

# BE ALERT: Is fungicide resistance coming to your vineyard?



Suzanne McKay  
Barbara Hall  
SARDI

# Why do you think you may have resistance?

- Fungicide not working

## Possible causes?

- Coverage
- Fungicide choice
- Correct rate
- Application timing
- Resistance

# How does resistance develop?

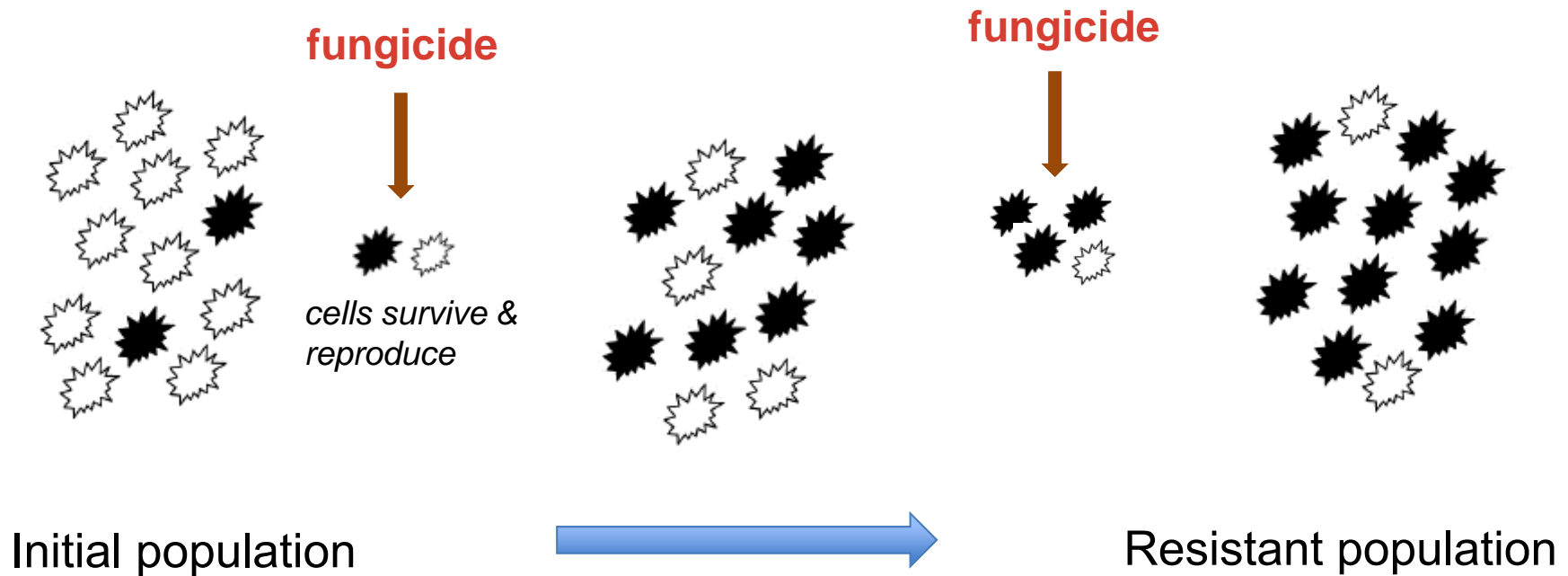
## DNA mutations affect fungicide activity

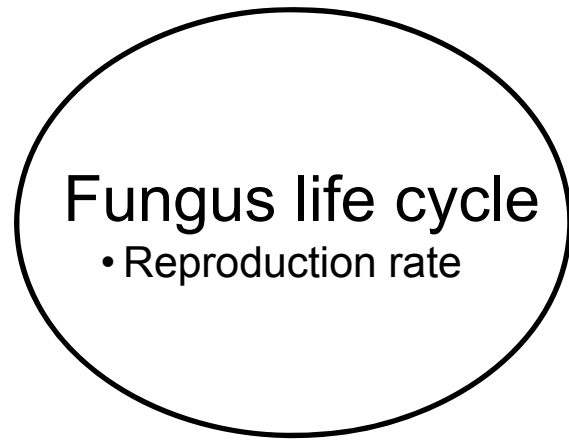


Sensitive: no mutation

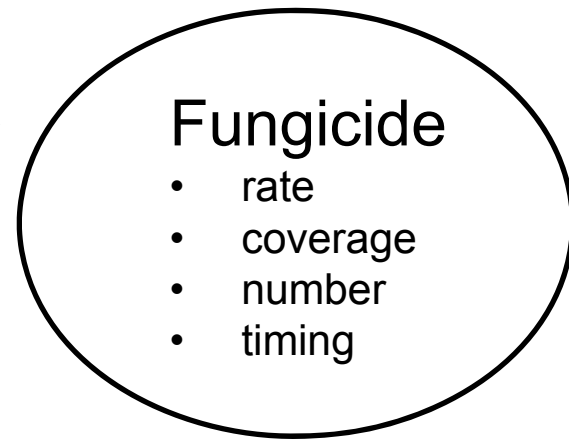
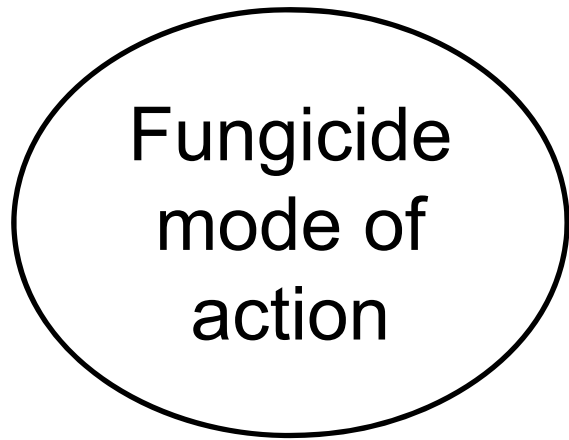


Resistant: naturally occurring mutation

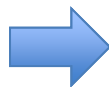
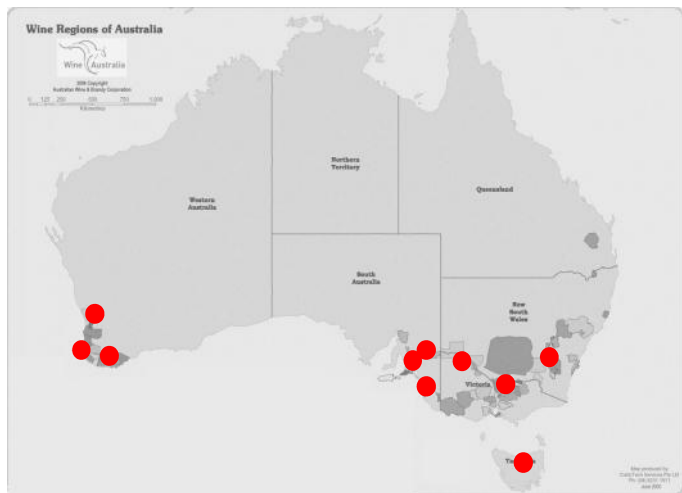




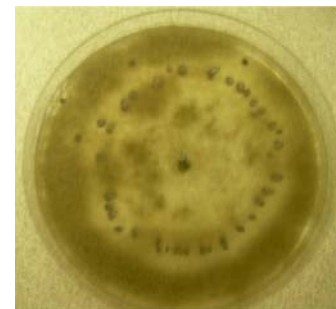
Resistance



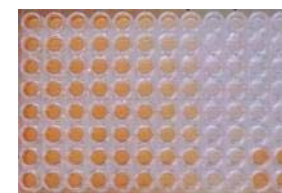
# Testing for resistance Methods



Powdery & downy



*Botrytis*



Lab tests for sensitivity

**Sensitive  
OR  
Resistant?**



DNA

- Adenine
- Thymine
- Cytosine
- Guanine
- Phosphate backbone



Detect mutation(s)

# Resistance detected – powdery mildew

|                                   |     |
|-----------------------------------|-----|
| pyraclostrobin (Cabrio® gp 11)    | 53% |
| penconazole (Topas® gp 3)         | 0   |
| myclobutanil (Mycloss Xtra™ gp 3) | 14% |
| tetraconazole (Domark® gp 3)      | 0   |

# Resistance detected - *Botrytis*

|   |     |
|---|-----|
| iprodione (Rovral <sup>®</sup> gp 2)      | 28% |
| pyrimethanil (Scala <sup>®</sup> gp 9)    | 38% |
| fenhexamid (Teldor <sup>®</sup> gp 17)    | 7%  |
| boscalid (Filan <sup>®</sup> gp 7)        | 21% |
| azoxystrobin (Amistar <sup>®</sup> gp 11) | 5%* |
| fludioxonil (gp 12)                       | 0%* |



# Resistance detected - *Botrytis*

| Modes of action (MOA) | % of samples with reduced sensitivity |
|-----------------------|---------------------------------------|
| 1 MOA                 | 21%                                   |
| 2 MOA                 | 11%                                   |
| 3 MOA                 | 11%                                   |
| 4 MOA                 | 3% (1 site each in SA & Vic)          |

**\*\*54% of all sites sensitive 😊**

# Resistance detected - Downy

**Metalaxyl (gp 4): 67% resistant**

**Mandipropamid (gp 40): 1 sample reduced sensitivity**

**Qols (gp 11): 1 sample reduced sensitivity**

Limited samples – testing ongoing

# Fungicide resistance in Australian viticulture

| Botrytis               | Downy mildew                      | Powdery mildew        |
|------------------------|-----------------------------------|-----------------------|
| iprodione (2)          | metalaxyl (4)                     | QoI (11)              |
| anilinopyrimidines (9) |                                   | DMI (3) / DMI (3)     |
| QoI (11)               | Carboxylic acid amides (CAA) (40) | metrafenone (U8)      |
| fenhexamid (17)        | QoI (11)                          | SDHI (7)*             |
| boscalid – SDHI (7)    |                                   | azanaphthalenes (13)* |
| fludioxonil (12)       | phosphonates (33)                 | spiroxamine (5)       |
|                        |                                   | cyflufenamid (U6)     |

Red = resistance detected

Green = not detected

Black = not tested

Purple = possible - more testing needed

\* Limited numbers tested

SARDI

# Issue to be solved:

Relationship between:

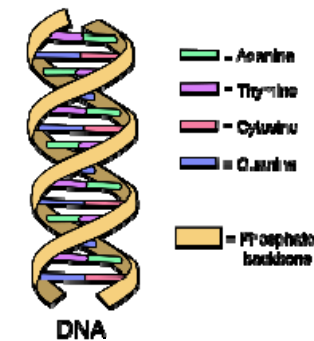
**phenotypic testing** (growing on fungicide treated leaf material)

**genotypic testing** (molecular test for mutation)

Botrytis – good ✓

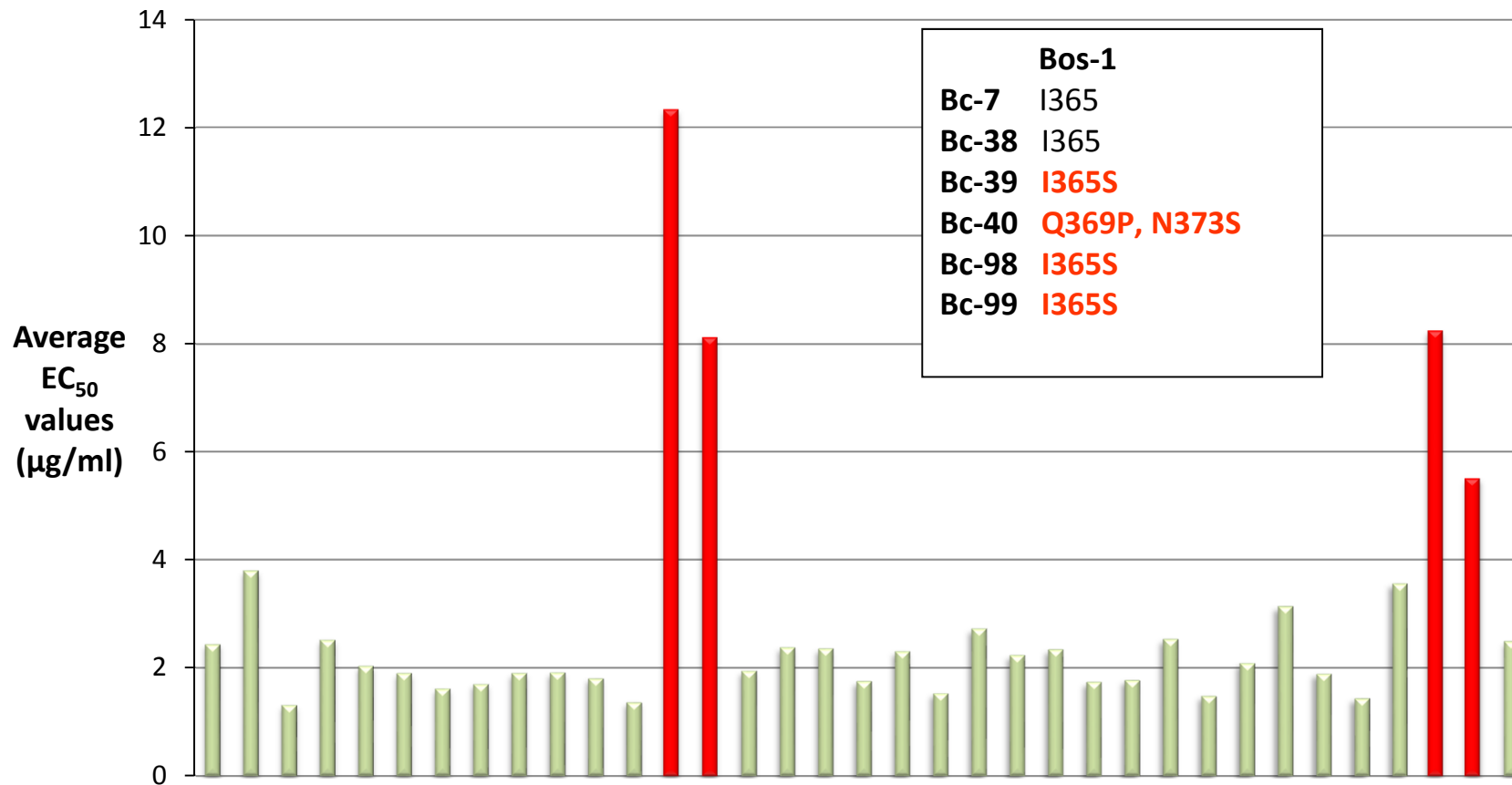
Powdery – poor ✗

Downy – ??



# EC<sub>50</sub> values for *B. cinerea* isolates against iprodione

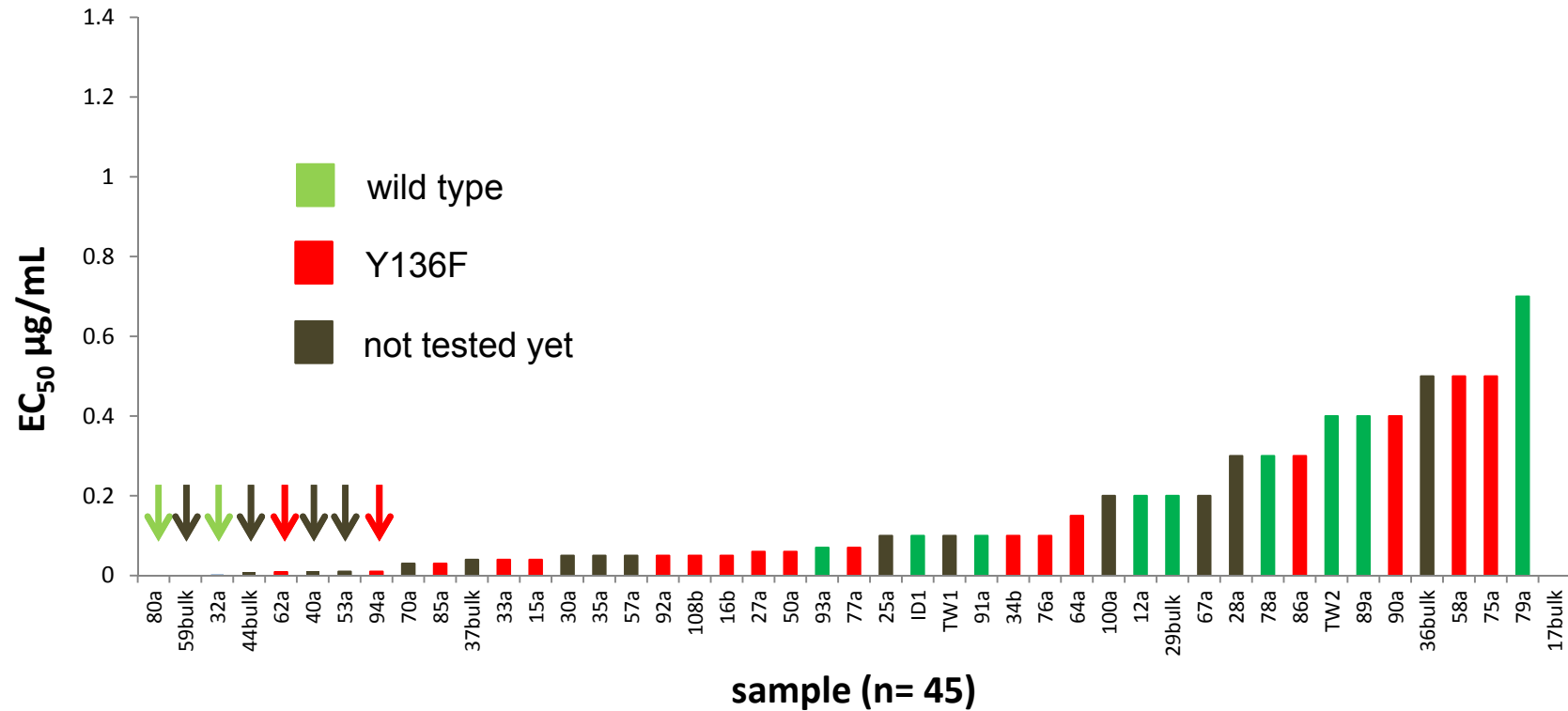
good ✓



- Phenotype = genotype
- Molecular test good but expensive

EC<sub>50</sub> values for PM isolates against penconazole (Topas®)

poor ✗



- Phenotype ≠ genotype
- Molecular test not able to be used yet

# Powdery mildew

|                                   | <b>Reduced sensitivity</b> | <b>Mutant present</b> |
|-----------------------------------|----------------------------|-----------------------|
| pyraclostrobin (Cabrio® gp 11)    | 53%                        | 86%                   |
| penconazole (Topas® gp 3)         | 0                          | 68%                   |
| myclobutanil (Mycloss Xtra™ gp 3) | 14%                        | 84%                   |
| tetraconazole (Domark® gp 3)      | 0                          | 82%                   |

- Poor link between mutant & reduced sensitivity. Why?
  - DMI mutation is a precursor for resistance

# Issue to be solved:

Relationship between:

**Lab results** – how many samples?

**Field performance** – what level failure?

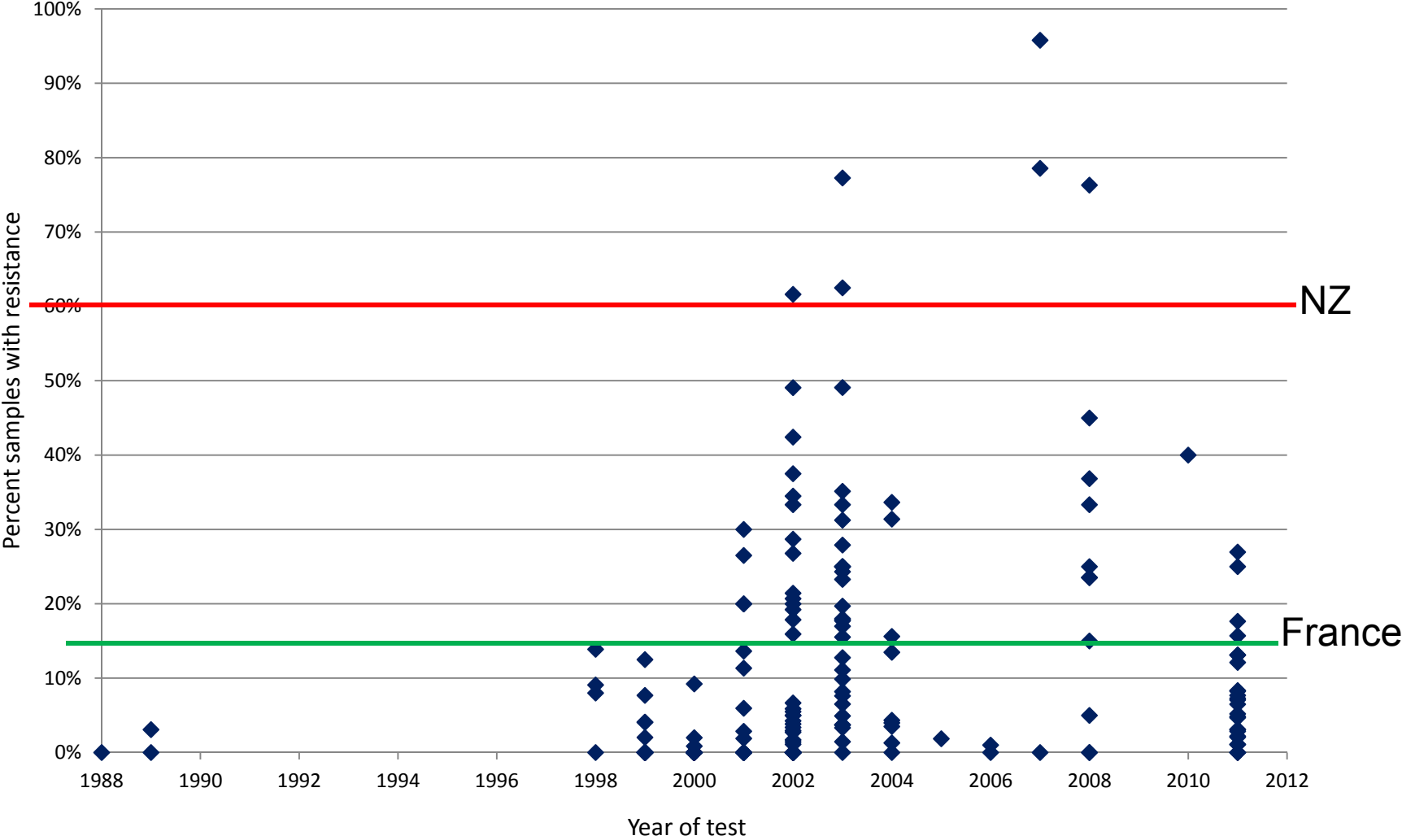
Botrytis – some known

Powdery – unknown

Downy – ??

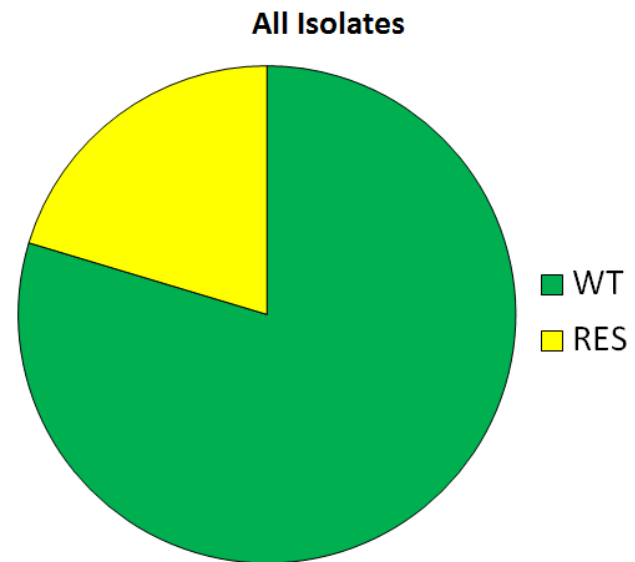
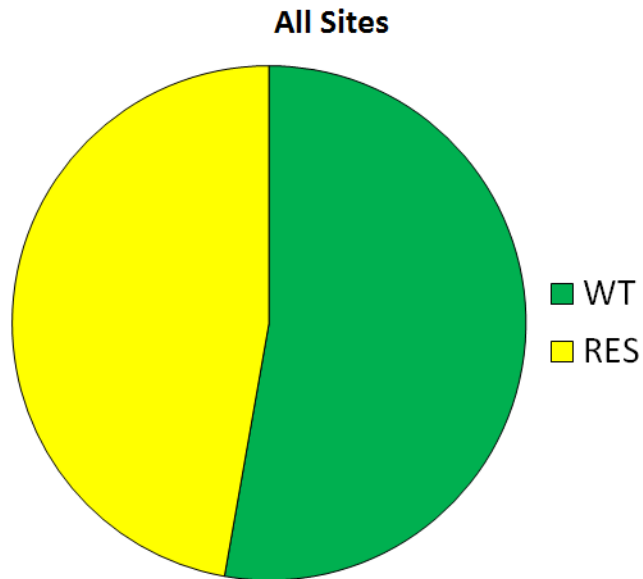


# Botrytis - dicarboximide



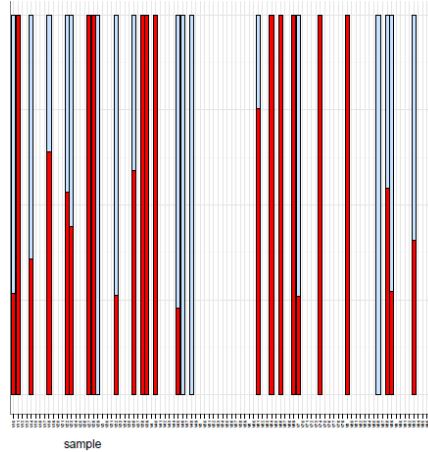
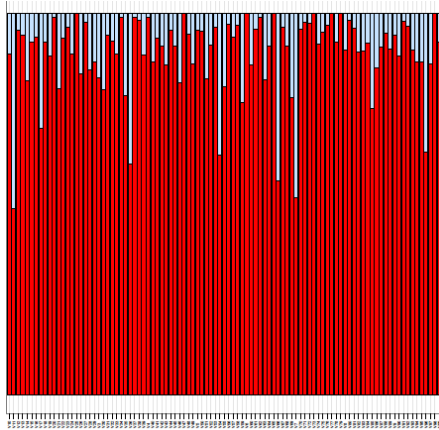
# Result summary - *Botrytis*

- 46% of all sampling sites tested have some degree of resistance
- 20% of all isolates tested have some degree of resistance



# Population studies

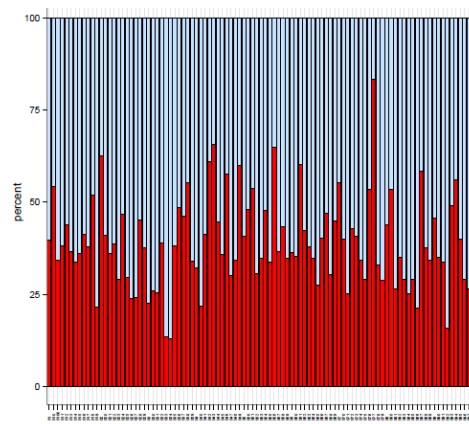
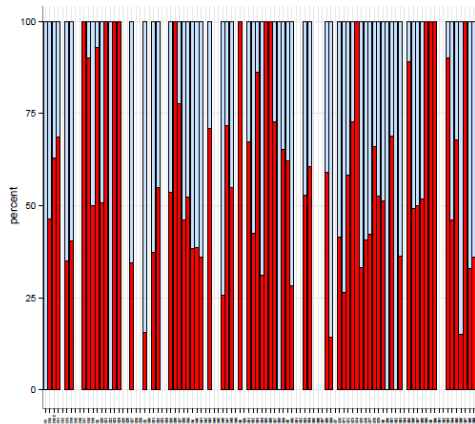
Resistance gene frequency% - 4 vineyards



- How many samples are needed?
- Distribution of resistance in a block?

## Issues

- Consistency of sample collection



# Where are we now with testing?

## Botrytis:

- Relationship between lab test and field performance known for older fungicides
- Good relationship between phenotypic and genotypic tests
- Potential for in field testing eg LAMP assays
- Commercial testing available (plate assays)

## Powdery mildew:

- Phenotypic tests work but laborious and sample size needed unknown
- Relationship between phenotypic and genotypic tests not clear
- Commercial testing not available

## Downy mildew:

- Phenotypic tests work but consistency of results an issue
- Metalaxyl has no known mutation
- Commercial testing not available

# New research

- Link between laboratory results and field failure
  - Intensive monitoring needed, link with sprays & field efficacy
  - How many samples?
  - Other mutations or genetic causes?
- Understanding differences among DMIs
  - Which DMI is best to use?
- Fitness of resistant populations
  - When can you reintroduce that chemistry again?
- Regional resistance monitoring - non-biased sampling
  - Spore trapping technologies
- Powdery – sensitivity to other fungicide groups
- Quick, reliable in-field test for resistance

# Manage poor performance

- Good coverage
- Fungicide choice
  - Correct rate
  - Timing
- Manage resistance risk

# Managing resistance risk

***Always follow resistance management guidelines***

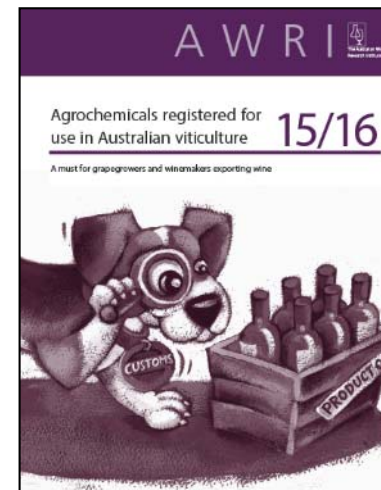
**R**otate or mix different modes of action

**U**se label rates

**L**imit total number of applications per fungicide group

**E**ducate yourself about fungicide activity, modes of action, resistance groups & management practices

**S**tart a fungicide program with a multi-site MOA to reduce populations – **DO NOT** use single-site MOA to control well-established infections



Thanks to Wine Australia, growers & viticulturists



**Project team & industry collaborators**



**Industry reference group**



Vitisolutions



SARDI