

SIFTING AND WINNOWING TO IDENTIFY FUNGAL PATHOGENS CAUSING PROBLEMS IN MISSOURI VINEYARDS

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Grape and Wine Institute

Thursday, March 10, 2022

If you combine wine and dinner,
the new word is winner.

MEME

A decorative graphic consisting of several parallel white lines of varying lengths, slanted upwards from left to right, located in the bottom right corner of the slide.

- ▶ Academics/Science/Research
 - ▶ Focus on new pathogens
- ▶ The Industry
 - ▶ Focus on current pathogen threats
- ▶ Extension
 - ▶ Inform industry of new pathogens
 - ▶ Provide management information

SIFTING AND WINNOWING



- ▶ GRBV Update
- ▶ *Pestalotiopsis* spp. Update
- ▶ *Drosophila* Update
 - ▶ Dave Kang USDA
- ▶ Cultivar Trial
- ▶ Grape Virus Trial

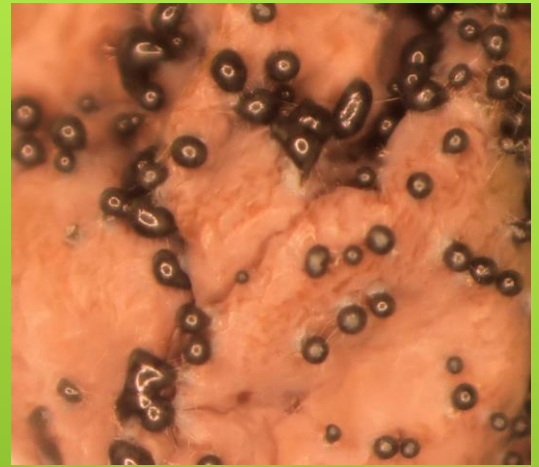
ACADEMICS/RESEARCH





GRBV





PESTALOTIOPSIS SPP.

Table 1. Insecticides in which fruit flies *Drosophila* spp. have developed cross-resistance from a vineyard in Missouri in 2020 and New York state in 2018.

Trade Name	Common Name	IRAC	Sub-group or active ingredient
Assail	acetamiprid	4A	Neonicotinoids
Malathion	malathion	1B	Organophosphates
Mustang Max	zeta-cypermethrin	3A	Pyrethroids/ Pyrethrins

DROSOPHILA SPP.



CULTIVAR TRIAL





10W14N



OTHER NOTABLES

- ▶ NC-6 (white) Norton x Cabernet sauvignon, MSU Wenping Qiu
 - ▶ Loose clustered Vignole selections
 - ▶ Nine *V. vinifera* cultivars
 - ▶ Petite Manseng
 - ▶ Petite Verdot
 - ▶ Regent
 - ▶ Gruner veltliner
 - ▶ Cabernet franc
 - ▶ Saperavi
 - ▶ Alberino
 - ▶ Kerner
 - ▶ Lemberger
- 



108 Norton
60 Chardonel
84 Vidal
blanc

HARC PLANTING

HARC PLANTING

- Norton
 - Healthy, GRBV, GLRaV3, GLRaV2, GLRaV2RG
GRBV+GLRaV3, GLRaV2RG+GLRaV3
 - Chardone l
 - Healthy, GRBV, GVCV, GLRaV3, GRBV+GVCV
 - Vidal blanc
 - Healthy, GVCV, ToRSV, GLRaV2+GLRaV3,
GVCV+GLRaV2+GLRaV3,
ToRSV+GVLRaV2+GLRaV3,
GVCV+ToRSV+GLRaV2+GLRaV3
- 

Why is this
information not
going viral?
Like a MEME

- ▶ Academics/Science/Research
 - ▶ Focus on new pathogens
- ▶ The Industry
 - ▶ Focus on current pathogen threats
- ▶ Extension
 - ▶ Inform industry of new pathogens
 - ▶ Provide management information

SIFTING AND WINNOWER

- ▶ Protective Disease Management
- ▶ Postmortem Disease Management

DISEASE MANAGEMENT PROGRAMS





Postmortem



Protective

- ▶ 12 – week plan
 - ▶ ½-inch shoot to 4 to 6 weeks post bloom
 - ▶ April 15 to July 15
- ▶ Focus on persistent disease pathogens

PROTECTIVE DISEASE MANAGEMENT PLAN



	Budbreak	Pre-bloom	Bloom	1 st and 2 nd Post-bloom	Cluster closing	Veraison	Harvest	Leaf drop
Anthraco nose	+++++++	++	++	++	++	+	+	+
Phomopsis	+++++++	+++++	+++++	+++	++	++++	+++++++	+++
Black rot	+++	+++++	+++++++	+++++++	++	0	0	0
Powdery Mildew	++	+++	+++++	+++++	+++++	+++++++	+++++++	+++++++
Downy Mildew	++	+++	+++	+++	+++++	+++++++	+++++++	+++++++

+, ++, +++, etc. denotes fungus activity

+++++++ denotes appropriate time to spray

WHEN ARE PATHOGENS ACTIVE

- ▶ Mancozeb containing products
 - ▶ Phomopsis, Black rot, Downy mildew
- ▶ Ziram
 - ▶ Comparable activity as mancozeb on Black rot
 - ▶ Reduced activity on Phomopsis and Downey mildew compared to mancozeb
- ▶ Captan
 - ▶ Phomopsis
 - ▶ Reduced efficacy on Black rot compared to Mancozeb

1/2" -SHOOT TO IMMEDIATE PRE-BLOOM



Ziram being discontinued
December
2022

- ▶ Mancozeb containing products
 - ▶ Phomopsis, Black rot, Downy mildew
- ▶ ~~Ziram~~
 - ▶ ~~Comparable activity as mancozeb on Black rot~~
 - ▶ ~~Reduced activity on Phomopsis and Downey mildew compared to mancozeb~~
- ▶ Captan
 - ▶ Phomopsis
 - ▶ Reduced efficacy on Black rot compared to Mancozeb

1/2" -SHOOT TO IMMEDIATE PRE-BLOOM

- ▶ 4 to 6 weeks after bloom
 - ▶ Grape berries develop age related resistance to infection from
 - ▶ Black rot
 - ▶ Powdery mildew
 - ▶ Downey mildew
- ▶ Other green tissue remains susceptible to infection
 - ▶ Focus on keeping canopy intact to ripen fruit
 - ▶ Powdery mildew
 - ▶ Downy mildew
 - ▶ Rots

AGE RELATED RESISTANCE OF FRUIT



Florets separate from
inflorescence

IMMEDIATE PRE-BLOOM



50% of flowers open on
50% of inflorescences

BLOOM

- ▶ Immediate Pre-Bloom to Post-Bloom
 - ▶ Rots: Phomopsis, Bitter rot, Botrytis
 - ▶ After bloom fruit highly susceptible to disease infection
- ▶ Apply
 - ▶ QoI (Frac 11) Stobies; Flint Extra, Pristine (11+7), Sovran and other Frac mixes
 - ▶ DMI (Frac 3) Mettle, Rally, Tebustar
 - ▶ Typically tank mixed with Captan or Mancozeb (66 day PHI)

CRITICAL PERIOD OF DISEASE
PROTECTION



- ▶ Limit applications to two per growing season of Frac code 3 and 11
- ▶ Non-sequential applications
- ▶ Tank mix with Captan or mancozeb products

FUNGICIDE RESISTANCE

A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, located in the lower right quadrant of the slide.

- ▶ Black rot, Phomopsis, Anthracnose can all cause fruit rot
- ▶ Bitter, Ripe and Sour rots

THE ROTS

A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right, set against a dark green background.

- ▶ Black rot, Phomopsis, Anthracnose can all cause fruit rot
- ▶ Bitter, Ripe and Sour rots



SporeQuell is
not going to
be available

THE ROTS

- ▶ Can infect at bloom and remain quiescent
- ▶ Disease process starts once secondary ripening phase begins
- ▶ Stobilurins and mancozeb provide good control
- ▶ DMI (Frac code 3) not effective: Rally, Tebuzol, Mettle, Procure
- ▶ No age related resistance to Bitter rot unlike Black rot
- ▶ Bitter rot often confused with Black rot

BITTER ROT

GREENARIA UVICOLA

	Black rot	Bitter rot
Symptoms on berries	Fruit set to 4 to 6 weeks after flowering	At veraison
Appearance on berry	Sooty	Sooty (will stick to fingers if wet)
Progression on berry	Mummy	Mummy
Primary infection spore source	Mummy berries	Mummy berries
Berry age related resistance	4 to 6 weeks after flowering	No age related resistance
Disease Management Period	Bud burst to 4 to 6 weeks post bloom	Bloom to Harvest

- ▶ Late season rot
- ▶ Captan, Ziram, Strobilurins (FRAC 11)
- ▶ Switch (FRAC 9+12)
 - ▶ *C. acutatum* complex
 - ▶ *C. gloeosporioides* complex
 - ▶ Note: should also have activity on *Pestalotiopsis* spp. and *Neopestalotiopsis* spp.
- ▶ Disease management typically is reduced as the harvest season approaches thereby providing an opening for Ripe Rot

RIPE ROT

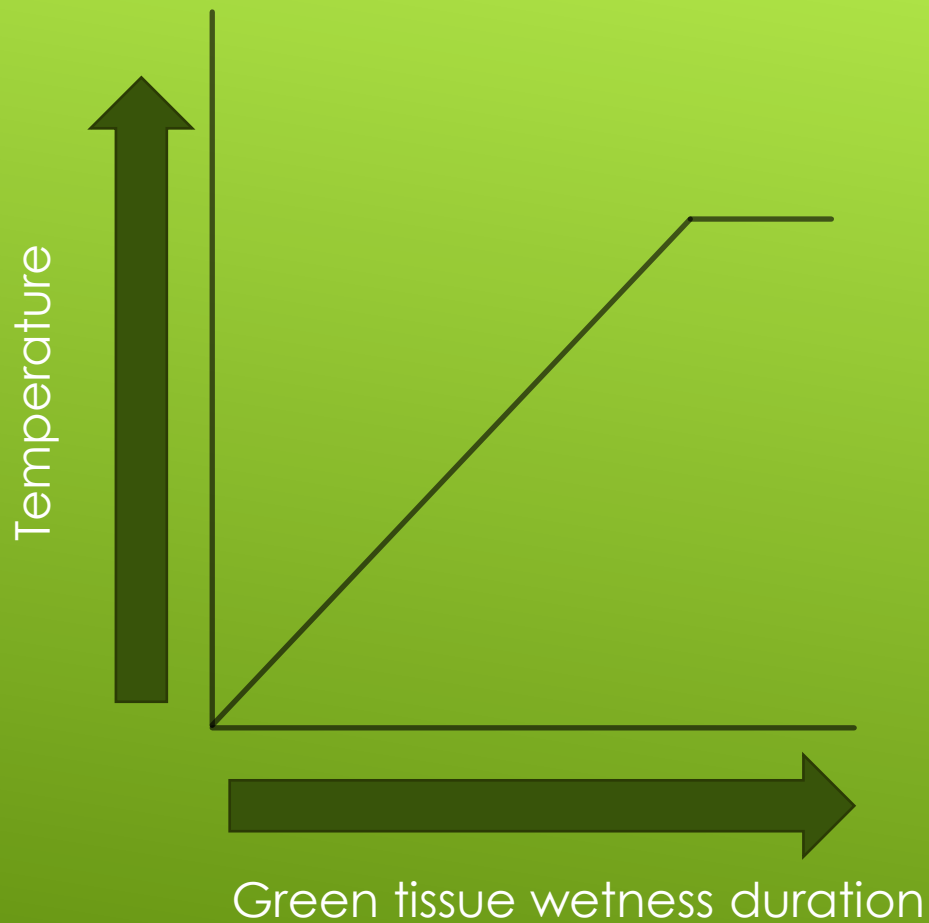
COLLETOTRICHUM GLOEOSPORIOIDES



RIPE ROT
COLLETOTRICHUM GLOEOSPORIOIDES

- ▶ Protective Disease Management
 - ▶ You know the pathogen is present but you can't see it.
 - ▶ Similar to pre-emergent weed management
- ▶ Reactive Pest Management
 - ▶ You can see the weeds. Post-emergent weed management
 - ▶ You can see the insects. Japanese beetles

LET ME BE CLEAR



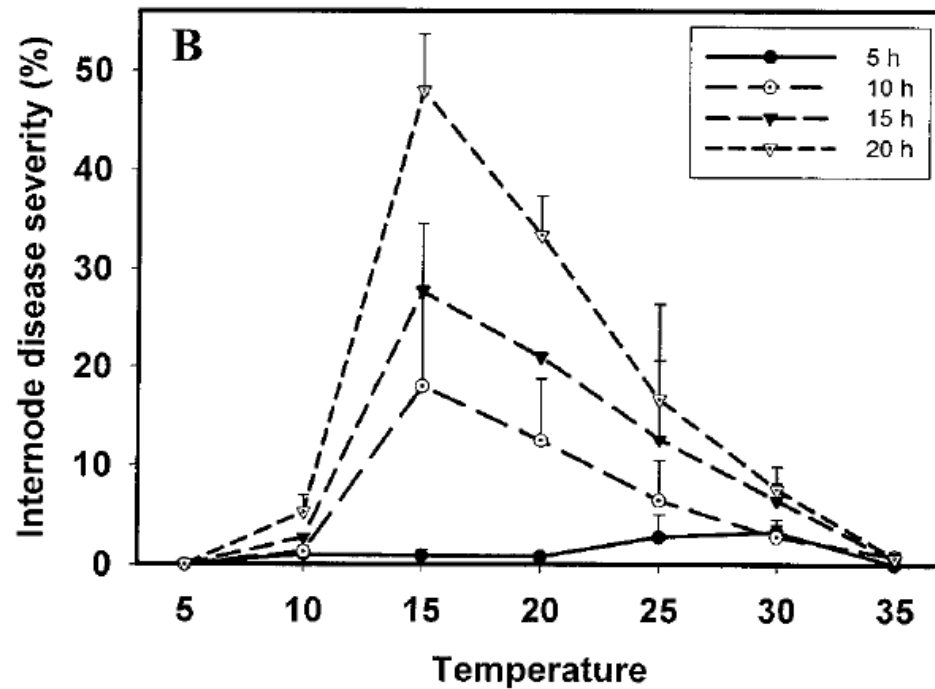
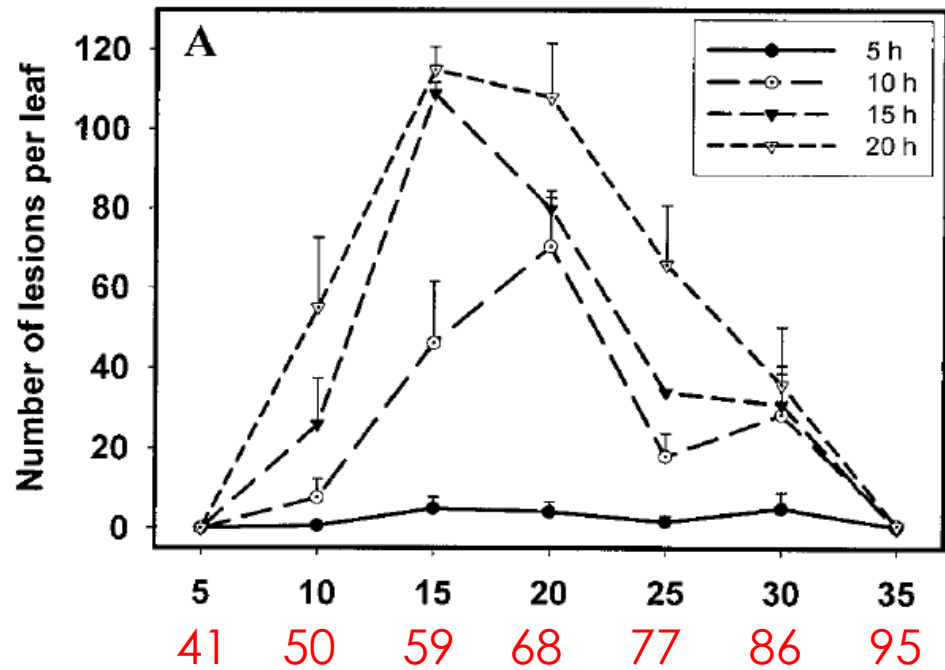
INFECTION BY ANTHRACNOSE,
BLACK ROT, PHOMOPSIS, DOWNY
MILDEW



BLACK ROT

Temperature	Leaf Wetness
(F)	(Hours)
45	No infection
50	24
55	12
60	9
65	8
70	7
75	7
80	6
85	9
90	12

PHOMOPSIS



Spore
release
lower limit is
41 °F

- ▶ Rainfall event shortly after a spray cover has been applied
- ▶ Nearing the end of your protective cover and rainfall predicted
- ▶ Highly disease susceptible grape cultivar

WHEN SHOULD A SPRAY
INTERVAL BE SHORTENED



- ▶ Currently sell 1.16 million gallons of wine annually
- ▶ If 1,700 acres x 3.5 tons/acre x 160 gallons/ton = 952,000 gallons/wine
- ▶ Currently sell 1.16 million gallons of wine – 952,000 = 208,000 gallons
- ▶ Or short:
 - ▶ 208,000 gallons of wine
 - ▶ ~1,300 tons of fruit
 - ▶ ~ 370 acres

NUMBERS-WHY THIS IS ALL IMPORTANT

Loss	Loss¹	Total¹	Wine²
%	tons	tons	gallons
5	0.175	3.325	904,400
10	0.35	3.15	856,800
15	0.525	2.975	809,200
20	0.7	2.8	761,600
25	0.875	2.625	714,000
30	1.05	2.45	666,400
35	1.225	2.275	618,800
40	1.4	2.1	571,200

¹Based on 3.5 tons/acre.

²Based on 1,700 acres and 160 gallons/ton.

YIELD LOSS

- ▶ Occurrences
 - ▶ New pests appear
 - ▶ Pesticide resistant pests appear
 - ▶ Spray timing
 - ▶ Spray coverage/calibration
 - ▶ Climate or rainfall
 - ▶ Human error; loading mixing, wrong chemical

POSTMORTEM DISEASE
MANAGEMENT



- ▶ Determining what went wrong
 - ▶ What is the pathogen
 - ▶ What was the spray program
 - ▶ What is the cultivar

POSTMORTEM DISEASE MANAGEMENT



- ▶ If you do everything right in a preventative disease management program
- ▶ I should not have to show you these anymore!!

POSTMORTEM DISEASE
MANAGEMENT





BLACK ROT





PHOMOPSIS



Phomopsis (*Phomopsis viticola*)

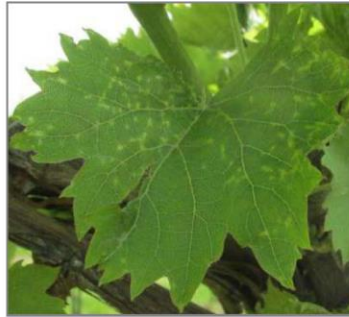
Phomopsis is caused by a fungal pathogen. Small dark spots develop on leaves, often with a small yellow halo. When severe, these spots may come together to form one, and the entire leaf becomes malformed. Infected shoots develop distinctive necrosis mostly limited to the first three internodes. This necrosis is often associated with deep fissures in the young bark that run up and down the shoot, generally from 5-15mm long, surrounded by dark brown to black necrosis. Phomopsis has a life cycle of 21-30 days and spreads slowly within the vineyard, but if left unchecked it can be severely debilitating to individual vines.



D. S. Vollenberg



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DOWNY MILDEW





POWDERY MILDEW





ANTHRACNOSE



- ▶ Once buds are swollen watch the forecast temperatures
 - ▶ 1/2" –shoots are small and Phomopsis spores are much smaller
- ▶ Flowering is driven by temperature
 - ▶ It's all over in 3 to 5-days typically

NEED TO KEEP AN EYE ON
PHENOLOGY

A decorative graphic consisting of several parallel white lines of varying lengths, slanted diagonally from the bottom right towards the top right of the slide.

- ▶ Powdery mildew-High PM pressure
 - ▶ 200 to 400 gallons water/acre
 - ▶ 1 to 2% Horticultural mineral oil within 2-days of water
 - ▶ Be aware if you have been applying sulfur
 - ▶ Fungicide within 5 to 7-days of oil
- ▶ Powdery mildew-low to moderate PM pressure
 - ▶ Bicarbonates
- ▶ Downy Mildew
 - ▶ Phosphorous acids
 - ▶ Followed by fungicide

RESCUE TREATMENTS

- ▶ Preventative Disease Management for the Persistent five Pathogens
- ▶ Focus period: ½"-shoots to 4 to 5 weeks post bloom
- ▶ You need a 12-week Disease Management **Plan**
 - ▶ April 15 to July 15
- ▶ Recognize past disease problems in your vineyard when planning
- ▶ Very difficult to rescue a disease infested crop
- ▶ Do not apply highly selective fungicides such as FRAC 3 and 11 to highly disease infested vineyards
- ▶ Postmortem disease management helps us learn but certainly fails to pay the bills

SUMMARY



UPDATE

CHLORPYRIFOS (E.G. WARHAWK,
LORSBAN) BANNED BY EPA

- ▶ Grape and Wine Institute University of Missouri
- ▶ Missouri Wine and Grape Board Marketing
- ▶ Missouri Wine and Grape Board
 - ▶ Technical Committee
 - ▶ Marketing Committee



THE MISSOURI GRAPE AND WINE
INDUSTRY TODAY - SUPPORT

Weekly Grape IPM Scouting Reports

Subscribe to our newsletter

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INFORMATION



Cultivar	Black rot	Downy Mildew	Powdery Mildew	Phomopsis	Anthracnose
Chambourcin	+++	+	+++	+	+
Chardonel	++	++	++	+++	+
Norton	+	++	+	+	+
Noiret	+++	++	++	+	+
Vignoles	+	++	+++	++	+++

+ slightly susceptible, ++ moderately susceptible, +++ highly susceptible

CULTIVAR SENSITIVITY TO SELECT PATHOGENS



Dormant



Early bud swell



Late bud swell




Bud burst



1- to 3-inch shoots



4- to 8-inch shoots



10- to 16-inch shoots



Immediate prebloom



First Bloom



Full bloom



Buckshot berries



Bunch closure



Veraison



Ripe for harvest

FUNGICIDES TYPES

- ▶ Systemic –absorbed

- ▶ Xylem mobile
- ▶ Amphimobile
- ▶ Locally systemic

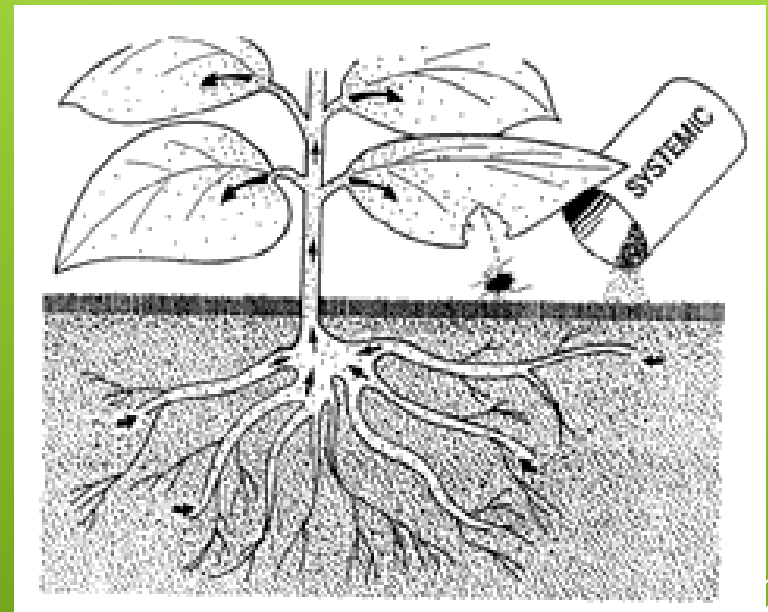
(Strobilurins: Abound, Sovran, Pristine, & Flint)

(Sterol Biosynthesis inhibitors (SBI) or Demethylation Inhibitors (DMI): Rally, Rubigan, Elite, & Procure)

- ▶ Translaminar

- ▶ Contact – adsorbed

(mancozeb and Captan)



Rainfall amount	Residues of Ziram removed
(inches)	(%)
0.1	25
0.5	30
1.0	65
2.0	75

MSU Annemiek Schilder



RAINFALL AND FUNGICIDES

Recommendations

- ▶ 2 inches or more of rainfall on recently applied protectant fungicide – then reapply
- ▶ Protectant fungicide ≥ 7 days old and 1 inch rainfall – then reapply
- ▶ Applied fungicides must dry before a rainfall event

RAINFALL AND FUNGICIDES



Growth Stage	Fungicide	Disease
½-1-inch shoots, 3-5-inch shoots, 8-10-inch shoots followed every 7-10-days until fruit set	Mancozeb (1.5 lb per 25 GPA early in season. Increase rate and volume as vines grow	Phomopsis , black rot and downy mildew
Immediate pre-bloom, bloom and 2 to 3 times more at 10-14-day intervals	Mancozeb plus DMI or a strobilurin Rotate fungicides	Black rot , Phomopsis, and downy and powdery mildew
Bunch closure	Capta, Ziram, phos acid plus DMI or strobilurins or combos	Downy and Powdery mildew on foliage
Post veraison	Pristine	Rots
Post harvest	Mancozeb	Downy mildew

BASIC SPRAY PROGRAM

GRAPE PESTS AND PHENOLOGY

Growth stage Visual	Bud swell	Shoot 1-5"	Shoot 8-12"	Pre- bloom	Bloom	Pea- sized	Berry touch	Bunch closing	Verais on	Pre- harvest	Harvest	Post- Harves t
Growth stage Modified Eichhorn- Lorenz	2-3	7-13	14-18	19-22	23	31	32	33-34	35	36-37	38	39-47
Insects												
Cutworm	+	+										
Grape Flea beetle	+											
Rose Chafer				+	+	+						
Grape Berry Moth				+	+	+	+	+	+	+	+	+
Grape Leafhopper				+	+		+	+	+	+	+	
Potato Leafhopper			+	+	+		+	+	+			
Japanese beetle								+	+	+		
Diseases												
Phomopsis		+	+	+	+	+	+	+	+	+	+	
Black rot		+	+	+	+	+	+	+	+			
Downy mildew			+	+	+	+	+	+	+	+	+	+
Powdery mildew		+	+	+	+	+	+	+	+	+	+	+
Botrytis bunch rot					+			+	+	+	+	

- ▶ Strobilurins are Frac Code 11
 - ▶ Abound, Flint, Sovran, Intuity, Reason
 - ▶ Remember premixes: Merivon
Xemium (11+7), Pristine (11+7),
Quadris Top (11+3), Tanos (11+27)
- ▶ Rotate fungicides with different Frac Codes
- ▶ Fungicides that are susceptible to selecting for resistance should be tank mixed with Mancozeb or Captan
- ▶ Strobilurins and DMI fungicides should only be used 2 times in a growing season

FRAC AND IRAC

14 grape growers scouting 20 acres each, saved on average 1.1 fungicide treatments and 0.7 insecticide treatments/acre.

Isaacs, Rufus. 2005. Online

<http://www.agcenter.org/proggroundupprojmi.html>

- What are some potential economics
 - Pristine \$430.00/7.5 lbs (\$3.58/oz)
 - Use rate 23 oz./acre (high rate)
 - \$82.42/acre
 - 20 acres x \$82.42/acre = \$1,648.40

IPM – DOES IT WORK?

- Needs free water
- Overwinters leaf debris
- All green tissue susceptible
- Berries become resistant 4 to 5 weeks after bloom



DOWNY MILDEW

- ▶ Phomopsis, Black rot, Anthracnose, and downy mildew
- ▶ Mancozeb limits: 24 to 25.6 lb per acre per season with 66 day PHI
- ▶ Early season 1.5 lbs 25 gpa and then increase rate and sufficient water for through coverage as the canopy increases
- ▶ 7 to 10 day intervals up to fruit set

EARLY SEASON CONTROL - MANCOZEB

- Does not require free water except initially
- Overwinter as cleistothecia on trunks and cordons
- Colonies develop in shade
- Berries susceptible immediate pre-bloom through fruit set
- Berries become resistant 2 to 4 weeks postbloom



POWDERY MILDEW

- ▶ DMI's (Mettle, Procure, Quadris Top, Rally, Tebuzol) often applied to control black rot will also control powdery mildew
- ▶ Mid to late season infections –SCOUT focusing on interior canopy shaded leaves
 - ▶ DMI's, Endura, Quintec, Vivando, Tavano, Fracture, Torino, potassium salts
- ▶ Late season: PHI plays a role

POWDERY MILDEW MANAGEMENT

Powdery Mildew



Downy Mildew



ANTHRACNOSE



- Vidal Blanc, Marquette, Frontenac, La Crescent and Swenson cultivars – Edelweiss, Espirit, Brianna, St. Pepin, Swenson White
- Prune out infected canes and infected berries
- Needs free water
- Prolonged wet warm (mid-70's to 80's)
- Mancozeb, captan, ziram



ANTHRACNOSE

- ▶ Berries do not develop resistance
- ▶ Initial infections can take place at bloom
- ▶ Protect with a strobile, Captan or Mancozeb (watch PHI) at bloom
- ▶ Early season infections latent until veraison
- ▶ Berries susceptible from bloom to harvest
- ▶ Often confused with Black rot

THE ROTS WITH EMPHASIS ON BITTER ROT