# Diseases of ~~Tree Fruit~~ Apple: Diagnosis and Management

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# Apple Disease Challenges in the S.E.

- Several apple diseases to contend with

# Apple Disease Challenges in the S.E.

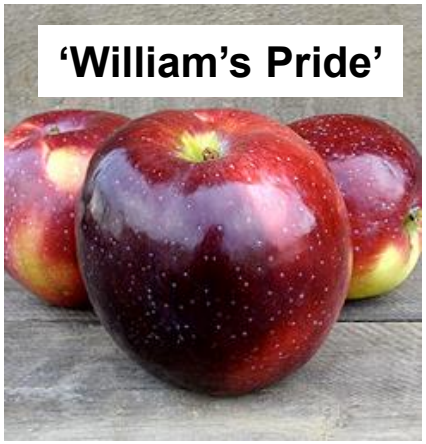
- Paucity of disease resistant cultivars
  - Breeding efforts focus on consumer preference
  - Usually single-disease resistance


http://www.eatlikenoone.com/prima-apples.htm


http://www.eatlikenoone.com/enterpris-apples.htm


http://kuffelcreek.wordpress.com/


http://www.eatlikenoone.com/pristine-apples.htm

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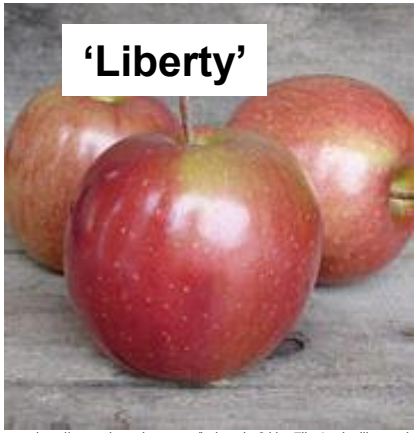



http://www.plant.photos.net/index.php?title=File:Apple_libertye.jpg

# Apple Disease Challenges in the S.E.

- Warm, humid climate
  - Favorable for pathogen infection and disease development
  - Inadequate chilling hours: longer period of susceptibility to blossom infection

**Susceptible Host**

**Biology and availability of pathogen**

**Conducive Environment**

# Apple Disease Challenges in the S.E.

- Maintaining practices of fungicide resistance management and maximum annual applications
  - Commercial apple growers in Hendersonville NC: Up to 24 fungicide applications in 2017!

| Multi-site Protectants | Single-site Fungicides | Biologicals |
|---|---|---|
| **Mancozeb** | **Group 3: S.I.'s** | ***Bacillus* spp.** |
| **Captan** | **Group 11: "Strobys"** | ***A. pullulans*** |
| **Copper** | **Group 7: SDHIs** | |
| **Sulfur** | **Group 1: "T-Methyl"** | |
| **ziram** | **U12: Dodine** | |
| **Phosphorous Acid** | | |

# Confusing Fungicide Jargon

**Fungicides are classified in a number of ways:**

1. **Chemical Group**
   - **e.g. triazoles, benzimidazoles**
2. **Biochemical Mode of Action (my preference, common in academia)**
   - **e.g. Demethylation inhibitor (DMI); Quinone-outside inhibitor (QoI)**
3. **Physical Mode of Action**
   - **e.g. Protectant, curative, eradicant**
4. **Mobility in Plant**
   - **e.g. Contact, systemic, locally systemic**

# Confusing Fungicide Jargon

Ex: Propiconazole (chemical name/a.i.); Orbit EC, Banner Maxx

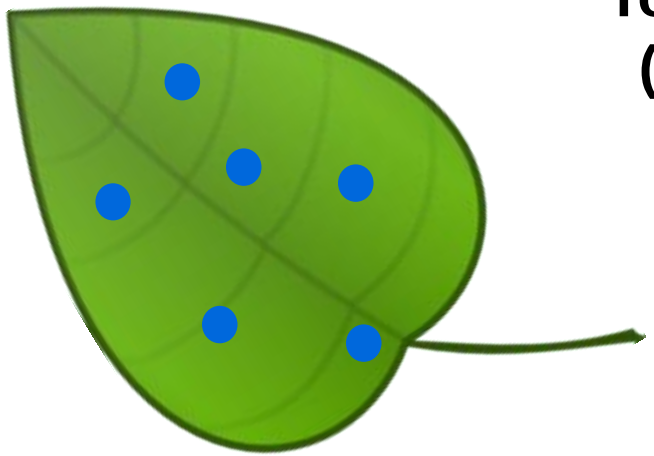
1. **Chemical Group**
   - **Triazole**
2. **Biochemical Mode of Action**
   - **Demethylation inhibitor (DMI)**
3. **Physical Mode of Action**
   - **Curative**
4. **Mobility in Plant**
   - **Locally Systemic**

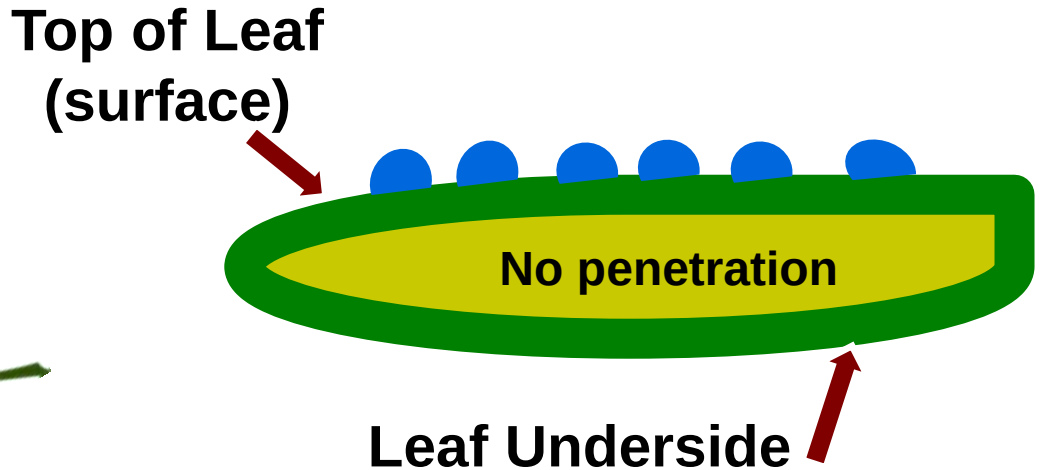

# Physical Mode of Action: Protective

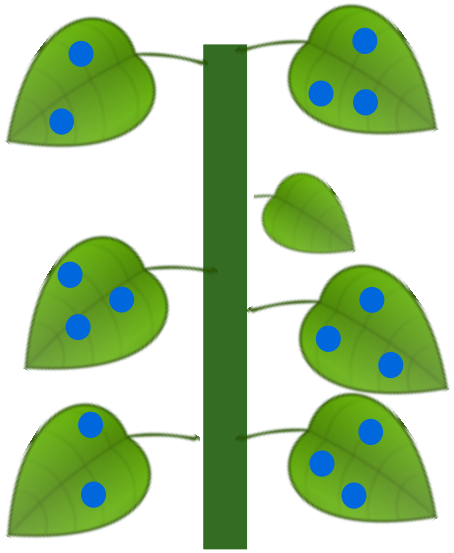
- Prohibit fungal spore germination
- Must be applied before fungal spore arrives
  - (-) Application by prediction, phenology, gut feeling
- Control and are registered for several diseases
  - (-) Risk of harming non-targets (i.e. beneficials)
- Often multiple pathogen enzymes targeted
  - (+) Low risk for resistance development



# Fungicide Movement in Plant: Non-Systemic





- Fungicide remains on surface where applied
  - Rain can redistribute (move it to other surface parts)
- Plant tissue (i.e. leaves) emerging after application or tissue missed during application not protected
  - Unless material redistributed

# Physical Mode of Action: Curative

- Arrest/inhibit fungal growth (predominantly fungistatic)
- Applied post infection (after germination) but before symptoms occur
  - (+) 24-72 hours post-infection application, usually 24-48 hrs
- Highly specific mode of action-target FUNGAL enzymes
  - (+) More safe; (-) High risk for resistance development
- Many also have protective properties

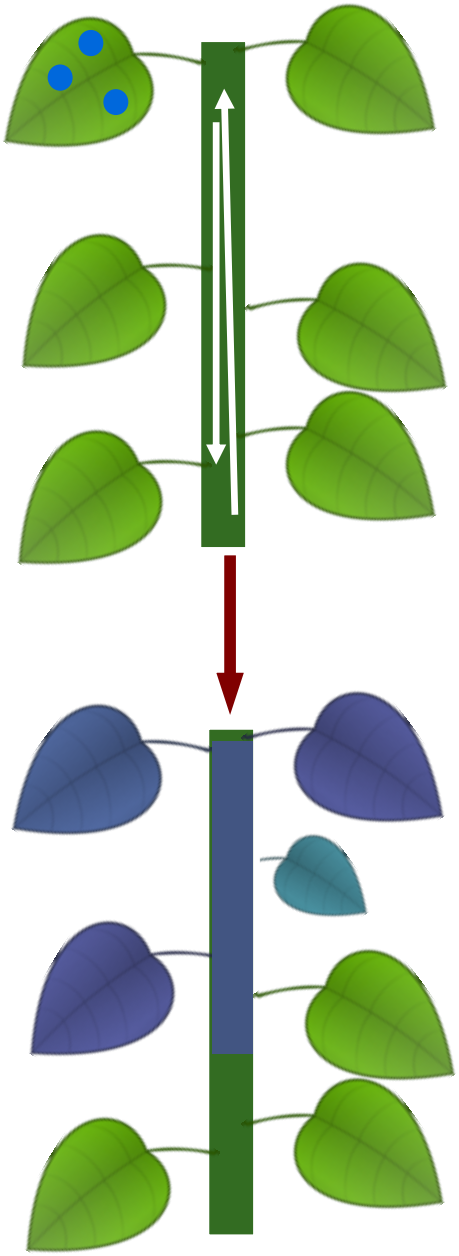


Aprovia®

# Fungicide Movement in Plant: Systemic

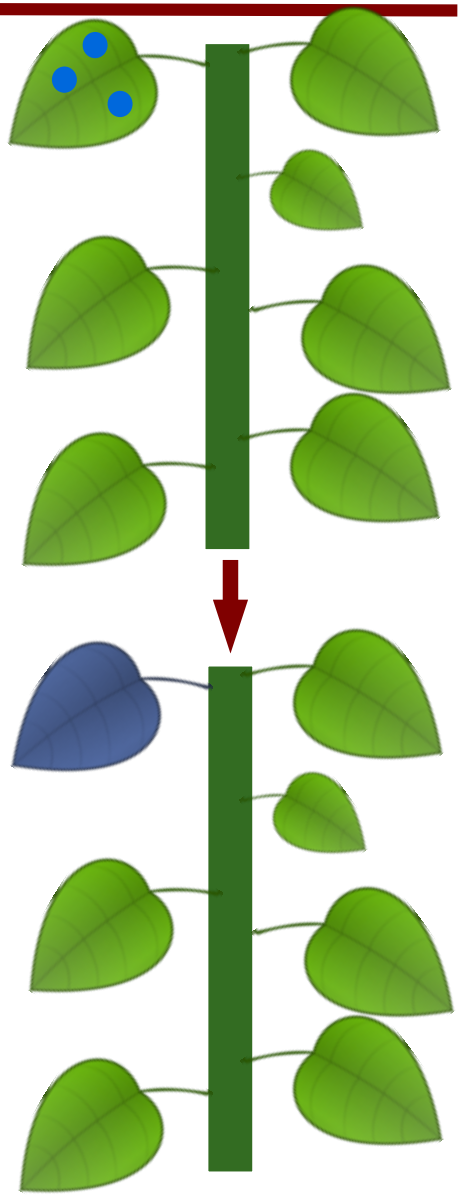


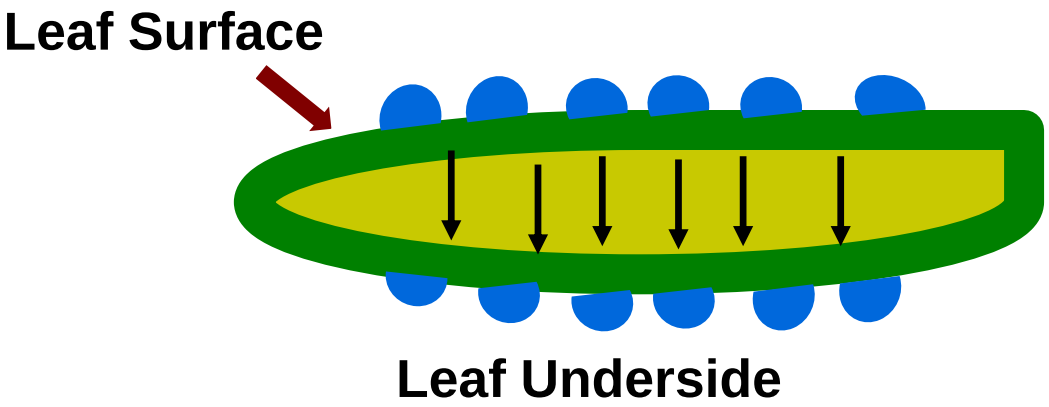
- Moves through vascular tissue (xylem and/or phloem) to reach parts of plant not directly sprayed with fungicide
- Primarily interfere with fungal growth processes after infection and penetration
- New leaves may be protected depending on movement rate
- Rare
  - Phosphorous acid fungicides and mefanoxam/metalaxyl (good on root diseases)



# Fungicide Movement in Plant: Locally Systemic

- Absorbed by plant but do not travel far
  - Move within a treated plant organ (primarily leaf)
- Interfere with fungal growth, have post infection activity
- Movement of most modern fungicides
- Translaminar movement: Spray from one side of leaf moves to other side





# Specific Fungicides and Groups: Confusing Classification

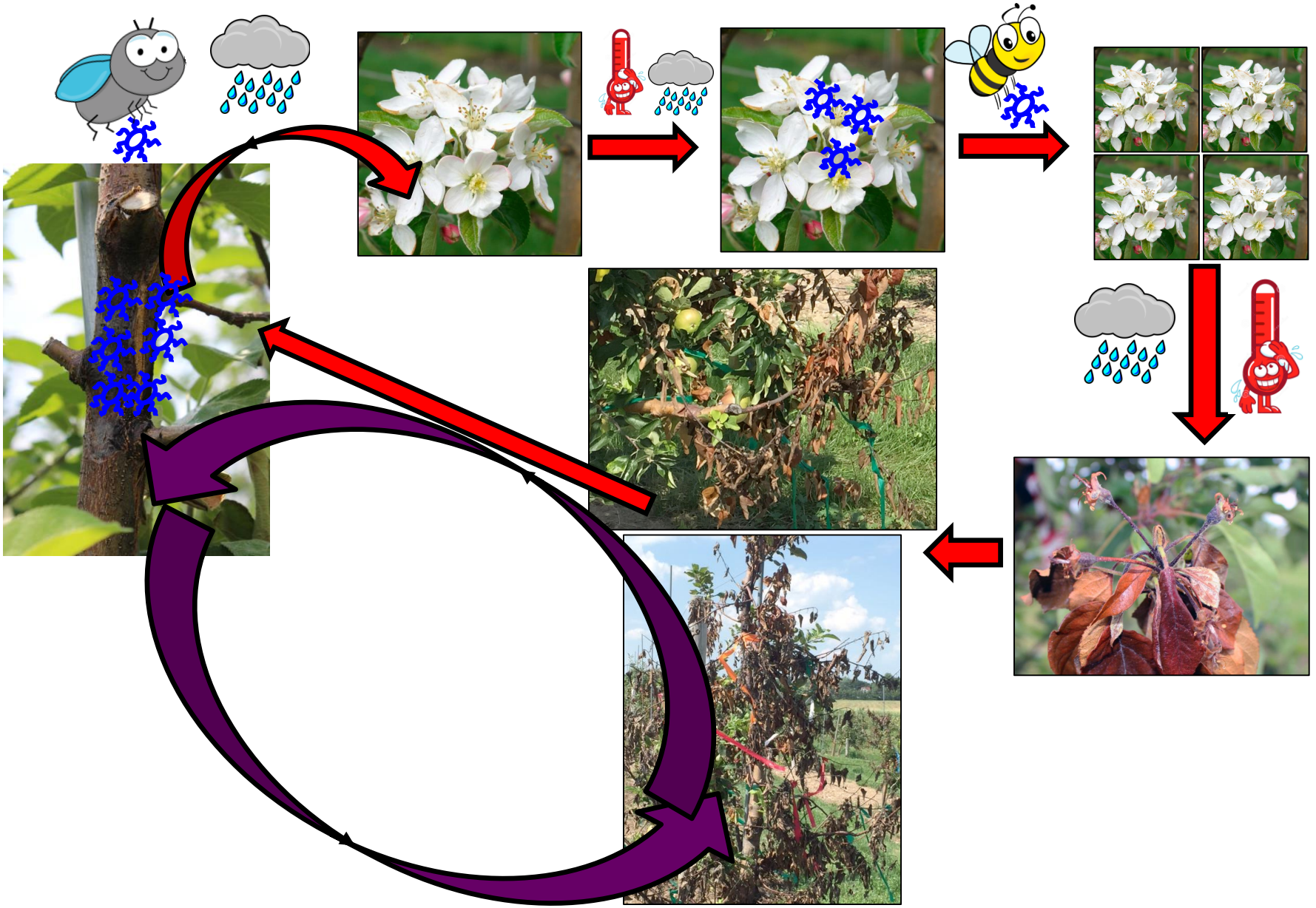
| MOA | TARGET SITE AND CODE | GROUP NAME | CHEMICAL GROUP | COMMON NAME | COMMENTS | FRAC CODE |
|---|---|---|---|---|---|---|
| ucleic acids synthesis | **A1**: RNA polymerase **I** | **PA** – fungicides (**P**henyl**A**mides) | acylalanines | benalaxyl<br>benalaxyl-M (=kiralaxyl)<br>furalaxyl<br>metalaxyl<br>metalaxyl-M (=mefenoxam) | Resistance and cross resistance well known in various Oomycetes but mechanism unknown.<br>**High risk.**<br>**See FRAC Phenylamide Guidelines for resistance management** | **4** |
| | | | oxazolidinones | oxadixyl | | |
| | | | butyrolactones | ofurace | | |
| | **A2**: adenosin-deaminase | hydroxy-(2-amino-) pyrimidines | hydroxy-(2-amino-) pyrimidines | bupirimate<br>dimethirimol<br>ethirimol | Medium risk Resistance and cross resistance known in powdery mildews. Resistance management required. | **8** |

- FRAC CODE: Distinguishes fungicide groups according to cross-resistance behavior

# Apple Diseases: Fire Blight

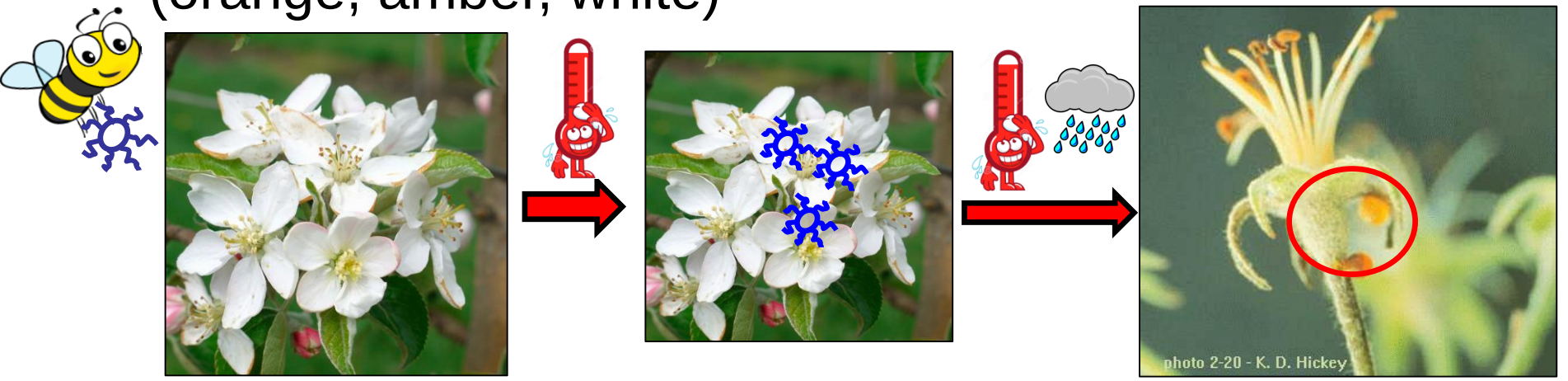
## Fire Blight: *Erwinia amylovora* (Bacteria)

# Bacteria in the Wood: Fire Blight



# Apple Diseases: Fire Blight

- Blossom blight
  - Petal fall: Darkening of petiole or base of flower, ooze (orange, amber, white)




  - Mummy or blight?

# Apple Diseases: Fire Blight

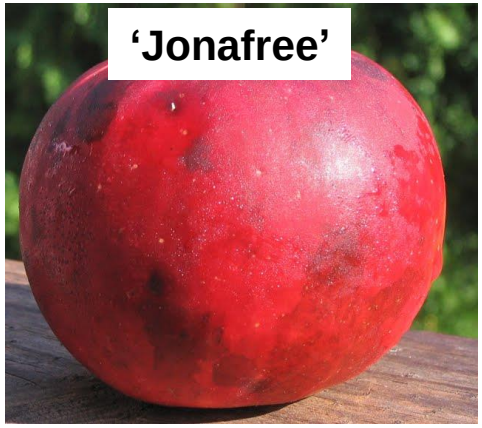
- Shoot blight
  - Symptoms: Shepherd's crook, blackening/necrosis of leaf mid-vein and pedicel
  - Reduces bearing wood for following season
  - Managed with prohexadione-calcium (Apogee)

# Apple Diseases: Fire Blight

- Canker Blight
  - Narrow, water soaked-zone in healthy tissue bordering cankers, ooze droplets in spring
  - Managed with high copper rate before green tip
- Rootstock Blight
  - Systemic infection of rootstock from blossom or shoot blight
  - Managed with resistant rootstocks
- Trauma Blight
  - Results from wounds caused by hail, wind, animals (deer)

# Fire Blight Management: All Orchards

- Cultural Control
  - Pruning cankers (wood with previous infections) at least 12 inches from infection margin
  - Prune during late winter (ideal), or aim to prune in later summer on dry day
  - Remove cut wood from tree area and destroy
- Plant resistant rootstocks and “resistant” cultivars

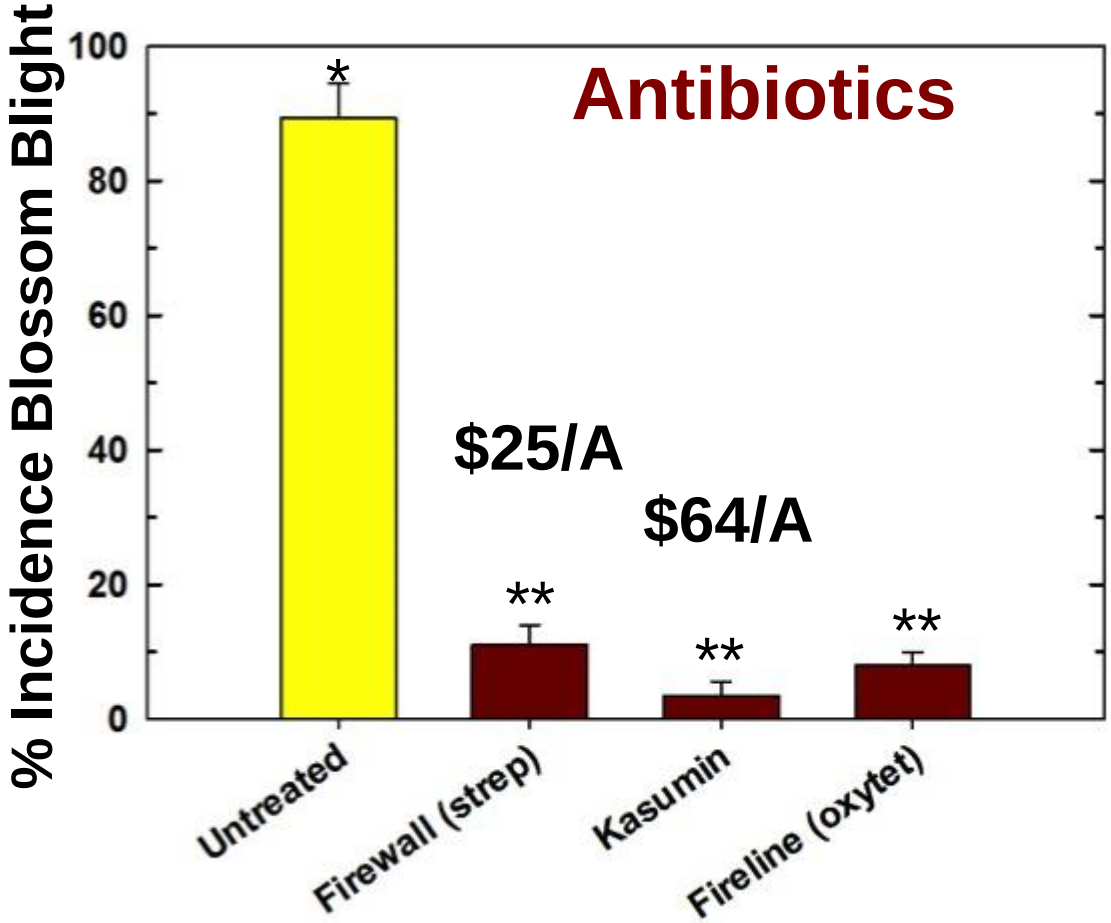




http://adamapples.blogspot.com/2011/10/jonafree.html

# Blossom Blight Management

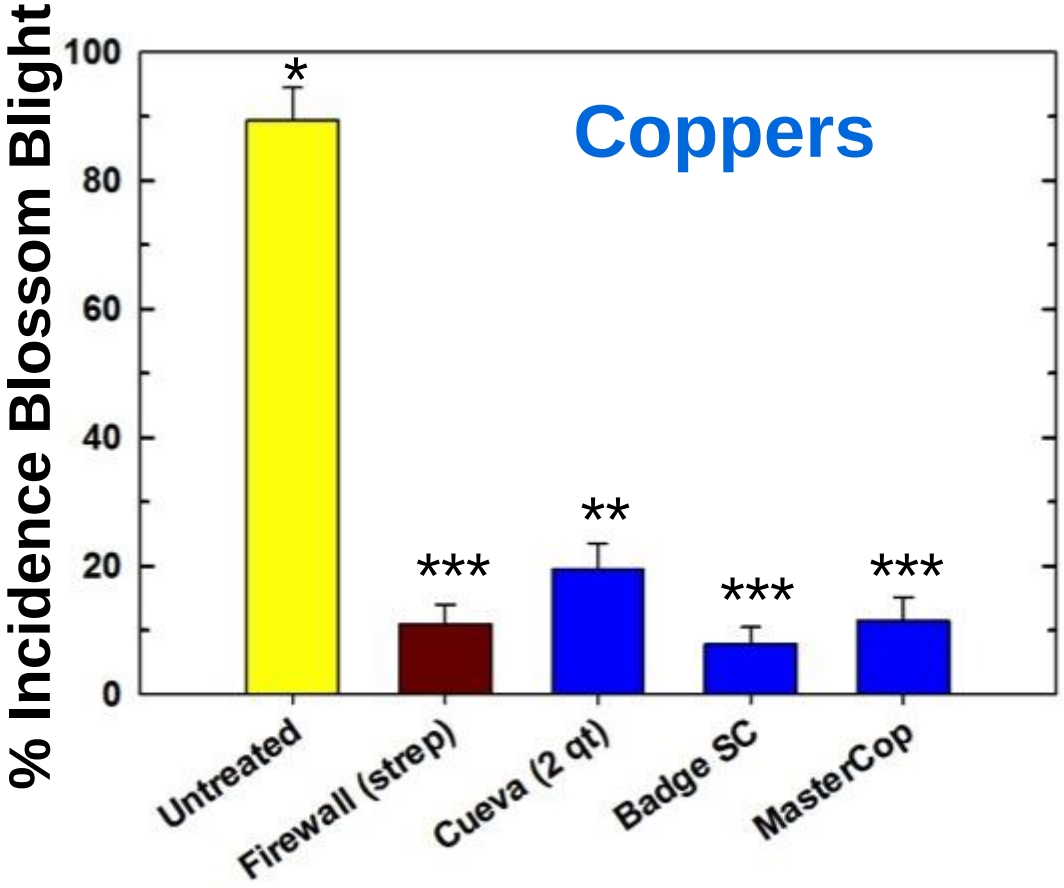
- Blossom blight application timing
  - Pre-bloom timings for biopesticides
  - All antibiotics & biopesticides @ 80% bloom
- Inoculation with *E. amylovora* after 80% BL application
- Blossom blight incidence: percentage of blighted blossoms (5 reps)

# Blossom Blight Management: Commercial Orchards



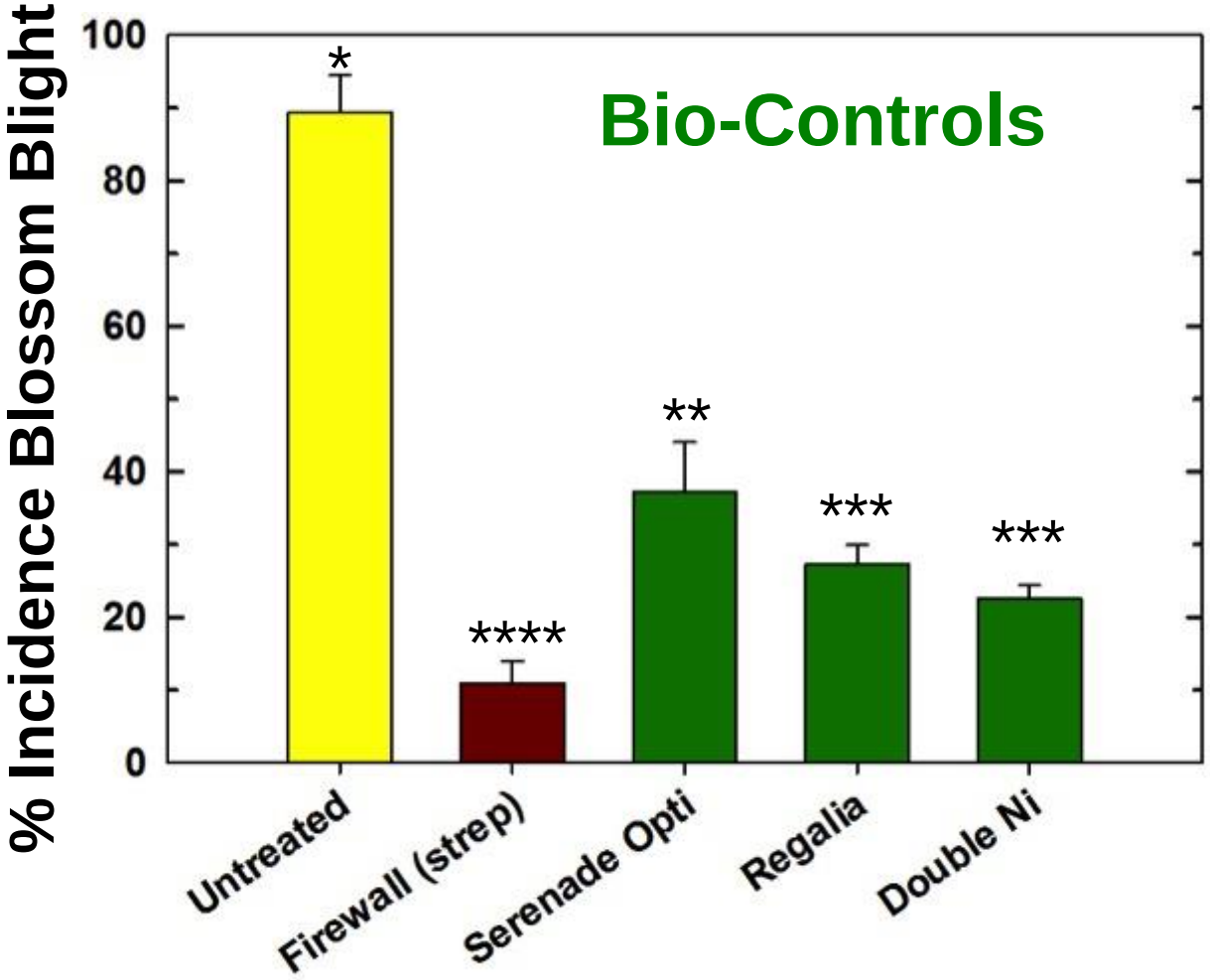

- Inoculum pressure higher than commercial orchards
- Preserve streptomycin efficacy!

# Blossom Blight Management: Commercial Orchards




- Badge SC, Mastercop similar to strep (not consistent)
- Injury when applied during early shoot development

# Blossom Blight Management: Commercial Orchards




- Bio-controls significantly lowered blossom blight incidence-low pressure orchards? Risk?

# Fire Blight Management in Home Orchards

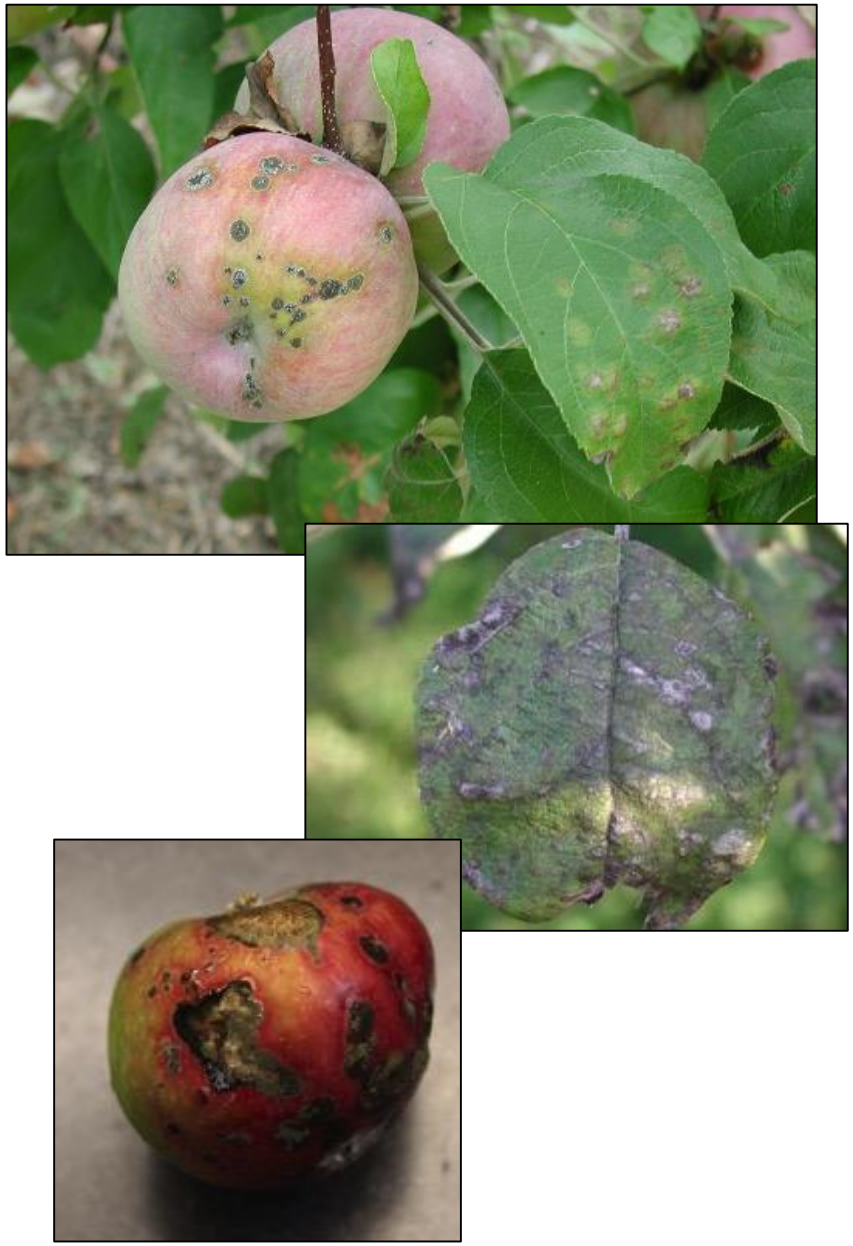
- Chemical Management
  - Late Dormant to Green Tip: Copper

  - Bloom: Models + Streptomycin (Agri-strep) OR Copper + Mancozeb

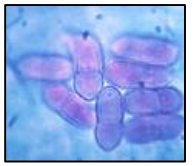
  - Petal Fall (shoot blight control): Copper (phytotox. concern)

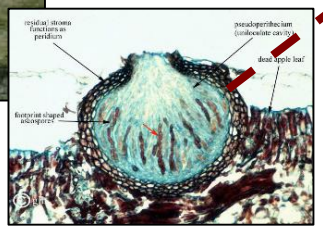
# Apple Diseases: Apple Scab

- **Apple Scab**
  - Early: Causes lesions on leaves and fruit
  - Late: Premature defoliation, fruit cracking
  - Cool, humid spring climate + highly susceptible cultivars: favorable infection conditions
  - Management: Green Tissue through 1st cover (primary infection, then scout)



# Apple scab management in NY

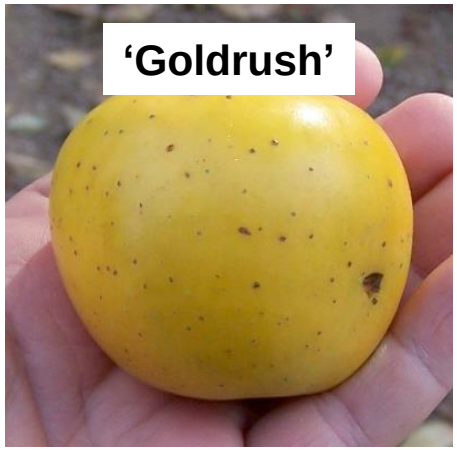


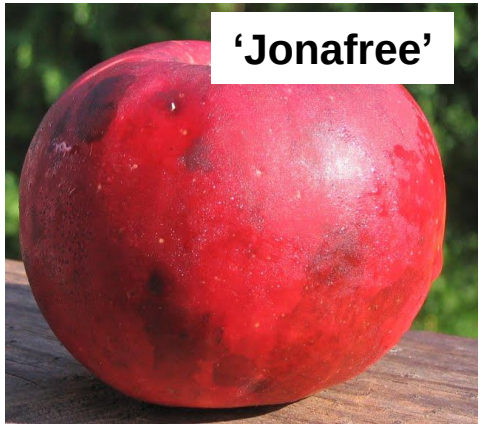


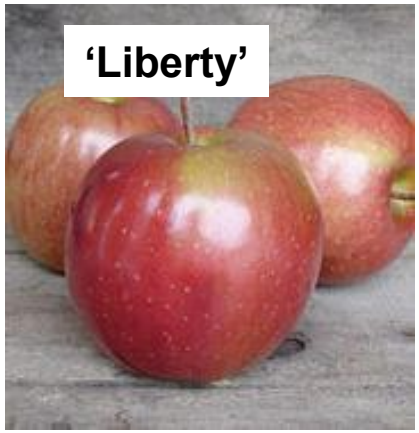

# Apple Scab Management in Home + Commercial Orchards

- Cultural Control/Sanitation
  - Horticultural practices that promote fast drying conditions
  - Mulch/flail mow leaves in autumn, remove all leaf liter, urea application

- Plant resistant cultivars (25+ available)



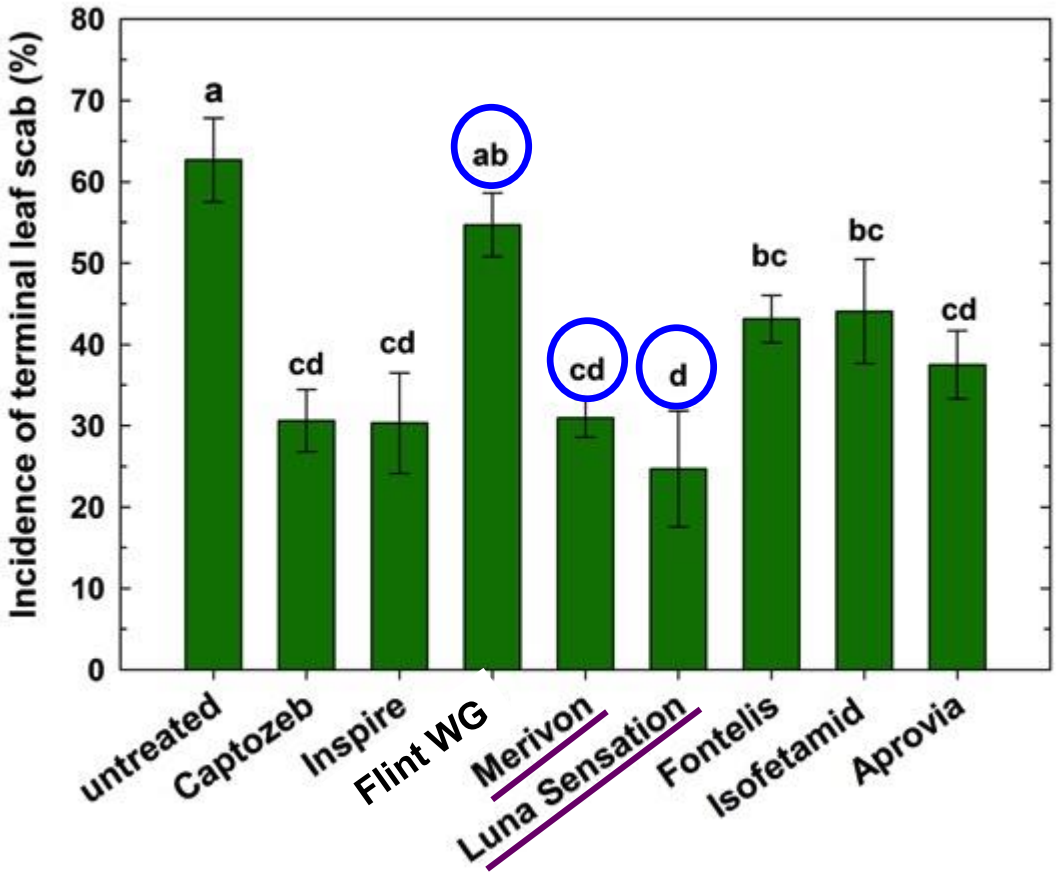





http://www.hebofrut.com/wp-content/uploads/2014/11/Modi-mittel.jpg

# Apple Scab Management: Commercial

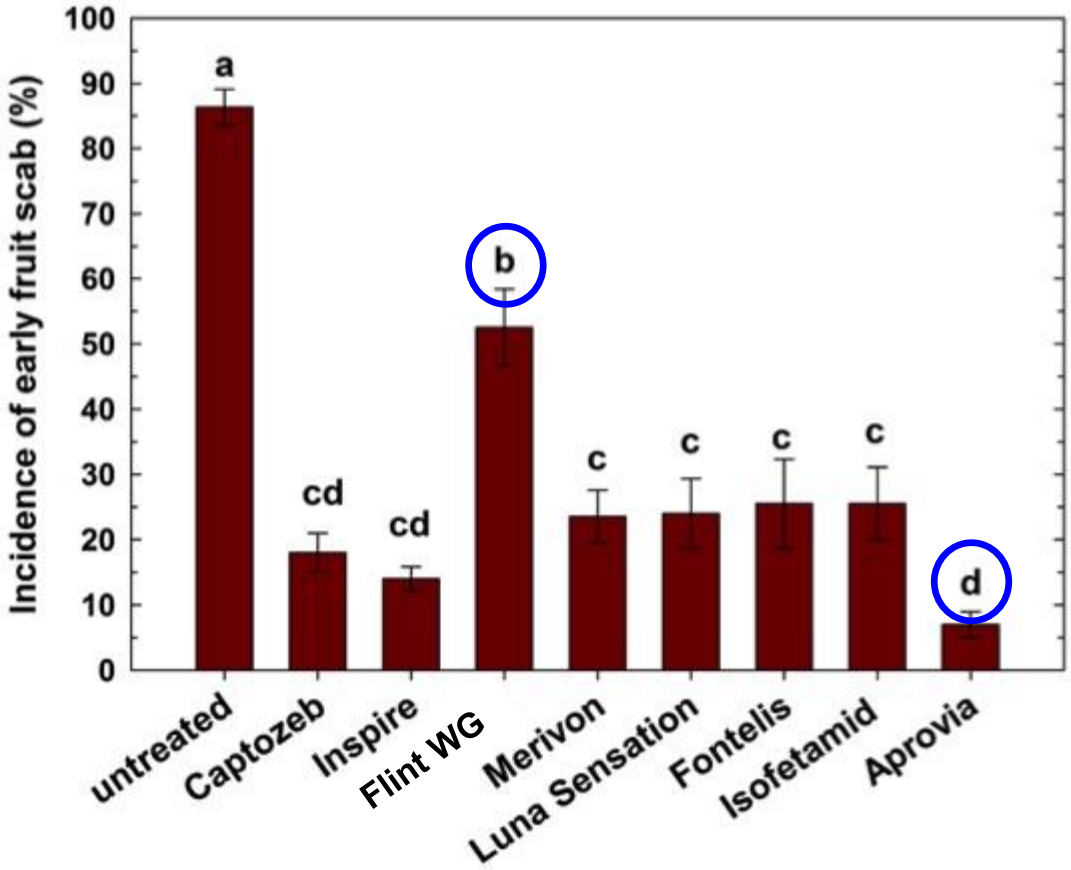
## Fungicide Performance: Terminal Leaves




- High disease pressure in orchard: Resistance apparent
- SDHI/QoI premix products: lower incidence of apple scab on leaf terminals

# Apple Scab Management: Commercial

## Fungicide Performance: Mature Fruit




- No difference in apple scab incidence on fruit between stand alone SDHI and SDHI/QoI premix in most cases
  - Aprovia exception

# Apple Scab Management in Home Orchards

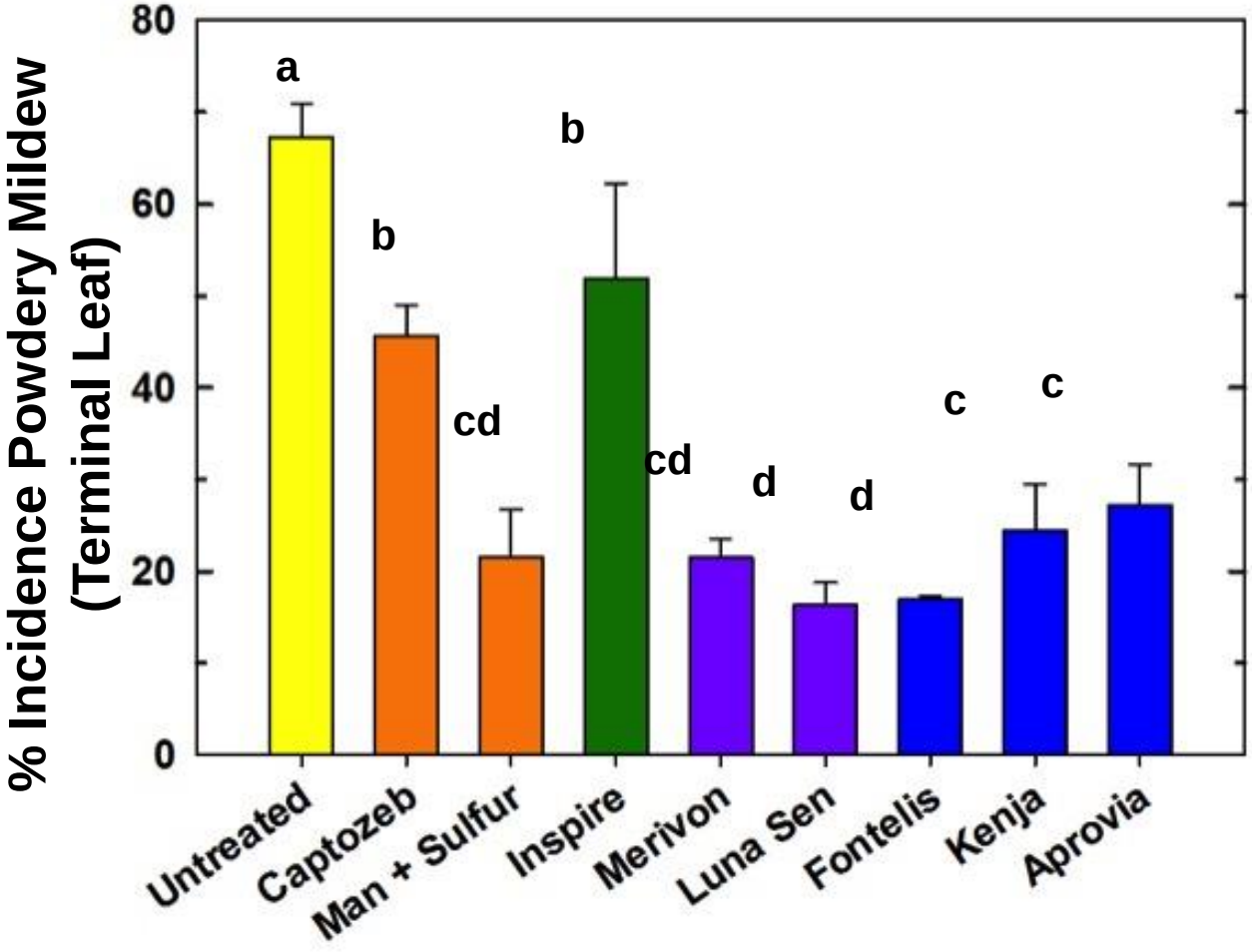
- Chemical Control
  - Necessary for scab management on susceptible cultivars
  - For homeowners: most available fungicides are protectants
    - 7 to 14 day fungicide application interval: less if rain

| Multi-site Protectants | Single-site Fungicides | Biologicals |
|---|---|---|
| **Mancozeb** | **Group 3: Myclobutanil (Immunox)** | |
| **Captan 50 WP** | **Group 1: T-Methyl (3336 WSP): Resistance!** | |
| **Copper** | | |
| **Wettable Sulfur** | | |

# Apple Diseases: Powdery Mildew

- **Powdery Mildew**
  - Infection favored by warm, humid to dry periods during spring and summer
  - Silvery, malformed shoots with white spores; netlike russeting on fruit
  - Fungi causing mildew on other plants not same apple powdery mildew pathogen
  - Management: Fungicides: Tight cluster through 2nd cover then scout

# Powdery Mildew Management: Commercial




- 2015: High disease pressure: Aprovia best on scab, worst SDHI on mildew

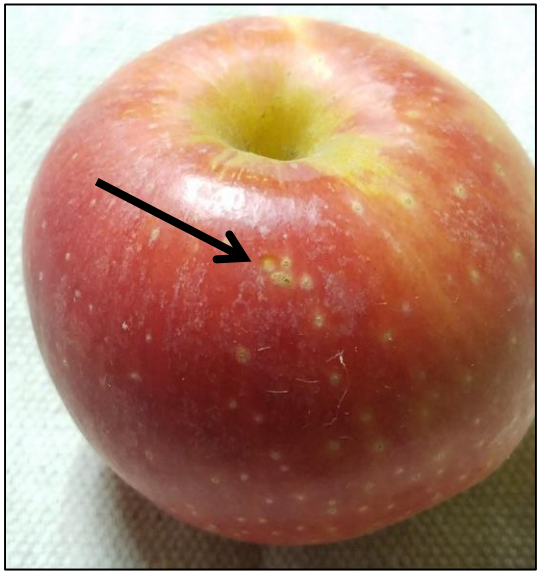
# Apple Diseases: Cedar Apple Rust

- **Cedar Apple and Quince Rust**
  - Two hosts needed: cedar and pome (i.e. apple)

- Management: Alternate host removal, sanitation of galls, fungicides (myclobutanil or other FRAC 3 (DMI) and mancozeb pink bud  to 10 days after petal fall)

# Glomerella Leaf Spot and Fruit Rot

***Not your typical bitter rot of apple……..***

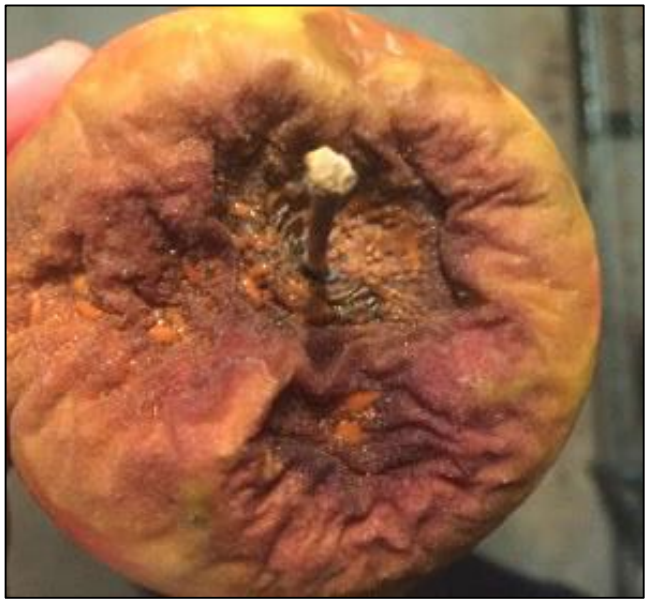


# Glomerella Leaf Spot and Fruit Rot

***Not your typical bitter rot:***

- Species:
  - Primarily *Colletotrichum gloeosporoides* species complex (*G. cingulata*, *C. gloeosporoides, C. fructicola*) in S.E. U.S.
- Leaf symptoms: Concentric leaf spots, chlorosis, premature defoliation
- Sporulation on apple:Very uncommon to non-existent
- Cultivars: Golden Del., Gala, Pink Lady, Granny, ??

# Apple Diseases: Bitter Rot



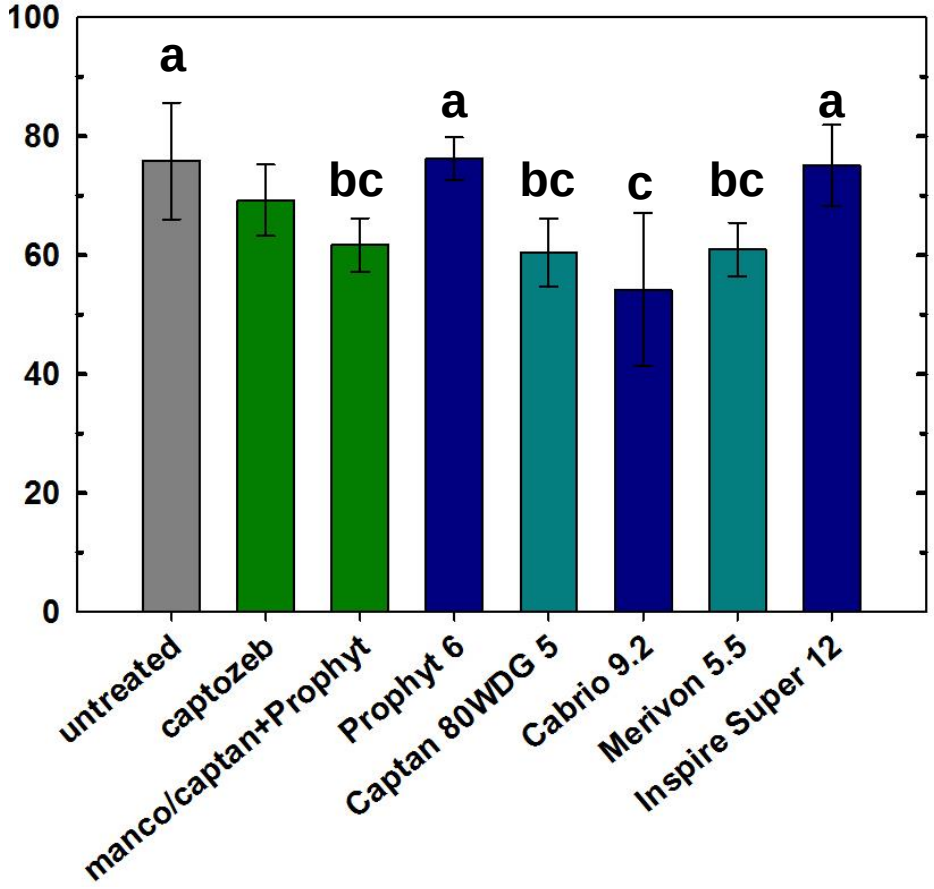
- Scouting: Orange/salmon colored spores in concentric ring
  - Yellow skinned cultivar: Red ring around lesion
  - “V” rot in flesh
- Affected cultivars: Most! Even ‘Rome Beauty’ and ‘Red Delicious’ (“moderately resistant”)

# Bitter Rot/Glomerella Management in Home Orchards

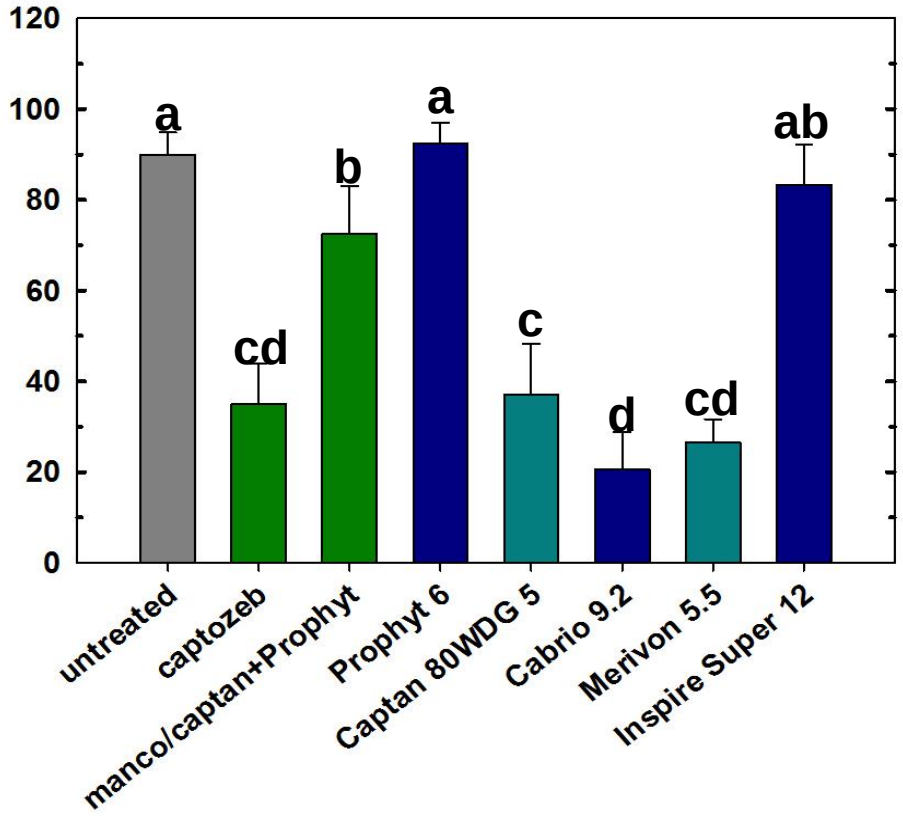
- Cultural/Sanitation
  - Open canopy to encourage air movement and rapid drying
  - Mummy and canker removal

- Chemical Control
  - Mancozeb (until bloom)
  - Captan and/or thiophanate methyl (3336 WSP): 10 days after petal fall until harvest (14 day interval)

# Bitter Rot/Glomerella Management in Commercial Orchards




rAUDPC: Leaf spots




Harvest: Fruit Spots + Rots

# Apple Diseases: The Summer Rots

## *White Rot/ Black Rot*

- Scouting: Tiny red/brown spots around fruit lenticels
  - Turgid fruit
  - Red-skinned cultivars: Bleached appearance; Yellow-skinned: Red halo around lesion
  - Symptoms not apparent until 4-6 weeks before harvest

# Any Questions?

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