

**Fungicide application planning**  
**NC Winegrower's Association Conference**  
**29 Jan 2021**

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**VCE Online meetings and workshops:**  
grapeIPM.org workshop -- 11 March and 15 April 2021  
Vineyard IPM meeting -- 17 March 2022  
Disease Management Workshop (English) -- 30 March 2022  
AND at VVA meeting (2/17)  
Disease Management Workshop (Spanish) -- 31 March 2022

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## Grape disease management resources

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

Links will be available

Horticultural & Forest Crops 2020  
**Grapes: Diseases and Insects in Vineyards**


*Douglas G. Pfeiffer, Extension Entomologist, Virginia Tech*  
*Anton B. Bandoni, Plant Pathologist, Virginia Tech*  
*J. Christopher Bergh, Extension Entomologist,*  
*Alison H. Smith Jr., AREC*  
*Mitsuo Nita, Extension Plant Pathologist,*  
*Alison H. Smith Jr., AREC*

Additional information on pest and beneficial species identification is available online at <http://www.virginia.edu/entom>. Disease updates and management information is available at <http://www.grapepathology.blogspot.com>.

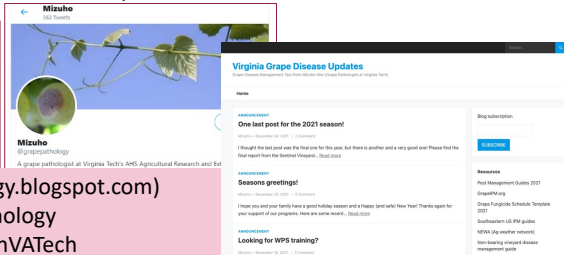
In January 2018, a new invasive insect was found in Virginia. Spotted lanternfly came to Virginia from southeastern Pennsylvania, and had been expanding its range within Frederick County. SLF feeds on more than 70 different hosts, and can cause significant injury on some.

part of the quarantine effort (<https://register.ext.vt.edu/search/publicCourseSearchDetails.do?method=load&courseId=210875&courseProgramAreaId=235776&courseProgramStreamId>). So far, SLF has not caused economic loss in our agricultural crops. Nevertheless, fruit growers should be aware of the pest's appearance, and how to handle finds you may make in your operations. For information on **SLF appearance and management in vineyards**, refer to our fact sheet (<https://www.pubs.ext.vt.edu/ENTO/ENTO32/PENTO323.html>). For updated information, visit the spotted lanternfly page in the Virginia Cooperative Extension web site (<http://www.vce.edu>). For updated control information, visit the SLF page in Virginia Fruit (<https://www.virginiafruit.com/collections/fruit>). To report suspected discoveries, please visit the SLF reporting page (<https://ask.extension.org/groups/1981/ask>).

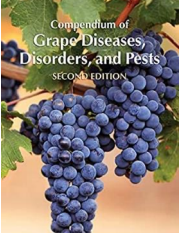
**Application rates:** The rate per acre column gives rates for low.



Grape Pathology at Virginia Tech  
@GrapePathVAtech - Agricultural Service



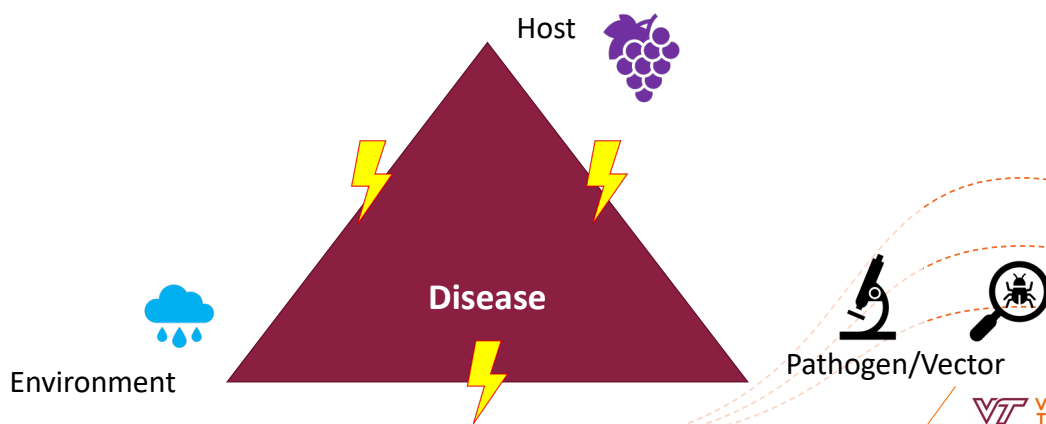
Blog (grapepathology.blogspot.com)  
Twitter @grapepathology  
Facebook GrapePathVATech



Picture is taken from publisher's websites

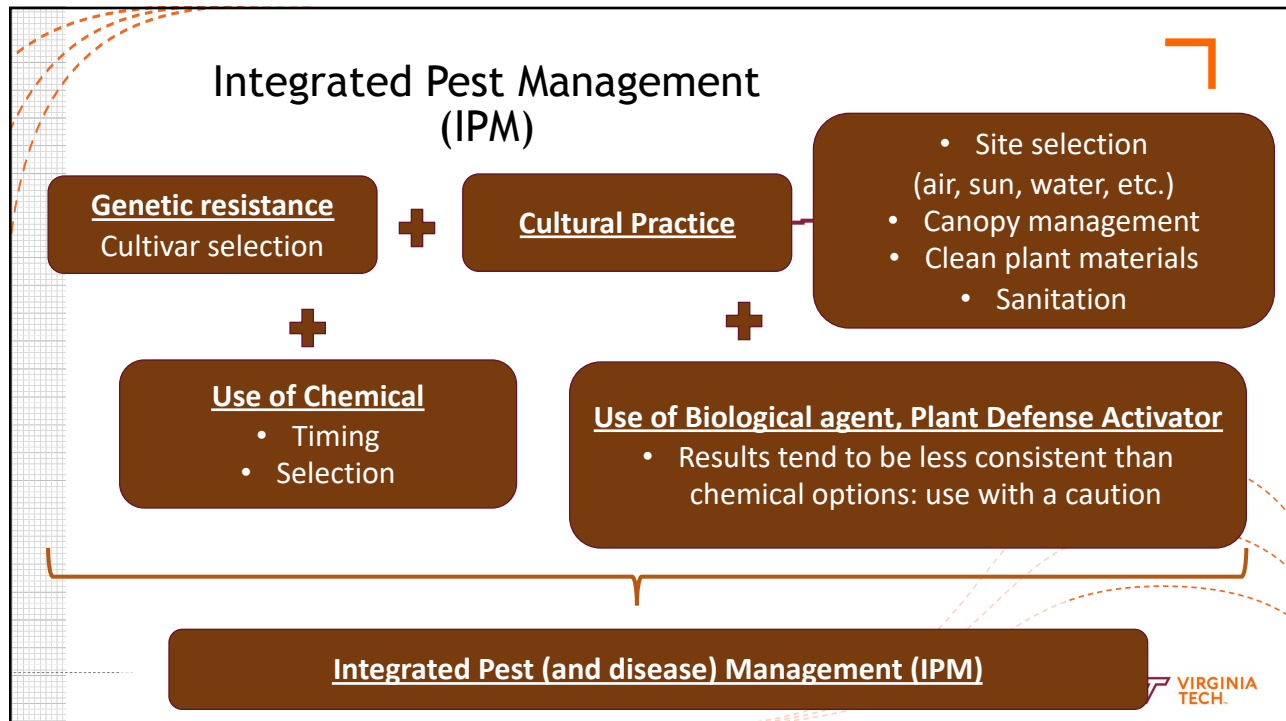
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## The management of disease = aiming to break the disease triangle



The diagram illustrates the disease triangle with three vertices: Host (top), Disease (bottom), and Pathogen/Vector (right). A lightning bolt strikes the Host-Pathogen/Vector side, another strikes the Pathogen/Vector-Disease side, and a third strikes the Disease-Host side. To the left, Environment is shown with a cloud and rain icon, connected to the triangle by a dashed line. The Virginia Tech logo is in the bottom right corner.

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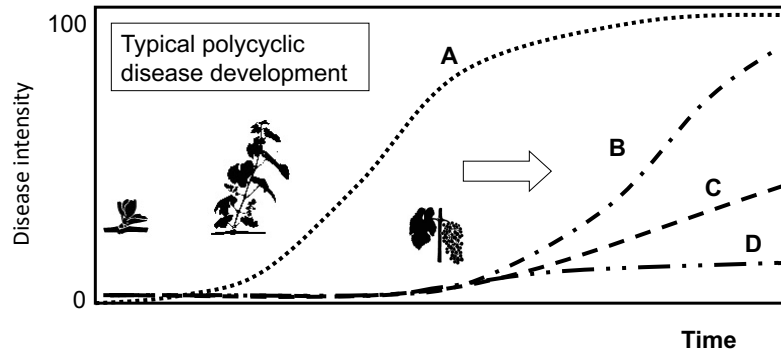
## Canopy management is a critical component of disease management

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

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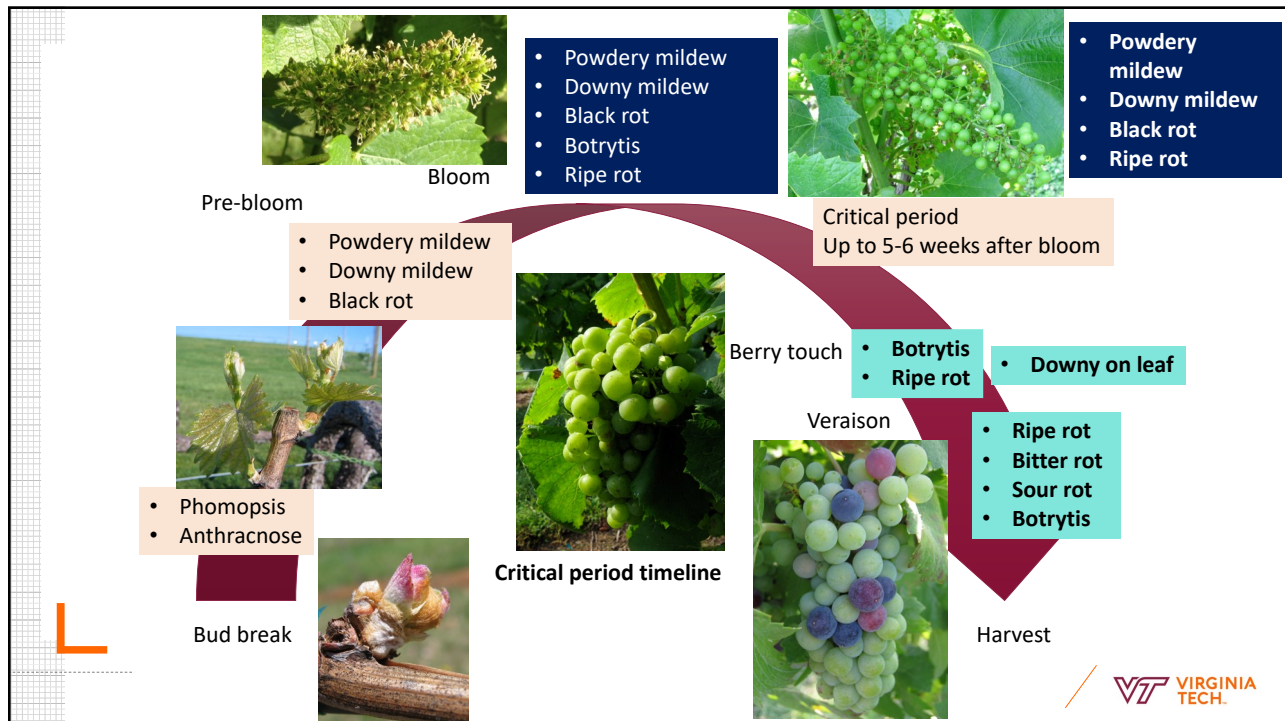
## You cannot eliminate grape diseases, manage them reasonably.



- Line A: a disease development without any management strategies.
- Idea of disease management is to increase the lag period to the point that the development of the disease is not economically significant (lines B and C).
- In the case of berry protection for BR, PM and DM, you can push the lag period to the point when the berries become resistant, then you could suppress these diseases on berries to the end of the season (line D)



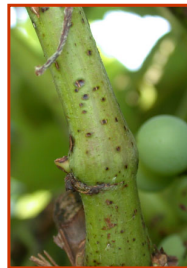
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## Phomopsis cane and leaf spot of grape

- 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.



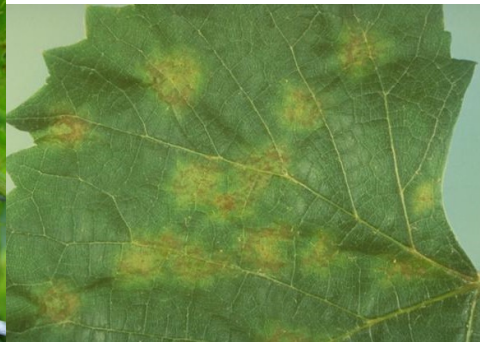
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## Downy Mildew

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



Oily spot appearance on the upper surface



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



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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!)
- Scouting: Know your vineyard!
  - Downy mildew tends to show up on a certain corner of the vineyard prior to spread to the entire vineyard



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## Downy Mildew

Timing: pre-bloom to harvest

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)
- 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), ~~Presidio (Group 43)~~, Tanos (Group 11 + 27) note: we did not find a good result with Tanos in VA), both ~~Presidio~~ and Tanos need a mixing partner
  - QoI fungicides (Flint, Sovran, Abound, etc.) are no longer effective in VA vineyards.

NIA

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## Black Rot

- It is a fungal disease caused by *Guignardia bidweillii*.
- 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



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## 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**
- 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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## Powdery Mildew



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## 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!!



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## Powdery Mildew

Timing: pre-bloom to harvest (? - risk is lower above 90F)  
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

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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!

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## 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 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 out break... *Contact me*)
- Materials: 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
- If the risk of ripe rot is not high, using iprodione may be enough.



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## Bitter rot

- Timing: after veraison
- Materials: captan (M4) or a Qol 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



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## 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)



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## 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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## Tank mixing partners

- **Please read the label!**
- Do not mix oil (of any kind) with sulfur or captan
- Do not mix copper with phosphorous acid
- Nutrients and adjuvants
  - They can cause phytotoxicity, depending on the cultivar, mix, and environment
  - Spray nutrients separately
- Water pH matters



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| Product name | a.i.           | Optimum pH | Comment                                                 | Other comment                                     |
|--------------|----------------|------------|---------------------------------------------------------|---------------------------------------------------|
| Aliette      | fosetyl-al     |            | 6 Stable at pH 4.0 to 8.0                               | Prophyt seems to adjust water pH = stable         |
| Benlate      | benomyl        |            | pH 5 = 80 hrs; pH 6 = 7 hrs; pH 7 = 1 hr; pH 9 = 45 min |                                                   |
| Bravo        | chlorothalonil |            | 7 Stable over a wide range of pH values                 |                                                   |
| Captan       | captan         |            | pH 5 = 32 hrs; pH 7 = 8 hrs; pH 8 = 10                  | Should not be mixed with oil                      |
| Dithane      | mancozeb       |            | 5 min<br>6 hrs                                          |                                                   |
| Fixed copper | copper         | ?          | ?                                                       | Should not be mixed with Phosphorous acid product |
| Rally        | myclobutanil   |            | Not affected by pH                                      |                                                   |
| Ridomil      | mefenoxam      |            | pH 5 - 9 = more than 4 weeks                            |                                                   |
| Rovral       | iprodione      |            | Chemical breakdown could take place at high pH          |                                                   |
| Orbit        | propiconazole  |            | Stable at pH 5 - 9                                      |                                                   |
| Sulfur       | sulfur         | ?          | ?                                                       | Should not be mixed with oil                      |



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# Demonstrations

- My blog: <https://ext.grapepathology.org/>
- Google sheets
- grapeIPM.org

## Online meetings and workshops:

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## Resources

- Blog: [ext.grapepathology.org](http://ext.grapepathology.org)
  - My slides will be available
  - You can find links to PMG's and other guide on the blog
- Twitter and Facebook (@grapepathology and GrapePathVATech - but please do not use Twitter or Facebook to ask questions)
- GrapelPM.org
- Email: [nita24@vt.edu](mailto:nita24@vt.edu)
- If you email me via SMS (text) or Google hangout, please state your name.

