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**3 conditions to meet for development of fungal grape diseases.**

1. Presence of pathogen
2. Environment for infection
3. Susceptible host



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*Phomopsis viticola*

- Over-winters on canes/rachises, live/dead wood
- Spores spread by spring rain
- Shoots/leaves susceptible while expanding - most infection occurs early...
- Disease development dependant on over-wintering inoculum load

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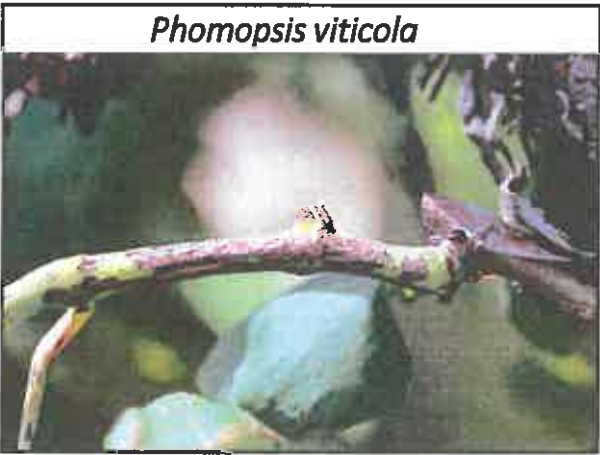
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**Reduce presence of pathogen;  
Spur vs cane prune (also br, pm)**

- Spur pruning
  - requires cordons
  - retains more old wood
  - retains more inoculum (pathogen source)



- Cane pruning systems
  - Minimizes older wood
  - Minimizes over-wintering inoculum - inoculum source is below trellis wire



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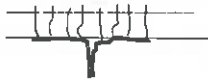
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**Trellis systems:  
reduce suscep/environ (also br, pm)**

- High wire, no tie
  - juice, hybrid wine
  - 3 D



- Vertical shoot position
  - hybrid, vinifera wine
  - 2D (aeration, sunlight, fungicides)



- Shred prunings

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**Phomopsis; Chemical Management**

- Dormant applications (spring) of fixed copper (3 lbs/A) or lime sulfur (10 gal/A) can reduce overwintering inoculum...enhance seasonal control.
- Seasonal sprays of Captan, Mancozeb, Ziram;
  - inexpensive and effective
  - protect shoots, rachises at first emergence
  - Immediate pre-bloom and 1st post-bloom sprays critical for fruit infections.
- Few spores available by mid July; infection risk low after pea sized berries (MSU and Cornell).

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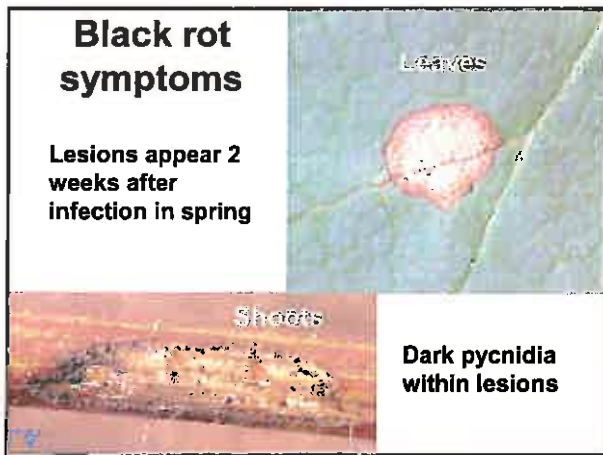
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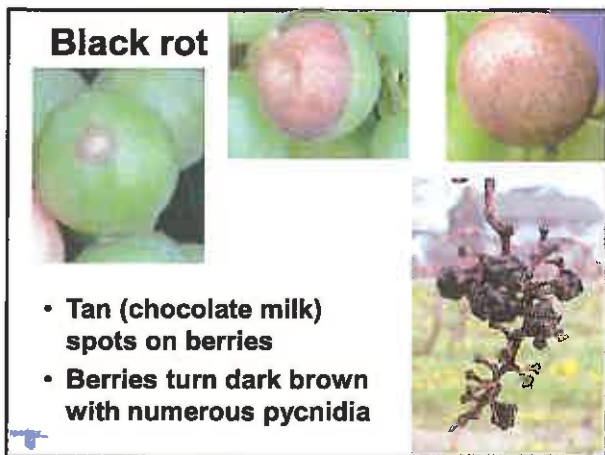
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### Black Rot; Biology/Disease Cycle

- Over-winters in infected fruit and wood on ground and in trellis.
- Spores released by rain, splashed to green tissue.
- New infections may produce inoculum in 2-3 weeks - **most fruit infection from secondary sources.**

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### Black rot

- Leaf and shoot tissue susceptible as long as still expanding.
- Fruit very susceptible from start of bloom to 3-4 (Concord) to 4-5 weeks (*vinifera*) after bloom.
- Fruit highly resistant by (Concord) to 8 weeks after



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### Cultural/Chemical control of black rot

- Reduce pathogen (sanitation)
  - remove fruit mummies; potent sources of inoculum
  - chop, plow, till into soil.
- Reduce environment/host suscep: Maximize air, light, pesticide penetration into fruit zone and canopy



- **Fungicides:**
  - Sterol inhibitors: (Rally, Elite, Mettle, Inspire Super/Revus Top)
  - Strobilurins: (Flint, Pristine, Sovran, Abound)
  - Qid Standards: Mancozeb, Ziram, Captan
  - Organic?...copper formulations

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**Powdery Mildew; *Erysiphe (Uncinula) necator***

- Affects all cultivated grapes, every season, wherever they are grown
- Affects all green tissues of the vine
- Can cause severe economic damage



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**Powdery mildew signs and symptoms: Leaves**



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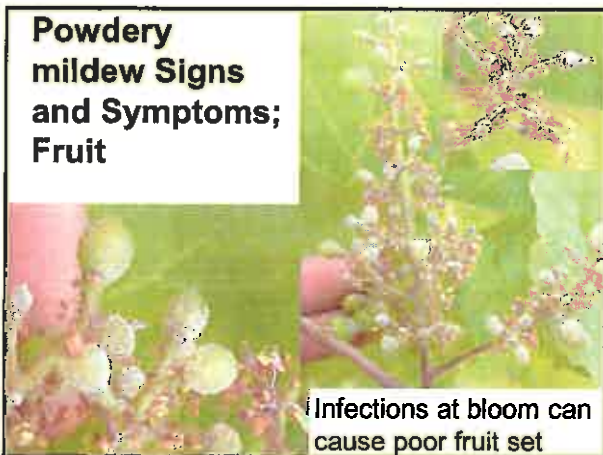
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**Powdery mildew Signs and Symptoms; Fruit**



Infections at bloom can cause poor fruit set

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## Powdery Mildew; Primary Infection Cycle

- Chasmothecia overwinter in bark
- Swell, split open during spring rain, ascospores released (0.1" rain, >50F)
- Ascospores blown to emerging tissue
- Can infect wet or dry tissue.



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## Powdery Mildew; Secondary Infection Cycles

- Spores (conidia) from primary infections wind dispersed
- Rainfall not required
- Generation time only 5-7 days under ideal conditions (constant 60s-80sF; 85% RH)



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## To manage powdery mildew on leaves, shoot, and canes

- Susceptible all season
- Pre-bloom infections provide inoculum for developing flowers/fruit.
- Mid-late season infections can lead to early defoliation, inhibit fruit/cane maturation
  - Sensitive hybrids and vinifera may need protection until veraison or beyond



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### Powdery Mildew Management; Fruit

- *Peak* fruit susceptibility period is limited
- Concord: immediate pre-bloom to 2-3 weeks post bloom
- Sensitive hybrids and vinifera: immediate pre- bloom to 4 weeks post bloom
- Best materials
- Full rates
- Best coverage
- Tighter intervals



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### Powdery Mildew; Cultural Control

- Reduce environment:
  - leaf removal/shoot thinning to maximize air circulation, sun exposure, pesticide penetration, reduce RH
  - good weed control
  - nutrient management/cover crops to limit canopies
- Reduce susceptibility
  - delay summer hedging with palissaging, minimize regrowth



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### Powdery Mildew; Chemical Control

- **Strobilurins**; Flint/Flint Extra, Sovran, Abound, Pristine
  - Combos: Luna Sensation, Quadris Top, Topguard EQ
  - **Resistance widespread; not recommended!**
- **Sterol inhibitors**; Rally, Elite/Orius/Tebuzol, Mettle, Procure/Viticure/Trionic, Rhyme, Topguard EQ
  - Combos: Inspire Super/Revus Top/Quadris Top (difenoconazole), Luna Experience (teb)
  - **efficacy slipped due to resistance**; restrict use to outside of critical fruit protection period.

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## Powdery Mildew; Chemical Control

- Quintec (quinoxifen)
- Vivando/Prolivo (metrafenone/pyriofenone)
- Torino (cyflufenamid)
  
- SDHIs: Succinate dehydrogenase inhibitors
  - Endura (boscalid)
  - Luna Experience (fluopyram + tebuconazole), Luna Sensation (fluopyram + trifloxystrobin)
  - Aprovia (benzovindiflupyr/solatanol)
  - Aprovia Top (+ difenoconazole)
  - Miravis Prime (pydiflumetofen + fludioxinil)

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## Powdery Mildew; Chemical Control Old standards, Alternatives

- Sulfur, lime sulfur
- Copper products
- Monopotassium phosphate (Nitrol)
- Potassium bicarbonate (Kalgreen, Amiteato, Mifstop...)
- Oils (Stylet, Parespray, Ultra-fine, soybean, etc...)
- Fungicides - (IMZOs, Vinyldimethylcarbamates, strobilurins, etc...)
- Biologicals: Bacillus bacteria (Serenade, Sonata), Teagro, Double nickel, etc.
- QSO, PHI-D, Tovanol (polyoxin D zinc salt)

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## Downy Mildew: *Plasmopara viticola*



Yellow "rain spots" in spring

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**Downy Mildew Signs and Symptoms;  
Underside of Leaves**

Downy  
sporulation  
on  
underside  
of leaf



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**Downy Mildew;  
Shoots**

Tissues thicken



White downy sporulation

Tissues blacken and die

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**Downy Mildew; Primary Cycle**



Over-winters as oospores in infected leaves on vineyard soil

Primary cycle: 5-6 leaf stage to fruit set

- spores released at 0.1" rain, >52F
- splashed from soil to canopy
- requires wet leaf surface for infection

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**Downy Mildew; Secondary Cycles**

- Infections sporulate at night, >95% RH
- spores blown to wet plant surfaces, infect



- 4-5 day generation time under ideal conditions
- Epidemics occur in warm, wet summers
- Hot, dry weather inhibits development

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## Downy Mildew; Management

- Leaves can be infected all season; less susceptible after fully expanding
- Clusters susceptible as soon as pathogen is active (5-6 leaf stage)
- Fruit resistant 2-4 weeks after bloom but...
- Rachises still susceptible after fruit are resistant (2-3 weeks longer?)

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## Downy Mildew; Chemical control Old Standard Protectants

- **Mancozeb, ziram**
  - protectant
  - low resistance risk
  - less rainfast
- **Captan; do not apply with other EC formulations, oils, organo-silicate surfactants.**
- **Copper; toxic to some varieties, add lime**

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### For downy mildew

- Mefanoxam (4): Ridomil Gold/MZ and CU
- Phosphorous acid (33): Prophyt, Phostrol, Reveille, Fosphite, etc.
- Mancozeb/zoxamide (22): Gavel
- **Fluopicolide (43): Presidio (no longer labeled)**
- Mandipropamid (40): Revus
- Cyazofamid (21): Ranman
- Fenamidone (11): Reason
- Ametoctradin + dimethomorph (45, 40): Zampro
- *Bacillus mycoides*: LifeGuard

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### Botrytis (*Botrytis cinerea*)

- Colonizes/Over-winters on *any* plant debris in the vineyard.
- Spores present all season; most numerous during ripening
- **Compactness** determines susceptibility and spread within cluster (berry-berry contact)



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### Reduce environ/suscep

Leaf pulling,  
shoot thinning,  
shoot positioning



- Cover crops (competition for water/N/K/etc)
- Wound management: birds, bugs, pm
- **MANAGE COMPACTNESS!**

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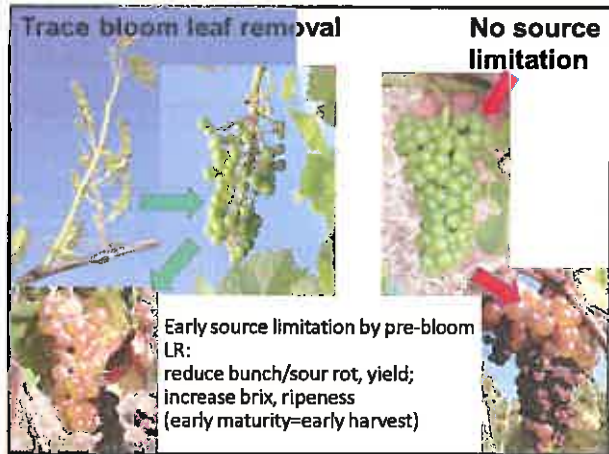
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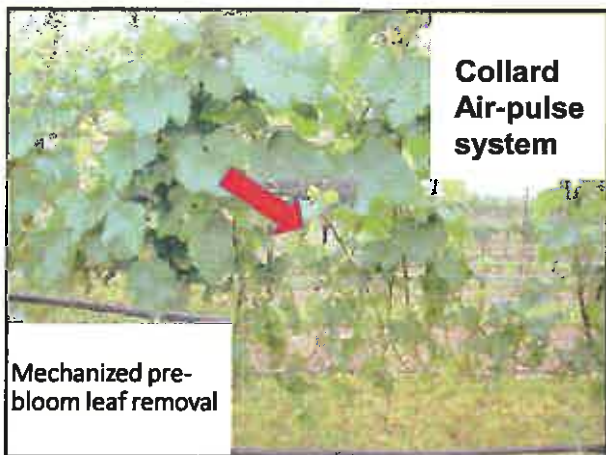
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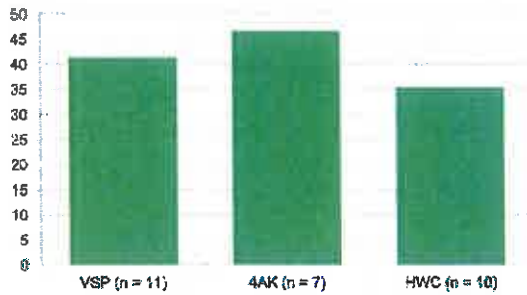
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2015-2018: Avg % leaf area removed from fruit zone (oldest 5-6 nodes) by mechanical pre-bloom leaf removal



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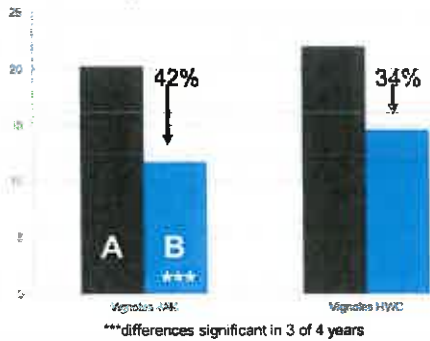
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Bunch/sour rot control with early mechanical defoliation

Vignoles over 4 years



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Botrytis; Chemical Control Timing

- **Bloom**; control latent infection if weather wet.
- **Pre-close**; last chance to reach inside of compact cluster.
- **Veraison**; protect from direct invasion from outside cluster.
- **Pre-harvest**; controls spread until harvest, especially if wet.



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### For Botrytis: chemistries

- Vanguard, Inspire Super (cyprodinil), Scala (pyrimethanil)
- Switch (relatively new) – cyprodinil (systemic) + fludioxonil (contact)
- Elevate (fenhexamid)
- Rovral, Meteor (iprodione) - efficacy improved with surfactant
- Strobilurins - Flint effective at 3 oz rate, Pristine at 18.5-23 oz rate, Intuity at 6 fl oz rate.
- SDHIs: Endura (boscalid), Luna Experience (fluopyram), Miravis Prime - effective against Botrytis and powdery mildew.
- Alts: Fracture, Botector, Ph-D/OSO/Tavano (PolyD)
- Rotate, rotate, rotate!...no more than 2 apps of any chemistry per season.

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### Smile...

Spring is just around the corner!



Thanks to PA Wine Marketing and Research Board, NY Wine and Grape Foundation, LERGP, Certis USA, Kaken, Syngenta, Valent

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