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GRDC GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

VETCH

SECTION 7

INSECT CONTROL

KEY MESSAGES | INTEGRATED PEST MANAGEMENT | COWPEA APHID (APHIS CRACCIVORA) | LUCERNE FLEA (SMINTHURUS VIRIDIS) | NATIVE BUDWORM (HELICOVERPA PUNCTIGERA) | REDLEGGED EARTH MITE (HALOTYDEUS DESTRUCTOR)

Insect control

Key messages

- Integrated Pest Management strategies can be effective in controlling insect pests while reducing reliance on chemical control and help to limit pesticide resistance.
- Earth mites, aphids and caterpillars can cause serious damage to vetch.
- Take time to consider relevant withholding periods before applying chemical control.
- For current chemical control options refer to the Pest Genie or Australian Pesticides and Veterinary Medical Authority.

In early growth stages vetches are sensitive to redlegged earth mite, locusts, cutworm, slugs, snails, cabbage white butterflies and lucerne flea, and in mid to later growth to cowpea aphids as well to Native budworm at flowering and podding stages. [1]

There is limited information on the amount of damage caused by other insect pests to vetch in Australia.

Vetch supports strong populations of generalist insect predators. [2]

7.1.1 Insect sampling methods

Monitoring for insects is an essential part of successful IPMs. Correct identification of immature and adult stages of both pests and beneficials, and accurate assessment of their presence in the field at various crop stages will ensure appropriate and timely management decisions. Good monitoring procedure involves not just a knowledge of and the ability to identify the insects present, but also good sampling and recording techniques and a healthy dose of common sense.

Factors that contribute to quality monitoring:

- Knowledge of likely pests/beneficials and their life cycles is essential when planning your monitoring program. As well as visual identification, you need to know where on the plant to look and what is the best time of day to get a representative sample.
- Monitoring frequency and pest focus should be directed at crop stages likely to incur economic damage. Critical stages may include seedling emergence and flowering/grain formation.
- Sampling technique is important to ensure a representative portion of the crop has been monitored since pest activity is often patchy. Having defined sampling parameters (e.g. number of samples per paddock and number of leaves per sample) helps sampling consistency. Actual sampling technique including sample size and number, will depend on crop type, age and paddock size, and is often a compromise between the ideal number and location of samples and what is practical regarding time constraints and distance covered.
- Balancing random sampling with areas of obvious damage is a matter of common sense. Random sampling aims to give a good overall picture of what is happening in the field, but any obvious hotspots should also be investigated. The relative proportion of hotspots in a field must be kept in perspective with less heavily infested areas.

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1 R Matic, S Nagel, G Kirby (2008) Common Vetch. Pastures Australia. http://keys.lucidcentral.org/keys/v3/pastures/Html/Common_vetch.htm

2 CRDC. Comparative advantages/disadvantages of rotation crops with cotton. http://www.cottoninfo.com.au/sites/default/files/tools/CottonRotation/Rotation_chart_Page_1small.pdf

Keeping good records

Accurately recording the results of sampling is critical for good decision making and being able to review the success of control measures (Figure 1). Monitoring record sheets should show the following:

- numbers and types of insects found (including details of adults and immature stages)
- size of insects—this is particularly important for larvae
- date and time
- crop stage and any other relevant information (e.g. row spacings, weather conditions, and general crop observations).

Consider putting the data collected into a visual form that enables you to see trends in pest numbers and plant condition over time. Being able to see whether an insect population is increasing, static or decreasing can be useful in deciding whether an insecticide treatment may be required, and if a treatment has been effective. If you have trouble identifying damage or insects present, keep samples or take photographs for later reference.

Site: Camerons
Date: 15/9/06
Row spacing: 75cm

Sample (1 m row beat)	VS	S	M	L
1	8	5	1	0
2	1	1	1	0
3	3	3	0	1
4	3	2	1	0
5	2	6	0	0
Average		3.4	0.6	0.2
Adjust for 30% mortality (S*0.7)	(3.4*0.7) = 2.4			
Mean estimate of larval number (Adjusted S)+M+L	2.4 0.6 0.2 = 3.2			

Adjust for row spacing divide by row spacing (m): 3.2 / 0.75

4.2 Density Estimate per square metre

Figure 1: *An example of a field check sheet for crops, showing adjustments for field mortality and row spacings.*

Source: QDAF

Records of spray operations should include:

- date and time of day
- conditions (wind speed, wind direction, temperature, presence of dew and humidity)
- product(s) used (including any additives)
- amount of product(s) and volume applied per hectare
- method of application including nozzle types and spray pressure
- any other relevant details.

Sampling methods

Beat sheet

A beat sheet is the main tool used to sample row crops for pests and beneficial insects (Photo 1). Beat sheets are particularly effective for sampling caterpillars, bugs, aphids and mites. A standard beat sheet is made from yellow or white tarpaulin material with heavy dowel on each end. Beat sheets are generally between 1.3–1.5

m wide by 1.5–-2.0 m deep (the larger dimensions are preferred for taller crops). The extra width on each side catches insects thrown out sideways when sampling and the sheet´s depth allows it to be draped over the adjacent plant row. This prevents insects being flung through or escaping through this row.

How to use the beat sheet:

- Place the beat sheet with one edge at the base of plants in the row to be sampled.
- Drape the other end of the beat sheet over the adjacent row. This may be difficult in crops with wide row spacing (one metre or more) and in this case spread the sheet across the inter-row space and up against the base of the next row.
- Using a one-metre stick, shake the plants in the sample row vigorously in the direction of the beat sheet 5–10 times. This will dislodge the insects from the sample row onto the beat sheet.
- Reducing the number of beat sheet shakes per site greatly reduces sampling precision. The use of smaller beat sheets, such as small fertiliser bags, reduces sampling efficiency by as much as 50%.
- Use the datasheets to record type, number and size of insects found on the beat sheet.
- One beat does not equal one sample. The standard sample unit is five non-consecutive one-metre long lengths of row, taken within a 20 m radius; i.e. 5 beats = 1 sample unit. This should be repeated at six locations in the field (i.e. 30 beats per field).
- The more samples that are taken, the more accurate is the assessment of pest activity, particularly for pests that are patchily distributed such as pod-sucking bug nymphs.

When to use the beat sheet:

- Crops should be checked weekly during the vegetative stage and twice weekly from the start of budding onwards.
- Caterpillar pests are not mobile within the canopy, and checking at any time of the day should report similar numbers.
- Pod-sucking bugs, particularly green vegetable bugs, often bask on the top of the canopy during the early morning and are more easily seen at this time.
- Some pod-sucking bugs, such as brown bean bugs, are more flighty in the middle of the day and therefore more difficult to detect when beat sheet sampling. Other insects (e.g. mirid adults) are flighty no matter what time of day they are sampled so it is important to count them first.
- In very windy weather, bean bugs, mirids and other small insects are likely to be blown off the beat sheet.
- Using the beat sheet to determine insect numbers is difficult when the field and plants are wet.

While the recommended method for sampling most insects is the beat sheet, visual checking in buds and terminal structures may also be needed to supplement beat sheet counts of larvae and other more minor pests. Visual sampling will also assist in finding eggs of pests and beneficial insects.

Most thresholds are expressed as pests per square metre (pests/m^2). Hence, insect counts in crops with row spacing less than one metre must be converted to pests/m^2. To do this, divide the 'average insect count per row metre' across all sites by the row spacing in metres. For example, in a crop with 0.75 m (75 cm) row spacing, divide the average pest counts by 0.75.

Other sampling methods:

- Visual checking is not recommended as the sole form of insect checking; however it has an important support role. Leaflets or flowers should be separated when looking for eggs or small larvae, and leaves checked for the presence of aphids and silverleaf whitefly. If required, dig below the soil surface to assess soil insect activity. Visual checking of plants in a crop is also important for estimating how the crop is going in terms of average growth stage, pod retention and other agronomic factors.

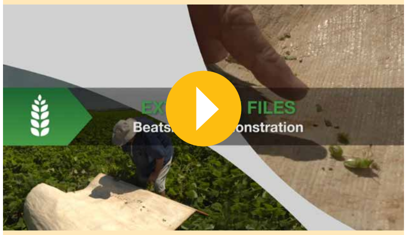
- Sweep net sampling is less efficient than beat sheet sampling and can underestimate the abundance of pest insects present in the crop. Sweep netting can be used for flighty insects and is the easiest method for sampling mirids in broadacre crops or crops with narrow row spacing (Photo 1). It is also useful if the field is wet. Sweep netting works best for smaller pests found in the tops of smaller crops (e.g. mirids in mungbeans), is less efficient against larger pests such as pod-sucking bugs, and it is not practical in tall crops with a dense canopy such as coastal or irrigated soybeans. At least 20 sweeps must be taken along a single 20 m row.
- Suction sampling is a quick and relatively easy way to sample for mirids. Its main drawbacks are unacceptably low sampling efficiency, a propensity to suck up flowers and bees, noisy operation, and high purchase cost of the suction machine.
- Monitoring with traps (pheromone, volatile, and light traps) can provide general evidence on pest activity and the timing of peak egg lay events for some species. However, it is no substitute for in-field monitoring of actual pest and beneficial numbers. [3]

Photo 1: *Sweep netting for insects (left) and use of a beat sheet (right).*

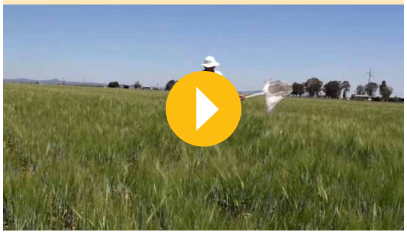
Source: DAFWA and The Beatsheet

VIDEOS

WATCH: GCTV16: Extension files—IPM beat sheet demo



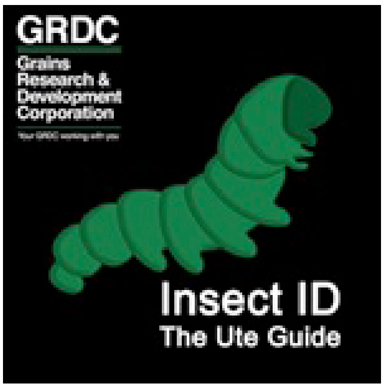
WATCH: How to use a sweep net to sample for insect pests



MORE INFORMATION

IPM guidelines for monitoring tools and techniques.

For pest identification see the A-Z pest list or consult the GRDC Insect ID: The Ute Guide.



The Insect ID: The Ute Guide is a comprehensive reference guide for insect pests commonly affecting broadacre crops and growers across Australia, and includes the beneficial insects that may help to control them. Photos have been provided for multiple life cycle stages, and each insect is described in detail, with information on the crops they attack, how they can be monitored and other pests that they may

3 QDAF (2012) Insect monitoring techniques for field crops. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/help-pages/insect-monitoring

VIDEOS

WATCH: GCTV11: GRDC's Insect ID App

MORE INFORMATION

IPM Guidelines website.

GrowNotes Alert™

PestFacts south-eastern

be confused with. Use of this app should result in better management of pests, increased farm profitability and improved chemical usage. [4]

App features:

- Region selection
- Predictive search by common and scientific names
- Compare photos of insects side by side with insects in the app
- Identify beneficial predators and parasites of insect pests
- Opt to download content updates in-app to ensure you are aware of the latest pests affecting crops for each region
- Ensure awareness of international bio-security pests

Insect ID, The Ute Guide is available on Android and iPhone.

7.1.2 GrowNotes Alert™

GrowNotes Alert is a free nationwide system for delivering urgent, actionable and economically important pest, disease weed and biosecurity issues directly to you, the grower, adviser and industry body, the way you want. Real-time information from experts across Australia, to help growers increase profitability.

A GrowNotes Alert notification can be delivered via SMS, email, web portal or via the iOS App. There are also three by dedicated regional Twitter handles – @GNAlertNorth, @GNAlertSouth and @GNAlertWest – that can also be followed.

The urgency with which alerts are delivered can help reduce the impact of disease, pest and weed costs. GrowNotes Alert improves the relevance, reliability, speed and coverage of notifications on the incidence, prevalence and distribution of these issues within all Australian grain growing regions.

7.1.3 Cesar PestFacts

PestFacts (south-eastern) is a free email service designed to keep growers and farm advisers informed about invertebrate issues – and solutions – as they emerge during the winter growing season. The service has a focus on pests of broadacre grain crops.

PestFacts map is an interactive tool that allows users to search and view historical pest reports across Victoria and NSW. The map is updated with each issue of PestFacts to include new reports.

7.2 Integrated Pest Management

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).

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

The fundamental principles of IPM includes:

1. Know the enemy

4 GRDC, https://grdc.com.au/Resources/Apps

VIDEOS

WATCH: GCTV2: Integrated pest management

WATCH: Integrated pest management and pest suppressive landscapes with Phil Bowden

MORE INFORMATION

Integrated Pest Management Factsheet

Chemical control

Cultural control

Biological control

NSW DPI – Insect and mite control in field crops

2. Know the control thresholds for pests according to crop type
3. Monitor populations
4. Select appropriate control methods, giving consideration to Biological and Cultural control options.

The presence of a pest in a crop is not an automatic trigger for control. Attempting to prevent all damage is usually uneconomic. Economic thresholds help to rationalise the use of pesticides and are one of the keys to profitable pest management. The development of economic thresholds requires knowledge of pests, their damage, the crop's response to damage, and estimates of likely crop value and costs of control.

7.2.1 Healthy crops are less prone to insect damage

The overall health and vigour of a crop will influence its susceptibility to insect attack, and its ability to compensate for insect damage. Below are some of the crop production factors that can affect plant-insect interactions.

Crop rotations

- Some crop rotations can result in a greater incidence of pests for the subsequent crop, especially soil insects and seedling pests such as mites. Check specific crops for more details.
- Crops sown in paddocks previously containing long term pastures are particularly susceptible to pasture pests (e.g. mites, lucerne flea, and soil insects). This will likely be an issue in vetch so careful monitoring is recommended throughout the season.
- Rotations may also assist with weed management, reducing the potential for green bridges.

Choice and variety of crop

- Choose a variety with inherited disease and pest resistance where agronomically and economically viable
- Seedling vigour and other physiological features such as hard seed coats will help to deter pests.

Soil preparation

- Cultivation or herbicide use during a fallow to eliminate weeds will minimise pest survival opportunities.

Optimum sowing time

- Select planting windows to minimise the likelihood of major pests during critical development phases of the crop. If possible, avoid staggered plantings in adjacent fields to minimise the opportunity for pests to move between fields as the crop develops.

Successful crop establishment

- Quick uniform establishment improves a crop's ability to withstand insect (and pathogen) attack.
- Seedlings suffering from stresses (moisture, temperature or water logging) are often more susceptible to pests
- Appropriate rates of treated seed (seed dressings) may suppress soil insects as well as aphids in the first three weeks

Irrigation

- Drought stressed crops are more susceptible to damage and yield penalties.
- Stressed crops are less able to compensate for damage

Nutrition

- High nitrogen levels in plant tissue can decrease resistance and increase susceptibility to pest attacks (particularly sap-sucking pests), however more research is needed to clarify the relationship between crop nutrition and pests. Most studies assessing the response of aphids and mites to nitrogen fertiliser have documented dramatic expansion in pest numbers with increases in fertiliser rates

Weed management

- Many insects use weeds as host plants.
- Control weeds in crop but also consider adjacent fields, borders and roadsides where possible.
- Also control volunteers from previous crops

Disease management

- Diseased plants are unthrifty and susceptible to insect attack.
- Some insects can transmit diseases/viruses.
- Insect damage can expose crops to disease infestations

Hygiene and sanitation

- Some insect pests are moved by machinery (e.g. harvesters), vehicles and people – e.g. on clothing and footwear.
- Practice good farm hygiene to minimise pest movement

Pesticide use

- Minimise exposure of pesticides to bees and birds
- Apply insecticides late in the day when birds and bees have finished feeding

Environmental conditions

- Know how weather affects some pests (e.g. heavy rain may wash some aphids off plants, winds can assist insect migration, some insects reduce feeding at lower temperatures etc)

Preserve beneficial insects

- Tolerate non-economic early season damage
- Minimise early season sprays to conserve beneficials
- Learn how to encourage beneficials into your crops
- Biological formulations such as NPV, Bt and Metarhizium are highly specific and do not harm beneficials.
- Integrate cultural and biological control strategies into the production system where practical. [5]

7.2.2 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.

- Ladybird beetles
  - » Ladybird adults and larvae are predatory and consume prey. Adults and larvae range from 3 to 7 mm 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.

5 IPM Guidelines. (2016). Growing a healthy crop. http://ipmguidelinesforgrains.com.au/ipm-information/growing-a-healthy-crop/

- » Pests attacked: most insects and mites, including other predators.
- Predatory mites
  - » Many predatory mites are found in cropping environments in Australia. Adult snout mites are 2 mm 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 of pests. Brown lacewing adults (6 to 10 mm) and larvae (5 mm) are both predatory. Adult green lacewings (15 mm) are not predatory; green lacewing larvae (8 mm) 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 25 mm) and adults (5 to 25 mm) 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 (10 mm) are effective predators of aphids. Pupae are stuck to the plant, teardrop shaped and green or brown in colour.
  - » Pests attacked: aphids.
- Damsel bugs
  - » Damsel bug adults (12 mm) 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 (0.5 mm) 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. [6]

Conserving or supplementing beneficial insects

The impact of beneficial insects can be maximised by conserving or encouraging naturally-occurring populations and encouraging population increases, or by supplementing the natural enemy complex by releasing mass-reared beneficials into the cropping system.

Conservation and promotion of beneficial arthropods

Crop management considerations to preserve and promote beneficial activity include:

- Regular monitoring for pests and beneficials
- Awareness of thresholds for specific pests
- Tolerance of early season damage (if the crop has time to compensate)
- Are there 'hotspots' that can be treated rather than the entire field?
- Can novel approaches be used (e.g. biological formulations such as NPV or Bt, or attractants such as Magnet®)
- Awareness of insecticide choices
- Seed treatments are generally more selective than foliar sprays foliar sprays

6 S Micic, P Umina, A Weeks, H Brier. (2009). Integrated Pest Management – Factsheet. GRDC.

- Know your pesticide: selective insecticides are generally considered to be 'softer' on natural enemies, but still may be highly toxic to certain arthropod groups
- Consider longer term economic benefit (e.g. a more expensive spray now may save money over the season by reducing the risk of secondary outbreaks)

Whole-of farm considerations include:

- Farm hygiene – control weeds and volunteer crop plants to minimise pest carry-over
- Farmscaping to provide habitat for beneficials within the farming system
- Insectary crops (provide a source of nectar and enhance beneficial activity)
- Preserving native/remnant vegetation as a good habitat for beneficials (see pest-suppressive landscapes)
- Windbreaks can also offer habitat for beneficial arthropods
- Prevent pesticide drift into areas where beneficials may be residing. [7]

MORE INFORMATION

Conserving or supplementing beneficials

Insecticides and beneficial insects

When deciding whether to use chemical control in managing crop pests, ensure to consider the effects of insecticides on beneficial insects (Table 1).

Table 1: *Impact of common insecticides on beneficial insects. Note that the values provided here are generalisations and there may be exceptions (e.g. relating to specific species or time of application). Pest resurgence is included as there may be an increase in non-targeted pests following application of insecticides. This is mainly due to the demise of beneficials that may keep pests in check.*

Insecticide group *	Persistence	Overall ranking	Impact on beneficial insects				
			Predatory beetles	Predatory bugs	Parasitic wasps	Spiders	Bees
FOLIAR-APPLIED							
Bio-pesticides							
Bt	Short	Low	L	L	L	L	L
Helicoverpa NPV	Short	Low	L	L	L	L	L
Metarhizium	Short	Low	L	L	L	L	L
Petroleum spray oils	Short	Low	L	L	L	L	L
Organophosphates							
omethoate	Medium	Moderate	M	M	M	L	H
dimethoate (low rate)	Short	Moderate	M	M	M	L	H
dimethoate (high rate)	Short	High	M	M	H	M	H
methidathion	Short	High	H	H	H	H	H
Indoxacarb	Medium	Low	L	L	L	L	no data
Phenyl pyrazoles (fipronil)	Medium	Low	L	L	L	M	H
Carbamates							
pirimicarb	Short	Low	L	L	L	L	L
thiodicarb	Long	High	H	M	M	M	M
methomyl	Short	High	H	M	M	M	H
Avermectins (emamectin benzoate)	Medium	Moderate	L	H	M	M	H
Synthetic pyrethroids	Long	High	H	H	H	H	H

7 IPM Guidelines. (2016). Conserving or supplementing beneficials. http://ipmguidelinesforgrains.com.au/ipm-information/biological-control/beneficial-insects/conservation-of-beneficials/

Insecticide group *	Persistence	Overall ranking	Impact on beneficial insects				
			Predatory beetles	Predatory bugs	Parasitic wasps	Spiders	Bees
SEED DRESSINGS							
fipronil	Medium	Low	Limited data available. Seed dressings generally less disruptive than foliar-applied formulations.				
imidacloprid	Medium	Low					
imidacloprid + thiomethoxam	Medium	Low					

Symbols used in the table:

L – Low toxicity	– nil or low impact on beneficials
M — Moderate toxicity	– activity is significantly reduced but beneficial populations are able to recover in a week or so
H — High toxicity	– high proportion of beneficial population killed and re-establishment will not occur for several weeks

Persistence of pest control:
Foliar applications: short = <3 days, medium = 3–7 days, long = >10 days
Seed treatments: short = 2–3 weeks, medium 3–4 weeks, long = 4–6 weeks
*Insecticides and the groups they belong to can be found in the insecticide groups table.

Information in this table has been derived from the Cotton Pest Management Guide (2014–15).

7.3 Cowpea aphid (*Aphis craccivora*)

Aphids are a group of soft-bodied bugs commonly found in a wide range of crops and pastures. Identification of crop aphids is very important when making control decisions. Distinguishing between aphids can be easy in the non-winged form but challenging with winged aphids.

Vetch is susceptible to damage from cowpea aphids during mid-late growth stages. [8]

Adult cowpea aphids are shiny black in colour and nymphs are dull grey (Figure 2). All stages have white and black legs. Nymphs are lightly dusted with wax. When fully grown adults are approximately 2 mm long.

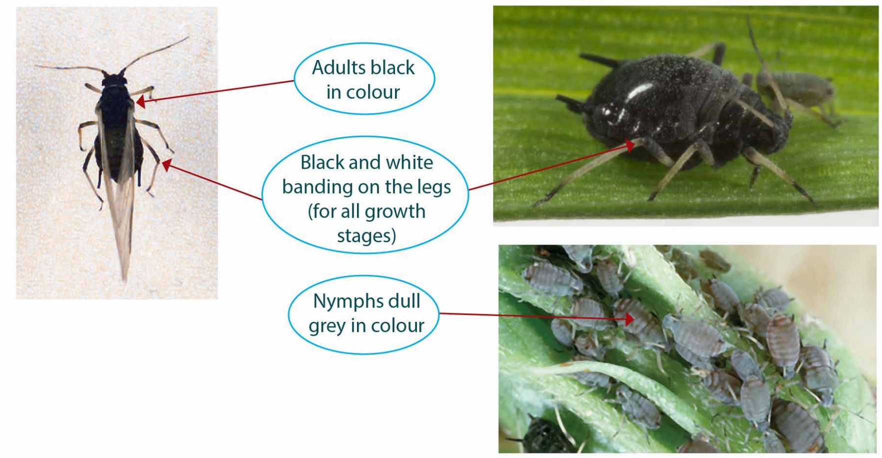


Figure 2: *Distinguishing characteristics/description of cowpea aphids*

Source: Bellati et al. 2012

The cowpea aphid is a widespread and relatively common pest of legume crops throughout Australia. They have a wide range of host plants and can tolerate warm, dry weather conditions that cause many other aphid species to suffer.

Cowpea aphids are capable of being transported (migrating on the wind) large distances from more favourable hosts, particularly during autumn. They tend to

8 R Matic, S Nagel, G Kirby (2008) Common Vetch. Pastures Australia. http://keys.lucidcentral.org/keys/v3/pastures/Html/Common_vetch.htm

colonise single plants before moving onto surrounding plants to form groups of plants in 'hot spots' within a crop. [9]

7.3.1 Damage caused by Cowpea aphid

Direct feeding damage

Aphids can cause direct feeding damage to plants when in large numbers (Photo 2) as they remove sap, which can cause wilting of plants. Cowpea aphids also inject toxins into the plant while feeding. Cowpea aphids form dense colonies on individual plants, with infestations usually starting on the growing tips and spreading down the stem. Initial signs of damage include yellowing or whitening of leaf veins, with heavy colonisation causing rapid wilting of leaves and eventually plant death. Other symptoms include leaf bunching and stem twisting. Secretion of honeydew by aphids can cause secondary fungal growth, which inhibits photosynthesis and can decrease plant growth.

Photo 2: *Cowpea aphid infestation on a vetch plant.*

Photo: S Nagel

In pulse crops, aphid feeding damage (in the absence of virus infection) can result in yield losses of up to 90% in susceptible varieties, and up to 30% in varieties with intermediate resistance.

Indirect damage

Cowpea aphids cause indirect damage by spreading plant viruses. Aphids spread viruses between plants by feeding and probing as they move between plants and paddocks. Cowpea aphids transmit important viruses including cucumber mosaic virus (CMV), bean yellow mosaic virus (BYMV), alfalfa mosaic virus (AMV) and pea seed-borne mosaic virus (PsbMV). Yield losses in some pulse crops as a direct result of viruses spread by cowpea aphids can reach as high as 80%. [10]

9 P Umina, S Hangartner (2015) Cowpea Aphid. Cesar PestNotes. http://cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Cowpea-aphid

10 P Umina, S Hangartner (2015) Cowpea Aphid. Cesar PestNotes. http://cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Cowpea-aphid

7.3.2 Thresholds for control

When determining economic thresholds for aphids, it is critical to consider several other factors before making a decision. Most importantly, the current growing conditions and moisture availability should be assessed. Crops that are not moisture stressed have a greater ability to compensate for aphid damage and will generally be able to tolerate far higher infestations than moisture stressed plants before a yield loss occurs.

Thresholds for managing aphids to prevent the incursion of aphid-vectored virus have not been established and will be much lower than any threshold to prevent yield loss via direct feeding. [11]

7.3.3 Management of Cowpea aphid

Monitoring

Cowpea aphids are most prominent in spring, but are also active during autumn and persist through winter. Regularly monitor vulnerable crops during bud formation to late flowering. Aphids will generally move into paddocks from roadsides and damage will first appear on crop edges. Aphid distribution may be patchy, so monitoring should include at least five sampling points over the paddock. Inspect at least 20 plants at each sampling point. Search for aphids by looking at the youngest inflorescence of each plant. Look for clusters of aphids or symptoms of leaf yellowing or leaf-curling.

In disease-prone areas, regular aphid monitoring from autumn onwards is recommended to detect aphids moving into crops, particularly along paddock edges. Symptoms of virus infections are very variable. Autumn is the critical infection period; the earliest-sown crops usually have the highest infection incidence.

Aphid infestations can be reduced by heavy rain events or sustained frosts. If heavy rain occurs after a decision to spray has been made, but before the insecticide has been applied, check the crop again to determine if treatment is still required.

Biological control

There are many effective natural enemies of aphids. Hoverfly larvae, lacewings, ladybird beetles and damsel bugs are known predators that can suppress populations. Aphid parasitic wasps lay eggs inside bodies of aphids and evidence of parasitism is seen as bronze-coloured enlarged aphid 'mummies'. As mummies develop at the latter stages of wasp development inside the aphid host, it is likely that many more aphids have been parasitized than indicated by the proportion of mummies. Naturally occurring aphid fungal diseases (*Pandora neoaphidis* and *Conidiobolyus obscurus*) can also suppress aphid populations.

Cultural control

Control summer and autumn weeds in and around crops, particularly legumes, to reduce the availability of alternate hosts between growing seasons.

Sow crops early to enable plants to begin flowering before aphid numbers peak in spring and use a high sowing rate to achieve a dense crop canopy, which will assist in deterring aphid landings. Select cultivars that are less susceptible to aphid feeding damage.

Consider seed testing to assess the level of virus infection of seed-borne viruses (e.g. CMV) before sowing.

Chemical control

The use of insecticide seed treatments can delay aphid colonisation and reduce early infestation and aphid feeding.

11 P Umina, S Hangartner (2015) Cowpea Aphid. Cesar PestNotes. http://cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Cowpea-aphid

A border spray in autumn/early winter, when aphids begin to move into crops, may provide sufficient control without the need to spray the entire paddock. Avoid the use of broad-spectrum `insurance` sprays and apply insecticides only after monitoring and distinguishing between aphid species. Consider the populations of beneficial insects before making a decision to spray, particularly in spring when these natural enemies can play a very important role in suppressing aphid populations if left untouched. [12]

Refer to the beneficial impact table (Table 1, Section 1.1.2 Natural enemies) from the IPM Guidelines website to identify products least likely to harm beneficials that aren't being targeted.

For up-to-date chemical registrations, see the APVMA website.

7.4 Lucerne flea (*Sminthurus viridis*)

The lucerne flea is an introduced pest commonly found in New South Wales, Victoria, Tasmania, South Australia and Western Australia. The lucerne flea is a springtail; this is a group of arthropods that have six or fewer abdominal segments and a forked tubular appendage or furcula under the abdomen. Springtails are one of the most abundant of all macroscopic insects and are frequently found in leaf litter and other decaying material, where they are primarily detritivores.

Vetch is susceptible to damage from Lucerne flea during early growth stages. [13]

The adult lucerne flea is approximately 3 mm long, light green-yellow in colour and often with mottled darker patches over the body (Figure 3). They are wingless and have enlarged, globular shaped abdomens. They are not related to true fleas. Newly hatched nymphs are pale yellow and 0.5–0.75 mm long, and as they grow they resemble adults, but are smaller.

12 P Umina, S Hangartner (2015) Cowpea Aphid. Cesar PestNotes. http://cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Cowpea-aphid

13 R Matic, S Nagel, G Kirby (2008) Common Vetch. Pastures Australia. http://keys.lucidcentral.org/keys/v3/pastures/Html/Common_vetch.htm

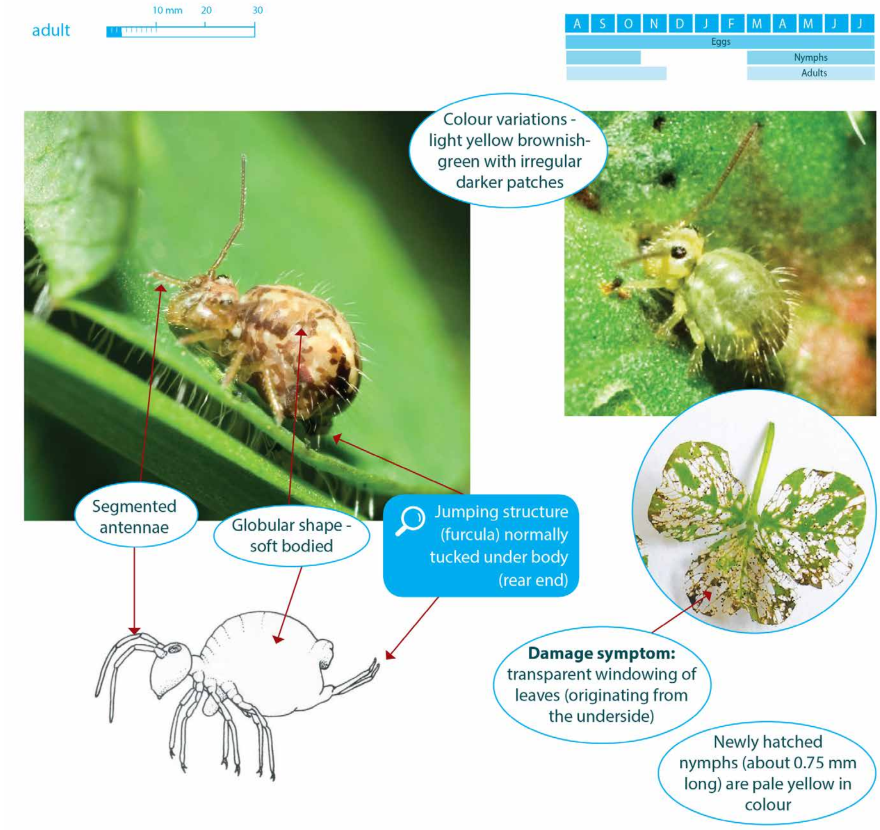


Figure 3: *Distinguishing characteristics/description of the lucerne flea*

Source: Bellati et al. 2012

Lucerne fleas have a furcula underneath their abdomen, which acts like a spring and enables them to 'spring off' vegetation when disturbed. This pest is distinctively patchy in distribution. These patches of intense feeding can move around paddocks, and can be obvious targets of spot spraying. [14]

7.4.1 Damage caused by Lucerne flea

Lucerne fleas move up plants from ground level, eating tissue from the underside of foliage. They feed through a rasping process, leaving behind a thin clear layer of leaf membrane that appears as transparent 'windows' through the leaf. In severe infestations this damage can skeletonise the leaf and stunt or kill plant seedlings. Crops and pastures are most susceptible at the time of emergence. [15]

7.4.2 Thresholds for control

As a guide, an average of 20 small holes per trifoliate legume leaf may warrant chemical control. If pasture is severely damaged it may be cost effective to spray. [16]

14 P Umina, S Hangartner, G McDonald (2016) Lucerne flea. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Lucerne-flea

15 P Umina, S Hangartner, G McDonald (2016) Lucerne flea. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Lucerne-flea

16 P Umina, S Hangartner, G McDonald (2016) Lucerne flea. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Lucerne-flea

7.4.3 Management of Lucerne flea

Monitoring

Crops should be inspected frequently at, and immediately following crop emergence, when plants are most susceptible to damage. Pastures should be monitored at least fortnightly from autumn to spring, and more often in paddocks with previous lucerne flea problems. Lucerne fleas are often concentrated in localised patches so it is important to monitor paddocks entirely. Examine foliage for feeding damage, and check the soil surface for sheltering insects. Damage levels can be used to determine whether or not spraying is necessary. Monitoring usually involves working on hands and knees. Monitoring populations for growth stage as well as numbers can also be important for accurate timing of sprays.

Alternatively, lucerne fleas can be sampled using a standard petrol powered garden blower/vacuum machine. A fine sieve or stocking is placed over the end of the suction pipe to trap mites vacuumed from plants and the soil surface.

Biological control

The pasture snout mite and spiny snout mite are effective predators, particularly in pastures where they can prevent pest outbreaks. Spiders and ground beetles also prey on lucerne flea. The complex of beneficial species should be assessed before deciding on control options.

Cultural control

Grazing management by reducing the height of pasture will limit food resources and increase mortality of lucerne fleas. Control broadleaf weeds (e.g. capeweed) to remove alternative food sources that would otherwise assist in population build up. In pastures, avoid clover varieties that are susceptible to lucerne flea damage, and avoid planting susceptible crops such as canola and lucerne into paddocks with a history of lucerne flea damage.

Chemical control

In paddocks where damage is likely, a border spray may be sufficient to prevent movement of lucerne fleas into the crop from neighbouring paddocks. Lucerne fleas are often patchily distributed within crops, so spot spraying may be sufficient. Do not blanket spray unless the infestation warrants it.

If the damage warrants control, treat the infested area with an insecticide three weeks after lucerne fleas first emerge in autumn. This will allow for the further hatching of over-summering eggs but will be before they reach maturity and begin to lay winter eggs. Where there is a consistent pattern of lucerne flea damage in autumn/early winter, spray four weeks after the first significant rain of the season.

In pasture, best results are achieved by spraying when there is sufficient leaf matter for the insects to feed on and shelter under. This is usually about seven days after a paddock has been cut for hay or heavily grazed, rather than immediately after hay making or grazing.

Lucerne fleas have a high natural tolerance to synthetic pyrethroids and should not be treated with insecticides from this chemical class. When both lucerne fleas and redlegged earth mites are present, it is recommended that control strategies consider both pests, and a product registered for both is used at the highest directed rate between the two to ensure effective control. [17]

Refer to the beneficial impact table (Table 1, Section 1.1.2 Natural enemies) from the IPM Guidelines website to identify products least likely to harm beneficials that aren't being targeted.

For up-to-date chemical registrations, see the APVMA website.

17 P Umina, S Hangartner, G McDonald (2016) Lucerne flea. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Lucerne-flea

7.5 Native budworm (*Helicoverpa punctigera*)

The native budworm, sometimes known as Heliothis, is a common and widespread pest of vetch, pulse crops and canola. It occurs in most years and often migrates into agricultural areas from nearby or distant rangelands.

Vetch is susceptible to damage from Native budworm during flowering and podding stages. [18]

Native budworm eggs can be found singly on the growing tips and buds of plants. They are small (about 0.5 mm in diameter) but quite visible to the naked eye after close inspection of the plant. They are white when first laid but change colour from yellow through to brown, as they get closer to hatching.

Newly hatched caterpillars (larvae) are very small (approximately 1.5 mm), light in colour with dark brown heads. They can easily be missed when inspecting a crop. They will grow through six or seven stages or instars until reaching maturity (up to 40 mm long).

Larvae vary substantially in colour that includes shades of brown, green and orange. Regardless of colour, they usually have darkish stripes along the body and bumpy skin with sparse, stiff, stout hairs (Figure 4). One distinguishing feature of *Helicoverpa* larvae is the sharp downward angling at the rear of the body. However, in contrast to cotton bollworm (aka corn earworm) and lesser budworm, larvae of native budworm have black hairs around the head and along the body.

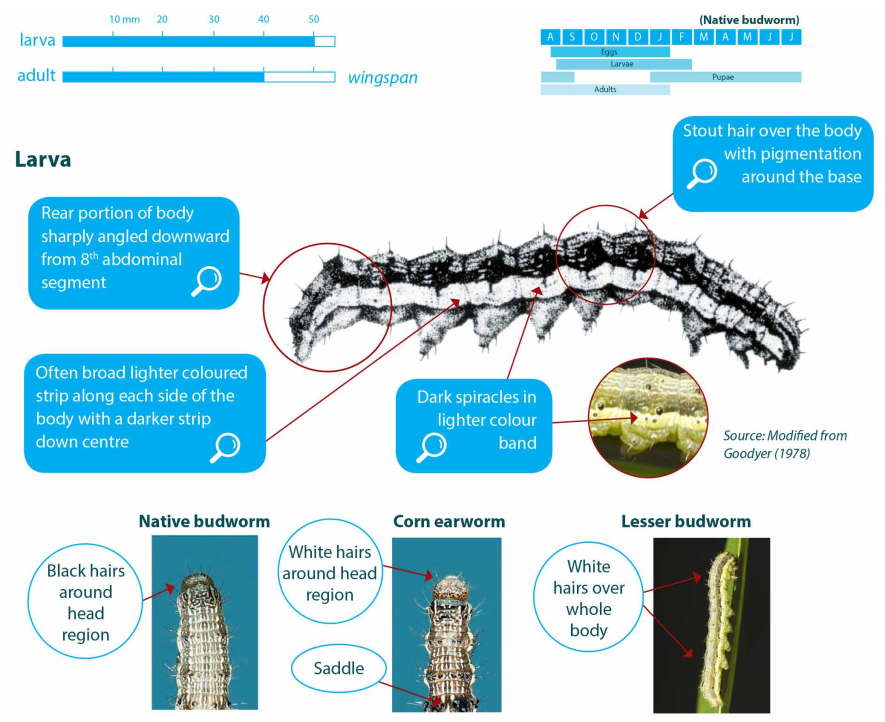


Figure 4: *Distinguishing characteristics/description of native budworm*

Source: Bellati et al. 2012

Early instar larvae, less than 7 mm, generally feed on leaves, or graze on the surface of pods. Exceptions can be following periods of unseasonably warm when even very small larvae burrow into young pods, making them difficult to monitor.

Adult moths are approximately 15–18 mm long and buff, light brown to red-brown in colour, with numerous dark spots and blotches. The hind wings of the adult moth are pale with a dark band along the lower edge and span 30–35 mm (Figure 5).

18 R Matic, S Nagel, G Kirby (2008) Common Vetch. Pastures Australia. http://keys.lucidcentral.org/keys/v3/pastures/Html/Common_vetch.htm

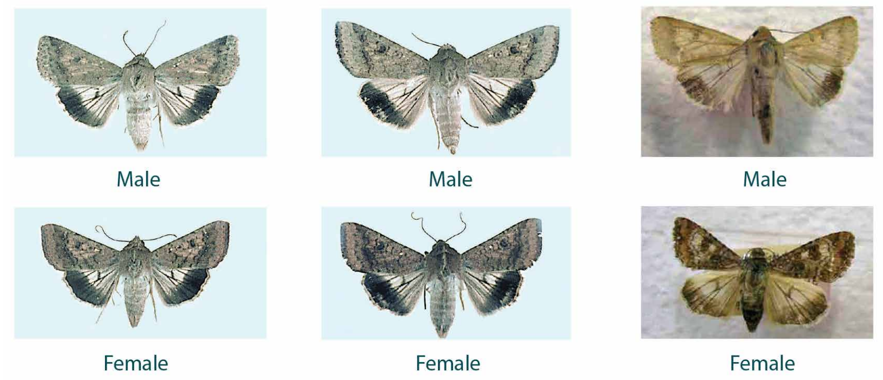


Figure 5: *Distinguishing characteristics/description of native budworm*

Source: Bellati et al. 2012

A notable feature of this pest is its capacity to migrate at high altitudes over large distances (100–1000 km) at night. The moths fly from areas where conditions do not favour another generation to where there are abundant food plants for further breeding.

Moths live for two to four weeks; they rest during the day and become active after sunset, feeding on nectar from flowers and laying eggs on many types of herbaceous plants (weeds and crops). They fly rapidly from plant to plant throughout the night in a darting motion, feeding and laying eggs; this behaviour is often used to recognise budworm moths. They are also capable of flying from paddock to paddock and of course, from one region to another. [19]

7.5.1 Damage caused by Native budworm

Budworms are at their most damaging when they feed on the fruiting parts and seeds of plants. During the formation and development of pods, vetch, field pea, chickpea, lentil and faba bean crops are very susceptible to all sizes of native budworm caterpillars. Small caterpillars can enter emerging pods and damage developing seed while larger caterpillars may devour the entire pod contents.

Holes or chewing damage may be seen on pods and/or seed heads. Grubs may be seen or may remain embedded in the pod. Losses attributed to budworms come from direct weight loss through seeds being wholly or partly eaten. Grain quality may also be downgraded through unacceptable levels of chewed grain.

Caterpillars eat increasing quantities of seed and plant material as they grow. The last two growth stages (5th & 6th instar) account for over 90% of their total grain consumption. [20]

7.5.2 Thresholds for control

Comprehensive and dynamic economic thresholds have been developed for native budworm in major pulse crops in Western Australia, which also apply to eastern Australia. Thresholds for control in vetch have not been specified, with the only the more general threshold control set at 1 larva per 10 sweeps. [21]

19 G McDonald (2015) Native budworm. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Native-budworm

20 G McDonald (2015) Native budworm. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Native-budworm

21 G McDonald (2015) Native budworm. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Native-budworm

7.5.3 Management of Native budworm

Monitoring

The use of pheromone traps (which attract male moths) provides an early warning of moth arrival and abundance, following their migration from inland regions. These should be set up in late winter or early spring. Observing the activity of moths in the crop and the presence of eggs may also be indicative of future larval activity. However, egg and early larval mortality of native budworm through natural courses can be very high. Eggs and very small larvae can be dislodged and will die after heavy rain or wind.

Either a sweep net (e.g. vetch, peas, lentils) or beat sheet (eg. chickpeas, lupins, beans) should be used to monitor larval activity in crops. Monitor field pea, faba bean, lentil and chickpea crops from budding and flowering development through to maturity for larval activity. Native budworm infestations are most problematic in spring and early summer, and may be greater when aphid infestations are heavy as the moths are attracted to the sugary honeydew produced by aphids.

During monitoring, record numbers of larvae according to size; very small (< 3 mm), small (4–7 mm), medium (8–23 mm) and large (>24 mm). Numbers of larvae used to calculate economic thresholds exclude very small larvae. Large larvae cause 90% of the damage.

Biological control

A key component to any IPM is to maximise the number of beneficial organisms and incorporate management strategies that reduce the need for pesticides. Correct identification and monitoring is the key when checking for build up or decline in beneficials. There are many natural enemies that attack native budworm. The egg stage is susceptible to the parasite *Trichogramma ivalae*, a minute wasp that has been recorded in up to 60% of eggs along with egg predators such as ladybird beetles, lacewings and spiders. Beneficials attacking larvae include shield bugs, damsel bugs, assassin bugs, tachinid flies (their larvae prey on caterpillars), orange caterpillar parasite, two-toned caterpillar parasite, orchid dupe, lacewings and spiders. Naturally occurring fungal diseases and viruses also play an important role in some seasons.

Cultural control

Windrowing or desiccating crops may be an option to advance the drying of crops when small-medium size larvae are present near crop maturity.

Chemical control

There are several insecticides registered for the control of native budworm. Timing and coverage are both critical to achieving good control. Try to target small larvae up to 7 mm in length and apply insecticides before larvae move into flowering pods. IPM options include the use of Bt (*Bacillus thuringiensis*) and nuclear polyhedrosis virus (NPV) based biological insecticides. Small larvae are generally easier to control because they are more susceptible to insecticides, and leaf feeding makes them susceptible to ingestion of active residues on the plant surface. Larvae entrenched in buds and pods will be more difficult to control and chemical residual will be important in contacting them.

The crop should be re-inspected 2 to 4 days after spraying to ensure enough caterpillars have been killed to prevent future damage and economic loss. In years of very high moth activity and extended egg lays, a second spray may be required.

In choosing a registered product, be aware of the withholding period for harvest or windrowing/ swathing which is the same as harvest. Residue testing is routinely conducted on grain destined for export and domestic stock feed markets. [22]

22 G McDonald (2015) Native budworm. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Native-budworm

Refer to the beneficial impact table (Table 1, Section 1.1.2 Natural enemies) from the IPM Guidelines website to identify products least likely to harm beneficials that aren't being targeted.

For up-to-date chemical registrations, see the APVMA website.

7.6 Redlegged earth mite (*Halotydeus destructor*)

Redlegged earth mites are one of the most important invertebrate pest species in Australian agriculture. They are very common and widespread pest of pastures and most broadacre crops.

Vetch is vulnerable to damage from Redlegged earth mites in early growth stages. [23]

Redlegged earth mites are 1 mm in length. Adults and nymphs have a velvety black body with eight orange-red coloured legs. Newly hatched mites are pinkish-orange with six legs and are 0.2 mm long (Figure 6).

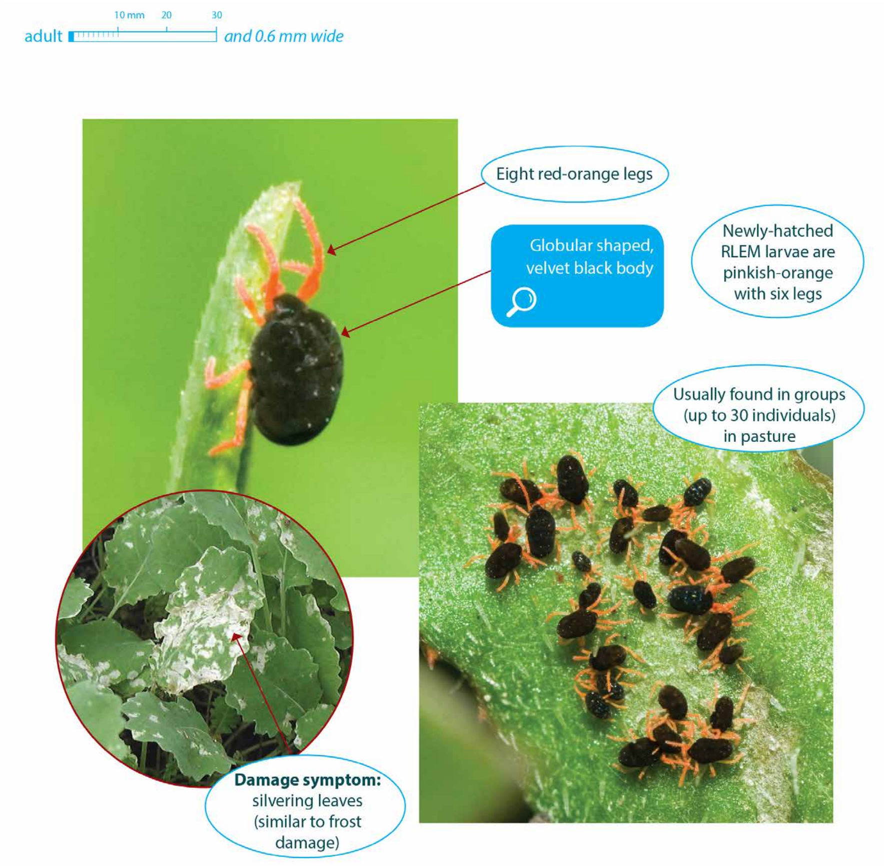


Figure 6: *Distinguishing characteristics/description of redlegged earth mites*

Source: Bellati et al. 2012

They are common and widespread, and active from autumn to late spring in southern Australia, but not as common in northern NSW, where blue oat mite are the more dominate species. Redlegged earth mites often occur in situations with other mites, such as blue oat mites, *Bryobia* mites and *Balaustium* mites.

23 R Matic, S Nagel, G Kirby (2008) Common Vetch. Pastures Australia. http://keys.lucidcentral.org/keys/v3/pastures/Html/Common_vetch.htm

Redlegged earth mites are often found on the leaf surface in feeding aggregations, of up to 30 individuals. In the warmer part of the day, redlegged earth mites tend to gather at the base of plants, sheltering in leaf sheaths and under debris. [24]

7.6.1 Damage caused by Redlegged earth mite

Feeding causes silvering or white discoloration of leaves and distortion or shriveling in severe infestations. Affected seedlings can die at emergence with high mite populations. Feeding symptoms can be mistaken for frost damage. Redlegged earth mites have been found to be directly responsible for a reduction in pasture palatability. [25]

7.6.2 Thresholds for control

The threshold for control in pulses is 50 mites per 100cm^2. [26]

7.6.3 Management of Redlegged earth mite

Monitoring

Inspect susceptible pastures and crops from autumn to spring for the presence of mites and evidence of damage. It is important to inspect crops regularly in the first three to five weeks after sowing. Mites are best detected feeding on the leaves in the morning or on overcast days. If mites are not observed on plant material, inspect soil for mites. Be aware of edge effects; mites move in from weeds around paddock edges. An effective way to sample mites is to use a standard petrol-powered garden blower/vacuum machine. A fine sieve or stocking is placed over the end of the suction pipe to trap mites vacuumed from plants and the soil surface.

Biological control

French *Anystis* mites can suppress populations in some pastures. Snout mites and other predatory mites are also effective natural enemies. Leaving shelterbelts or refuges between paddocks will help maintain natural enemy populations.

Cultural control

Do not sow susceptible crops (e.g. canola) into pastures or paddocks known to contain high mite numbers. Rotate paddocks with non-preferred crops (e.g. chickpeas). Pre- and post- sowing weed management (particularly broadleaf weeds) is important. Heavy pasture grazing in spring can help to reduce mite numbers the following autumn.

Chemical control

Rotate chemical classes of insecticides as resistance to synthetic pyrethroid and organophosphate chemicals has been detected (in WA). For low-moderate mite populations, insecticide seed dressings are an effective method. Avoid prophylactic sprays; apply insecticides if control is warranted. Pesticides used at or after sowing should be applied within three weeks of the first appearance of mites, before adults commence laying eggs. Insecticides do not kill mite eggs. Border spraying can be an effective way to control mites, as mites will often move in from crop edges and roadside vegetation. Carefully timed spring spraying using TIMERITE® will reduce mite populations the following autumn, but could also exacerbate other mite problems. [27]

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24 P Umina, G McDonald (2015) Redlegged earth mite. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Redlegged-earth-mite

25 P Umina, G McDonald (2015) Redlegged earth mite. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Redlegged-earth-mite

26 P Umina, G McDonald (2015) Redlegged earth mite. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Redlegged-earth-mite

27 P Umina, G McDonald (2015) Redlegged earth mite. Cesar PestNotes. http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/Redlegged-earth-mite

Refer to the beneficial impact table (Table 1, Section 1.1.2 Natural enemies) from the IPM Guidelines website to identify products least likely to harm beneficials that aren't being targeted.

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