Organic control options a dark future for the light brown apple moth

With its significant potential for economic damage to grapevines and fruit, a paper by researcher Russell Moss analyses strategies for deterring this invasive pest.

Pests & diseases

THE LIGHT BROWN apple moth is a pest native to Australia but can now be found in New Zealand, the UK and US and Ireland.

LBAM is a leaf roller about 9mm long, pale brown and the adult males have dark brown/black splotches on the back of their wings (figure 1).

The moth is seldom seen during the day as it is most active at dusk and dawn. The moth lays eggs in spring and summer in batches of about 30-50 at a time.

There are approximately three generations of LBAM per year.

The winter generation can cause a problem for grapevines at budburst, as the caterpillar can crawl onto the vine and eat the developing shoots. The spring generation can feed on the flowers and newly-set berries and the summer generation feeds on the fruit as well as moving into the clusters before bunch closure.

When the caterpillars hatch they roll the plant leaves and form a web of silk around the leaves and fruit.

This webbing forms a shelter within which they can feed on the leaves of the plant. The earliest LBAM instars feed on the abaxial leaf surfaces at the shoot tip.

The first instar (growth stage) is approximately 1.5mm and the last instar can reach 10mm in length (figure 2).

The stage of growth of the caterpillar can be roughly determined by the area of the plant on which it feeds. The caterpillars move from the top of shoots to the bottom of shoots as they progress through their life stages. LBAM is polyphagous and has the ability to feed on more than 2000 susceptible host species.

The main vineyard issue presented by LBAM comes from its invasion of the fruit. By boring into fruit LBAM provides wounds susceptible to infection by *Boytrytis cinera, Aspergillus* and *Aectobacter* (Nicholas et al., 2007).

BACILLUS THURINGIENSIS CONTROL

Bacillus thuringiensis var. Kurstaki is a Bt subspecies is a naturally occurring insecticide which attacks LBAM and leaves its natural enemies unharmed.

However, Bt is not selective, as it may have detrimental effects upon native butterflies.

Bt is a gram positive bacterium which, when consumed by LBAM, interferes with digestion and the insect soon dies of hunger after consumption of Bt.

Bacillus thuringiensis has been the focus of a large amount of research.

However a lot of this research has been negative towards the effectiveness of Bt. In fact, many farmers find the effectiveness of Bt to be variable at best.

Bailey et al. (1996) found Bt was relatively ineffectual in controlling LBAM because the larvae would stop feeding on Bt-treated leaves and find unaffected leaves instead.

Further, this study suggests the exposure of Bt to ultraviolet light causes a rapid degradation of the bacterium. Further, the Bt half life is about two days (Beegle et al., 1981). However with the development of more effective UV stabilisers and UV tolerant mutant Bt strains, Bt sprays may become more effective.

PHEROMONE MATING DISRUPTION

Pheromone mating disruption is exactly as it sounds. The female LBAM releases natural bio-chemicals, known as pheromones, which attract male mates.

When an abundance of these pheromones are released into the environment, it disrupts this communication and makes it difficult for the males to find mating partners.

This will eventually lead to the male moth dying without having reproduced. This pheromone has been recommended by the US Department of Agriculture as a means of control of the recent invasion of LBAM in the US. Further, these pheromones are selective and don't affect natural enemies of the pest.

Suckling and Shaw (1995) found high doses of a Lepidopteran pheromone can confuse the male LBAM and reduce mating. In turn, the reduction in mating has caused a significant reduction in the LBAM population when compared to a control.

However, some believe pheromone disruption is not viable as it interferes with LBAM monitoring systems.

These LBAM monitoring systems use attracticides in the form of pheromones. By emitting large amounts of pheromones into the

AT A GLANCE:

- The leaf-rolling light brown apple moth is a native pest but has spread its trail of destruction as far afield as New Zealand and the UK and US.
- The winter generation can cause a problem for grapevines at budburst, as the caterpillar can eat the developing shoots. The spring generation feeds on flowers and newly-set berries and the summer generation feeds on the fruit as well as moving into clusters before bunch closure.
- LBAM's main threat in the vineyard comes from invasion of fruit. By boring into the fruit it provides wounds susceptible to infection by *Boytrytis cinera, Aspergillus* and *Aectobacter*
- Although conventional means of LBAM control are effective, they can have detrimental effects on unintended targets, including beneficial insects and humans.
- The organic methods which have been presented have not only have been shown to be effective to varying degrees, but have also been shown to have a solid scientific and ecological foundation.

environment for mating disruption, it would likely render these pheromone-based monitoring systems irrelevant.

Contemporary pest management strategies (IPM) call for pest monitoring and action based upon detection of a pest or disease so if you can't monitor for LBAM due to the release of lepidopteran pheromones, it would become difficult to follow this rule.

HABITAT MANIPULATION

Habitat manipulation is a simple concept which involves a complex ecosystem.

The success of classical bio-control methods for pest mediation is less than 10% (Gurr & Wratten, 2000).

However, by using habitat manipulation you can enhance the native beneficial organisms and success rate of bio-control can be vastly greater.

By creating an environment conducive to the natural enemy of a pest, you theoretically increase the enemy population within an area in which it they are agronomically beneficial.

Steve Wratten (personal communication, 2011) uses the acronym SNAP (shelter, nectar, alternative food and pollen) when describing an effective habitat manipulation program for increasing beneficial biota.

The use of flowering plants to provide resource subsidies for parasites of a given pest has been the focus of many publications. Research has shown planting a flowering plant such as alyssum or buckwheat in the inter-row spaces of a vineyard can effectively increase the population of *Dolichogenidea tasmanica*, a parasitoid of LBAM larvae (figure 3) (Berndt & Wratten, 2005; Berndt et al., 2002).

New Zealand vineyard research found planting buckwheat in the inter-row spaces can increase the number of parasitoids (D. tasmanica). However, this research also examined the rate of parasitism of the leaf roller and found no significant difference between the parasitism rates of the control and the buckwheat sown rows.

But this study also found when a second generation of D. tasmanica was produced there were significantly more females than in the first generation.

This greater proportion of females provides a greater possibility of increased LBAM parasitism (Berndt et al., 2002).

Berndt et al. (2006) conducted a study which examined parasitism rates of LBAM in two Marlborough vineyards in which buckwheat had been sown down the inter-rows.

It found an increase in the parasitism rate of more than 50% in the buckwheat sown plots when compared to the control.

Researchers also found an increase in parasitism, but were unable to demonstrate if it had a significant effect on the LBAM population due to an unexpected end to the study, brought on by a severe drought preventing a second flowering of buckwheat.

A 2005 experiment examined the relationship between the provision of alyssum flowers to *D. tasmanica* and the longevity, fecundity and sex ratio of the population.

It has shown when female *D. tasmanica* had access to the nutritional subsidies of alyssum, their lifespan increased, on average, seven times more than female parasitoids which did not have access to the flower.

Also, male D. tasmanica had an average lifespan increase of three times when they had access to alyssum. The study also found an increase in fecundity; however this is likely due to the increased lifespan, as the parasite had more time to attack their respective hosts.

Furthermore, the study demonstrated

by providing *D. tasmanica* with a flower source they were able to equilibrate the sex ratio between the insects (Berndt & Wratten, 2005).

Amongst producers who do plant inter-row buckwheat it is common practice to sow buckwheat every 10 rows. This practice is largely due to a study conducted by Scarratt et al. (2008) which demonstrates *D. tasmanica* can venture as far as 30m from the food source, buckwheat. Therefore, because the average distance between vineyard rows in NZ is 2-3m buckwheat, at most, should be planted every 10 inter-rows.

As shown by this research, it is possible to decrease LBAM through increased parasitism due to the inclusion of a flowering plant.

However, grape growing is a business and like any business must examine the economic impact of employing this pest-management strategy.

Fortunately Dr Sam Scarratt monitored the proportion of grape bunches at harvest which were infested with LBAM during a three-year study.

This revealed the clusters which came from the buckwheat-sown treatment were below the economic threshold for LBAM infestation (<5%).

In this study the bunches harvested within the control treatment were found to be above the acceptable proportion of LBAM infestation (>5%) (Figure 6) (Barnes et al. 2010).

CONCLUSION

Although conventional means of LBAM control are effective, they can have detrimental effects on unintended targets, including beneficial insects and humans.

In the past, organophosphates were the industrially preferred method of LBAM control. However these highly-effective means of chemical control are rapidly being removed from the market with more stringent environmental protection legislation.

But the organic methods presented have not only have been shown to be effective to varying degrees, but also to have a solid scientific and ecological foundation.

It would be prudent for the grapegrower to understand the ecosystem within which they work and to prepare management strategies which effectively diminish a pest issue beneath the economic threshold without causing detriment to the greater ecosystem.

There will never be one right solution to any issue in the vineyard. Therefore, it would benefit the grapegrower to examine all of the options available and to choose the method(s) which most appeal to their ethos, finances and particular issue.

Habitat manipulation for LBAM control has not only been shown to be effective in diminishing LBAM vineyard populations, it has diminished the population below the accepted economic threshold.

This illustrates by sowing buckwheat every 10 rows in a vineyard, relatively low-cost option; you can effectively and economically control LBAM while having a positive impact on the ecosystem.

This practice should not just be considered exclusive to organically-farmed vineyards, as it is simply an effective means of pest control.

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