CRC for Viticulture
Pesticide application fact sheet 4

Cooperative Research Centre for Viticulture

Managing pesticide resistance in the vineyard

The way in which a pesticide works on the structure or metabolism of a pest in order to kill that pest is known as its **mode of action**. Understanding the modes of action of pesticides can help in deciding which is the best one to use for a particular situation and also for managing resistance in the target pest or disease.

Once a pesticide has made its way inside a pest or disease, whether this occurs by contact or systemic activity, it will disrupt the structure or physiology of the fungus, insect or weeds in one or many ways. This is the mode of action of the pesticide. For example some fungicides such as the DMI's can be used as eradicants or curatives because they are capable of destroying fungi that have already invaded and begun to damage plant tissue. Their mode of action is to inhibit the metabolic processes of the growing fungi. Protectants have a mode of action that prevents fungal infection through acting as a physical barrier or slowing growth of fungi.

Pesticides are divided into **activity groups** or families of related chemical compounds that:

- Have a similar chemical structure
- The same **mode of action**
- A different mode of action from pesticides in another group

Example – DMI fungicide mode of action

- The DMI's (Demethylation Inhibitors) have been one of the most important groups of fungicides for powdery mildew control over the last decade.
- They are a chemically diverse group and include penconazole (Topas®), triadimenol (Bayfidan®) and myclobutanil (Mycloss®).
- BUT they all inhibit the same demethylation step in the biosynthesis of ergosterol, a vital component of cell walls in many fungi.
- All DMI's kill fungi in this way, this is the **mode of action** of this group of fungicides.
- As all DMI's work at the same single site in fungi they belong to the same activity group ie. Group C

The activity group of a pesticide is classified by a letter code on the chemical label. For example, a fungicide belonging to activity group C will have the following code on the product label:

GROUP **C** FUNGICIDE

Resistance management involves restricting the use of high-risk (single-site) pesticides, and not overusing fungicides from the same activity group that have the **same mode of action**. This applies whether spraying for weeds, pests or diseases.

How resistance develops

Broad-spectrum fungicides such as copper, captan and sulphur act by interfering with several of a fungus' vital life functions. Their multi-site activity allows little chance for development of resistance since the fungus must undergo multiple changes to counteract the fungicide. On the other hand translaminar fungicides usually interfere with one vital life function, so only a single genetic change is needed for the fungus to become resistant to this type of chemical.

The majority of systemic and translaminar pesticides appear to be single-site inhibitors while the majority of conventional protectant fungicides such as sulphur are classified as multi-site inhibitors.

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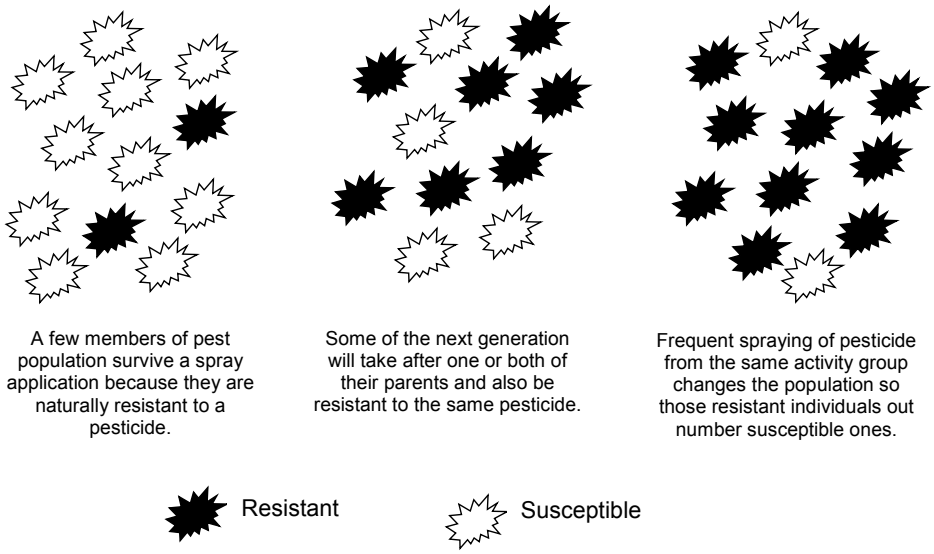
Genetic variation within a pest or disease population makes it possible that a few individuals will be able to withstand, avoid or detoxify the active ingredient in a pesticide (there are variable levels of resistance within a population).



1. A resistant population develops when these individuals survive a spray application and then reproduce.
2. They can then pass their resistance on to at least some of their offspring. Those individuals who are not resistant to the pesticide die and have no offspring.
3. Eventually only disease organisms with the higher levels of resistance to the active chemical are left in the population, and continuing applications of that pesticide is less effective or can become completely ineffective.
4. Due to the rapid reproductive rate of many pests and diseases an entire population can become resistant very quickly resulting in fungicide failure in the field.

Benzimidazole resistance
Development of resistance can be rapid and permanent such as *Botrytis* resistance to benzimidazoles eg. Benlate. In this situation the resistant strain has other traits that allow it to continue reproducing and dominate the fungal population once the fungicide is discontinued from use.

Dicarboximide resistance
Strains with resistance to dicarboximides eg. Rovral are less hardy, having reduced spore production and establish less quickly. Once use of dicarboximides is stopped the resistant population will slowly decrease as the population of more susceptible but hardier strains reproduce and become more common than the resistant fungi.

The inability of resistant strains to compete when the fungicide is not being used is called **loss of fitness**. It is the reason why resistance can be managed in some diseases by limiting the number of fungicide applications.

Resistance countering measures

Read the label as it is a LEGAL document

Always read the resistance management statement on the chemical label as it will provide specific information for that pesticide that must be followed. Chemical registrations vary between states. Check the product label for appropriate use in your vineyard. Also check the specific chemical and spray program requirements of the winery or customers you supply.

High and continuous selection pressure favours development of resistance in pests, diseases and weeds and this should be avoided. Important factors that can influence selection pressure for resistant strains include:

- Pesticide doses applied
- Frequency of application
- Type of application
- Alternating or combined use of pesticides

By using several of the resistance management strategies below ie. A “multiple attack” strategy, a disease population is exposed to selective pressures that change from generation to generation. Natural selection for a resistant strain is less likely to occur when selective pressures are continually varied.

- **Reducing pest and disease exposure** to the same activity group by alternating at risk chemical groups, and not applying fungicides with the same mode of action to consecutive generations of the disease. It is probably most effective to apply 2 or 3 consecutive sprays of one fungicide activity group and then to switch to a chemical with a different mode of action.
- **Spraying strategically** (optimum timing and targeting), to ensure maximum effective control when using pesticides. Applying pesticides late to control a disease that has reached high levels in the vineyard can increase the opportunity for resistance due to high inoculum levels and greater variability present in the fungal population (Aim to use all fungicides as protectants if possible).
- **Using recommended label rates** of pesticide as lower rates can subject the pest or disease to less than a full dose of chemical. Individual organisms with some degree of 'built-in" resistance may survive contact with reduced levels of pesticide and reproduce, increasing the potential for resistance. Uneven or poor spray coverage can also result in a sub-lethal dose being applied to the pest or disease (Avoid very high or low chemical rates as both will select out for resistant strains in a population).
- **Minimise pesticide applications** using IPM strategies and non-chemical measures where available such as monitoring to determine the best application timing, and canopy management such as trellising and pruning to encourage open canopies.

AVCARE fungicide resistance management strategies

AVCARE has developed fungicide resistance management strategies for fungicides used in viticulture to:

- Prevent the build up of resistant strains in fungal populations.
- Minimise fungicide selection pressure by not overusing fungicides from the same activity group.

These provide recommendations for a fungicide program that ensures effective disease control with the least risk of developing resistance. The current AWRI agrochemical booklet contains fungicide resistance management strategies for the main pests and diseases in viticulture.

Further information

- *Spray Application Viticulture: Research to Practice*® is a training package that can be fine-tuned to suit regional requirements and includes workshops, short courses and a comprehensive manual.
- *Agrochemicals registered for use in Australian Viticulture 2003/2004*. Australian Wine Research Institute. Note: Booklet is updated every year.
- *Resistance management strategies*. Australian Wine Research Institute/ AVCARE. www.awri.com.au/agrochemicals/fungicide_resistance/

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