Viti-Notes

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Cooperative Research Centre for Viticulture

Current topics in this Effective chemical use Vitinotes series include:

Effective chemical use

5. Managing chemical resistance in the vineyard

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 decide which is the best product to use for a particular situation, and manage 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) 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®).

- HOWEVER, they all inhibit the same demethylation step in the biosynthesis of ergosterol, a vital component of cell walls in many fungi.

- All DMIs kill fungi in this way; this is the mode of action of this group of fungicides.

- This means that they act on a 'single-site' to kill the organism rather than more generally disrupting metabolic functions ('multi-site').

- As all DMIs work at the exact same single site in fungi they, belong to the same activity group; Group C.

The activity group 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

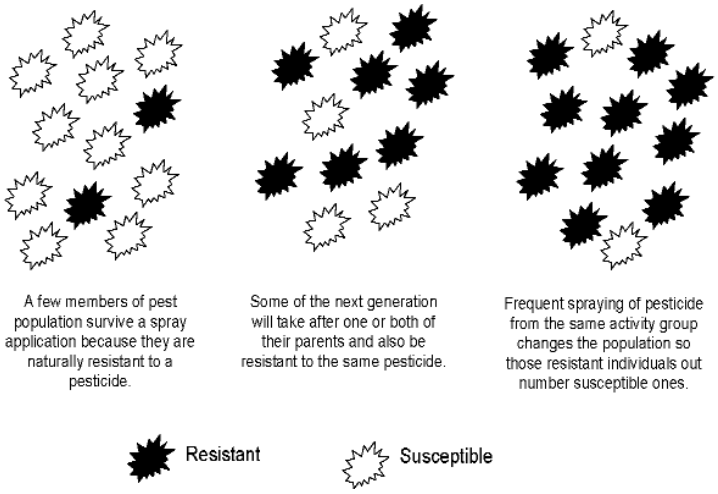
RESISTANCE MANAGEMENT INVOLVES RESTRICTING THE USE OF HIGH-RISK (SINGLE-SITE) CHEMICALS, AND NOT OVERUSING THOSE FROM THE SAME ACTIVITY GROUP THAT HAVE THE SAME MODE OF ACTION. THIS APPLIES WHETHER SPRAYING FOR WEEDS, INSECTS, OR OTHER PESTS OR DISEASE ORGANISM.

How resistance develops

Broad-spectrum products (those with multi-site activity, such as the fungicides copper, captan and sulphur) act by interfering with several of a target organism's vital life 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.

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, and 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 AND DICARBOXIMIDE RESISTANCE IN BOTRYTIS

- Development of benzimidazole resistance can be rapid and permanent (eg. Benlate). 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 (eg. Rovral) 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') favours development of resistance in pests, diseases and weeds. Important factors that can influence selection pressure for resistant strains include:

- The doses applied.
- Frequency of application.
- Type of application.
- Alternating or combined use of other active ingredients.

By using several of the resistance management approaches below in a 'multiple attack' strategy, 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, and not applying products with the same mode of action to consecutive generations of the organism. It is generally most effective to apply 2 or 3 consecutive sprays of one activity group, and then to switch to a chemical with a different mode of action.

• Spray strategically by monitoring to determine the best application timing, and ensuring sprayer setup for effective targeting. This will ensure maximum 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 due to there being a greater chance of resistant individuals in a larger population. Aim wherever appropriate to use protectant chemicals.

• Minimise applications using IPM strategies and non-chemical measures where available, such as canopy management techniques, trellising styles and pruning systems which encourage open canopies.

• Always use recommended label rates. 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 (very high or low chemical rates can result in resistant strains increasing in a population).

NOTE: READ THE PRODUCT LABEL AS IT IS A LEGAL DOCUMENT

The resistance management statement on the chemical label will provide specific information for that product 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.

Avcare resistance management strategies

Avcare, the National Association for Crop Production and Animal Health, has developed resistance management strategy guidelines for a number of chemicals and pest/disease organisms. These strategies aim to prevent the build up of resistant strains in pest populations, and minimise selection pressure by not overusing chemicals from the same activity group. The guidelines provide recommendations for a fungicide program that ensures effective disease control with the least risk of developing resistance.

Avcare resistance management strategies can be found at www.avcare.org.au

Further information

Product or service information is provided to inform the viticulture industry about available resources, and should not be interpreted as an endorsement.

A useful reference is:

• Diseases and Pests, editors, Nicholas, P., Magarey, P.A. and Wachtel, M., 1994, Grape Production Series 1, Hyde Park Press, Adelaide, (available Winetitles, 08 8223 4700, or www.winetitles.com.au).

• See also the glove box edition of the above, Field Guide to Diseases and Pests.

• Spray Application Viticulture: Research to Practice® is a training program whose delivery can be fine-tuned to suit each region. Enquiries to Peter Mansfield at Winetac on (08) 8373 7090 or visit www.crcv.com.au for more information.

• Agrochemicals registered for use in Australian Viticulture 2003/2004. Australian Wine Research Institute. Note: Booklet is updated every year.

Visit the web site at www.crcv.com.au/viticare/vitinotes/ for updates and more Vitinote titles.

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