



Botryosphaeria, Phomopsis and Anthracnose Management in Walnuts

Themis J. Michailides

Yong Luo¹, Dan Felts¹, Dani Lightle², Roger Duncan³, & Joseph Connell⁴

¹ Dept. of Plant Pathology, University of California Davis/ Kearney Agricultural Research & Extension Center;
UC Cooperative Extension, ² Glenn & Butte Counties, Orland; ³Stanislaus County, Modesto

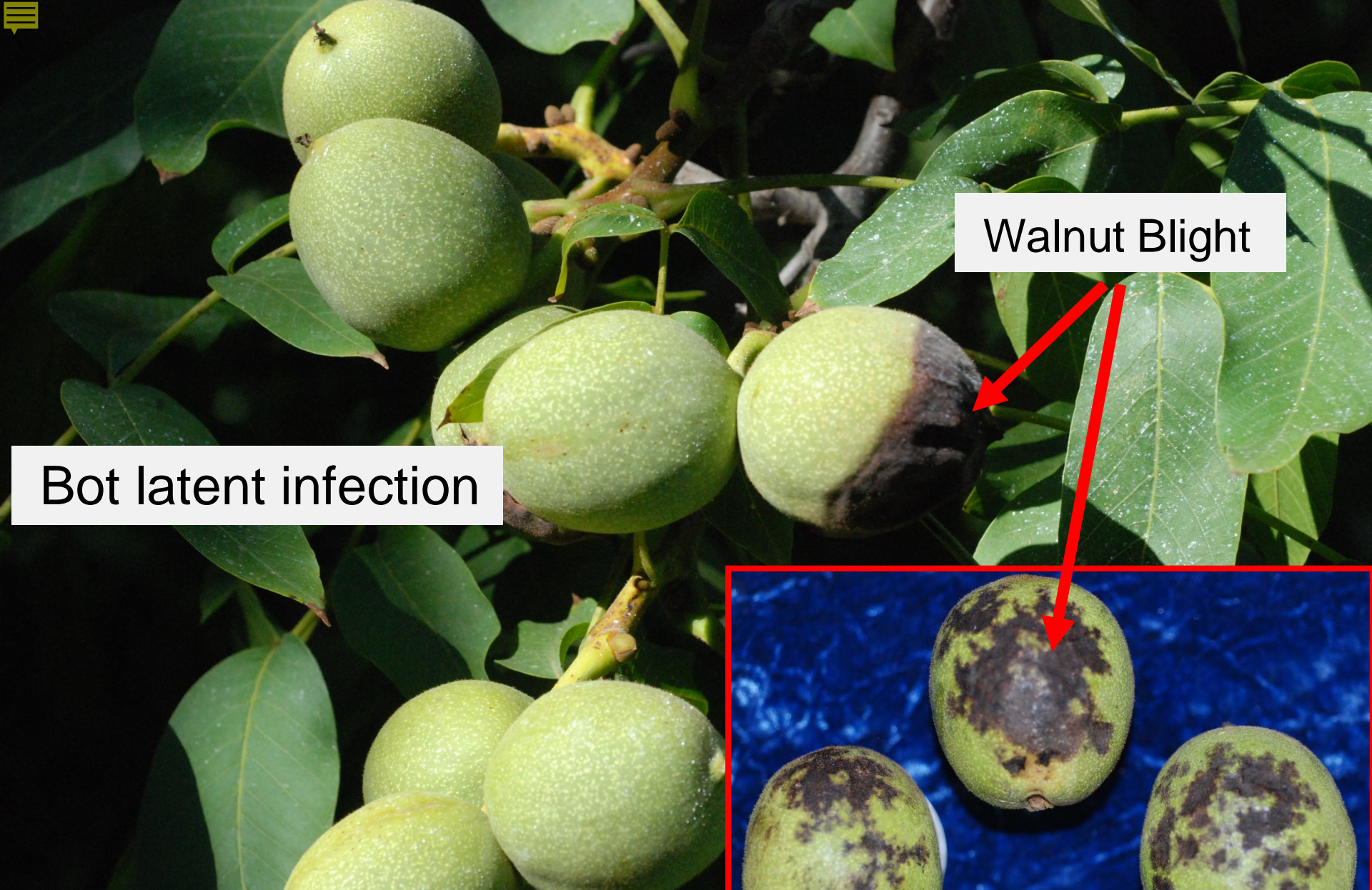
⁴ Butte County, Oroville.

49th Quad-County Walnut Institute, 5 Feb 2019



Bot and Phomopsis canker and blight of walnut:

- Infection of walnut fruit & killing of spurs
- Development of blight and canker
- The causes of the disease
- Contributing factors
- Best disease management



Bot latent infection

Walnut Blight





1

--- **Disease Progress** ---
Infection of intact fruit in the orchard

All the species of *Botryosphaeria* and *Phomopsis*



2

Fruit

Fruit

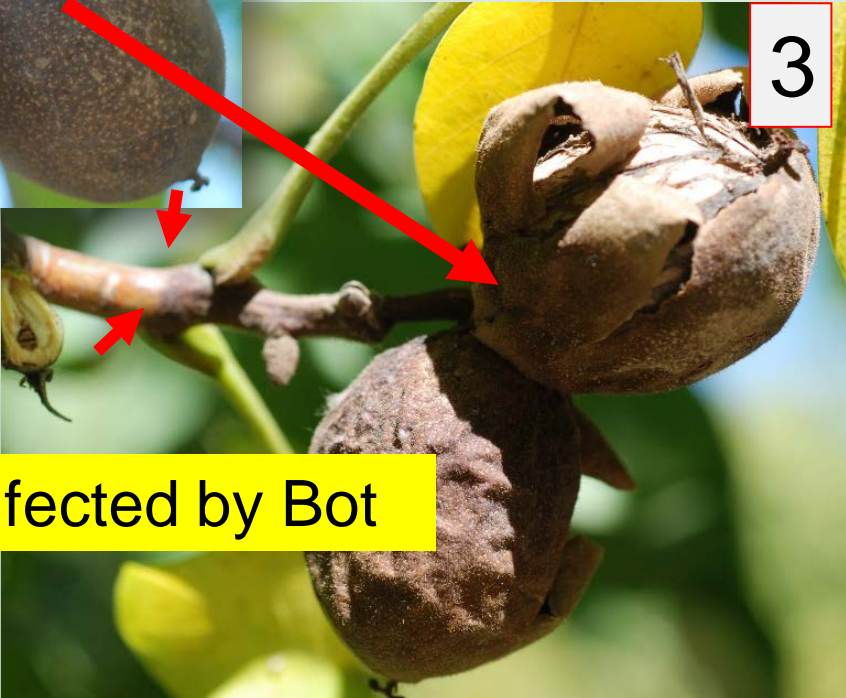


Peduncle



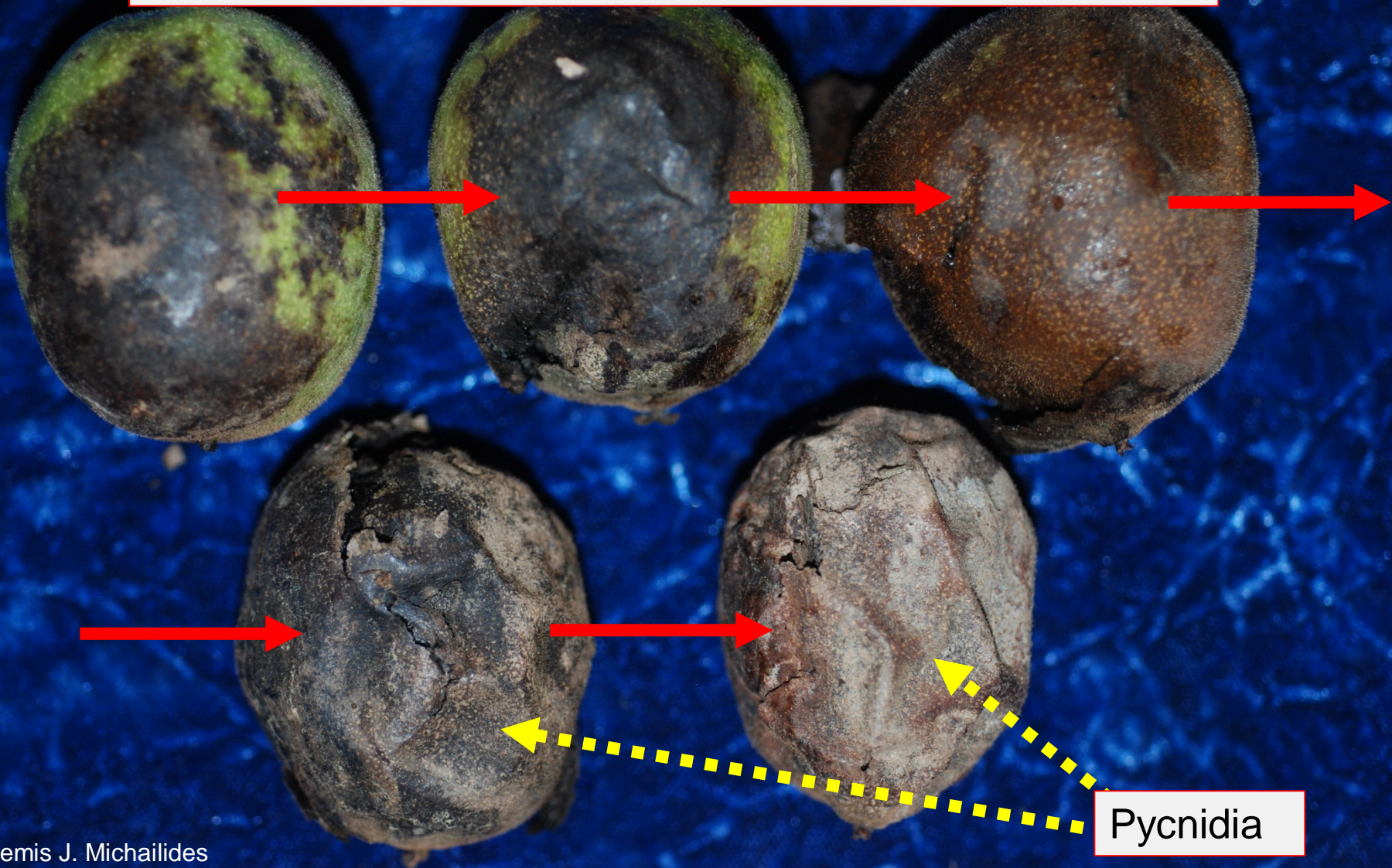
Infect Spurs/shoots

Walnut leaves are not infected by Bot



3

Progress of infection by *Botryosphaeria* in the orchard



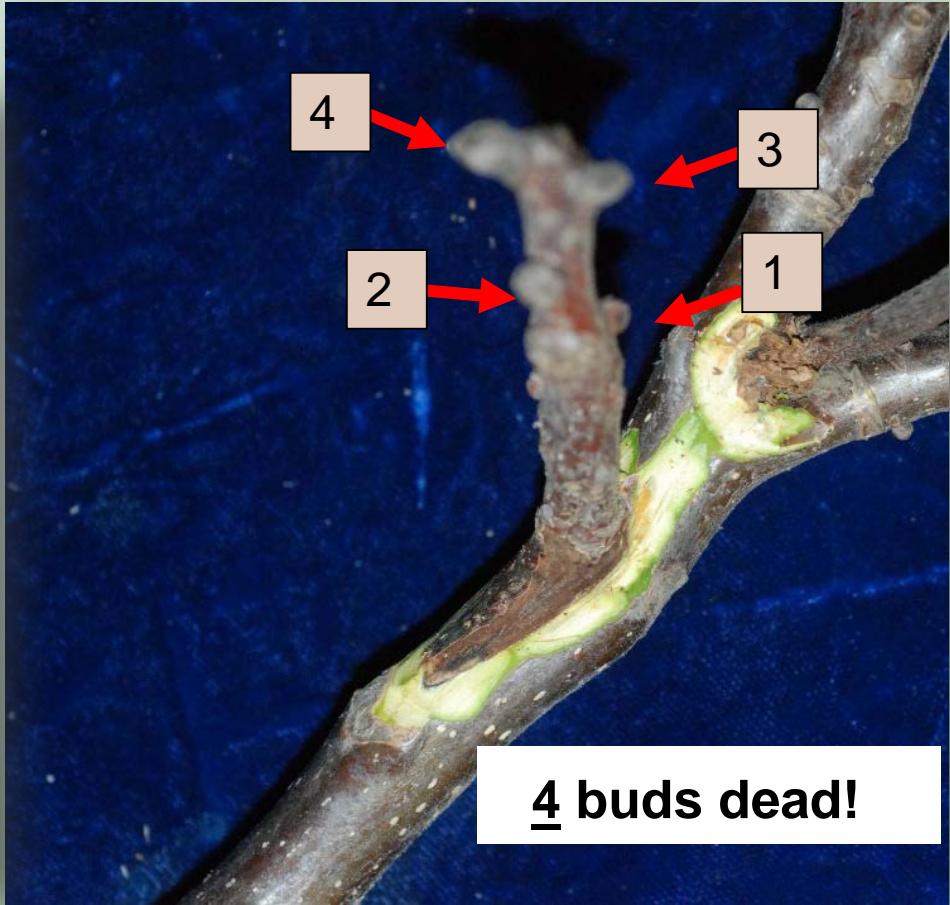
Symptoms in the orchard...

Blighted nuts (late August, September, & October)

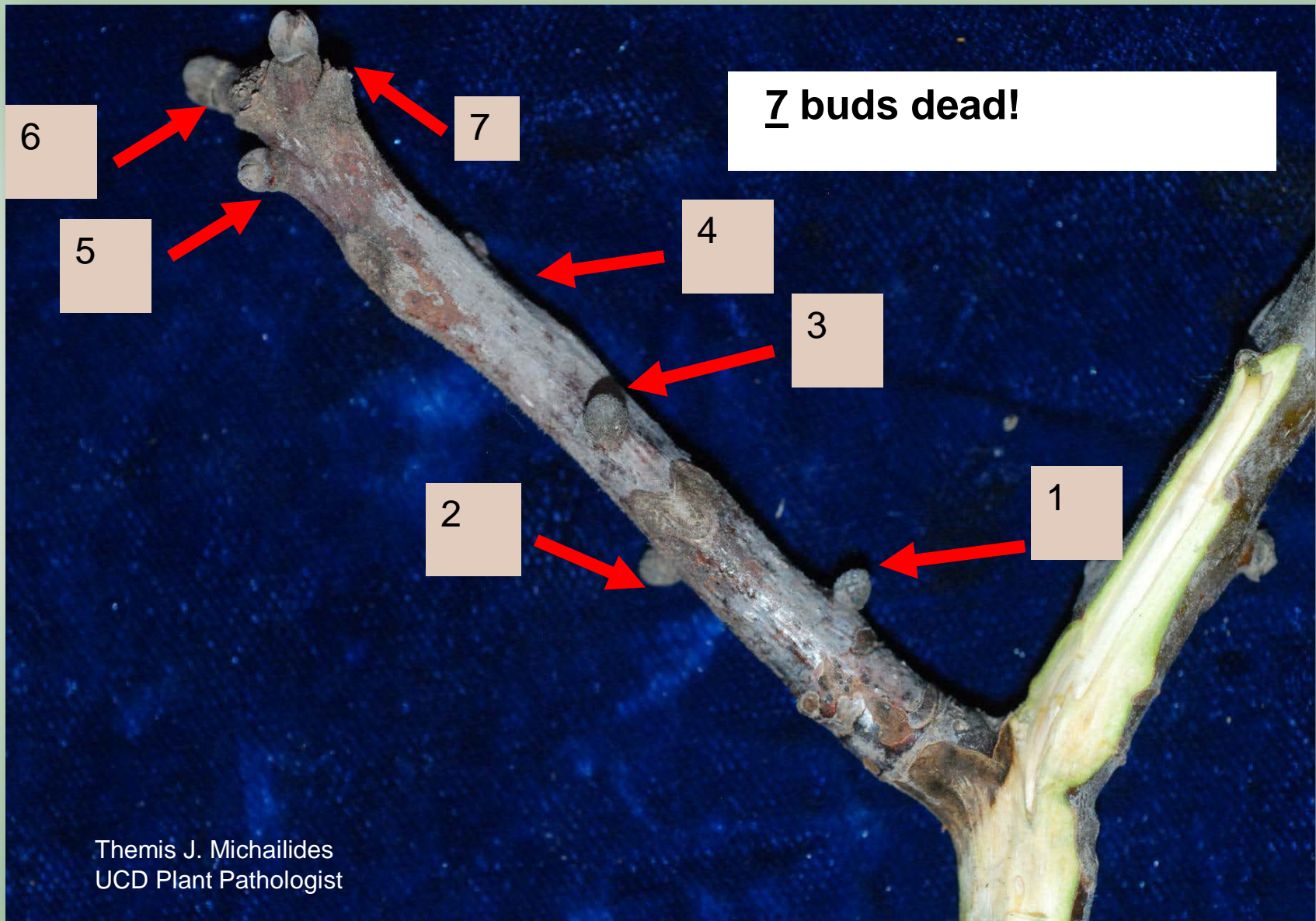


Symptoms in the orchard...

Blighted fruit and spurs



Symptoms in the orchard...



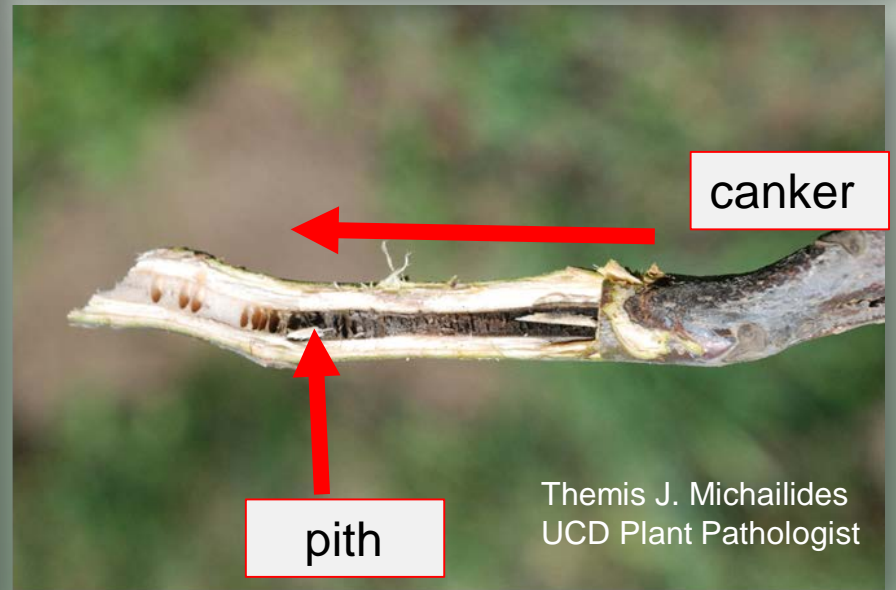
Other Symptoms in the orchard...



Trunk cankers (in young trees)

J. Hasey

Branch cankers



Themis J. Michailides
UCD Plant Pathologist

The Causes:

Themis J. Michailides
UCD Plant Pathologist

Fungal species	Walnut	Pistachio	Almond
<i>Botryosphaeria dothidea</i>	+		
<i>Neofusicoccum parvum</i>	+		
<i>Neofusicoccum mediterraneum</i>	+		
<i>Diplodia mutila</i>	+		
<i>Neofusicoccum nonquaesitum</i>	+		
<i>Neofusicoccum vitifusiforme</i>	+		
<i>Diplodia seriata</i>	+		
<i>Dothiorella iberica</i>	+		
<i>Lasiodiplodia citricola</i>	+		
<i>Neoscytalidium dimitiatum</i> (= <i>Hendersonula toruloidea</i>) – branch wilt pathogen	+		

The Causes

Themis J. Michailides
UCD Plant Pathologist

Fungal species	Walnut	Pistachio	Almond
<i>Botryosphaeria dothidea</i>	+		
<i>Neofusicoccum parvum</i>	+		
<i>Neofusicoccum mediterraneum</i>	+		
<i>Diplodia mutila</i>	+		
<i>Neofusicoccum nonquaesitum</i>	+		
<i>Neofusicoccum vitifusiforme</i>	+		
<i>Diplodia seriata</i>	+		
<i>Dothiorella iberica</i>	+		
<i>Lasiodiplodia citricola</i>	+		
<i>Neoscytalidium dimitiatum</i> (= <i>Hendersonula toruloidea</i>) – branch wilt pathogen	+		
<i>Diaporthe rhusicola</i> (<i>Phomopsis</i>)	+		
<i>Diaporthe neitheicola</i> (<i>Phomopsis</i>)	+		

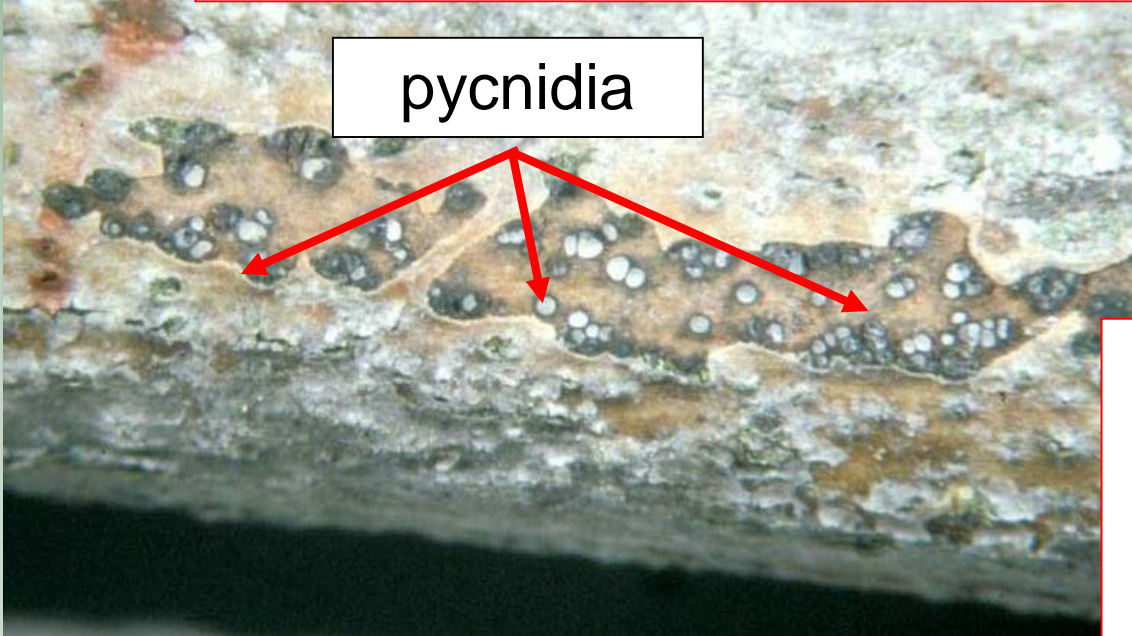
The Causes:

Themis J. Michailides
UCD Plant Pathologist

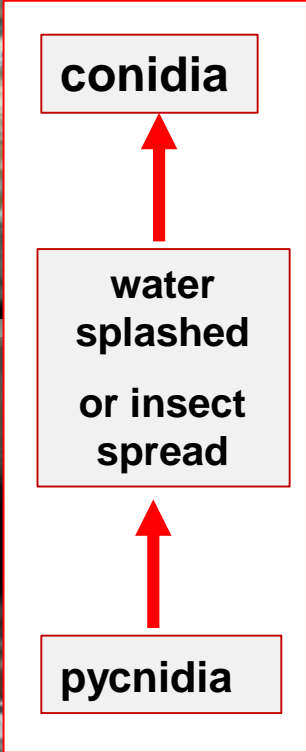
Summary of Botryosphaeriaceae in nut crops – California

Fungal species	Walnut	Pistachio	Almond
<i>Botryosphaeria dothidea</i>	+	+	+
<i>Neofusicoccum parvum</i>	+	+	+
<i>Neofusicoccum mediterraneum</i>	+	+	+
<i>Diplodia mutila</i>	+	---	---
<i>Neofusicoccum nonquaesitum</i>	+	---	+
<i>Neofusicoccum vitifusiforme</i>	+	+	---
<i>Diplodia seriata</i>	+	+	+
<i>Dothiorella iberica</i>	+	+	+
<i>Lasiodiplodia citricola</i>	+	+	+
<i>Neoscytalidium dimitiatum</i> (= <i>Hendersonula toruloidea</i>)	+	+	+
<i>Diaporthe rhusicola</i> (<i>Phomopsis</i>)	+	+	+
<i>Diaporthe neitheicola</i> (<i>Phomopsis</i>)	+	---	---

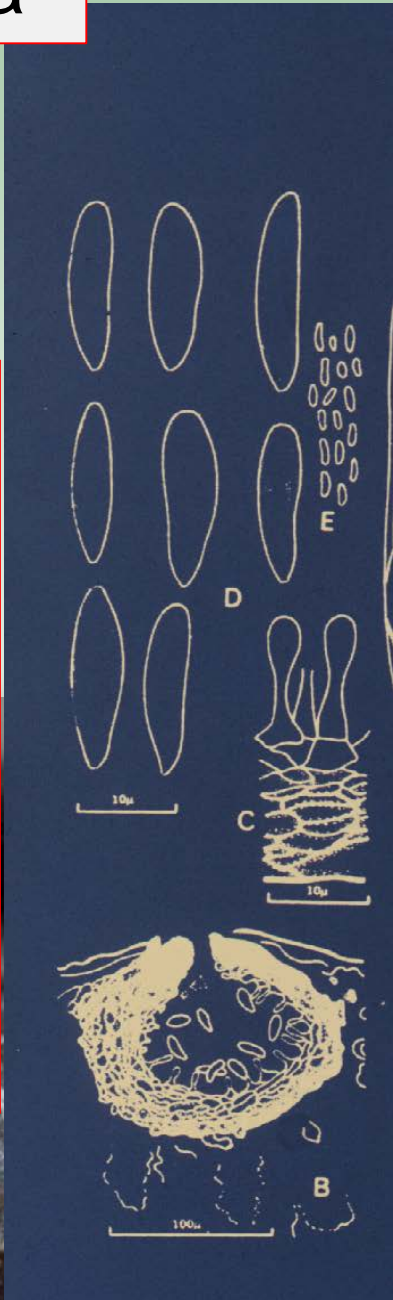
Water-splashed inoculum in pycnidia



pycnidia

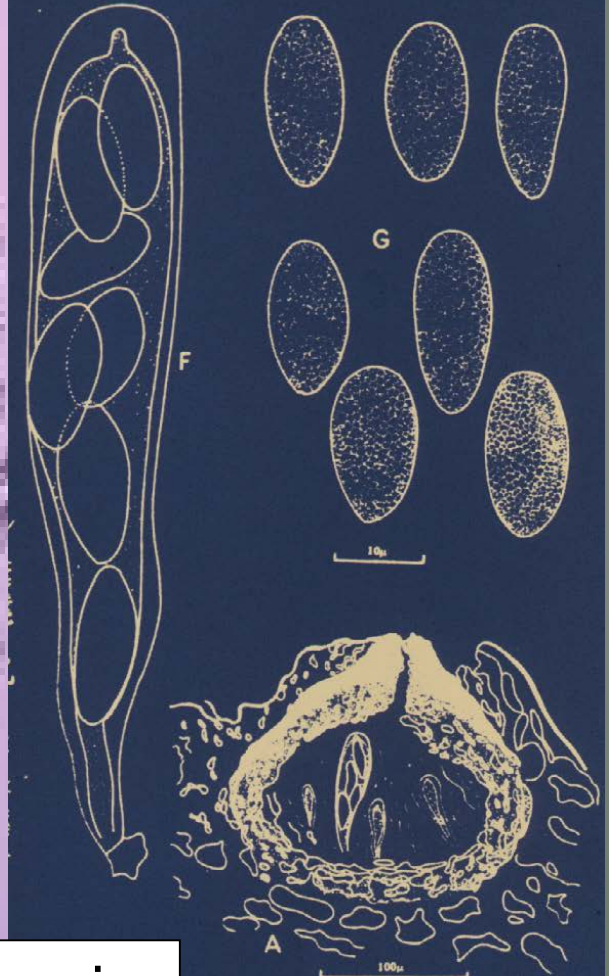


oozing pycnidia



Inoculum in pseudothecia

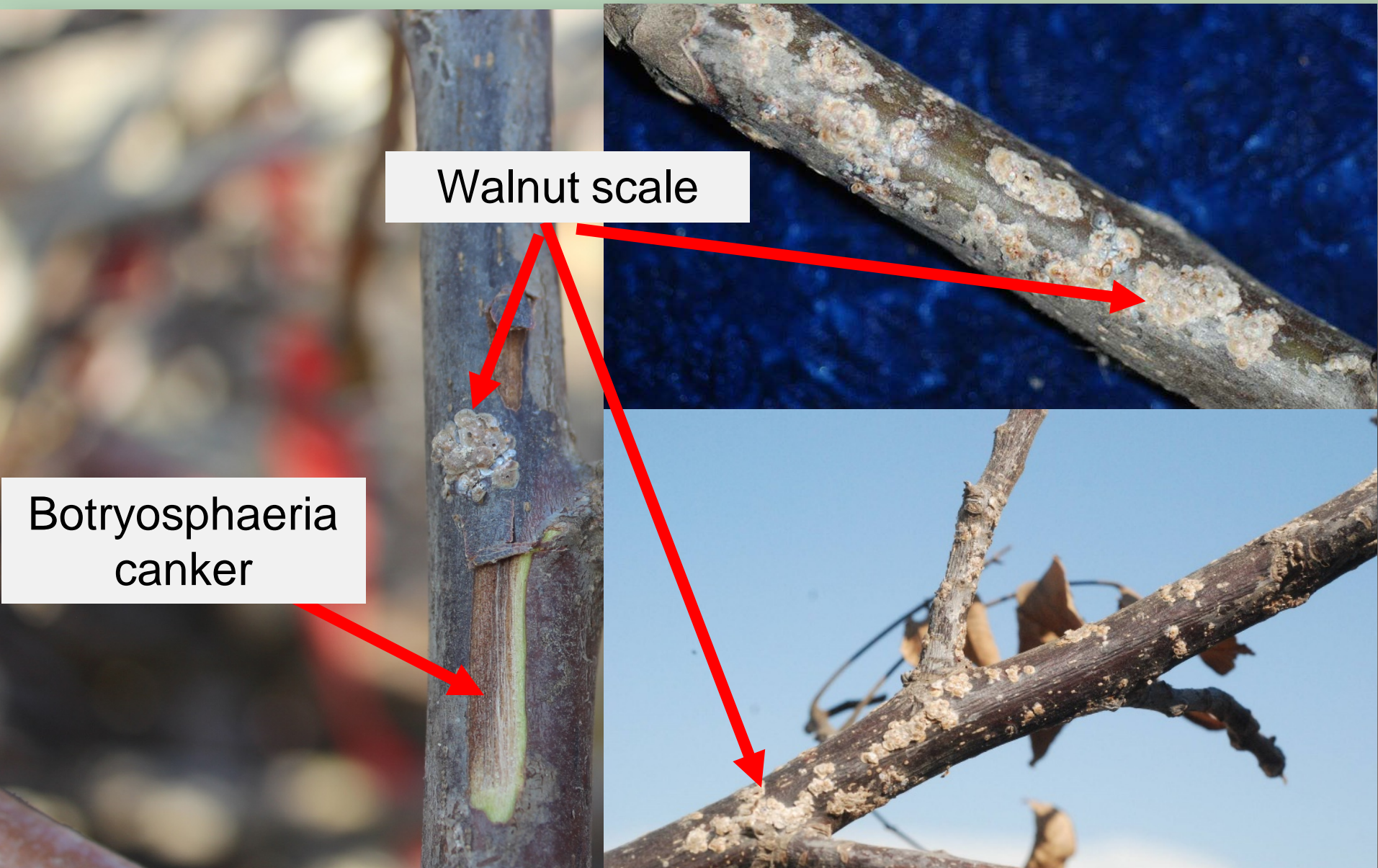
Ascospores:
airborne-spread



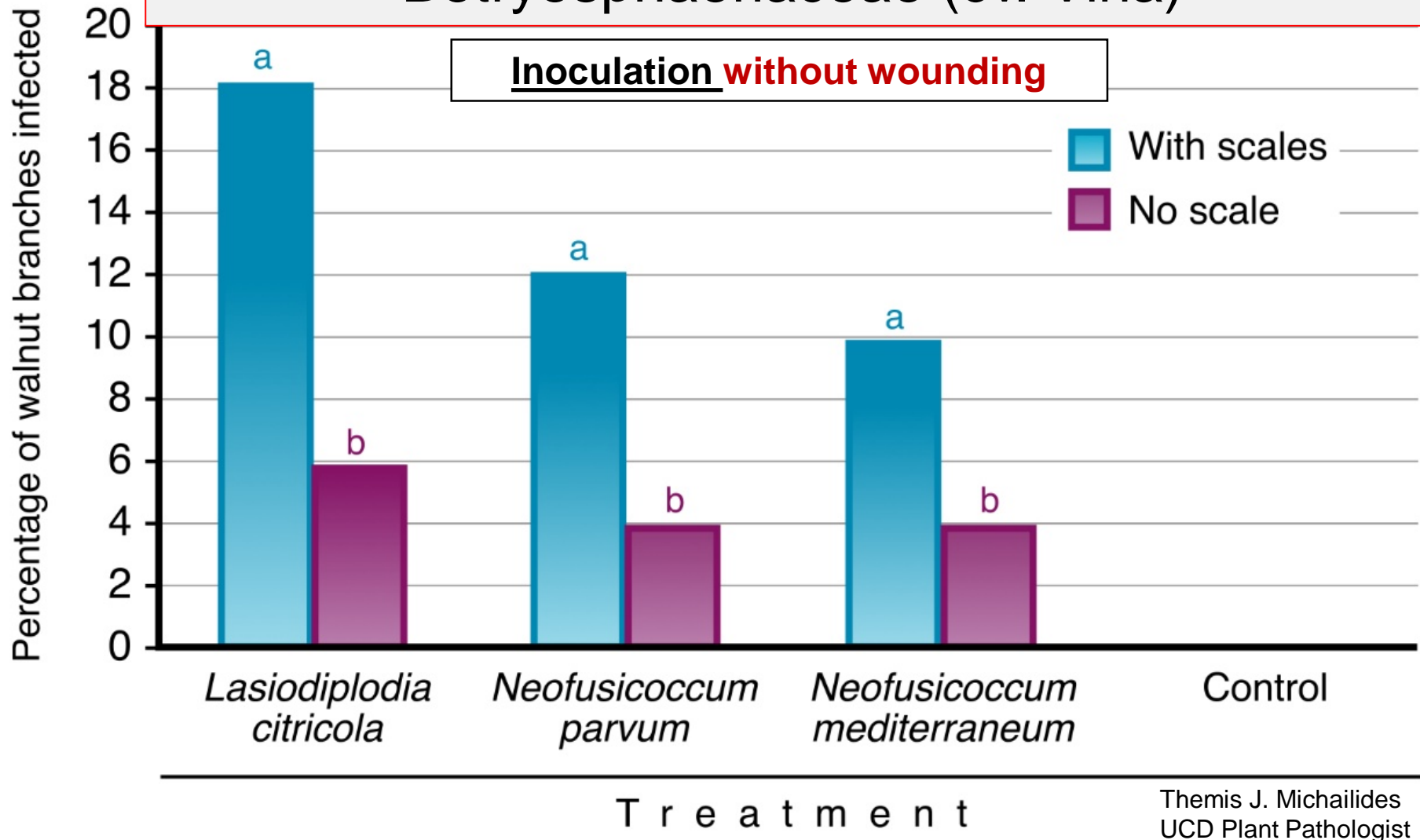
pseudothecia

- Contributing factors: walnut scale

Themis J. Michailides
UCD Plant Pathologist

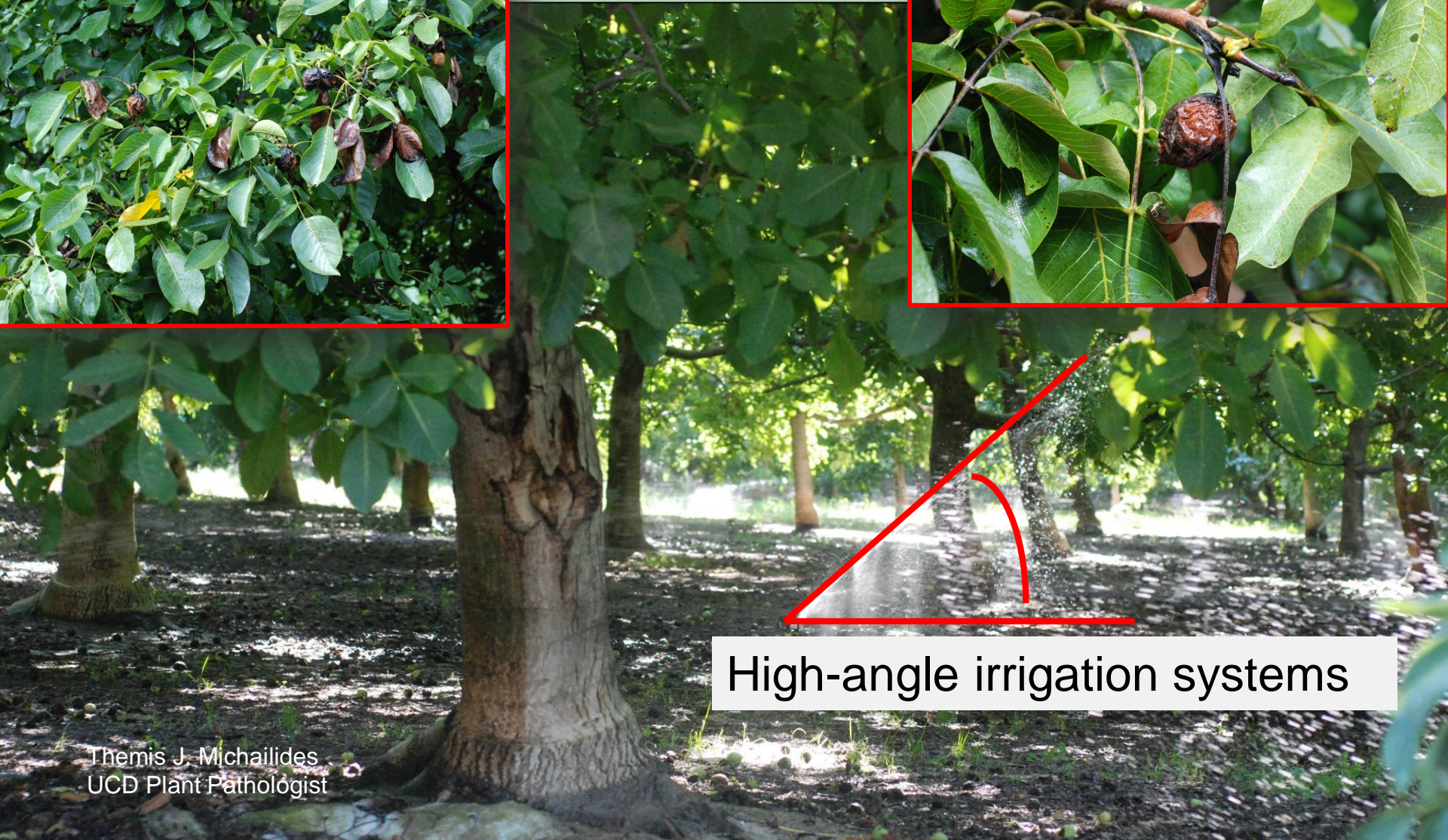


Effect of walnut scales on infection of walnut by Botryosphaeriaceae (cv. Vina)



60-75% more shoots were infected when scales were present

- Contributing factors: Irrigation



High-angle irrigation systems

Themis J. Michailides
UCD Plant Pathologist

Sprinkler irrigation wetting the tree canopy

High risk for Bot disease to start early in this orchard



© D. Lightle 2018

Themis J. Michailides
UCD Plant Pathologist

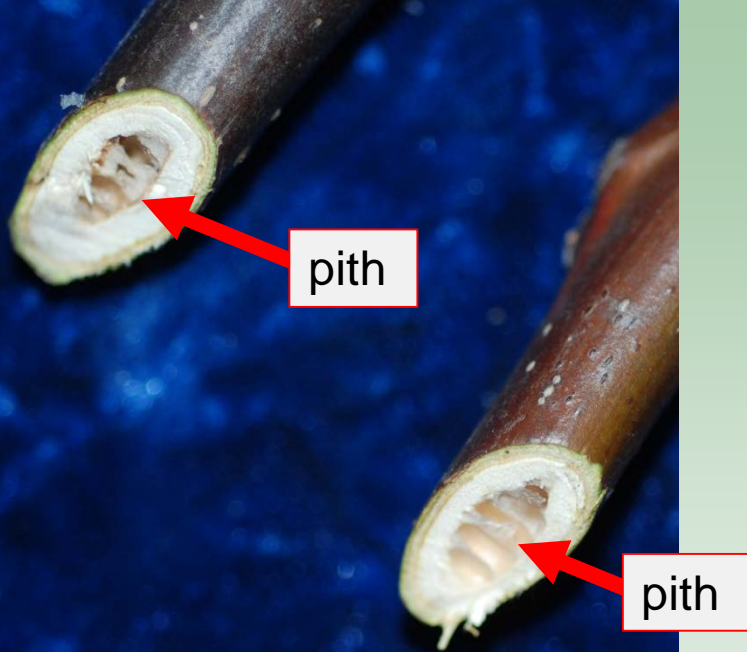
- Contributing factors: Pruning wounds



Susceptible for

4 months!

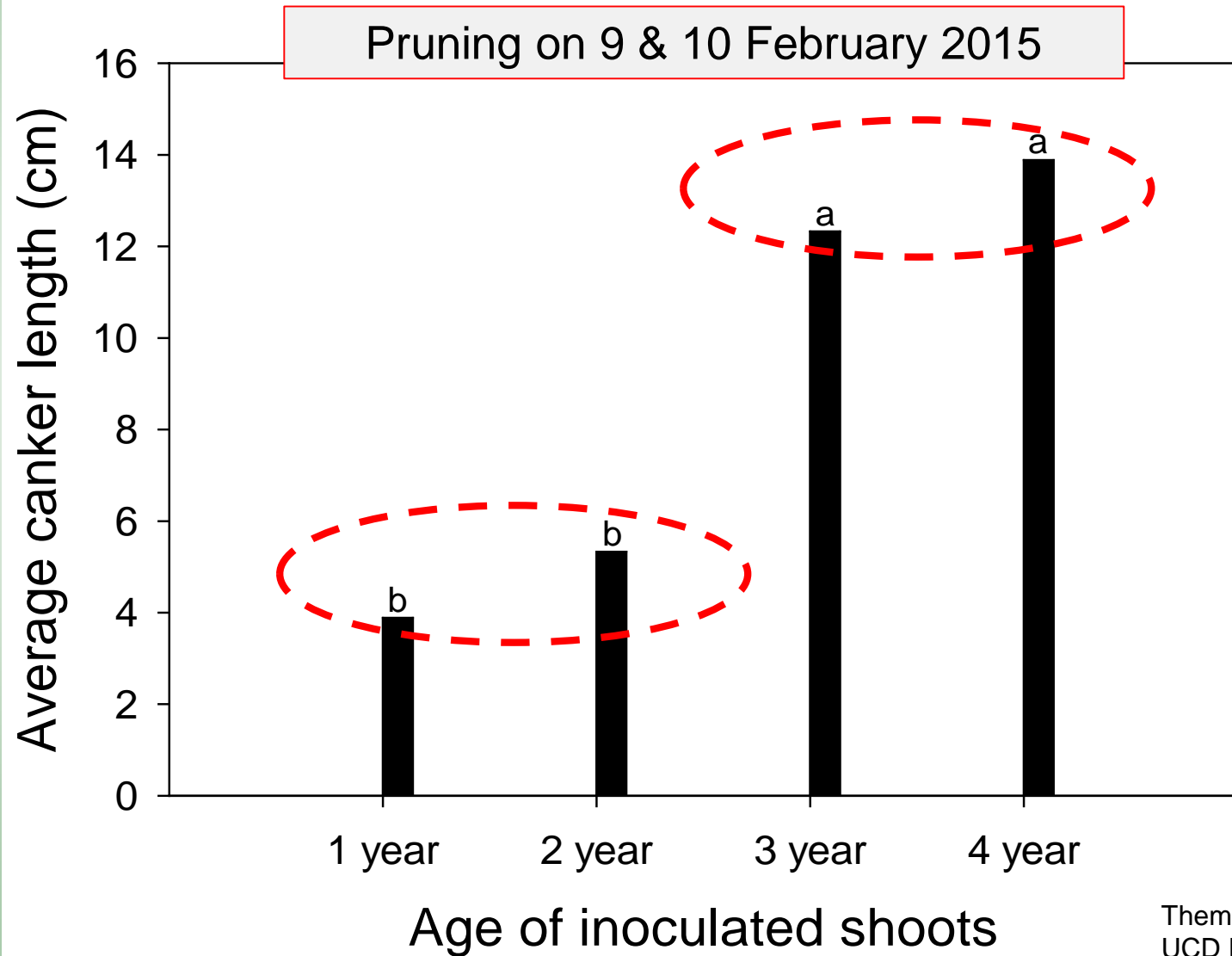
Themis J. Michailides
UCD Plant Pathologist



Pith in the center of walnut shoots and
Botryosphaeria infections



Effect of shoot age on infection of pruning wounds to infection by Bot



Accumulated dead wood on the tree



Themis J. Michailides
UCD Plant Pathologist

- Contributing factors: nut and shoot wounds

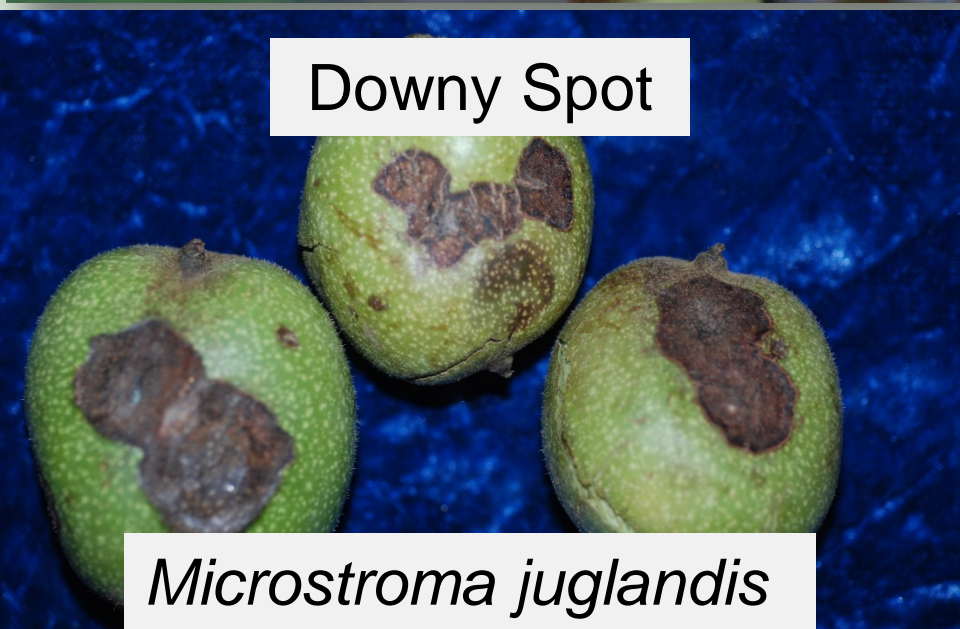
Sunburn



Hail Damage



Downy Spot



Leaf Scars



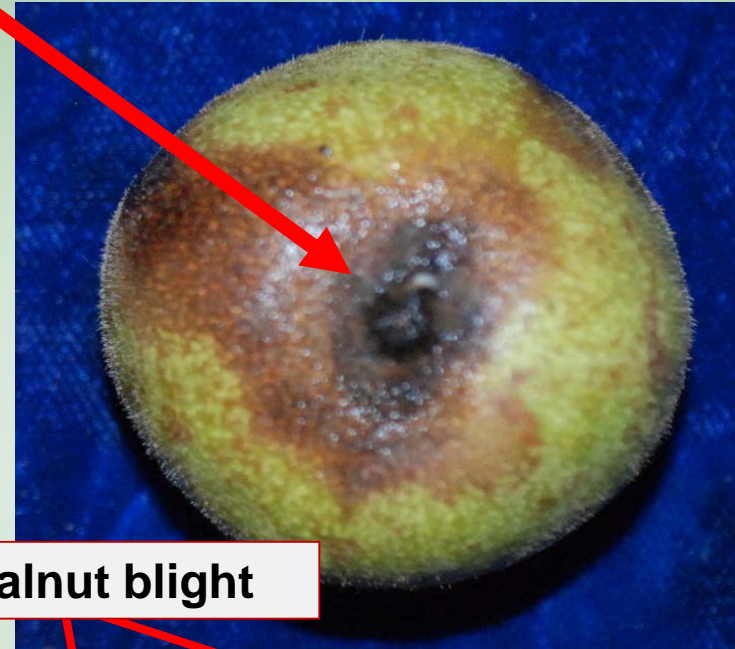
Microstroma juglandis

Themis J. Michailides
UCD Plant Pathologist

- Contributing factors: Brown Apical Necrosis



Themis J. Michailides
UCD Plant Pathologist



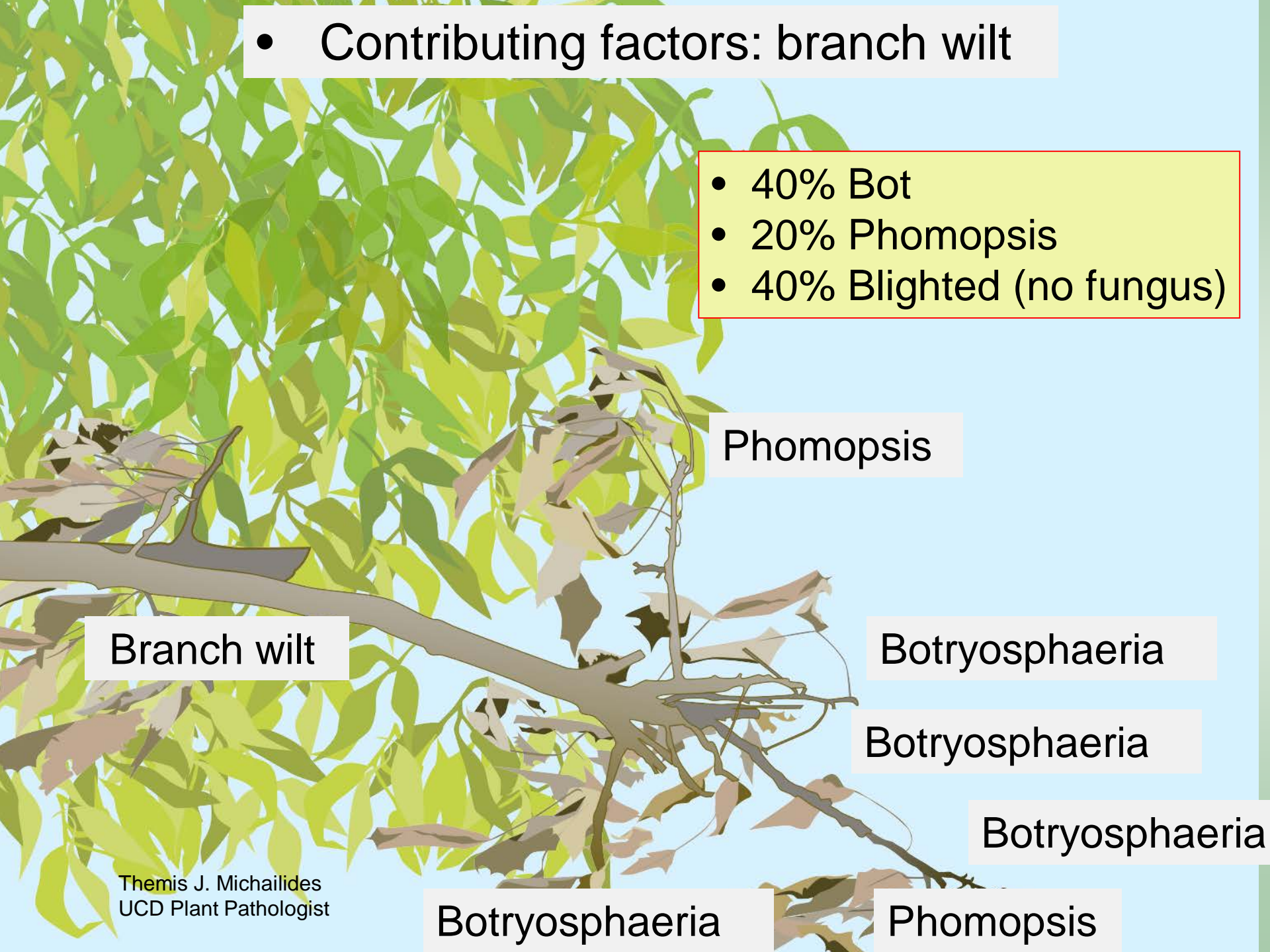
Walnut blight



- Contributing factors: Branch wilt:
(*Neoscytalidium dimitiatum*)

- Contributing factors: branch wilt

- 40% Bot
- 20% Phomopsis
- 40% Blighted (no fungus)



Branch wilt

Phomopsis

Botryosphaeria

Botryosphaeria

Botryosphaeria

Botryosphaeria

Phomopsis

- Contributing factors: frost damage



Themis J. Michailides
UCD Plant Pathologist



About 50% of the frost damaged shoots/spurs developed pycnidia in a year.

Disease management



Themis J. Michailides
UCD Plant Pathologist

Sanitation: Pruning dead wood is very important

What is wrong in this orchard?



Themis J. Michailides
UCD Plant Pathologist

Too much inoculum is present on the trees

What is wrong with this photo?



1

2

Themis J. Michailides
UCD Plant Pathologist

Too much inoculum is left in or brought back in the orchard

Huller debris

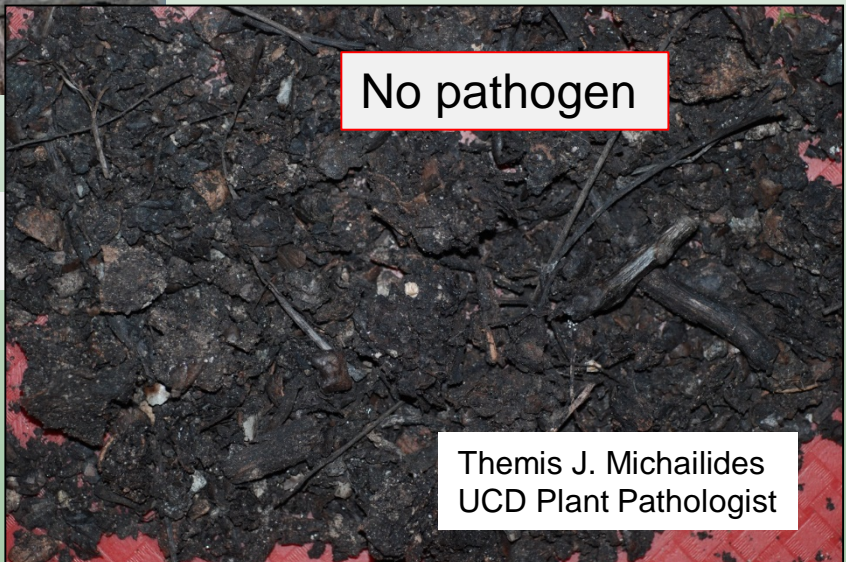


90% infected

Botryosphaeria	40%
Phomopsis	30%
Botryosphaeria + Phomopsis...	20%
No fungus	10%

Compost: 0% pathogens

Botryosphaeria	0%
Phomopsis	0%
Botryosphaeria + Phomopsis...	0%



No pathogen

Themis J. Michailides
UCD Plant Pathologist

Which orchard is more at risk?

Winter pruning - February



Fall pruning - November



Themis J. Michailides
UCD Plant Pathologist

Brush Disposal Recommendations

Infestation level	Chip?	Remove?	Fungicide program?
None	Yes	No	Not needed
Light (1-20%)	No	Yes	1 spray
Moderate (20-50%)	No	Yes	1+ sprays
Heavy (> 50%)	Yes	No	Full program

Themis J. Michailides
UCD Plant Pathologist

Chipping brush reduces inoculum by two-thirds (66%)

Fungicide efficacy:

Fungicide	Active ingredient (FRAC #)	Efficacy
Quash	metaconazole (3)	++++
Merivon	fluxopyroxad + pyraclostrobin (7/11)	++++
Pristine	boscalid + pyraclostrobin (7/11)	++++
K-Phite	polyphosphite	++++
Luna Experience	fluopyram + metaconazole (7/3)	++++
Luna Sensation	fluopyram + trifloxystrobin (7/11)	++++

There is no fungicide resistance selection in Botryosphaeriaceae

++++ = excellent and consistent

Themis J. Michailides
UCD Plant Pathologist

Timing sprays



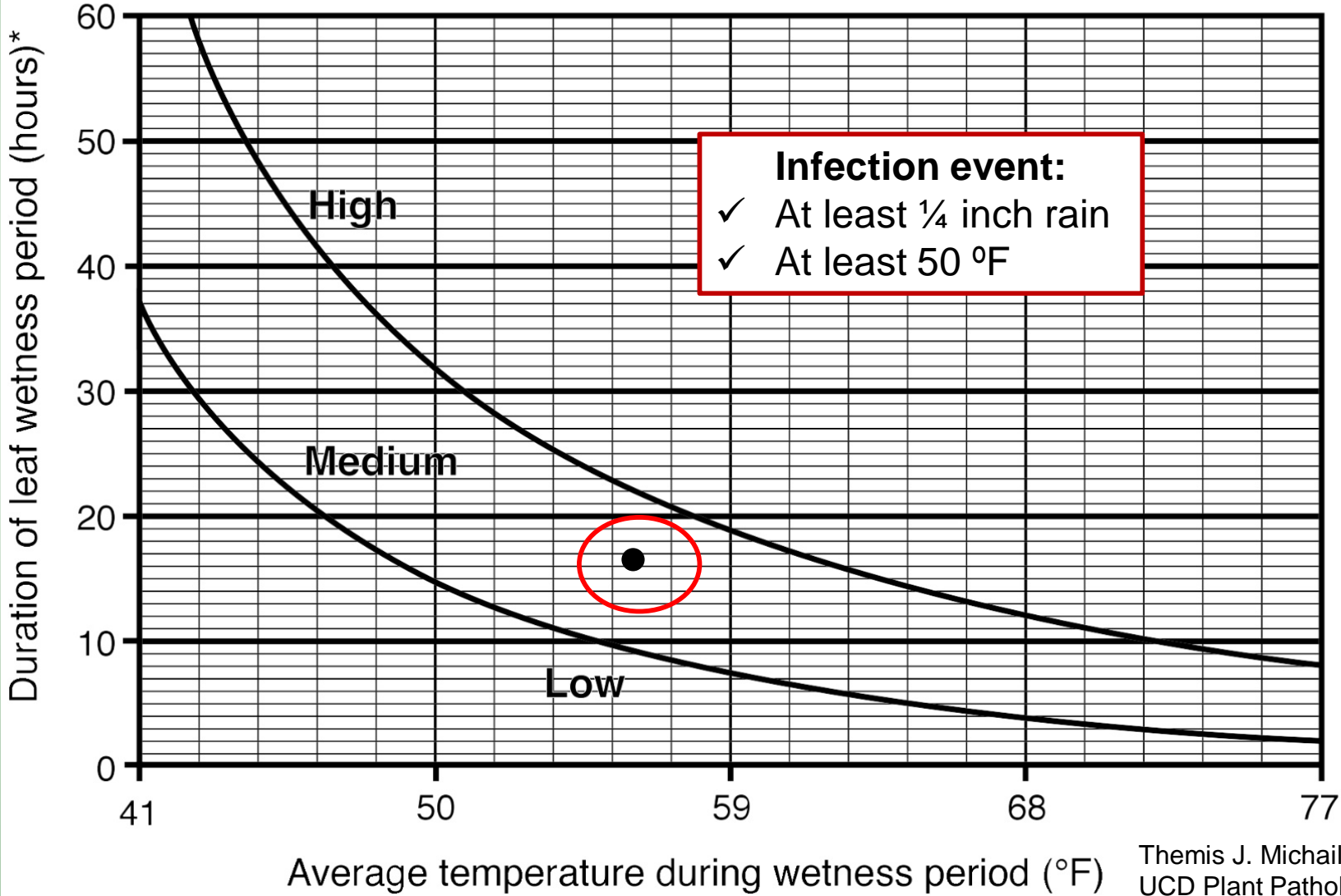
Option 1: Late June/ early July (1x)

Option 2: Standard calendar sprays (3x)
mid-May, mid-June, mid-July (PCAs' and
Growers' favorable)

Option 3: Leaf wetness model (weather dependent)

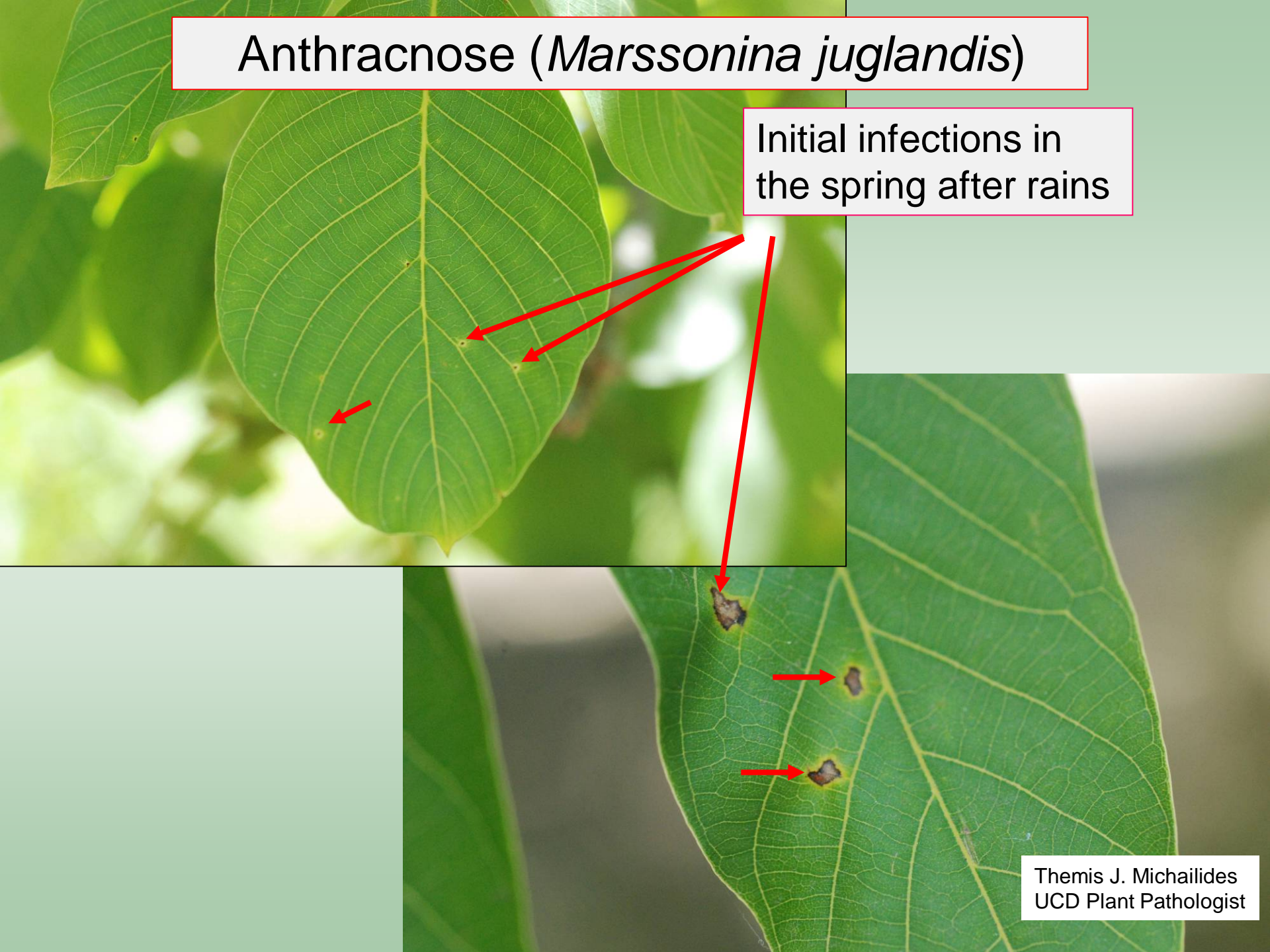
Using the Leaf Wetness Model

Rain: April 22-23: 0.6"



Anthracnose (*Marssonina juglandis*)

Initial infections in the spring after rains



Themis J. Michailides
UCD Plant Pathologist

Severe anthracnose – leaf blade necrotic lesions

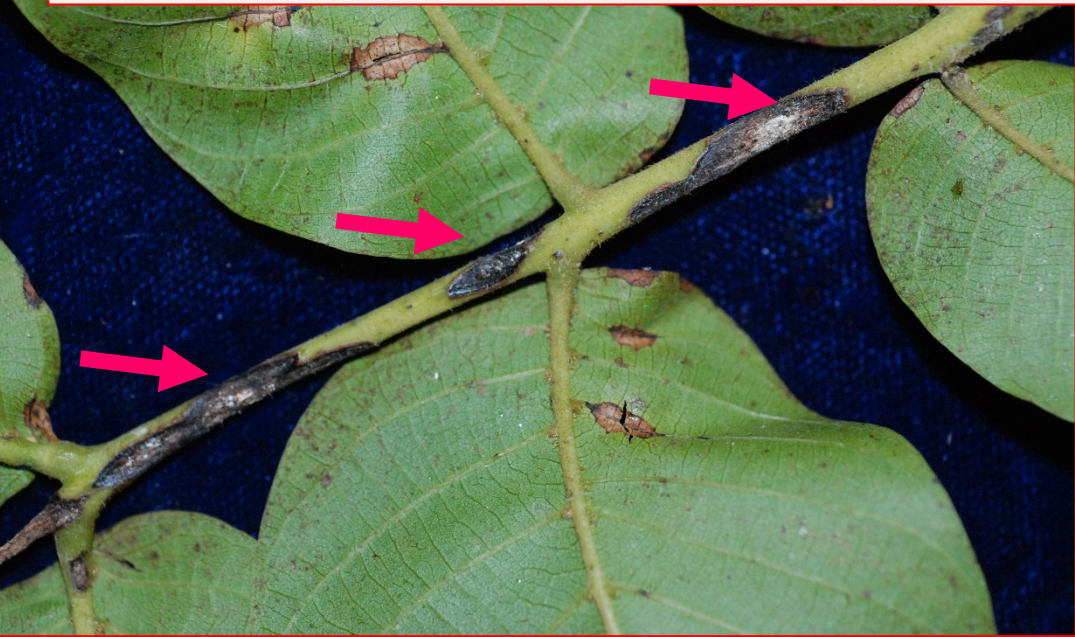


Themis J. Michailides
UCD Plant Pathologist

Salt burn symptoms



Severe anthracnose – leaf petiole necrotic lesions

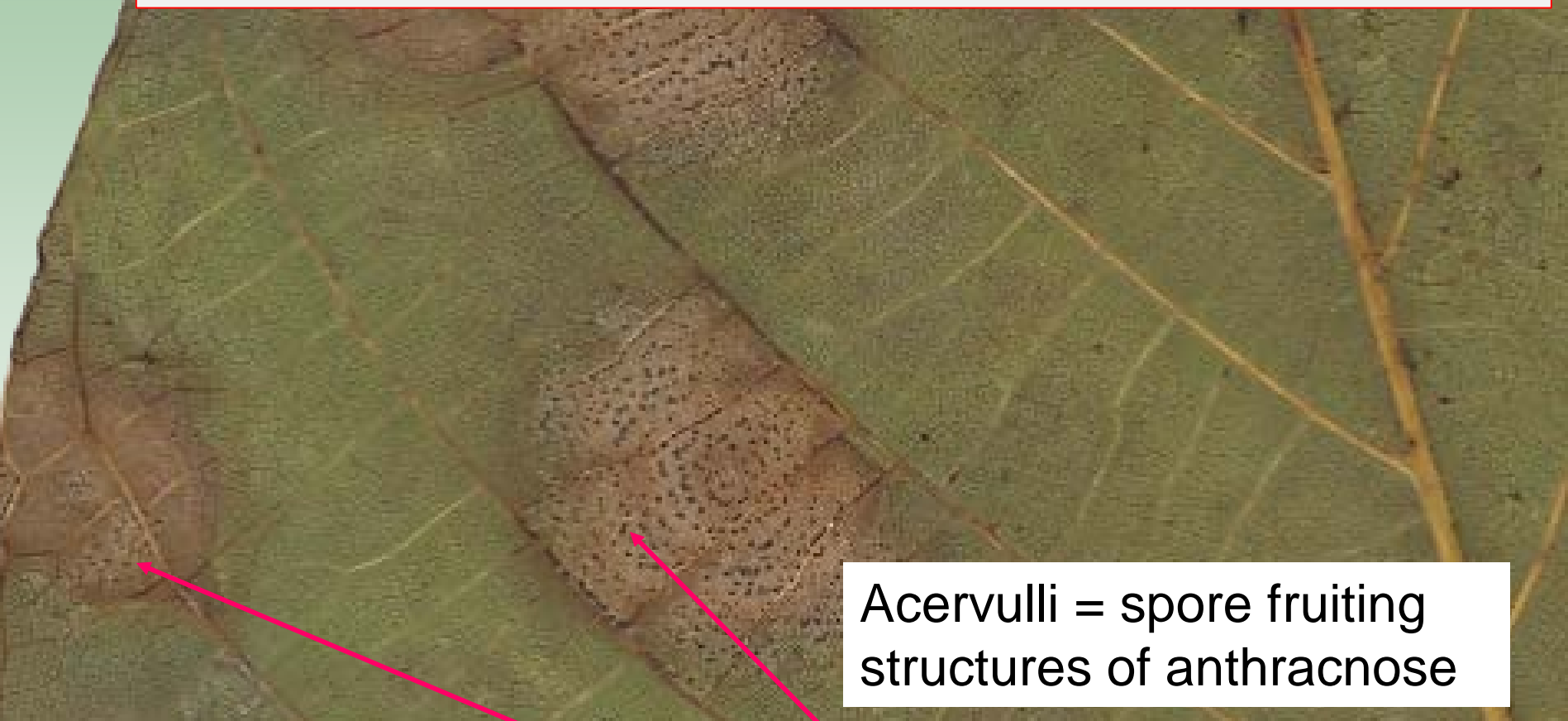


Themis J. Michailides
UCD Plant Pathologist

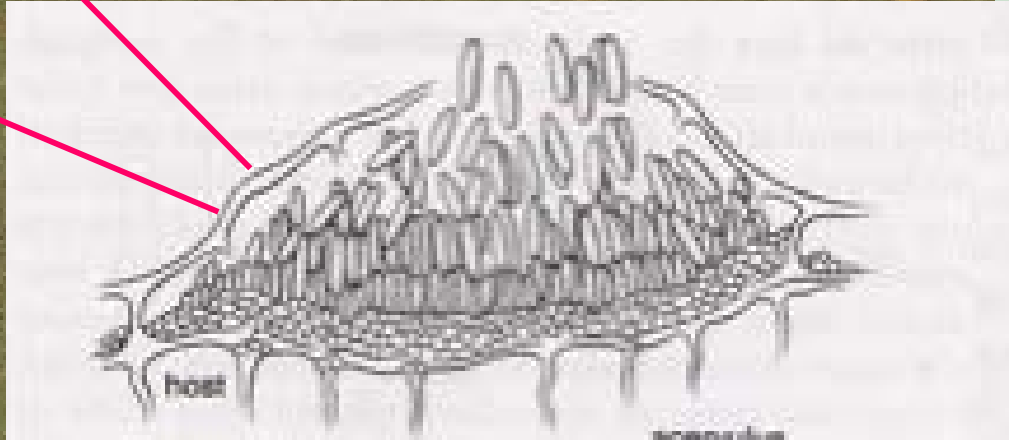


Themis J. Michailides
UCD Plant Pathologist

Inoculum of the pathogen *Marssonina juglandis*



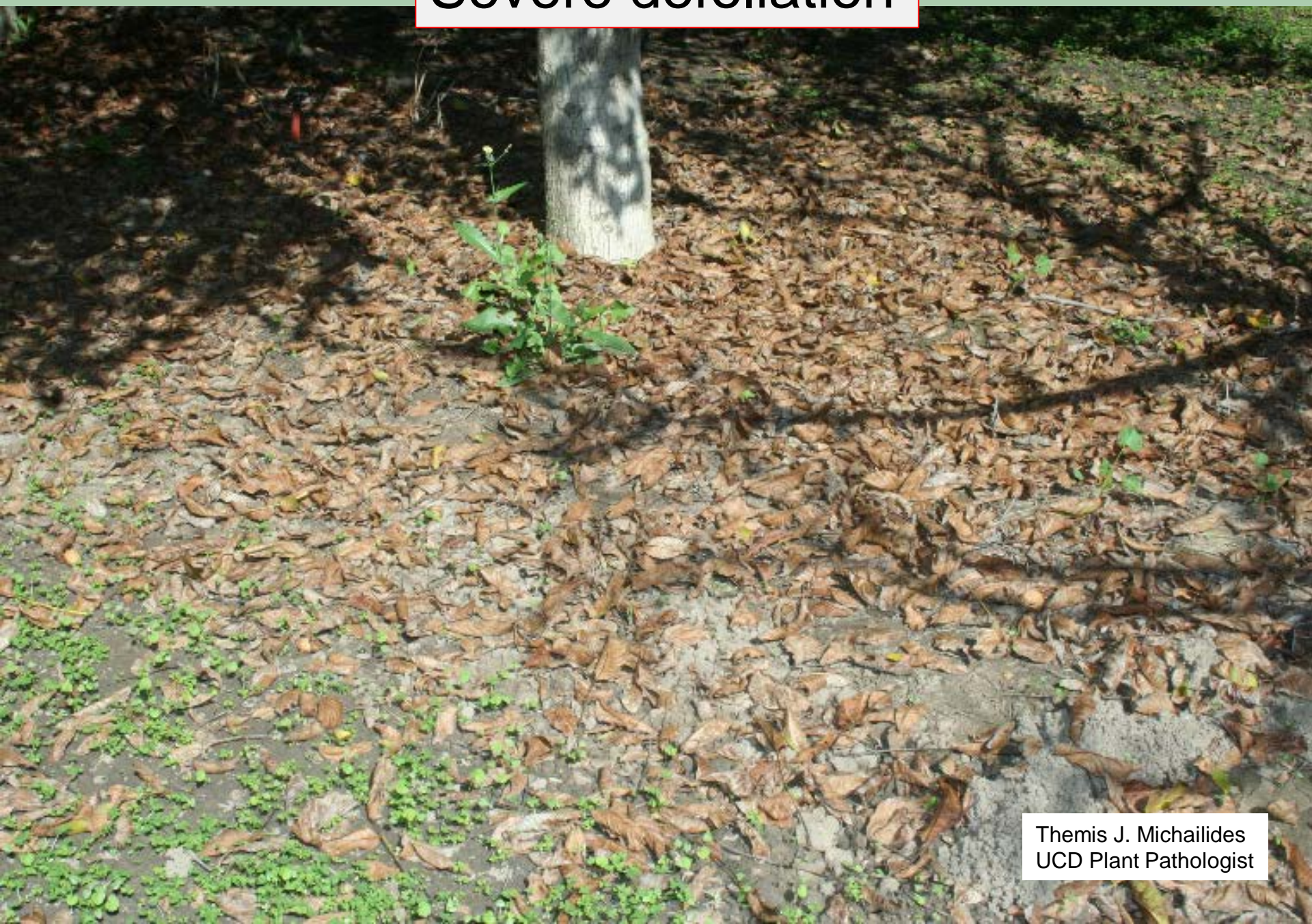
Acervulli = spore fruiting structures of anthracnose



=

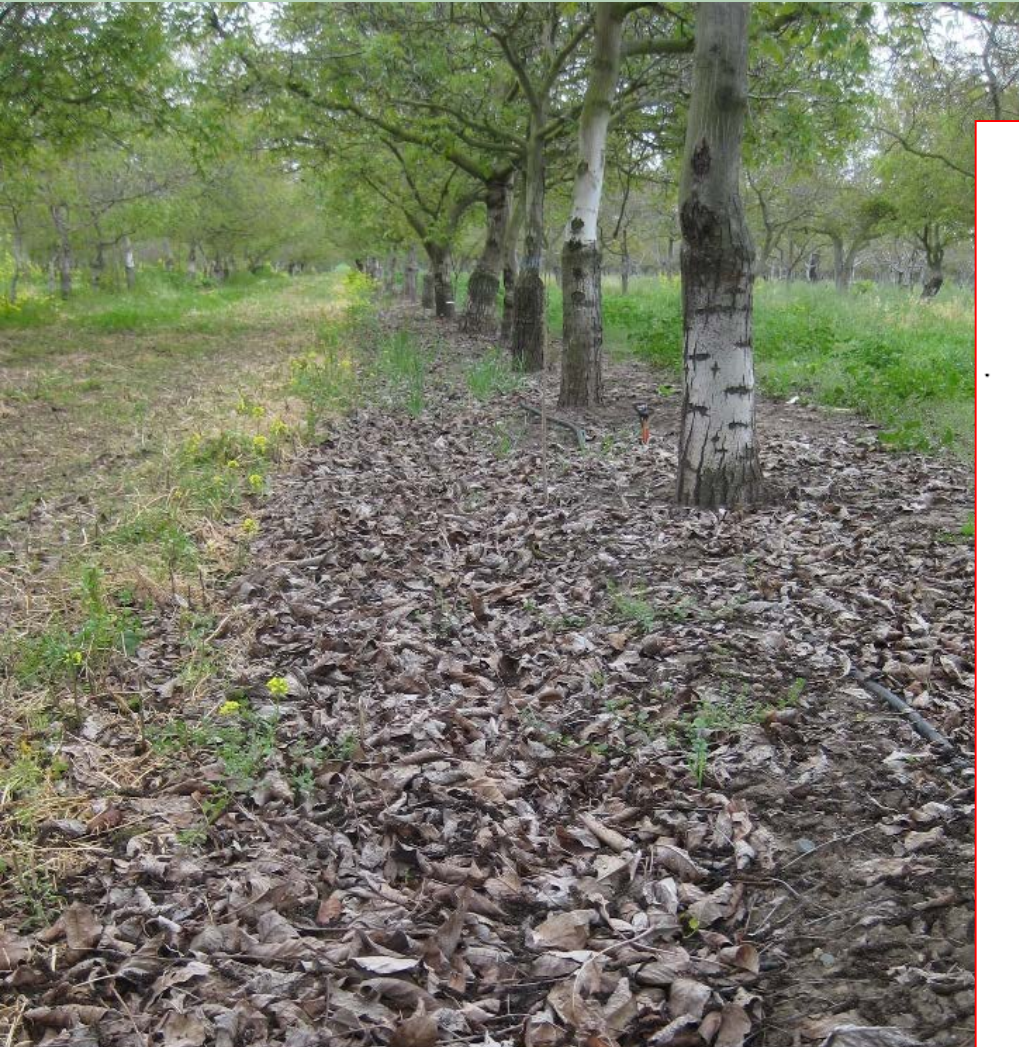
s
st

Severe defoliation



Themis J. Michailides
UCD Plant Pathologist

Airborne phase (*Gnomonia leptostyla*) perithecia with ascospores



MURRAY.—*Three Fungous Diseases of Salix in New Zealand.* 67



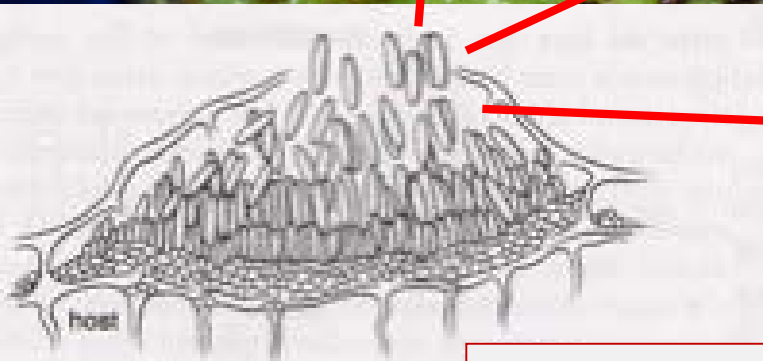
Themis J. Michailides
UCD Plant Pathologist

Initial Anthracnose lesions on fruit

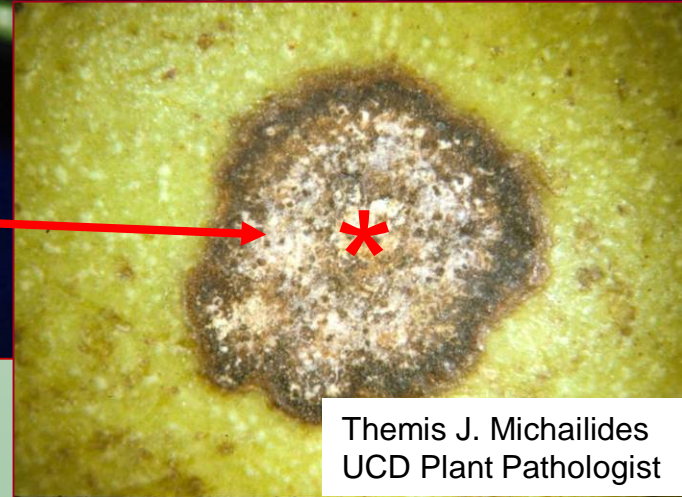


Themis J. Michailides
UCD Plant Pathologist

Anthracnose of walnut fruit



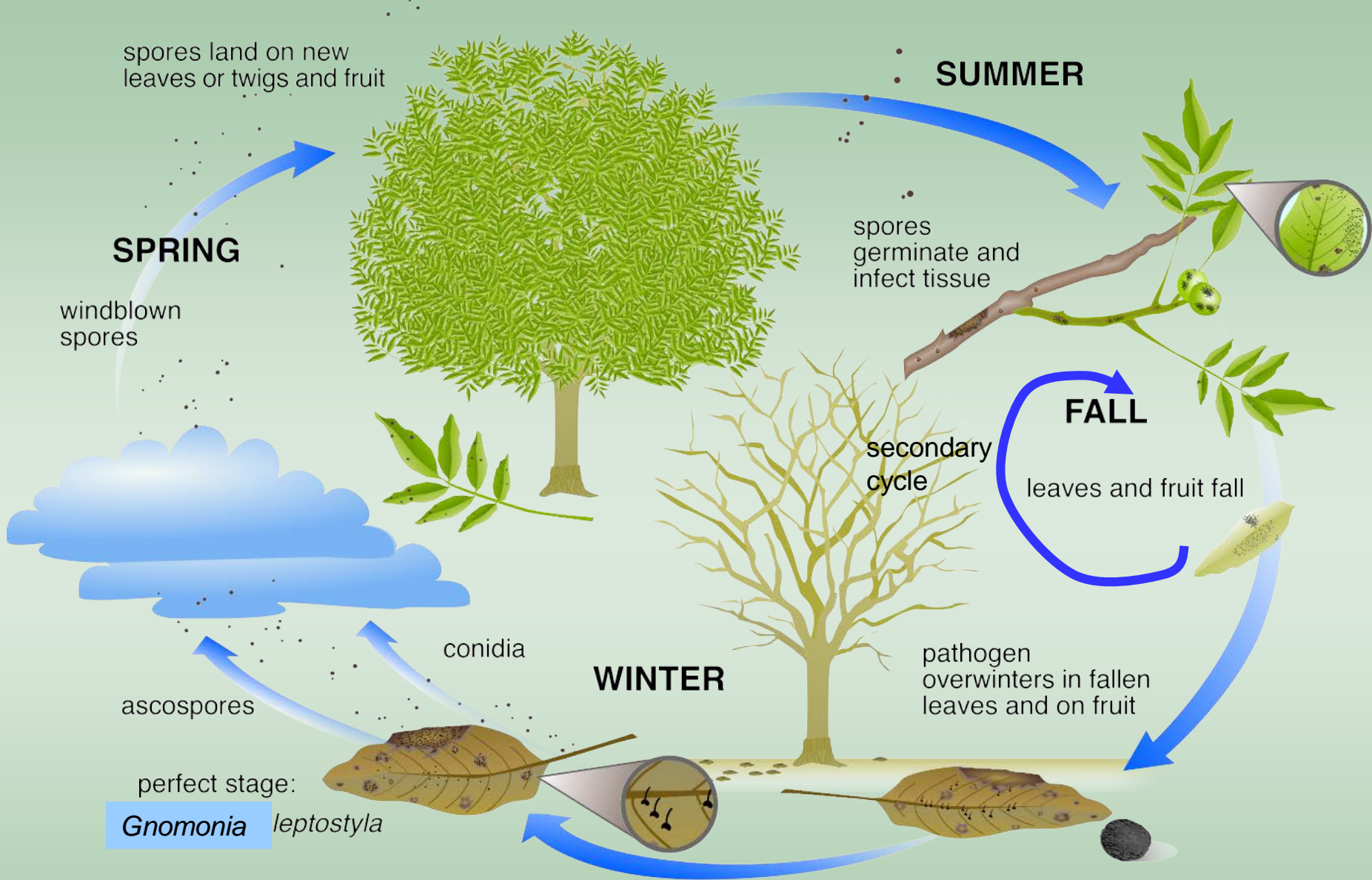
Acervellus = spore producing structure



Themis J. Michailides
UCD Plant Pathologist

Walnut blight – bacterial disease





Disease cycle of anthracnose

Marssonina juglandis

Themis J. Michailides
UCD Plant Pathologist

Anthracnose of black walnut

Necrotic lesions on leaves and fruit



Themis J. Michailides
UCD Plant Pathologist



Paradox

Black walnut

Themis J. Michailides
UCD Plant Pathologist

Anthracnose Foliar Disease Ratings (by Bill Coates, FA, San Benito Co.)

1 = NO DISEASE, 5 = SEVERE DISEASE

	RATING	# OF OBS
Serr	4.5	4
92-016-1	4.2	5
Payne	4.0	1
Hartley	2.7	3
Chandler	2.4	9
93-045-1	2.3	3
Pedro	2.0	1
Howard	2.0	4
64-57	2.0	3
Tulare	1.3	3

Themis J. Michailides
UCD Plant Pathologist

Most
susceptible

Least
susceptible

Serr, Payne > **Hartley, Chandler** > **Howard** > **Tulare**

Precipitation from March to September and anthracnose incidence (San Benito Co.; 2012-2018)

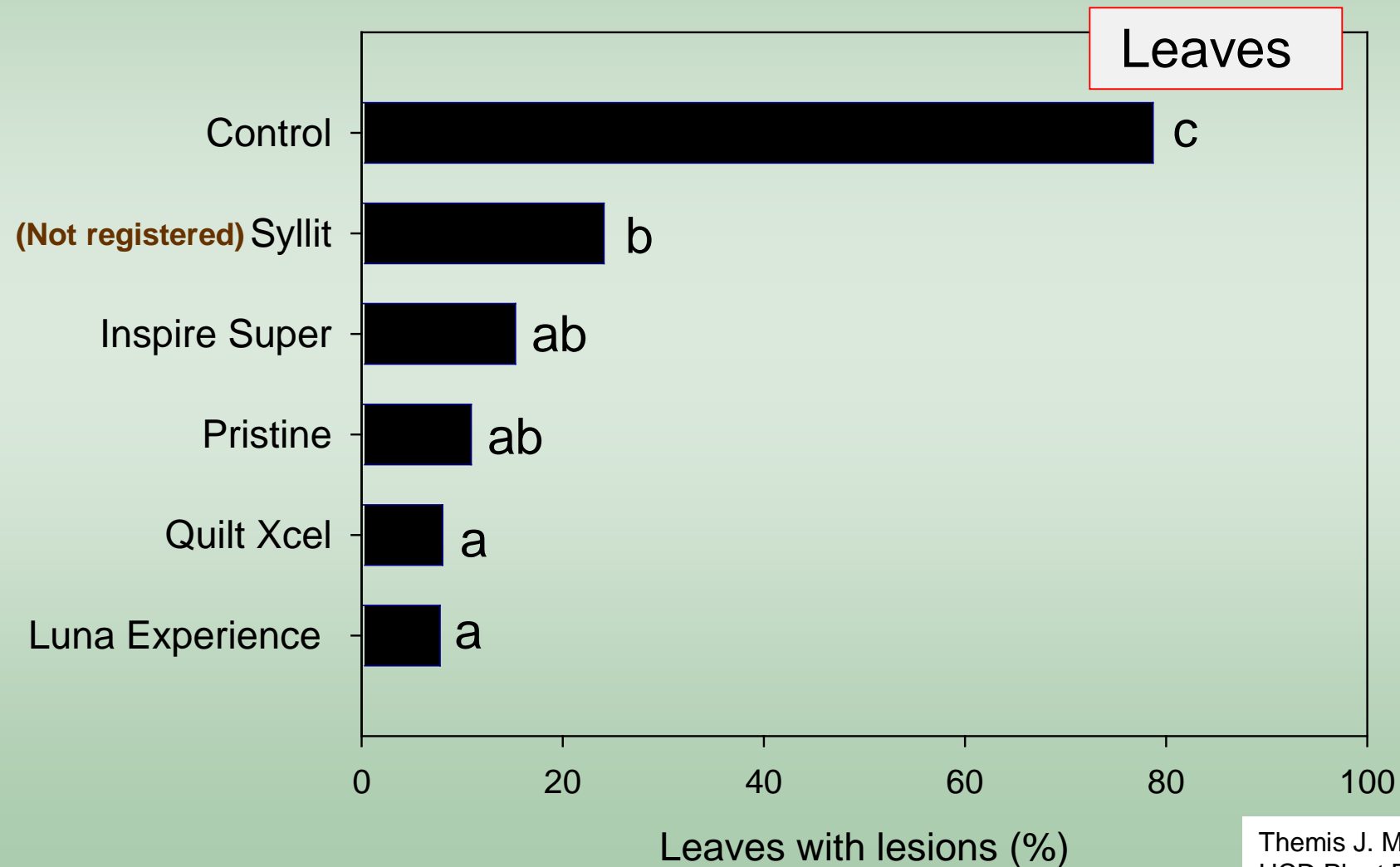
----- Rainfall from March to September -----

2012	2013	2014	2015	2016	2017	2018
5.3 inches (133 mm)	0.4 inches (10.6 mm)	2.6 inches (66 mm)	1.4 inches (34 mm)	1.4 inches (36 mm)	3.4 inches (85 mm).	5.1 inches (129 mm)

----- Anthracnose -----

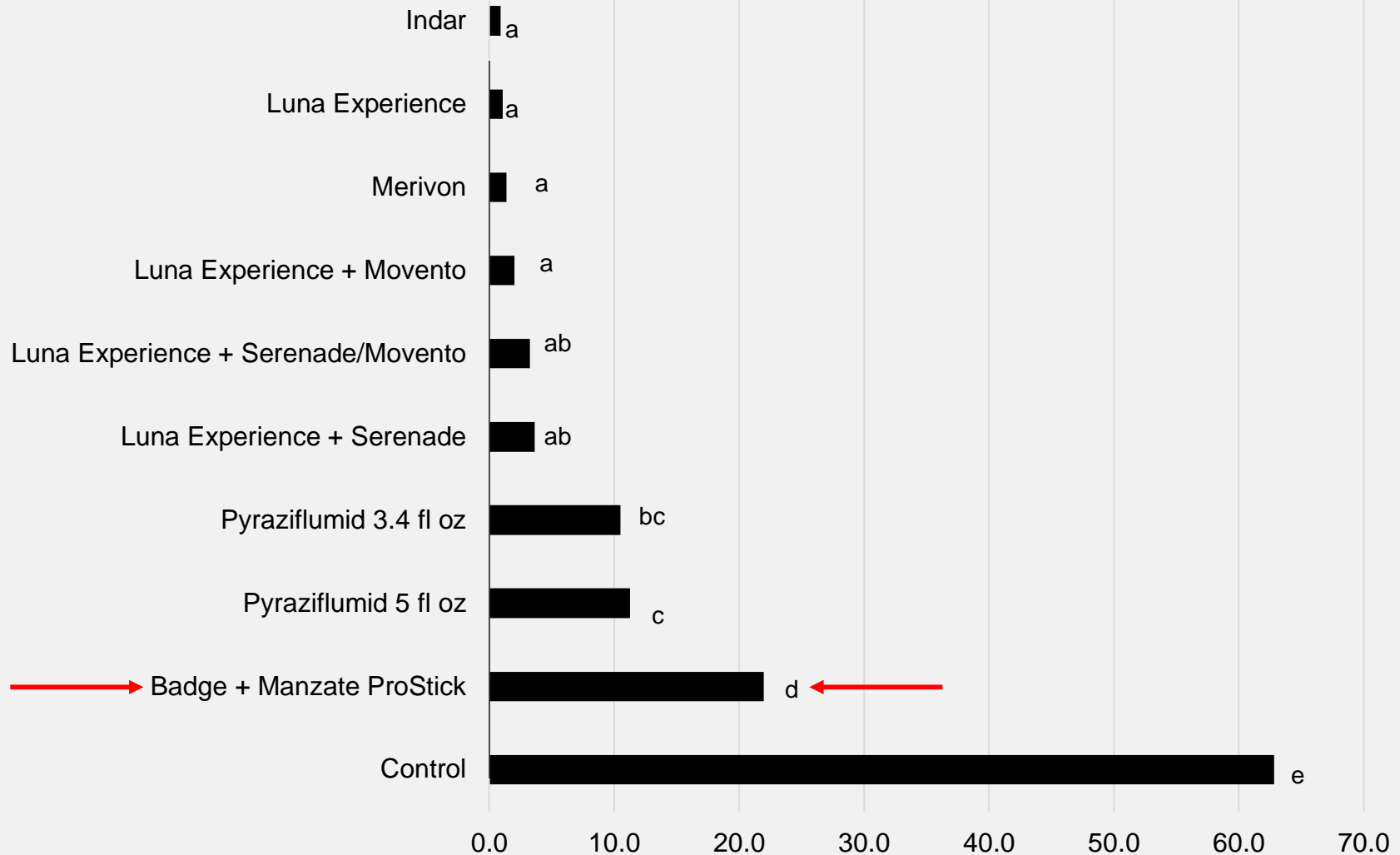
70%*	0%	0%	0%	41%	85.7%	27%
------	----	----	----	-----	-------	-----

Anthracnose Fungicide Trial (Hollister; Serr, recorded July 5, 2012)



Anthracnose Efficacy Trial (Serr, 2017)

Spray dates: 24 April; 12 May; 2 June



Themis J. Michailides
UCD Plant Pathologist

Leaves with lesions (%)

Fungicide efficacy against Anthracnose

Fungicide	Active ingredient (FRAC #)	Efficacy
Copper mancozeb (Manzate/Dithane)	Carbamate (EBDC) ² (M3)	++++
Luna Experience	fluopyram + tebuconazole (7/3)	++++
Merivon	fluxopyroxad + pyraclostrobin (7/11)	++++
Pristine	boscalid + pyraclostrobin (7/11)	++++
Ph-D	chitin synthesis inhibitor (19)	++++
Quadris Top	Difenoconazole (3)+azoxystrobin (11)	++++
Quash	metaconazole (3)	++++
Quilt Excel	Propiconazole (3)+azoxystrobin (11)	++++

TIMING: 1st spray: 3rd week in April (1/2 first leaves size);
2nd spray: 1st – 2nd week in May; and 3rd spray: 4th week in May

Themis J. Michailides
UCD Plant Pathologist

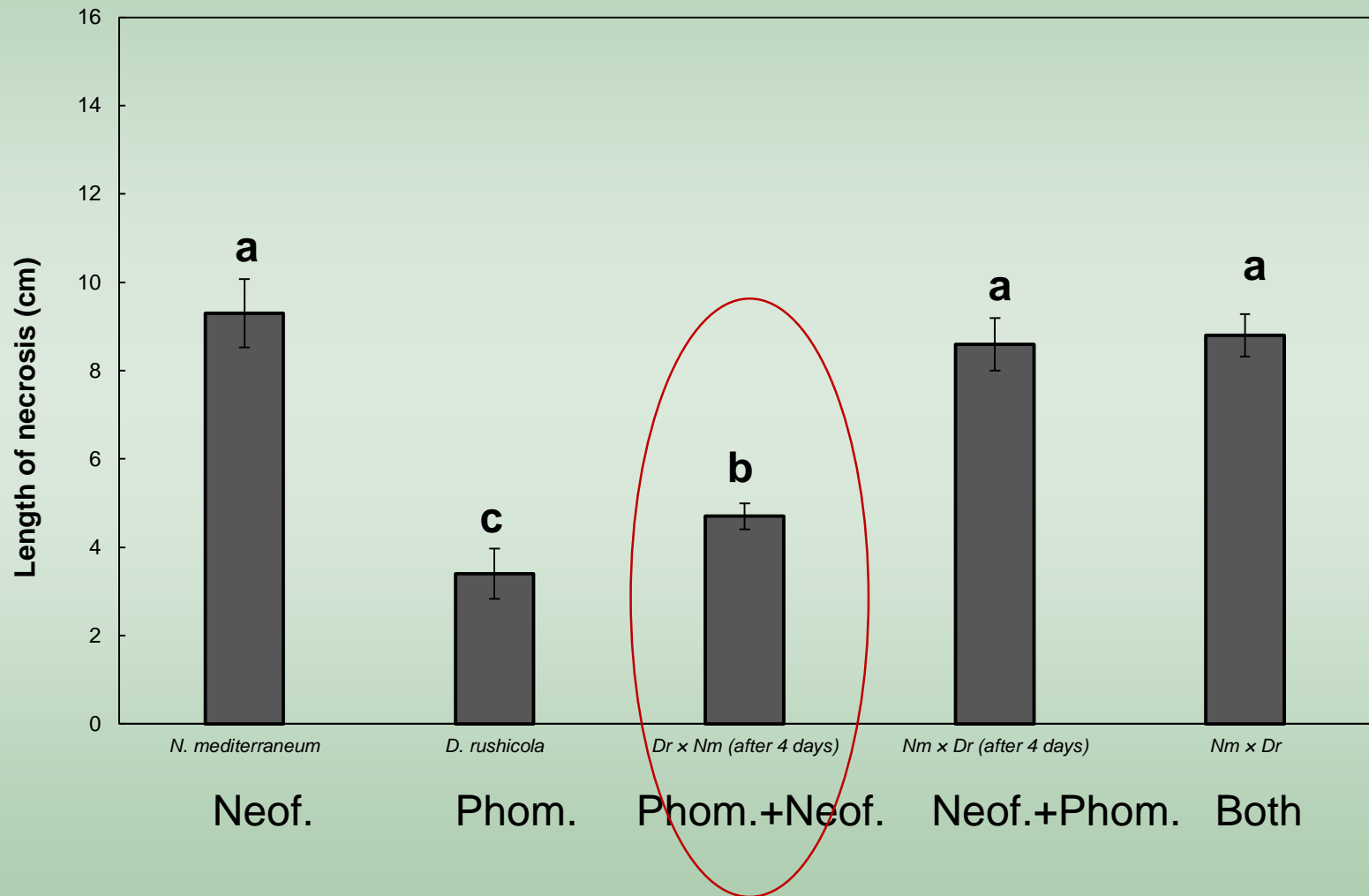
Thank you for your attention



We also thank: California Walnut Board, UC Farm Advisors, PCAs, & BASF, Syngenta, Bayer, DuPont, Nishino, Valent, FMC, et al. ...

... and a multitude of walnut growers

Interaction of Botryosphaeria (*Neofusicoccum med.*) and *Phomopsis*



Effect of temperature on growth of *Phomopsis*, *Neofusicoccum*, and *Lasiodiplodia* species

