



Great Lakes Fruit, Vegetable & Farm Market EXPO Michigan Greenhouse Growers EXPO

December 4-6, 2018

DeVos Place Convention Center, Grand Rapids, MI



3 Apple II

Where: Ballroom D

MI Recertification Credits: 2 (1C, 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**

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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

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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?

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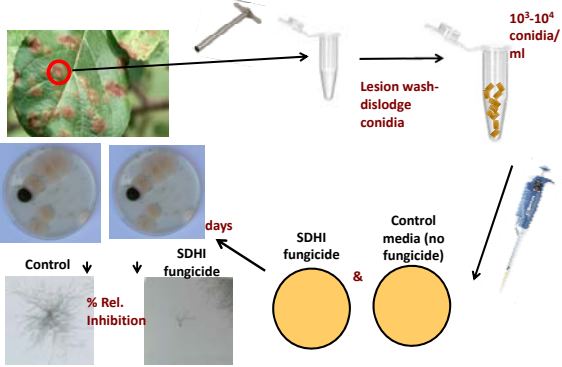
SDHI Fungicides: A Brief History

- 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



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Question 1: Efficacy of SDHI Fungicides



10³-10⁴ conidia/ml

Lesion wash-dislodge conidia

Control & SDHI fungicide


days

% Rel. Inhibition

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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)

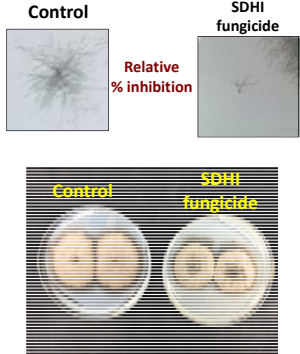


Pristine boscalid	Merivon Fluxapyroxad	Luna SENSATION Luna TRANQUILITY fluopyram
KENJA isofetamid	Aprovia benzovindiflupyr	DuPont Fontelis penthioopyrad

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Baseline SDHI Fungicide Sensitivity

- Germination assays
 - Evaluation of fungicide pre-infection/protectant mode
- Mycelial growth assays
 - Evaluation of fungicide post-infection/kick-back mode






Control & SDHI fungicide

Relative % inhibition

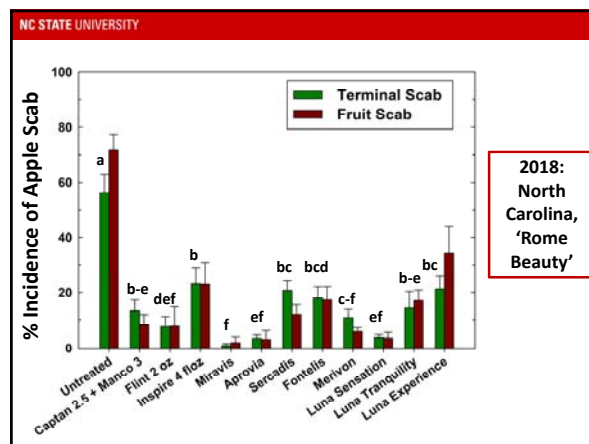
Control & SDHI fungicide

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NCSU Apple Scab/Powdery Mildew Trials








- 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

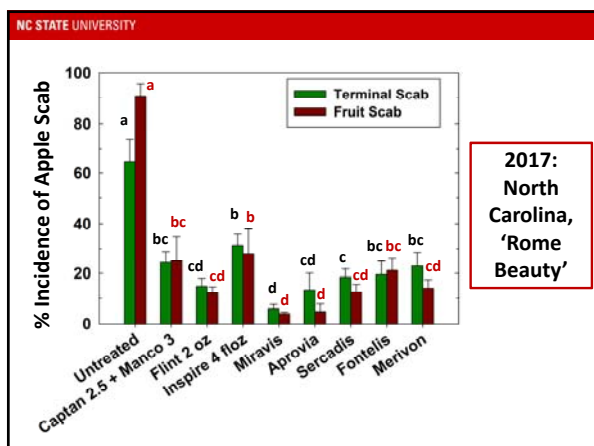
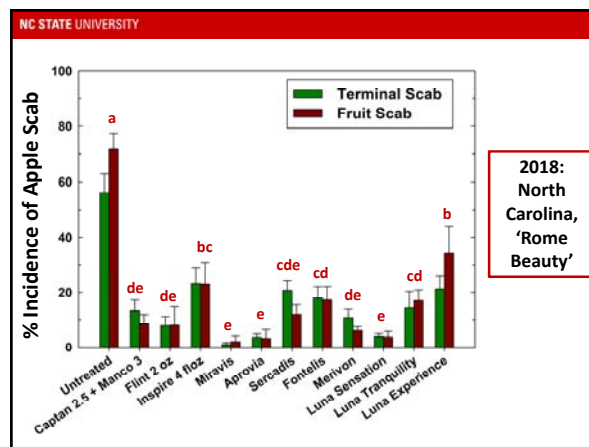


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NCSU Apple Scab/Powdery Mildew Trials

- % 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



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Cornell Apple Scab/Powdery Mildew Trials



- 3.1-acre planting site Empire' and 'Jonagold'- M.9/M.111 interstem (18-20 years old)
- Widely-spaced two tree plots

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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)

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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

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Cornell Apple Scab Trials

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



Cluster leaves & fruit (June) Terminal leaves (July) Mature fruit (Sept)

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NCSU and Cornell Powdery mildew Trials

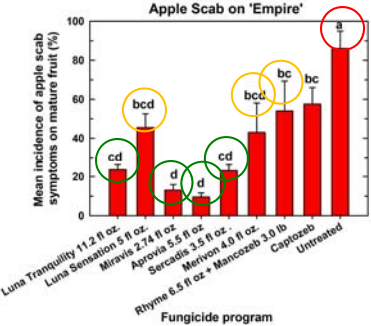
Disease assessment

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



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Cornell Apple scab trials (2017)

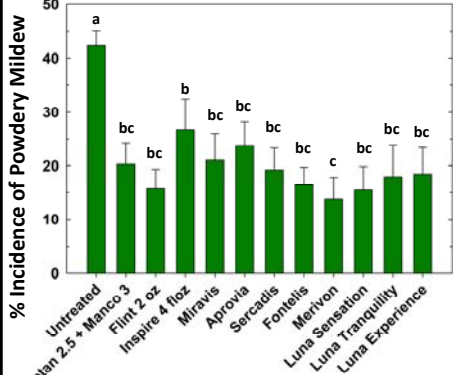


Fungicide program	Mean incidence of apple scab symptoms on mature fruit (%)	Significance
Luna Tranquility 11.2 fl oz	~25	cd
Luna Sensation 5 fl oz	~45	bcd
Miravis 2.74 fl oz	~15	d
Aprovia 5.5 fl oz	~10	d
Sercadis 3.5 fl oz	~15	cd
Merivon 4.0 fl oz	~45	bcd
Rhyme 6.5 fl oz + Mancozeb 1.0 lb	~55	bc
Captazab	~55	bc
Untreated	~95	a

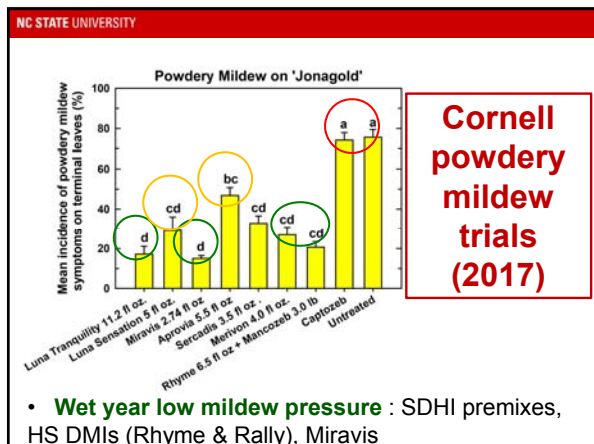
- Wet year – high levels of fruit infection:** Aprovia, Miravis, Luna tranquility, Sercadis, SDHI(premixes), > protectant & DMIs

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2018: North Carolina 'Rome Beauty' Powdery Mildew Trial



Treatment	% Incidence of Powdery Mildew	Significance
Untreated	~42	a
Captan 2.5 + Manco 3	~20	bc
Flint 2 oz	~15	bc
Inspire 4 fl oz	~25	b
Miravis	~20	bc
Aprovia	~22	bc
Sercadis	~18	bc
Fontelis	~15	bc
Merivon	~12	c
Luna Sensation	~15	bc
Luna Tranquility	~18	bc
Luna Experience	~18	bc



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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:

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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

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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

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Mitigating SDHI Resistance

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

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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)



FLINT
Fungicide

Restrictions: Do not apply more than 11 oz of Flint Fungicide per acre per season. Do not apply Flint Fungicide within 14 days of harvest. To reduce the potential for resistance, limit Group 11 fungicides to two sequential applications and alternate with at least two applications of fungicides from a different Group before making a third application with a Group 11 fungicide. ~~Do not apply more than 4 applications of Flint Fungicide or any other Group 11 fungicide per season.~~ Do not apply Flint Fungicide where spray drift may reach Concord grapes or crop injury may occur. Spray equipment must be rinsed after applying Flint Fungicide before application of other products to Concord grapes or crop injury may occur.



LIMBIC GENERATOR
Fungicide

Restrictions:

- Do not apply more than 2.5 oz of Limbic Generator per acre per year.
- Apply using ground, aerial, or chemigation equipment.
- Regardless of formulation or method of application, do not apply more than 0.448 lbs flupyradifurone per acre per year, including soil and foliar uses.
- Do not make more than 4 applications per year.

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Acknowledgements and Questions?

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