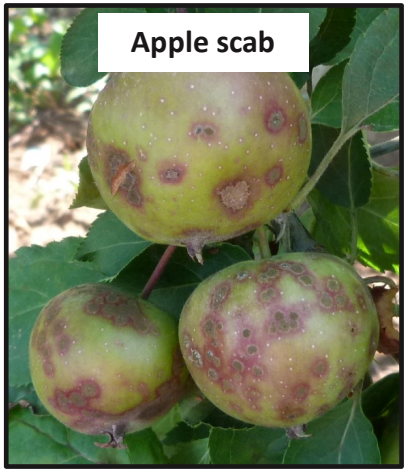
Optimizing disease management strategies for a very wet season

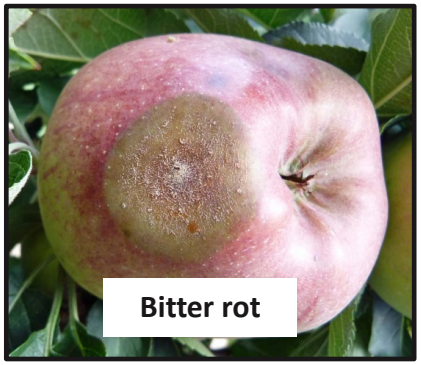
2019 Winter Commercial Tree Fruit School

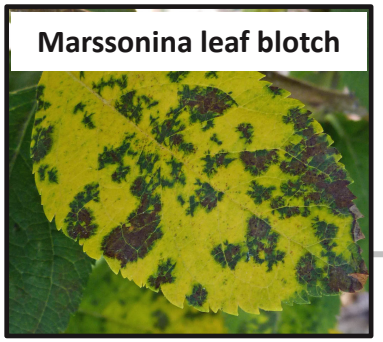
PennState Extension

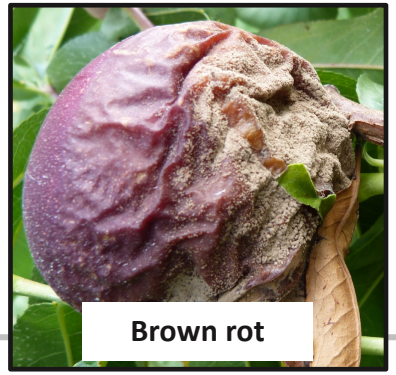
Kari Peter, Ph.D.
Department of Plant Pathology and Environmental Microbiology
Penn State University Fruit Research and Extension Center
Biglerville, PA
kap22@psu.edu 717-677-6116 Ext 223
@drtreefruit

Biggest headaches during 2018 due to the persistent wet conditions









- Understanding critical time for disease management
- Understanding how protection works (fungicides)
- Management strategies for when rain is constantly in the forecast

PennState Extension

Photos: K. Peter

Photo: K. Peter

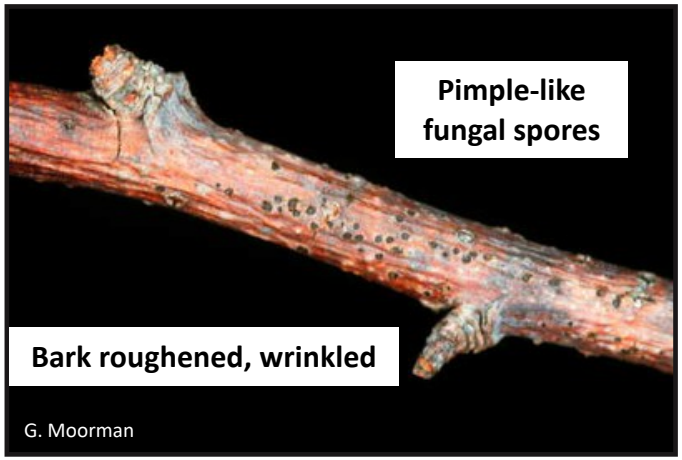
Friendly reminder during dormancy = Sanitation

- **Dormant**
  - Prune out cankers (dead wood) = overwintering source for bacteria (and fruit rots!)
  - Copper sprays = kills bacteria as cankers "wake up" in spring
    - 2 lbs/A of metallic copper at green tip

*Metallic Copper (Cu) Equivalent is 20% by weight or 2.27 Pounds Metallic Copper per gallon
Badge SC is a suspension concentrate fungicide/bactericide.

Dry Flowable	
Active Ingredients	***By Weight***
Copper Hydroxide* (CAS No. 20427-59-2)	46.1%
Inert Ingredients	53.9%
	TOTAL 100.0%

(* Metallic Copper Equivalent 30%)



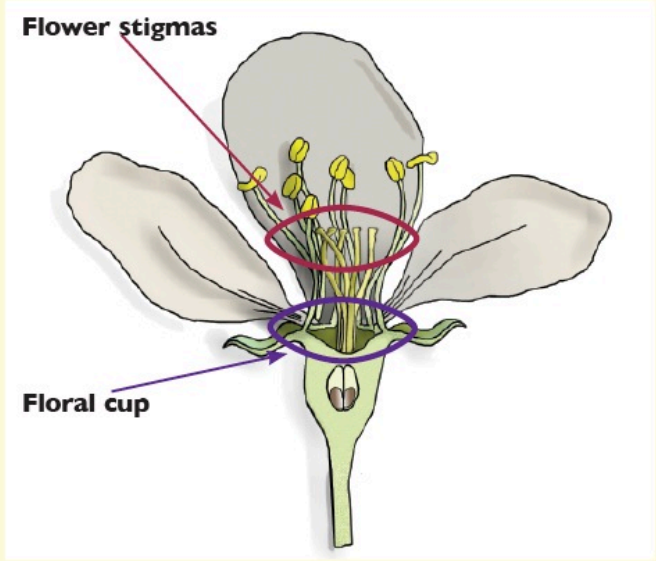
Recognizing cankers

Fire blight: Bloom → Post bloom* = Protection

*Want to be vigilant until early June

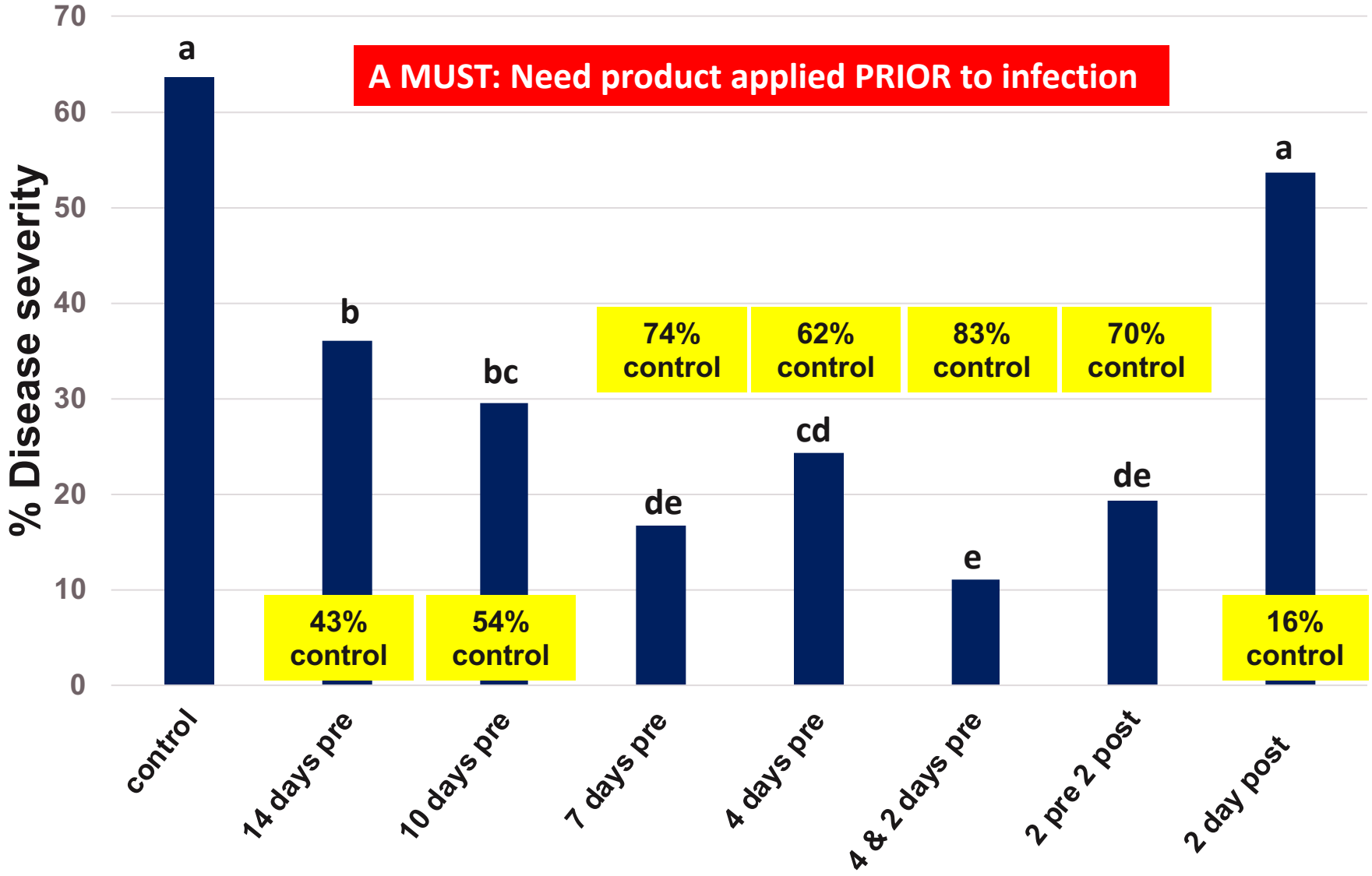
Two-prong approach

To improve fire blight control, use a stigma product during early bloom, followed at full bloom to petal fall by a product that suppresses the pathogen when it reaches the nectary.



SOURCE: Ken Johnson, OSU

Why Actigard* is a good investment (plant defense elicitor product): 2018 Greenhouse Trials – Persistence of Actigard over time



*In field: Actigard is tank mixed with strep; it is not applied alone

Supported by SHAP, 2018

Fire blight: Management options for Bloom through early/late June (severe disease pressure years)

➢ Monitor rainfall post-bloom = tree growth

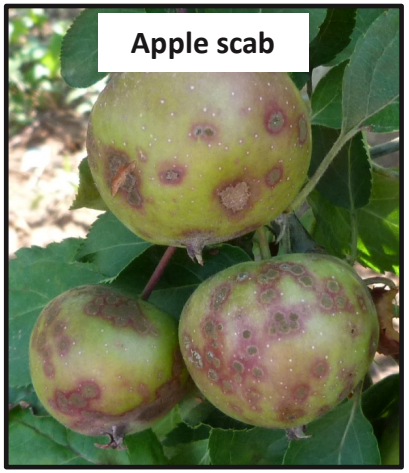
Growth stage	Option 1 (young)	Option 2 (young)	Option 2 (older trees)
10-20% Bloom			
48 hours later			
Late bloom (~5-7 day later)			
5-7 days later			
7 days later			
7 days later			
7 days later			
7 days later			

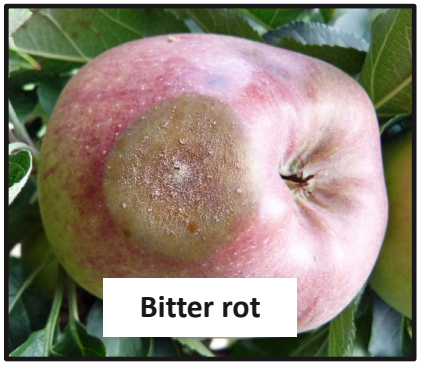
For semi-dwarf trees (susceptible): Consider Apogee/Kudos 6 – 12 oz/A

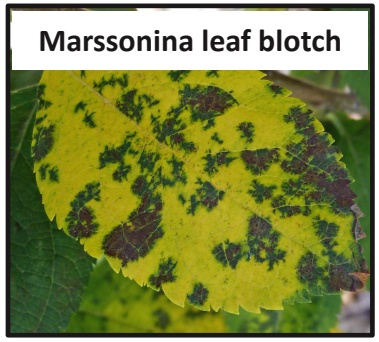
When using a plant defense elicitor: Do not mix = no added benefit mixing different products (≥14 d BTW different products)

Post-bloom: Trauma event (hail) = The SOONER you apply strep the better…do not wait, if possible!

Getting the upper hand on fungal diseases despite Mother Nature not cooperating: Effectively breaking the disease triangle







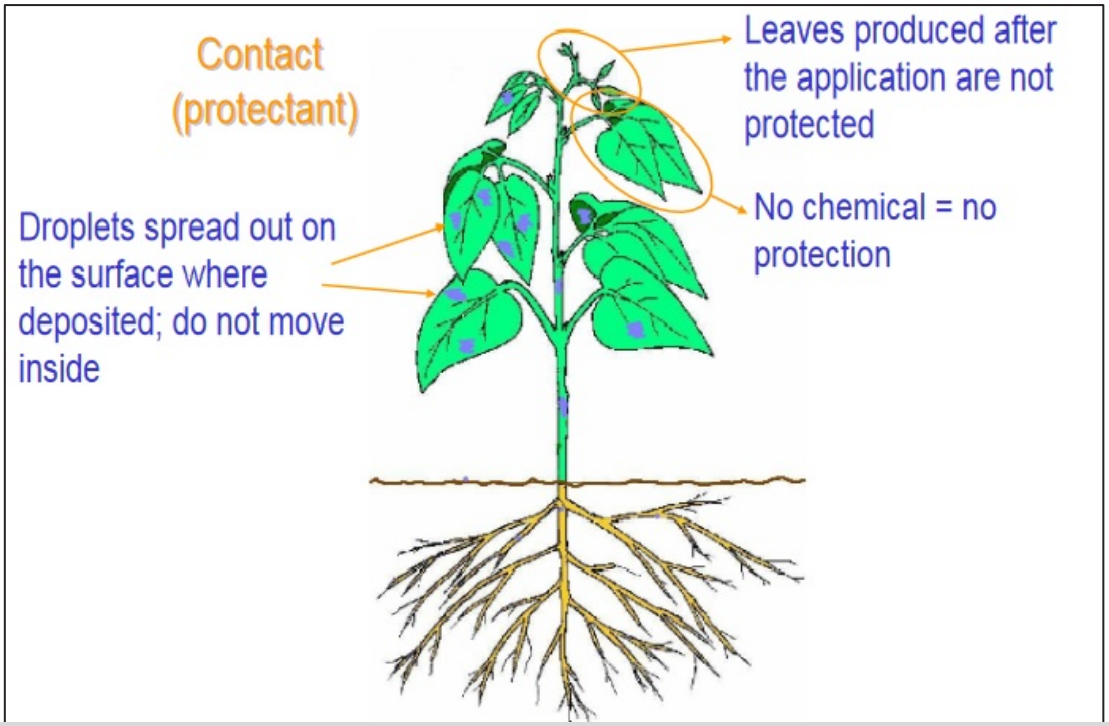
Important: Determining best products to use under high disease pressure conditions (= frequent rain events)

Fungicides 101: Understanding how fungicides work

- Protectant vs. Penetrant
- How long do fungicides last?
- Use of adjuvants
- Guidelines

Fungicide 101: Protectant v. Penetrant

Protectant

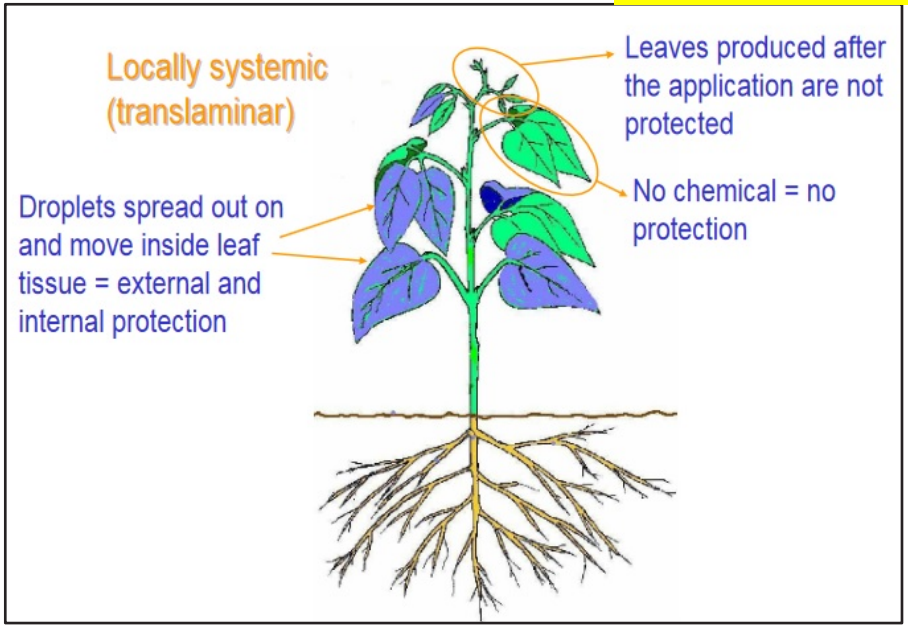


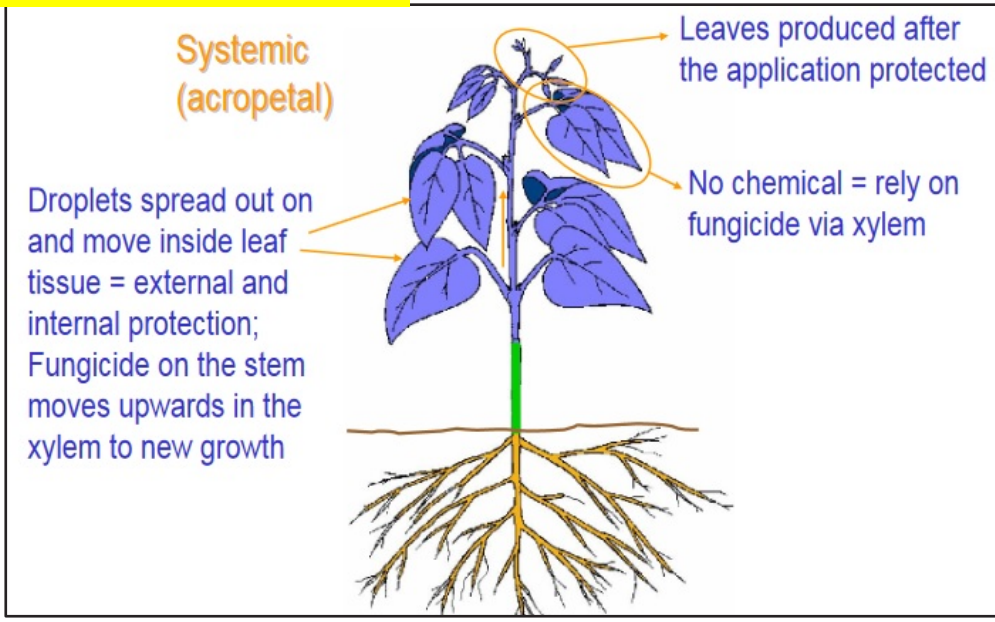
- Remain on outside of plant surface – no movement into plant
- Applied **prior** to infection
- **Kill fungal spores and hyphae upon contact – prevents infection**
- **Needs to be re-applied**
  - New growth
  - Not rainfast
- Examples:
  - Captan, copper, mancozeb, sulfur, biopesticides

https://www.extension.iastate.edu/sites/www.extension.iastate.edu/files/greene/Fungicide101.pdf

Fungicide 101: Protectant v. Penetrant

Penetrants = Systemics





- Locally systemic (within leaf)
- **Absorbed** into plants following application
  - **Rainfast**: **why not easily washed off**
- Less thorough coverage to be effective
- Protectant and/or "curative":
  - **Kill spores/hyphal growth after penetrating plant surface**
- **Anti-sporulants: after symptoms appear, reduce/inhibit sporulation**
- Examples: Merivon, Indar, Fontelis, Flint Extra

- Systemic throughout the plant (to the roots)
- **Absorbed** into plants following application
  - **Rainfast: why not easily washed off**
- Less thorough coverage to be effective
- Protectant and/or "curative":
  - **Kill spores/hyphal growth after penetrating plant surface**
- **Anti-sporulants: after symptoms appear, reduce/inhibit sporulation**
  - Examples: ProPhyt, Aliette

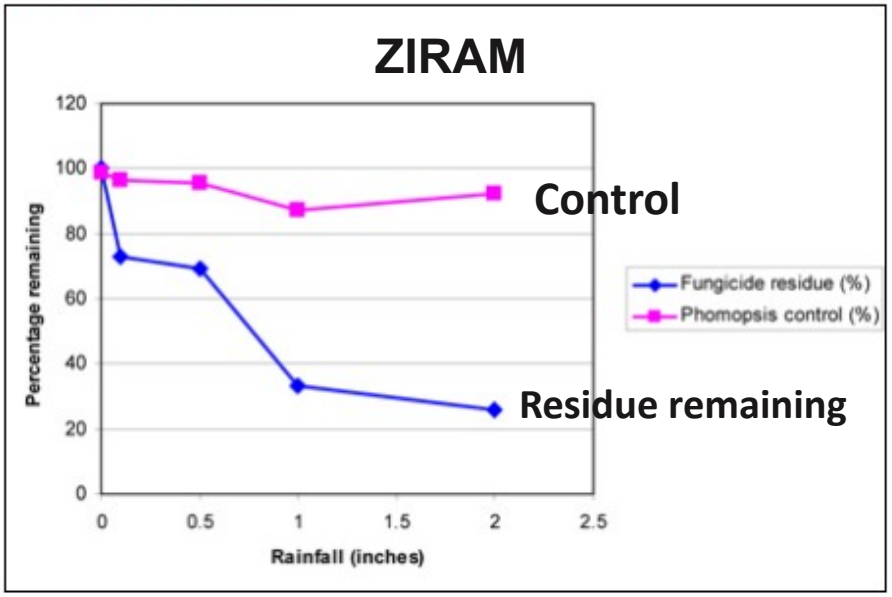
Fungicide 101: What is the duration of efficacy for different fungicides when it rains?

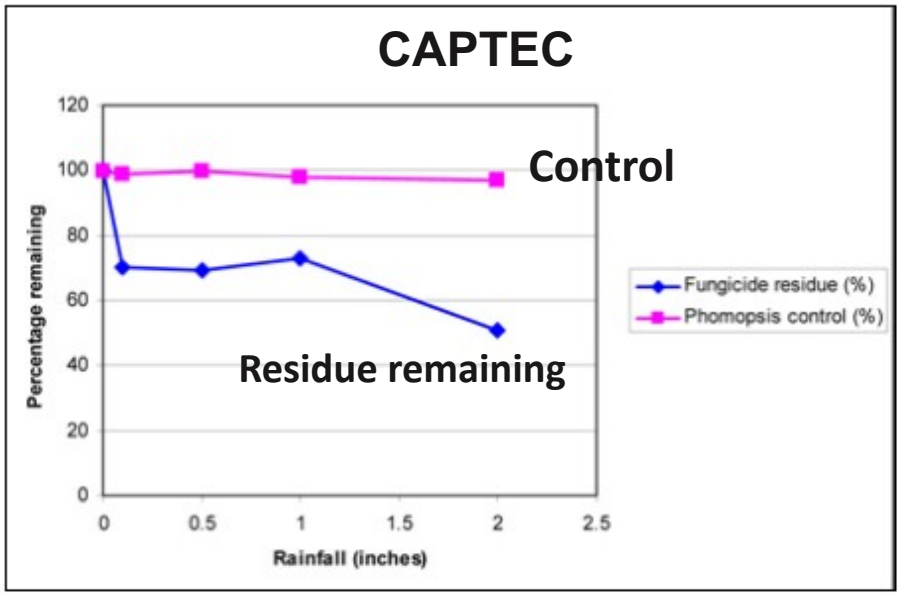
- All fungicides: Effective when applied BEFORE infection occurs
  - Systemic fungicides: have efficacy AFTER fungus has penetrated plant tissue (24-72 hours: limited depending on fungicide, disease, and rate)

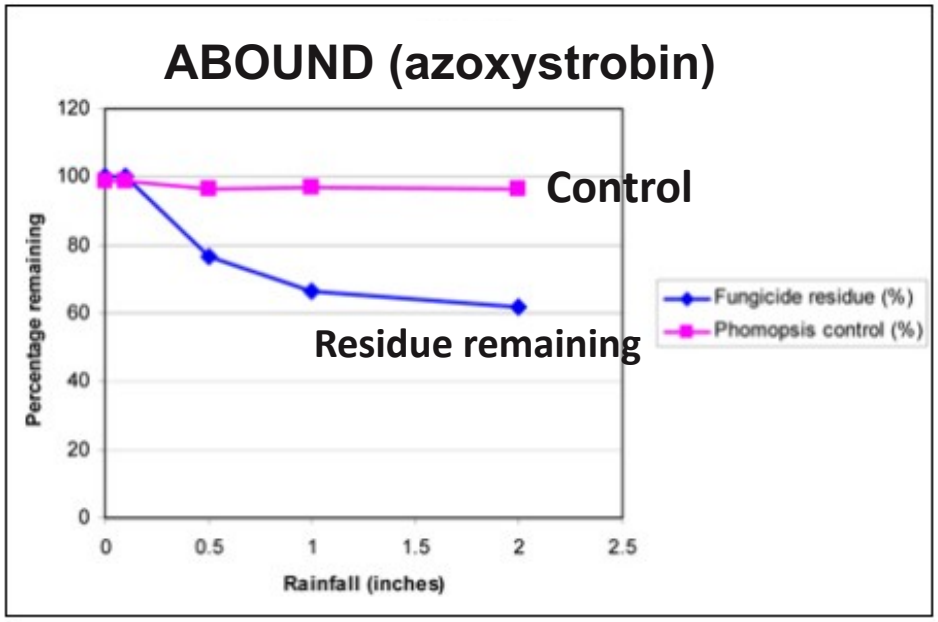
- Rain and fungicides
  - Penetrants/systemics: less susceptible to wash-off (inside leaf tissue)
  - Protectants washed off when…
    - 0.1 in rain = 50% removed
    - > 2 in rain = will remove most
    - Exception: "Sticky" fungicides
      - Fungicides applied with spreader-stickers more resistant
        - Brave Weather Stik, Dithane Rainshield, Mazate Pro-Stik
          - mancozeb + spreader sticker; Ziram + spreader sticker
        - Do not use spreaders with captan
      - Formulations vary in ability to stick to plant surface
        - **Research needed

Fungicide 101: What is the duration of efficacy for different fungicides after rain events?

Example: Efficacy of fungicides to control Phompsis on grapes after simulated rainfall (A. Schilder, MSU)







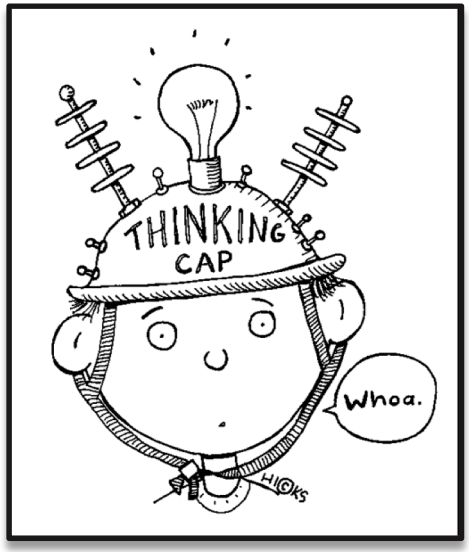
Take home message:

- **Protectants vary in their "stickability"**
- **Despite significant removal of fungicides after 2 inches = good disease control = fungicide activity**
- **Abound (systemic): some washed off = some of the fungicide remains outside plant (cuticle)**
- **Results = NEW fungicide residues; OLD residues may not be as robust**
- **If it rains the day after you sprayed: have some buffer…but don't wait too long to reapply (especially if persistently rainy…)**

Fungicide 101: What is the duration of efficacy different fungicides?

Other considerations to keep in mind

- **Older residues (1 wk old): less active ingredient may remain = fungicide efficacy reduce**



- **Protectant fungicide residues naturally decrease over time (UV, heat, microbial activity, rainfall, dew)**

- **Systemic fungicides reduced due:**
  - **Redistribution and dilution (growing) plant tissues**
  - **Possible breakdown by the plant itself**

- **High pH (alkaline hydrolysis) = breakdown of some fungicides (e.g. captan)**

- **Most protectants: Good for 7 – 14 days**

- **Most systemics: Good for 7 – 21 days**
  - **Depends on: product, rate applied, weather conditions, disease pressure**

Fungicide 101:Getting the most out of your fungicides for rainy conditions

Guidelines

APPLE SCAB

- Wet weather in the forecast: Use systemics and rainfast protectants
  - Applying systemics when humid, cloudy = better absorbed
  - Be sure fungicide has dried well before rain
    - Systemic fungicides = rainfast after a few hours
  - Tank mix with a rainfast protectant during early season
    - Early season mancozeb: use "-Stik" or "Rainshield" or add a spreader sticker to your mancozeb of choice
  - Some systemics need a penetrant for better absorption (read label!)
    - e.g. Indar (+ LI-700)

SUMMER DISEASES

- Add a systemic to captan cover sprays: Topsin M (1 lb/A)
- Ziram + Topsin M = a spreader can be added, okay for Ziram
- Apply systemic during preharvest sprays: *Merivon/Pristine/Luna Sensation (*will depend if bitter rot an issue)

FOR BOTH EARLY AND SUMMER DISEASES

- RE-apply a recently applied fungicide if > 2 in of rain fell
- RE-apply after 1 in of rain if residue is 7 days old or older
- A little bit of rain = not all bad, can help to distribute the fungicide residue over plant surface

APPLE SCAB

Photos: K. Peter

Apple scab: Breaking the disease triangle = multiple strategies

✓ **Cultural: Before and/or after the season**
- **Sanitation**
- **Calibrate sprayers**

Chemical: Before and During season

➢ **Dormant copper sprays: knocks back overwintering spores on trees, buds**
- **Copper: 2 lbs/A of metallic copper ~ green tip**
  - **Use a copper with a high % metallic copper**

➢ **Apply protective sprays during early season: need to prevent primary infection!**
- **Understanding infection periods**
- **Applying protection wisely**
- **Rotate fungicides (by mode of action) to prevent fungicide resistance**
- **Wet weather considerations**

Photos: Wikicommons

Predicting apple scab infection: Mills Table

→ Average temperature + leaf wetness hours necessary = ability of spores to cause infection

Disease severity during the season
Severe: rainy spring
Little: hot and dry

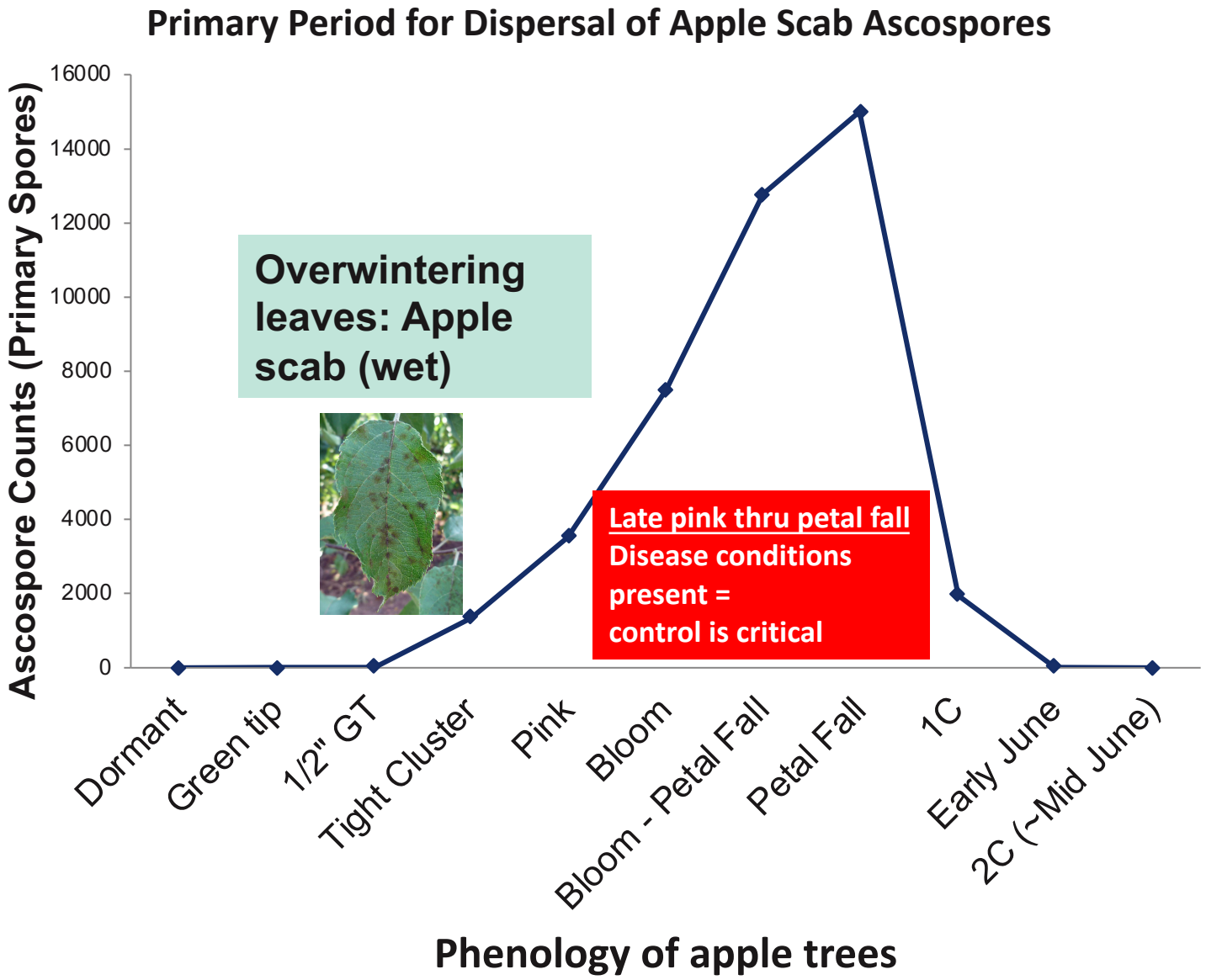
Riskiest conditions for infection

Temperature (°F)	Wetness hours	Scab Lesion appearance (days)
34	41	-
36	35	-
37	30	-
39	28	-
41	21	-
43	18	-
45	15	17
46	13	17
48	12	17
50	11	17
52	9	16
54 – 56	8	15
57 – 59	7	14
61 – 75	6	12 - 13
77	8	9 - 10
79	11	-
		-

Smart management: spraying only when you need to!

PennState Extension

Scab infection period presents itself, keep in mind where we are during the ascospore dispersal



Ascospore data: PSU Tree fruit pathology lab

PennState Extension

Photo: K. Peter

Apple scab: Strategy (<u>when bitter rot is not a problem</u>)

➢ <u>Keep intervals tight</u> when rain persists from pink → 1st cover (monitor weather!)







Dormant	Green tip	Tight Cluster	Pink → Bloom → Petal Fall	Covers	Preharvest
Copper	**EBDC +** Syllit OR Captan OR Potassium bicarbonate	**EBDC +** Syllit OR FRAC Groups **3** **9** OR Sulfur (PM control) Potassium bicarbonate	**EBDC+** **FRAC Group 7** (2 complete/4 half sprays) **Aprovia** **Fontelis** **Luna Tranquility** **Luna Sensation** **Merivon** **Pristine** **Sercadis**	Captan (alone) OR + TopsinM + Ziram	(2 complete/4 half) Merivon Pristine Luna Sensation + Captan

Powdery mildew control starts at TC

Pink → PF
Rotate during this period with another FRAC group: EBDC + FRAC Group 3 and/or 9

FRAC 7 and 11: 4 complete spray MAX per season of each = includes ALL products (single and premix)

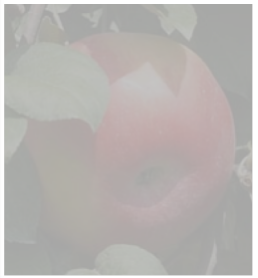
Photos: K. Peter

Apple scab: Strategy = Adjuvants (products w/ adjuvants) are your best friend during persistently wet weather early in the season









Dormant	Green tip	Tight Cluster	Pink → Bloom → Petal Fall	Covers	Preharvest
Copper					

Broad-spectrum products (a.i. mancozeb or ziram) to persist longer during rainy weather for early season:

Dithane Rainshield
Manzate Pro-Stik
Roper Rainshield
Penncozeb + spreader sticker (4 fl oz/100 gal)
other mancozeb + spreader sticker
Ziram + spreader sticker

Photos: K. Peter

PennState Extension

Scab management – Additional considerations for wet conditions

In very wet weather:
ABSOLUTELY MUST RE-APPLY FUNGICIDES IN THE RAIN

- Mancozeb, captan, and sulfur will all provide several days of protection if applied in the rain

- If extended <u>warm</u> rains occur over the next few days:
  → AN ABSOLUTE MUST to get out and renew coverage by spraying a protectant (mancozeb, captan, or sulfur) in the rain

- Duration of product: Avoid spraying in pouring rain = product washes off

- Duration of product: Applied during a drizzle = Uncertain about duration, but could expect 2 – 3 days

- Prioritize coverage: most susceptible cultivars/problem blocks

- Experience fungicide failure? Eliminate ALL possible causes before considering fungicide resistance

2019 FRAC Table for Apple Scab: Spray By The Numbers

Toss out the old one and replace it with the new one!

2019 Fungicide Resistance Management Guidelines for Apple Scab and Powdery Mildew Control in the Mid-Atlantic United States

Alan R. Biggs, West Virginia University and Kari Peter, Penn State University

Fungicide	Active Ingredient(s)	FRAC Code[4]	PHI (days)	Risk Rating[5]	Management Required[6]	Apple Scab[7]	Powdery Mildew[7]	General Fungicide Resistance Management Guidelines[8]
Kocide 3000 or similar	fixed copper(s)	M1	see label	L	N	G	N	FRAC code M fungicides are low risk, protectant fungicides. Use alone, or tank mix with high-risk fungicides to improve efficacy
Microthiol or similar	sulfur	M2	see label	L	N	F	G	
Dithane, Polyram, or similar	mancozeb, metiram	M3	77	L	N	G	N	
Ziram	ziram	M3	14	L	N	G	N	
Captan	captan	M4	0	L	N	G	N	
Dodine, Syllit	dodine	U12[R+]	see label	L-M	Y	F	N	

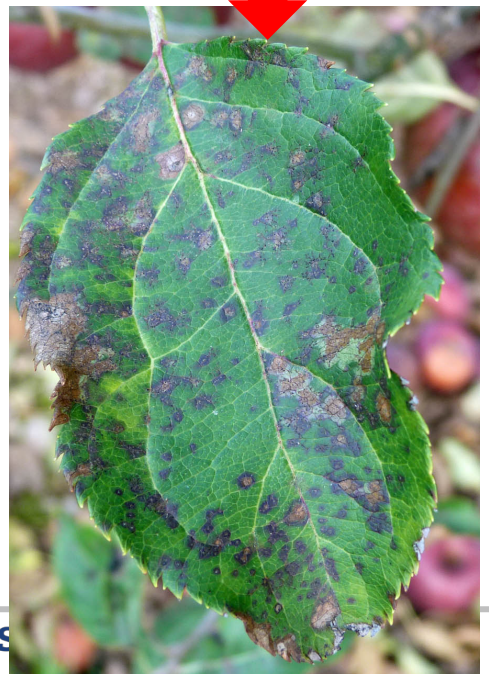
PennState Extension

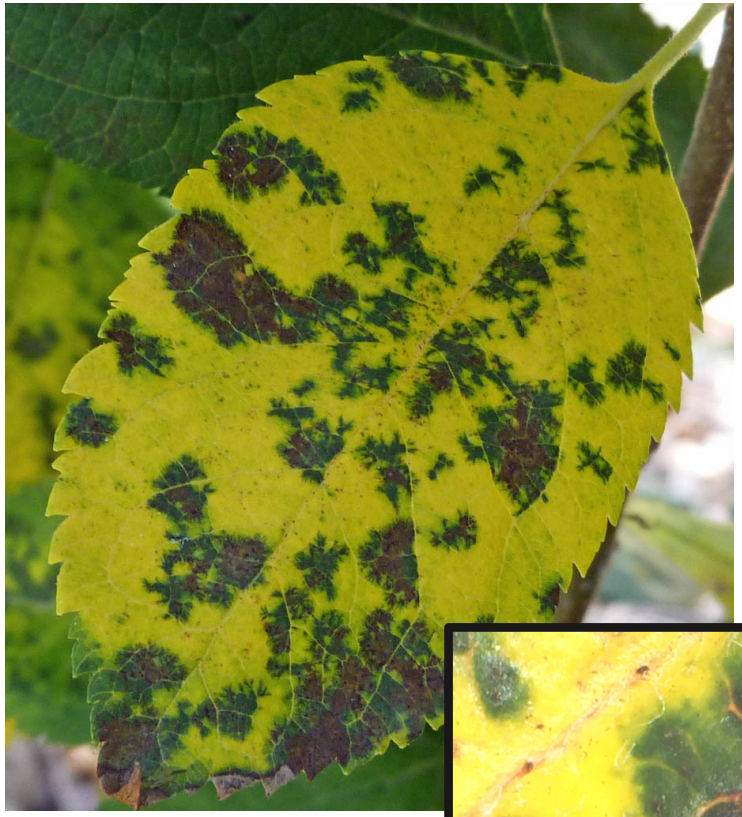
Marssonina leaf blotch on apple: “Late season apple scab”

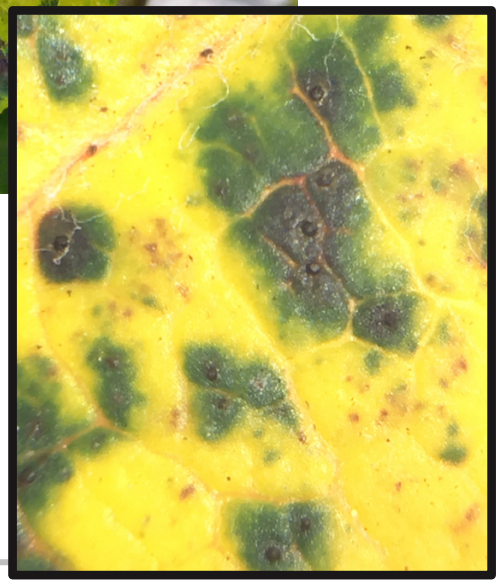
August – October 2018

- Caught a lot of people off guard in 2018
- Prevalent throughout PA and MD orchards
- A LOT of rain late season = removed coverage, encouraged disease
- Premature defoliation = can be severe
- Cultivars vary in susceptibility
  - Rome = VERY susceptible

Marssonina leaf blotch on apple (*Marssonina caronaria)*







Management: Avoiding premature defoliation (can be severe)

- Sanitation is key to limit disease in subsequent years
  - → Overwinters in infected fallen leaves
- Easy to control with conventional fungicides
  - Problem late season: being washed off and not reapplied quickly
  - Sulfur limited
  - Best options nearing harvest (systemics!):
    - Captan + Topsin 1 lb/A
    - Merivon
    - Luna Sensation

SUMMER DISEASES: Fruit problems

Bitter Rot

SBFS disease outbreaks:
Favored by extended periods of above-normal summer temperatures combined with frequent rainfall and high humidity
Control: Cover sprays through September

Bitter rot disease outbreaks:
Optimal temperature between 68 – 86°F + at least 13 hours of leaf wetness (what is known for strawberry anthracnose)
Control: Bloom through harvest

Photos: K. Peter

Sooty blotch and Flyspeck (SBFS): Management recommendations

New infections of sooty blotch and flyspeck can still occur late in the season = September!

- **Cultural control**
  - Remove alternate hosts, such as brambles from the orchard and surrounding hedgerows
  - Dormant and summer pruning
    - Opens up tree canopy to facilitate air movement and drying after a rainfall
  - Thinning to separate fruit

- **Chemical control = cover sprays (10 – 14 day interval)**
  - Captan 5 lb/A ALONE* = SB control, some FS control
  - Captan 3 lb + Topsin M 1 lb = SB AND FS control
  - Captan 3 lb + Ziram 3 lb = SB AND FS control

- Trees with open canopy w/ air movement:

*Captan alone okay = SBFS control

- Very dense, w/ little air movement:

Captan + Topsin or Ziram a must

Last 1 or 2 sprays before harvest (prevent SBFS and storage fruit rots):

- Luna Sensation (14 d PHI)
- Merivon/Pristine (0 d PHI)

To control flyspeck during high pressure years: MUST include Topsin M or Ziram WITH captan during several of your cover sprays

Photos: K. Peter

Bitter rot management recommendations for 2019 (will also control all other diseases)

Complete sprays best; IF ARM = KEEP INTERVALS VERY TIGHT

Bloom	**7 days later**	**7 – 10 days later (if rain = 7 days)**	**7 – 10 days later (if rain = 7 days)**	**Covers (10 – 14 day interval)**

Grower survey: Have issues with bitter rot in 2018? We'd like to know!*

***Especially those who donated rotten fruit in 2018**

- **Cultivars affected**
- **Fungicides applied**
- **Other crops grown within 1000 ft of apples**
- **Pattern of infection**

→ Will hand out at the end of the presentation

Grower survey for bitter rot research

Phillip Martin (researcher)
Penn State Fruit Research and Extension Center
290 University Drive
Biglerville PA 17307
(717) 353-5365, plm30@psu.edu

Dr. Kari Peter (principle investigator)
Penn State Fruit Research and Extension Center
290 University Drive
Biglerville PA 17307
(717) 677-6116, kap22@psu.edu

Background: We are conducting research on the best management practices to control bitter rot of apple. We have collected bitter rot apple samples from throughout PA and surrounding areas and have isolated the causal fungal species. Our initial tests have shown several species are causing bitter rot and that these species are not uniformly distributed, i.e., some orchards have only one species and some orchard have 2 or more species. These species vary in how sensitive they are to commonly used fungicides. These species can also cause diseases on other crops, and it is possible that cross-infection is occurring from one crop to another. We are also noticing large differences in susceptibility of apple cultivars to bitter rot. For these reasons, we are asking the growers from which we collected bitter rot samples to fill out this survey to see if management practices are correlated with the fungal species that are causing bitter rot.

1. Address of orchard

This should be the mailing address of the orchard. We use the location to find and compare historical climate and weather data from the National Weather Service. For samples submitted in 2018: If bitter rot apple samples were submitted from a location that is more than 5 miles from the orchard contact address, please give us the sampling location.

Contact info


BROWN ROT
Monilinia fructicola
Photo: K. Peter

Brown rot management: Friendly reminder

During dormancy: Effective pruning

- **Remove fruit "mummies" and cankered branches**
  → Decrease spores available to infect fruit for the coming season

Photos: K. Peter

Brown rot management**: Strategy from dormancy to harvest

Timing	Spray application	Notes
Dormant	Copper	
Bloom	Rovral	Do not use FRAC 1, 3, 7, 11 = save for preharvest
Shuck Split, 1C, 2C (up to pit hardening)	Captan* 2 – 2.5 lb/A	
4C, 5C (additional covers if late season cultivars)	Sulfur	
Last two cover sprays B4 preharvest sprays	Captan* 3.125 – 3.75 lb/A	Do not use lower than 3.125 lb/A
Preharvest Spray 1 (~18 days pre-harvest)	Rotate by FRAC group (High end: Merivon or LunaS)	Early maturing cultivars: 2 PH sprays needed If a dry year, use at least one Merivon spray (labelled for Rhizopus rot)
Preharvest Spray 2 (~9 days pre-harvest)	Rotate by FRAC group (High end: Indar 12 fl oz/A)	
Preharvest Spray 3 (~1 days pre-harvest)	Rotate by FRAC group (High end: Merivon or LunaS)	

*Captan comments: Sticks around longer than sulfur, ziram, thiram; more effective limiting spore germination; captan only needed in preharvest IF resistance is present

**Many thanks to Dr. Norm Lalancette (Rutgers) for his Jedi wisdom about brown rot control.

2019 FRAC Table for Brown Rot: Spray By The Numbers

Toss out the old one and replace it with the new one!

2019 Fungicide Resistance Management Guidelines for Brown Rot and Peach Scab Control in the Mid-Atlantic United States

Alan R. Biggs, West Virginia University and Kari Peter, Penn State University

Fungicide	Active Ingredient(s)	FRAC Code[4]	PHI (days)	Risk Rating[5]	Management Required[6]	Brown Rot[7]	Peach Scab[7]	General Fungicide Resistance Management Guidelines[8]
Kocide 3000 or similar	fixed copper(s)	M1	see label	L	N	N	N	FRAC code M fungicides are low risk, protectant fungicides. Use alone, or tank mix with high-risk fungicides to improve efficacy.
Microthiol or similar	sulfur	M2	see label	L	N	G	G	
Thiram Granuflo	thiram	M3	7	L	N	G	G	
Ziram	ziram	M3	14	L	N	N	G	
Captan	captan	M4	0	L	N	G	G	
Bravo or similar	chlorothalonil	M5	see label	L	N	N	E	
Topsin M, Cercobin	thiophanate methyl	1	1	H	Y	E	G	

Sanitation: Getting rid of those pesky mummies for fruit rot control during dormancy

Another use for the Darwin string thinner

Grower experience (Tom Haas, Cherry Hill Orchards):

- Some mummies come off easier
  - Honeycrisp is very difficult
  - Generally, the larger the fruit, the easier it comes off

- Tree structure plays a role in how effective the Darwin works

- Running all strings at 250 rpm 1-2 mph depending on variables: Structure, Mummy size, tree damage.
  - With minimal limb or spur damage

➢ You will get a little spur removal at this speed, but it depends on variety
  - Tall spurs/buds risk removal = consider this early thinning with the limited amount that are coming off

https://extension.psu.edu/peach-crop-load-management-blossom-thinning-and-fruit-size Photo: Mark Wherley

PennState Extension

Take home messages for wet weather warriors:

- Sanitation is key!
  - Fall/winter clean up: leaf removal, canker/dead wood removal during pruning, fruit mummies
  - Remove reservoir hosts when possible

- Dormant copper sprays: knocks back overwintering pathogens

- Keep an eye out for weather conditions conducive for disease = persistent rainy weather:
  - Apple scab: Use "sticky" mancozeb products
    - Late pink → petal fall: FRAC 7 products
  - Fire blight: Bloom through early June = Control needed
    - Consider using Actigard
  - Summer diseases and fruit rots: Add systemic fungicides in captan cover sprays
    - Merivon/Omega program for bitter rot

- Apply protection BEFORE the infection occurs!

- Reapply fungicides when it rains 1-2 inches!

- Promote healthy trees with proper fertilization, pruning, and water

---

- Maintain a good control program for other diseases and insect pests

Optimizing disease management strategies for a very wet season

2019 Winter Commercial Tree Fruit School

PennState Extension

Kari Peter, Ph.D.
Department of Plant Pathology and Environmental Microbiology
Penn State University Fruit Research and Extension Center
Biglerville, PA
kap22@psu.edu 717-677-6116 Ext 223
@drtreefruit