

A photograph of a pomegranate tree with green leaves and several ripe, red pomegranates hanging from the branches. The tree is set against a background of more foliage and a clear sky.

# **Botryosphaeria: A Manageable Disease in Pomegranates?**

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Parlier, CA

Florida Pomegranate Association 3<sup>rd</sup> Annual Meeting,  
October 10, 2014

## Sacramento







**Kearney Agricultural Research and Extension Center**

## **Major goals of our research efforts** (diseases of fruit trees, nut trees, & vines)

- The study of the epidemiology of tree fruit diseases and the development of practical techniques/assays for the detection and prediction of diseases to help pest control advisers & growers to manage these diseases.
- Whenever possible, we use and apply new technological advances to answer questions in disease biology, epidemiology and management.

# Summary of disease/fungi showing on fruit

<b>Diseases that show symptoms in the calyx (crown)/anthers:</b>	Alternaria Penicillium Botrytis Aspergillus niger Cladosporium Colletotrichum spp. Coniella granati
<b>Diseases that show symptoms internally:</b>	<b>Black heart</b> (Alternaria)*** Botrytis Penicillium Aspergillus Pilidiella
<b>Diseases that show symptoms in various wounds:</b>	Botrytis Penicillium Alternaria Aspergillus niger Monilia sp.



Black heart



# When do infections occur?

## Which stage is the most susceptible ?



Closed flower



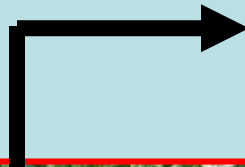
Open flower (full bloom)



Petal fall



Fruitlet





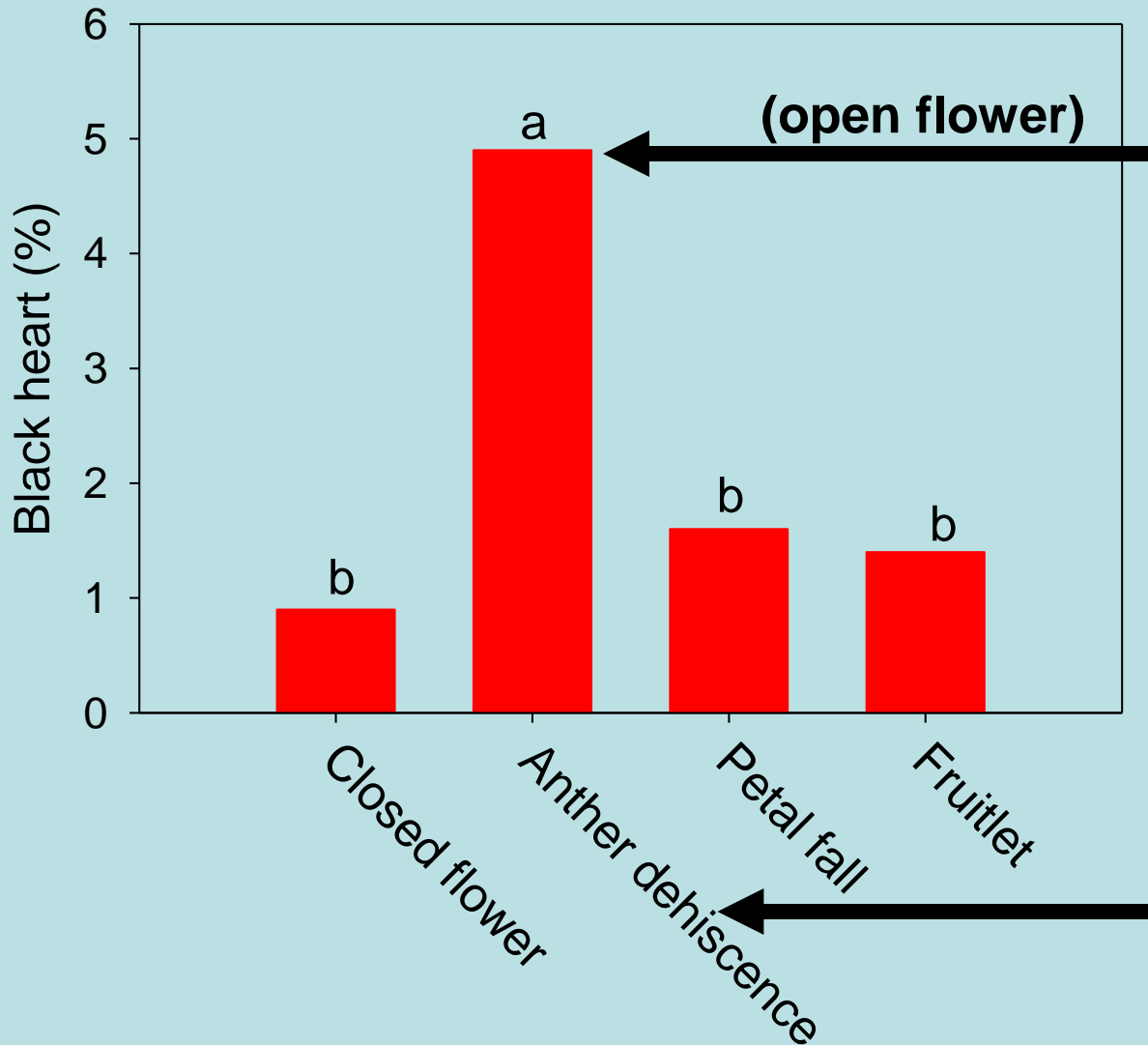








# The most susceptible **stage** of infection by *Alternaria alternata*



**Timing of fungicide  
sprays**



# Fungicide Trial – 2012

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Control (not treated) ----

Pristine .....15.5 oz

Luna Experience..... 6.0 oz

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250 flowers inoculated in three replications,

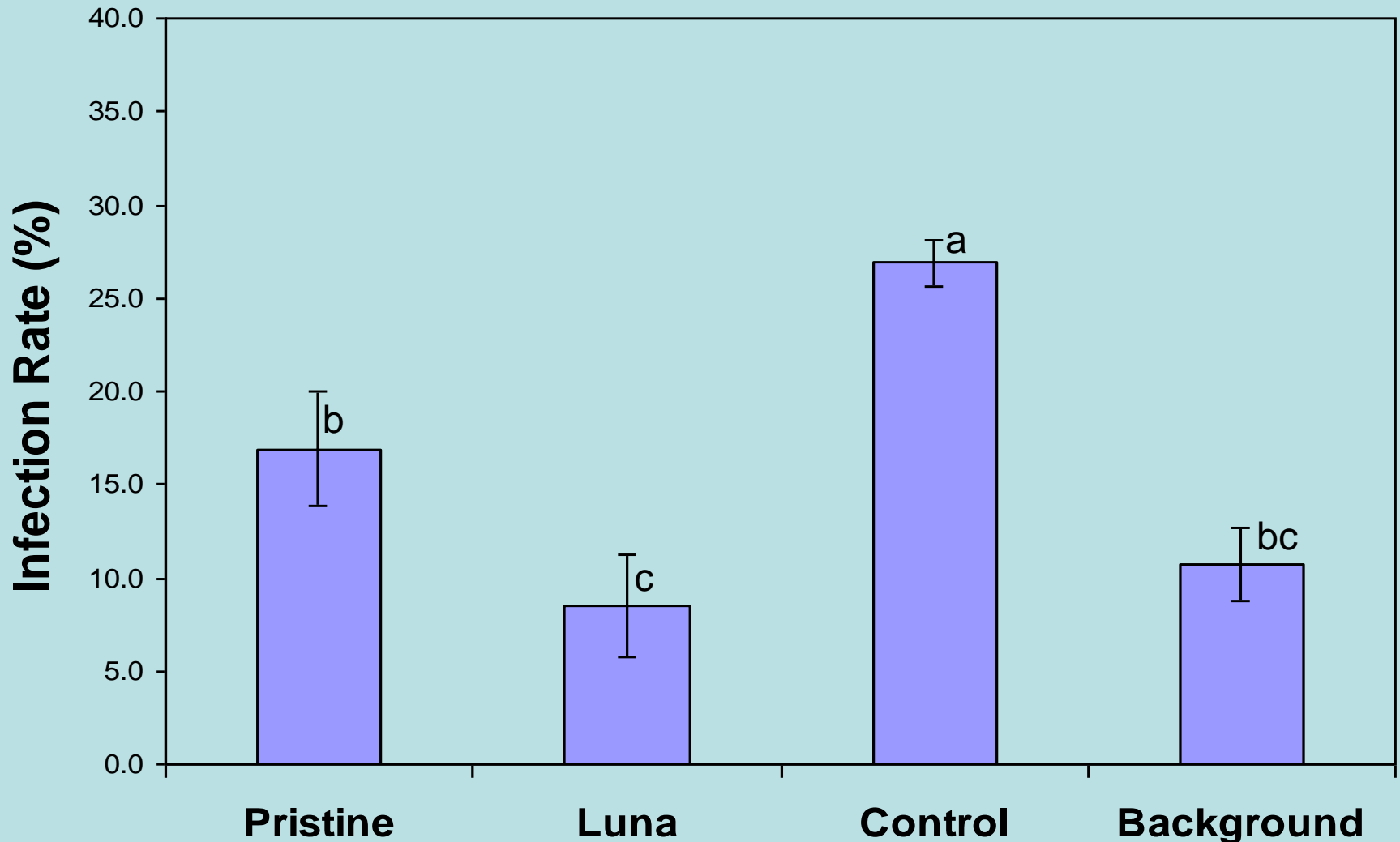
**14 May (1<sup>st</sup> exp.) and 21 May (2<sup>nd</sup> exp.)**

bagged, and bags were removed the following  
day

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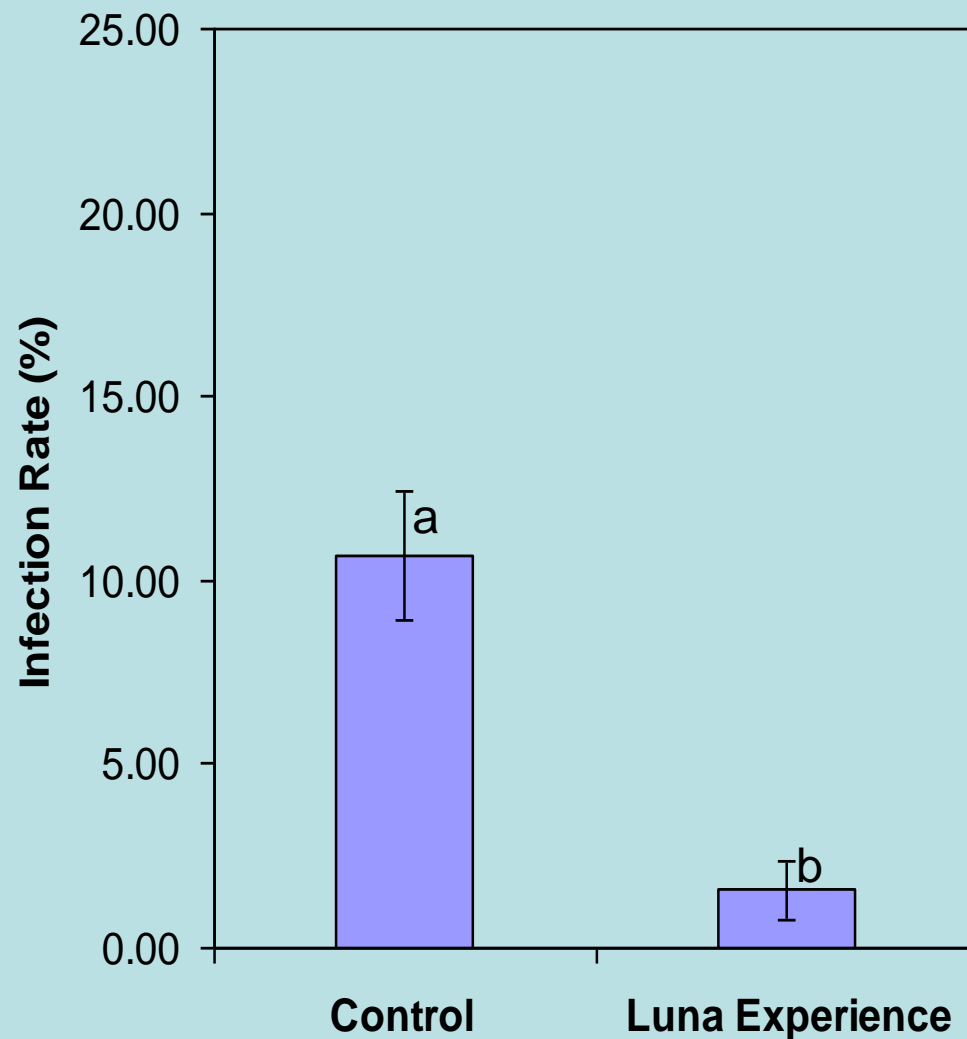
Fruit harvest on 10 October 2012

# Efficacy of two fungicides against black heart after inoculation on 14 May 2012

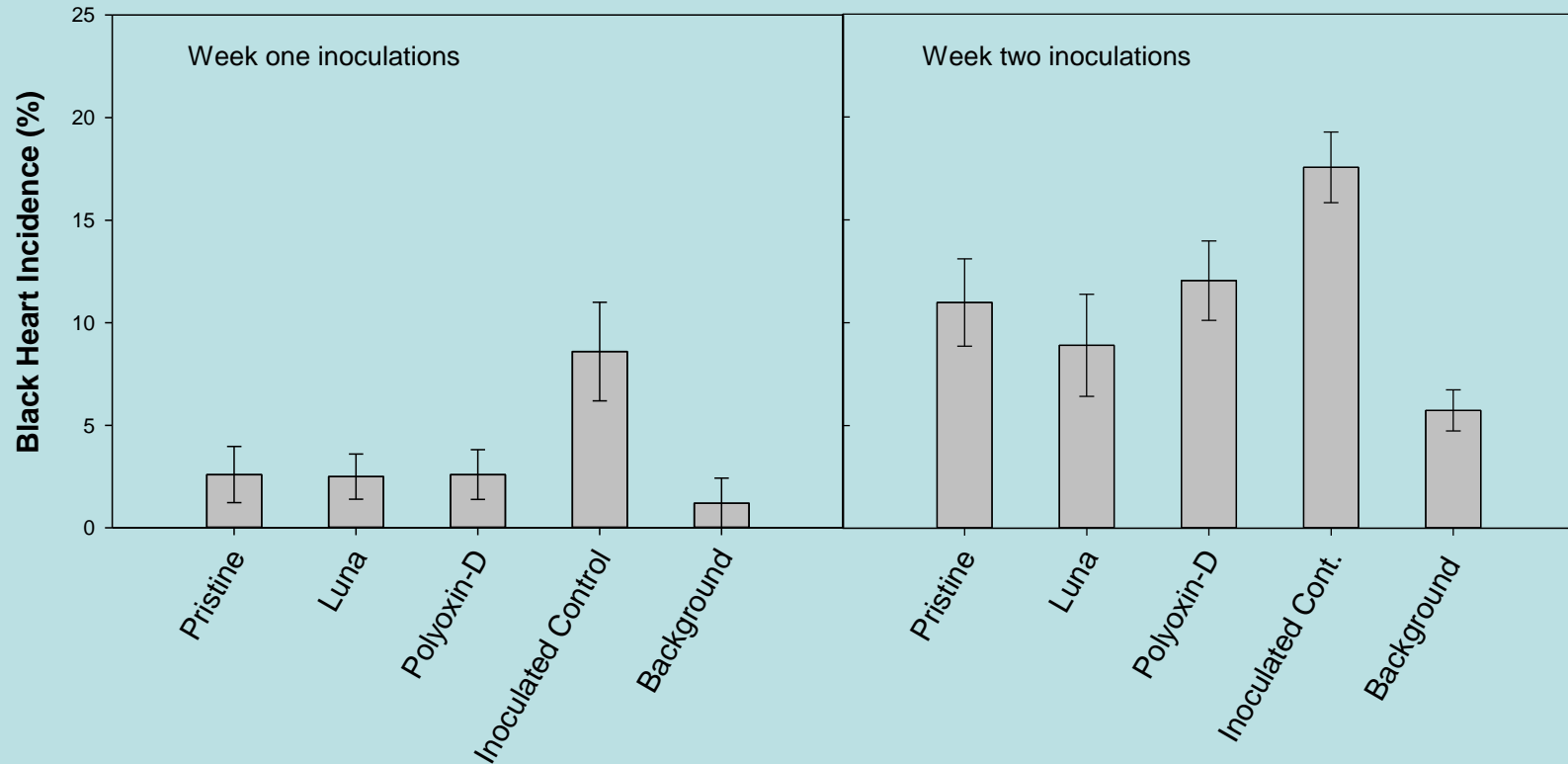




# Efficacy of Luna Experience against black heart after inoculation on 21 May 2012



# Efficacy of fungicides against black heart of pomegranates (inoculated on May 2<sup>nd</sup> (week one) and May 9<sup>th</sup> (week two), 2013)



Exprs. in 2013



# Botryosphaeria blight and canker in California





# Botryosphaeria cankers on the trunk



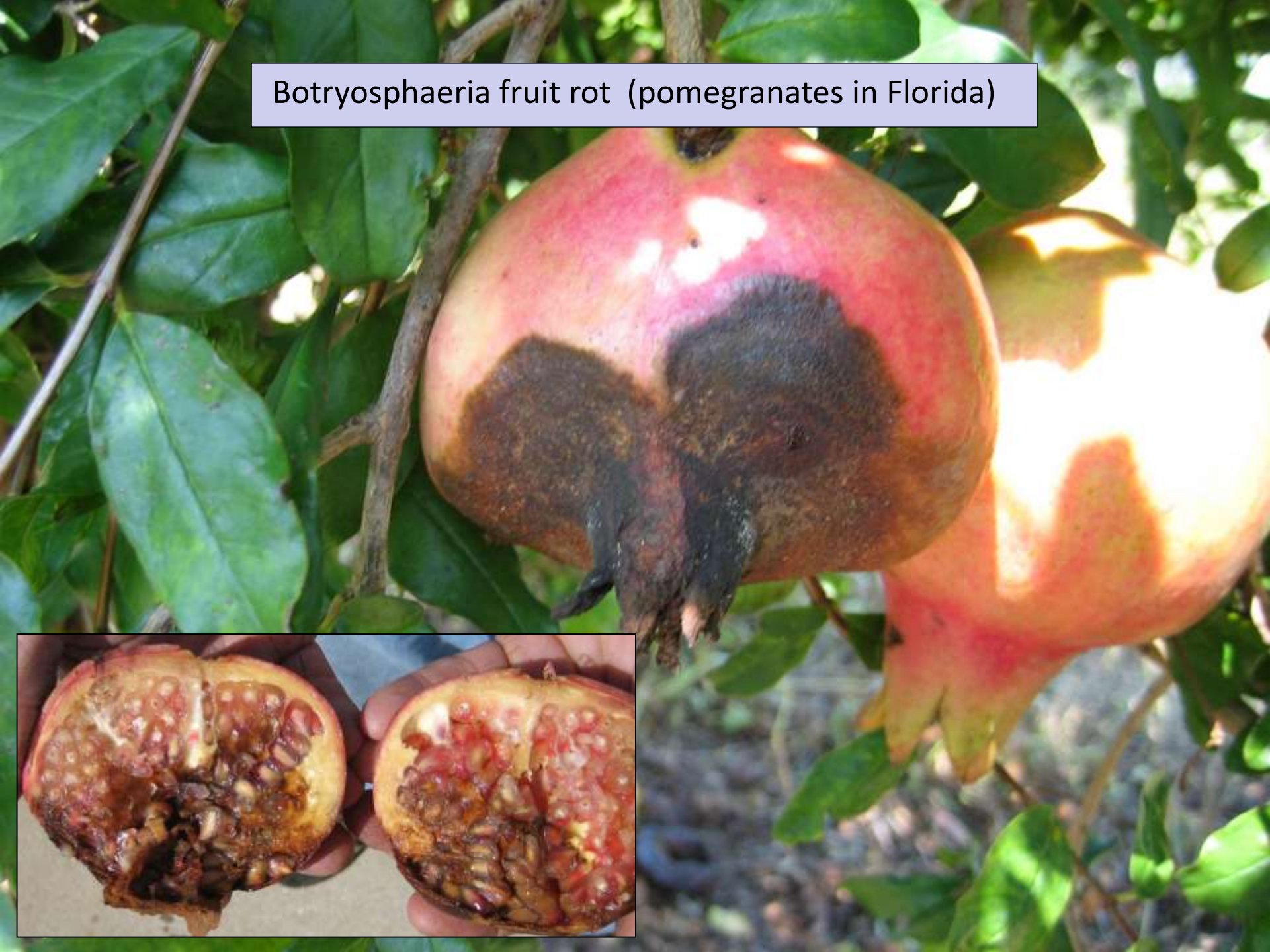
*Neofusicoccum mediterraneum*

*Diplodia seriata*

*Diplodia mutila*



Botryosphaeria fruit rot (pomegranates in Florida)





# Anthracnose



*Colletotrichum acutatum*

Aspergillus rot



*Aspergillus niger*





Botrytis gray mold





# UF /Department of Plant Pathology - PDC

## Plant Specimen Diagnostic Report Summary

### **Fruit**

- 2 *Lasiodiplodia theobromae*
- 2 *Neofusicoccum parvum*

### **Dieback**

- 6 *Neofusicoccum parvum*

Usually these fungi occur in larger groups (more species)

# Summary of Botryosphaeriaceae in nut crops – California

Fungal species	Walnut	Pistachio	Almond
<i>Botryosphaeria dothidea</i>	+	+	+
<i>Neofusicoccum parvum</i>	+	+	+
<b><i>Neofusicoccum mediterraneum</i></b>	+	+	+
<b><i>Diplodia mutila</i></b>	+	---	---
<i>Neofusicoccum nonquaesitum</i>	+	---	+
<i>Neofusicoccum vitifusiforme</i>	+	+	---
<b><i>Diplodia seriata</i></b>	+	+	+
<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> )	+	---	---

**conidia**

✓ water  
splashed

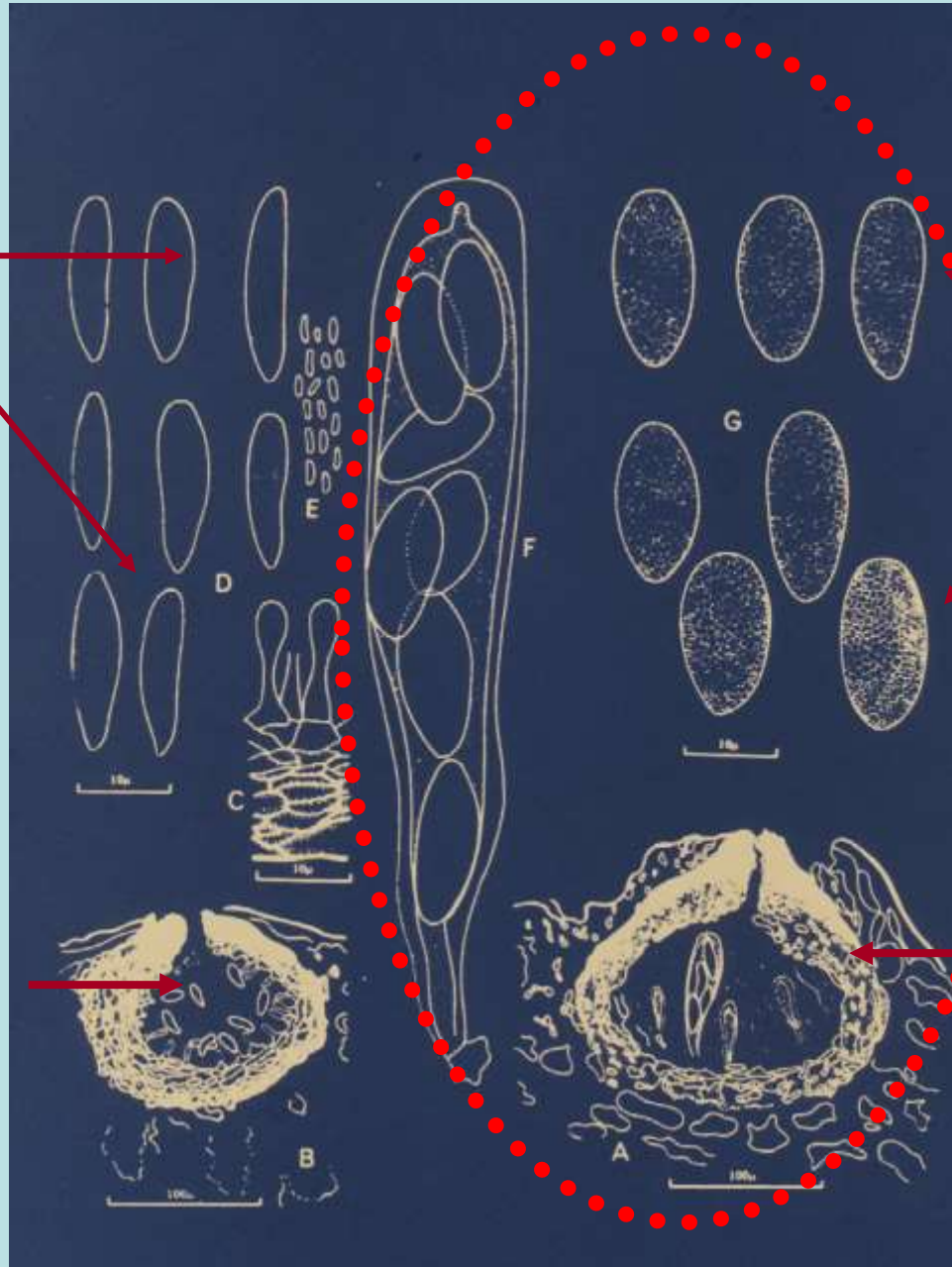
✓ insect  
spread

**pycnidia**

**ascospores**

✓ airborne

**perithecia  
(ascocarps)**

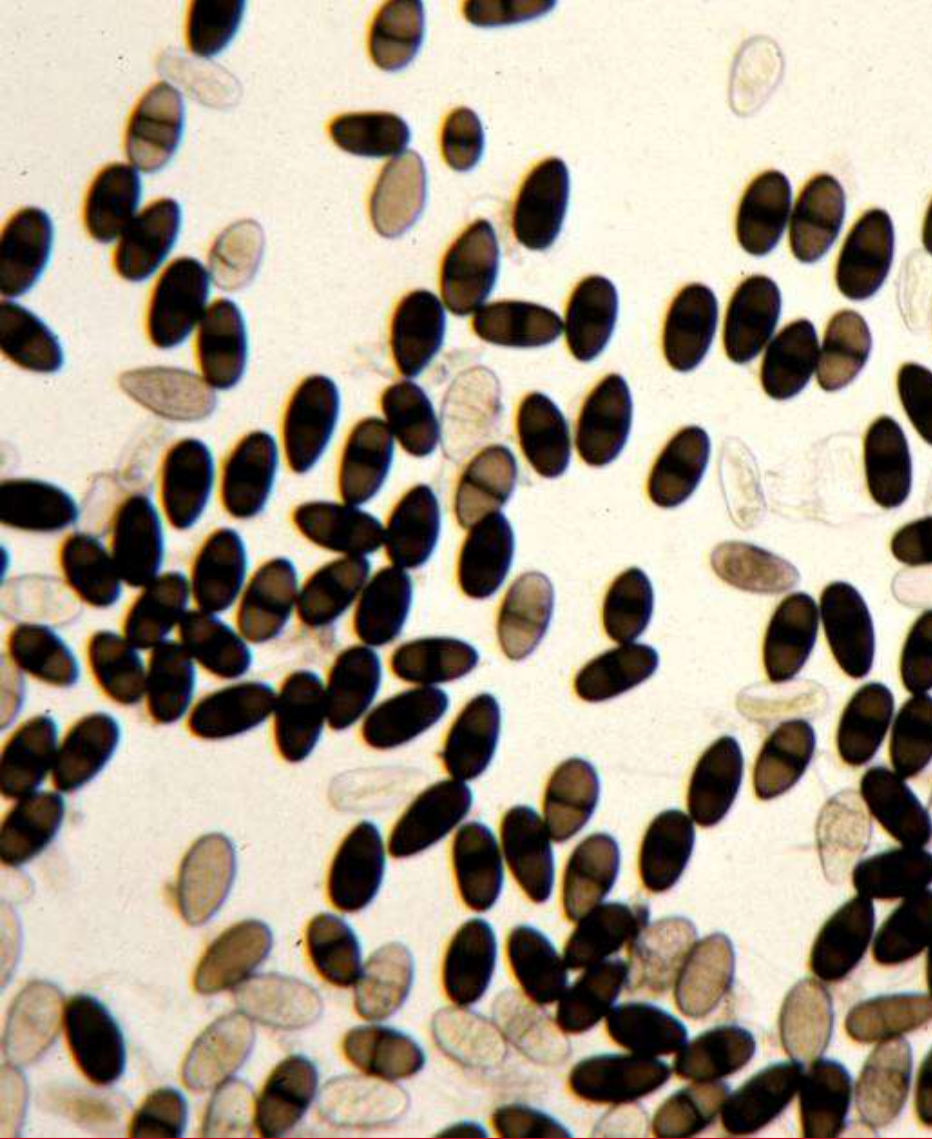


***Botryosphaeria* reproductive structures**

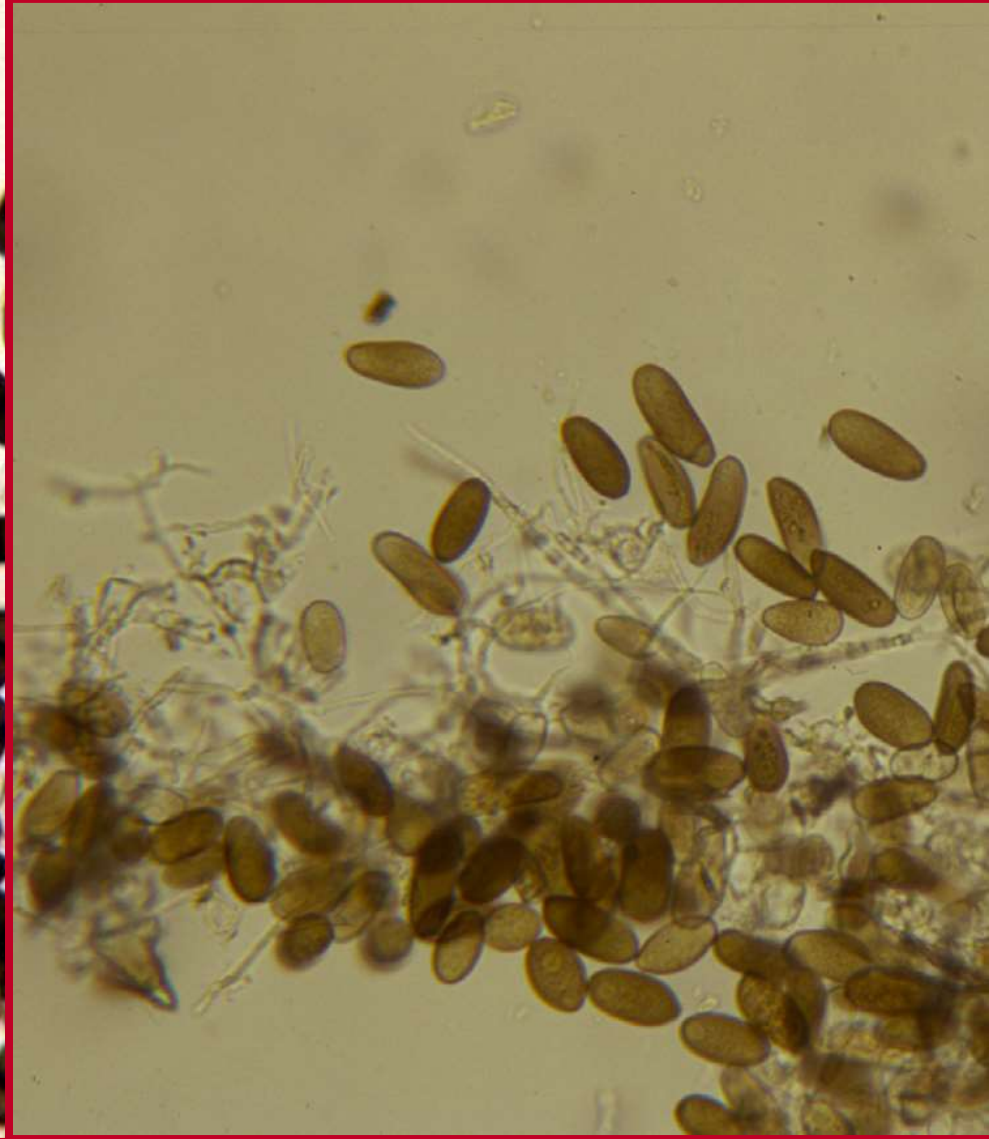


1. *Botryosphaeria dothidea*
2. *Neofusicoccum mediterraneum*
3. *Neofusicoccum parvum*
4. *Neofusicoccum nonquaesitum*
5. *Dothiorella vitifusiforme*
6. *Dothiorella sarmentorum*





**1. *Lasiodiplodia citricola***



**2. *Diplodia seriata***

**3. *Neoscytalidium dimittatum*  
(*Hendersonula toruloidea*)**

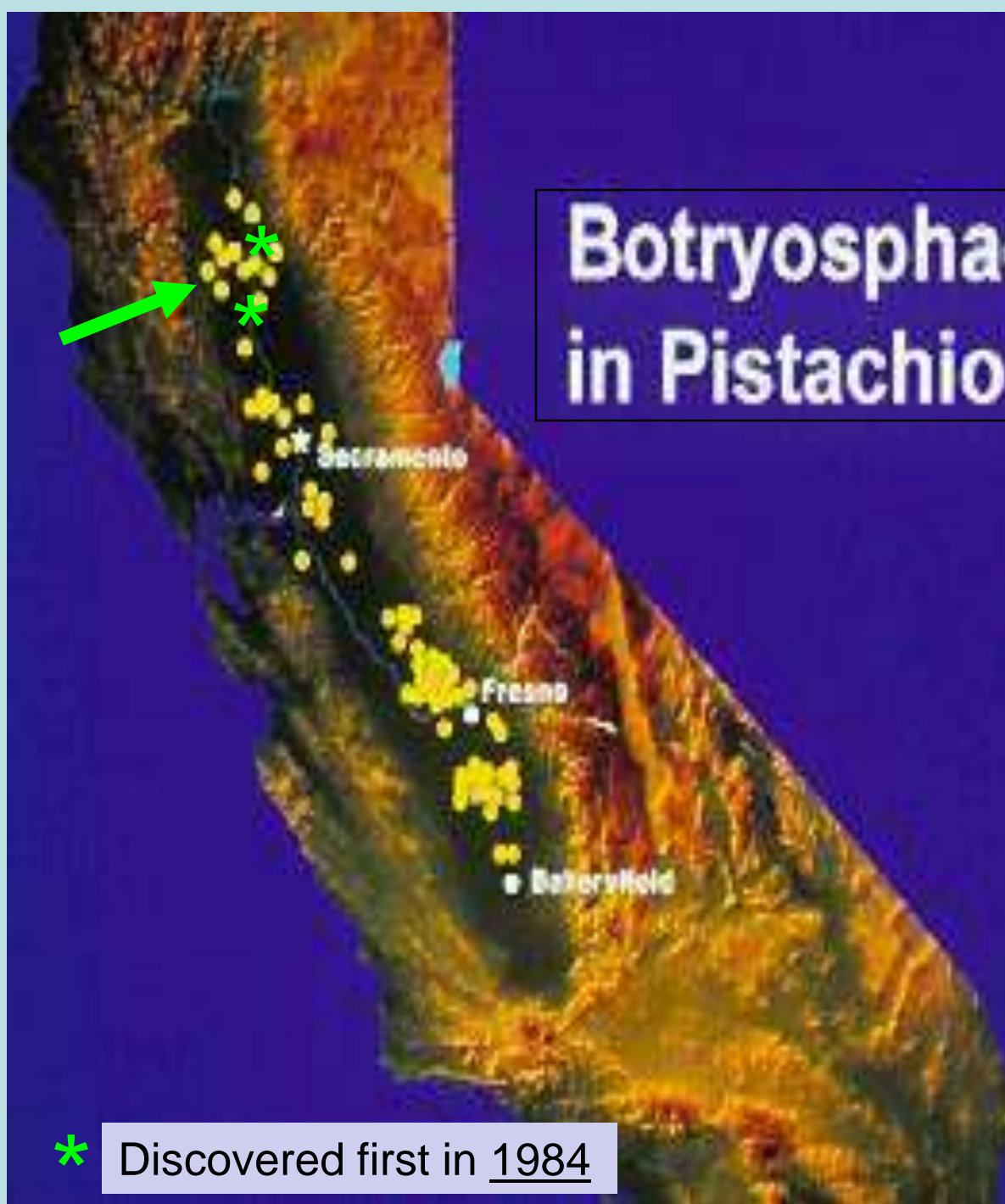
**4. *Macrophomina phaseolina***



# 1. Botryosphaeria panicle and shoot blight



# Botryosphaeria Blight in Pistachio Orchards



\* Discovered first in 1984



1996-1997







Botryosphaeria blight in  
1997-98



...because of Botryosphaeria blight (1998)





# Botryosphaeria Working Group - Fall 1997

## Priorities and questions to be answered

October 15, 1997  
Botryosphaeria Working Group  
Jean Phillimore

Date: \_\_\_\_\_  
To: \_\_\_\_\_  
From: \_\_\_\_\_  
Subject: Botryosphaeria Unanswered Questions

This set of questions has been compiled from input by the Botryosphaeria Working Group. It is in no way meant to be all inclusive at this point, but rather a starting point for Research and Project Development.

### I. Pruning and Sanitation Issues

1. Do all prunings, including mummy nuts need to be removed from the orchard?
2. What are optimum pruning times for maximum disease (pyrenidia) reduction?
3. Where should pruning cuts be made, and is cluster removal sufficient versus a limb cut?
4. Can Botryosphaeria be transmitted between trees/orchards by means of tools or hedging equipment?
5. At what point is the orchard beyond reclamation?


### II. Disease Movement, Vectors and Host Plants

1. What insects and birds are spreading this disease?
2. What are the modes of action by the vectors: topical, injection (by feeding) etc.?
3. How long does the disease remain viable in/on the vector?
4. What are the economic levels of the various epicarp lesions?
5. Are the vectors moving this disease from host plants?
6. Are the vectors moving this disease from nut to nut, canker to nut, mummy on ground to nut, prunings on ground to nut etc?
7. Is there the possibility of a wind borne form disseminating this disease?
8. How are neighboring orchards affecting each other and what is the most likely method of transmission?

### III. Mapping, Demographics and Industry

1. What is the history of the industry?
2. What has been the impact of the disease?
3. What methods for control are growers using?
4. Are there well defined growing regions?

**MESSAGE FROM  
THE PRODUCTION  
RESEARCH COMMITTEE  
CHAIRPERSON  
JEAN PHILLIMORE**



Research Committee

February 1998

# reports

## Botryosphaeria: #1 Priority

Because Botryosphaeria is currently the highest research priority for the industry, it was determined that additional resources should be applied to further investigate this costly disease. In February, the Commission voted to contribute \$121,000 toward Botryosphaeria-related research projects this year.

In an effort to help growers and farm managers to identify Botryosphaeria early and control it before it gets to a critical stage, the Commission will include information in each edition of *The Pistachio Perspective* emphasizing the current season's symptoms to be monitored, and how to respond once Botryosphaeria has been identified.

Also available through the Commission is a 22-minute videotape of the field tour that occurred on October 8, 1997. Dr. Themis Michailides of the U.C. Kearney Agricultural Center and Gary [unclear] of the Commission's Research [unclear] Jack Gilbert's



Can you recognize Botryosphaeria?



## 2. Botryosphaeria (band) canker of almond





# Occasional symptoms of Botryosphaeria (band) canker of almond









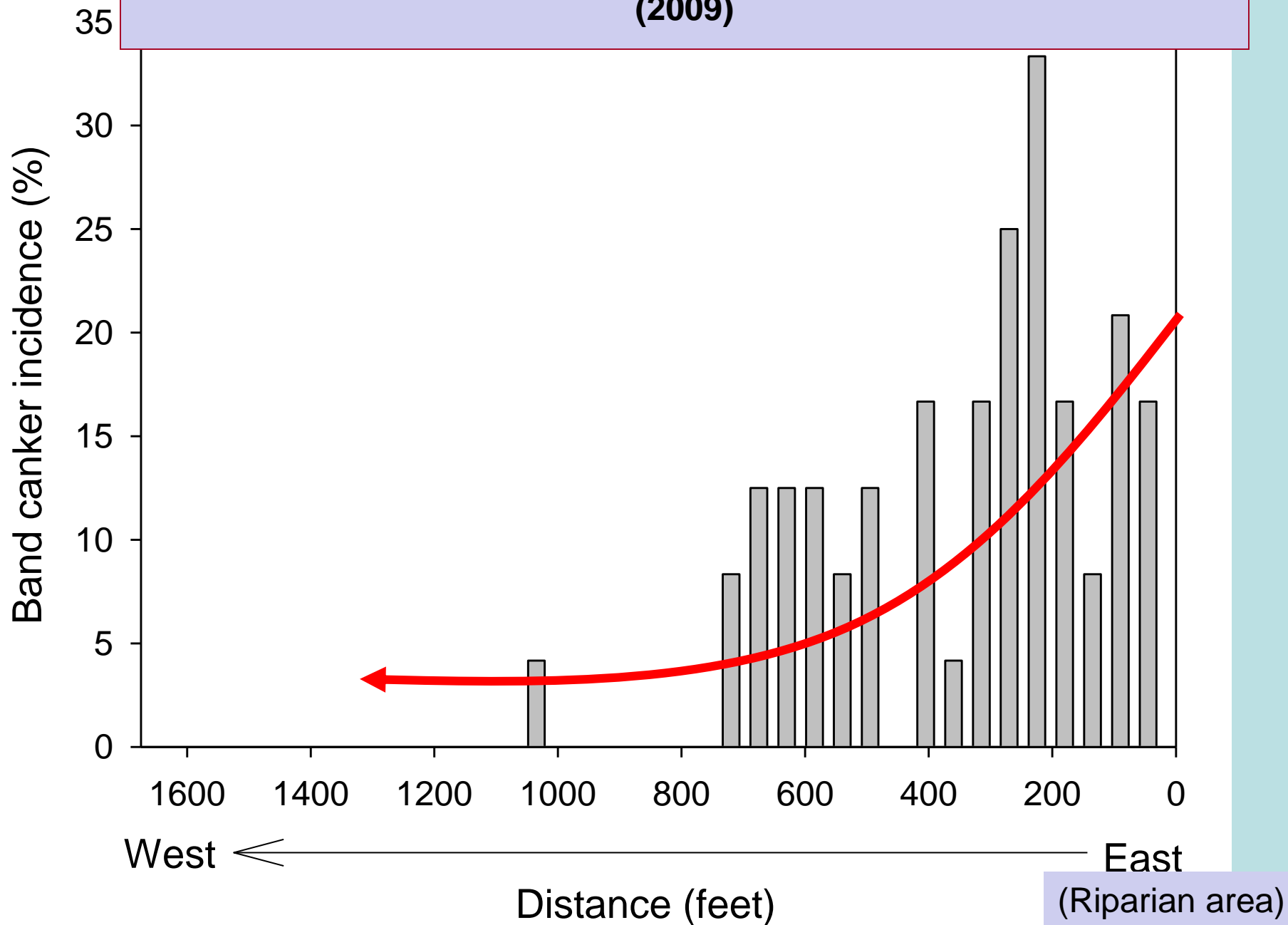
Airborne ascospores in the orchard

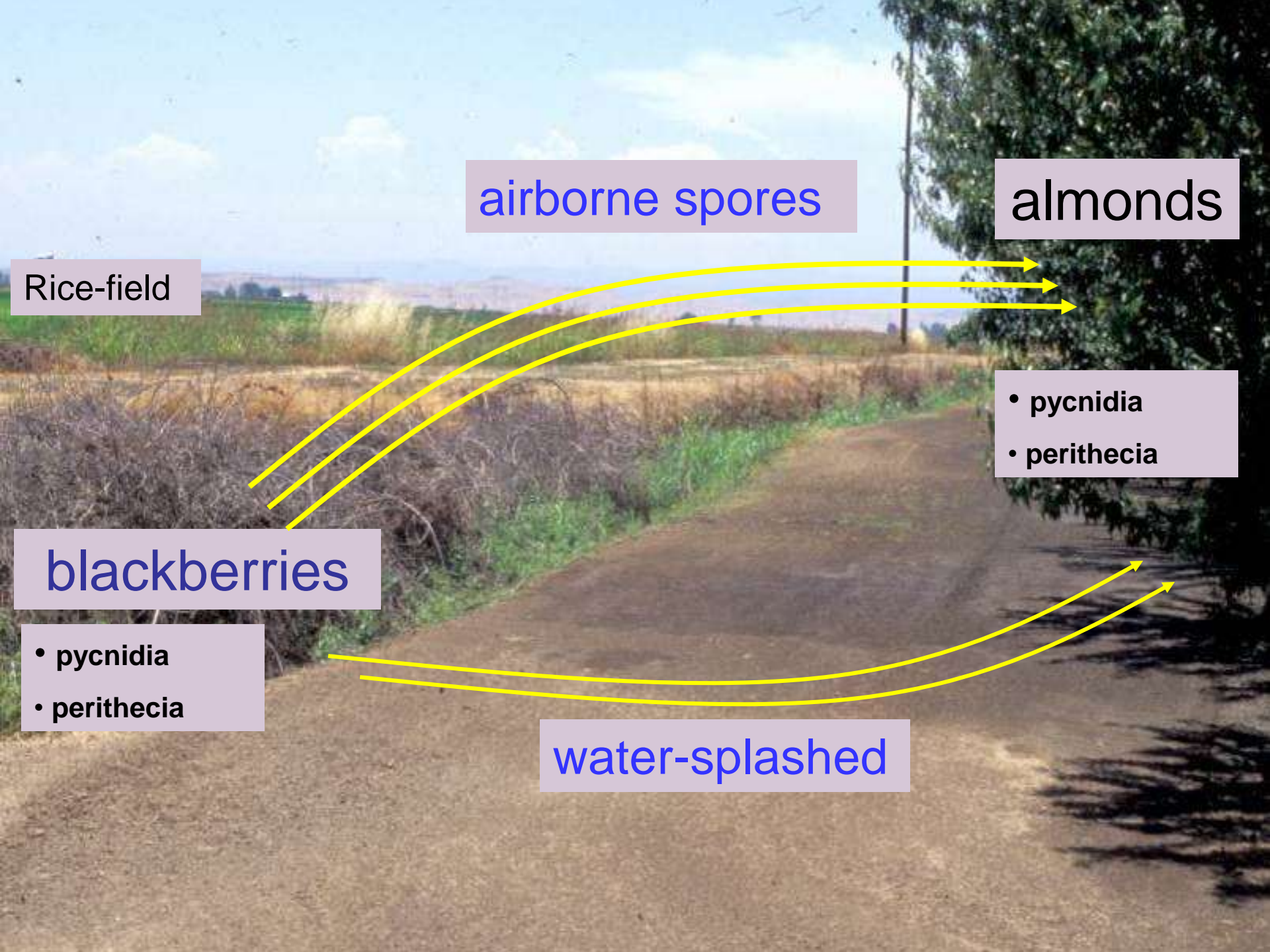
East





# Distribution of almond band canker in a third-leaf almond orchard (2009)





airborne spores

almonds

Rice-field

blackberries

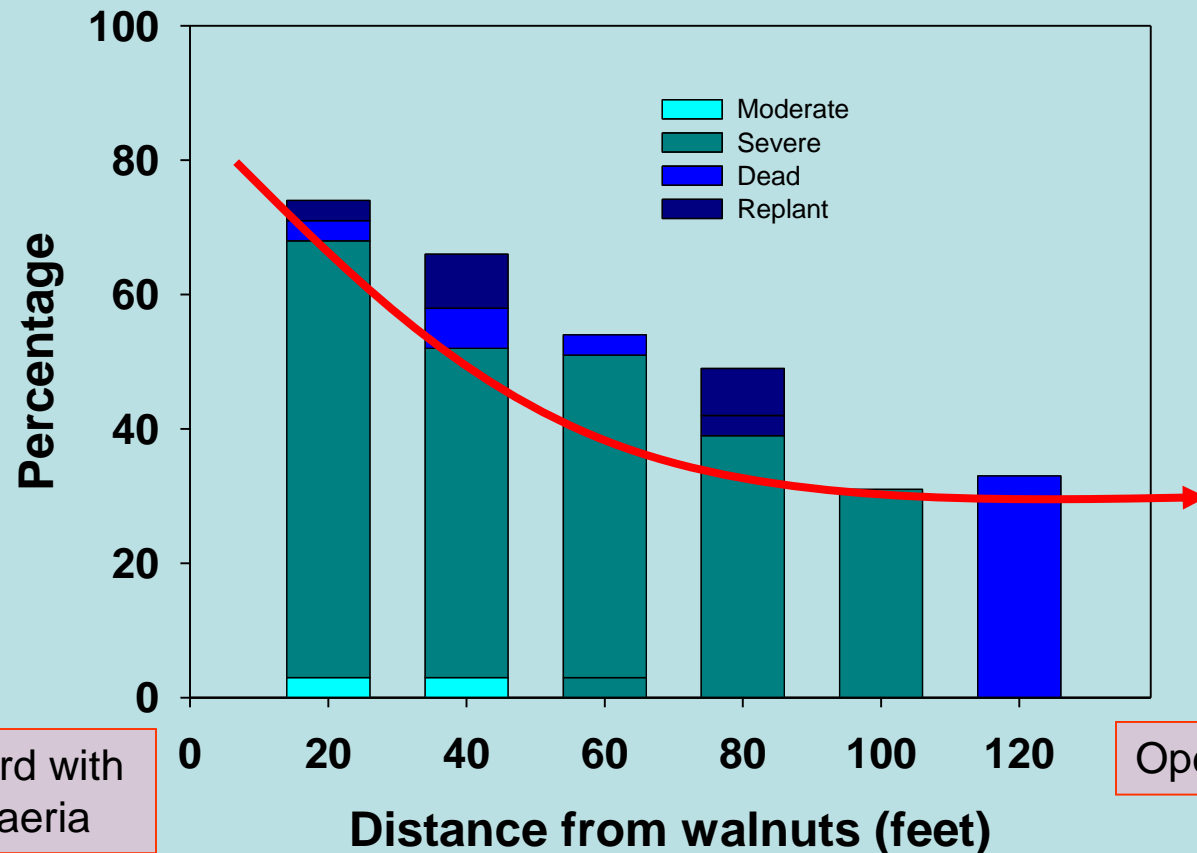
- pycnidia
- perithecia

- pycnidia
- perithecia

water-splashed

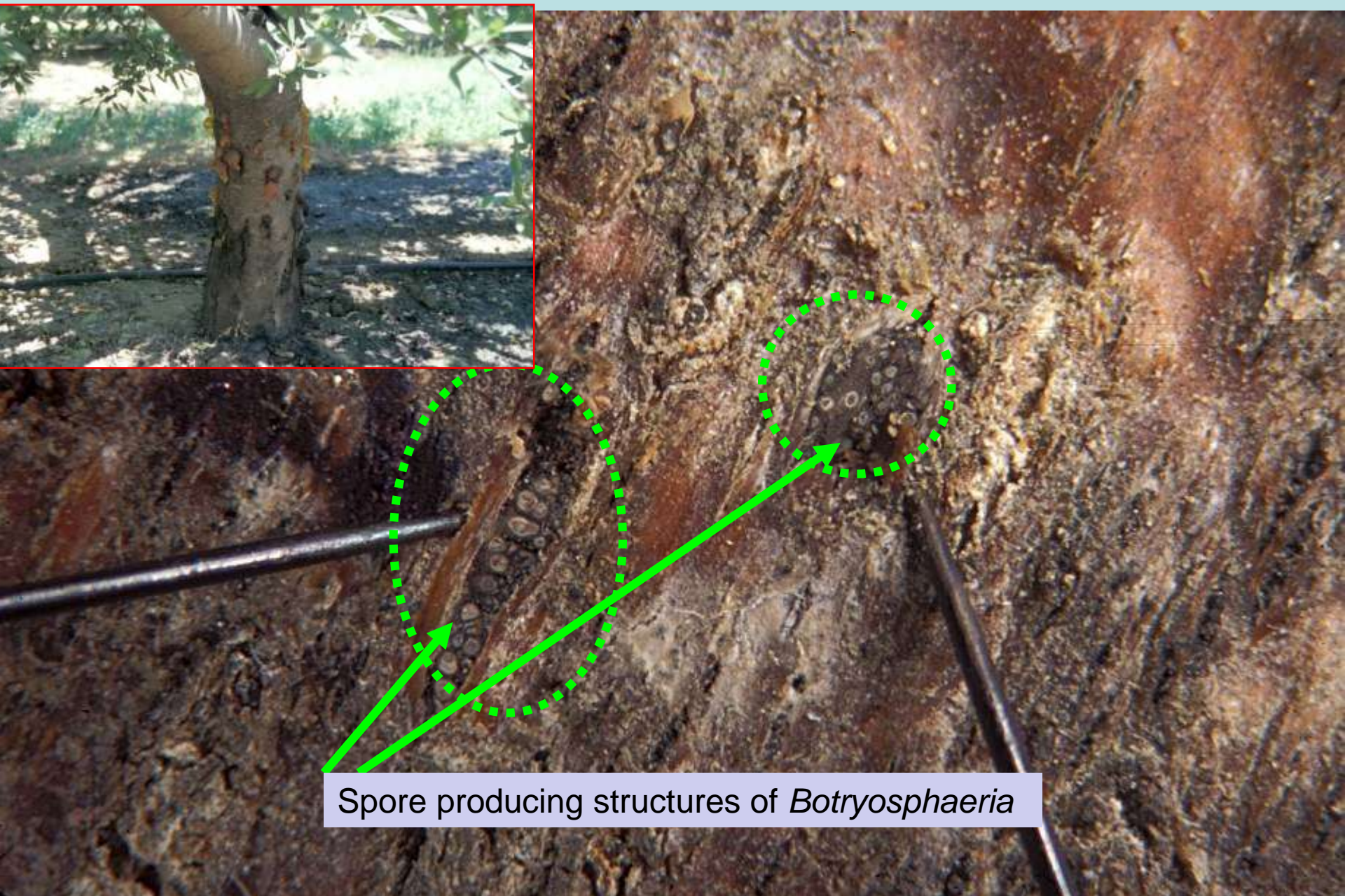


# Amator band canker incidence from walnuts



Old walnut orchard with heavy Botryosphaeria

Open field (no trees)



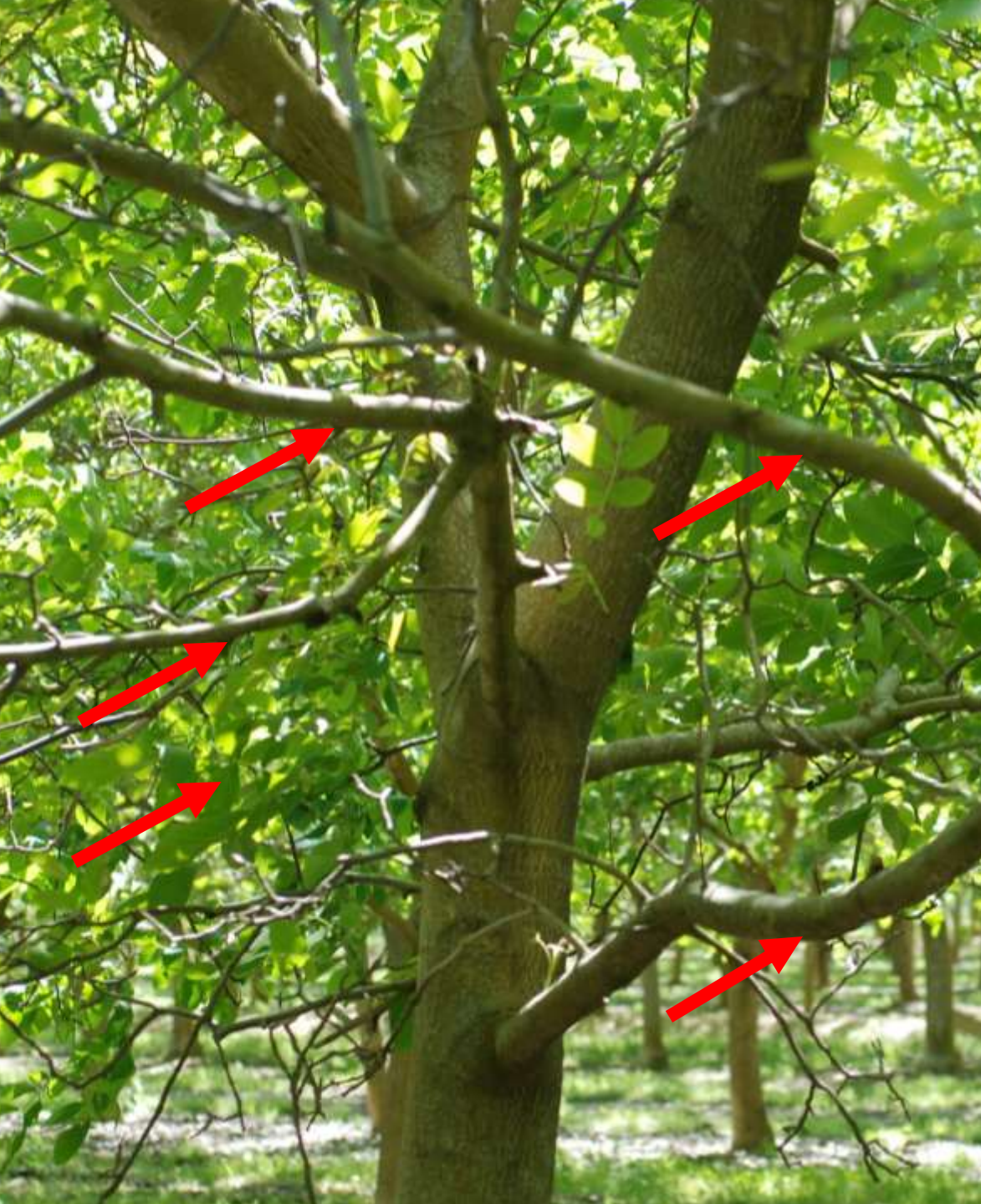
Spore producing structures of *Botryosphaeria*



### 3. Botryosphaeria blight & canker of walnut

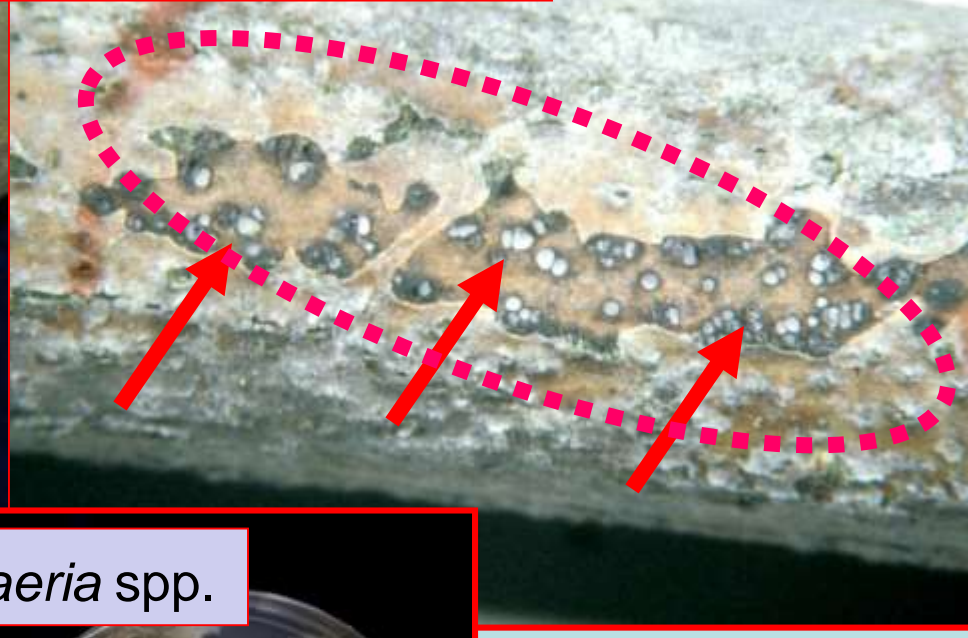








# Spore inoculum in walnut



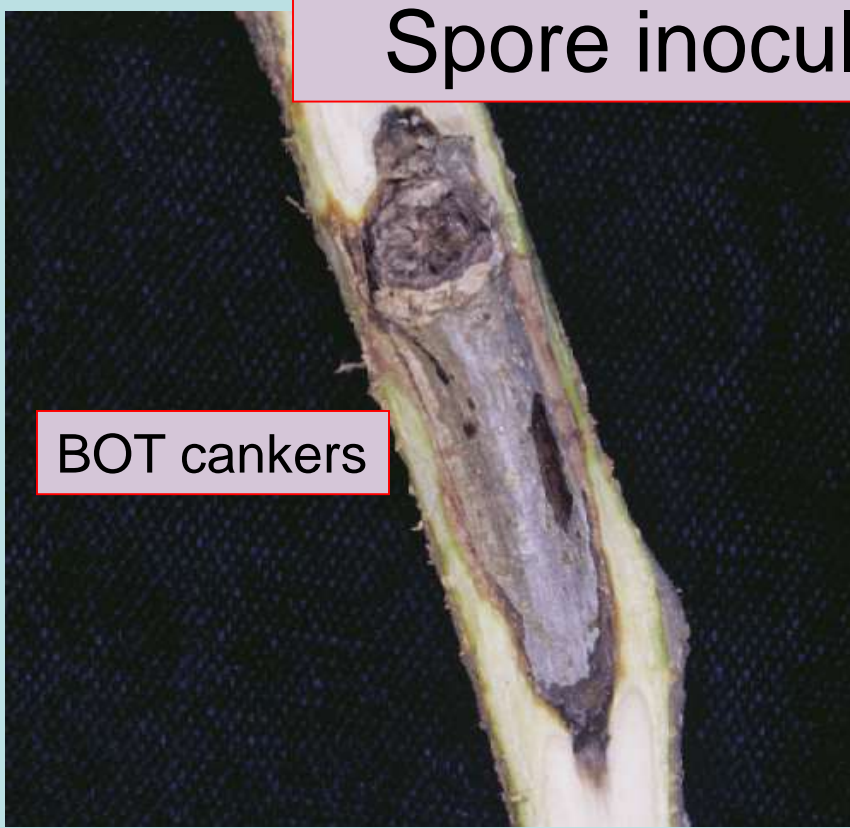
*Botryosphaeria* spp.



Cankers, pycnidia, and *Botryosphaeria*

# Spore inoculum in pistachio

BOT cankers



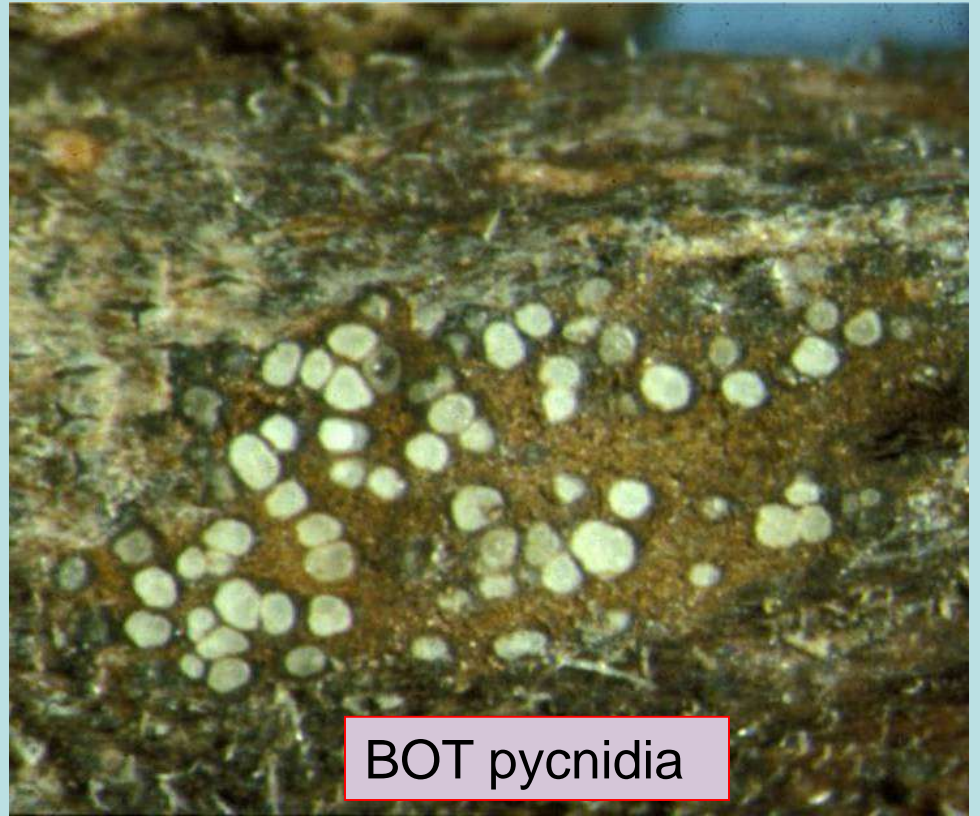
BOT pycnidia



Killed buds



BOT pycnidia





# Sources of inoculum

## Pistachio

- Cankers
- Rachises
- Petioles,
- Killed buds
- Fruit
- Bark (even healthy)

## Almond

- Cankers
- Trunk bark

## Walnut

- Cankers
- Spurs
- Petioles
- Killed buds



At least 35 other host plants (California)

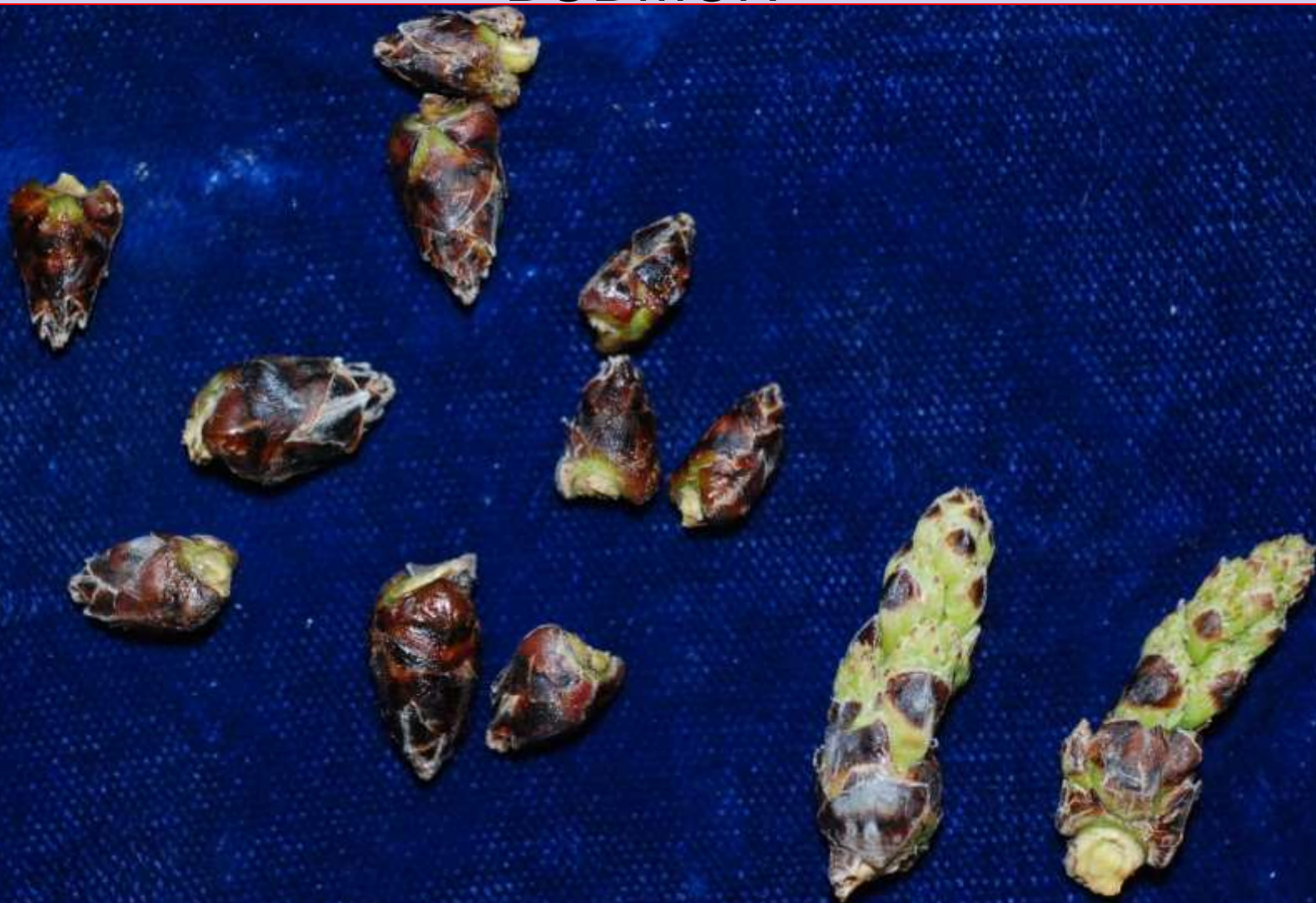


# Severely infected pistachio by *Botryosphaeria*



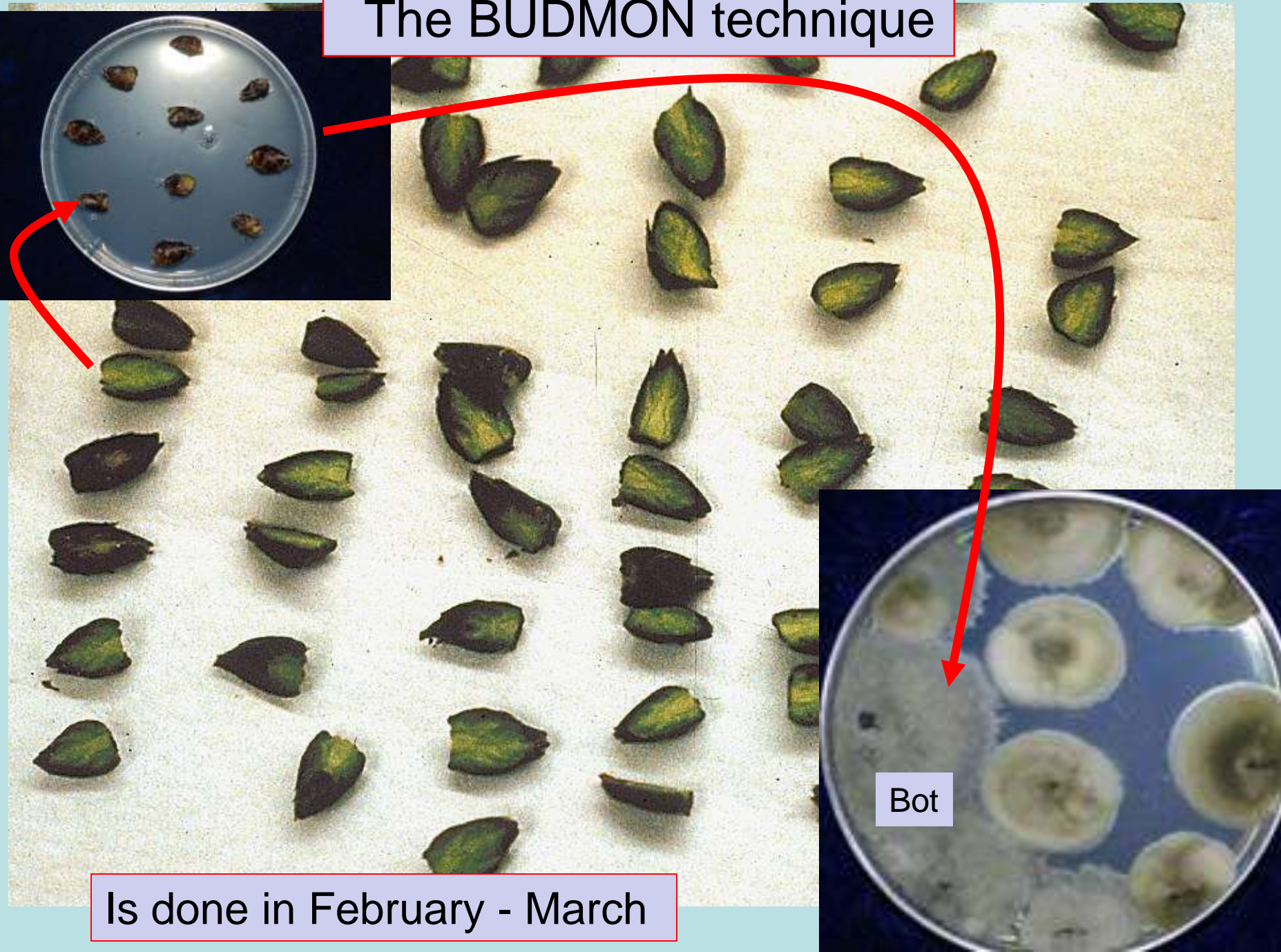


Monitor the Botryosphaeria in dormant buds  
= BUDMON





# The BUDMON technique



Is done in February - March



# Laboratory BUDMON results of commercial pistachio samples

Lab No. VI 1440765

6360 Hahn Road  
Arbuckle, CA 95912

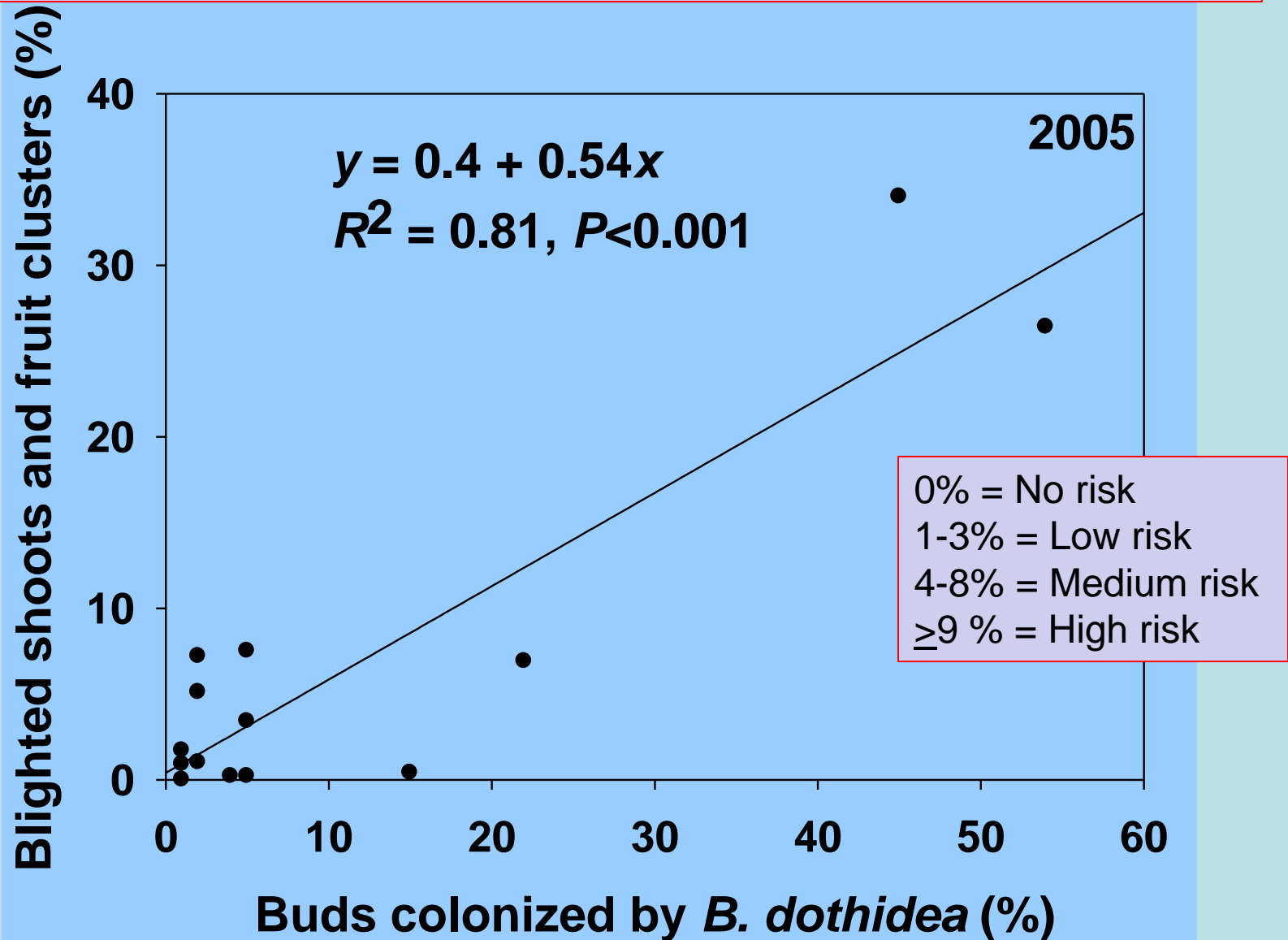
## SUBJECT: RESULTS OF CULTURE FOR BOTRYOSPHERA BLIGHT - (BOTRYOSPHERA DOTHIDEA)

Sampled by:

Analysis by: George

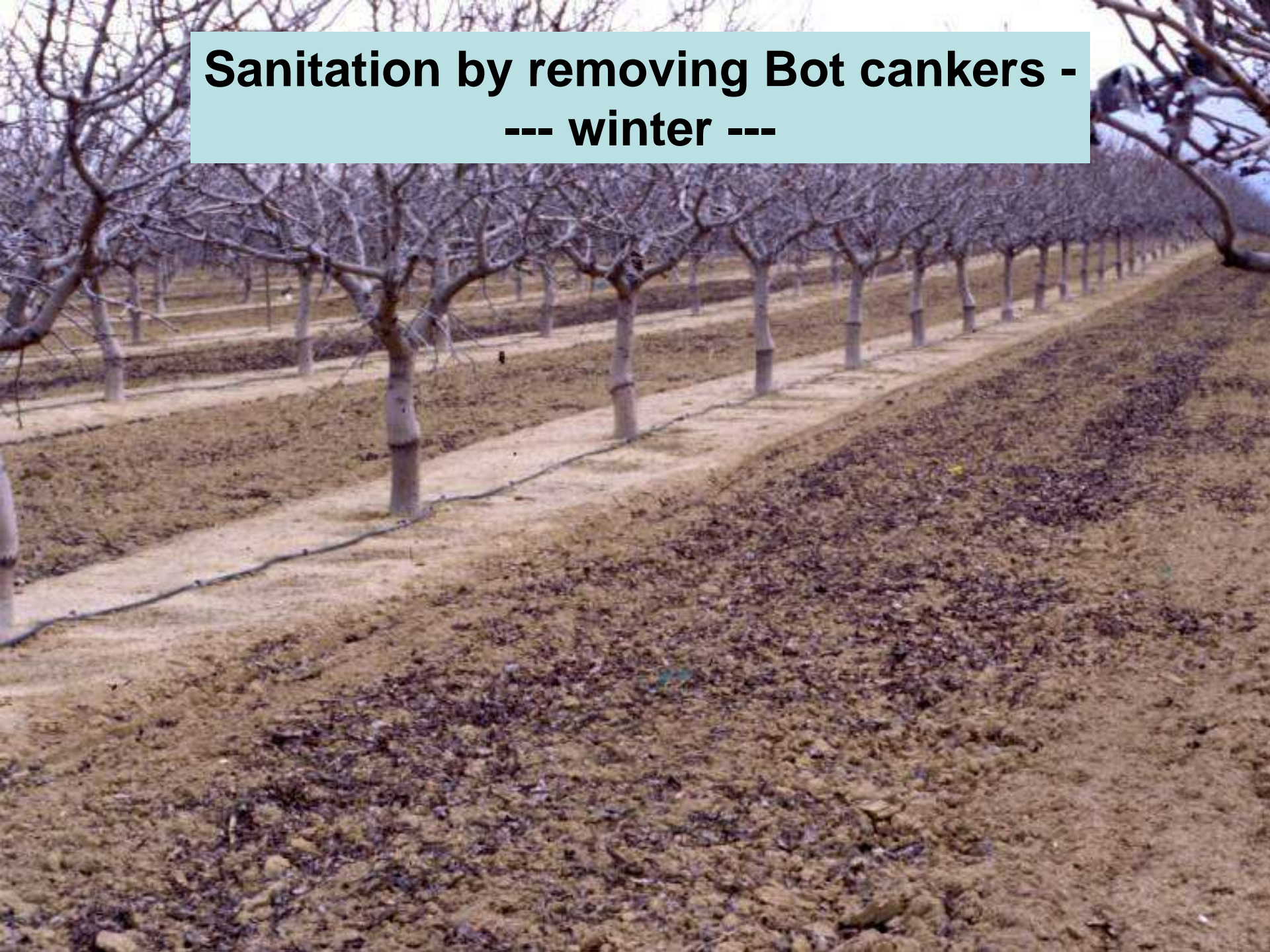
<u>Culture Description</u>	<u>Sampling Date</u>	<u>Date Culture Started</u>	<u>Date Culture Completed</u>	<u>Count Results</u>
1. 140 North	03/18/14	03/20/14	03/27/14	2%
2. 140 Middle	03/18/14	03/20/14	03/27/14	3%
3. 140 South	03/18/14	03/20/14	03/27/14	3%
4. 150 North	03/18/14	03/20/14	03/27/14	9%
5. 150 Middle	03/18/14	03/20/14	03/27/14	10%
6. 150 South	03/18/14	03/20/14	03/27/14	16%
7. 200 North	03/18/14	03/20/14	03/27/14	3%
8. 200 South	03/18/14	03/20/14	03/27/14	5%
9. 201 North	03/18/14	03/20/14	03/27/14	9%
10. 201 South	03/18/14	03/20/14	03/27/14	8%
11. 202 Northeast	03/18/14	03/20/14	03/27/14	7%
12. 202 Northwest	03/18/14	03/20/14	03/27/14	8%
13. 202 Southeast	03/18/14	03/21/14	03/28/14	8%
14. 202 Southwest	03/18/14	03/21/14	03/28/14	10%
15. 203 North	03/18/14	03/21/14	03/28/14	10%
16. 203 South	03/18/14	03/21/14	03/28/14	4%
17. 204 Northeast	03/18/14	03/21/14	03/28/14	2%
18. 204 Northwest	03/18/14	03/21/14	03/28/14	10%
19. 204 South	03/18/14	03/21/14	03/28/14	5%
20. 800 Blk 1 No.	03/18/14	03/21/14	03/28/14	2%
21. 800 Blk 2 No.Mid	03/18/14	03/21/14	03/28/14	1%
22. 800 Blk 3 So.Mid	03/18/14	03/21/14	03/28/14	2%
23. 800 Blk 4 So.	03/18/14	03/24/14	03/31/14	1%

# Relationship between BUDMON and disease at harvest





# **Sanitation by removing Bot cankers - --- winter ---**





# Summer pruning & removal of prunings in pistachios

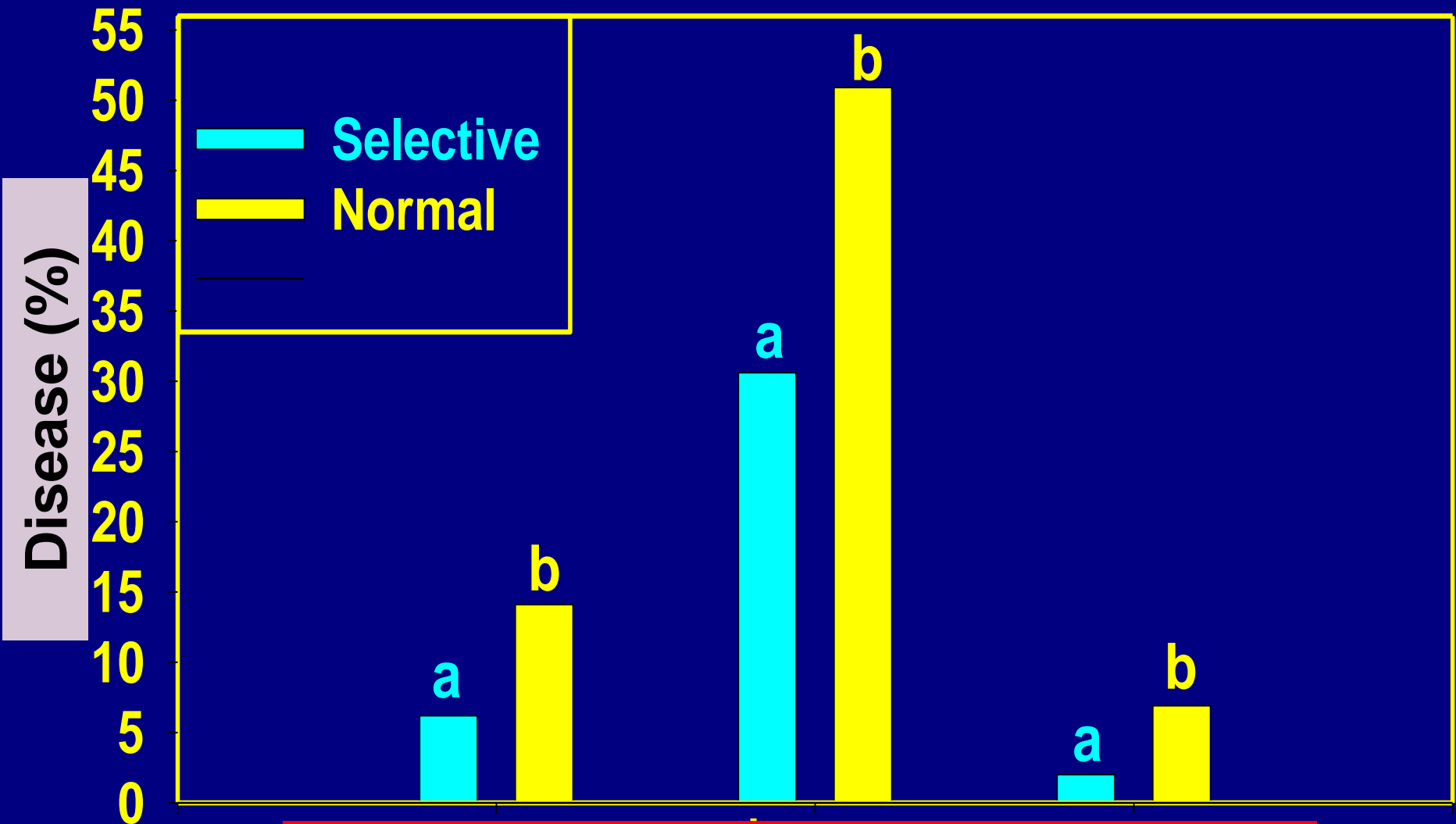




# Summer pruning in walnut



# Removal of Bd Cankers by Pruning



By just doing selective pruning: 50% reduction in Botryosphaeria disease





Prunings

In pomegranate  
orchards:

Are these the overwintering  
spore sources?



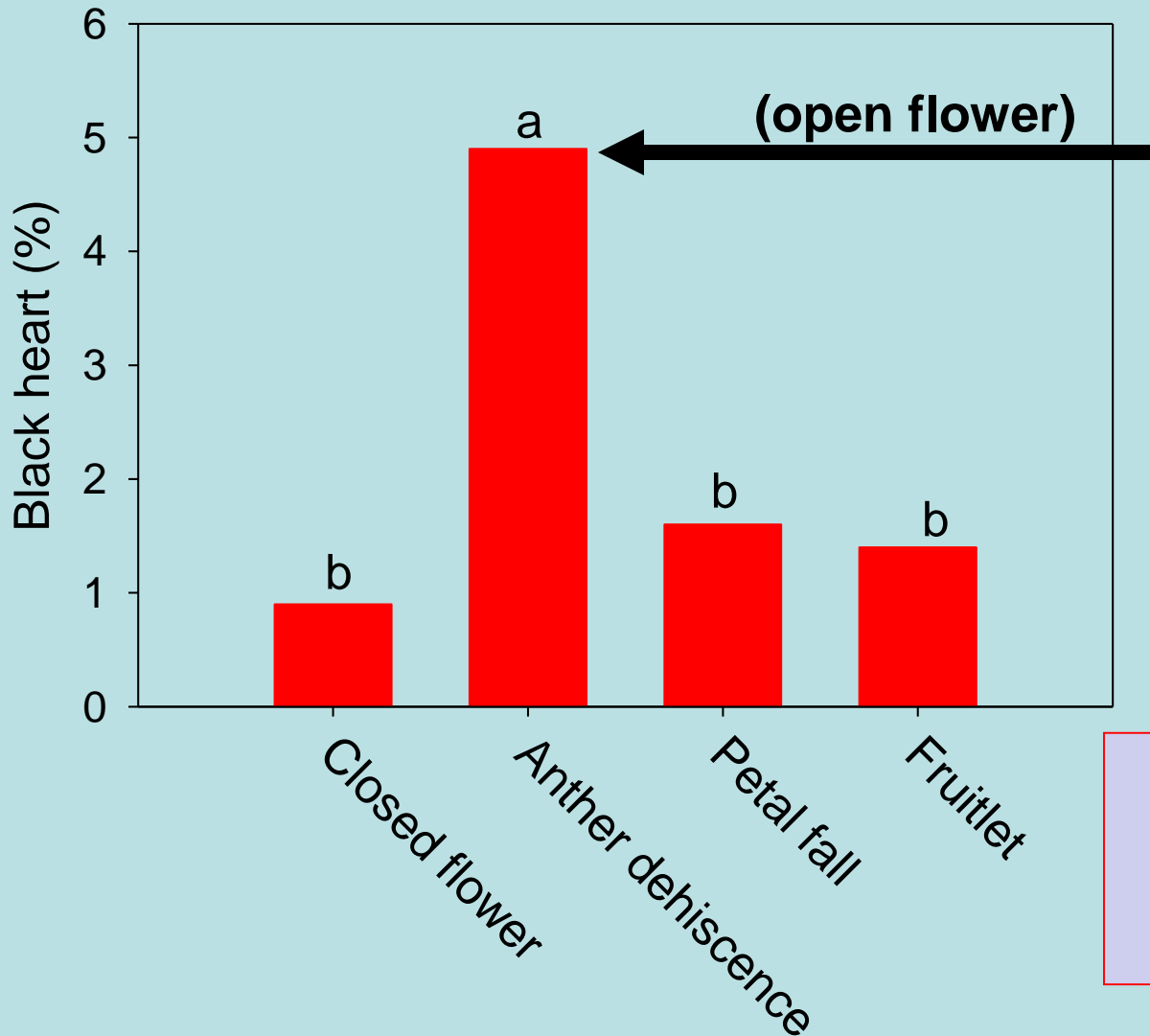
mummies







# The most susceptible **stage of infection** by *Alternaria alternata*



When do infections by *Botryosphaeria* occur?









# Surface sterilization of immature nuts





# Overnight Freezing - Incubation Technique (ONFIT)



1. Surface sterilized.
2. Frozen at  $-16^{\circ}\text{C}$  overnight (about 15 h).
3. Incubated at 20 to  $25^{\circ}\text{C}$ .
4. Bot is recorded 7 days later.

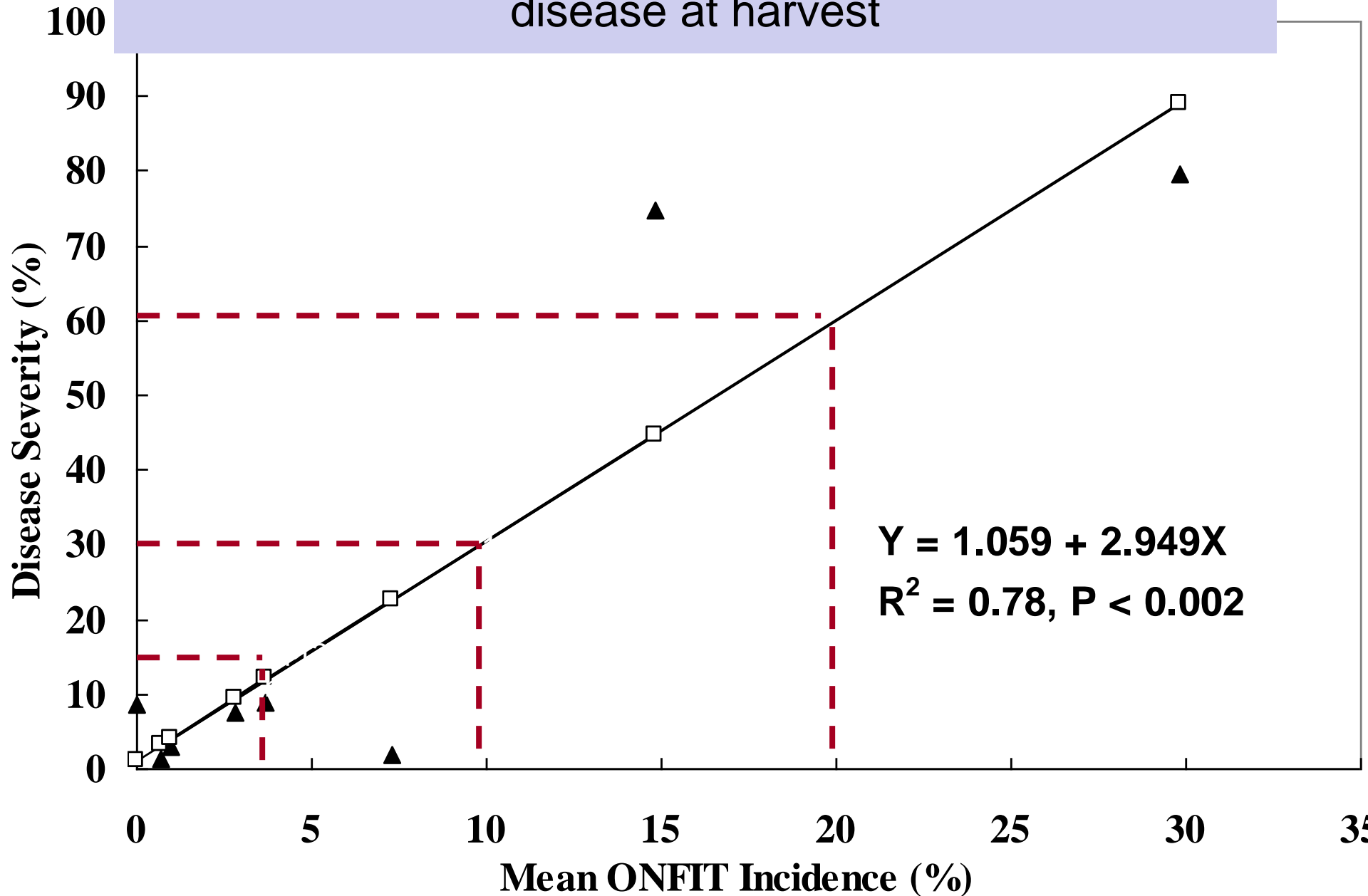
The technique is done in June – July  
after the end of the rainy season)

**After freezing (-16 C for 15 hours) and incubation for  
5-7 days**






# Relationship of incidence of Botryosphaeria in fruit and disease at harvest



# Management of Botryosphaeria in pistachio and walnut

- **Cultural control:** Prune dead branches and blighted shoots, avoid sprinkler irrigation, remove tree stumps, etc ...)
- **Chemical control:** Apply effective fungicides (no resistance in these fungi!)
- **Integrated disease control:** Use both cultural & chemical control  **best effect!**



FUNGICIDES, BACTERICIDES, AND BIOLOGICALS  
FOR  
DECIDUOUS TREE FRUIT, NUT,  
STRAWBERRY, AND VINE CROPS  
2012



ALMOND  
APPLE/PEAR  
APRICOT  
CHERRY  
GRAPE  
KIWIFRUIT

PEACH/NECTARINE  
PISTACHIO  
PLUM  
PRUNE  
STRAWBERRY  
WALNUT

Jim Adaskaveg, Professor  
*University of California, Riverside*

Doug Gubler, Extension Plant Pathologist  
*University of California Davis*

Themis Michailides, Plant Pathologist  
*University of California, Davis/Kearney Agricultural Center*

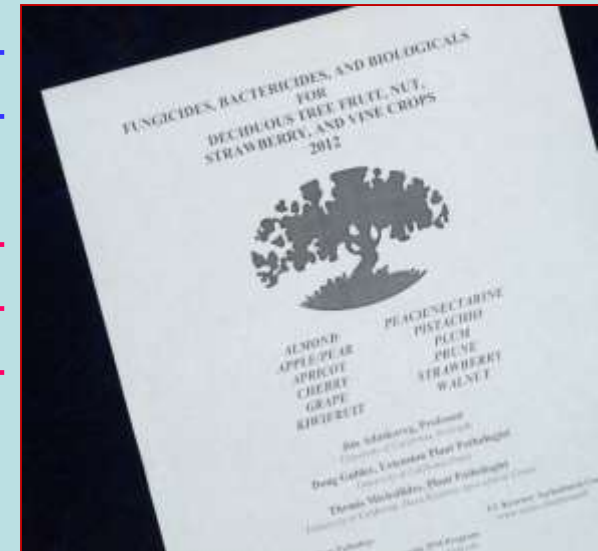
UC Kearney Agricultural Center  
[www.uckac.edu/plantpath](http://www.uckac.edu/plantpath)

Plant Pathology

Riverside IPM Program  
[davis.edu](http://davis.edu)

# Fungicides registered for Botryosphaeria blight in pistachio

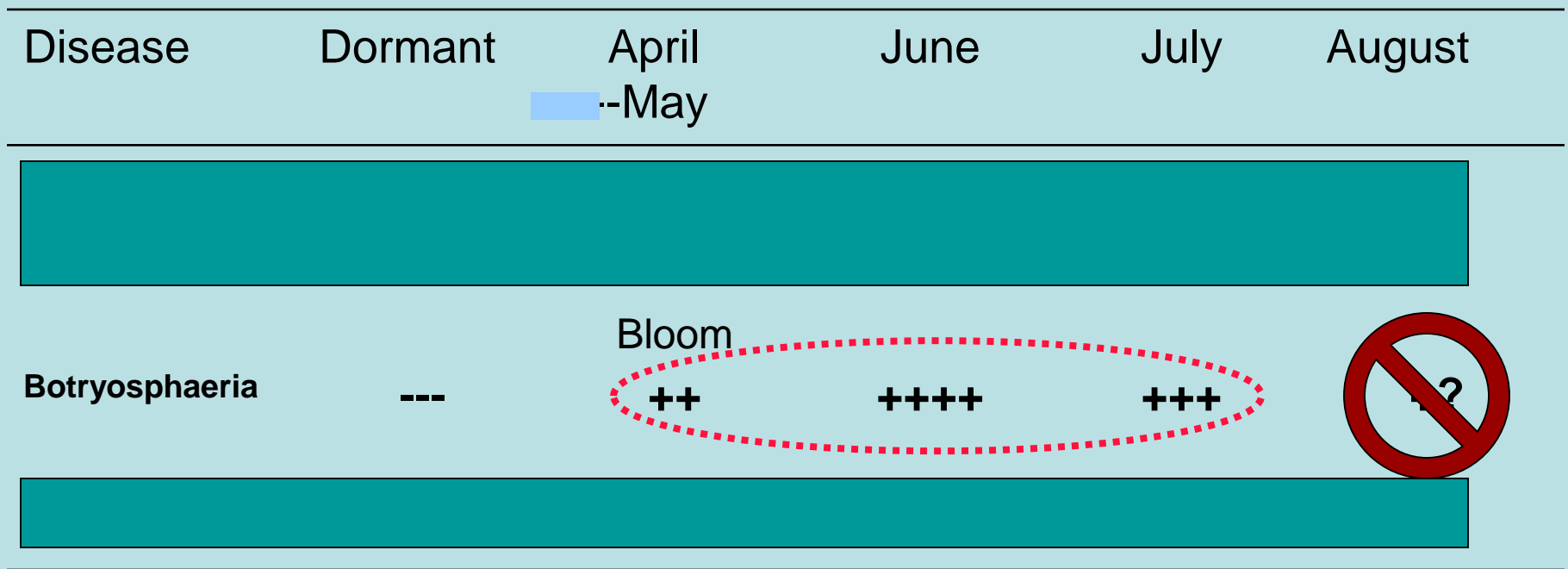
Fungicide	Active ingredient	Efficacy
Adament.....	trifloxystrobin+tebuconazole	+++
Abound .....	azoxystrobin	++++
Bravo.....	chlorothalonil	++
Bumper/Tilt.....	propiconazole	++
Cabrio.....	pyraclostrobin	++++
Gem .....	trifloxystrobin	++++
Quash.....	metconazole	+++
Inspire Super...	difenoconazole + cyprodinil	++++
Pristine .....	boscalid + pyraclostrobin	++++
Quilt-Xcel.....	azoxystrobin + propiconazole	++++
Scala.....	pyrimethanil	+++
Switch.....	cyprodinil + fludioxonil	++
Tebuzol.....	tebuconazole	+++
Topsin-M.....	thiophanate-methyl	++
Copper.....	copper	+/-
Luna Experience	fluopyram + tebuconazole	++++
Luna Sensation	fluopyram + trifloxystrobin	++++
Fontelis	penthiopyrad	++++



<http://www.ipm.ucdavis.edu>



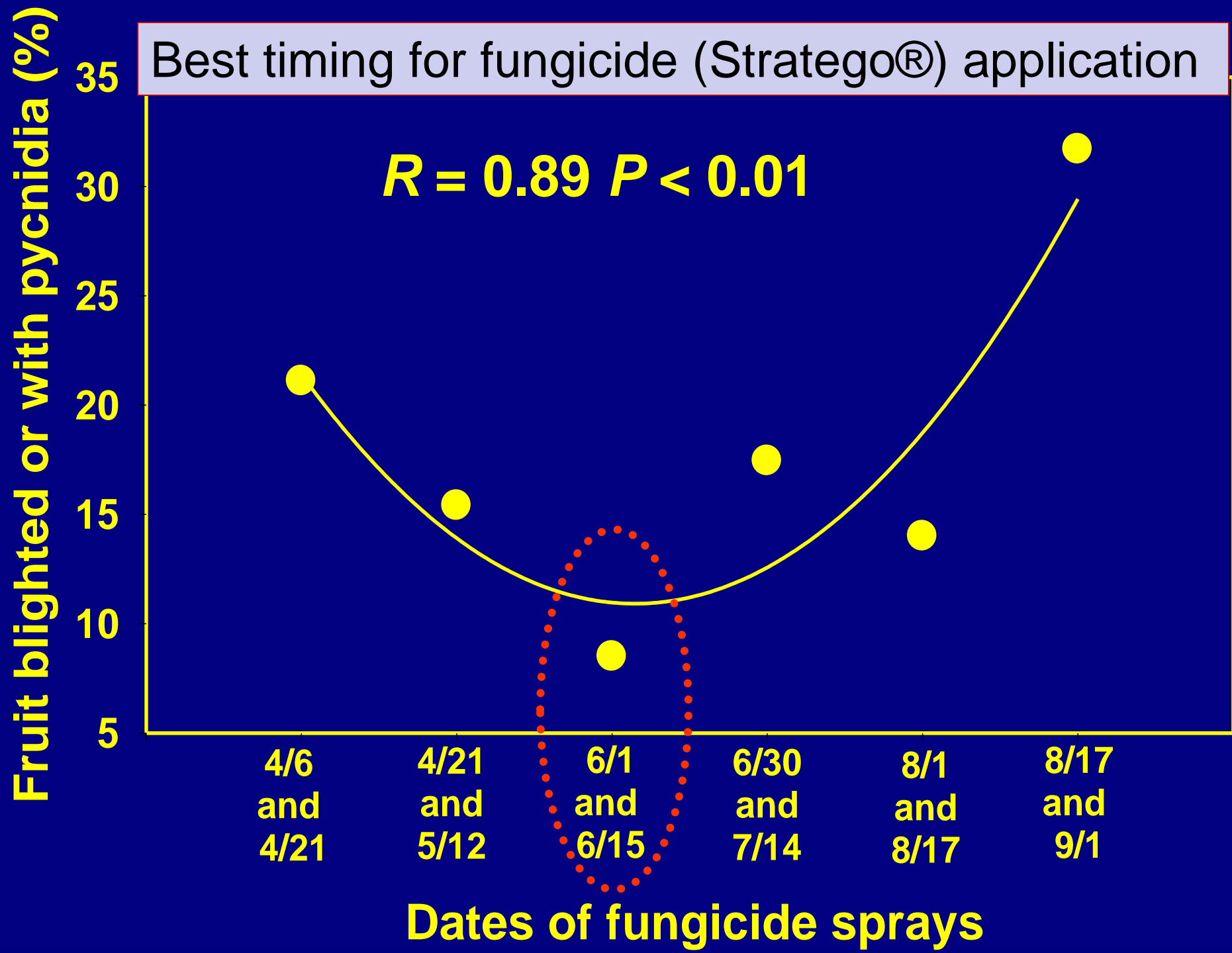
# Timing of Fungicide Sprays for Botryosphaeria Control of Pistachio



➡ Source: <http://www.ipm.ucdavis.edu>

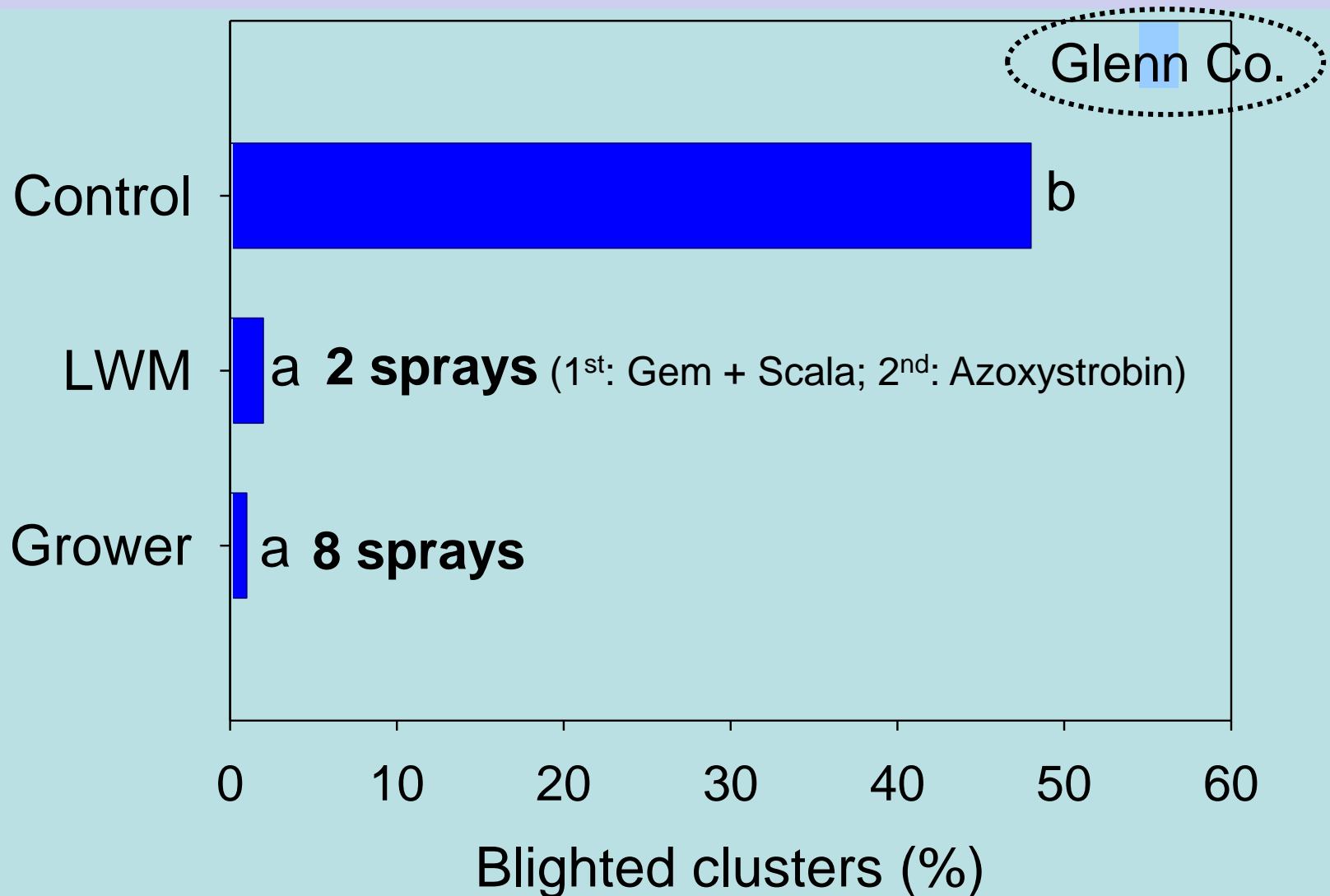
# Best timing for fungicide (Stratego®) application

$R = 0.89$   $P < 0.01$





# Disease control based on the Leaf Wetness Model in 2010

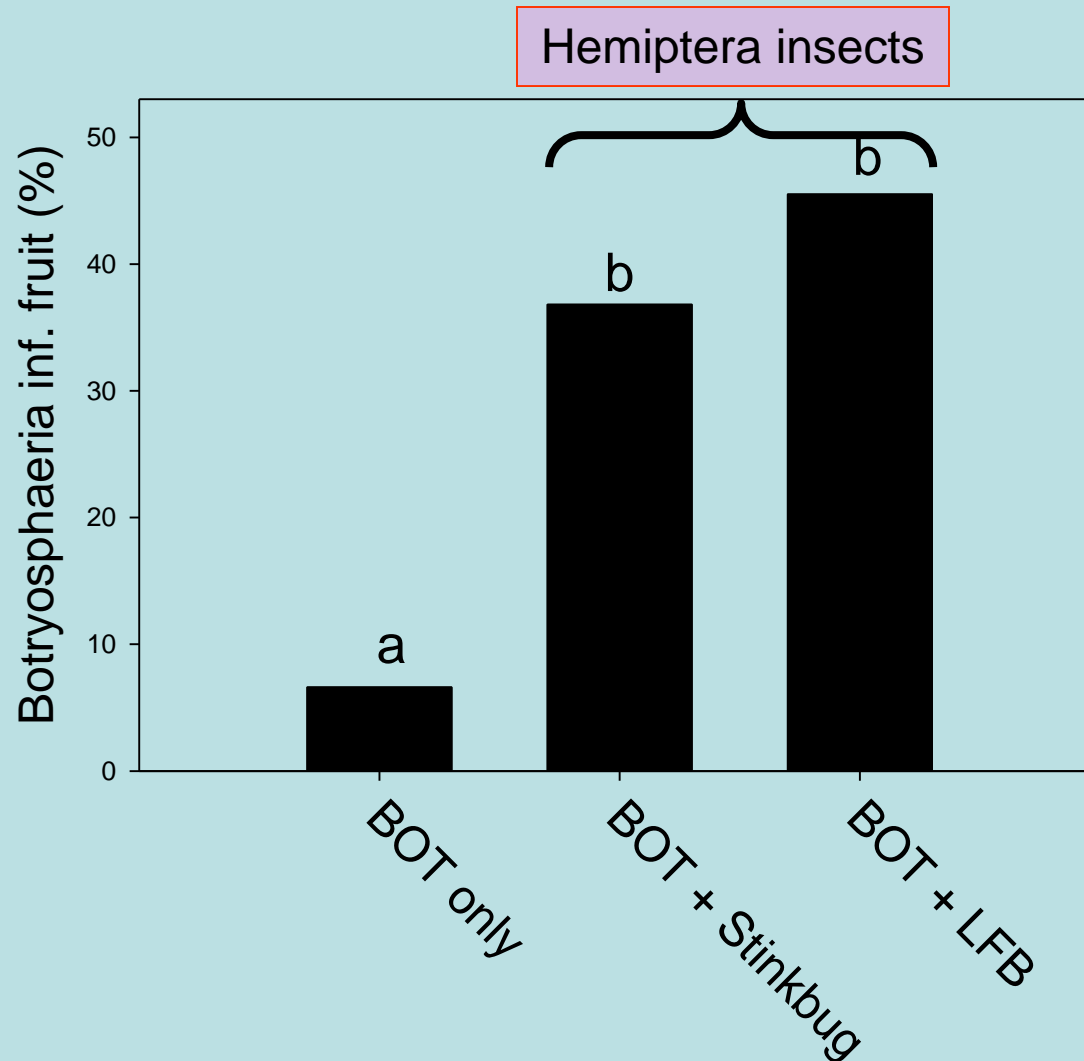


# Hemiptera insects major pests in pistachio

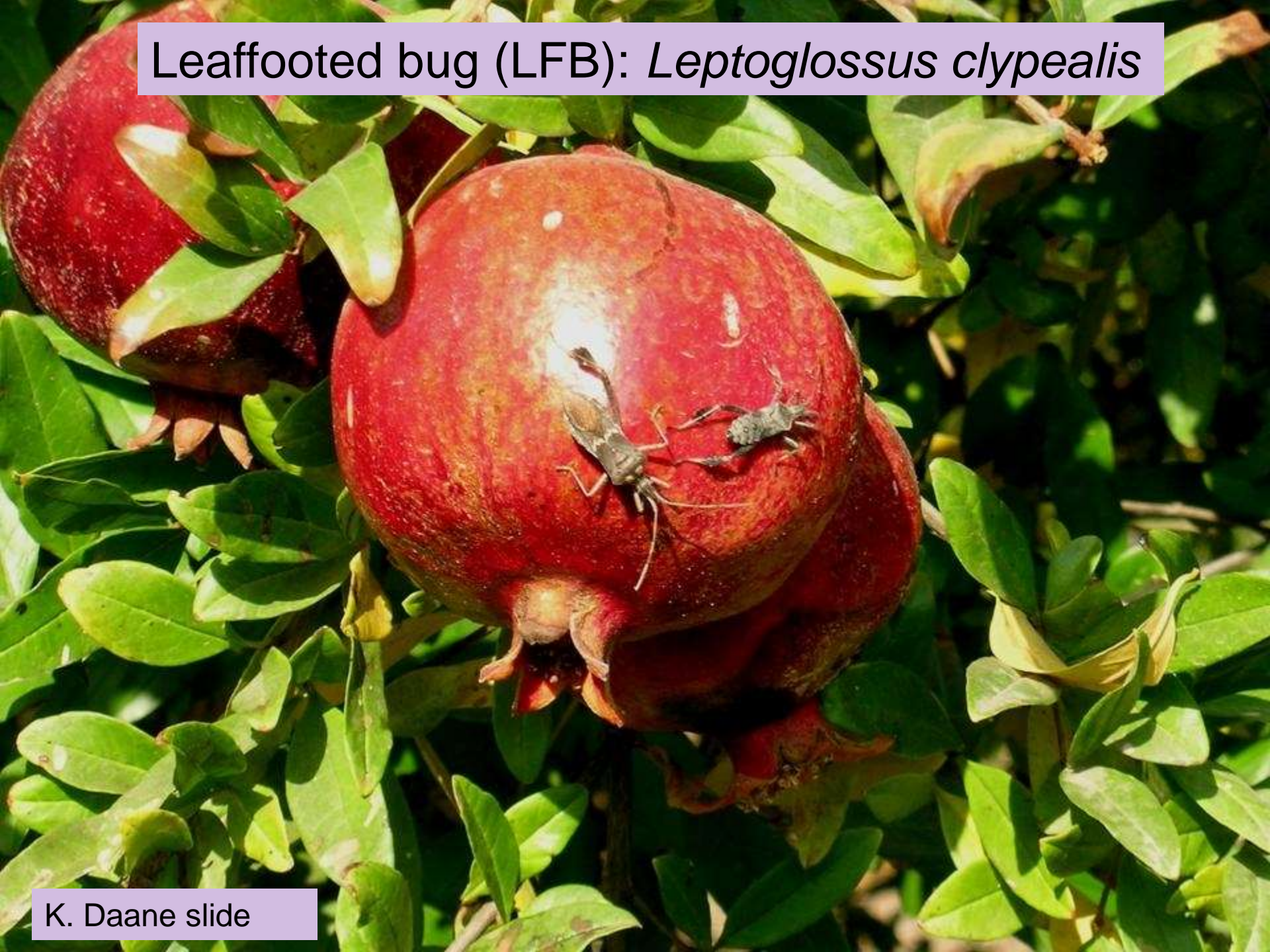




# Transmission of Botryosphaeria by Hemiptera insects



Leaffooted bug (LFB): *Leptoglossus clypealis*





## Take-home message

- ✓ We know that fungi of Botryosphaeriaceae accumulate in older trees (The Sleeping Dragon!)
- ✓ Our growers do as much pruning as possible to remove dead branches.
- ✓ We monitor *Botryosphaeria* inoculum and /or infections with the BUDMON and/or ONFIT Techniques to determine the disease risk and make decisions for management.
- ✓ We apply a spray or sprays either before or after spring/early summer rains (... very effective!)
- ✓ Under California conditions, sprays start at bloom and finish before August (sprays in August not effective in pistachios\*)
- ✓ In addition, our growers apply sprays to control stinkbugs.

*Botryosphaeria* is not a major concern of our growers any longer

Thank you



**The Sleeping Dragon**