

# Grape disease management overview

VCE Viticulture Grape Disease Management Workshop  
For North Carolina Vinedresser program  
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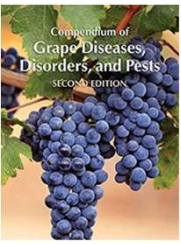
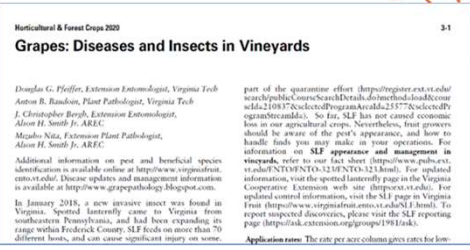


## Announcements

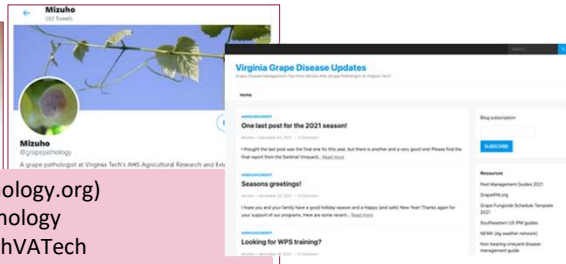
- VCE meetings and workshops (please see the handouts)
- Captan and Iprodione (Meteor/Rovral)

## Grape disease management resources

- VCE Pest Management Guide (PMG)
- Southeastern IPM guide (bunch grapes)
- My blog (Virginia Grape Disease Updates)
  - <http://ext.grapepathology.org>
- My pesticide management tool
  - <http://grapeIPM.org>
- Wilcox, W. et al. (2015) Compendium of Grape Diseases, 2<sup>nd</sup> edition



Picture is taken from publisher's websites



Blog ([ext.grapepathology.org](http://ext.grapepathology.org))  
 Twitter @grapepathology  
 Facebook GrapePathVATech



## A quick reminder: sprayer calibration

The operator should confirm the sprayer is emitting the correct rate at the **beginning of the season**



Then, after any significant change to the sprayer setup, including:

- New nozzles
- New tractor tires
- using a different tractor
- after replacing a pump or any lines/hoses

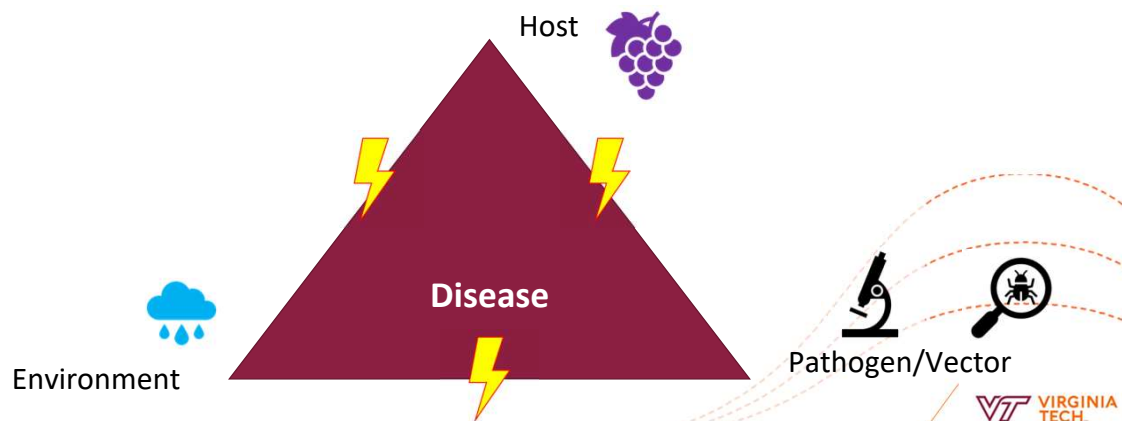


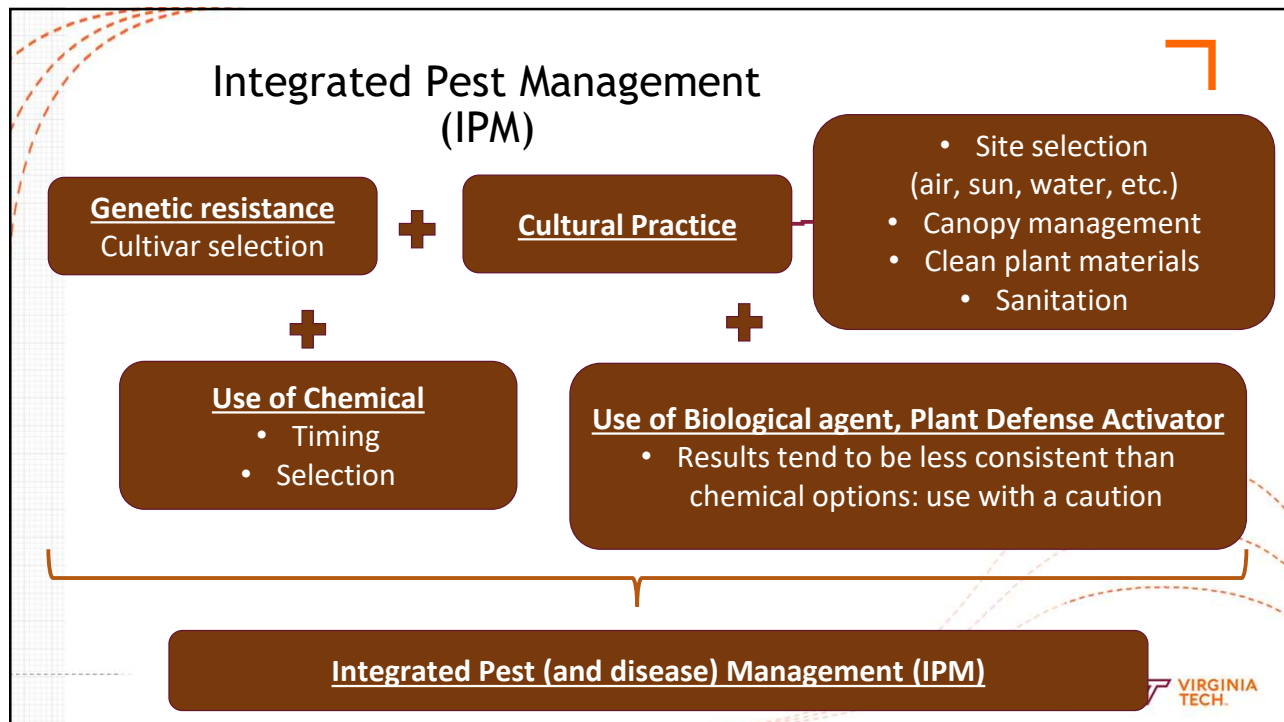
## Five simple checks before daily operation

On the first fill of the day, before adding formulated product to the tank when it's half full (to facilitate good mixing)

1. Universal joint(s), sprayer-tractor hitch, and all connections are clean, lubricated and secure.
2. Tire pressure (tractor and sprayer) is correct and all guards (e.g. air-intake grill and PTO shaft shield) are in place and intact.
3. Lines/hoses and fittings do not show signs of wear or cracking and do not leak or bulge while under pressure.
4. Each nozzle shut-off valve or nozzle body flip position is working.
5. Filters, screens, strainers and nozzles are clean and unbroken.

The management of disease = aiming to break the disease triangle





## Canopy management is a critical component of disease management

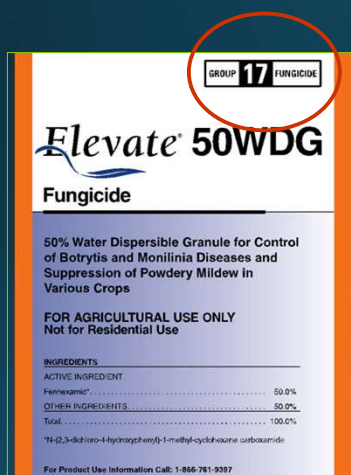
- Benefits
  - Reduce moisture
  - Increase sunlight penetration
    - Bud formation for the next season
    - Reduce powdery mildew risk
  - Increase fungicide coverage!

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# Pesticide resistance

- After several years of use, some pesticides, especially newer ones, become less effective
- Many new pesticides are targeting a specific gene or gene function
  - Highly specific and thus often safer to other organisms.
  - Other benefits such as movement of the chemical into plant tissues
- Some of population (isolates) were not sensitive to begin with
- Mutation of the target gene (or gene function) happened after exposed to the fungicide.

FRAC groups describe the mode of action = how the pesticide kills or inactivates the target pest and pathogen



E.g., fungicides in FRAC = 11 works in the same manner regardless of chemical names or manufacturer.

**FRAC (Fungicide Resistance Action Committee)**  
<http://www.frac.info/>

**IRAC (Insecticide Resistance Action Committee)**  
<https://www.irac-online.org/>

Why do we need to care about it?  
Chemical companies will come up with  
more products to sell!

Well, not really...  
Here is a list of recently introduced  
materials.

## Examples of relatively new fungicides for grape production and their mode of action

Trade name	Chemical name	FRAC group	Year introduced	Materials in the same FRAC group
Aprovia	Benzovindiflupyr	7	2018	Boscalid, Luna
Miravis	Pydiflumetofen	7	2019	Boscalid, Luna
Kenja	isofetamid	7	2018	Boscalid, Luna
Rhyme	flutriafol	3	2019	Rally, Elite, etc.
Ceyva	mefentrifluconazole	3	2021	Rally, Elite, etc.
Intuity	mandestrobin	11	2018	Abound, Flint, etc.
Oso	Polyoxin-D	22	2016	Ph-D, and the same chemical was available since 80's
Prolivo	Pyriofenone	50	2018	Vivando

## Not all fungicides in the same group made equal.

- Newer generations of group 7 materials (Luna, Aprovia, Kenja, Miravis, etc) have different way to attach to the target site
- These differences were enough to make each chemical unique
  - I.e., Not all the boscalid-resistant isolates (previous generation group 7 material) are resistant to Kenja or Luna, or Aprovia
  - Aprovia and Miravis work differently too.
- However, fundamentally, these materials work the same way.

## Fungicide resistance risk management tips

## Timing of application differ among different targets

- **Fungicide:** fungal diseases in our environment are better managed by protecting vines BEFORE infections. Once they establish their foothold in the plant, it will be very difficult to manage.
  - i.e., do not wait until you see diseases!!!
- **Insecticides:** often applied AFTER you see enough number of the target insect pest
- **Herbicides:** pre-emergence to target seeds and post-emergence to target seedlings

## Use the appropriate material for the pest

- Misuses of pesticides can lead to unnecessary applications.
- E.g. 1) We do not recommend Botrytis fungicide application before bloom because clusters are not susceptible.
- E.g. 2) Fungicides for downy mildew often does not work on powdery mildew or any other fungal diseases.
- → Interaction depends on the host and pathogen. Please consult with extension agents and specialists.



## Use the recommended rate of the material

- Do not use a lower rate than listed on the label.
- Exposure to a lower than lethal dose can lead to the development of resistance
- Make sure that your sprayer provides a good coverage!

With fungal diseases in our area, a combination of 1) more than one application and 2) use of multiple modes of action are required

### **In commercial settings:**

- Mix with a relatively low-risk fungicide
  - Do not rely on the material with number-only FRAC (e.g., 3, 40, etc.)
- Rotate pesticide mode of action between treatments.
  - Limit the use of high-risk materials

## Example of the mixing partner in grape production: Mix one of them with other MOA

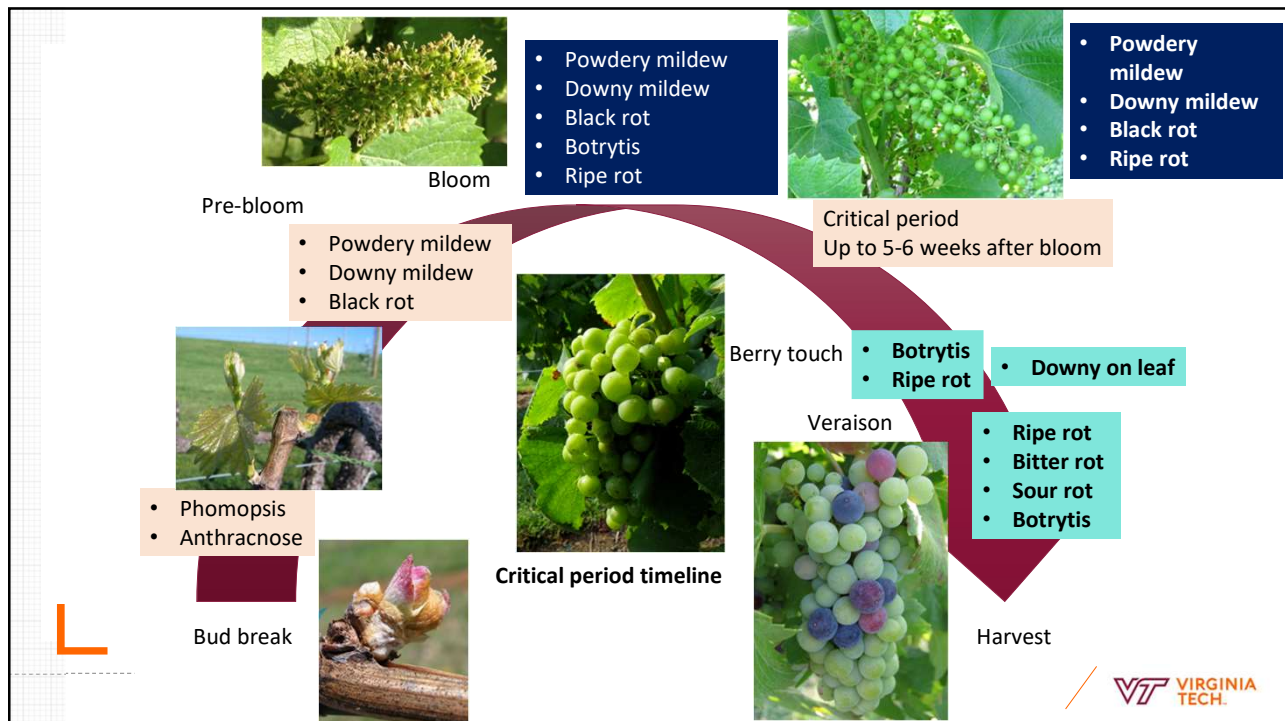
- Black rot: mancozeb (M<sub>3</sub>), ziram (M<sub>3</sub>)
- Downy mildew: mancozeb (M<sub>3</sub>), copper (M<sub>1</sub>), captan (M<sub>4</sub>), ziram (M<sub>3</sub>), phosphite (P<sub>07</sub> - please do not overuse!)
- Powdery mildew: sulfur (M<sub>2</sub>) [some growers use stilet oil, but the oil cannot be used with sulfur or captan - make sure to have at least two weeks in between sprays!]
- Botrytis: captan (M<sub>2</sub>) or copper (M<sub>1</sub>) (both are poor-to-fair materials for Botrytis, but I think they are good mixing partners)
- Ripe rot and bitter rot: mancozeb (M<sub>3</sub>), captan (M<sub>4</sub>), or copper (M<sub>1</sub>) (copper products do not list ripe rot as a target, but provided moderate reduction in some of our trials)

## Spend time BEFORE the season starts!

- You can create your plan(s) using tools I mentioned earlier.
- Yes, your plan will change depending on the weather, but it will help you plan your season and purchase materials.
- Please attend one of our workshops. ;)



*Questions?*

## Phomopsis cane and leaf spot of grape

- It can infect shoots, leaves, berries, and rachis, and the pathogen is active in spring (i.e., 40-50F wet condition).
- Protection of young shoots (~ 1 to 3 inches) is important.



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## Protective application at 1-3 inch shoot growth is the best for management of Phomopsis cane and leaf spot

- Good materials (*Note: Group = FRAC group = Mode of action*)
  - Mancozeb (Group M3), Ziram (Group M3), and Captan (Group M4)
- Fair
  - QoI/Strobilurins (Abound, Flint, Intuity, Group 11), Topsin-M (thiophanate-methyl, Group 1), Pristine (pyraclostrobin + boscalid (Group 11 and 7), and some SDHI (Aprovia, Miravis Prime, etc. , but you probably want to keep these for other diseases)
- Poor
  - Fixed copper (Group M1), sulfur (Group M2), **lime sulfur** (Group M2)
    - For organic production use either fixed copper or lime sulfur (for foliar application, use a low rate (1 pt/100 gal water, see label)

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## Dormant application of lime sulfur against Phomopsis (and very effective on anthracnose!)

- Phomopsis survives in infected woody tissues from the previous years.
- If you have a serious Phomopsis issue, a dormant application of lime sulfur (10 gal/A or 1 gal/A with Sulforix) is recommended
- Even with the dormant fungicide application, in-season applications of mancozeb to protect young shoots (from 1 inch to several inches, until your downy mildew treatment starts) is very important.



*Questions?*



## Downy Mildew

- It can infect leaves and berries, berry infection can cause serious damage
- Heavy leaf infection can cause defoliation



Picture on the center: Organic grape production guide: OSU, Ellis and Nita 2004



Does it matter if you had an outbreak in the previous year?



Yes, a study in Canada showed that vineyards with high downy mildew incidence will result in higher risk of downy mildew in the following year (Carisse, 2016).

## The grape downy mildew pathogen are active from the beginning of the season

- Overwintering Oospore become active at ~120 Degree Days with base temperature of 8C
  - Happens by mid-April in Winchester...
  - Remain active for 30-60 days
- Need to protect new shoots.
- Keep your eyes on warm and humid nights (>60F, 80-90%) that promote spore production
  - (2009, 2013, 2018...)



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## Humidity drives downy mildew

- **Canopy management**
- Pre-bloom: Consider not only infection event (=rain), but also warm and humid nights (>65F and >90%) that promote spore production (2013 and 2018!)
- After bloom: Critical time runs about 4-6 weeks, protect the cluster.
- After critical time: Do not forget about downy in August!



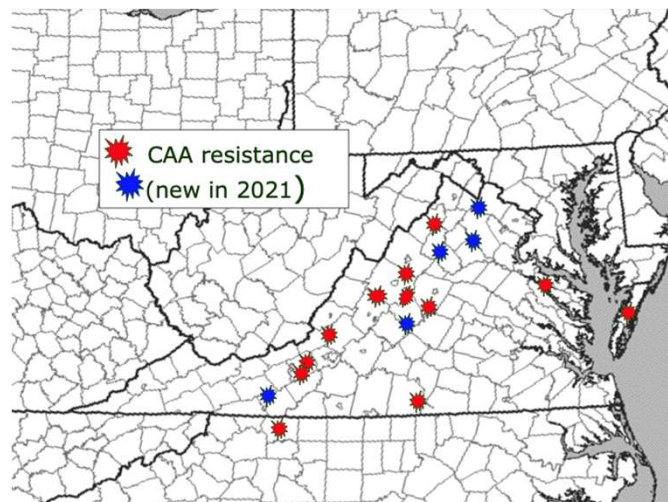
## Downy Mildew

Timing: all season  
Clusters are susceptible from bloom to 4-6 wks after bloom

- Preventative fungicide application
  - Mancozeb, ziram (Dithane, Penncozeb, Gavel, etc. Group M3), Ranman (Group 21), **Revus/Forum (Group 40 - resistance)**, Zampro (Group 40 + 45), captan (Group M4), copper (Group M1)
  - Lifeguard and Zonix (biological controls) - inconsistent reports, please use them with a caution (can be a good rotation or tank mix partner)
- Curative fungicide application (after the rain, not after you see downy!)
  - Phosphonate (Prophyt, Phostrol, etc. Group P07 (used to be 33)), Ridomil products (Group 4), Tanos (Group 11 + 27) note: we did not find a good result with Tanos in VA), Tanos need a mixing partner
  - QoI fungicides (Flint, Sovran, Abound, etc.) are no longer effective in VA.

## Group 40 (Revus, Forum, and part of Zampro)

- Dr Anton Baudoin's lab has been tracking resistance isolate against dimethomorph (the a.i of Revus), and results are not promising...
- If you suspect that Revus is not working for you, it is probably better not purchase in the future.
- If you have some, my recommendation is to use it early in the season as **protectant** and **mix** with captan, mancozeb, or copper.





## Black Rot

- It is a fungal disease caused by *Guignardia bidwellii*.
- The fungus tends to be active in relatively higher temperature ranges, and it takes about 7-8 hours to complete infection = good air circulation helps!!
- It can infect leaves and berries, berry infection can cause serious damage



## Black rot

Timing: pre-bloom to 4-6 wks after bloom

Clusters are susceptible from bloom to 4-5 wks after bloom

- Preventative fungicide options
  - Mancozeb, Sterol-inhibitors (Rally, Mettle, Rhyme, Luna Experience, Top Guard EQ, etc., **Group 3**), Strobilurins (QoI, Pristine, Abound, Flint, Intuity, Group 11), SDHI (Pristine, Luna Experience, Aprovia, Kenja, Miravis Prime, etc. Group 7)
  - Note: Captan and copper do not work against black rot**
  - There may be resistance issue with group 3 fungicides...**
- Curative fungicide options
  - Myclobutanil (Rally) is known to have a good curative (kick-back) activity against black rot fungus. It has an efficacy up to 6 days after infection.
  - Azoxystrobin (Abound) does have some curative activity against black rot fungus; however, the efficacy is not as good as that of myclobutanil.

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*Questions?*

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The slide features a white background with decorative orange dashed lines in the corners and a central wavy pattern. The word "Questions?" is written in a stylized orange font. The Virginia Tech logo is positioned in the bottom right corner.

*Powdery Mildew*



The slide displays three photographs illustrating powdery mildew on grapevines. The leftmost image is a close-up of a green leaf with a white powdery coating. The middle image shows a cluster of green grapes with some white powder on the stems and leaves. The rightmost image shows a cluster of grapes that are partially covered in white powder, with some grapes appearing darker and more affected.



The Virginia Tech logo is located in the bottom right corner of the slide.

## Powdery Mildew Management

- Canopy management for
  - Good air circulation
  - Good light penetration
- Timing for chemical management is pre-bloom to harvest
  - However, the risk of infection is low when the temperature hits 90F or higher, so, if you keep the vines clean until mid-July or so, you may not need to worry about powdery mildew.
- Young berries infected by the powdery mildew pathogen tend to crack open later, thus, early season PM management will be important for Botrytis, sour rot, and fruit fly management too!!



## Powdery Mildew

Timing: pre-bloom to harvest

Clusters are susceptible from bloom to 4-6 wks after bloom

- Sulfur (Group M2), Fixed copper (Group M1), DMI (Sterol-inhibitor, Rally, Mettle, Rhyme, Top Guard EQ (3+11), etc., Group 3), Quintec (Group 13), Vivando (50 (used to be U8)), SDHI (Pristine, Endura, Luna Experience, Kenja, Aprovia, Miravis Prime, etc. Group 7), Torino (Group U6), etc.
  - DMI: there are evidence of chemical resistance in Europe, AND good evidence of resistance development among VA isolates
  - Torino works, but not as strong as others. Good mixing partner to sulfur to have an extra kick
  - QoI (group 11) most likely not going to be help



## Sulfur injury at high temperature

- Sulfur can cause “burning” on the leaves
- Condition: the spray materials is still wet when the temperature hits 85F or higher.
- Tip: Spray in the morning (with no-dew condition) or use other materials (cupper, DMI, SDHI, Torino, Vivando, etc.)

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## Powdery Mildew Management “Curative” fungicide options


- Stylet Oil (Group M) [early season, some varieties may show phytotoxicity when applied on premature fruits];
  - **DO NOT mix oil with sulfur or captan!!!**
  - **Cannot spray within two weeks of each other**
- Potassium salt products (Group M)
  - requires through coverage, expensive!





## Botrytis management

- Timing: At bloom, bunch closure (the last opportunity to deliver fungicides inside of the cluster), and at veraison (spore availability)
- Canopy management is critical because the outbreak is often associated with a long wetness event.
- Injury management (**GBM**, Birds, PM) is also important



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## Botrytis Management Preventative fungicide options

- Group 2: iprodione (Rovral/Meteor – resistance = low/mod risk),
- Group 7 (SDHI): boscalid (Endura), Luna Experience, Kenja, Miravis Prime (– resistance = high)
- Group 9: cyprodinil (Vanguard, Inspire super, Switch- resistance = mod)
- Group 12: cyprodinil + fludioxinil (Switch – resistance = mod)
- Group 17: fenhexamid (Elevate – resistance = unknown)
- Group 19: polyoxins (Oso, Ph-D – resistance = mod)
- Group M4: captan – fair activity, but it will be a good mixing partner!
- Group M1: copper (the same comment as above)
- Please rotate among different mode of action (FRAC) groups
- These fungicides were tested for curative activity in the lab. They had some efficacy within 12 hr of infection; however, it is a lab experiment using detached berries (i.e., I wouldn't risk your vines.)

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## Ripe rot

- Caused by *Colletotrichum* species.
- We found the average of 2.7 species per vineyard in our previous survey.
- They vary in the level of susceptibility against fungicides.
- We tested 10 modes of action, but none produced satisfying results consistently.
- Our inoculation study showed clusters are susceptible to infection from bloom to harvest...



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## Ripe rot

- Cultivar susceptibility varies
  - Susceptible: Chardonnay, Traminette, Cabernet Sauvignon, Cabernet franc
  - Less susceptible: Merlot, Petit Manseng
  - **However**, even with less susceptible cultivars, we have seen outbreaks...
- Very inconsistent field test results when we rely on one product
  - Probably due to multiple species in the vineyard
  - However, a lab test with a mix of two materials produced promising results



## Mixing multiple MOA is probably the key for ripe rot management

### Mixing partners for mancozeb/ziram or captan (Timing: bloom, veraison, + 7-10 days after veraison)

Moderate level of reduction	Low level of reduction	No or limited effect
<ul style="list-style-type: none"> <li>• <b>Aprovia</b> (Benzovindiflupyr, FRAC= 7)</li> <li>• <b>Cueva</b> (Copper (M1))</li> <li>• <b>Intuity</b> (mandestrobin, (11))</li> <li>• <b>Viathon</b> (Phos acid (33) + tebuconazole (3))</li> <li>• <b>Switch</b> (cyprodinil (9) + fludioxonil (12))</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Elevate</b> (fenhexamid (17)) alt. w/ <b>Rovral</b> (iprodione (2))</li> <li>• <b>PhD</b> (polyoxin-D (19))</li> <li>• <b>Luna Experience</b> (Fluopyram (7) + tebuconazole (3))</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Endura</b> (Boscalid (7))</li> <li>• <b>Oso</b> (polyoxin-D (19))</li> <li>• <b>Rally</b> (myclobutanil (3))</li> <li>• <b>Miravis</b> (Adepidyn (7))</li> </ul>



## The same MOA provided different level of control...

### Mixing partners for mancozeb/ziram or captan (Timing: bloom, veraison, + 7-10 days after veraison)

Moderate level of reduction	Low level of reduction	No or limited effect
<ul style="list-style-type: none"> <li>• <b>Aprovia</b> (<b>Benzovindiflupyr</b>, <b>FRAC= 7</b>)</li> <li>• <b>Cueva</b> (Copper (M1))</li> <li>• <b>Intuity</b> (mandestrobin, (11))</li> <li>• <b>Viathon</b> (Phos acid (33) + <b>tebuconazole (3)</b>)</li> <li>• <b>Switch</b> (cyprodinil (9) + fludioxonil (12))</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Elevate</b> (fenhexamid (17)) <b>alt. w/ Rovral</b> (iprodione (2))</li> <li>• <b>PhD</b> (<b>polyoxin-D (19)</b>)</li> <li>• <b>Luna Experience</b> (<b>Fluopyram (7)</b> + <b>tebuconazole (3)</b>)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Endura</b> (<b>Boscalid (7)</b>)</li> <li>• <b>Oso</b> (<b>polyoxin-D (19)</b>)</li> <li>• <b>Rally</b> (<b>myclobutanil (3)</b>)</li> <li>• <b>Miravis</b> (<b>Adepidyn (7)</b>)</li> </ul>

Resistance issue with Qol fungicides...



## Ripe rot chemical management Timing of application

- Timing: at bloom, bunch closure, and veraison (you may need one or two more, if you have susceptible cultivars with a history of outbreak... **Contact me**)
- MIX mancozeb (M3), captan (M4) or a fixed copper (M1)
  - with a Qol (Pristine, Flint, Abound, FRAC = 11), Rovral (2), Switch (9 + 12), or tebuconazole (3)
  - Copper is not as effective as mancozeb or captan







## Bitter rot

- Timing: after veraison
- Materials: captan (M4) or a QoI fungicide (Abound, Flint, Pristine, Intuity, etc., FRAC = 11)
  - Copper (M1) seems to be not effective





Photo courtesy of Mike Ellis (OSU)  
Note the characteristic concentric rings of black fruiting bodies



## Sour rot management

- Timing: ~ 15 Brix
- Current recommendation is **TWO** applications of an insecticide (to control fruit flies, e.g., Mustang MAXX) plus a general fungicide (e.g., Oxidate), 7 to 10 days apart
  - Do not use Mustang Maxx more than twice a season!
- If you don't have OxiDate (NC), Switch (9 + 12) also lists sour rot (suppression only), and other broad-spectrum fungicides such as captan (M4) and fixed copper (M1), probably have some efficacy too.
- We are currently conducting field experiments:
  - E.g., Double nickel *plus* Oso (19) worked very well in one trial (but need more data)



*Questions?*



## Re-cap: Tank-mix materials to target multiple diseases and fungicide resistance management

- Please mix materials with the FRAC code starting with a number (e.g., 11, 3, 19, etc.) with a material with FRAC code starting with M which are:
  - Downy mildew and Phomopsis: Mancozeb/Ziram (M3), Captan (M4), or Copper (M1)
    - Phos acid (P07) can be used for downy mildew, but do not a) use it extensively and b) mix with a copper material
  - Black rot: Mancozeb or Ziram (M3)
  - Powdery mildew: Sulfur (M2) or Copper (M1)
  - Botrytis: Captan (M4) or Copper (M1)
  - Ripe rot: Captan (M4) or Mancozeb/Ziram (M3)

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## Acknowledgement

### 2021-22 Grape Path Team



Kenny Savia



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