BUG VS BUG
WORKING WITH NATURAL ENEMIES

POTATO R&D FORUM 2022

On a fine summer's day, plants fairly buzz with insect life. The vast majority of insects are harmless, some are beneficial, and a very few are damaging to potato crops. Encouraging beneficial insects into the crop can save time and money, avoid negative side effects and prevent development of resistance.

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KEY POINTS

- Predators, parasites and parasitoids can all be beneficial
- Beneficial insects occur naturally in Australia; they don't need to be purchased, just provided with food and habitat
- Maintaining a diverse insect population is key to IPM success
- Avoid broad-spectrum insecticides that kill beneficial insects

Most growers will be familiar with the term Integrated Pest Management (IPM). IPM is neither chemical focussed nor organic, but instead chooses the most appropriate management method based on pests and diseases found within the crop.

Strategies can include cultural controls, such as ensuring hills are intact to protect developing tubers from potato tuber moth, and controlling weeds that act as alternative hosts for pests and diseases. They can also be biological, using beneficial insects or pathogens that target pest species. IPM does not rule out chemicals, it just utilises them in a focussed way, supporting other strategies.

The aim of IPM is to bring these controls together to work in a collaborative way.

Beneficial organisms can generally be categorised as:

- Predators
- Parasites, and
- Parasitoids

Some species of predators and parasitoids are sold commercially. However, buying these organisms is not usually necessary. Instead, if you provide a suitable environment, with food and shelter, they will arrive.

Predators eat other organisms. For example, lacewing larvae are

Figure 1. Predators include brown lacewing (left, source: P. Horne) and white collared ladybird (right, source J. Ekman) larvae, both of which prey on aphids.

voracious hunters of aphids. Many species of ladybirds are also efficient predators, especially as both the adult and larvae are carnivorous. While adult ladybirds are easily recognised, their larvae look (and act) a little like tiny crocodiles (Figure 1).

Parasites live in or on their host. Some parasites kill their host, others spread disease or impair proper function. For example, we have heard a lot in recent months about varroa mites, which parasitise honey bees, with devastating impact.

However, there are also beneficial parasites. Examples include entomopathogenic (insect-killing) fungi and nematodes. From the spectacular *Cordyceps* fungus to species of *Metarhizium* (green mould), these fungi grow within the insect, eventually killing it (Figure 2).

There are also several species of entomopathogenic nematodes (*Steinernema* spp., *Heterorhabditis* spp.) which attack soil borne insects. They multiply inside the insect, eventually bursting out and spreading in search of new hosts.

Parasitoids lay eggs in or on their hosts. Like the creature in Alien, the larvae live off their host, eating non-vital organs and bodily fluids as they develop.

Figure 2. Entomopathogenic fungi include *Cordyceps* spp., (left, source: J. Ekman) and *Metarhizium* spp. (right, source: CSIRO)

Generally, parasitoids are host-specific, which means they only target a limited range of prey.

Adult parasitoids are often very small and their larvae are hidden within the bodies of their hosts. This means that they can be overlooked by growers and advisors. Despite this, they can have very significant impacts on pests.

The smallest insect recorded is a parasitoid wasp; the male *Dicopomorpha echmepterygis* wasp is a mere 0.127 mm long (University of Nebraska-Lincoln). Thankfully, most potato pest-focused parasitoids are not this small. Many are around 1 mm long or larger, just big enough to view under a hand lens.

Adult parasitoids are may be tiny, but they are highly mobile. For example, *Trichogramma* wasps are only 0.5mm long but can travel at least 30m during their 2 week lifespan (equivalent to a tall human walking 120km). Moth

Figure 3. Moth eggs parasitised by *Trichogramma* wasps. Source: P. Horne

Figure 4. and an aphid parasitised by *Aphidius colemani*. Source: N. Dimmock, Uni. Northampton, Bugwood.org

Figure 5. A female *Orgilus lepidus* wasp, a parasitoid that attacks potato moth. Source: P. Horne

Figure 6. Potato moth caterpillar parasitised by *Copidosoma* (left) and a non-parasitised PTM pupa (right). Source: P. Horne

eggs parasitised by *Trichogramma* turn black just before the wasps emerge (Figure 3). Other useful species include *Orgilus lepidus* and *Copidosoma* spp., which parasitise potato tuber moth (Figure 4 and 5).

This highlights the difficulty of identifying the insects in action. With lacewings or lady beetles, you can watch them work. It is much harder with parasitoids, with only the mummified remains of host insects left behind.

WHICH BENEFICIAL INSECTS ARE IMPORTANT FOR POTATO GROWERS?

There are many beneficial species that occur naturally in Australia to help control potato crop pests, including:

- *Trichogramma spp.* – targets moth eggs (Figure 3)
- *Aphidius spp.* – targets aphids (Figure 4)
- *Encarsia spp.* – targets whitefly
- Tachinid flies (Tachinidae) – target caterpillars
- *Orgilus lepidus* – targets potato tuber moth (PTM) caterpillars (Figure 5)
- *Apanteles subandinus* – targets potato tuber moth (PTM)
- *Copidosoma spp* – targets potato tuber moth (PTM) eggs and caterpillars (Figure 6)

Maintaining a biodiverse insect population will encourage other native parasitoids and predators in your crop.

The key factor for succesful IPM is to avoid insecticides that kill beneficial insects. Instead, choose selective insecticides, using only once pest populations exceed damage thresholds (Figure 7).

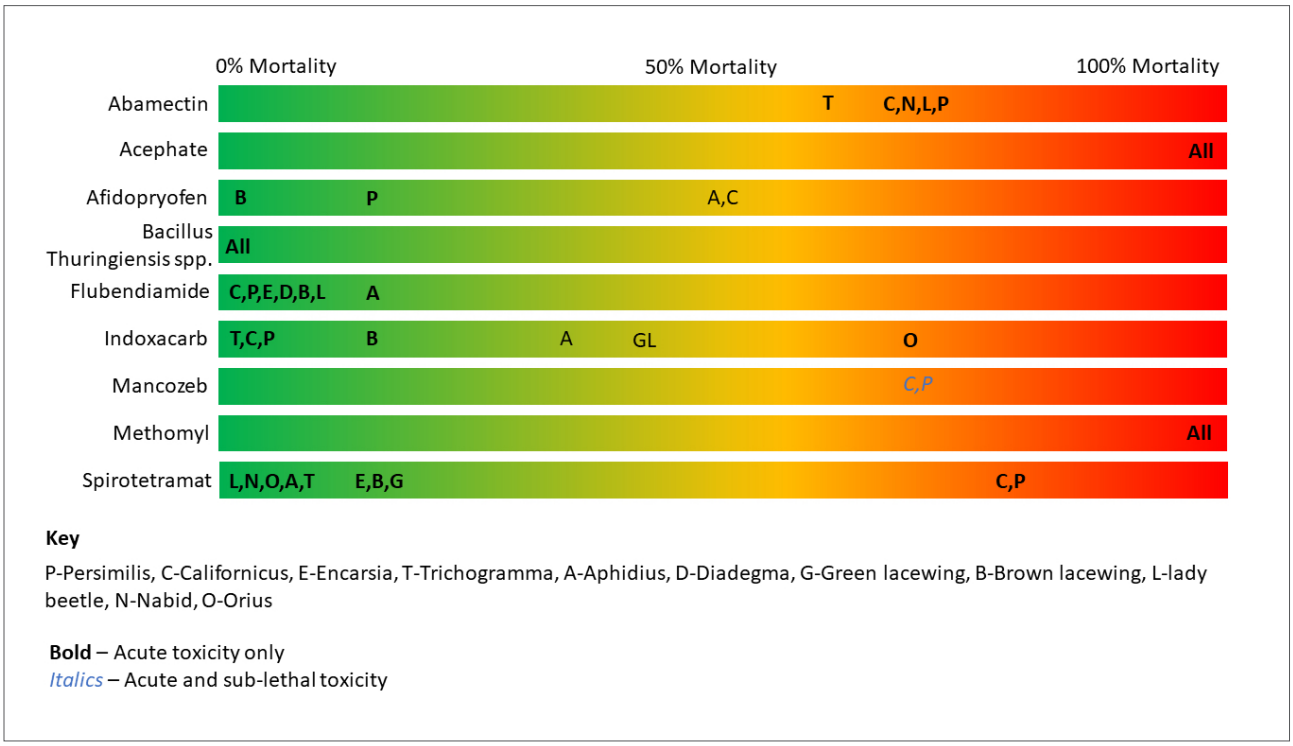

Figure 7. Table of common chemicals and their impacts on various beneficial species including predators and parasitoids

MORE INFORMATION

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*Information current as of 2019. Check with the AVPMA website to ensure any chemicals are still registered before use. If in doubt, consult your agronomist.

CONTROLLING SERPENTINE LEAF MINER

Exotic leaf miners have well and truly arrived in Australia, with the first infestation of a potato crop reported this winter in the Lockyer Valley. Focus has now shifted from elimination to finding ways to manage these new pests.

Leaf miners are not fussy eaters. *Liriomyza huidobrensis* (serpentine leaf miner, SLM), *L. sativae* (vegetable leaf miner) and *L. trifolii* (American serpentine leaf miner, ASLM, Figure 1) can attack approximately 200 different host species across 15 families, including potatoes.

Adult leaf miners poke a hole in the leaf and lay their eggs under the surface. This means insecticides need to be systemic (moving through the plant), or at least translaminar (penetrates the outer layers of the leaf), to have any impact against their target. However, over reliance on a limited range of insecticides has already increased resistance by SLM in many countries.

Once SLM eggs hatch, larvae burrow under the leaf surface. As they feed, they leave behind characteristic squiggly white 'mines' through the inside of the leaves. Pupae (Figure 2) re-emerge and, in most cases, drop into the soil, where they can safely over-winter.

Figure 1. American serpentine leaf miner. Source: DAFF

Figure 2. Serpentine leaf miner pupae. Source: DAFF

PARASITOIDS AS A METHOD OF BIOLOGICAL CONTROL

With much of the life cycle occurring within the leaf, a parasitoid wasp that can attack the SLM larvae as they feed provides a neat solution.

There are more than 50 species of parasitoid wasp species that target leaf miners. Many are already present in Australia and provide an effective non-chemical control option.

Four are particularly good at targeting SLM:

- *Opius spp.* (Figure 3)
- *Diglyphus isaea* (Figure 4)
- *Hemiptarsenus varicornis*
- *Zagrammosoma latilineatum*

The tiny parasitoid wasps of the leaf miner prevent further development of the host after initial paralysis. Typically, a wasp attacks SLM larvae and then lays its eggs on or in the larvae. The SLM larvae are often initially paralysed, then die once the wasp larvae hatch and starts to feed. The wasp larvae pupate beside their dead host before emerging from the leaf mine.

Some adult wasp species are also predators, killing and feeding on leaf miner larvae. Not only do these larvae nourish the wasps, they act as a nutrient boost for improved egg development.

A well-managed IPM plan using parasitoids can result in mortality rates of SLM as high as 80 percent[1].

Ongoing project MT20005 (Management strategy for serpentine leafminer, *Liriomyza huidobrensis*) is further refining this control strategy.

Figure 3. Braconid wasps (*Opius sp.*) Source: Bugwood.org

Figure 4. Eulophid wasp (*Diglyphus isaea*). Source: Joseph Berger, Bugwood.org

ATTRACTING PARASITOIDS TO A CROP

Flowering strips

A Hort Innovation study from 2020, led by Charles Sturt University and The Graham Centre for Agricultural Innovation, examined ways to provide suitable habitat for beneficial insects. The focus of the study was to test whether flowering strips could attract beneficials, including wasps.

The project demonstrated that fast-growing, nectar-producing species can increase activity of beneficial insects, providing cost-effective pest control. The team proposed the following steps[2] :

1. To improve beneficial activity in the crop, establish strips of flowering (nectar-producing) plants approximately 30 metres apart.
2. Plant flowering strips that are single-species or mixed-species depending on seed availability and cost.
3. Cornflower (*Centaurea cyanus*, Figure 5) was the best choice for enhancing parasitoid wasps. Cornflower strips also attract some generalist predator species and provide shelter for beneficials even pre-flowering.

Patience

Presenting at the recent R&D forum in Ballarat, Zarmeen Hassan from AUSVEG emphasised the need for patience. Experience has shown that parasitoid wasp populations increase naturally over time. So, while there may be a spike in leaf miner in year 1, avoiding use of insecticides will allow wasps to establish and eventually provide effective control.

Figure 5. Cornflower (*Centaurea cyanus*). Source: Lucy Kral on Unsplash

Figure 6. Hedgerow planted next to a potato field in Dublin, Ireland

REFERENCES AND OTHER SOURCES

[1] https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/1274661/Primefact-Management-of-SLM.pdf

[2] https://www.horticulture.com.au/globalassets/hort-innovation/resource-assets/vg16062-boosting-beneficials-in-your-vegetable-crop.pdf

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