3 Apple II

Where: Ballroom D
MI Recertification Credits: 2 (IC, COMM CORE, PRIV CORE)
OH Recertification Credits: 0.5 (presentations as marked)
CCA Credits: CM (1) PM (1)
Moderator: Chris Kropf, MSHS Board, Lowell, MI

2:00 PM Adaptations for Fire Blight Management Based on 2018 Resistance Screening
  • Amy Irish-Brown, Michigan State University Extension
  • David Jones, Michigan State University Extension

2:20 PM Incorporating SDHI Fungicides into Apple Scab Programs: Efficacy, Cross-Sensitivity, and Resistance Management (OH 2B, 0.5 hr)
  • Sara Villani, North Carolina State University

2:50 PM Use of DrapeNet in 2018 Apple Plantings - Results and Ideas
  • Phil Schwallier, Michigan State University
  • Amy Irish-Brown, Michigan State University Extension

3:10 PM Brown Marmorated Stink Bug - Status Report
  • John Pote, Michigan State University

3:30 PM Apple Rootstocks for Modern Orchards
  • Amy Irish-Brown, Michigan State University Extension
  • Phil Schwallier, Michigan State University

3:50 PM Michigan Tree Fruit Commission Summary
  • Amy Irish-Brown, Michigan State University Extension
  • Phil Schwallier, Michigan State University

4:00 PM Session Ends
Incorporating SDHI Fungicides into Apple Scab Management Programs: Efficacy, Cross-Sensitivity, and Resistance Management

Sara M. Villani, North Carolina State University
Kerik Cox, and Katrin Ayer, Cornell University

Questions Surrounding the SDHIs
- Are all similarly effective against specific apple pathogens?
- What growth stage should we be targeting?
- Protectant/germination? Curative/mycelial growth inhibition?
- Is there cross-sensitivity between SDHI fungicides?
- In vitro studies (completed in lab with Venturia inaequalis)
- How do SDHI fungicides perform with fungal populations resistant to other single-site fungicide classes (i.e., QoI, DMI)
- What is the risk of resistance development among the SDHI fungicides?

SDHI Fungicides: A Brief History
- 50 years ago: First SDHI product (carboxin) released for seed treatments
  - Very limited m.o.a (mushrooms and smuts)
- 1971-1997: 6 additional SDHI fungicides
  - Still very narrow spectrum
- 2003: Boscalid hits the market
  - Endura, Pristine (+ pyraclostrobin)
  - Broad spectrum, foliar disease

SDHI Fungicide Overview
- “Next generation” Succinate Dehydrogenase Inhibitor fungicides
  - New spin on an old chemistry
- FRAC 7
  - 9 chemical groups
  - Standalone and pre-mix products for apple disease control
  - Broad spectrum (no oomycetes yet)

Baseline SDHI Fungicide Sensitivity
- Germination assays
  - Evaluation of fungicide pre-infection/protectant mode
- Mycelial growth assays
  - Evaluation of fungicide post-infection/kick-back mode
**Relative SDHI Fungicide Sensitivity**

- High overall efficacy of SDHI fungicides

<table>
<thead>
<tr>
<th>Chemical Group</th>
<th>Common Name</th>
<th>Comments</th>
<th>FRAC Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDHI Cross Sensitivity</td>
<td>Luna products (fluopyram)</td>
<td>Fontelis (penthiopyrad)</td>
<td>Miravis (pydiflumetofen)</td>
</tr>
<tr>
<td>Fontelis (penthiopyrad)</td>
<td>0.819</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Miravis (pydiflumetofen)</td>
<td>0.749</td>
<td>0.823</td>
<td>-</td>
</tr>
<tr>
<td>Aprovia (benzovindiflupyr)</td>
<td>0.745</td>
<td>0.903</td>
<td>0.7395</td>
</tr>
<tr>
<td>Merivon (fluopyram)</td>
<td>0.716</td>
<td>0.6127</td>
<td>0.673</td>
</tr>
</tbody>
</table>

- Positive linear correlation between all SDHIs

**SDHI Cross Sensitivity**

- SDHI fungicides can inhibit both conidial germ tube growth and mycelial growth however greater efficacy during early growth stages.
- Aprovia (benzovindiflupyr) EC\textsubscript{50}: 0.002 vs. 0.043 µg/ml
- Luna products (fluopyram) EC\textsubscript{50}: 0.176 vs. 2.02 µg/ml
- Higher energy requirements during different growth stages?
- Greatest control when applied in protective mode
- Cross-sensitivity observed across SDHI chemical groups

**SDHI Baseline Sensitivity Summary**

- In vitro studies (completed in lab with *Venturia inaequalis*).
- How do SDHI fungicides perform with fungal populations resistant to other single-site fungicide classes (i.e. QoI, DMI)?
- What is the risk of resistance development among the SDHI fungicides?

**Questions Surrounding the SDHIs**

- Are all similarly effective against specific apple pathogens?
- What growth stage should we be targeting?
- Protectant/germination? Curative/mycelial growth inhibition?
- Is there cross-sensitivity between SDHI fungicides?

- Similar and significant levels of cross-sensitivity observed between penthiopyrad or benzovindiflupyr and fluopyram
20 year old ‘Rome Beauty’ planting
• Treatments initiated @ Pink and applied at Pk, Bl, PF, 1C, 2C
• 7 to 14 day intervals
• Treatments applied with Solo Mist Blower: 100 gal/A

% incidence of terminal leaf scab and fruit scab assessed 11 Jul (2017) and 13 Jun (2018)
• 2017: 4 applications of fungicide
• 2018: 5 applications of fungicide

3.1-acre planting site Empire’ and ‘Jonagold’- M.9/M.111 interstem (18-20 years old)
• Widely-spaced two tree plots
Cornell Fungicide Trials

- Fungicide treatments
  – Dilute handgun application timed at 7-10 day intervals from TC - 2nd cover
  – Alternated with effective protectant standards → not to exceed max applications (4 applications)

SDHI Apple Scab Trials: Trends and Considerations

- Standalone SDHI fungicides in general demonstrate high efficacy against apple scab: Aprovia and Miravis: Best
- Orchards with DMI (FRAC 3) resistance: Luna Experience (SDHI + DMI) not statistically greater than DMI (Inspire) program (wet year)
- QoI/SDHI premixes may be affected by practical resistant to QoI fungicides in wet years
- Miravis not yet registered for disease management on apple

Cornell Apple Scab Trials

- Apple scab evaluation
  – Incidence any lesion on cluster leaves and fruit (June), terminal leaf scab (July), & fruit (Sept)

Cornell apple scab trials (2017)

NCSU and Cornell Powdery mildew Trials

Disease assessment

- Secondary mildew: NCSU: June; Cornell: July
- % Incidence: Any lesion; 8 leaves evaluated
- 10 shoots evaluated per treatment replicate (per tree)

Bioassay of 30 apple cultivars

2018: North Carolina ‘Rome Beauty’ Powdery Mildew Trial

- Wet year – high levels of fruit infection: Aprovia, Miravis, Luna tranquility, Sercadis, SDHI(premixes), > protectant & DMIs
• **Wet year low mildew pressure**: SDHI premixes, HS DMIs (Rhyme & Rally), Miravis

**SDHI Powdery Mildew Trials: Trends and Considerations**
- NCSU: Wet 2018: Not great conditions for powdery mildew development
- NCSU: SDHI + QoI premix products provided numerically greater control against powdery mildew than standalone SDHIs
- Cornell: DMIs Topguard (Rhyme) or Rally still strongest mildew fungicides – high rates w/ mancozeb to manage DMI resistant scab
- Cornell: Miravis best standalone SDHI for mildew control BUT not yet registered for disease management on apple

**Mitigating SDHI Resistance: What We Know**
- Mutation #, location, and SDHI active ingredient can all affect resistance level (partial resistance vs. complete)
- Cross-resistance has been observed across some SDHIs and not others
  - Depends on where mutation is: Mutation in SDHC subunit may result in cross-resistance between 2 SDHI fungicides, but mutation in SDHB may only confer resistance to one of those fungicides

**Mitigating SDHI Resistance**
- Apply fungicides when fungal population numbers are low - apply before infection when possible
  - Use highest legal rates of fungicide
  - Get complete coverage of host, make sure sprayer is calibrated, avoid ARM

**Questions Surrounding the SDHIs**
- Are all similarly effective against specific apple pathogens?
- What growth stage should we be targeting?
- Protectant/germination? Curative/mycelial growth inhibition?
- Is there cross-sensitivity between SDHI fungicides? In *vitro* studies (completed in lab with *Venturia inaequalis*)
- How do SDHI fungicides perform with fungal populations resistant to other single-site fungicide classes (i.e. QoI, DMI)

**Mitigating SDHI Resistance**
- Apply fungicides in tank mixture with effective, unrelated fungicides
  - i.e. Mancozeb + Fontelis: Mancozeb should “clean up” any resistant “survivors”
Mitigating SDHI Resistance

• Use correct SDHI fungicide for target pathogen
  • Be aware that SDHI fungicide may not be efficacious against other major pathogens (Aprovia: apple scab and powdery mildew)
• Rotate and be careful of promoting pre-mix partner resistance (QoI)

Acknowledgements and Questions?

• State, federal, and institutional funds appropriated to the Cornell NYSAES and to NCSU, NYSAES
• Agrichemical company support through product testing
  – Bayer, BASF, Syngenta, Dow/DuPont, FMC, Albaugh Chemical,
• Technical Support:
  Rachel Kreis
  Mei Wah Choi
  Cody Justus
  Kendall Johnson