Pest Management Update: Insects, Disease and Weeds

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2013 Headlines in Almond Entomology

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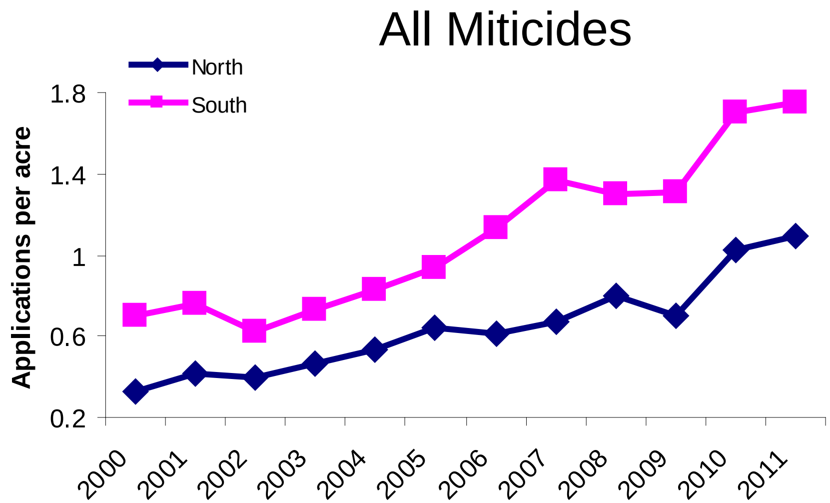
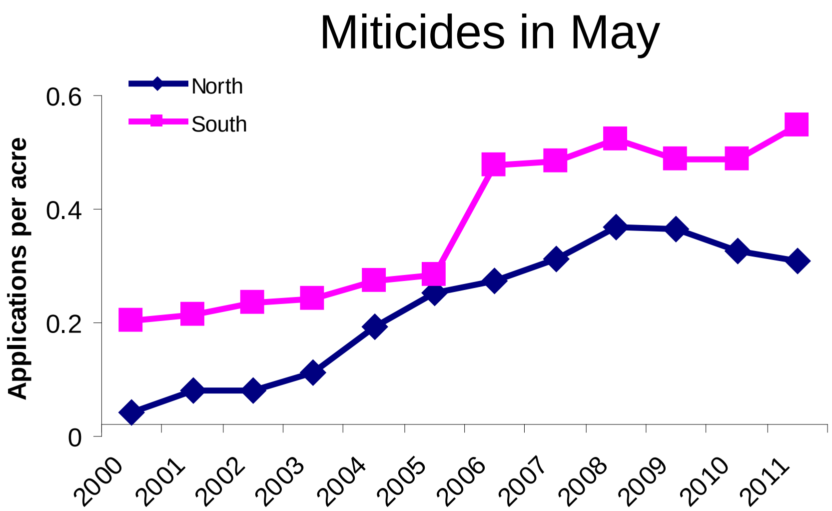
2013 Headlines

1) Spider mites in the Lower San Joaquin Valley
2) Pesticide use trends- judicious pyrethroid use
3) Utilizing pheromone traps for navel orangeworm

Long-term trends in miticide use





- Miticide applications per acre are 2-3X higher than 10 years ago
- This is despite the registration of improved miticides
- The tolerance for mites has decreased
- Threshold-based programs are being replaced by calendared and preventative programs
- Greatest increase in miticide use is in May (abamectin)

What happened in 2013

<u>Factors outside of our control</u>

- Minimal rain
  - Good overwintering survival of mites
  - Dust on leaves promotes mites
  - Dust affects coverage
  - Translaminar activity of miticides is neutralized
- Erratic/warm spring weather
  - Mites got started a month early
  - Emergence of mites not synchronized (some early, some later)
  - Beneficial organisms seemed out of sync with mites
  - Mites moved from the crotch to the tree canopy quicker than normal

What happened in 2013

Factors within our control

- Coverage issues
  - Insufficient water volumes
  - Driving too fast (>2mph) to cover lots of acreage in a short amount of time
- Early application timings
  - Many miticides tank mixed with a 1st flight NOW spray in mid to late-April
- Impacts to biological control
  - Coming off of an all-time record year for pyrethroids at hull split in 2012
  - Many pyrethroids used in April 2013
  - Almonds blanketed with abamectin-based miticides that kill the primary predator in almonds (sixspotted thrips)

What happened in 2013

<u>Results</u>

- Widespread mite outbreaks throughout the lower SJV in May and June
- Common for orchards to be sprayed 2-3X by mid-June
- Widespread miticide 'failures' reported in June
- Many trees green (bottom two thirds) and brown and webbed on the top

What happened in 2013

Results

- Widespread mite outbreaks throughout the lower SJV in May and June
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But.......

- Please ask a southern valley PCA how many mites they saw after July 1
- Mite survivors became predator food
- Thrips, lacewings, *Rhyzobius*, and pirate bugs got established in treetops
- Miticides changed predator/prey ratios
- By hull split the mites were gone and they never came back
- Defoliation practically non-existent
- 2013 = best biocontrol year ever!

Ideal mite management programs

- Tolerate low mite population early in the season
- Biological control organisms get established
- Monitor mite densities (presence/absence on leaves)
- If less than 25 to 40% of leaves infested, do not treat, mites will reproduce geometrically and biocontrol can keep up
- If more than 25 to 40%, mite growth turns geometric and biocontrol cannot keep up, treat with a miticide that kills mites but maintains biocontrol organisms
- Miticide controls most of the mites, predators eat up any mites that survive
- Predator/prey ratios typically remain balanced for the rest of the season

Pesticide use trends- Pyrethroids

Advantages

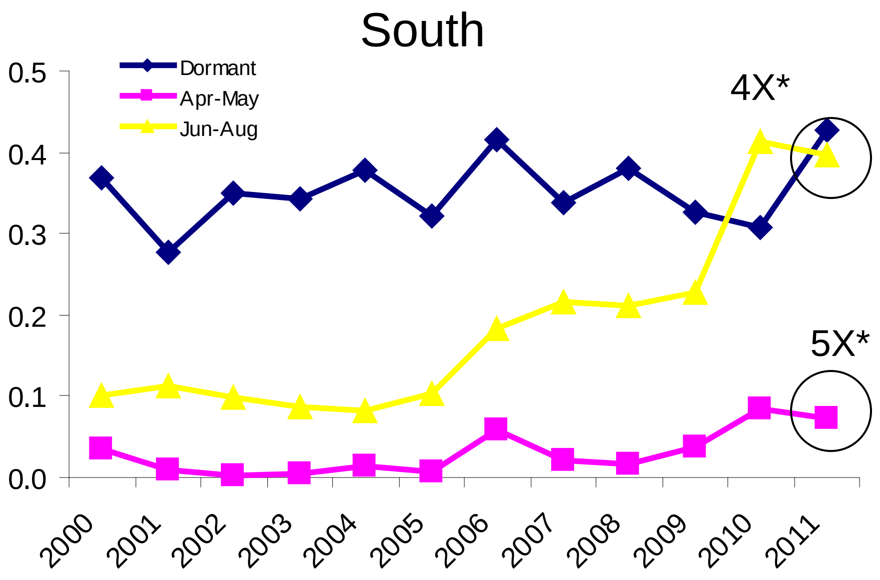
- New-generation pyrethroids more effective than their predecessors
  - Increased photostability
  - Isomers more refined
- Inexpensive
  - Half the cost of the application
- Effective on a range of pests
  - NOW, PTB, OFM
  - San Jose Scale
  - Leaffooted bug and stink bug

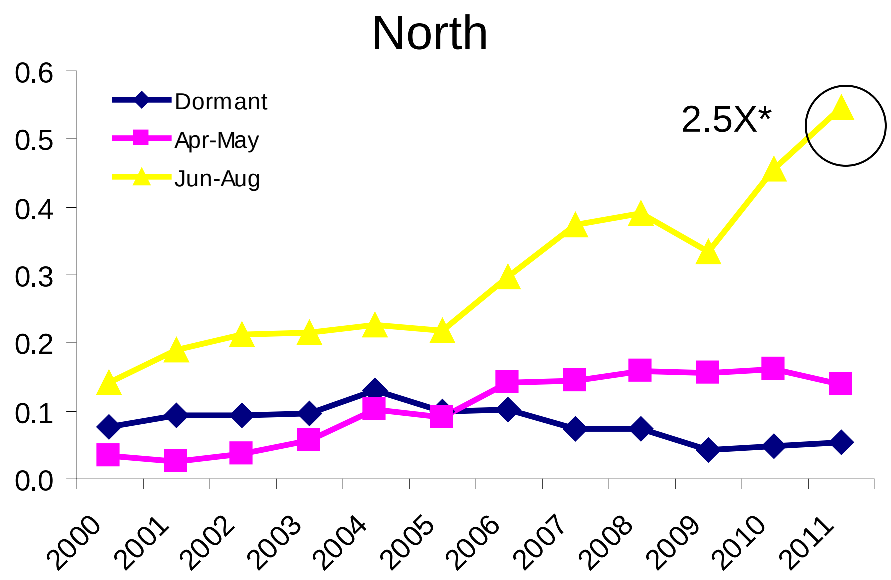
Concerns

- Toxic to predatory insects and mites
- Long persistence means long impacts on biocontrol
- Inexpensive price makes overuse easy
- History of resistance development
- Prone to causing secondary pest outbreaks
  - esp. mites and scale

Pesticide use trends- Pyrethroids

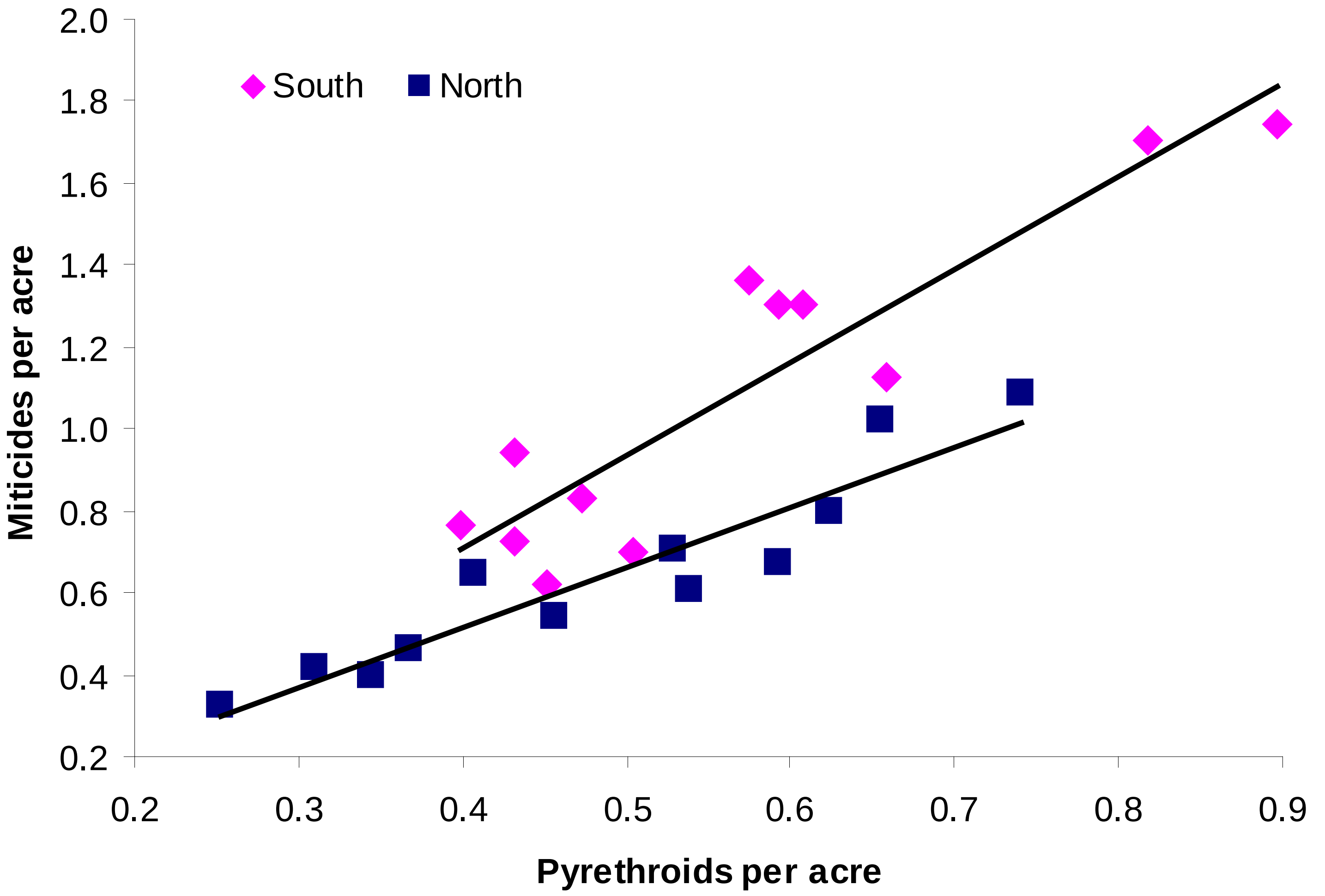
- Dormant treatments fairly static 2000 to 2011
- Southern Counties
  - April-May applications increased by 5X since 2005
  - Hull split applications increased by 4X since 2005
  - Data from 2012 and 2013 will be off the charts
- Northern Counties
  - April-May applications increased by 5X since 2005
  - Hull split applications increased by 2.5X since 2005





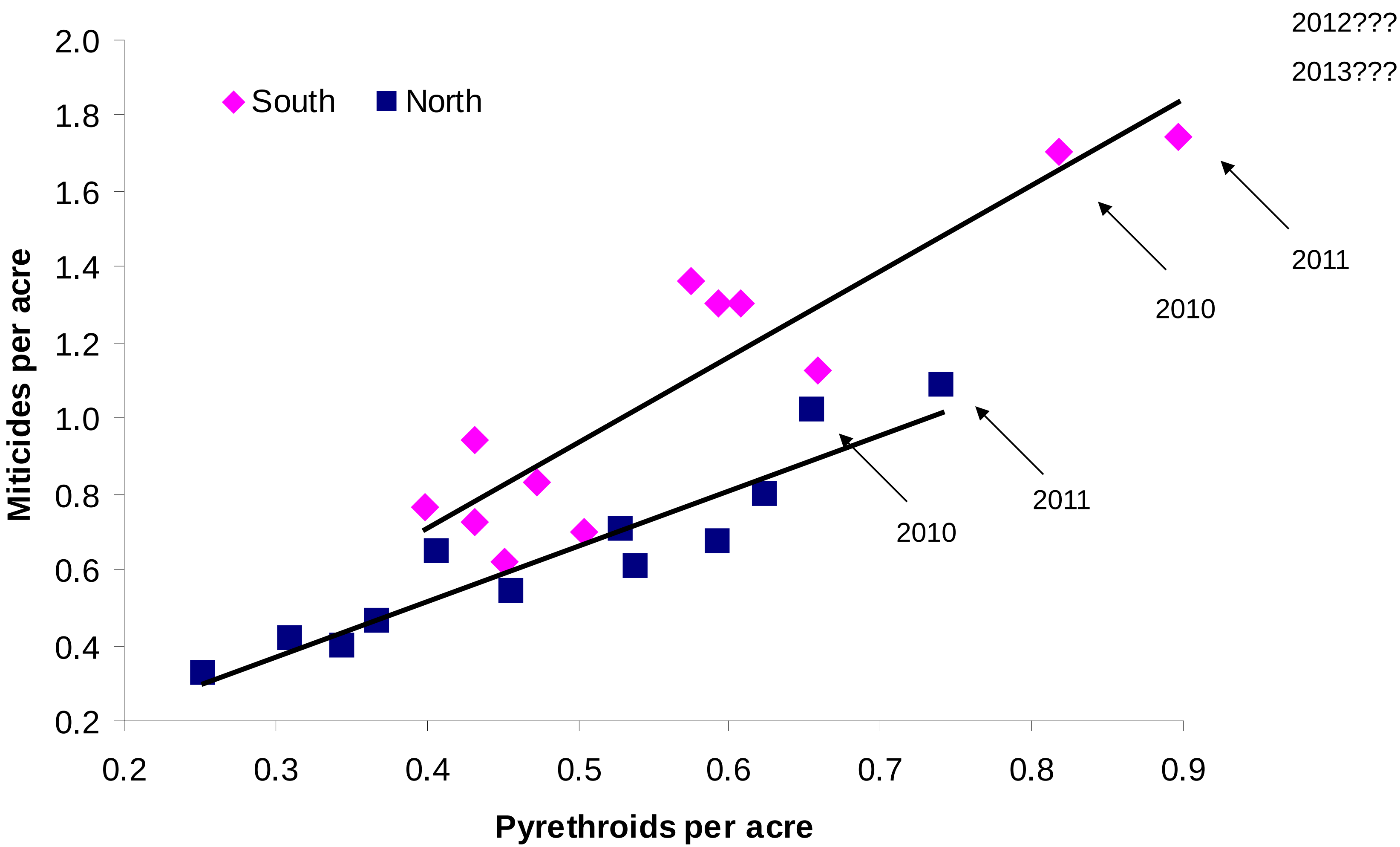
*Increases compare 2005 to 2011

Correlation between Pyrethroid and Miticide Applications Per Acre Each Year



Each datapoint represents one year between 2000 and 2011

Correlation between Pyrethroid and Miticide Applications Per Acre Each Year



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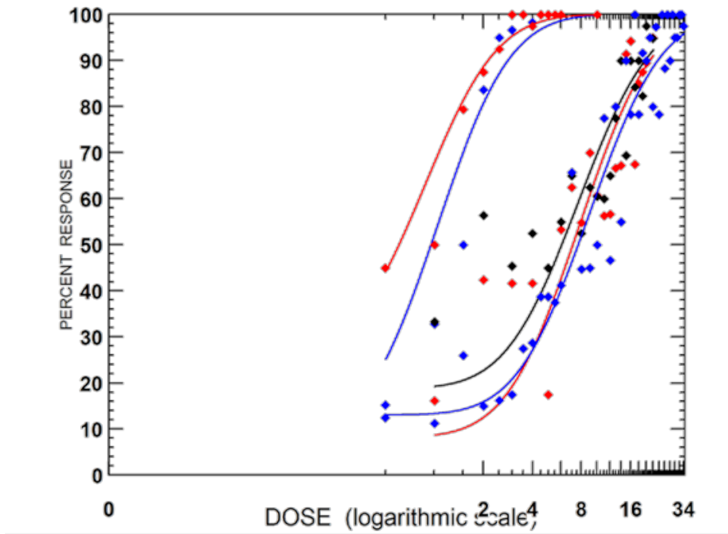
Resistance assays

B. Higbee, PFC



RF=Resistance factor = LC_{50} of field strain/LC_{50} of USDA strain

Bifenthrin is evaluated as a surrogate for all pyrethroids (Brigade, other bifenthrin products, Danitol, Warrior II, Voliam XPress, Pounce, Ambush, other permethrins)

48 hr mortality tables

Low or no bifenthrin

	LC50		RF	
Year	Male	Female	Male	Female
2009	0.7	0.5	1.3	0.8
2010	2.1	2.1	2	2
2011	1	1.1	0.7	0.75
2012	1.8	2.35	2.4	3.5
2013	5.4/5.3	6.6/6.1	4.0/3.9	4.8/4.5

High bifenthrin

	LC50		RF	
Year	Male	Female	Male	Female
2009	0.3	0.5	0.6	0.8
2010	1.35	1.8	1.3	1.65
2011	1.7	2.1	1.2	1.5
2012	2.4	2.5	3.1	3.8
2013	7.9	8.8	5.8	6.5

Judicious use of pyrethroids

- Navel Orangeworm
  - Start with a solid foundation of sanitation
  - Optimize treatment timings with trapping
  - Base post hull-split applications on data
  - Rotate a.i.s (Intrepid, Belt, Altacor, Delegate)

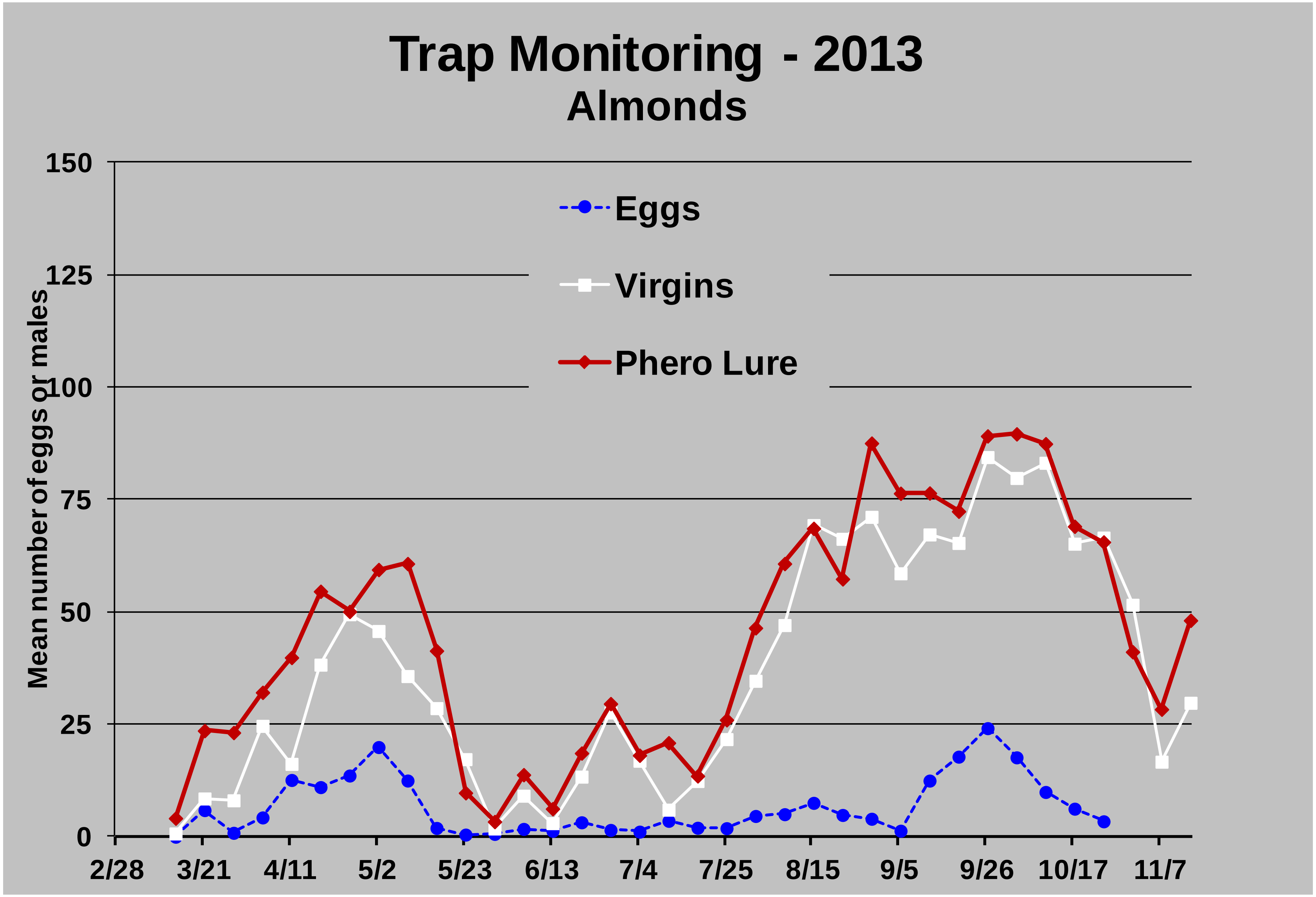
- Peach Twig Borer
  - Base treatments on monitoring and degree-days
  - Many non-pyrethroid insecticides effective in-season
  - Maximize use of dormant oil
- San Jose Scale
  - Treat only when needed (dormant spur samples)
  - Maximize use of parasitoids and dormant oil
  - Consider alternatives like Sieze and Centaur
- Leaffooted bug and stink bug
  - Base treatments on monitoring
  - Consider alternatives such as Lorsban or Belay

Navel Orangeworm Traps

- Reasons for trapping
  - Improve application timing
  - Treatment thresholds
  - Evaluate insecticide efficacy
  - Confirm trap shutdown within mating disruption
  - Determine moth sources (internal or external)
  - Compare moth density across seasons
- Different traps can serve different purposes

Egg, Pheromone, Virgin-baited female traps Southern SJV Almonds

B. Higbee, PFC



Egg, Pheromone, Virgin-baited female traps Southern SJV Almonds

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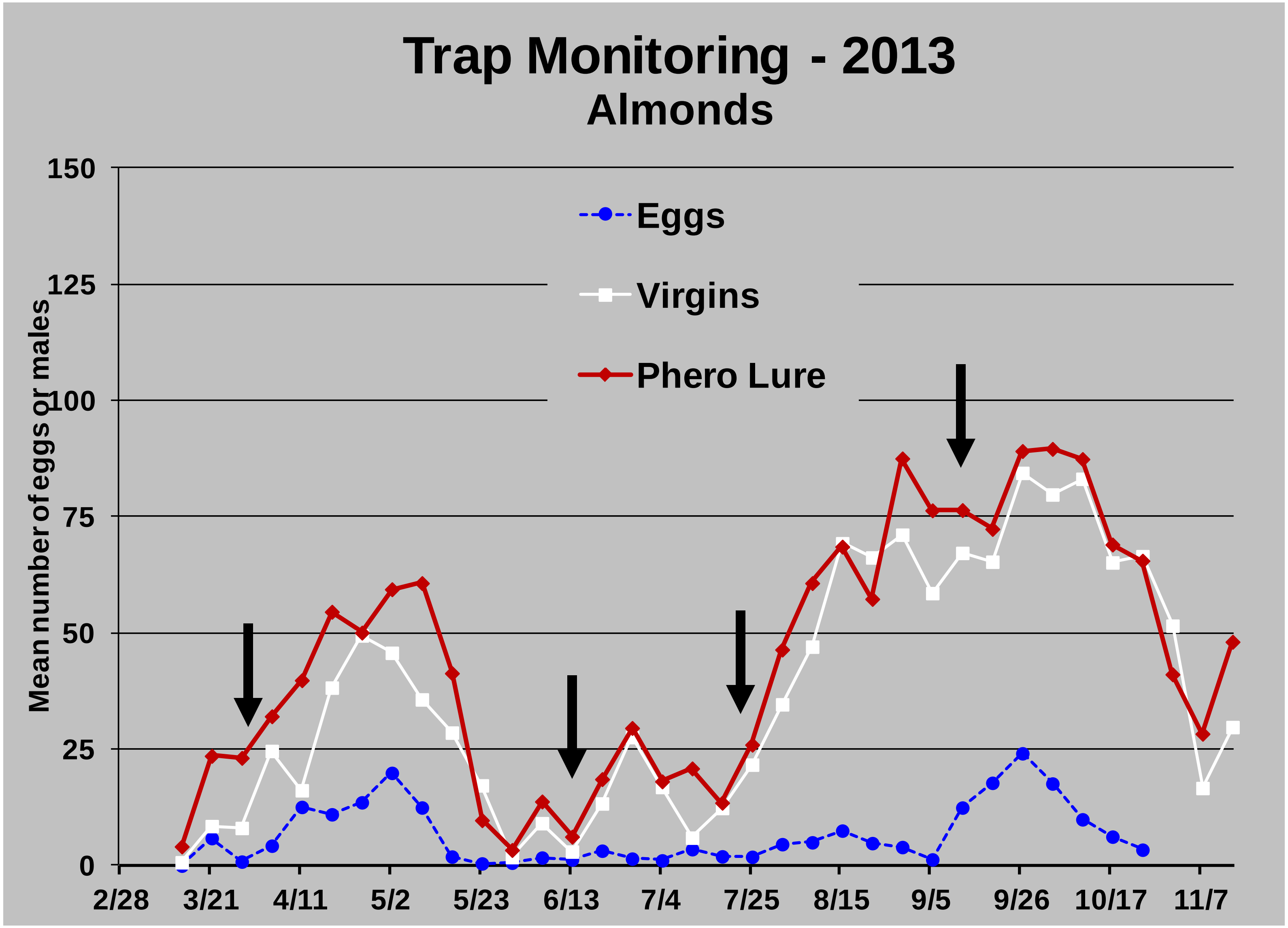
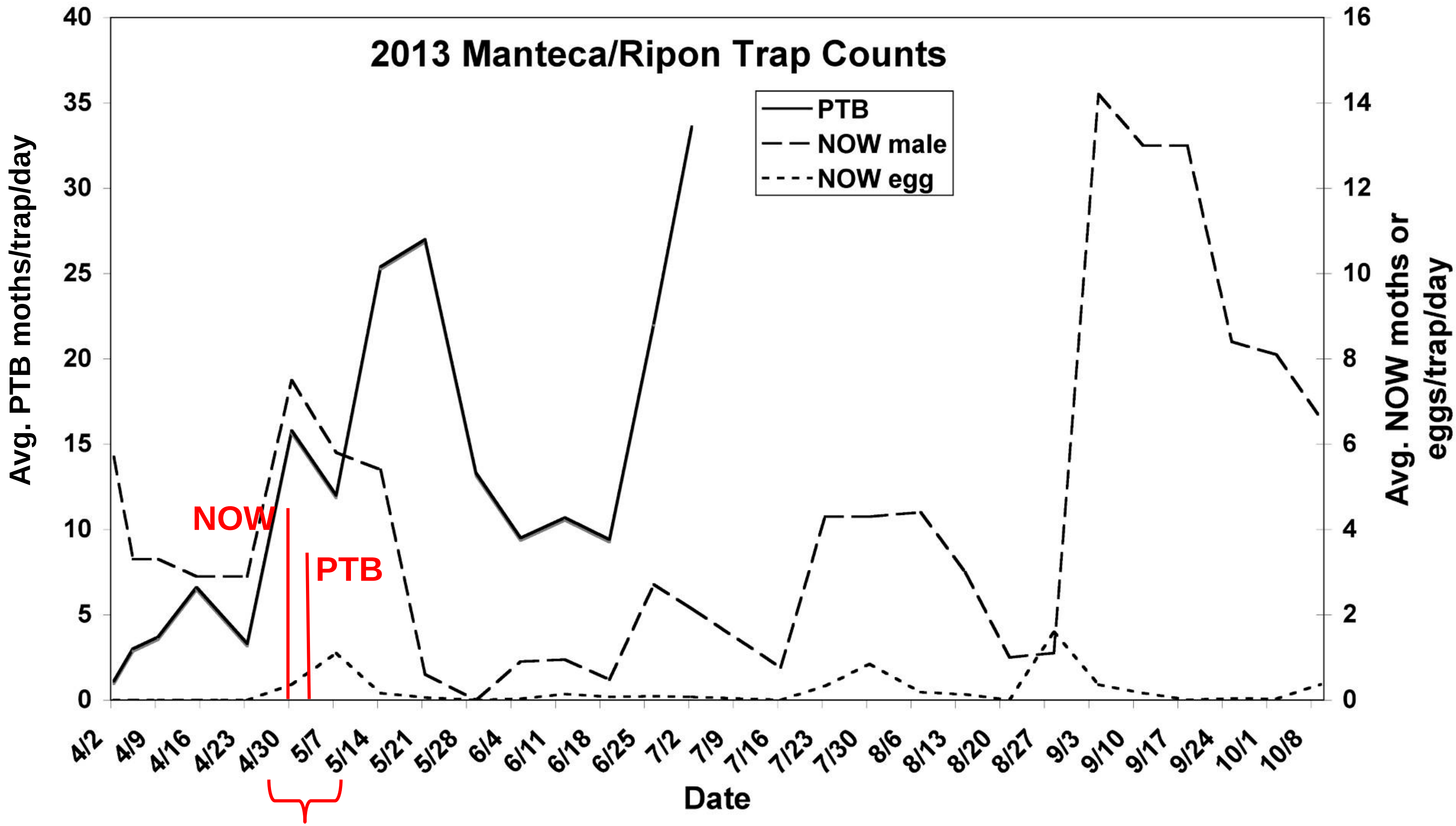


Egg and Pheromone traps in the North

F. Zalom. UCD



Based on current recommendations

Trapping take-home messages

- Egg traps still valuable
  - Degree-day models are still based on egg traps
- Pheromone traps are available
  - Use in thresholds not established
  - May provide assistance with treatment timing
  - Better resolution than egg traps in 2nd/3rd flights
  - Creative uses are possible
    - Residual effects of insecticides that kill adults
    - Document shut-down in mating disruption orchards
  - Lures are good 5-6 weeks, traps should be checked weekly
  - Wing traps or Large Plastic Delta traps work with the lure
    - Choose one trap type and stick with it over time.

Almond Weed Control Update

Brad Hanson

UC Davis Weed Science

T&V weed science team

- T&V research and extension focused
  - Brad Hanson – Weed Extension Specialist
    - Chemical weed control, herbicide resistance, herbicide fate, methyl bromide
  - Lynn Sosnoskie - Project Scientist
    - Weed biology, ecology and resistance management
  - Sorkel Kadir - Visiting Scientist
    - Herbicide fate in plants and soil
  - Don Stewart - Staff Research Associate
    - IR-4 minor crop pesticide residue testing program
  - Seth Watkins – Staff Research Associate
    - Orchard and vineyard herbicide efficacy and crop safety evaluations
  - Marcelo Moretti - PhD Student
    - Mechanisms of resistance in glyphosate- and paraquat-resistant Conyza,
  - Andrew (Bob) Johnson - MS Student
    - Non-fumigant approaches for orchard re-plant issues, herbicide performance
  - Oscar Morales – undergrad lab assistant
  - UCCE and industry cooperators

Tree & Vine herbicide registrations

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Herbicide Registration on Horticultural Tree and Vine Crops -(updated December 2012 - UC Weed Science)

	Herbicide-Common Name *(example trade name)*	Site of Action Group[1]	Almond	Pecan	Pistachio	Walnut	Apple	Pear	Apricot	Cherry	Nectarine	Peach	Plum / Prune	Avocado	Citrus	Date	Fig	Grape	Kiwi	Olive	Pomegranate
			----- tree nut -------				- pome -		---------stone fruit ---------												
Preemergence	dichlobenil *(Casoron)*	L / 20	N	N	N	N	R	R	N	R	N	N	N	N	N	N	N	R	N	N	N
	diuron *(Karmex, Diurex)*	C2 / 7	N	R	N	R	R	R	N	N	N	R	N	N	R	N	N	R	N	R	N
	EPTC *(Eptam)*	N / 8	R	N	N	R	N	N	N	N	N	N	N	N	R	N	N	N	N	N	N
	flazasulfuron (Mission)	B / 2	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	R	N	N	N
	flumioxazin (Chateau)	E / 14	R	R	R	R	R	R	R	R	R	R	R	NB	NB	N	NB	R	N	NB	NB
	indaziflam (Alion)	L / 29	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	N	N	R	N
	isoxaben *(Trellis)*	L / 21	R	R	R	R	NB	NB	NB	NB	NB	NB	NB	NB	NB	N	NB	R	NB	NB	NB
	napropamide *(Devrinol)*	K3 / 15	R	N	N	N	N	N	N	N	N	N	N	N	N	N	N	R	R	N	N
	norflurazon *(Solicam)*	F1 / 12	R	R	N	R	R	R	R	R	R	R	R	R	R	N	N	R	N	N	N
	oryzalin *(Surflan, Farm Saver)*	K1 / 3	R	R	R	R	R	R	R	R	R	R	R	R	R	N	R	R	R	R	R
	oxyfluorfen *(Goal, GoalTender)*	E / 14	R	R	R	R	R	R	R	R	R	R	R	R	NB	R	R	R	R	R	R
	pendimethalin *(Prowl H_2O)*	K1 / 3	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	R	R
	penoxsulam *(Pindar GT)*	B / 2	R	R	R	R	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	pronamide *(Kerb)*	K1 / 3	N	N	N	N	R	R	R	R	R	R	R	N	N	N	N	R	N	N	N
	rimsulfuron (*Matrix, Mana*)	B / 2	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	N	N
	simazine *(Princep, Caliber 90)*	C1 / 5	R	R	N	R	R	R	N	R*	R	R	N	R	R	N	N	R	N	R	N
	thiazopyr *(Visor)*	K1 / 3	NB	N	NB	NB	N	N	NB	NB	NB	NB	NB	N	R**	N	N	NB	N	N	N
Postemergence	carfentrazone (Shark, Rage)	E / 14	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	clethodim *(Prism)*	A / 1	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	N	R	N	N	NB	N	NB	N
	clove oil (*Matratec*)	NC[3]	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	2,4-D *(Clean-crop, Orchard Master)*	O / 4	R	R	R	R	R	R	R	R	R	R	R	N	N	N	N	R	N	N	N
	diquat (*Diquat*)	D / 22	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB
	d-limonene (*GreenMatch*)	NC[3]	R	R	R	R	R	R	R	R	R	R	R	N	R	N	R	R	R	N	N
	fluazifop-p-butyl *(Fusilade)*	A / 1	NB	R	NB	NB	NB	NB	R	R	R	R	R	NB	NB	NB	NB	R	N	NB	NB
	glyphosate *(Roundup)*	G / 9	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	glufosinate *(Rely 280)*	H / 10	R	R	R	R	R	N	N	N	N	N	N	N	N	N	N	R	N	N	N
	halosulfuron *(Sandea)*	B / 2	N	R	R	R	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	paraquat *(Gramoxone Inteon)*	D / 22	R	R	R	R	R	R	R	R	R	R	R	R	R	N	R	R	R	R	N
	pelargonic acid (*Scythe*)	NC[3]	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	N
	pyraflufen (*Venue*)	E / 14	R	R	R	R	R	R	R	R	R	R	R	N	N	R	R	R	R	R	R
	saflufenacil (*Treevix*)	E / 14	R	N	R	R	R	R	N	N	N	N	N	N	R	N	N	N	N	N	N
	sethoxydim *(Poast)*	A / 1	R	R	R	R	R	R	R	R	R	R	NB	NB	R	NB	NB	R	N	NB	NB

Updated annually and available online - easiest way is to find it is on the UC Weed Science blog

CA almond herbicide use

	Top 10 active ingredients	2011 treated acreage
1	glyphosate	1,464,216
2	oxyfluorfen (Goal, Goaltender)	758,463
3	glufosinate (Rely)	281,930
4	paraquat (Gramoxone Inteon)	202,621
5	pendimethalin (Prowl H2O)	160,434
6	oryzalin (Surflan, etc)	133,084
7	2,4-D	106,641
8	flumioxazin (Chateau)	90,856
9	simazine (Princep, etc)	69,193
10	carfentrazone (Shark)	53,754
11	rimsulfuron (Matrix)	52,577
12	penoxsulam (PindarGT)	46,035

* strip treatments!   760,000 A bearing almond (2011)

Resistance management

Confirmed glyphosate resistance

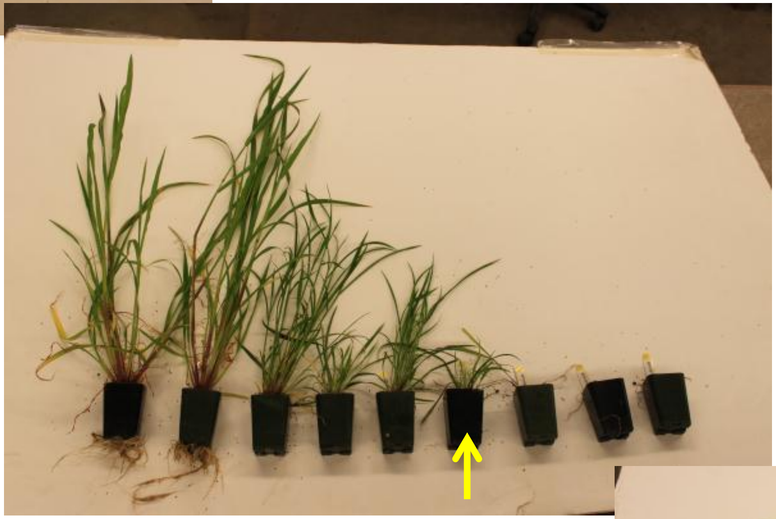
(grouped by genus)	USA	CA	WA	OR
Palmer amaranth and com. waterhemp	☑ ☑	✚		
Giant and common ragweed	☑ ☑			
Australian fingergrass				
Hairy fleabane and horseweed	☑ ☑	☑ ☑		
Sourgrass				
Junglerice	☑	☑		
Goosegrass		✚		
Wild poinsettia				
Italian and rigid ryegrass	☑ ☑	☑ ☑		☑
Ragweed parthenium				
Buckhorn plantain				
Johnsongrass	☑			
Liverseedgrass				

Junglerice – orchards and corn

SJV junglerice

Greenhouse dose response

- 0.75 lb ae/A use rate
- Up to 4x
- Photos taken 21 DAT



Species of concern - goosegrass

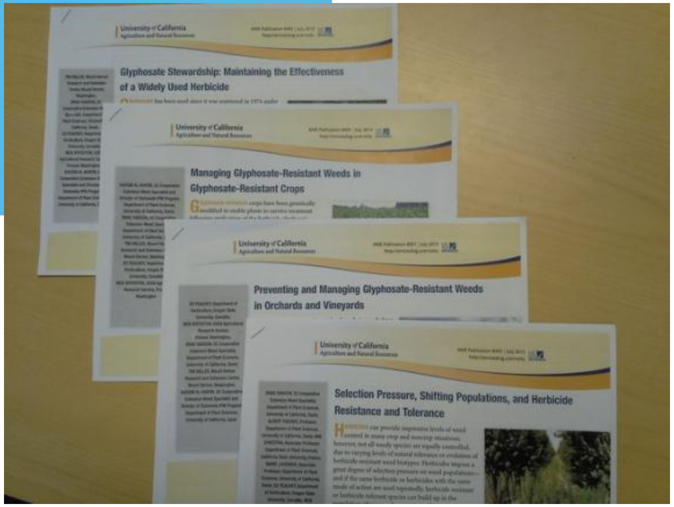
- Eleusine spp.
  - Goosegrass and threespike goosegrass

C190-05

C190-07

Three-spike goosegrass

Resistance publications



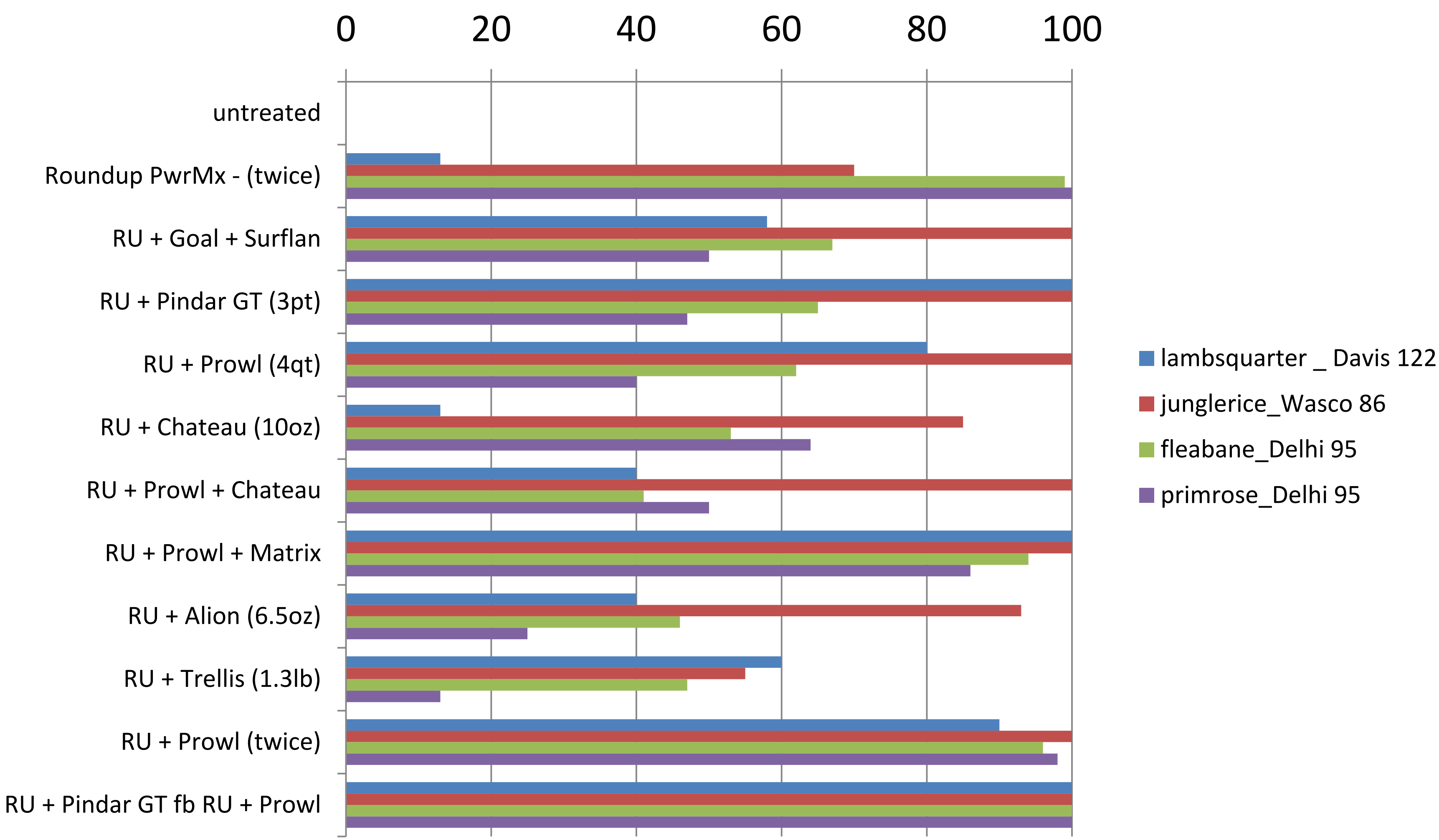
- Recent series of UC IPM publications
  - ***Selection Pressure, Shifting Populations, and Herbicide Resistance and Tolerance***
  - ***Glyphosate Stewardship: Maintaining the Effectiveness of a Widely Used Herbicide***
  - ***Preventing and Managing Glyphosate-Resistant Weeds in Orchards and Vineyards***
  - ***Managing Glyphosate-Resistant Weeds in Glyphosate-Resistant Crops***
  - http://anrcatalog.ucdavis.edu/ (type “glyphosate” in the search box)

Tree & Vine weed management challenges

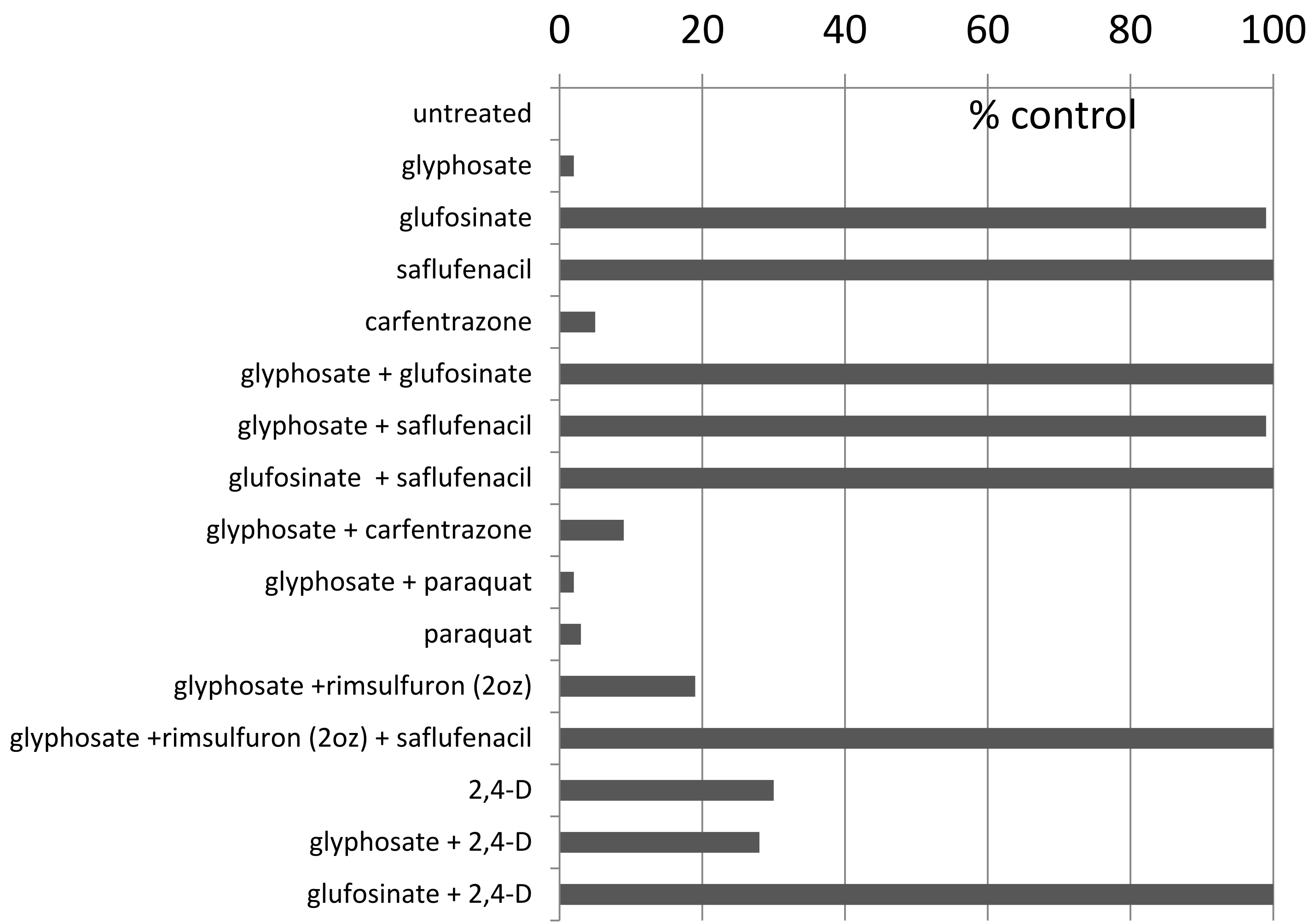
- Reliance on a few herbicide MOA
- Glyphosate-resistance is a different than other HRW
  - Some cases are non-target site, polygenic resistance, environmentally variable
- Simply "switching herbicides" may not be viable
  - Switch to what?
    - eg. glufosinate resistance in ryegrass in OR
- "Stacked" resistance to multiple herbicides
  - This is here in a limited manner already (gly-paraquat)
    - eg. Australia nontarget site resistance in ryegrass

Efficacy evaluations

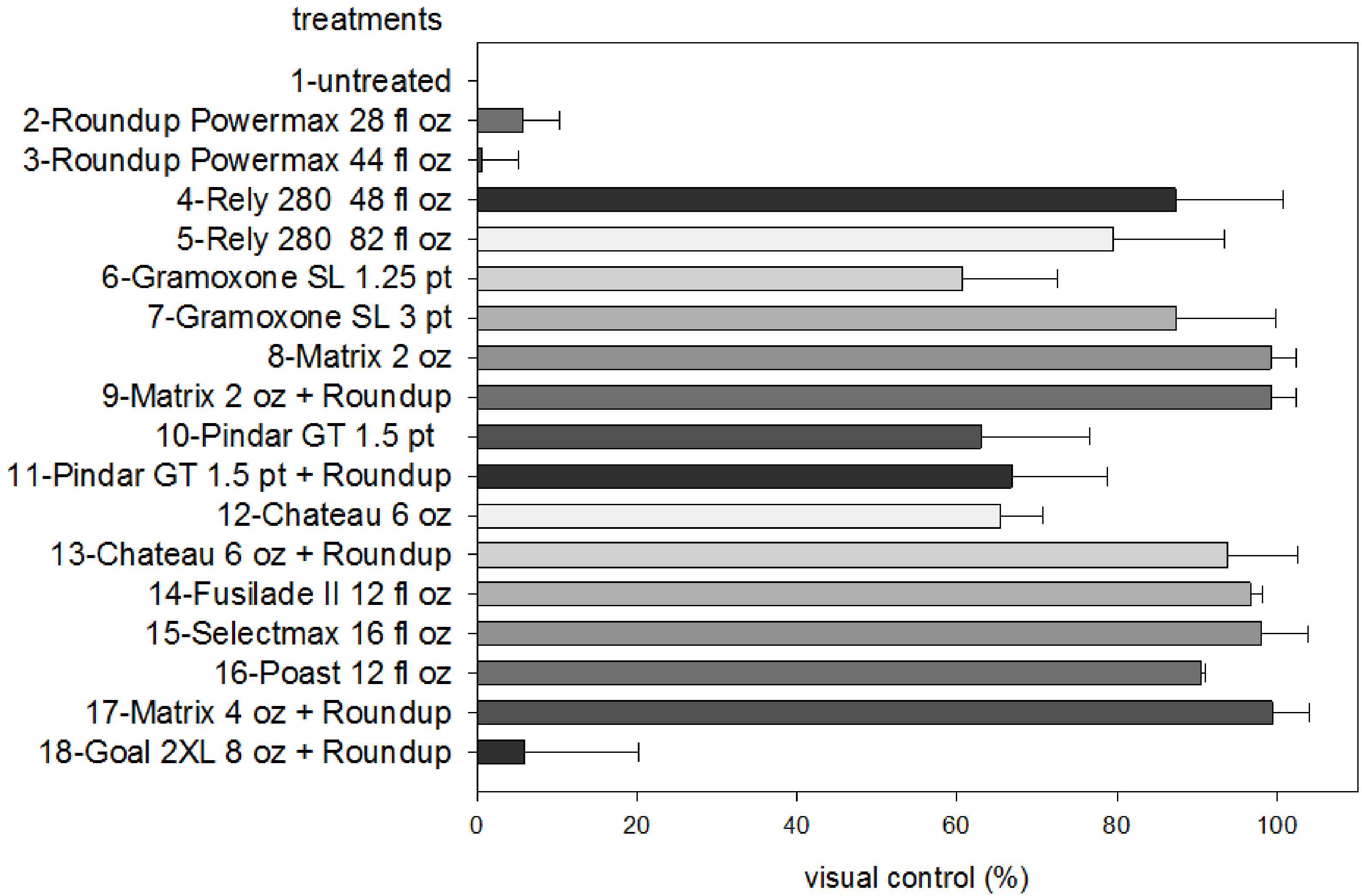
PRE herbicide comparisons



Glyphosate-paraquat resistant fleabane – 14 DAT



GR junglerice – Wasco 28 DAT



POST junglerice – Wasco 28 DAT

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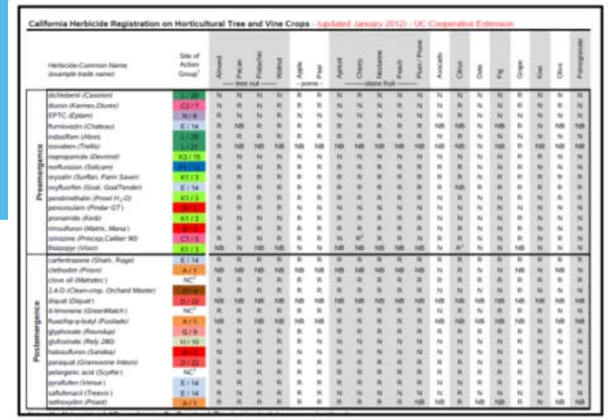
Table10: Effect of herbicide treatment combinations on junglerice visual control, biomass, and stand 28 days after treatment in a 2013 almond orchard trial near Wasco, CA. (Moretti, Watkins, and Hanson)

№	Treatment	active ingredient	rate		visual control %	biomass g/m^2	Density plants/m^2
1	untreated control				0	256	558
2	Roundup Powermax + NIS + AMS	glyphosate	1	lb ae/a	8	80	174
3	Roundup Powermax + NIS + AMS	glyphosate	44	fl oz/a	3	109	305
4	Rely 280 + AMS	glufosinate	48	fl oz/a	78	24	49
5	Rely 280 + AMS	glufosinate	82	fl oz/a	70	27	26
6	Gramoxone SL + NIS	paraquat	1.25	pt/a	58	25	94
7	Gramoxone SL + NIS	paraquat	4	pt/a	80	3	58
8	Matrix + NIS + AMS	rimsulfuron	2	oz/a	98	14	35
9	Roundup Powermax + NIS + AMS	glyphosate	1	lb ae/a	99	9	48
	Matrix	rimsulfuron	2	oz/a			
10	Pindar GT+NIS + AMS	penox/oxyfl	1.5	pt/a	63	6	54
11	Roundup Powermax + NIS + AMS	glyphosate	1	lb ae/a	67	23	45
	Pindar GT	penox/oxyfl	1.5	pt/a			
12	Chateau + NIS + AMS	flumioxazin	6	oz/a	66	7	33
13	Roundup Powermax + NIS + AMS	flumioxazin	6	oz/a	88	0	30
	Chateau	glyphosate	1	lb ae/a			
14	Fusilade II + AMS + COC	fluazifop	12	fl oz/a	95	29	23
15	Envoy + AMS	clethodim	16	fl oz/a	92	15	53
16	Poast + AMS+COC	sethoxydim	1.5	pt/a	90	0	91
17	Roundup Powermax + NIS + AMS	glyphosate	1	lb ae/a	98	19	59
	Matrix	rimsulfuron	4	oz/a			
18	Roundup Powermax + NIS + AMS	glyphosate	1	lb ae/a	18	143	487
	Goal 2XL	oxyfluorfen	0.125	lb ai/a			
Tukey's HSD (P = 0.05)					45	65	57

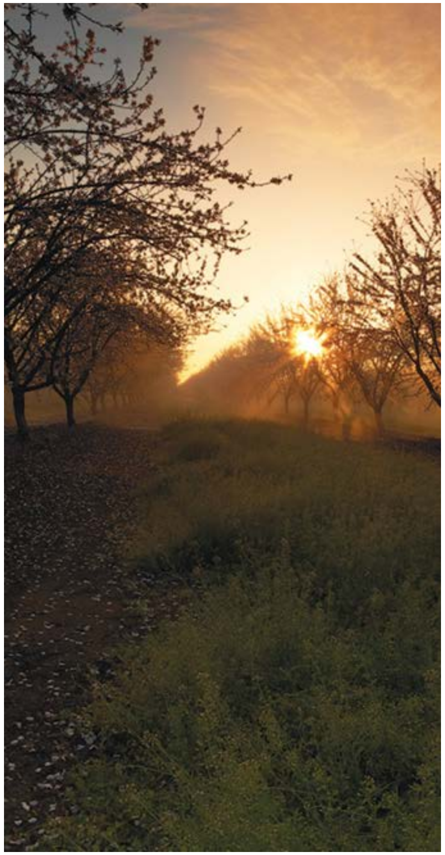
Abbreviations: NIS - non-ionic surfactant at 0.25 % V/V; AMS - ammonium sulfate 10 lbs/100 gallons; COC - crop oil concentrate 1 % V/V; penox/oxyfl – penoxsulam / oxyfluorfen

A few product updates

- PRE
  - flazasulfuron
  - indaziflam
  - penoxsulam
  - rimsulfuron
  - isoxaben
- POST
  - glufosinate
  - saflufenacil
  - pyraflufen
  - graminacides



California Herbicide Registration on Horticultural Tree and Vine Crops - (updated January 2012) - UC Cooperative Extension



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BAYER Bayer CropScience

BASF
The Chemical Company

DOW®

syngenta

DUPONT®

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

FMC
Agricultural Products

UPI

USDA United States Department of Agriculture
National Institute of Food and Agriculture

Littlejohn Farm

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UC Davis Weed Research and Information Center
http://wric.ucdavis.edu/
http://ucanr.org/blogs/UCDWeedScience/
@UCWeedScience on Twitter

UC Davis Statewide Integrated Pest Management Program
http://www.ipm.ucdavis.edu/

Almond Pathology:

Bacterial Spot
Almond Cankers
Biocontrol of Aflatoxins – AF36

Themis J. Michailides

UC Davis

Kearney Agricultural Research and Extension Center

David A. Doll

University of California – Cooperative Extension, Merced County

Cooperators: Several farm advisors and PCAs

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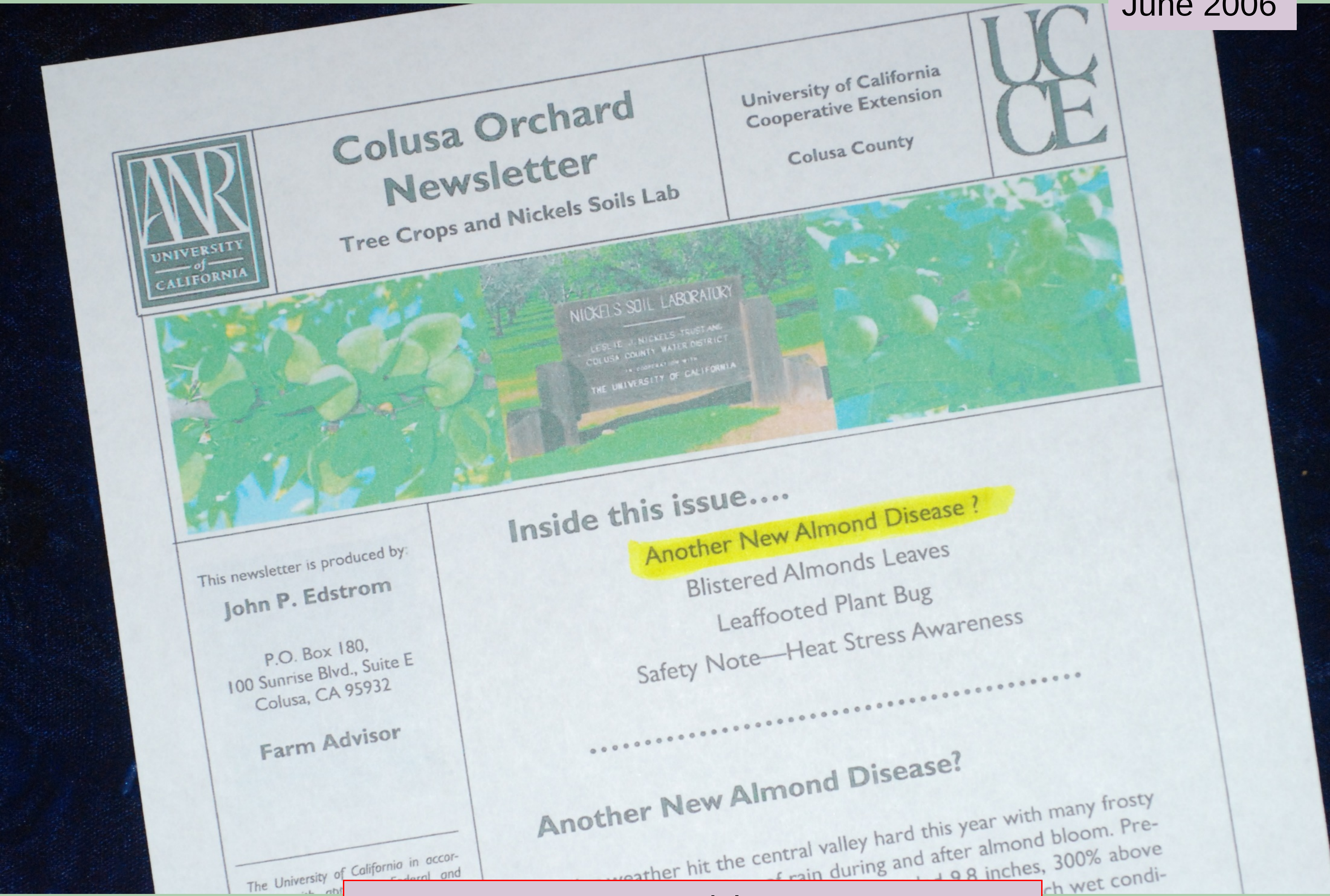
Bacterial spot of almond:

J. Adaskaveg, D. Doll, R. Duncan, B. Holtz, J. Edstrom, T. Michailides

History of Bacterial Spot in California Almonds

- **John Edstrom, Farm Advisor in Colusa Co.,** observed the devastation of Fritz by the **Bacterial Spot** during his sabbatical leave to Australia in 2003.
- In 2006, he detected symptoms resembling **bacterial spot** in Neplus almonds in Colusa Co. and sent two samples to my lab for diagnosis.
- We isolated consistently the pathogen (*Xanthomonas* sp., a bacterium) causing **bacterial spot of almond**, and reported the diagnosis to the farm advisor (May 2006).

June 2006



Colusa Orchard Newsletter

Tree Crops and Nickels Soils Lab

University of California Cooperative Extension

Colusa County

This newsletter is produced by:

John P. Edstrom

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100 Sunrise Blvd., Suite E
Colusa, CA 95932

Farm Advisor

Inside this issue....

Another New Almond Disease ?
Blistered Almonds Leaves
Leaffooted Plant Bug
Safety Note—Heat Stress Awareness

Another New Almond Disease?

... weather hit the central valley hard this year with many frosty ... of rain during and after almond bloom. Pre- ... 9.8 inches, 300% above ... ch wet condi-

Western Farm Press article --- August 2006

History of Bacterial Spot in California Almonds

2006: sample # First Report: **John Edstrom**,

2010: 1 sample, **Roger Duncan**, Farm Advisor, Stanislaus Co.: Again the pathogen was isolated and reported to the farm advisor.

2012: 2 samples, **Roger Duncan**: #12027 & #12031 (May 2012).

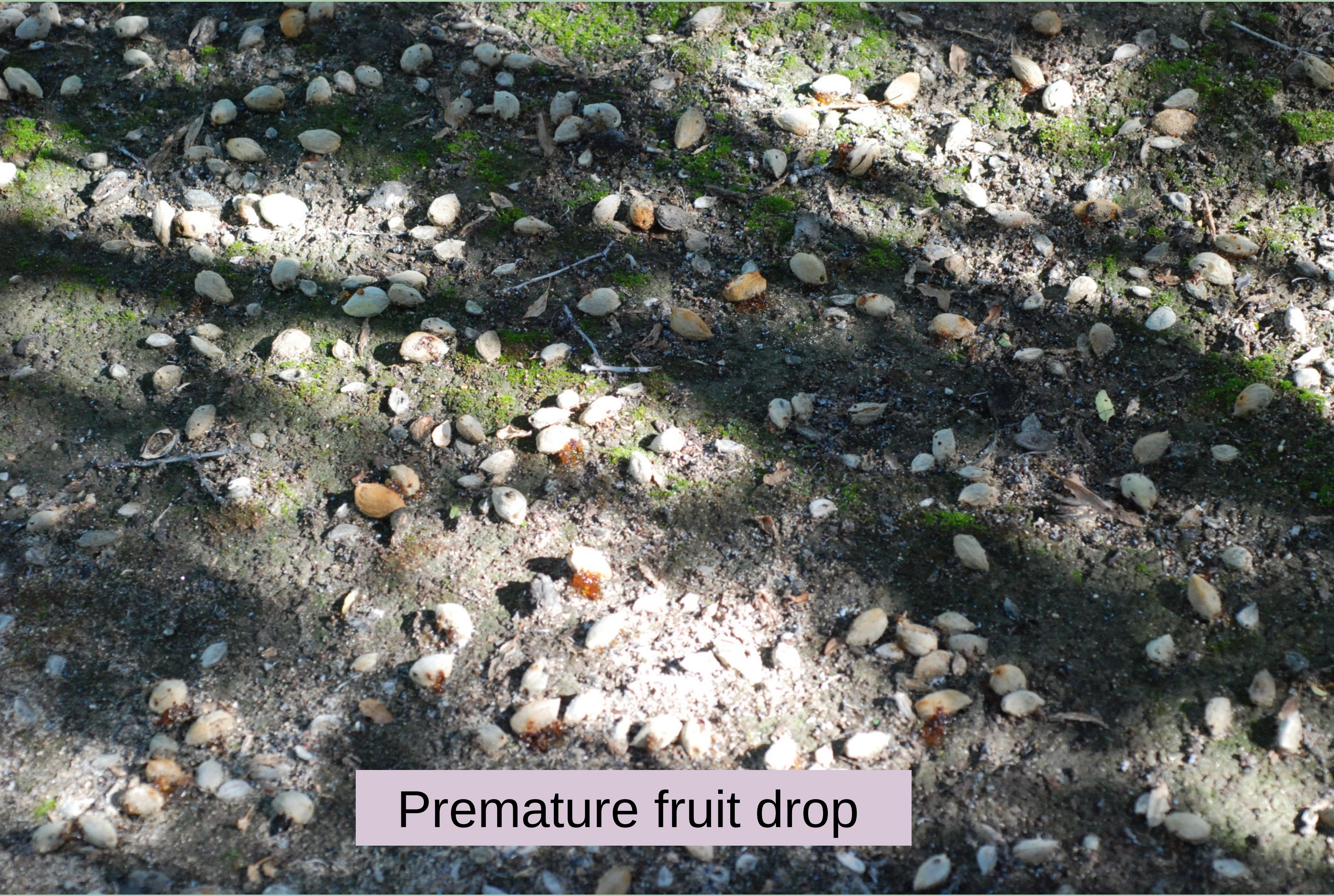
2013: more samples, **D. Doll, R. Duncan, & B. Holtz:** samples #13054, #13060, #13095.

First reports on new diseases should not be ignored!

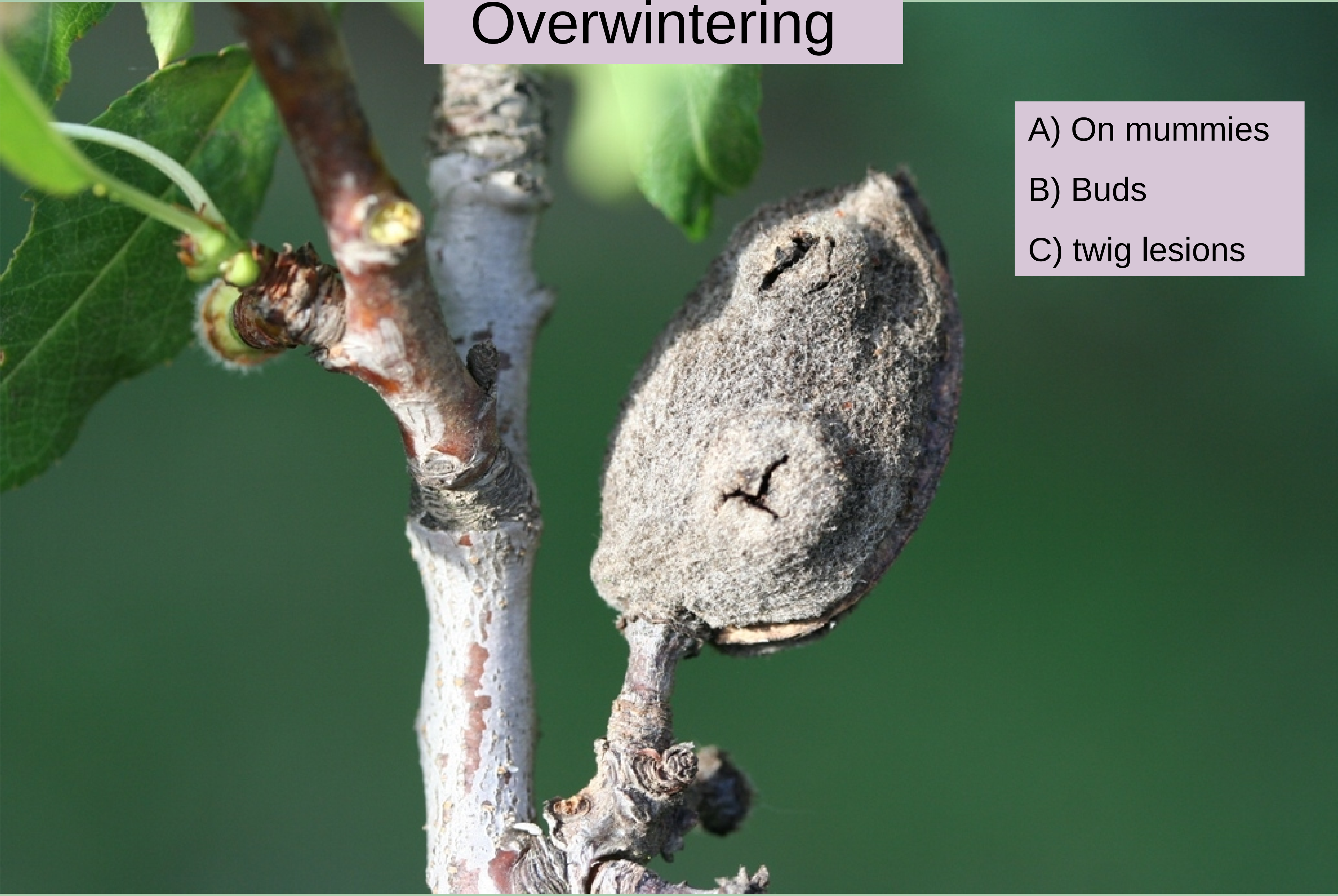
- ✓ Pathogen: *Xanthomonas arboricola* pv. *pruni*
- ✓ Koch's postulates have been completed

Lesions under the sap


2013
Twig lesions


Premature fruit drop

Overwintering



A) On mummies

B) Buds

C) twig lesions

Australian Almond Grower's Association

FACT SHEET

Bacterial Spot of Almonds

(Xanthomonas campestris pv pruni)

INTRODUCTION

Bacterial spot is a disease caused by the bacterium *Xanthomonas campestris pv. pruni* (Xcp). First confirmed as present on almonds in Australia in 1994/95, this disease had previously been observed in 1993/94 in South Australia and possibly earlier. The similarity of leaf and nut symptoms of this disease and those of fungal 'shot-hole' in all likelihood allowed this disease to go unrecognised as a new disease for sometime prior to 1993. Many growers have first been alerted to the disease in their orchards, after 'ineffective shothole chemical applications'.

By 1996/97, Bacterial Spot had been confirmed as present on almonds in South Australia, Victoria and New South Wales. Unconfirmed outbreaks have also been reported from Western Australia.

NePlus and Fritz are susceptible cultivars with both young and established trees being affected. The losses attributed to this disease have ranged from minimal to severe. Yield reductions through nut gumming or premature nut fall cause the major economic losses. The longer term effects of defoliation and twig dieback on almond tree vigour and economic life have not been determined.

Management requires a combination of strategic chemical applications, cultural modifications and 'best practices' orchard hygiene.

Typical nut symptoms.
Note corky spots, gumming and sunken grey lesions.

OTHER HOSTS

Stone fruit, including plums, apricots and nectarines are susceptible to Bacterial Spot. As with almonds, some cultivars are highly susceptible while others exhibit tolerance. This bacterium is endemic in northern New South Wales and Queensland and Bacterial Spot is increasingly difficult to manage in these areas which frequently experience spring and summer rains and humidity.

SYMP

On almon
may be ex
your orch
symptom

Laborator
symptoms

Leaf and n
some orchards.

SYMPTOM DESCRIPTIONS

Leaves

Circular, angular or irregularly-shaped reddish lesions on the leaf blades. They may be discrete or coalesced along the mid-veins or at the leaf margins. As the lesions dry out, shotholes and leaf tatter result. These symptoms have been confused with those resulting from infection by the fungus *Wilsonomyces carpophilus*, the cause of fungal 'shothole'.

Nuts

Infected nuts develop corky lesions from which ooze and gum may stream. The ooze is clear to orange-tan in colour and hardens as it dries. Other lesions may be larger, sunken and covered in gum. Gummed nuts tend to be clustered within the canopy. In some severely affected trees greater than 90 percent of nuts are gummed and premature nut drop results. In trees with fewer infected nuts, the gummed nuts remain attached to the tree after harvest, as stick-tights. *These 'mummies' harbour viable bacteria and potentially serve as inoculum sources thereafter.*

Twigs

Twig lesions have been observed in trees with extensive leaf and nut symptoms. The lesions are dark, slightly sunken and shiny. They extend along the length of the twigs. Twig dieback has been observed when the lesions have expanded sufficiently to girdle the small twigs. The observed twig lesions have developed on green wood. Cankers on older wood, as frequently develop on infected stone fruit, have not been observed on almonds.

Leaf and twig symptoms.
Note circular, angular spots, holes and tatter on leaves and dark shiny lesions on stems.

Varietal Susceptibility

Extensive gumming of nuts, leaf tatter and shotholes have been observed on the pollinator cultivars Fritz and NePlus. While a small number of gummed nuts have been found on Carmel, this cultivar is considered to have some tolerance to Bacterial Spot. Price and Nonpareil appear to have a high degree of tolerance.

Bacterial Spot may be introduced to an orchard in budwood or nursery trees. The bacteria may also be introduced from neighbouring infected almonds or stone fruit.

The bacteria are spread by wind, rain and splash from overhead irrigation.

The role of insects and equipment in tree-to-tree spread is unknown.

Entry and Infection

Bacteria require a wound or natural entry site to enter a plant. These sites may be microscopic. Sandblast and wind abrasion spots on leaves, leaf scars, frost or growth cracks, pruning wounds are all suitable entry sites.

Bacteria also require a moisture film in which to proliferate. The conditions conducive to these bacteria and diseases development are mild, wet periods. Heavy dew, fogs, irrigation and rain during the growing season increase the potential for development. Exposed orchards in windy areas, are particularly prone to the disease if wet conditions also prevail.

Control

This is a bacterial disease and cannot be controlled with chemicals alone.

An effective management program for bacterial spot should include:

- Cultural modifications
- Spray programs
- Orchard sanitation

- **Cultural modifications**
  - Avoid planting NePlus or Fritz
  - Ensure all planting material is "disease-free"
  - Avoid overhead irrigation
  - Avoid exposed and windy planting sites
  - Avoid tree injuries
  - Establish windbreaks
  - Practice good frost control
  - Pruning - open up dense canopies to improve air flow and reduce leaf wetness periods.

- **Spray program**
  - Protect injury sites and natural entry points
  - Copper is the only available chemical active against bacteria:
    Apply copper at leaf fall to protect leaf scars
    Apply copper at pink bud and again if wet conditions persist*

  *The addition of mancozeb to copper sprays in 1996/97 was effective, but requires more investigation re rates and timing. NOTE: copper has phytotoxic potential on almonds.

ffective in stone fruit
rther.

runings from infect-

ancy.
d nuts from orchard

of Prue McMichael, *Scholefield Robinson Pty Ltd and edited by Chris Bennett, Industry Development Officer.*

For further information contact Chris Bennett,
Horticulture House
P.O. Box 52, 7 Wilson Street,
Berri, S.A. 5343
Phone (08) 85822055
Fax (08) 8582 3503

✓ Dormant and spring time copper sprays.
✓ Sprays with bactericides.

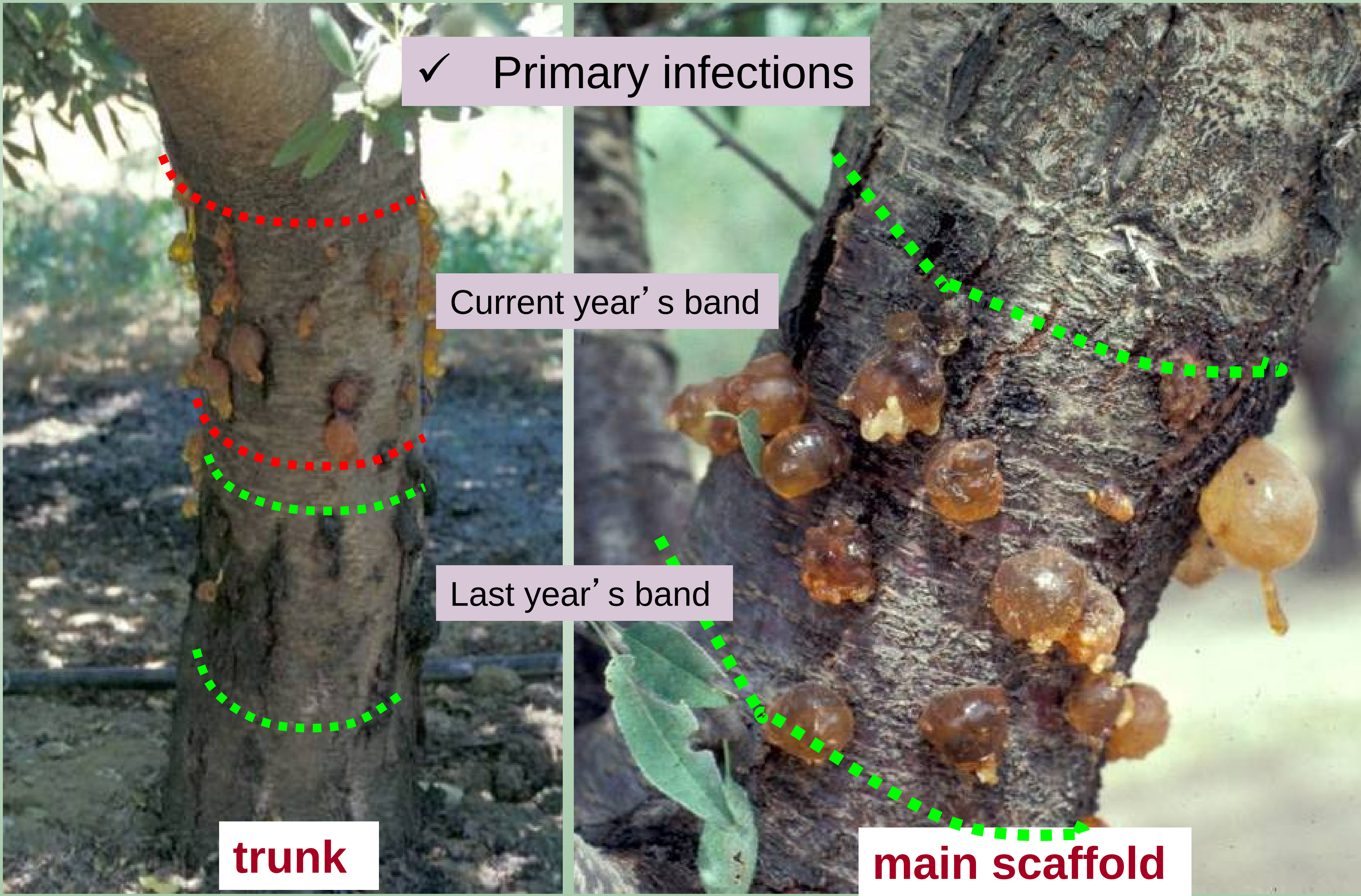
end

Wood Canker Diseases of Almond:

D. Doll, P. Rolshausen, K. Baumgartner, R. Travadon, R. Duncan, T. Michailides

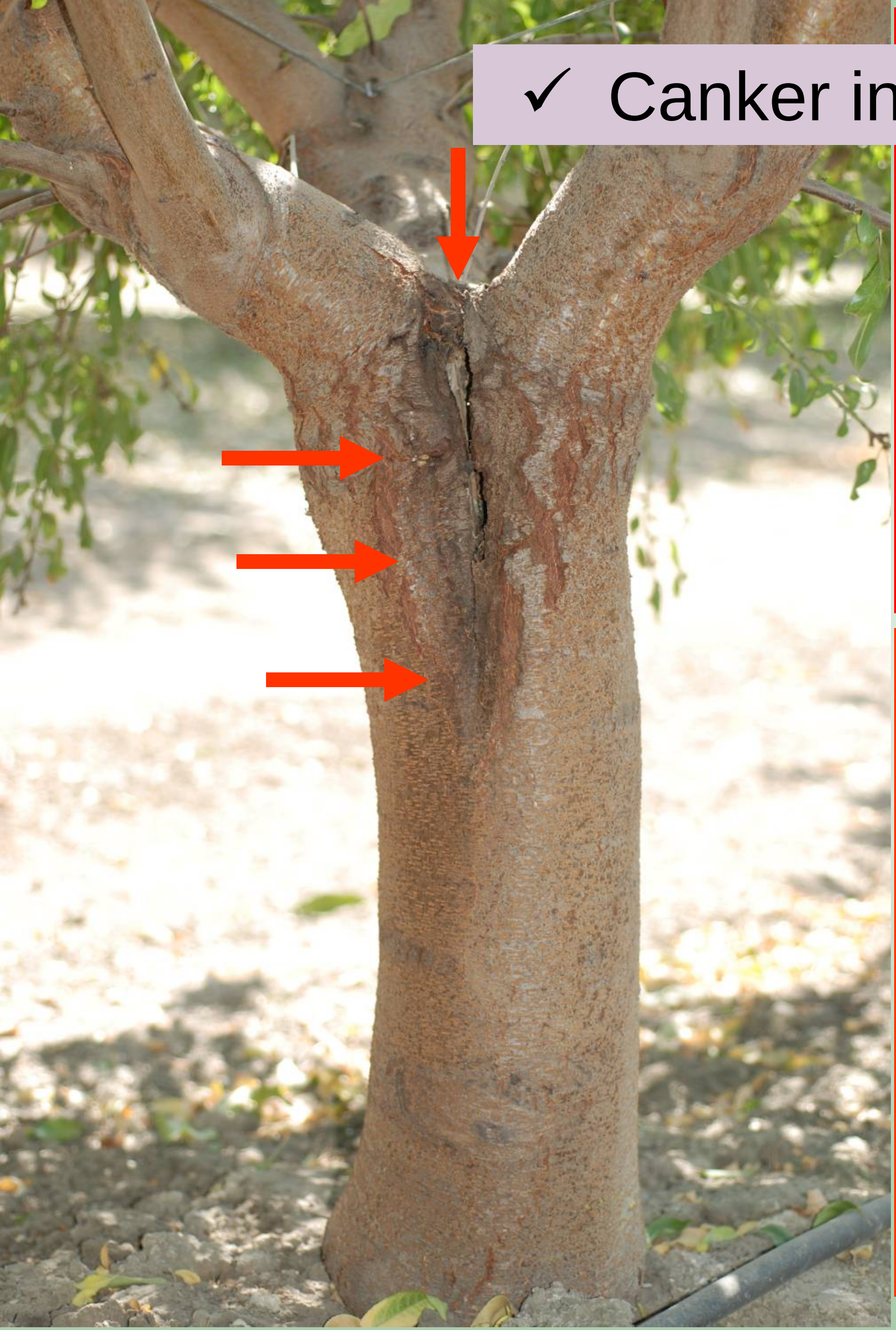
Name of canker disease	**Causal pathogen**
Band canker*	*Botryosphaeriaceae* species
Ceratocystis canker	*Ceratocystis fimbriata*
Cytospora (Leucostoma) canker	*Leucostoma cincta*
Eutypa canker *	Eutypa lata
Foamy canker *	*Zymomonas* species?
Phomopsis canker	*Phomopsis & Diaporthe* species
Other canker diseases	
Phytophthora cankers *	*Phytophthora* species
Bacterial canker *	*Pseudomonas syringae* pv. *syringae*

Band canker

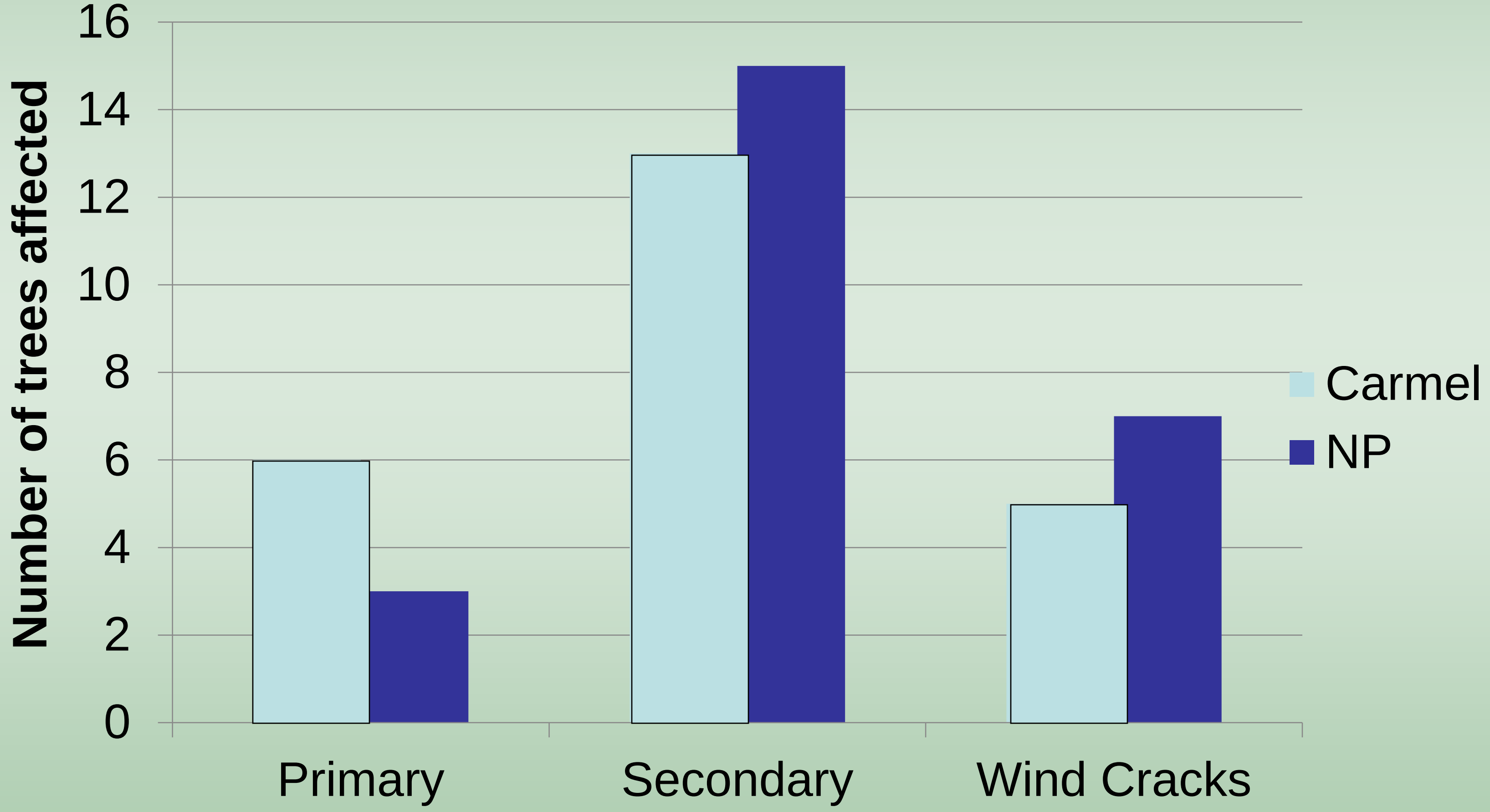

✓ Primary infections
Current year's band
Last year's band
trunk
main scaffold

✓ Secondary infections through pruning wounds

✓ Canker in wind cracks



Cankers of almond trees in a Livingston orchard (#1)



Botryosphaeriaceae on almond in California:

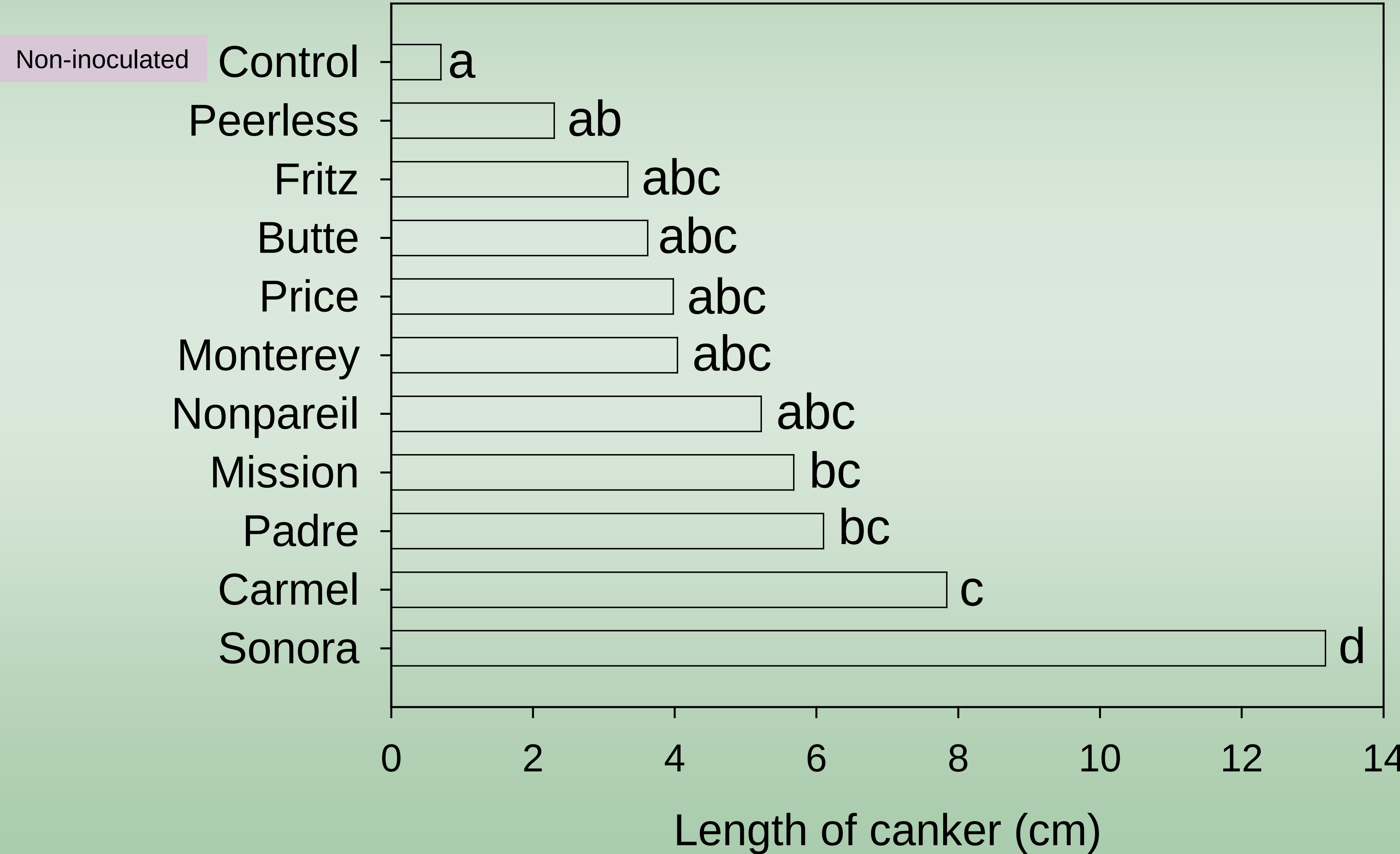
1. *Botryosphaeria dothidea* *
2. *Neofusicoccum parvum* *
3. *Neofusicoccum mediterraneum* *
4. *Neofusicoccum nonquaesitum**
5. *Diplodia seriata* *
6. *Macrophomina phaseolina**
7. *Dothiorella sarmentorum*
8. *Dothiorella iberica* …(2012-13)

} Almond

Eutypa lata ………….(2012-13)

(* also on pistachio & walnut)

Susceptibility of almond cultivars inoculated with *Neofusicoccum nonquesitum*



Foamy Canker

Isolated:
A *Zynomonas* sp. (bacterium) &
a yeast

Conclusions

1. **Surveys show that cankers sometimes can reach high levels.**

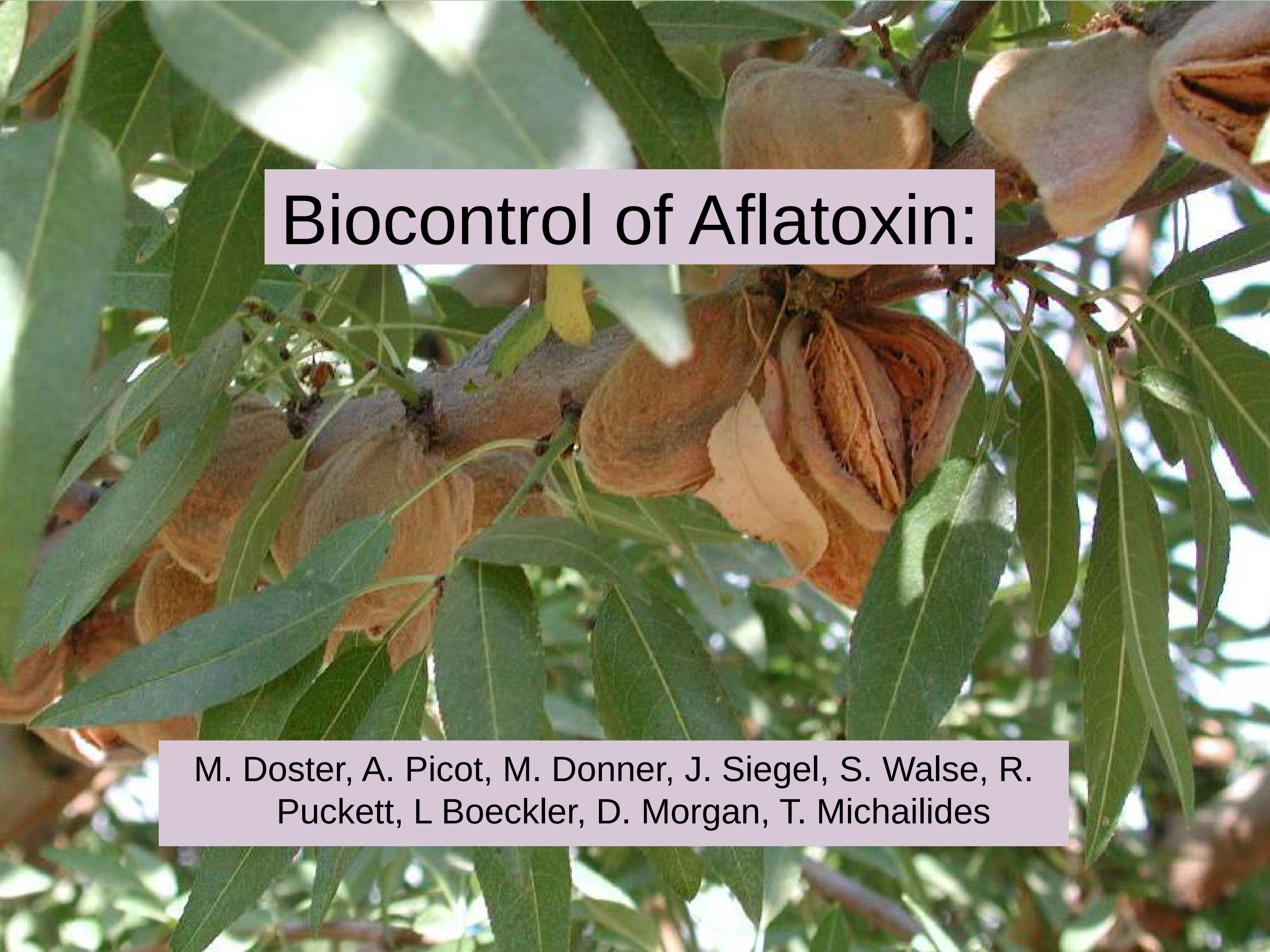
2. **Cankers develop in growth cracks, pruning wounds, and wind cracks (1st - 3rd leaf trees) and pruning wounds mainly (4th leaf & older trees).**

3. **Eight species of Botryosphaeriaceae are associated with cankers plus *Eutypa lata* (another canker fungus).**

4. **Almond cultivars show differences in susceptibility but none is resistant to canker diseases.**

5. **Management of canker diseases is critical when trees are young; limit big cuts and time pruning during dry weather.**

end →



Biocontrol of Aflatoxin:

M. Doster, A. Picot, M. Donner, J. Siegel, S. Walse, R. Puckett, L Boeckler, D. Morgan, T. Michailides

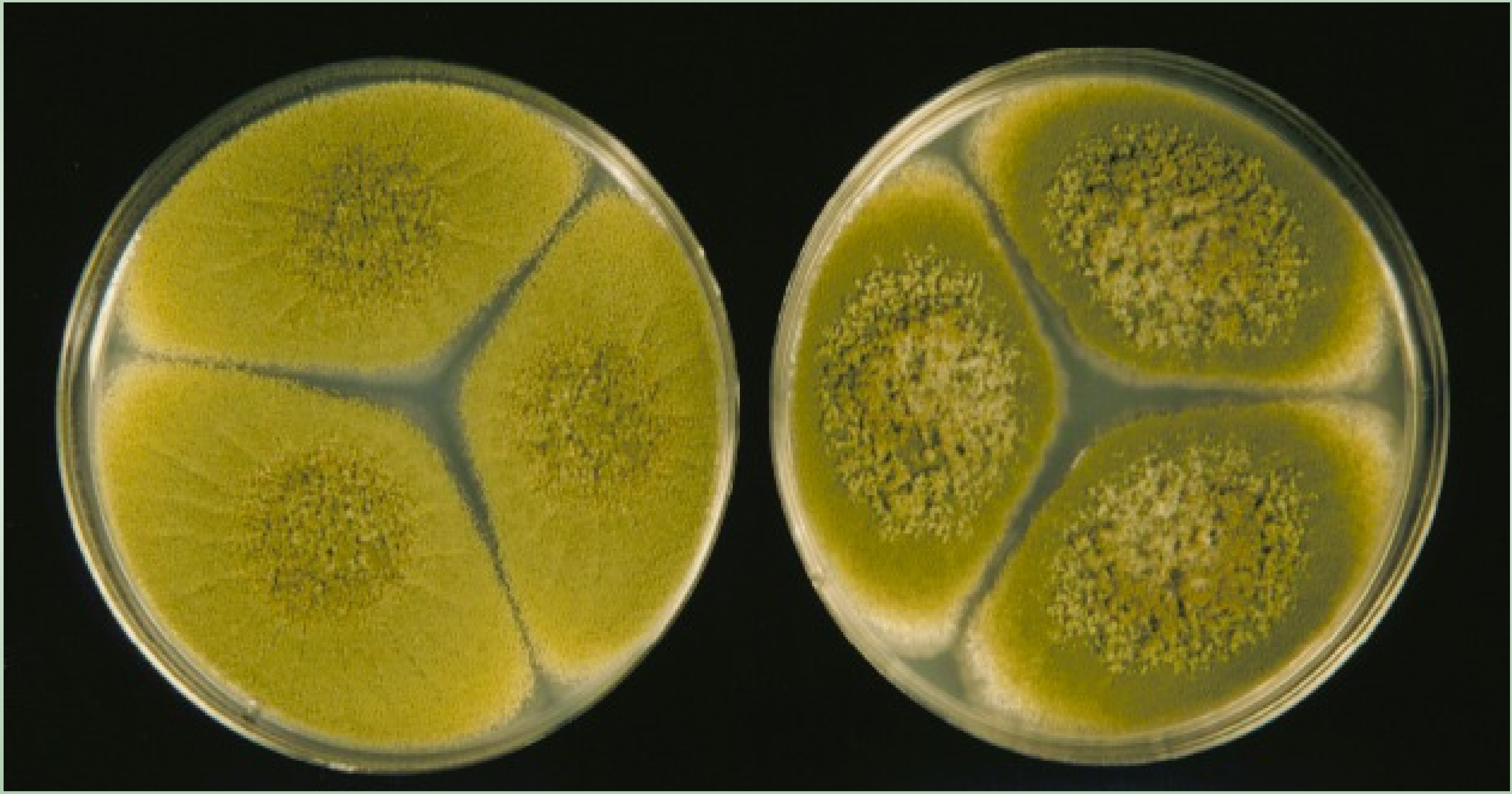
Definition:

Aflatoxins are secondary, toxic metabolites of certain fungal species that contaminate some agricultural commodities

Incidence of aflatoxin contamination
in California almonds

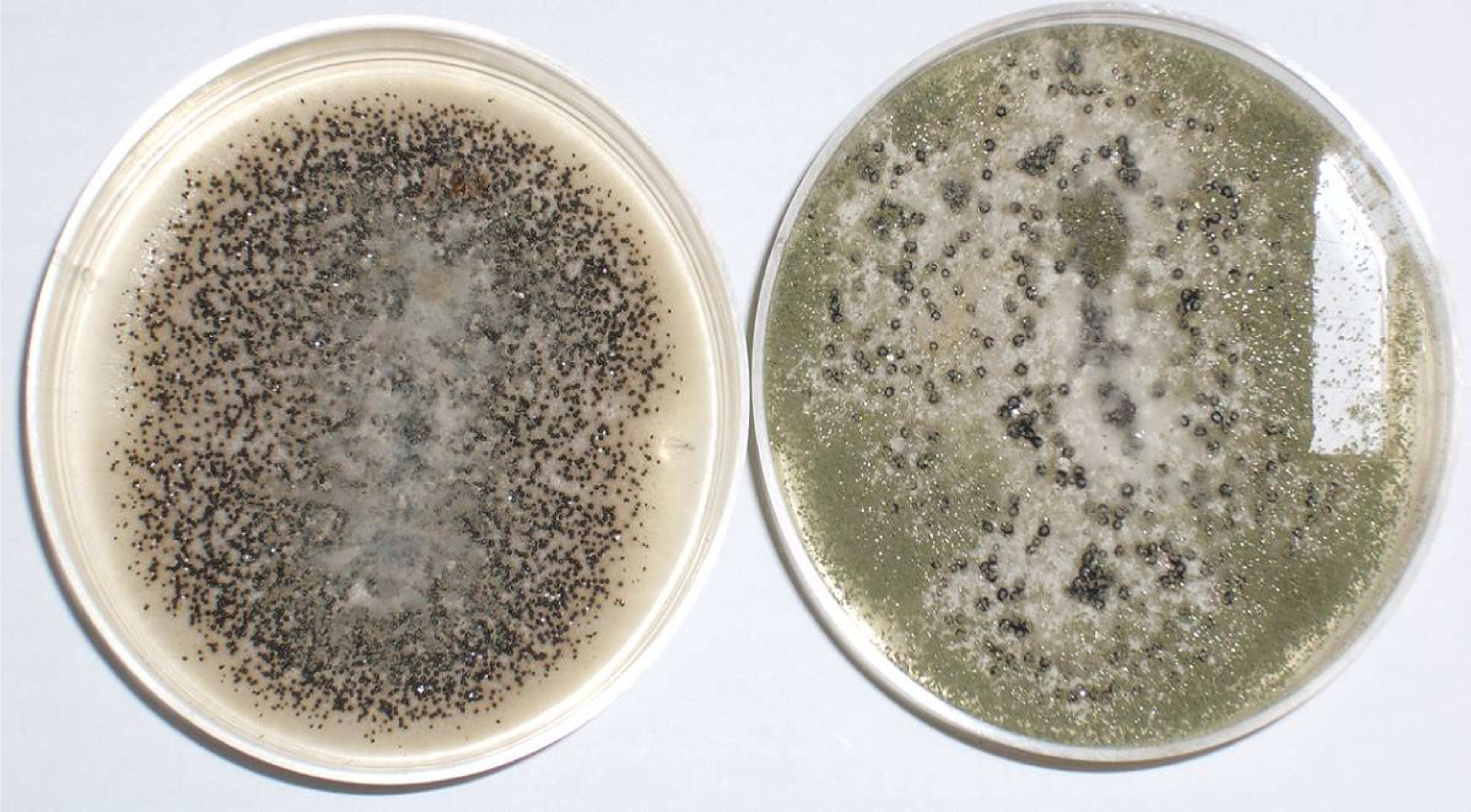
1 in 25,000 to 35,000 nuts

Molds that can produce aflatoxin in almonds in California



Aspergillus flavus *Aspergillus parasiticus*

Aspergillus flavus



S strain
(almost all toxigenic)

L strain
(about 50% atoxigenic)

Selected one L strain, the AF36

Incidence of AF36, 4.6%

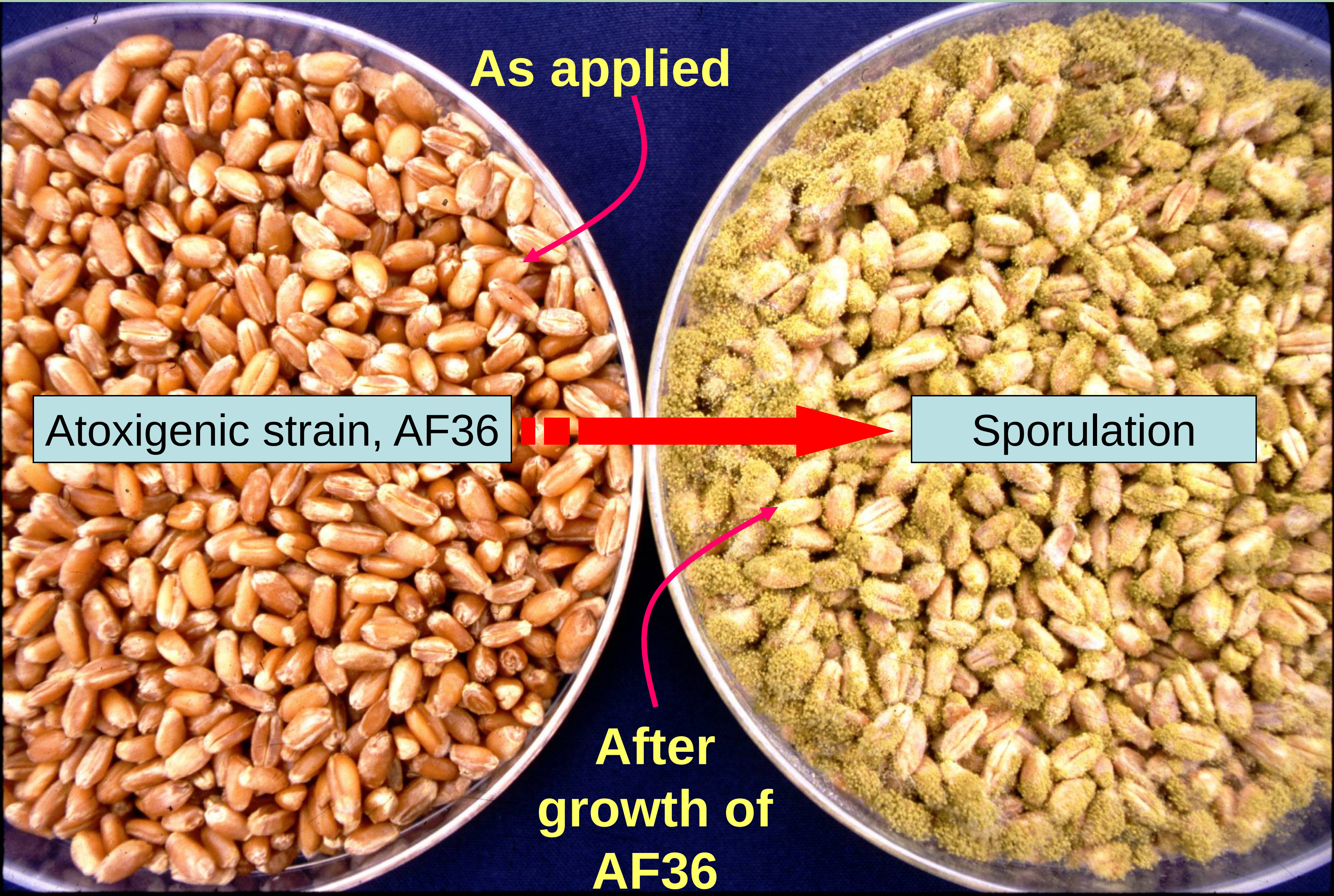
Rationale: Use the <u>AF36</u> to displace the toxigenic *A. flavus and A. parasiticus* in orchards

The strain AF36 is widespread

	AF36 (%)		
County	Almond	Pistachio	Fig
Butte	6.5	…	…
Colusa	3.0	…	…
Fresno	…	3.1	6.1
Glenn	4.4	…	…
Kern	8.5	12.7	…
Madera	5.0	7.2	7.2
Merced	…	15.0	5.8
Tulare	…	2.9	…

All the other atoxigenic strains < 1%

Irrigation is needed for spore production



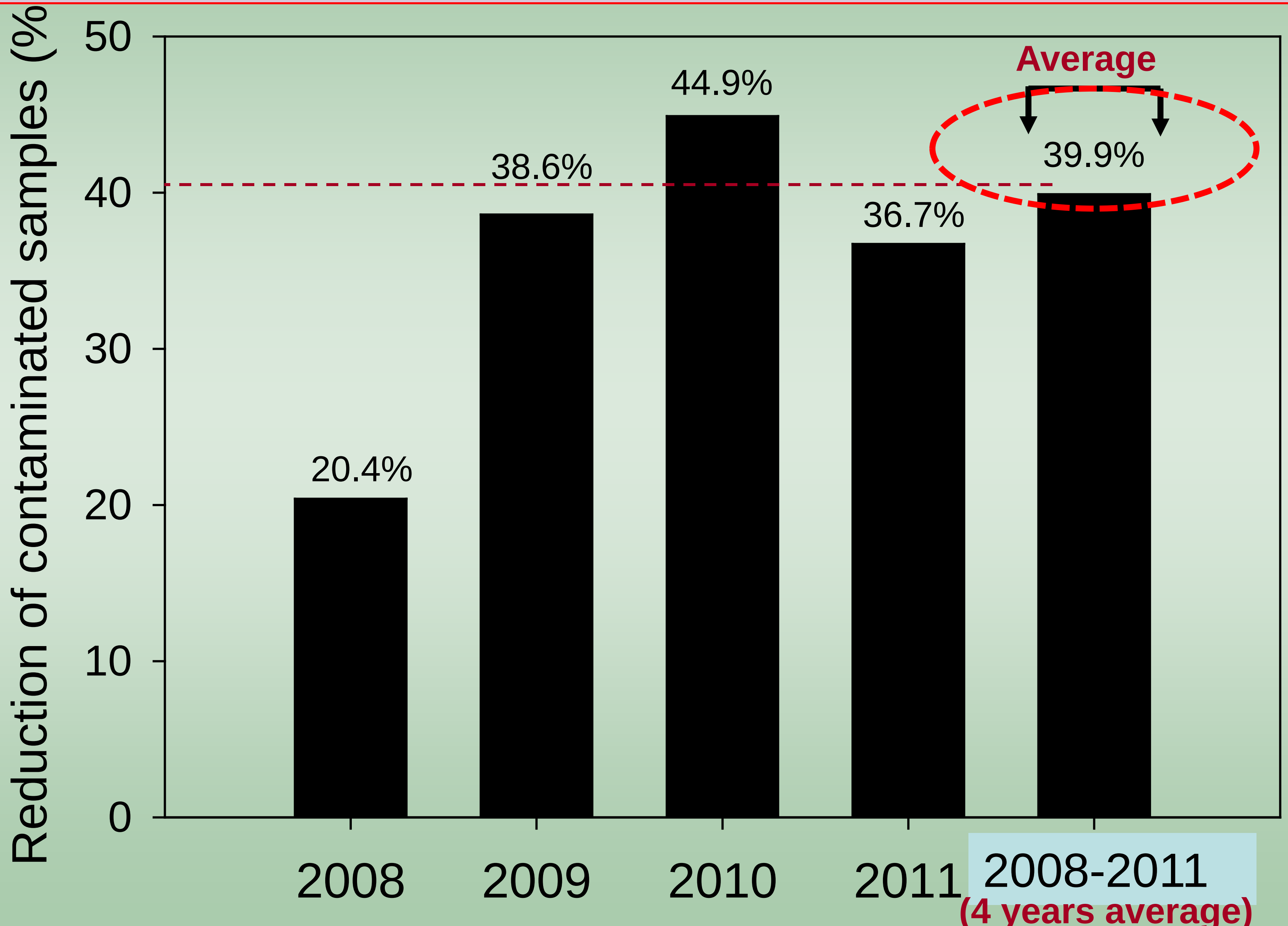

AF36
Inoculum

Application rate: 10 lbs. per acre

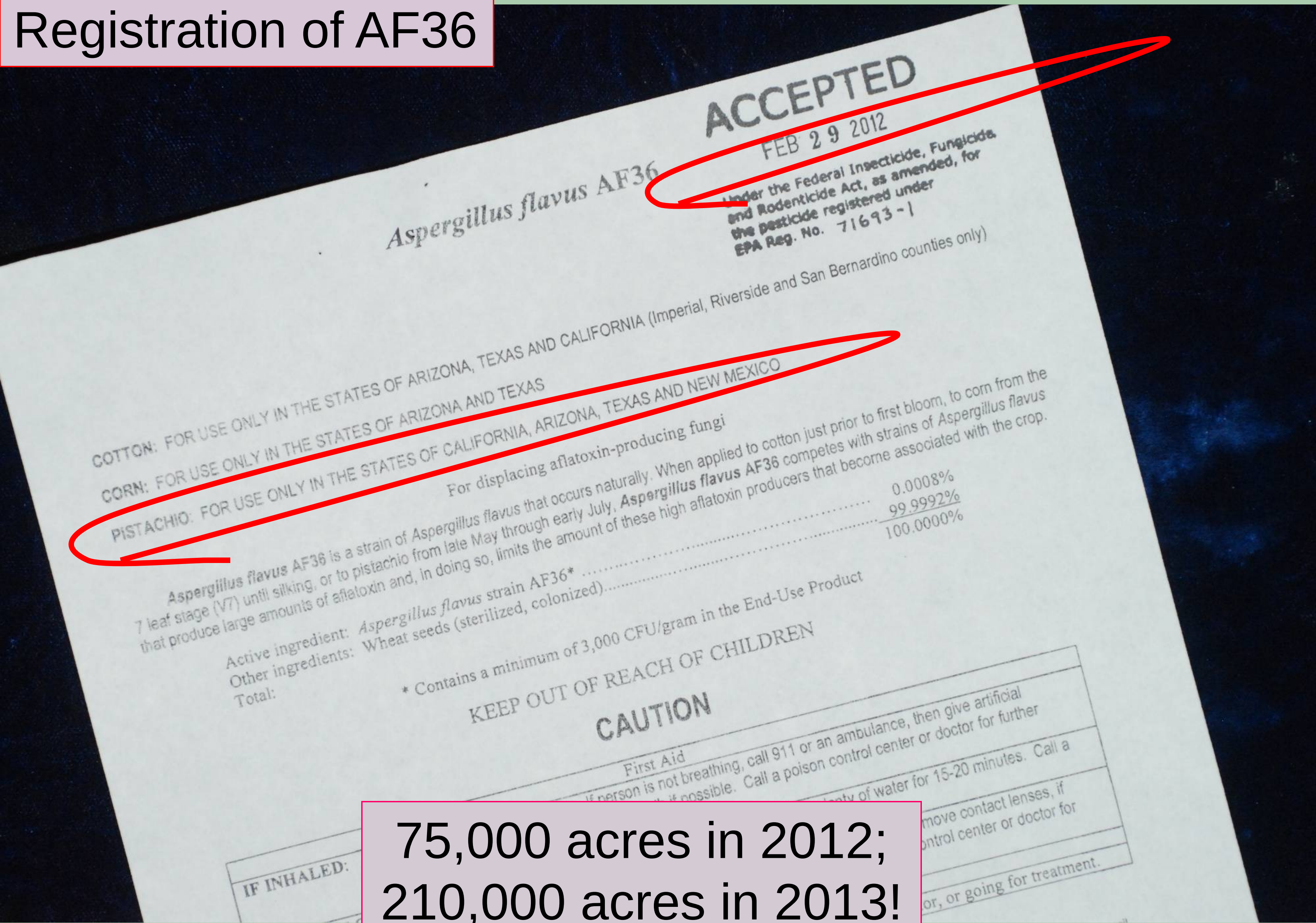
Library samples for aflatoxin analysis – brought to Kearney

Samples taken at processing plant as nuts are being unloaded.

Reduction in aflatoxin-contaminated pistachio samples: (all harvests)



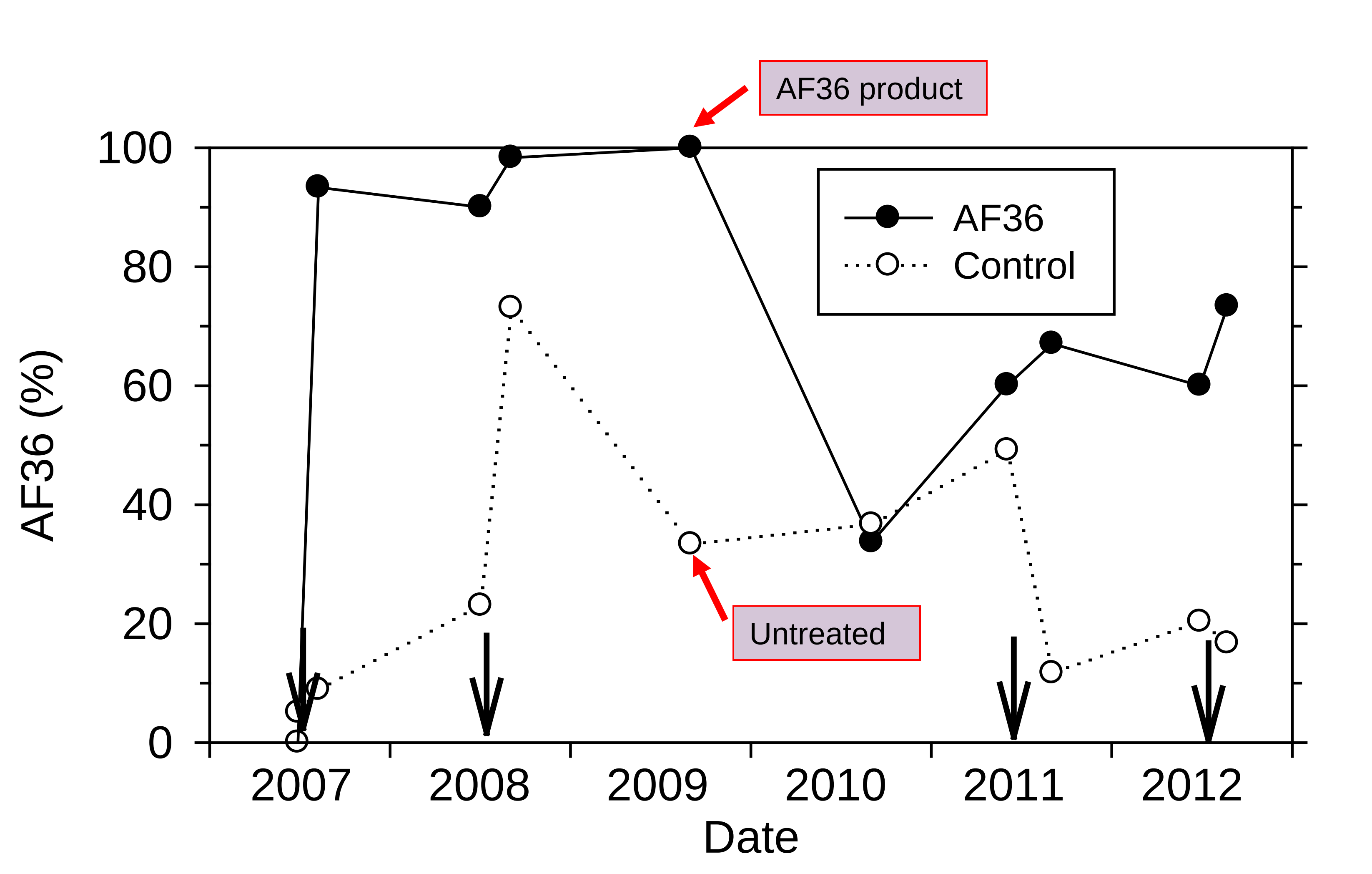
Registration of AF36



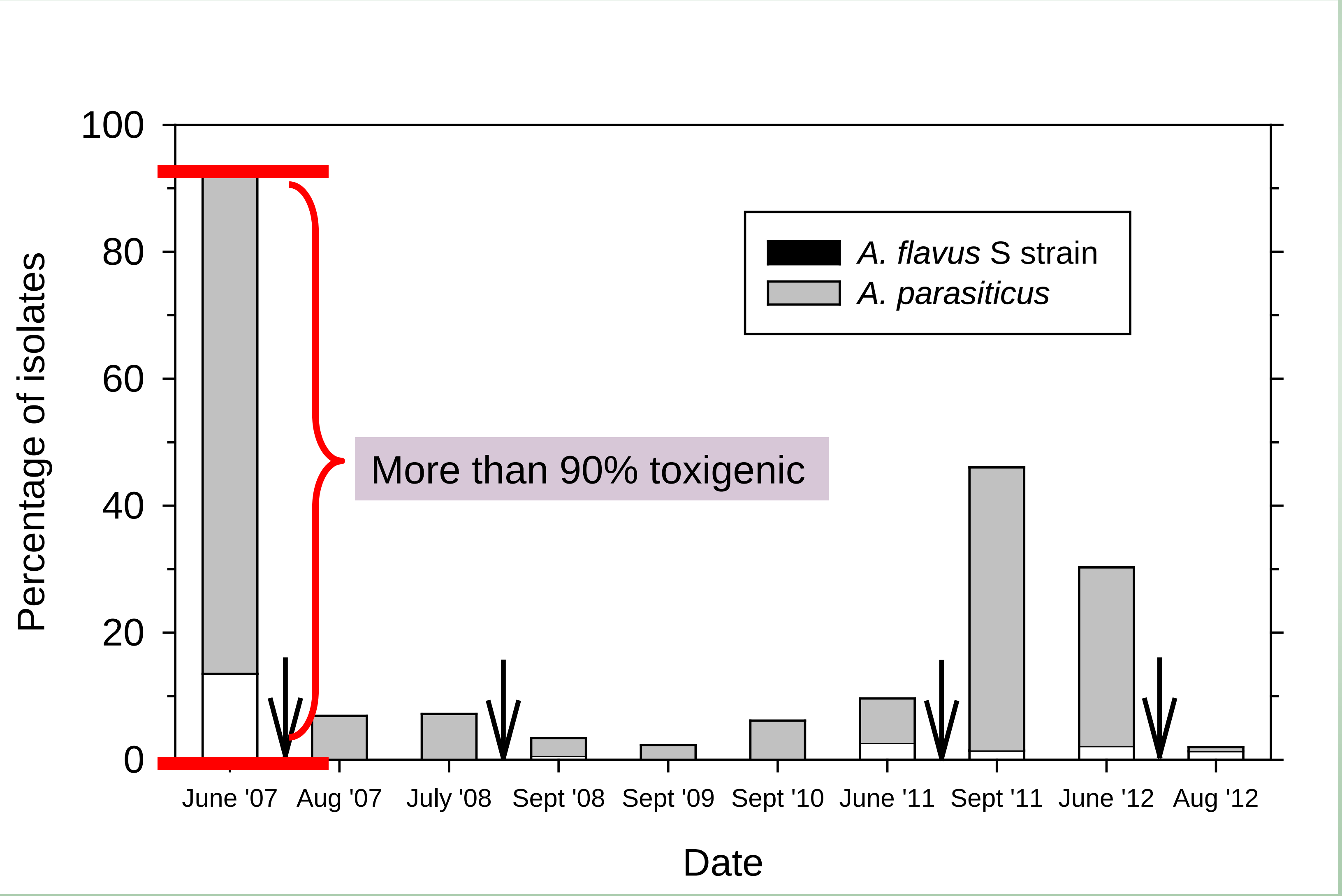
75,000 acres in 2012;
210,000 acres in 2013!

Almond experimental orchard

Percentage of *A. flavus* isolates from soil belonging to AF36



Percentage of toxigenic *Aspergillus flavus/A. parasiticus* isolates in the experimental almond orchard after application of AF36



Conclusions from the AF36 study in an exp. almond orchard

- ✓ The atoxigenic strain AF36 became the dominant strain in the soil where the AF36 product was applied.
- ✓ The atoxigenic strain AF36 persisted well in the soil for 2 years.
- ✓ No increase in nut decay.
- ✓ The *sorghum-AF36* product shows promise as an alternative to the *wheat-AF36* product.

The registration of AF36 in almonds is along the way!

Acknowledgments

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- Mark Doster
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USDA/ARS-Univ. of Arizona

- Peter Cotty
- Ramon Jaime Garcia

USDA/ARS-Parlier, California

- Joel Siegel
- Spencer Walse

Thank you

Almond Flower, Foliar, and Fruit Disease Management

Dr. J. E. Adaskaveg

Department of Plant Pathology and Microbiology

UC Riverside

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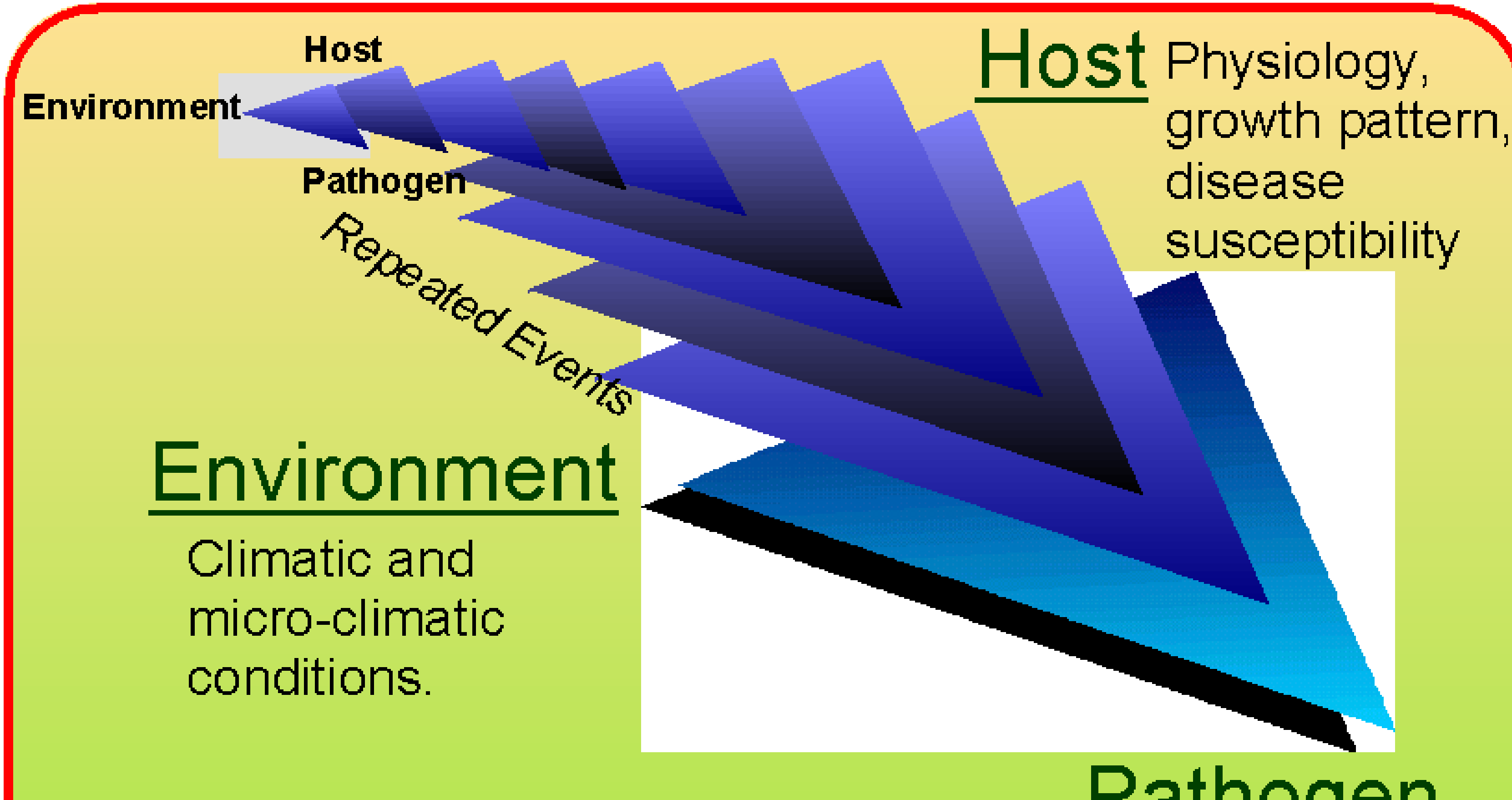
Today's almond horticultural practices have changed to increase production

Changing practice	Effects
High-density planting	Less air circulation, increase in shading and orchard humidity
Higher nitrogen fertilization	Rapid growth, plant tissues more susceptible
Increase in irrigation duration	Increase in orchard humidity
Planting in areas less suitable for almond production	Environments may be more favorable for disease. Increased stress on trees.

Conditions that weaken trees and favor plant pathogens

The Disease Triangle of Plant Pathology



Interactions between the components effect the amount of disease.

Almond diseases that have increased with changes in production

Scab – *Fusicladium (Cladosporium) carpophilum*
Alternaria leaf spot – *Alternaria* spp.
Hull rot – *Rhizopus stolonifer, Monilinia fructicola*

Scab

Alternaria leaf spot

Hull rot

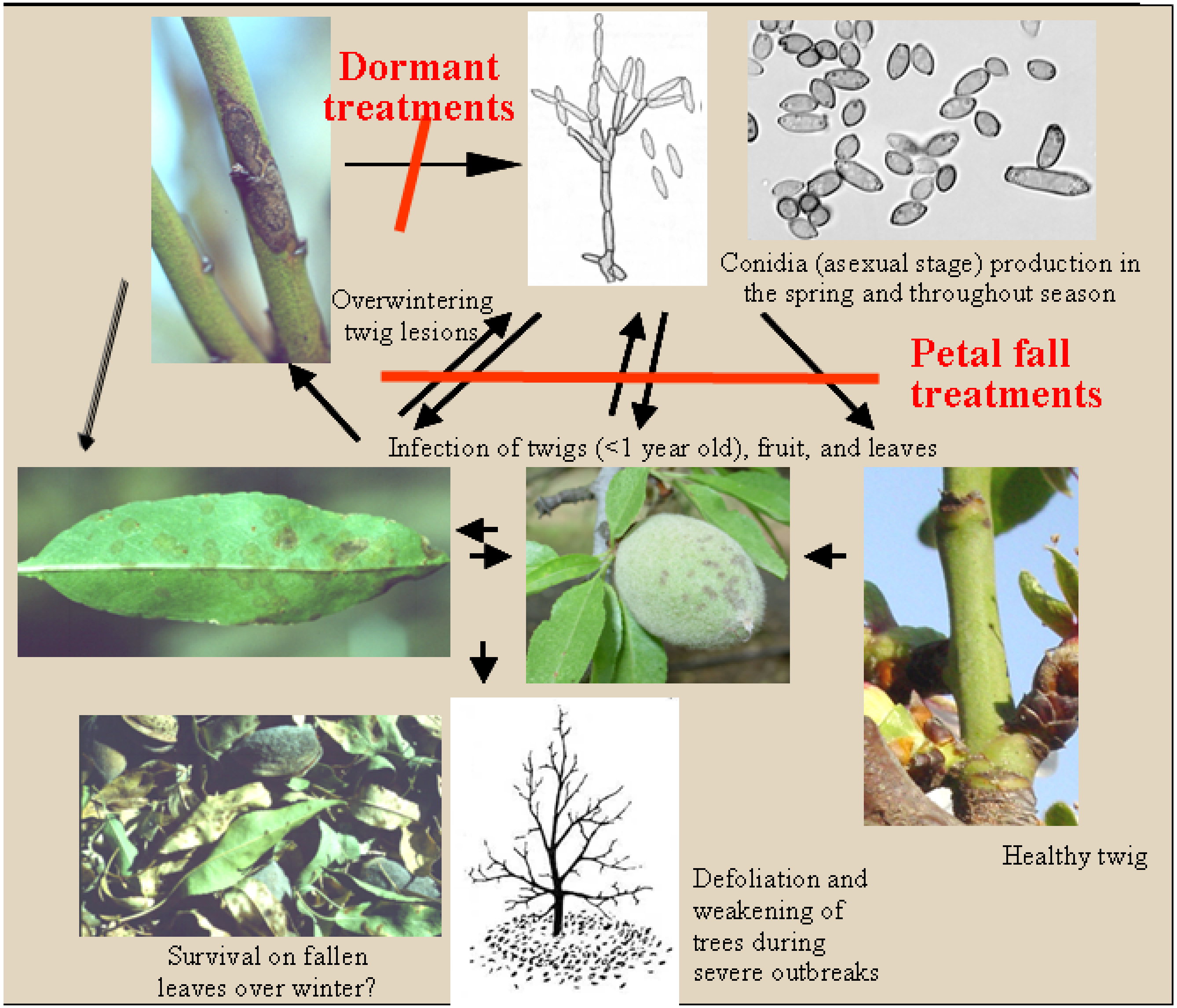
Management of Scab: Cultural Practices

- **Planting: Varietal Susceptibility**
  - *Most Susceptible:* Carmel, Merced, NePlus Ultra, Peerless, Price, Ruby, Sonora, Winters.
  - *Less Susceptible:* Butte, Fritz, Mission, Monterey, Wood Colony, Thompson.
  - *Least Susceptible:* Nonpareil

Practice	Goal
Planting Design	Allow air circulation
Tree Pruning	Increase air movement and reduce RH
Irrigation Management	Reduce orchard RH
Clean Cultivation	Reduce orchard RH
Avoid heavy late-summer/fall fertilization with N	Reduce production of highly susceptible host tissues

Management of Scab with Fungicides

Dormant and in-season (after petal fall) treatments



Disease epidemiology determines most effective timings of fungicide applications

Fungicides for Managing Almond Diseases

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Inorganics — Copper, Sulfur — M1&2 — 1960s

Dithiocarbamates — Ziram, Manzate, Dithane — M3 — 1940s

Phthalimides — Captan — M4 — 1950s

Isophthalonitriles — * Bravo, Echo, Equus — M5 — 1960s

Guanidines — * Syllit — U12 — 1960s

Benzimidazoles — Topsin-M, T-Methyl — 1 — 1970s

Dicarboximides — Rovral, Iprodione, Nevado, Meteor — 2 — 1980s

Sterol inhibitors (DMIs) — * Rally, Indar, Tilt, Bumper, Quash, Inspire, Tebuzol — 3 — 1970s - 1980s

SDHIs — Xemium, Luna Privilege, Fontelis — 7 — 1960s

Anilinopyrimidines — Vangard, Scala — 9 — 1990s

QoIs — * Abound, Gem, Headline, picoxystrobin — 11 — 1990s

Hydroxyanilides — Elevate — 17 — 1990s

Polyoxins — Ph-D — 19 — 1960s

Pre-mixtures

- * Inspire Super — 3+9
- * Quadris Top, Quilt Xcel — 3+11
- * Pristine, Luna Sensation, Merivon — 7+11
- * Luna Experience — 3+7
- Viathon — 3+33

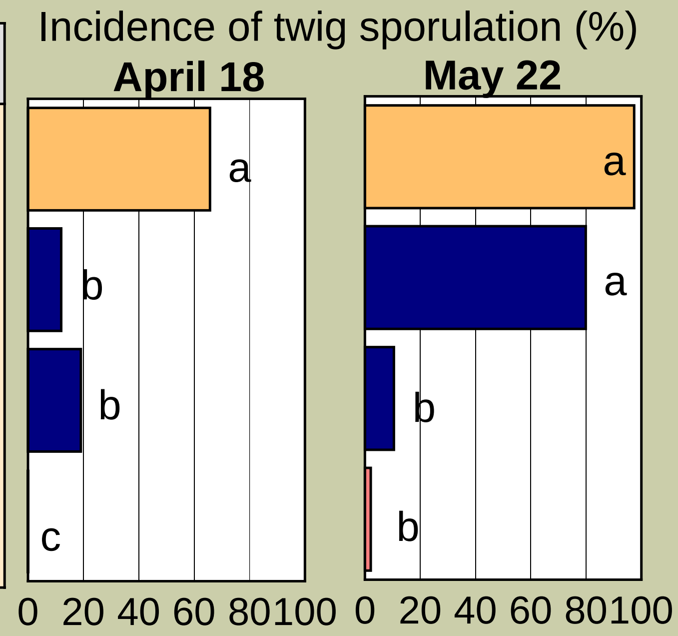
*** Best activity against scab**

Multi-site mode of action | Single-site mode of action | Reduced risk fungicides | FRAC group

Management of Scab:
Dormant applications to reduce inoculum in the spring

2013

Fungicide	Oil	Timing
---	-	-
Kocide 3000 5 lb	+	Jan. 2013
Bravo WeatherStick 4 pts	+	Jan. 2013
Bravo WeatherStick 6 pts	+	Jan. 2013




Control


Bravo

Comparison of copper-oil and chlorothalonil–oil: Extended prevention of twig sporulation into early summer with chlorothalonil-oil.

Dormant treatments to reduce scab inoculum in the spring

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- Bravo WeatherStik received a Section 2(ee) registration for dormant application between Dec. 1 and Jan. 10 (before bud swell)
- Higher rates and oil improved performance
- Full registration is planned through IR-4 to change PHI to 60 days and rate to 6 pts/A.
- Additional benefit: Align scab with Alternaria treatments

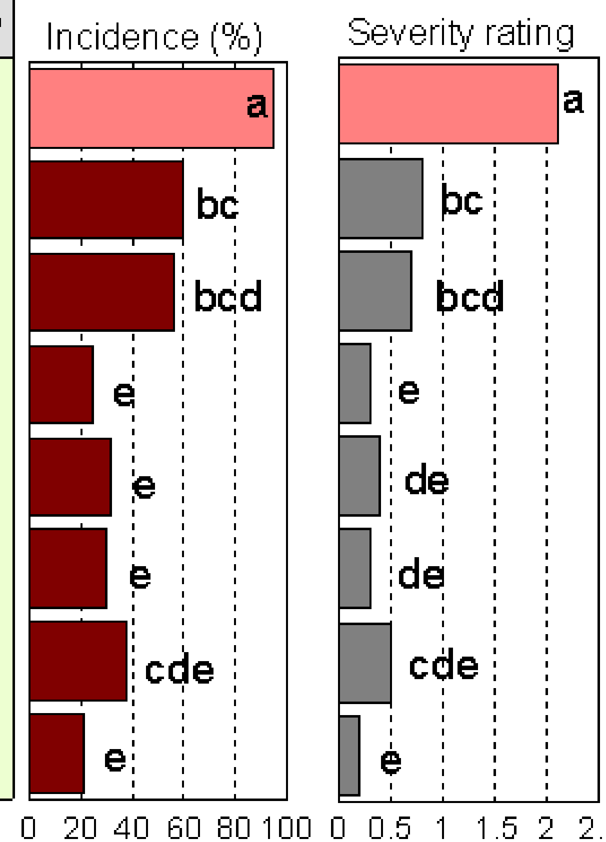
		Bloom			Spring		Summer	
Disease	Dormant	Pink bud	Full bloom	Petal fall	Two week	Five week	May	June
Scab	++	-	-	+	+++	+++	+/-	+/-
Scab Dormant Chlorothalonil+oil	++	-	-	-	-	+++	+++	+/-
Alternaria	-	-	-	-	-	+++	+++	+++

Management of Scab

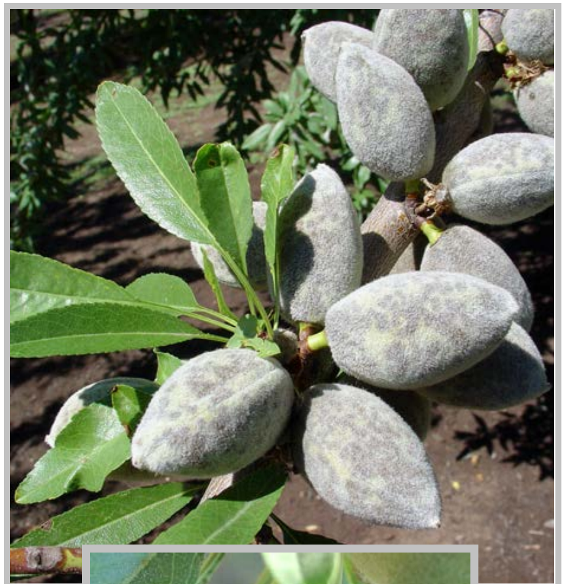
In-season applications after start of twig sporulation

cv. Monterey
Colusa Co., 2013

Treatment	Rate (/A)	4/23	5/15
Control	---	---	---
Ph-D 11.3DF + NuFilm P	6 oz	@	@
Syllit 65WG	2 lb	@	@
Syllit + Tebuconazole*	2 lb + 6 oz	@	@
Syllit + Tebuconazole*	1.5 lb + 6 oz	@	@
Luna Experience	6 fl oz	@	@
Luna Sensation	5 fl oz	@	@
Merivon	5 fl oz	@	@



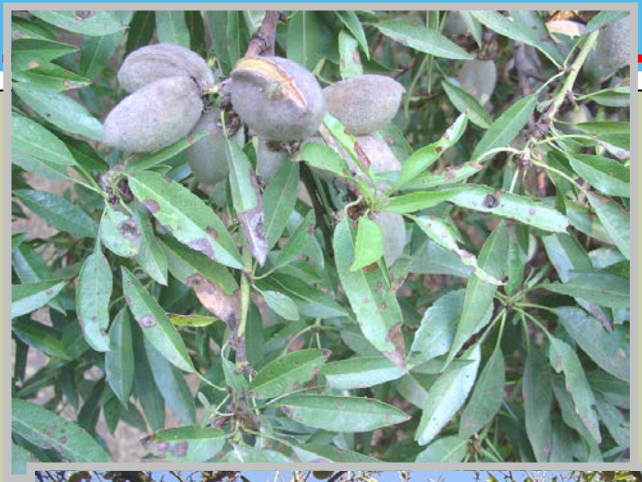
Management of Scab - Summary



- At locations with high disease levels, a dormant application should be done.
- An effective 3-spray program includes dormant and two applications after twig infection sporulation.
- Multi-site fungicides with low resistance potential (chlorothalonil, possibly mancozeb, captan, ziram) should be in rotations with the newer single-site and pre-mix fungicides.
- Syllit is a new scab material and should be used at 32 oz/A.
- **Single-site fungicides should not be applied once disease is developing.**

Management of Alternaria Leaf Spot – Field Efficacy trials

Alternaria alternata, A. arborescens, A. tenuissima

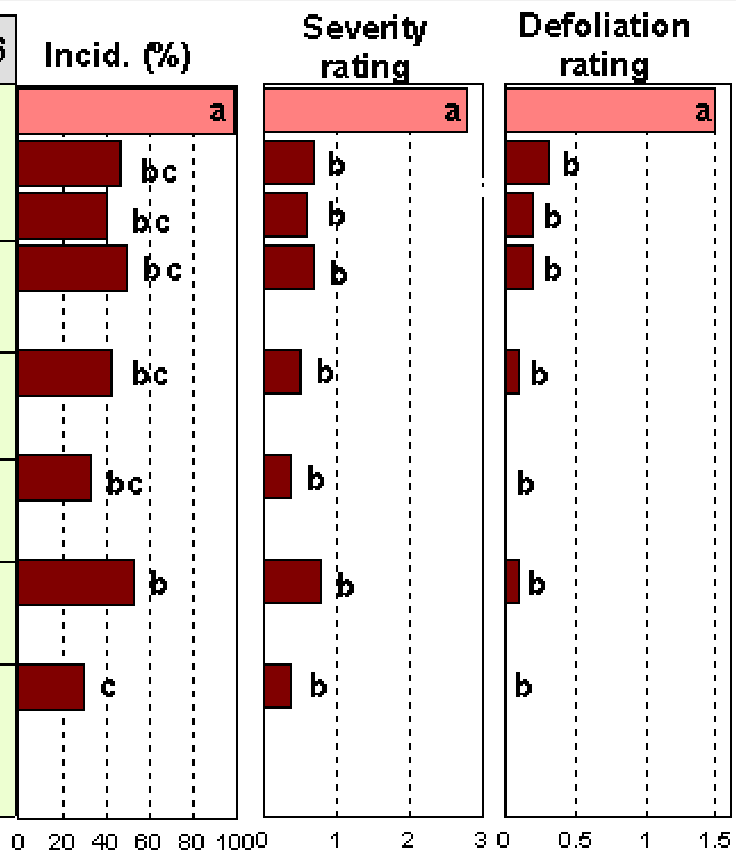


cv. Monterey, Kern Co.

Management of Alternaria Leaf Spot – Field Efficacy trials 2013

Rotations

Treatment	Rate (/A)	5-29	6-18	7-16
Control	---	---	---	---
Custodia	17.25 fl oz	@	@	@
Captan Gold + Custodia	2.5 lb + 17.25 fl oz	@	@	@
Bravo Weather-Stick	4 pt	@	@	---
Quadris Top + Dyne-Amic	14 fl oz + 16 fl oz	@	@	@
Bravo Weather-Stick	4 pt	@	@	---
A13703N + Dyne-Amic	14 fl oz + 16 fl oz	@	@	@
Bravo Weather-Stick	4 pt	@	@	---
Inspire Super + Dyne-Amic	20 fl oz + 16 fl oz	@	@	@
Catamaran	4 pt	@	@	@
Viathon	32 fl oz	@	@	@
Ph-D 11.3DF	6.2 oz	@	---	---
Quash 50WG	3.5 oz	---	@	---
Ph-D + Inspire Super + D.	6.2 + 20 + 16 fl oz	---	---	@



cv. Monterey, Colusa Co.

Disease incidence and severity on leaves and defoliation reduced by all treatments.

Management of Alternaria leaf spot - Summary

- Late-spring/early-summer applications (based on the DSV model).
- Newer materials (e.g., Quash, Inspire Super, Ph-D, Quadris Top, Luna Sensation, and Luna Experience) have to be strictly used in rotations and mixtures for resistance management.
- Other components of an integrated approach in disease management are highly critical for management of Alternaria leaf spot.

Almond Hull Rot Control

- Caused by *Rhizopus stolonifer* or by *Monilinia fructicola*
- Both pathogens infect fruit and cause dieback

Rhizopus stolonifer

Monilinia fructicola

- Inoculum of *Rhizopus stolonifer* is omnipresent (soil)
- Inoculum of *Monilinia fructicola* originates from other stone fruits (peaches, cherries) or almond. Blossom blight can be caused by *M. laxa* (North) and *M. fructicola* (South regions).

Control of Hull Rot Caused By Brown Rot

Applications with Luna Experience,
cv. Nonpareil, Stanislaus Co.

4-4	4-25	6-6	7-13
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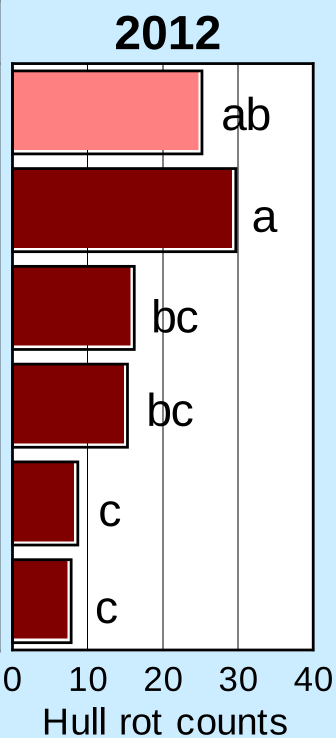
9.5 mm (0.37 in)



5-9	6-5	6-18
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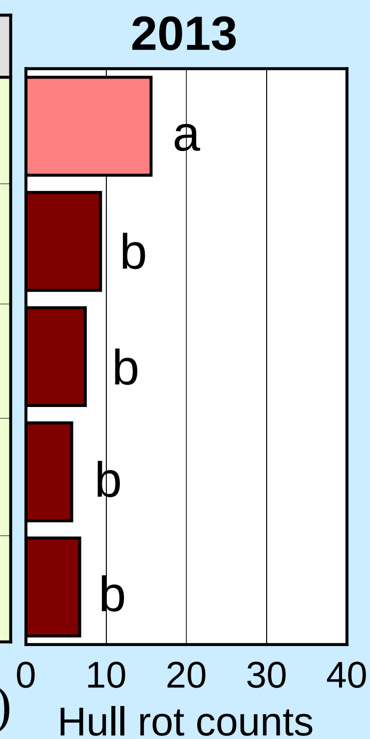
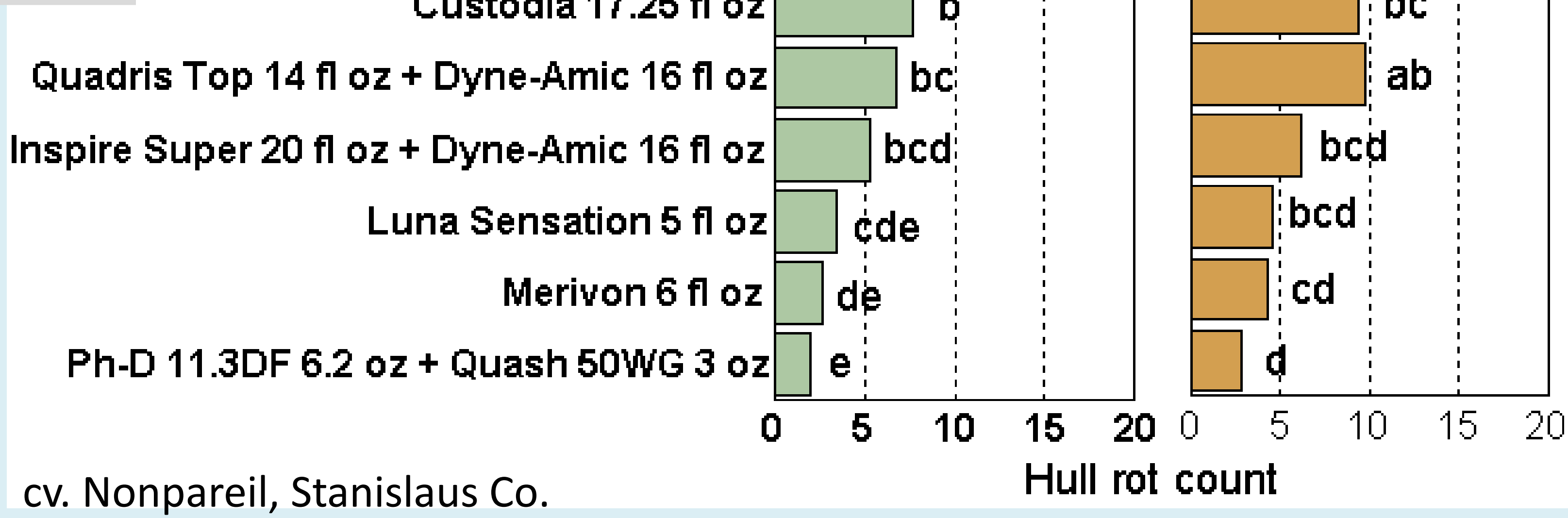
3.6 mm (0.14 in)



Hull rot caused by *M. fructicola* or by both pathogens is best managed by late-spring applications.

Control of Hull Rot caused by both pathogens - Field trials 2013



Hull rot caused by *M. fructicola* or by both pathogens is best managed by late-spring applications.

Hull Rot Control - Summary

growing ADVANTAGE™ The Almond Conference

- **Knowledge on the management of hull rot is accumulating.**
- **Fungicide treatments can be effective in reducing hull rot caused by *R. stolonifer* and by *M. fructicola*.**
  - **For *Rhizopus* hull rot, early hull split applications when susceptibility is high should be done. Fungicides are applied most effectively with NOW applications.**
  - **For *Monilinia* hull rot, applications should be done earlier (late spring).**
- **For the most effective integrated management of hull rot, hull split should be induced simultaneously with proper water management (i.e., deficit irrigation).**

New challenges – Bacterial spot of almond

- Causal agent: *Xanthomonas arboricola* pv. *pruni*
- Was found in spring 2013 on almond, cherry, and possibly other stone fruit crops. On almond, - Colusa, San Joaquin, Stanislaus, Merced and Madera Co.

- Little is known about the disease:
- Bacterial spot of peach (eastern US) occurs during high moisture conditions.
- Fritz is one of most susceptible varieties, but isolations have also been made from Nonpareil, Butte, Carmel, and Price.
- Management strategies are being explored: dormant and springtime applications with bactericides.

Thank you

UCCE Farm Advisors,
Grower Cooperators,
Industry Reps,
and PCAs