Innovation in vineyard IPM and biocontrol release technology

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Why take a softer 'integrated' approach?

There are many good reasons to move away from synthetic chemicals as the mainstay of pest control and look instead at taking a softer integrated approach.

Concerns about worker, consumer and environmental safety are important factors driving a shift towards reduced reliance on pesticides, but there are also very practical reasons for growers to look beyond the spray tank for solutions to manage difficult pests in the vineyard. Withdrawn pesticide products and insecticide resistance issues have left growers with a much smaller selection of viable spray options in their pest control toolkit. There is also increasing awareness of how insecticides can cause ongoing problems when a broad-spectrum spray targeted at one pest disrupts a biological control using other pests, resulting in secondary pest-flare.

With the availability of an increasingly comprehensive range of selective chemistry that is soft on beneficials, it is easier now than ever before to implement effective integrated pest management (IPM) in the vineyard. IPM is an approach that aims to achieve good quality and high yields with minimal pesticides. The focus is on biological and cultural controls, and when chemicals are required, soft products that will have minimal impact on the key biocontrol agents are favoured over disruptive, broad-spectrum products.

The imperative to use available chemistry judiciously in order to slow the development of resistance is another good reason to use an IPM approach. By relying on biological and cultural controls as the first line of defence, we can reduce the need for insecticide applications and slow resistance development to the valuable IPM compatible products currently available.

Biological solutions for vineyard pests

Most insects and mites have natural enemies. An abundance of predators and parasites occur naturally in Australian vineyards, and in an IPM strategy these powerful allies are conserved (by minimising broad-spectrum insecticide applications) and encouraged (through cultural practices) to play a key role in controlling pests.

Sometimes a little extra help is needed. It can be worthwhile to supplement natural populations of beneficials with strategic releases of mass-reared biocontrol agents.

Bugs for Bugs is one of Australia's leading biocontrol producers and we are actively researching and developing biocontrol solutions for difficult vineyard pests. We have a long history supporting grape growers to develop and implement effective IPM strategies, and supplying predators and parasitoids to this industry.

We produce a range of beneficial organisms that can help control major vineyard pests including mealybugs, scale insects, light brown apple moth and other caterpillar pests. We are currently also working with AeroBugs to develop improved drone-based biocontrol release strategies that have the potential to increase the efficiency and effectiveness of biocontrol delivery into vineyards.

Cryptolaemus and lacewings for mealybug and scale control

Figure 1. Long tailed mealybug and sticky honeydew on grape bunch (photo by Dan Papacek).

Mealybugs and scale insects are becoming increasingly important pests of vineyards in many grape-growing regions across Australia (see Figure 1). They feed by sucking sap, but this alone rarely causes economic damage. They are a problem because they excrete honeydew, which contaminates leaves and bunches, leading to the development of sooty mould. This reduces photosynthesis and can cause bunches to rot.

Mealybugs and scale insects are difficult to control with pesticides. This is largely due to their waxy covering, their habit of infesting sheltered plant parts, and the consequent difficulty in achieving effective spray coverage. They also readily develop resistance to pesticides.

Instead of relying on chemicals to manage these pests, we suggest growers use cultural practices to encourage natural enemies and reduce pest pressure. If extra help is needed, we recommend strategic releases of two excellent native biocontrol agents:

1. ladybird *Cryptolaemus montrouzieri*

2. green lacewing *Mallada signata*.

Cryptolaemus are very efficient natural enemies of mealybugs. They have been exported to many other countries and are recognised as powerful predators of mealybugs. The larvae look very much like mealybugs and are often confused with them. Adult beetles and young larvae feed on mealybug eggs and young stages, while the large larvae can also feed on adult mealybugs (Figure 2).

Figure 2. Cryptolaemus adult (above, photo by Denis Crawford) and larva (below, photo by Dan Papacek) feeding on mealybugs.

In addition to mealybugs, Cryptolaemus will also feed readily on many species of soft scales, including grapevine scale.

Cryptolaemus are supplied both as larvae and adults. We recommend larvae for treating hotspots, or a combination of larvae and adults to ensure both rapid hotspot clean-up and optimal coverage and establishment across the vineyard.

After release, larvae should start feeding immediately. It will take around two weeks for them to complete their development (at 25 °C). They will pupate nearby and adult beetles should emerge to continue the cycle in another 2–3 weeks. Significant control is possible within one generation of Cryptolaemus (about four weeks). However, high pest populations can take longer to control and we usually suggest two releases a fortnight apart. Our recommended release rates vary depending on the economic importance of the pest being targeted and the severity of the infestation.

Green lacewing larvae are generalist predators that feed on a wide range of vineyard pests including mealybugs, scale insects, caterpillars and mites. We have seen excellent results from green lacewings released in vineyards that have persistent scale and mealybug problems. Boosting natural populations of green lacewings early in the season can enhance biological control of these difficult pests and contribute to the control of various mite and caterpillar pests.

Lacewings are despatched as eggs and should hatch into the larval stage during transit. Eggs are packed with shredded paper and wheat husks, with a small quantity of sterilised moth eggs for food. Upon arrival, larvae can be distributed by sprinkling the wheat husks and shredded paper onto the vines. It is best to release larvae into pest hotspots to ensure they have an immediate food supply.

We recommend two or three releases 10–14 days apart to improve lacewing establishment in the field. Larvae usually take about 12 days to develop before they pupate. After this time, there will be few lacewing larvae in the field, as it takes a further 16 days before adults emerge and lay eggs. Once again, the recommended release rate will vary depending on the economic importance of the pests being targeted and the infestation severity.

For best results, Cryptolaemus and lacewings should be released before pests have built up to high and damaging levels. It is also worth noting that ants like to feed on honeydew and they encourage the development of mealybug and scale colonies by interfering with natural enemies. Controlling or reducing ant numbers can help to establish beneficials and make a big difference to the success of biological control.

Trichogramma for light brown apple moth control

Figure 3. Trichgramma carverae on light brown apple moth egg mass (photo by Denis Crawford).

The light brown apple moth (LBAM, Epiphyas postvittana) is a native leaf-roller with a wide host range. This species does not survive well at high temperatures so it is typically a problem in cooler areas or during mild summers.

In vineyards, LBAM feed on grapevine foliage and fruit (Figure 3). Feeding within the bunches can reduce crop yield, but more importantly it increases the risk of infection by Botrytis and other bunch-rotting fungi.

Removing other broadleaf hosts, such as capeweed and clover in and around the vineyard is an important cultural control that can significantly reduce the overwintering LBAM population and contribute to improved management. Cultural practices and naturally occurring biological control agents might be sufficient in some instances, but in areas where pressure is high or seasonal conditions favour the pest, additional control measures are often required.

The parasitoid wasp *Trichogramma carverae* is recognised as the best available natural enemy of LBAM. This minute wasp lays its eggs into the LBAM egg mass. Parasitised egg masses turn black as the wasp larvae inside devour the developing LBAM caterpillars. After pupating within the LBAM egg mass, adult Trichogramma wasps emerge and females proceed to parasitise more LBAM eggs.

The advantage of this natural enemy is that it provides optimal crop protection by controlling the pest in the egg stage. However, Trichogramma wasps are very sensitive to insecticides and are best suited to those crops grown organically or under an IPM strategy.

Monitoring regularly for moth eggs is essential in order to determine the best time for release and the release rate. Trichogramma should be released when moths are active and laying eggs. Local history and pheromone traps provide a good guide to moth activity timing. Peak egg laying usually occurs just after a peak in the number of moths caught in pheromone traps.

Trichogramma are despatched in the form of parasitised moth eggs, housed in cardboard capsules. The more Trichogramma applied, the quicker the pest is controlled. However, economics will also dictate the number released. Experience overseas and in Australia suggest that regular releases of Trichogramma at variable rates, according to pest pressure and plant development, is appropriate.

To establish a continuous Trichogramma population in the field, it is necessary to make two releases between five and seven days apart. The wasps only live for that period in the field and it takes approximately nine days for any attacked eggs to produce a wasp. Thus seven days after the original release, all the original wasps will have died. It will take a further 2–5 days before their offspring emerge.

A second release will ensure that there are still adults present while the first generation completes its development.

Innovative biocontrol release technology

Manual distribution of biocontrol agents over large areas in field crops can be very labour-intensive and therefore costly. Bugs for Bugs has been working closely with AeroBugs's founder Nathan Roy to develop more efficient ways to deliver biocontrol agents, using unmanned aerial vehicles (UAVs, or drones) (Figure 4).

Nathan is a former strawberry grower and he is passionate about biological control, having seen the benefits on his own farm. Having recognised that labour costs associated with manually distributing beneficials are a considerable barrier to adoption, he set about developing improved release methods.

The result of Nathan's R&D efforts is his patented drone release technology, which enables efficient targeted distribution of our beneficials, and ensures that they arrive safe and sound in the crop.

AeroBugs are Australia's first operators accredited to use UAVs for this purpose, and the results have been excellent. So far, the technology has been successfully used to distribute predatory mites and parasitoid wasps in strawberry, melon, sweet corn and tomato crops.

This technology offers improved biocontrol distribution and considerable cost-savings compared with traditional manual distribution. There is potential to use this technology in vineyards, particularly for the release of Trichogramma, and we look forward to working with AeroBugs and interested growers to trial this approach.

Figure 4. AeroBugs drone delivering beneficials to a melon crop (photo by Dan Papacek)