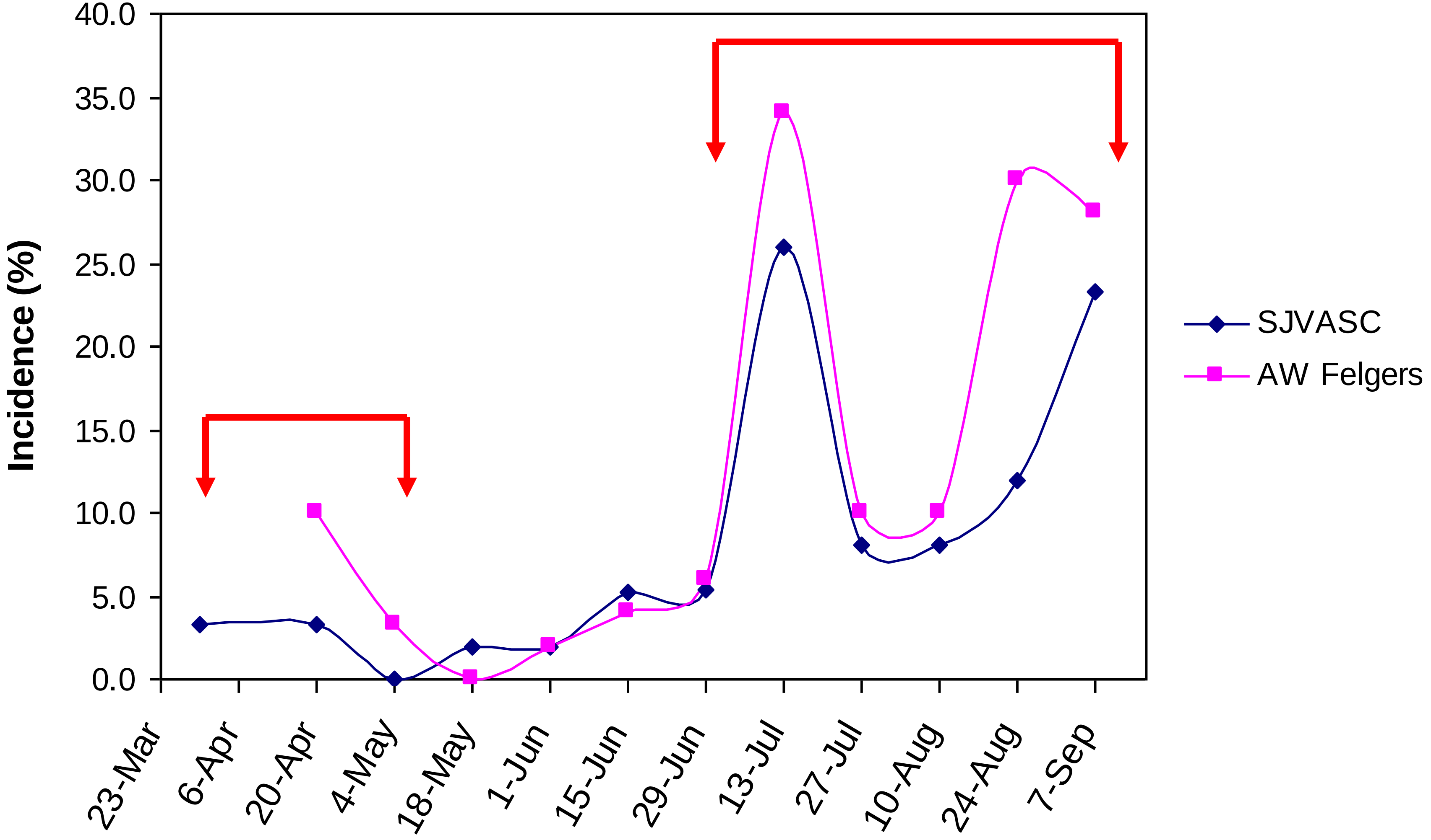
Molds that can produce aflatoxin in almond orchards in California

Aspergillus flavus *Aspergillus parasiticus*

Life cycle of *Aspergillus flavus* in almond orchards



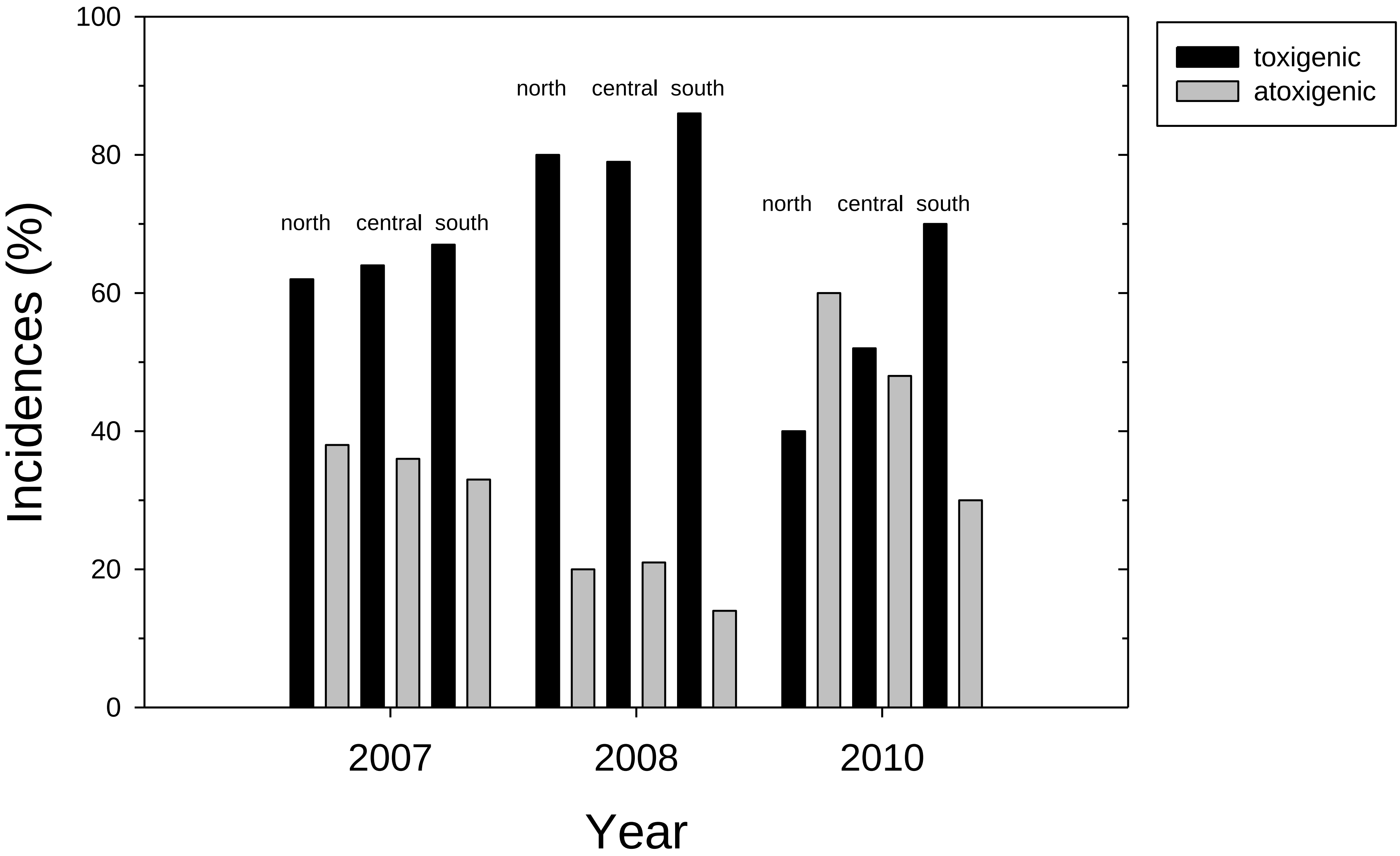
Aspergillus flavus & A. parasiticus from NOW in almond orchards **(SJVASC, Fresno Co. and AW, Madera Co. – 2012)**



Objectives (2011-2012)

- **Identify risk factors associated with aflatoxins in California almonds.**
- **Develop biological control of aflatoxins in almonds.**
- **Obtain an EUP and registration for AF36 in almonds.**

Objective 1: Incidence of toxigenic and atoxigenic strains of *Aspergillus* in almond orchards



Objective 2:

→→→ **Biological control of aflatoxins in almonds**

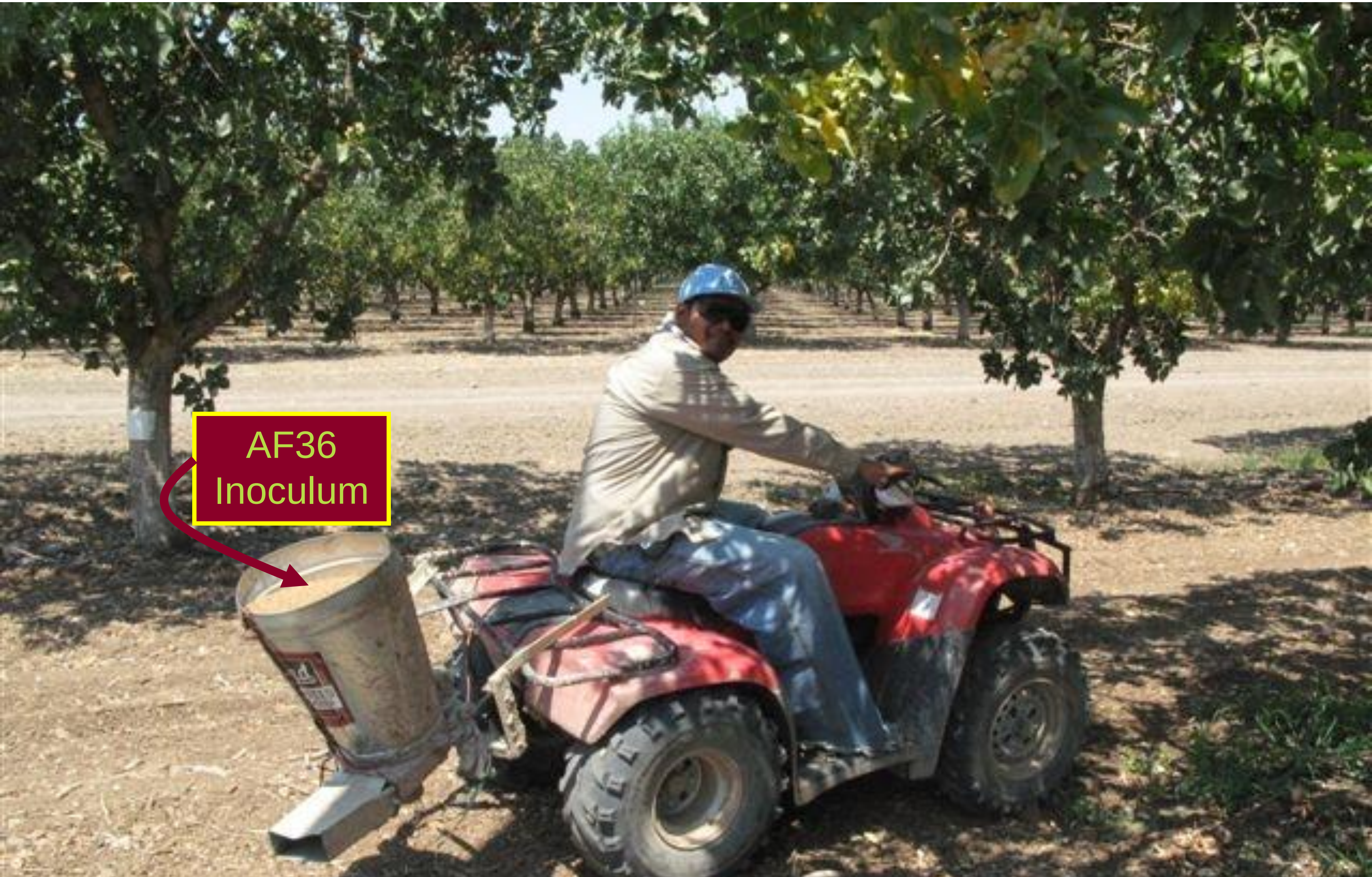
- ✓ **Prepare data for EUP and then registration of AF36 in almonds.**

AF36 = atoxigenic strain = not producing aflatoxin

(**Rationale:** The atoxigenic strain when applied in the field increases in numbers and displaces the toxigenic strains.

Wheat inoculum of AF36

10 lbs/acre

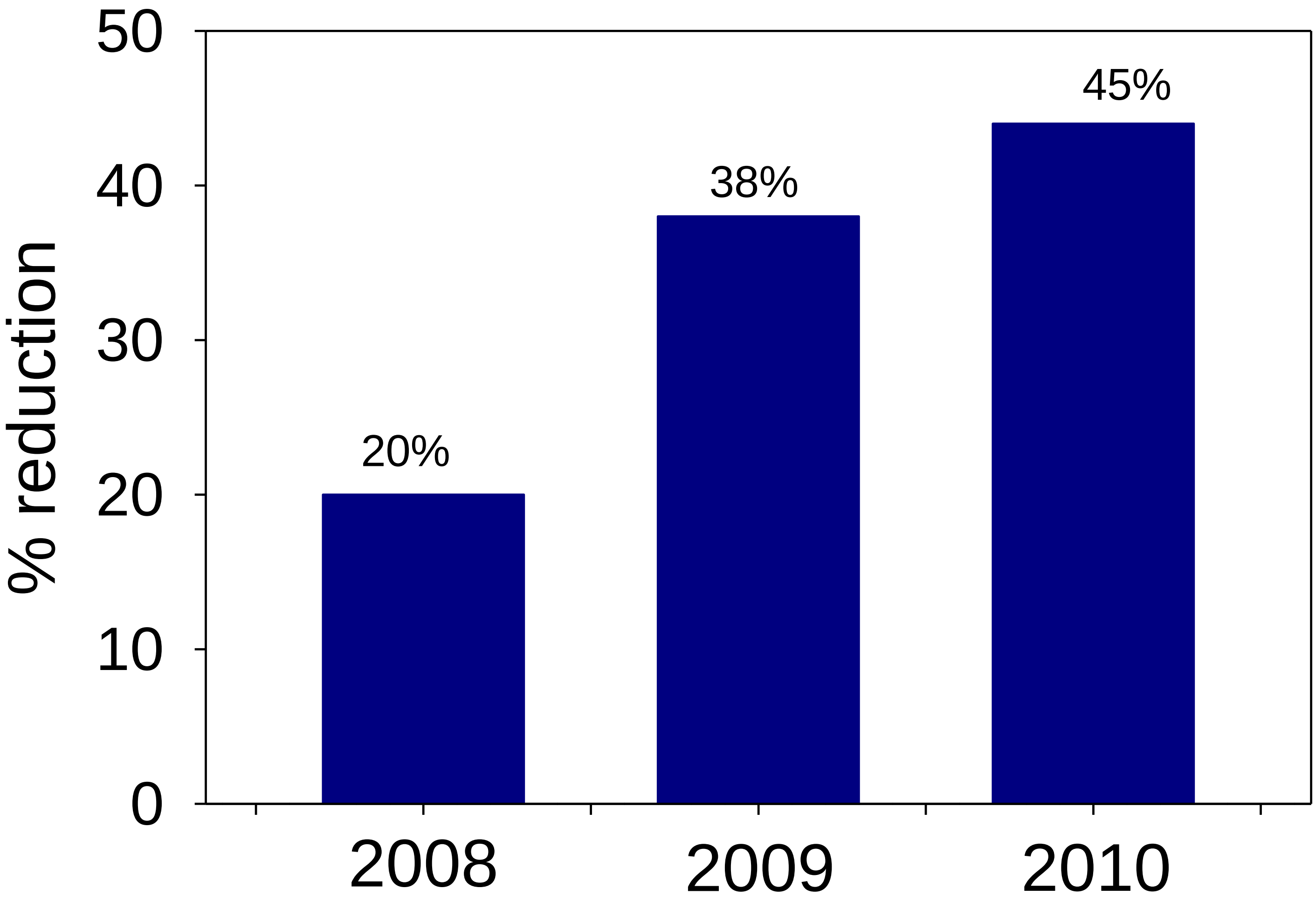


AF36 Inoculum

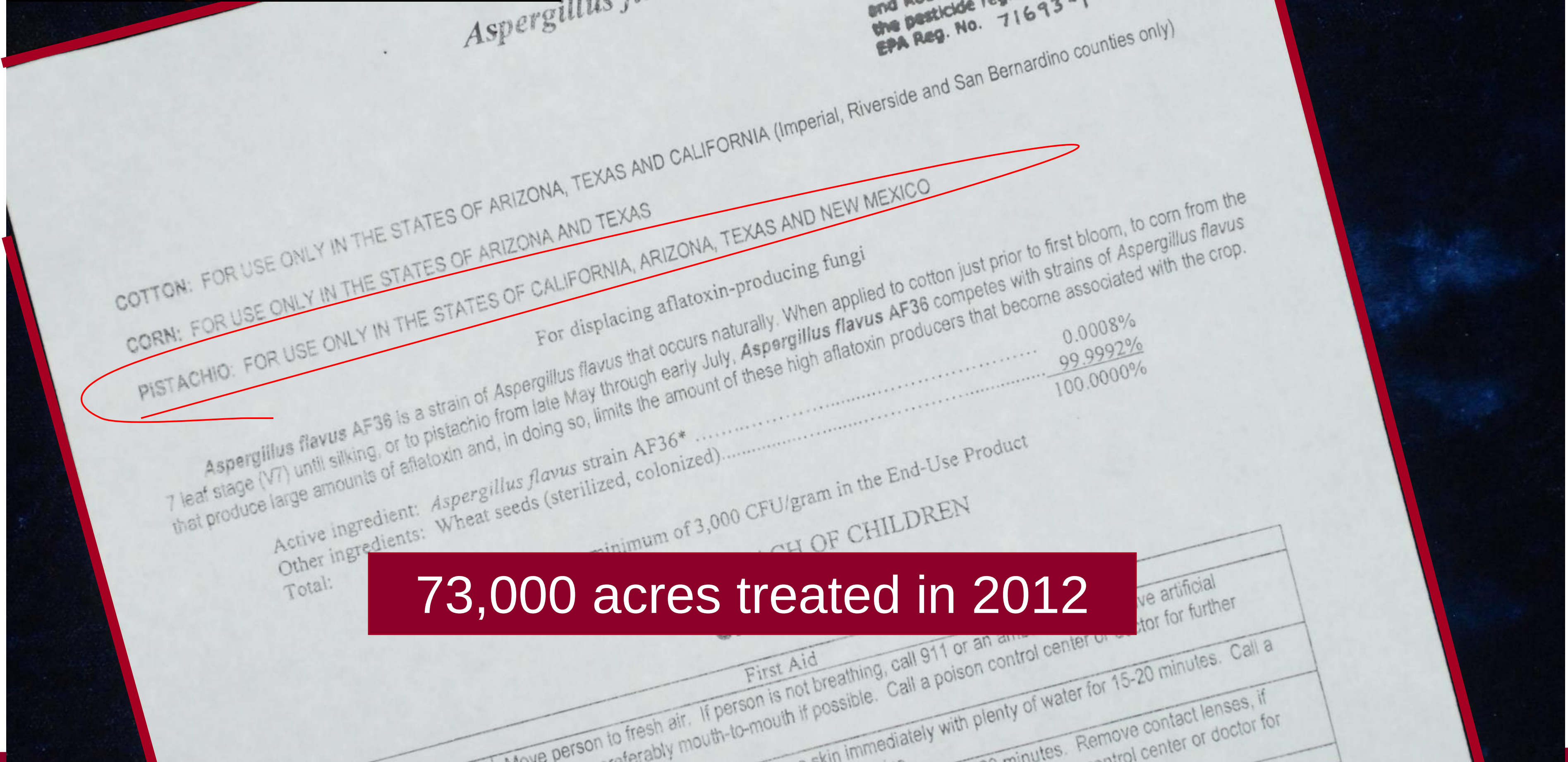
irrigation

… allows the fungus in the wheat to grow and produce spores

Example: Reduction of aflatoxins in pistachio samples after treating 3,000 acres with AF36



Registration of AF36



ACCEPTED
FEB 29 2012
Under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, for the pesticide registered under
EPA Reg. No. 71693-1

Aspergillus flavus AF36

COTTON: FOR USE ONLY IN THE STATES OF ARIZONA, TEXAS AND CALIFORNIA (Imperial, Riverside and San Bernardino counties only)

CORN: FOR USE ONLY IN THE STATES OF ARIZONA AND TEXAS

PISTACHIO: FOR USE ONLY IN THE STATES OF CALIFORNIA, ARIZONA, TEXAS AND NEW MEXICO

For displacing aflatoxin-producing fungi

Aspergillus flavus AF36 is a strain of Aspergillus flavus that occurs naturally. When applied to cotton just prior to first bloom, to corn from the 7 leaf stage (V7) until silking, or to pistachio from late May through early July, **Aspergillus flavus AF36** competes with strains of Aspergillus flavus that produce large amounts of aflatoxin and, in doing so, limits the amount of these high aflatoxin producers that become associated with the crop.

Active ingredient:	*Aspergillus flavus* strain AF36*	0.0008%
Other ingredients:	Wheat seeds (sterilized, colonized)	99.9992%
Total:		100.0000%

inimum of 3,000 CFU/gram in the End-Use Product

CH OF CHILDREN

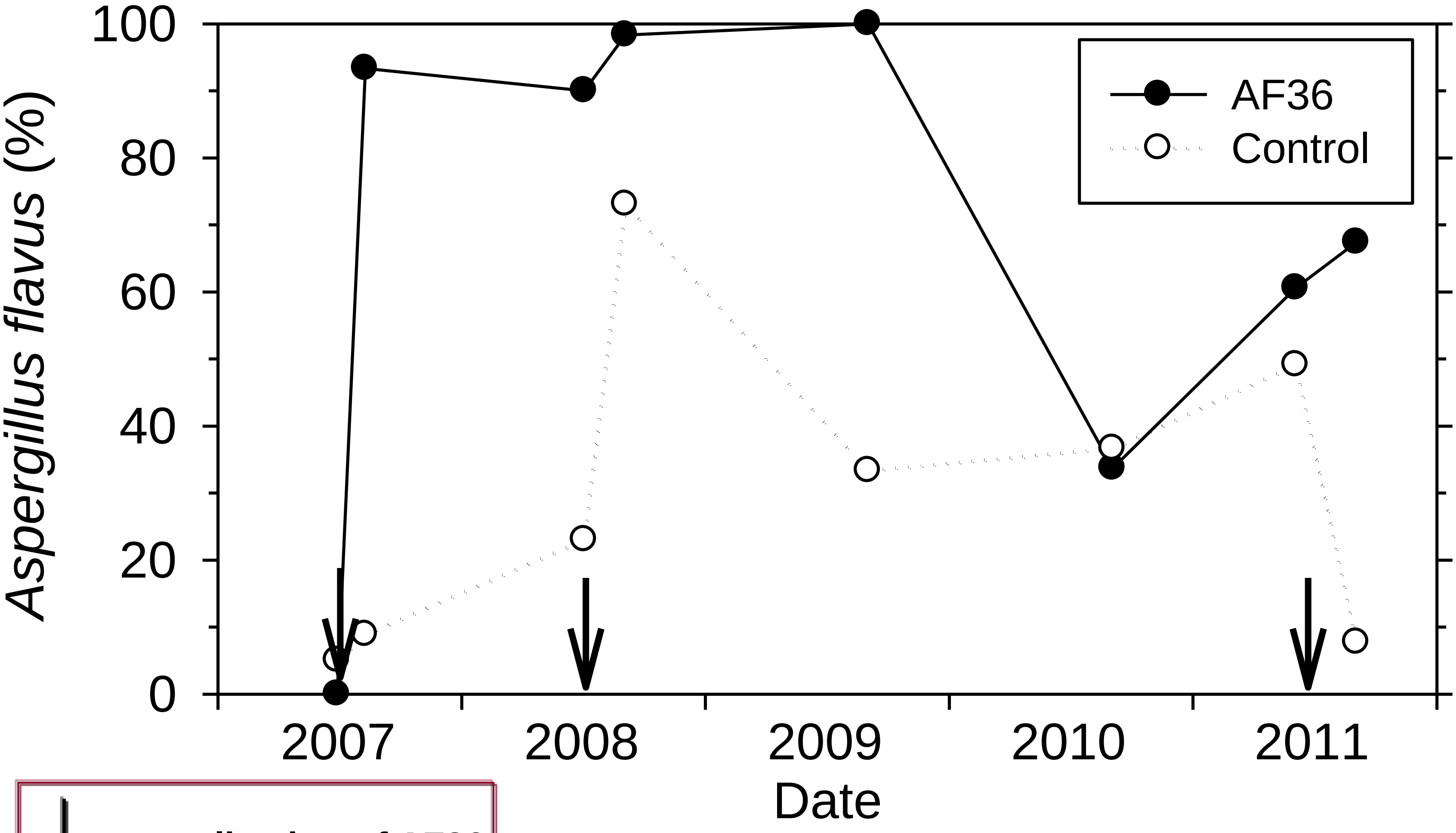
First Aid

Move person to fresh air. If person is not breathing, call 911 or an am ve artificial
eferably mouth-to-mouth if possible. Call a poison control center o ctor for further

skin immediately with plenty of water for 15-20 minutes. Call a
minutes. Remove contact lenses, if
ntrol center or doctor for

73,000 acres treated in 2012

Percentage of *Aspergillus flavus* in soil (AF36 treated vs. untreated - Nickels Soil Laboratory)



↓ = **application of AF36**

Collection of almond samples

Decay by various *Aspergillus flavus* for nuts harvested from areas treated with AF36 product or from untreated areas

		Percentage of hulls/shells with decay
Year	**Treatment**	***A. flavus* group**
2007	AF36 (applied)	0.197 ns^{y}
	Untreated control	0.000
2008	AF36 (applied)	0.028 ns
	Untreated control	0.007
2009	AF36 (no applic.)	0.028 ns
	Untreated control	0.004
2010	AF36 (no applic.)	0.000 ns
	Untreated control	0.000

Burkard spore traps in a pistachio orchard

Acknowledgments:

- Mark Doster
- David Morgan
- Matthias Donner
- Ryan Puckett

Kearney
Ag Center

- Peter Cotty, ARS/USDA, Arizona
- Joel Siegel, ARS/USDA, Parlier
- Bob Curtis, ABC
- Michael Braverman, IR-4 &

Almond Tree Growth and Development Model

Ted DeJong

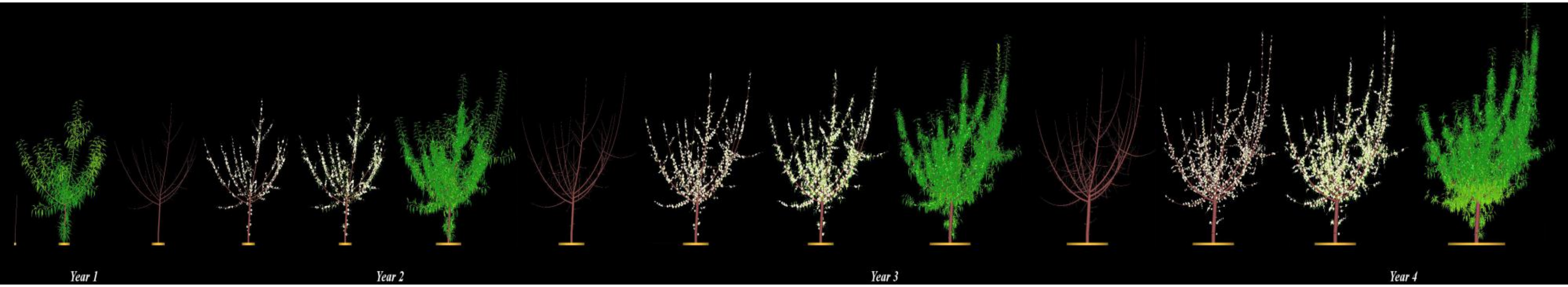
Professor/Pomology Specialist
Department of Plant Sciences

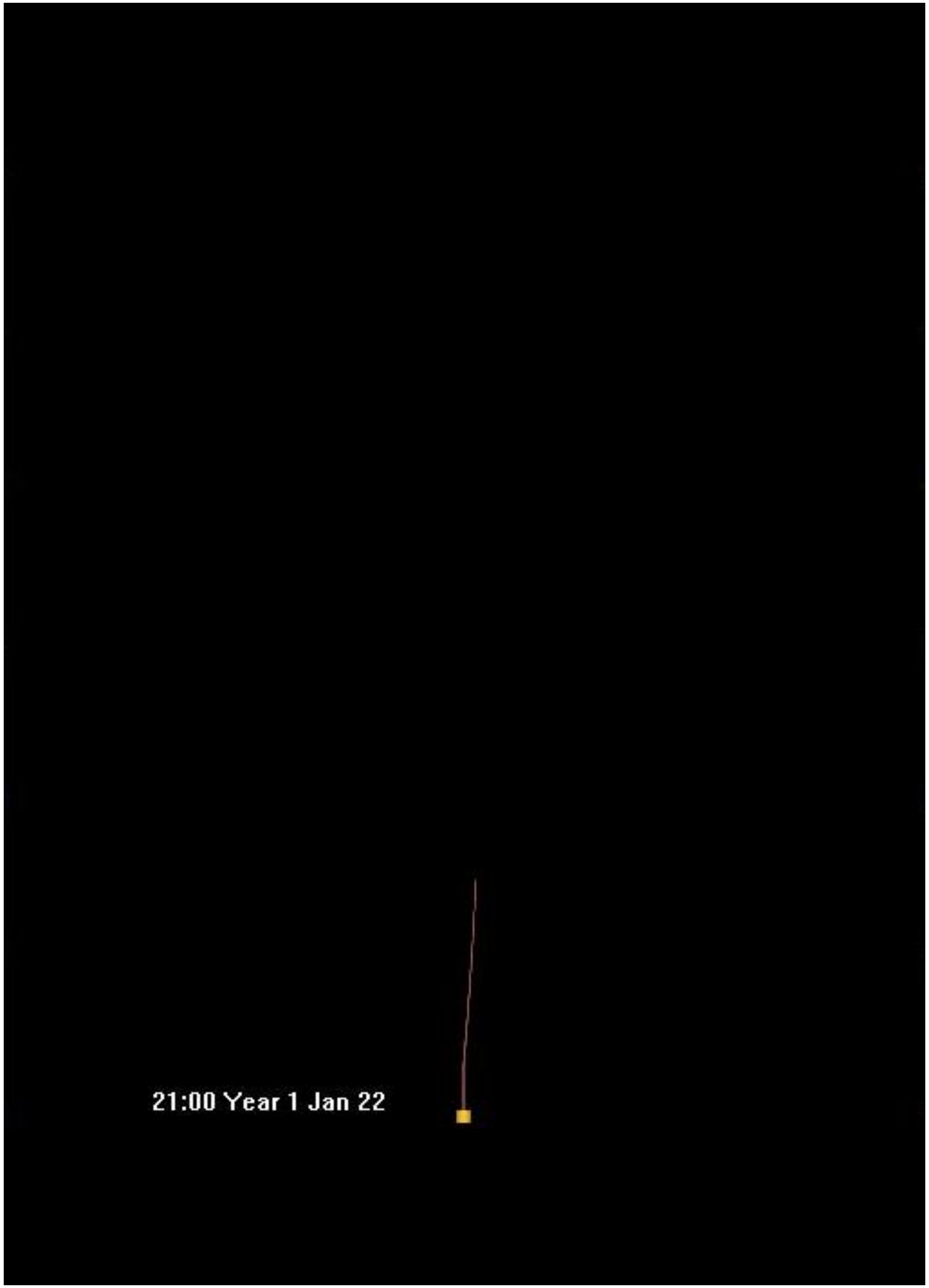
UC Davis

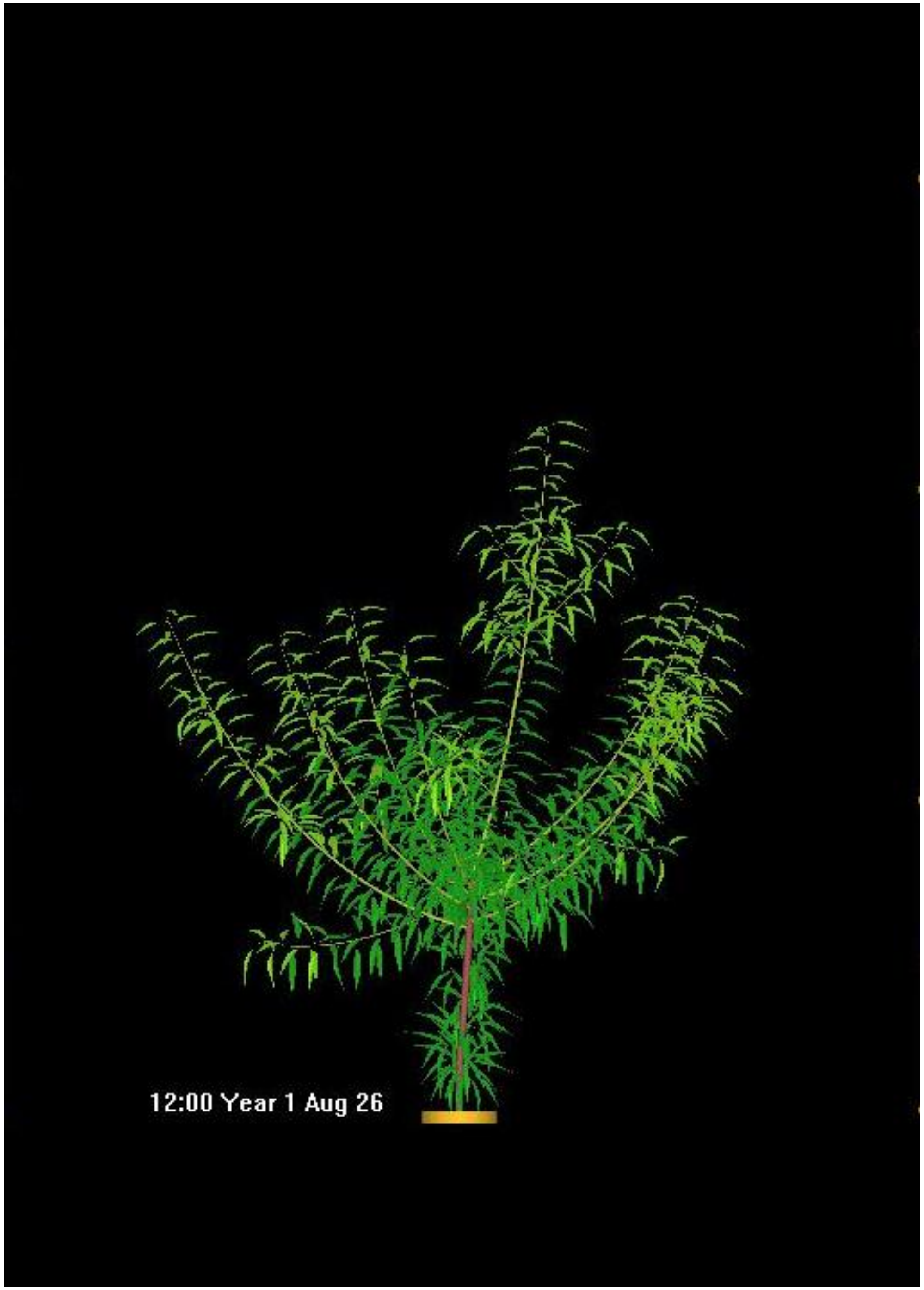
The L-Almond Model

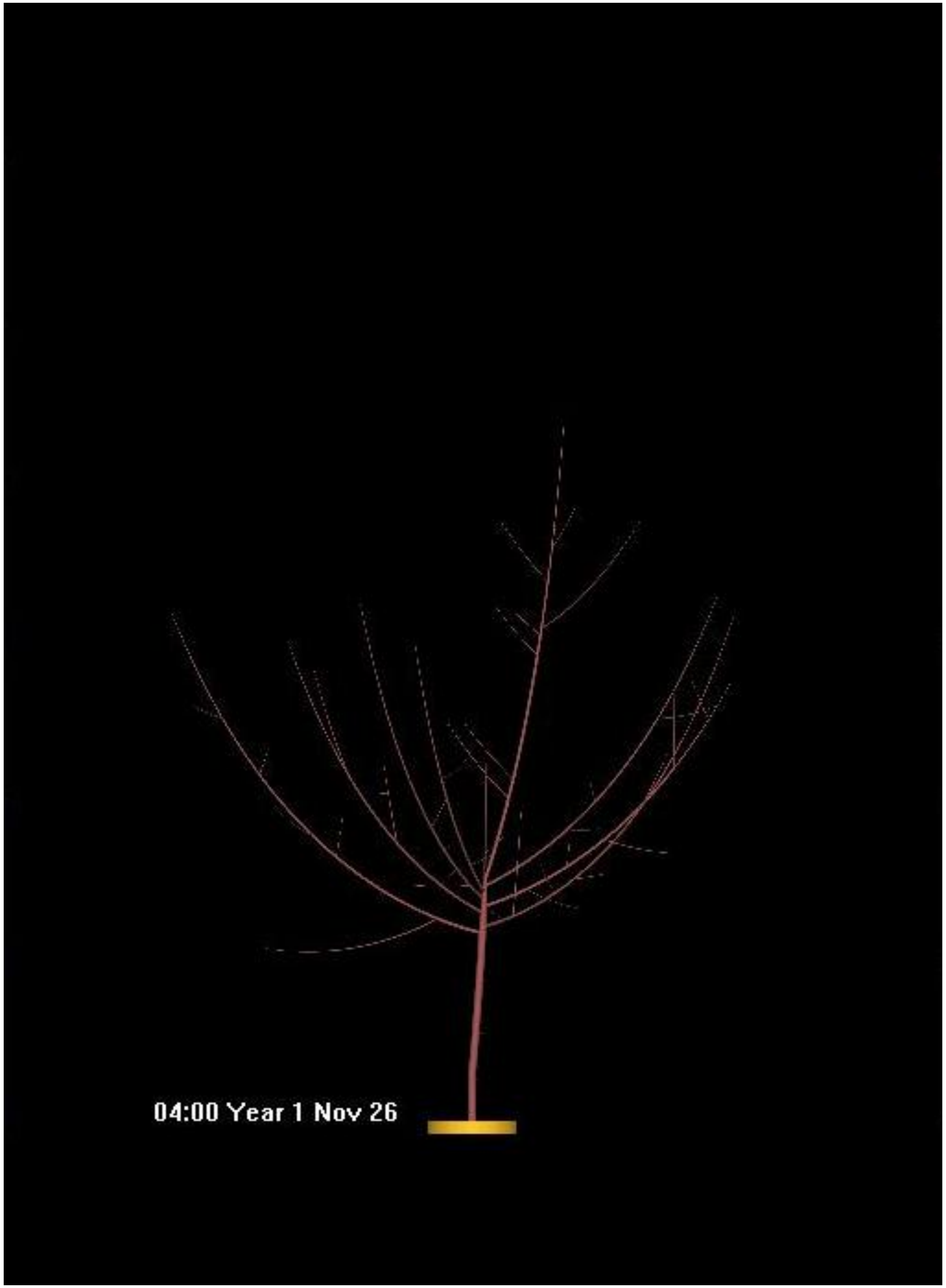
The L-Almond model is a functional-structural computer simulation model that:

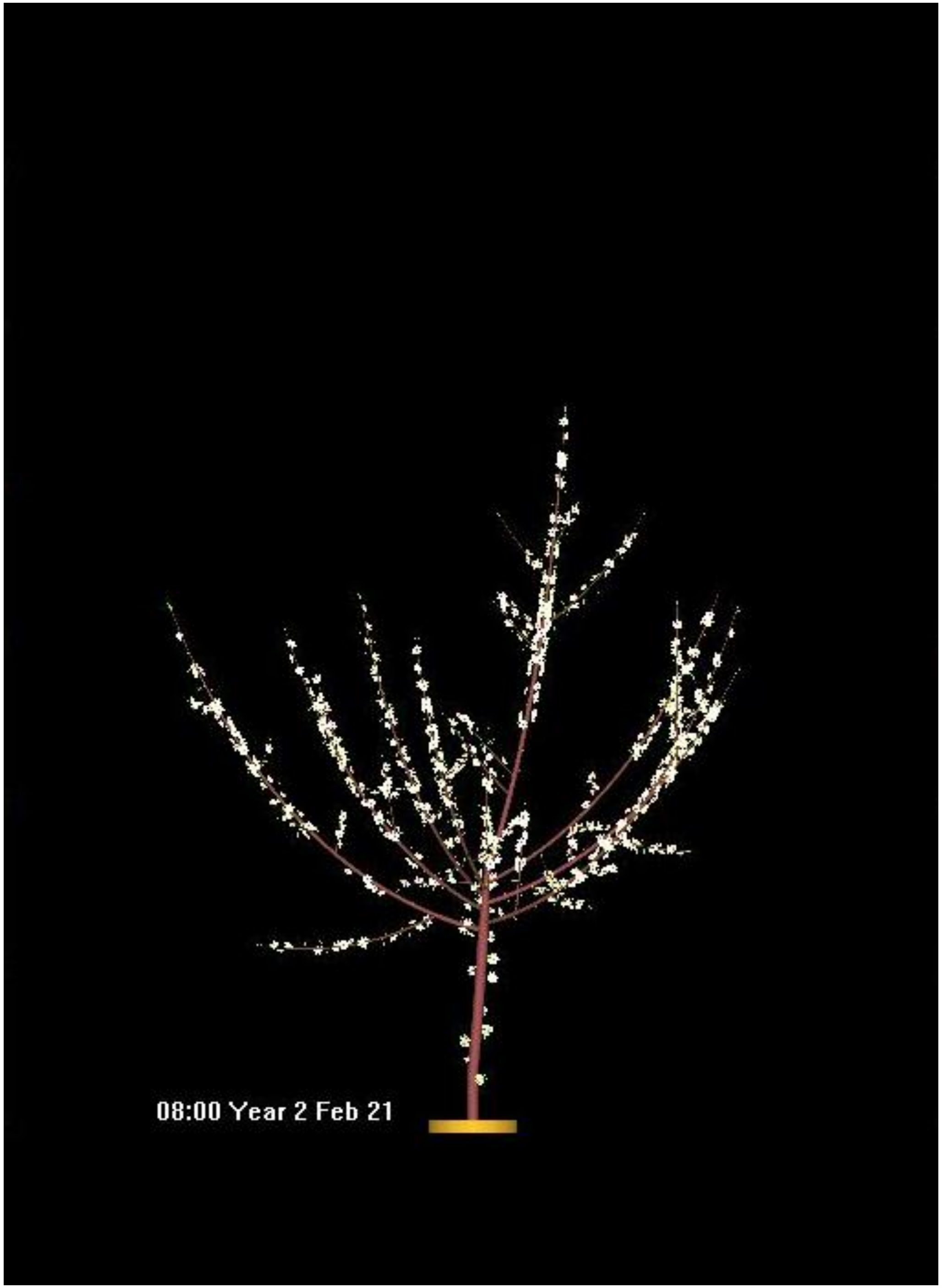
- Grows 3-dimensional virtual trees on a computer screen.
- Simulates the functioning and biomass of the organs of the trees growing in the field.
- Responds to actual environmental data collected in the field.

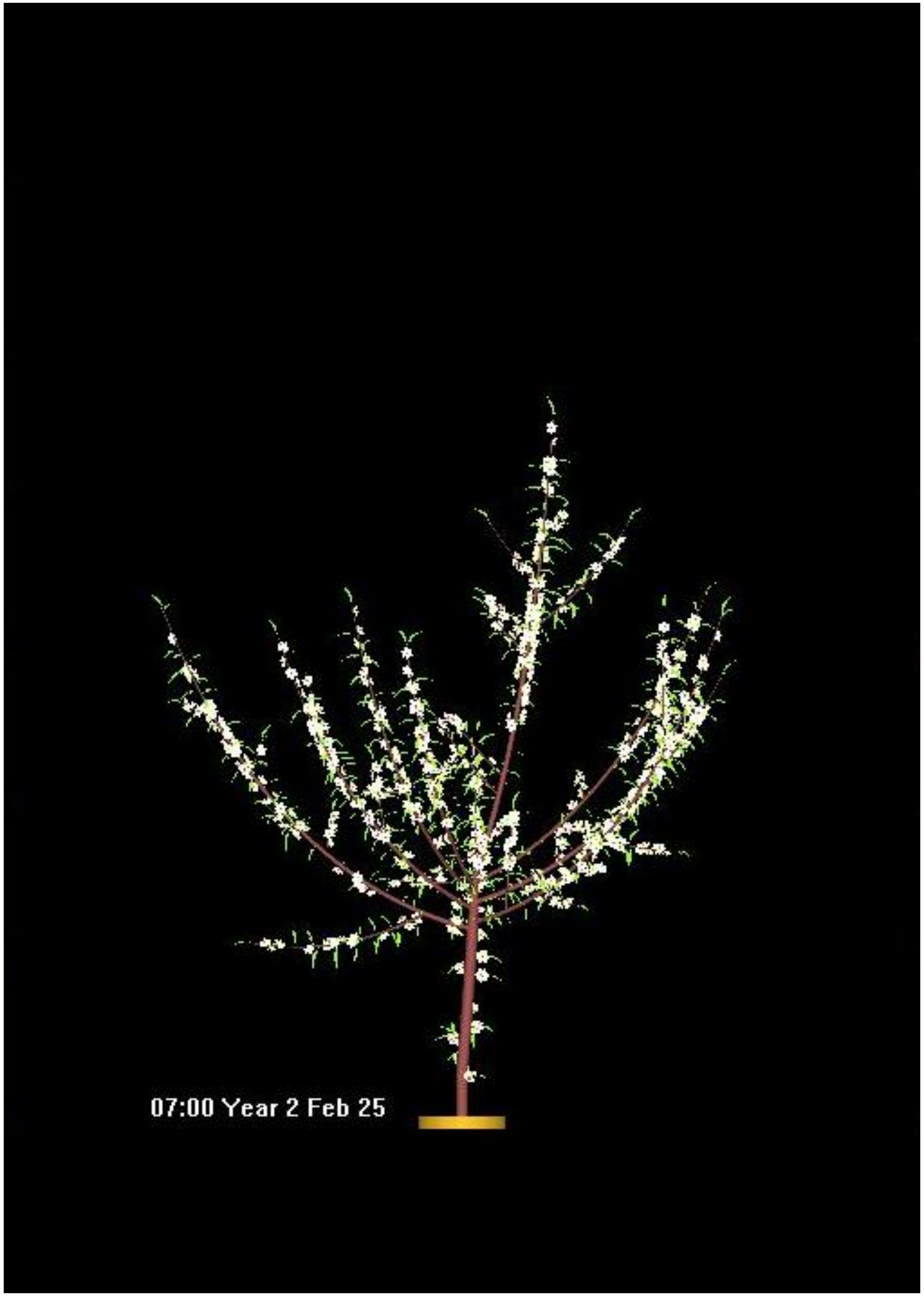


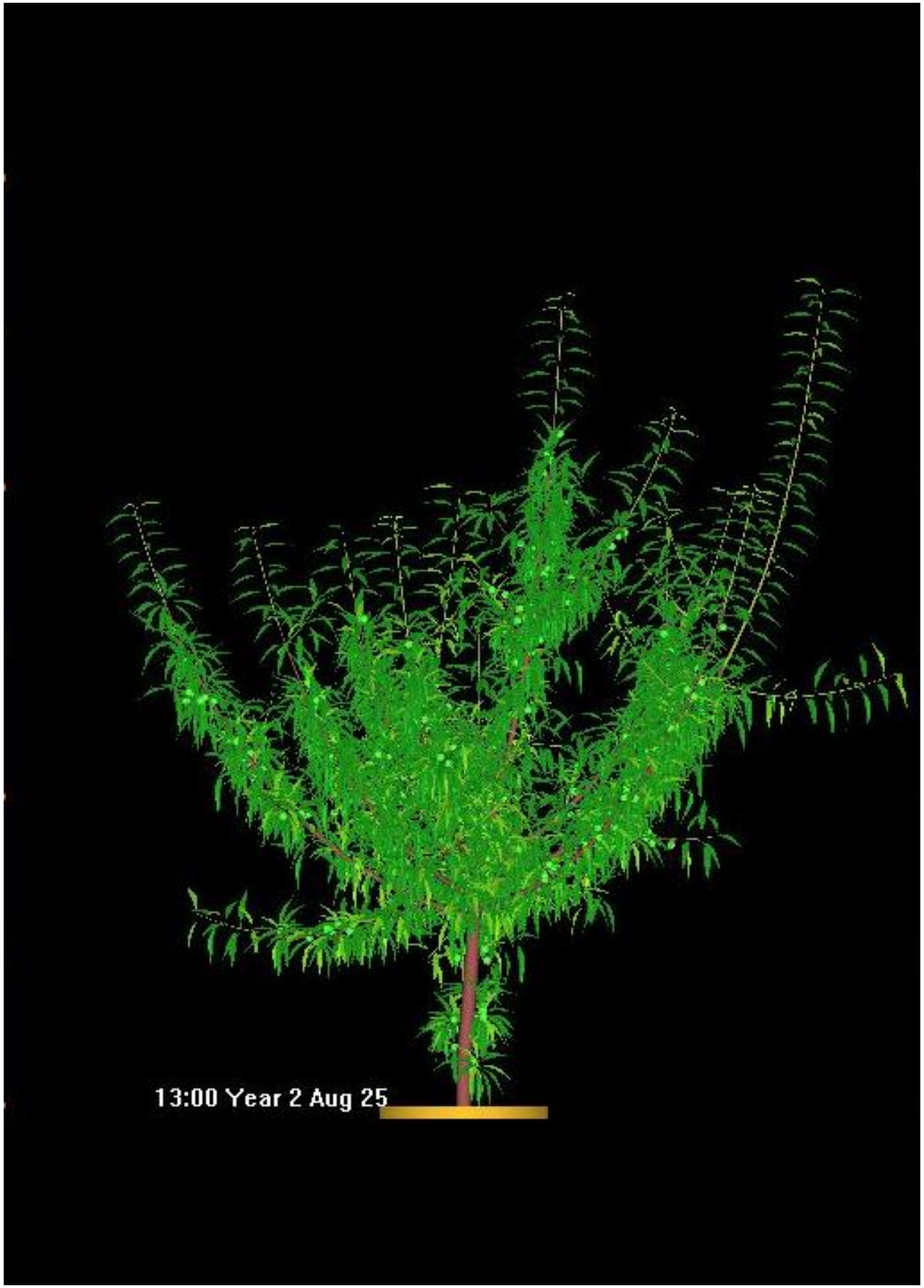

21:00 Year 1 Jan 22

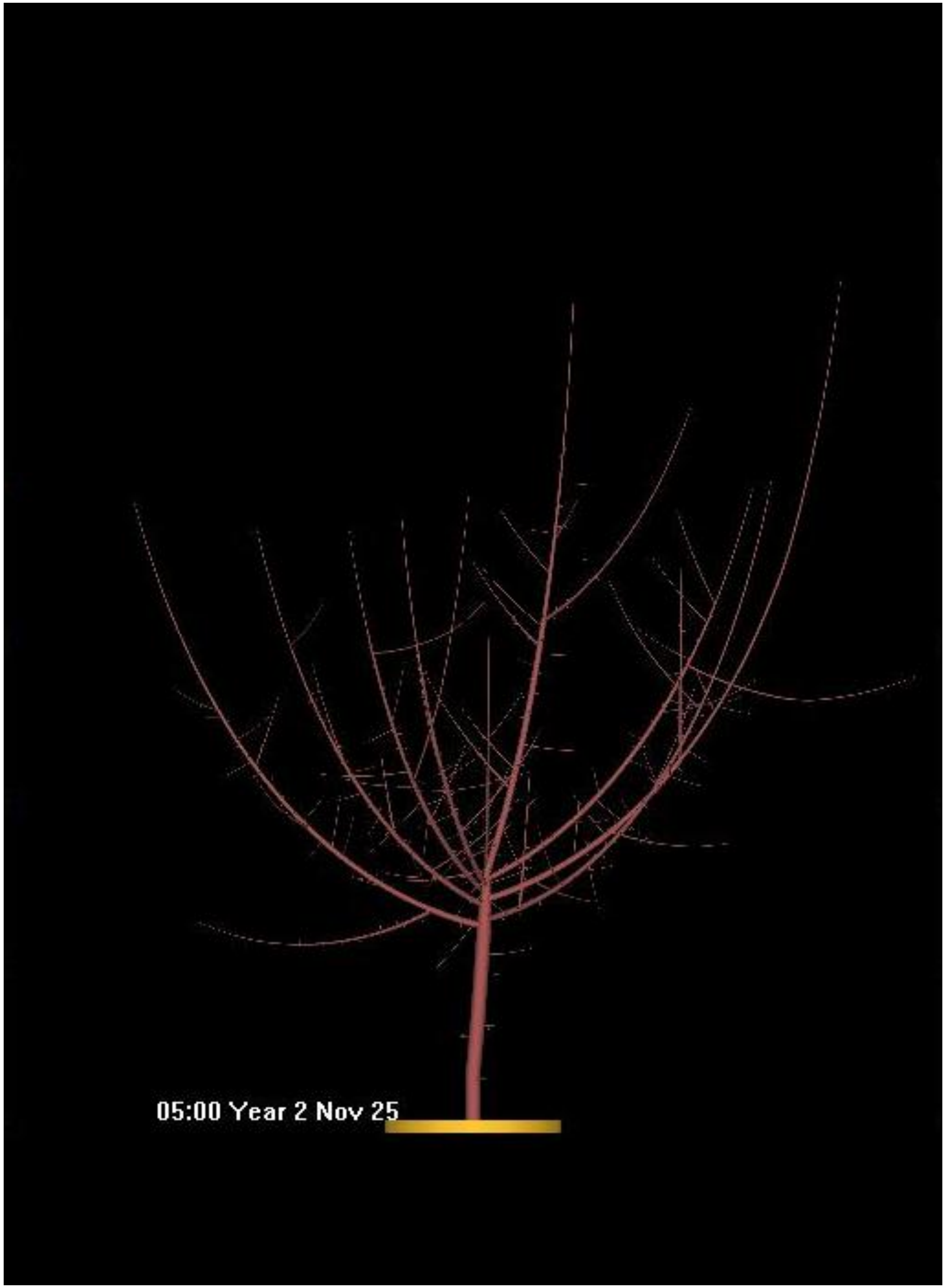

12:00 Year 1 Aug 26

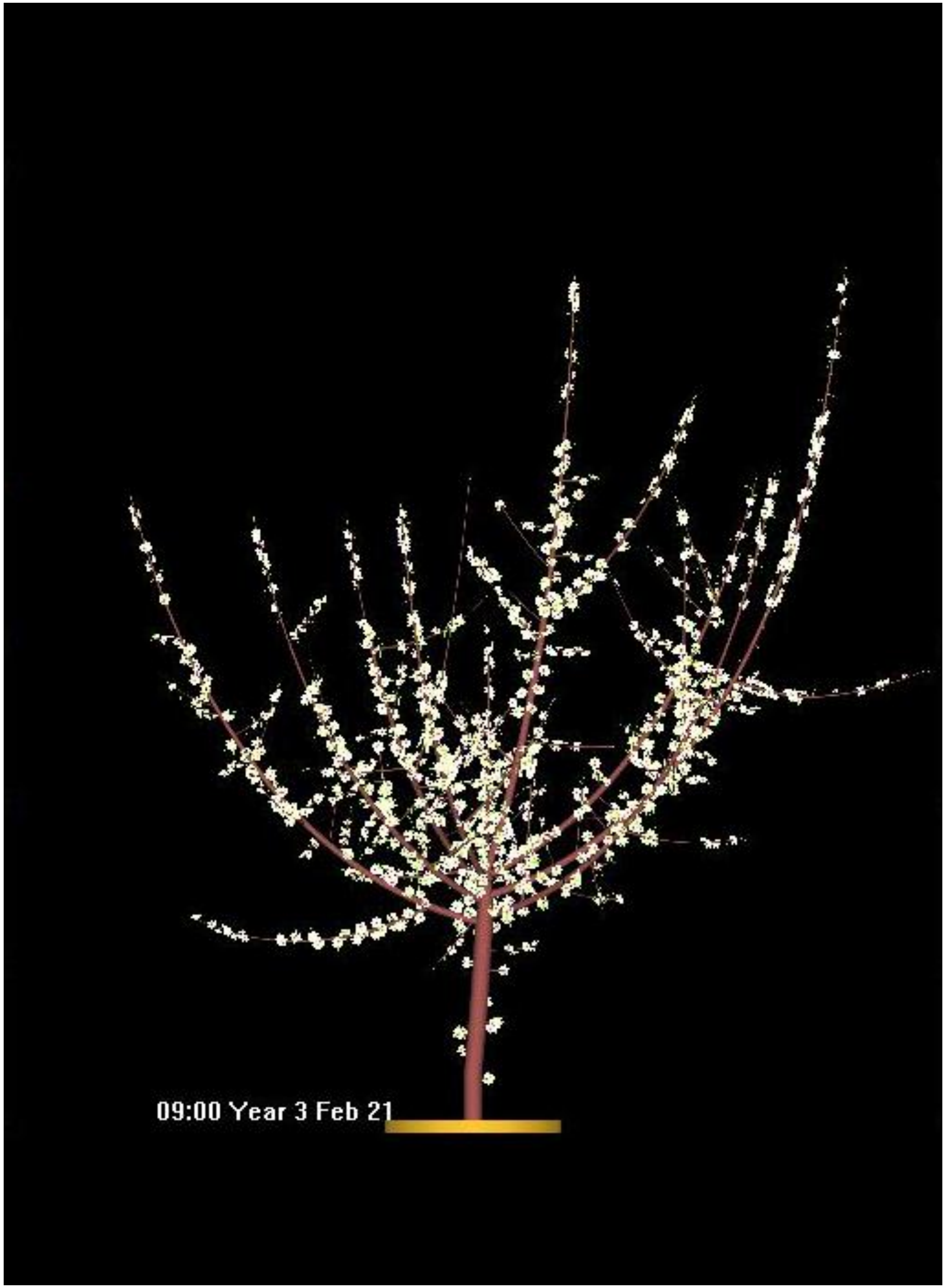

04:00 Year 1 Nov 26


08:00 Year 2 Feb 21

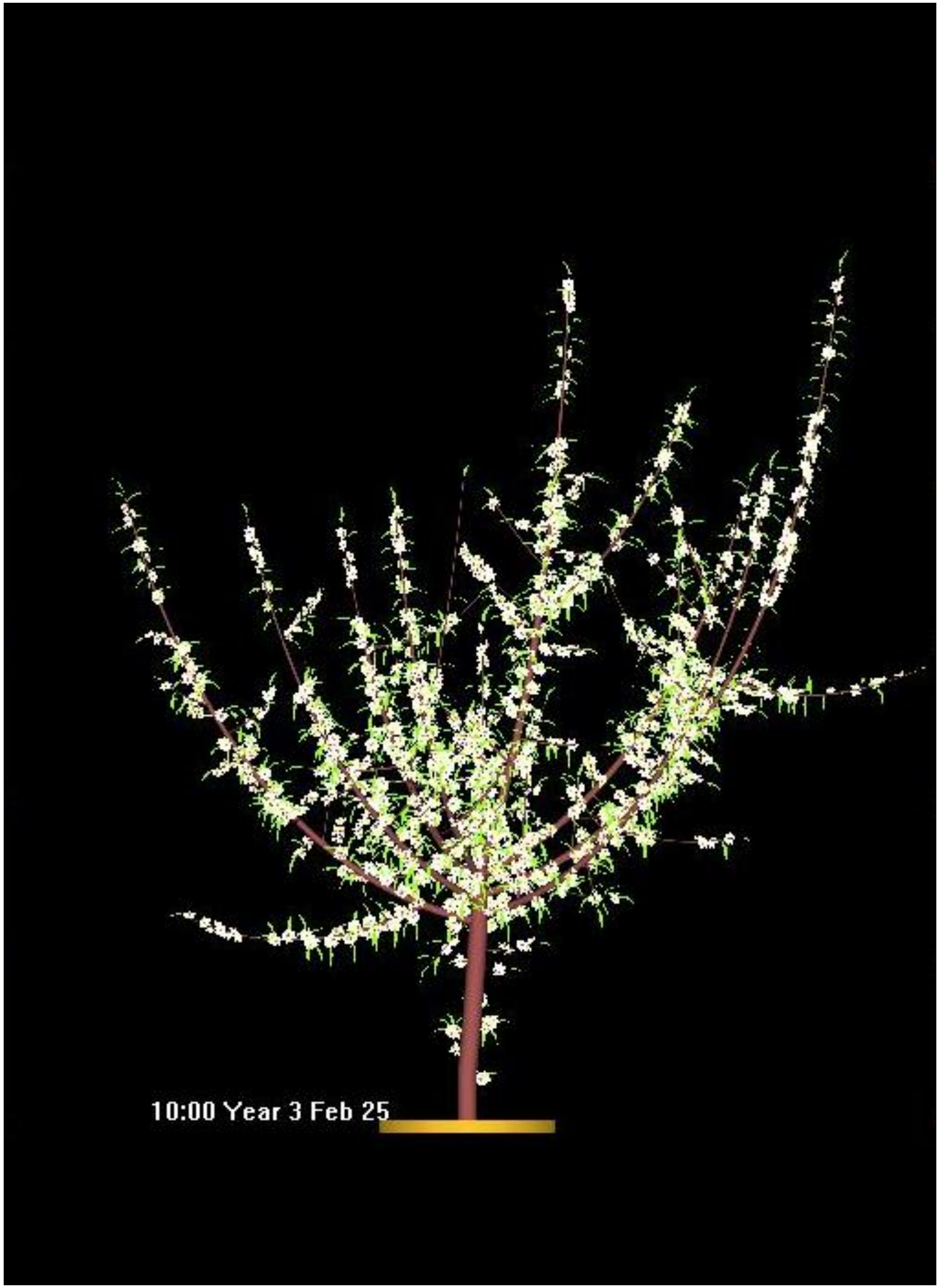

07:00 Year 2 Feb 25

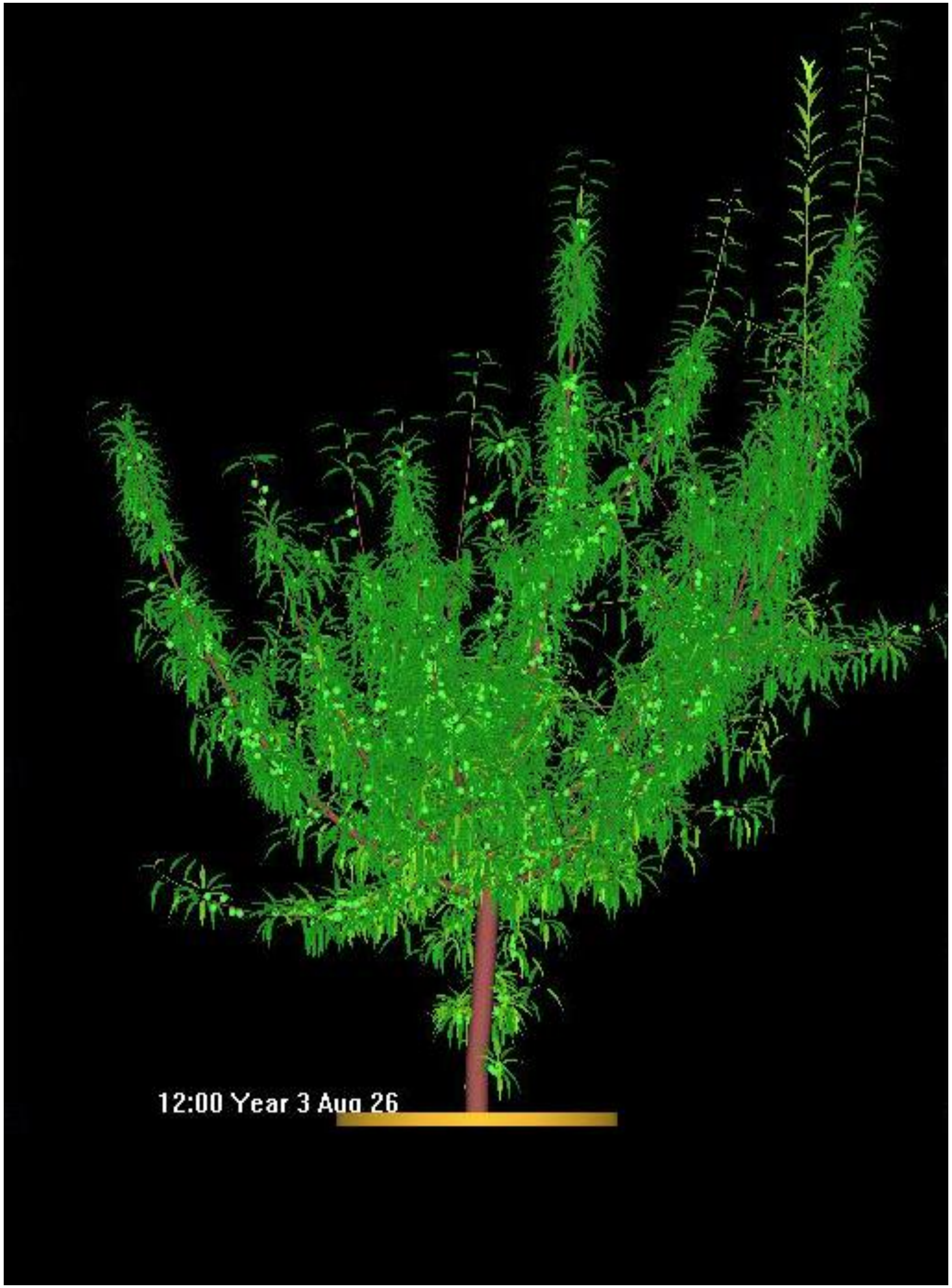

13:00 Year 2 Aug 25

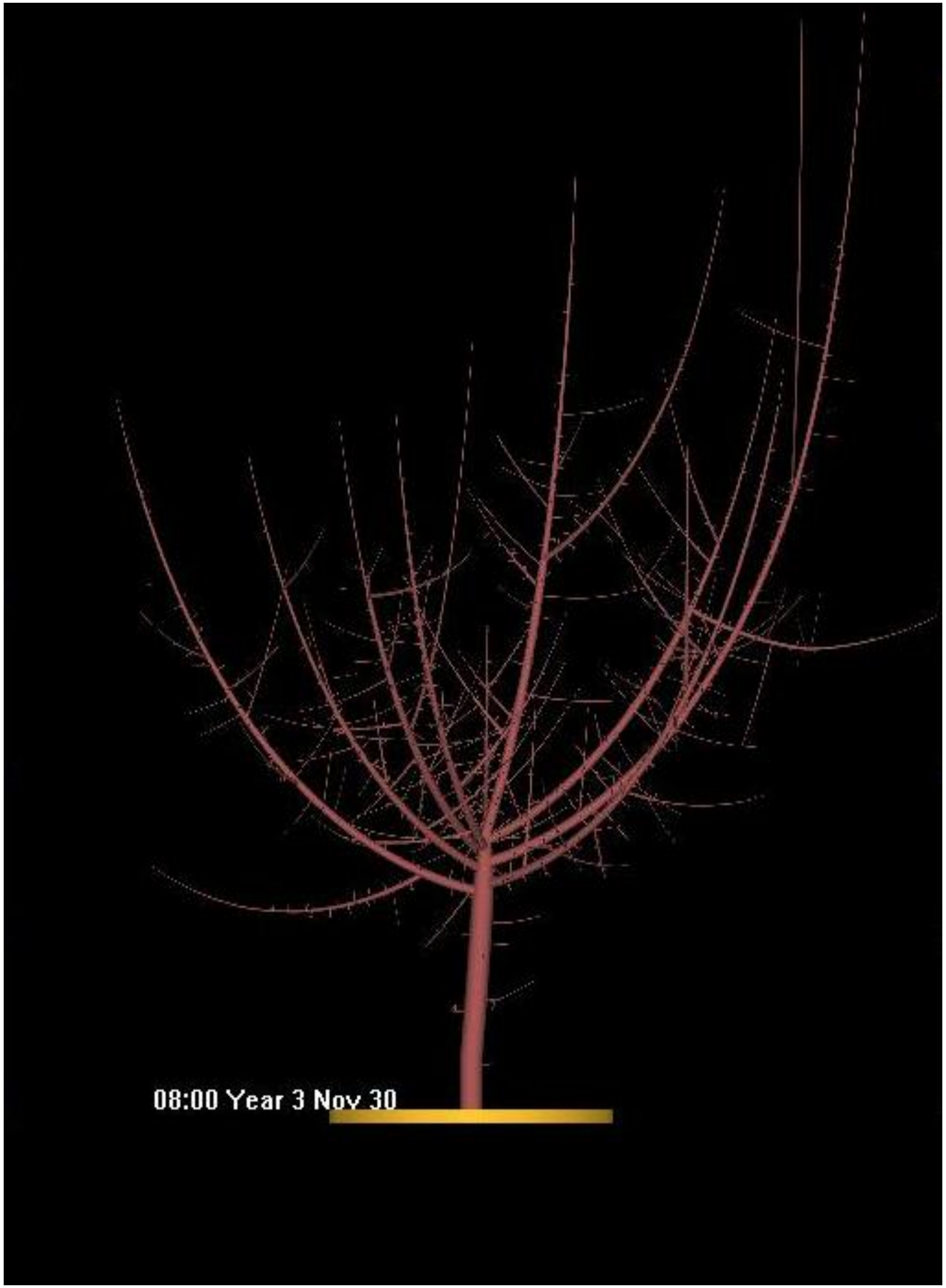

05:00 Year 2 Nov 25

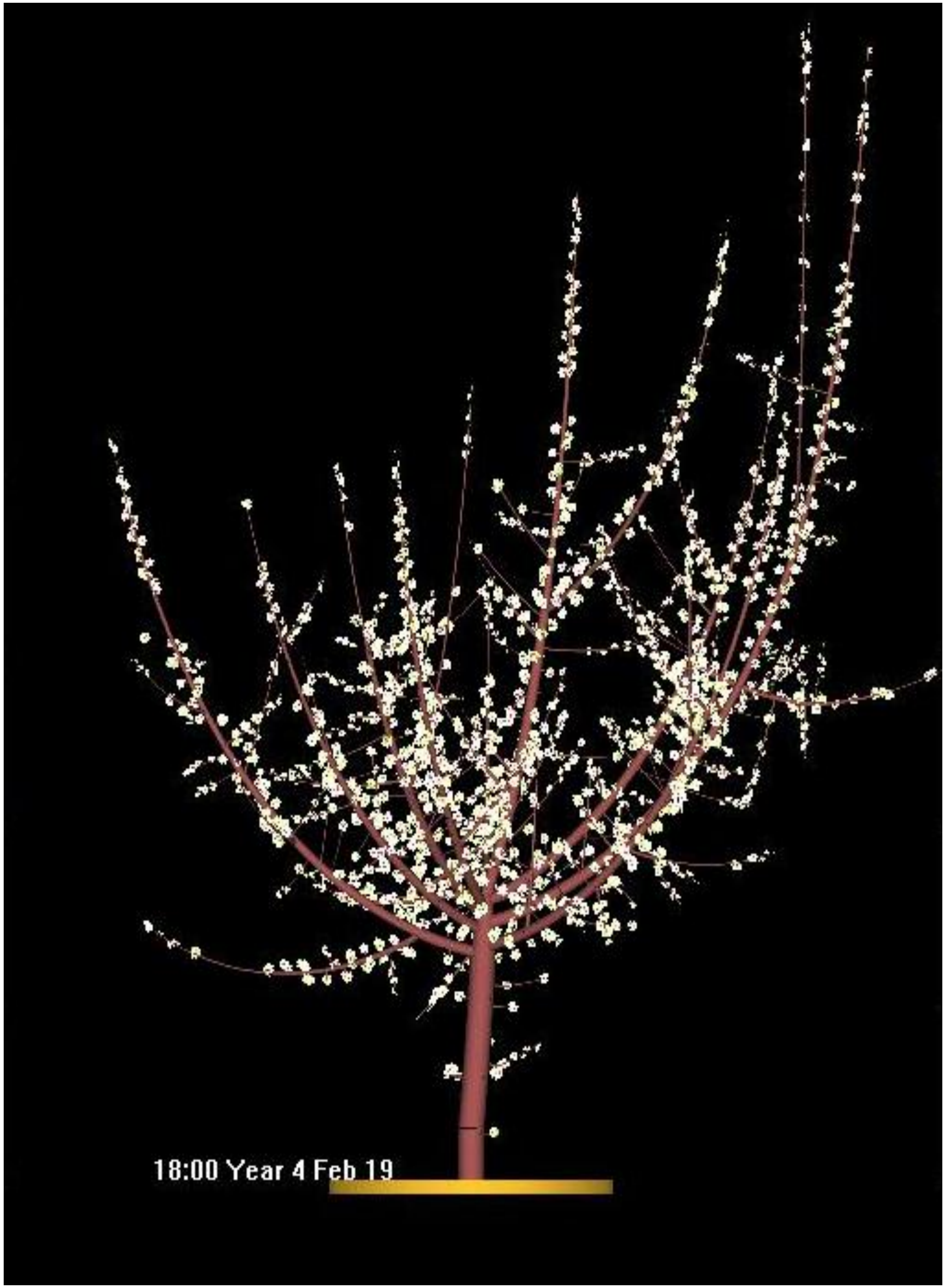


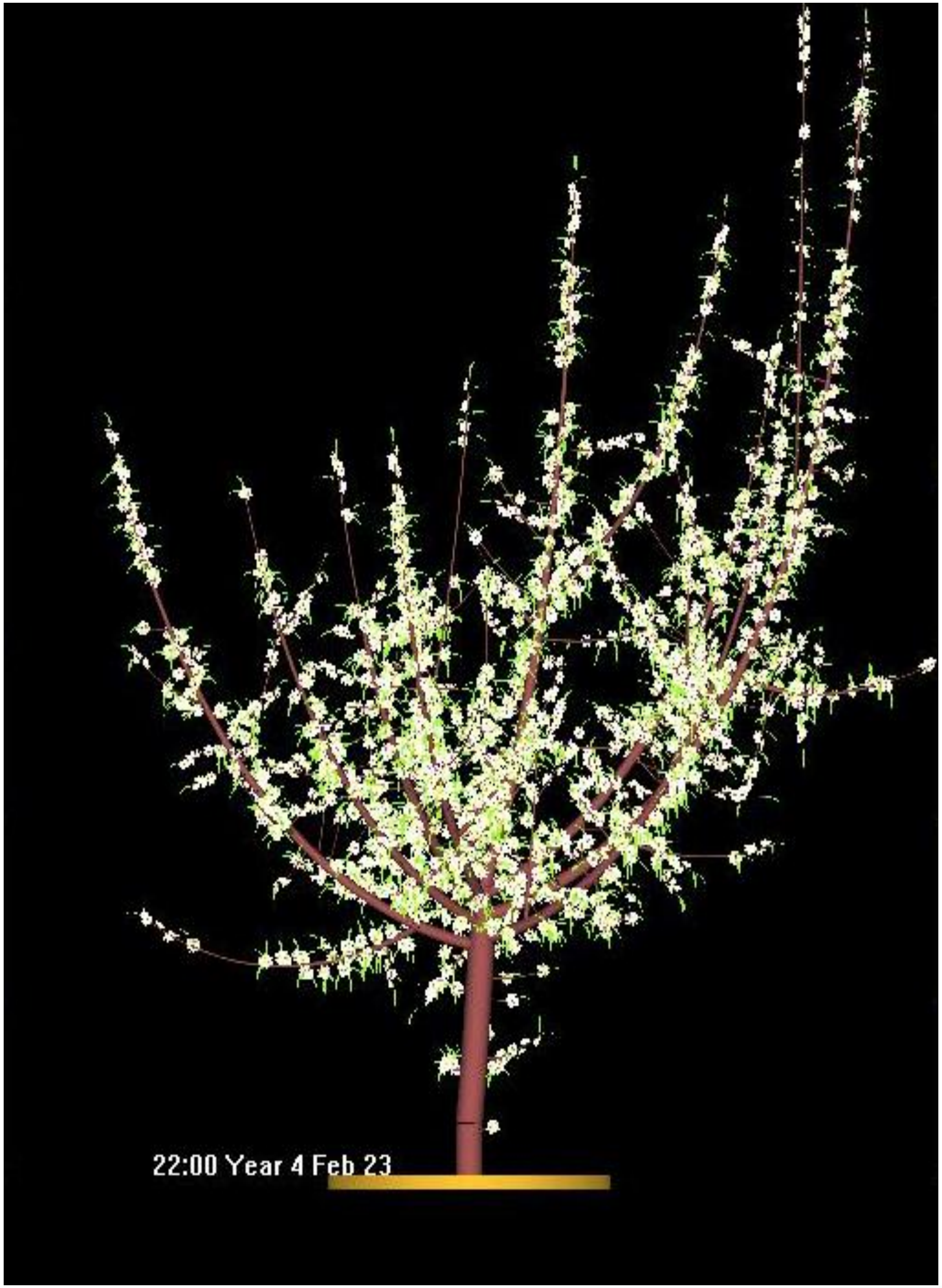
09:00 Year 3 Feb 21

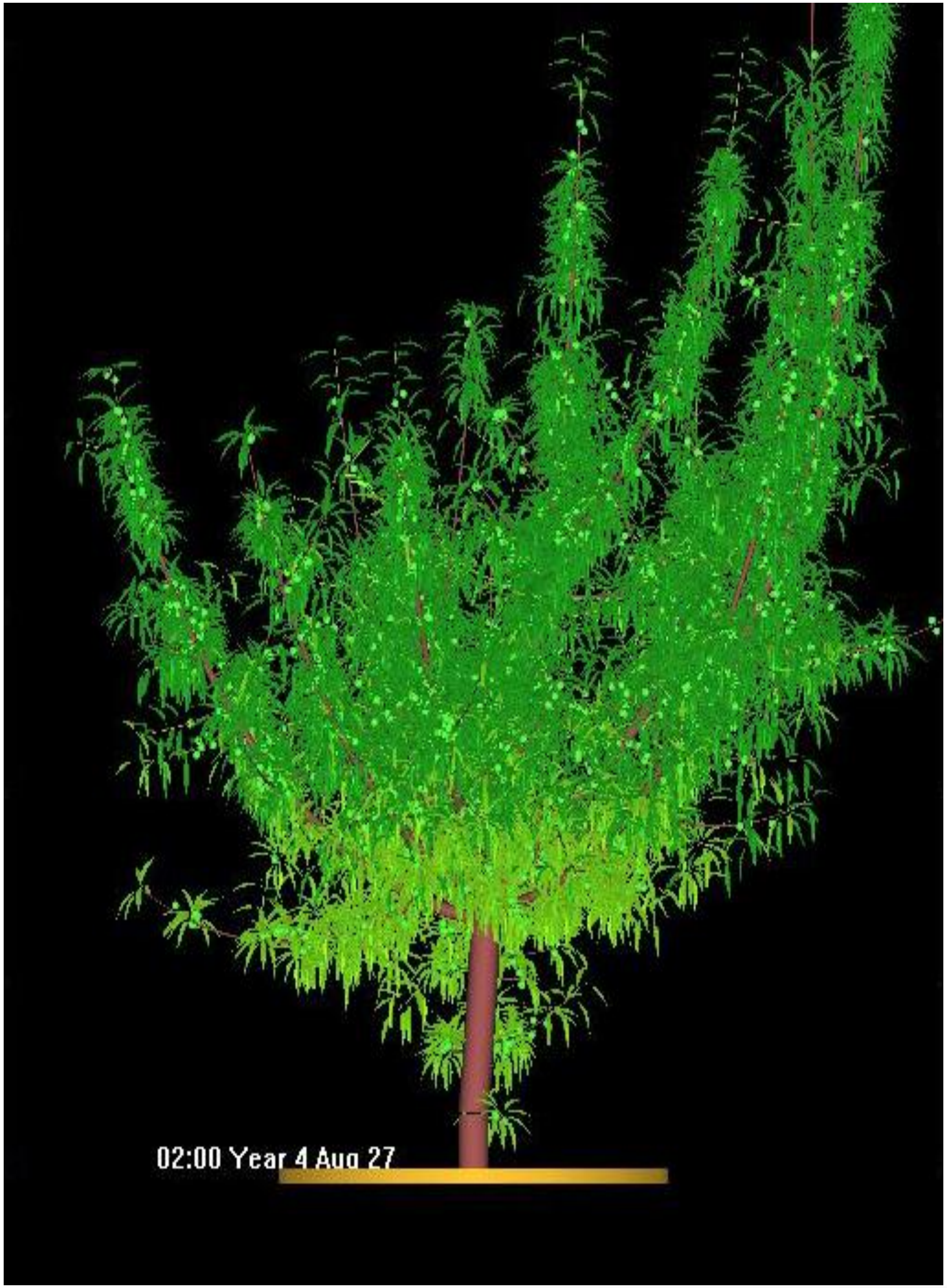

10:00 Year 3 Feb 25


12:00 Year 3 Aug 26


08:00 Year 3 Nov 30


18:00 Year 4 Feb 19


22:00 Year 4 Feb 23


02:00 Year 4 Aug 27

The L-Almond model calculates all the carbohydrate supply and demand functions for each hour of a day.

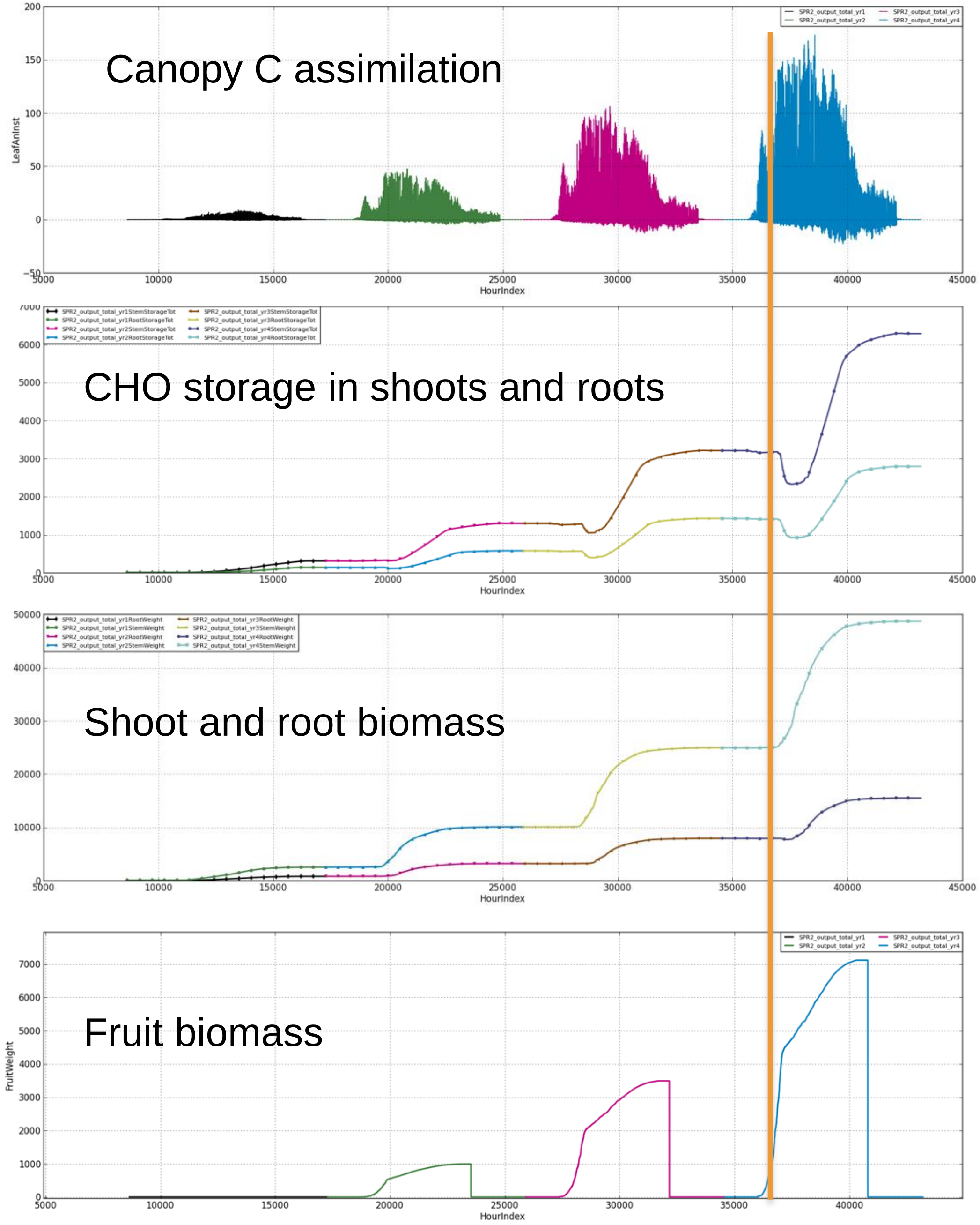
The model indicates that the period corresponding to early fruitlet growth is a time when carbohydrate availability may be particularly limiting.

This may help explain annual variations in yield that do not appear to be related to weather during bloom.

We plan to explore this more in the next year.

Supply functions

Demand functions

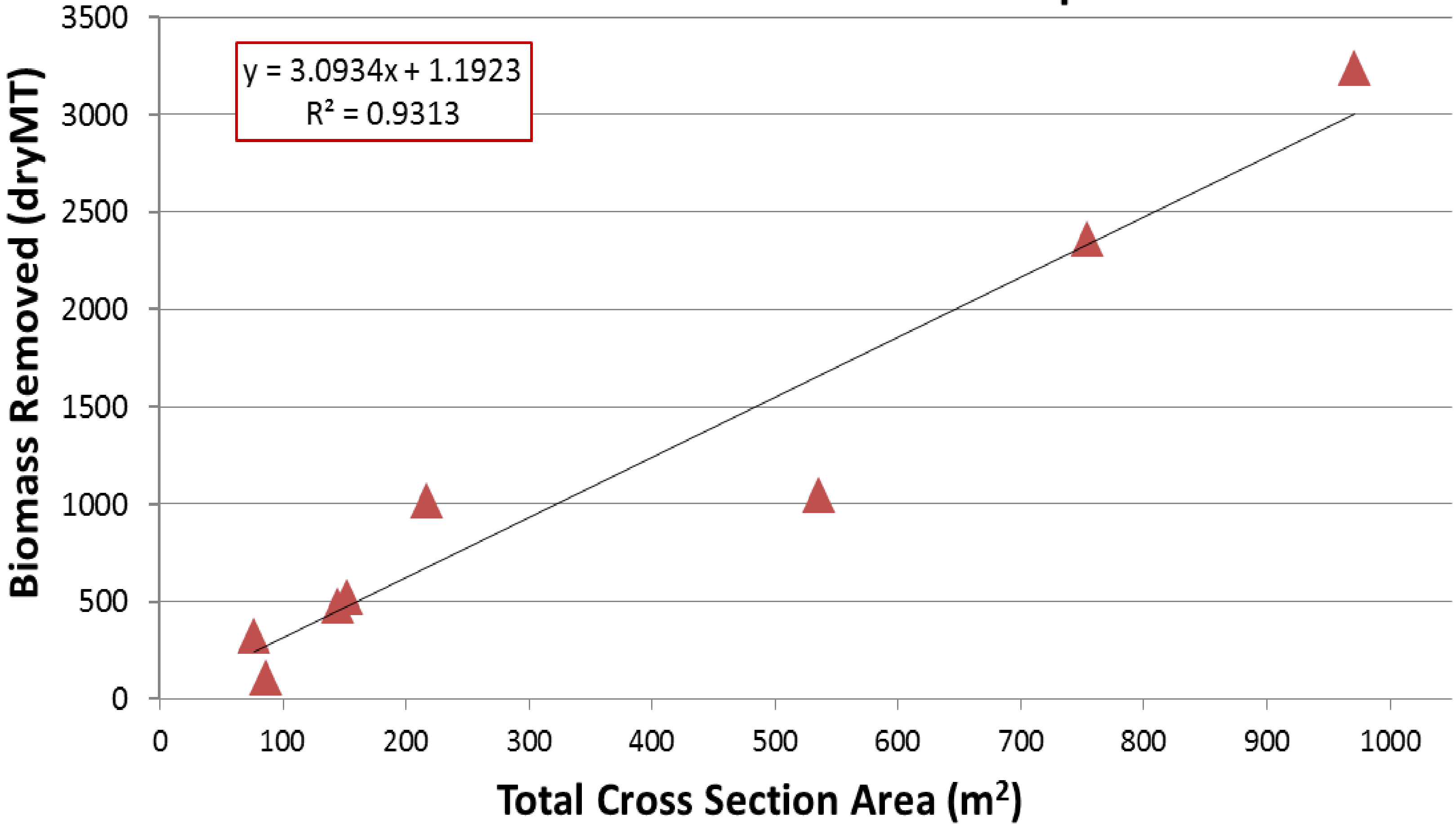


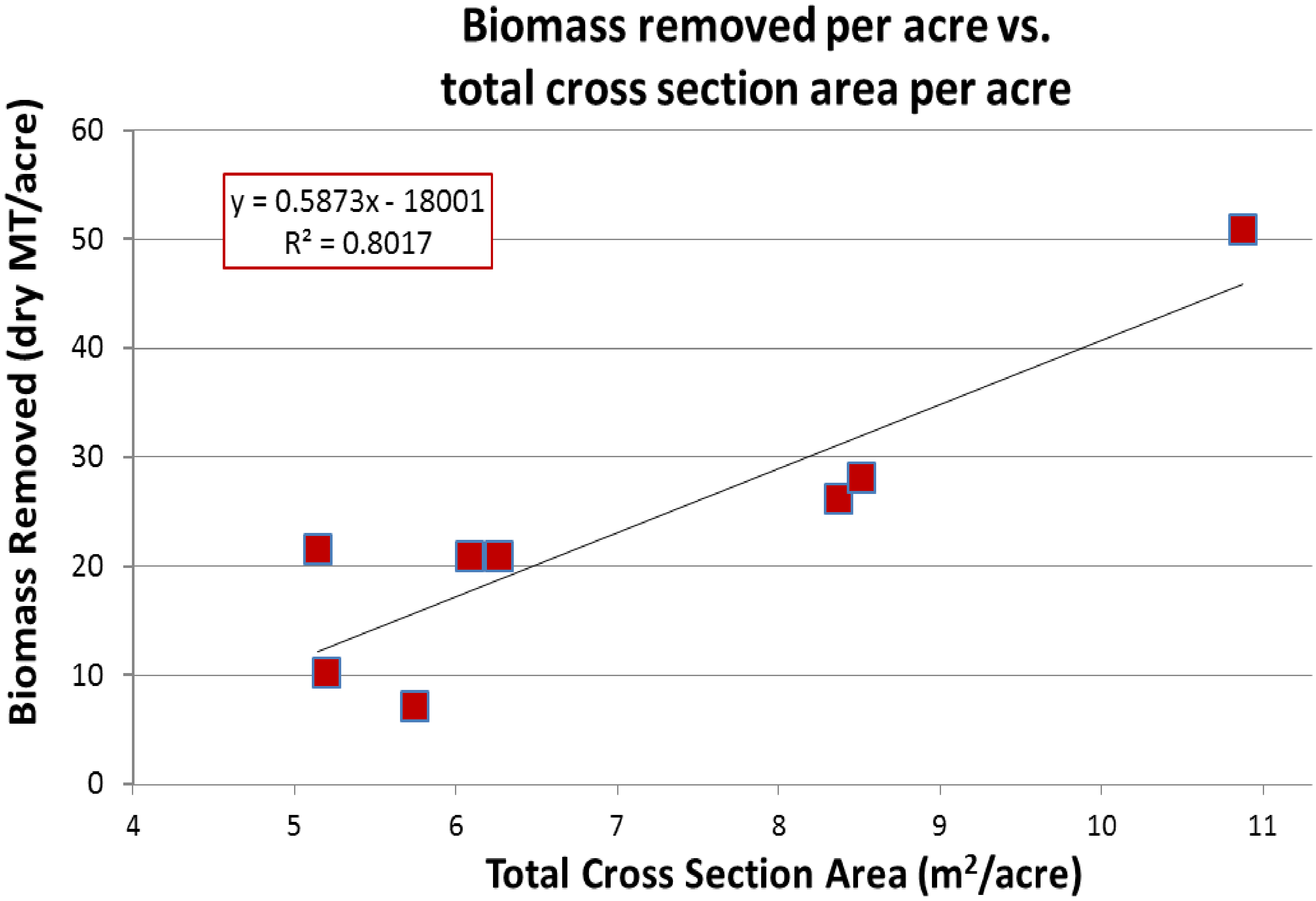
Estimating almond orchard biomass

The objective of this part of the research was to develop a simple method to estimate almond orchard biomass. To do this we:

- Surveyed the trunk diameters of orchards slated for removal
- Calculated mean tree trunk cross sectional area per site and per acre
- Obtained biomass removal data from a commercial orchard removal company

Total biomass removed per site vs. total estimated cross section area per site




Biomass removed per acre vs.
total cross section area per acre
y = 0.5873x - 18001
R² = 0.8017
Biomass Removed (dry MT/acre)
0
10
20
30
40
50
60
4
5
6
7
8
9
10
11
Total Cross Section Area (m²/acre)

Recent publications that may be of interest

Fruit development in almond is influenced by early Spring temperatures in California*
S. Tombesi, R. Scalia, J. Connell, B. Lampinen and T.M. DeJong
***Journal of Horticultural Science and Biotechnology* (2010) 85:317-322.**
(Data from this paper have been used to develop a web-based model to help growers predict hull-split in their orchards by late May of each year.)
See: Hull-split Prediction Model at http://fruitsandnuts.ucdavis.edu/Weather Services/

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**

Relationship between spur fruit set and spur leaf dry weight in almond.
Sergio Tombesi, Bruce D. Lampinen, Samuel Metcalf AND Theodore M. DeJong
***Tree Physiology* (submitted)**

"Branching and Flowering Patterns of Almond Shoots: A Modeling Approach"
Dr. Claudia Negron's Ph.D. dissertation

Copies of these publications can be obtained by contacting *tmdejong@ucdavis.edu

Thanks to:

David Da Silva
Claudia Negron
Elias Marvinney
Bruce Lampinen
G & F Agri Services

Orchard Carbon Recycling

Brent A. Holtz
UCCE San Joaquin County

Cooperators:
David Doll, UCCE Merced County
Greg Browne, USDA, UC Davis

University of California
Agriculture and Natural Resources

- I would like to see whole orchards and vineyards incorporated back into the soil from where they were growing and not burned or removed and burned in a co-generation plant!

- Redwood forest nutrition comes from decomposing logs (carbon)
- These logs or stored carbon represent the productivity of a forest ecosystem over thousands of years.

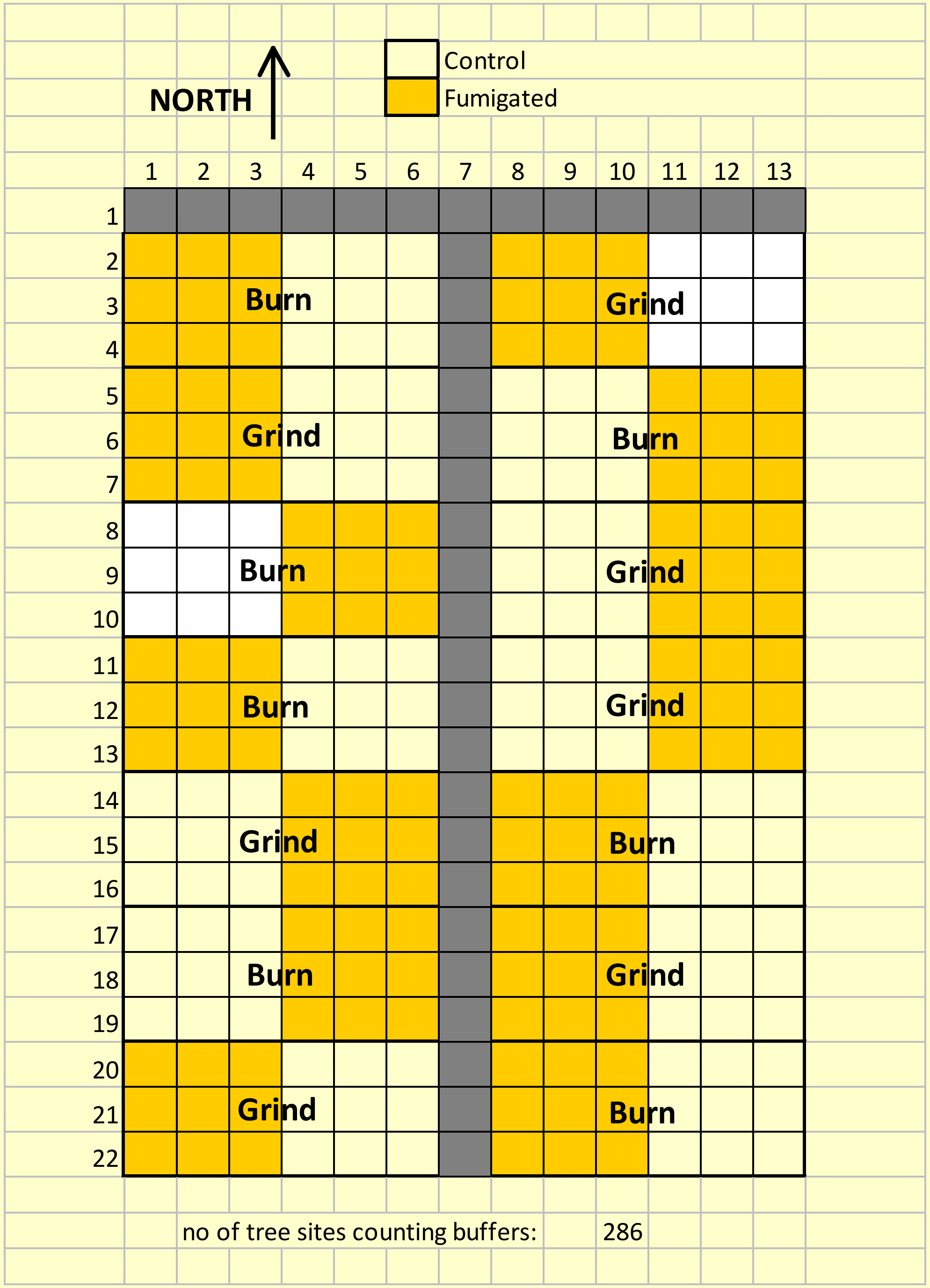
- When we remove an orchard we grind up 30 years worth of photosynthesis and carbon accumulation and we haul it out of the orchard to burn in co-generation plants. 30 years of organic matter is lost from our system, estimated at 30 tons per acre for almond. SJV soils are typically low in organic matter.

- Can we return this organic matter to our orchard soils?

The Iron Wolf

The Iron Wolf

The Iron Wolf-Orchard Grinding



NORTH ↑

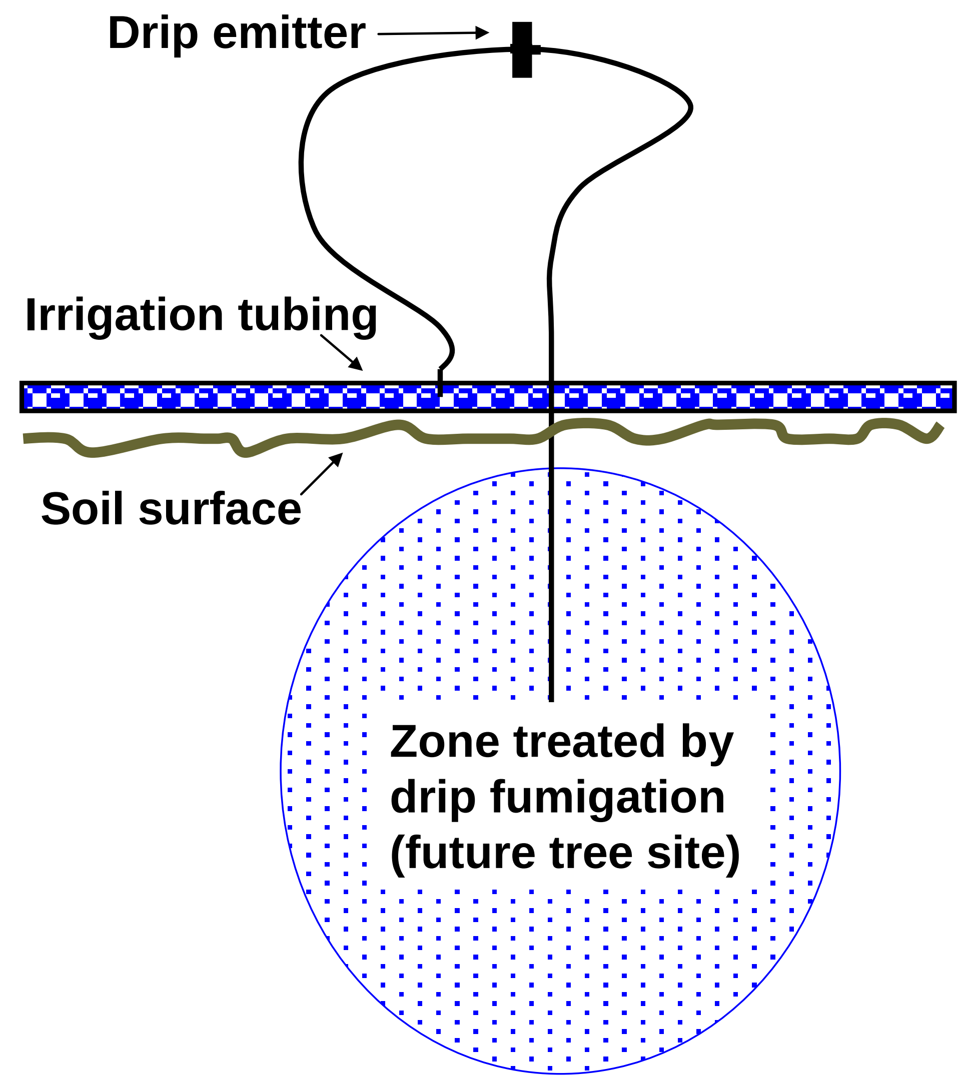
⬜ Control

🟨 Fumigated

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛
2	🟨	🟨	🟨	⬜	⬜	⬜	⬛	🟨	🟨	🟨	⬜	⬜	⬜
3	🟨	🟨	🟨 Burn	⬜	⬜	⬜	⬛	🟨	🟨	🟨 Grind	⬜	⬜	⬜
4	🟨	🟨	🟨	⬜	⬜	⬜	⬛	🟨	🟨	🟨	⬜	⬜	⬜
5	🟨	🟨	🟨	⬜	⬜	⬜	⬛	⬜	⬜	⬜	🟨	🟨	🟨
6	🟨	🟨	🟨 Grind	⬜	⬜	⬜	⬛	⬜	⬜	⬜ Burn	🟨	🟨	🟨
7	🟨	🟨	🟨	⬜	⬜	⬜	⬛	⬜	⬜	⬜	🟨	🟨	🟨
8	⬜	⬜	⬜	🟨	🟨	🟨	⬛	⬜	⬜	⬜	🟨	🟨	🟨
9	⬜	⬜	⬜ Burn	🟨	🟨	🟨	⬛	⬜	⬜	⬜ Grind	🟨	🟨	🟨
10	⬜	⬜	⬜	🟨	🟨	🟨	⬛	⬜	⬜	⬜	🟨	🟨	🟨
11	🟨	🟨	🟨	⬜	⬜	⬜	⬛	⬜	⬜	⬜	🟨	🟨	🟨
12	🟨	🟨	🟨 Burn	⬜	⬜	⬜	⬛	⬜	⬜	⬜ Grind	🟨	🟨	🟨
13	🟨	🟨	🟨	⬜	⬜	⬜	⬛	⬜	⬜	⬜	🟨	🟨	🟨
14	⬜	⬜	⬜	🟨	🟨	🟨	⬛	🟨	🟨	🟨	⬜	⬜	⬜
15	⬜	⬜	⬜ Grind	🟨	🟨	🟨	⬛	🟨	🟨	🟨 Burn	⬜	⬜	⬜
16	⬜	⬜	⬜	🟨	🟨	🟨	⬛	🟨	🟨	🟨	⬜	⬜	⬜
17	⬜	⬜	⬜	🟨	🟨	🟨	⬛	🟨	🟨	🟨	⬜	⬜	⬜
18	⬜	⬜	⬜ Burn	🟨	🟨	🟨	⬛	🟨	🟨	🟨 Grind	⬜	⬜	⬜
19	⬜	⬜	⬜	🟨	🟨	🟨	⬛	🟨	🟨	🟨	⬜	⬜	⬜
20	🟨	🟨	🟨	⬜	⬜	⬜	⬛	🟨	🟨	🟨	⬜	⬜	⬜
21	🟨	🟨	🟨 Grind	⬜	⬜	⬜	⬛	🟨	🟨	🟨 Burn	⬜	⬜	⬜
22	🟨	🟨	🟨	⬜	⬜	⬜	⬛	🟨	🟨	🟨	⬜	⬜	⬜

no of tree sites counting buffers: 286

Drip spot fumigation



2007: 1 gph, 22” depth, 7.5 h, 0.2 lb Inline per tree site

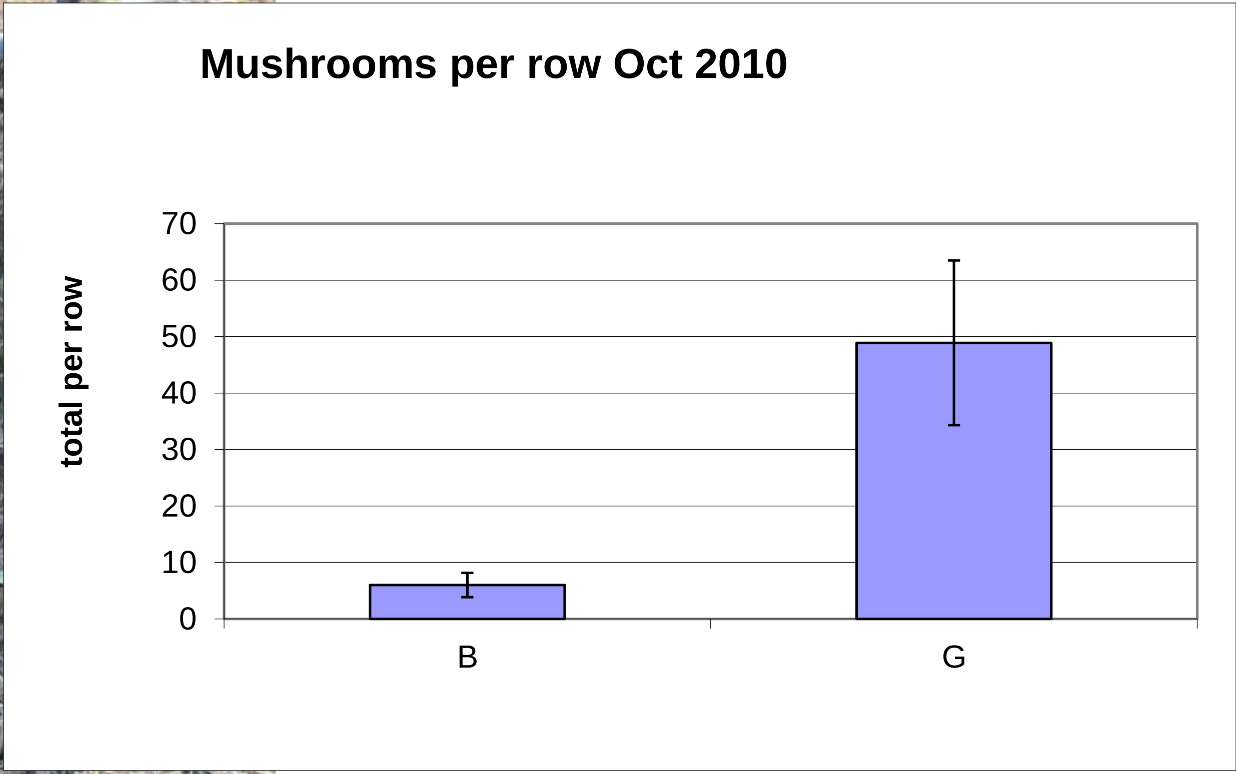
Drip spot fumigation

2009 First leaf trees growing in grinding plot

2010 Second leaf trees growing in grinding plot

2011 Third leaf trees growing in grinding plot

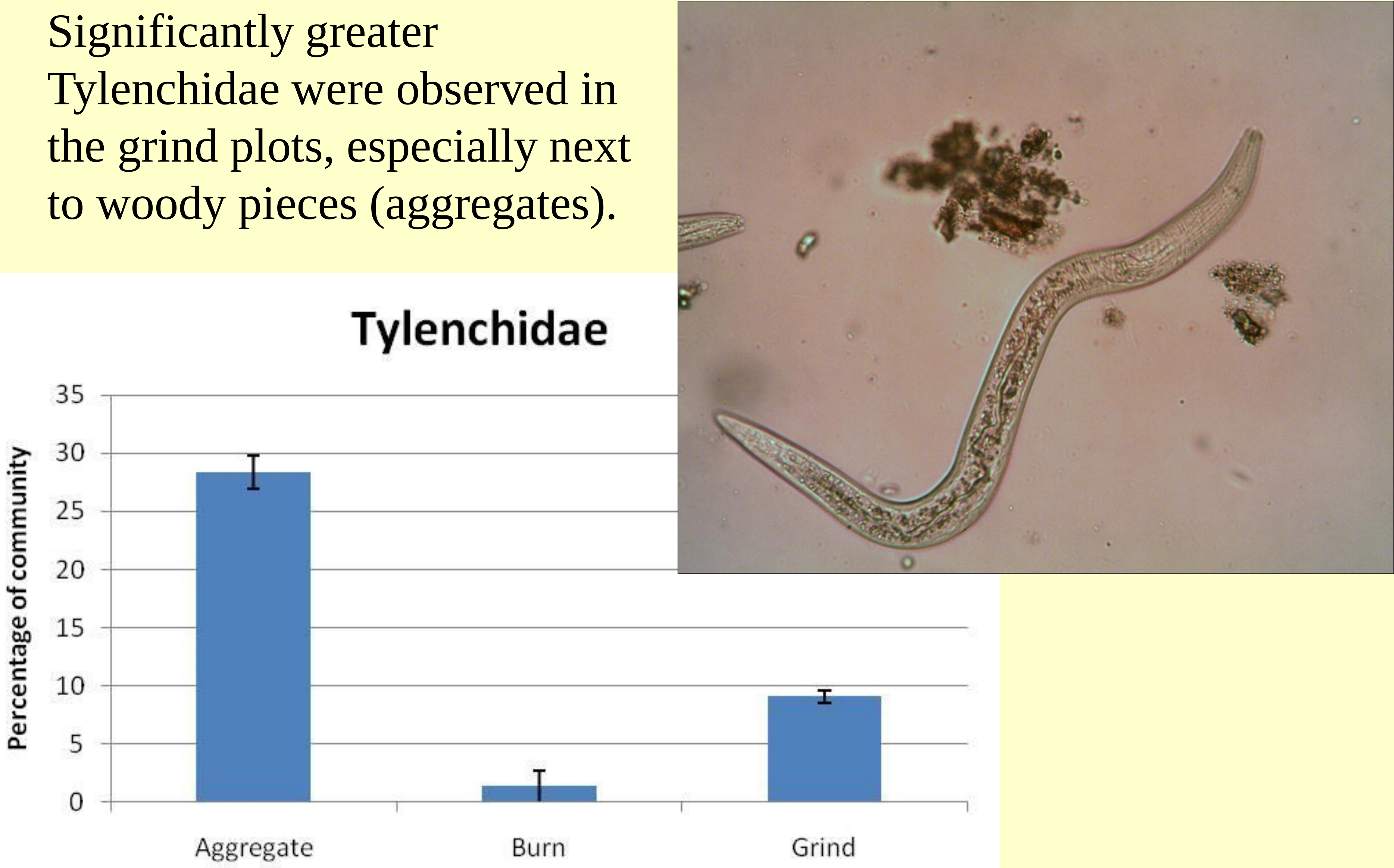
2012 Fourth leaf trees growing in grinding plot



Mushrooms per row Oct 2010

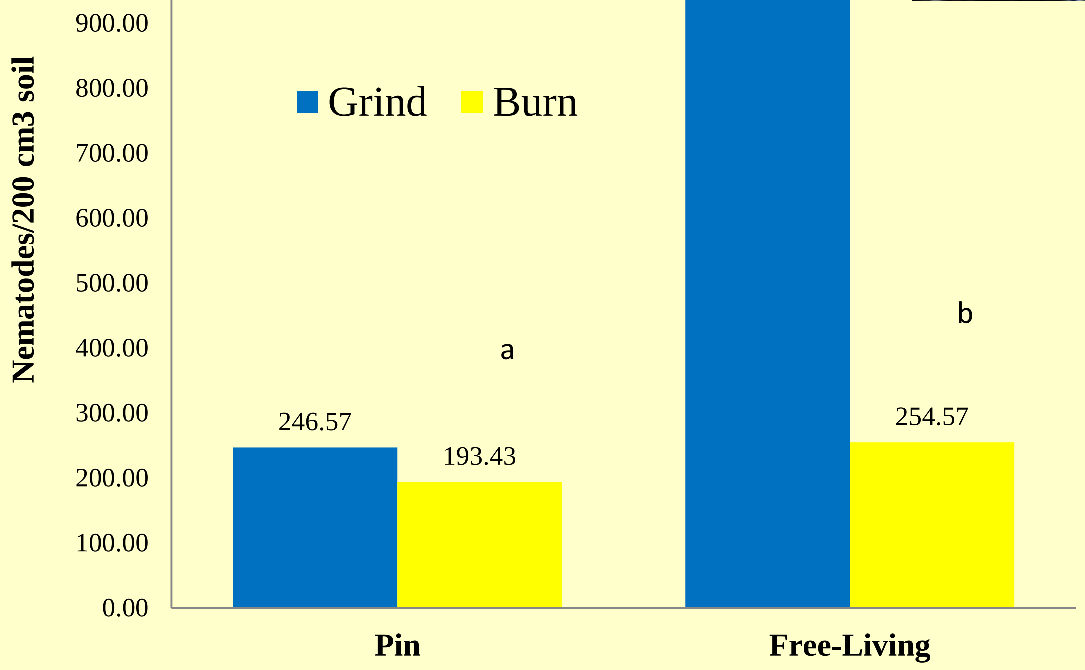
Nematode species of the family Tylenchidae feed on algae and fungi and are not parasitic. Significantly greater Tylenchidae were observed in the grind plots, especially next to woody pieces (aggregates).

2010



If wood debris is in contact with moist soil it is rapidly colonized by fungal mycelium that binds organic matter with inorganic matter, forming soil aggregates.

2012



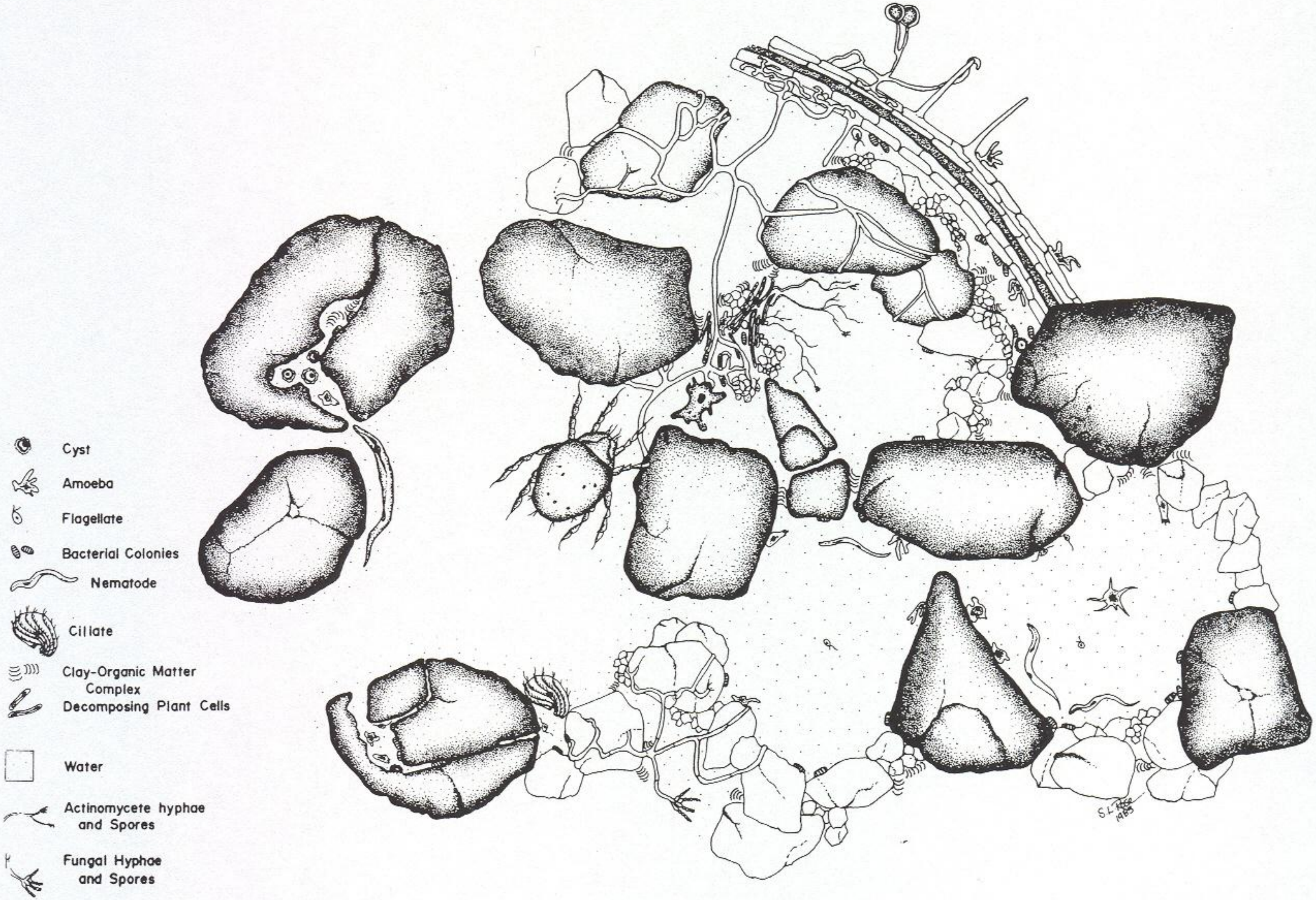
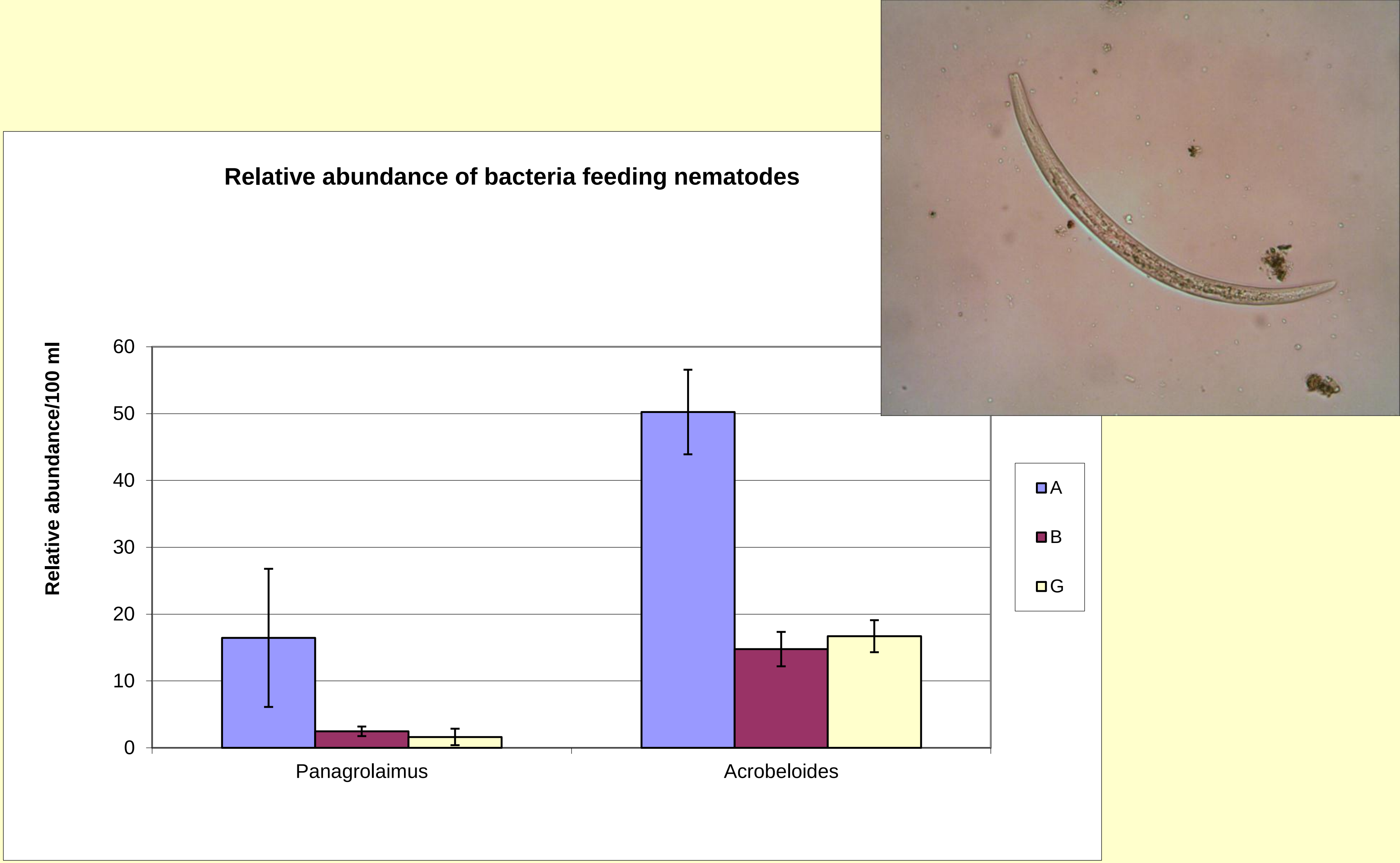
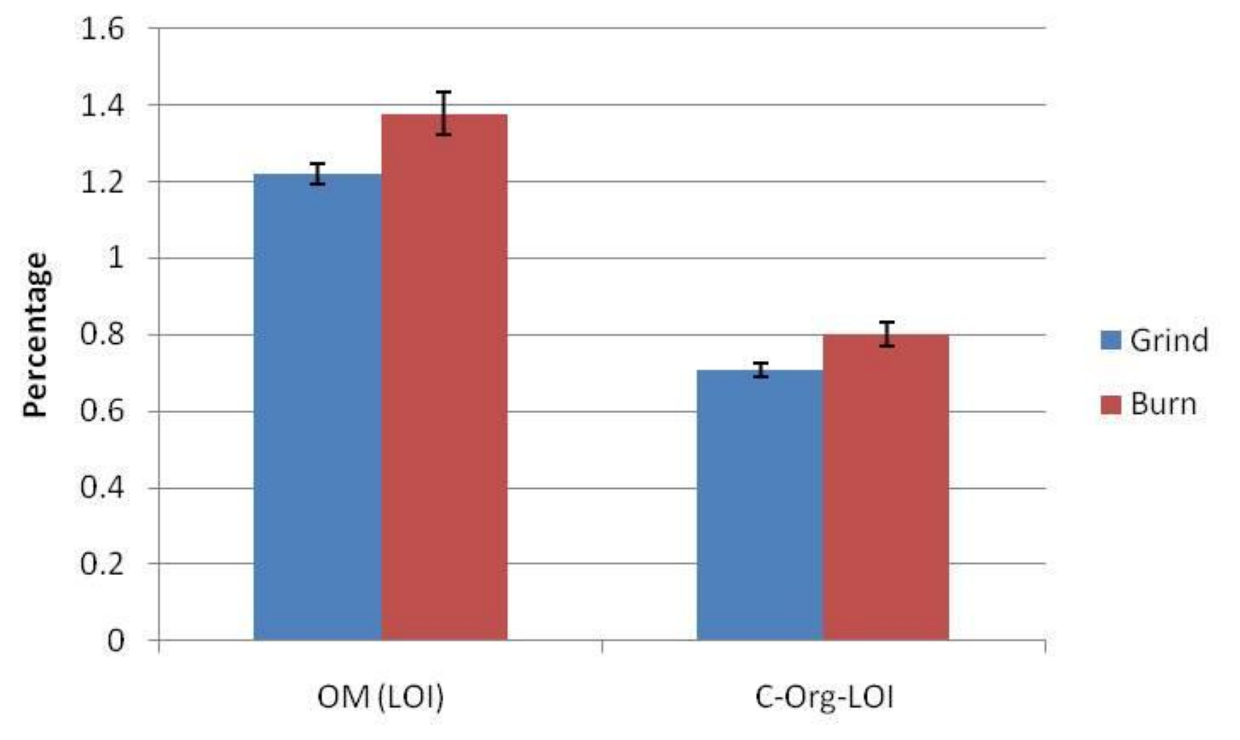


Figure 5.2. Trophic relationships among different groups of soil organisms are controlled by accessibility to their resources. This illustration represents approximately 1 cm^2 of a highly structured microzone in the surface horizon of a grassland soil. Courtesy of S. Rose and T. Elliott, personal communication.)



Panagrolaimus and Acrobeloides are bacterial feeding nematodes (not parasitic), and their populations were significantly greater on soil aggregates (wood).

In 2010, Burn treatments had significantly more organic matter (OM), carbon (C), Cation Exchange Capacity (CEC) in the top 5 inches of soil.



Burning appears to release nutrients back into the orchard soil more rapidly than decomposition.

Soil Analysis

	Ca meq/L		Na ppm		Mn ppm		Fe ppm		Mg (meq/L)		B (mg/L)		NO3-N (ppm)		NH4-N (ppm)	
	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn
2010	4.06 a	4.40 b	19.43 a	28.14 b	11.83 a	8.86 b	32.47 a	26.59 b	0.76 a	1.52 b	0.08 a	0.07 a	3.90 a	14.34 b	1.03 a	1.06 a
2011	2.93 a	3.82 b	13.00 a	11.33 b	12.78 a	9.19 b	27.78 a	22.82 b	1.34 a	1.66 a	0.08 a	0.08 a	8.99 a	11.60 a	2.68 a	2.28 a
2012	4.27 a	3.17 b	11.67 a	12.67 a	29.82 a	15.82 b	62.48 a	36.17 b	2.05 a	1.46 b	0.08 a	0.05 b	19.97 a	10.80 b	1.09 a	1.06 a

	pH		EC (dS/m)		CEC meq/100g		OM %		C (total) %		C-Org-LOI %		Cu ppm	
	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn
2010	7.41	7.36	0.33 a	0.64 b	7.40 a	8.47 b	1.22 a	1.38 b	0.73 a	0.81 a	0.71 a	0.80 b	6.94 a	6.99 a
2011	6.96 a	7.15 b	0.53	0.64	8.04	7.88	1.24	1.20	0.79 a	0.73 a	0.72	0.70	7.94 a	7.54 a
2012	6.78 a	7.12 b	0.82 a	0.59 b	5.34	5.32	1.50 a	1.18 b	0.81 a	0.63 b	0.87 a	0.68 b	8.87 a	7.92 b

Blue Pair = grinding significantly less than burning

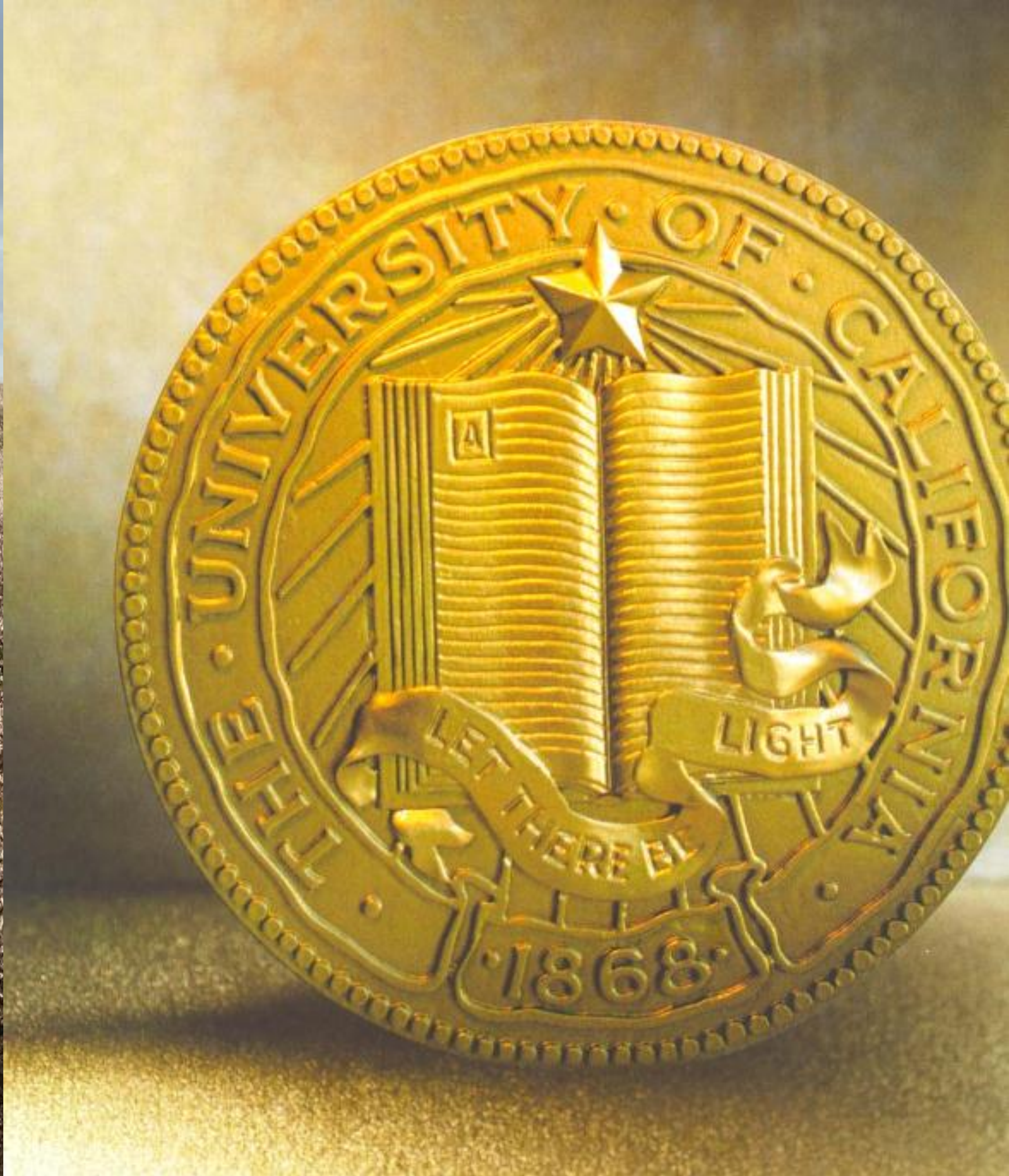
Yellow pair = grinding significantly greater than burning

- Fungal decomposition of organic matter may be contributing to elevated nutrient levels, released as the woody aggregates are decomposed.

We believe orchard recycling will ultimately:

- Increase organic matter
- Increase soil carbon, nutrients
- Increase water holding capacity
- Increase soil microbial diversity
- Increase orchard productivity
- Bind pesticides and fertilizers

Thank You!



Can Chipped Almond Prunings Provide Carbon Sequestration?

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Bill Salas, PhD

Problem and Project Purpose

Challenges

- Air quality regulations
  - Burning restrictions
- Climate change
  - Potential carbon market
- Sustainability
  - Soil health

Project Purpose

- Carbon sequestration potential
  - DNDC model – carbon and nitrogen dynamics (how)
  - Remote sensing – biomass (how much and where)

Objectives

Overall objective: Improve understanding of how management affects carbon stocks

Determine carbon sequestration potential

- Field survey
- Geospatial resources
- DNDC model

Develop efficient and accurate method to determine biomass

- Remote sensing

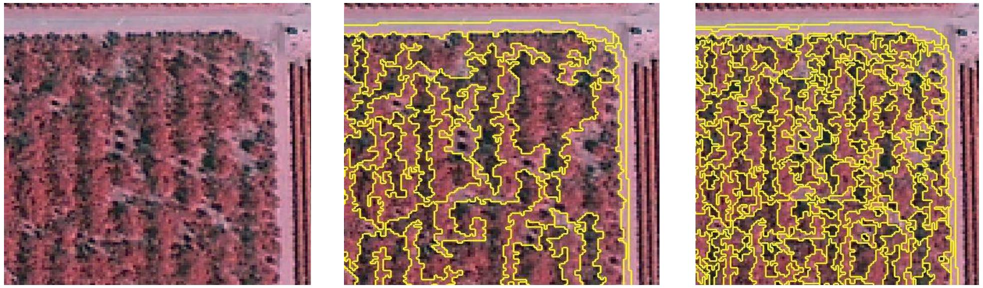
Improve spatial database of almond acreage

- Remote sensing

Approach

1. Identify imagery sources suited to analyzing almond orchard characteristics
2. Analyze remotely sensed imagery to determine orchard age and other characteristics
3. Determine which characteristics are correlated to biomass
4. Establish statistically valid method to predict carbon stocks in almond orchards

Results



Imagery

- NAIP (no-cost)
- LandSat (no-cost)

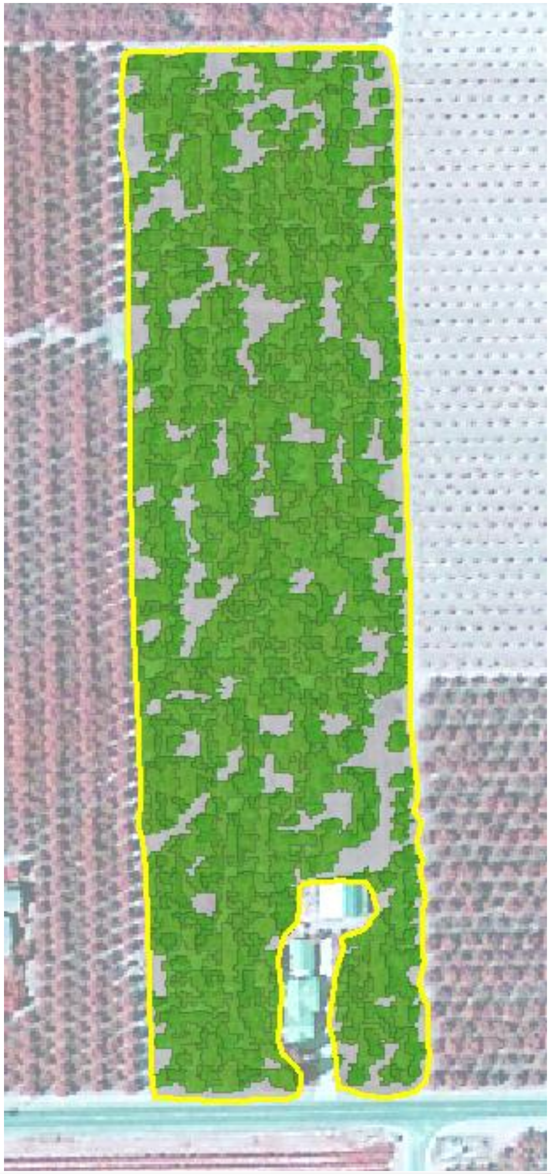
Remote sensing analysis

- Object-Based Image Analysis (OBIA)
  - Leverages advantages of each imagery source and mitigates its shortcomings

Biomass correlations

- Orchard age *not* correlated to biomass
- Textural characteristics correlated to biomass

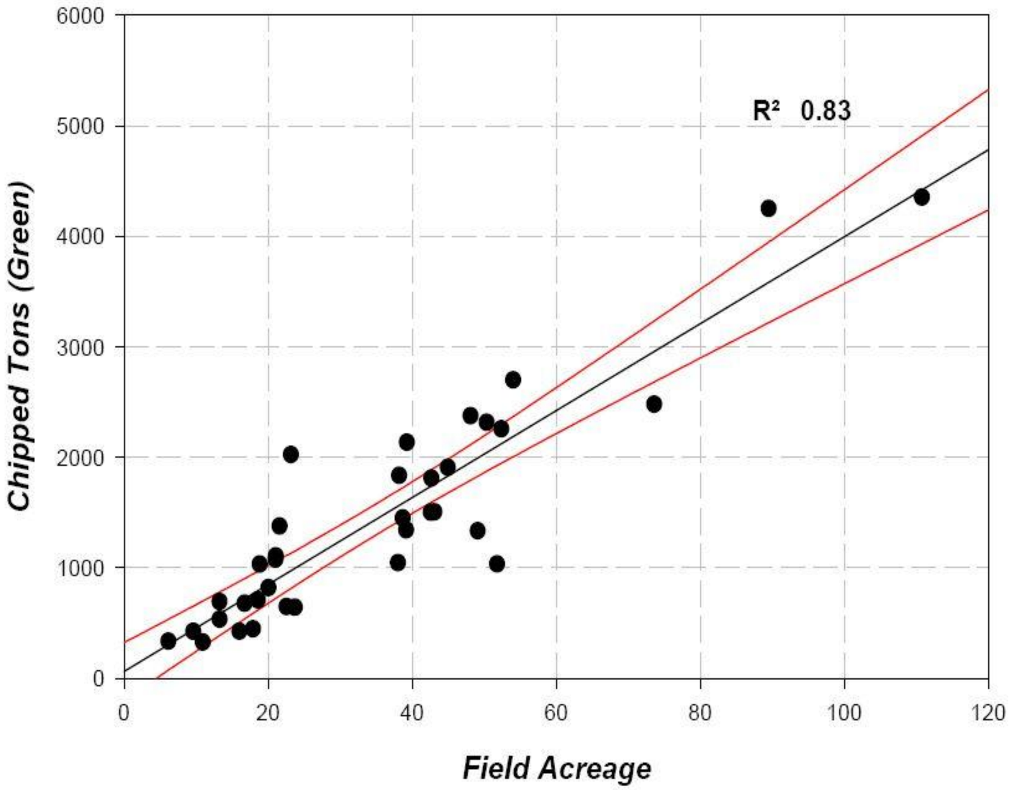
Results – Canopy Delineation



Results

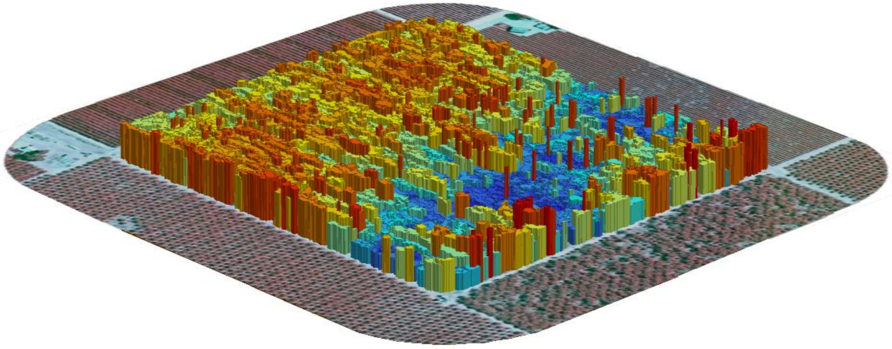
Take-home message:

Almond orchard biomass can be fairly <u>accurately estimated</u> using free/inexpensive imagery and advanced remote sensing analytical techniques with an object-based approach



Next Steps

1. Refine the method to estimate almond orchard biomass using remote sensing methods.
2. Explore the potential LiDAR mass point multi-return data to determine tree height and canopy extent.
3. Improve statewide geospatial dataset of almond orchards with crop mapping.



Almond Orchards and Greenhouse Gases: Impact of Nitrogen Fertilization

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Almond Orchards and Greenhouse Gases: Impact of Nitrogen Fertilization

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LEED Platinum

Department of Viticulture & Enology

University of California, Davis

Climate Change ● Sustainable Viticulture

Environmental Quality ● Flavor Chemistry

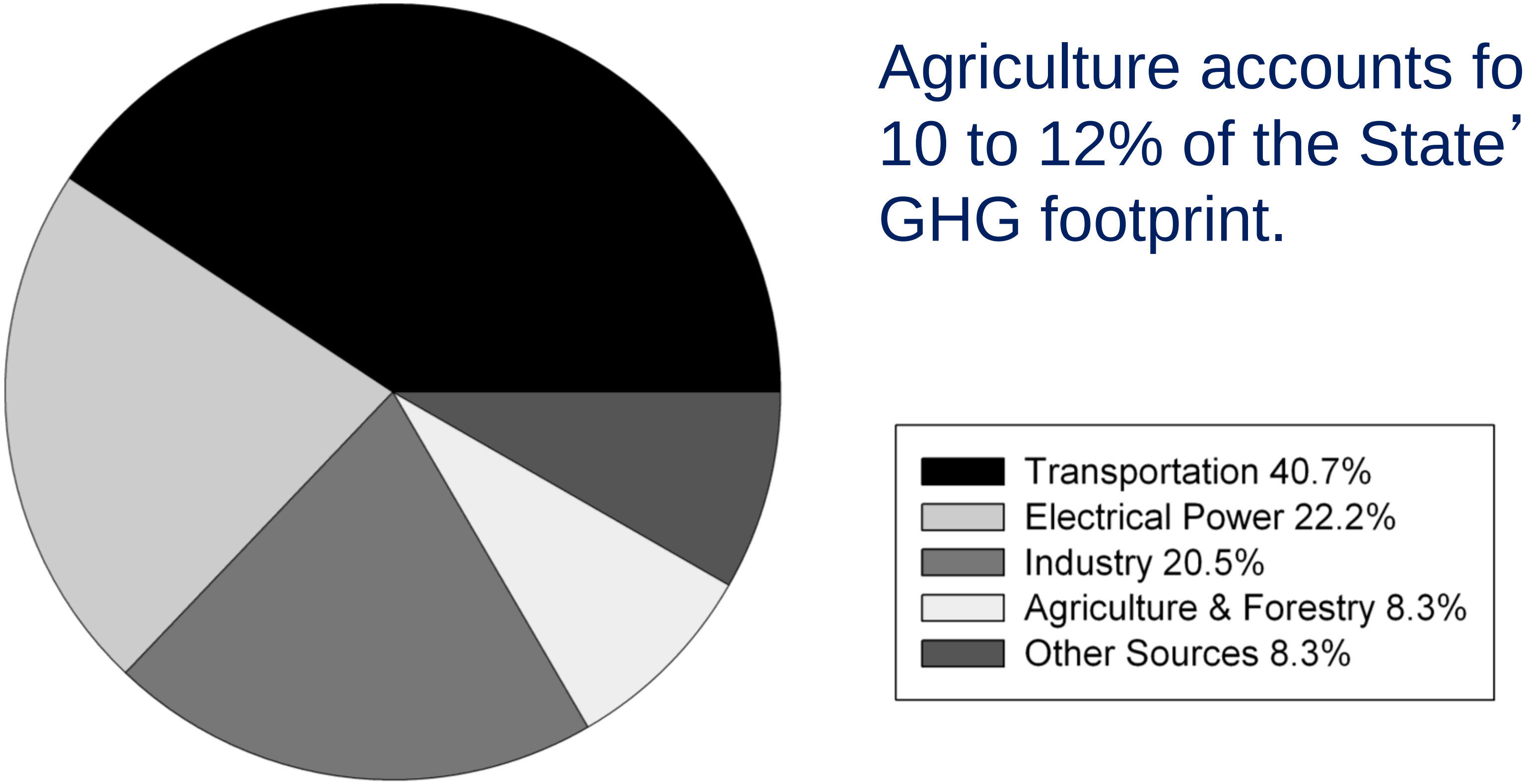
James Lovelock: The GAIA Hypothesis

Lovelock (1965) A physical basis for life detection experiments. Nature 207:568–570

Political Considerations:

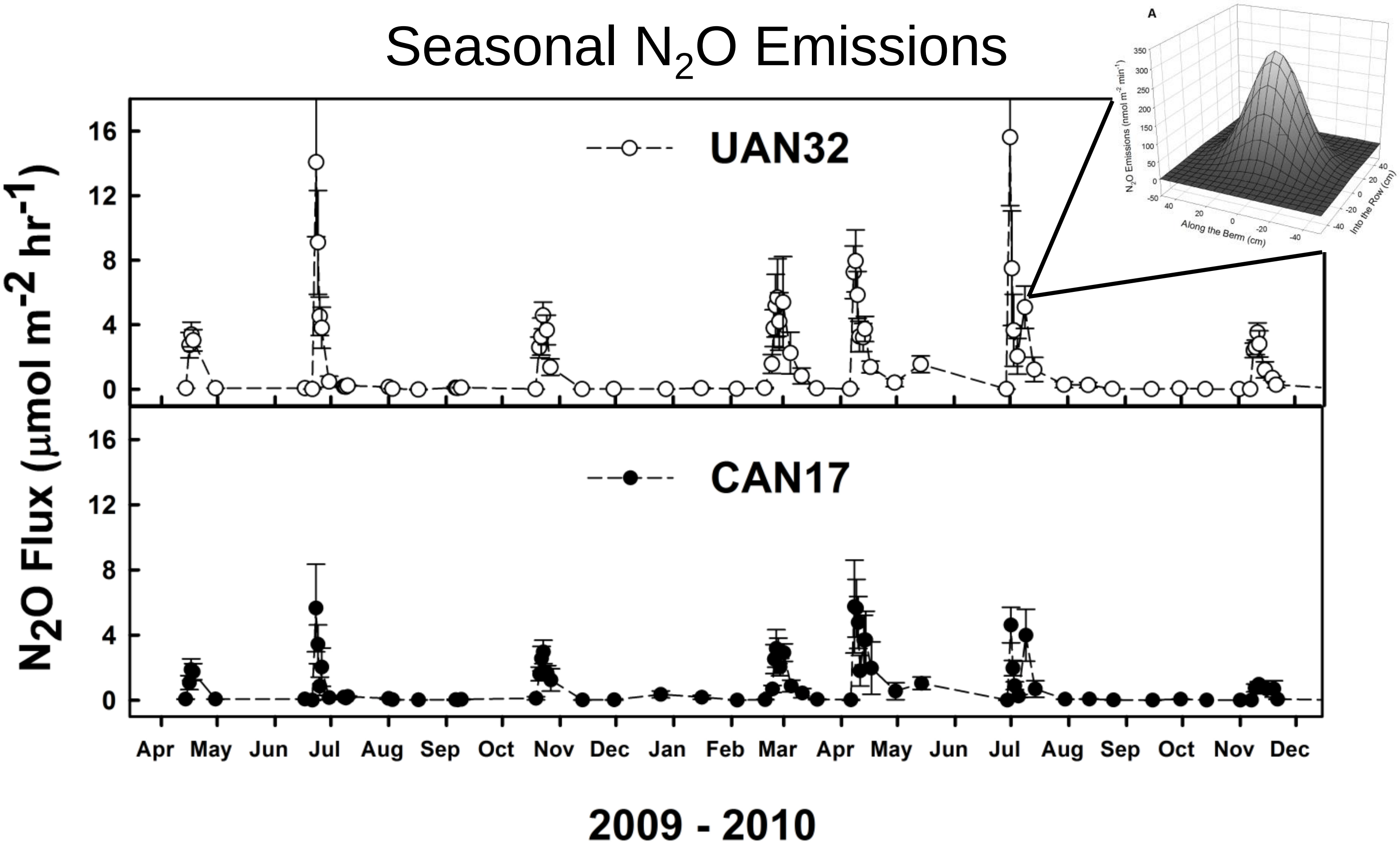
1) Executive Order S-3-05 signed by Governor Arnold Schwarzenegger on June 1, 2005.
2) California Global Warming Solutions Act AB32 signed into law on June 26th 2006.
3) United States Environmental Protection Agency, declared endangerment finding for GHG’s on December 7, 2009.
4) GHGs subject to regulation under conditions set forth by the Clean Air Act, Section 202(a).
5) GHGs now subject to regulation under the California Environmental Quality Act, CEQA.

Agriculture accounts for 10 to 12% of the State's GHG footprint.



Of Agriculture's 10 to 12% contribution, > 50% is attributed to N_2O.

Seasonal N_2O Emissions



D.L. Schellenberg et al., Agricultural Ecosystems and Environment, 2011

N_2O Footprints of California Almond Orchards

Crop	Management	N-Applied (lbs acre^{-1})	N_2O Emitted (lbs acre^{-1})	Fraction Emitted	N_2O-N Emitted (lb CO_2 acre^{-1} y^{-1})*	Location
Almond	**Conventional / CAN**	**200**	**0.48**	**0.24%**	**143.0 ± 26.7**	**Belridge CA**
Almond	**Conventional / UAN**	**200**	**0.74**	**0.37%**	**110.6 ± 23.4**	**Belridge CA**
Almond	**Conventional / Drip**	**235**	**1.48**	**0.63%**	**441.2 ± 60.1**	**Nickel**
Almond	**Conventional / Microjet**	**235**	**0.59**	**0.25%**	**175.1 ± 33.6**	**Nickel**

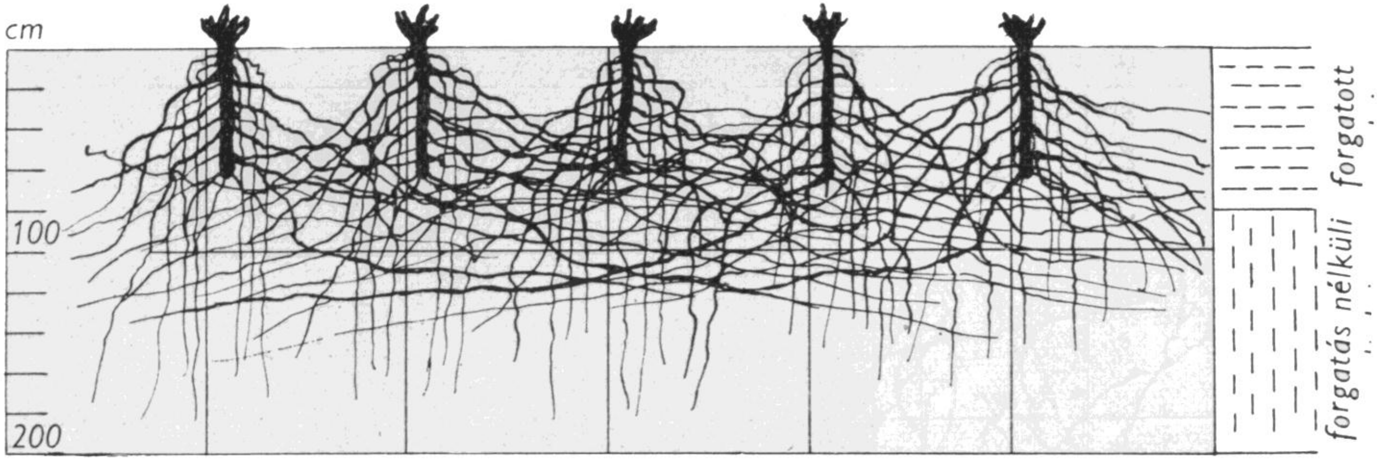
reported as CO_2 equivalents using the IPCC (2007) conversion factors.

Key: Multiple fertilizer-N applications at moderate rates of 35-50 lbs per acre, and targeted to tree demand and/or root growth!

Acknowledgements:

UC & UCCE: Daniel Schellenberg & Maria Mar Alsina, Blake Sanden, Patrick Brown and students, Nickels Soil Laboratory

Almond Board California: Gabrielle Ludwig, Robert Curtis, Paramount Farming Company



A Life Cycle Assessment of Energy and Greenhouse Gas Emissions for Almond Production in California

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Sonja Brodt, Agricultural Sustainability Institute, UC Davis

Elias Marvinney, Doctoral Student, Horticulture and Agronomy, UC Davis

Research Goals

Life cycle greenhouse gas (GHG) and energy "footprint" for California Almond production

- Stage 1: Field to Farm Gate
- Stage 2: Hulling and Shelling

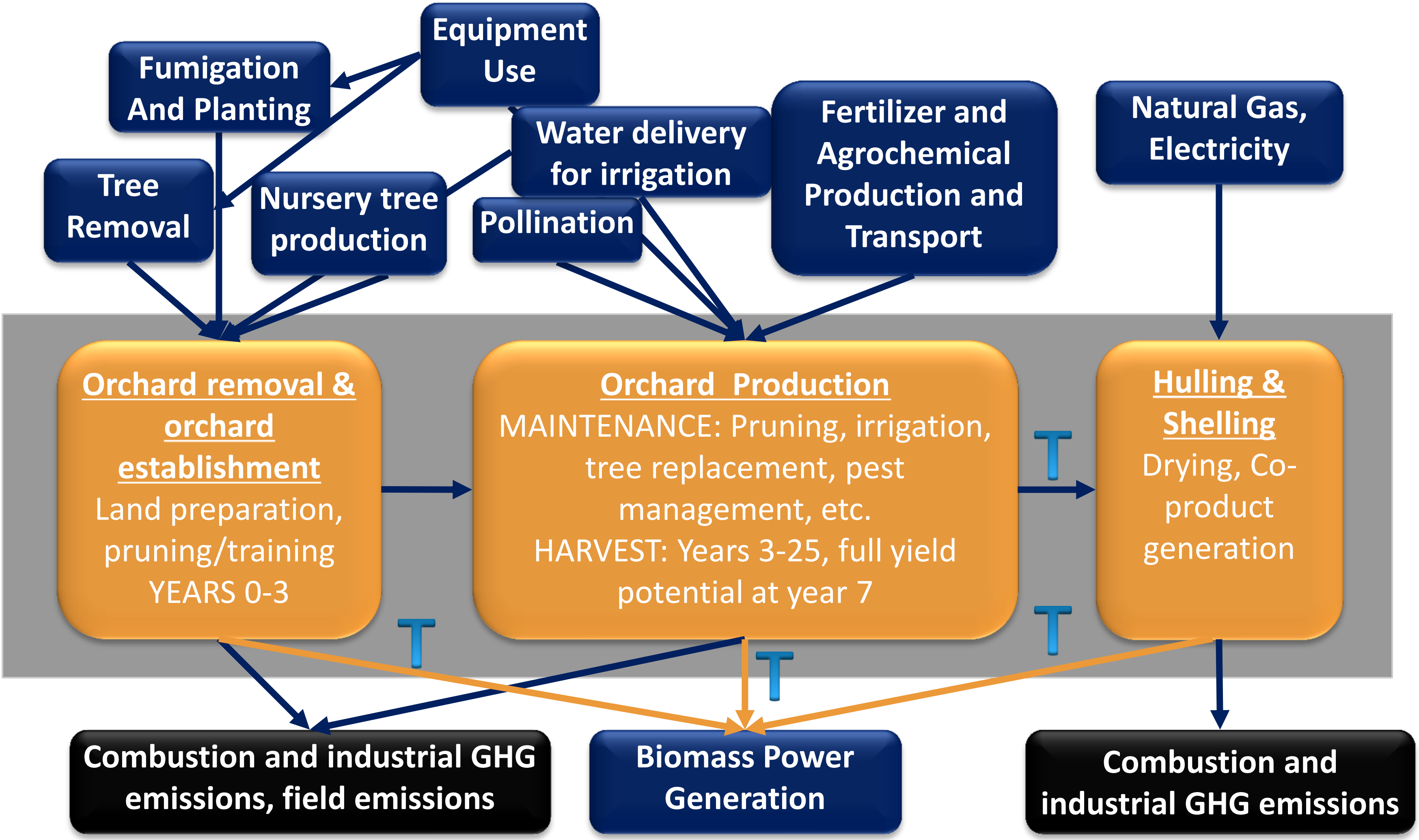
Why do these calculations matter?

- Consumer and retailer demand, particularly in Europe for "carbon footprints" (another phrase for life cycle GHG assessment)
- Potential AB32 Offsets
- Understand energy over the production life cycle to improve efficiency and mitigate energy-related costs

Life Cycle Assessment (LCA)

- An environmental accounting process applying a“cradle-to-grave” perspective for quantifying environmental impacts of products or systems
- Carbon or energy footprints are narrow applications of LCA
- We track GHGs, or carbon, in units of carbon dioxide equivalents, or “CO_2e”

Almond Production System



Equipment Use

Fumigation And Planting

Tree Removal

Nursery tree production

Water delivery for irrigation

Pollination

Fertilizer and Agrochemical Production and Transport

Natural Gas, Electricity

Orchard removal & orchard establishment
Land preparation, pruning/training
YEARS 0-3

Orchard Production
MAINTENANCE: Pruning, irrigation, tree replacement, pest management, etc.
HARVEST: Years 3-25, full yield potential at year 7

Hulling & Shelling
Drying, Co-product generation

Combustion and industrial GHG emissions, field emissions

Biomass Power Generation

Combustion and industrial GHG emissions

T = transport

Results by category and life cycle phase

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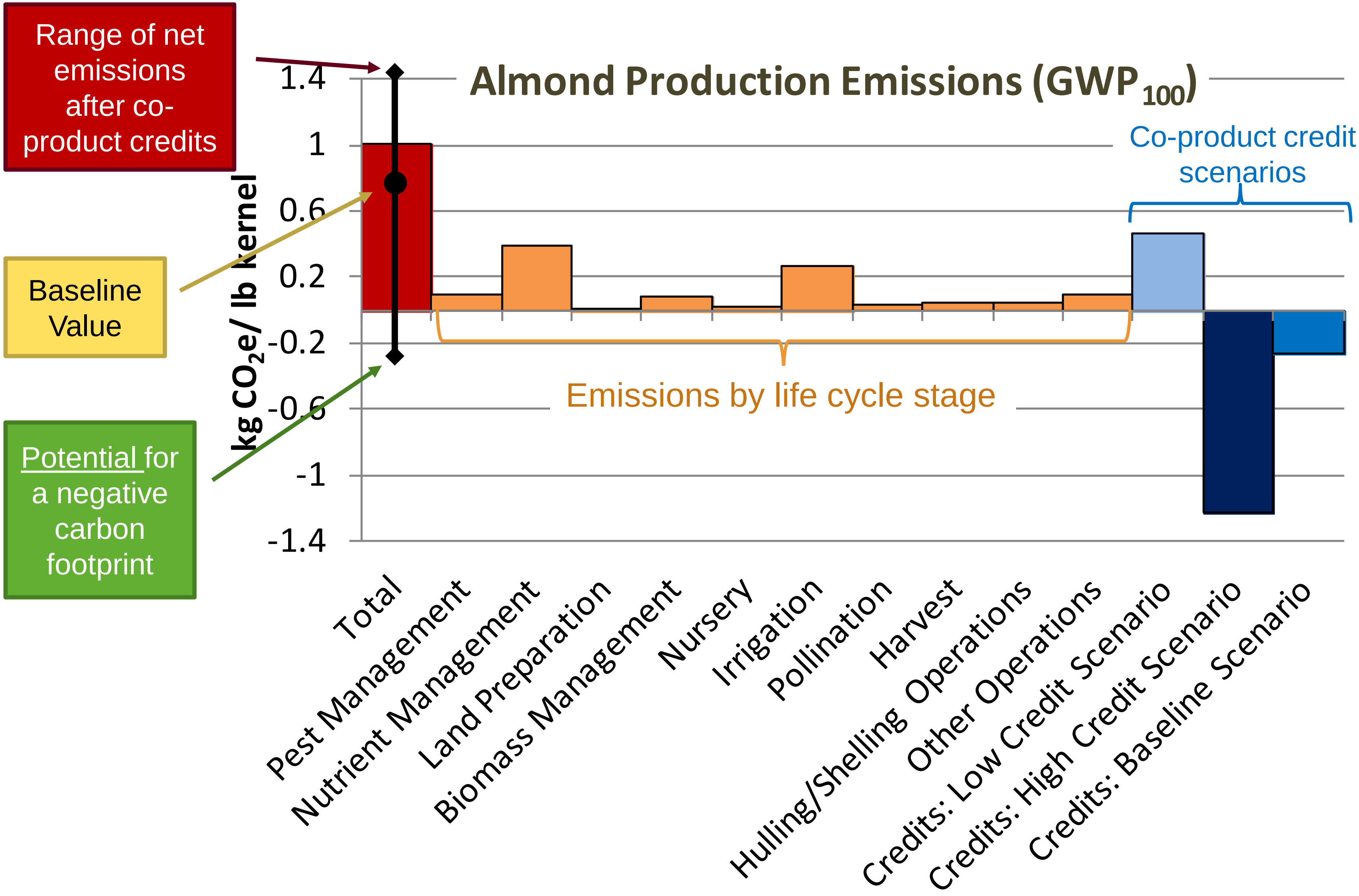
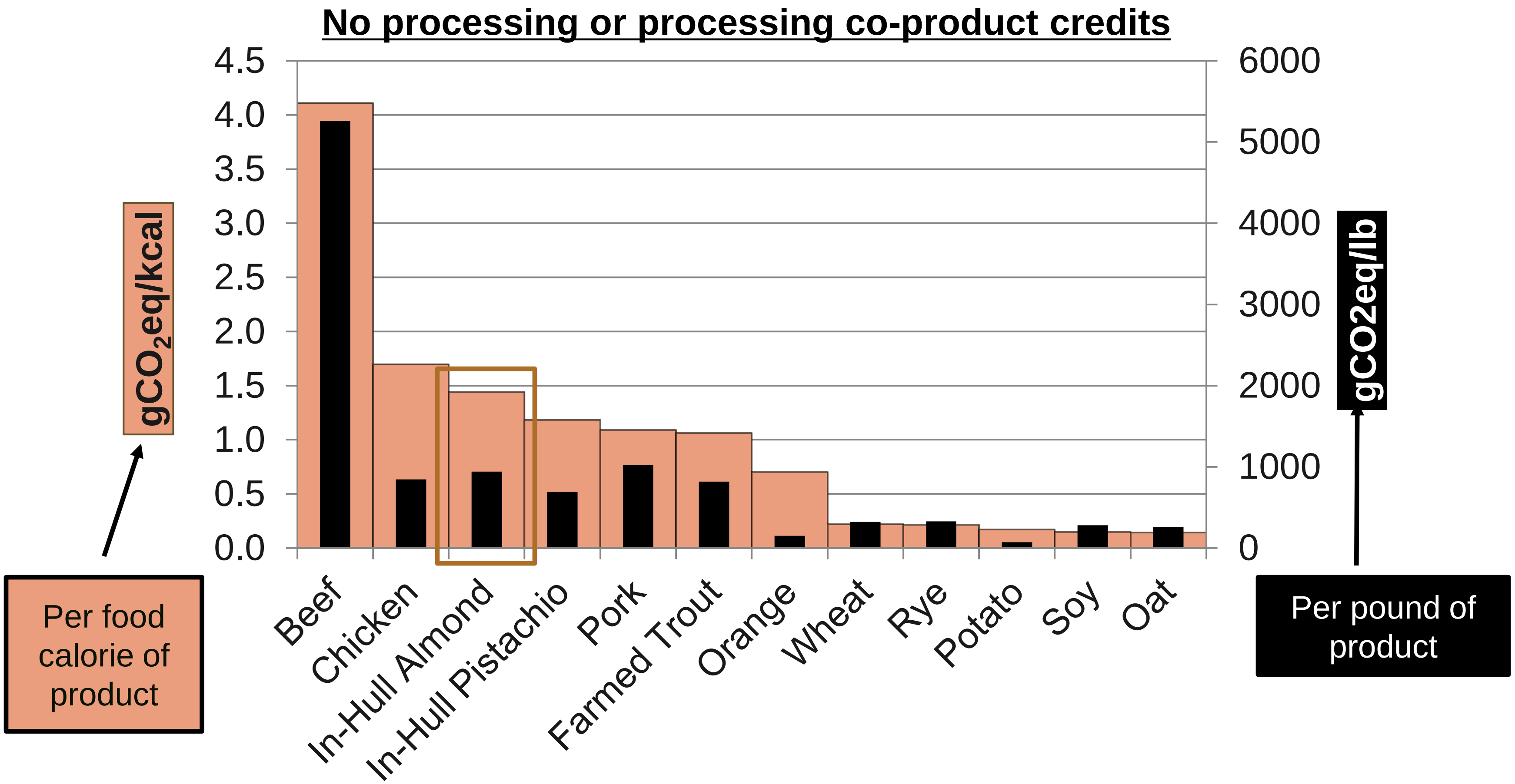


Results in Context – Foods at Farm Gate



*Note – While all results are based on life cycle calculations, only Almond and Pistachio calculations reflect the same assumptions and system boundaries

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Posters and Pollination Pavilion

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poster session maps