



2016 WSGS  
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# FUNGICIDE RESISTANCE MANAGEMENT

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## END OF THE WORLD?

What hearing “fungicide resistance” can initially feel like...





## CHALLENGES CAN BE OVERCOME



- Resistance is an important issue
- Most other regions of the world deal with some form of fungicide resistance
- Strategies can be used
  - Some are tried-and-true
  - Some are theory
- Knowledge is power



## WHY SHOULD YOU CARE?

- All management efforts could be for nothing
  - Spend money to lose money?
  - Loss in quality
- Consumers purchase based on reputation
  - Regional reputation still important for WA
  - Poor quality fruit from one vineyard can hurt everyone



## TODAY'S DISCUSSION

- Brief overview on how we classify pesticides / fungicides
- What fungicide resistance is
  - How it occurs
  - Different types of resistance
  - A case study
- Strategies for mitigating resistance





# UNDERSTANDING FUNGICIDES

## Overview



## FUNGICIDES CLASSIFIED IN MANY WAYS

Classification Scheme	Trade Name		
	Flint	Rally	Sulfur
1) Active Ingredient	trifloxystrobin	myclobutanil	sulfur
<b>2) Mode of action</b>	<b>QoI</b>	<b>DMI</b>	<b>Multi-site contact</b>
3) Chemical group/class	strobilurin	triazole	sulfur
<b>4) Mobility in plant</b>	<b>Locally systemic</b>	<b>Locally systemic</b>	<b>Contact</b>
5) Role in protection	Protectant	Protectant and early infection	Protectant
6) Breadth of activity	Single-site	Single-site	Multi-site
<b>7) FRAC Code</b>	<b>11</b>	<b>3</b>	<b>M2</b>



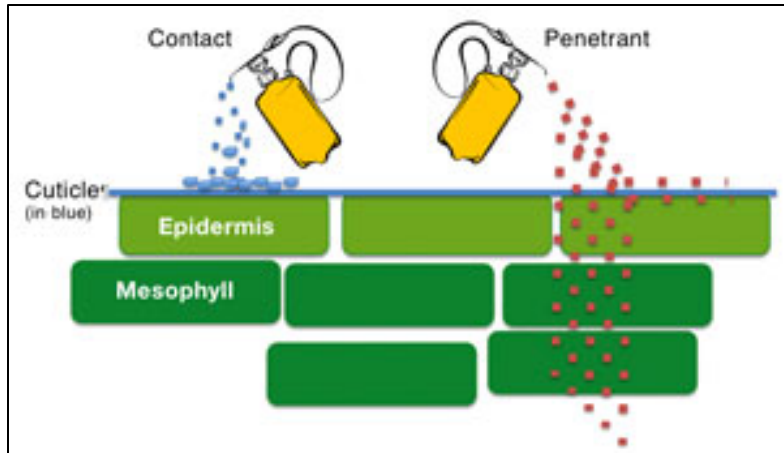
## OVERVIEW – MODE OF ACTION

Code	MOA	Example
2	Signal transduction (osmotic signal transduction)	iprodione (Rovral)
3	DMI- Sterol biosynthesis in membranes (demethylation inhibitors)	fenarimol (Rubigan), myclobutanil (Rally), tetraconazole (Mettle), triflumizole (Procure)
7	SDHI- Respiration (succinate dehydrogenase inhibition)	boscalid (Endura), Luna Privilege (Luna Privilege), benzovindiflupyr (Aprovia)
9	AP- Amino acid and protein synthesis (methionine biosynthesis)	cyprodinil (Vanguard), pyrimethanil (Scala)
11	QoI- Respiration (ubiquinol oxidase)	azoxystrobin (Abound), kresoxim-methyl (Sovran), trifloxystrobin (Flint)
13	Signal transduction (mechanism unknown)	Quintec (Quintec)
17	Sterol biosynthesis in membranes	fenhexamid (Elevate)
44	Microbial - Lipid synthesis and membrane integrity	Bacillus spp. (Serenade, Sonata)
M's	Multi-site modes of action	Copper, sulfur, ziram, captan
U's	Unknown	cyflufenamid (Torino U6), metrafenone (Vivando U8)





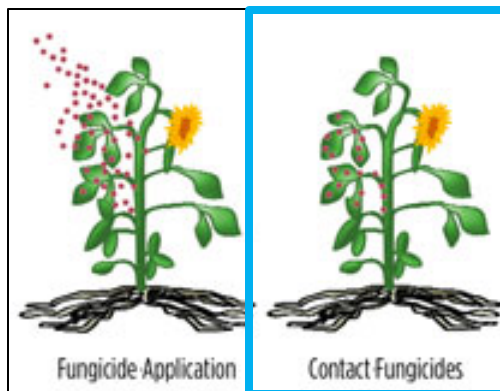
## OVERVIEW – MOBILITY IN PLANT



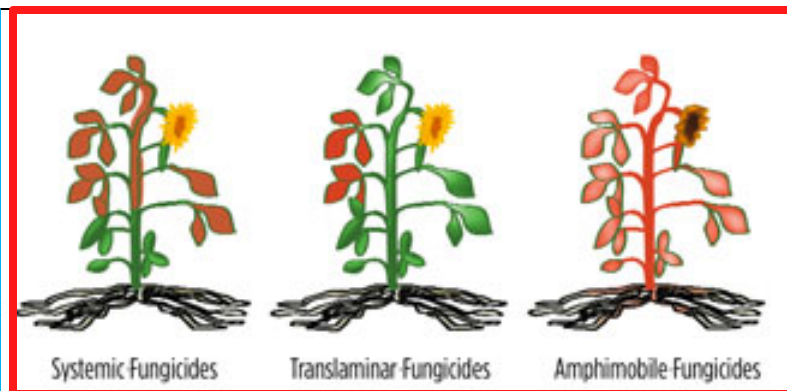
Two main groups of pesticides:

- **Contact** Pesticide
- **Penetrant** Pesticide

### Contact



### Penetrant





## OVERVIEW – FRAC CODES

Fungicide Resistance Action Committee




- Home
- What's New
- About FRAC
- Organisation
- Working Groups
- Expert Fora
- Monitoring Methods
- Publications
- FRAC Regional
- Links

**Welcome**

**Welcome To FRAC**

Fungicides have become an integral part of efficient food production. The loss of a fungicide to agriculture through resistance is a problem that affects us all.

FRAC works to prolong the effectiveness of fungicides liable to encounter resistance problems and to limit crop losses should resistance appear.

FRAC is a specialist technical group of

**What's New**

2014-08-02 - The 2014 FRAC Code List has been updated

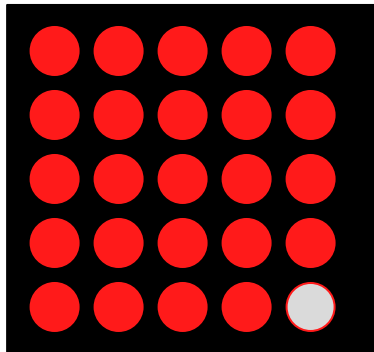


# WHAT IS “RESISTANCE” ANYWAYS?

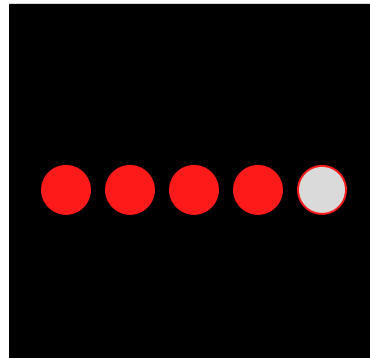
How resistance occurs.



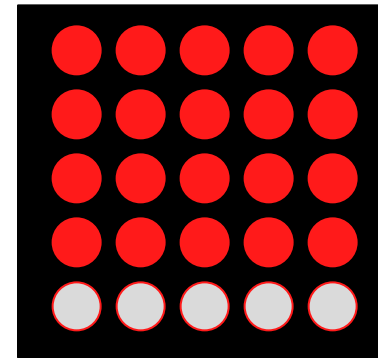
# HOW RESISTANCE OCCURS



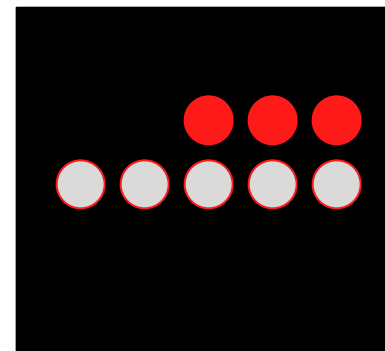
Some small level of natural resistance



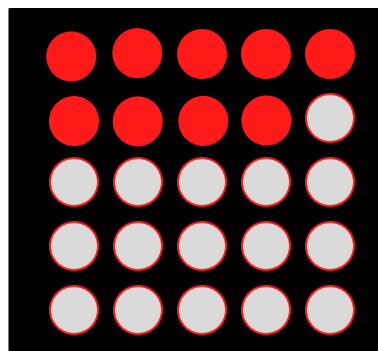
First fungicide application; no complete coverage



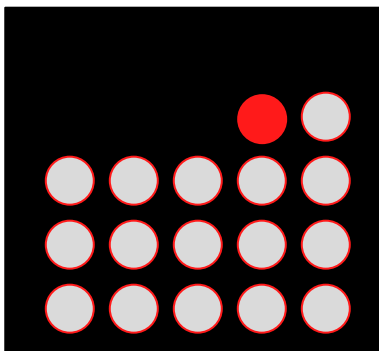
Resistant population grows



Second fungicide application



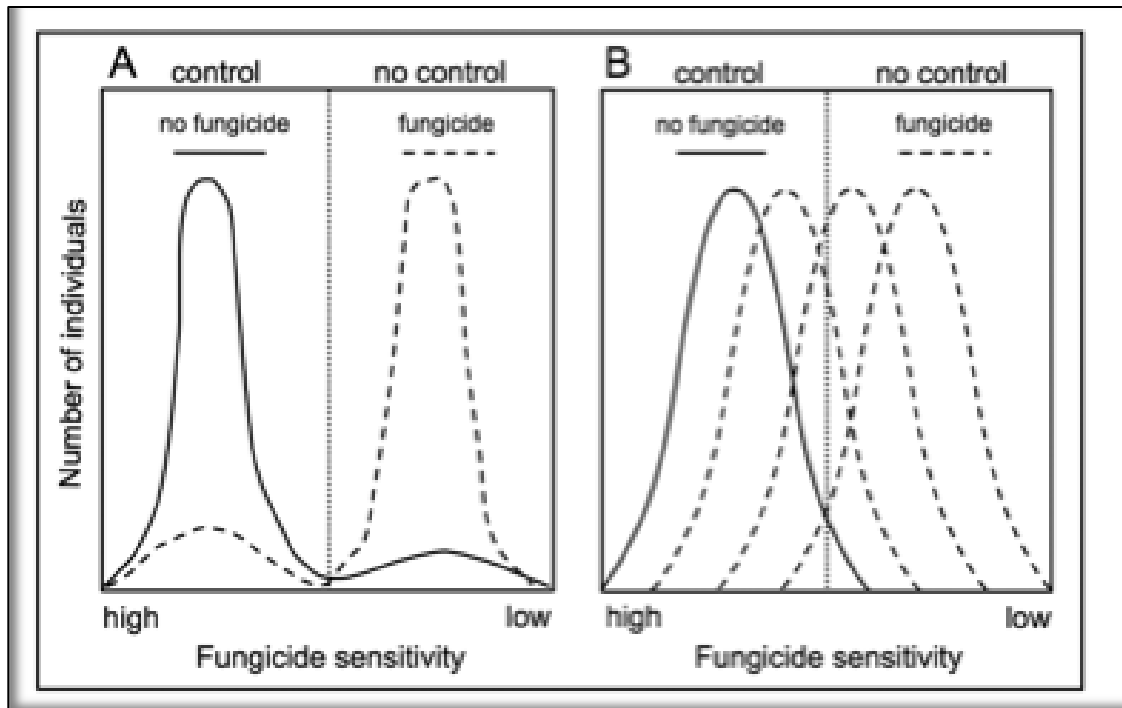
Resistant population grows



After third fungicide application



# TYPES OF RESISTANCE



**Qualitative**  
(sudden)

QoI

**Quantitative**  
(gradual/rate dependent)

DMI

## QoI

- Flint** (trifloxystrobin)
- Pristine** (pyraclostrobin + boscalid)

## DMI

- Procure** (triflumizole)
- Rally** (myclobutanil)
- Vintage** (fenarimol)
- Elite** (tebuconazole)



## RESOURCES FOR UNDERSTANDING RESISTANCE

- PNW Pest Management Handbooks
  - <https://pnwhandbooks.org/plantdisease/pesticide-articles>
- Pesticide Environmental Stewardship
  - <https://pesticidestewardship.org>
- Fungicide Resistance Action Committee
  - <http://www.frac.info/resistance-overview>



## THE NY LESSON

- Strobilurin resistance already in NY
  - Azoxystrobin (QoI, FRAC 11)
  - Labeled for use in 1997; **resistance found in 1999**
- In vineyards where 15-20 applications had been made **since introduction**
  - Note: typically more fungicide applications in NY than in WA
  - Programs may include 4-6 (or more!) QoI applications **in a single season**
- Also noted partial cross-resistance with myclobutanil (DMI, FRAC 3)



## THE NY LESSON TAKE-HOME?

- Resistance can develop rapidly with new fungicides
- There is a ticking bomb for number of applications before resistance is likely
- Completely eliminating one class and relying on another sets one up for failure
  - Must have multiple FRAC classes represented in a spray rotation





## FRAC 11'S AREN'T THE ONLY CONCERN

- Resistance to metrafenone (Vivando; FRAC U8) found in Italy
- Resistance to quinoxifen (Quintec; FRAC 13) found in Virginia
- Resistance to boscalid (Endura; FRAC 7) in *Botrytis* in multiple regions





# MANAGING RESISTANCE

Tips and Tricks



# CULTURAL PRACTICES

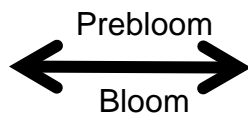
- Irrigation management



**VS.**



- Canopy management

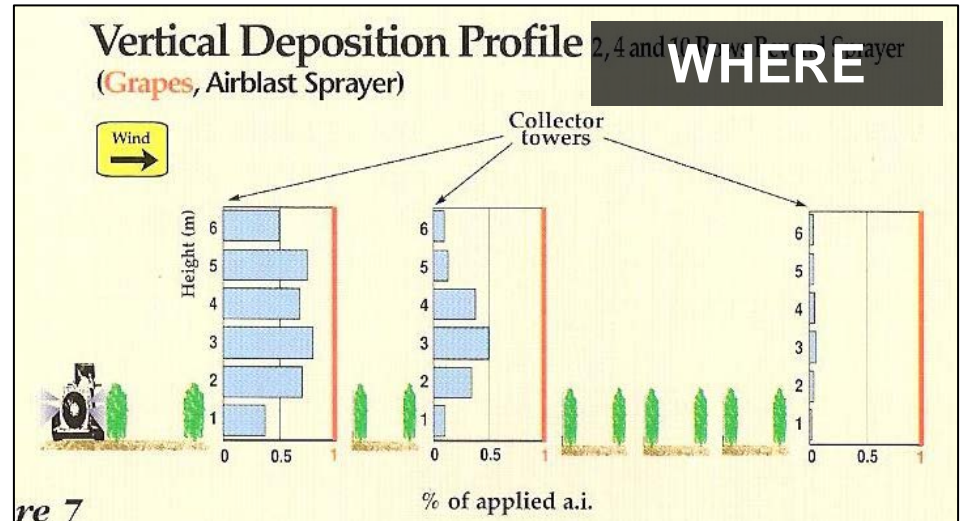




## SPRAY PRACTICES



**WHEN**



**HOW**



## TANK-MIXING

- Tank-mixing involves applying 2 MOAs simultaneously in the field
- Some product formulations already do this for you
  - Pristine, Unicorn, Inspire Super, etc.
- A cheap tank mix is the addition of sulfur (or another contact product)
  - Example: 3-5 lbs sulfur
  - Check for phytotoxicity
  - Check for chemical incompatibility



## FUNGICIDE ROTATION

- Rotating MOAs helps reduce the build-up of resistant populations
  - Within FRAC groups, there is often cross-resistance
  - Most of the time, resistance has not developed to multiple products
- Rotation should occur within a growing season
- Some products need to be rotated for non-resistance issues (e.g., sulfur, oil)



## CURRENT RECOMMENDATIONS FOR MANAGEMENT:

- 1. Option 1:** Avoid the FRAC group for at least 1 year
- 2. Option 2:** Limit the FRAC group to 1 application in a season
  - Tank mixed with a contact if possible
- 3. Option 3:** If you have to spray the FRAC group twice, then:
  - Tank mix with a contact
  - Never spray back-to-back
  - Avoid late-season spraying (i.e., FRAC 11 for Botrytis)



**PLAN--- THEN EXECUTE!** 😊







# FUNGICIDE RESISTANCE MANAGEMENT TAKE-HOMES

1. Resistance isn't the end of the world...
  - Has occurred in other locations
  - We have other chemistry options
2. ...but we shouldn't ignore it
  - Loss of products = loss of control options
  - Loss of control options = increase in costs
3. Fungicide program planning and appropriate spray techniques are great insurance



# STILL TIME FOR 2017 PLANNING!





## QUESTIONS?

# VITICULTURE EXTENSION

## WASHINGTON STATE UNIVERSITY



*World Class. Face to Face.*

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