Foliar and Fruit Diseases of Pistachio

Themis J. Michailides

Department of Plant Pathology
University of California, Davis
Kearney Agricultural Center

5th PISTACHIO SHORT COURSE 2008

Alternaria, Botryosphaeria, & Botrytis

Alternaria late blight

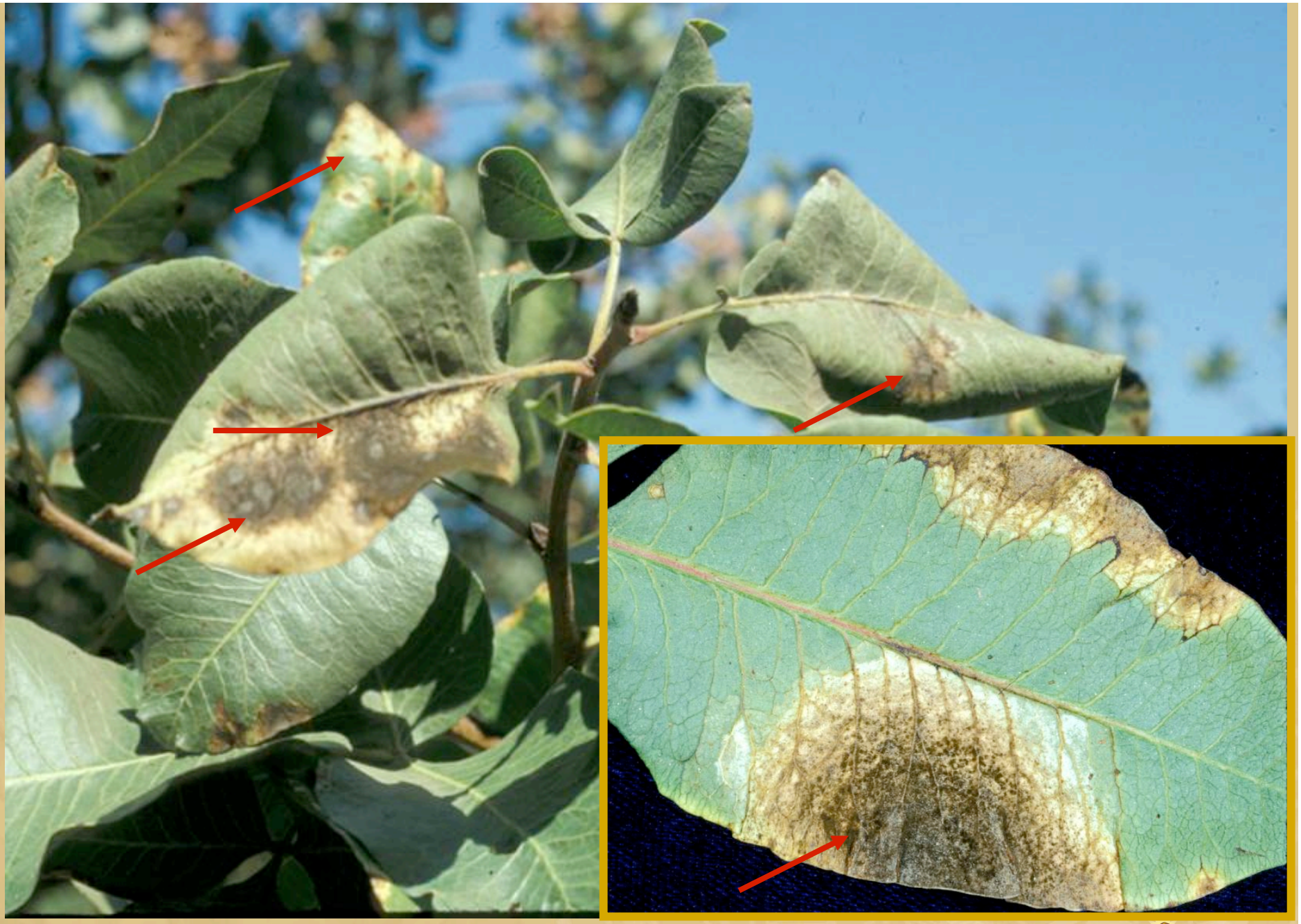
Infections begin as soon as leaves and fruit emerge (no symptoms)

=

“Latent infections”

(some of these infections will develop to symptoms later in season usually in July/ and during August)

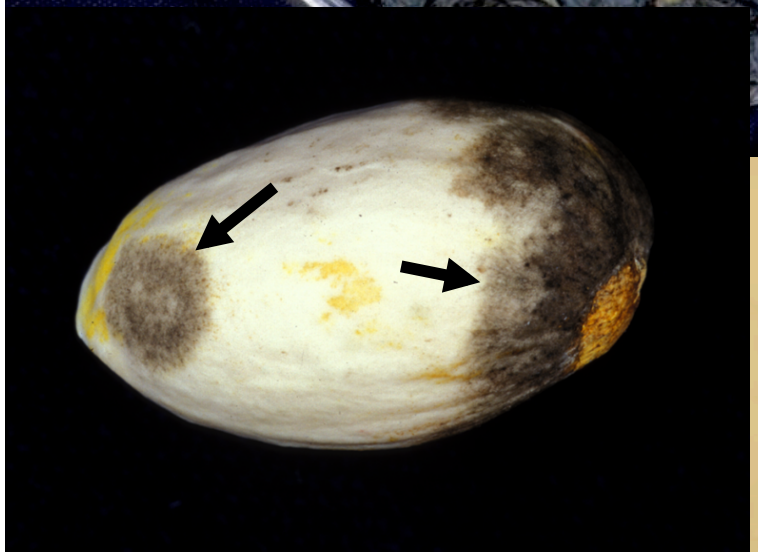
Symptoms develop on leaves first …



fruit infections


Fruit lesions appear later than those on leaves …
5th PISTACHIO SHORT COURSE 2008

Hull infections will lead to shell staining and mold in the kernel



Reasons we study Alternaria late blight in California

1. Early defoliation and thus reduction of photosynthetic area.
2. Problems at harvest
3. Shell staining.
4. Kernel mold.

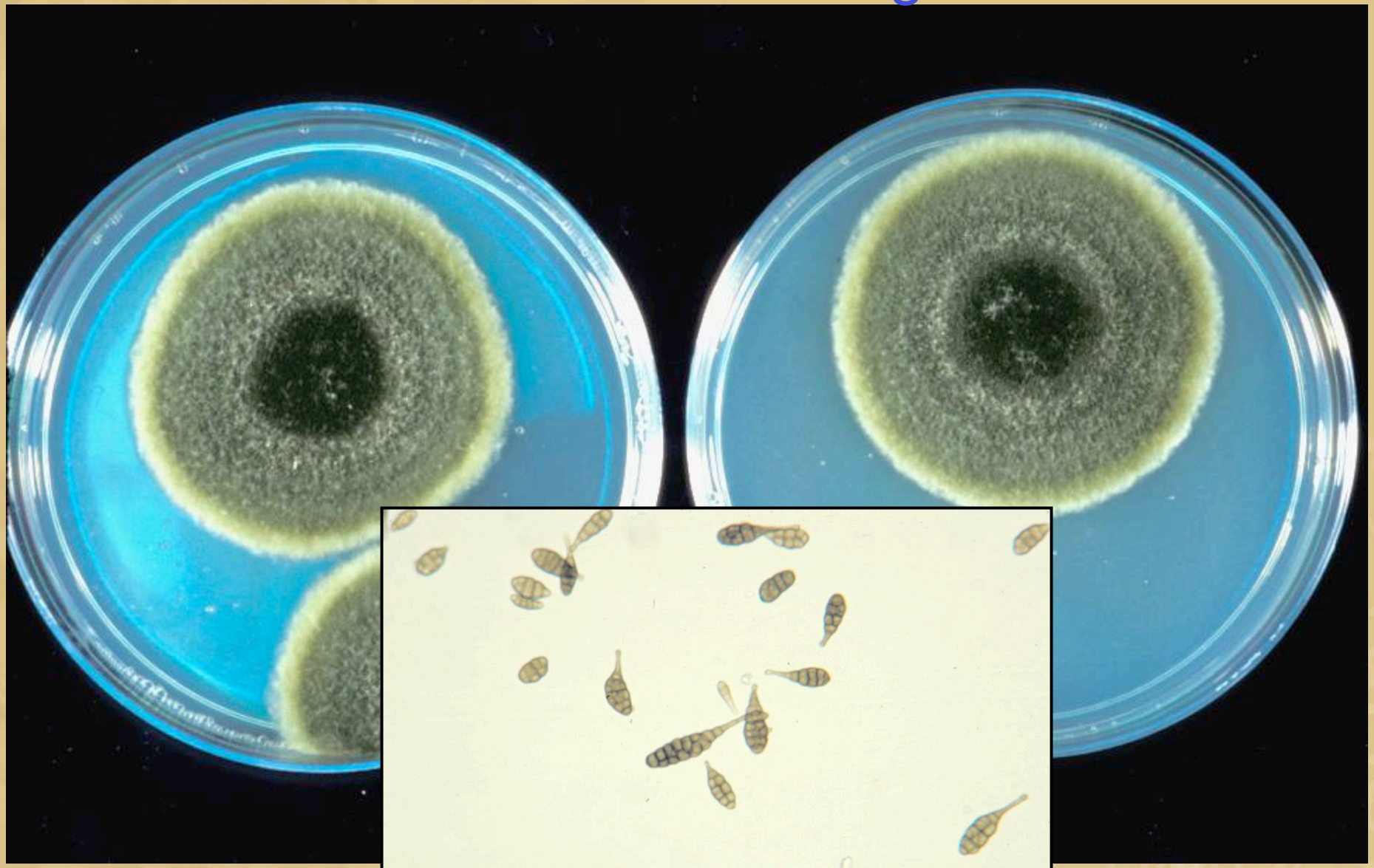
Pathogens causing Alternaria late blight:

Alternaria alternata,

Alternaria tenuissima, &

Alternaria arborescens

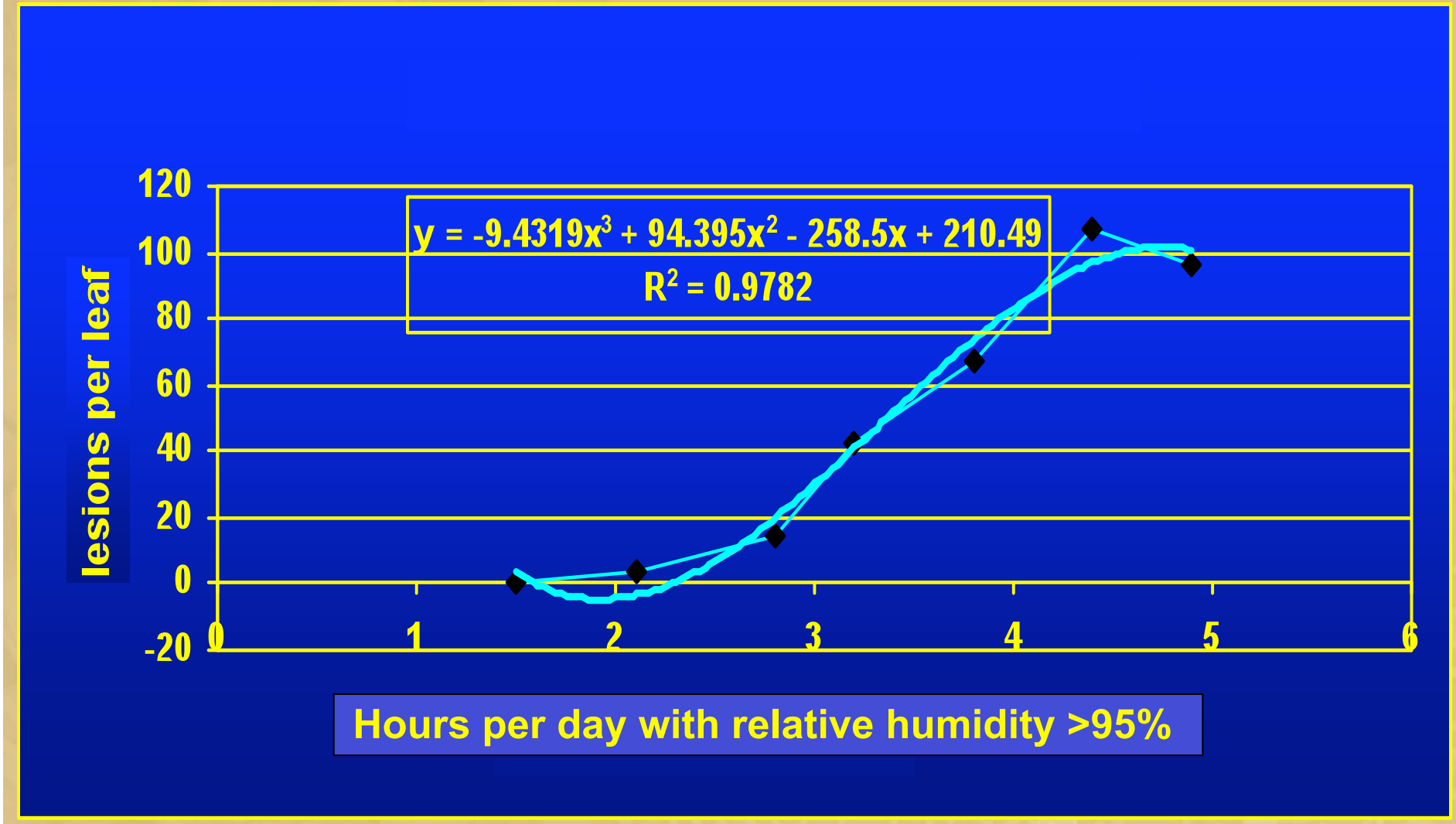
Alternaria isolates on agar media



Spores of *Alternaria* species

Conditions for *Alternaria* late blight

- ✓ Spore inoculum is **abundant**.
- ✓ Fruit and leaves become **more susceptible as they age.**
- ✓ Conditions become **more favorable** (high temperatures and humidity, & longer dew duration) **later in season**.


lesions per leaf
120
100
80
60
40
20
0
-20
0
1
2
3
4
5
6
y = -9.4319x3 + 94.395x2 - 258.5x + 210.49
R2 = 0.9782
Hours per day with relative humidity >95%

Management of Alternaria late blight:

1. Cultural practices (various ways)
2. Chemical control (fungicides)
3. **Best:** Integrated disease control (cultural & chemical control)

1. Cultural control:

- ✓no irrigation between 1-10 August
- ✓subsurface irrigation
- ✓disc soil
- ✓improve water infiltration
- ✓hedge trees to increase air movement
- ✓no cover crops

5th PISTACHIO SHORT COURSE 2008

2. Chemical control (fungicides)

- ✓ Bloom sprays (not important for Alternaria late blight)
- ✓ Mid season (June & July) sprays very important (start in June to early August)
- ✓ Late season sprays not important

Single sprays (timing)

One spray of Pristine® end of June to early July provided excellent control

Pristine® = pyraclostrobin+boscalid

Fungicides registered (**Alternaria**)

Trade name	Active ingredient	Efficacy
Abound	azoxystrobin	+++*
Bravo	chlorothalonil	++
Cabrio	pyraclostrobin	+++*
Distinghuish	Pyramethanil + trifloxystrobin	++
Gem	trifloxystrobin	+++*
Pristine	pyraclostrobin+ boscalid	++++*
Scala	pyrimethanil	++
Switch	Cyprodinil+ fludioxonil	+++
Copper	copper hydroxide	+

* **Good control if there is no resistance to these fungicides.**

Treatment Timing (**Alternaria**)

Disease	Dormant	April	June	July	August
Alternaria	---	--- (bloom)	+++	+++	++
Botryosphaeria	+	++	+++	+++	++
Botrytis	---	+++	---	---	---

Rating: +++ = most effective, =++ = moderately effective,
+ = least effective, and --- = ineffective

Website for fungicide efficacy and timing:

go to the UC-IPM web site:

http://www.ipm.ucdavis.edu/PDF/PMG/fungicideefficacytiming.pdf

Fungicide resistance in *Alternaria* species?

- Strobilurin resistance:

✓ **Yes, resistance to Azoxystrobin and cross resistance to other strobilurins.**

Tulare, Kern, Glenn, Placer Counties

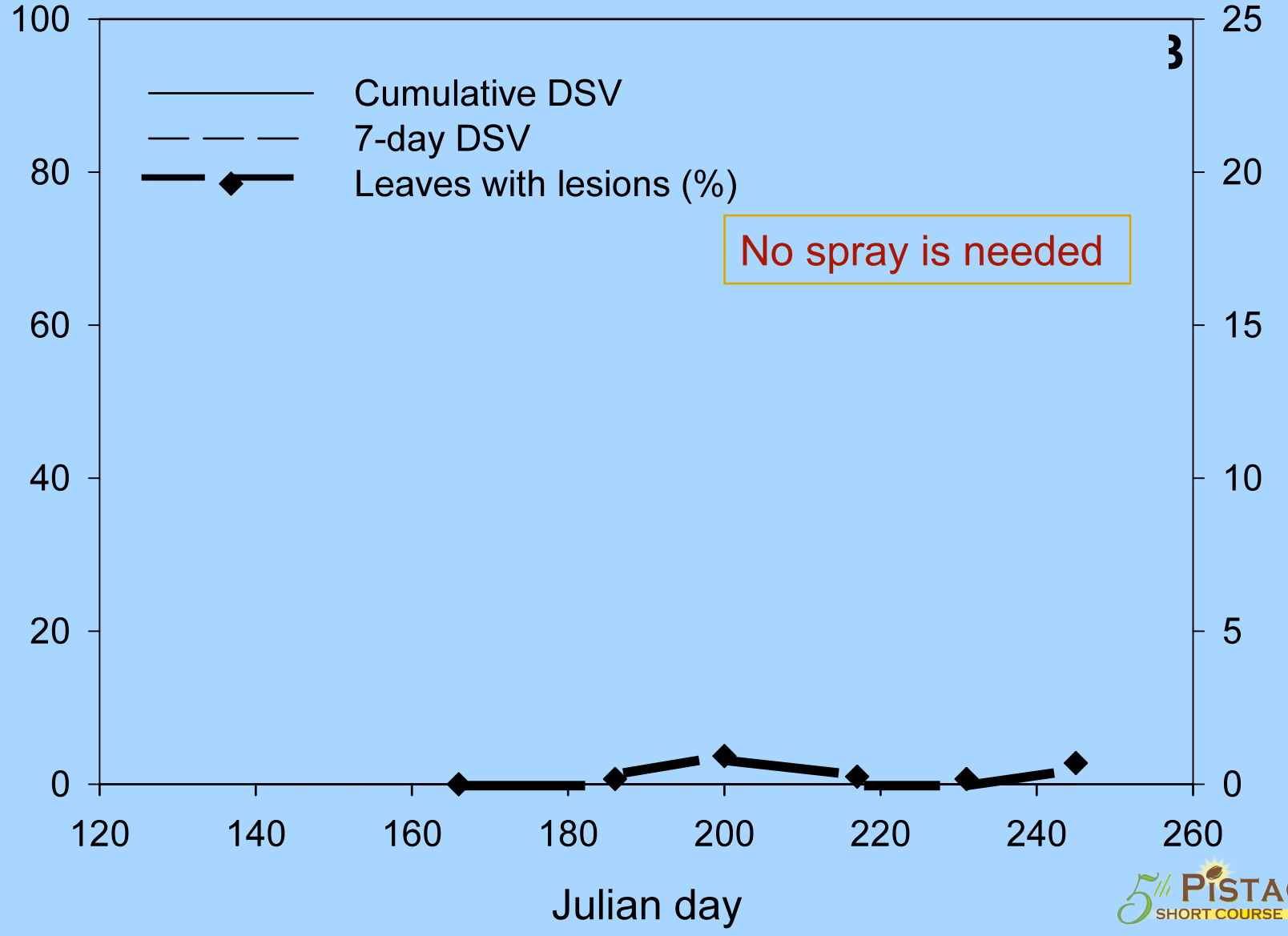
- Boscalid resistance

✓ **Yes, resistance to boscalid and Pristine® (since 2006).**

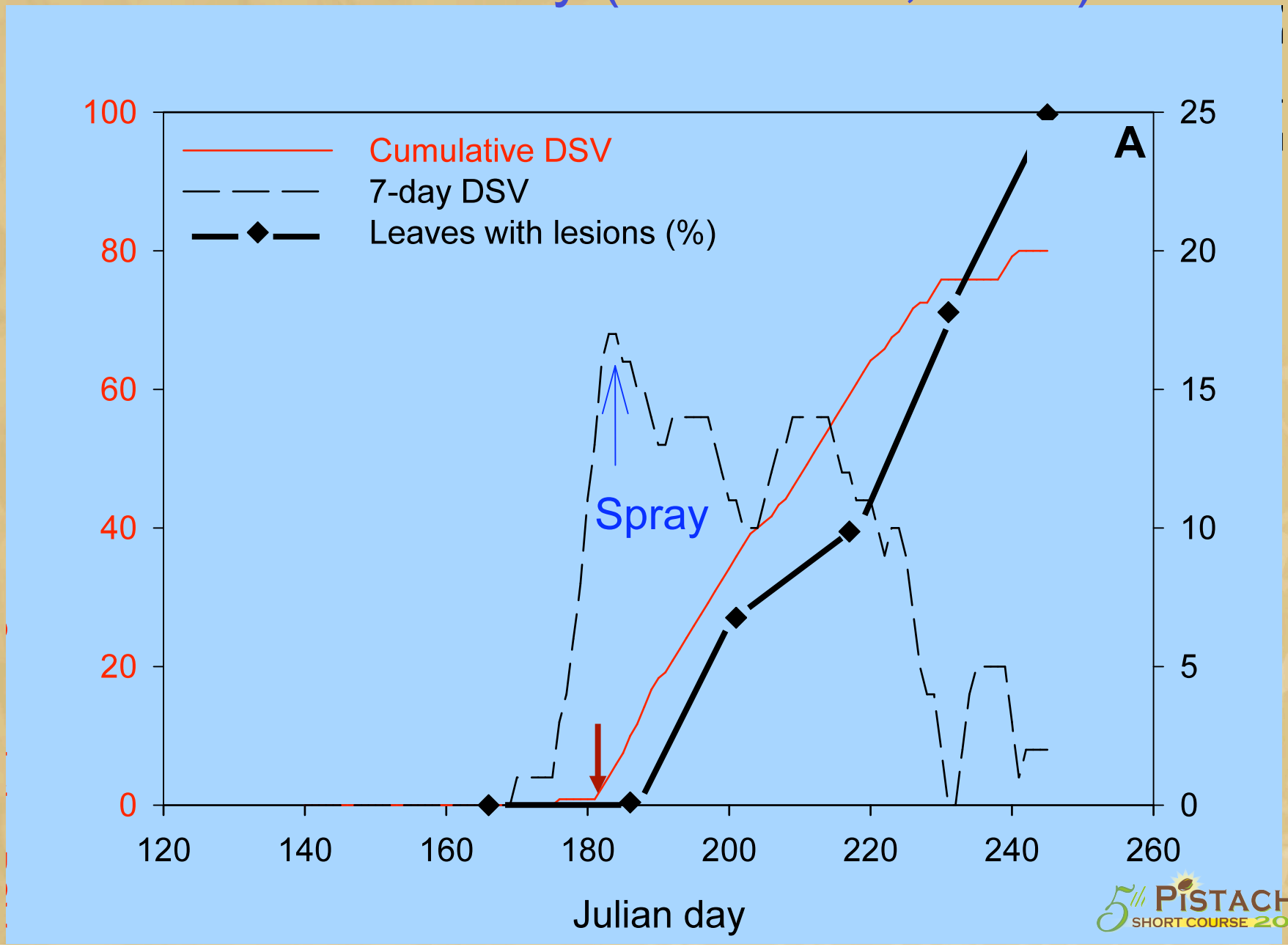
DSV's for Alternaria blight

	Leaf wetness hours required to produce disease severity values (**DSV**) of:				
Mean air temp. ºF	0	1	2	3	4
55-63	0-6	7-15	16-20	21+	
64-68	0-3	4-8	9-15	16-22	23+
69-78	0-2	3-5	6-12	13-20	21+
79-84	0-3	4-8	9-15	16-22	23+

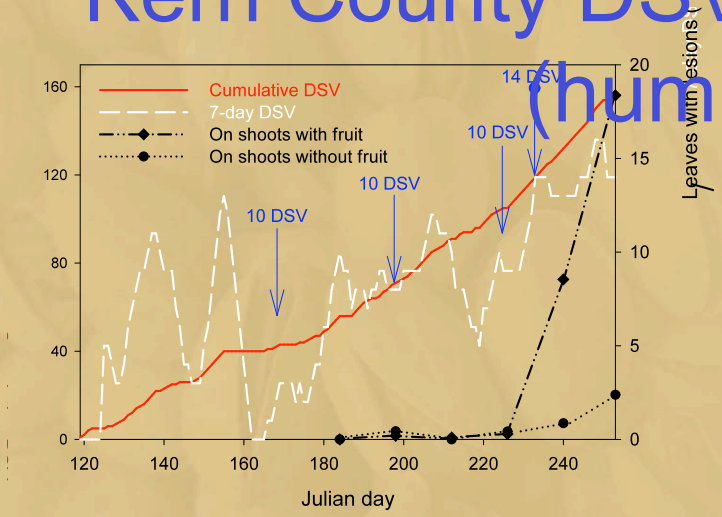
Eastern Kern County (dry site, 2005)

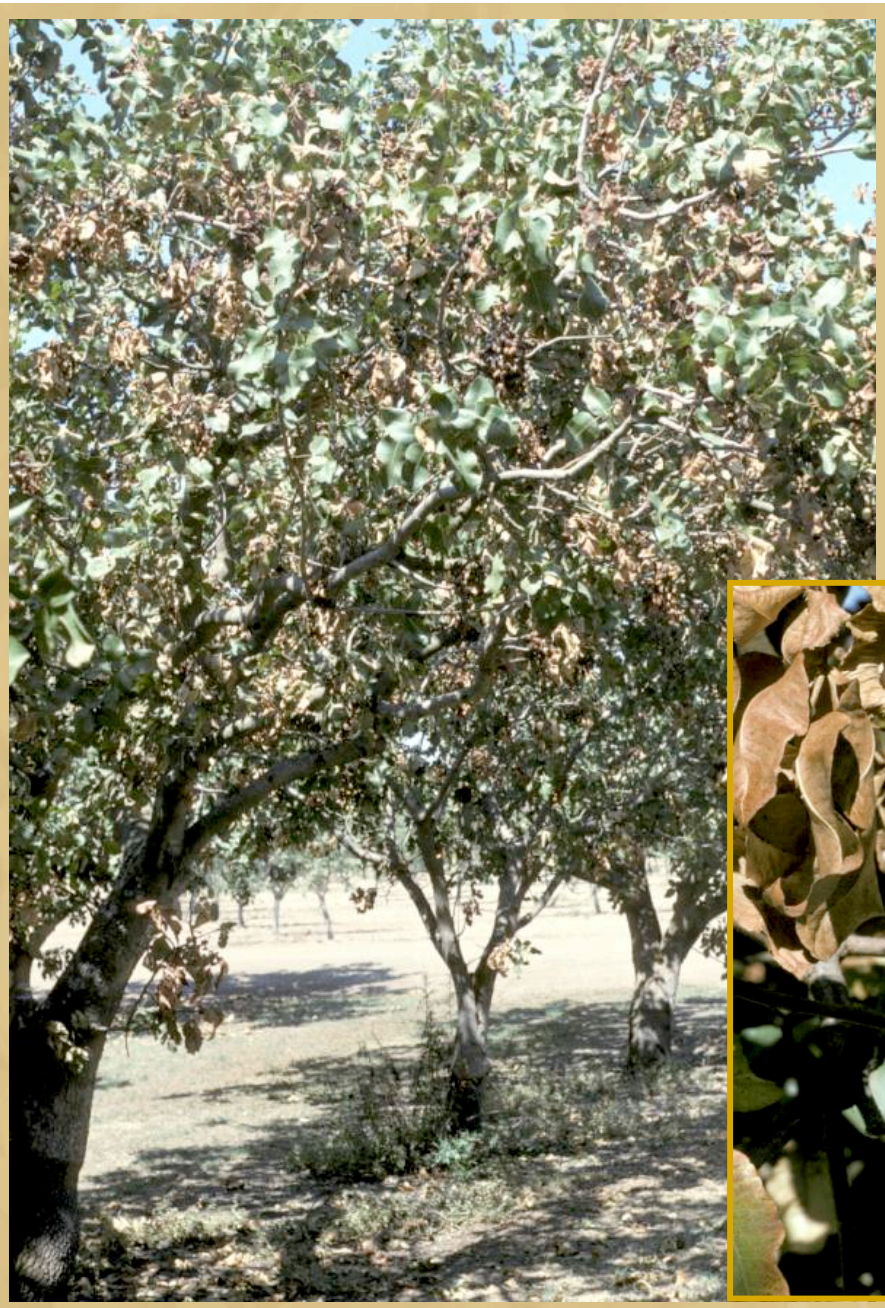


Tulare County (humid site, 2005)



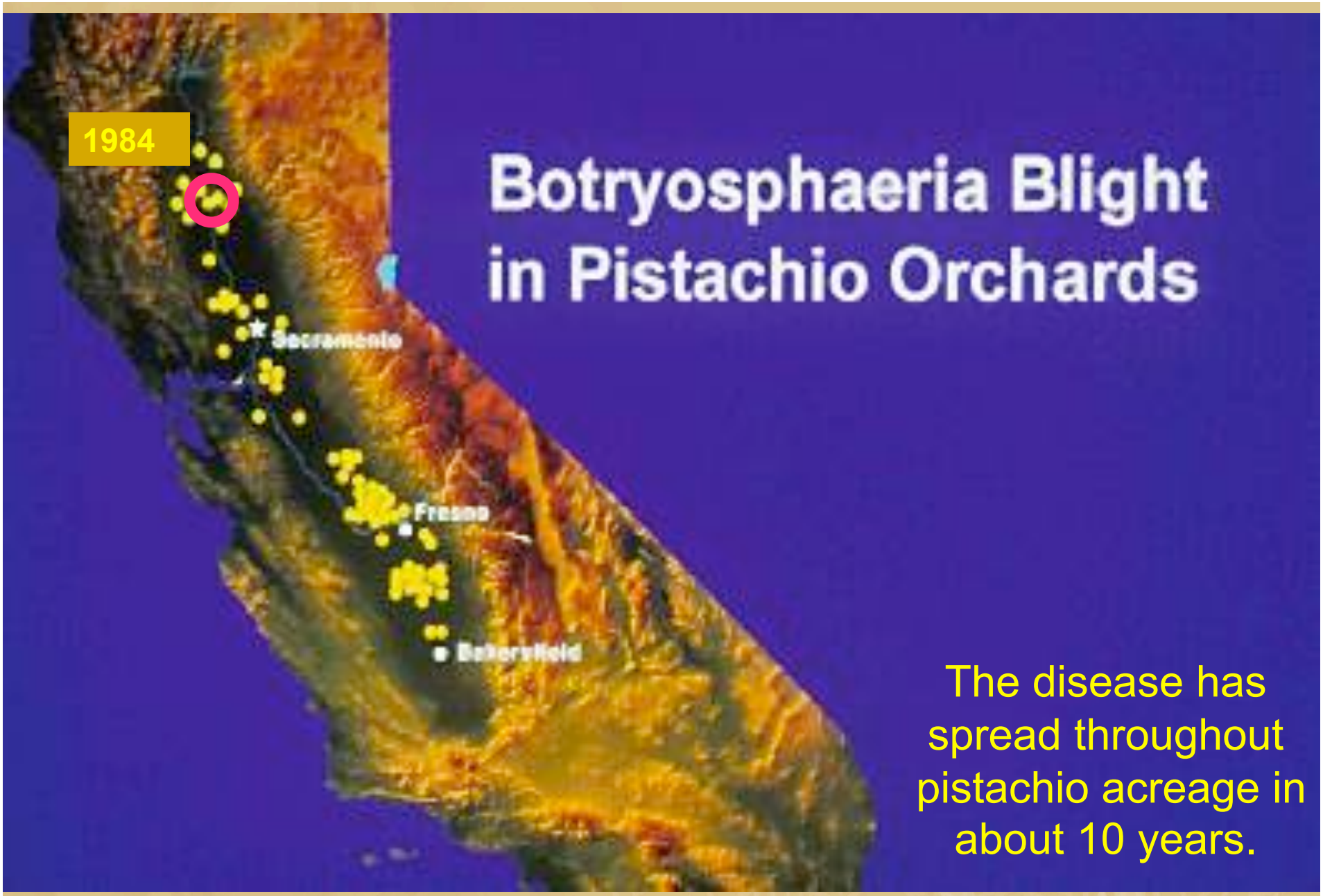
Kern County DSV and DSV-timed sprays (humid site, 2006)





“Botryosphaeria”, “Bot”, Panicle and shoot blight

Botryosphaeria Blight in Pistachio Orchards



The disease has spread throughout pistachio acreage in about 10 years.


5th PISTACHIO
SHORT COURSE 2008

Epidemic in 1998

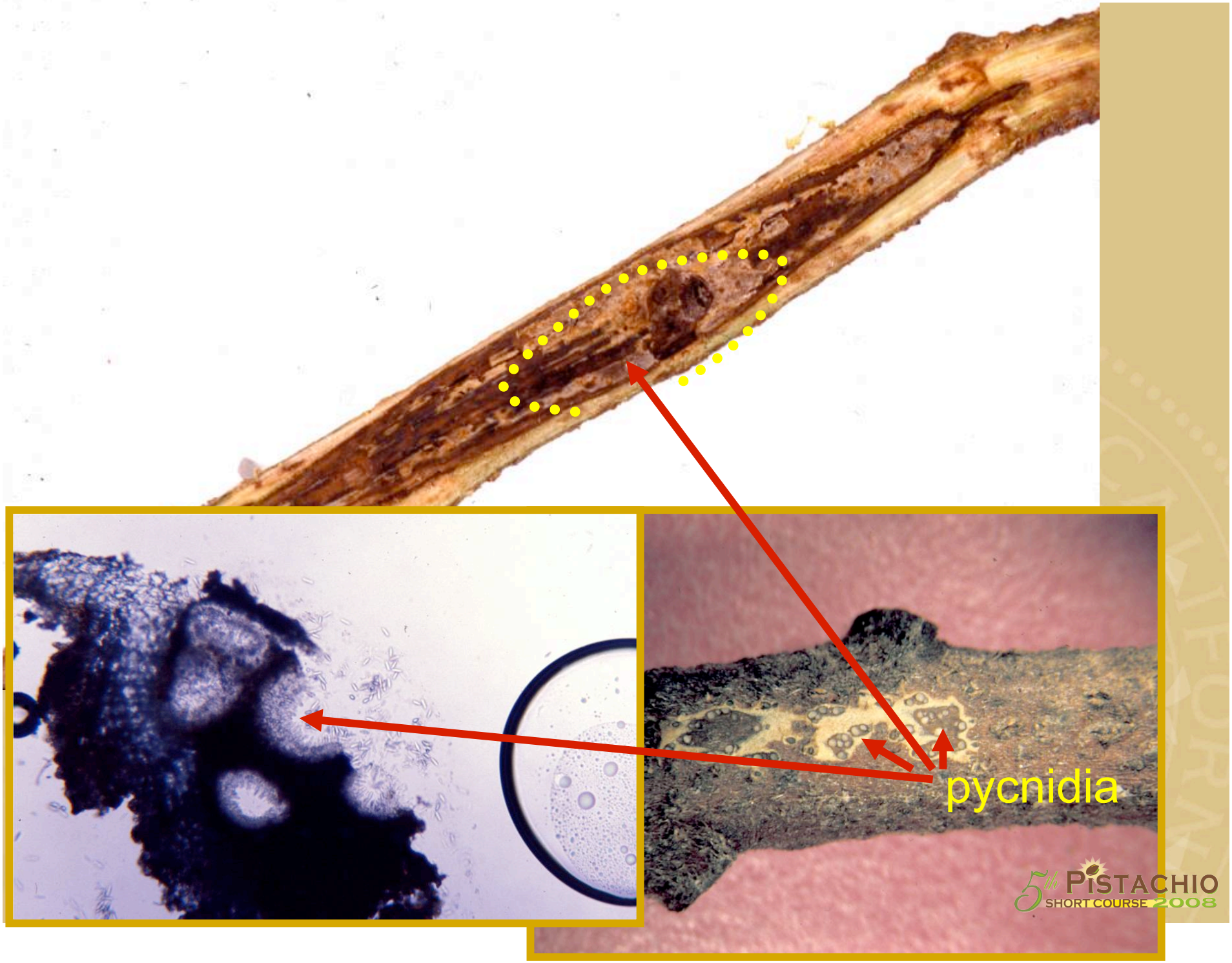
In spring …


5th PISTACHIO
SHORT COURSE 2008


5th PISTACHIO
SHORT COURSE 2008

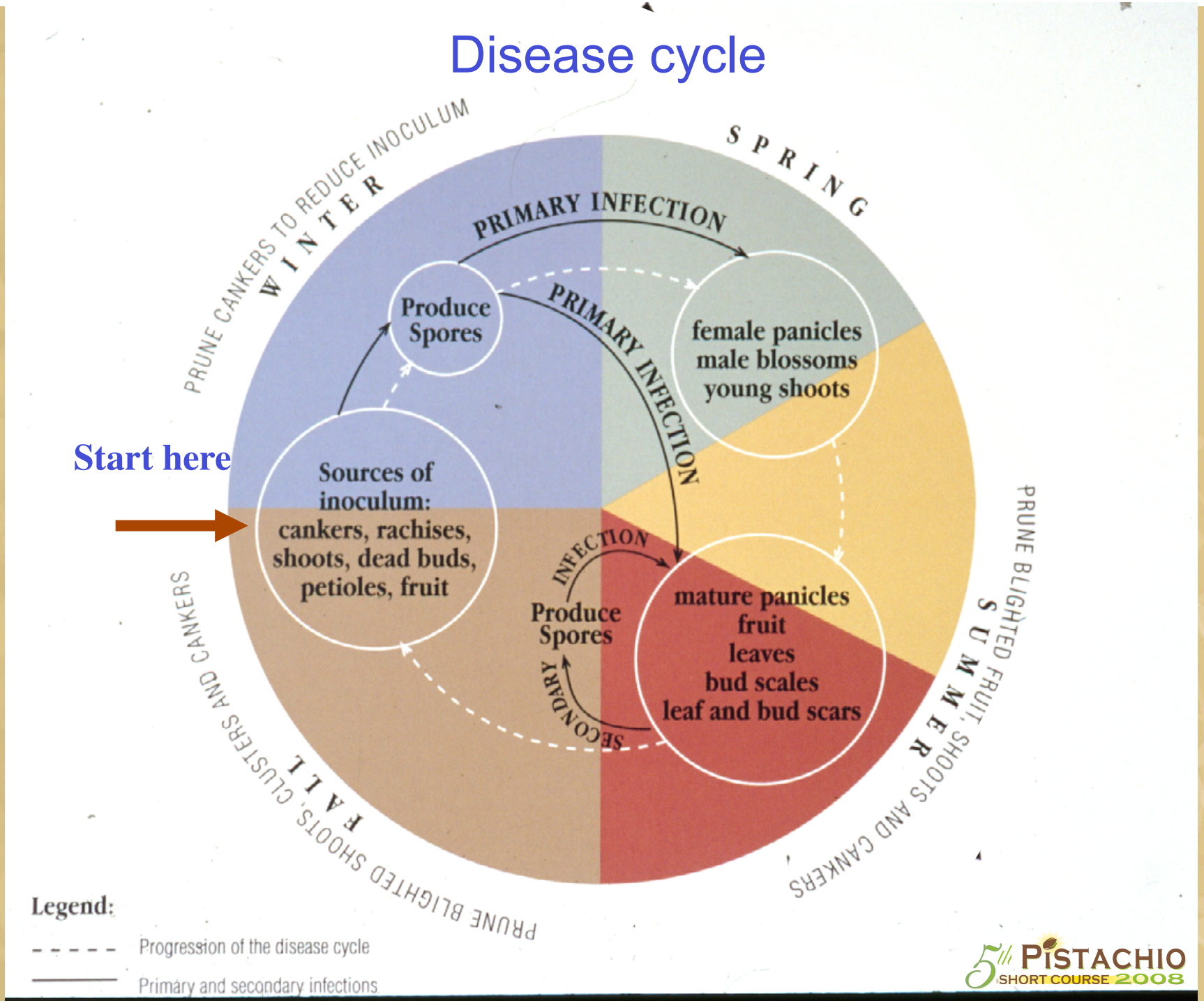

5th PISTACHIO
SHORT COURSE 2008


initial fruit
infections …


pycnidia
5th PISTACHIO
SHORT COURSE 2008


5th PISTACHIO
SHORT COURSE 2008

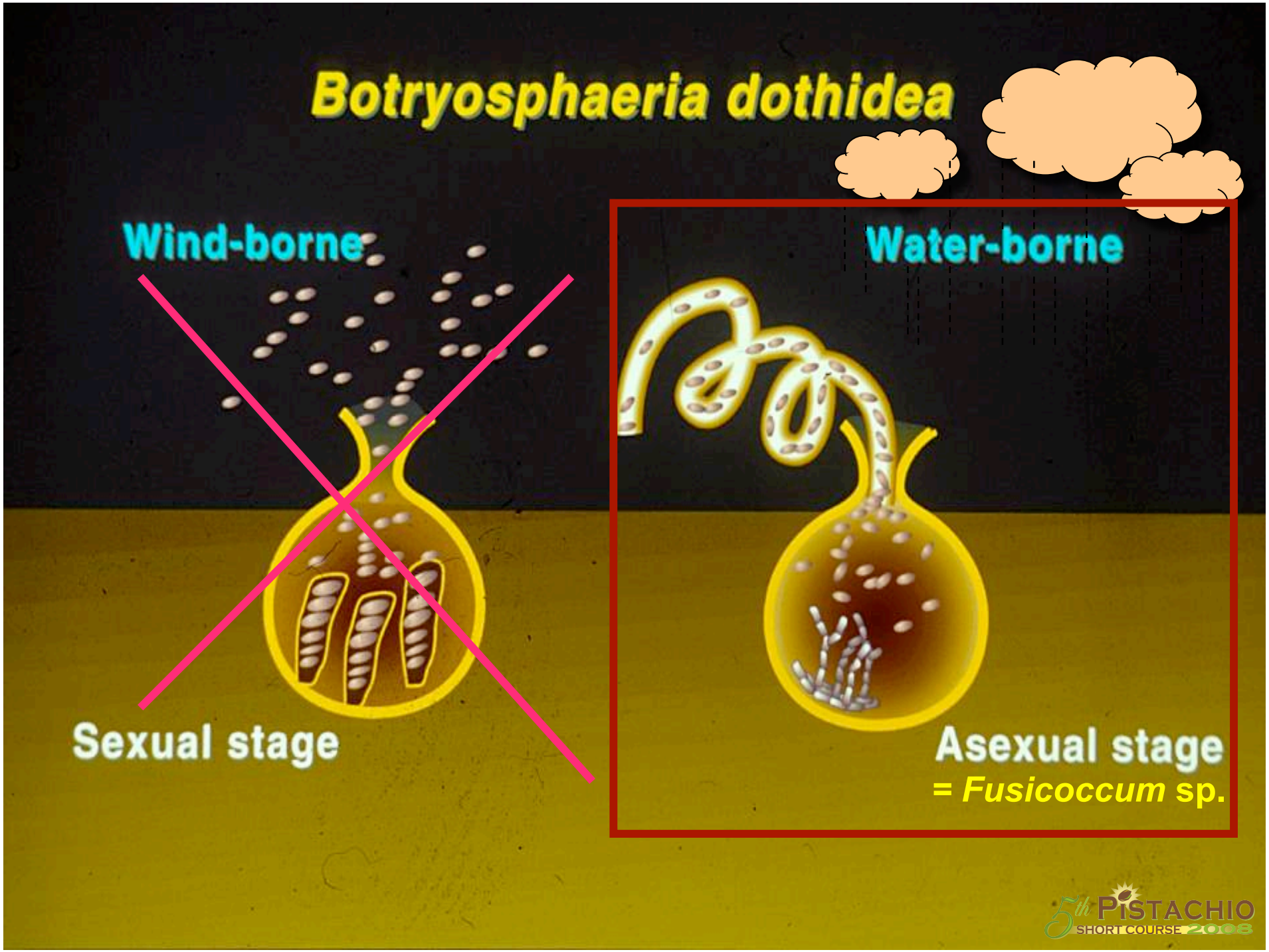
Disease cycle

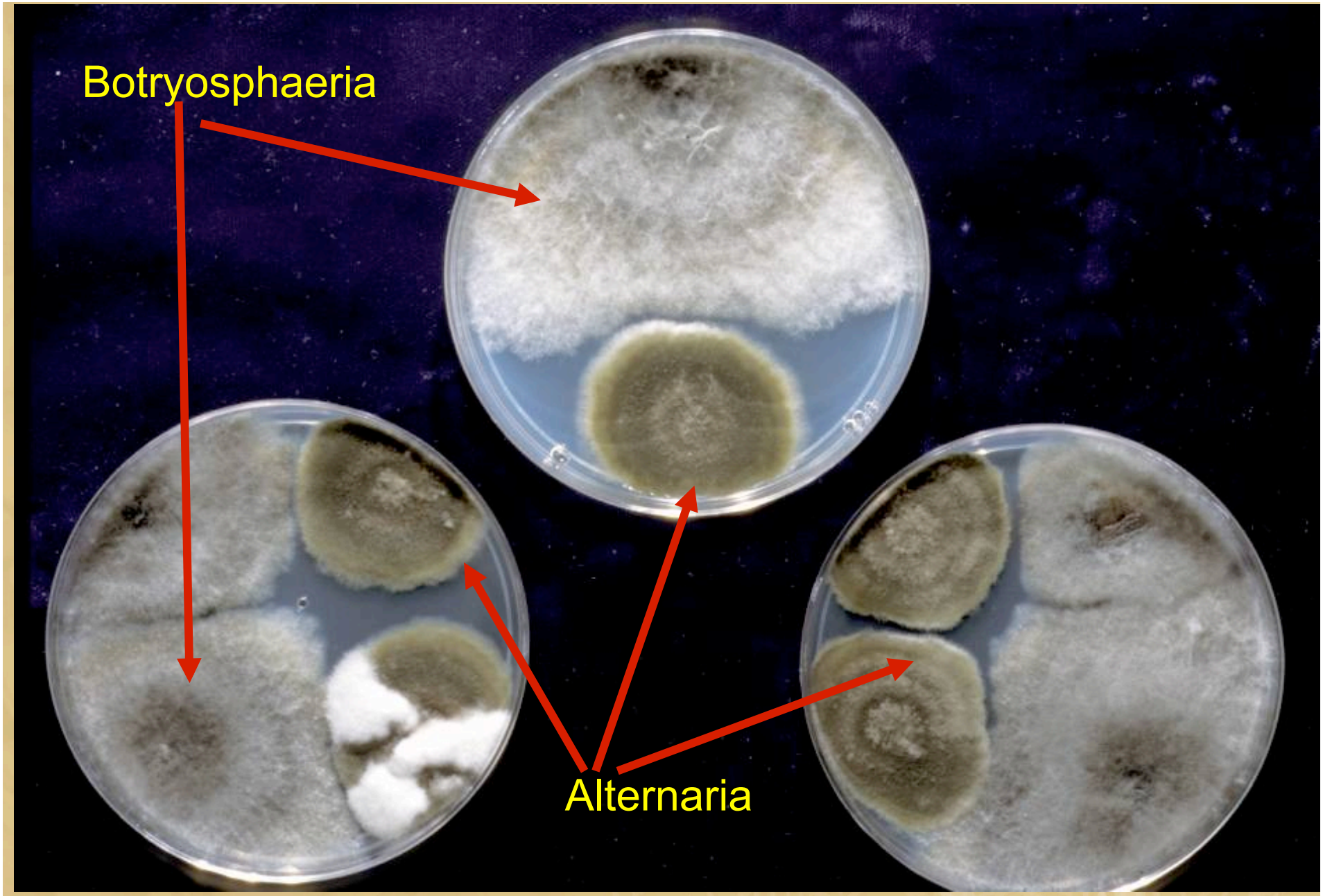


Understanding “Bot” blight damage

- “Bot” attacks current season growth
  - ✓ Buds, shoots, leaves
  - ✓ Rachises, fruit

- “Bot” does not attack older wood
  - ✓ Limbs, branches
  - ✓ Trunk


Botryosphaeria dothidea
Wind-borne
Water-borne
Sexual stage
Asexual stage
= Fusicoccum sp.
5th PISTACHIO
SHORT COURSE 2008


Botryosphaeria
Alternaria

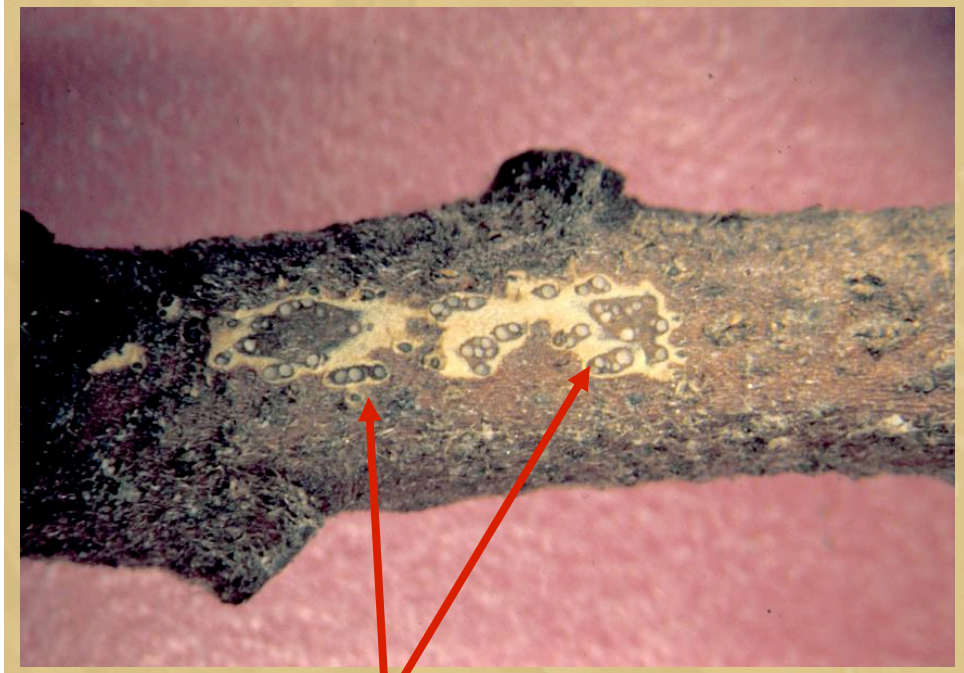
Optimum temperatures for *Botryosphaeria* or *Fusicoccum*

Germination:	**75-97° F**
Growth:	**80-86° F**
Disease development	**80-91° F**
Pycnidial development:	**80° F**

So, it is a warm weather disease

"Asexual stage, *Fusicoccum* sp.

- abundant on pistachio
- produced in culture



pycnidia

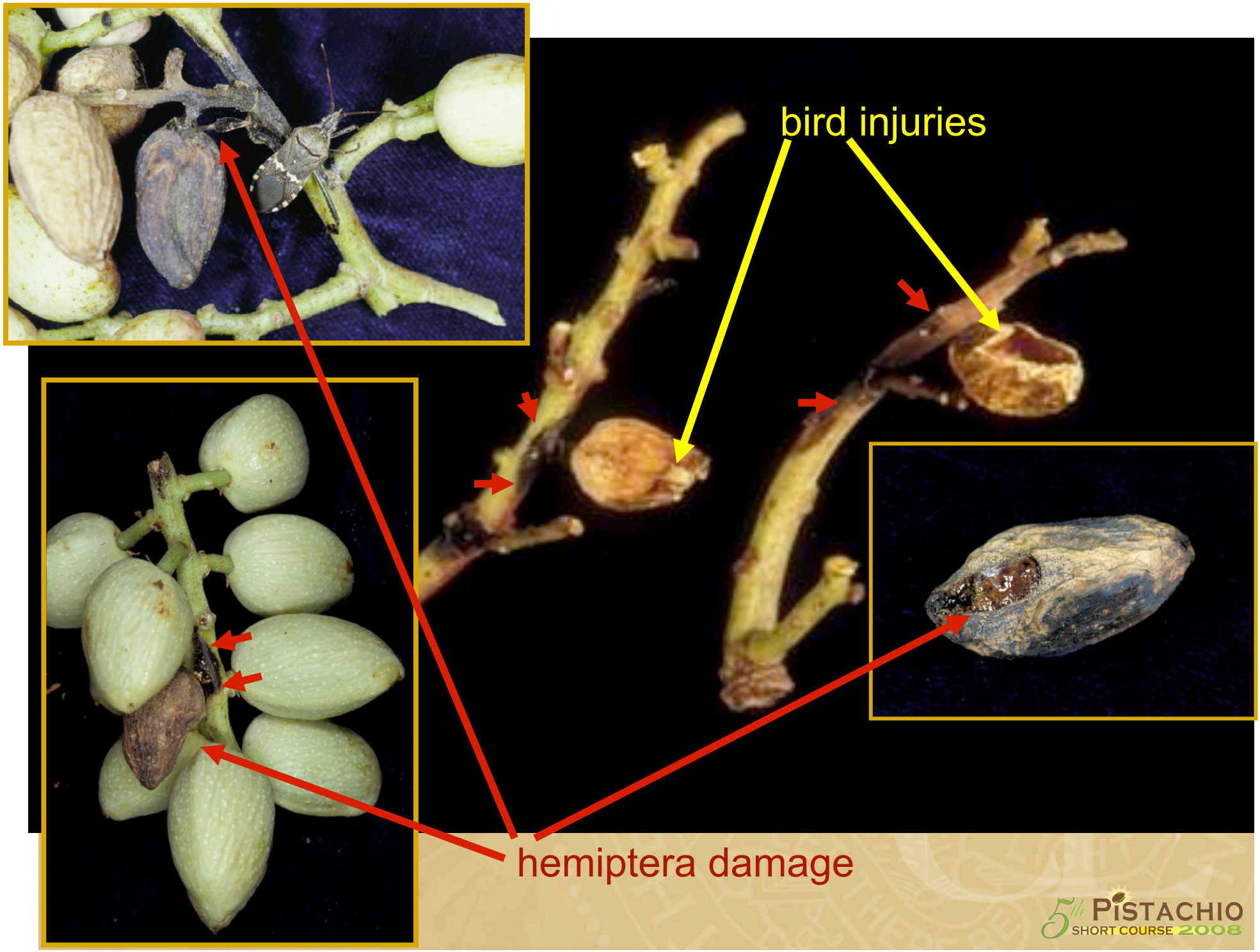
(water-borne conidia are very important)


5th PISTACHIO
SHORT COURSE 2008

Botryosphaeri blight spread

- moving water in the orchard ++++++
- insect transmission +
- pollen +
- pruning equipment ++
- Budding -*

* Infested buds die.


bird injuries
hemiptera damage

Characteristics of spore inoculum and "Bot" disease

- Spores produced for at least 6 years in cankers
- Spores accumulate year after year
- The disease is chronic
- Cumulative
- Worse in wet years
- Worse in on-years

All nut crops grown in California susceptible to *B. dothidea* strains

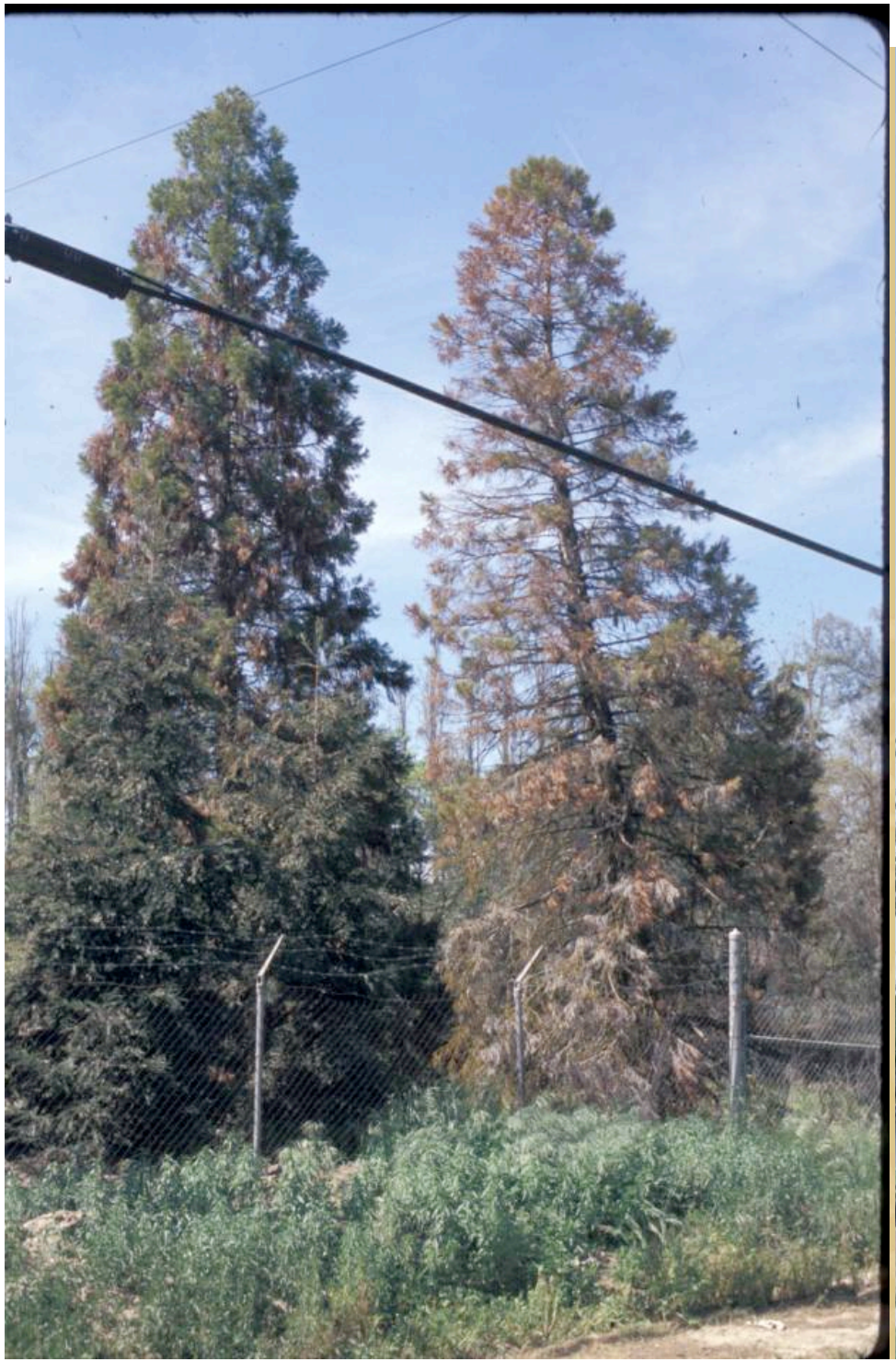
Host	Family	Incidence of disease
Almond	Rosaceae	more and more
English walnut and black walnut	Juglandaceae	some
Pistachio	Anacardiaceae	a lot
Pecan	Juglandaceae	little – some

Botryosphaeria blight inoculum source and spread

Other hosts next to pistachio

Almond	Olive
Apple	Prune
Avocado	Redwoods
Blackberry	Sycamore
Cedar	Walnut
Cotton wood	Wild rose
Eucalyptus	Willow
Giant Sequoia	Other riparian

* 25 more species of fruit trees, ornamentals, and forest trees.




5th PISTACHIO
SHORT COURSE 2008

Managing Bot blight

Eradication difficult, if not impossible.

Can be managed? Yes! Yes! Yes!

(by pruning, cultural practices, & fungicides)

Sanitation questions:

- How long will prunings on ground contribute spores? …… (**about 1.5 years…)**
- When do I decide to prune?... (**check for cankers**)
- How effective is pruning for “Bot” control? …. (**it removes spore inoculum and it is very effective**)

Irrigation questions:

How do I irrigate when I have “Bot” in my orchard?

- … keep water out of the tree
- … shorten irrigation period
- … water during the day

If I do not have “Bot” in my orchard, what do I do?

- Learn what the symptoms look like.
- Become a careful observer.
- Survey orchard for any shoot blights.

(“Bot” usually starts with sporadic shoot and/or cluster blights and it does not take very long to build up spore inoculum (exponential increase)

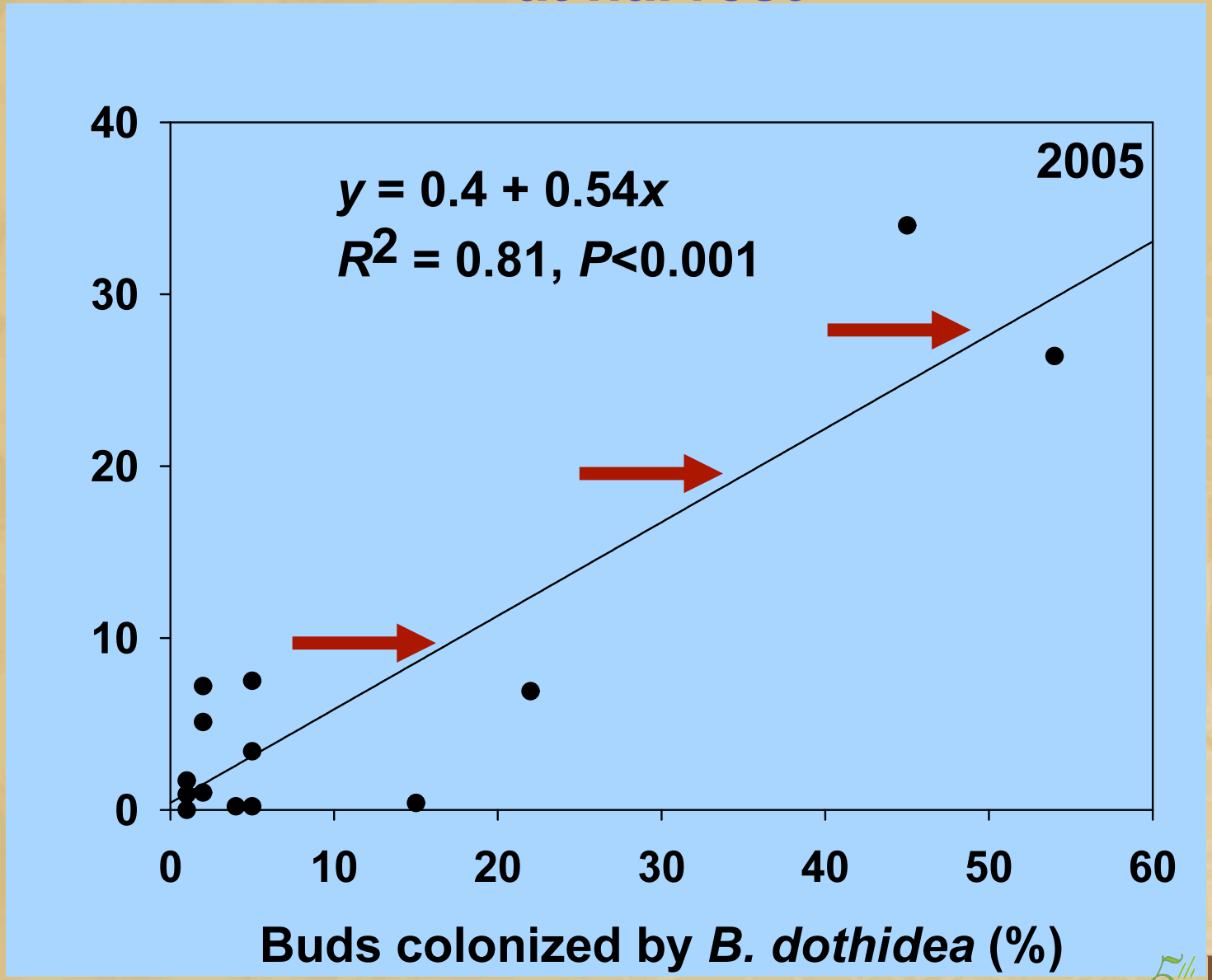
BUDMON Technique:

Bud monitoring of Botryosphaeria

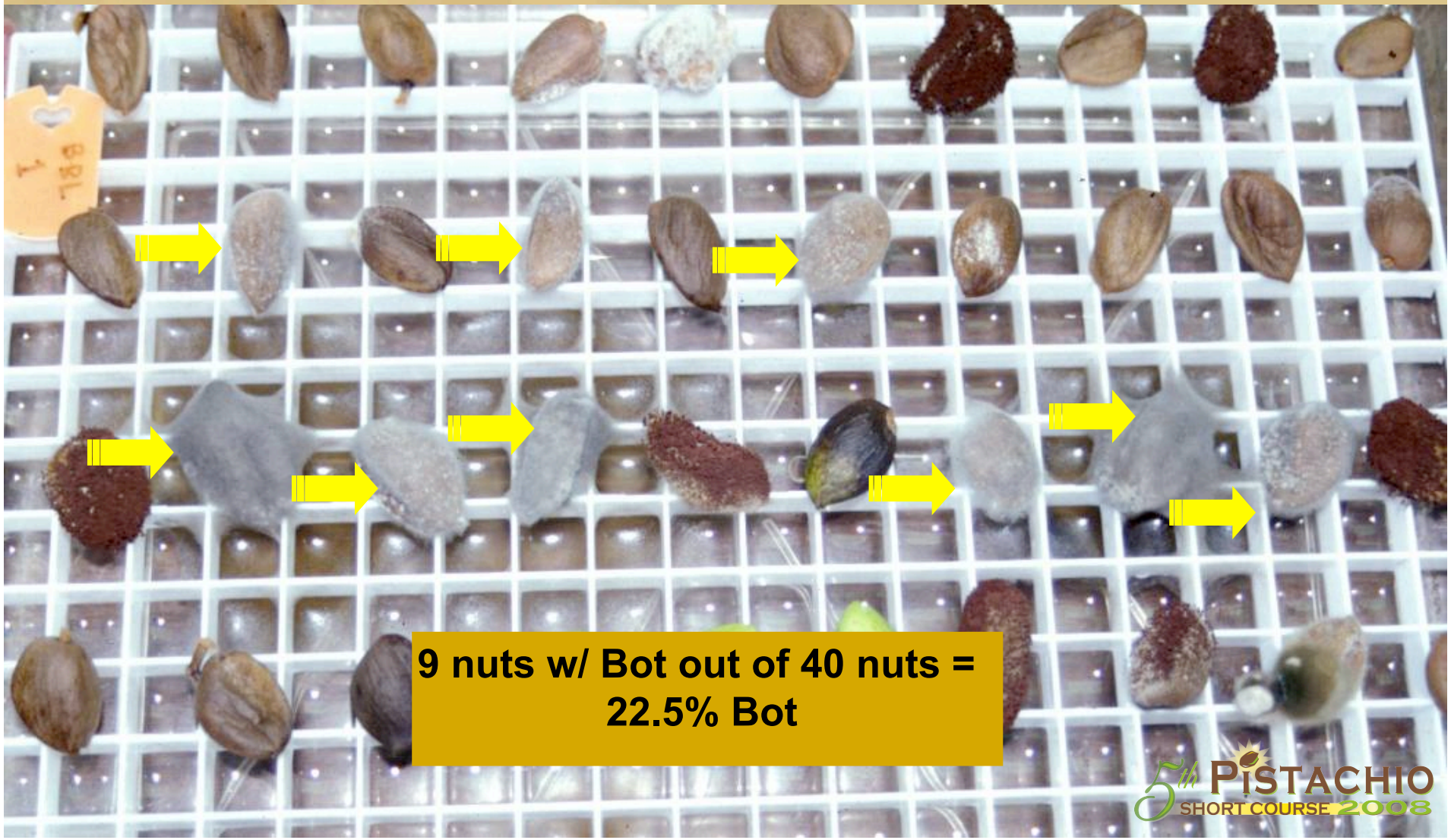
buds plated

growth of Botryosphaeria

Relationship between BUDMON and disease at harvest



ONFIT: Overnight Freezing Incubation Technique



9 nuts w/ Bot out of 40 nuts = 22.5% Bot

Fungicides registered (Botryosphaeria)

Trade name	Active ingredient	Efficacy
Abound	azoxystrobin	+++*
Bravo	chlorothalonil	++
Cabrio	pyraclostrobin	+++*
Liquid lime sulfur	---	+/-
Gem	trifloxystrobin	+++*
Pristine	pyraclostrobin+ boscalid	++++*
Scala	pyrimethanil	+++* ¶
Switch	cyprodinil+ fludioxonil	++
Topsin-M	thiophanate-methyl	+

¶ **Under low and moderate disease pressure.**

There is no resistance of *Botryosphaeria* to any fungicides

Treatment Timing (Botryosphaeria)

Disease	Dormant	April	June	July	August
Alternaria	---	---	+++	+++	++
Botryosphaeria	+	++ (bloom)	+++	+++	++
Botrytis	---	+++	---	---	---

Rating: +++ = most effective, =++ = moderately effective,
+ = least effective, and --- = ineffective

Website for fungicide efficacy and timing:

go to the UC-IPM web site:

http://www.ipm.ucdavis.edu/PDF/PMG/fungicideefficacytiming.pdf

Success in disease management due to these very effective fungicides:

- ✓ **Azoxystrobin (Abound®)*****
- ✓ **Trifloxystrobin (Gem®)*****
- ✓ **Pyraclostrobin (Cabrio®)*****

} **strobilurins**

- ✓ **Pyraclostrobin + boscalid (Pristine®)*****

***** **No resistance in the field to these fungicides has been found.**

Summary of “Bot” blight management

- ✓ Learn what “Bot” looks like
- ✓ Watch your orchard carefully
- ✓ If “Bot” appears act immediately
- ✓ Prune out infections
- ✓ Consider bud monitoring (BUDMON) in Feb/ March
- ✓ Consider ONFIT at end of rainy season (June)
- ✓ Evaluate your irrigation system
- ✓ Do more selective pruning
- ✓ Apply registered fungicides as needed

Botrytis blossom and shoot blight

and now…

fruit blight

(when spring is wet and cool)

Early infections (start in bud scales)

blossom and shoot blight

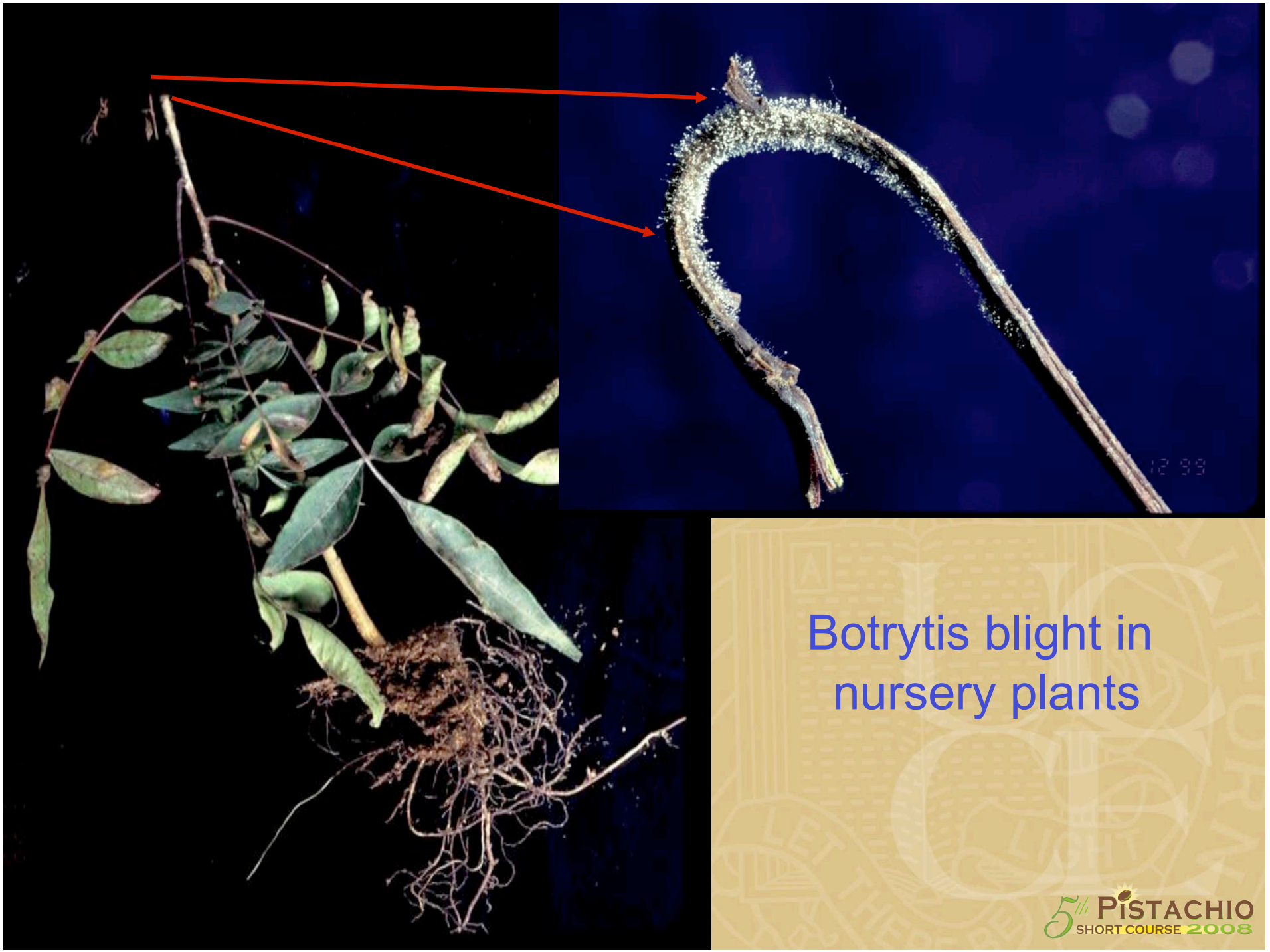
… and now Botrytis fruit blight


5th PISTACHIO
SHORT COURSE 2008


5th PISTACHIO
SHORT COURSE 2008

Peters 02-16 & 02-18

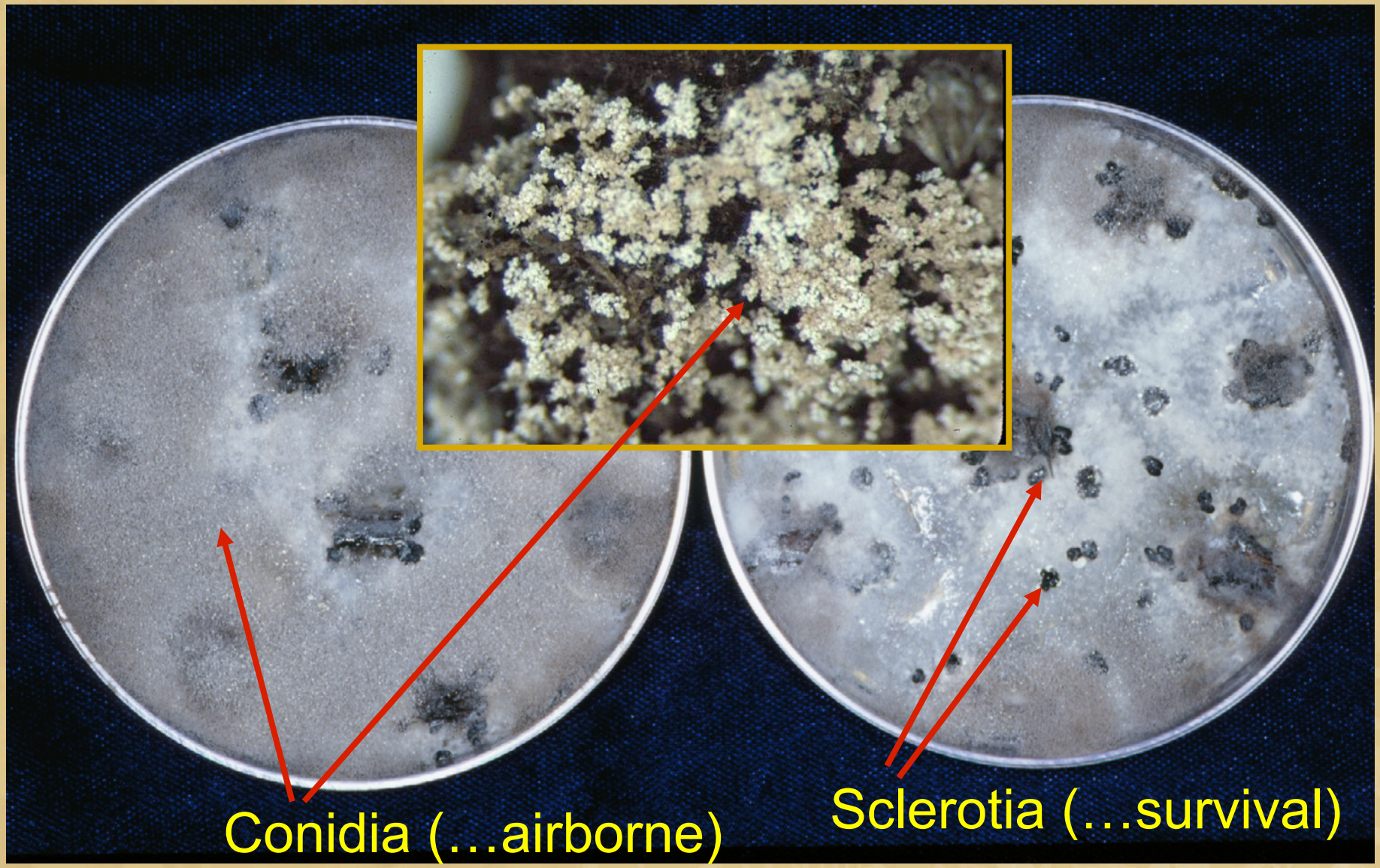
Cankers started
from male flowers



Botrytis blight in nursery plants

Budded rootstock infected by *Botrytis*

Pathogen: *Botrytis cinerea*



Fungicides registered (Botrytis)

Trade name	Active ingredient	Efficacy
Benlate ¶	benomyl	+++
Distinguish	pyrimethanil + trifloxystrobin	++
Elevate	fenhexamid	++++
Pristine	pyraclostrobin+ boscalid	++++
Scala	trifloxystrobin	++
Switch	cyprodinil + fludioxonil	+++
Topsin-M	Thiophanate methyl	+++*

¶ **Benlate label withdrawn.**

* **Some resistance to Topsin-M.**

Treatment Timing (Botrytis)

Disease	Dormant	April	June	July	August
Alternaria	---	---	+++	+++	++
Botryosphaeria	+	++	+++	+++	++
Botrytis	---	+++ bloom	---	---	---

Rating: +++ = most effective, =++ = moderately effective,
+ = least effective, and --- = ineffective

http://www.ipm.ucdavis.edu/PDF/PMG/fungicideefficacytiming.pdf

Diseases of pistachio (2008)

1. Alternaria late blight***** (*Alternaria* spp.)
2. Anthracnose (*Colletotrichum acutatum* & *C. gloeosporioides*)
3. Aspergillus fruit blight (*Aspergillus niger* & other spp.)
4. Blossom and shoot blight* (*Botrytis cinerea*)
5. Eutypa dieback (*Eutypa lata*)
6. Gum canker (*Cytospora terebinthi*)
7. Panicle and shoot blight** (*Botryosphaeria dothidea*)

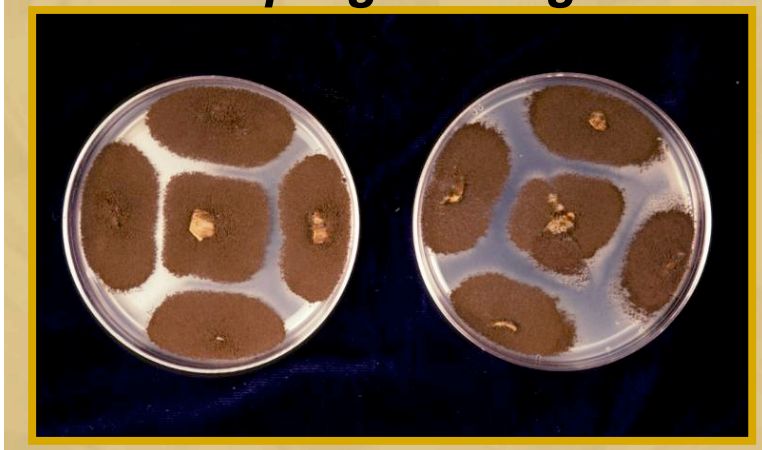
Diseases of pistachio (2008)

8. Phomopsis blight (*Phomopsis* sp.)
9. Powdery mildew (*Oidium* sp.?)
10. Rust (*Pileolaria terebinthi*)
11. Sclerotinia blight (*Sclerotinia sclerotiorum*)
12. Septoria leaf spot (3 *Septoria* spp.)
13. Stem canker (*Botryosphaeria obtusa*)
14. Stigmatomycosis *(Eremothycium coryli)*

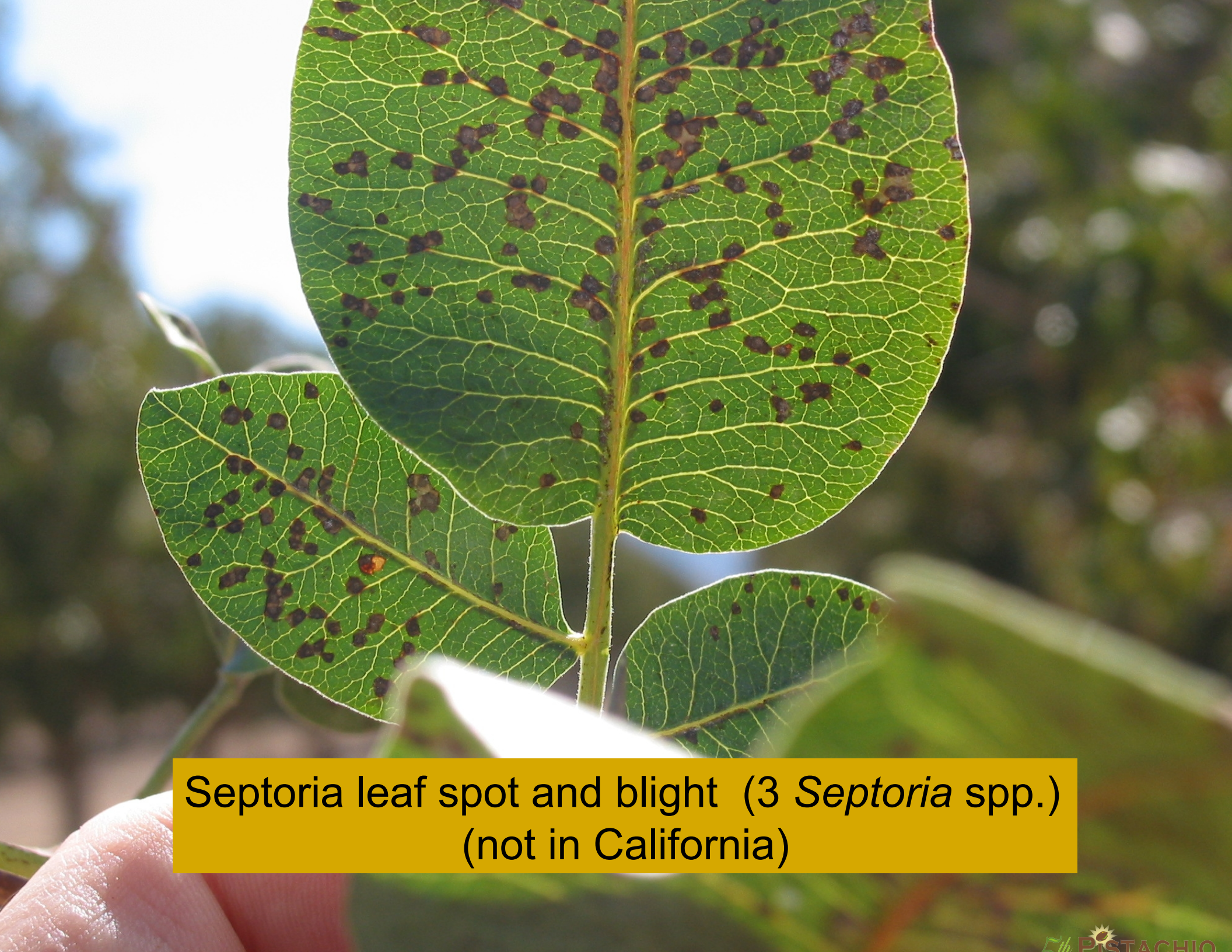
Anthracnose of pistachio

Aspergillus blight

Aspergillus niger



Yellow staining


Septoria leaf spot and blight (3 *Septoria* spp.)
(not in California)

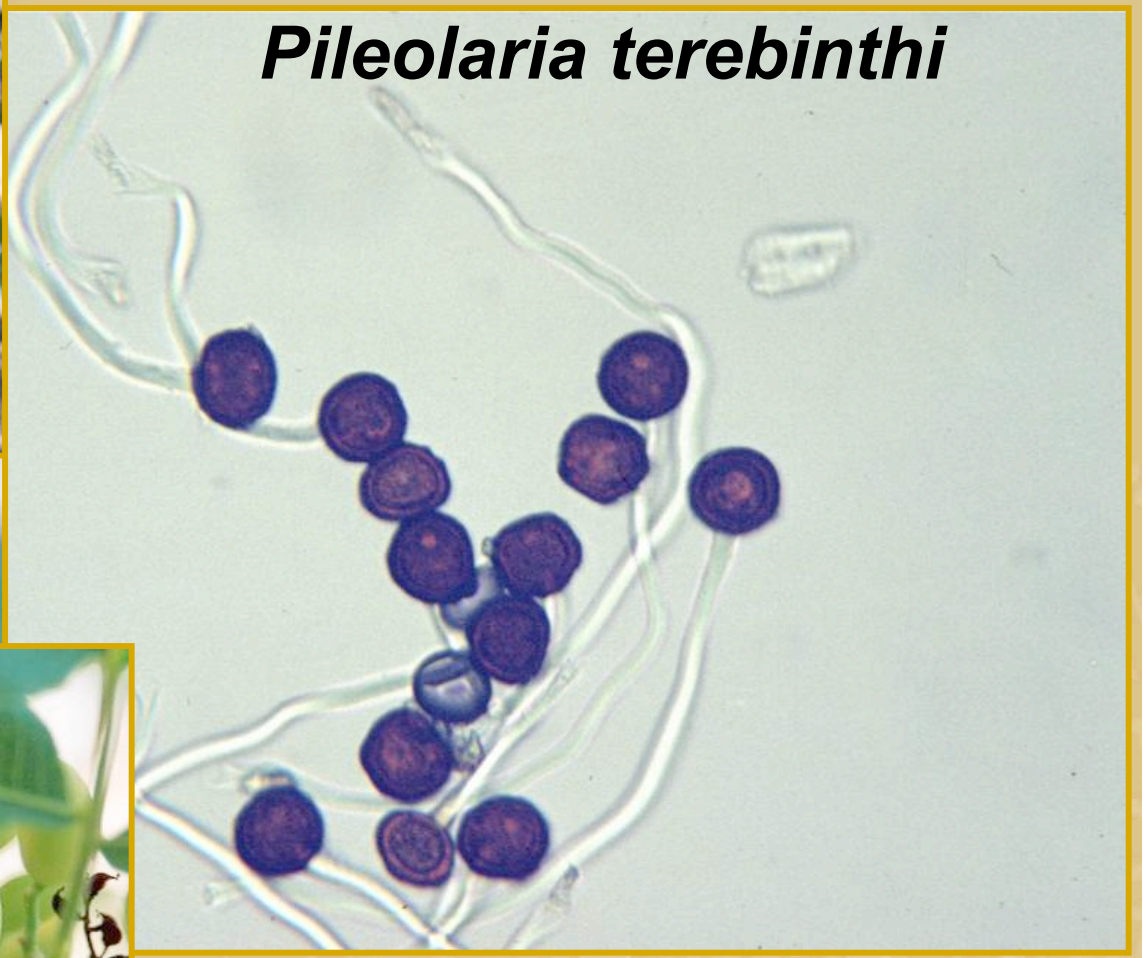
Septoria sp.
(pistachio, Arizona)

Severe defoliation
at harvest

Rust of pistachio

(not in USA pistachios)

Pileolaria terebinthi

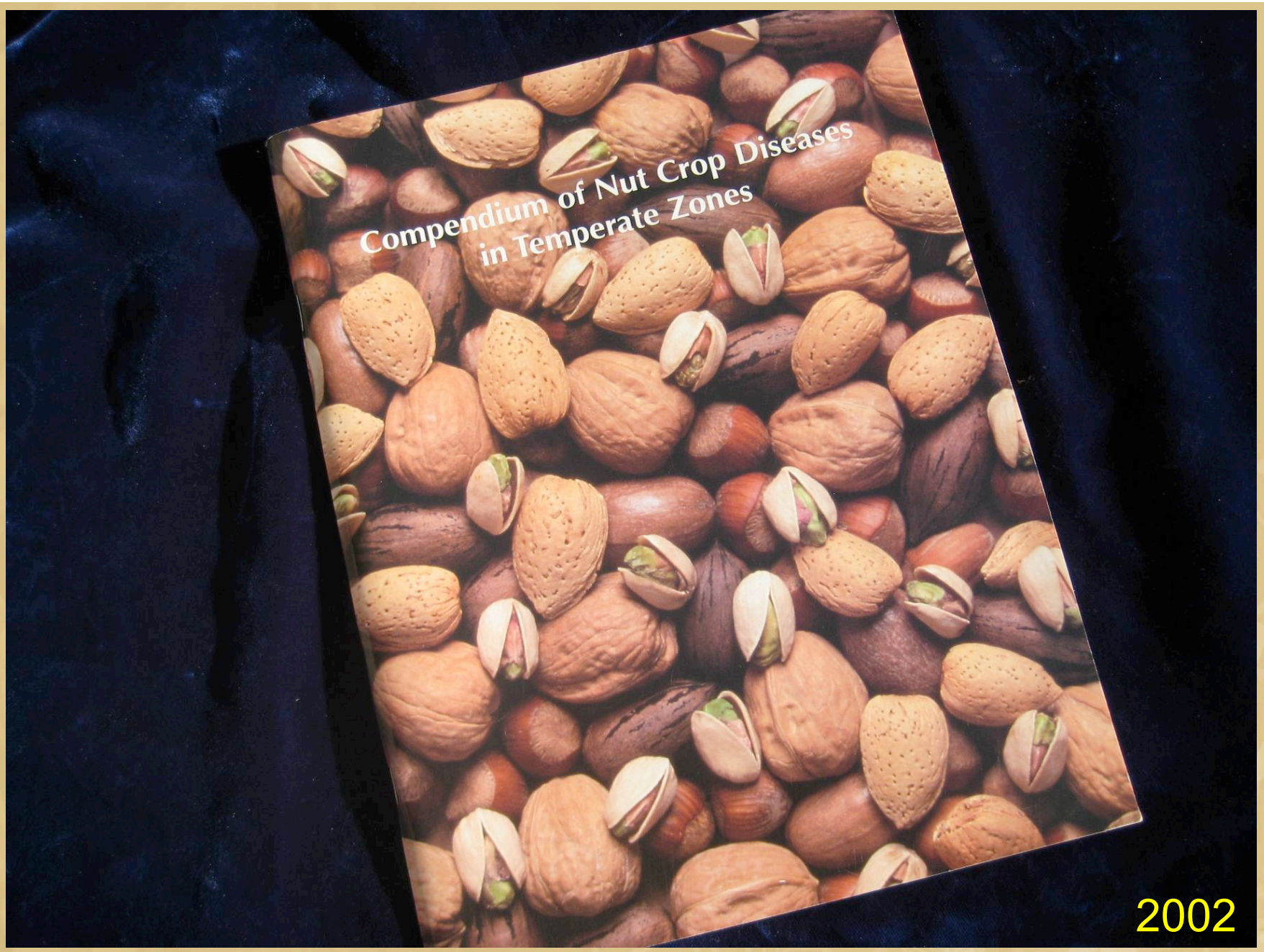


Stigmatomycosis

Caused by *Eremothycium coryli* (a yeast)

Damage caused by hemipteran insects

Kernel necrosis (damage by large hemiptera)



American Phytopathological Society: order 1-880-328-7560 (http://www.scisoc.org)

Acknowledgments

David Morgan

Mark Doster

Herve Avenot

Barry Pryor (U. AZ)

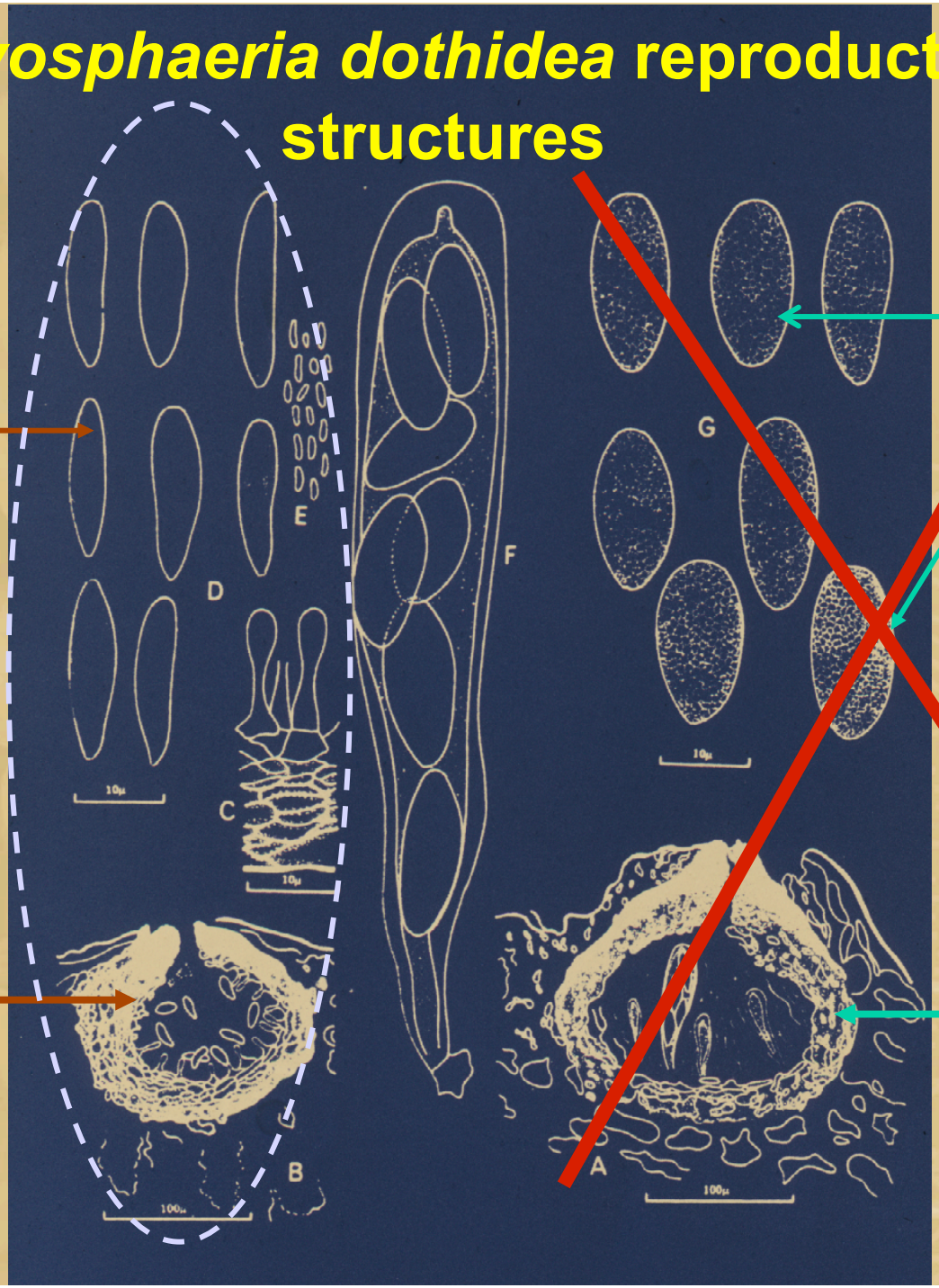
Neph Ahimera

Heraclio Reyes

Jessica Windh

Ryan Puckett

Botryosphaeria dothidea reproductive structures



conidia

Water-splashed

or insect spread

pycnidia

asco-spores

airborne

ascocarps (pseudothecia)

Name of the pathogen of “Bot” blight

Sexual: *Botryosphaeria dothidea*

(not found on pistachio yet)

Asexual: *Fusicoccum* sp.

(found on pistachio)

Managing “Bot” blight

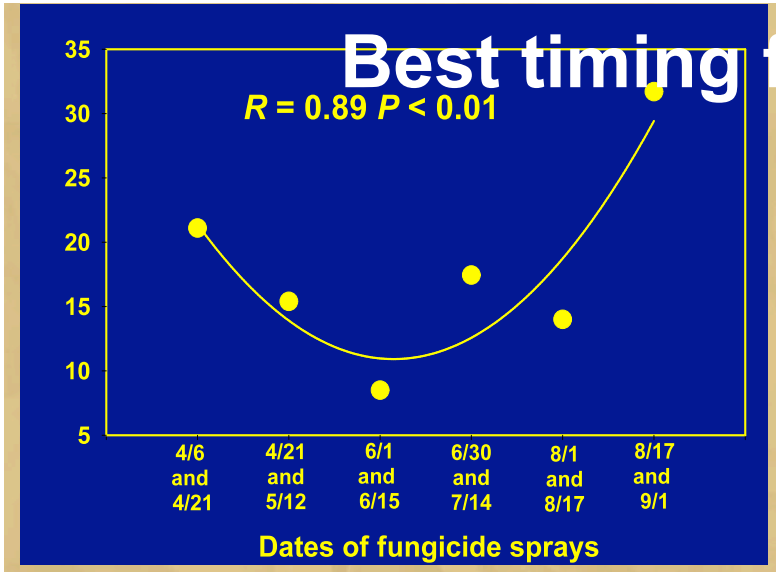
Timing:

- ✓ Dormant: none
- ✓ Bloom: one spray*
- ✓ Summer: start in May/early June at 2-3 weeks or monthly …finish in early August.

When high disease pressure: up to 6 sprays

* Many infections can start during bloom → importance of bloom spray

Best timing for fungicide application



(Stratego®)