Managing chemical resistance in the vineyard

Viti-note Summary:

- How resistance develops
- Counteracting resistance

The way in which a control agent works on the structure or metabolism of an organism to prevent it from causing damage to vines is known as the 'mode of action'. Understanding modes of action can help in product decision making and in managing resistance in the target pest or disease.

Control agents are divided into activity groups or families of related chemical compounds that have a similar chemical structure and similar mode of action.

Example – DMI group fungicides mode of action

The DMIs (Demethylation Inhibitors) comprise an important group of fungicides for powdery mildew control. They are a chemically diverse group and include the active constituents penconazole, triadimenol and myclobutanil but the mode of action is the same - they all inhibit the demethylation step in the biosynthesis of ergosterol, a vital component of cell walls in many fungi. DMIs act on a 'single-site' to kill the organism rather than disrupting numerous metabolic functions ('multi-site'). DMIs belong to activity Group 3 (previously group C) and this is displayed on product labels. Multi-site fungicides are denoted Group M (previously group Y) and are differentiated by numbers i.e. M1 comprises the copper based fungicides.

GROUP	C	FUNGICIDE
GROUP	3	FUNGICIDE

Figure 1. DMI fungicide activity group codes.

Resistance management involves restricting the use of high-risk (single-site) chemicals, and preventing the overuse of chemicals with the same mode of action. This concept applies to control of weeds, insects, or other pests or disease organisms.

How resistance develops

Broad-spectrum products or those with multi-site activity such as the fungicides copper (M1), captan (M4) and sulfur (M2) act by interfering with several of a target organism's metabolic functions. Their activity allows little chance for development of genetic resistance in populations since individuals need a number of genes which convey resistance. By comparison, the majority of systemic and translaminar chemicals are single-site inhibitors, meaning they interfere with one vital life function. Individuals require only a single beneficial genetic difference to survive.

Other topics in this Viti-Notes series include:

- Targeting sprays for vineyard pests and diseases
- Maintaining product performance in spray mixes
- Selecting and using spray adjuvants
- Understanding chemical 'modes of action'
- Equipment adjustment and evaluation to maximise spray coverage
- A single rate per hectare – why it shouldn't be used
- Determining chemical rates for dilute and concentrate spraying
- Determining dilute water volumes for spraying
- Calculating chemical rates for vines

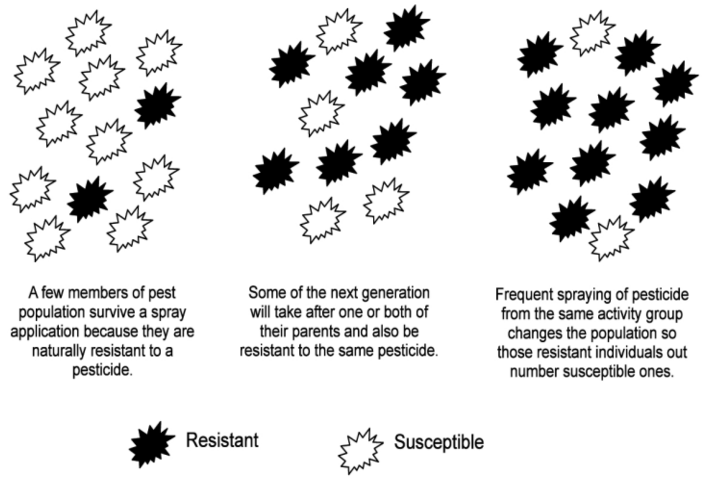

Figure 1. Schematic of how resistance in a population develops.

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

Resistance by an organism can be achieved in a number of ways, and there may be several methods and variable levels of resistance within a population. Individuals may be able to physically withstand, exclude or excrete the products, avoid them through different habitat or feeding behaviours, or actively detoxify the chemical agents.

Example: Benzimidazole (Group 1) and dicarboximide (Group 2) resistance in Botrytis

- Development of benzimidazole resistance can be rapid and permanent. In this situation the resistant strain of the fungus is very competitive and also has other traits that allow it to continue reproducing and dominate the population – this is known as inherent 'hardiness' or 'fitness'. Even after use of the fungicide is discontinued, benzimidazole resistance remains in the population.
- By comparison, strains of Botrytis with resistance to dicarboximides are less competitive or hardy, having reduced spore production, and establish less quickly. Once use of dicarboximides is stopped, the resistant population slowly decreases as more competitive strains reproduce and become more common than the less 'fit' dicarboximide-resistant strain.
- 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.

Counteracting resistance

High application rates and continuous use of a limited range of products with similar modes of action ('selection pressure') favour development of resistance in pests, diseases and weeds. Important factors that can influence selection pressure for resistant strains include:

- the doses applied
- the frequency of application
- the type of application
- alternating or combined use of other active ingredients.

By using resistance management strategies, a disease population is exposed to selection pressures that change from generation to generation. Natural selection for a resistant strain is less likely to occur when selection pressures are continually varied.

- Reduce pest and disease exposure to the same activity group by alternating 'at risk' chemical groups. Refrain from applying products with the same mode of action to consecutive generations of the organism.
- Monitor to determine the best application timing, and ensuring sprayer setup for effective targeting. This will enable the most effective control. Applying sprays late to control a pest or disease that has reached high levels in the vineyard can increase the opportunity for resistance developing due to the increased likelihood of resistant individuals in a larger population.
- Minimise the need for chemical applications by using non-chemical means where available. Cultural practices and pest predator populations can reduce the requirement for chemical use.
- Always follow label instructions. Using below recommended label rates of a product is not advisable as this can subject the pest or disease to less than a full 'killing' dose of the active ingredient/s in a product. Individual organisms with some degree of resistance may survive contact with a reduced dosage application 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 for resistant strains increasing in a population.

Croplife Australia outlines resistance management strategies on its website: www.croplifeaustralia.org.au.

Acknowledgement

The Australian Wine Research Institute would like to acknowledge the Cooperative Research Centre for Viticulture (CRCV) and all involved in the VitiNotes series (1996 - 2006).

Further information

Contact the AWRI helpdesk on 08 8313 6600 or helpdesk@awri.com.au

www.awri.com.au

For region-specific training in pest and disease control, contact the AWRI about the Research to Practice module: 'Integrated Pest Management for changing viticultural environments'.

Other resources can also be found on the Wine Australia website: http://research.wineaustralia.com/

Agrochemical information

Information about agrochemicals is published annually by the AWRI in a booklet titled *Agrochemicals registered for use in Australian viticulture*, commonly known as the 'Dog book'. Access the latest version and the app from AWRI website.

The Australian Wine Research Institute

Wine Australia for Australian Wine