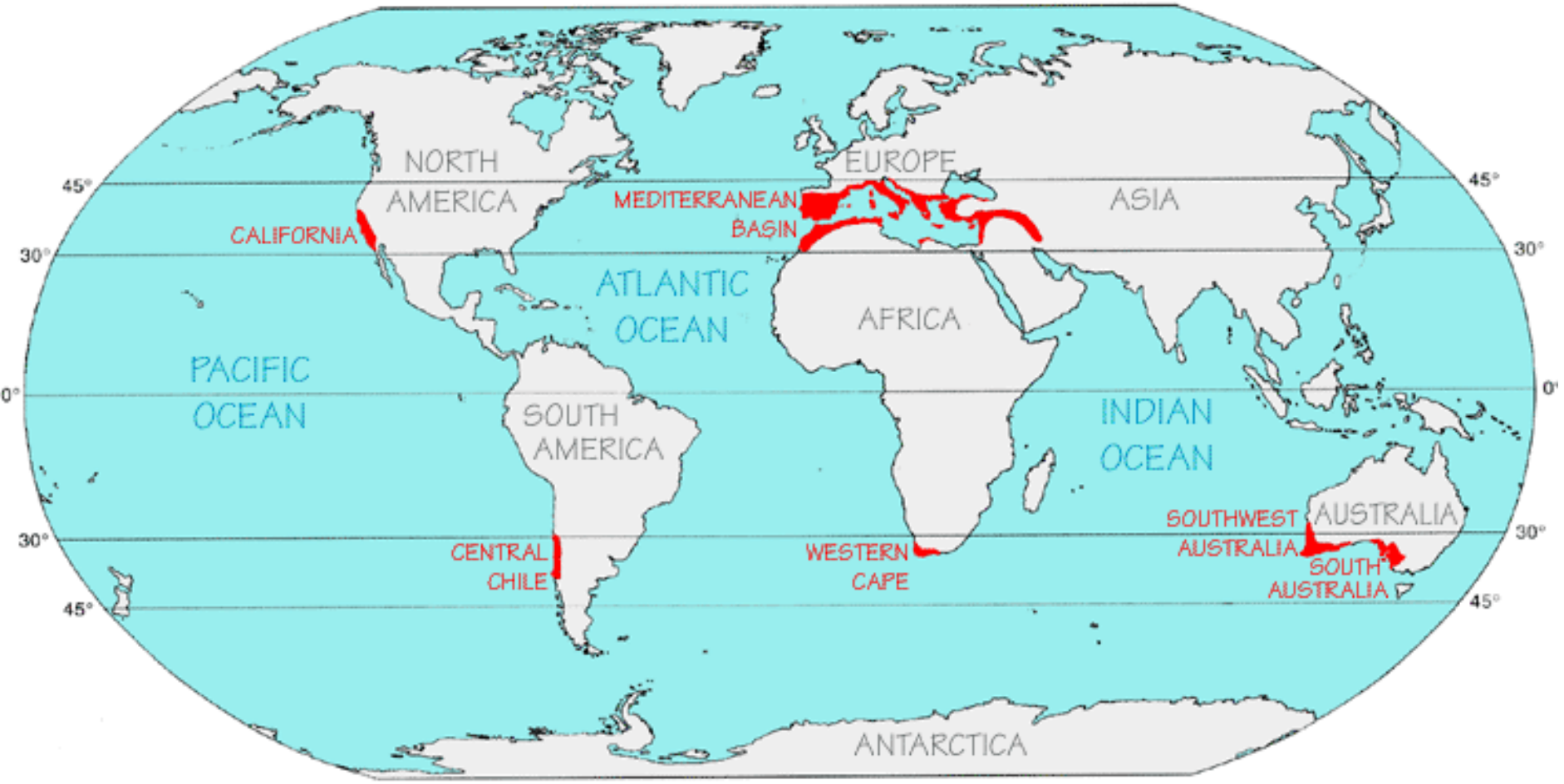
Research Update: i) mitigation of alternate bearing and, ii) disease management and cold tolerance

Elizabeth Fichtner, UCCE Tulare Co.

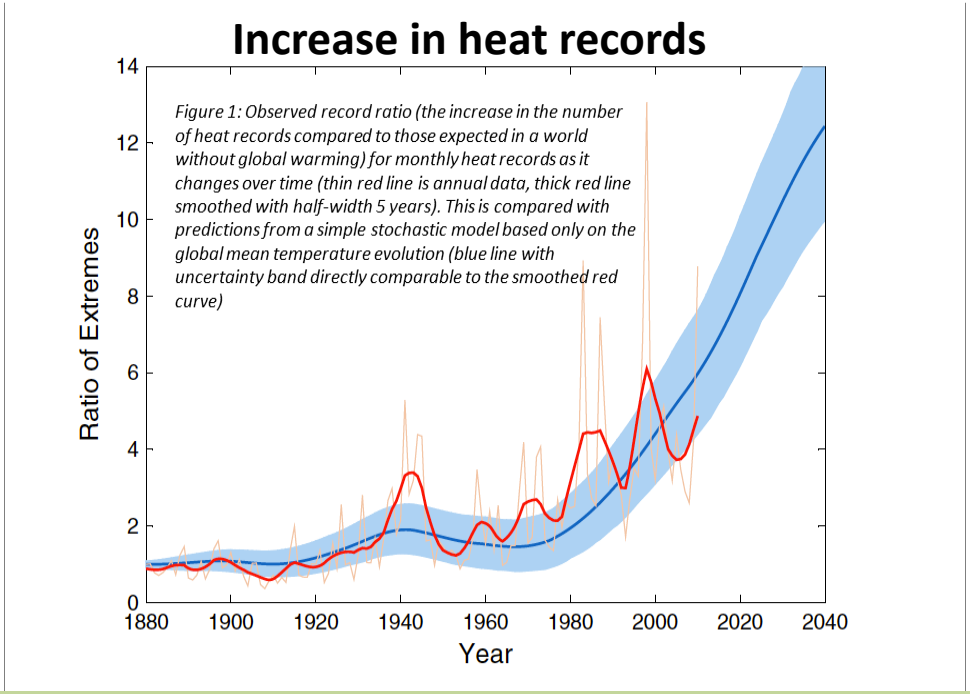
Olives: Native to Asia Minor (Anatolia)

Olives and the Mediterranean Climate:

- Long, hot growing season
- Cool winter
- Cold Injury below 25F; mortality below 15F
- Too humid---disease
- Too little chilling---no fruit



Commercial Olive Production: 30-45o N or S

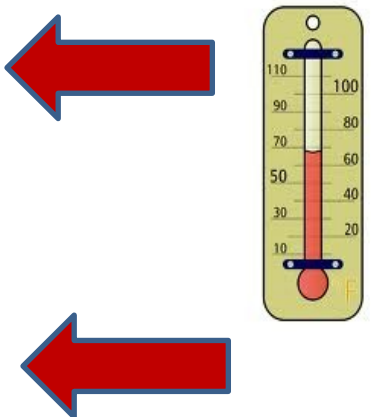


Anthropogenic vs. Natural

Tulare County Olive Production

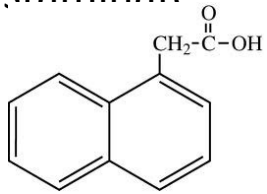
	(Tons/Acre)	Value ($)
2009 “OFF”	0.40	5.7 million
2010 “ON”	7.23	74.1 million
2011 “OFF”	1.82	23.3 million
2012 “OFF+”	3.55	35.8 million

Heat at bloom



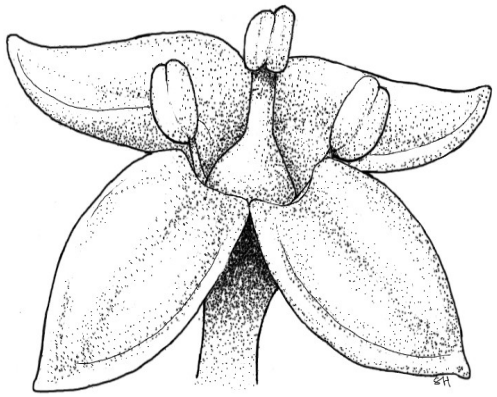
Alternate Bearing– initiated by factors either limiting or promoting production.

1. Climate/Environmental:
   -adverse conditions at bloom or fruit set.
   -cold/freeze damage.
   -stress prior to bloom (# staminate flowers)



2. Management of Crop load:
   -failure to thin
   -over-thinning with NAA

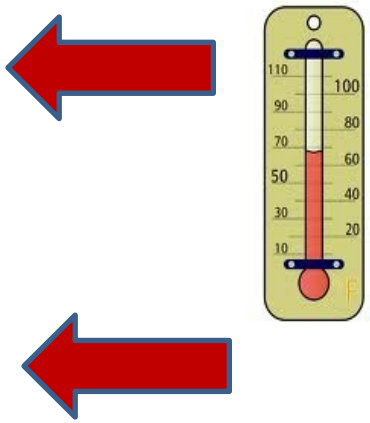
3. Harvest management
   ot economical)
   es)



'Andromonoecious'

Illustration: Stacy Hishinuma, UC Davis graduate student

Heat at bloom

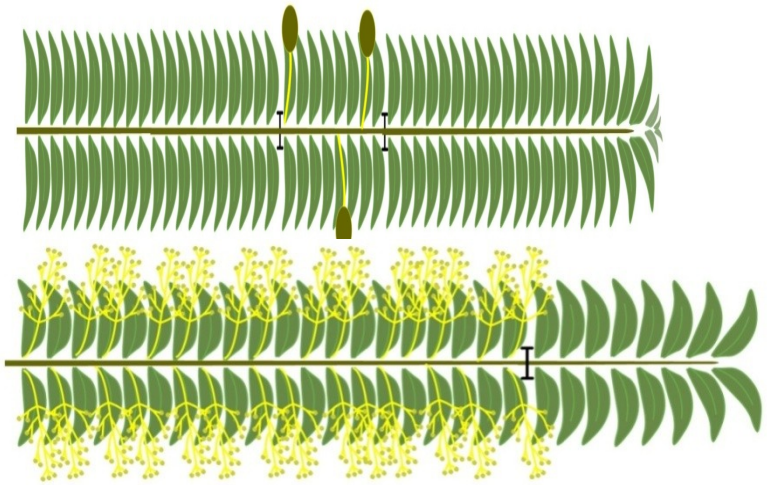


Shotberries

Pollination failure

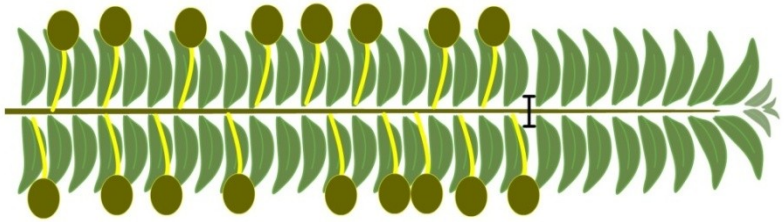
(not from an overabundance of staminate flowers)

Alternate Bearing Cycle Illustrated

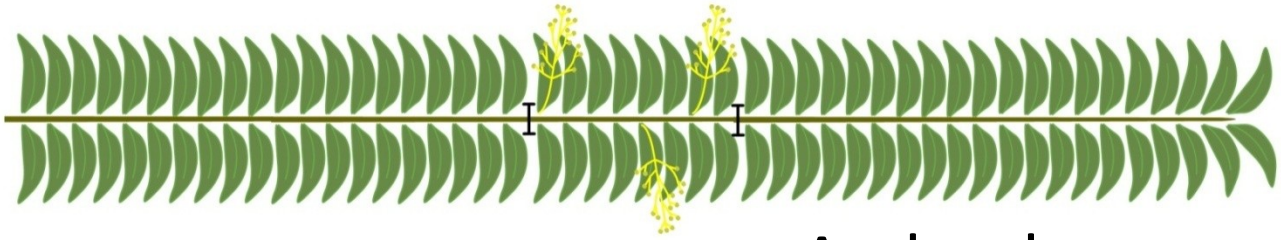


OFF year's vegetative growth

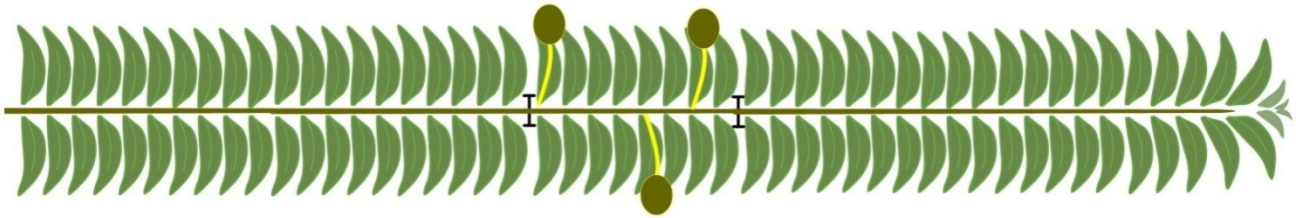
Supports next (ON) year's flowers



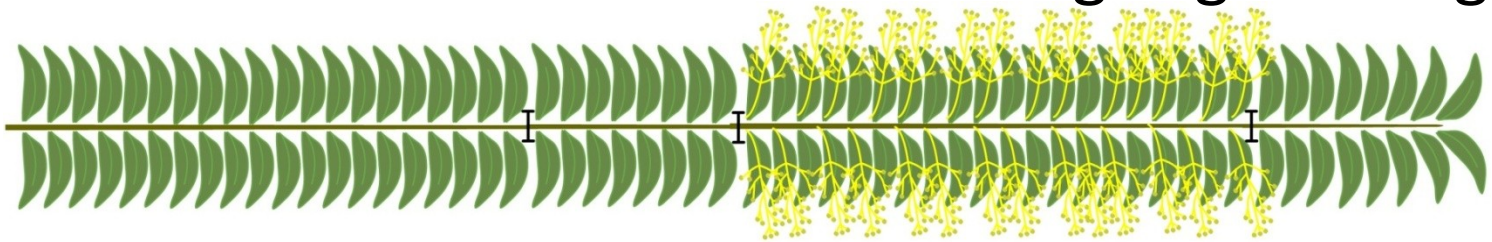
ON year's fruit load inhibits vegetative growth…



And reduces return bloom (OFF)…



And minimizes crop load (OFF)…
Promoting vegetative growth…



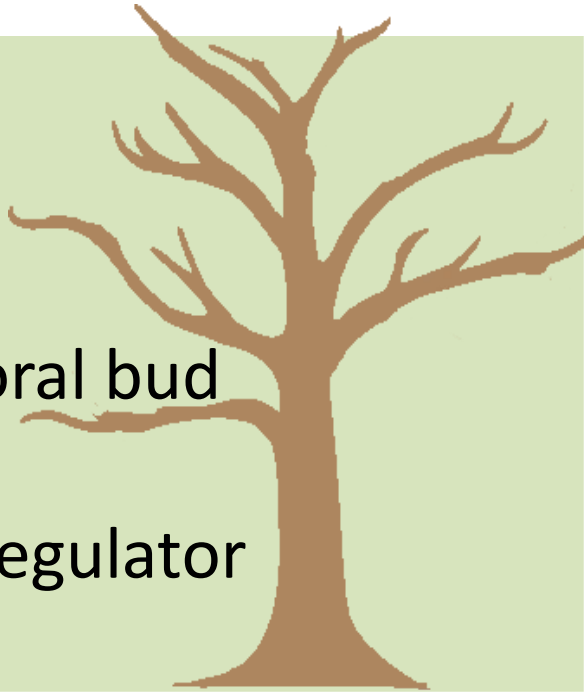
Enhancing return bloom (ON)…

Experimental Strategies to mitigate AB in olive

1. Enhance vegetative shoot growth—nodes for flower buds.
2. Increase floral bud break—push flower buds to open.
3. Maintain number of flowers capable of setting fruit (ie. pistillate)

Research Steps…

1. Understand the tree phenology.
2. Determine timing of fruit's impact on floral bud development.
3. Test Summer and Spring Plant Growth Regulator treatments.



The ON-crop reduces return bloom in olive by inhibiting bud break for summer vegetative shoot extension growth.

Lindcove: 2012- 2013

Tree Status	Branch Status	# Nodes July 2012	# Nodes July-Aug. 2012
ON Control	Fruit	0.2 b	0.5 b
OFF Control	No Fruit	2.2 a	2.9 a
ON Control	No Fruit	0.6 b	0.7 b
P value		≤0.0019	≤0.0047

During summer, one can see affect of bearing status on vegetative growth.

Tree Status	Branch Status	Δ Nodes Sept-Oct 2012	Δ Nodes Feb-Apr 2013
ON Control	Fruit	0.0 a	2.5 a
OFF Control	No Fruit	0.0 a	1.4 b
ON Control	No Fruit	0.0 a	1.7 b
P value		≤0.8732	≤0.0158

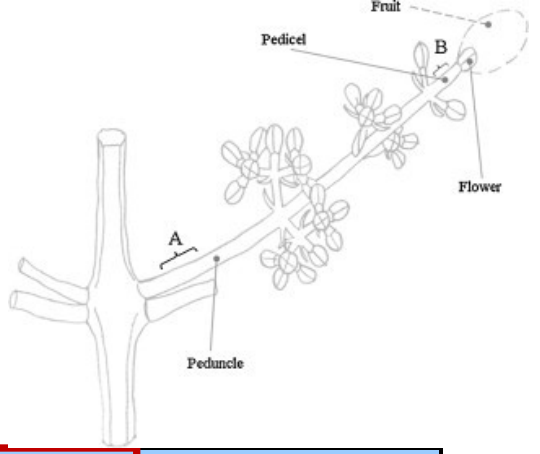
Minimal vegetative shoot growth during autumn;
Vegetative shoot growth during late winter and early spring- “the flip occurs”

The ON-crop reduces return bloom in olive by inhibiting floral development and/or spring bud break in Year 2 (2013).

				# of nodes in shoot section			
Tree Status 2012	**Branch Status**	**New Nodes April-May 2013**	**Total Influor.**	**1-5**	**6-10**	**11-15**	**16-20**
ON Control	Fruit	0.1 a	0.6 c	5.0 a	2.9 ab	2.0	.
OFF Control	No Fruit	0.3 a	9.3 a	5.0 a	3.5 a	1.9	5.0
ON Control	No Fruit	0.3 a	2.8 b	5.0 a	2.3 b	3.0	.
P value		≤0.6262	≤0.0001	≤0.4096	≤0.0443	.	.

				# inflorescences in shoot section			
Tree Status 2012	**Branch Status**	**New Nodes April-May 2013**	**Total Influor.**	**1-5**	**6-10**	**11-15**	**16-20**
ON Control	Fruit	0.1 a	0.6 c	0.6 c	0.1 b	0	.
OFF Control	No Fruit	0.3 a	9.3 a	5.5 a	3.3 a	0.9	2.5
ON Control	No Fruit	0.3 a	2.8 b	2.1 b	0.8 b	0	.
P value		≤0.6262	≤0.0001	≤0.0001	≤0.0002	.	.

Could not statistically analyze nodes 11-20; too few nodes to calculate standard deviation.



Floral Data at Bloom: 2013

Treatment	Branch Status	Total Inflorescences	Total Flowers	Total Pistils	Flowers/ Inflorescence	Pistils/flower
ON_Control	Fruit	0.4 b	0.0 b	0.0 b	0.0 a	
OFF_Control	No Fruit	9.2 a	24.6 a	21.4 a	3.3 a	
ON_Control	No Fruit	0.2 b	1.6 b	1.4 b	1.6 a	
P-value		≤0.0009	≤0.0001	≤0.0001	≤0.1745	

Tree Status affected:

Total influorescences
Total number of flowers
Total number of pistillate flowers

No influence on:

Flowers/inflorescence

Branch status may influence:

Percent of flowers that can set fruit.

Floral development is *not* inhibited by the ON-crop in olive so PGRs that increase spring bud break increase inflorescence number in Year 2 (2012).

Tree/shoot	Inflor. per	% Bud break of floral buds (spring 2012)			New nodes
status (2011)	5 shoots	Nodes 1-5	Nodes 6-10	Nodes 11-15	BB-May
	--no.--	*---------- % of Total inflor. ----------*			*--no.--*
OFF/-fruit	76.8 bz	142.7 ab	108.8 bcd	48.6 de	8.7 cdefg
ON/-fruit	66.6 bc	129.1 abc	90.7 cd	57.3 cd	16.7 ab
Jan TIBA+BA	52.6 bcd	88.6 cdefg	89.6 cd	45.6 de	9.0 cdef
Feb TIBA+BA	81.5 ab	121.3 abcd	123.4 abc	81.1 bcd	13.5 abc
Feb NATI+BA	84.3 ab	112.0 abcedf	127.7 abc	109.1 ab	14.0 abc
Feb TIBA+PCK	79.0 ab	121.1 abcd	111.5 bcd	76.5 bcd	12.1 bcd
Feb NATI+PCK	43.3 cde	66.0 fgh	73.1 d	45.8 de	15.5 ab
Feb BA	110.0 a	155.9 a	158.1 a	103.6 ab	9.4 cde
Feb PCK	111.0 a	138.3 ab	150.3 ab	127.4 a	8.0 defg
Mar TIBA+BA	76.6 b	102.1 bcdefg	128.5 abc	78.7 bcd	16.0 ab
Apr TIBA+BA	79.8 ab	116.0 abcde	125.6 abc	93.2 abc	16.0 ab

Benefit of February Cytokinin injection on inflorescence number.

PGR Branch Injections-inflorescence data reported as percent On Control (+ Fruit)

2 Timings: Summer, Summer+ Spring.

2 Cytokinins: Proprietary Cytokinin and 6BA

2 Auxin Transport Inhibitors: "Natural (NATI)

Treatment	Inflorescences (% control)
ON Control + Fruit	100.0 g
TIBA+6BA_SUM + Fruit	233.2 g
TIBA +PCK_SUM + Fruit	20.0 g
NATI + 6BA_SUM + Fruit	180.0 g
NATI + PCK_SUM + Fruit	40.0 g
TIBA_SUM + Fruit	13.4 g
NATI_SUM + Fruit	233.2 g
6BA_SUM + Fruit	23.2 g
PCK_SUM + Fruit	213.2 g
TIBA+6BA_SUM+SPR + Fruit	153.4 g
TIBA+PCK_SUM+SPR + Fruit	140.0 g
NATI+6BA_SUM+SPR + Fruit	46.6 g
NATI+6BA_SUM+SPR + Fruit	246.6 g
TIBA_SUM+SPR + Fruit	100.0 g
NATI_SUM+SPR + Fruit	60.0 g
NATI_SUM+SPR + Fruit	26.6 g
PCK_SUM+SPR + Fruit	25.0 g

Treatment	Inflorescences (% control)
OFF_Control_ NF	1767.8 bcd
ON_Control_NF	1168.0 cde
TIBA+6BA_SUM_NF	286.6 g
TIBA+PCK_SUM_NF	633.2 efg
NATI+6BA_SUM_NF	386.6 g
NATI+PCK_SUM_NF	273.4 g
TIBA_SUM_NF	206.6 g
NTIarig_SUM_NF	606.6 efg
6BA_SUM_NF	429.0 fg
PCK_SUM_NF	279.8 g
TIBA+6BA_SUM+SPR_NF	366.6 g
TIBA+PCKSUM+SPR_NF	273.4 g
NATI+6BA_SUM+SPR_NF	220.0 g
NATI+PCK_SUM+SPR_NF	453.2 fg
TIBA_SUM+SPR_NF	633.4 efg
NATI_SUM+SPR_NF	286.8 g
6BA_SUM+SPR_NF	113.2 g
PCK_SUM+SPR_NF	400.0 fg

Treatment	Inflorescences (% control)
ON Control + Fruit	100.0 g

Treatment	Inflorescences (% control)
OFF_Control_ NF	1767.8 bcd
ON_Control_NF	1168.0 cde

Treatment	Inflorescences (% control)
B.I.-Feb_TIBA+6BA + Fruit	445.8 fg
B.I.-Feb_NATI6BA + Fruit	482.1 efg
B.I.-Feb_TIBA+PCK + Fruit	608.1 efg
B.I.-Feb_NATI+PCK + Fruit	256.3 g
B.I.-Feb_6BA + Fruit	510.7 efg
B.I.-Feb_PCK + Fruit	642.0 efg
B.I.-Feb_TIBA + Fruit	592.9 efg
B.I.-Feb_NATI+ Fruit	485.7 efg

Treatment	Inflorescences (% control)
B.I.-Feb_TIBA+6BA_NF	2037.5 b
B.I.-Feb_NATI+6BA_NF	2107.1 ab
B.I.-Feb_TIBA+PCK NF	1975.0 b
B.I.-Feb_NATI+PCK NF	1083.3 def
B.I.-Feb_6BA_NF	2750.0 a
B.I.-Feb_PCK_NF	2775.0 a
B.I.-Feb_TIBA_NF	1850.0 bc
B.I.-Feb_NATI _NF	1085.7 def
P-value	<.0001

Treatments that enhanced inflorescences in comparison to non-bearing branches on ON trees.

Treatments that enhanced inflorescences in comparison to non-bearing branches on OFF trees.

Floral Data at Bloom 2013: Plant Growth Regulator Treatments

		Total Inflor	Total Flower	Total Pistil	Flowers per Inflor	Pistils per Flower
ON_Control	Fruit	0.4 b	0.0 d	0.0 d	0.0 a	0.0
TIBA+6BA_SUM	Fruit	0.0 b	0.0 d	0.0 d	0.0 a	0.0
TIBA+PCK_SUM	Fruit	0.2 b	0.4 d	0.4 d	0.4 a	1.0
NITA+6BA_SUM	Fruit	3.0 b	4.8 bcd	3.0 bcd	0.7 a	0.6
NITA+PCK_SUM	Fruit	0.0 b	0.0 d	0.0 d	0.0 a	0.0
TIBA_SUM	Fruit	0.0 b	0.0 d	0.0 d	0.0 a	0.0
NITA_SUM	Fruit	2.0 b	3.8 bcd	3.5 bcd	0.7 a	0.9
6BA_SUM	Fruit	0.3 b	1.7 cd	1.7 cd	1.7 a	1.0
PCK_SUM	Fruit	1.4 b	4.2 bcd	4.2 bcd	0.6 a	1.0
TIBA+6BA_SUM+SPR	Fruit	1.2 b	2.8 bcd	2.6 bcd	1.5 a	0.9
TIBA+ PCK_SUM+SPR	Fruit	0.0 b	0.0 d	0.0 d	0.0 a	0.0
NITA+6BA_SUM+SPR	Fruit	0.3 b	0.3 d	0.0 d	0.3 a	0.0
NITA+PCK_SUM+SPR	Fruit	0.0 b	0.0 d	0.0 d	0.0 a	0.0
TIBA_SUM+SPR	Fruit	1.3 b	1.5 cd	0.8 d	0.8 a	0.5
NITA_SUM+SPR	Fruit	0.8 b	2.3 bcd	2.3 bcd	0.8 a	1.0
6BA_SUM+SPR	Fruit	0.0 b	0.0 d	0.0 d	0.0 a	0.0
PCK_SUM+SPR	Fruit	0.0 b	0.0 d	0.0 d	0.0 a	0.0
OFF_Control	No Fruit	9.2 a	24.6 a	21.4 a	3.3 a	0.9
ON_Control	No Fruit	0.2 b	1.6 cd	1.4 d	1.6 a	0.9
TIBA+6BA_SUM	No Fruit	2.8 b	3.8 bcd	3.0 bcd	0.5 a	0.8
TIBA+PCK_SUM	No Fruit	4.2 b	10.4 bcd	9.2 bcd	1.2 a	0.9
NITA+6BA_SUM	No Fruit	1.6 b	6.6 bcd	6.4 bcd	0.8 a	1.0
NITA+PCK_SUM	No Fruit	0.2 b	1.0 d	1.0 d	1.0 a	1.0
TIBA_SUM	No Fruit	1.8 b	3.8 bcd	2.6 bcd	1.2 a	0.7
NITA_SUM	No Fruit	3.8 b	7.8 bcd	6.4 bcd	2.8 a	0.8
6BA_SUM	No Fruit	4.0 b	13.0 b	11.3 bc	2.5 a	0.9
PCK_SUM	No Fruit	0.8 b	2.2 bcd	1.8 cd	0.6 a	0.8
TIBA+6BA_SUM+SPR	No Fruit	2.0 b	12.4 bc	11.6 b	2.1 a	0.9
TIBA+PCK_SUM+SPR	No Fruit	0.0 b	0.0 d	0.0 d	0.0 a	0.0
NITA+6BA_SUM+SPR	No Fruit	2.0 b	3.3 bcd	2.5 bcd	0.6 a	0.8
NITA+PCK_SUM+SPR	No Fruit	3.8 b	10.4 bcd	4.2 bcd	1.1 a	0.4
TIBA_SUM+SPR	No Fruit	3.8 b	8.8 bcd	8.0 bcd	0.6 a	0.9
NITA_SUM+SPR	No Fruit	4.0 b	8.3 bcd	8.0 bcd	2.1 a	1.0
6BA_SUM+SPR	No Fruit	1.4 b	6.0 bcd	2.0 cd	0.9 a	0.3
PCK_SUM+SPR	No Fruit	4.0 b	7.2 bcd	5.8 bcd	1.1 a	0.8
P-value		0.0154	0.0098	0.0084	0.297	

PGR Treatments did NOT affect:

- Number of influorescences
- Number of flowers per influorescence

PGR Treatments did NOT affect:

- Total flowers on fruit-bearing branches on ON trees.

6BA Summer treatment:

Enhanced total flowers compared to non-bearing branches on ON trees.

		Jul - month nodes		New nodes	
		Feb	Apr	Dec-Feb	Feb-Apr
ON_Control	Fruit	0.8 l	3.3 jkl	0.1 lm	2.5 a
TIBA+6BA_SUM	Fruit	2.3 hijk	4.6 cdefghij	0.4 ghijklm	2.3 abc
TIBA+PCK SUM	Fruit	2.5 ghij	4.9 bcdefghij	0.1 lm	2.4 a
NATI+6BA_SUM	Fruit	2.7 fghij	4.2 fghijkl	0.2 ijklm	1.5 abcdefghi
NATI+PCK_SUM	Fruit	2.2 hijk	3.9 hijkl	0.2 ijklm	1.7 abcdefghi
TIBA_SUM	Fruit	2.4 hij	4.9 bcdefghij	0.6 defghijkl	2.5 a
NATI_SUM	Fruit	2.5 fghij	4.3 efghijkl	0.3 hijklm	1.8 abcdefg
6BA_SUM	Fruit	2.2 ijkl	4.2 fghijkl	0.4 ghijklm	2.0 abcdef
PCK_SUM	Fruit	2.6 fghij	4.7 cdefghij	0.1 lm	2.1 abcde
TIBA+6BA_SUM+SPR	Fruit	2.4 hij	4.5 defghijk	0.0 m	2.1 abcde
TIBA+PCK SUM+SPR	Fruit	3.0 efghi	4.5 defghij	0.4 fghijklm	1.6 abcdefghi
NATI+6BA_SUM+SPR	Fruit	2.6 fghij	5.0 abcdefghij	0.1 lm	2.5 a
NATI+ PCK_SUM+SPR	Fruit	2.2 ijk	3.7 ijkl	0.2 ijklm	1.5 abcdefghi
TIBA_SUM+SPR	Fruit	2.0 ijkl	4.1 ghijkl	0.2 klm	2.1 abcde
NATI_SUM+SPR	Fruit	3.1 defghi	5.5 abcdefghi	0.5 efghijklm	2.4 ab
6BA_SUM+SPR	Fruit	2.7 fghi	4.9 bcdefghij	0.2 jklm	2.2 abcd
PCK SUM+SPR	Fruit	1.3 jkl	2.5 l	0.3 ijklm	1.2 cdefghi
OFF_Control	No Fruit	3.6 abcdefgh	5.0 bcdefghij	0.2 jklm	1.4 bcdefghi
ON_Control	No Fruit	1.0 kl	2.7 kl	0.2 ijklm	1.7 abcdefgh
TIBA+6BA_SUM	No Fruit	3.8 abcdefg	4.7 cdefghij	0.8 bcdefgh	0.8 ghi
TIBA+PCK_SUM	No Fruit	4.7 ab	5.9 abcdefg	1.2 ab	1.1 defghi
NATI+6BA_SUM	No Fruit	4.8 a	6.3 abcd	0.8 bcdefg	1.5 abcdefghi
NATI+PCKSUM	No Fruit	4.5 abc	6.0 abcde	1.0 bcde	1.6 abcdefghi
TIBA_SUM	No Fruit	4.4 abcd	6.0 abcdef	0.7 cdefghij	1.6 abcdefghi
NATI_SUM	No Fruit	4.2 abcde	4.9 bcdefghij	1.0 abcd	0.7 hi
6BA_SUM	No Fruit	3.4 bcdefghi	4.0 hijkl	0.6 defghijk	0.7 i
PCK_SUM	No Fruit	4.3 abcde	5.5 abcdefghi	0.9 bcdef	1.2 defghi
TIBA+6BA_SUM+SPR	No Fruit	4.2 abcde	5.2 abcdefghi	0.7 cdefghij	1.0 fghi
TIBA+PCK SUM+SPR	No Fruit	4.8 a	5.7 abcdefgh	1.2 abc	0.9 ghi
NATI+6BA_SUM+SPR	No Fruit	3.9 abcdef	5.1 abcdefghi	1.0 abcd	1.2 defghi
NATI+PCK SUM+SPR	No Fruit	3.2 cdefghi	4.2 efghijkl	0.7 cdefghi	1.0 efghi
TIBA_SUM+SPR	No Fruit	4.8 a	6.5 ab	1.5 a	1.7 abcdefghi
NATI_SUM+SPR	No Fruit	4.5 abc	6.8 a	1.0 bcde	2.4 ab
6BA_SUM+SPR	No Fruit	4.8 a	6.4 abc	1.0 bcde	1.6 abcdefghi
PCK SUM+SPR	No Fruit	3.6 abcdefgh	4.7 cdefghij	0.9 bcdef	1.1 efghi
P-value		<.0001	0.0003	<.0001	0.0025

Plant Growth Regulator Injections: Vegetative Growth

Treatment Timing

* Summer 2012
* Summer 2012 + Spring 2013

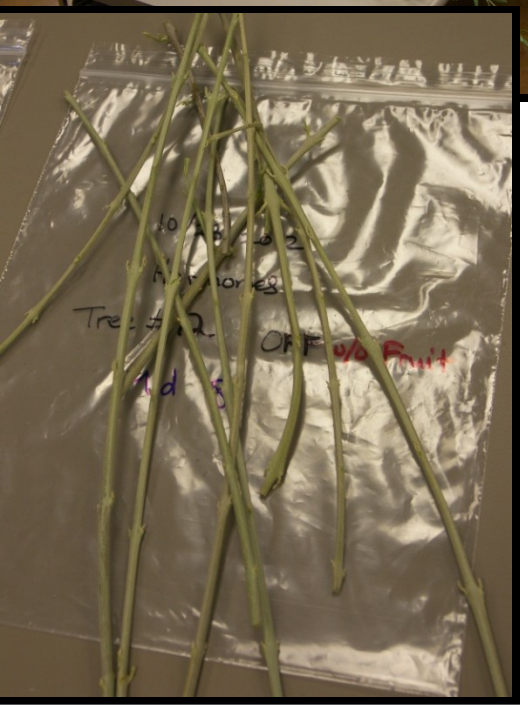
PGRs

Cytokinins: PCK, 6BA

Auxin Transport Inhibitors: NATI, TIBA

Highlight=significantly different than control

In general: Spring treatment no benefit over summer only



On-going Research

Preliminary work to determine:

a) when fruit inhibit vegetative shoot growth.

b) When flower buds are induced.

Monthly fruit removal from branches .

Collection of branch segments for analysis of:

-endogenous plant growth regulator production

-expression of floral genes (RNA extraction)

-visualization of bud anatomy

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Mandarin rootstock trial

Posted 8/19/2013 - The mandarin trees in this one-year-old rootstock trial at Lindcove are getting their annual health evaluations, conducted by Dr. Mikeal Roose and Dr. Tracy Kahn (UC Riverside, Dept. of Botany and Plant Sciences). The varieties in this...

Citrus Tristeza Virus-Infected Tree Removal

Posted 8/7/2013 - During the spring of 2013, all 12,000+ trees at the Lindcove Research and Extension Center were tested for citrus tristeza virus (CTV). This week, LREC staff treated and removed 36 CTV-infected trees. The CTV strains found at LREC have...

Alternate bearing research in olives

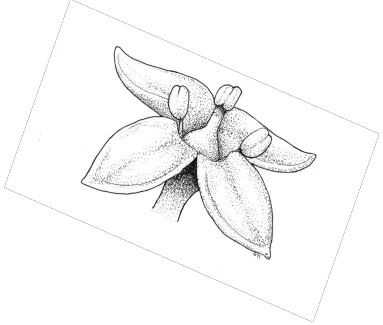
Posted 7/26/2013 - Lindcove REC has a small block of mature Manzanilla and Sevillano olive trees. In past years the trees have been used for olive fruit fly research and mechanical harvester field trials, but now are currently being used by Dr. Carol Lovatt,...

Neonicotinoid Uptake in Citrus Trees Tested at Lindcove

Posted 7/17/2013 - Field trials evaluating the systemic uptake of neonicotinoid insecticides into citrus trees are in their third year of evaluation at Lindcove REC. Dr. Frank Byrne (right) and Richard Aubert (left) from the Department of Entomology (UC...

CCPP Invites Industry to Collaborate

Posted 7/8/2013 - Citrus germplasm and nursery stock production have been through dramatic changes the last few years in California. The CCPP Foundation



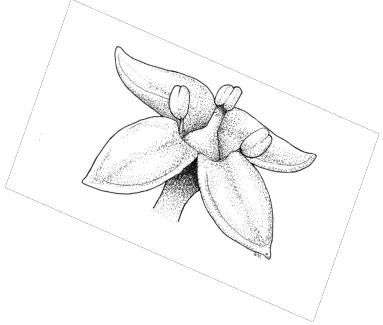
Major Progress Points:

1. Increased understanding of olive tree phenology and mechanism of AB.

    a) Model of branch/tree status affect on vegetative growth and return bloom.

    b) Model tree/branch status affects inflorescences, number of flowers, number of pistillate flowers, and % pistillate flowers.

    c) Floral buds may be present, but not break.



Major Progress Points:

2. PGR Treatments:

a) have identified PGR treatments (Feb) to enhance floral bud break, and

b) Summer treatments (August) for enhancing vegetative shoot growth.

Some potential for Summer + Spring treatment to enhance spring vegetative growth; may be of benefit in year 3.


Photo: **Donato Boscia**
CNR - Institute of Plant Virology, Bari (Italy)


Photo: **Donato Boscia**
CNR - Institute of Plant Virology, Bari (Italy)


Photo: **Donato Boscia**
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Photo: **Donato Boscia**
CNR - Institute of Plant Virology, Bari (Italy)

Olive Knot Disease

Pseudomonas savastanoi
formerly *P. syringae*

- Most important disease on olive worldwide.

- Geographic distribution expanding:
  - Egypt
  - Nepal
  - Australia
  - Turkey

- Girdles stems, branches, trunks

- Affects fruit flavor

Passive entry

Leaf scar infection; abscission in spring

Re-emergence of ‘old’ disease in new olive systems?

Higher planting densities- table and oil olives.

High plant density enhances disease severity

Tree damage caused by mechanized harvest

Harvest Timing:
Oil Olives Harvested in October-December

Current Management Strategies

- Prune out gall tissue
- Do not prune during rainy season (early summer-post fruit set)
- Post harvest application of Cu bacteriacides

Considerations and Concerns

1. Epiphytic populations serve as primary inoculum (Spain). Is pruning out galls enough?

2. How does epiphytic population vary during rainy season? Can one “get away” with early winter pruning?

3. Can pathogen survive as an “endophyte” (live inside plant)

4. Is there a possibility of Cu resistance in pathogen population?

Research Topics Addressed:

· Does mechanical harvest enhance tree damage compared to hand harvest?

· How long do galls produce viable inoculum (ie. how long are they infective)?

· Does epiphytic pathogen population density vary between sites and regions?

· Can pathogen live as an endophyte (inside the plant)?

· Is there potential for development of resistance to Cu?

· Does coating plants with film-forming polymers offer i) protection from cold, ii) protection from bacterial infection, iii) aid in Cu persistence?

2010: Mechanical Harvest Data

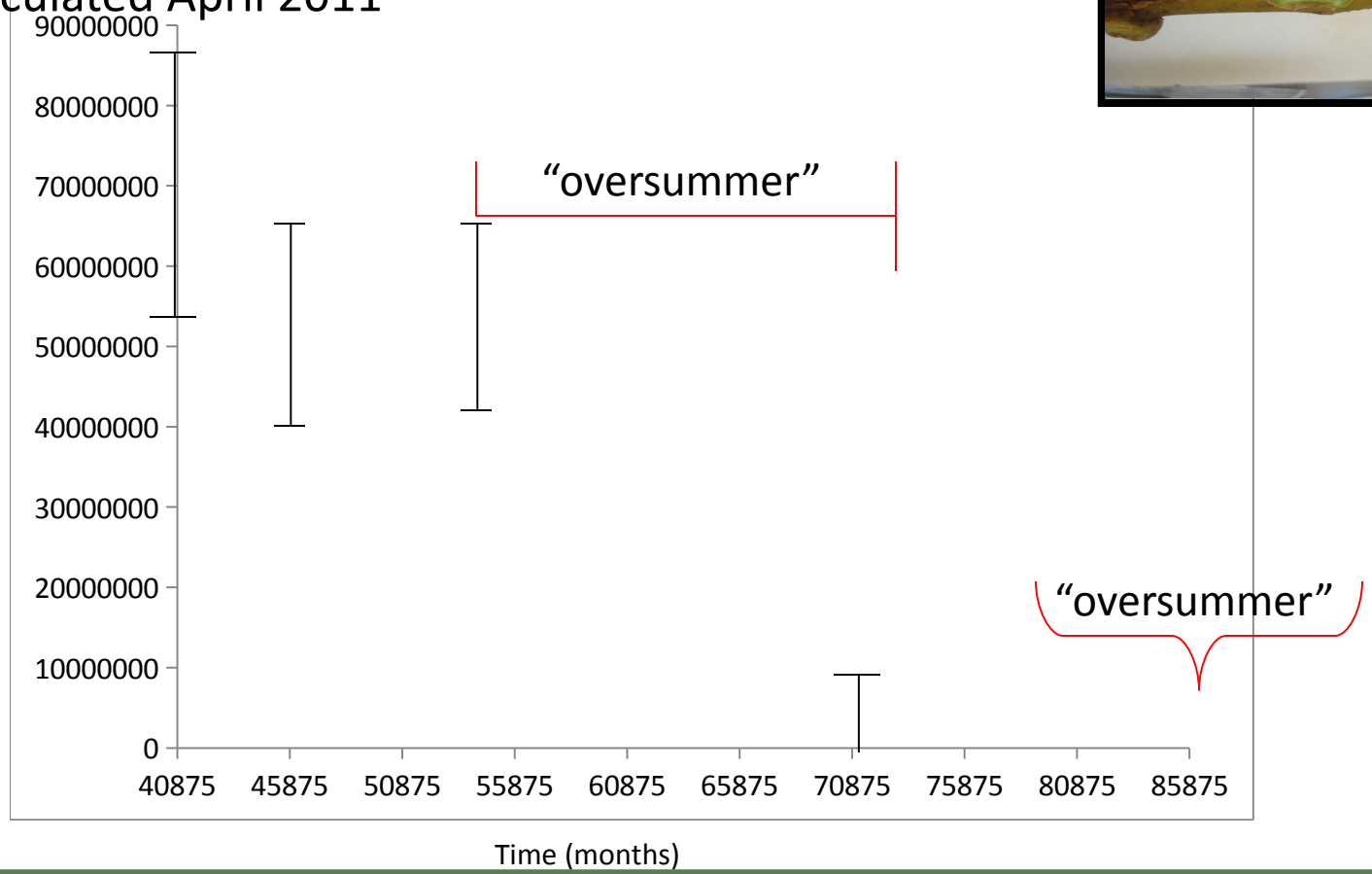
*Canopy contact harvester caused more tree damage than hand harvest.

·Wounds provide infection courts; disease likely if environment is conducive and pathogen population is available.

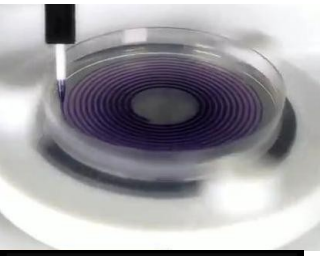
*Mechanical pruning reduces damage caused by canopy-contact harvester.

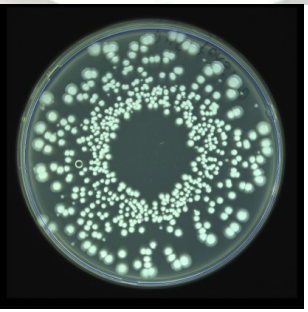
Survival determined in galls of uniform age over time.

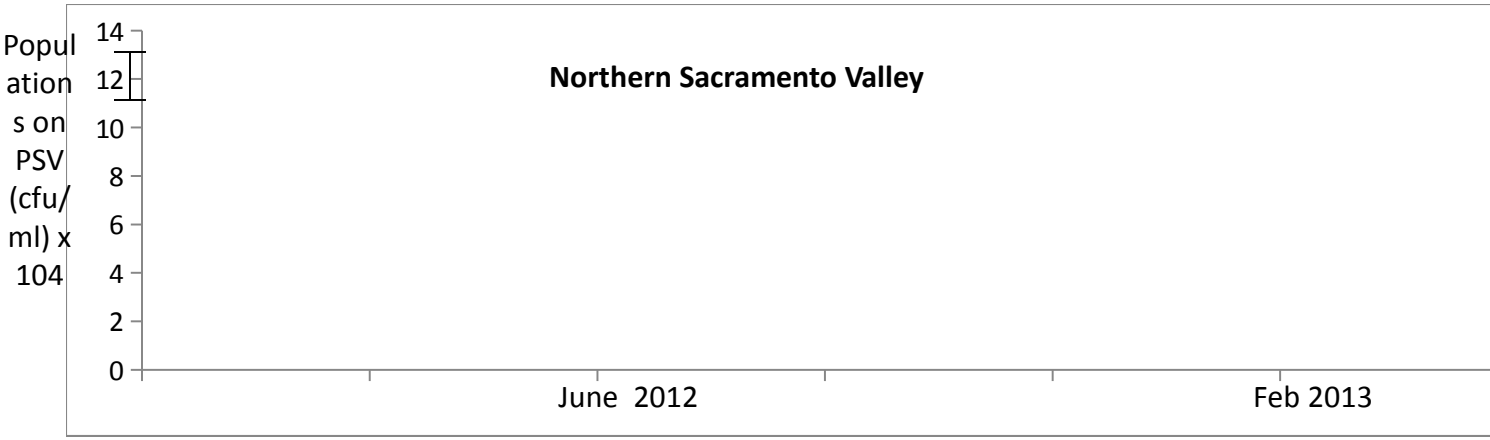
Leaf scars inoculated April 2011

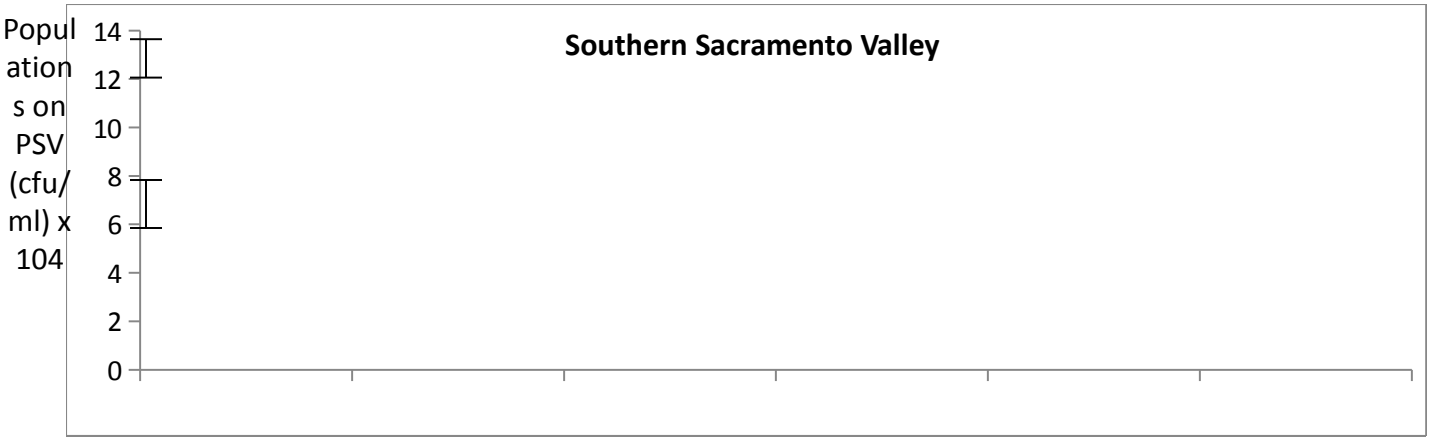


Infections formed in spring become symptomatic in late summer/early autumn; remain infective only 1-2 winters. Difficulty in timing pruning to manage disease!

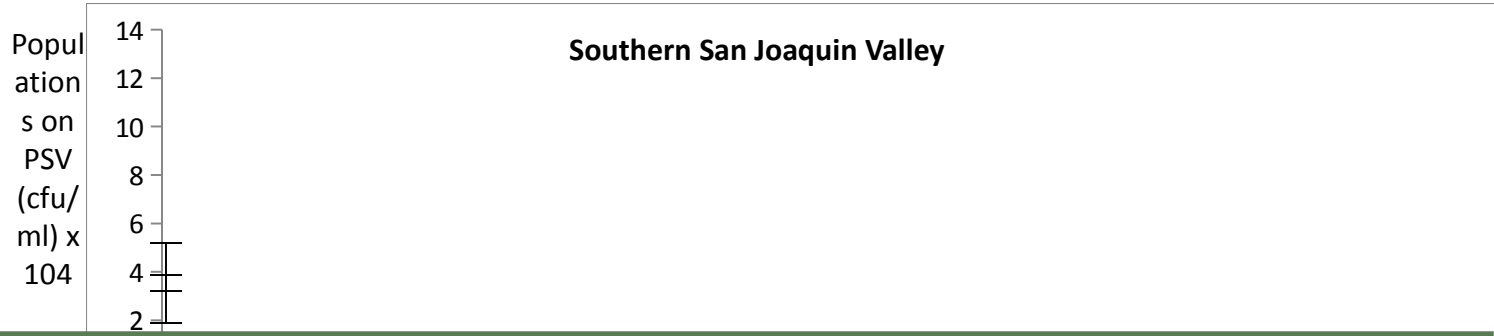








Epiphytic populations in CA olives

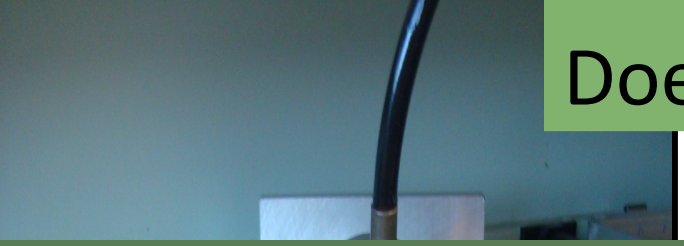


Populations vary between geographic regions and individual orchards.
Geographic differences only detectible after “wet” winter. Winter 2012/2013 = “low” pressure.

Pathogen populations differ between southern SJV and Sacramento Valley

* Sacramento Valley: 2 genes conferring Cu resistance
* Southern San Joaquin Valley: 1 gene conferring resistance

Dr. Ali Rhouma,
Borlaug Scholar

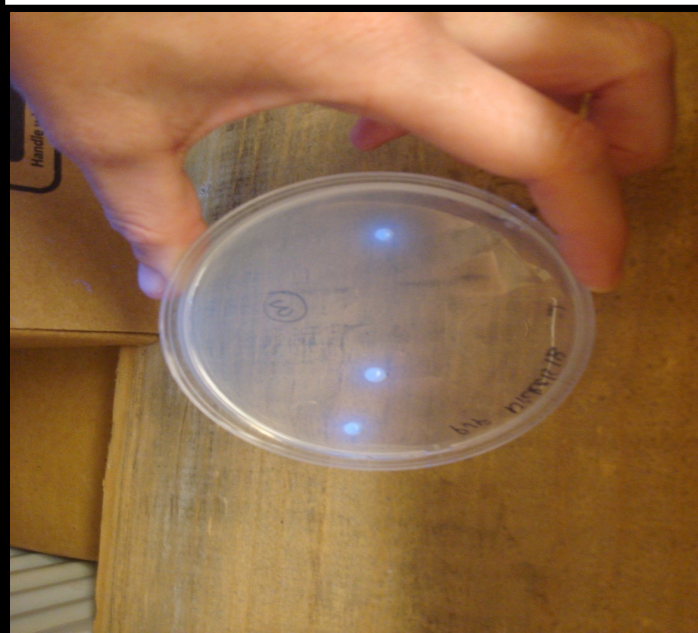


Does pathogen persist “inside” plant?

Paired Symptomatic and Asymptomatic branches

Pathogen unlikely to persist as an edophyte.

Removal of galls and reduction of epiphytic populations key to mgmt.



Film-Coating Polymers

Non-phytotoxic
Gas-permeable
Biodegradable

Weathering/persistence properties
Some OMRI Listed
Efficacy for protection from fungi

Physical barriers to infection?
Protect from frost/freeze?
Additional/alternative to Cu?

FreezePruf HortTech.pdf - Adobe Reader

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Technology and Product Reports

A Topical Spray to Enhance Plant Resistance to Cold Injury and Mortality

David A. Francko[1,4], Kenneth G. Wilson[2], Qingshun Q. Li[3], and Maria A. Equiza[2,5]

Additional index words. ornamentals, fruit crops, azalea, *Begonia*, *Clematoclethra actinotricha*, *Citrus limon*, *Citrus sinensis*, *Citrus×tangerina*, *Fragaria ×ananassa*, *Lycopersicon esculentum*, *Musa lasiya*, *Musa acuminata*, *Rhododendron indica*, *Rosa chinensis minima*, *Salal palmetta*, *Spathiphyllum*, *Trachycarpus fortunei*

Summary. A novel topical spray was developed to increase resistance to both cold damage and cold mortality in plant foliage, flowers, and fruits. In environmental chamber experiments, application of the spray to monocot and dicot foliage lowered the environmental temperatures associated with the first onset of cold injury and with cold mortality from 2.2 to 9.4 °F, compared with controls sprayed with tap water, over an effective temperature range (depending on species) of +9 to 32 °F. The threshold temperature for flower mortality was lowered from 2.2 to 8.2 °F depending on species. Mature fruit suffered significantly less freeze damage when pretreated with the spray formulation. The spray is composed of ingredients that are non-toxic to plants, humans, and other animals. The patent-pending formulation has been commercialized under the trade name FreezePruf.

The severity and duration of low temperatures that cause frost or freeze damage in plant tissues and organs are important abiotic factors limiting plant distribution and horticultural economics. Commercial growers often experience periodic frost/freeze damage to their crops even in areas where those species are normally well adapted. Many plant enthusiasts grow species at or even beyond their nominal U.S. Department of Agriculture (USDA) Plant Hardiness Zone ratings. Thus, there is great interest in developing methods to improve the cold tolerance characteristics of existing plant cultivars.

The variable ability of plant species to withstand frost or freeze conditions is genetically determined, and cold-tolerant plants, like their animal counterparts, exhibit two interrelated cold tolerance strategies: freeze tolerance and freeze avoidance (Lee, 1991). Freeze avoidance mechanisms use a variety of cryoprotectant molecules and other strategies that lower the intracellular freezing temperature (supercooling). For example, Francko and Wilson (2004) demonstrated that although cold hardy palms (Palmae) exhibit a significant constitutive foliar cold-resistance capability, enhanced cold tolerance (an additional 5 to 10 °F) can rapidly be induced by exposure to above-freezing chilling temperatures. Freeze-point depression and thermocouple studies conducted on chinese windmill palm [*Trachycarpus fortunei* (Larcher et al., 1991)] and needle palm [*Rhapidophyllum hystrix* (Taskaya, 2006)] point to supercooling enhancement as a likely freeze-avoidance mechanism involved in cold acclimation. However, supercooling alone is insufficient to protect plant tissues when temperatures drop low enough for ice crystals to form. Freeze tolerance mechanisms involve structural, anatomical, and biochemical adaptations to prevent or minimize damage to cells and tissues caused by ice formation. For example, addition of soluble silicates to soil media may enhance cold tolerance in crops via silica deposition-induced strengthening of cell walls (PQ Corporation, 2008). Larcher et al. (1991) suggested that low supercooling points noted in chinese windmill palm may have been due at least in part to cell walls strengthened with silica.

Thus, a topical spray designed to improve plant cold tolerance would ideally enhance both freeze avoidance and freeze tolerance mechanisms. To date, limited success has been reported in the development of foliar sprays designed to enhance supercooling in or on plant leaves and thus reduce frost, freeze damage, or both. These methods induce freezing point depression, inhibit ice-nucleating bacteria via

This work was supported by grants from the Ohio Plant Biotechnology Consortium, a Miami University Academic Challenge research grant, and the University of Alabama.

Under a licensing agreement between the University of Alabama and GeoTechnics, LLC, The Liquid Fence Company is sublicensed to produce and distribute FreezePruf and EcoLogic FreezePruf to homeowner and some professional markets. Additional sublicensing agreements are in process.

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
2.7936	gal	L	0.2642
1	ppm	$mg \cdot L^{-1}$	1
0.9464	qt	L	1.0567
(°F − 32) ÷ 1.8	°F	°C	(1.8 × °C) + 32

http://pro.liquidfence.com/tech/pdf/EcologicFreezePruTDS.pdf

pro.liquidfence.com

freeze pruf

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EcoLogic

TECHNICAL DATA SHEET: Eco-safe Plant Frost Protectant

FreezePruf

Features and Benefits

- Improves cold tolerance 2° to 9° Fahrenheit, depending on plant variety
- Protects both externally and systemically
- Shields foliage & flower from ice crystal damage
- Biodegradable, non-toxic
- No REI
- Protection lasts up to 4 weeks

Active Ingredients (Concentrate %s)

Polyethylene glycol 8000 6.0000%
Silicic acid, potassium salt 0.7510%
Silicone Polyether Copolymer 0.5000%
Glycerin 0.2500%
Bicyclic Oxazolidines 0.0165%

Other Ingredients (Concentrate %s)

Water 90.4835%

Physical and Chemical Characteristics

Form: Liquid
Viscosity: 1.2 cP @ 20°C
Specific Gravity: 1.006 g/mL @ 20°C
Color: Colorless
Odor: Mild
pH: Concentrate - 9.5 Ready To Use - 8
Solubility in Water: Miscible
Reactivity in Water: None

Mix / Spread & Coverage Rates

General application: Agitate well before each use. Dilute 1:4; 32 Ounces of Concentrate makes 1 Gallon of sprayable product. Apply to runoff.

Product Size Availability

Quart, Gallon, 2.5 Gallon, 15 Gallon, 50 Gallon and 250 Gallon Concentrates

A scientific breakthrough

Liquid Fence® FreezePruf™ is a foliar / floral spray that increases plant resistance to both cold damage and cold mortality. Application of FreezePruf to healthy foliage or flowers of both monocot and dicot plants improves cold tolerance by approximately 2° to 9°F, depending on the variety of plant and the duration / intensity of frost or freeze event.

Developed by botanists at The University of Alabama and Miami University (Ohio), FreezePruf protects the plant externally and systemically by enhancing its natural antifreeze-like properties. It also adds extra frost / freeze protection capacity to a plant's normal capabilities without replacing or diminishing the plant's native capacity. It's as though FreezePruf moves the planting location 200 miles south, the equivalent of about one half of a USDA zone.

The test results are obvious... FreezePruf improves a healthy plant's natural cold tolerance by approximately 2 to 9 degrees Fahrenheit.

How it works

FreezePruf is a proprietary combination of cryoprotectants, a surfactant, a cell wall reinforcing compound and an antidessicant. This patented combination produces a synergistically beneficial effect on plant foliage and flowers, including:

- Reduces the environmental temperature at which foliage and flowers first become damaged or are killed by cold.
- Improves healthy plants' cold tolerance by approximately 2° to 9° F, depending on the variety of plant and the duration / intensity of the frost or freeze event.
- Enhances the strength of cell walls.
- Depresses the freezing point of both intracellular and extracellular compartments in plant tissue.
- Stabilizes cell membranes against ice crystal damage.

Downloaded (1.65 MB of 1.70 MB) : http://pro.liquidfence.com/tech/pdf/EcologicFreezePruTDS.pdf

6:23 PM 7/23/2013

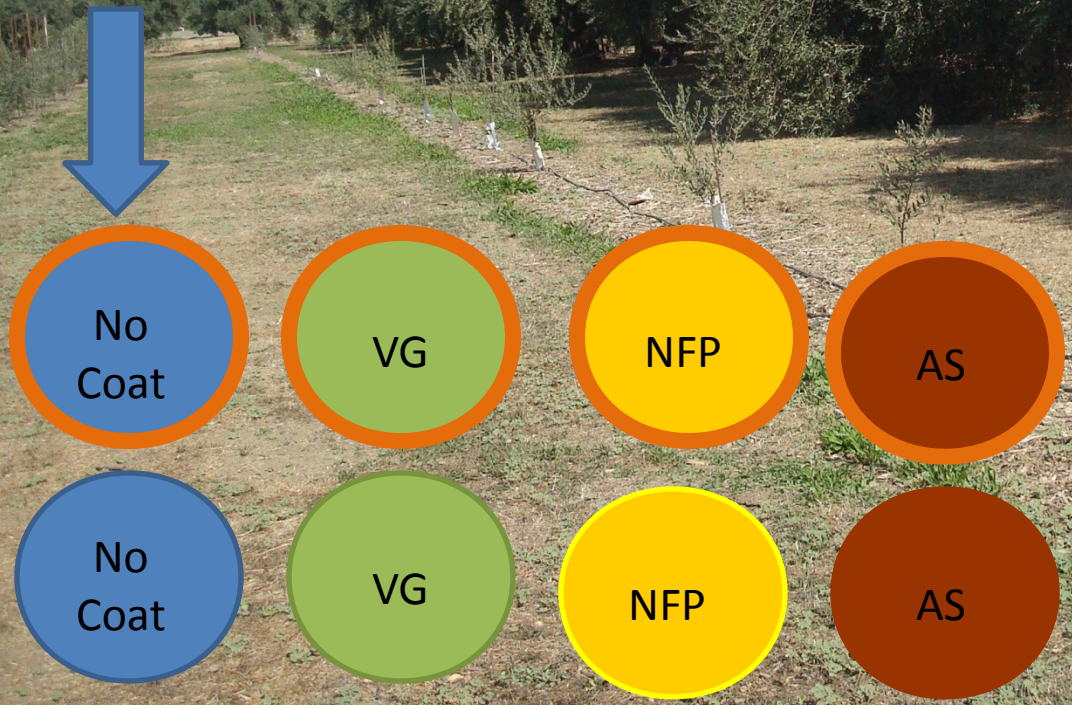
6:27 PM 7/23/2013

UCDAVIS OLIVE CENTER
at the Robert Mondavi Institute

RCBD

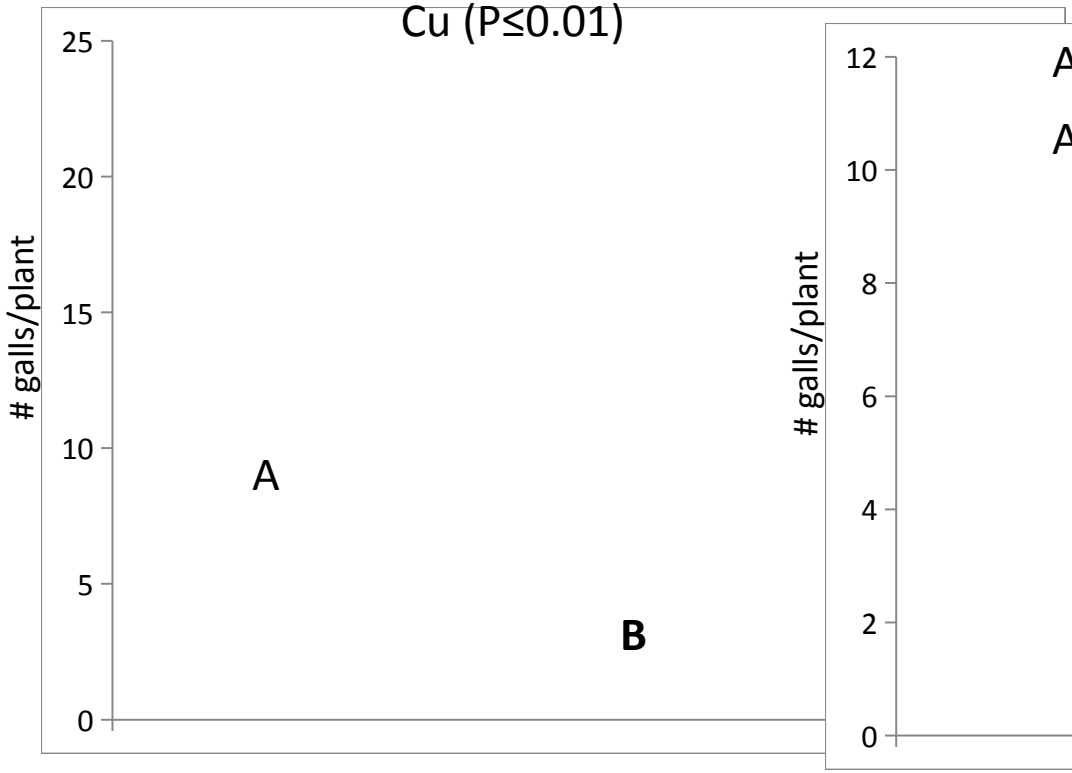
7 blocks x 8 treatments: 2011
7 blocks x 10 treatments: 2012

Industry Std- Kocide 3000

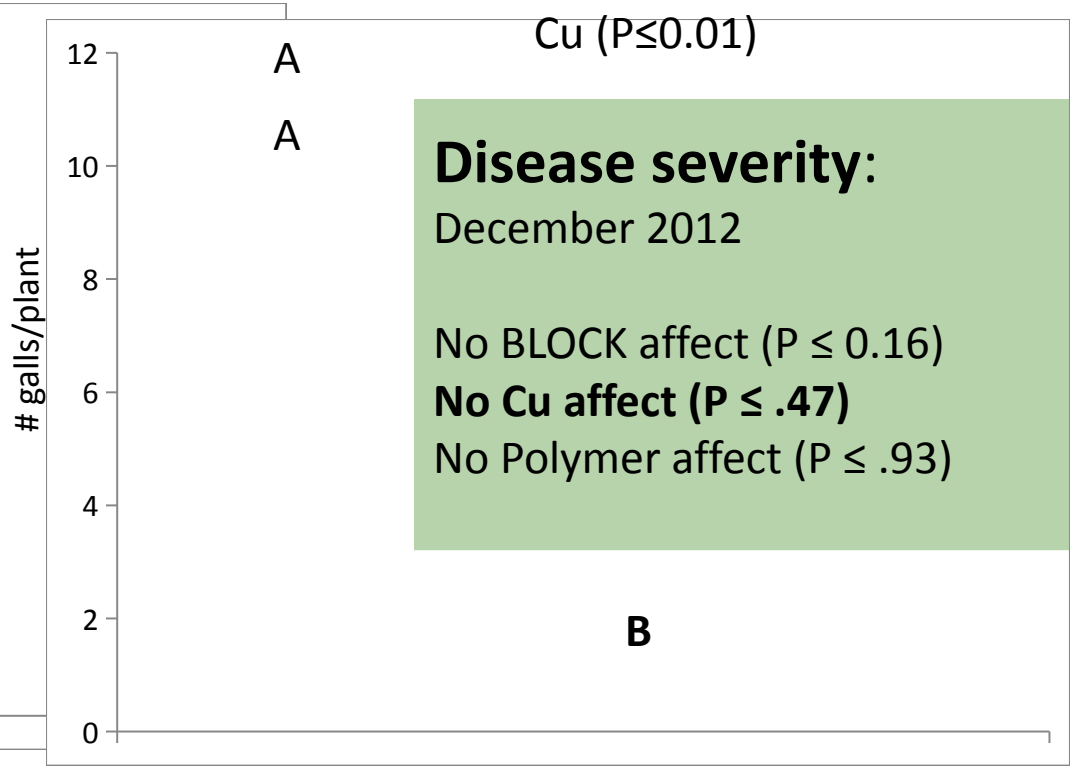


Potted Plant Study
Natural Inoculum

2011: Disease Incidence
Cu (P≤0.01)



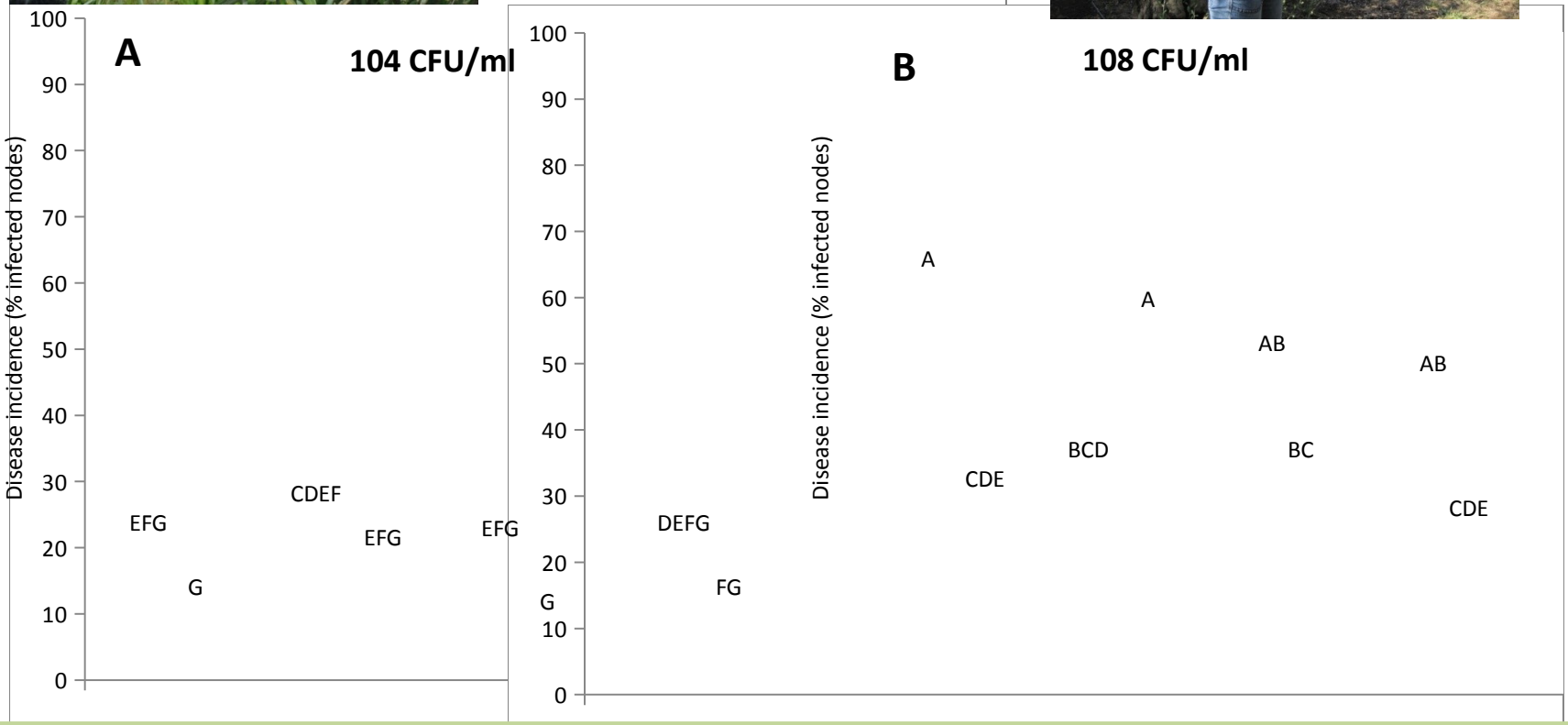
2012: Disease Incidence
Cu (P≤0.01)



Disease severity:
December 2012

No BLOCK affect (P ≤ 0.16)
No Cu affect (P ≤ .47)
No Polymer affect (P ≤ .93)

Mature Tree Study: Artificially Inoculated, 2011 data



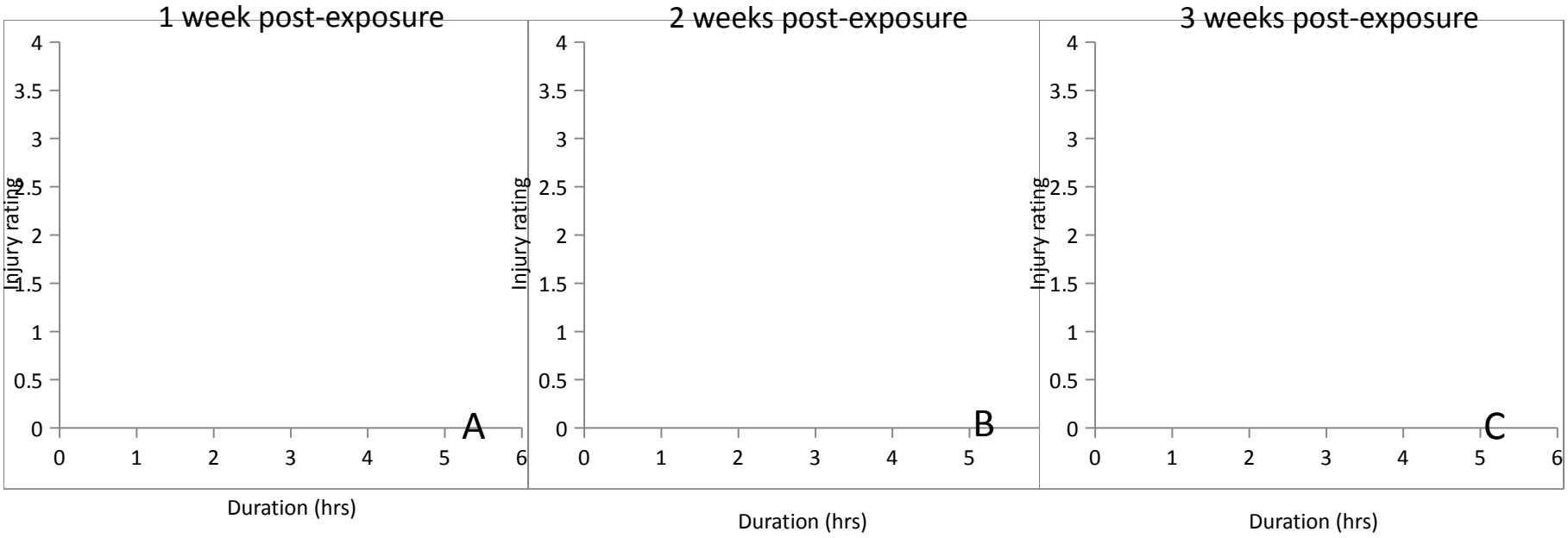
Take Home Message:

Under the conditions of these studies, polymers did not protect leaf scars from infection by the pathogen, nor did they enhance the efficacy of Cu in managing disease.

Can film forming polymers protect olives from cold damage?

Can film forming polymers protect olives from cold damage?

Summary of two experimental runs in 2012



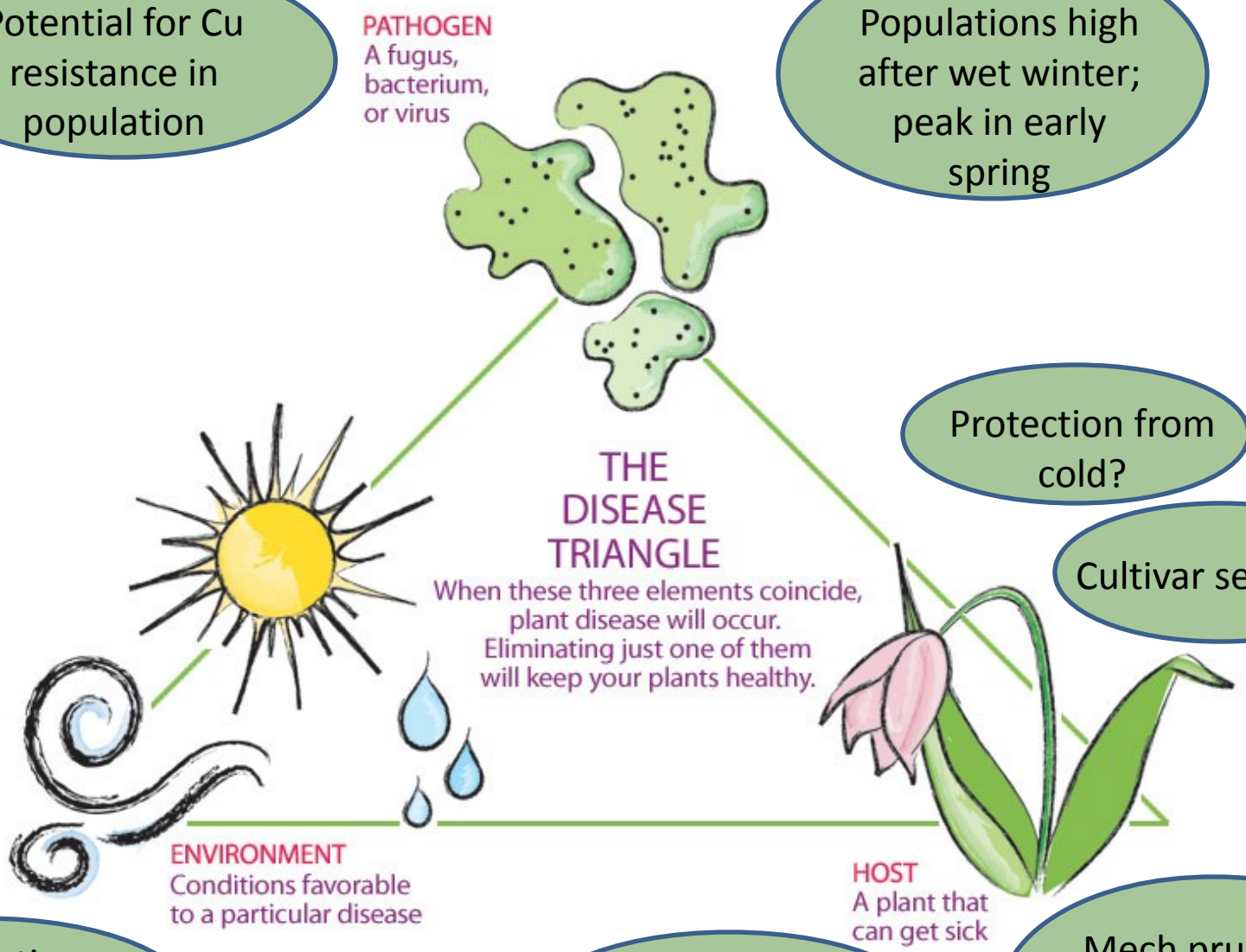
Interaction of product coating and duration in cold over time (P≤0.0001)

Take Home Message:

Under the experimental conditions utilized, neither polymer protected plants from cold damage. Cold damage occurred 1-3 hr post- exposure at -5C (23○ F)

Potential for Cu resistance in population

Populations high after wet winter; peak in early spring



Protection from cold?

Cultivar selection

Precipitation
Summer survival
Spring pop. growth

Pruning timing- summer best; early winter second best

Mech pruning in conjunction w/ mech harvest

Acknowledgements

Funding: California Olive Committee

Lindcove Research and Extension Center
Nickels Soils Lab, Arbuckle, CA
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H. Fox, grower
J. Kirkpatrick, grower
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B. Kirkpatrick and lab, UC Davis
C. Lovatt and lab, UC Riverside
L. Ferguson and lab, UC Davis
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George Kasun, UC Davis
Katie Wilson, UCCE
Walter Martinez, Tulare County
Matt Mills, Tulare County
Yvonne Lopez, Porterville College student
Erica Emmette, Tulare County
Teresa Gomes, Tulare County

Bad for Alternate Bearing

Good for olive knot management

http://kplu.org/post/oregon-farmer-hopes-repeat-wine-success-olive-oil

armer hop... X

olive shotberries

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SUCCESS WITH OLIVE OIL

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Oregon farmer hopes to repeat wine success with olive oil

By Deena Prichep

1 of 3

Credit Deena Prichep

Enlarge image

These Willamette Valley olives are called 'shot berries' because they're the size of a bb.

Northwest farmers--like all farmers, really--are known for their grit. A few decades ago, nobody thought you could grow wine grapes in Oregon. But the early growers worked hard at it and made some great wine. Today, it's a $1.4 billion a year industry. Now, there's a new crop on the horizon.

Listen 3:22

Paul Durant farms with his parents on the rolling hills of Dundee, Oregon. For several decades, they've grown pinot noir, pinot gris, and chardonnay grapes. And now, they're starting to grow arbequina, leccino and frantoio. Olives. Yes, olives. In Oregon. And yes, he's heard the skeptics:

http://westernfarmpress.com/orchard-crops/olive-plantings-expand-southern-california-arizona

Olive plantings exp... X

Western Farm Press Olives

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Olive plantings expand into Southern California, Arizona

Olive growers optimistic

Cary Blake

Jul. 23, 2013

EMAIL SHARE Tweet +1 Recommend 59 COMMENTS 1

- About 200 acres of olives grown for olive oil are planted in California's Imperial County and Arizona's Yuma County.
- About 160 of the acres are planted at the Beach Line Citrus farm in Niland, Calif.
- Olives require about half of the water than many other major crops in the desert environment.

What is in this article?:

Olive plantings expand into Southern California, Arizona

Olive tree requirements

UCCE olive field trial

The Barkley experience

More About: Lygus, PBWs

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New imidacloprid alternative coming

Dom Barkley of Beach Line Citrus and his partners grow about 160 acres of olives for the oil in Niland, Calif. They plan to open a new olive mill this fall in Imperial County to produce extra virgin olive oil.

Advertisement

The bird's eye-view from the century-old-plus Beach Line Citrus farm in Niland in California's Imperial County is a commanding vision of the azure waters in the Salton Sea several miles to the West and the towering Chocolate Mountains to the East.

Closer to the ground, a crop relatively new to this area is

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