Field Identification and Management Strategies of Common Diseases in Small Fruit Production

Patrick Byers
MU Extension – Greene County
University of Missouri
byerspl@missouri.edu
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Outline for Today’s Presentation

• Today’s presentation:
  – Principles of disease management with small fruits
  – Field identification and management of diseases of primary concern
    • Bramble diseases
    • Blueberry diseases
    • Strawberry diseases
Principles

- What causes plant disease?
  - Fungi
  - Bacteria
  - Viruses and virus-like organisms
  - Nematodes
  - Parasitic plants
Principles

• Realities of small fruits and organic disease management
  – Plants are perennials
  – Proper site selection and preparation are critical
  – Critical to foster good plant health
  – Several diseases have wide host ranges
  – Plantings can accumulate problems over time
  – Few organic fungicides available that have a high level of efficacy
Principles

• Integrated disease management practices
  – Avoidance/exclusion
    • Select sites with good soil drainage
    • Select sites with good air drainage
    • Plant only disease free planting stock
    • Mulches to prevent rain splash
    • Weed management
    • Remove alternate hosts
Principles

• Integrated disease management practices
  – Avoidance/exclusion
  – Eradication
    • Sanitation
Principles

• Integrated disease management practices
  – Avoidance/exclusion
  – Eradication
  – Protection
    • Plant resistant or tolerant cultivars
    • Avoid excessive nitrogen fertilization
    • Keep fruit from contacting soil
    • Harvest fruit promptly and store under refrigeration
    • Application of approved fungicides
Principles

• Approved organic fungicides for small fruit
  – Fungicides based on elements copper and sulfur
    • Copper fungicides
    • Bordeaux mixture
    • Fixed copper fungicides
    • Sulfur fungicides – dry or flowable
    • Liquid lime sulfur
  – Other organic fungicides
    • Armicarb and Kaligreen (potassium bicarbonate)
    • Nutrol (manopotassium phosphate)
    • Oxidate (hydrogen dioxide)
    • Trilogy (extract of neem oil)
**Biological Disease Control**

Nematicides:
- BioNem (*Bacillus firmus*)
- DiTera (*Myrothecium verrucaria*)

Fungicides and bactericides:
- Serenade, Kodiak (*Bacillus subtilis*)
- Sonata, Yield Shield (*Bacillus pumilis*)
- Contans (*Coniothyrium minitans*)
- Mycostop Biofungicide (*Streptomyces griseoviridis*)
- SoilGard (*Gliocladium virens*)
- Blight Ban (*Pseudomonas fluorescens*)
- PlantShield (*Trichoderma harzianum*)
- Galltrol (*Agrobacterium radiobactor*)

Antibiotics for control of bacterial diseases:
- Agri-Mycin (Streptomycin)
- Firewall (Streptomycin)
- Mycoshield (Oxytetracycline)
Brambles

• Diseases of primary concern
  – Cane/twig diseases
    • Raspberry anthracnose
    • Cane blight
    • Spur blight
  – Crown/root diseases
    • Phytophthora
  – Fruit diseases
    • Botrytis rot/Gray mold
  – Rust diseases
Cane/Twig Diseases

• Common themes
  – Caused by fungi
  – Spread from last year’s canes (floricanes) to new canes (primocanes) in wet weather in late spring/early summer
  – Canker/girdling
Anthracnose

- Fungus – *Elsinoe veneta*
- Results in cane dieback, loss of fruit production
- Particularly severe on black and purple raspberries, also blackberry
- Small purple spots, enlarge to become oval and sunken
- Girdles the cane
- Fruit may fail/shrivels
- Fungus survives winter in lesions on the canes
- Spores germinate and spread to new tissue in spring, usually in between where the leaves attach (internodes)
Anthracnose

http://www.extension.umn.edu/distribution/horticulture/dg1152.html

Charles Drake, Virginia Polytechnic
http://www.extension.umn.edu/garden/yard-garden/fruit/integrated-pest-management-for-home-raspberry-growers/cane-diseases/
Spur Blight

• Fungal disease (*Didymella applanata*)
• More common on red raspberry than black/purple
• Damage
  – Blighting of fruit-bearing spurs
  – Kill buds
  – Dry/small seeds
  – More prone to winter injury
Spur Blight

- Dark areas form in late spring/early summer, often where leaf attaches (node)
- Girdle cane
- Canes crack/split
- Spore-producing structures form
  - Summer (pycnidia)
  - Winter (perithecia)

Mary Ann Hansen, Virginia Polytechnic Institute and State University, Bugwood.org
http://www.extension.umn.edu/garden/yard-garden/fruit/integrated-pest-management-for-home-raspberry-growers/cane-diseases/
Cane Blight

• Fungal pathogen (*Leptosphaeria coniothyrium*)

• More common on black raspberry, but also on red and purple raspberry and blackberry

• Damage
  – Shoot death, low yield
  – Often starts at wounds
Cane Blight

http://ipm.illinois.edu/fruits/diseases/spur_blight/index.html
Anthracnose, Spur Blight, Cane Blight

• Management strategies
  – Pruning strategies
    • Avoid wounding primocanes
    • Pruning wounds are the primary site of infection, use pinch pruning especially during summer pruning
    • Prune and destroy infected plant material, especially floricanes following harvest
  – Refrain from overhead irrigation
  – Improve airflow with proper pruning and thinning
  – Avoid winter injury – appropriate fertility, especially avoid excessive nitrogen fertilization
  – Reduce or eliminate wild populations of brambles
  – Late dormant applications of lime-sulfur or copper hydroxide
Phytophthora Root Rot

• Several *Phytophthora* species affect brambles
• The disease is most commonly associated with heavy soils or portions of the planting that are the slowest to drain (lower ends of rows, dips in the field, etc.).
• In fact, most declining plants that are considered to be suffering from “wet feet” may be suffering from Phytophthora root rot.
• Symptoms
  – general lack of vigor and a sparse plant stand.
  – Apparently healthy canes may suddenly decline and collapse during the late spring or summer.
  – leaves may initially take on a yellow, red, or orange color or may begin scorching along the edges.
  – affected canes wilt and die.
  – Infected plants frequently occur in patches, which may spread along the row if conditions remain favorable for disease development.
Phytophthora Root Rot

http://www.ipm.ucdavis.edu/PMG/P/D-CB-PSPP-FS.001.html
Phytophthora

• Management strategies
  – Use disease-free planting stock preferably maintained in a greenhouse without field soil;
  – Choose sites that drain well
  – Avoid heavy soils and manage irrigation carefully
  – Use raised beds
  – Resistant cultivars
  – Recent research has shown that soil solarization prior to planting reduced levels of the disease
Botrytis Rot/Gray Mold

- Causal agent – *Botrytis cinerea*; fungus – spreads by spores
- Overwinters in many plants, plant parts, debris in the soil
- Infects flower parts then spreads to fruit, often staying latent
- Fruit rot activates as it matures/ripened
- Temps 70-80°F, moisture, and high humidity favor disease
- Rotting problems in the field and after harvest
Botrytis Rot/Gray Mold

http://www.berriesnw.com/BerryDisordersDetail.asp?id=72
Botrytis Rot/Gray Mold

• Management strategies
  – Pruning to promote faster drying
  – Avoid excess N
  – Fungicides – at bloom through petal fall
  – Discard rotting fruit
  – Careful handling at harvest and prompt refrigeration
Orange Rust

- Causal agent *Arthuriomyces peckianus* and *Gymnoconia nitens*
- Blackberry and black raspberry are susceptible; red raspberries are not susceptible
- **Systemic** fungal pathogen often introduced on infected planting material
- Variability in cultivar resistance
- Bright orange pustules form on bottom surface of leaves in spring
Late Rust

• Causal agent *Pucciniastrum americanum* (fungus)

• Severe on red raspberry

• Occurs on the underside of leaves and on fruit

• Disease occurs during periods of cool, damp weather, especially in autumn.

• Alternate host – white spruce
Rust Diseases

• Use healthy, disease-free planting material
• Select site with good air movement and sun
• Eradicate wild hosts
• Prune/canopy management for airflow
• Orange rust - rogue all infected plants as soon as they appear
• Resistance
  • Plant resistant cultivars
  • Orange rust – red raspberries immune
  • Late rust – black raspberries and blackberries immune
Blueberries

- Diseases of primary concern
  - Cane/twig diseases
    - Phomopsis twig blight
    - Botryosphaeria stem blight
  - Crown/root diseases
    - Phytophthora
  - Fruit diseases
    - Botrytis fruit rot
Phompsis Twig Blight and Canker

• Causal agent - *Phomopsis vaccinii*
• Disease attacks several parts of the blueberry
• The disease is often introduced with the planting material
• Rainy seasons are conducive to infection and spread
• Fungus can infect young canes and twigs directly but needs wounds to enter older wood
• Most infections occur in spring and early summer, role of frost and herbicides unclear
• A hard winter or drought stress may exacerbate symptoms
Phomopsis Twig Blight

Twig and blossom blight, dying fruit clusters
Spores are produced in bleached areas and are dispersed by rain splash.
Phomopsis Canker

Cane collapse in mid-summer

Cankers on canes
Phomopsis Leaf Spot and Fruit Rot

Phomopsis leaf spot

Phomopsis fruit rot leads to soft berries and berry splitting

Phomopsis spore droplets on fruit postharvest
Botryosphaeria Stem Blight

- Causal agent *Botryosphaeria dothidea*, *B. ribis*, and other species
- Primary disease limiting establishment of blueberry plantings in SE US
- Fungus enters the plant through wounds (mechanical, insect, freeze injury)
- Disease causes rapid death of canes, especially in 1- and 2-year-old plantings
- Most infections occur early in the growing season, but infection can take place year-round
- The disease also occurs in other wild and cultivated hosts, e.g., holly, blackberry, willow
Botryosphaeria Stem Blight
Phomopsis and Botryosphaeria

• Management strategies
  – dormant applications of lime sulfur or copper hydroxides.
  – Applications of fungicides during bloom may also be beneficial
  – Plant resistant cultivars, or cultivars that are less susceptible
  – Avoid planting on sites with frost pockets or other areas prone to spring frosts or provide frost protection.
  – Minimize mechanical injuries to plants, especially those from mechanical harvesters.
  – Employ fertilization, irrigation, and weed control practices that discourage late season growth and promote early hardening.
  – Prune out and destroy dead twigs and canes before bud break; cut as deeply into the crown as possible to ensure removing the canker.
Phytophthora Root Rot

• Causal agent: *Phytophthora cinnamomi*
• Disease is promoted by rainy periods resulting in standing water in the field and heavy soils with poor drainage
• Oospores can survive in the soil for more than 10 years
• The disease can spread via movement of soil from infested fields, with run-off water, on equipment and boots, and via infected planting material
Phytophthora Root Rot

Wilting, defoliation, and plant death

Yellow/red leaves

Small root system
Phytophthora

- **Management strategies**
  - Use disease-free planting stock preferably maintained in a greenhouse without field soil;
  - Choose sites that drain well
  - Avoid heavy soils and manage irrigation carefully
  - Use raised beds
  - Resistant cultivars
  - Recent research has shown that soil solarization prior to planting reduced levels of the disease
Strawberries

- Diseases of primary concern
  - Leaf/petiole diseases
    - Leaf blight
    - Leaf scorch
    - Leaf spot
    - Powdery mildew
  - Crown/root diseases
    - Red stele
    - Phytophthora
  - Fruit diseases
    - Gray mold or Botrytis fruit rot
    - Anthracnose
    - Leather rot
Diagnostics on strawberry

• Disease symptoms can appear the same
• Symptoms similar to abiotic issues
• Root and crown issues:
  – Above ground issues can look similar
  – Must split crown
    • Symptoms can look similar
    • Secondary invader issues
• Leaf issues:
  – Scorch, Blight and Spot
    • Advanced infections can appear the same
• Fruit issues:
  – Soft and leaky
  – Gray/white and fuzzy (reproductive structures)
  – Bronzed
  – Latent infections
• Runner lesions

[Images of various strawberry issues: Winter injury, Calcium deficiency, Sun scald, Frost damage, Runner lesions]
Easy to distinguish?

Leaf spot

Leaf blight

Leaf scorch

Powdery mildew

Angular leaf spot

[Image of leaf spot, powdery mildew, leaf blight, leaf scorch, angular leaf spot]

Leaf Blight

- *Phomopsis obscurans*
- Rain followed by warm and humid conditions
- Reddish-purple lesions
- Lesions expand and develop zones:
  - a purple, red or yellow outer margin,
  - a light-brown inner zone,
  - a dark-brown central zone.
- Infected areas near a major vein are often oval or V-shaped
- Lesions coalesce into large necrotic areas

Leaf Spot

- *Mycosphaerella fragariae*
- Throughout growing season
- Minimum 12 hours leaf wetness
- Small lesions on upper leaf surface
  - Deep-purple, round
  - 3-6 mm (1/8-1/4 in.) in diameter
  - Centers of turn brown, then grey and eventually white
- Reddish (purple) to rusty brown border surrounds center

Leaf Scorch

- *Diplocarpon earlianum*
- Infests leaves, runners, flowers, fruit and calyx
- Purplish-brown lesions
- Lesions join together and may turn bright red
- Leaves die and curl up at the edges
  - “scorched”

Powdery Mildew

- *Sphaerotheca macularis f. sp. fragariae*
- Warm and humid weather
- Reddish-purple lesions on upper and lower leaf surface
- Can see signs = white powder = spores
  - Underside of leaves mostly
- Leaf edges roll up
- Spores may form on the fruit
  - Small, misshapen fruits
    - raised seeds
    - Scarred surface

Foliar Diseases

• Management strategies
  – Consider resistant cultivars
  – Removal of diseased leaves at renovation
  – Weed control
  – Avoid excess nitrogen fertilizer
  – Approved fungicides
Easy to distinguish?

Red stele  Black root rot  Verticillium wilt

Red Stele

- Phytophthora fragariae
- Cool and wet soils
- Infected plants are stunted
  - Reduced runner and fruit production
- Leaves wilt / collapse
- Roots rot from tip to crown
- No feeder roots
  - Main tap root looks like ‘rat tail’
- Stele of root red
  - Outer tissues white
- Resistant cultivars are available (MAB)

[Link](http://www.omafra.gov.on.ca/IPM/english/strawberries/diseases-and-disorders/red-stele.html)
Other *Phytophthora* spp.

- Root and crown diseases, but don’t cause a red stele
- *P. cactorum* (roots, crown and fruit)
- *P. citricola* (roots, crown and fruit)
- *P. citrophthora* (fruit)
- *P. nicotianae* (fruit)
Crown Diseases

- Accurate identification is important
- Plant resistant cultivars
- Plant in well drained soil or on raised beds
- Measures to reduce winter injury
Easy to Distinguish?

[Images of strawberries with three different types of rot: Botrytis rot, Anthracnose, Leather rot]
Anthracnose

- *Colletotrichum fragariae, C. acutatum, C. gloeosporioides*
- Distinct brown or black sunken lesions develop
- Lesions remain round, sunken and fairly firm
- Salmon-colored spore masses
  - Humid conditions
- Can infect entire plant!!!
- Outer leaves die
- Daughter plants die
- Entire plant collapse
- Crown rot

[Link to OMAFRA website]
Gray Mold

- *Botrytis cinerea*
- Infect flowers → fruit
  - Latent infections
- Brown lesions
- A mass of grey, powdery mold
- Can see reproductive structures for clear ID
- Infected berries become dried and mummified
- Can cause crown diseases
  - High rainfall
  - Cool temperatures

Leather Rot

- *Phytophthora cactorum*
- Favors cool, wet conditions
- Crown rot
- Infects flowers and green or mature fruit
- Occurs where berries are exposed to soil
- Infected blossoms turn brown and die
- Green fruit become hard and leathery
- Lesions are not distinct but are usually somewhat soft
- Inner tissues dark in color, foul smell
- White mold may grow from the diseased fruit

Fruit Diseases

• Management strategies
  – Weed management
  – No spring nitrogen applications
  – Prompt harvest
  – Destroy rotted fruit
  – Mulching to reduce soil splash
  – Plant on raised beds
  – Allowed fungicides
Any Questions?

• Patrick Byers
• Byerspl@misouri.edu
• 417-881-8909