Cornell University
Department of Plant Pathology
and Plant-Microbe Biology

F.A.R.M.

Hudson Valley
Research Laboratory

Controlling Fruit Rots and Other Summer Diseases

Srdjan G. Acimovic

Senior Extension Associate

CCE Webinar Series, CCE ENYCHP - HVRL Pathology
7 July 2020

Preventing fruit rots
- Fungi -

- Black rot (*Botryosphaeria obtusa*)
- White rot (*Botryosphaeria dothidea*)
- Bitter rot (*Colletotrichum spp*.)
- SBFS
- Marssonina Leaf & Fruit Blotch
- Gray mold (*Botrytis cinerea*) – not covered today

- All these fungi can later become storage-decays

1. Black Rot
- *Botryosphaeria obtusa* -

Red Delicious

Cortland - Frogeye leaf spot

Gala

Black Rot – Symptoms

B. obtusa Life Cycle

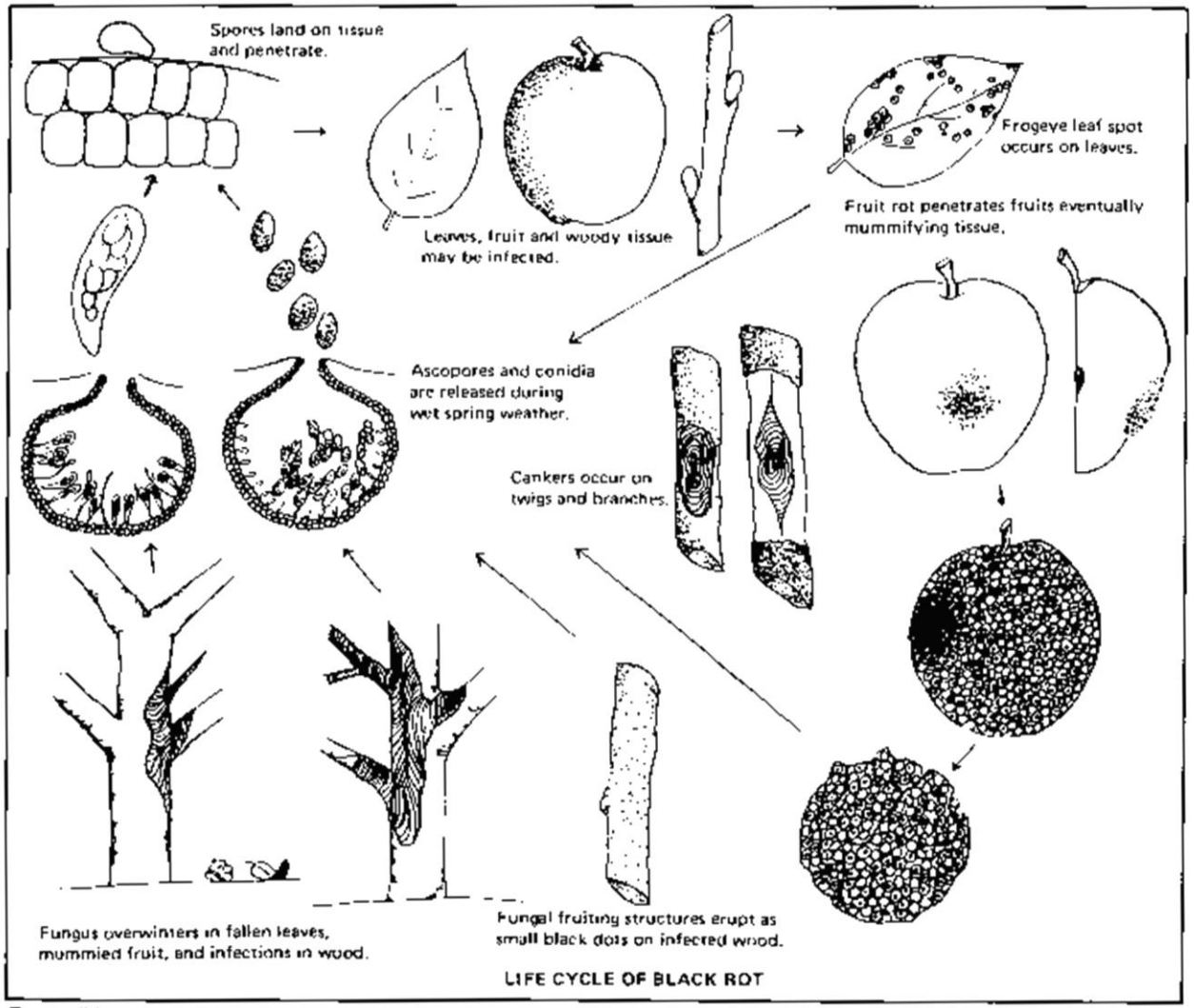


Figure 84

Source: https://eap.mcgill.ca/CPAP_6.htm

1. Black Rot
- *B. obtusa* -

- Overwinters in cankers, mummy fruitlets, dead bark, brush, trunk cankers (internal fungi decay), multiple hosts
- Infects fruit at warm rains (Spring: perithecia, Summer: pycnidia)
- Infects from Petal fall to Harvest
- Forms dormant infections
- Fruit ripening activates the fungus
- It is a firm rot, mostly drier
- It inhabits fruitlet mummies after thinning
  - Lenticel infections occur on semi-mature fruit during summer
  - These infections are visible as lenticel spots
  - Later it can activate and continue to cause decay in storage
- Lenticel spots caused by white, black, and bitter rot possible if spray residue was lost before harvest.

Photo by D. Rosenberger

Photo by D. Rosenberger

2. White rot
- Botryosphaeria dothidea -

Soft, soggy, drippy rot
Irregular margins

White rot
- B. dothidea -

- Overwintering same as black rot
- Causes infections in hot summer days
- **Soft rot (soggy, drippy fruit)**
- **Has irregular margins**
- **White rot on fruit in fall is firm similar to black rot**
- It causes shallow bark cankers (trunk, branches)
- Typical sign is flaky bark on the trunk
- Drought stress helps trunk and branch infections (Schoeneweiss 1981)
- Do herbicides that hit trunk drought-stress

the tree allowing *B. dothidea* in?

Black & White Rot Management

Good orchard sanitation:

- Prune, remove, burn, cankers & mummies
  - Brush should not be left flail mowed
  - Avoid pruning stubs
  - Prevent fruit bruising

Fungicides

- QoI (FRAC 11)
- Thiophanates (FRAC 1)
- Phthalimides (FRAC M4 – multi-site contact activity)
  - captan

Top choice products

- Topsin-M / Thiophanate Methyl + Captan (8 - 16 oz + 2.5 lb)
- **Topsin - no bitter rot control**
- Flint + Captan (1.5 - 2.5 oz + 2.5 lb, also SBFS, bitter rot)
- Luna Sensation 4 - 5.8 oz (also SBFS, bitter rot)
- Merivon 4 - 5.5 oz (also SBFS, bitter rot)
- Sovran (3.2 - 6.4 oz + 2.5 lb, also SBFS, bitter rot)
- Pristine 14.5 - 18.5 oz (also SBFS, bitter rot)
- **Do not miss 10-15 July (based on lower Hudson Valley weather conditions)**
- **You must re-cover after >2-inch rain**
- **Make sure the residue is maintained on the fruit until harvest**
- Problem in organic orchards: liquid-lime sulfur for SBFS, oil (~1%), damage fruit skin
- Therefore fruit surface injury worsens rots in organic orchards

3. Bitter Rot – Causal Fungi?

- Know the Enemy: *Colletotrichum acutatum* clade
  - *Colletotrichum fioriniae* - Dominant
  - Different species of *Colletotrichum* cause bitter rot in various parts of the world

Bitter Rot - A Growing NY Issue

- Outbreaks 2015, 2016
  - Central and lower Hudson Valley
  - Canada
  - No fungicide residue close to harvest
  - Storage incidence 2015, 2016
    - Stem and calyx infections in Fall
  - Loss 5-7% in storage (2016)
  - 20 - 60% ‘Honeycrisp’ in orchards (2017)
  - 20 - 100% in organic production (2018)
- No outbreaks 2017, but present
- Outbreaks in 2018

More Bitter Rot, Why?
- Causes? -

- Rare before mancozeb 77 PHI
- Hot, humid summers
- **Highly susceptible cultivars**
- **No fire blight removal**
- **No orchard sanitation**
  - Remove floor decayed fruit
  - Remove fruit mummies
  - Remove cankers, fire blight
  - Gras strip helps

- Late-maturing cultivars
- More sprays Sep - Oct
- Less problems in North NY

- Worse on drought-stressed trees
- Fruit injury
- Spread rapidly if no fungicides
- Small bitter rot lesions near harvest
- Storage incidence West NY

- Dorman infection?
- Heat fruit injury?
- Sunny side infections?
- Different species – biology?
- Different management?
- Overwintering in NY?
- Relative importance of infection sources?

- Irrigate ahead of heat waves?
- Fruit cooling - overhead nets?

18 Species on Apple: Which Are in NY?
- Is *Cg* group in NY? -

Colletotrichum acutatum complex - cooler regions:

- *C. fioriniae (Clade 2)*
- *C. nymphaeae (Clade 3)*
- *C. acutatum (Clade 4)*
- *C. parananse, C. melonis, C. acerbum, C. godetiae, C. pyricola, C. rhombiforme, C. salicis, C. piri*

C. gloeosporioides complex - warmer regions:

- *C. gloeosporioides (G. cingulata)*
- *C. siamense*
- *C. theobromicola*
- *C. fructicola*
- *C. alienum*
- *C. aenigma*

C. boninense complex

- *C. karstii*

Glomerella leaf spot in Warwick NY on Fuji, Jonagold - low crown defoliation

In Knowing Causal Species Important?

MANAGEMENT

- *C. acutatum* complex spp. more tolerant to fungicides vs. *Cg* complex
  - Thiophanate-methyl (Topsin), myclobutanil (Rally), trifloxystrobin, captan
- Does tolerance explain more bitter rot in NY?
- Susceptibility to DMI-s varies
- Resistance to QoI, SDHI-s varies: Fontelis good on *Ca*, not *Cg*
- Location species differences
- *C. acutatum* complex grows below 41°F

DO BIOLOGY, ECOLOGY, VIRULENCE DIFFER?

- Weed endophytes – no symptoms
- Insect pathogens - hemlock scale, citrus scale, Asian chestnut gall wasp
- Quiescent infections?
- Insect, rain dispersed, wind (*C. fructicola* ascospores)

Bitter Rot Sampling Locations

60% *Colletotrichum fioriniae*
25% *C. chrysophilum*
12.5% *C. noveboracense*

- Hudson River Valley Map with sampled locations

www.nature.com/scientificreports

SCIENTIFIC REPORTS

natureresearch

OPEN

Identification and characterization of *Colletotrichum* species causing apple bitter rot in New York and description of *C. noveboracense* sp. nov.

Fatemeh Khodadadi[1], Jonathan B. González[2], Phillip L. Martin[3], Emily Giroux[4], Guillaume J. Bilodeau[4], Kari A. Peter[3], Vinson P. Doyle[5] & Srđan G. Aćimović[1]✉

Apple bitter rot caused by *Colletotrichum* species is a growing problem worldwide. *Colletotrichum* spp. are economically important but taxonomically un-resolved. Identification of *Colletotrichum* spp. is critical due to potential species-level differences in pathogenicity-related characteristics. A 400-isolate collection from New York apple orchards were morphologically assorted to two groups, *C. acutatum* species complex (*CASC*) and *C. gloeosporioides* species complex (*CGSC*). A sub-sample of 44 representative isolates, spanning the geographical distribution and apple varieties, were assigned to species based on multi-locus phylogenetic analyses of *nrITS*, *GAPDH* and *TUB2* for *CASC*, and *ITS*, *GAPDH*, *CAL*, *ACT*, *TUB2*, *APN2*, *ApMat* and *GS* genes for *CGSC*. The dominant species was *C. fioriniae*, followed by *C. chrysophilum* and a novel species, *C. noveboracense*, described in this study. This study represents the first report of *C. chrysophilum* and *C. noveboracense* as pathogens of apple. We assessed the enzyme activity and fungicide sensitivity for isolates identified in New York. All isolates showed amylolytic, cellulolytic and lipolytic, but not proteolytic activity. *C. chrysophilum* showed the highest cellulase and the lowest lipase activity, while *C. noveboracense* had the highest amylase activity. Fungicide assays showed that *C. fioriniae* was sensitive to benzovindiflupyr and thiabendazole, while *C. chrysophilum* and *C. noveboracense* were sensitive to fludioxonil, pyraclostrobin and difenoconazole. All species were pathogenic on apple fruit with varying lesion sizes. Our findings of differing pathogenicity-related characteristics among the three species demonstrate the importance of accurate species identification for any downstream investigations of *Colletotrichum* spp. in major apple growing regions.

Bitter Rot Variety Resistance

There are differences in relative susceptibility of different varieties.

Based on the laboratory data from 2 years of study, cultivars were classified into four relative-susceptibility groups:

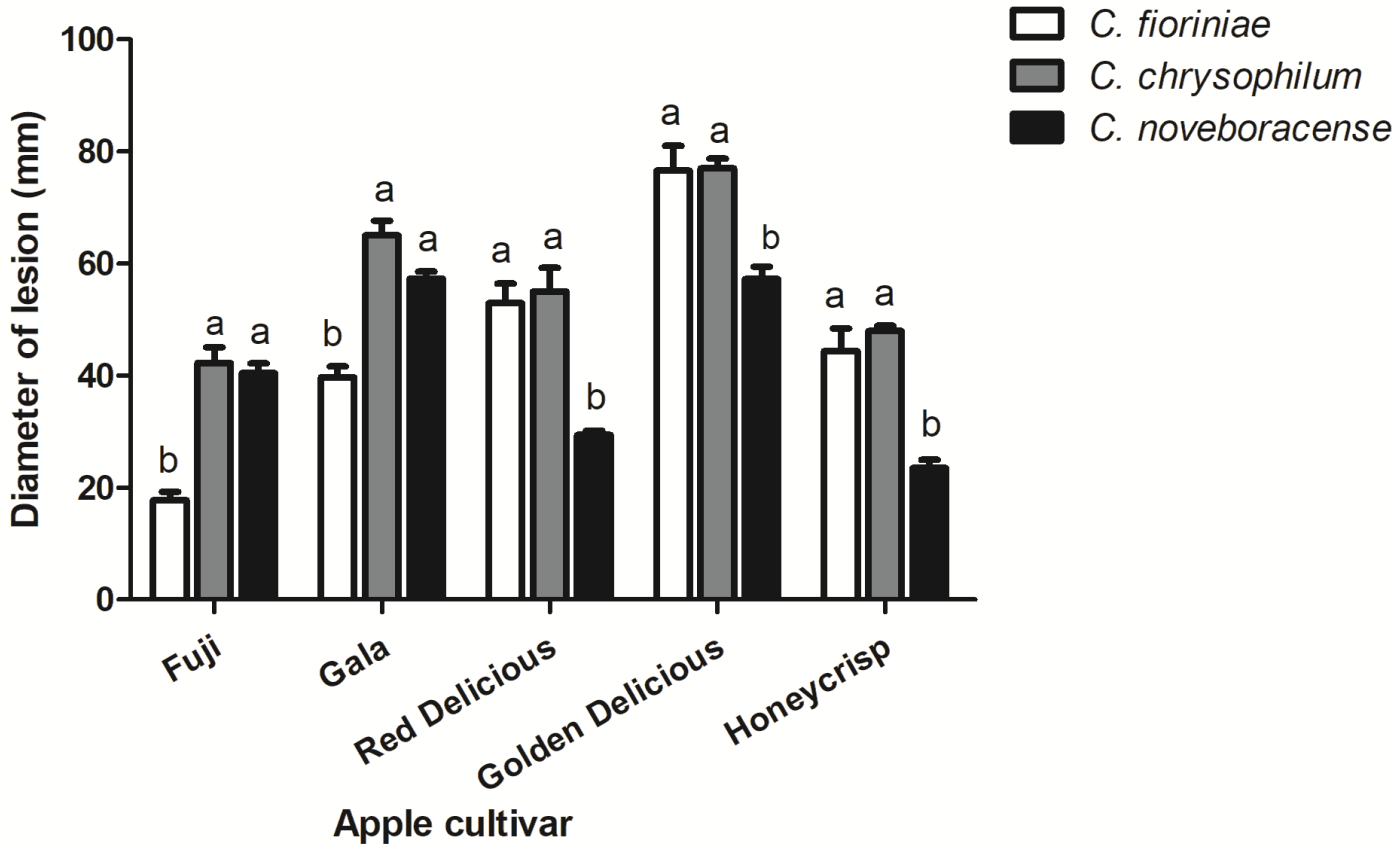
- most susceptible: Pristine, Honeycrisp, and Ginger Gold
- highly susceptible: Yataka,Sansa, Arlet, and Enterprise
- moderately susceptible: Sunrise, Golden Supreme, PioneerMac, GoldRush, Golden Delicious, and Creston
- least susceptible: Fuji

Biggs, A. R., and Miller, S. S. 2001. Relative susceptibility of selected apple cultivars to *Colletotrichum acutatum*. Plant Dis. 85:657-660.

Courtesy of Brannen P., University of Georgia

Compare 3 *Colletotrichum* Species on 5 Cultivars

- Mycelium Inoculation -



Khodadadi et al. 2020, Scientific Reports 10: 11043

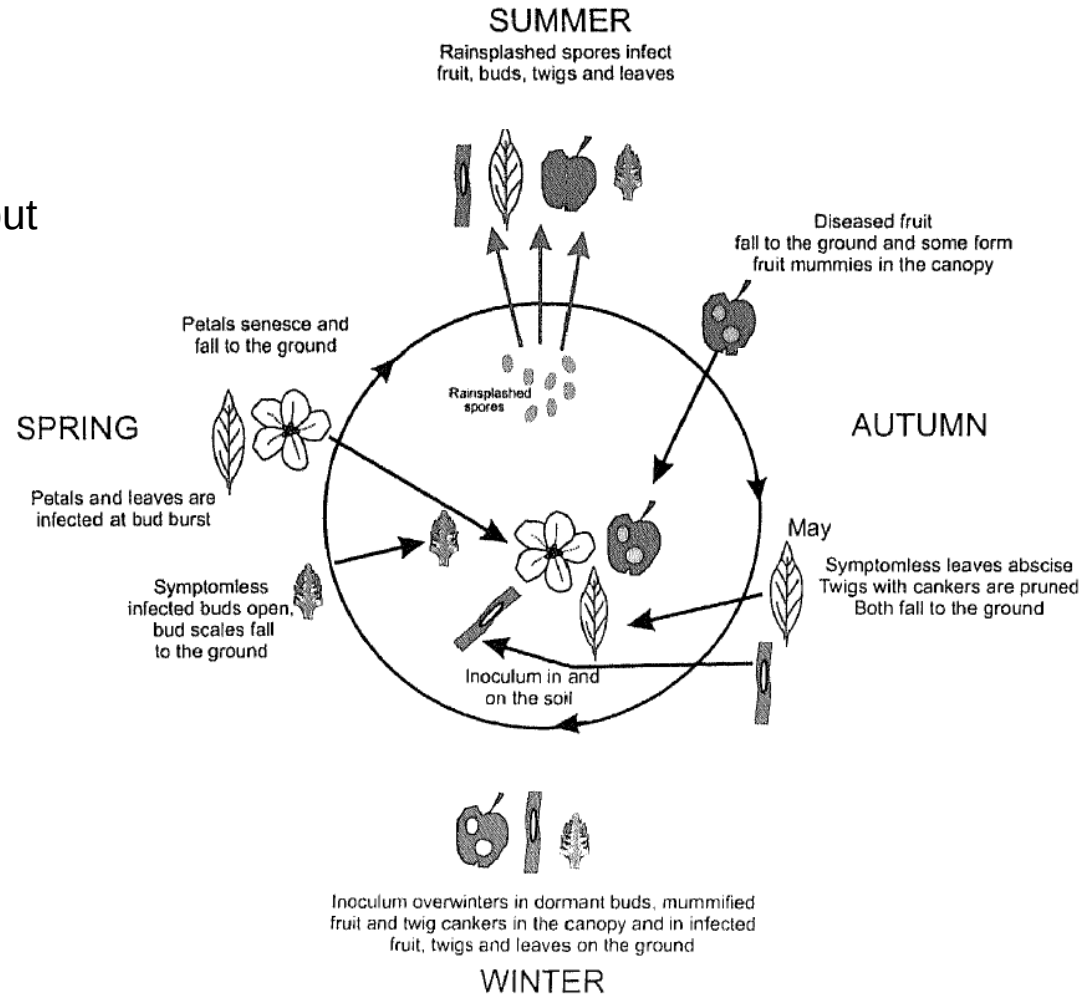
Bitter Rot Life Cycle – Everett et al. 2010

- Survives in apple buds, mummies, dead wood, cankers
- Spores released with rain throughout the growing season

- Infection in as little as 5 hours,
- Long warm wetting increases infection

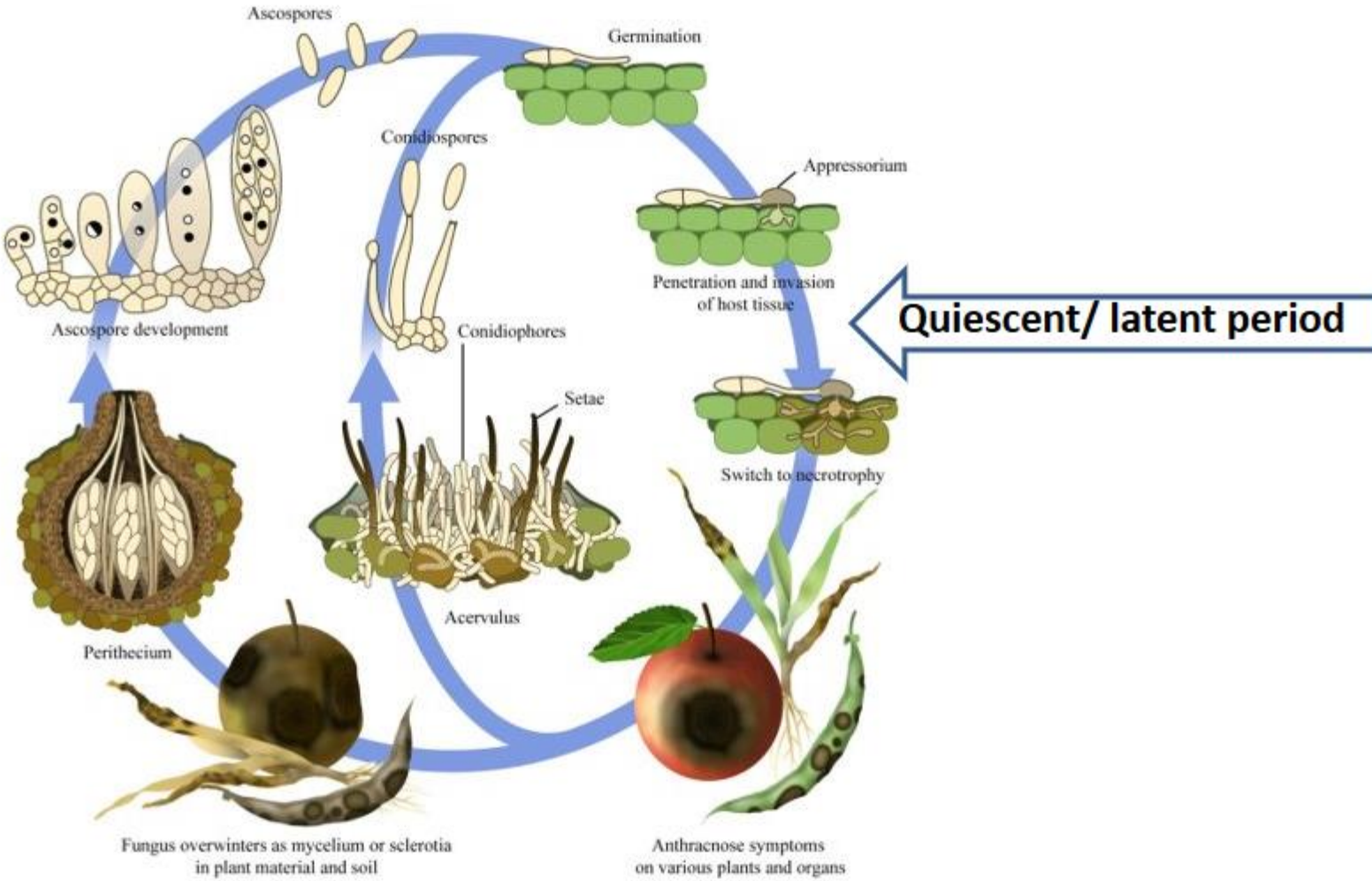
- Fruit infected as early as bloom,
- More prevalent mid to late season

- Severe epidemics when the early season is warm and wet, allowing early first primary infections and many secondary infections



Colletotrichum Life Cycle – De Silva et al 2017

- When are apples infected? -



Can Bitter Rot Overwinter in Buds?

- Two Years Data in NY -

- Percentage of buds with Colletotrichum isolated from them. Colletotrichum can survive in apple fruit/leaf buds.

Management - Fungicids

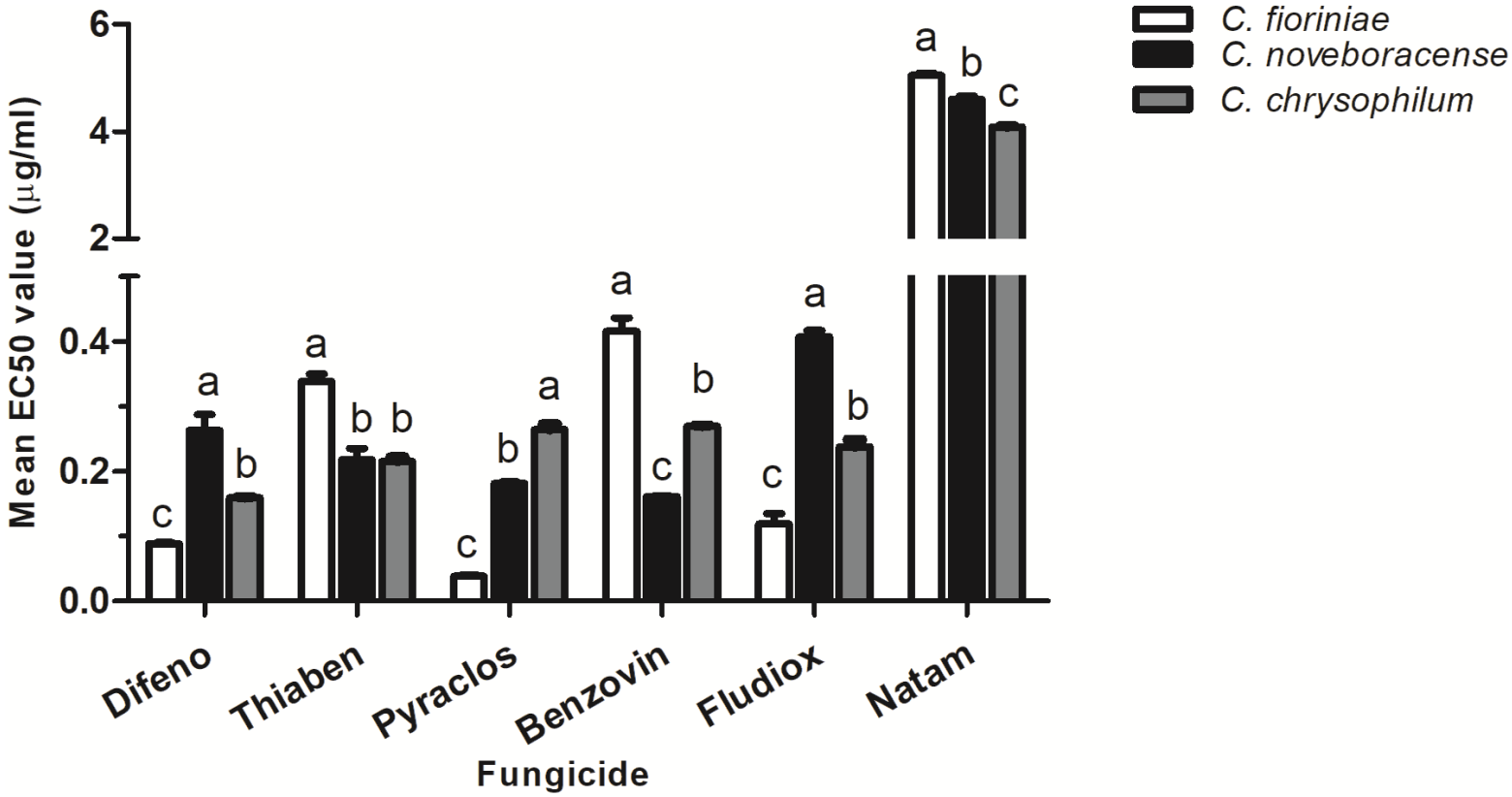
- Alternate Fungicides of Different MOA -

Main Groups:

- M3, M4 aka Multisite:
  - Phthalimides, Dithiocarbamates
- QoI (11)
- MBC (1) thiophanate-methyl
- DMI (3)
- SDHI (7) variable
- Omega - fluazinam (29)?

Fungicides in The Lab

- Avoid QoI Resistance -



Khodadadi et al. 2020, Scientific Reports 10: 11043

Fungicides in The Orchard

- Assume apples are susceptible at all stages of growth
- Weather conducive to infection and bitter rot development
  - Start 1-2 weeks after petal fall **until harvest**
  - In Hudson Valley - start 10 July
  - Spray before warm wetting events (warm nights)
  - 10, 14 to 21 day except 2.2 inches of rain has been reached
  - Late cultivars = more sprays, October, November
    - Flint, Pristine, Captan, Merivon, Sovran, Luna Sensation (control blossom end rot)
    - Ziram high rate (dithiocarbamate)
    - Ferbam granuflo (dithiocarbamate)
    - Topsin and DMI-s not effective under high infection pressure
    - Captan Alone (full rate): 4.0 lb / A (50 WP), 2.5 - 5.0 lb / A (80 WDG), 1.0 pt/100 gal (4L)
  - Sovran / Flint / Pristine / Topsin + Captan / Ziram, Effective on Sooty Blotch & Flyspeck
- Storage incidence: stem and calyx infection in Fall\
- Cool fruit below 40°F immediately
- Postharvest: Scholar (fludioxonil)
  - Only fresh infections

NY Strategy for Bitter Rot

- **Limit QoI applications to 4 per growing season in total**
- **Use DMI-s for mildew control at PK and PF (Rally, Rhyme, Indar, Procure)**
- **Or TC, PF, PF if you had a lot of powdery mildew last year**
- **Deliver QoI e.g. Flint, Flint Xtra, Sovran, Merivon, Luna Sensation, Pristine, before the hot summer days followed by rain then alternate with:**

- Captan 80 WDG @ 2.5 LB/A + Inspire Super @ 12 fl oz/A
- Captan 80 WDG @ 2.5 LB/A + Prophyt @ 64 FL/A
- Captan 80 WDG @ 2.5 LB/A + Topsin M @ 1 LB/A
- Captan 80 WDG @ 2.5 LB/A + Ferbam 76 WDG or Ferbam Granuflo at 4.6 lbs/A
- Captan 80 WDG @ 2.5 LB/A + Ziram @ 6 lbs/A (***residue a problem***)
- Captan 80 WDG @ 3 LB/A

- Mancozeb early, captan later
- Use AI-s less prone to resistance (e.g. Prophyt)
- Alternate chemical classes with different MOA
- Tank-mix single-site with contact fungicides to broaden efficacy
- ***2-inch rain re-spray!!!***

Spray Regimen for 2018 Disease Control

Source: Philip Brannen UGA – Georgia:

Timing of Applications					
Silver Tip (fire blight, apple scab, black rot)	**Green Tip to 0.5 Inch Green** (fire blight [between silver and green tip], apple scab)	**Early Tight Cluster to Pink** (apple scab, powdery mildew, cedar apple rust and quince rust, black rot, frogeye leafspot)	**Pink to Bloom** (apple scab, powdery mildew, cedar apple rust and quince rust, black rot, fire blight)	**Petal Fall** (apple scab, powdery mildew, cedar apple rust, black rot, white rot, Glomerella leaf spot/Bitter rot, Brooks fruit spot)	**Cover Spray 1** (apple scab, blister spot, flyspeck/sooty blotch, fire blight, Alternaria leaf blotch, black rot, white rot, Glomerella leaf spot/Bitter rot, powdery mildew)
Captan + Kocide 3000	Sylit at green tip; followed by Mancozeb + Sylit at 0.5 inch green (Note; Kocide 3000 can be sprayed again if needed for fire blight [e.g. sufficient time between silver tip and green tip], but discontinue use at ½ inch green, or damage to fruit may occur – largely russetting)	Sylit + Mancozeb + Captan + Topguard	Rally + Mancozeb + (Streptomycin or Kasumin or Streptomycin + Mycoshield or Kasumin + Mycoshield) -will need multiple fire blight applications (3 day interval or according to a predictive model); will likely need multiple fungicide applications depending on weather and bloom time [assume 2])	Mancozeb + Merivon	Indar + Mancozeb + Prophyt + Apogee
M1 + M4	U12 + M3	U12 + M3 + M4 + 3	3 + M3	M3 + 7 + 11	3 + M3 + 33 + Apogee

Timing of Applications					
Cover Spray 2	**Cover Spray 3**	**Cover Spray 4**	**Cover Spray 5**	**Cover Spray 6**	**Cover Spray 7**
(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]
Mancozeb + Prophyt + Topguard	Merivon + Captan	Captan + Prophyt	Merivon + Captan	Captan + Prophyt	Captan + Prophyt
3 + M3 + 33	7 + 11 + M4	M4 + 33	7 + 11 + M4	M4 + 33	M4 + 33

Cover Spray 8	Cover Spray 9	Cover Spray 10	Cover Spray 11	Cover Spray 12	Cover Spray 13
(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]
Captan + Prophyt	Inspire Super	Captan + Prophyt	Inspire Super	Omega (28 day PHI)	Inspire Super
M4 + 33	3 + 9	M4 + 33	3 + 9	29	3 + 9

Timing of Applications					
Cover Spray 14	**Cover Spray 15**	**Cover Spray 16**	**Cover Spray 17**	**Cover Spray 18**	**Cover Spray 19**
(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]
Omega	Inspire Super	Captan + Prophyt	Omega (28 day PHI)	Omega (28 day PHI)	Inspire Super
29	3 + 9	M4 + 33	29	29	3 + 9

Cover Spray 20	Cover Spray 21
(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]	(white rot, black rot, sooty blotch, flyspeck, black pox, Glomerella leaf spot/Bitter rot, powdery mildew, Alternaria leaf blotch, blister spot) [necrotic leaf blotch on Golden Delicious]
Captan + Prophyt	Merivon + Captan
M4 + 33	7 + 11 + M4

Source: Philip Brannen UGA - Georgia:

Note: keep in mind that in Georgia they likely have different (more) *Colletotrichum* species infecting apple, hence some fungicides might be effective or not depending on the species complex they have.

What About Organic Orchards?

- Problem -

- Dormant copper - reduces overwintering inoculum (not enough)
- Sulfur, fine ground, in summer; Can burn leaves at T > 90ºF; PF limited
- Cueva, Badge X2, low rates, avoid fruit russet; LLS + low copper rate.
- LLS in summer for SBFS and Oil ≥ 1% injures fruit = increases rots!

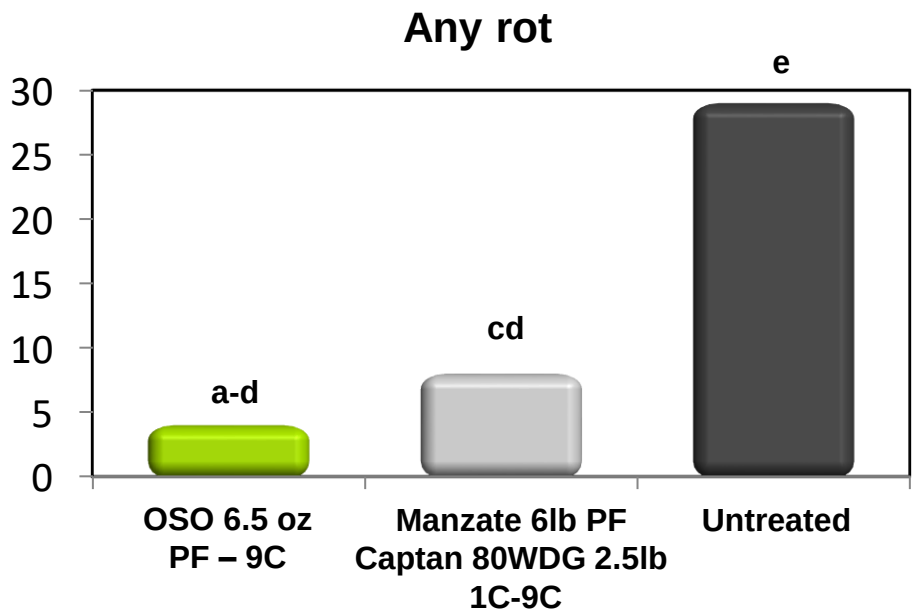
- Cultural practices to suppress fungi:
  - Prune out dead wood, rotted fruit mummies on tree or ground
  - Tree pruning = increase wind and light penetration
  - Avoid poor planting sites for an orchard
  - Irrigate well ahead of heat waves = Prevent tree drought/heat stress

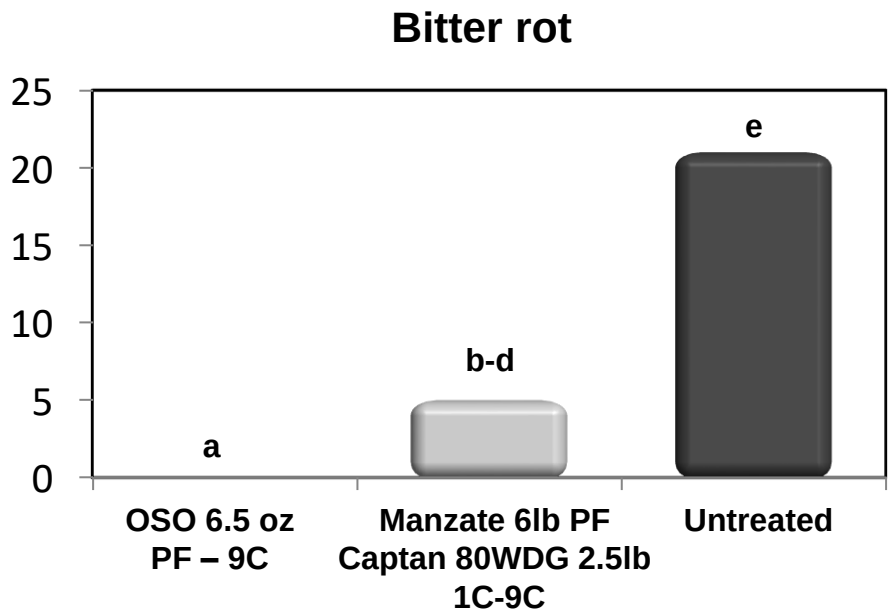
- **Differences in cultivar susceptibility to bitter rot (very relative):**
  - **Moderately Susceptible/ Resistant**: Gala, Fuji, Jonalicious (Daniels), Jonadel, Jonagold, Winesap, Melrose, Red Delicious, Rome Beauty, Stayman, Arkansas Black, Dayton, Melrose, Akane
  - **Susceptible**: Honeycrisp, Priscilla, Liberty, Elstar, Ed Fackler, Empire, King David, Golden Delicious, Freedom, Wolf River, Rome Beauty, Jonathan, Blushing Gold, Sir Prize.
- Cool harvested fruit below 42 - 44ºF asap (*Botryosphaeria, Colletotrichum*)

- Recently tested: Cueva, Double Nickel, Serenade Optimum, Oso (cell wall biosynthesis)

Storage Rot Control on Apples – polyoxin D zinc salt 5%

Yoder et al 2012: % Fruit Rot (28 Days After Incubation)



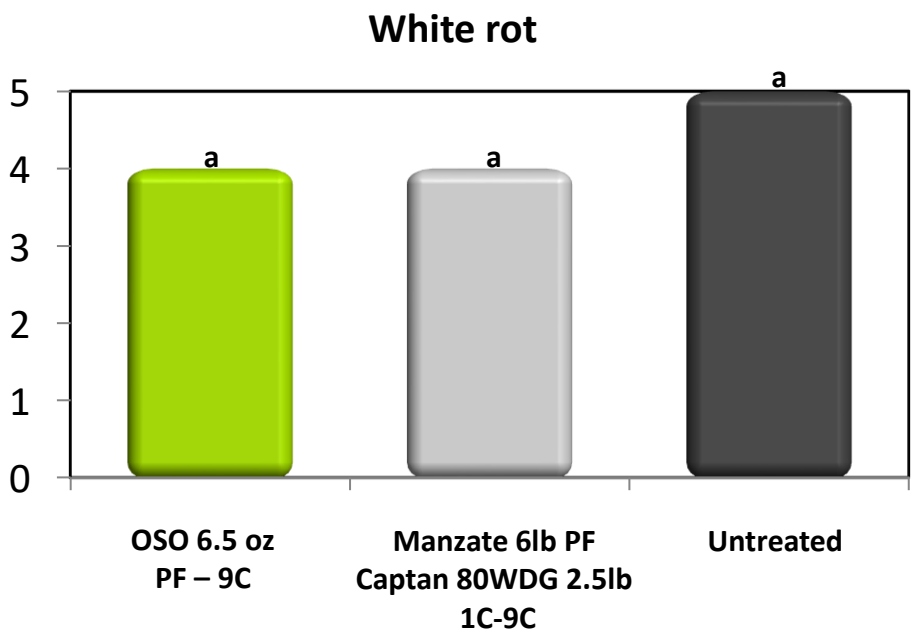


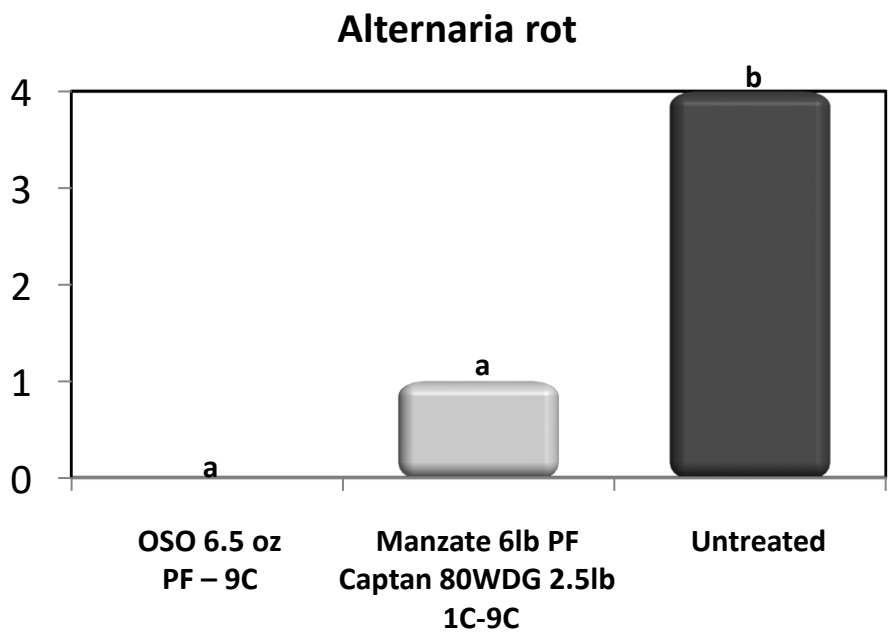
Yoder – VA Tech, 2012
Fuji apples
CER-2012-025

GROUP 19 FUNGICIDE

Storage Rot Control on Apples – polyoxin D zinc salt 5%

Yoder et al. 2002: % Fruit Rot (28 Days After Incubation)





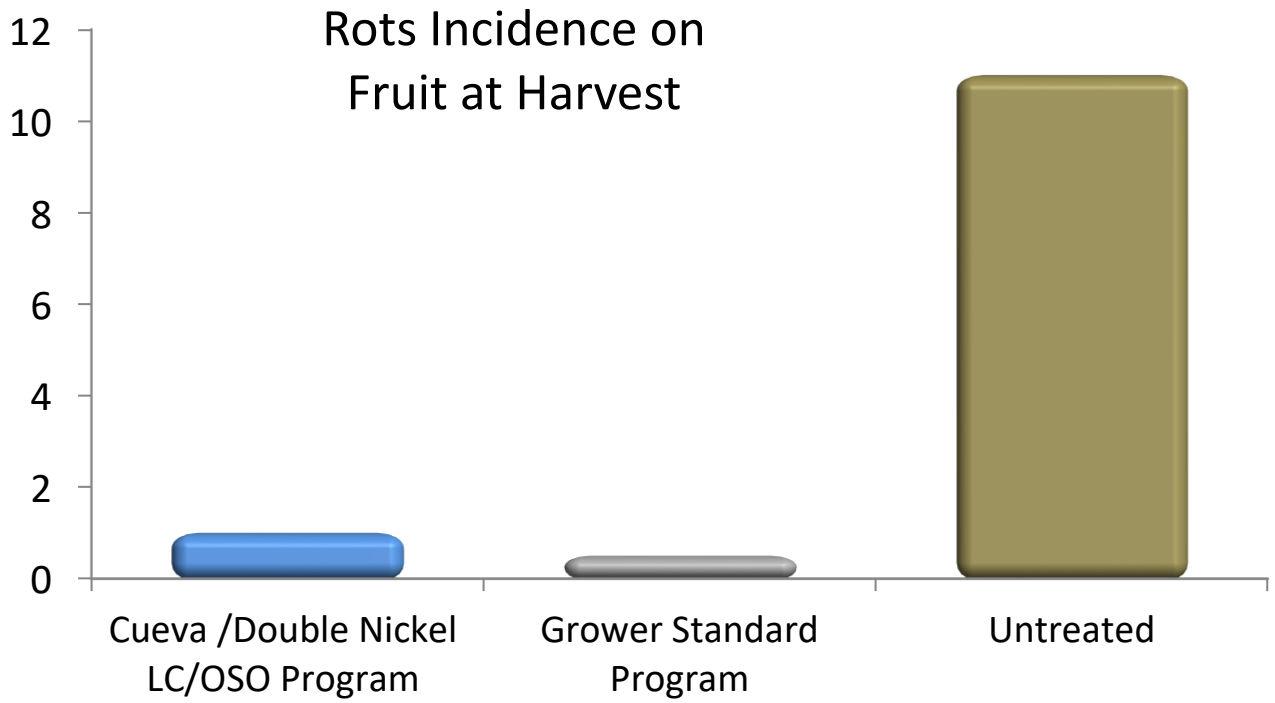
Yoder – VA Tech, 2012
Fuji apples
CER-2012-025

GROUP 19 FUNGICIDE

Cueva™
LIQUID COPPER FUNGICIDE CONCENTRATE

Double Nickel™ LC
BIOFUNGICIDE

OSO™ 5% SC



Jeff Alicandro, Agassistance, Ontario, NY. There were 4 replications, 100 GPA applied airblast, 10-14 day intervals from 1C through 6C. CER-2015-122.

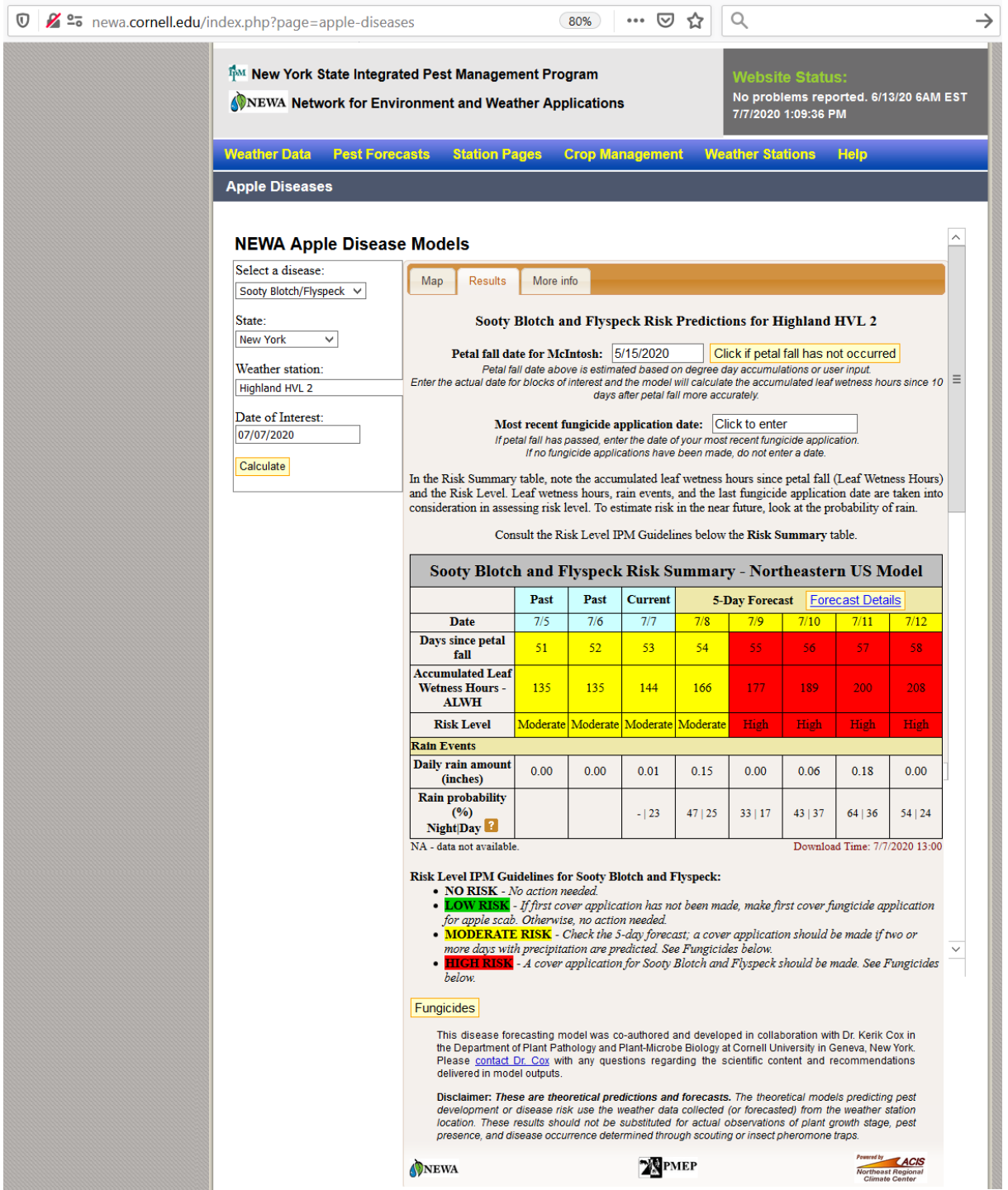
CERTIS

4. Sooty Blotch & Flyspeck

Gloedes pomigena and *Zygophiala jamaicensis*

NEWA SBFS Prediction Model – use them

Spray just before 190 ALWH reached after Petal Fall



newa.cornell.edu/index.php?page=apple-diseases 80%

New York State Integrated Pest Management Program

NEWA Network for Environment and Weather Applications

Website Status:
No problems reported. 6/13/20 6AM EST
7/7/2020 1:09:36 PM

Weather Data | Pest Forecasts | Station Pages | Crop Management | Weather Stations | Help

Apple Diseases

NEWA Apple Disease Models

Select a disease: Sooty Blotch/Flyspeck

State: New York

Weather station: Highland HVL 2

Date of Interest: 07/07/2020

Calculate

Map | Results | More info

Sooty Blotch and Flyspeck Risk Predictions for Highland HVL 2

Petal fall date for McIntosh: 5/15/2020 Click if petal fall has not occurred

Petal fall date above is estimated based on degree day accumulations or user input. Enter the actual date for blocks of interest and the model will calculate the accumulated leaf wetness hours since 10 days after petal fall more accurately.

Most recent fungicide application date: Click to enter

If petal fall has passed, enter the date of your most recent fungicide application. If no fungicide applications have been made, do not enter a date.

In the Risk Summary table, note the accumulated leaf wetness hours since petal fall (Leaf Wetness Hours) and the Risk Level. Leaf wetness hours, rain events, and the last fungicide application date are taken into consideration in assessing risk level. To estimate risk in the near future, look at the probability of rain.

Consult the Risk Level IPM Guidelines below the **Risk Summary** table.

Sooty Blotch and Flyspeck Risk Summary - Northeastern US Model

	Past	Past	Current	5-Day Forecast (Forecast Details)				
Date	7/5	7/6	7/7	7/8	7/9	7/10	7/11	7/12
Days since petal fall	51	52	53	54	55	56	57	58
Accumulated Leaf Wetness Hours - ALWH	135	135	144	166	177	189	200	208
Risk Level	Moderate	Moderate	Moderate	Moderate	High	High	High	High
Rain Events								
Daily rain amount (inches)	0.00	0.00	0.01	0.15	0.00	0.06	0.18	0.00
Rain probability (%) Night|Day			- | 23	47 | 25	33 | 17	43 | 37	64 | 36	54 | 24

NA - data not available. Download Time: 7/7/2020 13:00

Risk Level IPM Guidelines for Sooty Blotch and Flyspeck:

- **NO RISK** - *No action needed.*
- **LOW RISK** - *If first cover application has not been made, make first cover fungicide application for apple scab. Otherwise, no action needed.*
- **MODERATE RISK** - *Check the 5-day forecast; a cover application should be made if two or more days with precipitation are predicted. See Fungicides below.*
- **HIGH RISK** - *A cover application for Sooty Blotch and Flyspeck should be made. See Fungicides below.*

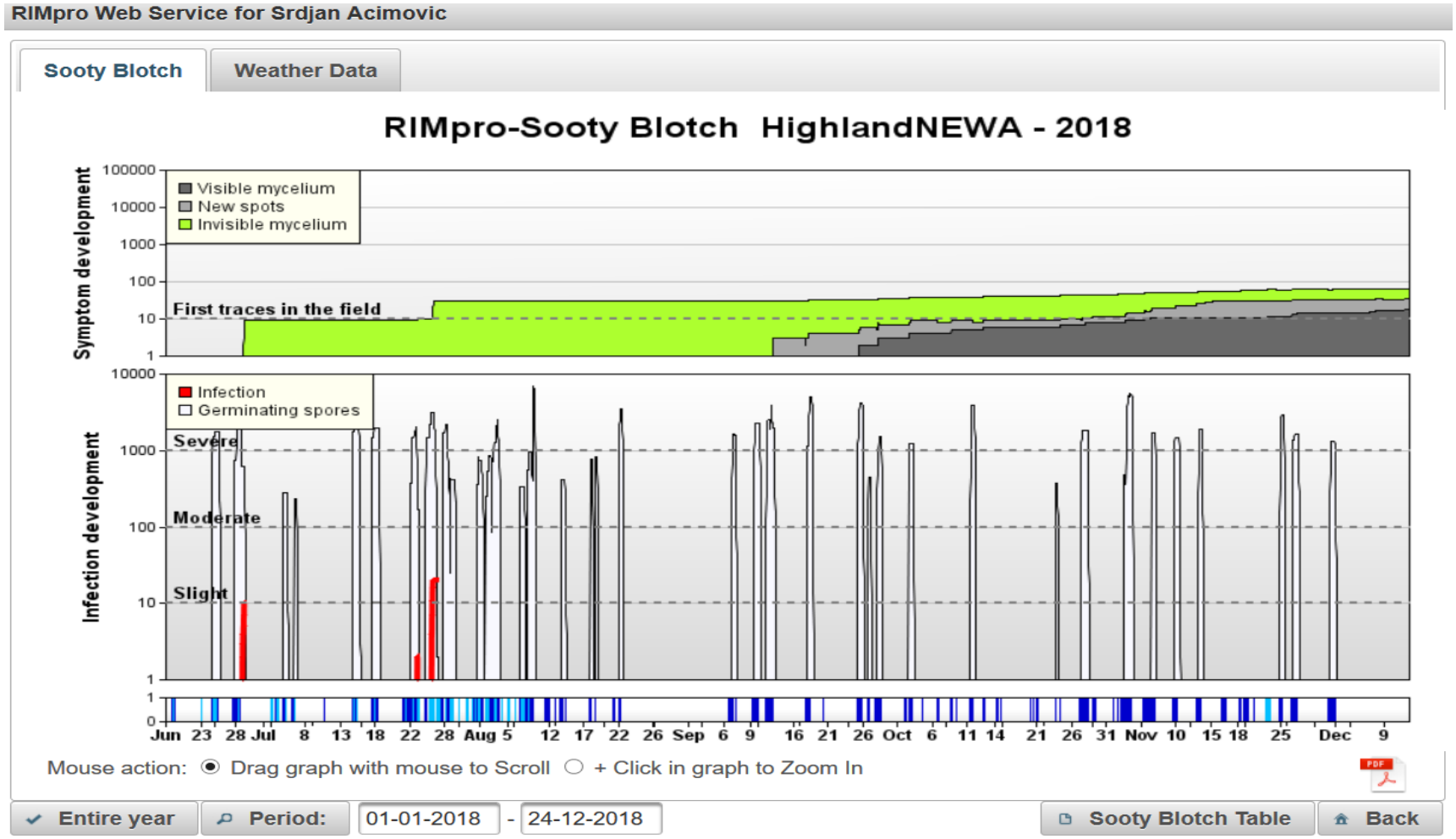
Fungicides

This disease forecasting model was co-authored and developed in collaboration with Dr. Kerik Cox in the Department of Plant Pathology and Plant-Microbe Biology at Cornell University in Geneva, New York. Please contact Dr. Cox with any questions regarding the scientific content and recommendations delivered in model outputs.

Disclaimer: ***These are theoretical predictions and forecasts.*** *The theoretical models predicting pest development or disease risk use the weather data collected (or forecasted) from the weather station location. These results should not be substituted for actual observations of plant growth stage, pest presence, and disease occurrence determined through scouting or insect pheromone traps.*

NEWA PMEP Powered by ACIS Northeast Regional Climate Center

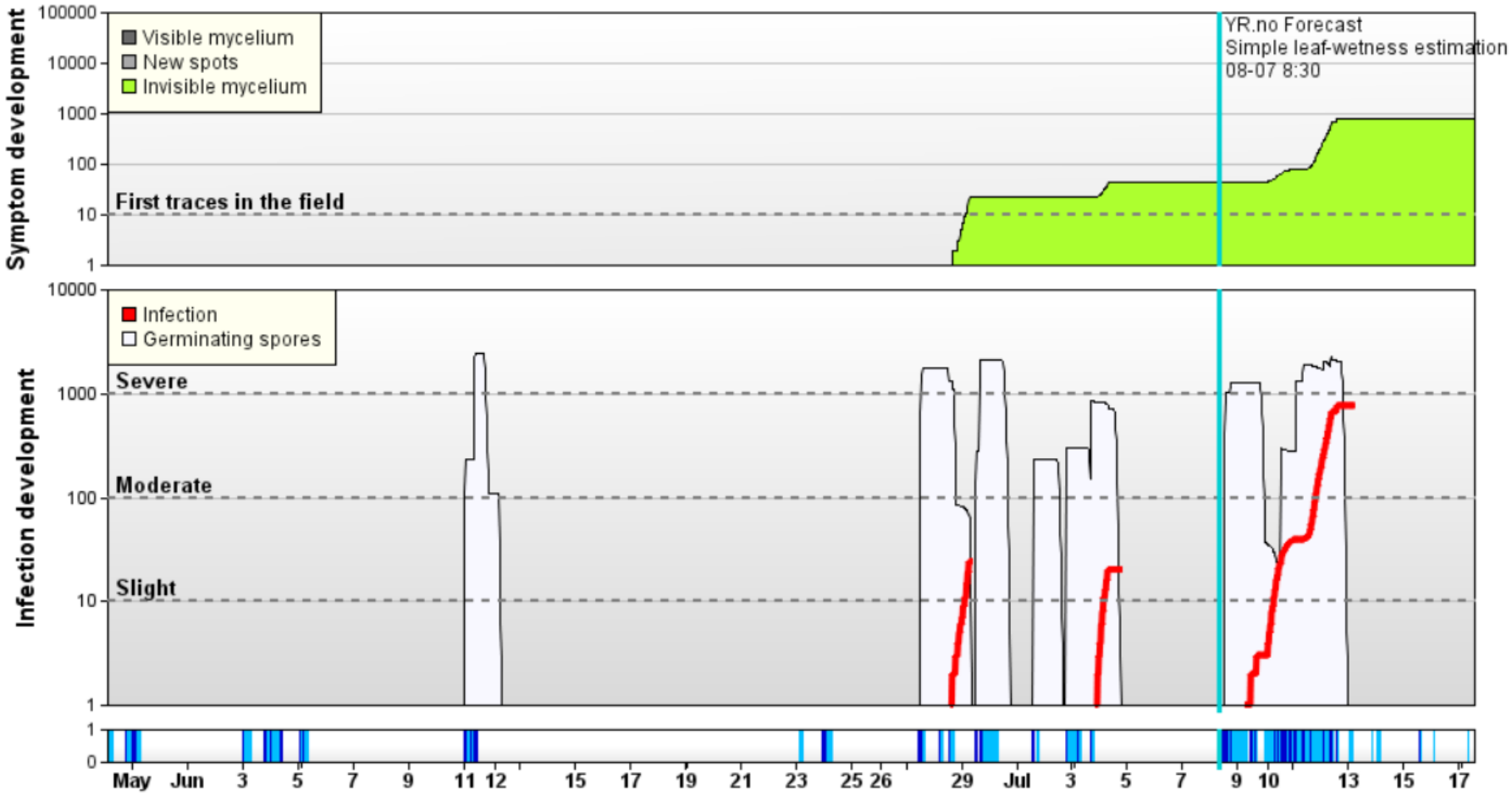
- RIMpro Sooty Blotch Infection Prediction -
- Use Models -



2020 Growing Season

Sooty Blotch | Weather Data

RIMpro-Sooty Blotch New Paltz - 2020



Mouse action: ○ Drag graph with mouse to Scroll ◉ Click in graph to Zoom In

Entire year | Period: 01-01-2020 - 17-07-2020 | Sooty Blotch Table | Back

Sooty Blotch & Flyspeck Trial

- 2018 -

Maintenance sprays: Apple scab and cedar apple rust at the beginning of the season, plus these sprays:

5/18/2018	3oz Rally + 3lbs Manzate
5/31/2018	3oz Rally
6/19/2018	3oz Rally

1.07% Citric acid

Spray dates for all treatments:

6/11/2018
6/25/2018
7/9/2018
7/21/2018
7/23/2018
8/4/2018
8/18/2018
8/31/2018 - Golden Del. & McIntosh only
9/11/2018 - Golden Del. & McIntosh only

Harvested:
8/30/2018 – Ginger Gold
9/21/2018 – McIntosh
9/29/2018 – Golden Delicious

Treatments/Programs:

1- Untreated Check – UTC

2- FungOut @ 3.75 GL/A (9 sprays)

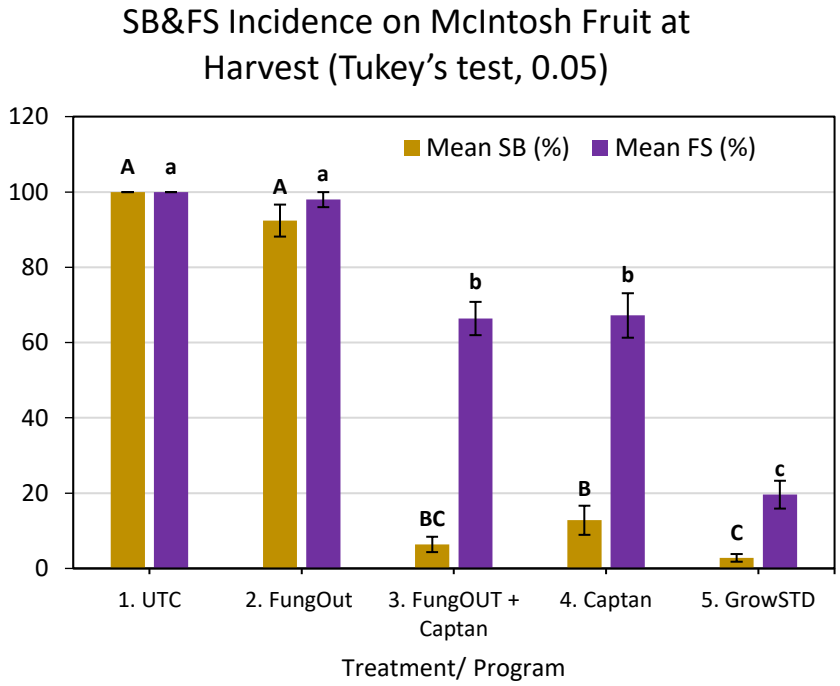
3- FungOut @ 3.75 GL/A (9 sprays)
+ Captan 80 WDG @ 2.5 LB/A

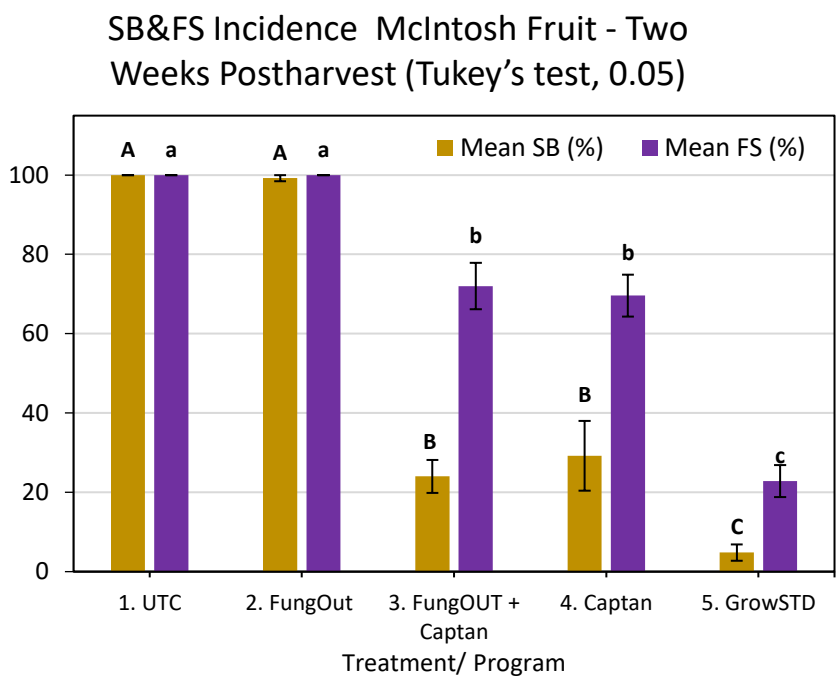
4- Captan 80 WDG @ 2.5 LB/A (9 sprays)

5- Grower Standard:
2 X Captan 80 WDG @ 2.5 LB/A
+ Prophyt @ 64 FL/A (6/11; 6/25)
4 X Captan 80 WDG @ 2.5 LB/A
+ Topsin M @ 1 LB/A 7/9, 7/21, 7/23 8/4
2 X Captan 80 WDG @ 2.5 LB/A
+ Merivon @ 5.5 FL/A (8/18 on 8/31/
1 X Captan 3 lb/A (9/11/2018)

2018 SBFS Results

- McIntosh -



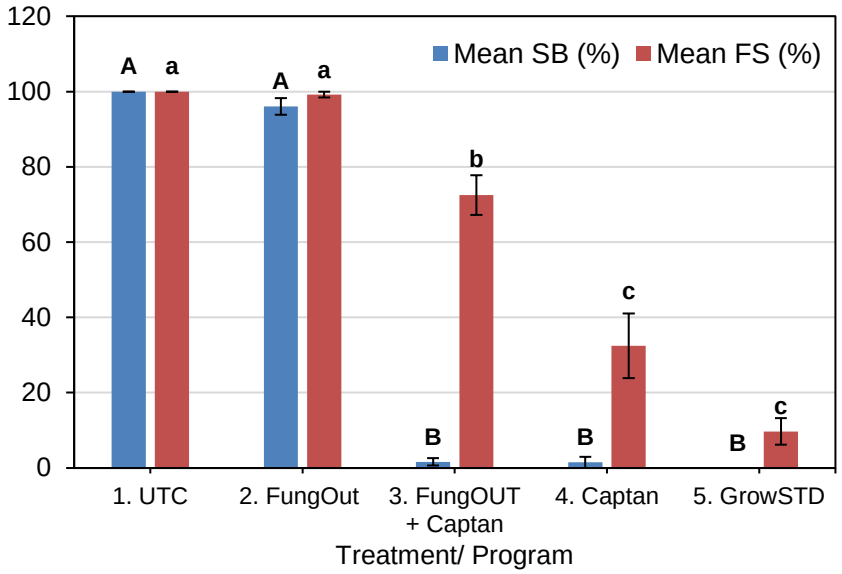


Source: https://blogs.cornell.edu/acimoviclab/files/2016/09/00.-REPORT-ALL-EFFICACY-TRIALS-2018-HVRL-11-8-2018-13e6215.pdf

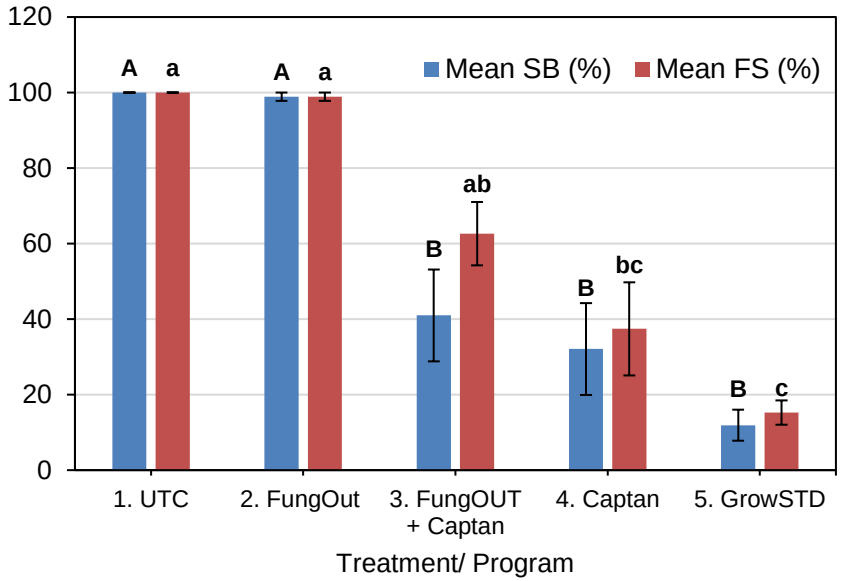
2018 SBFS Results

- Ginger Gold -

Incidence % on Ginger Gold at harvest on 30 Aug 2018 Tukey (*P*<0.05)



Incidence Ginger Gold 2-week postharvest (%) Tukey (*P*<0.05)

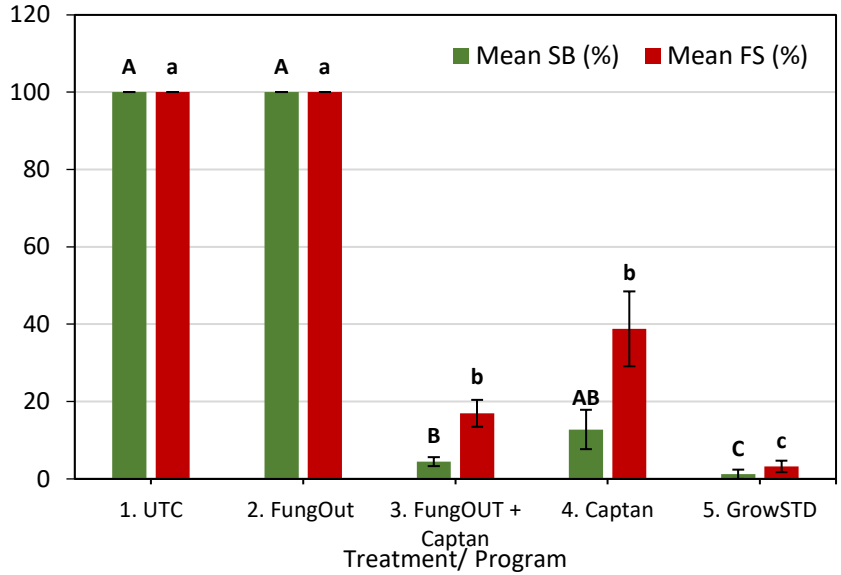


Source: https://blogs.cornell.edu/acimoviclab/files/2016/09/00.-REPORT-ALL-EFFICACY-TRIALS-2018-HVRL-11-8-2018-13e6215.pdf

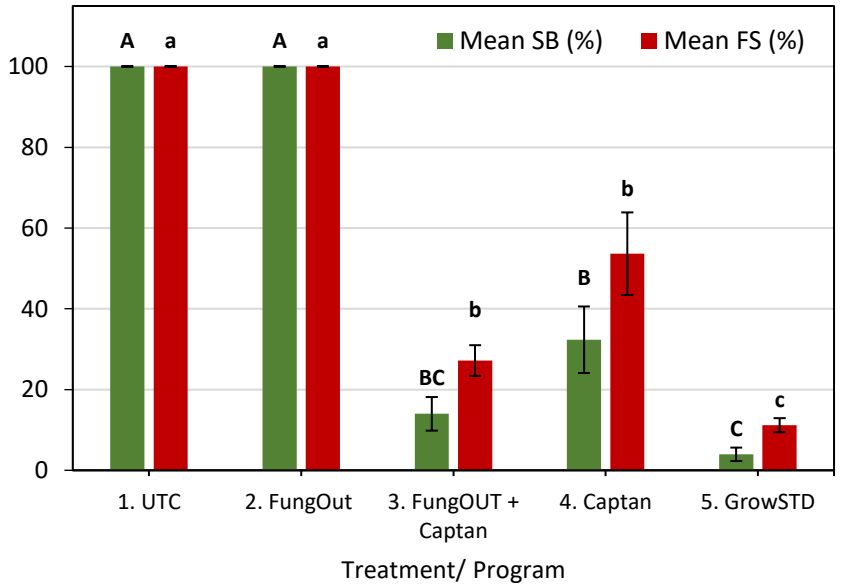
2018 SBFS Results

- Golden Delicious -

Incidence on Golden Delicious fruit at Harvest (Tukey's test, 0.05)



Incidence on Golden Del Fruit 2-weeks Postharvest (Tukey's test, 0.05)

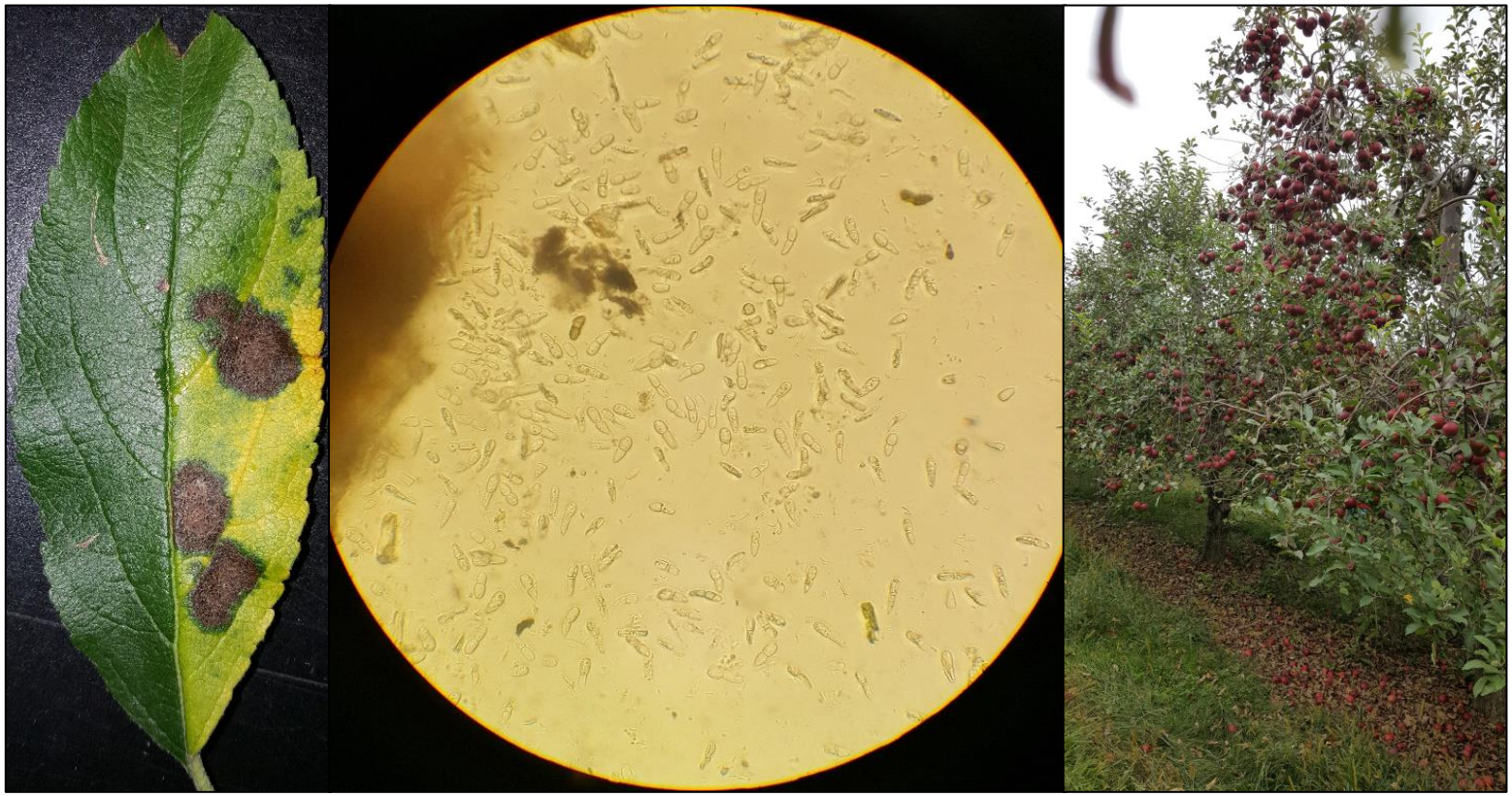


Source: https://blogs.cornell.edu/acimoviclab/files/2016/09/00.-REPORT-ALL-EFFICACY-TRIALS-2018-HVRL-11-8-2018-13e6215.pdf

5. Marssonina Leaf & Fruit Blotch

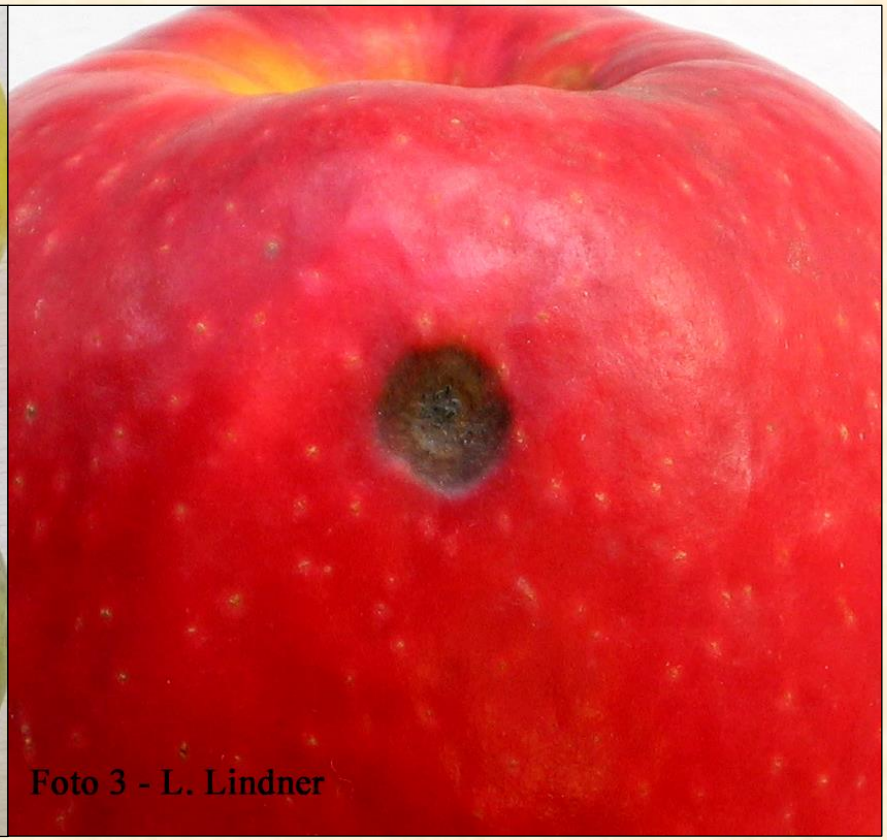
- *Marssonina coronaria* in NY -

Fatemeh Khodadadi



Fruit Symptoms in Switzerland

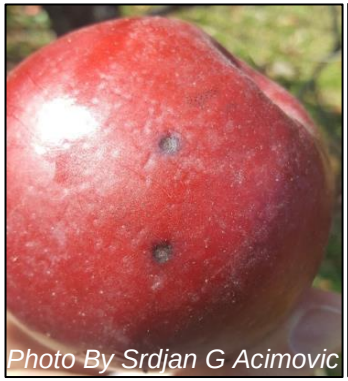
Source: Arboriculture and special crops FiBL, Switzerland



Source: Research Centre for Agriculture and Forestry, Italy

Identified In NY: Fruit Blotch, Isolation, Phylogeny

- Marssonina coronaria -



Gardiner NY – *Rome*

Monticello NY – *Jonagold*

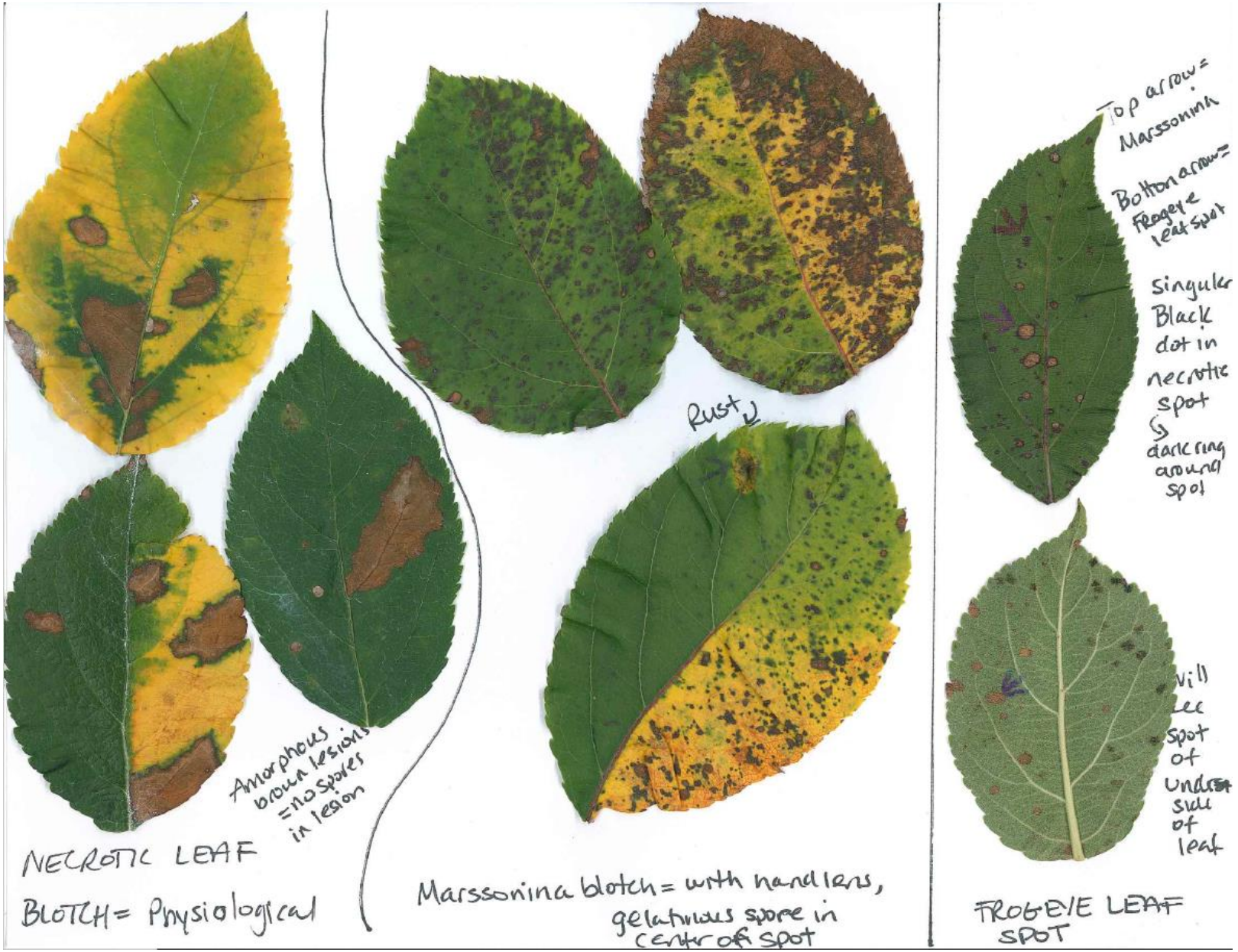
Kari Peter - Penn State
Collaboration

- BIO-PCR from leaves
- ITS sequencing
- Phylogeny analysis
- ML
- Bayesian Inference

Thomas Oberhänsli
FiBL - Switzerland
Collaboration

What's the Difference?

- Kari Peter, Penn State -



Late season look-alike of Marssonina Leaf Blotch:

Marssonina Leaf & Fruit Blotch

- History & Control -

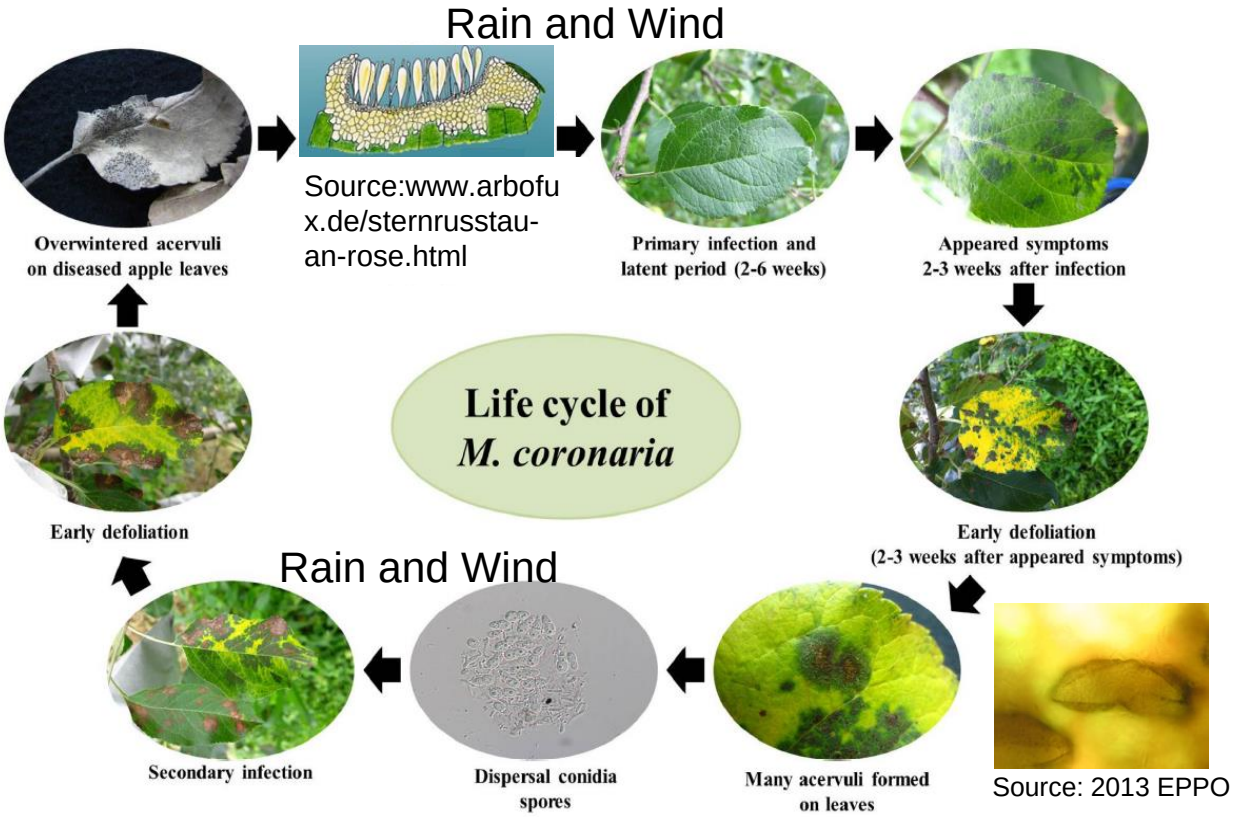
Epidemiology & Ecology:

- Symptoms 40~45 days after inoculation
- Successful infection depends on moist incubation at 100% RH, 20ºC, prior to drying (Lee et al. 2011):
  - 72% severity at 3-day moist incubation
  - 20% at 2-day moist incubation
  - 0% at 1-day moist incubation
- Needs extended period of moisture for infection
- Explains disease start after ample rains in June and July

Outbreaks & Control

- NY, PA, WI, VA, NC, Canada, Brazil, EU, Korea, China
- Wet summers of 2001, 2002, 2010, 2011, 2013, 2017, 2018
- **Organic orchards & conventional of reduced spray program –no labelled fungicides (!)**
- **Low sensitivity to copper**
- **Susceptible:** Gala, Mutsu, Fuji, Starkrimson, Northern Spy, Honeycrisp, NY-1, Rome, Topaz, Jonagold, Jonathan, Luna, Delicious, Golden Delicious, Ralls Janet, Starking Red (Wöhner et at, Li et al 2012),
- **Moderately to resistant** : Pinova, Akane, Astramel (Wöhner et at), Elstar, Jiguan, Qinguan, Qinxing, Xiangyanghong, Hongbaoshi, Jiguan (Li et al 2012)
- **Res. rootstocks**: Qingdao 598, Za'ai76, A03, JM7, P22, S64, SH-12, -17, -28 (Li et al 2012)
- Eliminate fallen leaves (urea 40 lb / A in 100 gal, dolomitic lime 2.5 t/A); prune for good air circulation;
- **Fungicides:** Mancozeb, Metiram, Topsin M, Thiophanate-Methyl, Merivon.
- Research: tebuconazole, hexaconazole, propiconazole, tebuconazole+ benziothiazolinone @ 20-day intervals, early July - late August; Bordeaux mix + tebuconazole or + propiconazole or + tebuconazole with benziothiazolinone, each @ 25 days (Dang et al. 2017)

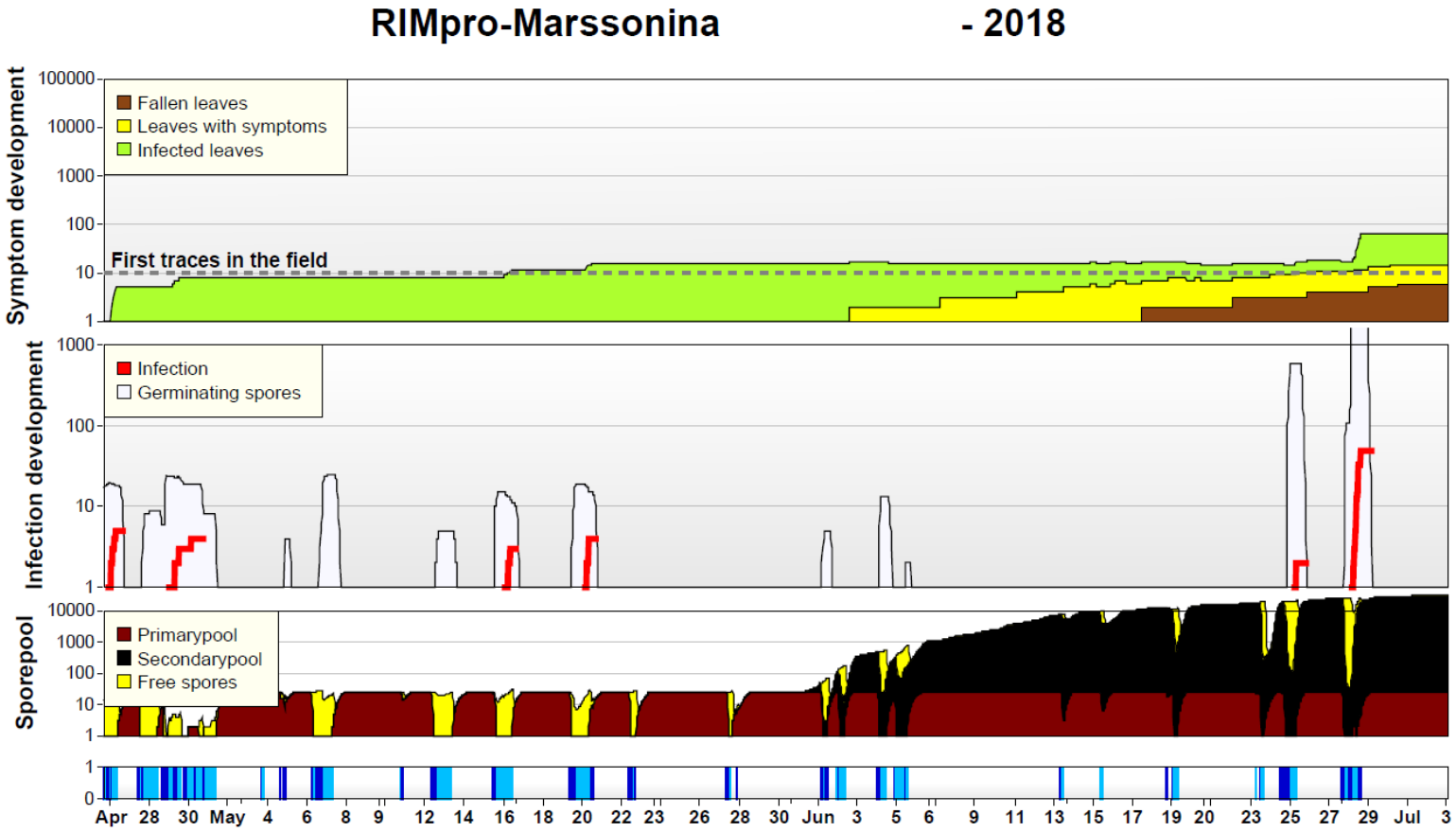
Life Cycle of *M. coronaria*



From: Back & Jung 2014, Journal of Medical Mycology 42(3):183-190

- RIMpro Has *Marssonina* Prediction Model -

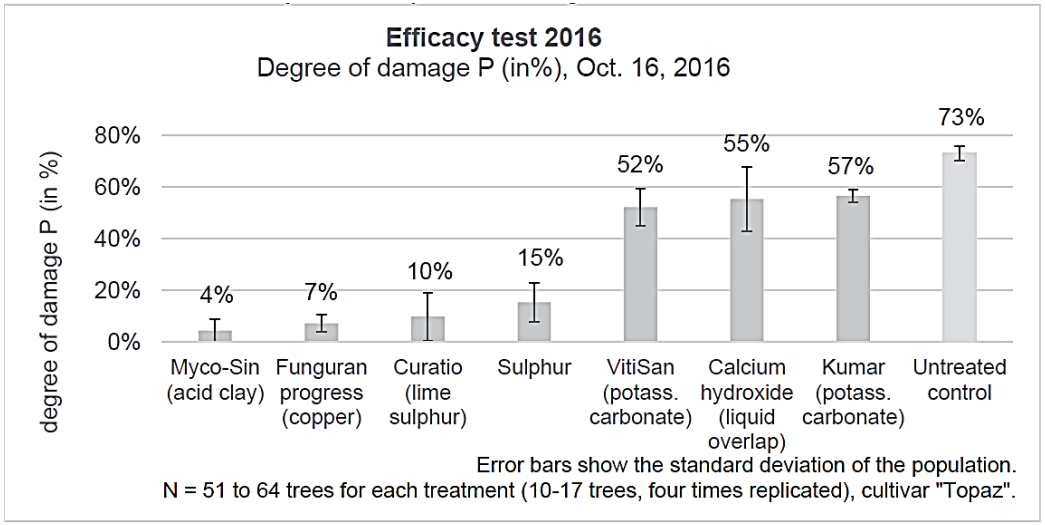
- Use Models -

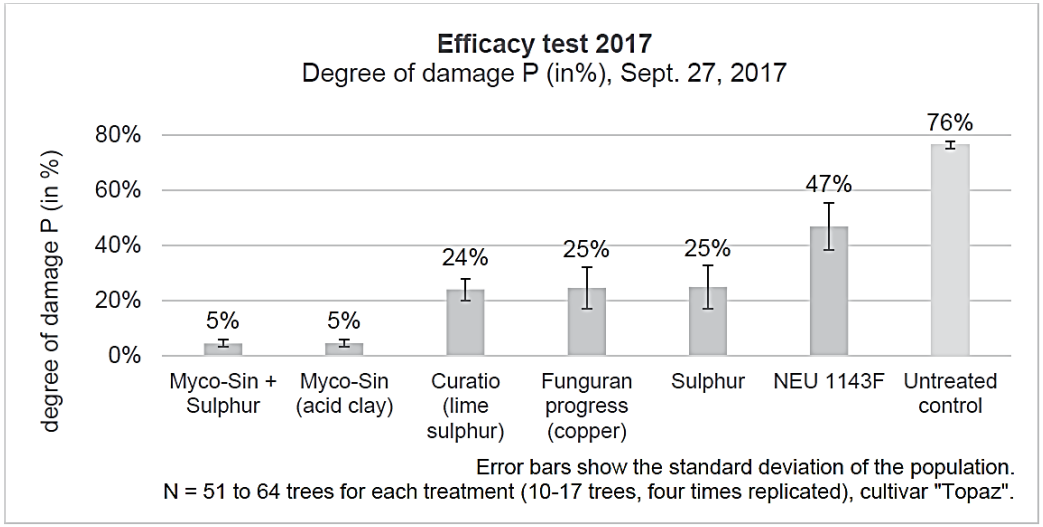


Characterization in Lab - Fungicides

Bohr et al. 2018, Germany

- Organic Orchards -



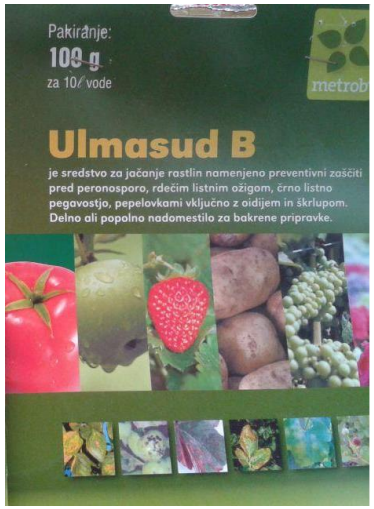


- 10-12 spray applications of each from 10 or 12 Jun - 30 Aug

www.ecofruit.net/2018/12_Bohr_36-42.pdf

Acid Clays Content
- Mode of Action -

- Clays control diseases by increasing Al on plant surfaces (Enkelmann and Wohlfarth, 1994).
- Al ions inhibit spore germination (Andrivon, 1995; Van Zwieten et al., 2007).
- Clay keeps leaves dry, reducing the risk of infections (La Torre et al. 2018).



Mycosin

Copper Oxychloride

Ongoing and Planned

- Projects -

Projects:

- NY Farm Viability institute - Bitter rot management with new fungicides (2 yr)
- Genome sequencing of *Colletotrichum* spp. from NY
- Resistance to strobilurins (FRAC 11)?
- Specialty Crop Block Grant - qPCR detection of *Colletotrichum spp.*
- *Marssonina coronaria* - characterization

Kerik Cox

Wayne Jurick II

Acknowledgements

This work was supported by the NY Apple Research and Development Program

Donors:
Albaugh LLC
Brandt Professional Agriculture
Jentsch Lab, Cornell University
Peter Schweitzer, Cornell Genomic Core

Collaborators:
Dr. Keith Yoder, Virginia Tech
Dr. Kerik Cox
Dr. Wayne Jurick II
Dan Donahue CCE ENYCHP
Michael Basedow
Anna Wallis
Cooley Lab, UMass
Jon Clements, UMass
Cold Spring Orchard Research & Education C. Belchertown, MA

Dr. David Rosenberger
Jentsch Lab, Cornell HVRL

ACIMOVIC LAB
FRUIT TREE PATHOLOGY AT CORNELL UNIVERSITY'S HUDSON VALLEY RESEARCH LABORATORY