What is Integrated Pest Management ?

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IPM – Integrated Pest Management

Use of multiple methods to ensure sustained management of major pests without disrupting the cropping system ecology

↓

Considered best management practices (BMPs)

↓

Foundation of informed, responsible farming

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Challenge:

Vines are perennials; management is critical from one year to the next.

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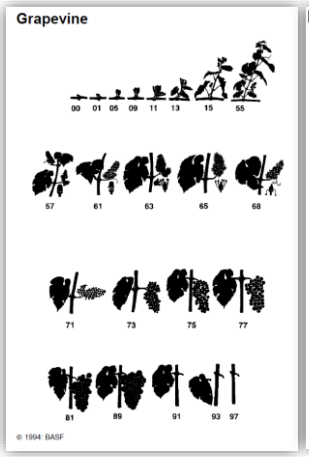
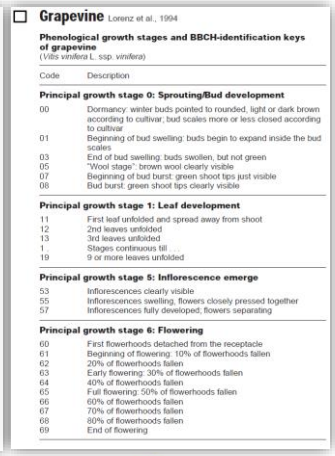
Reading the Vines: *Phenology*

Operations must adhere to vine growth stages

- Timing and sequence
- Spray programs
- Canopy management
- Fertilization
- Irrigation





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Seasonal Management of Pests in Oregon

Weeds

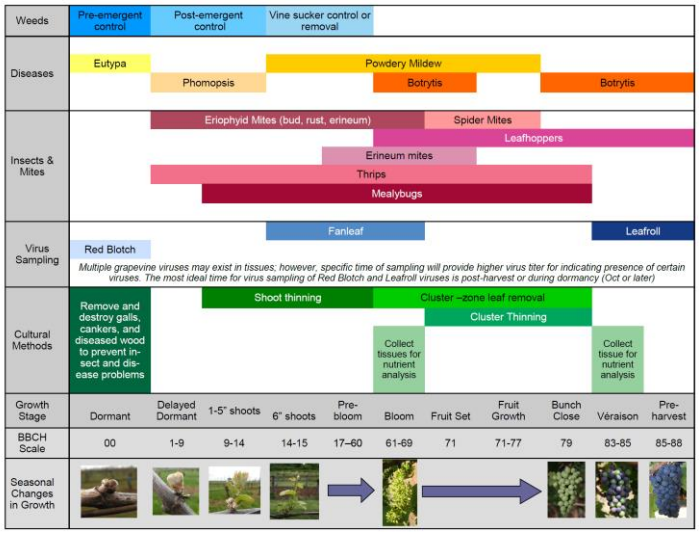
Diseases

Insects & Mites

Time of testing

Timing cultural practices

Phenology



Pest Management Guide for Wine Grapes in Oregon, EM8413

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Key Concepts in Vineyard IPM

- Use different methods of pest control
  - Chemical + cultural + biological
- Understand vineyard and surrounding ecosystem

General Method	Tactic
Chemical	Pesticides (conventional, organic, biodynamic)
Cultural	Vineyard design, training system, irrigation, canopy management, etc.
Biological	Increase biodiversity on site (cover crops, perimeter plantings, etc.) Introduce beneficial organisms

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Vineyard IPM –

- Pesticide use is required in all commercial vineyards
  - Grape powdery mildew, Botrytis, others…
  - Weeds – different products but fewer registered/effective for organic/BD
- Pair chemical control with cultural practices
  - Improve spray coverage
  - Sensitivity of crop (e.g., leaf removal for powdery mildew/botrytis)
  - Practices to alter vine microclimate

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Annual Pest Management

- Trunk Diseases
- Weeds
- Powdery Mildew
- Botrytis
- Mites & Insects

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Fungal Diseases

Annual foliar disease management

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Grape Powdery Mildew

Erisyphe necator / Uncinula necator

- **Infects:** buds, leaves, shoots, and berries
- **Infection period:** bud break → ripening
  - **SPRING:** Ascospores – sexual spores
  - **SUMMER:** Conidia - asexual spores
  - Different conditions for infection of ascospores vs. conidia
- Favored by mild conditions
  - Moderate temperatures (optimum 71-82°F)
  - Free water is NOT always needed for infection!

Conditions for good grape growth = those for powdery mildew infection!

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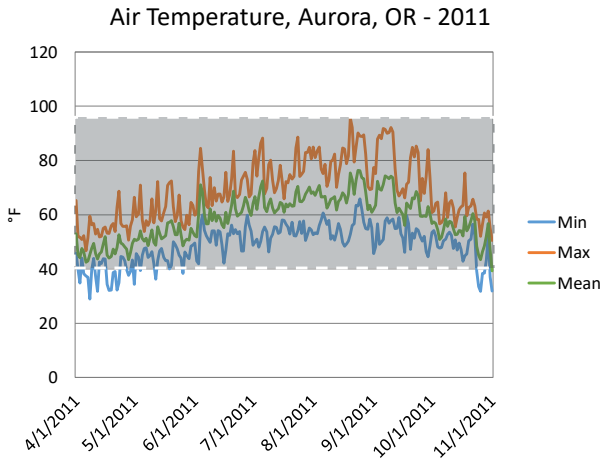
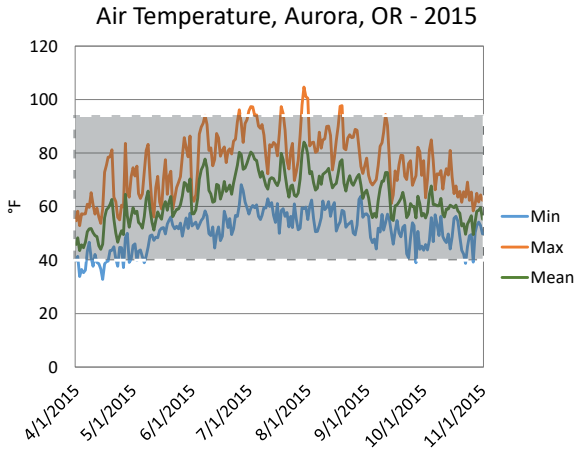
Cool season favorable to GPM



Hot season still favorable to GP!



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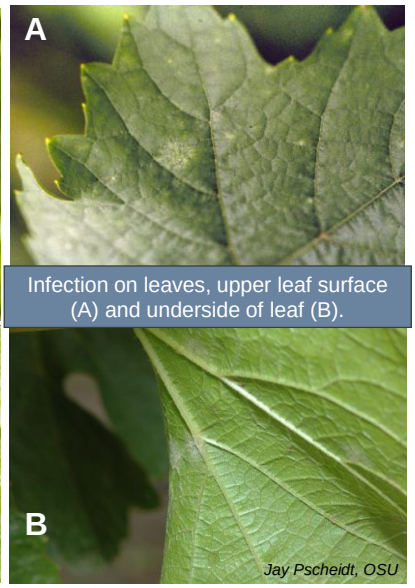
flag shoots in spring

Walt Mahaffee, USDA-ARS



Infection on leaves, upper leaf surface (A) and underside of leaf (B).

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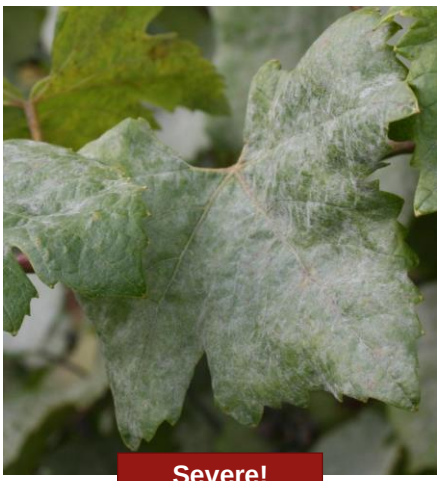
Leaf infection



Severe!

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Powdery mildew infection visible at fruit set

Grape Powdery Mildew - *Symptoms*

- Berry cracking may occur due to necrotic areas
- Later season infection of berries – scarring without cracking
- <5% infection = off flavors in wine

David Gadoury

Oregon State University
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Berry infection
pre-bunch closure

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Shoot – in season

Late season

Old scars on cane
the following season

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Powdery Mildew Management

Forecasting to determine spray timing, interval

- Gubler-Thomas Model
  - **Ascospore phase** – air temperature and duration of leaf wetness
  - **Conidia phase** – air temperature
  - Risk index used to make spray decisions
  - Linked with weather stations
  - Risk level determined through online heat unit mapping (uspest.org)

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Gubler-Thomas Model – *Conidia Phase*

Treatment timing guidelines based on risk index and spray material		
Powdery Mildew Risk Index	Spray Material	Spray Interval
0 to 30 (low risk)	sulfur dust	14 days**
	micronized sulfur	18 days**
	Synthetic fungicides*	21 days**
40 to 50	sulfur dust	10 days
	micronized sulfur	14 days
	Synthetic fungicides*	17 days
60 to 100 (high risk)	sulfur dust	7 days
	micronized sulfur	10 days
	Synthetic fungicides*	14 days
* Synthetic fungicide classes vary; 21 d not recommended in W.V. OR		
** Or label maximum.		

Higher risk = shorter interval between sprays

http://www.ipm.ucdavis.edu/DISEASE/DATABASE/grapepowderymildew.html

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Powdery Mildew Management

- **Chemical control**
  - Synthetic fungicides
  - Organic fungicides (sulfur, horticultural oils, etc.)
- **Canopy management**
  - ↑ sun exposure to canopy (UV light)
  - ↑ air flow/ ↓ relative humidity

Reduce canopy density, leaf removal, & hedging

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Example IPM strategies for Powdery Mildew and Botrytis Control

Growth Stage	Dormant—Early growth	6" shoots	Pre-bloom	Bloom	Fruit Set	Fruit Growth (summer)	Véraison	Pre-harvest
BBCH Scale	00-12	14-15	17–60	61-69	71	71-79	83-85	85-88
	POWDERY MILDEW							
Primary Applications		Sulfur: high label rate (7-10 days)	Products from groups 13, 50 or U6 alone or in mixes with other FRAC groups.[a]		Sulfur: high label rate (7-10 days)[a]	Groups 13, 50 or U6, alone or mixed with other groups[a]	Sulfur: half rate (7-14 days)[c]	Groups 13, 50 or U6, alone or mixed with other groups
Supplemental Applications		M-Pede or JMS Stylet Oil; use caution if applying after sulfur, do not mix with sulfur						
Cultural Methods		Shoot thinning and Positioning; sucker removal			Pull leaves in cluster-zone of dense canopies	Hedge dense canopies or regulate growth through irrigation		
	BOTRYTIS							
Primary Applications				Critical to spray at bloom (western OR)		Critical to spray at bunch closure (BBCH 77-79).	Use cultural control methods; spray only if necessary	
	Cultural methods to reduce canopy density and shading should be used with chemical applications to prevent Botrytis. Rotate and/or tank mix fungicides that have different mode of action (FRAC) groups so that no product is used more than two times per season to prevent fungicide resistance. Always use a product with a different FRAC group than was used for the previous application.							
Supplemental Applications			Fungicides that have Botrytis efficacy can be considered based on weather and cultivar susceptibility to Botrytis. Heed to warnings under "Primary Actions."					
Cultural Methods		Shoot thinning and positioning			Pull leaves in cluster-zone	Hedge or manage growth with irrigation	Pull leaves in cluster-zone	

Pest Mgmt Guide, EM8413

BLOOM: Critical for fungicide application; start at 10% bloom!

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Botrytis Bunch Rot

Fungal pathogen: *Botrytis cinerea*

- Infection risk at **bloom** and **ripening**
  - May be latent until late season
- Needs free water, 58-82°F
- **Symptoms**
  - Flag shoots
  - Stem necrosis
  - Flower infection → latent until ripening
  - Berry breakage and rot

Botrytis Bunch Rot

Impacts

- Reduced yield (culling affected fruit)
- Reduced fruit quality
- Fruit fly attractant and further rots

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Botrytis Management

- **Cultural methods**
  - Timely canopy management
  - Early leaf removal
- **Chemical controls**
  - Early season: prevent initial infection (bloom)
  - Ripening phase: prevent spread (bunch close, véraison and later)

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Cluster zone leaf removal

- Optimum timing = fruit set to BB or pea size
- Optimum amount?

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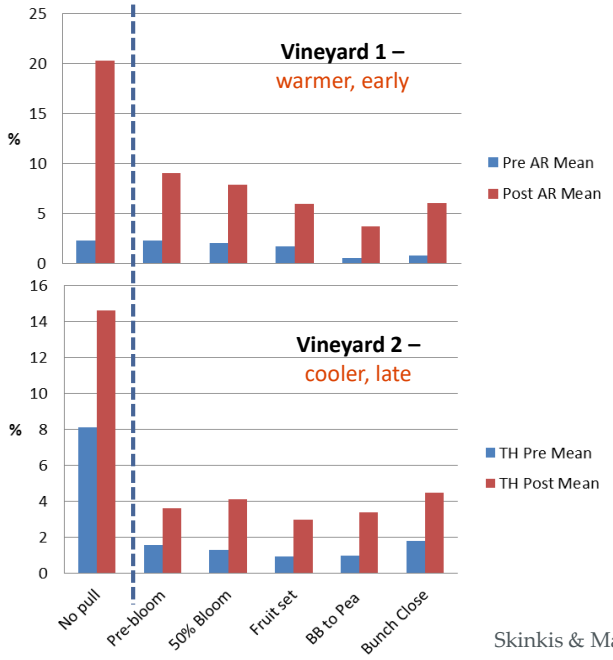
Botrytis severity ↓ with leaf removal



Skinkis & Mahaffee

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Temperature (°C)	Temperature (°F)	Minimum number of hours of berry wetness* (Medium risk)	Minimum number of hours of berry wetness* (High risk)
30	86	28.8	32.2
29	84.2	22.4	25.9
28	82.4	19.0	22.1
27	80.6	16.9	19.5
26	78.8	15.3	17.8
25	77	14.3	16.5
24	75.2	13.5	15.6
23	73.4	13.0	15.0
22	71.6	12.6	14.7
21	69.8	12.5	14.5
20	68	12.5	14.4
19	66.2	12.6	14.6
18	64.4	12.9	14.9
17	62.6	13.4	15.5
16	60.8	14.1	16.3
15	59	15.1	17.4
14	57.2	16.5	19.1
13	55.4	18.5	21.4
12	53.6	21.5	24.9

* If berries are dry for fewer than 4 hours, the wet periods are considered one event. If berries are dry for more than 4 hours, the wet periods are considered separate events.

Botrytis Management

- Infect at ≥53 ˚F and as few as 4 hr leaf wetness
- Follow temperature and berry wetness to determine when/if to spray
- Fungicides should be applied
  - **BEFORE** rain event
  - Medium risk level

Timing of Botrytis sprays:
- Bloom
- Bunch closure
- Véraison
- Ripening (post-véraison)

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Fungal Disease Management

- **Chemical**
  - Fungicides are used to protect plant tissues before infection (shoots, leaves, fruit)
  - Start applying at 6 in shoot growth (GPM)
  - Continue with conditions and/or product intervals
  - Rotate product modes of action to avoid pest resistance development
- **Cultural**
  - Canopy management
  - Shoot thinning
  - Hedging
  - Cluster zone leaf removal

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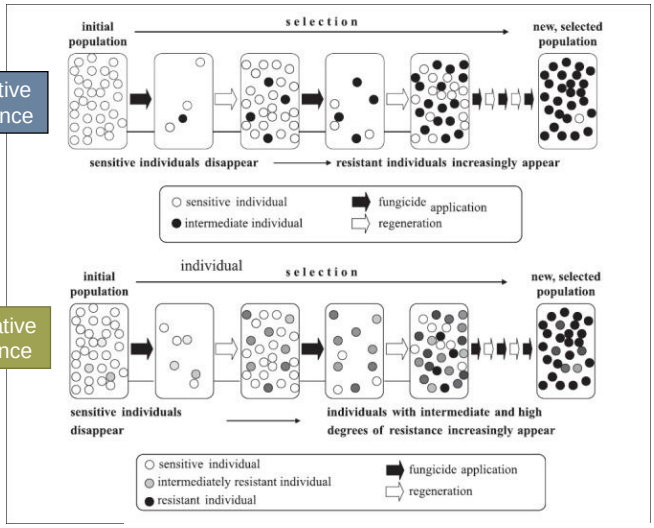
What is Fungicide Resistance?

- When the pathogen population is immune to the impacts of a fungicide.
- Fungicides have targeted modes of action (MoA)
- Over-application selects for a portion of the pathogen population that is resistant to the fungicide.
- Mixing MoA leaves a smaller portion of pathogens alive.

Qualitative Resistance

Quantitative Resistance



https://dx.doi.org/10.1590%2FS1517-838220080002000017

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Steps to Avoid Fungicide Resistance

- Alternate fungicides - different modes of action
  - FRAC Codes
- Tank mix different groups
- Rotate with low risk chemistries (multi-site MoA)
- DO NOT use resistance-prone products to control epidemic
- Limit resistance-prone groups to <2 applications/season
- Use the rates shown on the label
  - **Do not use lower rates** → increases resistance!

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Steps to Avoid Fungicide Resistance

- Ensure good coverage and application
  - Follow the label
  - Calibrate your sprayer
  - Have the correct sprayer for your canopy
  - Change spray volume with change in canopy size
  - Spray every row!
- Good coverage = prevent fungal pest infection
- Lack of coverage = pest can infect vines and subsequent sprays are “selecting” for resistance as population is present

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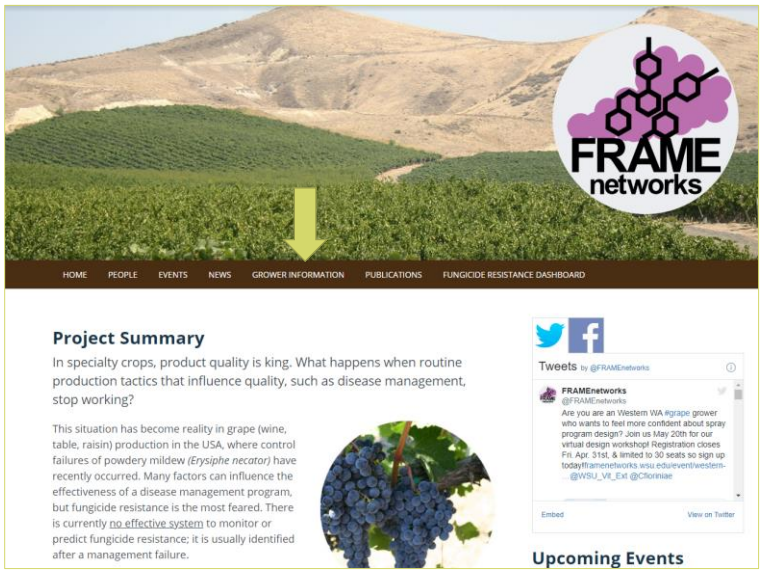

Multi-state research on fungicide resistance in vineyards.

OR, WA, CA, MI

Research and outreach objectives.

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Spray Programs: *Fungal Diseases*

- **Conventional**
  - Diverse classes of products (active ingredients)
  - Contact
  - Systemic
  - Most common products
    - Systemic fungicides
    - Sulfur or oils

+

- **Organic & Biodynamic**
  - Fewer products
  - Active ingredients less prone to resistance
  - Contact only
  - Most common products
    - Sulfur (M02)
    - Horticultural oils (NC)
    - Salts of fatty acids (NC)
    - Biologicals (BM)

FRAC FUNGICIDE RESISTANCE ACTION COMMITTEE

Fungicide resistance action committee (FRAC) provides modes of action (MoA) classes

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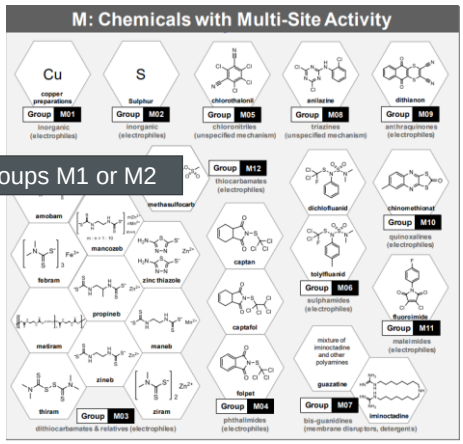
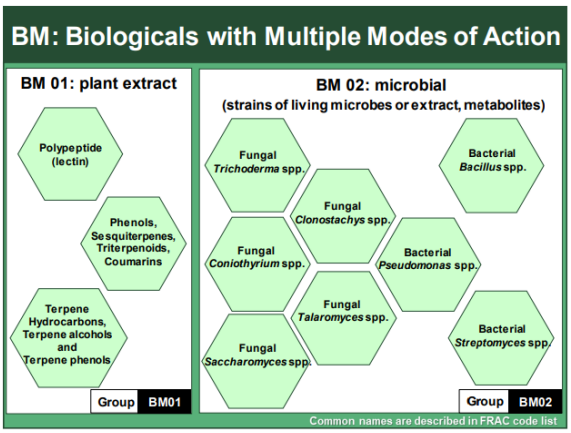
Organic approved products are less likely to form resistance in the pathogen population.





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Check efficacy reports for fungicide products

	INGREDIENTS Single active ingredie Count 38					
1	iprodione (Rovral, Nevado)	Group 2	Not effective	Not effective	Good**	
2	flutriafol	Group 3	??	Good**	Slight–fair	Powdery mildew resistance detected
3	mefentrifluconazole (Cevya)	Group 3	Good	Good–excellent	Not effective	
4	myclobutanil (Rally)	Group 3	Not effective	Good**	Not effective	Powdery mildew resistance detected
5	tebuconazole (Orius, Tebuc...	Group 3	Not effective	Fair–good**	Not effective	Powdery mildew resistance detected
6	tetriconazole (Mettle)	Group 3	Not effective	Good**	Not effective	Powdery mildew resistance detected
7	triadimefon (Bayleton)	Group 3	Not effective	Good**	Not effective	Powdery mildew resistance detected
8	triflumizol (Procure, Trionic)	Group 3	Not effective	Good**	Not effective	Powdery mildew resistance detected
9	boscalid (Endura)	Group 7	Not effective	Good–excelle...	Fair-Good**	Powdery mildew resistance suspected, Botrytis resistance detected
10	fluopyram (Luna Privilege)	Group 7	Not effective	Good–excelle...	Good**	Powdery mildew resistance suspected, Botrytis resistance detected
11	isofetamid (Kenja)	Group 7	Not effective	Good–excelle...	Good**	Powdery mildew resistance suspected, Botrytis resistance detected
12	solatenol (Aprovia)	Group 7	Good	Good–excelle...	Slight**	Powdery mildew resistance suspected, Botrytis resistance detected
13	cyprodinil (Vangard)	Group 9	Not effective	Not effective	Good**	Botrytis resistance detected
14	scala	Group 9	Not effective	None	Good**	Botrytis resistance detected
15	azoxystrobin (Abound)	Group 11	Fair–good	Good**	Slight–fair	Powdery mildew resistance detected
16	kresoxim-methyl (Sovran)	Group 11	Good	Good**	Slight–fair	Powdery mildew resistance detected
17	mandestrobin	Group 11	??	Poor to mode...	??	Powdery mildew resistance detected
18	trifloxystrobin (Flint)	Group 11	Fair	Good**	Slight–fair	Powdery mildew resistance detected

Just because a label says it can be used for a disease, does not mean it will work well!

Check local Extension pest guides for efficacy information.

Excerpt from OR Pest Guide, EM8413

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Insects, Mites, and Weeds

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Spray Program: *Insects, Mites, and Weeds*

- **Insecticides and Miticides**
  - Insecticide Resistance Action Committee (IRAC Codes)
  - Canopy applications: may tank-mix with fungicides
- **Herbicides**
  - Herbicide Resistance Action Committee (HRAC Codes)
  - NOT tank mixed with fungicides and insecticides!
  - Pre-emergent
  - Post-emergent

For both…

Apply only when pest is present

Must rotate product active ingredients and modes of action (MoA)

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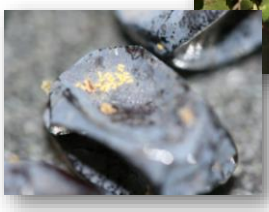
Spider Mites

- Potential causes
  - Over use of sulfur
  - Dust from tillage or traffic
  - Loss of natural biological control
- Cultural controls recommended:
  - Cover crops/vegetation
  - No till
  - Reduce pesticide use that reduce biological controls
- Chemical controls
  - When critical threshold reached



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Erineum Mite (Blister Mites)

Not pest of economic concern!
No chemical control required

Upper leaf surface

Lower leaf surface

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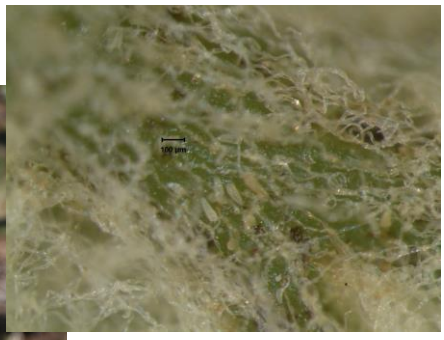
Rust Mites – Early Spring

Control:
Sulfur or oil applied just after bud break



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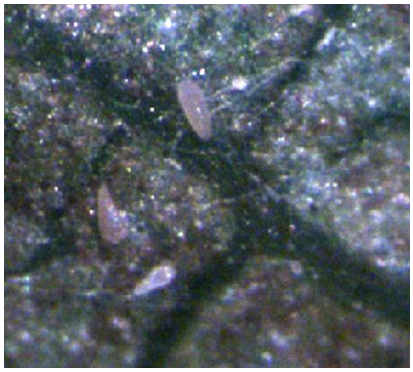
Rust Mites

Control:
Add sulfur in powdery mildew program



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Mite and Insect Management

- **Chemical**
  - Only use when needed
- **Cultural**
  - Avoid tillage, especially in summer → spider mites
  - Cover cropping → spider mites
  - Mowing timing → leafhoppers and thrips
- **Biological**
  - Encourage natural enemies
    - cover cropping
    - reduced pesticide use (e.g., Sulfur for spider mites)

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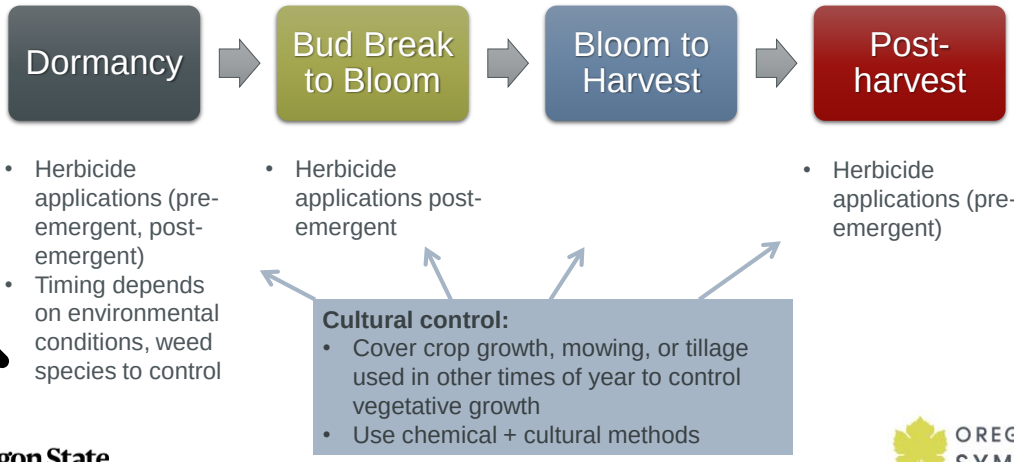
Weed Control Program – *Chemical + Cultural*



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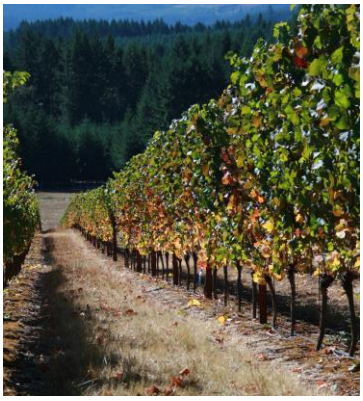
Integrated Pest Management - Summary

- Requires planning
- Knowledge of the pest, products, and vineyard
- Proper equipment
- Suitable products
- Personnel to apply practices in a timely manner
- Scouting and evaluating efficacy
- Expect to reevaluate and modify plans based on season, weather



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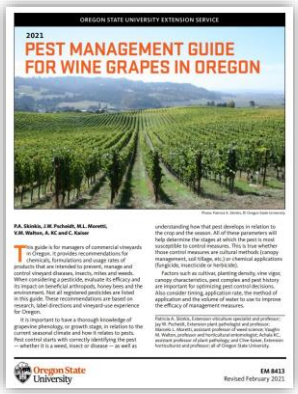
Pest Guides: Management, Pesticide use and Efficacy

University Extension System

- Regional or state guides prepared by Extension experts
- "Pest management guides" or "Spray Guides"
- Updated **annually**

DO NOT USE OUTDATED GUIDES

PNW Insect, Weed, and Disease Handbooks



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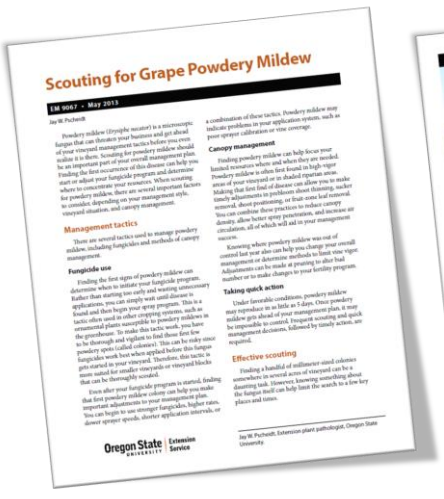
Handouts available for this session…


Scouting for Grape Powdery Mildew

EM 9067 - May 2013

Jay W. Pscheidt

Powdery mildew (*Erysiphe necator*) is a microscopic fungus that can threaten your business and get ahead of your vineyard management tactics before you even realize it is there. Scouting for powdery mildew should be an important part of your overall management plan. Finding the first occurrence of this disease can help you start or adjust your fungicide program and determine where to concentrate your resources. When scouting for powdery mildew, there are several important factors to consider, depending on your management style, vineyard situation, and canopy management.

Management tactics

There are several tactics used to manage powdery mildew, including fungicides and methods of canopy management.

Fungicide use

Finding the first signs of powdery mildew can determine when to initiate your fungicide program. Rather than starting too early and wasting unnecessary applications, you can simply wait until disease is found and then begin your spray program. This is a tactic often used in other cropping systems, such as ornamental plants susceptible to powdery mildews in the greenhouse. To make this tactic work, you have to be thorough and vigilant to find those first few powdery spots (called colonies). This can be risky since fungicides work best when applied before this fungus gets started in your vineyard. Therefore, this tactic is more suited for smaller vineyards or vineyard blocks that can be thoroughly scouted.

Even after your fungicide program is started, finding that first powdery mildew colony can help you make important adjustments to your management plan. You can begin to use stronger fungicides, higher rates, denser sprayer spends, shorter application intervals, or a combination of these tactics. Powdery mildew may indicate problems in your application system, such as poor sprayer calibration or vine coverage.

Canopy management

Finding powdery mildew can help focus your limited resources where and when they are needed. Powdery mildew is often first found in high-vigor areas of your vineyard or in shaded riparian areas. Making that first find of disease can allow you to make timely adjustments to problems about thinning, sucker removal, shoot positioning, or fruit-zone leaf removal. You can combine these practices to reduce canopy density, allow better spray penetration, and increase air circulation, all of which will aid in your management success.

Knowing where powdery mildew was out of control last year also can help you change your overall management or determine methods to limit vine vigor. Adjustments can be made at pruning to alter bud number or to make changes to your fertility program.

Taking quick action

Under favorable conditions, powdery mildew may reproduce in as little as 5 days. Once powdery mildew gets ahead of your management plan, it may be impossible to control. Frequent scouting and quick management decisions, followed by timely action, are required.

Effective scouting

Finding a handful of millimeter-sized colonies somewhere in several acres of vineyard can be a daunting task. However, knowing something about the fungus itself can help limit the search to a few key places and times.

Jay W. Pscheidt, Extension plant pathologist, Oregon State University

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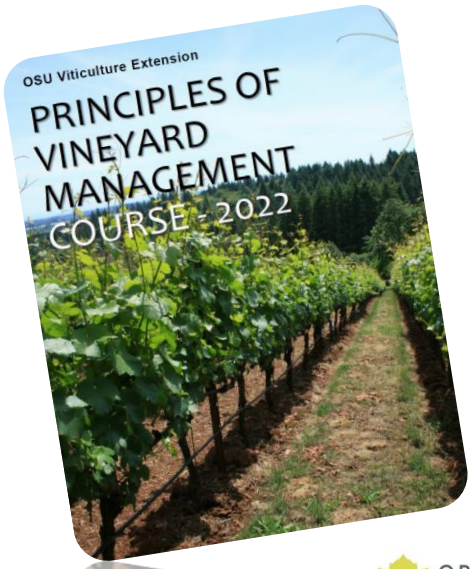

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Thank you!

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