

Beating Back Bitter Rot: Optimizing Management Strategies

2022 Mid-Atlantic Fruit and Vegetable Convention

February 3, 2022



Photo: K. Peter



PennState Extension

Kari Peter, Ph.D.

Department of Plant Pathology and Environmental Microbiology

Penn State University Fruit Research and Extension Center

Biglerville, PA



@drtreefruit

kap22@psu.edu 717-677-6116 Ext 223

extension.psu.edu

Bitter rot: Latest research and management strategies



Dr. Phillip Martin
2021 PSU Grad
(Slides courtesy of Phillip)

- **How to identify bitter rot**
- **Timing of spore dispersal**
- **Susceptibility of apple cultivars to bitter rot**
- **Optimal weather conditions for bitter rot**
- **Most effective fungicides for bitter rot management**
- **Cultural management**



Identifying bitter rot

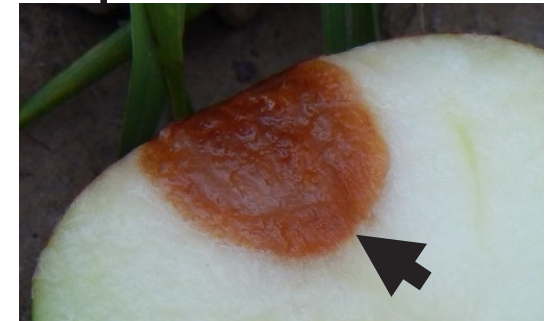
Sunken lesions



V-shaped lesion in apple flesh



Black and white rots have U-shaped lesions



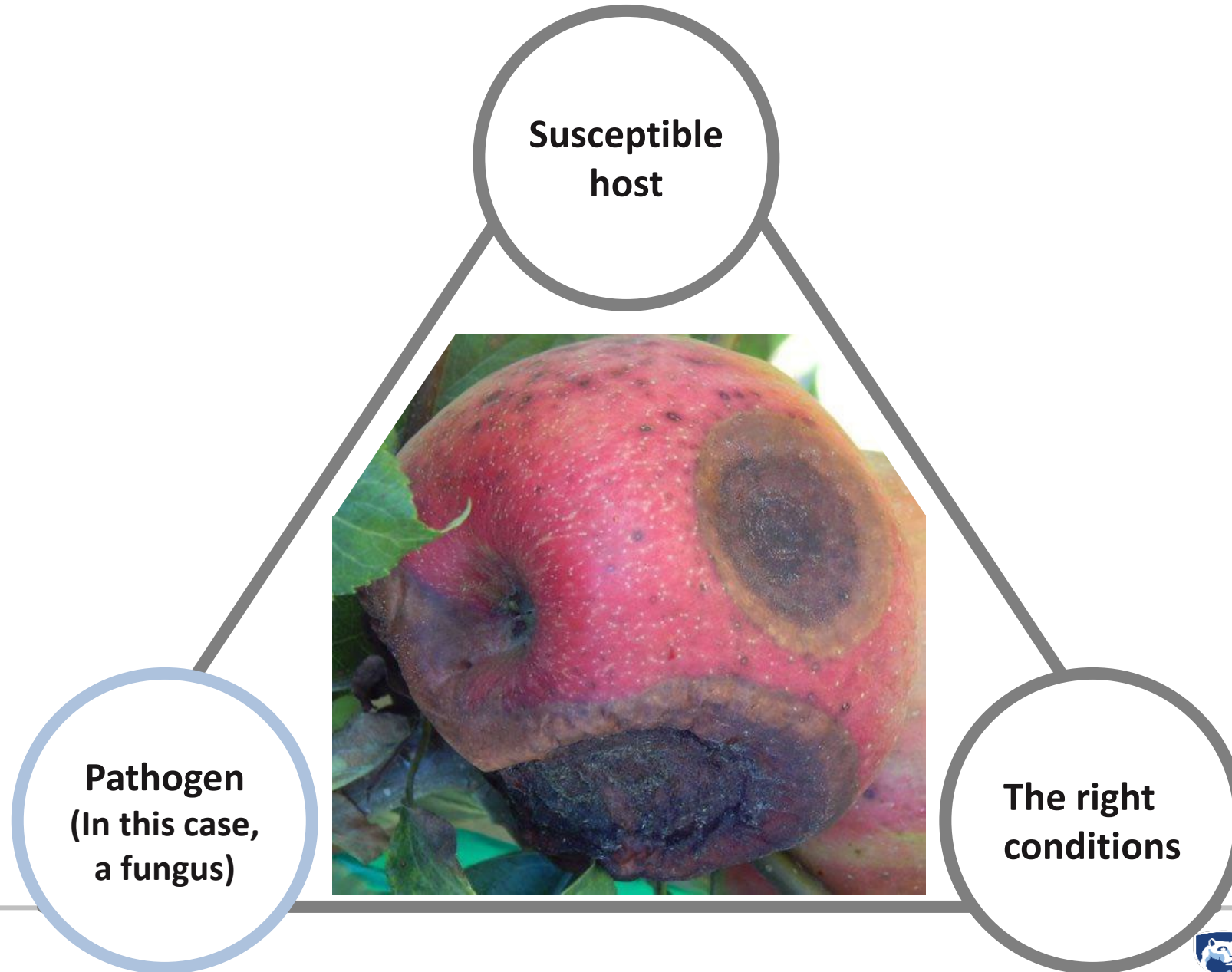
Orange spores (conidia)



Concentric rings



Understanding plant disease triangle for bitter rot: focus on the pathogen



Colletotrichum fungi that cause bitter rot also infect many other plants

Anthracnose



Photo: J. Pawlak

Strawberries



Photo: Bernadine C. Strik

Blueberries



Pears



Peaches

celery leaf curl



Photo: Michael Celetti

Celery

End rot/Anthracnose



Photo: Greg Miller

Chestnuts

Ripe rot

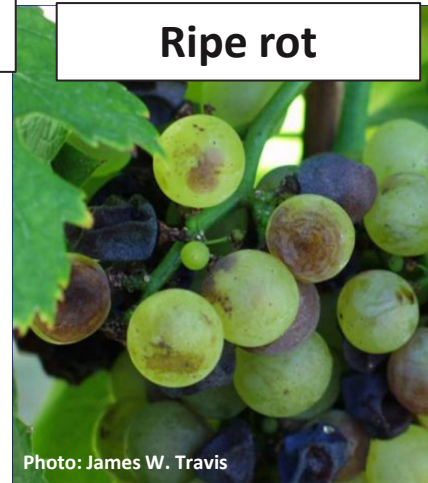
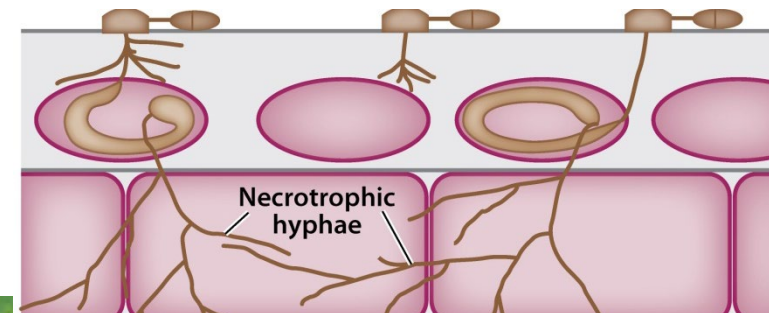
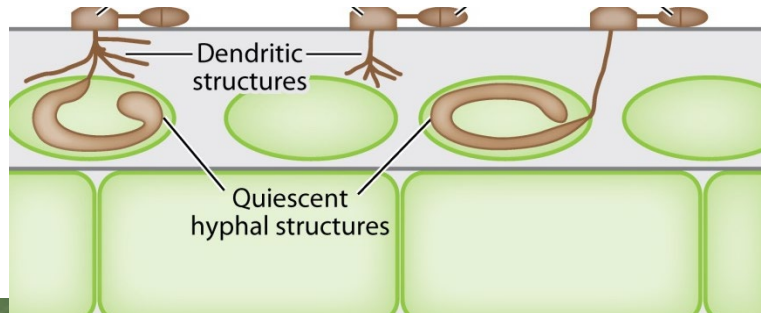
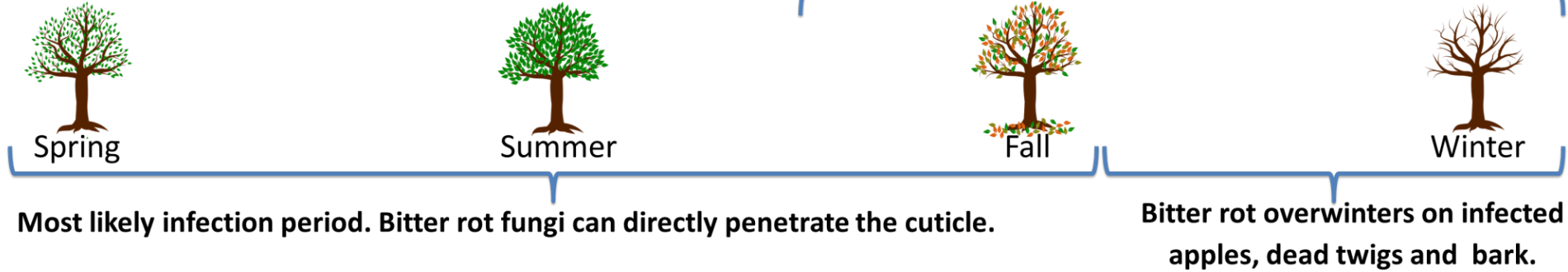


Photo: James W. Travis

Grapes

Colletotrichum fungi often have dormant stages

Bitter Rot Fungi Infection Cycle



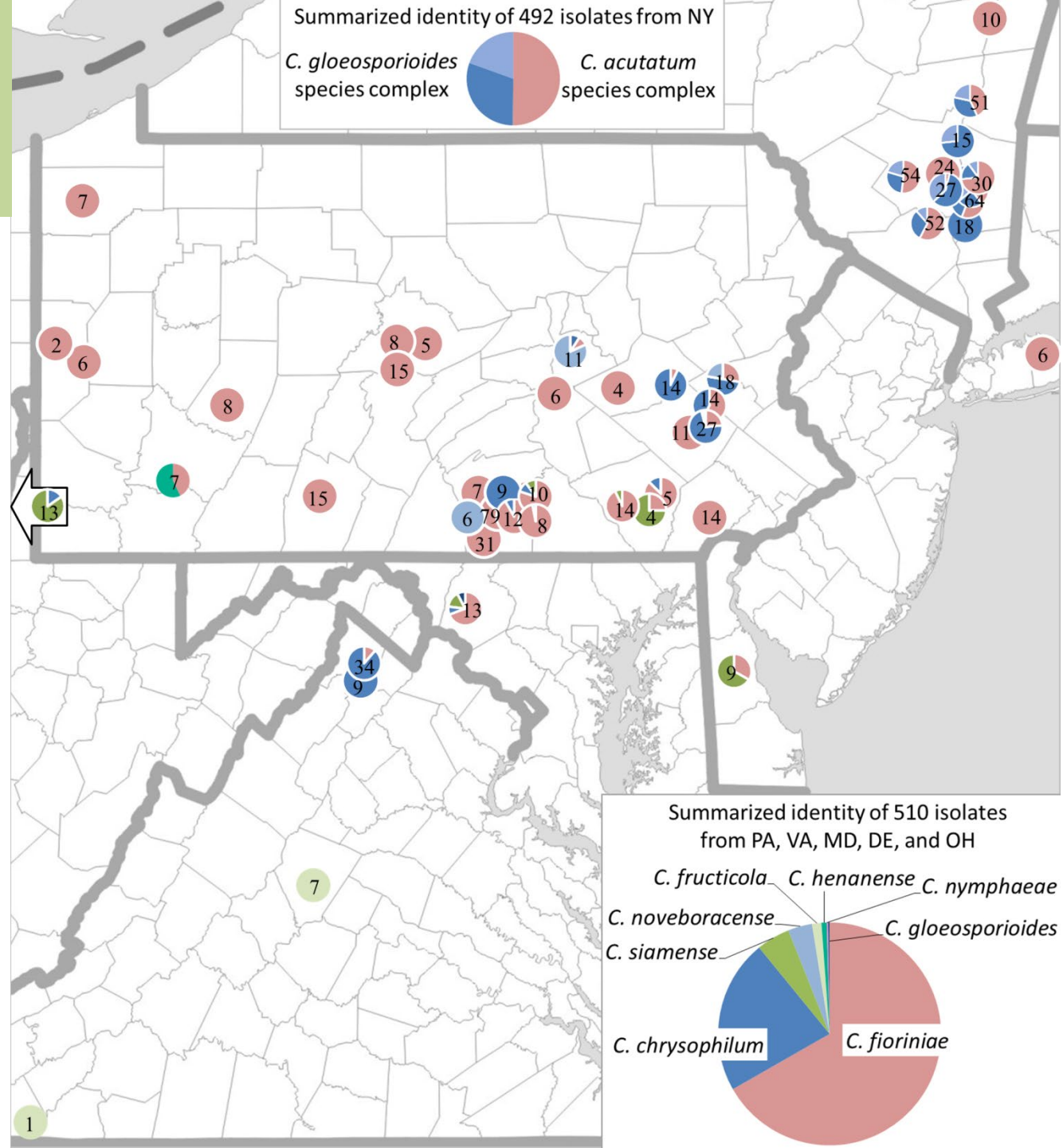
There are 8 different *Colletotrichum* species that cause bitter rot in the Mid-Atlantic region

Most common are *C. fioriniae* and *C. chrysophilum*.

These are part of the *C. acutatum* and *C. gloeosporioides* species complexes

These species have similar disease cycles and biology

**Take home message:
More than one species infecting
apples...will not affect management
strategies (so far)**



The bitter rot pathogen: When are spores being dispersed in orchards?

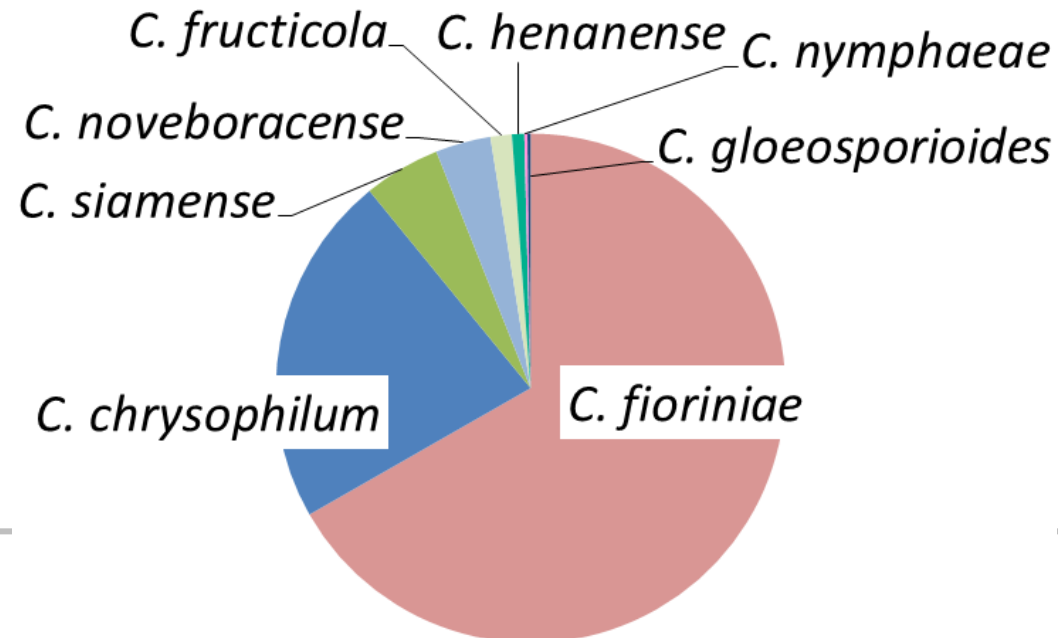
When are the key bitter rot infection periods?

This information could guide the timing of fungicide applications

When are spores being dispersed?

Focus on *C. fioriniae*

Summarized identity of 510 isolates
from PA, VA, MD, DE, and OH



C. fioriniae spores are dispersed throughout the growing season

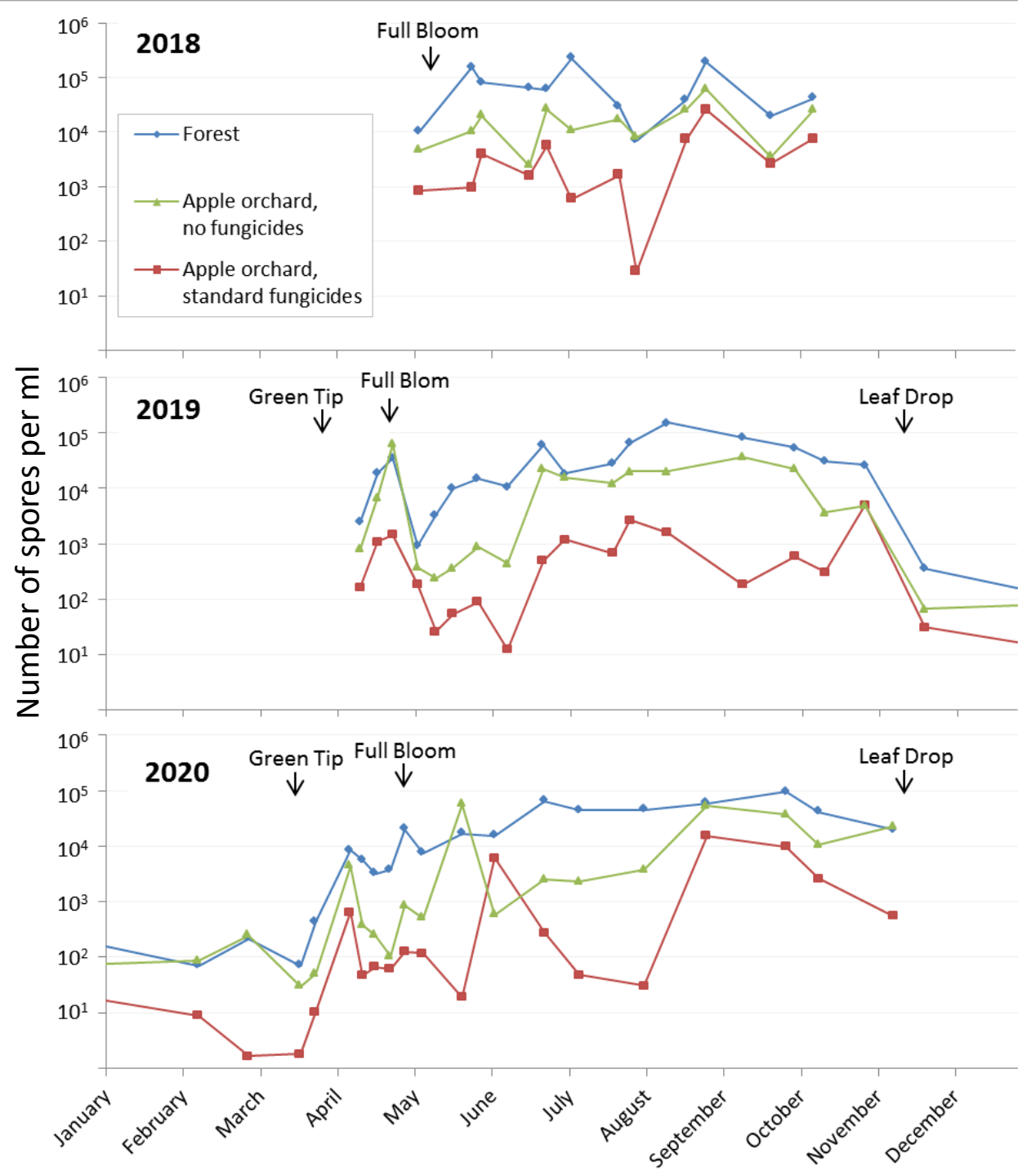


Photo: P. Martin

Spores were detected in rainwater collected under the trees

Take home message:
Spores are available all the time, everywhere, during the season...

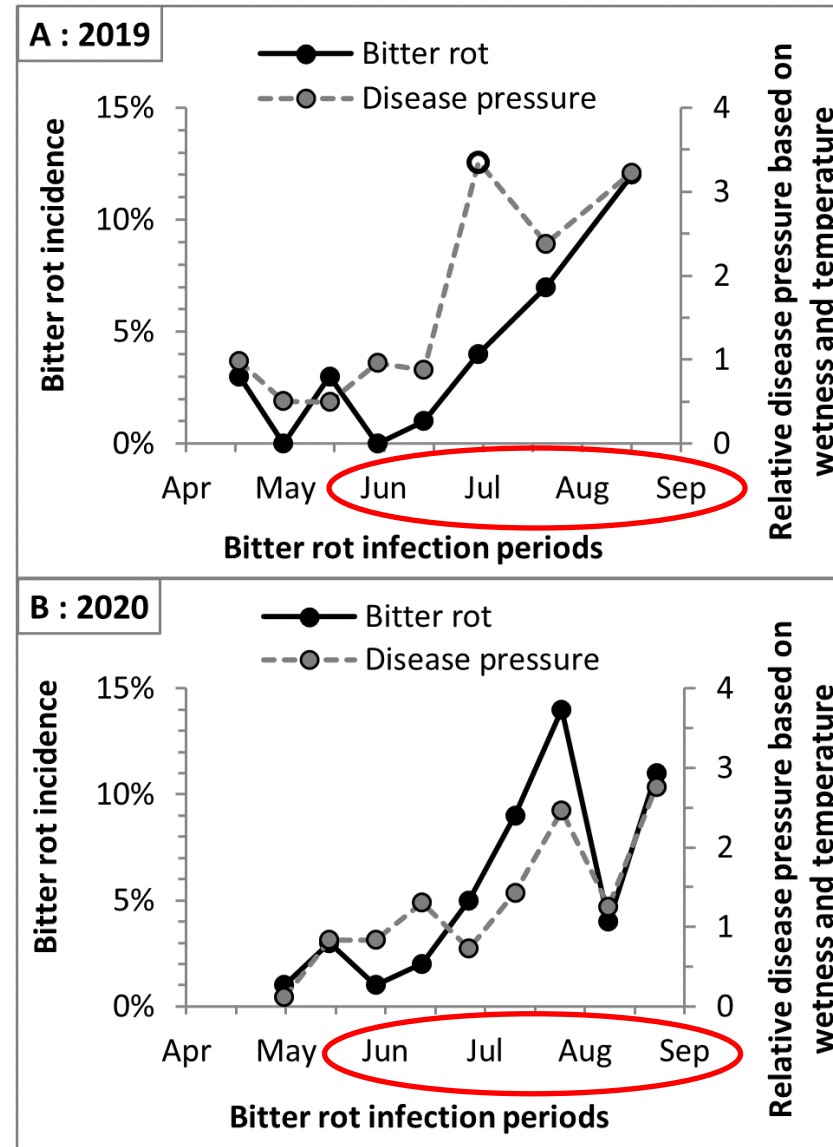
So when is protection most critical?



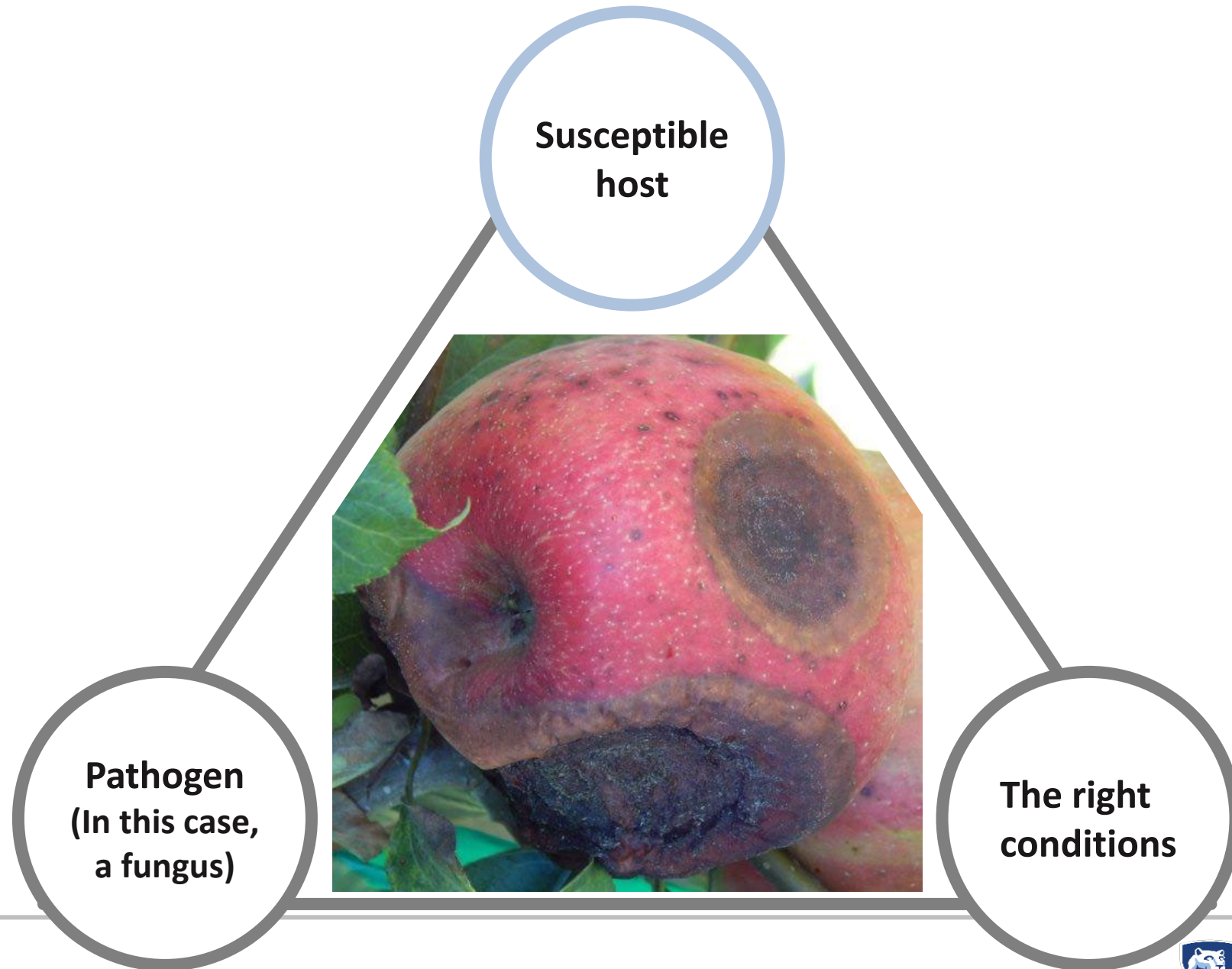
Key time for controlling bitter rot: Late June through harvest

Take home message:
Protection is most critical from
late June through August
DURING periods of warm wet
weather during the season =

Protection is needed **BEFORE** to
these events!



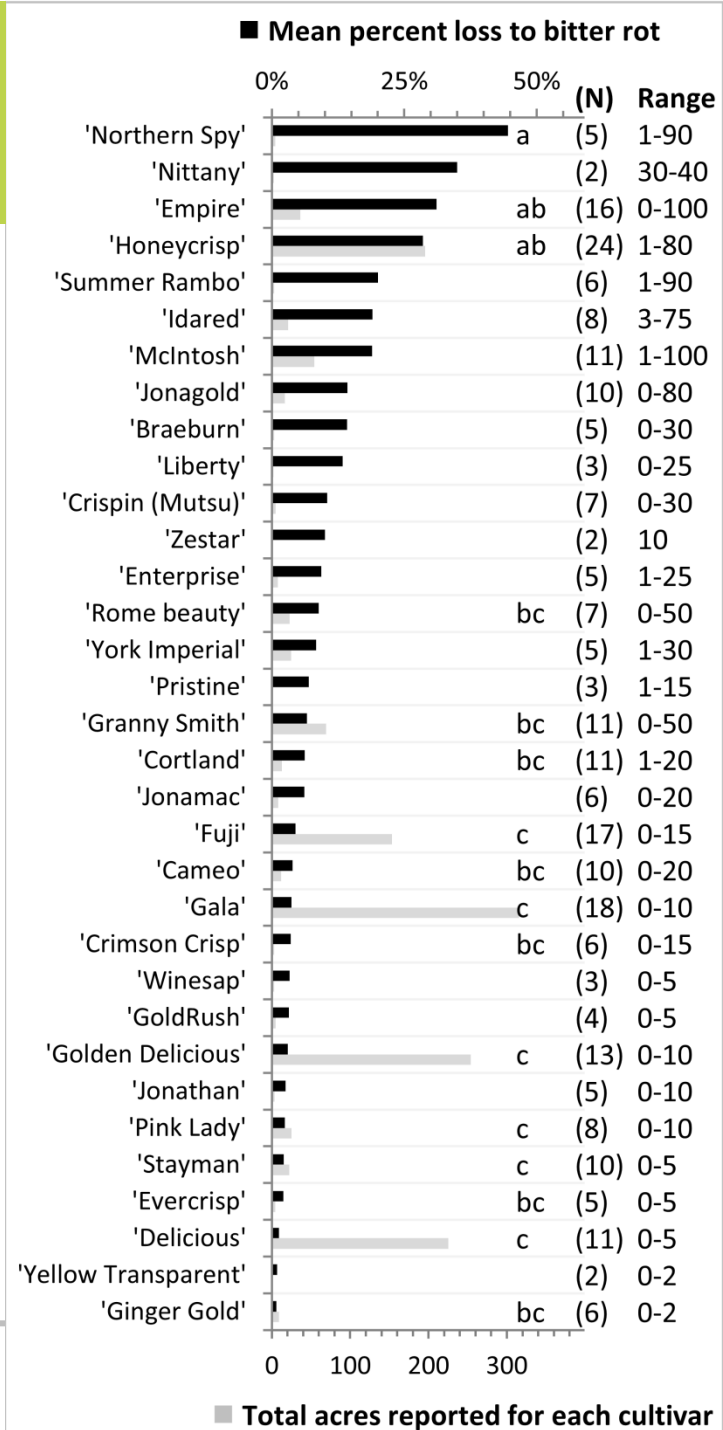
Understanding plant disease triangle for bitter rot: focus on the host



Apple growers reported large differences among cultivars in losses to bitter rot

Results from a survey of 34 apple growers, who grow a total of 1,527 acres of apples

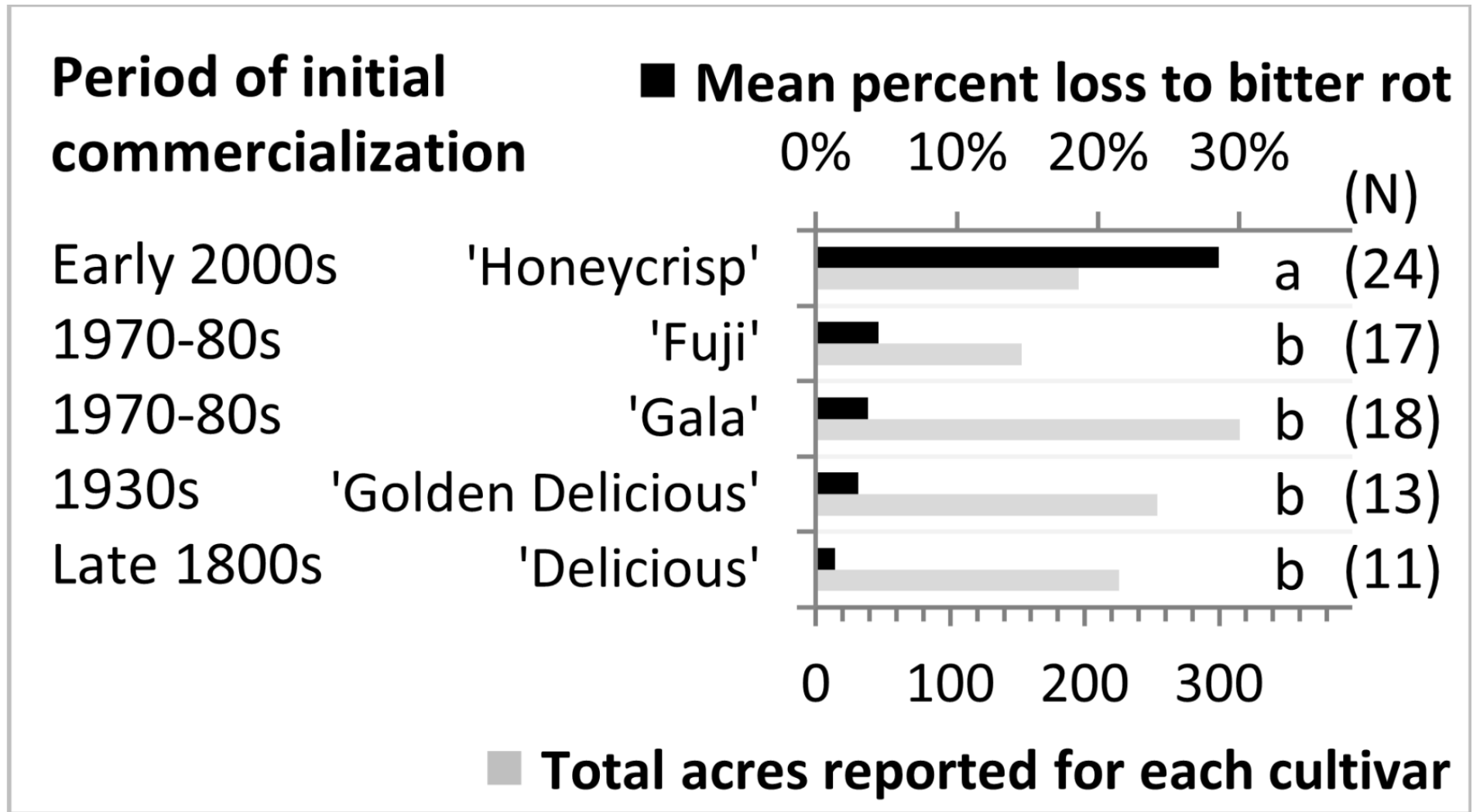
Longtime nurseryman: “bitter rot is very much variety specific”



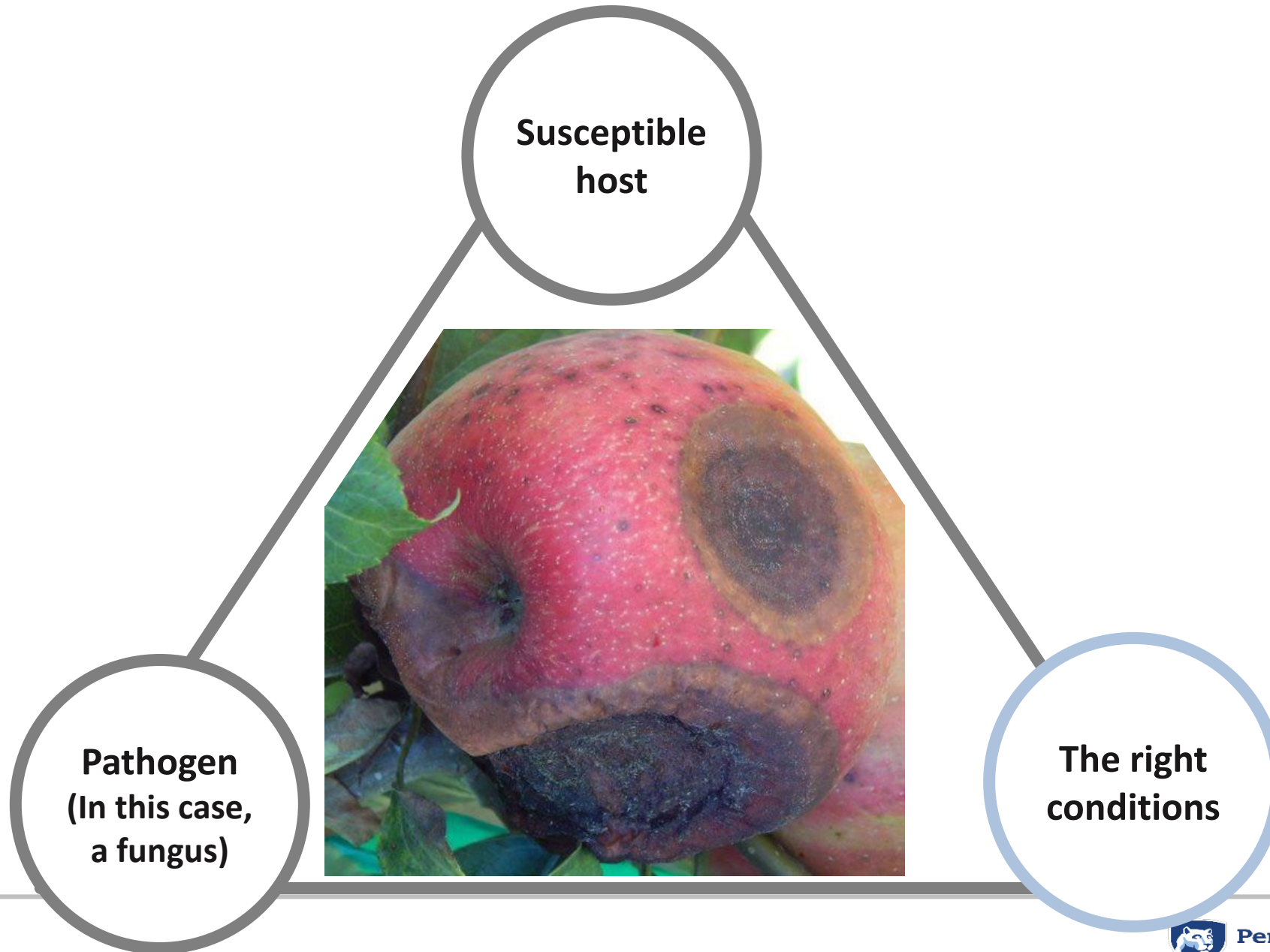
N is number of growers reporting for that cultivar

Range is the range of losses reported

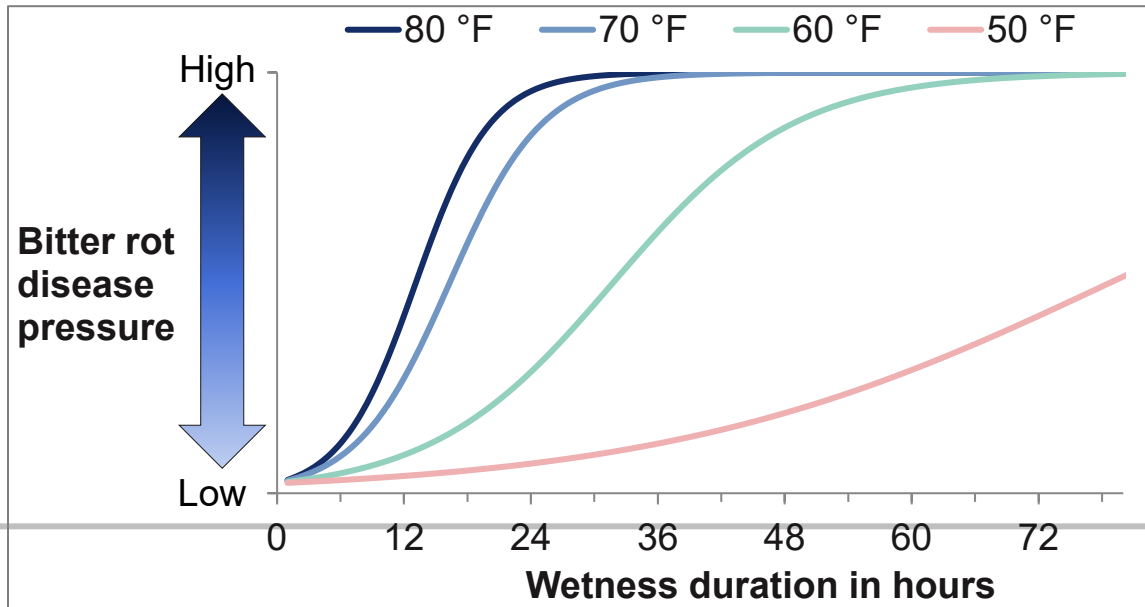
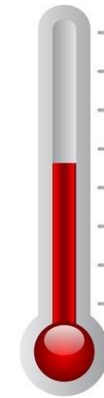
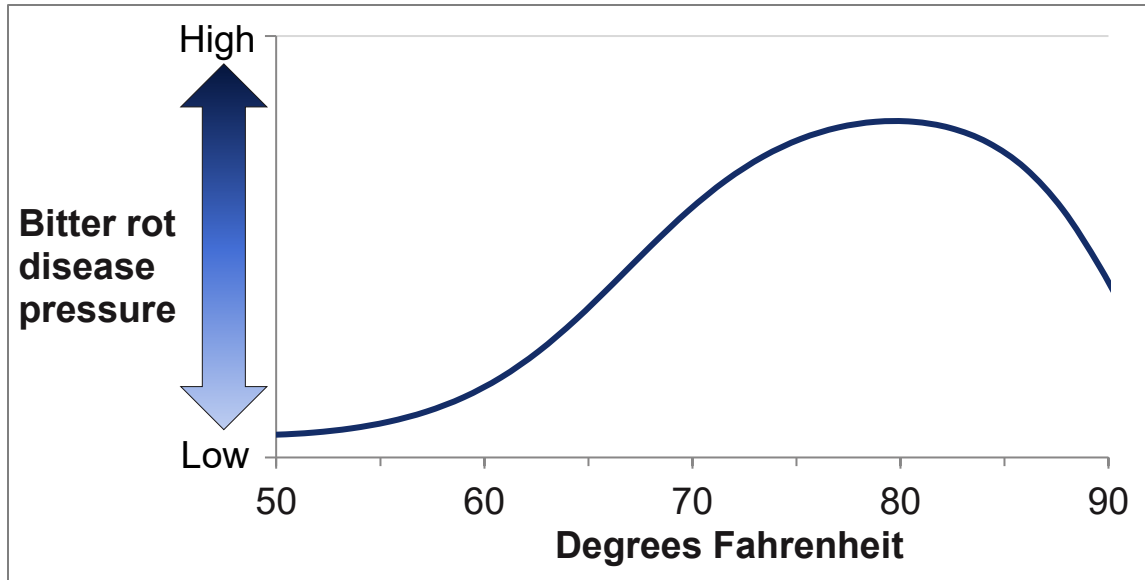
Of the top 5 cultivars the most recently popular and widely planted 'Honeycrisp' is highly susceptible to bitter rot



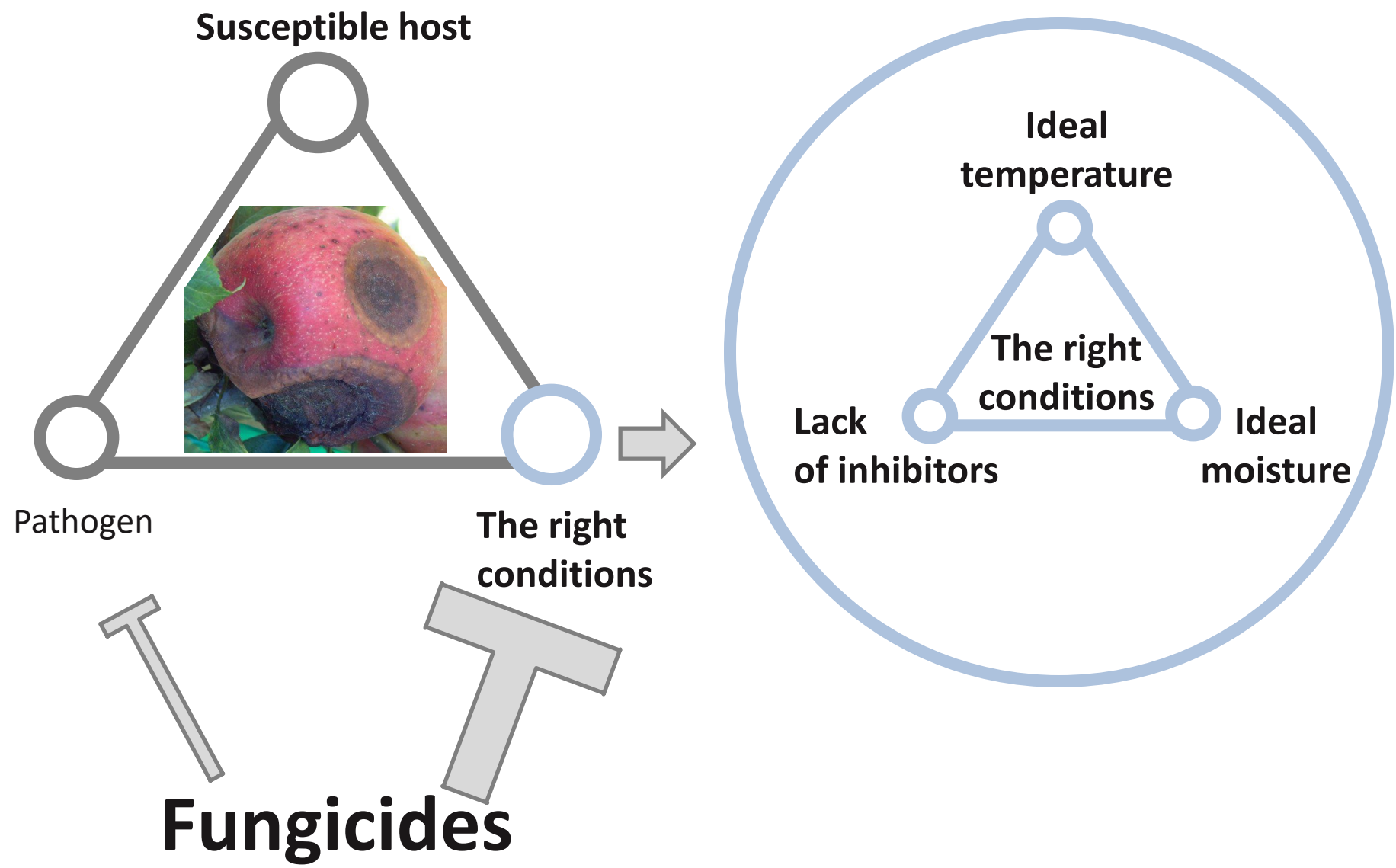
Understanding plant disease triangle for bitter rot: Right conditions



The two most important conditions are the right temperatures and enough wetness hours



Most of the time though, fungicides simply create poor conditions for fungi



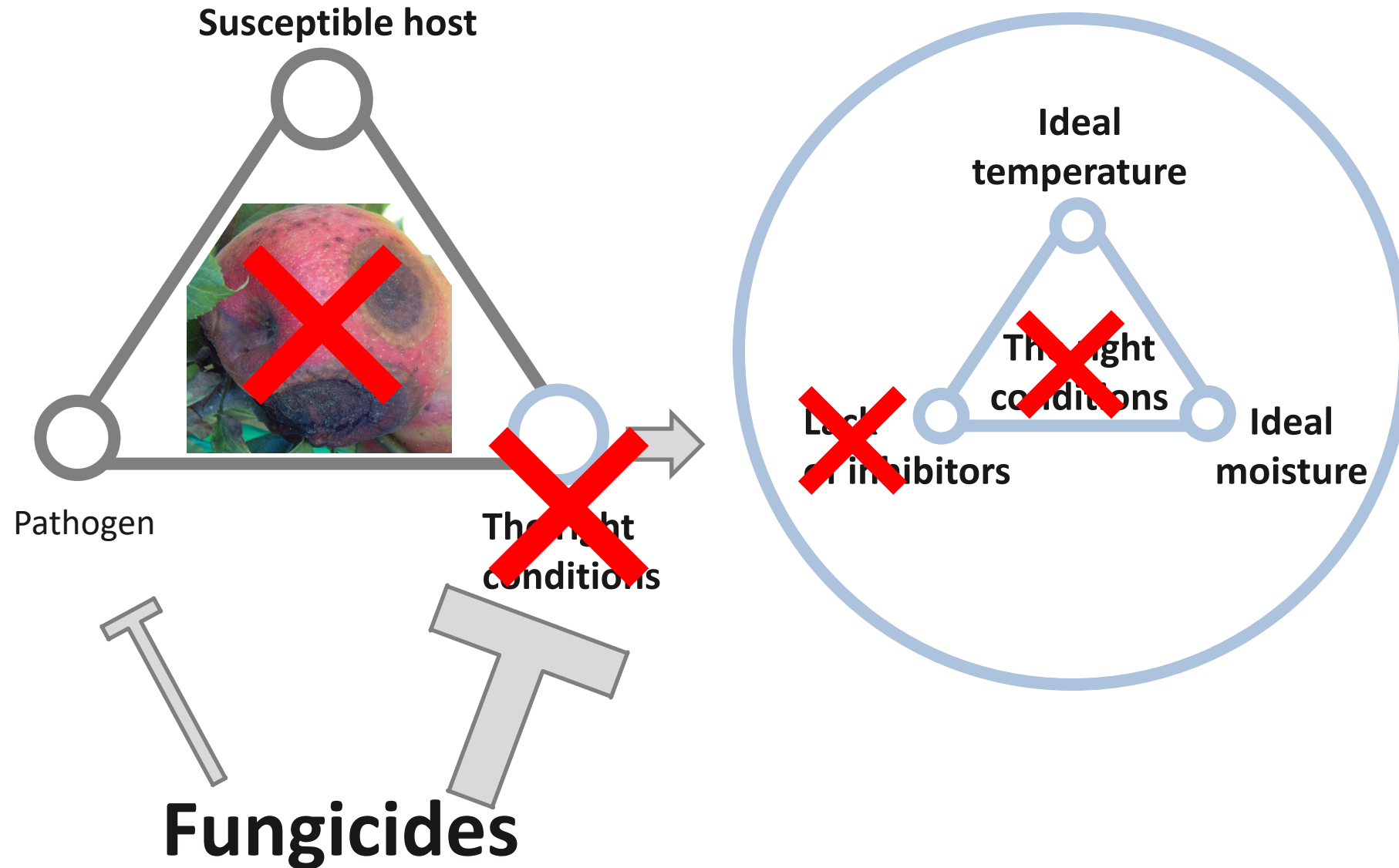
Fungi-cides

“denoting a substance that kills”

Fungi-stat

“lacking in movement, action or change”

Fungicides create poor conditions for fungi = prevent disease



Fungi-cides

“denoting a substance that kills”

Fungi-stat

“lacking in movement, action or change”

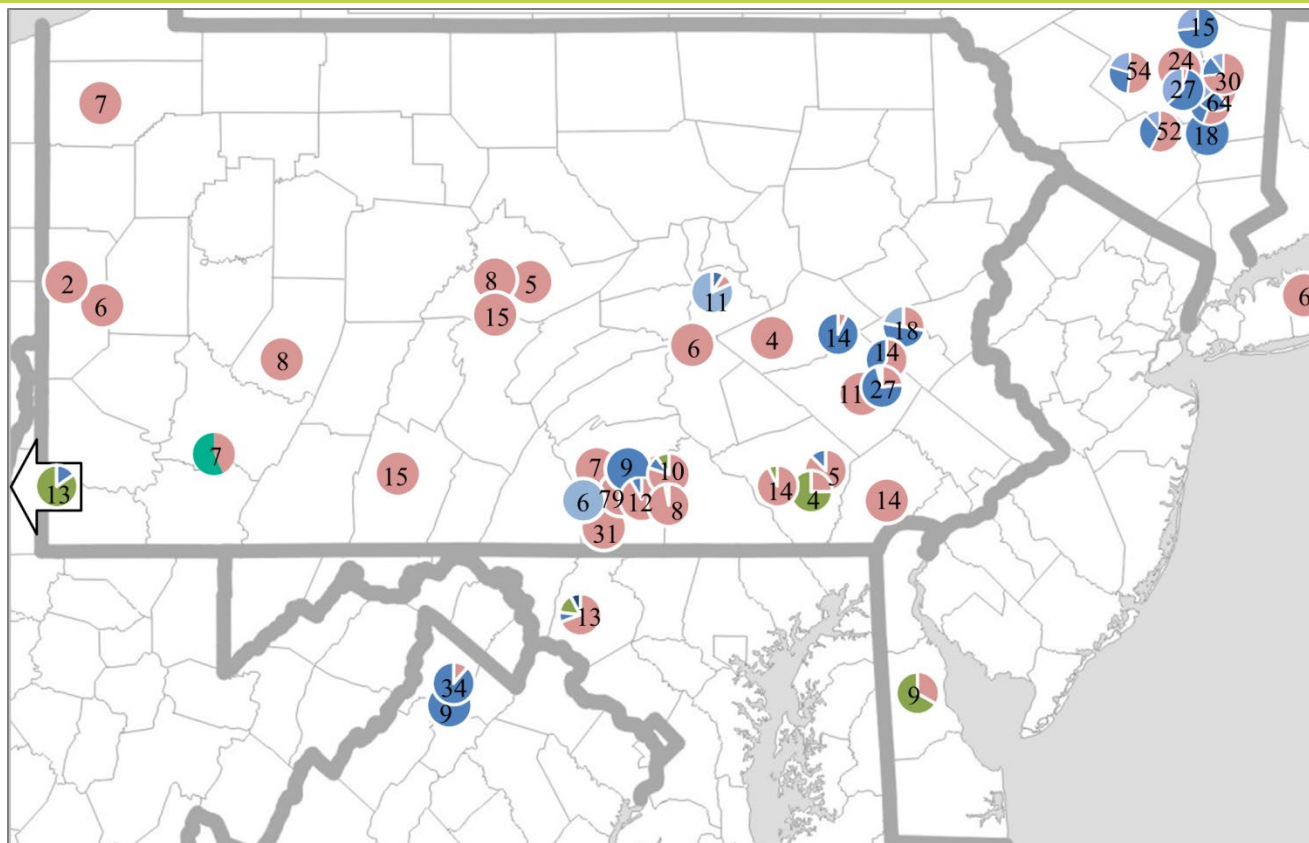
Which fungicides are most effective for bitter rot control?

Checking for fungicide resistance

220 fungal isolates from across the Mid-Atlantic region were screened for resistance to fungicides

5% were resistant to FRAC group 1 (Topsin)
(= 1 species: *C. siemense*)

Less than 1% were partially resistant to FRAC group 11 (Merivon, Luna Sensation, Flint Extra, Sovran)
(= 1 species: *C. siemense*)



Fungicide resistance is present, but at very low levels

Follow fungicide label restrictions to keep fungicide resistance from spreading

Which fungicides are most effective for bitter rot control?

Rating the fungicides for bitter rot control

		Product	FRAC group	Fungicide active ingredients	Notes
Bitter rot control ratings	Recommended	Captan	M4	Captan	
		Manzate, etc.	M3	Mancozeb	77 day PHI
		Scholar	12	Fludioxonil	Post-harvest only
		Omega	29	Fluazinam	Use the 13.8 oz. rate
		Merivon	11 + 7	Pyraclostrobin + fluxapyroxad	A maximum of four FRAC group 7 and four FRAC group 11 applications are allowed per season
		Pristine	11 + 7	Pyraclostrobin + Boscalid	
		Aprovia	7	Benzovindiflupyr	
		Luna Sensation	11 + 7	Trifloxystrobin + Fluopyram	
		Flint Extra	11	Trifloxystrobin	
		Ziram, etc.	M4	Ziram	
Fair	Fontelis	7	Penthiopyrad	Use 20 fl. oz. rate	
	Luna Tranquility	7 + 9	Fluopyram + Pyrimethanil	72 day PHI	
	Sovran	11	Kresoxim-Methyl		
	Topsin	1	Thiophanate-methyl		
	Inspire Super	3 + 9	Difenoconazole + Cyprodinil		
Poor	Cevya	3	Mefentrifluconazole		
	Miravis	7	Pydiflumetofen		
	Excalia	7	Inpyrfluxam		
	Kenja	7	Isofetamid		
	Regalia	P5	Giant Knotweed Extract	Labeled for organic production	
	OSO	H3	Polyoxin D zinc salt		
	Penbotec	9	Pyrimethanil	Post-harvest only	
	Vanguard	9	Cyprodinil		
	Indar	3	Fenbuconazole		
	Procure	3	Triflumizole		
Rhyme	3	Flutriafol			
Rally	3	Myclobutanil			

Spray program to manage bitter rot

Late dormant	Early Season	June	July	August	September	October
Copper (helps with scab, fire blight, rots)	Focus on controlling for scab* powdery mildew, rust ** Use a rainfast mancozeb		<p><u>BEFORE rain events - Options:</u></p> <ul style="list-style-type: none"> • Captan 2 – 3 lb/A (0-day PHI) • Ziram ~4 lb/A + spreader-sticker (14-day PHI) • Aprovia (FRAC 7; 30-day PHI) • Omega 6.9 fl oz/A (FRAC 29; 28-day PHI)+ Captan 2-3 lb/A • Omega 13.8 fl oz/A (FRAC 29; 28-day PHI) • Flint Extra (FRAC 11; 14-day PHI) • Luna Sensation (FRAC 7 + 11; 14-day PHI) • Merivon (FRAC 7+ 11; 0-day PHI) → Leave one spray prior to harvest = postharvest rot control • Organic: sulfur <p>With all applications = include Captan 2-3 lb/A* (Captan = the best product to control bitter rot...but doesn't persist...during rainy periods, include another MOA)</p> <p>***Be mindful of what was sprayed in the spring: a TOTAL of 4 application of a FRAC 7 and FRAC 11 are allowed per season (per the label) – does not matter if it is a single product or pre-mix</p>			

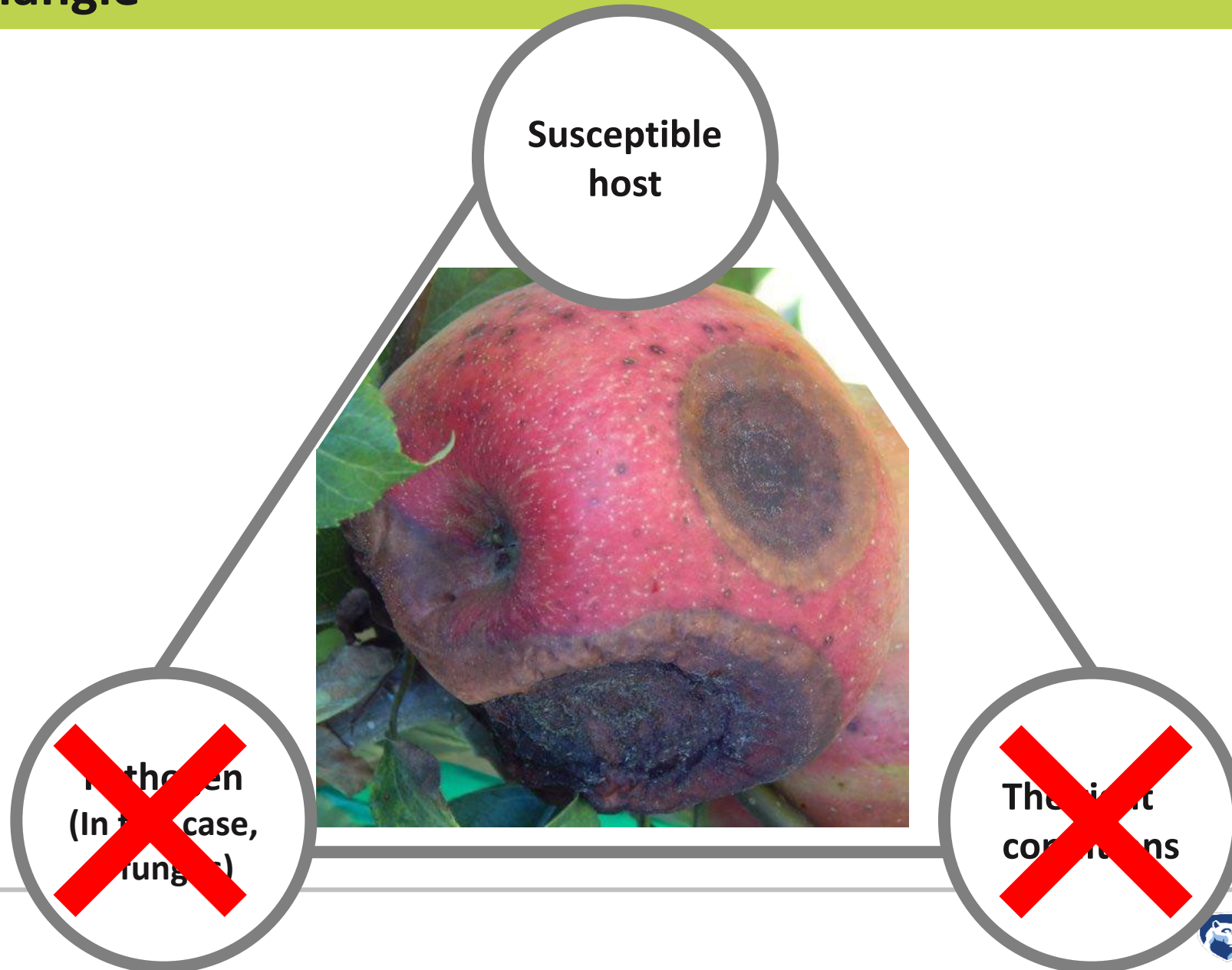
Fungicides should be applied before, rather than after a rain

Once the fungus has penetrated the apple skin and is under the surface, it is very hard to kill, even with systemic fungicides



****Most important timing:
Late June through harvest prior to rain event**

Understanding plant disease triangle for bitter rot : Cultural strategies to disrupt the disease triangle



Cultural management: Remove rotten apple mummies and diseased twigs from tree canopies

Removing mummies will not eliminate the pathogen, but it will reduce its numbers



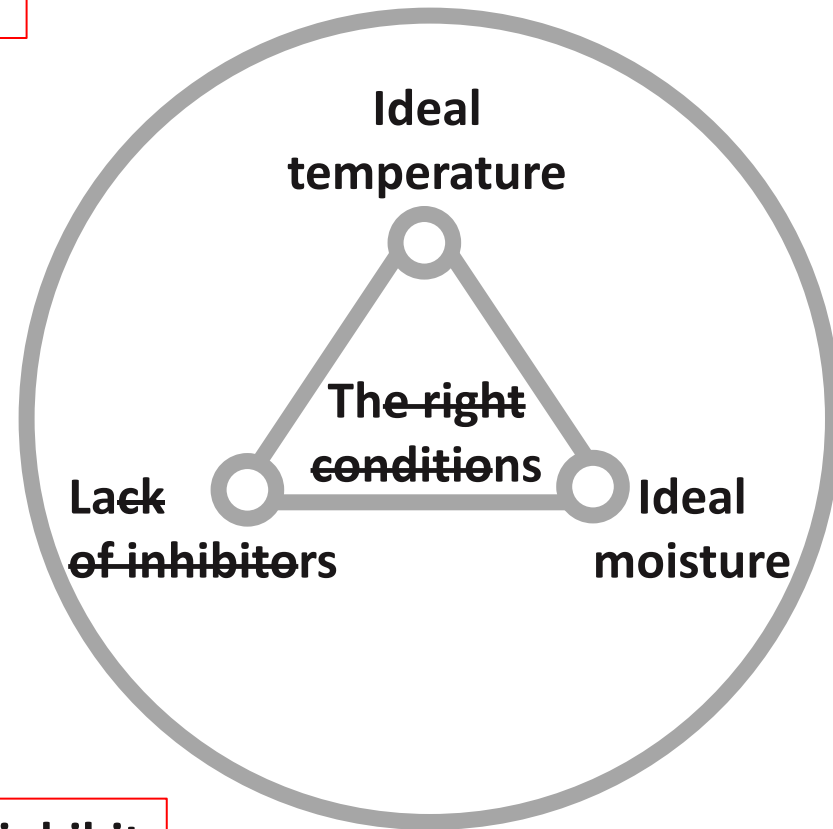
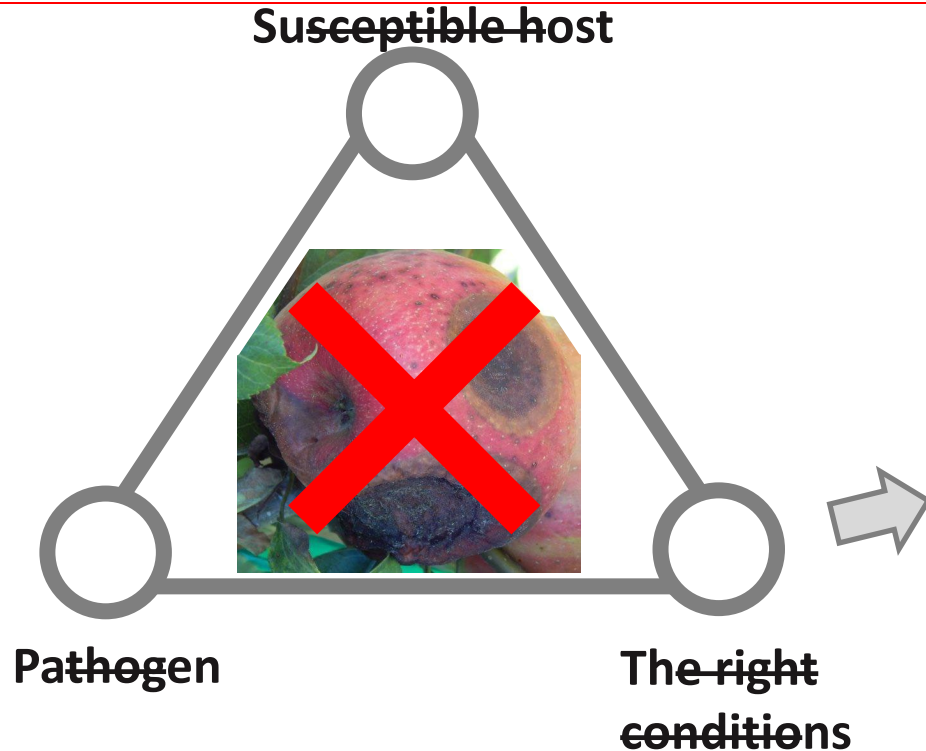
At harvest: drop rotten fruit to the ground

Cultural management: Use good horticultural practices (pruning, rootstocks, sanitation, weed control, plant nutrition, etc.) and manage for good airflow



Breaking the disease triangle: Bitter rot is best controlled with an integrated management approach

Plant cultivars that have low susceptibility to bitter rot. Use good horticultural practices (pruning, rootstocks, plant nutrition, etc.)



Reduce the amount of pathogen by removing rotten fruits from trees

Apply fungicides to inhibit fungal growth and produce non-ideal conditions for infections

Timing: Late June through harvest prior to rain event

Acknowledgments



Dr. Phillip Martin



Brian Lehman



Teresa Krawczyk

Bashar Jarjour
Carl Bower



Kate
Thomas



Kristen
Pierce

Apple growers in the Mid-Atlantic region who submitted samples and filled out surveys



PennState
College of Agricultural Sciences

**Department of Plant Pathology and
Environmental Microbiology**



Project #PEN04694 &
Accession #1018736



L. Earl and Veronica Casida
Graduate Scholarship

Beating Back Bitter Rot: Optimizing Management Strategies

2022 Mid-Atlantic Fruit and Vegetable Convention

February 3, 2022



Photo: K. Peter



PennState Extension

Kari Peter, Ph.D.

Department of Plant Pathology and Environmental Microbiology

Penn State University Fruit Research and Extension Center

Biglerville, PA



@drtreefruit

kap22@psu.edu 717-677-6116 Ext 223

extension.psu.edu