

# Grape Downy Mildew

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## Downy Mildew

- Caused by the oomycete *Plasmopara viticola*
- Infects all green tissue types but first symptoms are generally seen on leaves



Downy Mildew on Upperside of Leaves (Red Variety)





## Downy Mildew on the Underside of Leaves

Right Image: Ontario Grape IPM, OMAFRA



- A. Pre-bloom flowers, pedicels, and rachis
- B. Pedicel prior to appearance on berry
- C. Berry discolouration
- D. Necrotic pedicels prior to appearance on berry
- E. Sporangioophores on berry
- F. Sporangioophores on berry

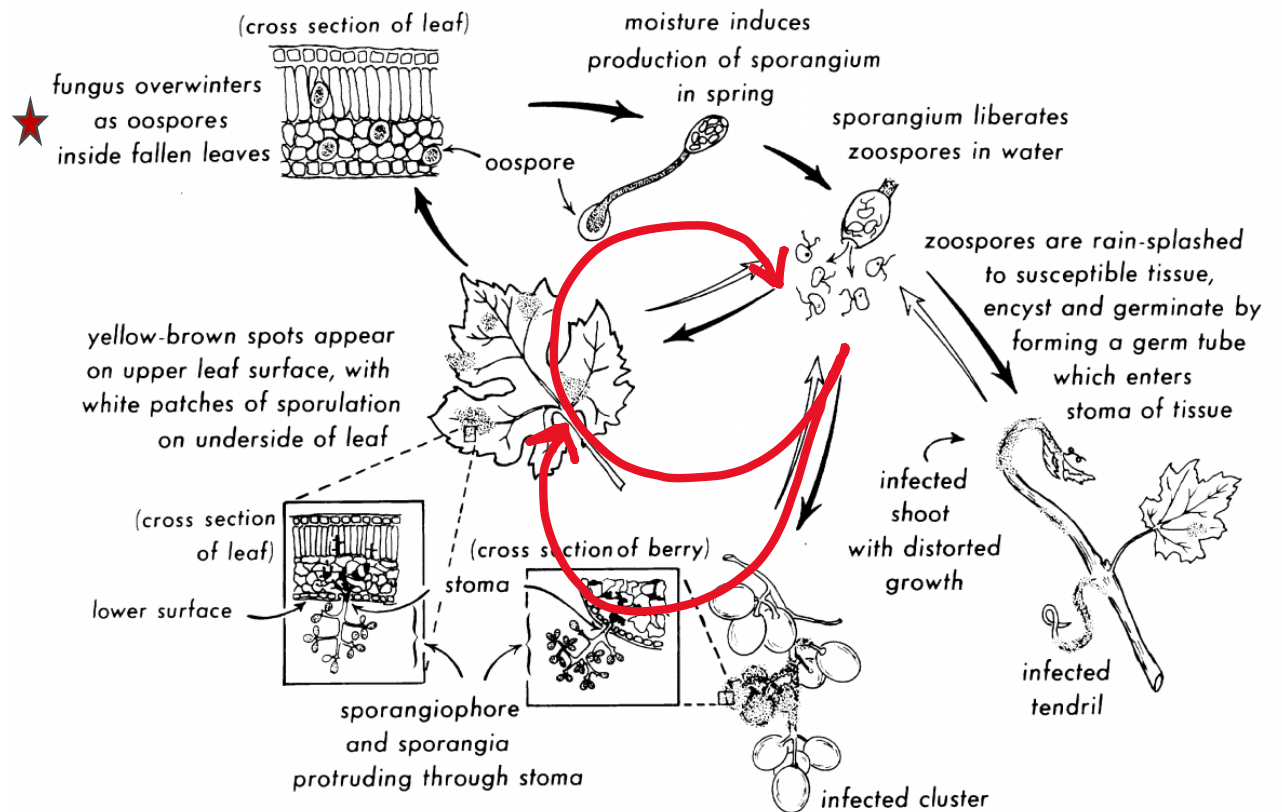
Kennelly et al. 2006. Phytopathology 95:1445



# Downy Mildew Disease Cycle

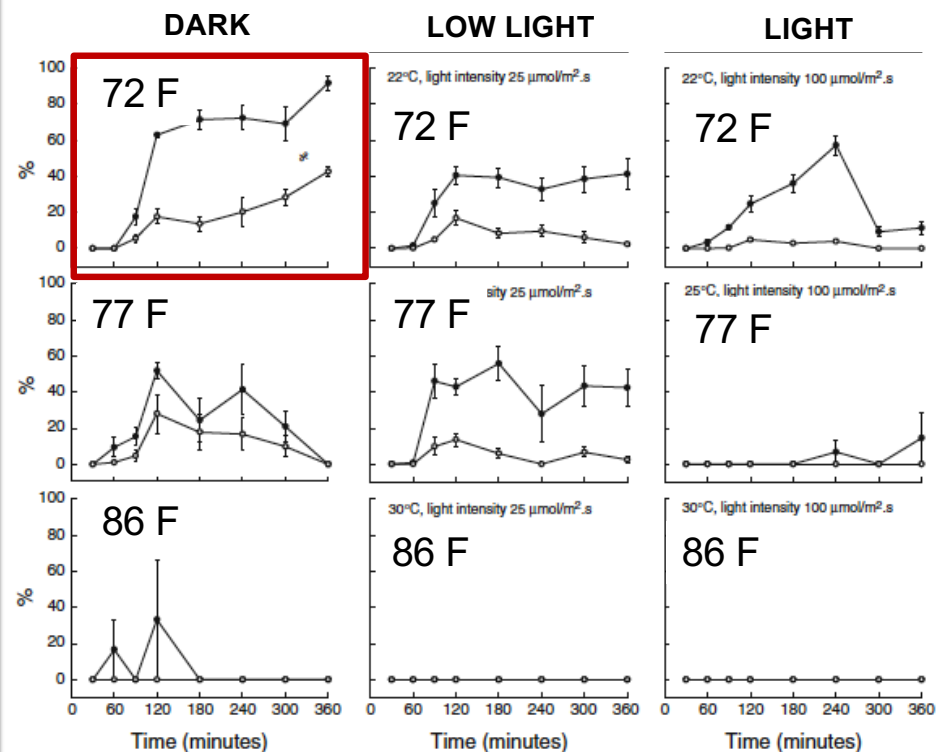
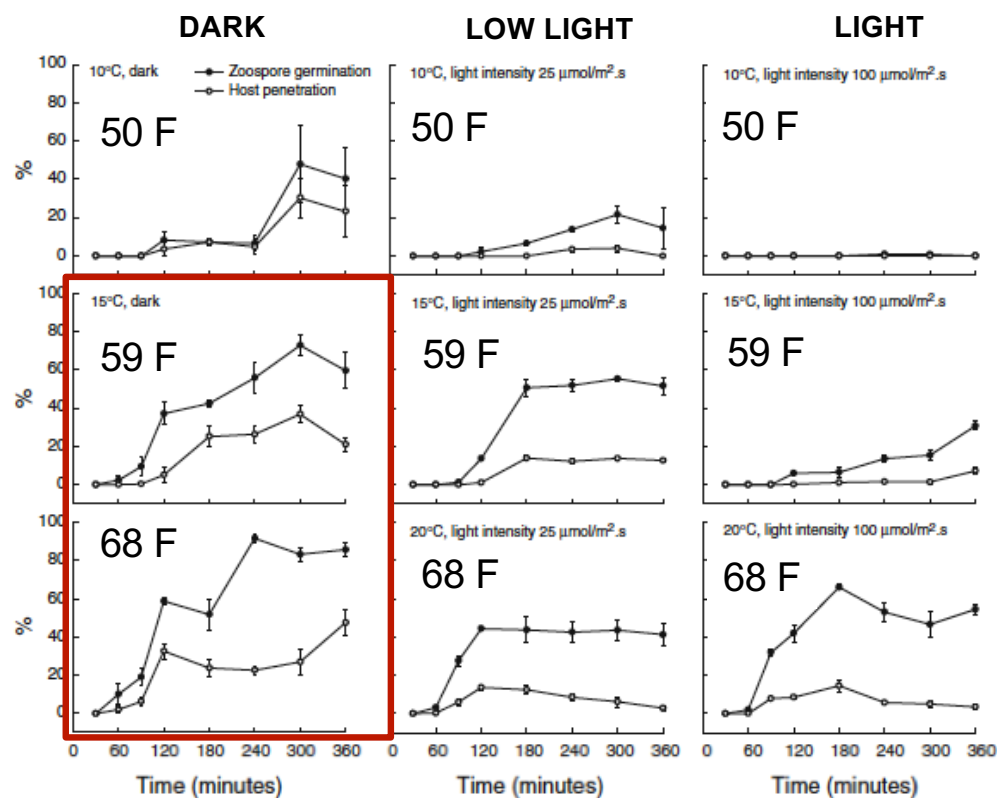
- Oospores-overwintering structure
- Sporangia
- Zoospores-primary inoculum

- Mild Temperatures (64-76 F)
- Free moisture (rain)
- High Humidity





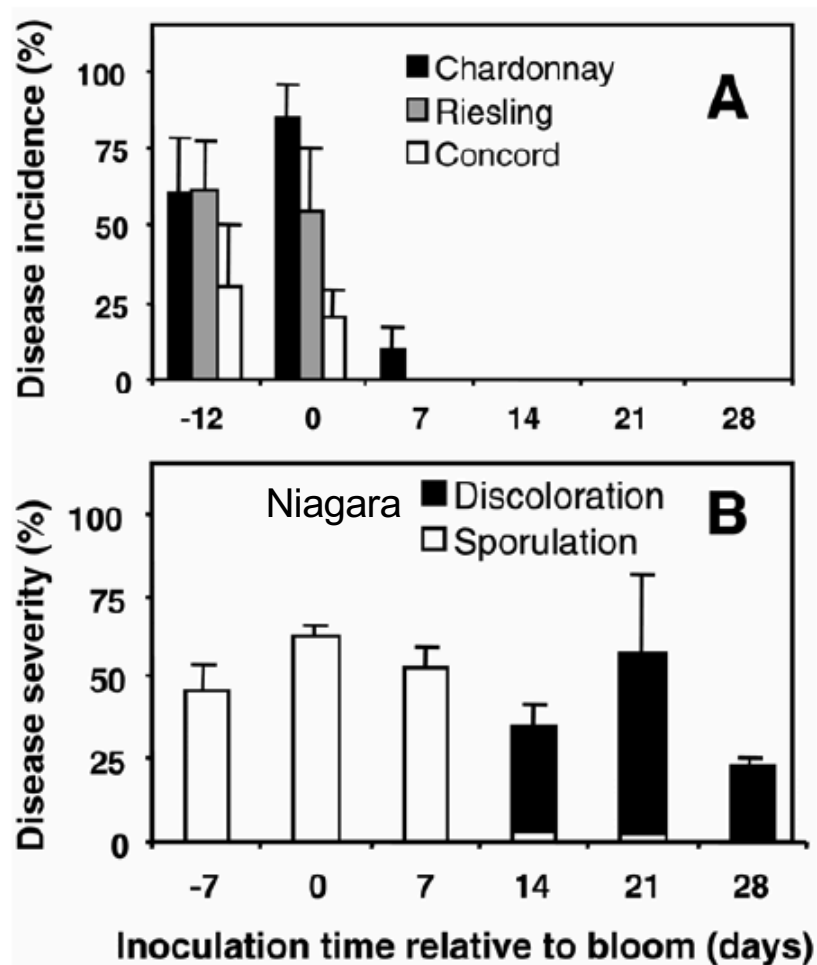


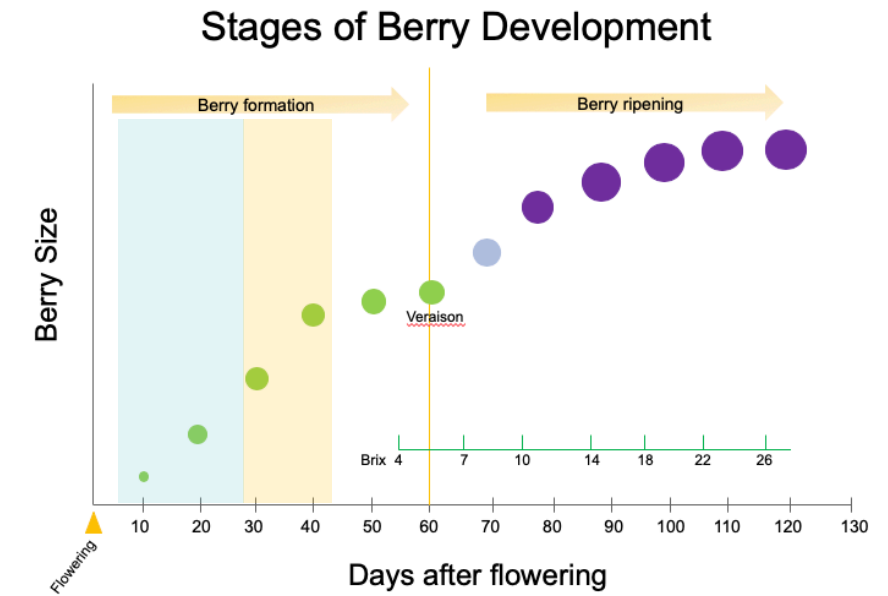
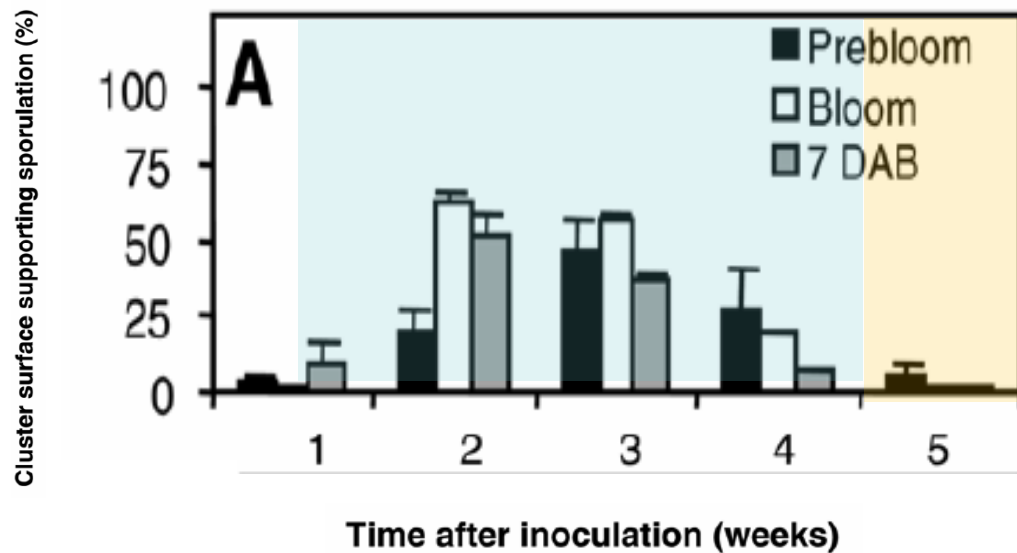


Temperature and light intensity affect zoospore germination and host invasion



- Disease incidence is highest pre-bloom and at bloom
- Post-bloom infected berries show symptoms but do not sporulate





Kennelly et al. 2006. Phytopathology 95:1445

- By five weeks post-bloom sporulation on clusters stops
- Attributed to conversion of stomata to lenticels and the onset of resistance



# Considerations for Management of Primary Infections

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- Overwinters as oospores in leaf tissue
- Sporangia produce the primary inoculum source (zoospores)
- Spores released at  $>52^{\circ}\text{F}$  and high humidity
- Clusters are most susceptible while stomata are functional
  - 1-2 weeks pre-bloom to 3 to 5 weeks post bloom

# Considerations for Management of Secondary Infections

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- Shoot to shoot infection cycles
  - wound required to infect berry and re-sporulate
- Spores released at night, 64-76 F, and > 95% relative humidity
  - 4 to 5-day generation time
- Spores are wind blown or splashed





# Integrated Disease Management

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- Host resistance
  - All cultivars of *V. vinifera* are susceptible
- Ontogenic resistance for clusters
- Forecast models
- Cultural practices
- Sanitation practices
- Fungicides
- Plant Immune System Activators





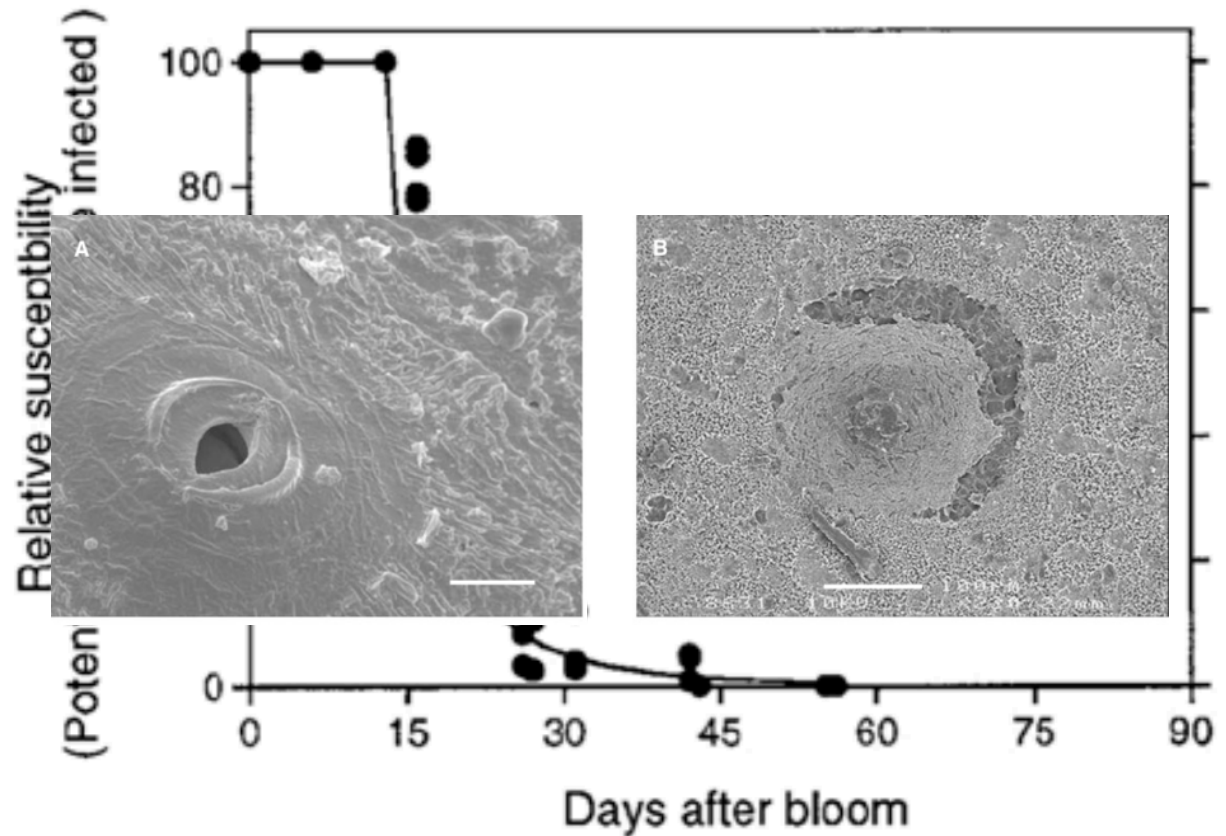
## Critical Period For Disease Control of Clusters

- Infections occur at night when temperatures are between 64-76 F)

# Ontogenic Resistance in Grape

- Begins as the grapes enter veraison (3 to 4 weeks post bloom)
- Occlusion of the stomata with waxes

Ficke et al. 2002. Phytopathology 92:671  
 Rogiers et al. 2017. Front. Plant Sci. 8:1629  
 Rogiers et al. 2005. Aus. Plant Pathol. 34:221



Development of ontogenic resistance to powdery mildew (*Erysiphe necator*) in berries of *Vitis vinifera*.



Spray No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Growth Stage	Dormant	Bud Break	1 inch	3-5 inch	6-9 inch	10-12 inch	Pre-bloom to early bloom	Pre-bloom to early bloom	(1st post-bloom)	Pea-size (2nd post-bloom)	Pea-size (3rd post-bloom)	Berry Touch (4th post-bloom)	Berry Touch (5th post-bloom)	Veraison	Pre-harvest	
	Anthracnose		Phomopsis									Botrytis Bunch Rot				
	Sulforix		Mancozeb (M)	Mancozeb (M)	Mancozeb (M)	Mancozeb (M)						Vangard (9)	Vangard (9)	Endura (7)		
	Powdery Mildew															
			Stylet Oil	Sulfur (M) or LifeGard	Sulfur (M) or LifeGard	Revus Top (40+3)	Inspire Super (3+9)	Pristine (7+11) or Sulfur (M)	Quintec (13)	Torino (U6)	Quintec (13) or LifeGard	Torino (U6)	Vivand (U8) or LifeGard	Potassium salts		
	Downy Mildew															
			Mancozeb (M)	Mancozeb (M)	Mancozeb (M)	Revus Top (40+3)	Zampro (45+40)	Pristine (7+11)	Captan (M) or Mancozeb (M)	Captan (M) or Mancozeb (M)	Captan (M)	Captan (M)	Captan (M)	Potassium salts or Revus (40)		
					Black Rot											
				Mancozeb (M)	Revus Top (40+3)	Inspire Super (3+9)	Pristine (7+11)	Captan (M) or Mancozeb (M)							Captan (M) or Mancozeb (M)	
								Critical Period								

# Critical Period for Fungicide Applications

- During this time you must protect the clusters from infections

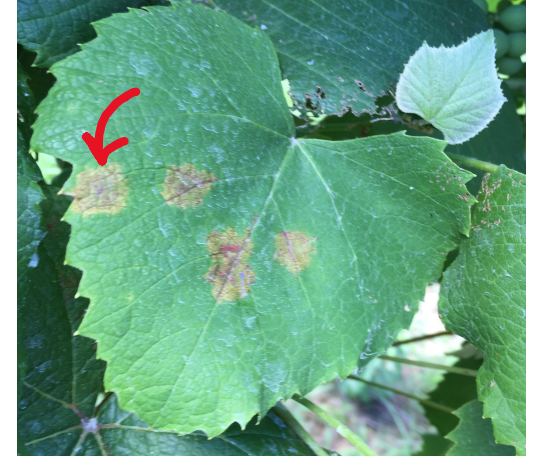
# Disease Prediction and Forecasting Models

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- DMCast
  - Phenology: Eichorn and Lorenz growth stage 12
  - Rain: 0.1 inch or more
  - Temperature: 52 F or higher

9 to 19 days later symptoms appear

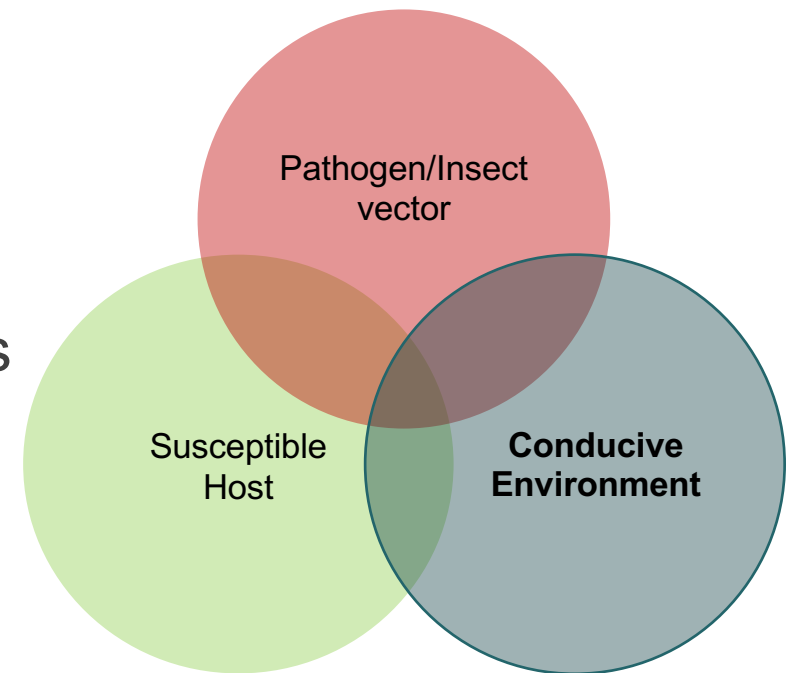
- Post-infection Application Strategy
  - Scout vineyard (200 vines or more)
  - Spray when  $\geq 2$  oilspots/50 vines



# Cultural Practices to Reduce Conditions Conducive to Disease

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- Canopy microclimate is a major influence on disease development
  - Light intensity affects zoospore germination
  - Low relative humidity (<50%) reduces sporulation
  - Good airflow reduces spore dispersal







## Cluster Zone Leaf Removal

- Removal of selected leaves from the area around the fruit cluster



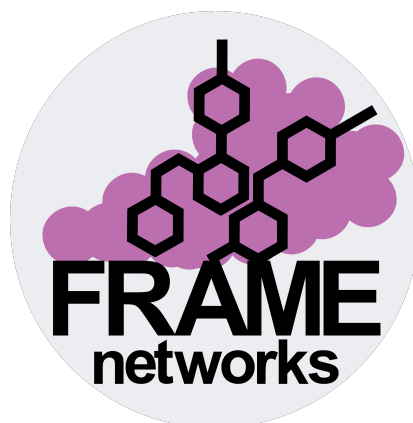


Powdery Mildew



Downy Mildew

Accurate Diagnosis is Critical



Viticulture and  
Enology Program

WASHINGTON STATE UNIVERSITY