2017 THE ALMOND CONFERENCE

DISEASE AND AFLATOXIN MANAGEMENT UPDATE

Room 308-309 | December 7 2017

california almonds
Almond Board of California

growing ADVANTAGE
The Almond Conference

CEUs – New Process

Certified Crop Advisor (CCA)

- Sign in and out of each session you attend.
- Pickup verification sheet at conclusion of each session.
- *Repeat this process for each session, and each day you wish to receive credits.*

Pest Control Advisor (PCA), Qualified Applicator (QA), Private Applicator (PA)

- Pickup scantron at the start of the day at first session you attend; complete form.
- Sign in and out of each session you attend.
- Pickup verification sheet at conclusion of each session.
- Turn in your scantron at the end of the day at the last session you attend.

Sign in sheets and verification sheets are located at the back of each session room.

AGENDA

- **Bob Curtis**, Almond Board of California, moderator
- **Mohammad Yaghmour**, UCCE Kern Co.
- **Jim Adaskaveg**, University of Riverside
- **Themis Michailides**, UC Davis/Kearney

CAUSAL AGENTS OF ALMOND HULL ROT

Mohammad Yaghmour, Orchard Systems Advisor,
UCCE Kern Co.

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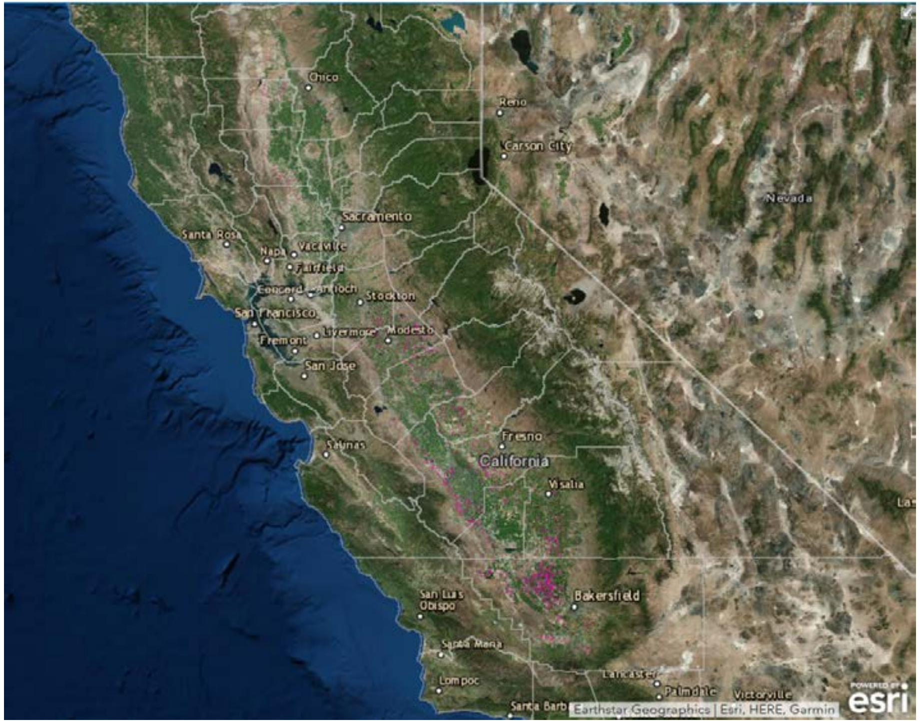
DISTRIBUTION OF THE DISEASE IN CALIFORNIA

- The disease affects almond orchards in all major almond production areas including Kern County with approximately 217,000 of bearing acres



CAUSAL AGENTS AND SOURCES OF INOCULUM

Monilinia spp.

Infected almond and stone fruit twigs, fruits, mummies, etc

Rhizopus stolonifer

Soil

SYMPTOMS AND SIGNS OF HULL ROT

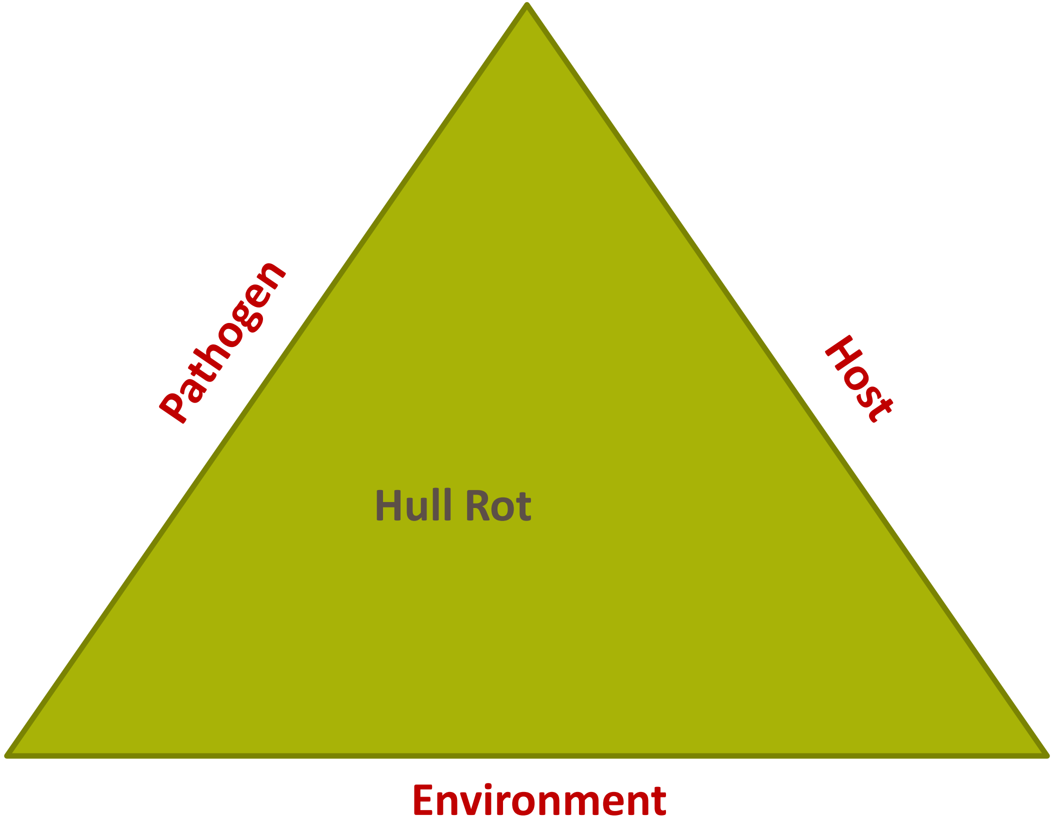
- When the hull is infected and disease progress, leaves near the infected fruit starts to dry and shrivel

- Monilinia: Infected hull has a brown area on the outside and either tan fungal growth in the brown area on the inside or outside of the hull

- Rhizopus: Black fungal growth on the inside of the hull between the hull and the shell.

Fungi produce a toxin that kills the fruiting spur and the twig

DISEASE TRIANGLE



Pathogen

Host

Hull Rot

Environment

FRUIT SUSCEPTIBILITY TO HULL ROT PATHOGEN *RHIZOPUS STOLONIFER*

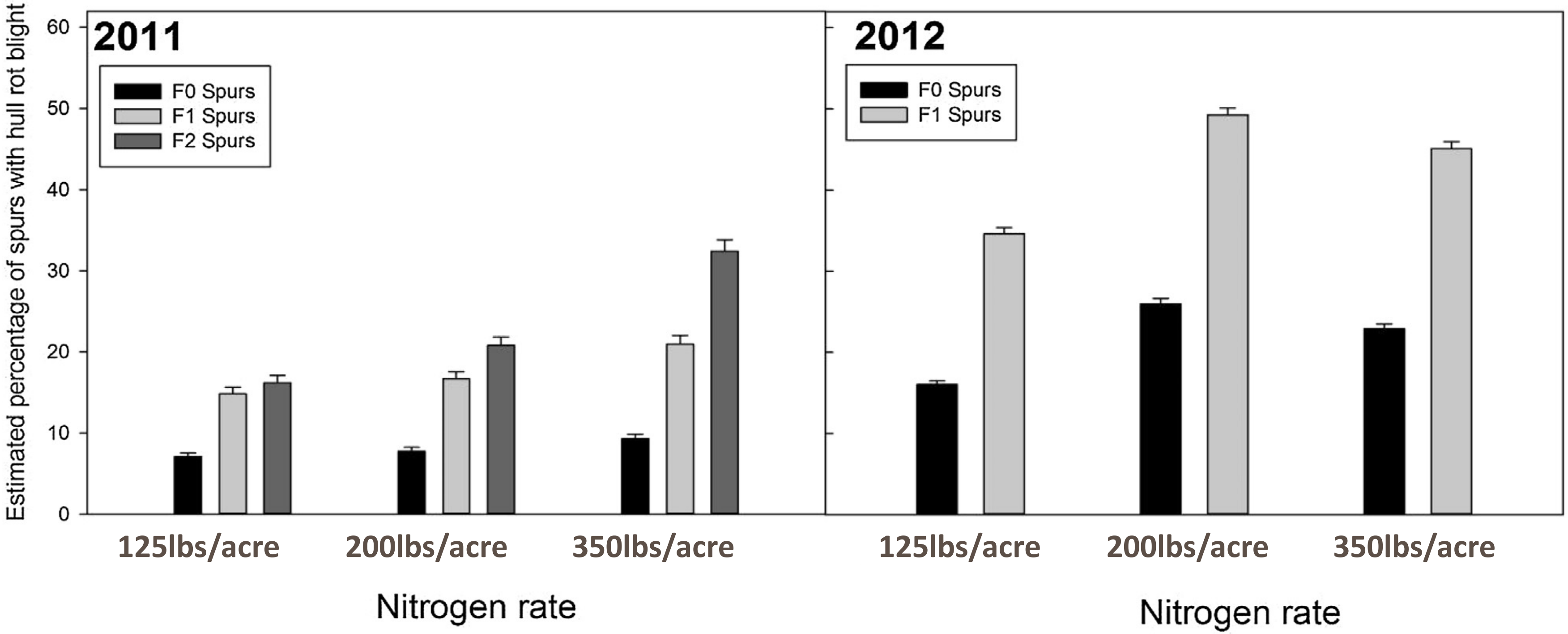
(b1) Initial separation-50% or more of a thin separation line visible

(b2) Deep V, is the most susceptible stage (source: Adaskaveg. 2010. Almond Board of California Research Proceedings # 09-PATH4-Adaskaveg)

(b3) Deep V, split-a deep "V" in the suture, which is not yet visibly separated, but which can be squeezed open by pressing both ends of the hull

(c) Split, less than 3/8 inch

HULL ROT INCIDENCE INCREASES WITH INCREASED NITROGEN RATE



Since hull rot incidence increased with nitrogen rates, nitrogen management is an important part of disease management by avoiding overfertilization and following nitrogen budgeting and management recommendations.

Source: Saa et al. 2016. Nitrogen increases hull rot and interferes with the hull split phenology in almond (*Prunus dulcis*). Scientia Horticulturae (199): 41-48.

IRRIGATION MANAGEMENT AND HULL ROT

Deficit irrigation decreased incidence of hull rot, and regulated deficit irrigation was more effective than sustained deficit irrigation

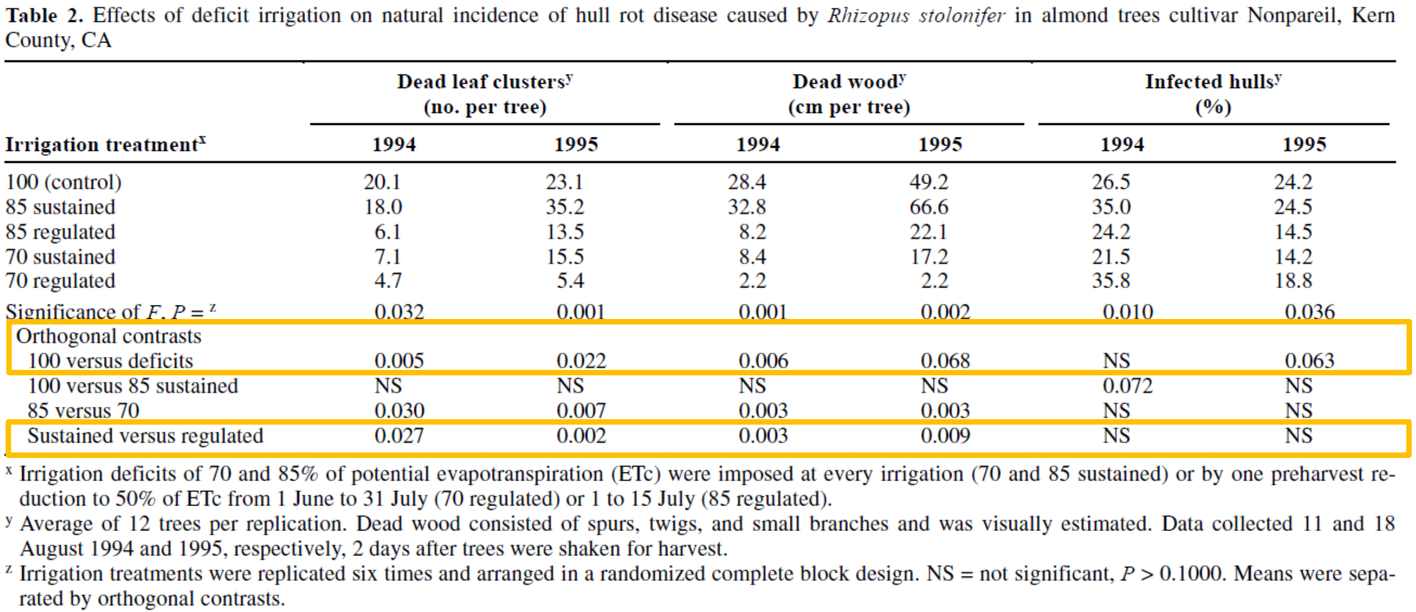


Table 2. Effects of deficit irrigation on natural incidence of hull rot disease caused by *Rhizopus stolonifer* in almond trees cultivar Nonpareil, Kern County, CA

	Dead leaf clusters[y] (no. per tree)		**Dead wood**[y] (cm per tree)		**Infected hulls**[y] (%)	
Irrigation treatment[x]	**1994**	**1995**	**1994**	**1995**	**1994**	**1995**
100 (control)	20.1	23.1	28.4	49.2	26.5	24.2
85 sustained	18.0	35.2	32.8	66.6	35.0	24.5
85 regulated	6.1	13.5	8.2	22.1	24.2	14.5
70 sustained	7.1	15.5	8.4	17.2	21.5	14.2
70 regulated	4.7	5.4	2.2	2.2	35.8	18.8
Significance of F, $P =$ [z]	0.032	0.001	0.001	0.002	0.010	0.036
Orthogonal contrasts						
100 versus deficits	0.005	0.022	0.006	0.068	NS	0.063
100 versus 85 sustained	NS	NS	NS	NS	0.072	NS
85 versus 70	0.030	0.007	0.003	0.003	NS	NS
Sustained versus regulated	0.027	0.002	0.003	0.009	NS	NS

[x] Irrigation deficits of 70 and 85% of potential evapotranspiration (ETc) were imposed at every irrigation (70 and 85 sustained) or by one preharvest reduction to 50% of ETc from 1 June to 31 July (70 regulated) or 1 to 15 July (85 regulated).

[y] Average of 12 trees per replication. Dead wood consisted of spurs, twigs, and small branches and was visually estimated. Data collected 11 and 18 August 1994 and 1995, respectively, 2 days after trees were shaken for harvest.

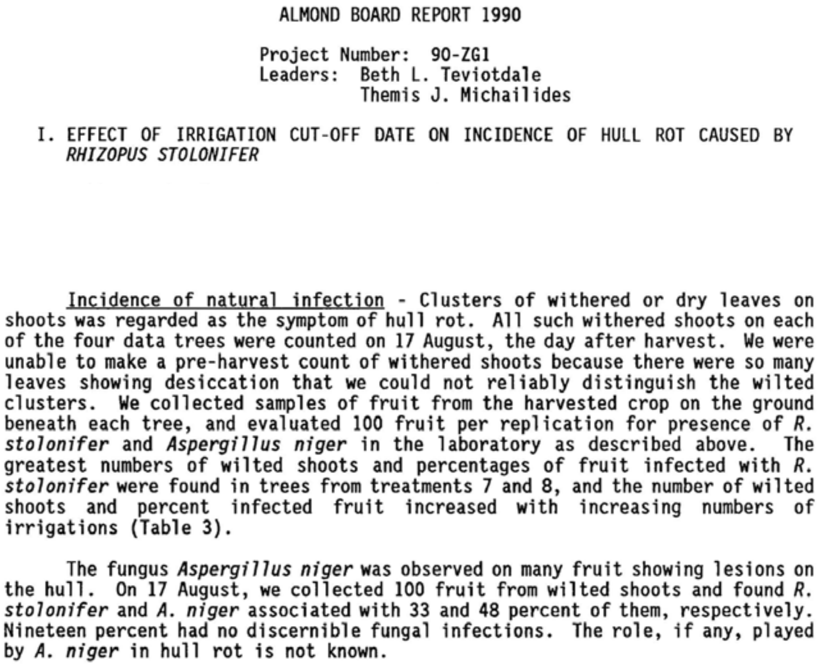
[z] Irrigation treatments were replicated six times and arranged in a randomized complete block design. NS = not significant, $P > 0.1000$. Means were separated by orthogonal contrasts.

Source: Teviotdale et al. 2001. Effects of deficit irrigation on hull rot disease of almond trees caused by *Monilinia fructicola* and *Rhizopus stolonifer.* Plant Dis. 85:399-403

ASPERGILLUS NIGER ASSOCIATION WITH HULL ROT IN KERN COUNTY

- In summer of 2016, Hull Rot infections was observed in almond orchards with flat jet black spores similar to *Aspergillus niger*

ASPERGILLUS NIGER ASSOCIATION WITH HULL ROT IN KERN COUNTY



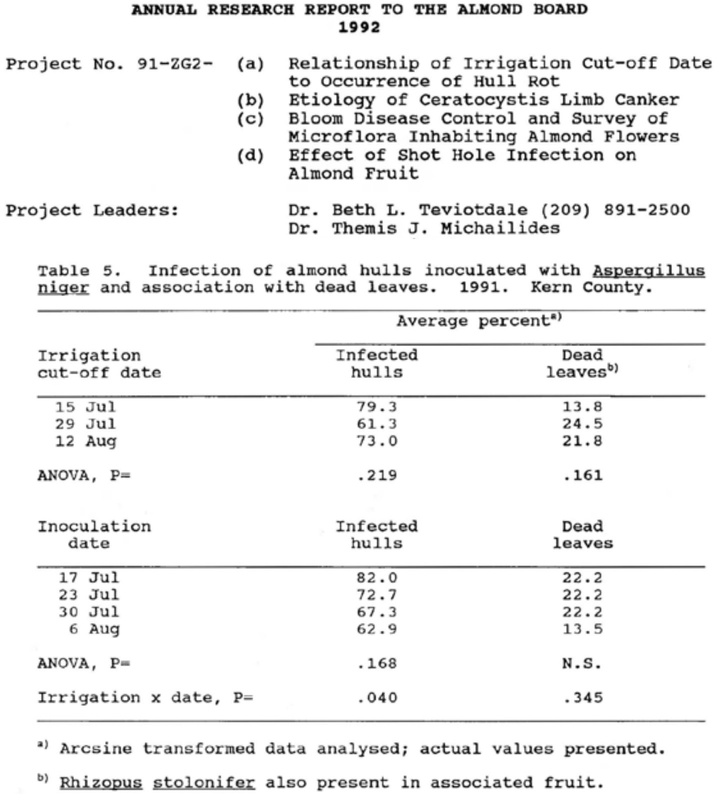
ALMOND BOARD REPORT 1990

Project Number: 90-ZG1
Leaders: Beth L. Teviotdale
Themis J. Michailides

I. EFFECT OF IRRIGATION CUT-OFF DATE ON INCIDENCE OF HULL ROT CAUSED BY *RHIZOPUS STOLONIFER*

Incidence of natural infection - Clusters of withered or dry leaves on shoots was regarded as the symptom of hull rot. All such withered shoots on each of the four data trees were counted on 17 August, the day after harvest. We were unable to make a pre-harvest count of withered shoots because there were so many leaves showing desiccation that we could not reliably distinguish the wilted clusters. We collected samples of fruit from the harvested crop on the ground beneath each tree, and evaluated 100 fruit per replication for presence of *R. stolonifer* and *Aspergillus niger* in the laboratory as described above. The greatest numbers of wilted shoots and percentages of fruit infected with *R. stolonifer* were found in trees from treatments 7 and 8, and the number of wilted shoots and percent infected fruit increased with increasing numbers of irrigations (Table 3).

The fungus *Aspergillus niger* was observed on many fruit showing lesions on the hull. On 17 August, we collected 100 fruit from wilted shoots and found *R. stolonifer* and *A. niger* associated with 33 and 48 percent of them, respectively. Nineteen percent had no discernible fungal infections. The role, if any, played by *A. niger* in hull rot is not known.



ANNUAL RESEARCH REPORT TO THE ALMOND BOARD
1992

Project No. 91-ZG2- (a) Relationship of Irrigation Cut-off Date to Occurrence of Hull Rot
(b) Etiology of Ceratocystis Limb Canker
(c) Bloom Disease Control and Survey of Microflora Inhabiting Almond Flowers
(d) Effect of Shot Hole Infection on Almond Fruit

Project Leaders: Dr. Beth L. Teviotdale (209) 891-2500
Dr. Themis J. Michailides

Table 5. Infection of almond hulls inoculated with Aspergillus niger and association with dead leaves. 1991. Kern County.

	Average percent[a]	
Irrigation cut-off date	Infected hulls	Dead leaves[b]
15 Jul	79.3	13.8
29 Jul	61.3	24.5
12 Aug	73.0	21.8
ANOVA, P=	.219	.161
Inoculation date	Infected hulls	Dead leaves
17 Jul	82.0	22.2
23 Jul	72.7	22.2
30 Jul	67.3	22.2
6 Aug	62.9	13.5
ANOVA, P=	.168	N.S.
Irrigation x date, P=	.040	.345

[a] Arcsine transformed data analysed; actual values presented.

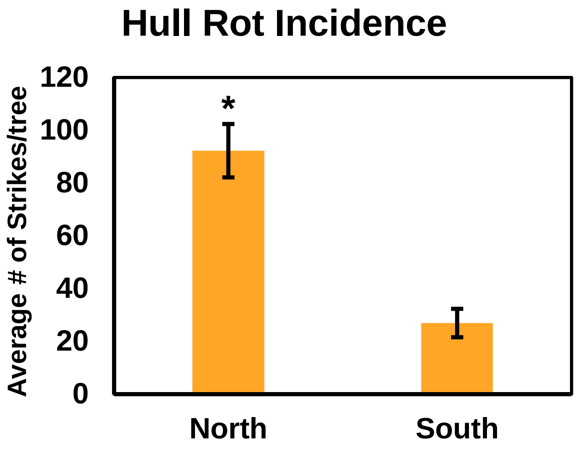
[b] Rhizopus stolonifer also present in associated fruit.

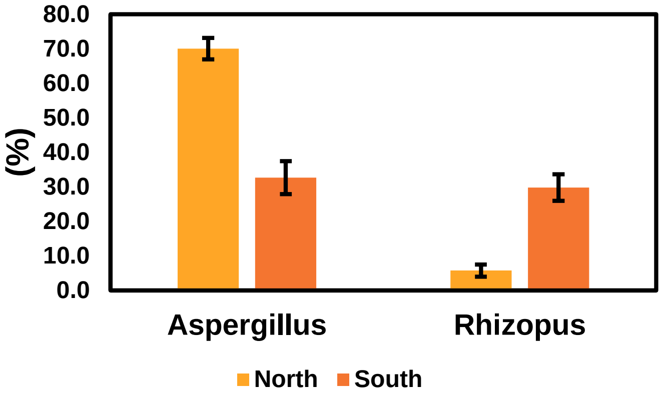
EXPERIMENTAL SITE

- Planted in 2011 in Arvin, CA with 50% Nonpareil, 25% Sonora, and 25% Monterey
- Planted 24’ × 24’ and irrigated with microsprinklers
- Five replicates in each main plot established on the NP row.

Percentage of Fruit Associated with Hull Rot that has *Aspergillus niger* or *Rhizopus stolonifer*

- The Northern plot had significantly higher natural incidence of hull rot
- Fruits associated with hull rot symptoms was collected from affected spurs and evaluated for *A. niger* and *R. stolonifer* infections
- When looking at each block within the orchard, the northern plot had higher fruit infected with *A. niger* while the southern plot had higher *R. stolonifer* infections compared to the northern plot



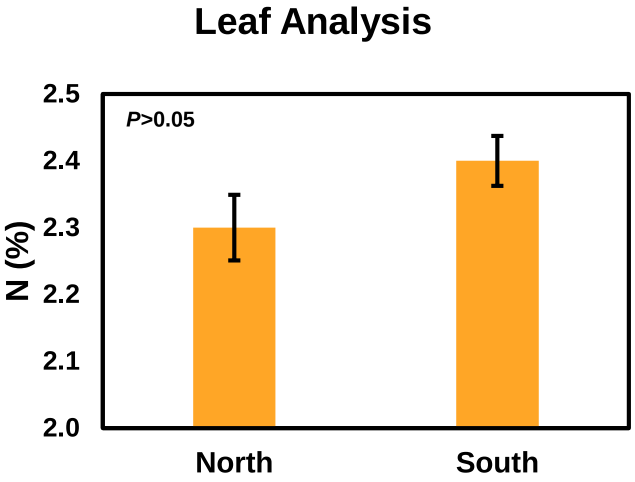


Leaf Analysis

- Leaf analysis resulted in normal Nitrogen content

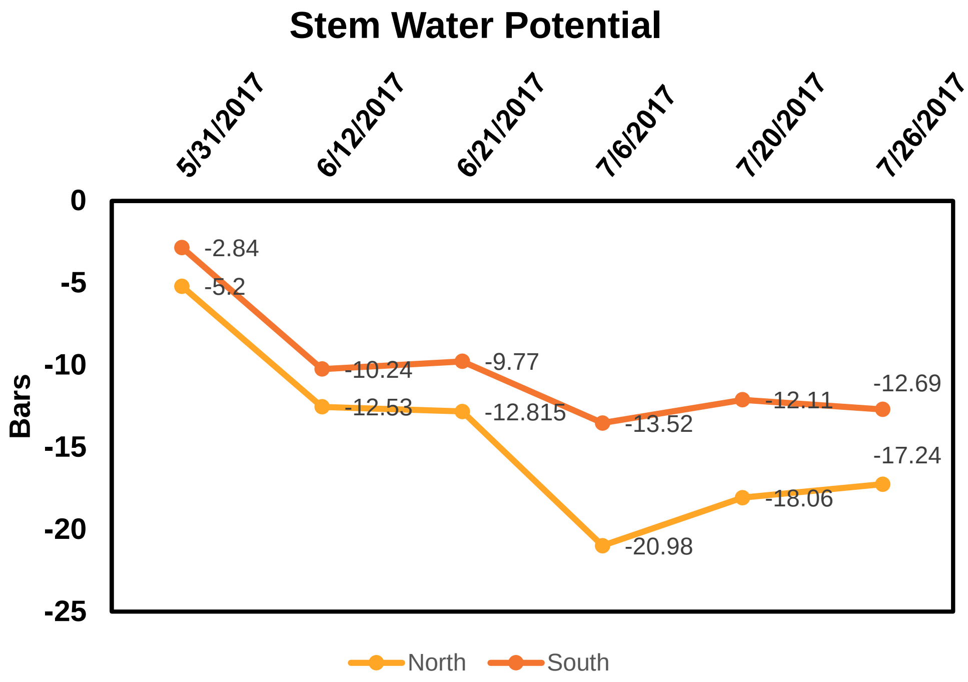
- Nitrogen levels was not significantly different between the two major plots

	N %	P %	K %	Zn mg/kg	Mn mg/kg	Na %	B mg/kg	Ca %	Mg %	Fe mg/kg	Cu mg/kg
North	2.3	0.1	3.0	107.7	69.0	0.01	45.3	4.2	0.7	185.0	6.0
South	2.4	0.1	2.7	69.7	115.3	<0.01	52.7	4.7	0.7	149.7	5.0



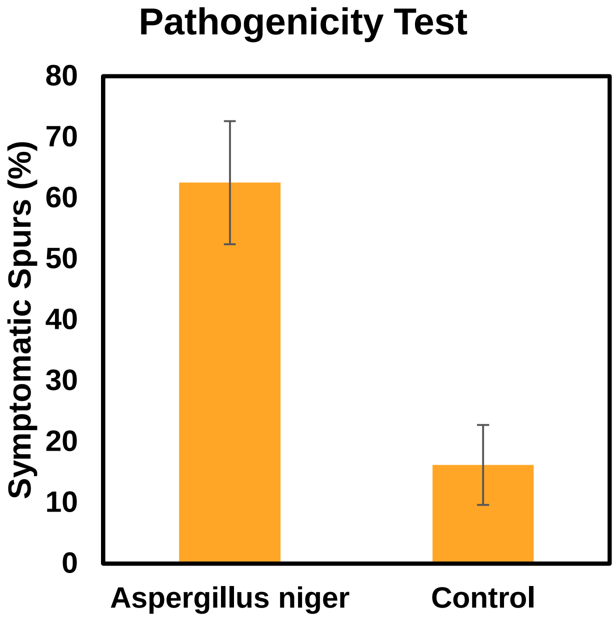
Stem Water Potential

- Trees in the Northern plot was more stressed compared to the trees in the Southern plot



Pathogenicity Test (Preliminary Results)

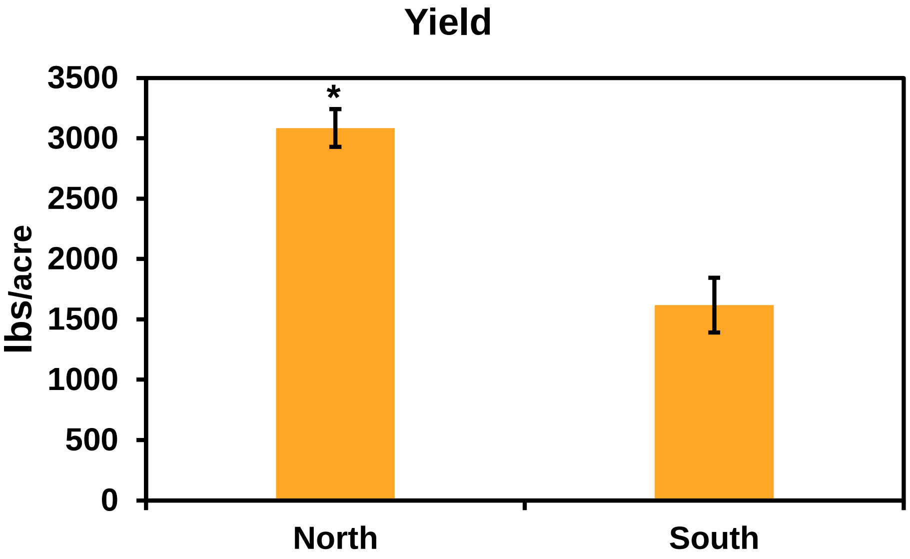
- Two branches per tree (cv. Nonpareil) was spray-inoculated with *A. niger* (1×10^5 spore suspension)-total 4 trees inoculated
- One branch on a different tree was sprayed with only water as a control



Yield (1st year)

Yield of Nonpareil was significantly higher in the northern plot

We will monitor yield to document the effect of disease on yield in this orchard

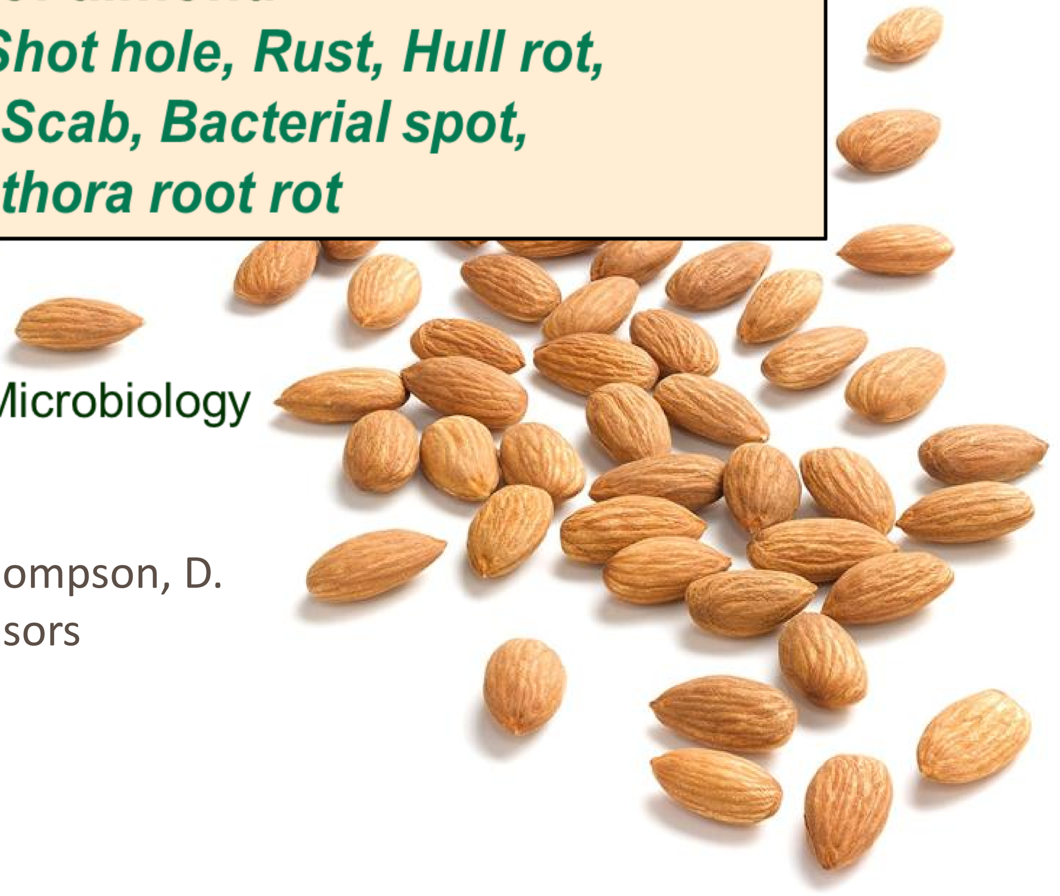


FINDINGS

- *Aspergillus niger* has been associated with hull rot in Kern County and was isolated from the cankers from samples sent to Dr. Michailides' lab.
- In preliminary pathogenicity tests, *A. niger* reproduced hull rot symptoms in field inoculations.
- Association of *A. niger* with hull rot has been also observed in Fresno, and San Joaquin Counties.

Epidemiology and control of fungal and bacterial diseases of almond

Brown rot, Jacket rot, Shot hole, Rust, Hull rot, Alternaria leaf spot, Scab, Bacterial spot, and Phytophthora root rot



Dr. J. E. Adaskaveg
Department of Plant Pathology and Microbiology
University of California, Riverside

In cooperation with lab personnel (D. Thompson, D. Cary, H. Förster, S. Haack) and Farm Advisors

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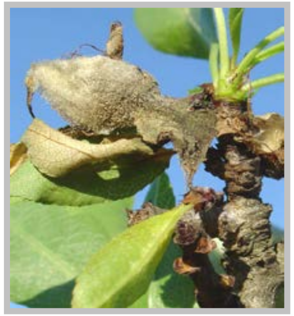
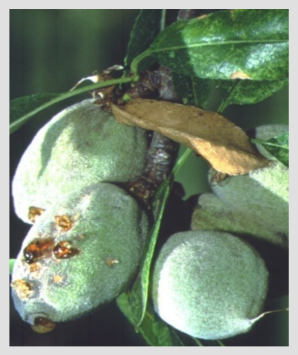
Flower, foliar, fruit, and root/crown diseases of almond


Brown rot blossom blight


Green fruit rot/Jacket rot


Shot hole


Bacterial spot


Anthracnose


Scab


Alternaria leaf spot

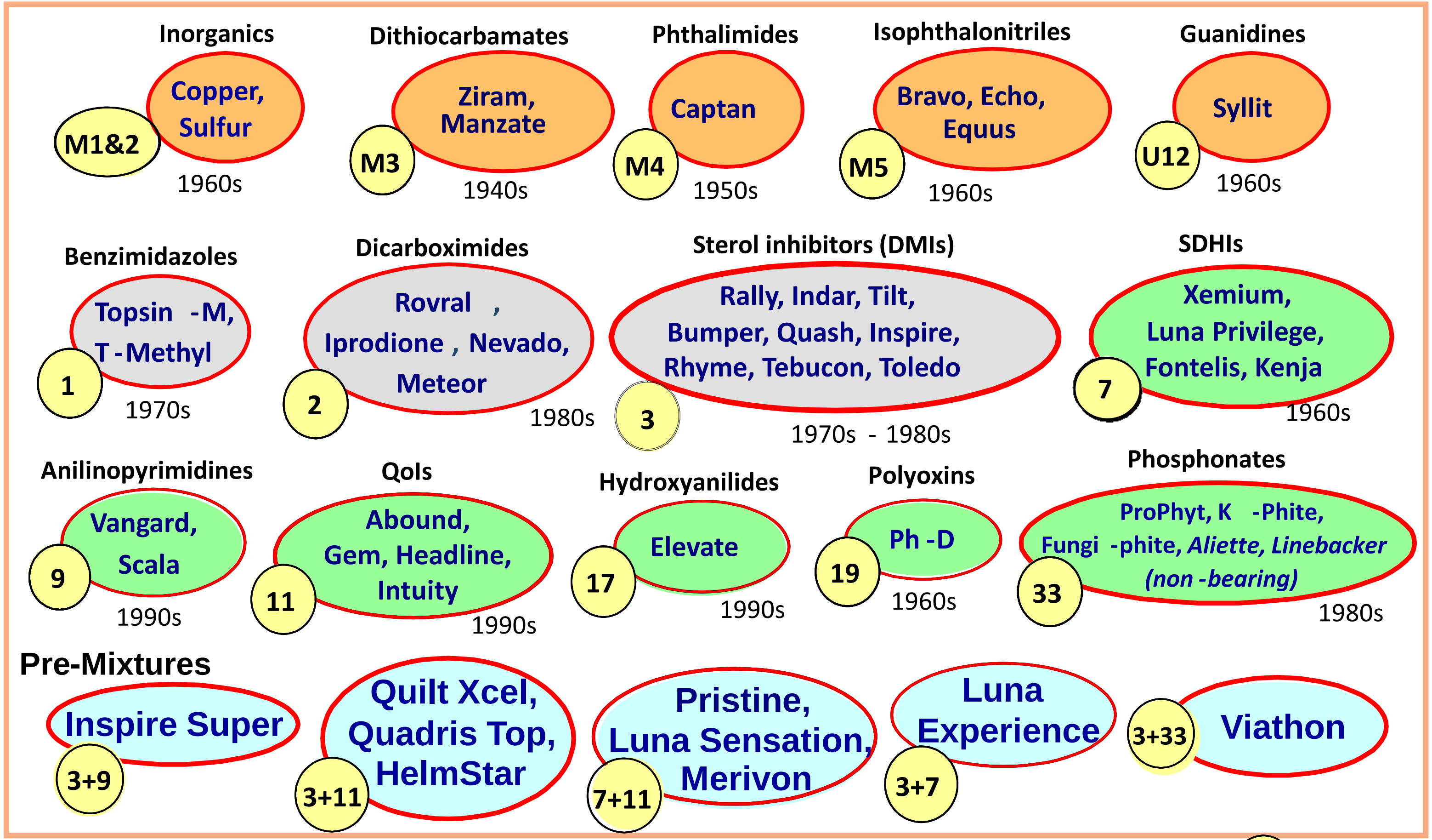

Rust


Hull rot

Phytophthora root and crown rot

Fungicides for Managing Almond Diseases

Inorganics and Conventional Synthetics



Inorganics
Copper, Sulfur
M1&2
1960s

Dithiocarbamates
Ziram, Manzate
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, Rhyme, Tebucon, Toledo
3
1970s - 1980s

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

Anilinopyrimidines
Vangard, Scala
9
1990s

QoIs
Abound, Gem, Headline, Intuity
11
1990s

Hydroxyanilides
Elevate
17
1990s

Polyoxins
Ph-D
19
1960s

Phosphonates
ProPhyt, K-Phite, Fungi-phite, *Aliette, Linebacker (non-bearing)*
33
1980s

Pre-Mixtures

Inspire Super
3+9

Quilt Xcel, Quadris Top, HelmStar
3+11

Pristine, Luna Sensation, Merivon
7+11

Luna Experience
3+7

Viathon
3+33

🟧 Multi-site mode of action ⬜ Single-site mode of action 🟩 Reduced-risk fungicide 🟡 FRAC Code

***New*:**
Rhyme (2016)
Helmstar (2018)

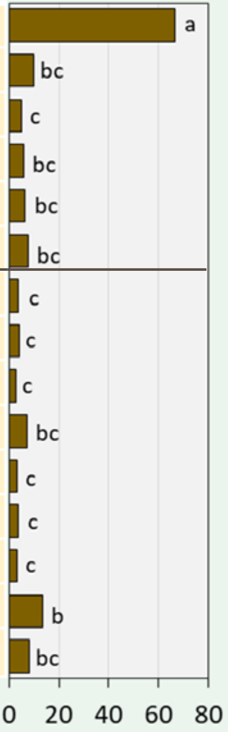
Ongoing:
Pydiflumetofen, Pyraziflumid, EXP-AD, IL-54112, UC-1, UC-2

BROWN ROT BLOSSOM BLIGHT

cv. Drake,
high disease pressure

Treatment	Rate(/A)	PB	FB	Brown rot strikes/tree
Control	---	---	---	a
Rhyme	7 fl oz	@	@	bc
Inspire EC	7 fl oz	@	@	c
Pyraziflumid + NIS	3.38 + 4 fl oz	@	@	bc
UC-1 + Sylcoat	4 + 3.84 fl oz	@	@	bc
Pydiflumetofen	5.13 fl oz	@	@	bc
Luna Sensation + NIS	7.8 + 8 fl oz	@	@	c
Luna Experience + NIS	8 + 8 fl oz	@	@	c
Merivon	6.5 fl oz	@	@	c
Helmstar	14.5 fl oz	@	@	bc
UC-2 + Sylcoat	6 + 3.84 fl oz	@	@	c
EXP-AD	13.7 fl oz	@	@	c
IL-5412	15 fl oz	@	@	c
IL-5413	15.5 fl oz	@	@	b
IL-5414	15.5 fl oz	@	@	bc

Pre-mixtures



NIS = non-ionic surfactant

Applications on 2-16, 2-21-17

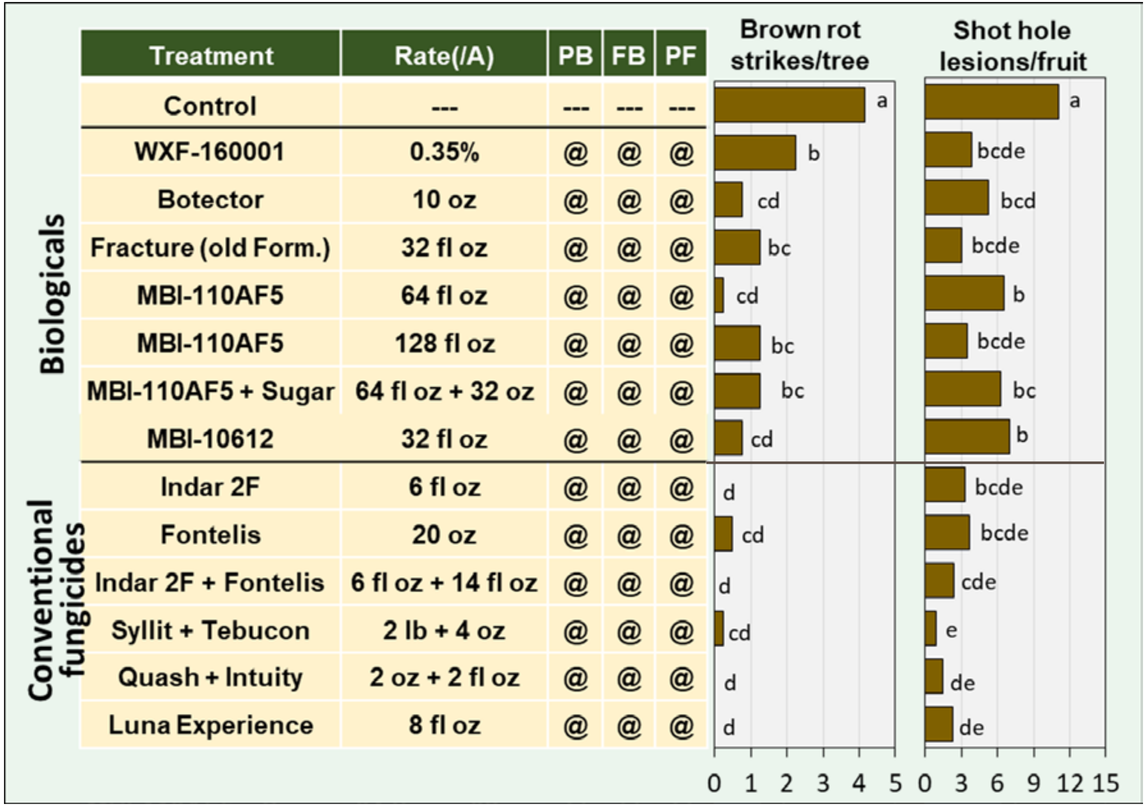
Most effective single: Dicarboximides (FG 2), DMIs (FG 3), SDHIs (FG 7), APs (FG 9).

New: Pydiflumetofen (7), Pyraziflumid (7), Helmstar (3/11), UC-1, UC-2, EXP-AD, IL compounds

Pre-mixtures: FG 3+7, 3+9, 3+11, and 7+11.

Pre-mixtures provide highest efficacy, consistency, and resistance management.

BROWN ROT BLOSSOM BLIGHT, SHOT HOLE



	Treatment	Rate(/A)	PB	FB	PF
	Control	---	---	---	---
Biologicals	WXF-160001	0.35%	@	@	@
	Botector	10 oz	@	@	@
	Fracture (old Form.)	32 fl oz	@	@	@
	MBI-110AF5	64 fl oz	@	@	@
	MBI-110AF5	128 fl oz	@	@	@
	MBI-110AF5 + Sugar	64 fl oz + 32 oz	@	@	@
	MBI-10612	32 fl oz	@	@	@
Conventional fungicides	Indar 2F	6 fl oz	@	@	@
	Fontelis	20 oz	@	@	@
	Indar 2F + Fontelis	6 fl oz + 14 fl oz	@	@	@
	Syllit + Tebucon	2 lb + 4 oz	@	@	@
	Quash + Intuity	2 oz + 2 fl oz	@	@	@
	Luna Experience	8 fl oz	@	@	@

cv. Sonora, Applications 2-16, 2-24, 3-15-17

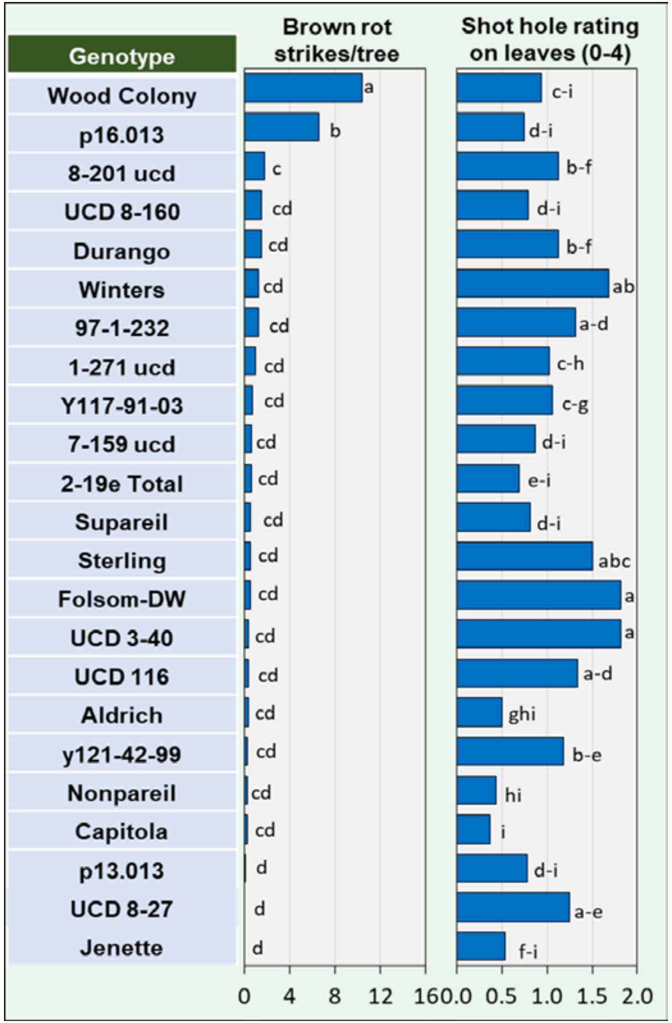
Brown rot

Biologicals: Botector, Fracture, MBI compounds - intermediate efficacy

Shot hole

Most effective: M3-M5, FG11, 19; pre-mixtures FG 3+7, 3+9, 3+11, 7+11, mixtures U12+FG 3, FG 3+19.

Natural host susceptibility to brown rot and shot hole among 24 cultivars and genotypes in the UCD variety block 2017



Some new cultivars such as Capitola and Jenette showed low susceptibility to brown rot and shot hole, similar to Nonpareil.

Trees were planted in 2014. Scions were grafted to Nemaguard and Krymsk rootstocks. Severity rating for scab was on a scale from 0 to 4 with 4 being the highest level of disease.

Almond Hull Rot

- Caused by *Rhizopus stolonifer* or by *Monilinia fructicola*
- Both pathogens infect fruit and cause dieback
- *Aspergillus niger* can also cause hull rot (occasionally found)

Rhizopus stolonifer (left),
Monilinia fructicola (right)

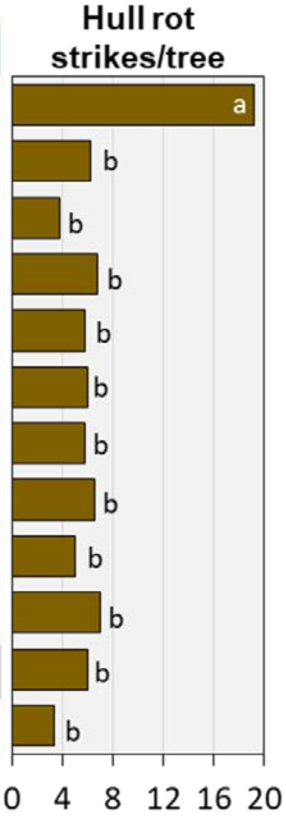
- For dieback of Rhizopus hull rot, fumaric acid production by the pathogen may be involved.
- The two pathogens require different management strategies

Almond Hull Rot – Alkaline treatments and fungicides

Rhizopus hull rot 2017

Alkaline foliar fertilizers

Treatment	Rate(/A)	7-18	8-3
Control	---	---	---
di-K-PO4	48 oz	---	@
di-K-PO4	48 oz	@	@
di-K-PO4 + Ca(OH)2	48+ 320 oz	---	@
di-K-PO4 + Ca(OH)2	48 + 320 oz	@	@
Ca(OH)2	320 oz	---	@
Cinetis	24 fl oz	@	@
Cinetis	24 fl oz	---	@
Fontelis + Tebucon	20 fl oz + 8 oz	---	@
Fontelis + Inspire	20 + 7 fl oz	---	@
Fontelis + Abound	20 + 15.5 fl oz	---	@
Fontelis + Ph-D	20 fl oz + 6.2 oz	---	@



7-18-17: early suture opening, 8-3-17: 5% hull split.

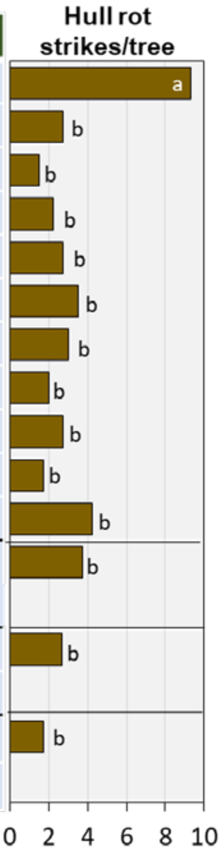
Alkaline fertilizers were effective, possibly neutralize fumaric acid that is released by *R. stolonifer* into host tissues

Fungicides: All were similarly effective, reduction of disease up to 80%.

Timing: Similar efficacy after one or two applications when *R. stolonifer* is the main pathogen

Almond Hull Rot – Fungicides for Rhizopus hull rot 2017

	Treatment	Rate(/A)	5-31	7-13
	Control	---	---	---
	Ph-D	6.2	@	@
	UC-1 + Sylcoat	4 + 8 fl oz	@	@
	Pyraziflumid + NIS	5.08 + 8 fl oz	@	@
	Ph-D + Tebucon	6.2 + 4 oz	@	@
	Luna Experience + NIS	8 fl oz	@	@
	UC-2 + Sylcoat	6 + 8 fl oz	@	@
	IL-5412 + NIS	15 + 8 fl oz	@	@
	IL-5413 + NIS	15.5 + 8 fl oz	@	@
	IL-5414 + NIS	15.5 + 8 fl oz	@	@
	Merivon + Sylcoat	6.5 + 6 fl oz	@	@
Rotations	Fontelis + Tebucon + NIS	20 fl oz + 8 oz + 8 fl oz	@	---
	Fontelis + Abound + NIS	20 + 15 + 8 fl oz	---	@
	Fontelis + Tebucon + NIS	20 fl oz + 8 oz + 8 fl oz	@	---
	Fontelis + Ph-D + NIS	20 fl oz + 15 oz + 8 fl oz	---	@
	Quash	3.36 oz	@	---
	Quash + Intuity	3.36 oz + 3.36 fl oz	---	@



5-31-17 application targeted against *Monilinia* pathogen
7-13-17: advanced suture opening stage

Fungicides evaluated

(FG 3, 7, 19, 3+19, 3+7, 7+11, 3+11, 7+19) significantly reduced the disease as compared to the control

Inoculum reduction treatments to soil:

Evaluated previously – not effective

Almond Hull Rot - Integrated management

- **Water management** - Reduce watering entering the hull split period (i.e., deficit irrigation).
- **Nitrogen fertilization** – restrict amount of nitrogen (apply based on replacement and do not apply close to hull split (estimated 40-60 days before hull split).
- **Dust control**
- The **different pathogens** are usually present at varying frequencies among locations and years.
- **Fungicides can reduce the incidence of disease, but different timings and fungicides are needed for the different pathogens:**

  Monilinia hull rot: late spring (late May/June).

  Rhizopus hull rot: early hull split (with NOW application).
- **Effective treatments**: FG 3, 7, 11, 19, 3+7, 3+9, 7+11, 3+11, 3+19.
- **New alkalizing treatments:** Di-K-PO_4

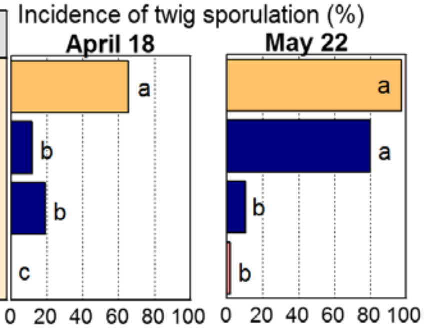
Almond scab

Pathogen: *Fusicladium carpophilum*
Phylogeny: Different from other scab fungi on
Prunus spp.
Biology: No evidence of sexual reproduction

- Previously, we established that chlorothalonil-oil is highly effective in delaying sporulation of twig lesions into late spring.
- Timing: Mid-December to mid-January.
- Copper-oil is also effective

- An effective 3-spray program includes a dormant and two applications after twig-infection sporulation
- First in-season scab application at the beginning of twig-lesion sporulation.
- **Multi-site fungicides** (e.g., chlorothalonil, captan, ziram) applied at petal fall. Rotations of captan with single-site and pre-mix fungicides are suggested.

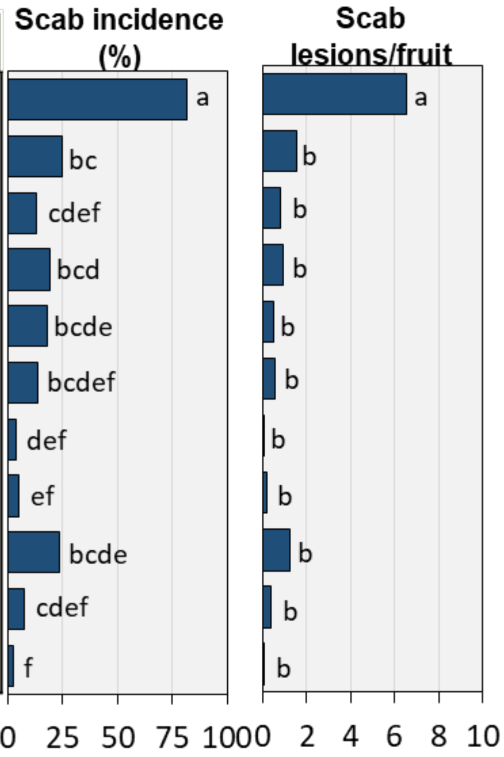
Fungicide	Oil
Control	-
Kocide 3000 5 lb	+
Bravo WeatherStick 4 pts	+
Bravo WeatherStick 6 pts	+



cv. Carmel, Butte Co.
Application: Delayed dormant - January.

EFFICACY OF SCAB TREATMENTS - 2017

Treatment	Rate(/A)
Control	---
Ph-D*	6.2 oz
Rhyme*	7 fl oz
Fontelis*	20 fl oz
Pyraziflumid + NIS	5.08 + 4 fl oz
UC-1 + Sylcoat	4 + 3.84 fl oz
Ph-D + Quash*	6.2 + 3.5
Luna Experience + NIS	8 + 8 fl oz
IL-5412	15 fl oz
UC-2 + Sylcoat	6 + 3.84 fl oz
EXP-AD	13.7 fl oz



cv. Monterey, Colusa Co.

Most effective in-season:

- **Single:** FGs 3, 7, 19, U12

  New: Pyraziflumid, UC-1
- **Pre-mixtures:** FG 3/9, 3/11, 7/11 **New:** EXP-AD, UC-2, IL5412

Resistance management:

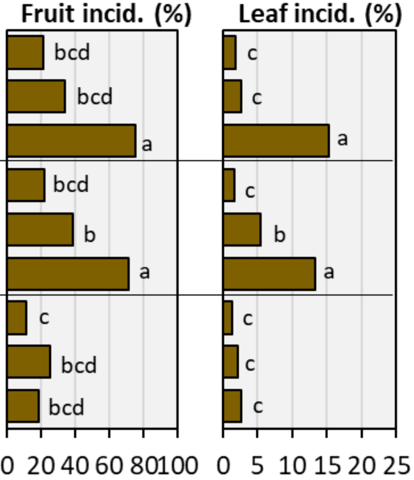
- Use single-site fungicides in rotations and/or mixtures.
- Do not apply single-site fungicides once disease is developing.
- ***No reports of new resistance***

Epidemiology of Bacterial Spot

- The pathogen *Xanthomonas arboricola* pv. *pruni* overwinters in fruit mummies and attached peduncles on the tree.
- Healthy flower buds and leaves in close proximity to mummies also yielded the pathogen.
- Isolates evaluated to date were all copper-sensitive

Inoculation of cv. Fritz almond with *X. arboricola* pv. *pruni* at selected phenological stages

Inoculation	Inoculum	Fruit incid. (%)	Leaf incid. (%)
Flowers Feb. 22, 2017	Water control	bcd	c
	Xap low inoc.	bcd	c
	Xap high inoc.	a	a
Immature fruit April 15, 2017	Water control	bcd	c
	Xap low inoc.	b	b
	Xap high inoc.	a	a
Mature fruit May 17, 2017	Water control	c	c
	Xap low inoc.	bcd	c
	Xap high inoc.	bcd	c



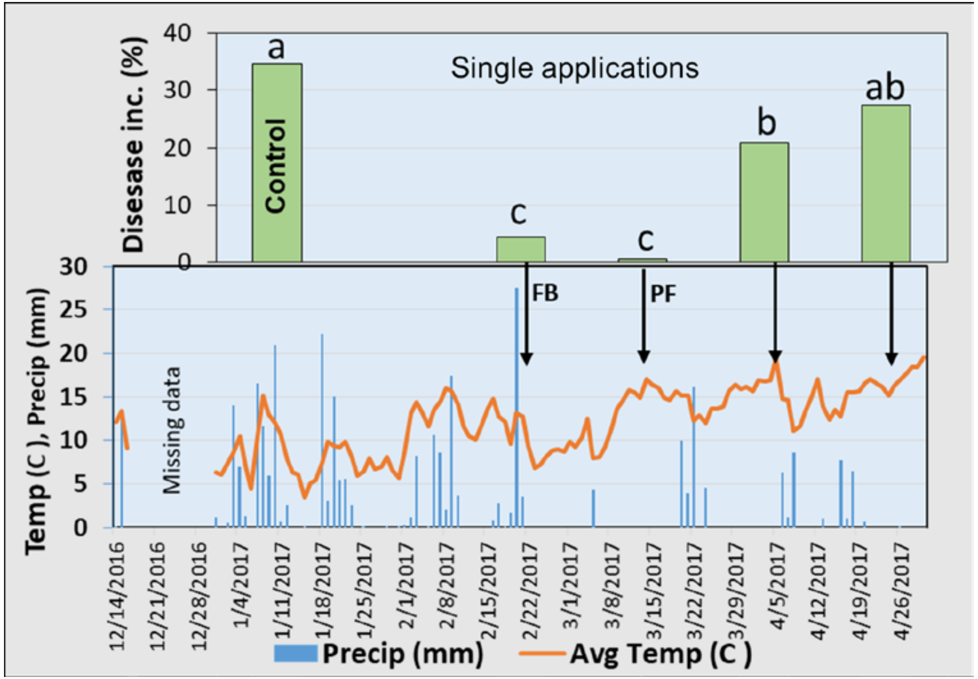
- Almond was susceptible to infection from flowering through fruit development in mid-May.
- Higher inoculum resulted in higher disease.
- Inoculated leaves developed lower disease levels.

Management – Dormant and in-season

Dormant treatments

- Early (Mid Dec) and delayed (late Jan) dormant copper-mancozeb treatments resulted in >75% reduction of disease –reduction of inoculum levels and pathogen dispersal.
- Additional in-season treatments reduced the disease to very low levels.

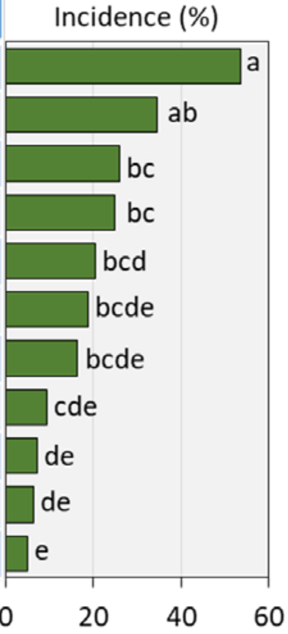
Single in-season treatments at full bloom or petal f with copper or copper-mancozeb



Environmental conditions in Ripon, CA, in the spring of 2017, and timing and efficacy of single applications (arrows) with Badge 3.3 lb/A or Badge 3.3 lb/A + Manzate 4 lb/A.

Management of Bacterial Spot – New in-season treatments

Treatment*	Rate(/A)
Control	---
Mycoshield	16 oz
ZTD + Kasumin	34 fl oz + 64 fl oz
Mycoshield + Manzate	16 oz + 64 oz
Kasumin	64 fl oz
ZTD	500 ppm = 34 fl oz
Kasumin + Manzate	64 fl oz + 64 oz
DAS-1 + ChampION^{++}	27 fl oz + 3.3-0.8 lb
Kasumin + ChampION^{++}	64 fl oz + 3.3-0.8 lb
ZTD + ChampION^{++}	34 fl oz + 3.3-0.8 lb
Mycoshield + ChampION^{++}	16 oz + 3.3-0.8 lb



Most effective and consistent: copper mixed with mancozeb, kasugamycin, copper-activity enhancers (ZTD, DAS-1), or Mycoshield.

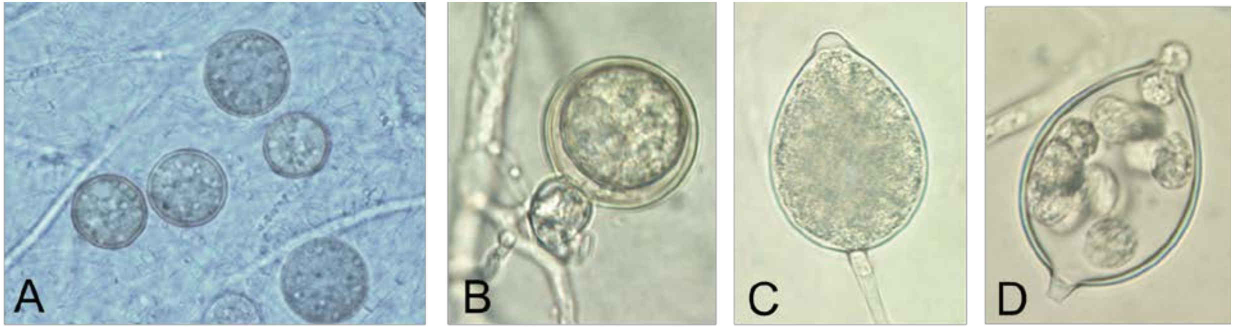
Biologicals: Serenade Opti mixed with sugar as a nutrient source for the biocontrol agent.

Summary: Management in high-disease years (as in 2017):

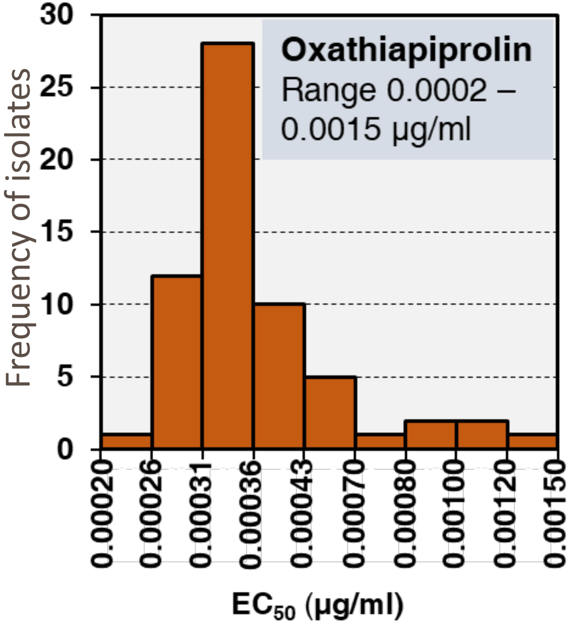
Delayed dormant treatments with copper, copper-mancozeb.

+ one (two) in-season treatment at full bloom/petal fall timed around rain events and before temperatures start to rise.

Epidemiology and Management of Phytophthora Root and Crown Rot of Almond



A) Chlamydospores of *P. parasitica*. B) Oospore of *P. cactorum*. C) Sporangium of *P. cactorum*. D) Sporangium of *P. cactorum* releasing zoospores.

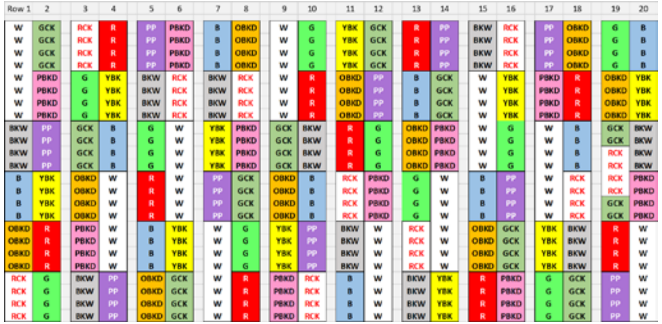


Frequency histogram of EC_{50} values to inhibit mycelial growth of 62 isolates of *Phytophthora citrophthora*.

Currently registered and new fungicides for managing Phytophthora Root and Crown Rot diseases

Common Name	Trade Name	Class	FRAC
metalaxyl, mefenoxam	Ridomil Gold	Phenylamides	4
fosetyl-Al, phosphorous acid	Various	Phosphonates	33
mandipropamid	Revus	CAAs	40
fluopicolide	Presidio	Benzamides	43
ethaboxam	Intego	Thiazole carboxamide	U5
oxathiapiprolin	Orondis	Piperidinyl thiazole isoxazolines	49

Field trial on the management of Phytophthora root and crown rot of almond

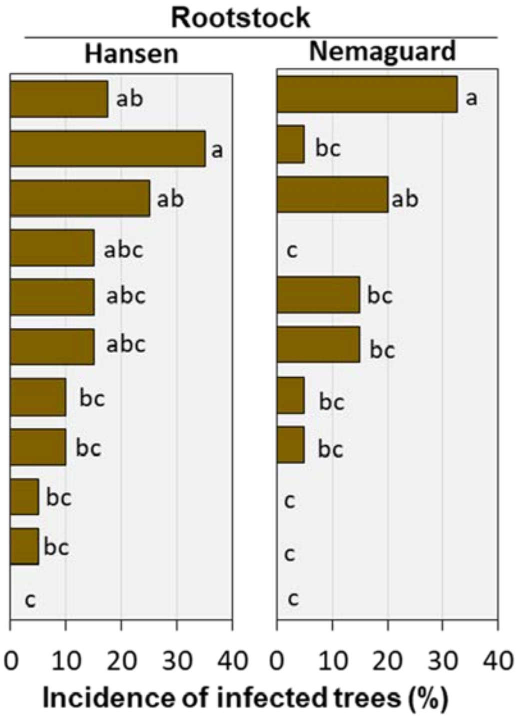


Row 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
W	GCK	RCK	R	PP	PBKD	B	OBKD	W	G	YBK	GCK	R	PP	BKW	RCK	PP	OBKD	G	B
W	GCK	RCK	R	PP	PBKD	B	OBKD	W	G	YBK	GCK	R	PP	BKW	RCK	PP	OBKD	G	B
W	GCK	RCK	R	PP	PBKD	B	OBKD	W	G	YBK	GCK	R	PP	BKW	RCK	PP	OBKD	G	B
W	GCK	RCK	R	PP	PBKD	B	OBKD	W	G	YBK	GCK	R	PP	BKW	RCK	PP	OBKD	G	B
W	PBKD	G	YBK	BKW	RCK	BKW	RCK	W	R	OBKD	PP	B	GCK	W	YBK	PBKD	R	OBKD	YBK
W	PBKD	G	YBK	BKW	RCK	BKW	RCK	W	R	OBKD	PP	B	GCK	W	YBK	PBKD	R	OBKD	YBK
W	PBKD	G	YBK	BKW	RCK	BKW	RCK	W	R	OBKD	PP	B	GCK	W	YBK	PBKD	R	OBKD	YBK
W	PBKD	G	YBK	BKW	RCK	BKW	RCK	W	R	OBKD	PP	B	GCK	W	YBK	PBKD	R	OBKD	YBK
BKW	PP	GCK	B	G	W	YBK	PBKD	GCK	BKW	R	G	OBKD	PBKD	W	G	W	B	GCK	BKW
BKW	PP	GCK	B	G	W	YBK	PBKD	GCK	BKW	R	G	OBKD	PBKD	W	G	W	B	GCK	BKW
BKW	PP	GCK	B	G	W	YBK	PBKD	GCK	BKW	R	G	OBKD	PBKD	W	G	W	B	RCK	BKW
BKW	PP	GCK	B	G	W	YBK	PBKD	GCK	BKW	R	G	OBKD	PBKD	W	G	W	B	RCK	BKW
B	YBK	OBKD	W	R	W	PP	GCK	OBKD	B	RCK	PBKD	G	W	B	PP	W	RCK	RCK	PBKD
B	YBK	OBKD	W	R	W	PP	GCK	OBKD	B	RCK	PBKD	G	W	B	PP	W	RCK	RCK	PBKD
B	YBK	OBKD	W	R	W	PP	GCK	OBKD	B	RCK	PBKD	G	W	B	PP	W	RCK	GCK	PBKD
B	YBK	OBKD	W	R	W	PP	GCK	OBKD	B	RCK	PBKD	G	W	B	PP	W	RCK	GCK	PBKD
OBKD	R	PBKD	W	B	YBK	W	G	YBK	PP	BKW	W	RCK	W	OBKD	GCK	YBK	BKW	R	W
OBKD	R	PBKD	W	B	YBK	W	G	YBK	PP	BKW	W	RCK	W	OBKD	GCK	YBK	BKW	R	W
OBKD	R	PBKD	W	B	YBK	W	G	YBK	PP	BKW	W	RCK	W	OBKD	GCK	YBK	BKW	R	W
OBKD	R	PBKD	W	B	YBK	W	G	YBK	PP	BKW	W	RCK	W	OBKD	GCK	YBK	BKW	R	W
RCK	G	BKW	PP	OBKD	GCK	W	R	PBKD	RCK	B	W	BKW	YBK	R	PBKD	G	GCK	PP	W
RCK	G	BKW	PP	OBKD	GCK	W	R	PBKD	RCK	B	W	BKW	YBK	R	PBKD	G	GCK	PP	W
RCK	G	BKW	PP	OBKD	GCK	W	R	PBKD	RCK	B	W	BKW	YBK	R	PBKD	G	GCK	PP	W
RCK	G	BKW	PP	OBKD	GCK	W	R	PBKD	RCK	B	W	BKW	YBK	R	PBKD	G	GCK	PP	W

Plot map

Treatment	Rate(/A)
Control	---
Ridomil Gold 480SL	1 pt
Intego	10 fl oz
Prophyt	64 fl oz
Presidio	6 fl oz
Presidio + Intego	6 + 10 fl oz
Prophyt + Ridomil Gold	64 + 16 fl oz
Revus 250SC	8 fl oz
Orondis 100 OD	9.6 fl oz
Orondis 100 OD	19.2 fl oz
Orondis 100 OD	4.8 fl oz

P. cactorum was isolated



Orondis and Revus were highly effective on both rootstocks. Presidio and Intego have high efficacy against Phytophthora root rot on other crops.

Thank you
Danke
Gracias
Merci
Cheers
谢谢
ありがとう
∞˚ ∑ª ρØ
спасибо
شكرا

california almonds®
Almond Board of California

Dr. J. E. Adaskaveg
Department of Plant Pathology
University of California, Riverside

AFLATOXIN MANAGEMENT UPDATE

Themis J. Michailides

Mark Doster,* Juan Moral*, Ramon Jaime*, Ryan Puckett,
Lorene Doster, Alejandro Ortega Beltran,* & Peter Cotty**

*University of California, Davis, CA

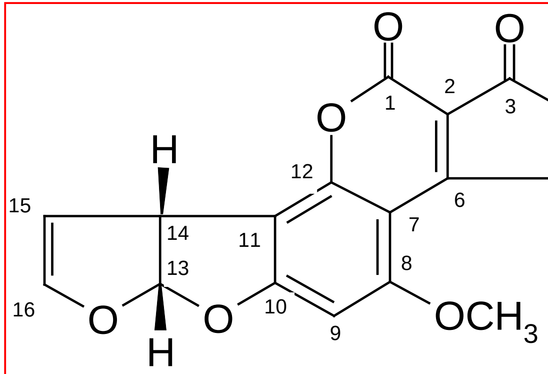
** USDA-ARS/University of Arizona, Tucson, AZ

… Molds that can produce aflatoxin in almond orchards in California

Aspergillus flavus *Aspergillus parasiticus*

Aspergillus flavus and *A. parasiticus* produce:

Aflatoxins B_1, B_2, G_1, G_2, M_1



Aflatoxin B_1

B1 is the most potent;
can cause liver cancer

Regulatory limits for aflatoxins

- **USA**

Aflatoxin B1➔10 ppb

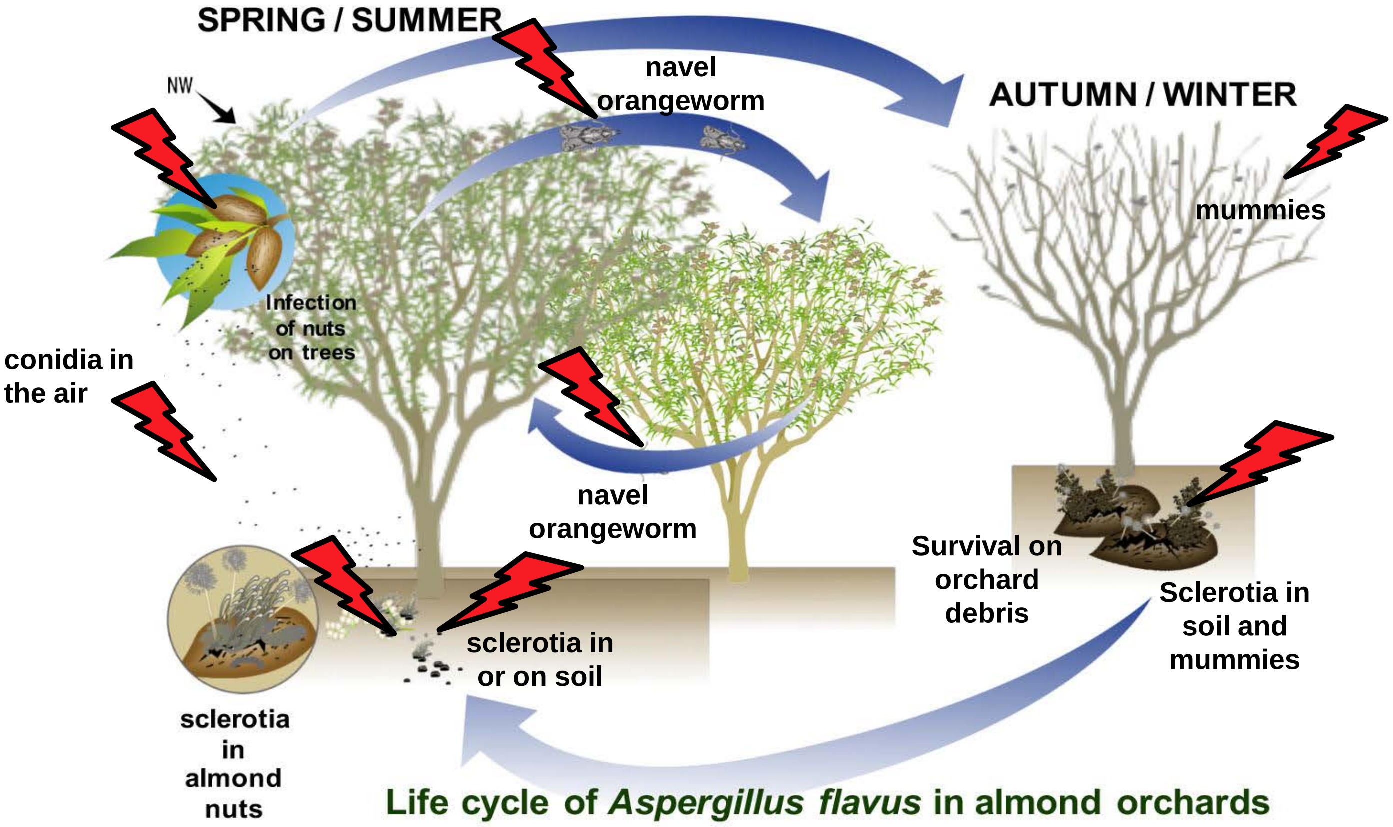
Total aflatoxins➔ 15 ppb

- **European Union**

Aflatoxin B1➔ 8 ppb

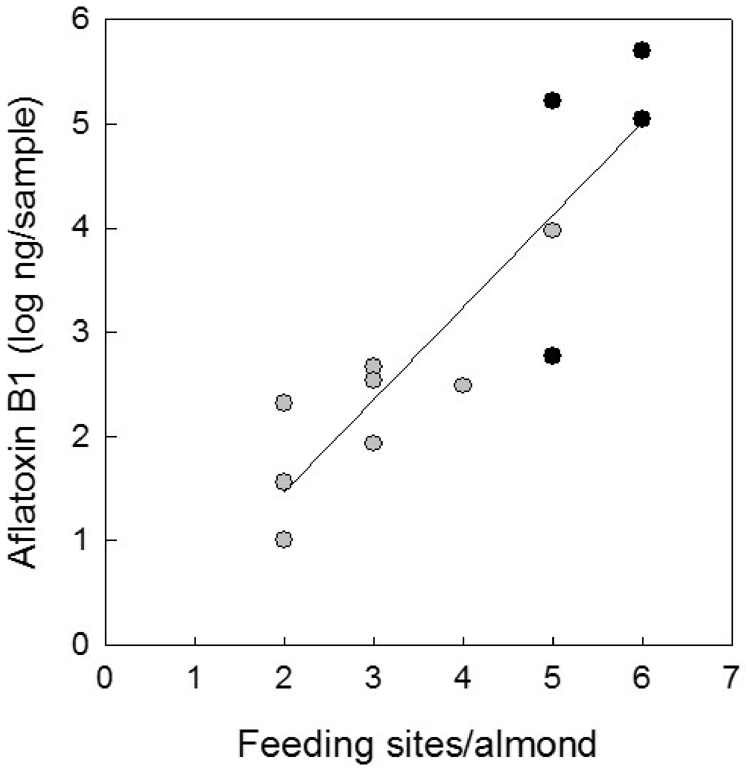
Total aflatoxins➔10 ppb

(in almonds for direct consumption)



Life cycle of *Aspergillus flavus* in almond orchards

Effect of feeding sites (wounds) by NOW on levels of aflatoxin contamination



Palumbo et al. 2014, Plant Disease 98:1194-1199.

Strains of *Aspergillus flavus* in soils

L - strain

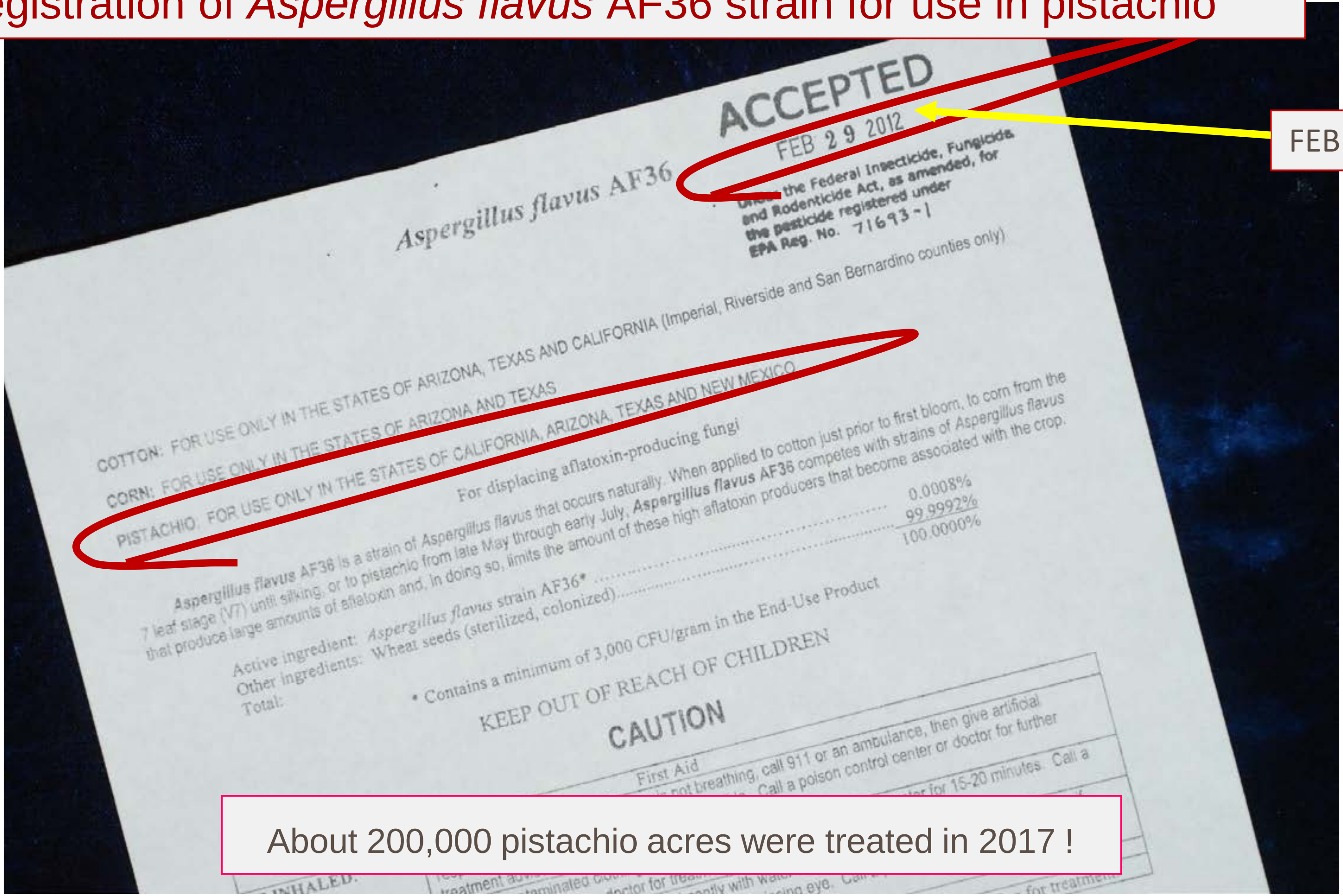
about 50:50 toxigenic: atoxigenic

AF36 atox. strain

S - strain

most toxigenic

Registration of *Aspergillus flavus* AF36 strain for use in pistachio



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%

* Contains a minimum of 3,000 CFU/gram in the End-Use Product

KEEP OUT OF REACH OF CHILDREN

CAUTION

First Aid

not breathing, call 911 or an ambulance, then give artificial

Call a poison control center or doctor for further

for 15-20 minutes. Call a

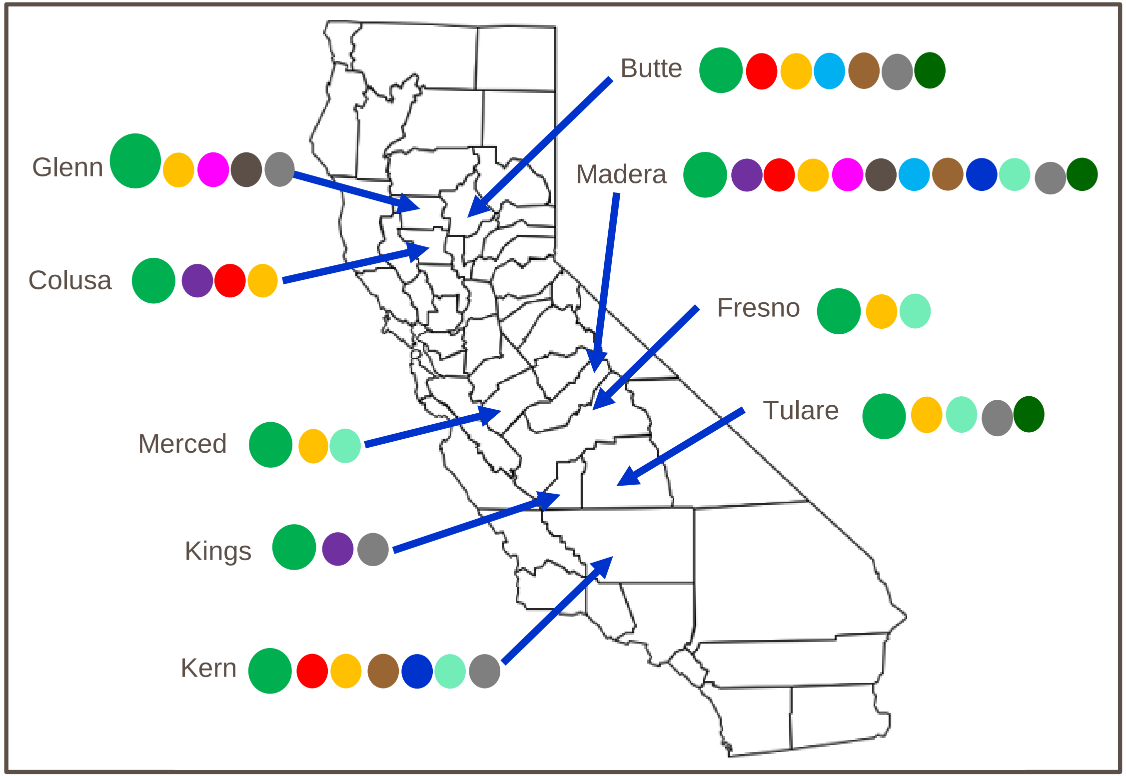
INHALED:

FEB 29, 2012

About 200,000 pistachio acres were treated in 2017 !

Occurrence of *A. flavus* atoxigenic strains in almond-growing counties of California.

Each colored circle represents a different atoxigenic strain; = A●6

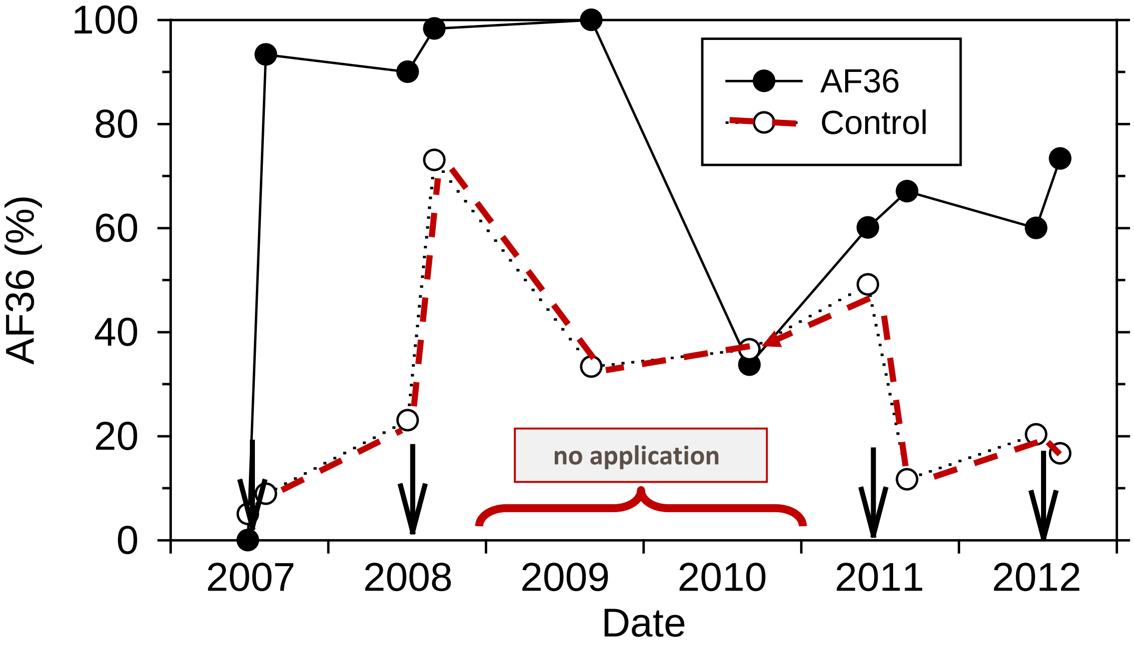


● AF36 incidence 3.0 to 8.5%

Picot et al. 2017, Intl J. of Food Microbiol. 265:55-64.

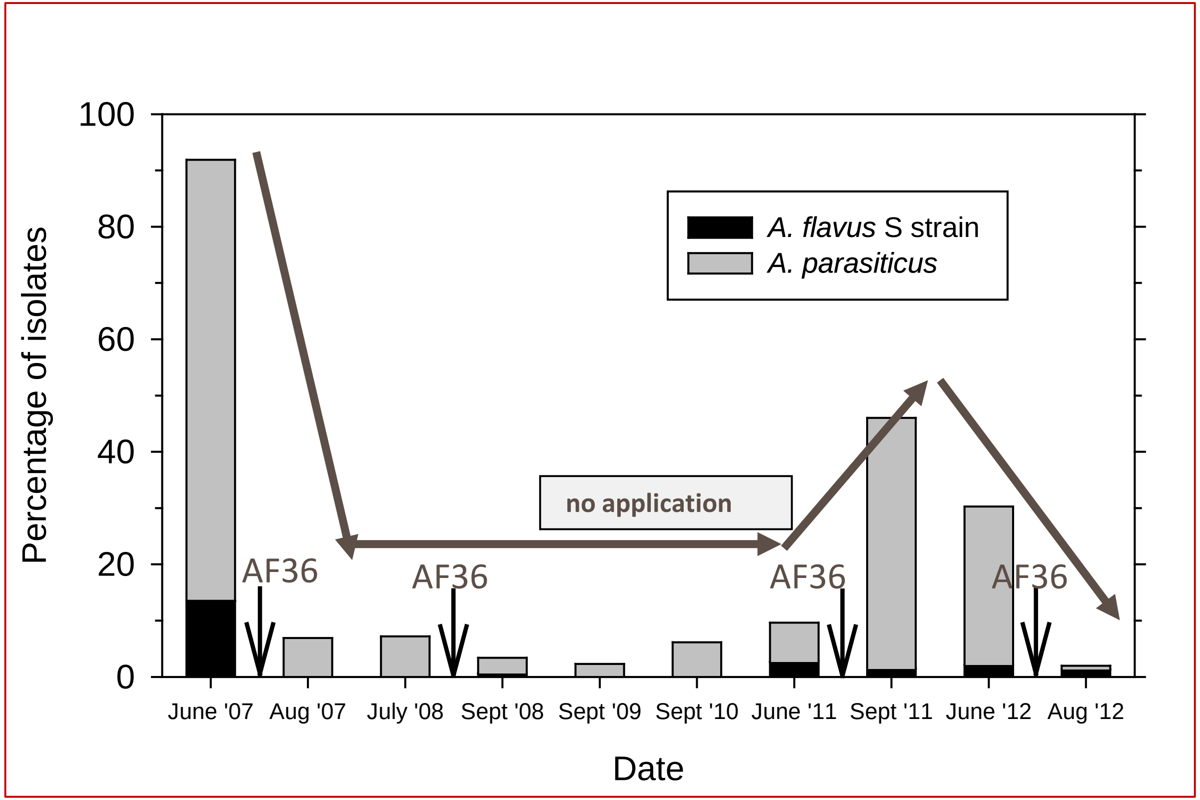
Percentage of *Aspergillus flavus* isolates from soil collected from Nickels almond orchard

(arrows indicate application dates)



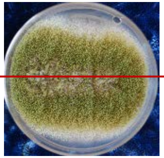
Nickels Soil Laboratory orchard

Reduction of aflatoxin-producing *Aspergillus flavus/A. parasiticus* isolates in areas of the almond orchard treated with the AF36 product

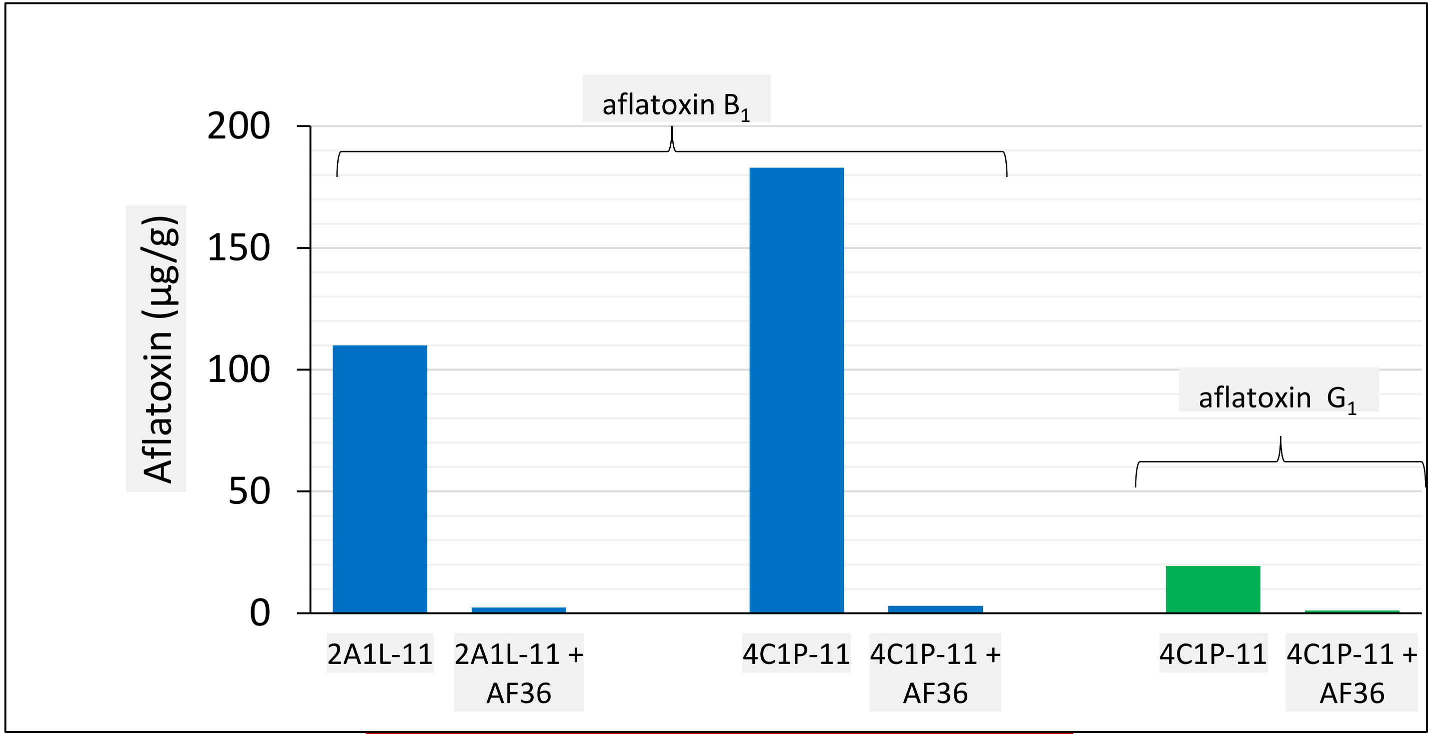


Aflatoxin reduction ability of AF36 when co-inoculated with highly toxigenic isolates of *Aspergillus flavus* and *A. parasiticus* on viable almond kernels (lab) conditions

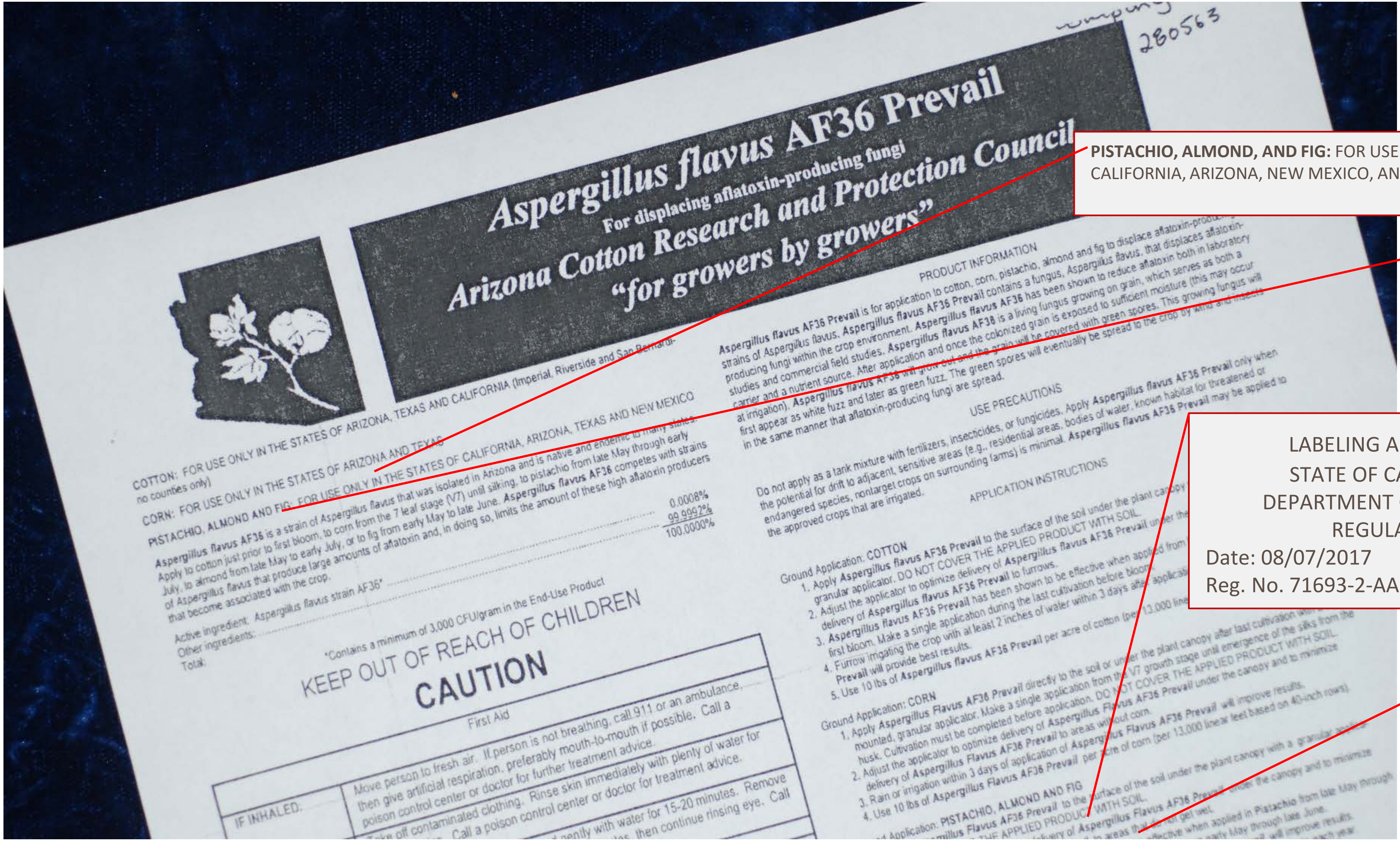
2A1L-11 : toxigenic isolate of *A. flavus*



4C1P-11 : toxigenic isolate of *A. parasiticus*



Aflatoxin reductions by AF36 were well over 94%.



280563

Aspergillus flavus AF36 Prevail

For displacing aflatoxin-producing fungi

Arizona Cotton Research and Protection Council

"for growers by growers"

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

Aspergillus flavus AF36 is a strain of Aspergillus flavus that was isolated in Arizona and is native and endemic to many states. Apply to cotton just prior to first bloom, to corn from the 7 leaf stage (V7) until silking, to pistachio from late May through early July, to almond from late May to early July, or to fig from early May to late June. **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:	99.9992%
Total:	100.0000%

*Contains a minimum of 3,000 CFU/gram in the End-Use Product

KEEP OUT OF REACH OF CHILDREN

CAUTION

First Aid	
IF INHALED:	Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call a poison control center or doctor for further treatment advice.
	Take off contaminated clothing. Rinse skin immediately with plenty of water for Call a poison control center or doctor for treatment advice.
	gently with water for 15-20 minutes. Remove les, then continue rinsing eye. Call

PRODUCT INFORMATION

Aspergillus flavus AF36 Prevail is for application to cotton, corn, pistachio, almond and fig to displace aflatoxin-produc
strains of Aspergillus flavus. **Aspergillus flavus AF36 Prevail** contains a fungus, Aspergillus flavus, that displaces aflatoxin-producing fungi within the crop environment. **Aspergillus flavus AF36** has been shown to reduce aflatoxin both in laboratory studies and commercial field studies. **Aspergillus flavus AF36** is a living fungus growing on grain, which serves as both a carrier and a nutrient source. After application and once the colonized grain is exposed to sufficient moisture (this may occur at irrigation), **Aspergillus flavus AF36** will grow out and the grain will be covered with green spores. This growing fungus will first appear as white fuzz and later as green fuzz. The green spores will eventually be spread to the crop by wind and insects in the same manner that aflatoxin-producing fungi are spread.

USE PRECAUTIONS

Do not apply as a tank mixture with fertilizers, insecticides, or fungicides. Apply **Aspergillus flavus AF36 Prevail** only when the potential for drift to adjacent, sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, nontarget crops on surrounding farms) is minimal. **Aspergillus flavus AF36 Prevail** may be applied to the approved crops that are irrigated.

APPLICATION INSTRUCTIONS

Ground Application: COTTON

1. Apply **Aspergillus flavus AF36 Prevail** to the surface of the soil under the plant canopy
   granular applicator. DO NOT COVER THE APPLIED PRODUCT WITH SOIL.
2. Adjust the applicator to optimize delivery of **Aspergillus flavus AF36 Prevail** under the
   delivery of **Aspergillus flavus AF36 Prevail** to furrows.
3. **Aspergillus flavus AF36 Prevail** has been shown to be effective when applied from
   first bloom. Make a single application during the last cultivation before bloom
4. Furrow irrigating the crop with at least 2 inches of water within 3 days after applica
   Prevail will provide best results.
5. Use 10 lbs of **Aspergillus flavus AF36 Prevail** per acre of cotton (per 13,000 line

Ground Application: CORN

1. Apply **Aspergillus Flavus AF36 *Prevail*** directly to the soil or under the plant canopy after last cultivation w
   mounted, granular applicator. Make a single application from the V7 growth stage until emergence of the silks from the
   husk. Cultivation must be completed before application. DO NOT COVER THE APPLIED PRODUCT WITH SOIL.
2. Adjust the applicator to optimize delivery of **Aspergillus Flavus AF36 *Prevail*** under the canopy and to minimize
   delivery of **Aspergillus Flavus AF36 *Prevail*** to areas without corn.
3. Rain or irrigation within 3 days of application of **Aspergillus Flavus AF36 *Prevail*** will improve results.
4. Use 10 lbs of **Aspergillus Flavus AF36 *Prevail*** per acre of corn (per 13,000 linear feet based on 40-inch rows).

d Application: PISTACHIO, ALMOND AND FIG
gillus Flavus AF36 *Prevail* to the surface of the soil under the plant canopy with a granular applica
THE APPLIED PRODUCT WITH SOIL.
livery of **Aspergillus Flavus AF36 Prevail** under the canopy and to minimize
to areas that do not get wet.
ffective when applied in Pistachio from late May through
early May through late June.
will improve results.
each year

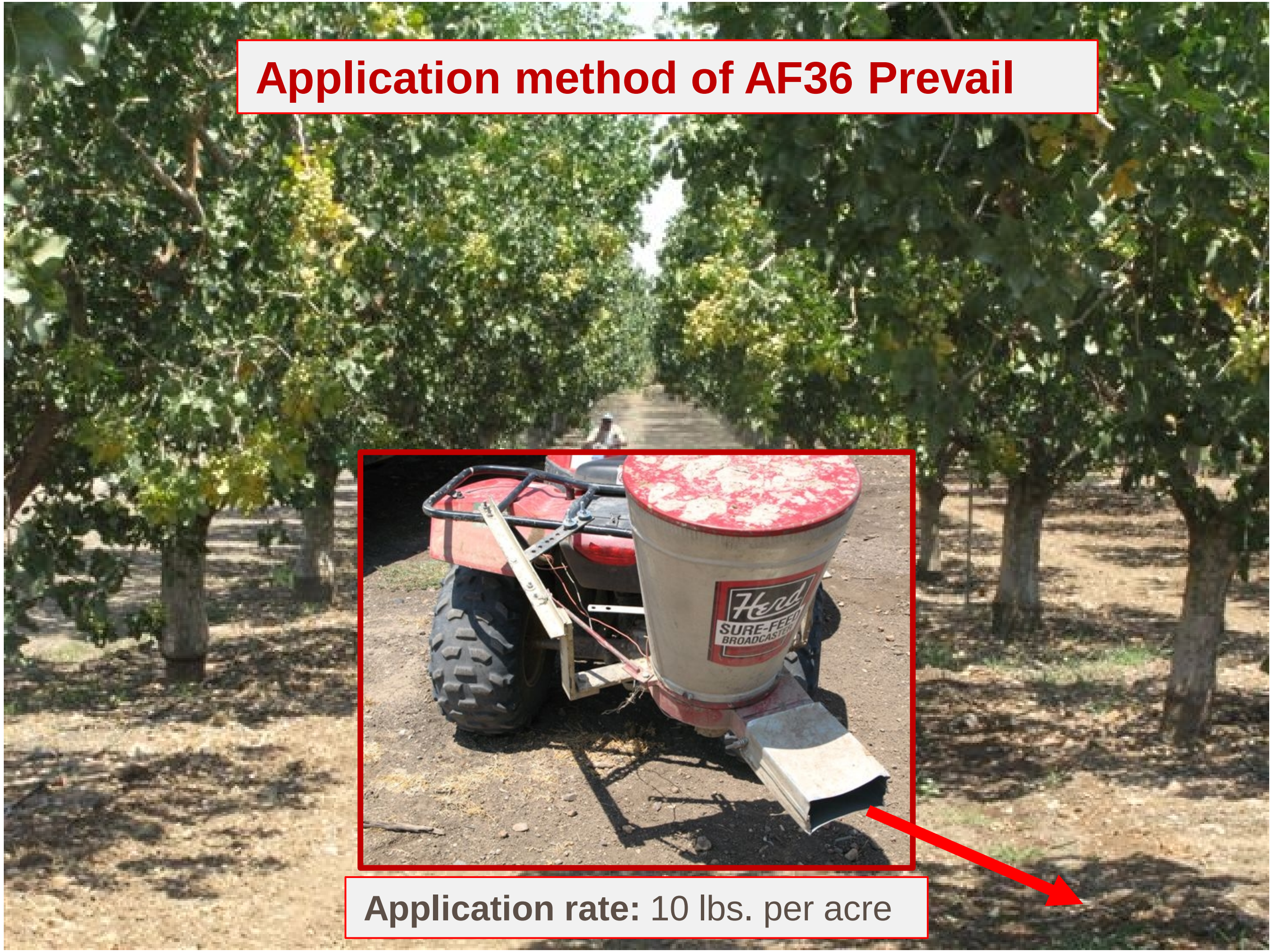
PISTACHIO, ALMOND, AND FIG: FOR USE ONLY IN THE STATES OF CALIFORNIA, ARIZONA, NEW MEXICO, AND TEXAS

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE
REGULATION
Date: 08/07/2017
Reg. No. 71693-2-AA

Delivery of AF36 inoculum (for pistachio treatment)

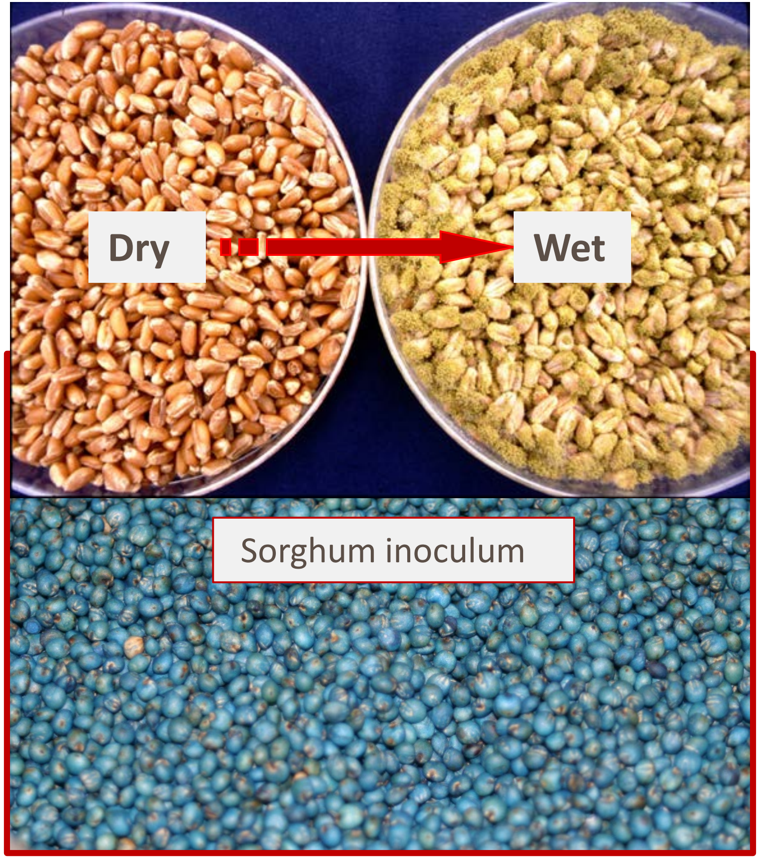
AF36 Inoculum

Application method of AF36 Prevail



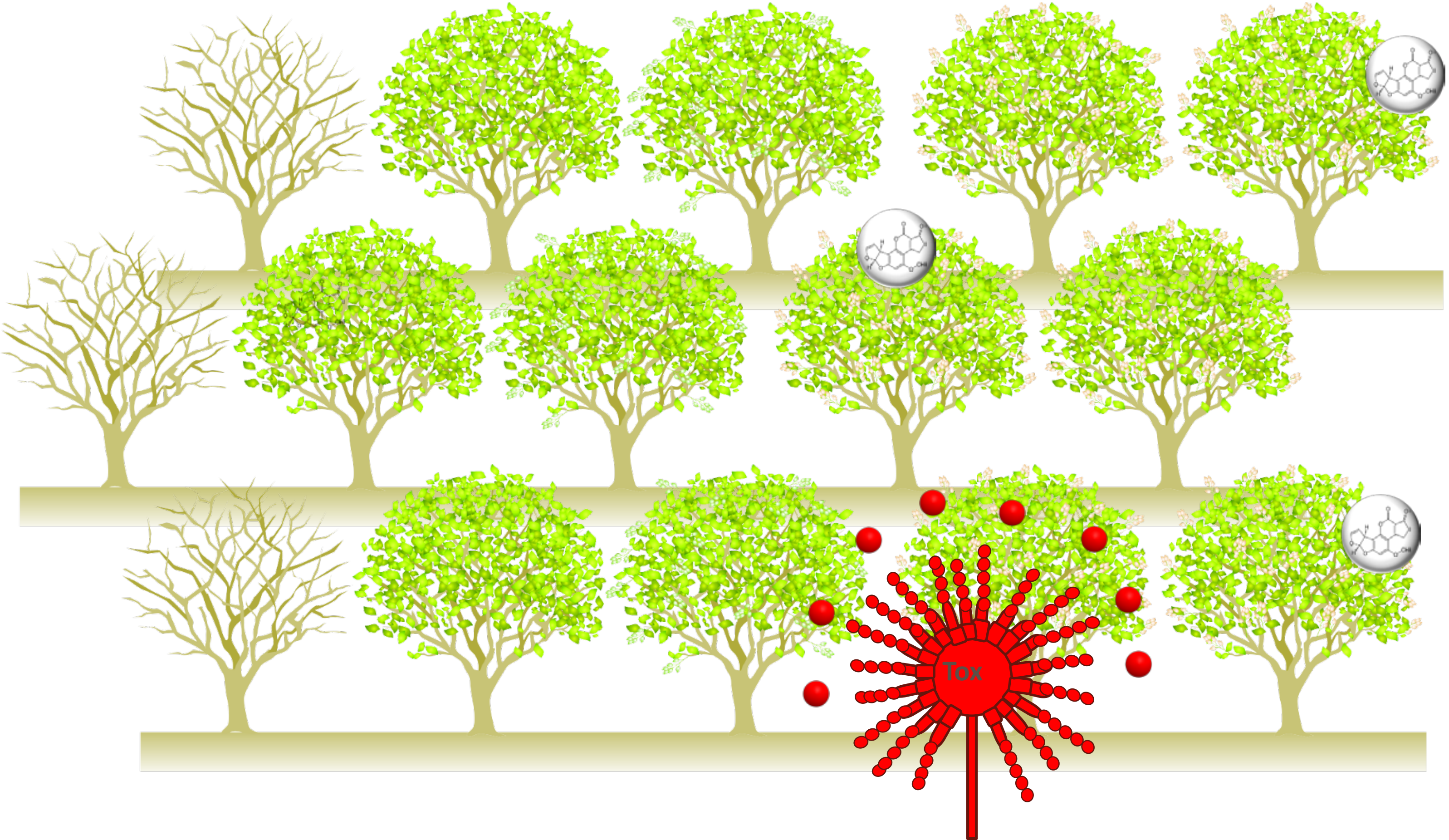
Application rate: 10 lbs. per acre

After irrigation, the wet seeds will produce spores of AF36

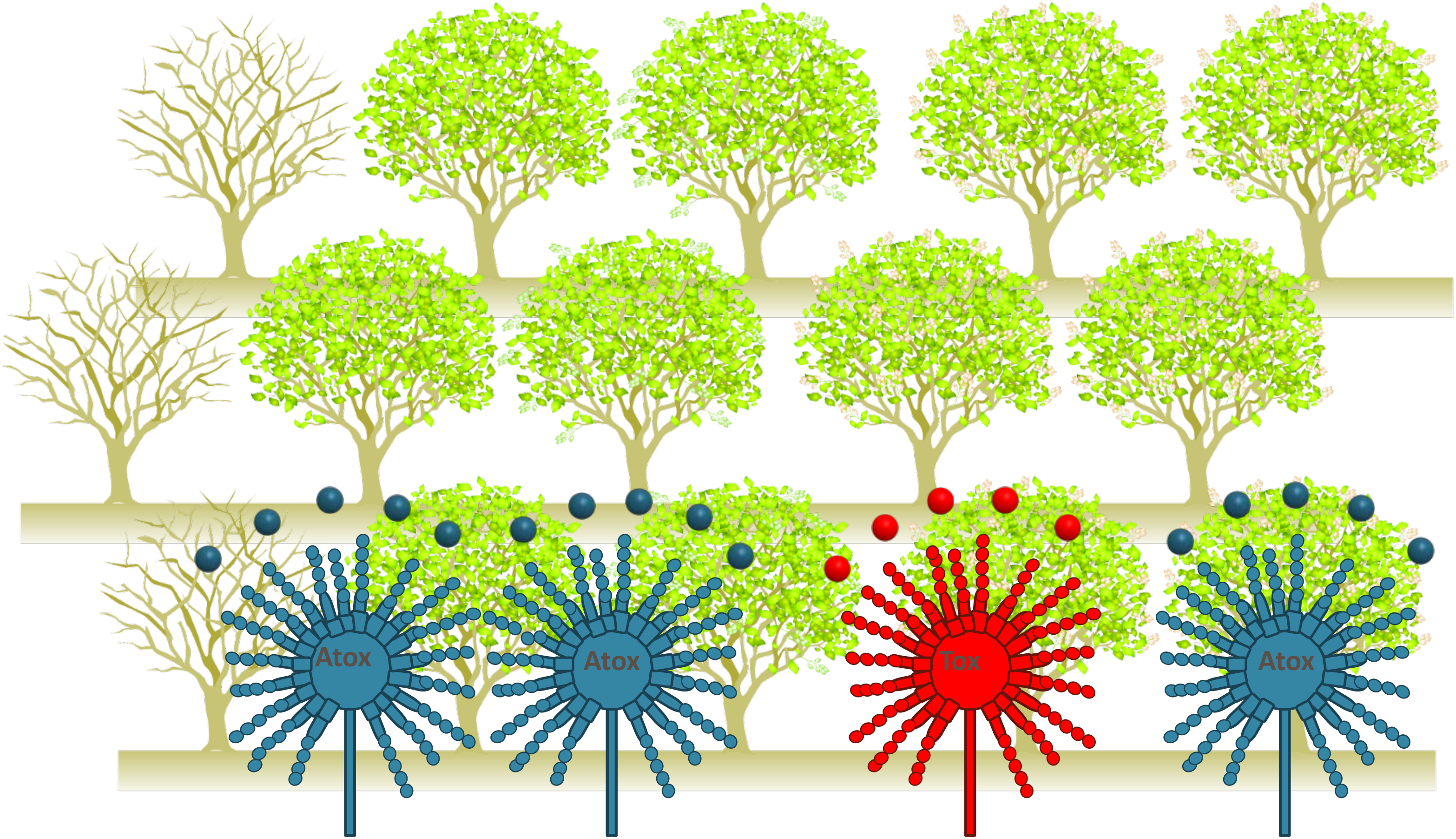


Predation of seeds by insects

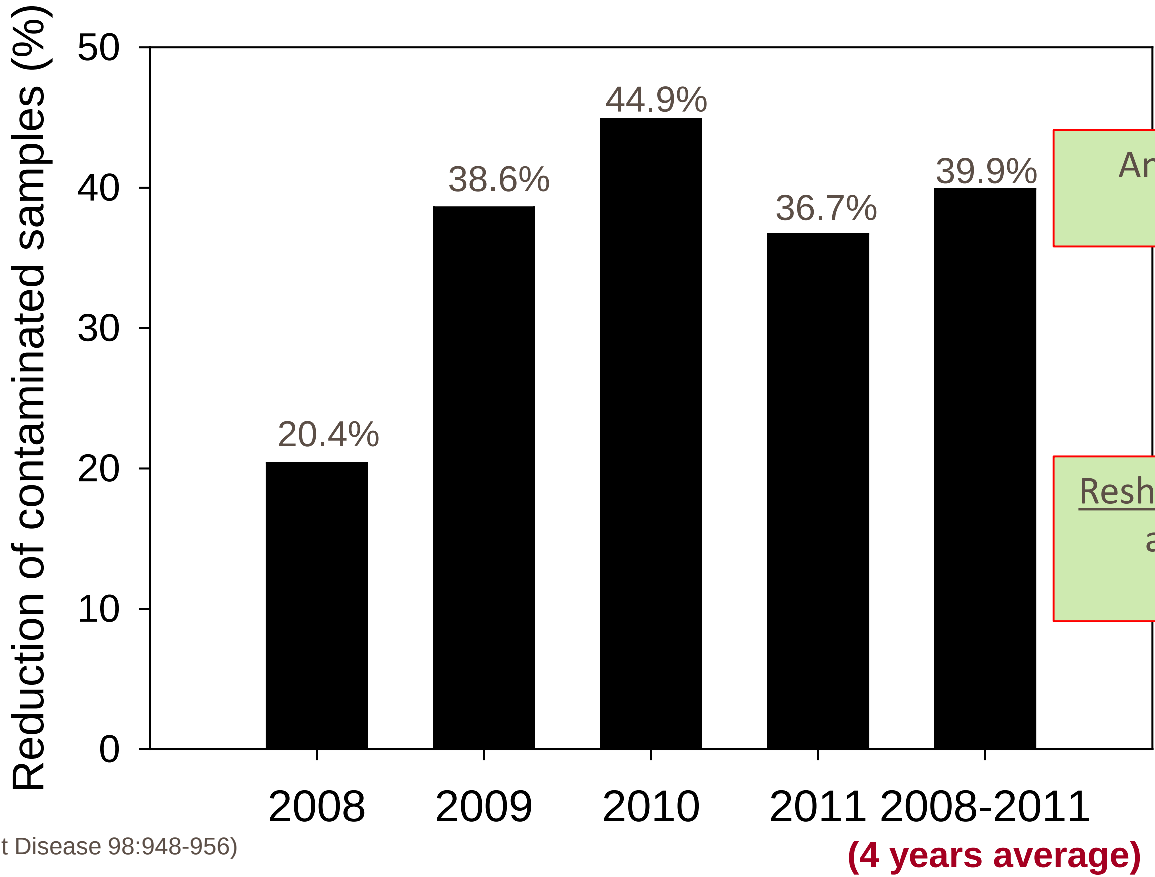
Non-treated orchard



Treated Orchard



Reduction in aflatoxin-contaminated pistachio samples (1st and 2nd harvests)



An average of 40% reduction

Reshakes of 3 years: An average of 55% reduction

P value =0.0033

(Doster et al. (2014), Plant Disease 98:948-956)

Suggestions for the AF36 application in almonds

- ✓ The application method and product rate are the same as those used in pistachio orchards.
- ✓ Apply product in late May to early July.
- ✓ Make sure that most of the inoculum is spread on the wet soil.
- ✓ Avoid covering the inoculum by plowing or with too much water.
- ✓ Do not spray herbicides 1 to 2 weeks after application.
- ✓ Control the ants in the orchard.
- ✓ This is a novel new way to reduce aflatoxin contamination in almonds!

Please visit poster #80

Acknowledgment: **Almond Board of California**

CEUs – New Process

Certified Crop Advisor (CCA)

- Sign in and out of each session you attend.
- Pickup verification sheet at conclusion of each session.
- *Sign in sheets are located at the back of each session room.*

Pest Control Advisor (PCA), Qualified Applicator (QA), Private Applicator (PA)

- Pickup scantron at the start of the day at first session you attend; complete form.
- Sign in and out of each session you attend.
- Pickup verification sheet at conclusion of each session.
- Turn in your scantron at the end of the day at the last session you attend.

Sign in sheets and verification sheets are located at the back of each session room.

What's Next

Thursday, December 7 at 3:30 p.m.

- What to Consider Before and After Harvest – Room 308-309
- FSMA and Electronic Record Keeping: Moving Beyond Paper Logs and Excel – Room 314
- Proposition 65: When Is a Warning Required? – Room 306-307

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