Fruit Disease Management

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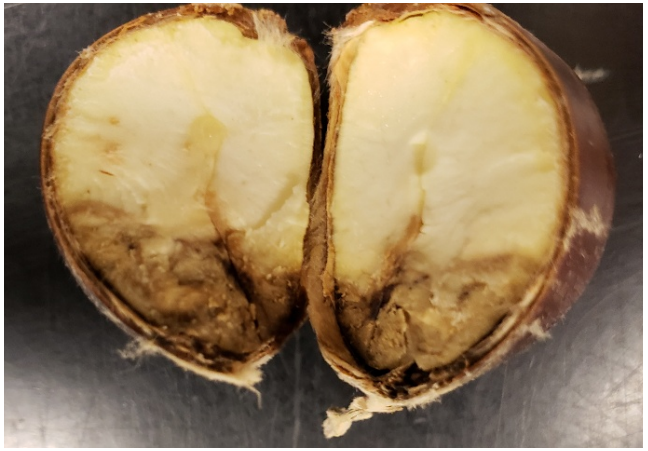
Fruit Pathology at The Ohio State University




Small fruit, tree fruit and hops

Fruit Pathology at The Ohio State University



Nuts, pawpaw, banana?

Fruit Diagnostic Laboratory

u.osu.edu/fruitpathology/

Other Fruit Disease Resources

u.osu.edu/fruitpathology/

Applied Research Program

- Development of sustainable disease management programs
  - Grapes, apples, hops, strawberries
- Evaluation of new technologies for managing diseases
- Assessing antimicrobial resistance in the environment
  - Apple, tomato
- Development of strategies to mitigate food safety hazards in hydroponic systems
  - Leafy greens and herbs

Integrated Pest Management for Fruit Crops

- Plant resistant varieties
- Plant top quality, healthy nursery stock
  - Certification programs (i.e. G1 stock for virus-tested material)
- Maintain a clean planting site
  - Remove alternate hosts
- Use biocontrol
- Fungicide spray programs

Strawberries

Disease Management Practices

- Practices will vary depending on the type of system

Annual Production System

- Plant in the fall on plastic
- Cover in mid-fall
- (Harvest in late fall)
- Harvest in the spring and summer
- Till under after harvest

Disease Management Practices

- Practices will vary depending on the type of system

Matted Row Production System

- Plant in early spring on plastic or bare ground
- Remove first season flowers
- Cover in the fall
- Harvest in the late spring and early summer
- Renovate after harvest
- Cover in fall

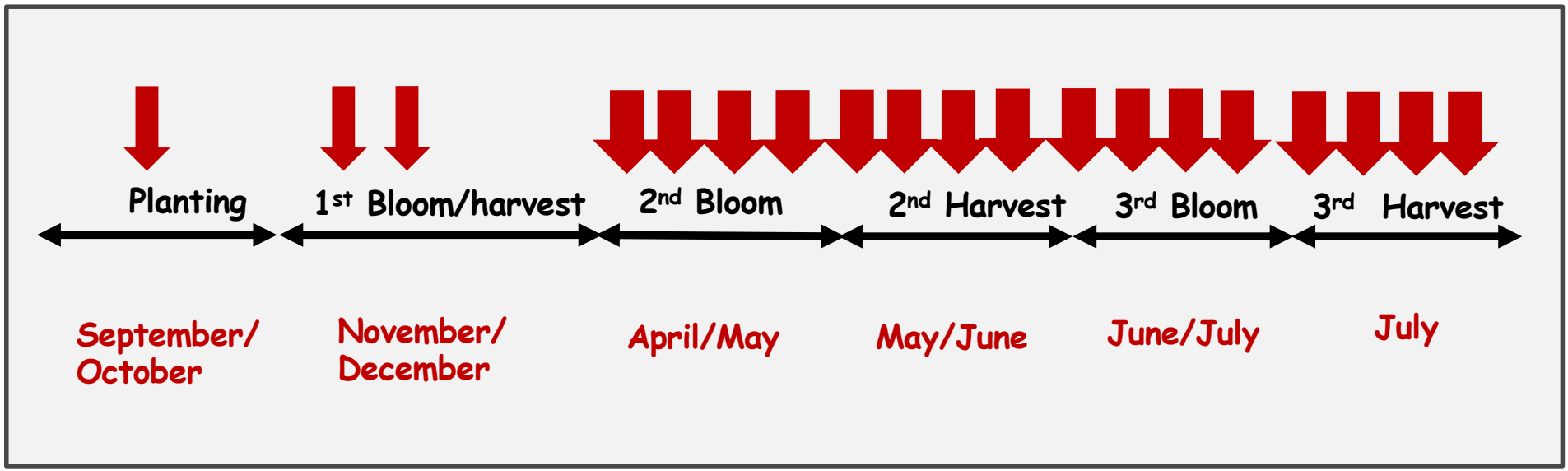
Cultural and Sanitation Practices

- Follow crop rotations
- Use clean straw
- Use clean irrigation water (especially for overhead applications)
- Avoid standing water
- Avoid harvesting when fruit are wet
- Keep weeds under control

Fungicide Spray Program for Strawberries

Developmental Stage	Disease
Pre-plant or early post-plant	Colletotrichum crown rot Phytophthora crown rot Red Stele Pythium root rot
New leaf growth to pre-bloom	Botrytis crown rot Leaf spots Powdery mildew Red Stele
Early bloom to pre-harvest	Anthracnose fruit rot Botrytis Leather Rot

Seasonal Fungicide Spray Program for Annual Strawberry Production Disease Control



Up to 19 fungicide applications in a single season!

Pre-Plant Disease Management

- Plant healthy, certified “pathogen-free” stock
  - 13 viruses
  - Phytoplasma diseases
  - Angular (Xanthomonas) leaf spot
  - Strawberry Crimp Nematode
  - Red Stele Root Rot

Strawberry mild yellow edge virus

Angular leaf spot

Images courtesy of F. Louws, NC State

Pre-plant Disease Management

- **Pre-plant Dips**
  - Bare roots only (other wise use a drench)
  - Plant immediately after dipping
  - Anthracnose crown rot:
    - Abound and others
    - Switch
  - Phytophthora crown rot, Red Stele, and Pythium root rot:
    - Aliette
    - Phosphorous acid (i.e. Phostrol, ProPhyt)

Anthracnose lesions on runners

Strawberry Disease Management

Phytophthora crown and root rot and red stele:

- Perennial-one application in the spring and one post-harvest
- Annual- one application at planting

- Aliette
- Phosphorous acid (i.e. Phostrol, ProPhyt)
- Ridomil Gold and others

Strawberry Disease Management

Colletotrichum crown rot:

- More severe in warmer parts of Ohio
- Common in second year plasticulture plantings
- One or two applications in the spring
  - Switch
  - Captan
  - Topsin M

•*Save strobilurins (FRAC11) for anthracnose fruit rot*

Strawberry Fruit Rots

Anthracnose fruit rot:

- Resistance management is critical
- Screening populations is recommended
- Strobilurins are the most effective but fungicide resistance is a concern
  - Abound and others
  - Cabrio and others

- Switch, Pristine, Kenja, Captan

Remember the two spray rule!

Strawberry Fruit Rots

Botrytis:

- Resistance management critical
- Screening populations is recommended

- Switch, Elevate, Fontelis, CaptEvate, Luna Sensation, Luna Tranquility

- Combine with a protectant to slow resistance (i.e. Captan, Captec)

Remember the two spray rule!

Brambles (Cane Fruit)

Cultural Practices

- Practices that promote good air flow through the patch
  - Pruning, plant spacing, weed control
- Avoid standing water
- Avoid harvesting when fruit are wet
- Remove wild brambles

Pre-plant Disease Management- Resistance

Disease	Blackberry	Red Raspberry	Black Raspberry
Anthracnose	VS*	S	T
Cane blight	S	S	VS
Spur blight	Non-host	S	T
Crown gall	S	S	S
Septoria leaf spot	S	T	T
Rosette	VS	R	R
Orange Rust	S to R	Non-host	S
Leaf and cane Rust	S	R	R
Powdery mildew	T to R	S	S

*thorny>thornless; erect>trailing

Pre-Plant Disease Management

- Plant healthy, certified “pathogen-free” stock
  - Raspberry- 18 viruses
  - Blackberry- 14 viruses
  - Phytoplasma diseases
  - Crown gall
  - *Xylella fastidiosa*

Crown gall of raspberry

Raspberry bushy dwarf virus

Images courtesy of OMAFRA

Seasonal Spray Program for Brambles

Developmental Stage	Diseases
Dormant	Anthracnose, Cane blight, Spur blight
Before bloom opens/pre-bloom	Anthracnose, Blights, Leaf spots, Powdery mildew, Rusts, Root rot
Bloom through harvest	Anthracnose, Blights, Leaf spots, Rusts, Botrytis, Double blossom
Post harvest	Cane blight, Leaf spots, Orange cane blotch

Bramble Diseases

Phytophthora root rot:

- Mefenoxam or metaxyl (i.e. Ridomol Gold, Orondis)
- Phosphorous acid based products
  - Requires pH ≥6 otherwise phytotoxicity can occur

Bramble Diseases

Rusts and fungal leaf spots

- *Orange Rust*-spring applications before pustules burst
  - Rally, Pristine, Cabrio
- *Leaf spots*-preventative applications
  - Abound and others, Cabrio, Pristine, Quilt Xcel or Cover XL, Tanos, Tilt and others, Captan
- Powdery mildew-preventative applications
  - Luna Tranquility, Prolivo, Rally

Orange rust on brambles

Raspberry leaf spot

Bramble Diseases

Blackberry downy mildew

- First reported last year in Ohio
- Systemic disease
- Nearly all varieties are susceptible
- Causes stunting, leaf spots and dry berries
- potassium phosphite applications
  - Begin applications when symptoms first appear on the leaves

Cane and Stem Blight Diseases

Cane blight

Anthracnose (raspberries only)

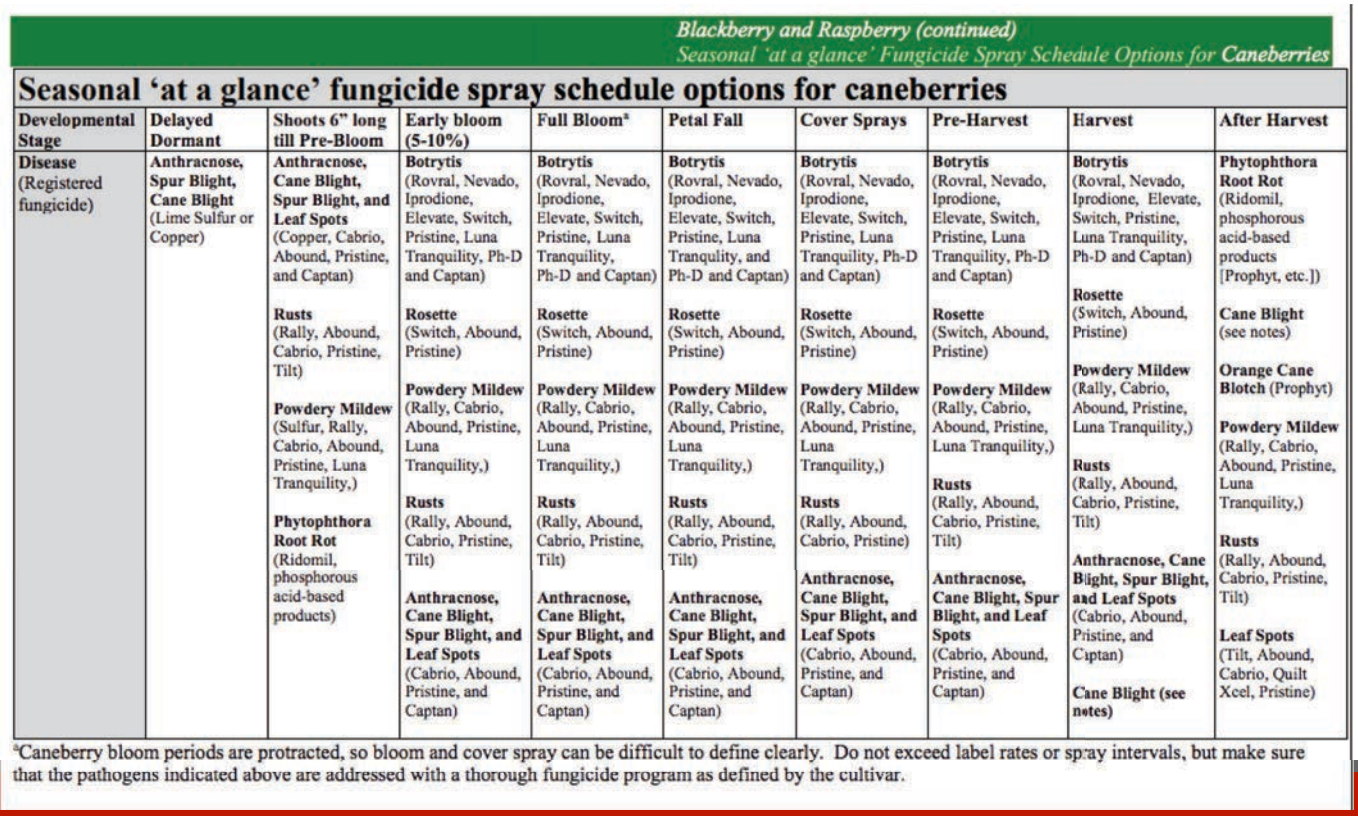
Spur blight on raspberry (black and red raspberries only)

Cane and Stem Blight Management

Cane blight, spur blight and anthracnose

- Prune out damaged flori- and primocanes after canes go dormant
- Balanced fertility (nitrogen)
- Remove wild brambles
- Dormant season application of Sulforix
- Fungicides during the season shouldn’t be needed if above practices are done
  - strobilurins>captan>copper

At a glance fungicide spray schedule



Blackberry and Raspberry (continued)
Seasonal 'at a glance' Fungicide Spray Schedule Options for ***Caneberries***

Seasonal 'at a glance' fungicide spray schedule options for caneberries

Developmental Stage	Delayed Dormant	Shoots 6" long till Pre-Bloom	Early bloom (5-10%)	Full Bloom[a]	Petal Fall	Cover Sprays	Pre-Harvest	Harvest	After Harvest
Disease (Registered fungicide)	**Anthracnose, Spur Blight, Cane Blight** (Lime Sulfur or Copper)	**Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Copper, Cabrio, Abound, Pristine, and Captan) **Rusts** (Rally, Abound, Cabrio, Pristine, Tilt) **Powdery Mildew** (Sulfur, Rally, Cabrio, Abound, Pristine, Luna Tranquility,) **Phytophthora Root Rot** (Ridomil, phosphorous acid-based products)	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine, Luna Tranquility,) **Rusts** (Rally, Abound, Cabrio, Pristine, Tilt) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan)	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine, Luna Tranquility,) **Rusts** (Rally, Abound, Cabrio, Pristine, Tilt) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan)	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine, Luna Tranqulity, and Ph-D and Captan) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine, Luna Tranquility,) **Rusts** (Rally, Abound, Cabrio, Pristine, Tilt) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan)	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine, Luna Tranquility,) **Rusts** (Rally, Abound, Cabrio, Pristine) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan)	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine, Luna Tranquility,) **Rusts** (Rally, Abound, Cabrio, Pristine, Tilt) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan) **Cane Blight (see notes)**	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine, Luna Tranquility,) **Rusts** (Rally, Abound, Cabrio, Pristine, Tilt) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan) **Cane Blight (see notes)**	**Phytophthora Root Rot** (Ridomil, phosphorous acid-based products [Prophyt, etc.]) **Cane Blight** (see notes) **Orange Cane Blotch** (Prophyt) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine, Luna Tranquility,) **Rusts** (Rally, Abound, Cabrio, Pristine, Tilt) **Leaf Spots** (Tilt, Abound, Cabrio, Quilt Xcel, Pristine)

[a]Caneberry bloom periods are protracted, so bloom and cover spray can be difficult to define clearly. Do not exceed label rates or spray intervals, but make sure that the pathogens indicated above are addressed with a thorough fungicide program as defined by the cultivar.

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Blueberries

Cultural Practices

- Plant on raised beds
- Practices that promote good air flow through the planting
  - Pruning, plant spacing, weed control
- Use clean irrigation water
- Use clean mulch
- Avoid standing water
- Avoid harvesting when fruit are wet

Disease Resistance: Blueberry

Cultivar	Mummy berry	Phomopsis twig blight	Anthracnose
Bluecrop	MR	?	S
Bluejay	R	S	S
Bluetta	S	R	S
Elliott	S	R	MR
Northblue	R	?	S
Spartan	MR	?	S

Blueberry Spray Program

Developmental Stage	Disease
Dormant	Phytophthora Root Rot
Pre-bloom to green tip and pink bud	Mummy berry, Phomopsis twig blight
10% to 90% bloom	Botrytis Flower blight, Mummy berry, Fruit rots
Petal fall to 1 month following bloom	Fruit rots, Phytophthora Root Rot
Cover sprays	Fruit rots
After harvest	Leaf spots, Phytophthora Root Rot

Blueberry Diseases

Phomopsis twig blight

- Dormant season pruning
- Apply sulforix after leaf buds begin to break
- Begin spray program at ¼ inch green tip
  - Indar + Captan
  - Quash
  - Ziram
  - Omega

- Apply captan after harvest until leaf drop for cankers

Blueberry Diseases

Mummy berry

- Berry removal for small farms
- Early spring cultivation to bury berries
- Apply fungicides pre-bloom until all flowers have dropped
  - Many of the same fungicides that are used for Phomopsis

Blueberry Diseases

Anthracnose (Ripe rot)

- Berry removal for small farms
- Early spring cultivation to bury berries
- Apply fungicides pre-bloom until all flowers have dropped
  - Many of the same fungicides that are used for Phomopsis

At a glance fungicide spray schedule

Seasonal 'at a glance' fungicidal spray schedule options for blueberry

Developmental Stage	Late Dormant	Green tip	Bloom (2-3 applications)[b]	Petal Fall	10-14 Days after Petal Fall	20-24 Days after Petal Fall	Pre-Harvest[e]	After Harvest Foliage Management
Disease Controlled (Fungicides)	Exobasidium (lime sulfur [NC])[a]	Mummy Berry (Pristine [11+7] or Indar [3] or Orbit or Tilt or Bumper or PropiMax or Quash [3] or Proline [3]) Twig blight (Pristine [11+7] or Indar) [3] If Exobasidium has been a problem, add Captan [M4]	Mummy Berry and Twig blight (Pristine [11+7] or Indar[c] [3] + Captan [M4] or Orbit or Tilt or Bumper or PropiMax or Quash[3] or Quilt Xcel [3+11] or Proline [3]) For serious Botrytis problems, add (CaptEvate [17+M4] or Elevate [17] or Pristine [11+7] or Switch [9+12]) If Alternaria and Ripe Rot have been a problem, add (Abound [11] or Pristine [11+7] or Switch [9+12]) or Omega [29][d] If Exobasidium has been a problem, add Captan [M4]	Alternaria and Ripe Rots (Abound [11] or Pristine [11+7] or Switch [9+12]) or Captan [M4] or Omega [29] or Quilt Xcel [3+11]) If Exobasidium has been a problem, add Captan [M4]	Alternaria and Ripe Rots (Abound [11] or Pristine [11+7] or Switch [9+12] or Captan [M4]) or Omega [29] or Quilt Xcel [3+11]) If Exobasidium has been a problem, add Captan [M4]	Alternaria and Ripe Rots (Abound [11] or Pristine [11+7] or Switch [9+12]) or Captan [M4]) or Omega [29] or Quilt Xcel [3+11]) If Exobasidium has been a problem, add Captan [M4]	Alternaria and Ripe Rots (Abound [11] or Pristine [11+7] or Switch [9+12]) or Captan [M4] or Omega [29] or Quilt Xcel [3+11]) Septoria Leaf Spot (Abound [11] or Aliette [33] or or Pristine [11+7] or Switch [9+12] or Quash [3]) or Quilt Xcel [3+11]) or Proline[3][f]	Septoria Leaf Spot (Abound [11] or Orbit or Tilt or Bumper or PropiMax or Quash [3] or AgriFos or Aliette or ProPhyt [33] or Bravo [M5] or Pristine [11+7] or Switch [9+12] or Indar[3]) or Quilt Xcel [3+11] or Proline [3]) Anthracnose (AgriFos or Aliette or ProPhyt [33] or Pristine [11+7]) or Quilt Xcel [3+11]) or Quash [3] Rust (Bravo [M5] or Orbit or Tilt or Bumper or PropiMax [3] or Pristine [11+7] or Indar or Quash [3] or Proline [3])[g]

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Product	Active ingredient	Frac
Abound	azoxystrobin	11
Aliette	Fosetyl-tris	33
Cabrio	pyraclostrobin	11
Captan	captan	M
CaptEvate	captan+ fenhexamid	M+17
Elevate	fenhexamid	17
Fontelis	penthiopyrad	7
Indar	fenuconazole	3
Kenja	isofetamid	7
Luna Sensation	fluopyram+ trifloxystrobin	7+11
Luna Tranquility	fluopyram+ pyrimethanil	7+9
Omega	fluazinam	29

Product	Active ingredient	Frac
Phostrol	phosphorous acid	33
Pristine	boscalid+ pyraclostrobin	7+11
Prolivo	pyriofenone	U8
Rally	myclobutanil	3
Ridomil	mefenoxam	4
Quash	metaconazole	3
Quilt Xcel	azoxystrobin+ propiconazole	11+3
Switch	cyprodinil + fludioxonil	9+12
Tanos	famoxadone+ cymoxanil	11+27
Tilt	propiconazole	3
Topsin M	thiophanate	1

Apples

Disease Resistance: Apple Cultivars

Cultivar	Apple Rust	Fire Blight	Scab
Cortland	S	S	S
Liberty	R	R	R
Fujii	R	S	S
Gala	R	S	S
Honey Crisp	S	R	MR
Baldwin	R	S	S
Crimson Crisp	S	R	R
Freedom	R	MR	R

Seasonal Spray Program for Apples

Developmental Stage	Diseases
Delayed dormant to ½ in green tip	Primary (1°) Scab
Green tip, white bud	1° Scab
Tight cluster, pre-pink	1° Scab
Pink bud	1° Scab, PM, Apple rust, Fire blight
Bloom	1° Scab, PM, Apple rust, Fire blight
Petal fall	Scab, PM, Apple rust, Fire blight
First cover spray	Scab, PM, Apple rust, Fire blight,
Second cover spray	Scab, Fruit rots
Third through seventh cover sprays	Scab, Fruit rots, Sooty blotch, Fly speck

Cultural and Sanitation Practices

- Pruning and fruit thinning
- Removal of plant debris from the orchard
- Use clean irrigation water (high density plantings)
- Use clean mulch
- Avoid standing water

Early Season Diseases

Scab

Early Season Diseases

Cedar Apple Rust

Early Season Diseases

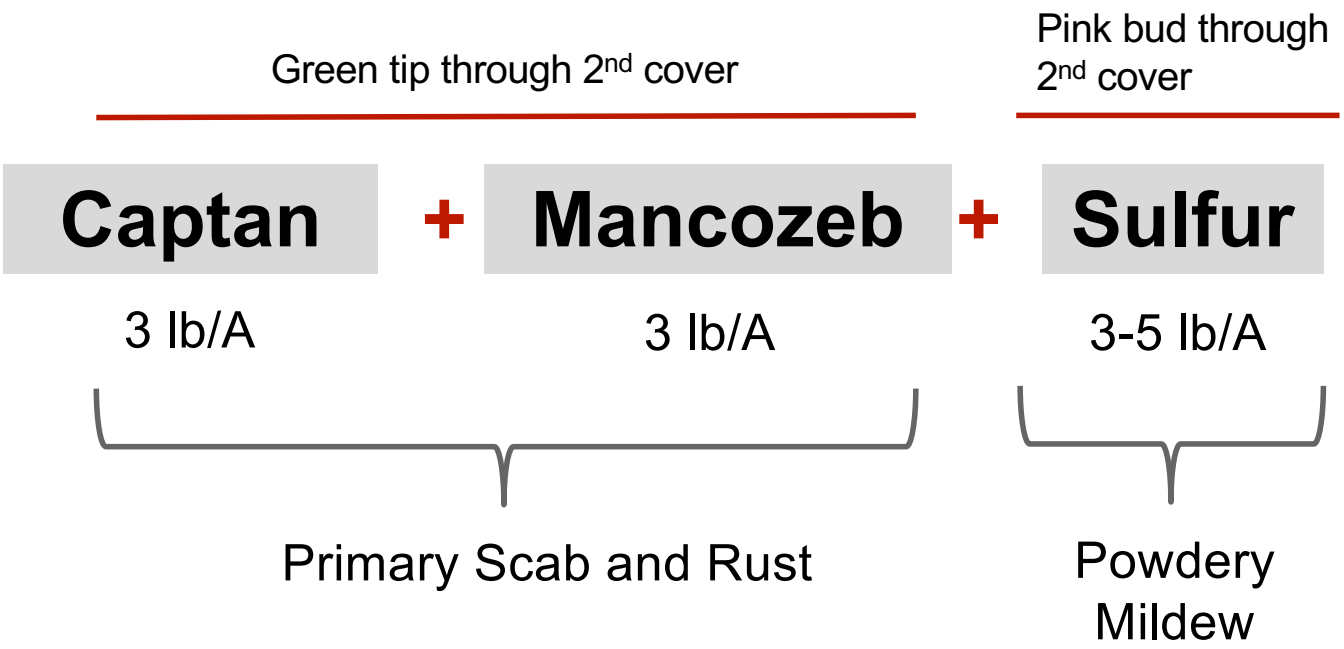
Powdery Mildew

Early Season Diseases: Fungicide Program

- Many highly effective fungicides on the market
- Monitoring and managing resistance is critical
- Two types of programs
  - Low Input
  - Intensive

Low Input Spray Program

- Protectant, contact fungicides



Intensive Spray Program

- Many highly effective fungicides on the market
  - Sterol inhibitors (SI or DMI)-systemic, curative activity (FRAC 3)
  - SDHI-partially systemic (FRAC 7)
- Combination products are becoming more common:
  - Inspire Super
  - Luna Series (Tranquility, Privilege and Sensation)
  - Pristine
  - Merivon
- Strategic use of strobilurins products:
  - Flint, Cabrio, Luna Sensation, Merivon

Intensive Spray Program

- Use as a protectant program
- Spray after 1 inch rain **OR** 7 days of new growth

Green tip through ½ in green — **2 sprays, 7 day intervals**

Captan	or	**Mancozeb**	or	**Scala**	or	**Vangard**
4-6 lb/A		4-6 lb/A		7-10 fl oz/A		5 oz/A

then

Open tight cluster to pink — 2 sprays, 7 day intervals

Flint 2-2.5 oz/A **or** **Sovran** 4-6 oz/A **or** **Pristine** 14.5-18.5 oz/A

OR

Fontelis 16-20 fl oz/A **or** **Inspire Super** 4-6.4 fl oz/A **or** **Luna Series** Check labels **or** **Merivon** 4-6.7 fl oz/A

+

Captan * 2-3 lb/A **or** **Mancozeb** * 2-3 lb/A **or** **Vangard** * 2.5 oz/A

then

* Half rates

Bloom to first cover — **2 sprays, 7 day intervals**

Rally 5-8 oz/A **or** **Inspire Super** 4-6.4 fl oz/A **or** **Indar** 6-8 fl oz/A

+

Captan 4-6 lb/A **or** **Mancozeb** 4-6 lb/A **or** **Vangard** 5 oz/A

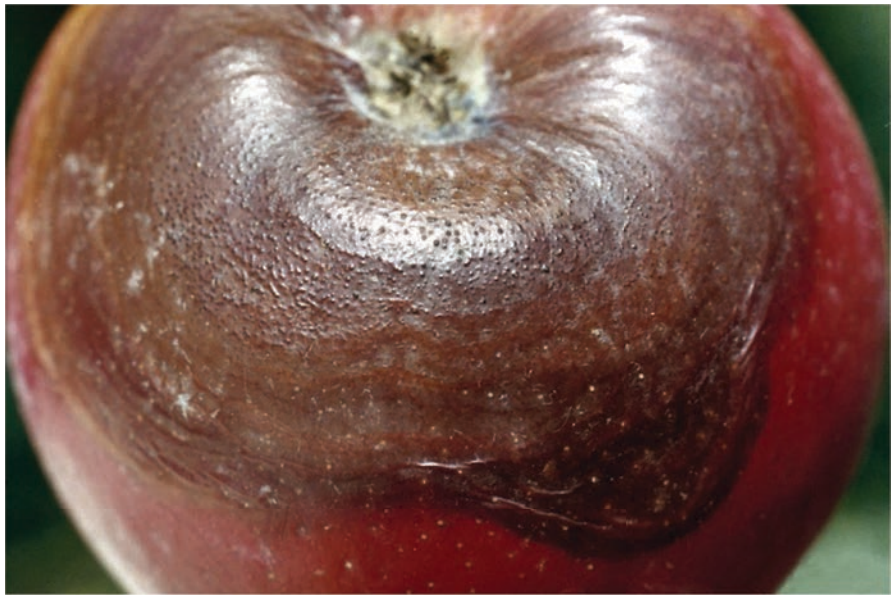
- End of primary scab infectious period and entering into summer rot control

Summer Fruit Rots

Bitter Rot

Summer Fruit Rots

Black Rot



Summer Fruit Rots

White Rot

N. Ward, UKAg Extension

Fungicide Spray Program for Summer Rots of Apple

- First cover through harvest
  - 7-10 days until third cover
  - 10-14 days through harvest

- Broad spectrum protectants most effective against summer rots
  - Captan (5 lb/A), Ziram (6 lb/A), Mancozeb (3 lb/A), Polyram (3 lb/A)

Apple and Pear

Fire Blight

Fire Blight Management for Apples and Pears

- **Canker phase**
  - Copper (dormant to pre-green tip)
  - Dormant season pruning

Fire Blight Management for Apples and Pears

- **Blossom and spur blight phase**
  - Antibiotics
  - Begin 7-10 after pink bud

Efficacy ↓

Antibiotic	Product	Rate
Streptomycin*	Streptomycin 17	1 lb/A
Kasugamycin (apples only)	Kasumin	64 fl oz/A
Oxytetracycline	Mycoshield FireLine	1 lb/100 gal/A

Streptomycin Resistance in Ohio

- 78% of the orchards sampled have resistant *Erwinia amylovora* populations
  - Resistance up to 2.5 ppm
- Resistance detected in non-*Erwinia* bacteria in the canopy

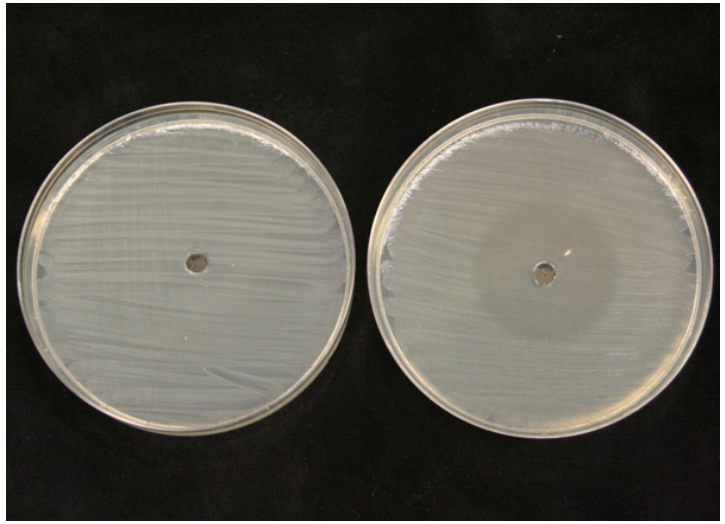


Image from *Plant Health Progress*

Fire Blight Management for Apples and Pears

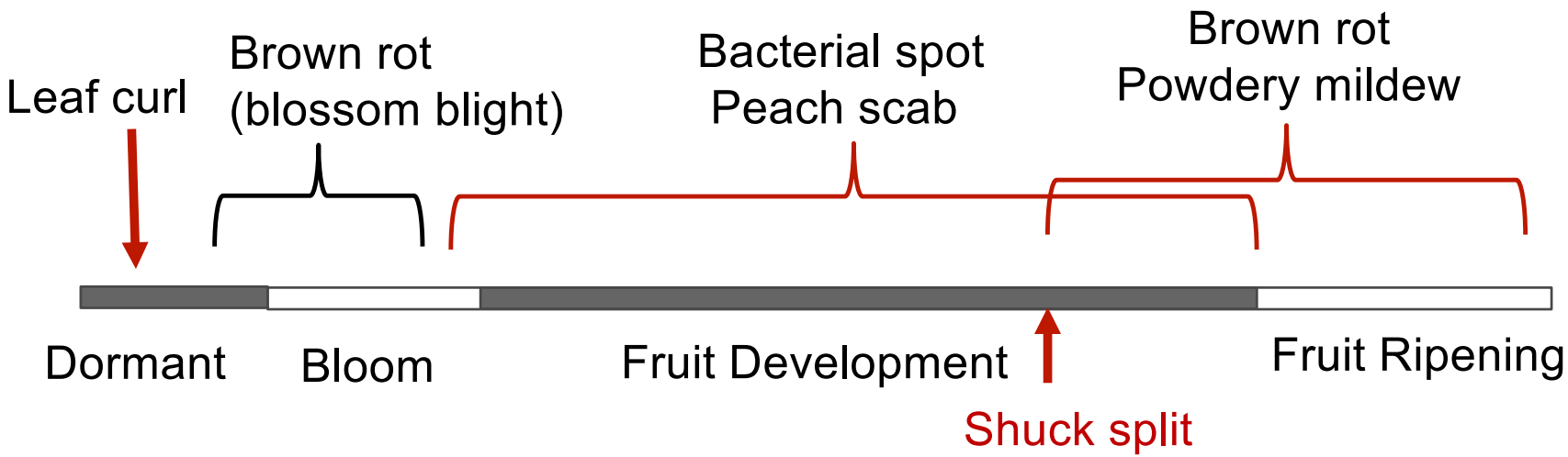
- **Shoot blight phase**
  - Plant growth regulator
    - Apogee/Kudos (6 oz/100gal)
  - Pruning
    - Incidence is low and outbreaks localized
    - Tool sterilization when accompanied by healthy pruning
  - Insecticides
    - Leaf hoppers, plant bugs, psylla

Peaches

Disease Resistance: Peach Cultivars

Cultivar	Bacterial Spot	Leaf Curl
Biscoe	R	-
Harken	MR	MR
Southhaven	R	-
Belle of Georgia	R	-
Carolina Gold	MR	-
Loring	R	-
Cherryred	R	-
Southern Pearl	R	-
Redhaven	MR	MR
Frost	S	R

Seasonal Spray Schematic for Peaches

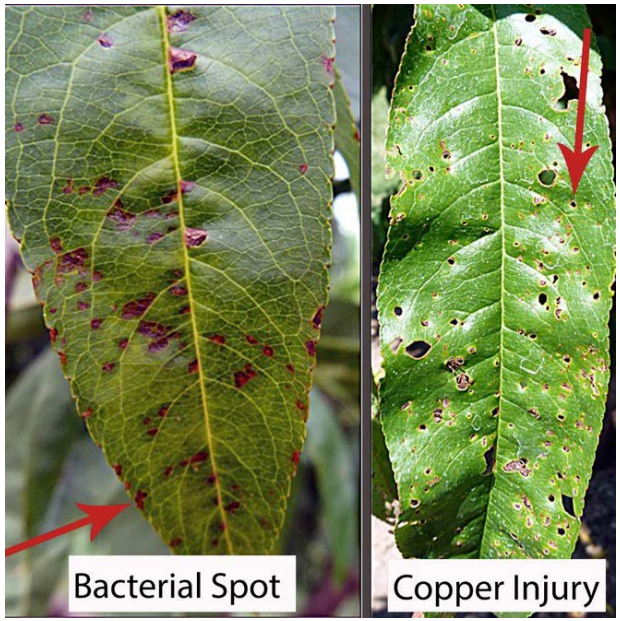


Peaches and Nectarines

Bacterial Spot

Bacterial Spot Management for Peaches and Nectarines

- Resistant varieties are your best bet!
- Copper
  - Dormant applications
  - Phytotoxicity can be a problem
- Antibiotics
  - Begin at petal fall
  - Oxytetracycline
    - Mycoshield (12 oz/A)
    - Fireline (12 oz/A)



K. Peter, PSU

Peaches and Nectarines

Leaf Curl

- Control
  - One well timed dormant application
  - Apply in autumn after 90% leaf drop OR before buds swell in the spring

  - Ferbam (4.5 lb/A) or
  - Chlorothalonil or
  - Copper (12-15.6 lb/A) or
  - Ziram (3.75-8 lb/A)

Peaches and Nectarines and Plums

Brown Rot

Peaches

Peach Scab

Fungicide Spray Program for Brown Rot and Peach Scab

- Many highly effective fungicides on the market
  - Sterol inhibitors (SI or DMI)-systemic, curative activity
  - SDHI-partially systemic
  - Strobilurins- partially systemic (translaminar)

- Combination products:
  - Inspire Super
  - Luna Series (Tranquility, Privilege and Sensation)
  - Pristine
  - Merivon

Fungicide Efficacy for Brown Rot and Peach Scab Control

Fungicide	FRAC Group	Brown Rot	Peach Scab
Adament	11+3	Excellent	Excellent
Bravo	M	No data	Good
Elevate	17	Excellent	Not registered
Fontelis	7	Excellent	Good
Inspire Super	3+9	Excellent	Good
Luna Sensation	7+11	Excellent	No data
Merivon Xemium	7+11	Excellent	Good
Pristine	11+7	Good	Good

- Indar, Procure, Rally, Rubigan (Vintage), Orbit, and Topsin M have reported isolates with resistance in the Midwest

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Ohio Fruit News

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Thank You!

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