Entomosporium Leaf and Berry Spot
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Alberta Farm Fresh School 2013

OVERVIEW
PART I. INTRODUCTION TO ELBS
PART II. DISEASE CYCLE
PART III. INFECTION PROCESS
PART IV. MEASURES OF DISEASE RESPONSE
PART V. CULTIVAR DISEASE RESPONSE
PART VI. CHEMICAL CONTROL
PART VII. CULTURAL CONTROL

The Saskatoon Industry
- first orchards established in 1970’s
  - today: 500 - 800 ha in the prairies
  - average yield: 3,300 - 4,500 kg per ha
- challenges:
  - production information
  - demand for fruit exceeds supply
  - fungal diseases

Disease Triangle

I. INTRODUCTION
- Entomosporium leaf and berry spot
- distributed throughout temperate zones worldwide
- affects genera of the subfamily Pomoideae (Rosaceae)
- most serious disease facing the saskatoon industry

The Pathogen
- imperfect stage:
  - Entomosporium mespili
  - causal organism
  - acervuli on leaves/fruit
  - 5-celled conidiospores
- perfect stage:
  - Fabrea maculata
  - rarely seen
  - Discomycete
The Host

- Saskatoon – *Amelanchier alnifolia*
- Numerous cvs
  - Selected from the wild
  - No breeding program
  - No disease screening
- Other factors:
  - Suckering habit = hedge
  - Growing out of range

Foliar Symptoms

- first evidence
- starts at plant base
  - basal shoots/suckers
  - moves up canopy
  - source of 2nd inoculum
    - splashed onto fruit
- symptoms:
  - brown spots (1-3 mm)
  - yellow halo -> leaf
  - defoliation

Fruit Symptoms

- greatest concern to growers
- symptoms:
  - angular, brown spots
  - watery, grey lesions
  - cracking, shriveling
  - stalks may also be infected
- fruit quality:
  - downgraded
  - unusable when >6% FAA

Twig Symptoms

- twigs:
  - cankers on 1-yr wood
  - may be a source of 1st inoculum
  - rarely persist

II. DISEASE CYCLE

Disease Pathway

- fungus overwinters:
  - diseased twigs
  - fallen leaves
  - retained fruit
- primary infection:
  - conidiospores are splashed onto new leaves
- secondary infection:
  - disease moves upwards
  - bounces from leaf to leaf
  - then leaf to fruit
**The Acervulus**
- site of spore production
  - upper leaf surface
  - rapid cell division
  - 1000's of conidiospores
  - leaf surface erupts
- disease spread:
  - conidiospores
  - 1st and 2nd inoculum
  - splash dispersal
  - rain / irrigation

**Ideal Conditions**
- ELBS will flourish when weather conditions include
  - high relative humidity or rainfall
  - temperatures between 20 and 26°C
- ELBS “explodes” in wet and warm weather
  - need for proactive control

**Protect the Flowers**
- flowers seem to be an important stage
- source of nutrition for fungus until leaves emerge?
  - e.g. Sclerotinia

**III. Infection Process**
- characterize host-pathogen interaction
  - detached leaves of 17 saskatoon cultivars
  - inoculated with spore suspension of ELBS
  - SEM microscopy
- steps in infection:
  - germination
  - penetration
  - invasion
  - sporulation

**Unique Spores**
- Unique 5 celled conidiospore with tiny bristles
- Mouse-like appearance
- Easy to distinguish from other spores on the leaf surface

**A. Conidiospore Germination**
- using energy reserves, spore produces germ tube
- seeks entry point on leaf
  - Germ-tube extrusion
  - Cell extension
  - 2 dpi
B. Leaf Penetration
- Using host energy, fungus moves into leaf
- Produces infection peg and haustorium
- Feeds on epidermal cells

C. Hyphal Colonization
- Fungus moves deeper into leaf mesophyll
- Sufficient network of hyphae to begin reproduction

D. Sporulation
- Conidiospore production results in an eruption on the leaf surface
- Splash dispersal to other leave or developing fruit

Mechanisms of disease resistance?
- Types of resistance:
  - Passive (pre-infectional)
  - Active (post-infectional)
- Resistant host may restrict:
  - Germination (G)
  - Penetration (P)
  - Colonization (C)
  - Sporulation (S)

Spore Dispersal

Pre-infectional Defenses
- Compared Buffalo and Success
  - Differ in severity of leaf infection
  - Pre-penetration response
    - Spore germination/penetration restricted on Success
- Possible explanations:
  - Leaf surface properties
  - Stimulatory / inhibitory compounds
III. MEASURING DISEASE

- reliable / repeatable measures of ELBS
- disease incidence
  - qualitative – yes or no
  - % plants / % leaves / % fruit
  - sporulation / infection
- disease severity
  - quantitative - numerical measure
  - infection: area affected, lesion size / number
  - sporulation: fruiting bodies, acervuli

A. Leaf Infection
- necrosis
  - fungal penetration
  - cell damage / death
- variables:
  - percentage of leaves infected (I)
  - percent leaf area affected (S)
  - leaf lesion number/size (S)
- SigmaScan software

B. Leaf Sporulation
- leaf acervuli
  - sites of conidiogenesis
  - 2nd inoculum production
- variables:
  - percentage leaves sporulating (I)
  - leaf acervuli number (S)
- visual counts
  - dissecting microscope
C. Fruit Infection/Sporulation

- fruit infection
  - result of leaf inoculum
  - further sporulation
- variables:
  - percentage fruit infected / sporulating (I)
  - fruit acervuli number (S)
- visual counts
  - dissecting microscope

IV. CULTIVAR RESPONSE

- resistance: active host response to infection
- possible outcomes of inoculation:
  - immunity – no infection
  - infection leads to:
    - complete resistance
    - partial resistance
    - complete susceptibility

Methodology

- identify saskatoons with resistance to ELBS
- 17 saskatoon cultivars
  - originating in AB., SK. and U.S.
  - replicated trials
- reported resistance to ELBS
  - Parkhill, Regent, Success
- disease screening:
  - natural infection: leaf / fruit disease
  - detached leaf assay

A. Leaf Response - Natural Infection

- Edmonton, 1997
  - 10 cultivars in four replicate RCBD
  - sample: 50 leaves per plant
  - leaf infection
- Hudson Bay, 1998 & 1999
  - 15 cultivars in three replicate RCBD
  - sample: 40 leaves per plant
  - leaf infection / sporulation

Incidence of Leaf Infection (two locations)

Severity of Leaf Infection (two locations)
B. Detached Leaf Assay

- inoculate leaves of 17 cultivars
- two experiments
  - four replicates
  - five leaf ages
- evaluation:
  - infection
  - sporulation

Disease on Detached Leaves

Susceptible: Buffalo

Resistant: Success

C. Fruit - Natural Infection

- Edmonton, 1997
  - 10 cultivars in four replicate RCBD
  - sample: 10 racemes per plant
  - fruit infection

- Hudson Bay & Moonlake, 1999
  - 15 cultivars in three replicate RCBD
  - sample: 6 racemes per plant
  - fruit infection and sporulation
Incidence of Fruit Infection (two locations)

Incidence of Fruit Sporulation (1999)

Severity of Fruit Sporulation (1999)

Cluster Analysis - Disease Response

IV. CHEMICAL CONTROL

- Need varies with site
  - South MB = "banana belt"
  - Heat, humidity, rainfall
- Protect your investment
  - $500 for $50,000
- Apply at flower stage
  - White tip
  - Petal fall
  - Green fruit
- New short PHI chemicals
Keep the foliage clean until harvest

Choices for Disease Control

<table>
<thead>
<tr>
<th>Product name</th>
<th>Registration number</th>
<th>Common name</th>
<th>Group</th>
<th>Preharvest interval</th>
<th>Minimum re-entry</th>
<th>Maximum # applications per season</th>
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</thead>
<tbody>
<tr>
<td>Funginex DC</td>
<td>27088</td>
<td>triforine</td>
<td>3</td>
<td>60 days</td>
<td>48 hours</td>
<td>1</td>
</tr>
<tr>
<td>Jade</td>
<td>24030</td>
<td>propiconazole</td>
<td>3</td>
<td>38 days</td>
<td>72 hours</td>
<td>3</td>
</tr>
<tr>
<td>Kumulus DF</td>
<td>18836</td>
<td>sulphur</td>
<td>M</td>
<td>1 day</td>
<td>24 hours</td>
<td>8</td>
</tr>
<tr>
<td>Microban Dispers</td>
<td>25487</td>
<td>sulphur</td>
<td>M</td>
<td>1 day</td>
<td>24 hours</td>
<td>8</td>
</tr>
<tr>
<td>Mission 415 EC</td>
<td>28016</td>
<td>propiconazole</td>
<td>3</td>
<td>38 days</td>
<td>72 hours</td>
<td>3</td>
</tr>
<tr>
<td>Nova ME W</td>
<td>22399</td>
<td>myclobutanil</td>
<td>3</td>
<td>14 days</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Pristine WG</td>
<td>27985</td>
<td>boscalid + pyraclostrobin</td>
<td>7+11</td>
<td>0 days</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Switch 62.5 WG</td>
<td>28189</td>
<td>cyprodinil + fludioxonil</td>
<td>9+12</td>
<td>1 day</td>
<td>12 hours/10 days</td>
<td>3</td>
</tr>
<tr>
<td>Topas 200EC</td>
<td>30163</td>
<td>propiconazole</td>
<td>3</td>
<td>38 days</td>
<td>72 hours</td>
<td>3</td>
</tr>
</tbody>
</table>

- **propiconazole** – group 3
  - older chemistry
  - more economical
  - the “glyphosate” of fungicides
  - systemic fungicide
  - fast uptake and penetration
  - strong translocation.
  - long-lasting preventative and curative activity
  - acts on the fungal pathogen
  - leaf penetration
  - haustoria formation
  - apply early enough to avoid irreversible crop damage and build up of the disease

- **cyprodinil + fludioxonil**
  - contains two active ingredients; unique and new modes of action
    - cyprodinil - group 9
    - fludioxonil - group 12
  - SWITCH® attacks the pathogen at four different sites:
    - inhibits germination of the spore
    - the growth of the germ tube
    - the penetration into the plant
    - growth of the inter and intracellular mycelium
  - It protects the leaves and fruits from outside and inside

- **pyraclostrobin + boscalid**
  - two active ingredients that are both highly effective for control
    - pyraclostrobin - group 11
    - boscalid - group 7
  - Both ingredients are systemic; move throughout leaf/plant
  - Pristine inhibits:
    - spore germination
    - mycelial growth
    - sporulation of the fungus
Pattern of Application

- Topaz 250E (also Jade, Mission)
  - relatively cheap
  - use for initial applications
  - white tip / petal drop
  - 35 day pre-harvest interval
- Switch 62.5 WG
  - expensive, new chemistry
  - use for final applications
  - green fruit / late stage
  - based on disease pressure
  - 1 day pre-harvest interval
- Pristine WG
  - an alternative to Switch

V. CULTURAL CONTROL

- Organic grower?
- Options for chemical-free disease control
  - May be possible in certain environments
  - dryer, cooler regions
  - combine with chemical applications as part of an integrated approach

Air Circulation

- practices that reduce the duration of surface wetness
- less spore germination
- achieved by:
  - controlling weeds
  - pruning excess suckers
  - thinning plants
  - watering at the soil surface

Bio-fungicides

- SERENADE MAX
  - unique, patented strain of Bacillus subtilis (strain QST 713)
  - 30 different lipopeptides that work synergistically to destroy disease pathogens and provide superior antimicrobial activity
- Sulfur
  - Kumulus DF (80% sulphur)
  - Microthiol Disperse (90% sulphur)
  - Residue may impact sales

Sanitation

- Break the disease cycle in spring
- Remove source of initial inoculum for the following year
  - vacuum up leaf litter in the fall
  - ensure that all fruit has been picked

Disease Forecasting

- Use weather data and computer model
- Apply fungicide only as needed
  - reduced cost
  - less environmental impact

Canadian Journal of Plant Pathology
Volume 26, Issue 3, 2004
The development of a dynamic disease forecasting model to control Entomosporium mespili on Amelanchier alnifolia
pages 304-313
THANKS FOR LISTENING!

QUESTIONS?