

INTEGRATED PEST MANAGEMENT FACT SHEET

Combating serial pests

IPM reduces reliance on pesticides, especially broad-spectrum pesticides, limiting the opportunity for resistance and promoting populations of beneficial species.

KEY POINTS

- Long-term use of broad-spectrum pesticides for invertebrate pest control is not sustainable.
- IPM integrates cultural, biological, chemical controls – where possible, choice of control(s) is based on economic thresholds.
- An understanding of pest and beneficial insect dynamics, and how to monitor them, is essential for successful IPM.
- Reducing reliance on broad-spectrum pesticides improves triple bottom line outcomes (economic, environmental and social).

Why use an integrated approach

Since the 1950s, synthetic pesticides have been the accepted method of controlling invertebrate crop pests. While these are relatively cheap and broad-spectrum, their widespread use has increased selection pressure for resistance in pests. At the same time, pesticide use has decreased many predators and parasites of crop pests.

Knock-on effects of broad-spectrum pesticide use include:

- pesticide resistance;
- eradication of beneficial species that can assist pest control; and
- secondary pest outbreaks.

The occurrence of all of these factors can be minimised by the use of integrated pest management (IPM).

IPM combines a wide range of tactics, including biological, chemical and cultural practices, to provide reliable, long-term pest control.

IPM integrates pest biology, environmental information and other relevant technologies to reduce pest damage, while minimising health and environmental risks.

IPM requires an understanding of pest and beneficial insect dynamics, economic control thresholds and how various control tactics interact.

Ideally, IPM uses selective control options that specifically target pests, reducing reliance on conventional broad-spectrum pesticides.

IPM uses chemical controls as a 'last resort' support tool rather than the main weapon.

Thinking ahead and long-term planning are vital to successful IPM. Working with experts in insect identification, monitoring and IPM can help accelerate the adoption of IPM in broadacre cropping.

The *Crop Insects: the Ute Guides*, produced for the northern, southern and western regions (see Useful resources) not only provide a useful regional identification reference but also include information on damage, monitoring and, in new editions, biocontrols.

If the adoption of IPM across the whole farm is too daunting, applying the principles to one or two paddocks has proved a successful way to start.

Courses on implementing IPM are available through many state departments of agriculture (see Useful resources).

An effective broadacre IPM strategy reduces pest damage and control costs by:

- encouraging beneficial species that act as natural pest biocontrols;
- adopting cultural controls that reduce pest populations and boost beneficial insect populations;
- using selective pesticides/biopesticides that target specific pests; and
- applying economic thresholds to avoid unnecessary spraying and to take advantage of a crop's ability to compensate for pest damage at certain crop stages.

Resisting resistance

Pest exposure to sub-lethal doses of pesticides can accelerate evolutionary changes that help pest populations adapt to their environment. Surviving pests carry genes that confer pesticide resistance. Repeated pesticide applications increase the proportion of resistant individuals in a pest population, until the majority are resistant to that particular pesticide.

For example, research has found a high level of tolerance to several organophosphates and/or synthetic pyrethroids in several common grain pests including redlegged earth mite, blue oat mite and lucerne flea (pictured).



PHOTO: CESAR CONSULTANTS

PUTTING IPM INTO ACTION

1 Know the enemy

Accurate identification of beneficial and pest species is fundamental to IPM. For example, there are four easily confused pest mite species commonly found in most grain production regions of Australia. Despite their similarity in appearance, these mites – redlegged earth mite, blue oat mite, clover or bryobia mite and balaustium mite – differ in their response to commonly used pesticides.

However, it is also important to understand the biology and life cycle of target pests and beneficial species. Knowing when populations are likely to increase or decrease can affect control decisions. Factors such as weather, presence of hosts, plant growth stage and balance of pest and beneficial species present can all cause insect populations to fluctuate. Peak populations of beneficial species generally occur after peak pest populations.

Understanding the behaviour of a pest can give an indication of when and where it is most likely to be found. For instance, slugs tend to inhabit heavier soils, especially those that form cracks and large clods, which they are able to use as refuges from hot and dry conditions. When favourable moist conditions prevail, these pests emerge and are more easily seen at night.

To know your enemy:

- establish the pests most likely to be a problem in the region;
- determine when crops are at greatest risk and be familiar with crop growth stages (Table 1);
- know the most appropriate monitoring technique and when to monitor the crop for the pest of interest, as pest thresholds are based on standardised sampling protocols, (see point 3 Monitor populations);

- use a 10-times magnification hand lens or basic dissecting microscope to accurately identify smaller pests or pests in their younger stages;
- refer to *Crop Insects: the Ute Guide* or similar illustrated reference guide to help identify pests; and
- maintain up-to-date records of observations.

Many pests are detectable during multiple stages of crop development but are most prevalent as listed (Table 1).

A free diagnostic service for pest, and beneficial species is provided through PestFacts/PestFax (see Useful resources).

On initial inspection these tiny mites look the same, but they are different and need different controls. Using a 10-times magnification hand lens and identification charts will help with correct identification.

Balaustium



Blue oat mite



Redlegged earth mite



Clover mite



TABLE 1 WHAT TO CHECK FOR WHEN

Crop establishment	Vegetative stage	Flowering	Podding to seed set
Mites (all crops and pastures)	Caterpillars (summer pulses and, under warm winter conditions, predominantly canola and pulses)	Aphids (all crops)	Caterpillars (all crops) – <i>Helicoverpa</i> , <i>Etiella</i> , armyworms
Lucerne flea (pastures, cereals and canola)	Silverleaf whitefly (pulses and sunflowers)	Caterpillars (all crops)	Mirids (primarily pulses and grain legumes)
Slugs and snails (predominantly canola, some cereals)	Slugs and snails (predominantly canola, if populations are high)	Mirids (primarily pulses)	Rutherglen bug (predominantly canola, some pulses)
Cockchafer (cereals and pastures)		Silverleaf whitefly (pulses and sunflowers)	Podsucking bugs (pulses – mainly summer)
Weevils (all crops)			Silverleaf whitefly (pulses and sunflowers)
Aphids			Aphids (all crops)
Bean fly (summer pulses)			Field crickets (sunflower, sorghum and pulses)
Field crickets (emerging cereal crops and pastures)			

Natural enemies

Beneficial species, sometimes referred to as 'natural enemies', help to control invertebrate pests as part of a successful IPM strategy. Many beneficial species occur naturally and populations can be encouraged by reducing pesticide use.

Beneficial species can be divided into three main groups:

- **parasites (parasitoids)** – lay their eggs on or in the host, and hatching larvae feed off the host pest's body, larvae or eggs, eventually killing the host;
- **predatory insects** – generalists, such as spiders, prey on a range of pests, whereas others are specialised, for example pasture snout mites feed on lucerne fleas and earth mites; birds are also useful predators; and
- **bacteria, fungi and viruses** – which can attack and cause disease in pests under favourable conditions.

2 Know the control thresholds for pests in your crops

Whether beneficial species will effectively control pests depends on the comparative numbers of different life stages present. Small predators cannot control large pests, large predators will devour a large quantity of small pests and some predators attack specific pest types. Small predators can be useful when they attack pests in their early (smaller) life stages or when they 'gang-up' on larger prey.

It is equally important to establish if there are enough pests present to warrant control and whether the population is changing.

Therefore, before decisions about control can be made it is necessary to:

- calculate the relative number of pests and beneficial species present;

- gauge the life stage of pests and beneficial species; and
- identify if pest and beneficial populations are increasing, stable or declining.

The ideal is to relate these figures to an economic threshold; the point where the balance between pests and beneficial insects is likely to result in economic crop damage greater than the cost of control.

Economic thresholds are best sourced from local entomologists and agronomists as they will vary with different cropping situations, grain prices, regions and choice of controls.

Ladybird beetle



Ladybird beetles

Ladybird adults and larvae are predatory and consume prey. Adults and larvae range from 3 to 7mm in length.

Pests attacked: aphids, leafhoppers, thrips, mites, moth eggs and small larvae.

Spiders

Spiders consume adult insects and larvae.

Groups that commonly occur in field crops include wolf, jumping and huntsman spiders.

Pests attacked: most insects and mites, including other predators.

Predatory mites

Many predatory mites are found in cropping environments in southern Australia. Adult snout mites are 2mm in length and are effective predators in autumn and winter. Nymphs are similar in appearance, but smaller with six legs.

Pests attacked: earth mites and lucerne flea.

Lacewings

Brown and green lacewings are effective predators of a range



Carabid beetle

of pests. Brown lacewing adults (6 to 10mm) and larvae (5mm) are both predatory. Adult green lacewings (15mm) are not predatory; green lacewing larvae (8mm) are camouflaged predators.

Pests attacked: a wide range including moth larvae and eggs, aphids, thrips and mites.

Carabid beetles

Carabid beetle species feed mostly on ground-dwelling pests. Larvae (10 to 25mm) and adults (5 to 25mm) are predatory and have prominent mouthparts (mandibles) that protrude forward.

Pests attacked: a wide range including true wireworms, false wireworms, moth larvae and slugs.

Hover flies

Larvae (10mm) are effective predators of aphids. Pupae are stuck to the plant,

Hover fly larvae



Lacewings

teardrop shaped and green or brown in colour.

Pests attacked: aphids.

Damsel bugs

Damsel bug adults (12mm) and nymphs (smaller, without wings) are both predatory.

Pests attacked: include moth larvae and eggs of *Helicoverpa* and diamondback moth, aphids, leafhoppers, mirids and mites.

Caterpillar parasites

Include beneficial species that parasitise caterpillar larvae or eggs. The adult female *Trichogramma* wasp (0.5mm) lays eggs inside the moth egg. The parasitised egg turns black, but the moth larva fails to hatch; instead a parasitic wasp emerges.

Pests attacked: *Helicoverpa*, diamondback moth, light brown apple moth, loopers and more.

Damsel bug



3 Monitor populations

Populations of pest and beneficial insects need to be monitored:

- prior to seeding;
- during the growing season; and
- after control treatments to establish success or the need for re-treatment.

Ideally, each species should be recorded by life stage and detailed records should help identify trends in species' population growth or decline, over time.

Details to be recorded for a paddock should include:

- key pests and beneficial species, ideally by life stage;
- insect location within a paddock;
- crop health and growth stage;
- paddock pesticide history;
- weed presence; and
- weather patterns.

Pitfall, shelter and sticky traps are especially useful methods of collecting insects early in pre-seeding to early post-emergence. These traps are a cheap and simple method of gauging what is in an area of a paddock. However, they can catch species that are not of interest, such as flies on sticky traps and frogs and lizards in pit-fall traps.

Dr Melina Miles (left, pictured with Richard Lloyd), encourages growers to use a beat sheet when assessing *Helicoverpa* to help accurately identify the size of the population and species present.

It is also a good idea to look on summer weeds, volunteer crops and vegetation near the paddock for pests and beneficial species. For instance, pest caterpillars and their predators can be found on host plants outside the crop, and aphids can breed up on host plants and then move into a crop.

Some pests, such as slugs and snails and beneficial species such as carabid beetles, can be found by looking under clods or stubbles.

Other pests, such as the larval stages of beetles like cockchafers and falsewire worms, live in the soil. These can be found by removing the stubble from the soil surface, or by using a hand trowel to gently dig in the top 2 to 5 centimetres of soil.

At crop emergence some pests are best identified by the type of damage they cause. For example, weevils cause crescent-shaped cuts in leaves. Visual observation of damage can be a substitute for actual insect counts. Using markers, identify a 2-metre section of crop row, then inspect emerging plants daily for leaf damage and plant loss. Thresholds for the numbers of plants required for good yield are readily available from local agriculture departments and agronomists.

It is a good idea to assess invertebrate pest populations or damage randomly throughout a crop, not just at one point or along one edge. Walk in a 'W' pattern into the crop and randomly pick plants to assess damage and pests present on them.

Care must be taken not to spread disease when sampling growing crops. For instance, some foliar diseases such as rusts and aschochyta can be spread by sampling infected crops and then sampling clean crops.

Monitor the crop for pests and beneficial species:

- weekly during the vegetative stage of crop growth; and
- twice a week during the flowering and podding stages.

A beat sheet is useful for sampling pests in row crops and a sweep net can be used to sample insects in broadacre crops, or in crops with narrow row spacing.

It is important that standardised protocols are followed for sampling pests as the economic thresholds are based on these. Details are available from local agriculture departments and agronomists.



4 Select appropriate control methods

An integrated approach to pest control includes the use of cultural and biological options and selective pesticides, that is, pesticides which do not kill non-target pests and beneficial insects. The objective is to use tactics that minimise the control of beneficial insects and result in a balance between minimising crop loss and treatment cost.

Cultural

Cultural control options identified by research to encourage predators or beneficial species include:

- conservation of remnant grasslands and native vegetation adjacent to cropping paddocks, which provide a haven for beneficial species;
- planting crop borders or shelter belts with grasses or shrubs that encourage biodiversity (beneficial species) and buffer against negative pesticide impacts; and
- replacing cultivation with no-till and stubble-retention practices that give refuge to beneficial species (but can harbour slugs, snails and some other pests which may require management).

Cultural control options that deter pests include:

- smarter use of crop rotations by understanding which crops are susceptible to different pests and planning consecutive plantings that minimise pest pressures;
- managing cropping intensity and soil moisture levels to limit opportunities for pest infestation and optimise plant health;
- planting susceptible crops earlier in the season to avoid risks associated with late season pest build-up;
- removal of weeds or other plant materials that host pests; and
- strategic grazing.

Biological

Biopesticides, also called bio-insecticides and biological pesticides, are insect diseases (fungal, bacterial and viral) that have been isolated and mass reared for use against insect pests.

One of the advantages of biopesticides is that they are very selective. As opposed to many chemical insecticides which are broad-spectrum, biopesticides only kill a single pest species or distinct group of insects.



Native ground beetles were found to reduce the population of grey field slugs. Management of their habitat in native grassland, conservation farming practices, and strategic use of insecticides, have all been found to help increase their populations in the paddock.

PHOTO: DAVID PAUL

By specifically targeting pests without harming beneficial species, biopesticides allow predators and parasitoids to help suppress pest numbers.

Bio-pesticides:

- have little or no effect on beneficial organisms;
- are harmless to humans and wildlife; and
- leave no toxic residues.

As biopesticides are specific to their target, correct identification of the pest species is vital for success.

The effectiveness of biopesticides can be compromised unless they are applied under optimal conditions. To ensure maximum efficacy it is vital that instructions on the product label are strictly followed.

Examples of biopesticides include *Bacillus thuringiensis* (Bt) products (for example, Dipel®) to control caterpillar pests, while nuclear polyhedrosis virus (NPV) products (for example, VivusMax® and Gemstar®) only control *Helicoverpa* species (native budworm, cotton bollworm/corn earworm).

To achieve good levels of control, biopesticides must be applied at the correct larval stage and provide excellent coverage of the pest species.

Australian researchers are developing and testing biopesticides for use against other major crop pests including mirids, aphids and silverleaf whitefly.

Chemical

IPM does not exclude the use of chemical pesticides. It encourages the use of selective pesticides that do not affect beneficial species, thereby enhancing the potential for biological control. For instance, using iron chelate baits to control slugs has little impact on predators, for example carabid beetles.

Using some broad-spectrum pesticides as seed dressings (for example, Gaucho®, Cosmos®) affects sucking pests with minimal impact on beneficial insects. Similarly applying pesticides in-furrow restricts the number of species exposed to the pesticide. Such use may also delay the requirement for a foliar application, giving beneficial insects time to build-up.

If a broad-spectrum pesticide has to be used it may be appropriate to apply only around the perimeter of a paddock, to control insects invading from vegetation outside the paddock boundary.

Useful resources:

NORTHERN REGION

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| ■ <i>Crop Insects: The Ute Guide (Northern Grain Belt edition)</i> , available from Ground Cover Direct | www.grdc.com.au/bookshop , free phone 1800 11 00 44, ground-cover-direct@canprint.com.au |
| ■ The Beat Sheet | www.thebeatsheet-ipmnews.blogspot.com |

SOUTHERN REGION

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| ■ <i>Crop Insects: The Ute Guide (Southern Region Grain Belt edition)</i> , available from Ground Cover Direct | www.grdc.com.au/bookshop , free phone 1800 11 00 44, ground-cover-direct@canprint.com.au |
| ■ PestFacts (Victoria, NSW) to subscribe, email Dr Paul Umina | www.cesarconsultants.com.au/services/pest-facts.html ; pumina@unimelb.edu.au |
| ■ PestFacts (SA, western Victoria) to subscribe, email Ken Henry | www.sardi.sa.gov.au/pestdiseases/publications/pestfacts2 ; henry.ken@saugov.sa.gov.au |

WESTERN REGION

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| ■ <i>Crop Insects: The Ute Guide (Western Grain Belt edition)</i> , available from Ground Cover Direct | www.grdc.com.au/bookshop , free phone 1800 11 00 44, ground-cover-direct@canprint.com.au |
| ■ PestFax to subscribe go to | www.agric.wa.gov.au/content/PW/pestfaxissues_2009.htm ; www.agric.wa.gov.au |

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| ■ GRDC Pest Links | www.grdc.com.au/pestlinks |
| ■ Centre for Environmental Stress and Adaptation Research (CESAR), University of Melbourne | www.cesar.org.au |
| ■ CESAR Consultants | www.cesarconsultants.com.au/services/agriculture |
| ■ Timerite® | www.timerite.com.au |
| ■ <i>Integrated Pest Management for Crops and Pastures (2008)</i> , Paul Horne and Jessica Page, Landlinks Press, copies available at | www.ipmtechnologies.com.au |

Further information

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All pesticide applications must accord with the currently registered label for that particular pesticide, crop, pest and region.

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