Factsheet

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Cover crops and vineyard biodiversity

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Introduction

All parts of the vineyard have the potential to foster biodiversity, including the vineyard floor. Management of the vineyard floor can enhance important aspects of the vineyard ecosystem, particularly pest control and soil health. There is increasing interest in establishing cover crops as a way of promoting beneficial invertebrates, improving soil structure, suppressing weeds and contributing to integrated pest management (IPM).

Any attempt to enhance biodiversity must take into account the impacts of chemicals that are applied in the vineyard. Such chemicals may be more or less toxic in their effects on soil organisms and on the natural enemies of vineyard pests.

Pest control in particular is frequently achieved through a combination of chemical applications and the actions of natural enemies, but the abundance of natural enemies will be influenced by aspects of crop management, including pesticide applications (Stark & Banks 2003; Thomson & Hoffmann 2006). An analysis of many studies of pest control in a wide variety of crops showed that increases in natural enemy populations can support reductions in pesticide applications while maintaining pest control and plant productivity (Bengtsson et al. 2005). Identifying and adopting practices that increase the abundance of natural enemies, such as IPM, can therefore help to reduce the need for chemical applications, and thereby promote agricultural sustainability.

The term *biodiversity* refers to biological diversity in an environment, and is difficult to measure accurately due to the complexity of natural systems. However, it is generally accepted that the more diverse a system is, the more resilient or self-regulating it will be. A wide range of potential natural enemies coexist with pests in vineyards and contribute to control of the pests through predation and parasitism (Thomson et al. 2007).

For example:

- jumping spiders lie in wait to 'jump' on prey
- web-building spiders snare prey in webs
- other spiders roam the canopy and the ground
- lacewings, especially as larvae, roam the canopy
- ground beetles (Carabidae) roam the vineyard floor
- rove beetles (Staphylinidae) are found both in the canopy and on the floor
- earwigs (including the introduced European earwig) move between floor and canopy
- many species of ants are known predators of many pests, especially of moth eggs
- several species of ladybird beetles, predatory thrips, predatory flies, predatory bugs … the list goes on.

In addition to the predators that are familiar sights throughout the vineyard, there are many parasitoids that contribute to the control of many vineyard pests. Parasitoids are useful natural enemies that lay their eggs in the larvae or pupae of other insects (and spiders), killing the host and providing more parasitoids to provide more control. The best known are of course the egg parasitoids of light brown apple moth (LBAM), namely the *Trichogramma* spp, but at least 27 other parasitoids attack caterpillars and pupae (Glenn *et al.* 1997; Paull & Austin 2006). Other parasitoids in vineyards attack scale, mealybugs, grapevine moths, weevils and even mites. This diversity of natural enemies enhances the control available at different times to attack pests at different life stages and with different life history traits such as flying, jumping, hiding, web building and walking.

A couple of examples related to economically important and well studied pests, namely LBAM and scale, illustrate the importance of this diversity. Natural enemies of LBAM include the parasitoids mentioned above, which not only parasitise eggs and caterpillars in the canopy, but also attack pupae on the vineyard floor. Eggs, caterpillars and pupae may also be eaten by a range of spiders,

brown and green lacewings, predatory bugs, ladybird beetles, ants, predatory thrips and earwigs, and moths, of course, frequently fall prey to spiders.

Probably the most important and well studied enemies of scale in vineyards are several minute wasps that parasitise the different soft scales, and ladybird beetles (Coccinellidae), which prey on eggs and caterpillars. Again, though, a diverse range of other enemies include wasp egg predators, green and brown lacewing larvae and even predatory caterpillars! The famous 'mealybug destroyer' *Cryptolaemus montrouzieri*, a ladybird beetle first exported to the US in the 19th century on its merits as a scale control agent in Australia, became better known as a mealybug predator (as the common name suggests) and continues to be an important predator of scale as well as mealybugs in vineyards. The caterpillar of the native moth *Mataeomera dubia* and the larvae of green lacewings are useful predators of the eggs and crawlers of grapevine scale. Other beetle predators from the Carabidae, Staphylinidae and Latridiidae families also probably eat scale.

So while the importance of natural enemies is well known, further research will bring more and more interactions to light. Diverse, abundant natural enemies are welcome components of vineyard biodiversity — how can we lend them a hand?

Beneficial organisms on the vineyard floor

What happens on the vineyard floor does have an effect on the abundance and diversity of natural enemies. Providing vegetation in the vineyard in the form of cover crops can increase the abundance of natural enemies. For some this is due to the provision of resources such as pollen and nectar, but for others the shelter provided will be more important. Cover crops have been shown to increase the abundances of a wide range of natural enemies and even to increase predation and parasitism of pests.

In cover cropping trials that investigated various native ground covers, planting windmill grass (*Chloris truncata*), saltbush (*Atriplex semibaccata*) and wallaby grass (*Austrodanthonia richardsonii*) in the understorey enhanced the abundances of a range of predators and parasitoids (Figure 1), not only on the ground but also in the canopy. The abundance of earwigs was increased with the native cover crops, especially windmill grass and saltbush (Figure 1).

The benefit of a cover crop is further demonstrated by increased predation of LBAM eggs in the canopy above it (Figure 2). The native ground covers provided suitable habitat for beneficial insect species, as determined over two years of sampling, without replanting of native grasses. Some of this increase may be related to food provided by plants that grow actively over summer, such as saltbush, while other predators, especially spiders and ground beetles, enjoy the shelter provided by cover crops and can even be encouraged by the introduction of straw or mulch.

The effect of the increased shelter provided by a cover crop is demonstrated by the enhanced abundances of a range of predators (spiders, beetles and brown lacewings) in the canopy and on the ground (Figure 3).

Trials using floral cover crops such as buckwheat (Scarratt *et al.* 2008) show that the impact of cover crops on parasitoids extends as far as 30 m from the cover crop row, so planting in alternate rows or at even greater distances may be effective. Some of these introduced cover crops will not be appropriate in Australia due to the lower availability of water but the principle of area-wide coverage from selected rows will be the same.

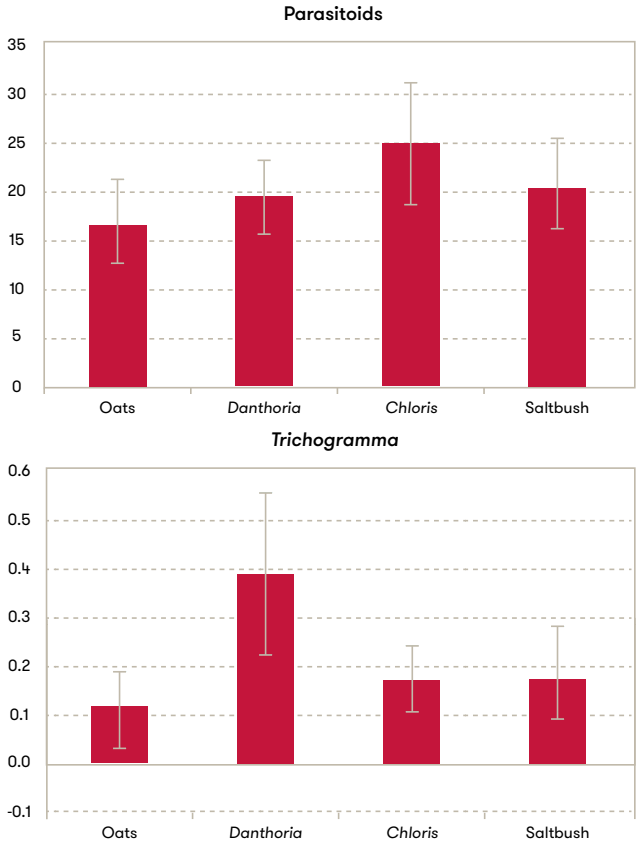

Figure 1: Parasitoid and *Trichogramma* populations in the canopy were enhanced with native grass cover crops.

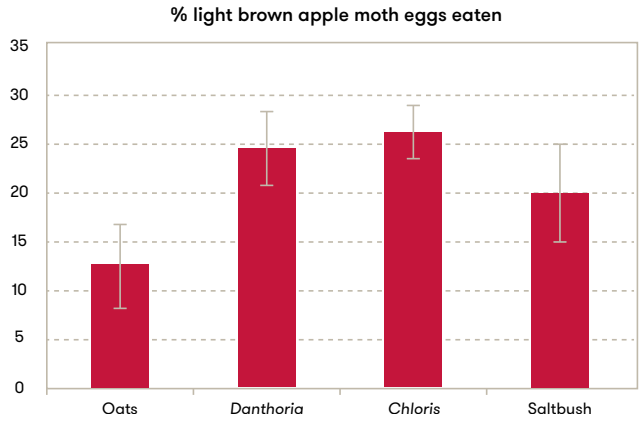

Figure 2: The benefit of increased predator abundance is shown by increased predation of LBAM eggs in the canopy above native grass cover crops.

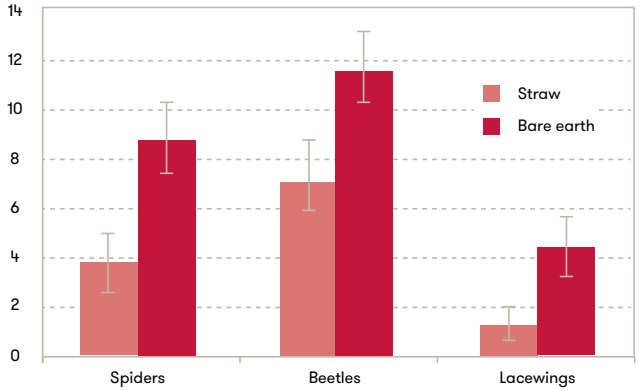

Figure 3: The benefits of shelter provided by cover crops and even straw are demonstrated by the increase in abundance of spiders, beetles and lacewings seen with a straw ground cover.

Soil improvement by beneficial organisms

In addition to their role in controlling pest taxa, invertebrates also play an important role in nutrient cycling and improving soil health. Soil is the critical component of the agricultural ecosystem, so encouraging biodiversity here is also of great benefit. Increased soil biodiversity encourages increased biological activity, providing an environment that will enhance the natural breakdown of organic material, aeration and nutrient cycling. Up to 1000 different species of invertebrates may be found in 1 m^2 of soil. The organisms that play this role are called detritivores; they are small to medium sized and, as with natural enemies, they include many that are familiar, such as millipedes, slaters and earthworms. Others, such as orabatid mites and springtails (Collembola), will be less well known because of their tiny size. One species of springtail is commonly seen in large numbers in puddles. These soil invertebrates accelerate decomposition and increase nutrient availability, effects that are especially important in nitrogen and carbon cycling. Their abundance increases with cover crops.

Key messages

- Biodiversity supports pest control and soil health.
- Biodiversity will be enhanced by sensitive chemical use in the vineyard.
- Moving the balance of pest control away from chemicals to the control provided by natural enemies supports IPM in the vineyard.
- Cover crops provide shelter for many invertebrates. Summer-active cover crops may also provide nectar and pollen, which supply the energy and protein essential for beneficial species.
- Abundant soil biodiversity supports pest predators that can keep harmful organisms from over-populating and destroying your crop.
- Abundant soil biodiversity also enhances the natural nutrient cycling that keeps plants healthy.

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Further reading

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Many interesting factsheets are also available, such as:

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