2023

THE ALMOND CONFERENCE

Connecting the Dots

GROWERS // HANDLERS // CUSTOMERS // CONSUMERS

Developing a Disease Management Strategy When Prices Are Low

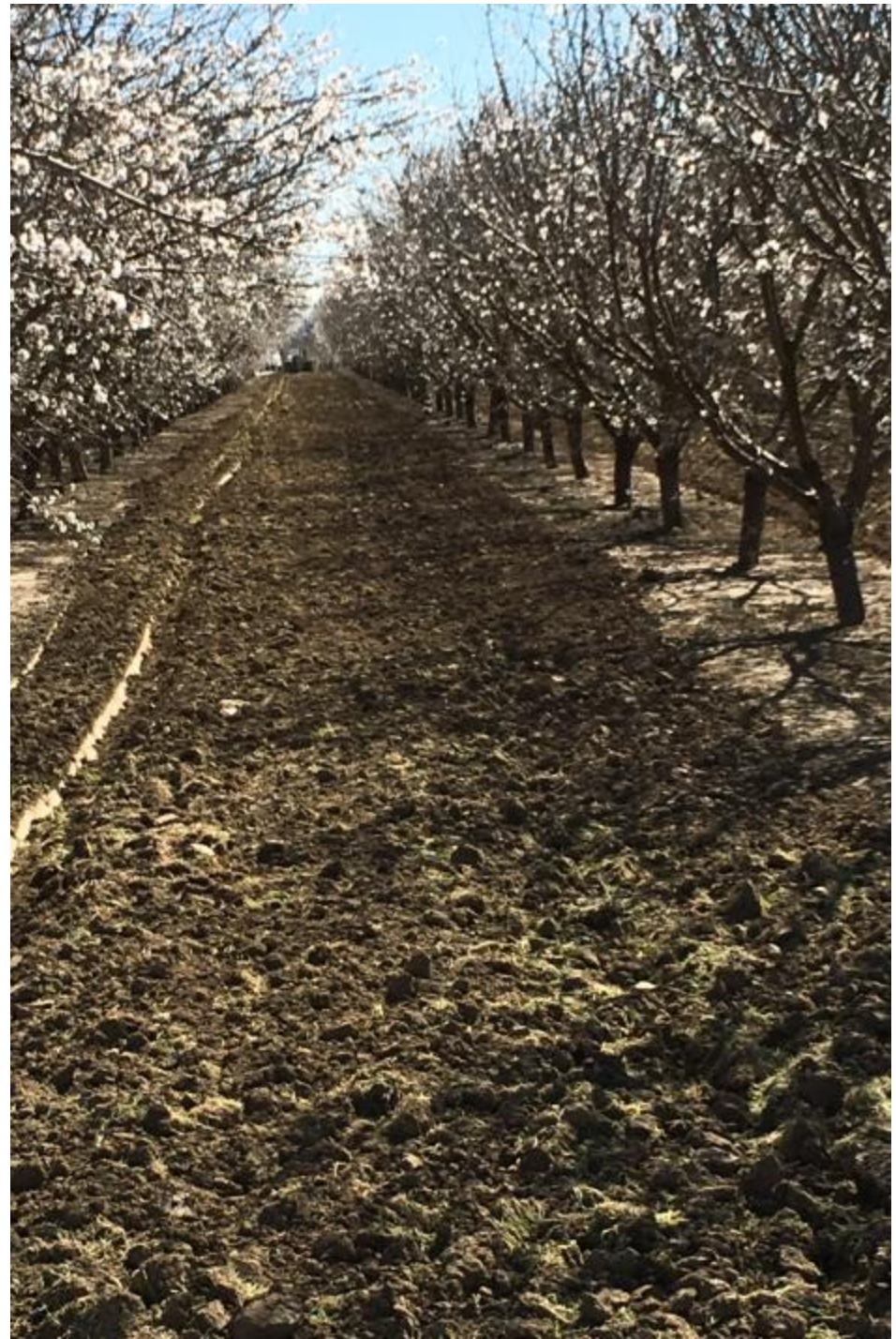
Moderator: Lauren Fann (ABC)

Speakers: Wes Asai (Pomology Consulting), Themis Michailides (UC ANR), Jim Adaskaveg (UC Riverside)

Managing Almond Diseases in a Challenging Economic Year

Pomology Consulting

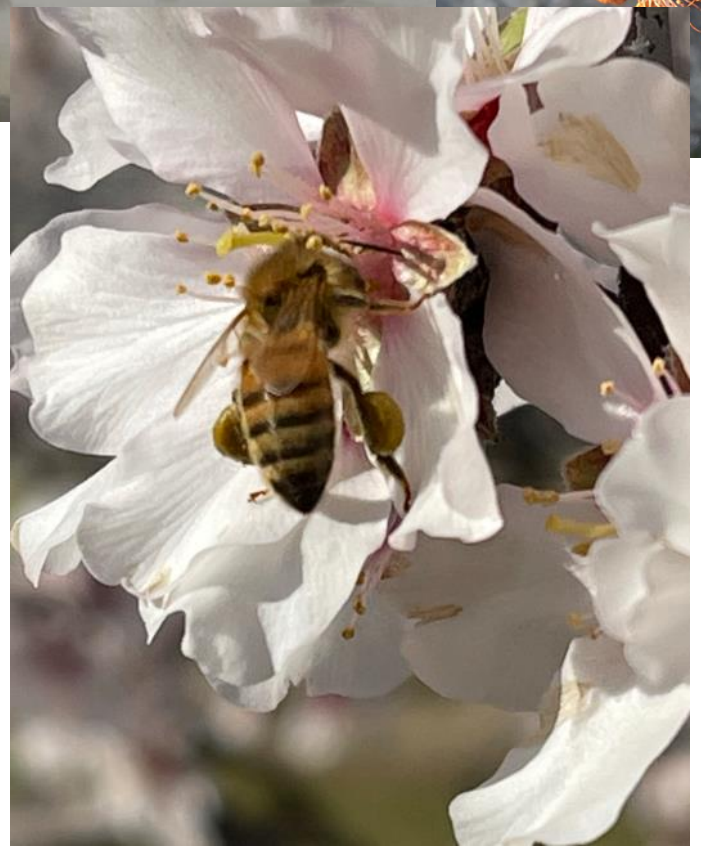
Turlock, California

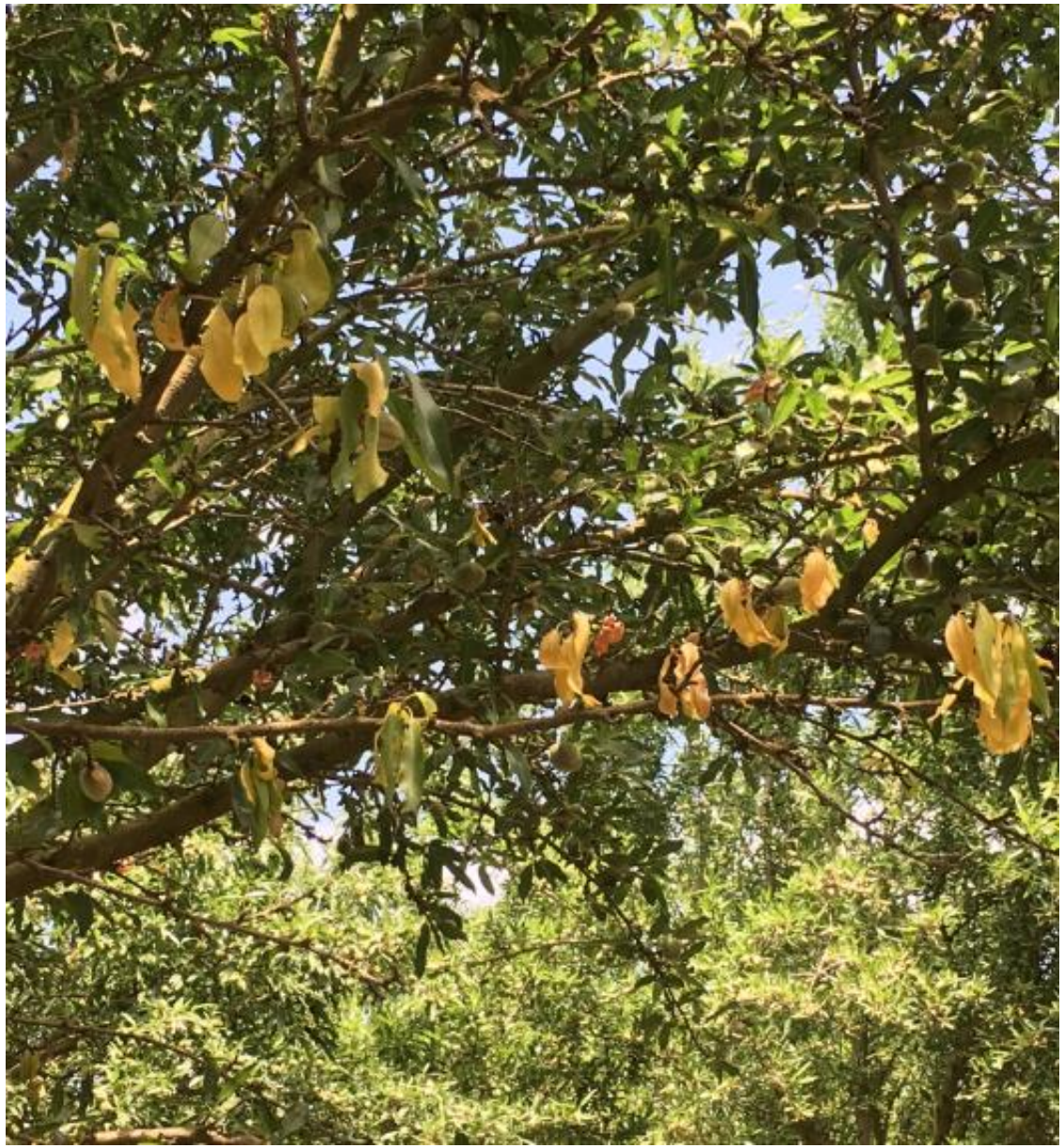


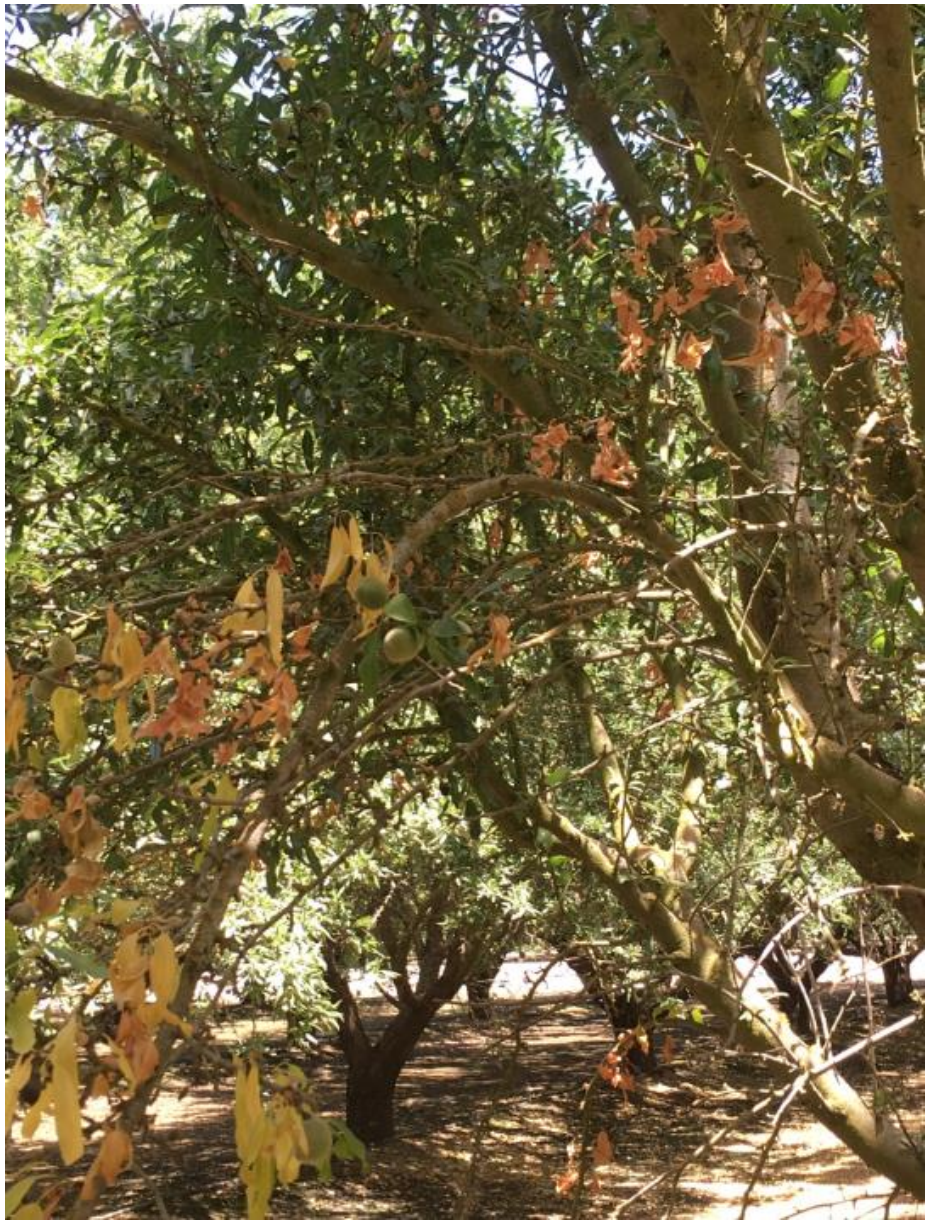
Pinkbud

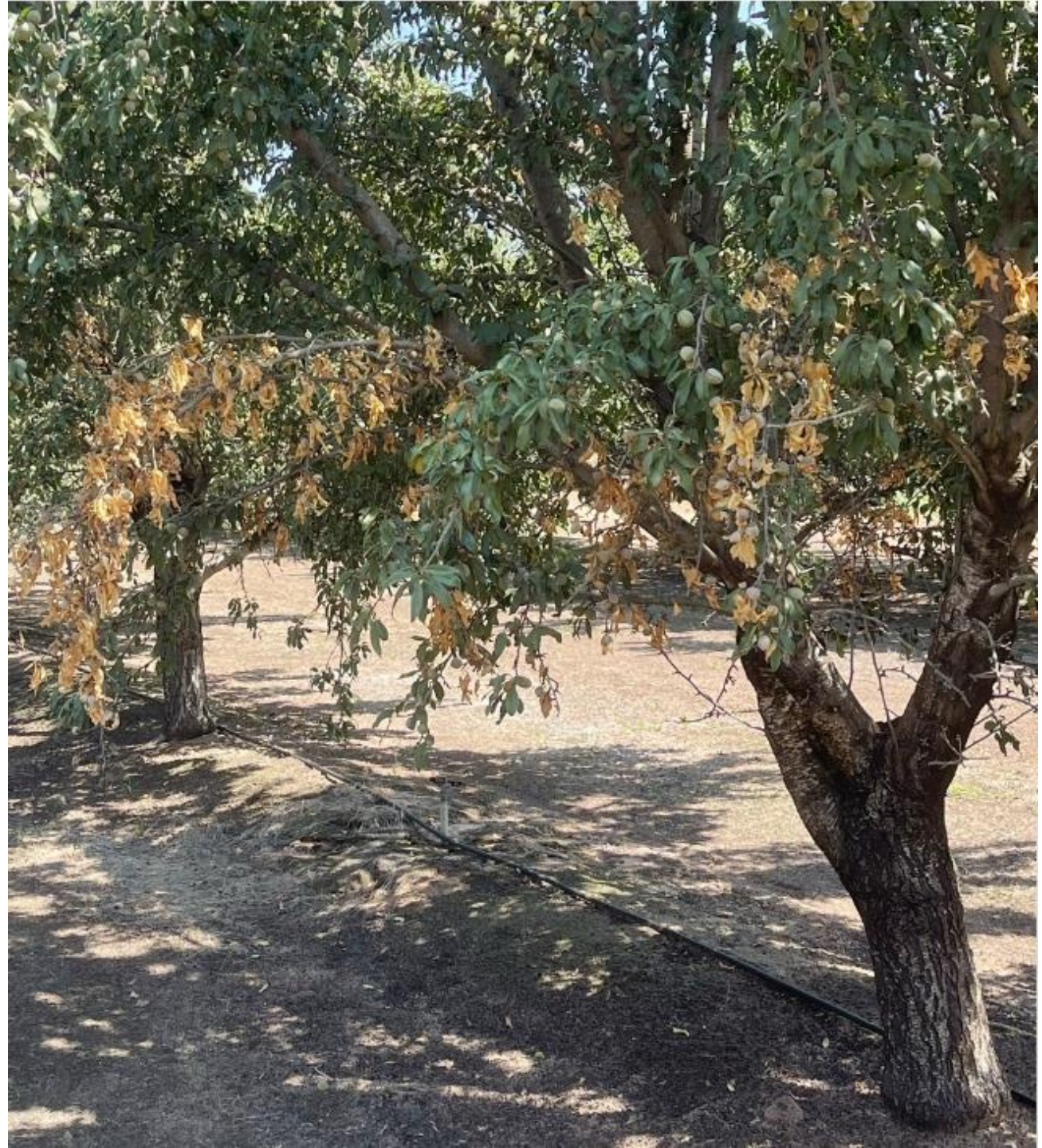
Full Bloom

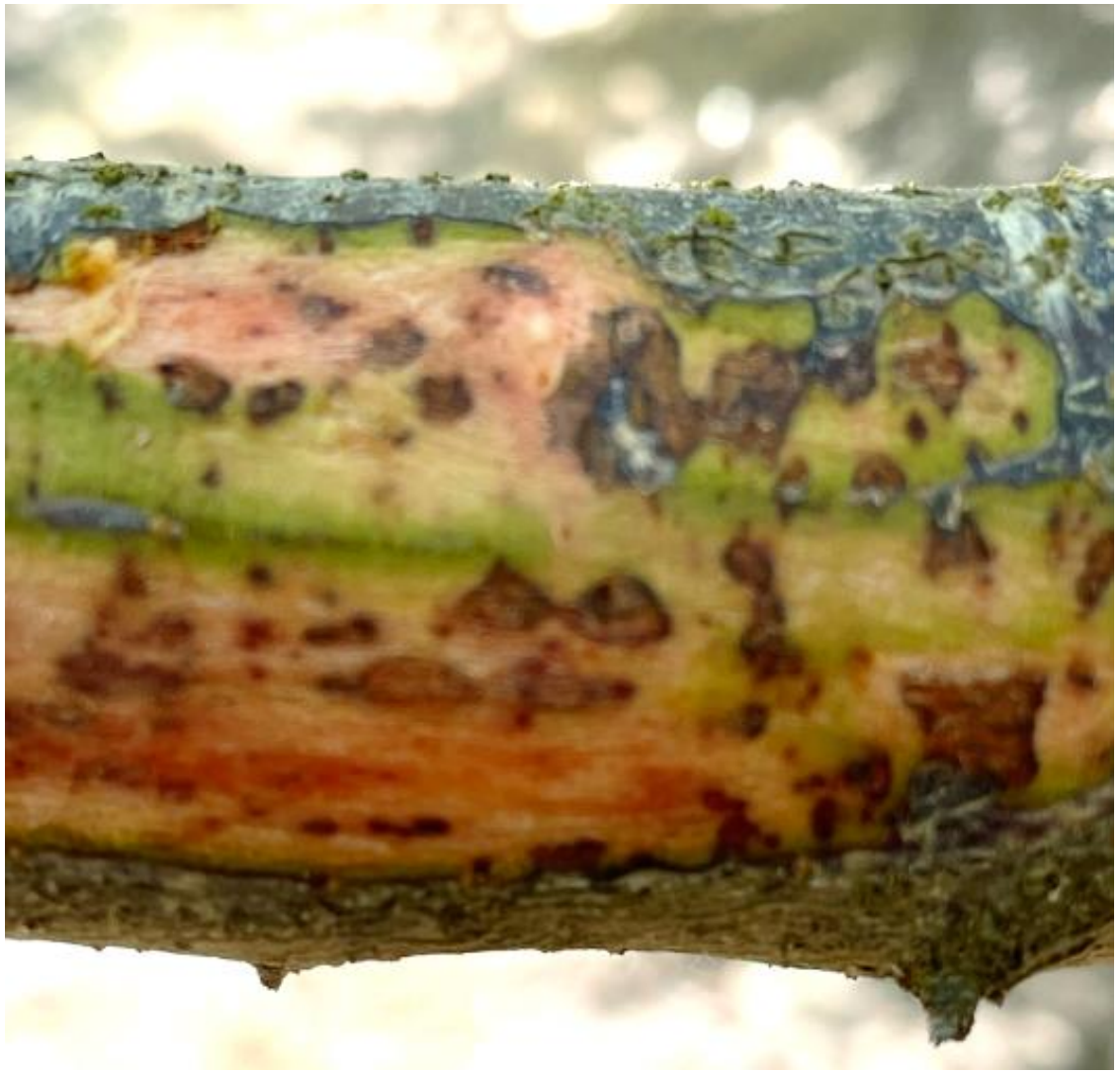
Petalfall

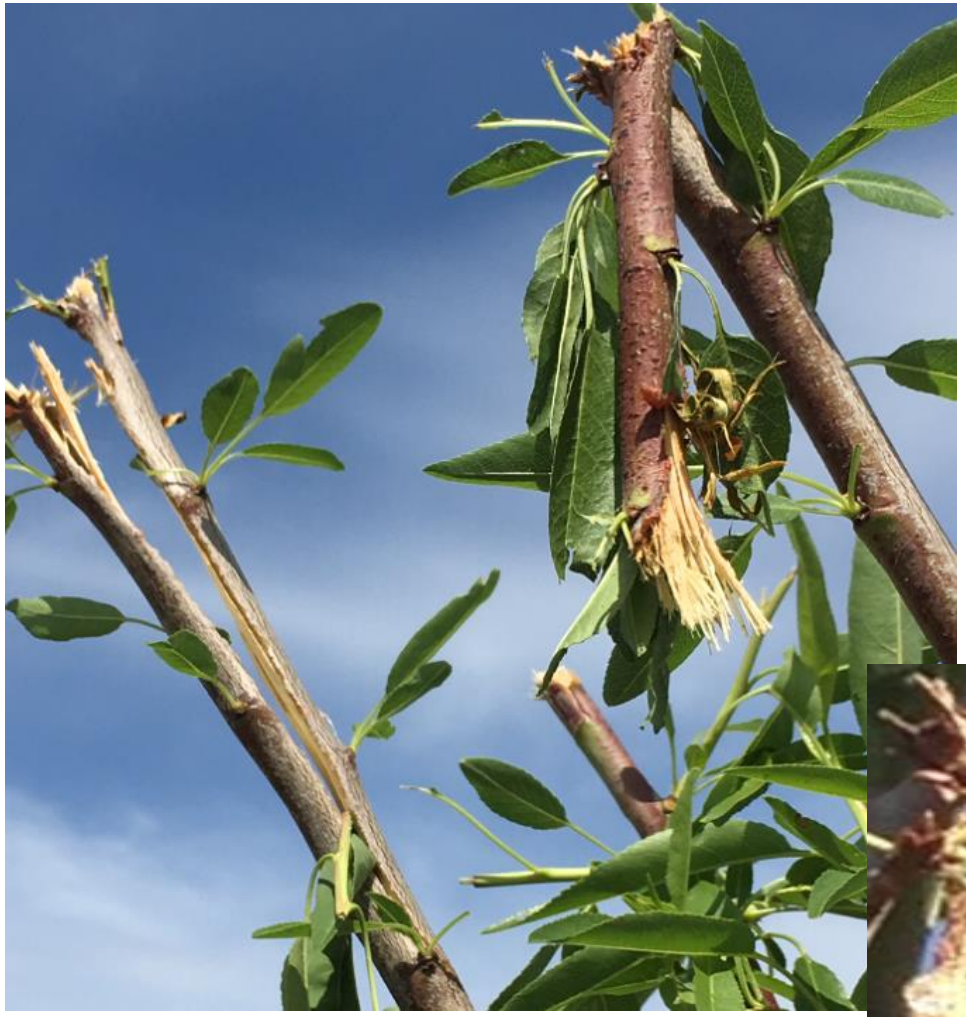












Rhizopus

Monilinia

Aspergillus


MAXIMUM
TANK
PRESSURE
207 BAR


112
112

Canker Diseases of Almond

THEMIS MICHAILIDES

UNIVERSITY OF CALIFORNIA, DAVIS /
KEARNEY AGRIC. RESEARCH AND EXTENSION CENTER

Definition

What is a canker?

- A continuous mass of killed tissues in trunks, scaffolds, branches, and shoots of plants.
- The canker pathogen colonizes the entire cankered tissues and beyond.
- A canker can result to the development of a blight, but a blight to occur does not need a canker.

O U T L I N E

(Above Ground Canker Diseases)

1. Band Canker****
2. Neoscytalidium canker (and hull rot)***
3. Ceratocystis canker**

1. Band canker

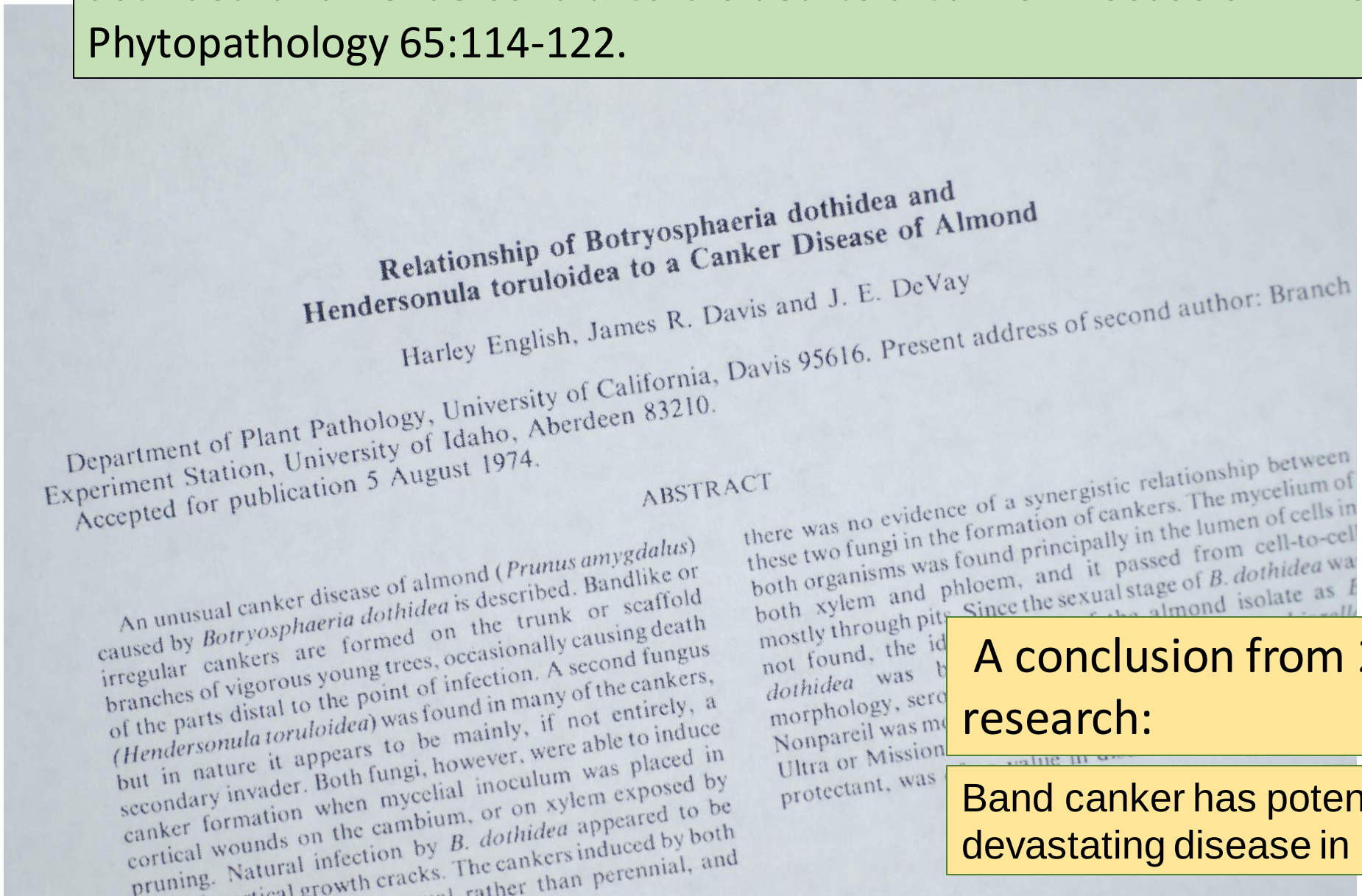
English, H. Davis, J.R., and J.E. DeVay. 1975. Relationship of *Botryosphaeria dothidea* and *Hendersonula toruloidea* to a canker disease of almond. Phytopathology 65:114-122.

- **Pathogens:** *Botryosphaeria dothidea* and *Hendersonula toruloidea* associated with "**band canker**"

- Reported on **walnut** causing cankers ("melaxuma canker") in 1915
- And again on **walnut**, **avocado**, and **citrus** causing cankers in 1935

Reported on walnut causing Branch wilt 1965

English, H. Davis, J.R., and J.E. DeVay. 1975. Relationship of *Botryosphaeria dothidea* and *Hendersonula toruloidea* to a Canker Disease of Almond. Phytopathology 65:114-122.



Relationship of Botryosphaeria dothidea and Hendersonula toruloidea to a Canker Disease of Almond

Harley English, James R. Davis and J. E. DeVay

Department of Plant Pathology, University of California, Davis 95616. Present address of second author: Branch Experiment Station, University of Idaho, Aberdeen 83210.

Accepted for publication 5 August 1974.

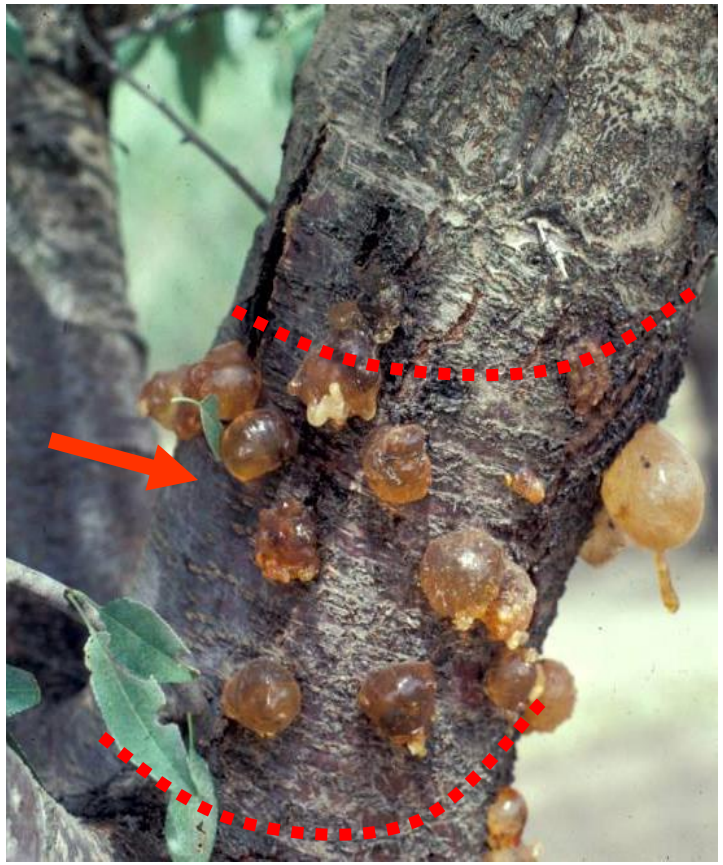
ABSTRACT

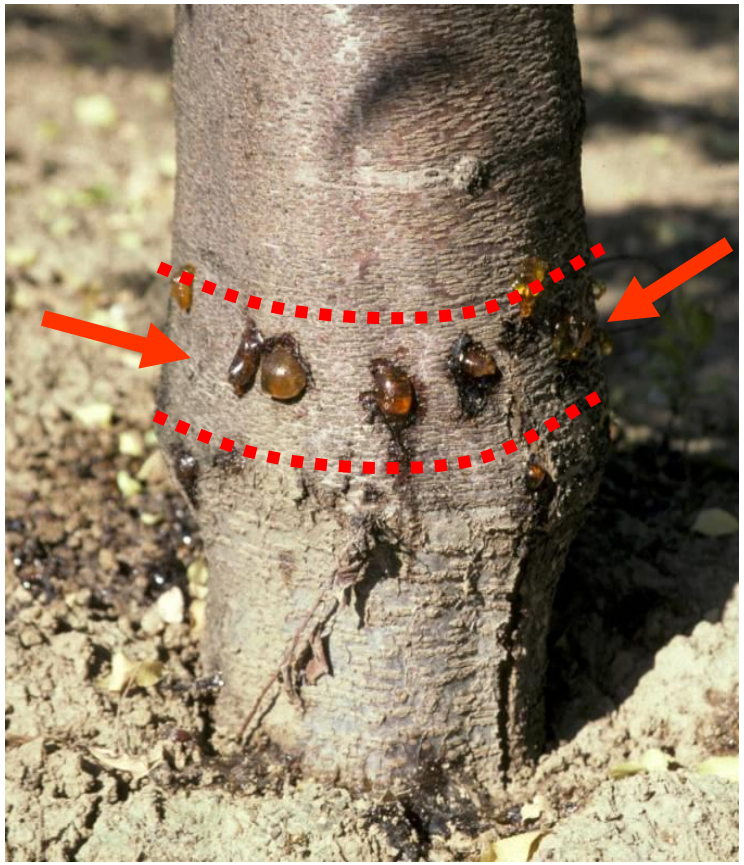
An unusual canker disease of almond (*Prunus amygdalus*) caused by *Botryosphaeria dothidea* is described. Bandlike or irregular cankers are formed on the trunk or scaffold branches of vigorous young trees, occasionally causing death of the parts distal to the point of infection. A second fungus (*Hendersonula toruloidea*) was found in many of the cankers, but in nature it appears to be mainly, if not entirely, a secondary invader. Both fungi, however, were able to induce canker formation when mycelial inoculum was placed in cortical wounds on the cambium, or on xylem exposed by pruning. Natural infection by *B. dothidea* appeared to be ...tical growth cracks. The cankers induced by both ... rather than perennial, and there was no evidence of a synergistic relationship between these two fungi in the formation of cankers. The mycelium of both organisms was found principally in the lumen of cells in both xylem and phloem, and it passed from cell-to-cell mostly through pit... Since the sexual stage of *B. dothidea* was ... almond isolate as ... not found, the id... *dothidea* was ... morphology, sero... Nonpareil was m... Ultra or Mission ... protectant, was ... value in ...

A conclusion from 2004 & 2005 research:

Band canker has potential of becoming a devastating disease in almond.

1. Band canker of almond





Causal agents

Neofusicoccum nonquaesitum

Neof. parvum

Neof. mediterraneum

Botryosphaeria dothidea

Diplodia seriata

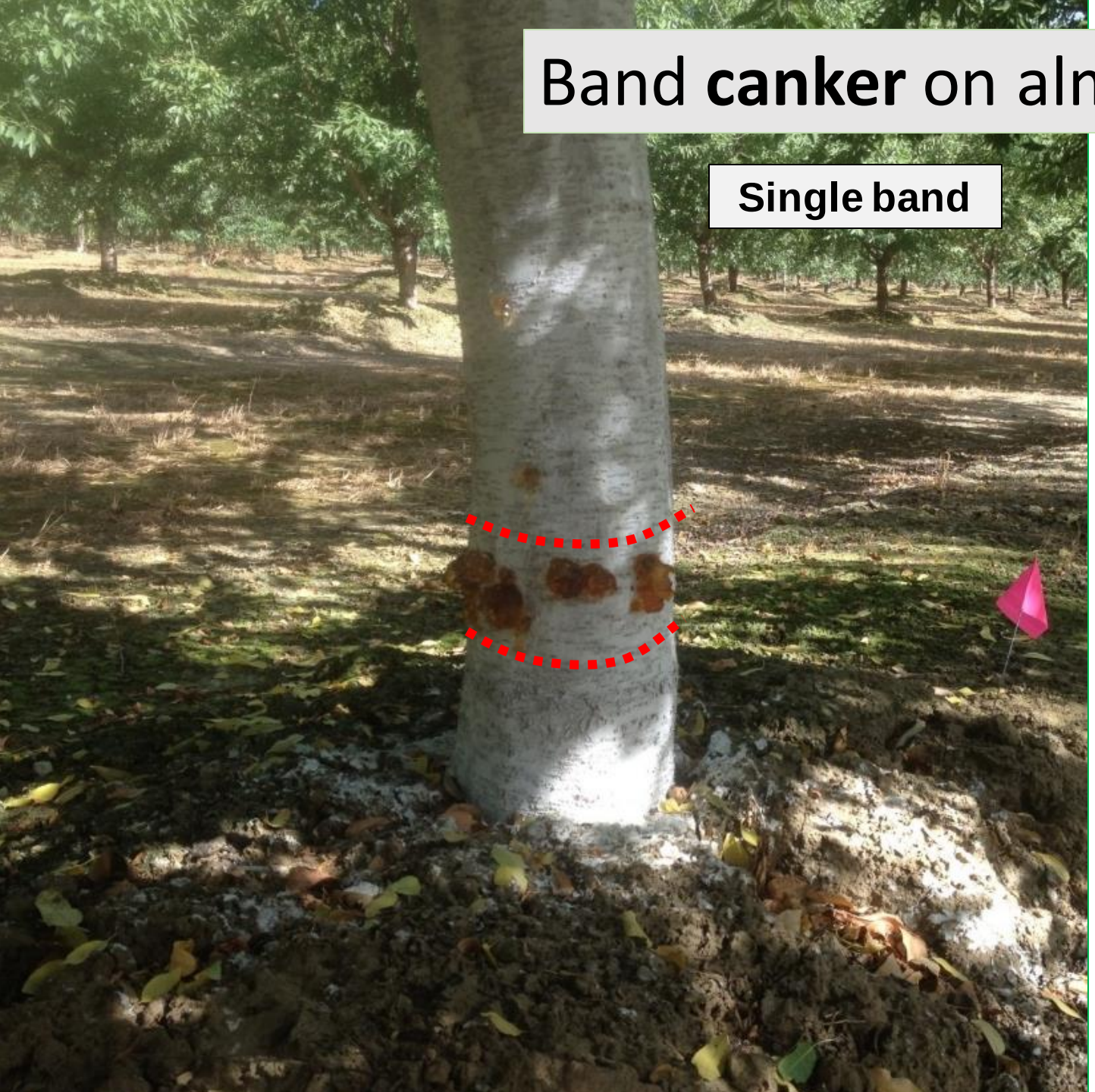
Dothiorella sarmentorum

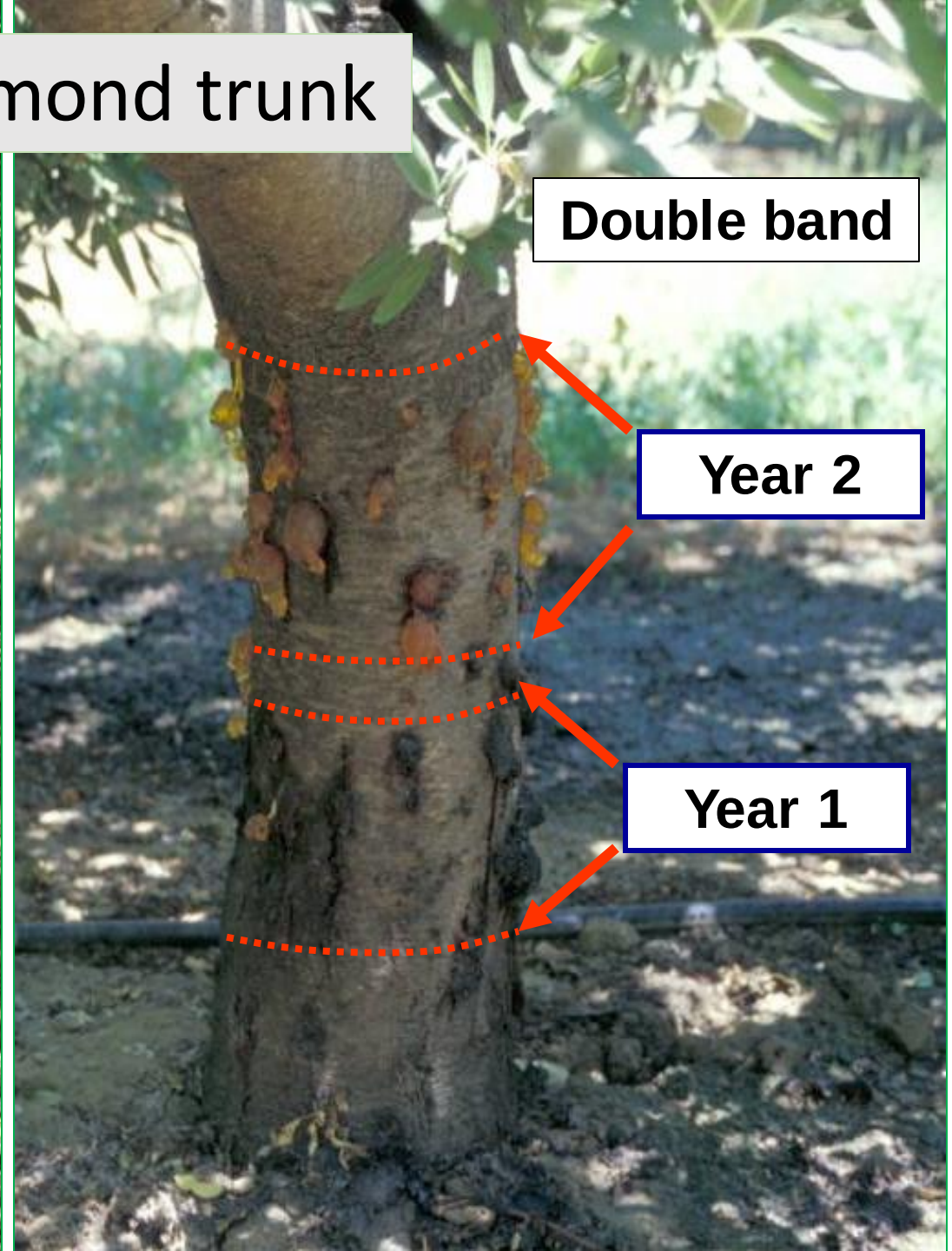
Macrophomina phaseolina

Lasiodiplodia theobromae

Neoscytalidium dimitiatum*****

Band **canker** on almond trunk

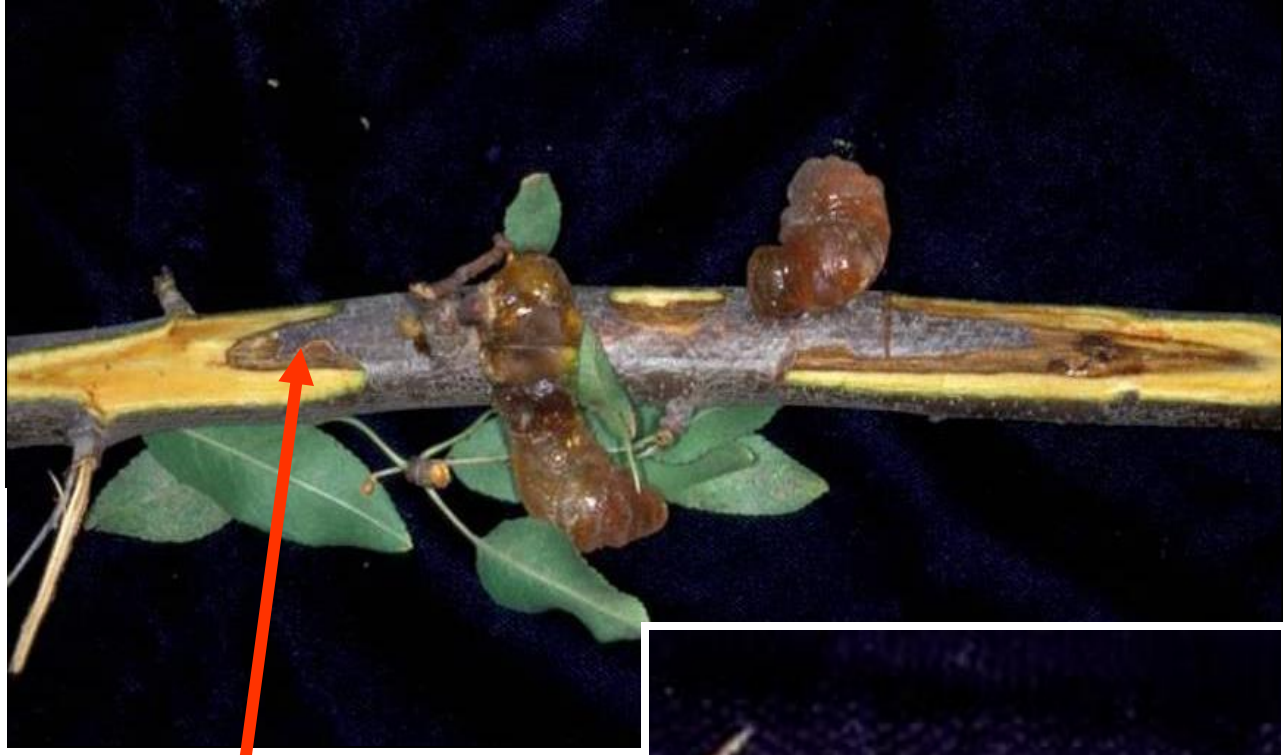




Tree death (note excess suckering)

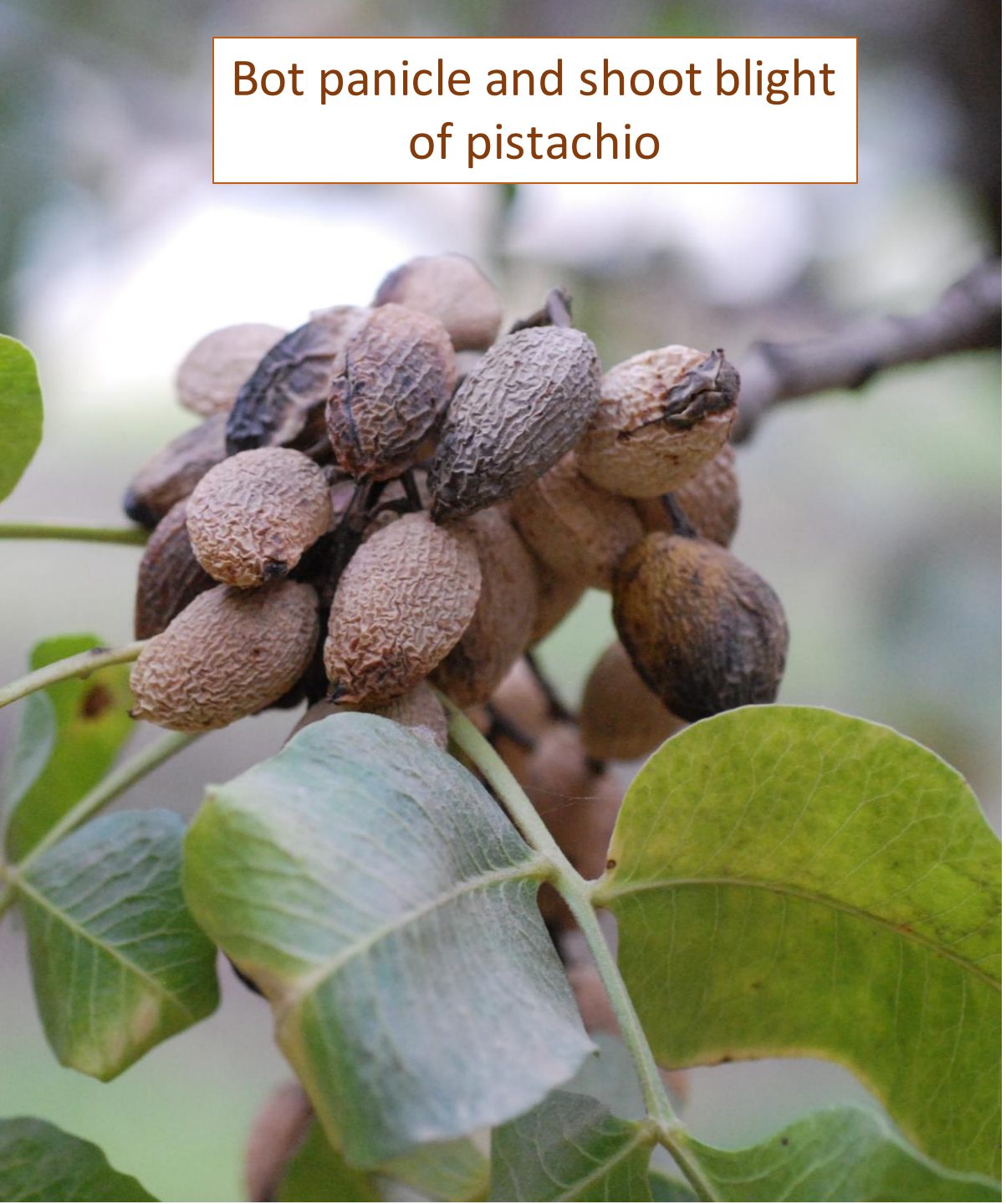
Infection of pruning wounds

Fruit blight: **very uncommon**

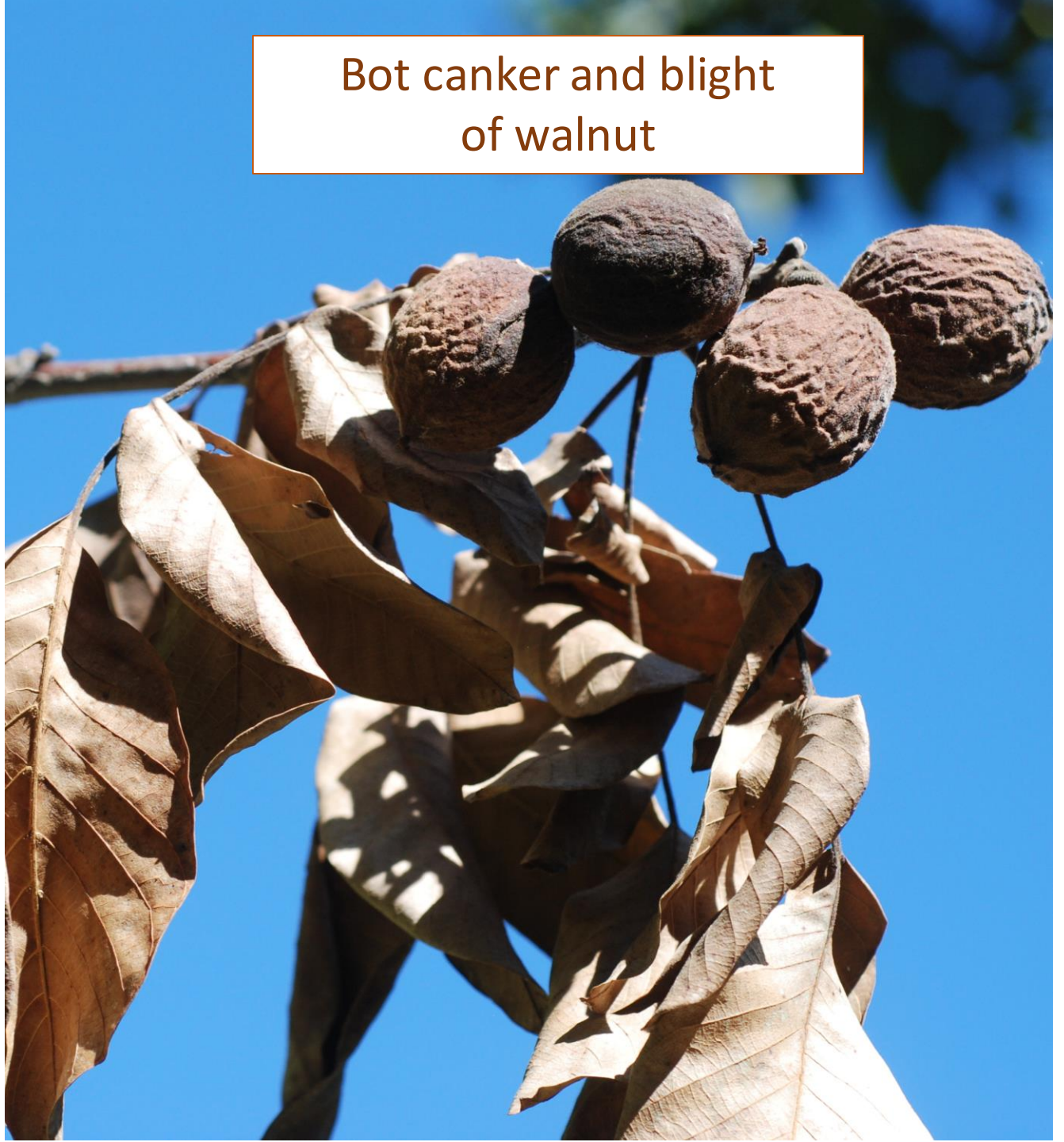


Cankers from fruit infection (blight): **very uncommon**

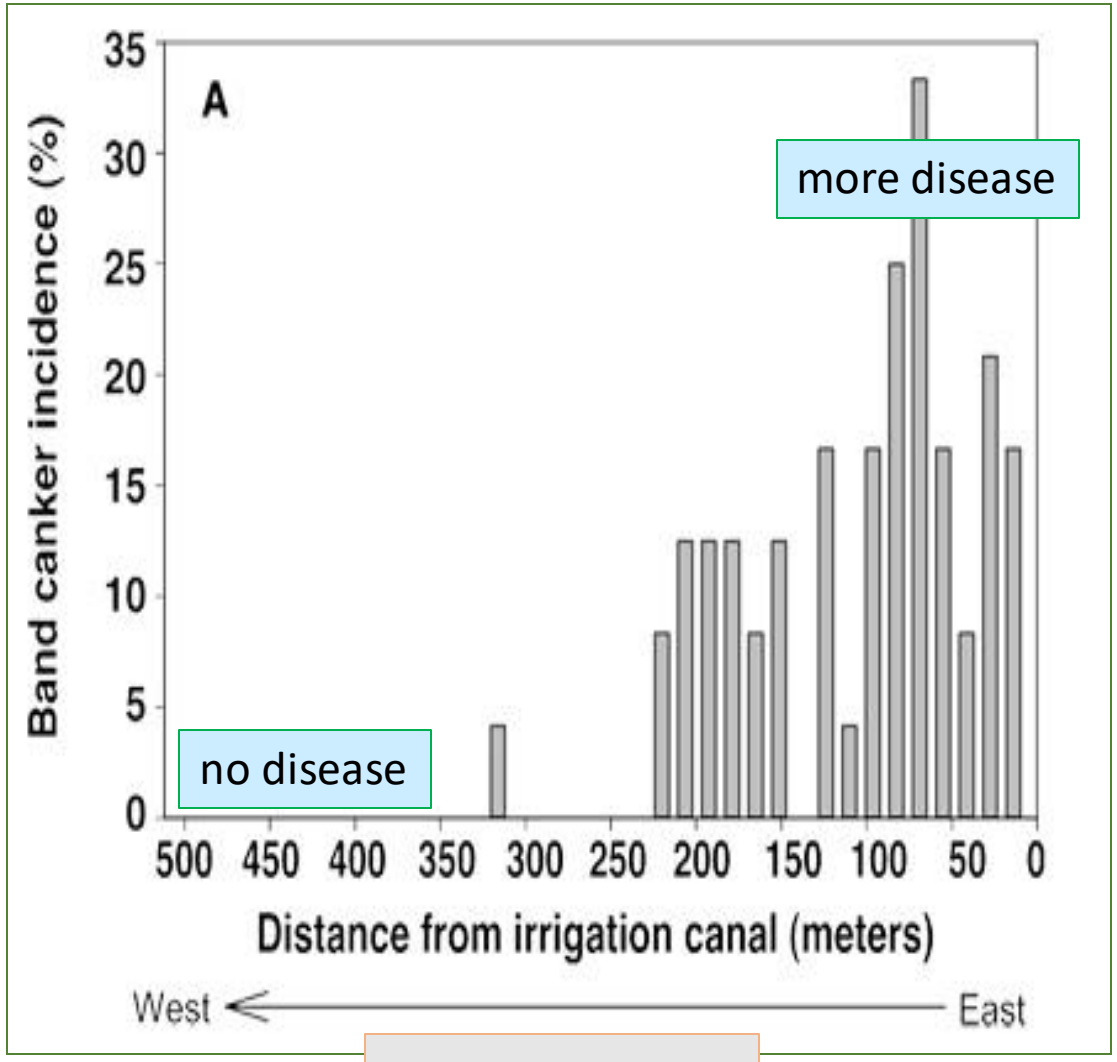
Bot panicle and shoot blight of pistachio



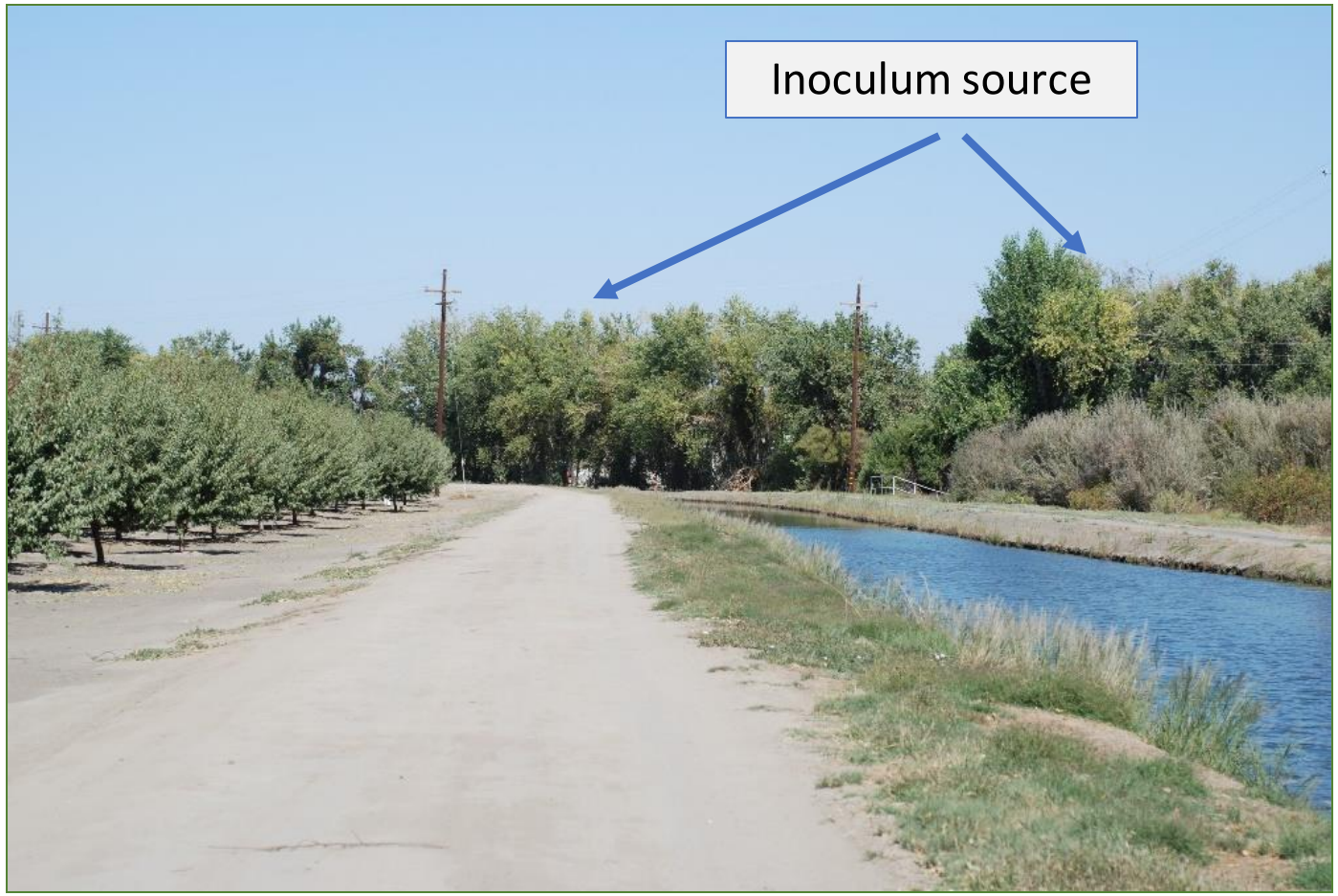
Bot canker and blight of walnut



Band canker **gradient with distance from the** inoculum source (riparian trees along the water canal)



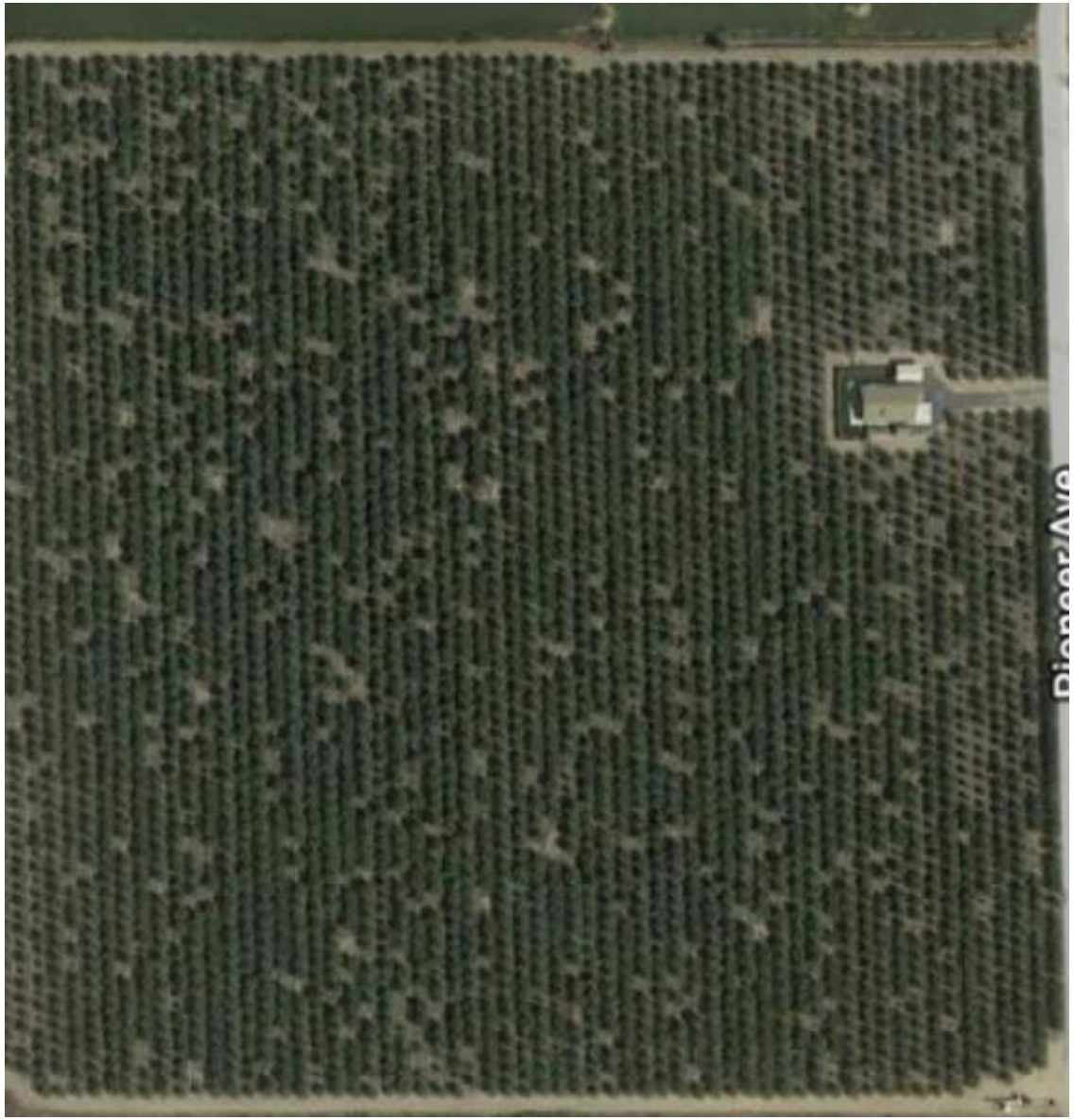
Almond orchard



3rd leaf Nonpareil/Padre; inoculum source: riparian trees and water canal

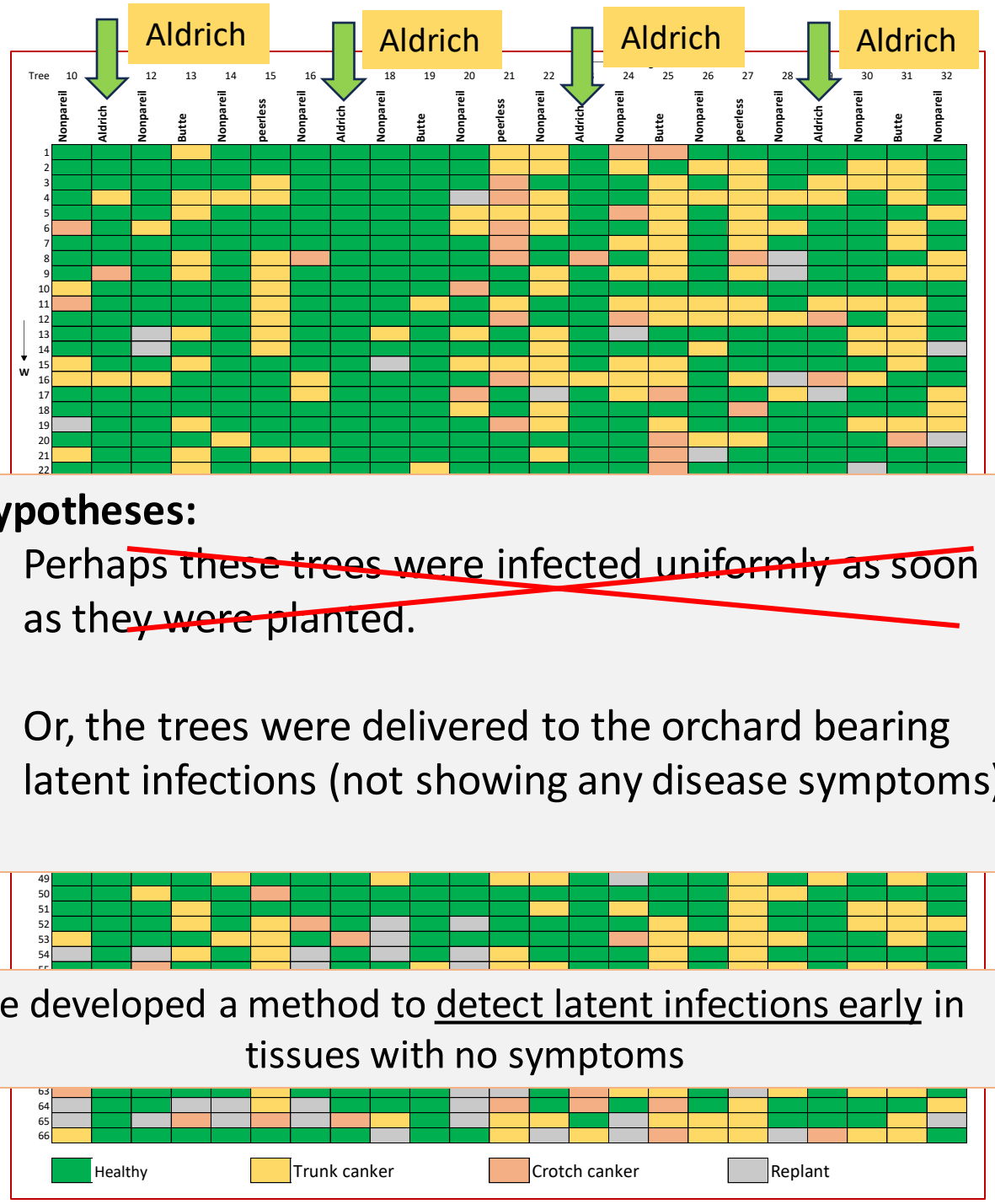
2nd - leaf orchard severely damaged by band canker (Butte County)

3rd-leaf almond orchard with gaps due to Band Canker (Stanislaus Co.)



Distribution of trees with various levels of cankers (4th –leaf almond orchard)

Cultivar	Replants/Row
Aldrich	1, 0, 0, 2
Nonpareil	9,8,6,10,19,14, 7,6,5,7,4,4
Butte	1, 0, 0, 0
Peerless	0, 3, 2



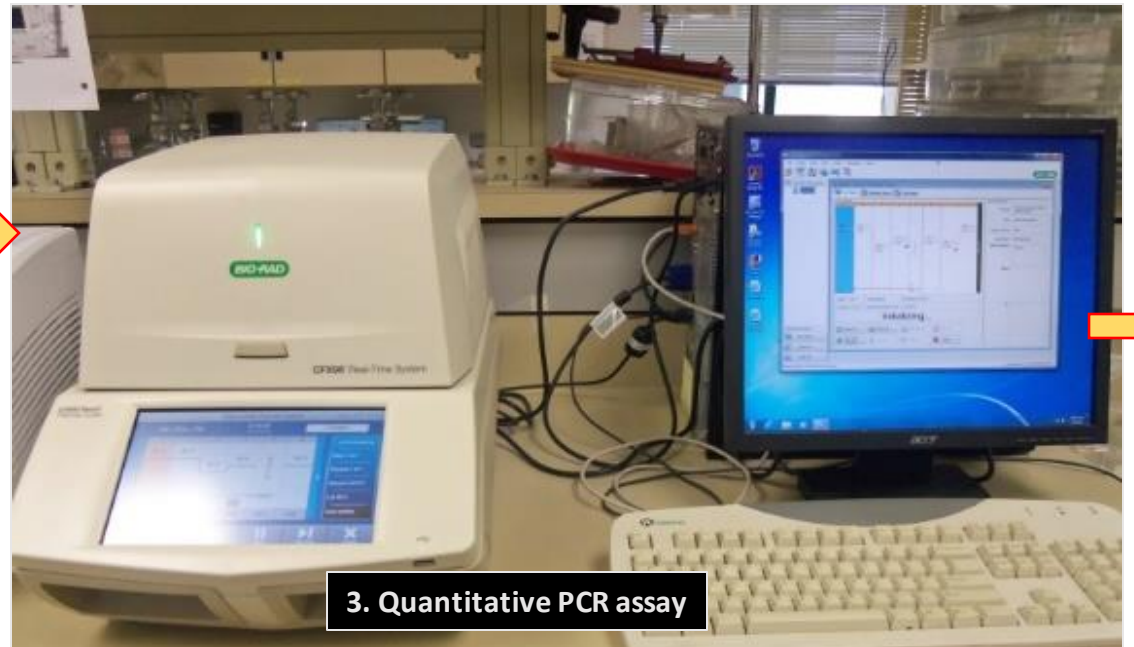
Hypotheses:

1. ~~Perhaps these trees were infected uniformly as soon as they were planted.~~

2. Or, the trees were delivered to the orchard bearing latent infections (not showing any disease symptoms).

We developed a method to <u>detect latent infections early</u> in tissues with no symptoms

*q*PCR, a molecular technique to quantify the DNA of canker pathogens

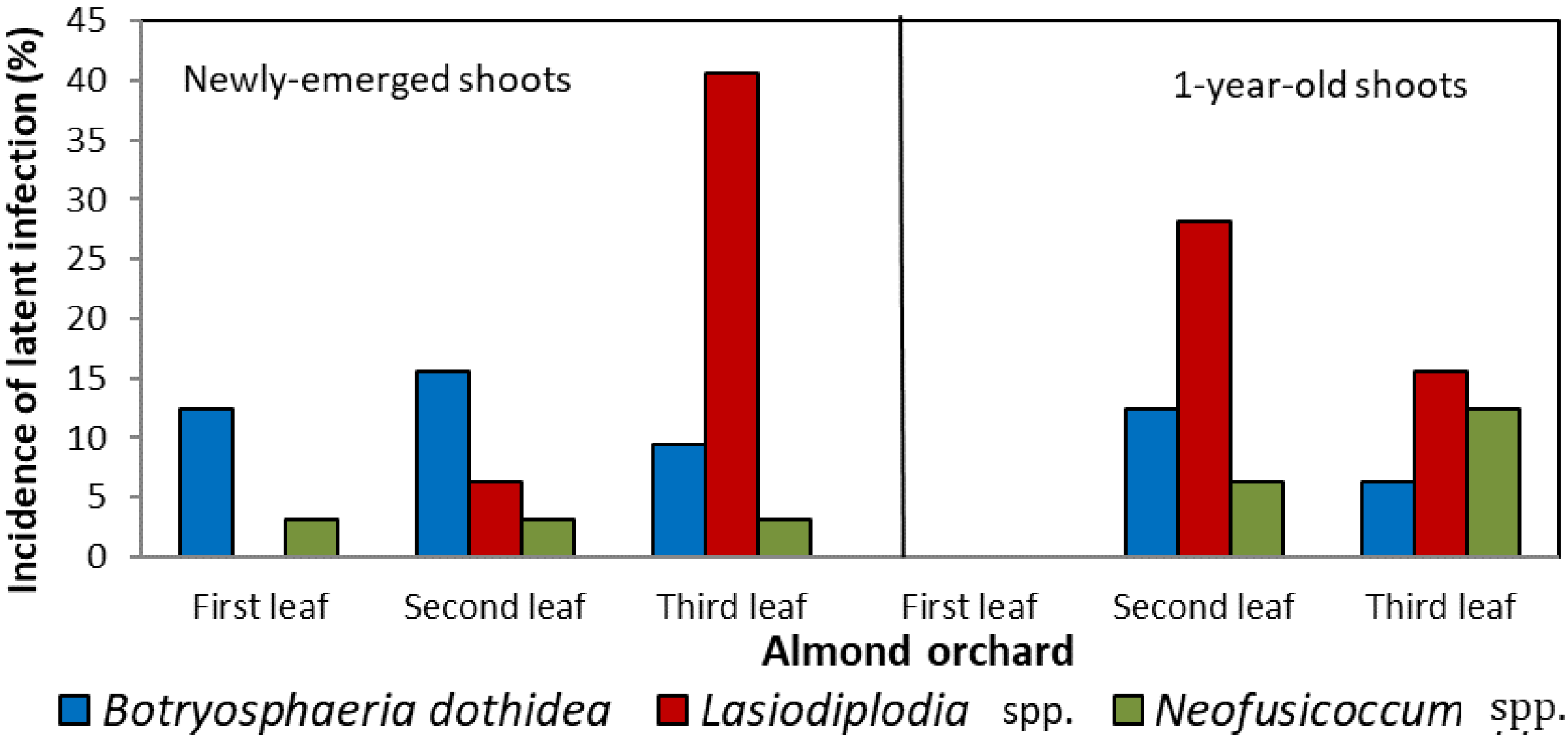


Sample	weight (g)	Dilution	Ct	calculation of fg		total fg	/weight	MS(a)
PAN4-1	0.32	60	36.47	2.194821	156.6105	4698.316	14682.24	4.17
PAN4-2	0.34	60	36.62	2.150466	141.4054	4242.162	12476.95	4.10
PAN4-3	0.33	60	N/A	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
PAN4-4	0.36	60	36.03	2.324929	211.3144	6339.431	17609.53	4.25
PAN4-5	0.29	60	36.62	2.150466	141.4054	4242.162	14628.15	4.17
PAN4-6	0.4	60	36.54	2.174122	149.3214	4479.641	11199.1	4.05
PAN4-7	0.32	60	35.65	2.437295	273.7127	8211.382	25660.57	4.41
PAN4-8	0.3	60	38.18	1.689174	48.88482	1466.545	4888.482	3.69
PAN4-9	0.34	60	38.29	1.656647	45.35728	1360.718	4002.113	
PAN4-10	0.36	60	39.03	1.437829	27.40495	822.1485	2283.746	3.36
PAN4-11	0.27	60	37.79	1.804497	63.75247	1912.574	7083.608	3.85
PAN4-12	0.31	60	36.88	2.073584	118.4633	3553.9	11464.19	4.06
PAN4-13	0.35	60	37.21	1.976003	94.62437	2838.731	8110.66	3.91
PAN4-14	0.38	60	37.68	1.837024	68.71064	2061.319	5424.524	3.73
PAN4-15	0.42	60	36.78	2.103154	126.8101	3804.304	9057.868	3.96
PAN4-16	0.39	60				4995.227	12808.28	4.11
PAN4-17	0.28	60				5763.048	20582.32	4.31
PAN4-18	0.37	60	38.28	1.659604	45.66716	1370.015	3702.743	3.57

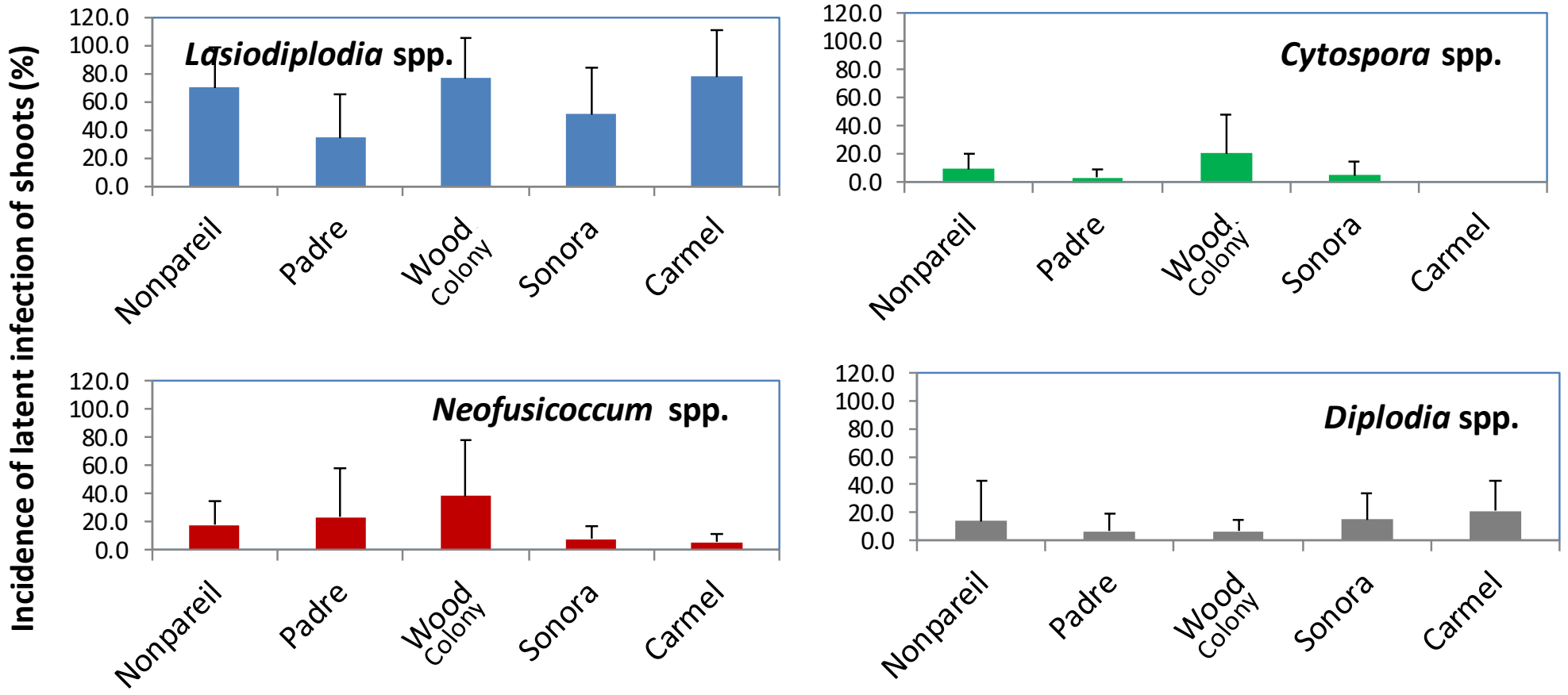
4. Data analysis

Results

Incidence of latent infection of canker pathogens in new and 1-year-old shoots from 3 almond orchards



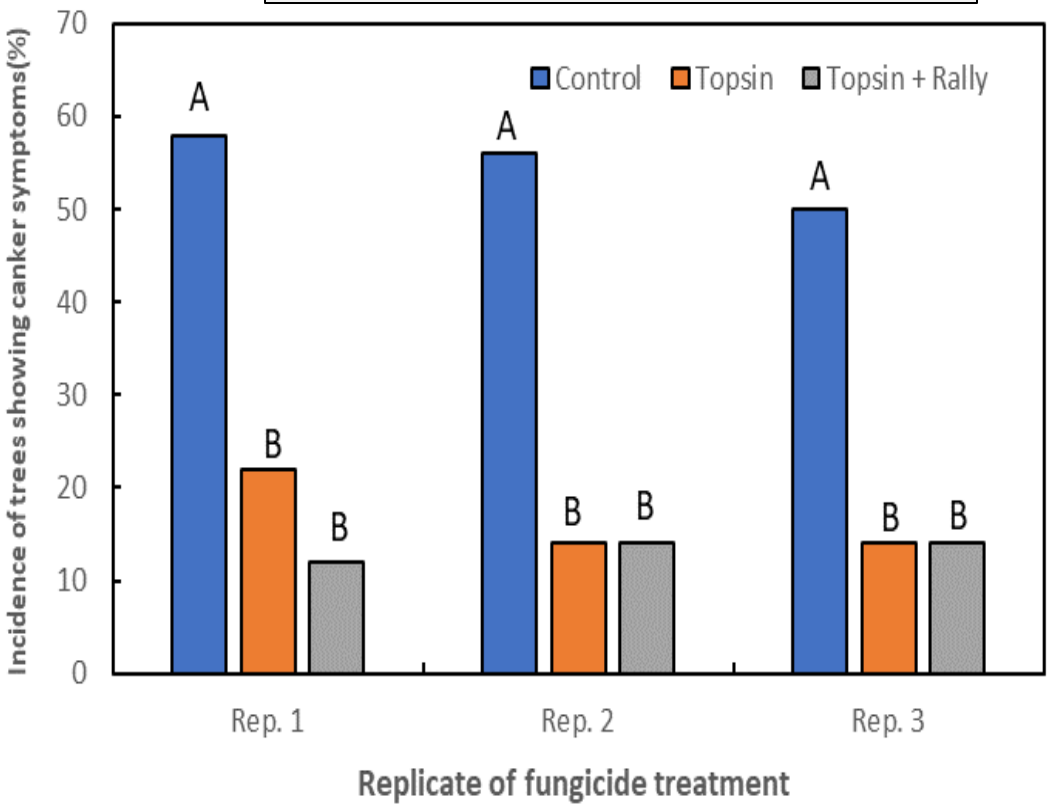
Incidence of latent infection by 4 canker pathogen groups from shoots of different almond varieties (nursery plants)



We started to focus on nurseries to investigate possible infections on young trees

Effects of Topsin-M applied in March 2019 in a 2nd - leaf orchard (before any symptoms of band canker were noticed)

8 months after treatment



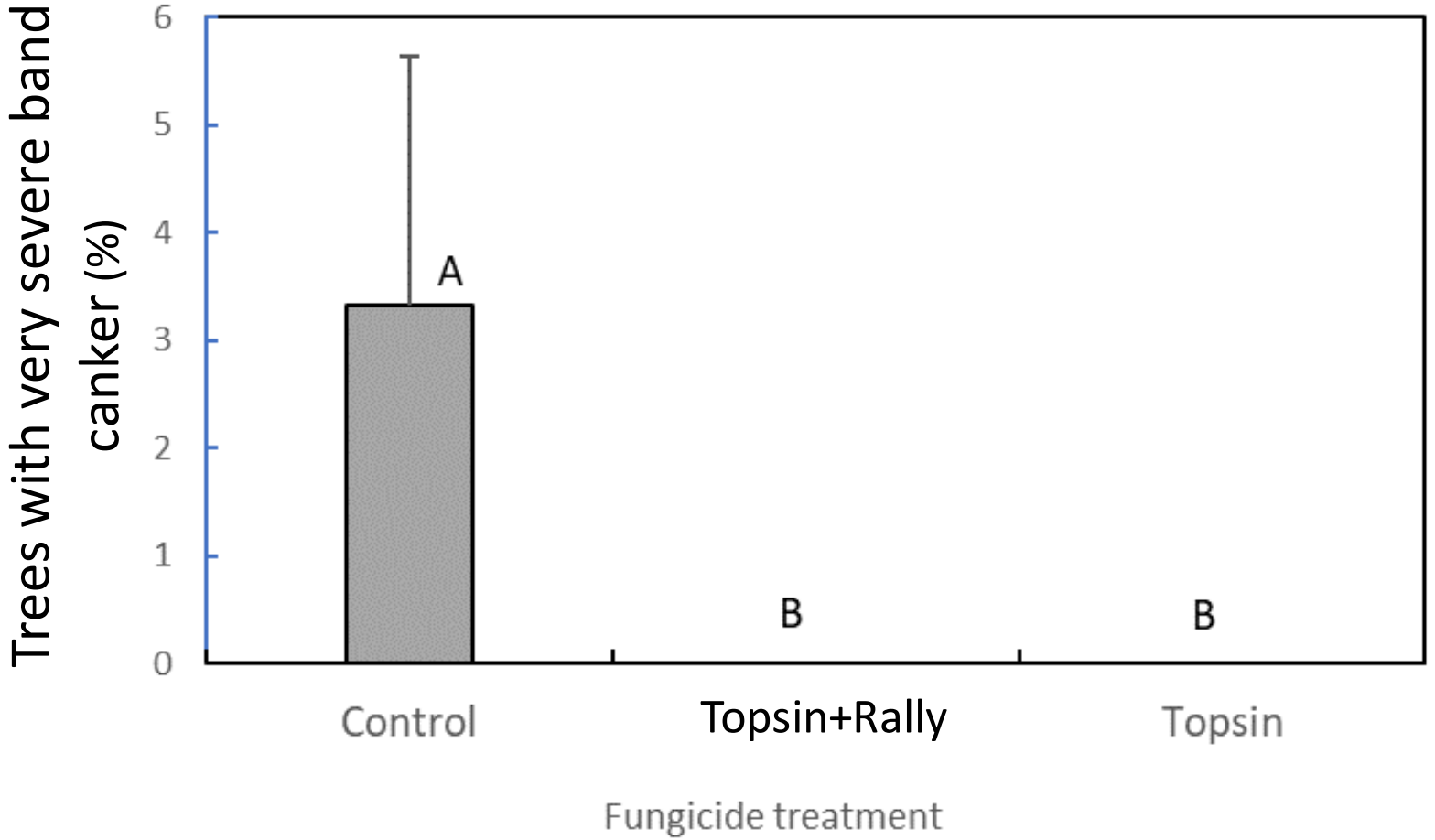
Topsin M WP 70 at 1.51 lb/acre; Rally at 8.0 oz/acre

Treatment: March 2019, Disease recording: Nov. 2019

(Each replication includes 50 trees)

The almond orchard treated in 2019 with fungicides in 4th - leaf now

33 months after treatment: October 2021



Effect of Topsin M spray(s) in reducing the incidence of band canker in a 3rd-leaf almond orchard in Yuba Co. (after symptoms of band canker were noticed)

Treatments:

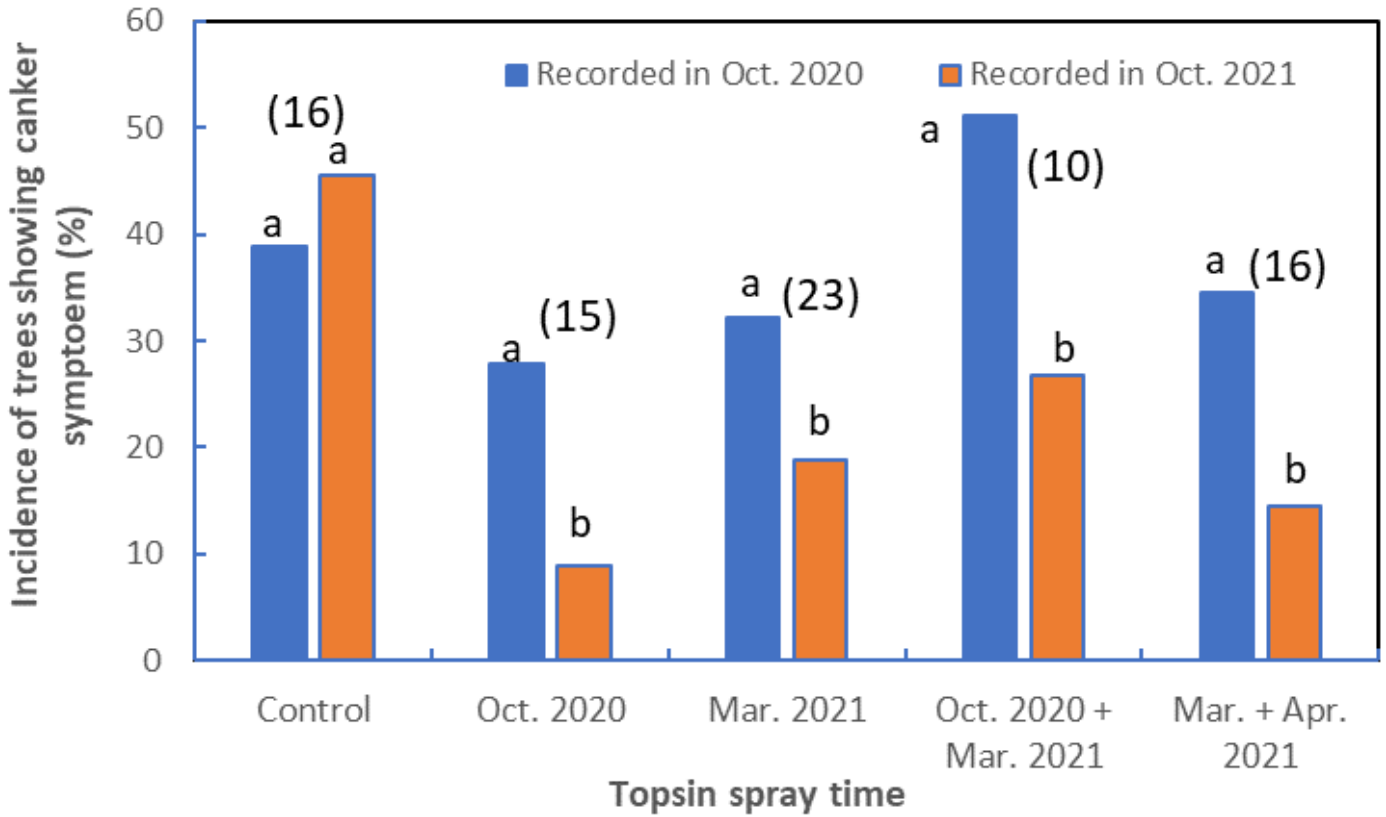
a) **Sprayed only in October 2020**

b) **Sprayed only in March 2021**

c) **Sprayed both in October 2020 & March 2021**

d) **Sprayed in March 2021 & in April 2021**

e) **Untreated control**



CONCLUSIONS:

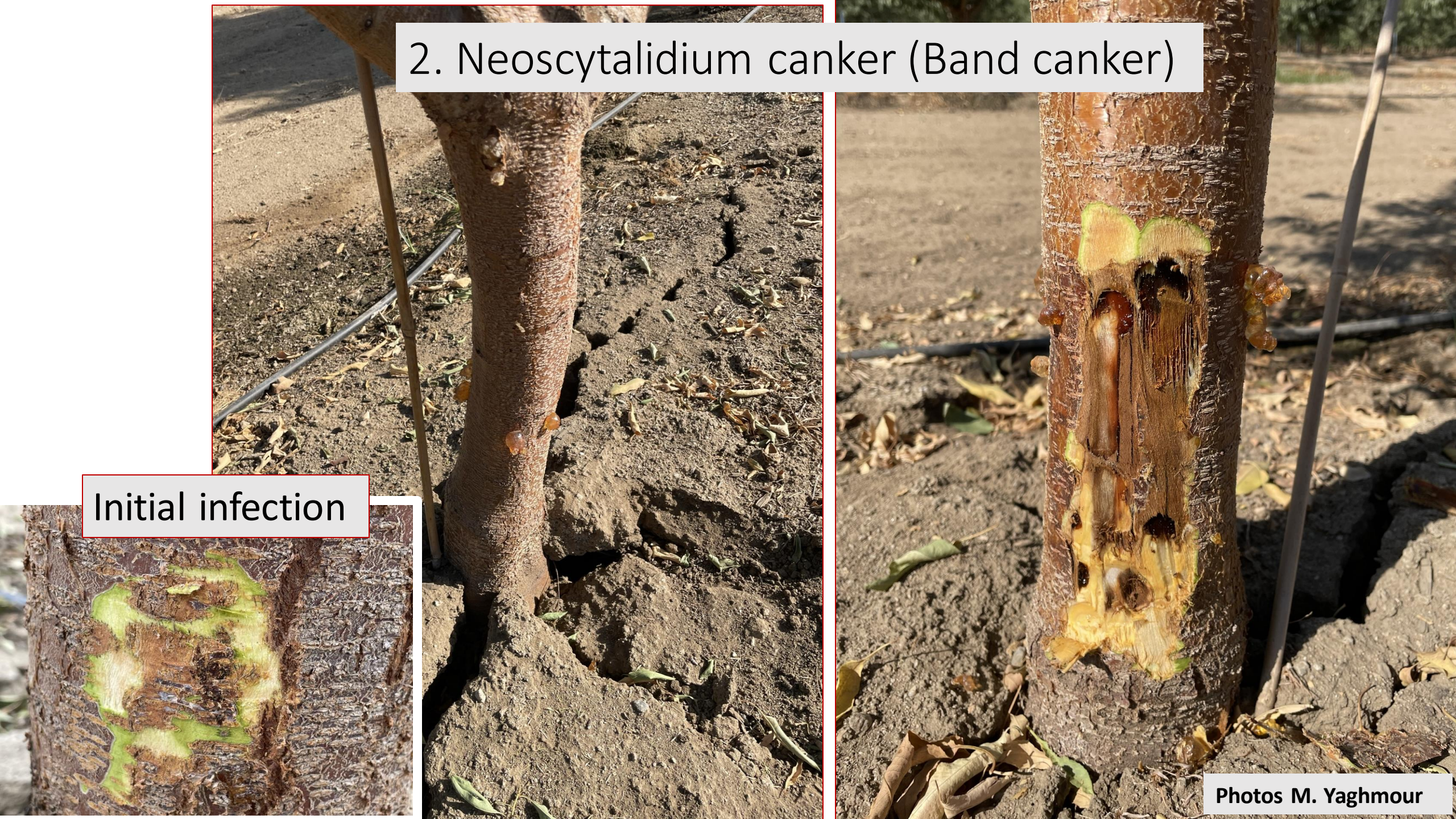
PREVENTATIVE APPROACH (YOUNG ORCHARDS):

- Obtain “clean” trees from nurseries.
- Spray the trunks in 1st,2nd, or 3rd leaf orchards with Topsin®-M at label rate.
- Keep the trunk of trees dry.
- Protect pruning wounds by spraying Topsin®-M at label rate.

WHEN BAND CANKER IS PRESENT (YOUNG ORCHARDS):

- Keep the trunk of trees dry.
- Spray trunk and scaffolds with Topsin®–M.
- Protect pruning wounds by spraying Topsin®-M at label rate.
- Remove killed trees and stumps (sanitation).
- Keep wood piles (spore inoculum) away from the orchard.

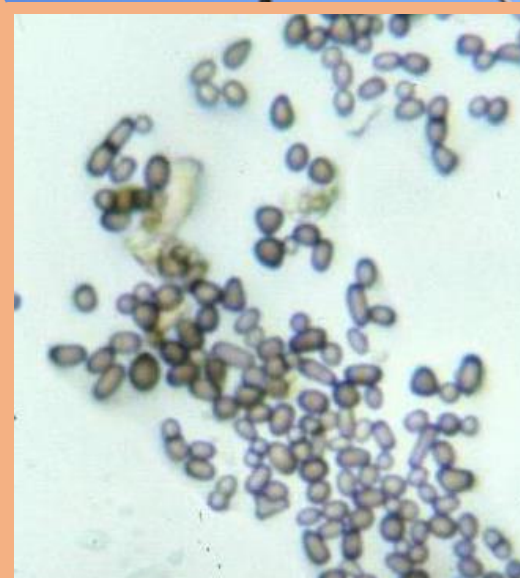
2. Neoscytalidium canker (Band canker)



Initial infection

Photos M. Yaghmour

Branch wilt of walnut



Hull rot

Rhizopus stolonifer

Aspergillus niger

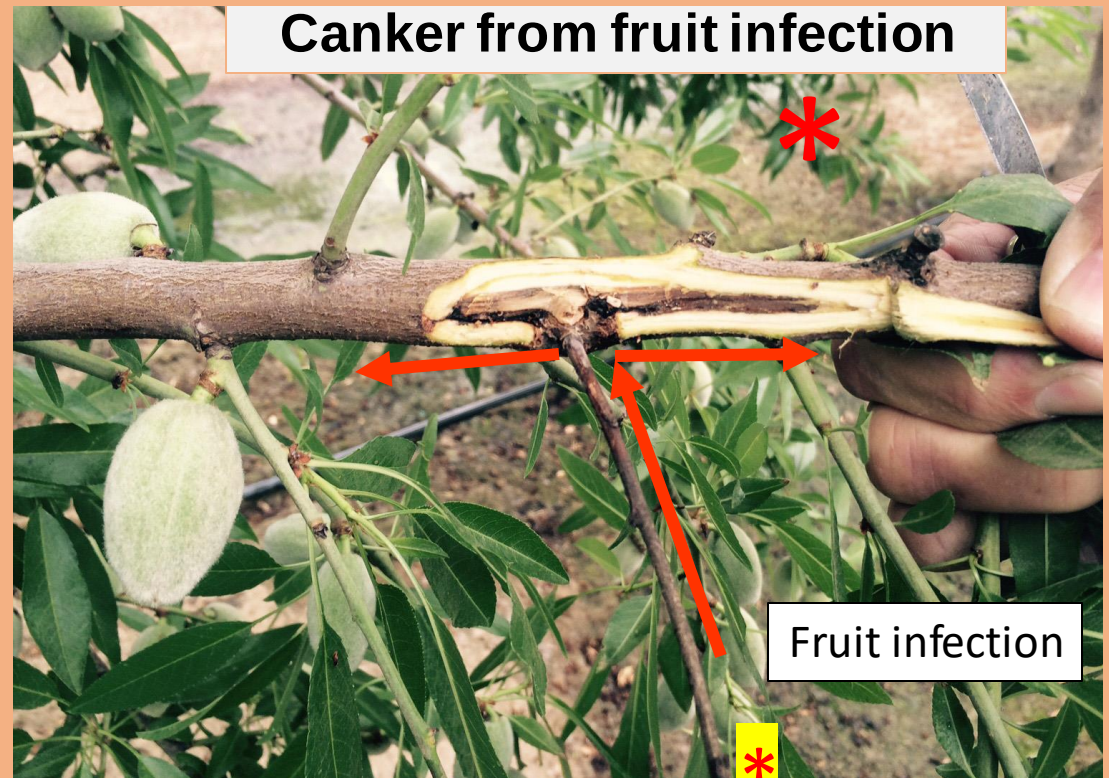
Symptoms and signs of a <u>new hull rot</u>

Blight from Neoscytalidium hull rot

Neoscytalidium canker

Neoscytalidium hull rot

Canker from fruit infection



Pruning wound protection trial (c/o Dr. Flo Troullias)

Products	*Cytospora sp.*	*Eutypa lata*	*C. fimbriata*	*B. dothidea*	*N. parvum*	*N. mediterraneum*	*** *Neosc. dimidiatum*	Avg. recovery
Control	25	75	50	50	100	50	50	57.1
Luna Experience	75	25	25	25	0	25	25	28.6
Merivon	50	25	25	0	25	50	50	32.1
Topsin M	0	0	0	0	0	0	0	0
Quash	25	50	0	0	25	50	50	28.6
Inspire Super	25	75	0	0	0	25	25	21.4
Quadris Top	100	0	0	0	0	0	100	28.6
Rally	50	25	0	0	25	0	50	21.4
thyme oil #1	100	100	0	75	50	75	50	64.2
thyme oil #2	75	25	0	50	100	75	100	60.7
neem oil	100	100	0	100	100	100	100	85.7
Avg. recovery	56.8	45.4	9.1	27.3	38.6	40.9	54.5	

Disease Management

- Avoid wounds on young trees (herbicide damage, sunburn, mechanical wounds) to reduce Neoscytalidium canker.
- Avoid practices in neighboring walnuts /figs /grapefruit to prevent inoculum load when almonds are at hull-split stage and thus reduce hull rot.
- Spray the fungicide Topsin M to prevent canker development.

3. Ceratocystis canker

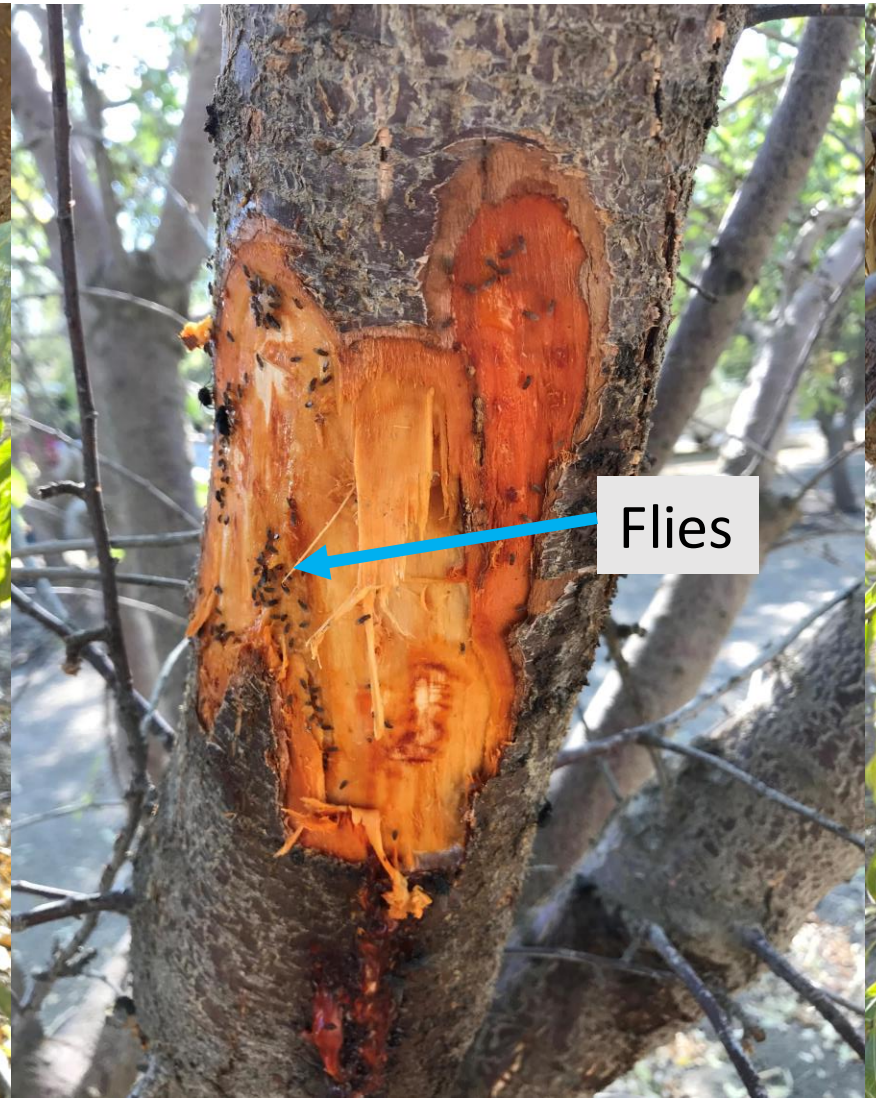
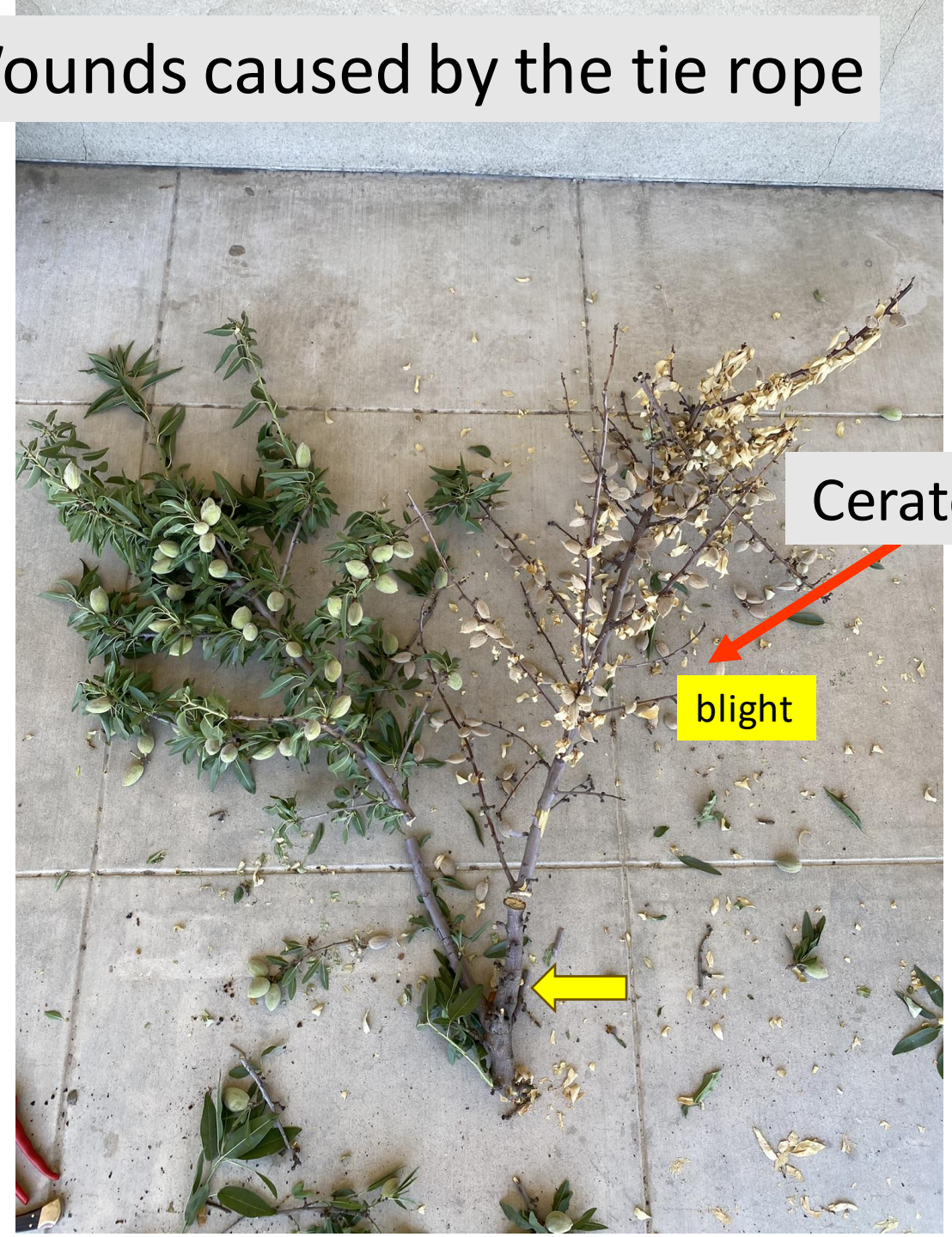


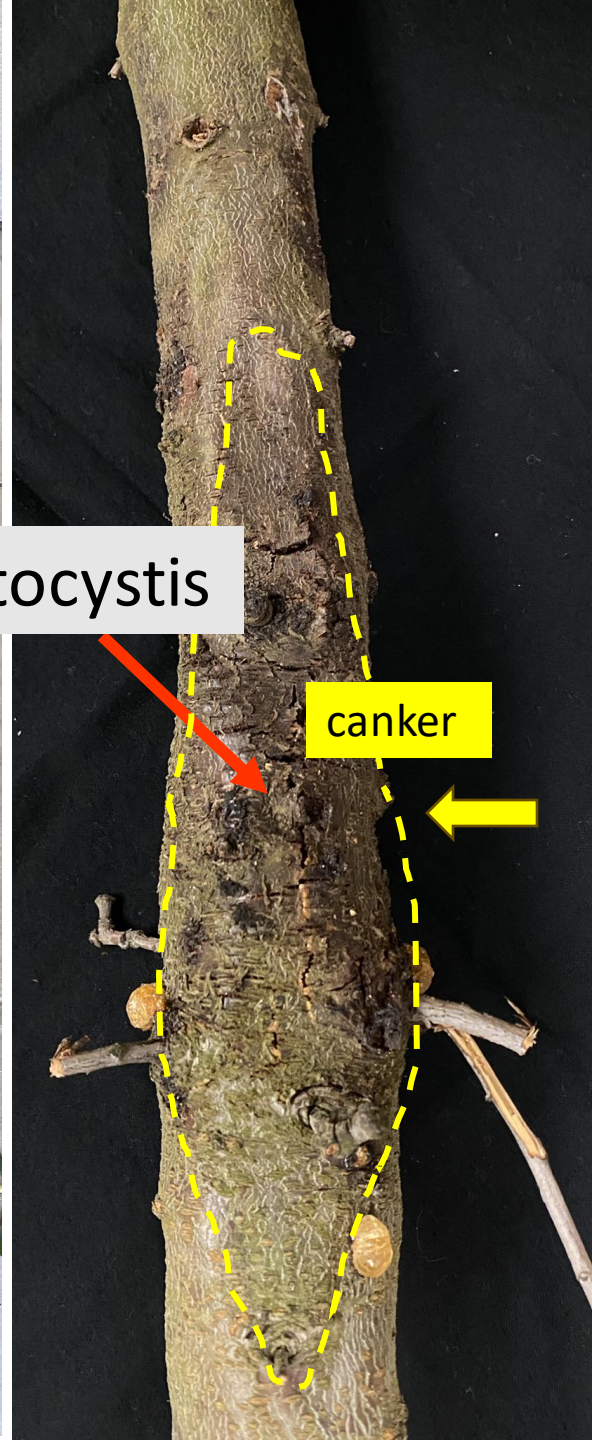
Photo Flo Trouillas

Photo M. Yaghmour

Wounds caused by the tie rope

Tree tie flat rope





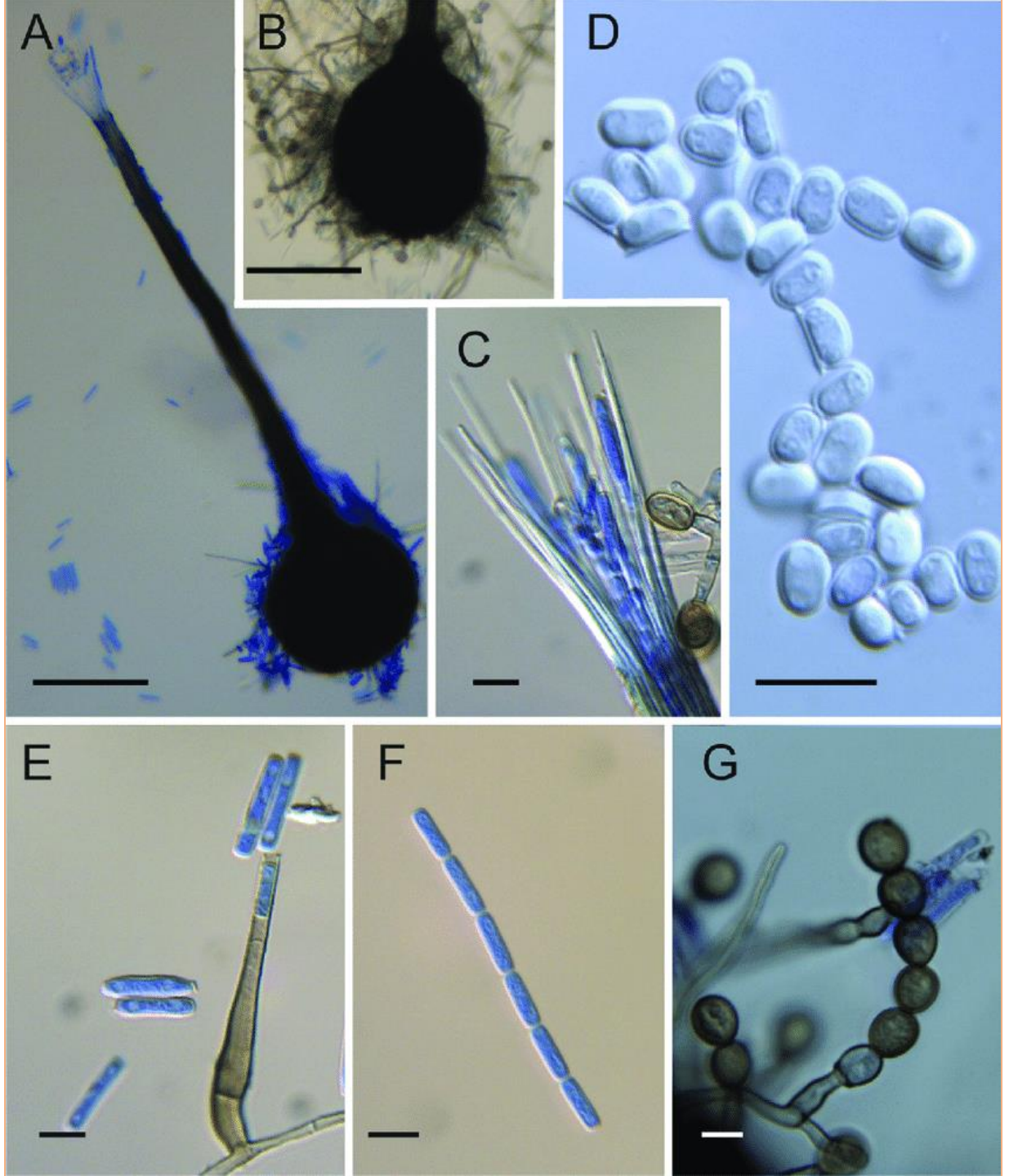
Ceratocystis canker

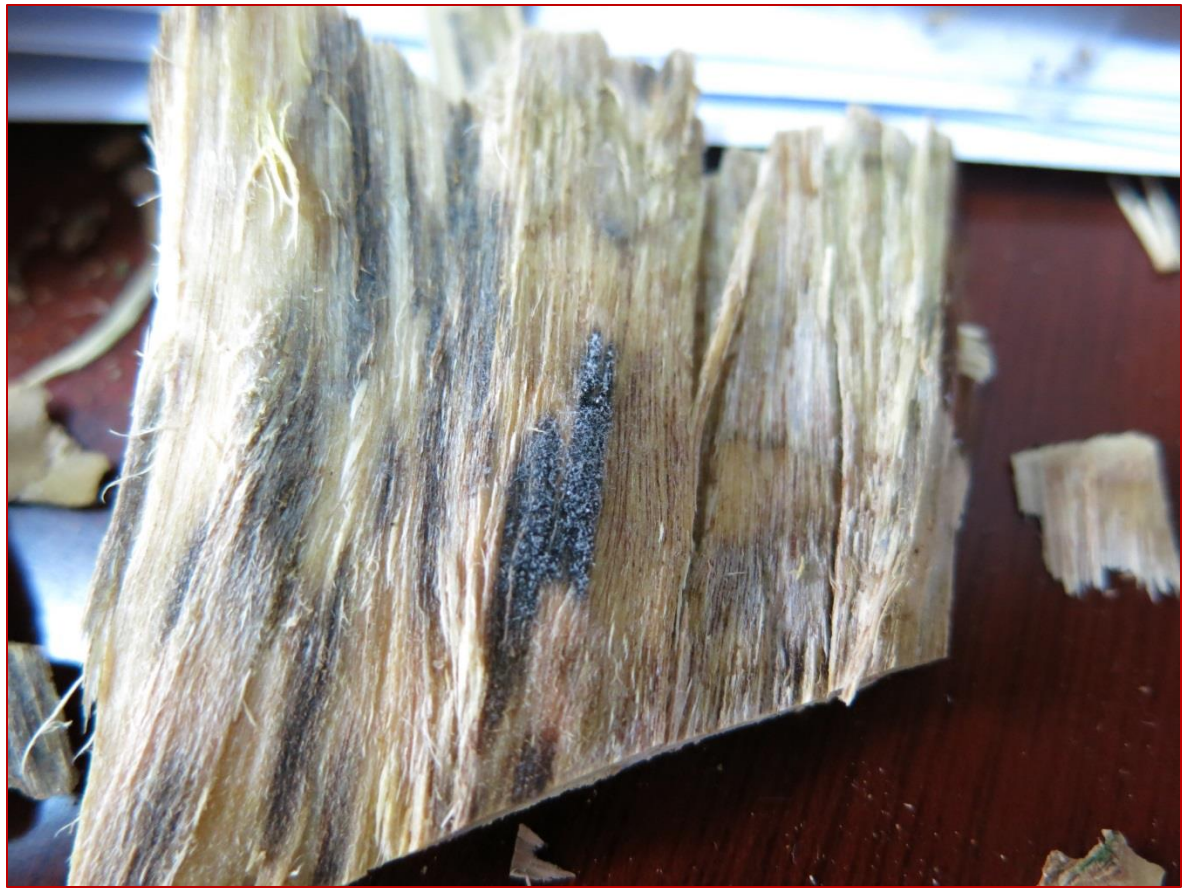
Caused by the fungus *Ceratocystis variospora* (Syn *Ceratocystis fimbriata*)

Infection courts:

- injuries from harvesters and other machinery
- Injuries from the tie rope
- insect damage

(Bark injuries and pruning wounds are susceptible for 14 days)





Perithecia are produced after infected wood chips enclosed in a plastic bag for **48** hours.

Management of Ceratocystis canker:

- Adjust shaker pads to avoid trunk injuries
- Do not irrigate within 2-3 weeks prior to harvest date
- Limit wounds on branches and scaffolds
- Use a flat tie rope to avoid injuries of branches
- Remove cankers by surgery in dry weather (in winter)

General measures for management of canker diseases:

Prevention and right spray & cultural practices:

- Protect young trees by spraying Topsin M.
- Prevent disease establishment in the early years.
- Protect pruning wounds by spraying Topsin M, or *Trichoderma*.
- Do not prune trees during rainy weather.
- Remove dead wood, stumps and dead trunks.
- Avoid wetting the trunk with sprinklers or micro-sprinklers.
- Remove cankered tissues (surgery).
- Avoid herbicide damage.
- Avoid water-stressing the trees.

Follow right tree training & scaffold selection, also do minimal pruning, if possible.

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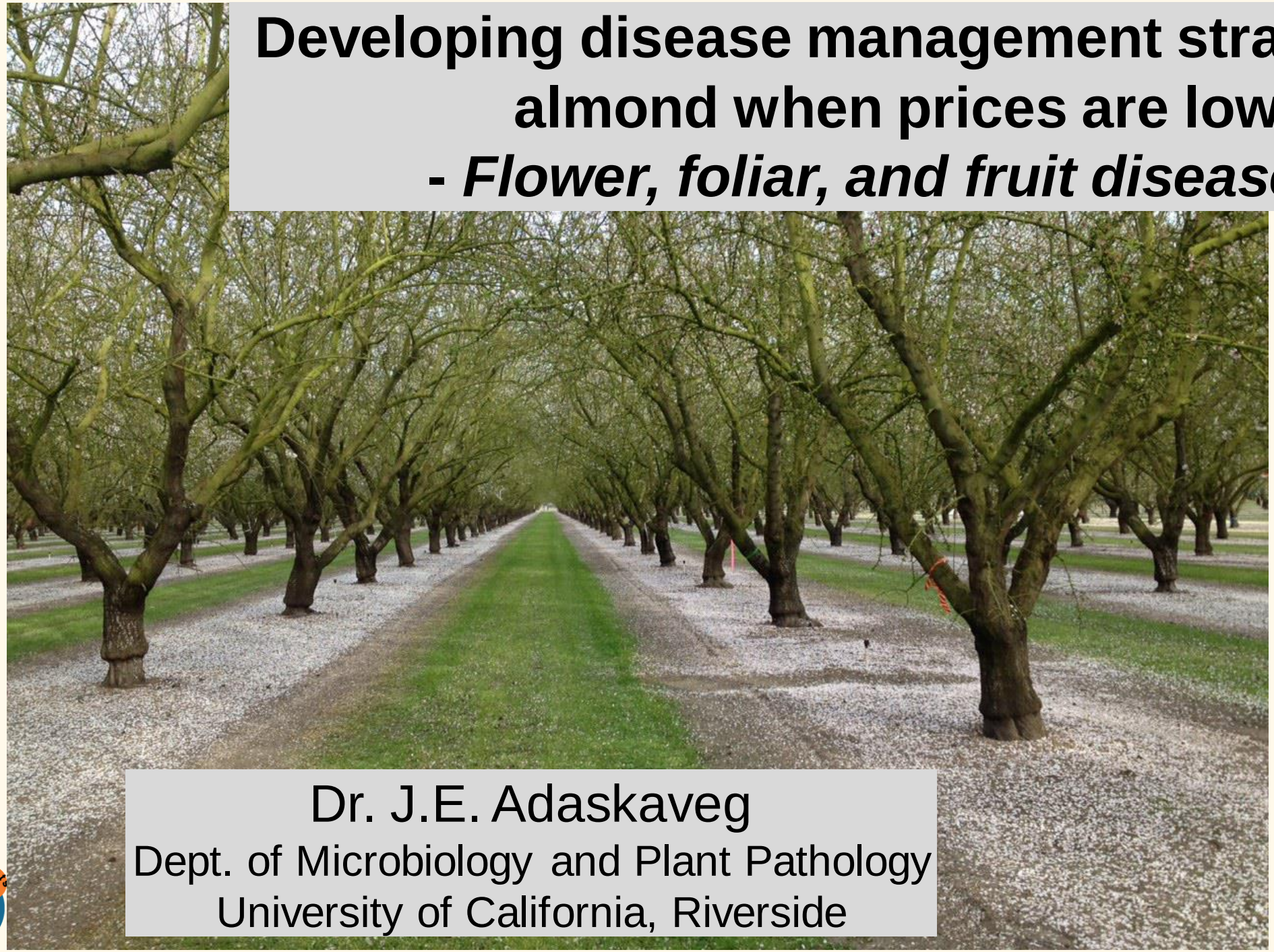
Developing a disease management strategies for almond when prices are low

Developing disease management strategies for almond when prices are low

- *Flower, foliar, and fruit diseases* -



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

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

Bacterial, Fungal, Oomycota, etc…..

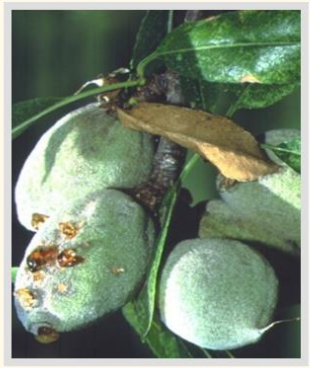

Brown rot blossom blight


Green fruit rot/Jacket rot


Shot hole


Bacterial spot


Bacterial blast


Anthracnose


Scab


Alternaria leaf spot

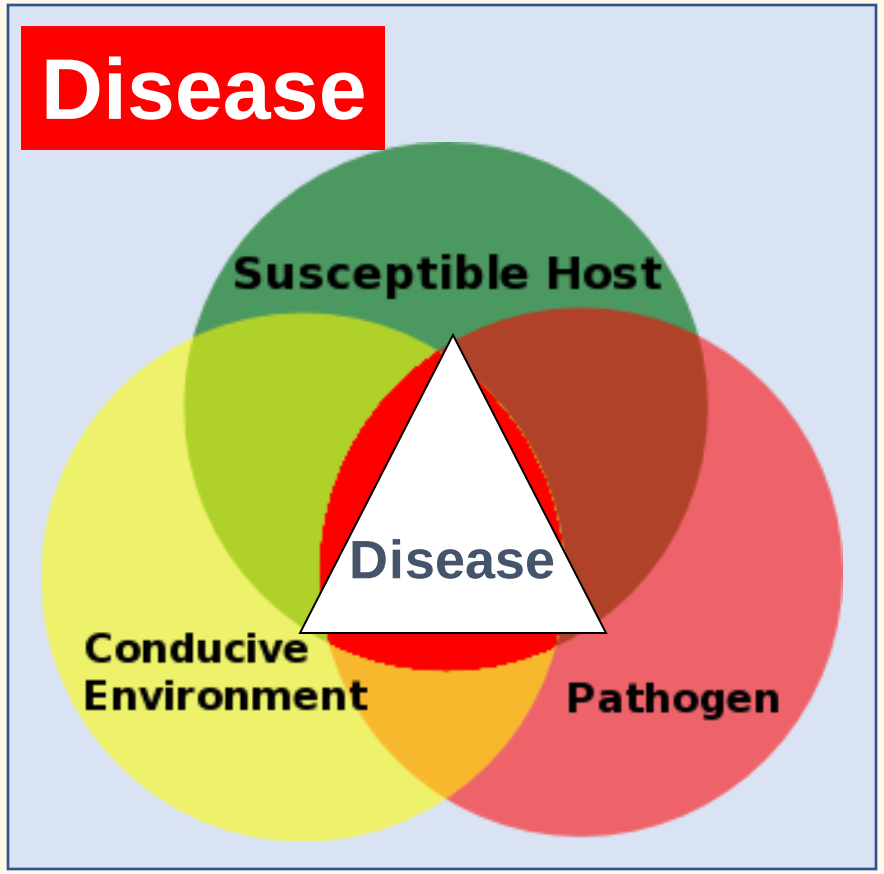

Rust

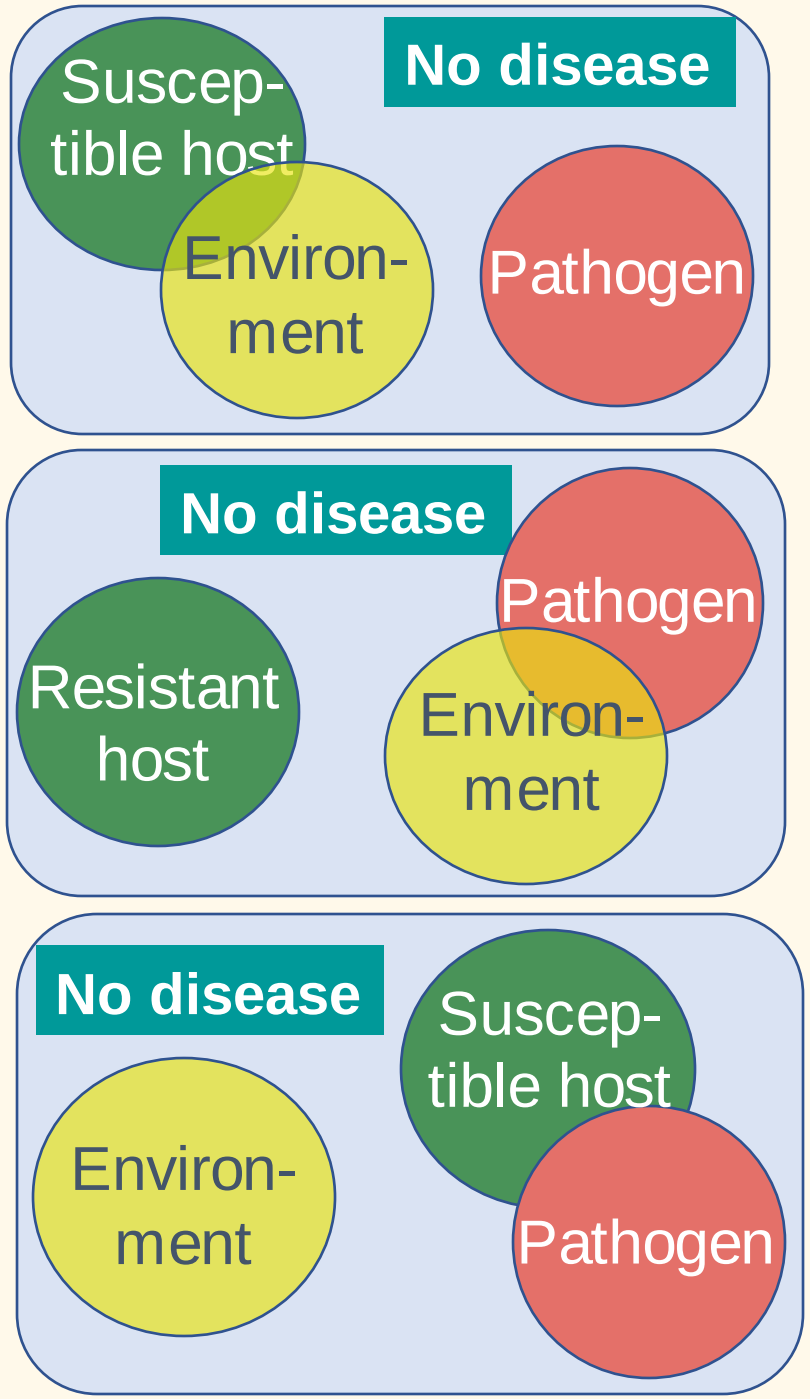

Hull rot


Phytophthora root and crown rot

- Although the almond crop can be affected by numerous diseases caused by fungi, fungal-like organisms and bacteria, climatic conditions of California generally limit severe disease outbreaks.
- Fungicide/bactericide applications have the potential to be minimized.

The foundation of Plant Pathology: *The Disease Triangle*





The impact of the components of the disease triangle can be modified:

- We can modify the **orchard environment** and **host susceptibility** to reduce disease pressure.
- We can monitor for the presence of the **pathogen** and look at disease history
- We can forecast **regional environments** and adjust management practices

Disease management

Orchard …..

Location:

- Low or high elevation
- Near riparian areas

Design:

- Number of trees per acre (density)
- Planting design (square, diamond)
- Irrigation system (drip, microsprinkler)
- Cultivar selection

Age:

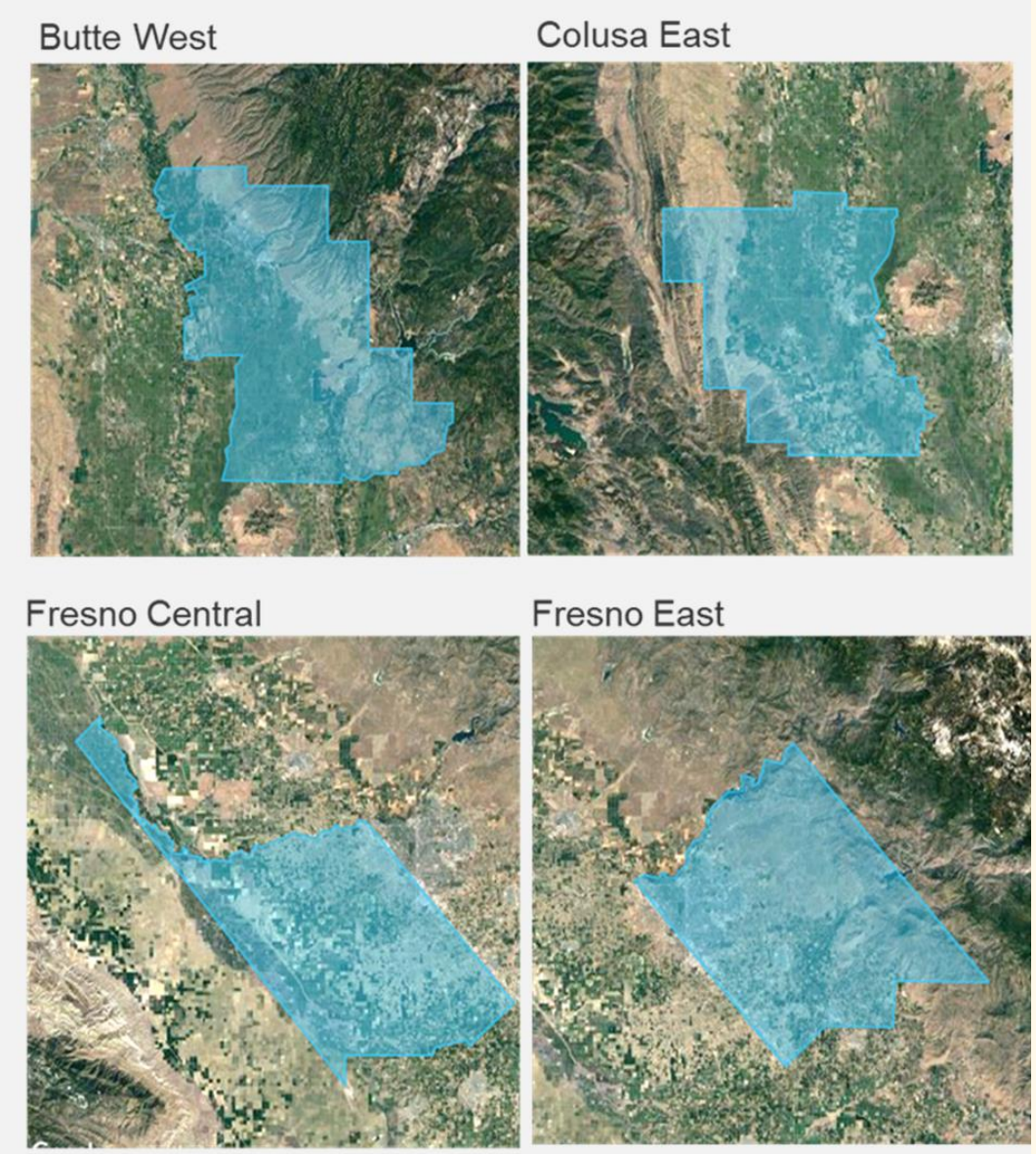
- New vs. established plantings

Disease risk:

- Historical records of diseases (by year)
- Presence of fungicide resistance
- Monitor for disease
- Use of disease forecasts

Almond Board of California and Semios Precision Agriculture

- Disease Forecasts in cooperation with the University of California -



california almonds

Why Almonds Almond Industry Tools & Resources

Regionalized Disease Forecasts – A pilot program

Disease risk forecasts for 5 counties based on regional in-orchard/near-orchard weather data and disease modeling. Powered by Semios(R) precision farming platform, the data is logged and then summarized by UC Riverside's Dr. Jim Adaskaveg.

See 7-day disease risk predictions for multiple diseases on the link below. Looking at the website allows growers to see up-to-date predicted disease risks. The combination of the disease prediction tool, along with the weekly interpretation by The University of California, will hopefully allow growers to make more nuanced disease management decisions. To view live conditions and modeling, visit the portal below and use **Almondboard2022** as the password.

Almond Board of California
<industry@almondboard.com>

Semios Precision Agriculture
<https://semios.com/>

Fungicide programs

Goals:

- **Minimize number of applications**
- **Use the most effective and least costly treatment –**
  - Conventional treatments – cost can be minimized by using generics
  - Biological treatments – cost generally more and are less persistent
- **Use effective, broad-spectrum MOAs** that target several diseases

- **Timing:**
  - Apply when infection risk is highest
  - Apply when several diseases can be targeted at once.
  - At bloom, a single application with a translaminar fungicide can replace two applications with a contact fungicide under moderately favorable conditions.

Orchard management is essential to disease management

Considerations for minimizing disease management input

Fungicide timing and choice of MOA

- **Apply when infection risk is highest**
- **Use the most effective and least costly treatment**
- **Use FRAC Codes that are effective against several diseases** – the best material with the broadest spectrum
- **Apply when several diseases can be targeted at once**
- **Consider presence of fungicide resistance**
- **Use generics to cut cost**

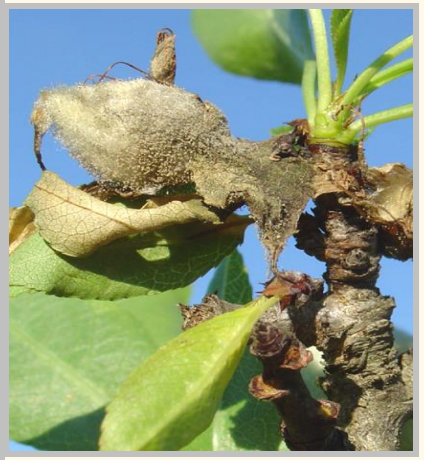
Other strategies

- **Orchard design** Tree density, irrigation, cultivar selection
- **Orchard history for disease, disease monitoring**
- **Use of disease forecasting systems**
- **Cultural practices** (modified deficit) irrigation

Connecting the Dots 2023

Springtime diseases of almond

Brown rot blossom blight



Green fruit rot/Jacket rot

Shot hole

Anthracnose

Bacterial spot

Bacterial blast

- The occurrence of these diseases is highly dependent on environmental conditions – rainfall and temperature.
- Under less favorable conditions, chemical disease management can be minimized.

Late spring and summer diseases of almond

Scab

Alternaria leaf spot

Rust

Hull rot

The occurrence of these diseases is highly dependent on microclimatic orchard conditions and cultural practices.

FUNGICIDES, BACTERICIDES, BIOCONTROLS, AND NATURAL PRODUCTS FOR DECIDUOUS TREE FRUIT AND NUT, CITRUS, STRAWBERRY, AND VINE CROPS IN CALIFORNIA 2022

ALMOND	GRAPE	PLUM
APPLE	KIWIFRUIT	POMEGRANATE
APRICOT	PEACH	PRUNE (DRIED PLUM)
CHERRY	NECTARINE	STRAWBERRY
CITRUS	PEAR	WALNUT
	PISTACHIO	

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Special thanks to Larry Bettiga, Farm Advisor, UCCE Monterey Co., for his review of grape fungicides and Gerald Holmes, Director of the Strawberry Center, CalPoly, for his review of strawberry fungicides

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UC Davis, Dept. of Plant Pathology
www.plpnem.ucdavis.edu

UC Kearney Agricultural Center
www.uckac.edu/plantpath

Statewide IPM Program
www.ipm.ucdavis.edu

Update planned in 2024

Timing of treatment applications for major fungal diseases

Disease	Dor-mant	Bloom			Spring		Summer	
		Pink bud	Full bloom	Petal fall	2 wks	5 wks	May	June/ July
Anthracnose	0	2	3	3	3	3	3	2
Shot hole	1	1	2	3	3	2	0	0
Brown rot	0	2	3	1	0	0	0	0
Green fruit rot	0	0	3	2	0	0	0	0
Scab	2	0	0	2	3	3	1	0
Alternaria	0	0	0	0	0	2	3	3
Rust	0	0	0	0	0	3	3	1
Hull rot	0	0	0	0	0	0	0	3
Disease pressure			4	4	3	5	3	3
Less favorable			▲		▲		▲	▲
More favorable		▲	▲	▲		▲	▲	▲

Timing

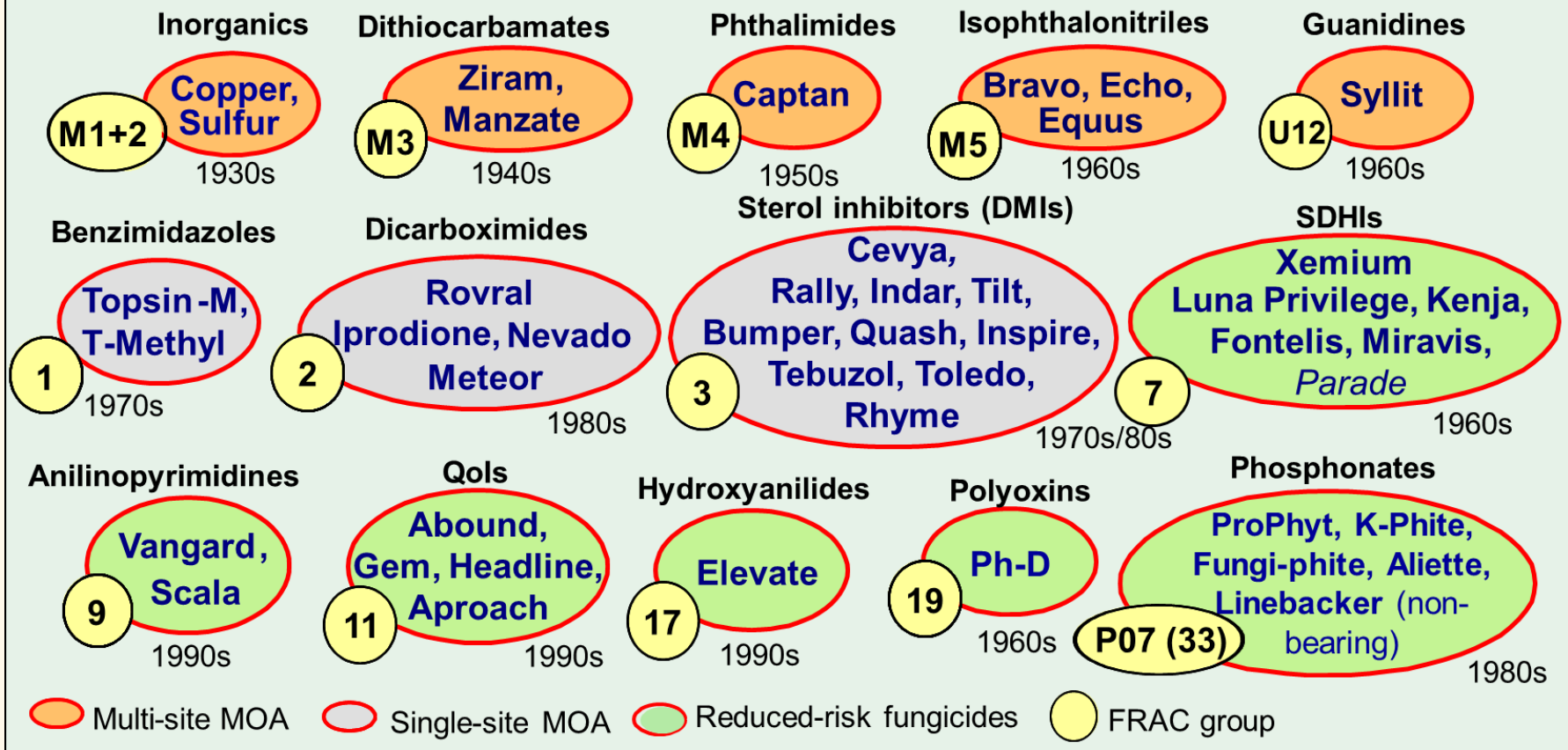
0	Ineffective
1	Least effective
2	Moderately effective
3	Most effective

Total:
4
6

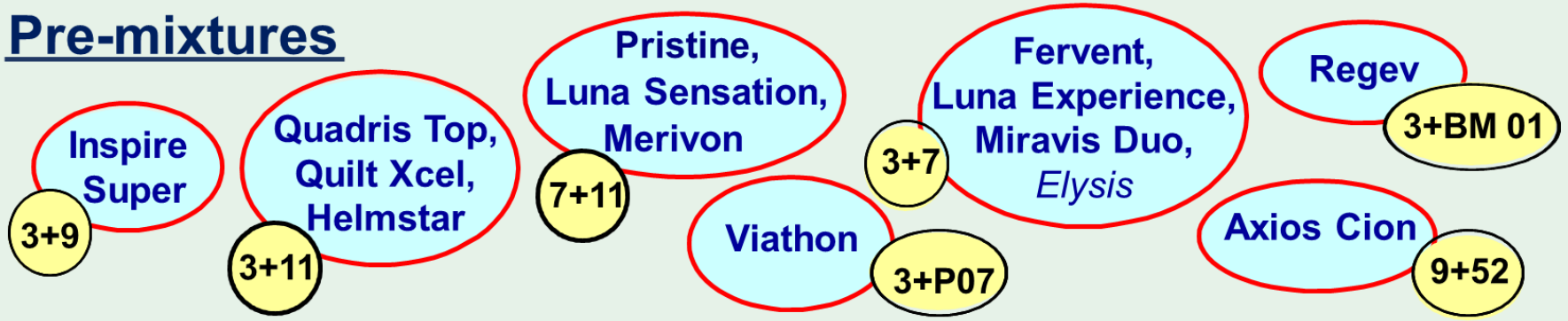
Critical timings where several diseases can be targeted with one application

Treatments for managing fungal diseases of almond

Inorganic and conventional synthetic fungicides



Pre-mixtures



Biological treatments

BM-01 – Natural products

Regalia, Oso (organic), **Ph-D** (exempt status), **ProBlad, EcoSwing, Dart,** others

BM-02 – Biological controls

Actinovate, **Botector, Serenade ASO, Serifel,** *CR-7*

Numerous new ones under evaluation

Disease	Dormant	Bloom			Spring		Summer	
		Pink bud	Full bloom	Petal fall	2 weeks	5 weeks	May	June/July
Anthracnose	----	3, 3/7, 3/9, 3/11, 3/33, 7	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11	3, 3/9, 3/7, 3/11, 3/33, 11, M3, M4, M5	3, 3/9, 3/11, 3/7, 3/33, 7, 7/11, 11, M3, M4, M5	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, M3, M4, M5	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, M4	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, M4
Shot hole	M1	2, 3, 3/7, 3/9, 3/11, 7, 9, 11	2, 3, 3/7, 3/9, 3/11,7, 7/11, 9, 11, 19	2, 3, 3/7, 3/9, 3/11,7, 7/11, 9, 11, 19, M5	7, 7/11, 11, 19, M3, M4, M5	7, 7/11, 11, 19, M3, M4, M5	----	----
Brown rot	----	1[2], 2 +oil, 3, 3/7, 3/9, 3/11, 3/33, 9	1[2], 2 +oil, 3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 9, 11, 19	1[2], 2 +oil, 3/11, 3/33, 7, 7/11, 9, 19	----	----	----	----
Jacket rot, green fruit rot	----	----	1[2], 2 +oil, 3/7, 3/9, 3/11, 7, 7/11, 9, 19	1[2], 2 +oil, 3/7, 3/9, 3/11, 7, 7/11, 9, 19	----	----	----	----
Scab	M1+oil, M2, M5+oil	----	----	1[2], 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, M3, M4, M5	1[2], 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, M3, M4, M5	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, M2, M3, M4	M2[3], M4	----
Alternaria	----	----	----	----	----	2	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, 19	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, 19
Rust	----	----	----	----	----	3, 3/7, 3/11, 3/33 [1], 7, 7/11, 11, 19, M3	3, 3/7, 3/11, 3/33, 7, 7/11, 11, 19	3, 3/7, 3/11, 3/33, 7, 7/11, 11, 19
Hull rot	----	----	----	----	----	----	3, 3/7, 3/9, 3/11, 7/11, 11, 19	3, 3/7, 3/9, 3/11, 7, 7/11, 11, 19
Dis. management by FRAC Code		3	9	M5	M3	3+11 or 7+11		3+7

Multiple FRAC Codes are available for each of the diseases

Identify FRAC Codes that are effective against multiple diseases at each timing

Code	FRAC
3	DMI
7	SDHI
9	AP
11	QoI
M3	EBDC
M5	IPN

Estimation of treatment costs using less costly conventional fungicides

Disease	Timing	Product	FRAC code	Rate/A	Approximate cost/A (+10%)	Low Disease	High Disease
BR	Pink bud	Tilt, Tebustar	3	8 oz	$5		X
BR	Full bloom	Vangard, Scala	9	5 oz	$19	X	X
BR/GM/SH	Petal fall	Bravo, Equus	M5	4 pts	$16		X
GM/SH	2 wk after PF	Manzate	M3	5 lb	$19	X	
Scab/Rust	5 wk after PF	Tilt/Tebustar+ Abound/Acadia	3+11	8 oz + 12.5 fl oz	$5 + $11=$16		X
ALS	Spring (May)	Fontelis+ Abound/Acadia	7+11	8 oz + 12.5 fl oz	$30 + $11=$41	X	X
ALS	Summer (June)	Tilt/Tebustar+ Fontelis/Sercadis	3+7	8 oz + 20 fl oz	$35	(X)	
HR	Hull split	Cinetis/MarVerde	Fert.	16-32/32-64 fl oz	$14	X	X
* Cost estimates for materials only.					**Total**	**$93**	**$130**

Resistance management with rotations of FRAC Codes.

Multiple organic products are available for each of the diseases with various efficacy ratings

Disease	Dormant	Bloom			Spring		Summer	
		Pink bud	Full bloom	Petal fall	2 weeks	5 weeks	May	June/July
Anthracnose	----	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer
Shot hole	M1 + BM 01 (oil)	M1+BM 01 (oil)	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	----	----
Brown rot	----	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	----	----	----	----
Jacket rot, green fruit rot	----	----	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	----	----	----	----
Scab	M1 + BM 01 (oil), M2	----	----	BM 01, BM 02, P 05, NC	BM 01, BM 02, P 05, NC	BM 01, BM 02, P 05, NC	BM 01, BM 02, P 05, NC	----
Alternaria	----	----	----	----	----	BM 01, BM 02, oxidizer	BM 01, BM 02, oxidizer	BM 01, BM 02, oxidizer
Rust	----	----	----	----	----	BM 01, BM 02, P 05, M2	BM 01, BM 02, P 05, M2	BM 01, BM 02, P 05, M2
Hull rot	----	----	----	----	----	----	----	BM 01, BM 02
Disease management by product/FRAC Code	M2	Botector/ Problad	Oso	Botector/ Problad	Oso	M2	EcoSwing	Acadia

Estimation of treatment costs using OMRI-approved fungicides

Disease	Timing	Product	FRAC code	Rate/A	Approximate cost/A	Low Disease	High Disease
BR	Pink bud	Botector/Problad	BM-01, -02	20 oz to 40 fl oz	$59-$125		X
BR	Full bloom	Oso	19	13 fl oz	$38	X	X
BR/GM/SH	Petal fall	Serenade ASO	BM-02	96 fl oz	$35		X
GM/SH	2 wk after PF	Oso	19	13 fl oz	$38	X	
Scab/Rust	5 wk after PF	Sulfur	M2	8 oz + 12.5 fl oz	$5		X
ALS	Spring (May)	EcoSwing	BM-01	8 oz + 12.5 fl oz	$41	X	X
ALS	Summer (June)	EcoSwing	BM-01	8 oz + 20 fl oz	$41	(X)	
HR	Hull split	Acadian	BM-01	12.5 fl oz	$20	X	X
					Total	**$135**	**$198**

Summary

- An increasing arsenal of fungicides is being introduced with different modes of action (FRAC codes), spectrum of activity, and efficacy. Best timings are based on monitoring and environmental conditions.
- Generic compounds can lower the cost with 4-6 timings for the season.
- Low-cost disease management using organic treatments is difficult.
- Selecting the best materials with the broadest spectrum and timing the application at a critical stage can lower costs.
  - Multiple diseases with one application
  - Timeline and cost based on disease pressure:
    A) Conventional: ca. $100-$130/A for products
    B) Organic: ca. $135-$198/A for products

Pink bud-Full bloom	Petal fall (March)	5-wk after PF (April)	Spring (May)	Late spring (June-July)	Hull split
BR, GM	BR, GM, SH, Scab, Anthracnose	Rust, Scab	Scab, Alternaria	Alternaria	Hull rot
3, 9	M5	M3	3+11	7+11	Fert. (low N, high K+P)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Almond Board of California
Thank you