SOUTHERN
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GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

FABA BEAN

SECTION 8

PEST MANAGEMENT

Pest management

Key points

- The key pests of faba bean in southern Australia are Helicoverpa punctigera (native budworm), snails, slugs and aphids. Mites, lucerne flea, locusts and H. armigera are occasional pests, while many other minor pests can affect faba bean.
- Integrated pest management (IPM) is an ecological approach aimed at significantly reducing use of pesticides while managing pest populations at an acceptable level.
- IPM involves planning, monitoring, recording, identifing, assessing options, controlling/managing and reassessing.
- Monitoring for beneficial species is important.
- Exotic bruchids and leaf miners pose a biosecurity threat.

MORE INFORMATION

GRDC Fact Sheet: Integrated pest management, https://grdc.com.au/__data/assets/pdf_file/0031/225877/integrated-pest-management.pdf.pdf

MORE INFORMATION

A GRDC Fact Sheet on pest-suppressive landscapes, 'Pest management using native vegetation', is at www.grdc.com.au/GRDC-FS-PestSuppressiveLandscapes

IPM guidelines for grains website: http://ipmguidelinesforgrains.com.au/

8.1 Integrated pest management (IPM)

8.1.1 IPM definition

Integrated pest management (IPM) is an integrated approach of crop management to reduce chemical inputs and solve ecological problems. Although originally developed for agricultural insect pest management, IPM programs have now been developed to encompass diseases, weeds, and other pests that interfere with the management objectives of sites.

IPM is an ecological approach aimed at significantly reducing the use of pesticides while managing pest populations at an acceptable level. IPM uses an array of complementary methods including mechanical and physical devices, as well as genetic, biological, cultural and chemical management. It uses strategies of prevention, observation and intervention with the primary goal of significantly reducing the use of pesticide. Benefits include the reduction in cost, contamination, residues and resistance to the pesticide.

8.1.2 Problems with pesticides

IPM does not mean abandoning pesticides – they are still the basis for pest control – but the impact on natural enemies is considered when selecting a pesticide. Regular monitoring needs to observe the pest and beneficial species dynamics. Beneficial species can provide control of most pests if they are present. By reducing the use of non-selective pesticides, the aim is to foster predators and parasites to stabilise pest populations and reducing the need to spray.

Overuse of pesticides can hasten pesticide resistance developing. It can also lead to a resurgence of pests, create new pests, potentially increase pesticide residues in grain and lead to off-target contamination including of wildlife reserves and waterways.[1]

8.1.3 IPM, organics and biological control

IPM is not the same as organic pest management, although many organic options are compatible with IPM. IPM is sometimes confused with classic biological control. While they are not the same, IPM plays an important role in maximising the success of biological control by reducing the use of non-selective sprays, boosting the survival of biological control agents.[2]

IN FOCUS

Native remnant vegetation can support beneficial predatory insects. Pest-suppressive landscapes are those that have the right mix of habitats that support beneficial insects and allow them to move into crop fields, while discouraging the build-up of pest insect species.

8.1.4 Soft *v.* hard pesticides

The terms 'soft' and 'selective' are terms used to describe pesticides that kill target pests but have minimal impact on parasites and predators attacking these pests. Parasites and predators are often called 'beneficials'.

1 H Brier (2008) Break crop IPM short course manual. Southern Region IPM Workshop Training Manual: Soybeans and Winter Pulses, 11 March 2008, Griffith and Coleambally, NSW, 82pp.

2 H Brier (2008) Break crop IPM short course manual. Southern Region IPM Workshop Training Manual: Soybeans and Winter Pulses, 11 March 2008, Griffith and Coleambally, NSW, 82pp.

Pesticides that impact on beneficial species are termed 'hard', 'non-selective' or 'broad-spectrum'.

In practice, there are varying degrees of softness, and many products may be hard on one group of beneficial species but relatively soft on another. (See Section 8.7 Beneficial species)

Insecticides that are less toxic to beneficial insects should be used where possible. For example, using pirimicarb (which is registered for broad bean) for aphid control may mean fewer repeat applications compared with synthetic pyrethroids, because beneficial insects are preserved.

Synthetic pesticides are generally only used as required and often only at specific times in a pest's life cycle.

Many newer pesticide groups are derived from plants or naturally occurring substances.[3] Examples are nicotine, pyrethrum and insect juvenile hormone analogues. Further 'biology-based' or 'ecological' techniques are being evaluated.[4]

8.1.5 IPM process

The process in managing insect pests to reduce damage in a profitable manner is:

1. Planning.
2. Monitoring and recording.
3. Identification.
4. Assessing options.
5. Controlling/managing.
6. Reassessing.

Regular monitoring, with accurate pest identification, is the key to IPM. For insects, monitoring for beneficial organisms and predators is important too. Record-keeping is essential, as is knowledge of the behaviour and reproductive cycles of target pests. For more information on monitoring, see Section 8.1.7 Monitoring methods.

Use the information gathered from monitoring to decide what sort of control action (if any) is required. Make spray decisions based on a combination of economic threshold information and your experience. Insecticide resistance and area-wide management strategies may also affect spray recommendations.

If a control operation is required, ensure application occurs at the appropriate time of day. Record all spray details including rates, spray volume, pressure, nozzles, meteorological data (relative humidity, temperature, wind speed and direction, inversions and thermals) and time of day.

Assess crops after spraying and record data. Post-spray inspections are important in assessing whether the spray has been effective.[5]

3 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

4 H Brier (2008) Break crop IPM short course manual. Southern Region IPM Workshop Training Manual: Soybeans and Winter Pulses, 11 March 2008, Griffith and Coleambally, NSW, 82pp.

5 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

8.1.6 IPM system

An IPM system is designed around some basic components:

- acceptable pest levels;
- preventative cultural practices;
- monitoring the crop;
- biological and environmental control; and
- responsible chemical use.

Acceptable pest levels

Emphasis is on control, not eradication. IPM programs work to establish acceptable pest levels (action thresholds) and then apply controls if those thresholds are exceeded.

The most common threshold used is an economic threshold, which involves control at a density that will prevent the pest numbers from reaching an economically damaging population. The aim of pest management is to keep pest populations below the economic threshold.

Guideline thresholds based on research exist for some pests but most thresholds fluctuate depending upon a number of factors. Monitoring and sampling of crops is essential to determine these factors and their influence on where the threshold lies. Growers who maintain a close watch on pest activity through regular crop inspections and thorough sampling are best placed to decide if and when treatment is needed.

Preventative cultural practices

Use varieties best suited to local growing conditions and maintain healthy crops. Mechanical methods may be possible under some circumstances, such as burning, rolling or cabling for snail control.

If faba bean is the first crop in the rotation after a pasture phase there can be a range of pests that occur naturally in pastures that can cause problems.

Blue oat mite will often be present in the pasture phase and attack lentil seedlings. A long fallow (September to April) with clean cultivation and good weed control before the faba bean crop can prevent this pest. Weedy fallows can provide resources and shelter for pests as well as taking soil moisture that could be used by the crop later in the season.

Monitoring faba bean crops

All faba bean crops should be scouted for insects at regular intervals, usually once per week prior to pod-set and 2–3 times a week from pod-set onwards.[6]

This includes monitoring for beneficial organisms and predators is important. Record-keeping is essential.

Prior to sowing, paddocks should be checked for signs of insect presence.

After sowing, monitor as the crop emerges, to check if the plant population has emerged as expected and there are not gaps from attack by insects or slugs. These can leave large bare patches which may need replanting, as they can affect yields and leave spaces for weeds later.

Monitoring weekly during the vegetative stages, looking for evidence of caterpillar or aphids. Beneficial species such as lady beetles, hoverflies and wasps are often seen during this phase as well and can be a good indicator to check for the pest species.

As crops close over before flowering, monitor each week to for pests.

6 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

Aphids will target stressed crops. They will move and can build up overnight. Monitoring needs to be completed more often. Many beneficial species will follow the aphid colonies.

When faba bean crops become dense, monitoring becomes more difficult.

Some paddocks are set out with 'tram tracks' that may be possible to navigate, otherwise monitoring is done along the edge of the crop at a number of sites. This is often acceptable as many pest insects move in from the edges.

Use a beat sheet or sweep net and a standardised protocol for each sample to compare numbers with previous counts.

Record results in a diary or spreadsheet to enable objective decisions.

Biological and environmental control

A range of organisms and environmental processes can provide control, with minimal crop damage, and often at low cost. The main focus is on promoting beneficial organisms that target pests. See Section 8.7 Beneficial species.

There is a lag period between when a pest is present and when the beneficial species affect the pest population. Predators destroy their prey and leave little evidence of their actions, so these effects are often underestimated. Some biological control agents are very prolific, relatively predictable and able to keep the pests at low levels so they do not impact on crop production.

In broadacre crops the best strategy is to preserve and encourage these beneficial organisms that are naturally occurring. Grow a diverse range of plant species around the farm, preserving native habitat near crop paddocks and reduce the use of broad-spectrum insecticides.

Use biological insecticides, derived from naturally occurring microorganisms (*Bt*, Viva Gold®, entomopathogenic fungi and nematodes) and chemicals specific to pest species where possible.

Responsible chemical use

Synthetic pesticides are generally only used as required and often only at specific times in a pest's life cycle. Many newer pesticide groups are derived from plants or naturally occurring substances.

Insecticides that are less toxic to beneficial insects should be used where possible. For example, pirimicarb for aphid control may mean less repeat applications compared with the use of synthetic pyrethroids because beneficial insects are preserved.

8.1.7 Monitoring methods

Sweep net monitoring

The easiest and quickest way to determine the number of grubs in a crop is to 'sweep' the crop with an insect sweep net. It is impossible to accurately determine numbers by simply looking in the crop.[7] Sweep-net sampling of faba bean can seriously underestimate the density of larvae, particularly smaller larvae. A visual inspection of faba bean terminals, flowers and buds is very important for smaller larvae estimates of *Helicoverpa* spp.[8]

A standard sized net (38 cm in diameter) can be purchased from most chemical suppliers.

- Take 10 sweeps of the net through the crop canopy while walking slowly through the paddock. A standard sweep of the net needs to be about 2 m.
- Empty the contents into a tray or bucket and count the caterpillars of various sizes. It is important to look very carefully for small caterpillars as these have the most potential to cause damage.
- Repeat this process at least 12 places throughout the paddock to obtain an average insect density.

VIDEO

To watch a video on how to use a sweep net to sample for insect pests, see: www.youtube.com/watch?v=fwesXzQ1pCc

Crop inspection

Sampling flowers and leaves in the crop can tell you much more than a sticky trap including:

- levels of non-flying juvenile stages (eggs, larvae, pupae);
- levels of non-flying adult insects (mites, snails etc); and
- early stages and extent of pest damage.

This information is much more powerful for assessing pest levels, accurately predicting trends and checking the effectiveness of control measures. It is essential for making decisions and following up on the results.

Depending on the pest, where it feeds, hides and breeds, you will need to check flowers, leaves, pods and stems. The pattern, frequency and level of sampling depend on the crop, pests of concern and beneficial insects of interest and the time of year.

Weeds near to your farm or crop will build up large numbers of pests in spring. Inspecting the weeds can keep you in touch with how the local pest pressure is building up. Ideally, remove the weeds before the pests build up on them.

7 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

8 M Miles, P Grundy, A Quade and R Lloyd (2015) Insect management in faba beans and canola recent research. GRDC Update Paper, 25 February 2015, https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2015/02/insect-management-in-fababeans-and-canola-recent-research

Yellow sticky traps or cards

Sticky traps are useful as a way of monitoring flying pests like thrips, whitefly and aphids. They attract these insects because of their colour. They are a useful way of sending samples away for identification of thrips species. However, they do not give a complete picture of pest dynamics in the crop. Adult insects may settle into the crop after flying in and juvenile non-flying stages may survive spray applications but will not show up on the traps.

Sticky traps should be changed or checked at least weekly. They need to be placed just above the growing tips of the plants to catch insects hovering above them and to avoid getting stuck and lost in the crop.[9]

Quadrats

Use quadrats to sample snails. See Section 8.3.2 Snails.

Tiles, hessian bags and slug traps

Use either a tile, hessian bag or slug trap left in the paddock over night to count snail or slug numbers. See Section 8.3.3 Slugs (Deroceras reticulatum, Milax gagates and others) Monitoring of slugs.

8.2 Identifying pests

8.2.1 Correct identification of insect species

It is important to be able to identify the various insect present in your crop, whether they are pest or beneficial species, and their growth stages.

Sending insect samples for diagnostics

SARDI Entomology Unit provides free insect diagnostic services for subscribers of PestFacts South Australia and western Victoria newsletter.

CESAR (University of Melbourne), SARDI and NSW DPI will identify insects for a fee. For more information: contact CESAR (03 9349 4723 or www.cesaraustralia.com/sustainable-agriculture/identify-an-insect/insect-identification-service/) or SARDI (www.pir.sa.gov.au/research/services/crop_diagnostics/insect_diagnostic_service) (prices available on application).

Agriculture Victoria does not offer a routine insect identification service.[10]

9 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

10 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

FEEDBACK

MORE INFORMATION

The GRDC has an App on insects:'Insect ID: the Ute Guide App', https://grdc.com.au/Resources/Ute-Guides/Insects/

8.2.2 Insect ID: The Ute Guide

While many resources are available, the primary insect identification resource for grain growers is 'Insect ID: The Ute Guide', a digital guide for smartphones and tablets that is progressively updated as new information becomes available (Figure 1).

Insect ID is a comprehensive reference guide to insect pests commonly affecting broadacre crops and growers across Australia, and includes the beneficial insects that may help to control the pests.

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 be confused with.[11]

Not all insects found in field crops are listed in this app, so further advice may be required before making management decisions.

Figure 1: *Screenshots from the iOS edition of 'Insect ID: The Ute Guide' app.*

Source: https://grdc.com.au/resources-and-publications/app

MORE INFORMATION

See https://grdc.com.au/GrowNotes™alert for alerts from the GRDC

8.2.3 GrowNotes™ Alerts

GrowNotes™ Alerts is a free, early warning system that notifies you of any emerging disease, pest and weed threats, specific to the user's chosen area. It provides real-time information from experts across Australia.

A GrowNotes™ Alert can be delivered via app, SMS, voice, email, social media or web portal (or a combination of preferred methods). The urgency with which they are delivered can help reduce the impact of weed, pest and disease costs. GrowNotes™ Alerts improves the relevance, reliability, speed and coverage of notifications on the incidence, prevalence and distribution of weed, pest and diseases.

11 GRDC (2014) Northern faba bean GrowNotes™, https://grdc.com.au/Resources/GrowNotes™

8.3 Key pests of faba bean

The key pests of faba bean in southern Australia are *Helicoverpa punctigera* (native budworm), snails, slugs and aphids. See sections 8.3.1 (*Helicoverpa punctigera* (native budworm), 8.3.2 (snails), 8.3.3 (slugs) and 8.3.4 (aphids) for more information). Table 1 shows the timing of damaging effects of the key and other pests in faba bean crops.

Table 1: Key and other pests of faba bean crops.

Pest	Crop stage				
	Emergence/ seedling	Vegetative	Flowering	Podding	Grain fill
Helicoverpa spp.		Present	Damaging	Damaging	Damaging
Slugs and snails*	Damaging	Damaging			
Aphids (virus vectors)	Damaging	Damaging	Present	Present	
Earth mites	Damaging	Present	Present		
Lucerne flea	Damaging	Present			
Cutworms	Damaging				
Thrips		Present	Present		

* Snails may also cause grain contamination at harvest

Present — Present in crop but generally not damaging

Damaging — Crop susceptible to damage and loss.

Source: Queensland Department of Agriculture and Fisheries (2016)

8.3.1 *Helicoverpa* species: native budworm and corn earworm (*Helicoverpa punctigera* and *H. armigera*)

The larva of native budworm (*Helicoverpa punctigera*) is the main insect pest of faba bean and broad bean late in the season in southern Australia.

Helicoverpa punctigera is different from the species *H. armigera*, which is commonly known as corn earworm or cotton bollworm.

Helicoverpa spp. are commonly referred to as helicoverpa, heliothis or 'helis'. It is technically more correct to refer to them as "*Helicoverpa* species" to distinguish them from true *Heliothis* sp.

Distribution of *Helicoverpa* spp.

Most *Helicoverpa* in southern Australia from September to early November will be *H. punctigera*. *H. punctigera* is native to Australia. It is more common in inland regions and southern Australia.

H. punctigera (native budworm) breeds over winter in the arid inland regions of Queensland, South Australia, Western Australia and New South Wales on desert plants before migrating into southern agricultural areas in late winter or spring. They can migrate as far south as Tasmania.[12]

H. armigera may become more problematic in summer crop irrigation areas. It rarely occurs in significant numbers in Victorian crops.[13] Although summer pulses are at greatest risk from *H. armigera*, spring outbreaks are possible.

12 G McDonald (2015) Native budworm. Pest Notes Southern. CESAR and South Australian Research and Development Institute, http://www.pir.sa.gov.au/__data/assets/pdf_file/0005/274181/Native_Budworm.pdf

13 G McDonald (1995) Native budworm. Agnote Ag0417. Agriculture Victoria, June 1995, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/pest-insects-and-mites/native-budworm

H.armigera is present in Europe, Asia, Africa and Australasia. While it is present in all Australian states, it is more common in the tropics and subtropics.[14] It is a major pest of chickpea and other pulses in northern Australia.[15]

Pest status of *Helicoverpa* spp.

Helicoverpa spp. are major pests and can severely damage all crop stages and all plant parts of all summer and winter pulses. Both species of *Helicoverpa* may be found in faba bean.[16]

While significant numbers of *H. armigera* are rare in Victoria, it is still an important pest when it does occur in large numbers, as it may be resistant to many of the commonly used insecticides.[17]

Identification of *Helicoverpa* spp. eggs and larvae

The adult moths lay round eggs singly on the host plant. Eggs are pale cream or white when laid, 0.6 mm diameter, ribbed and globular. Fertile eggs develop a red or brown ring after 1–2 days and become brown or black before hatching. They hatch 2–5 days after being laid.

The two *Helicoverpa* species can be differentiated for eggs and small larvae with a Lepton™ test.

Photo 1: *(From left) fresh white eggs of Helicoverpa, 1–2-day-old eggs showing brown ring and eggs close to hatching showing black larval head.*

Source: Northern Faba Bean GrowNotes™

Newly hatched larvae are pale with tiny dark spots and dark heads.

Medium larvae are usually brown and the darker spots become more obvious.

Medium larvae develop lines and bands running the length of the body in variable colours.[18]

MORE INFORMATION

GRDC app: Insect ID: The Ute Guide, https://grdc.com.au/resources-and-publications/app

14 H Brier (2008) Break crop IPM short course manual. Southern Region IPM Workshop Training Manual: Soybeans and Winter Pulses, 11 March 2008, Griffith and Coleambally, NSW, 82pp.

15 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

16 GRDC (2014) Northern faba bean GrowNotes™. https://grdc.com.au/Resources/GrowNotes™

17 G McDonald (1995) Native budworm. Agnote Ag0417. Agriculture Victoria. June 1995. http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/pest-insects-and-mites/native-budworm

18 GRDC (2013) Insect ID: The Ute Guide, iOs app, Version 1.1, 14 October 2013. https://grdc.com.au/Resources/Ute-Guides/Insects

Large larvae can reach 45 mm. Darker specimens are more common in high density populations. Large larvae vary from green, yellow, orange, pink and red-brown to black.[19]

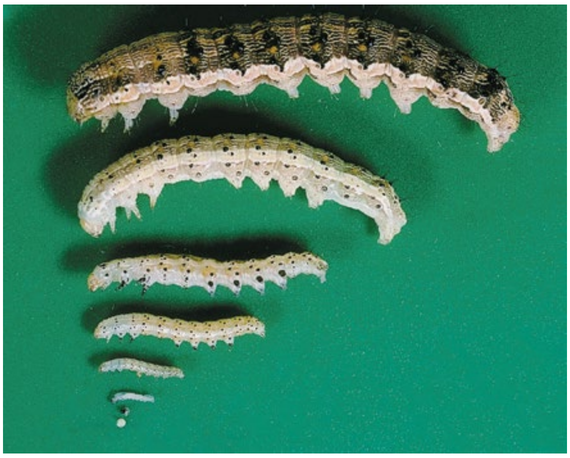

Photo 2: *It is important to be able to identify the different larval instars of Helicoverpa spp. The six larval instars and two eggs are shown. Helicoverpa spp. have four abdominal prolegs. Insecticides are more effective on smaller larvae.*[20]

Photo: Gabriella Caon, SARDI

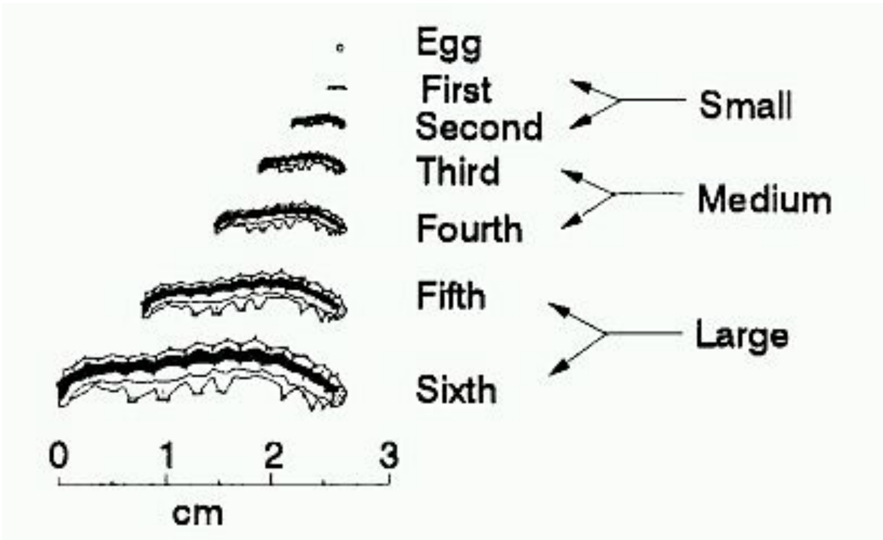

Figure 2: *Approximate sizes of the six instars of Helicoverpa spp.*

Source: G McDonald (1995), Agriculture Victoria

Sometimes the two *Helicoverpa* spp. can be identified by visually examining the larvae. Small *H. armigera* (third instar) have a saddle on the fourth segment but *H. punctigera* do not. While this method can be difficult in the field and is not completely reliable, it may provide a good guide.

In larger (fifth and sixth instar) larvae, hair colour in the segment immediately behind the head is a good species indicator. These hairs are white for H. *armigera* and black for *H. punctigera* (Photo 3).[21]

19 H Brier (2008) Break crop IPM short course manual. Southern Region IPM Workshop Training Manual: Soybeans and Winter Pulses, 11 March 2008, Griffith and Coleambally, NSW, 82pp.

20 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

21 GRDC (2014) Northern faba bean GrowNotes™. https://grdc.com.au/Resources/GrowNotes™

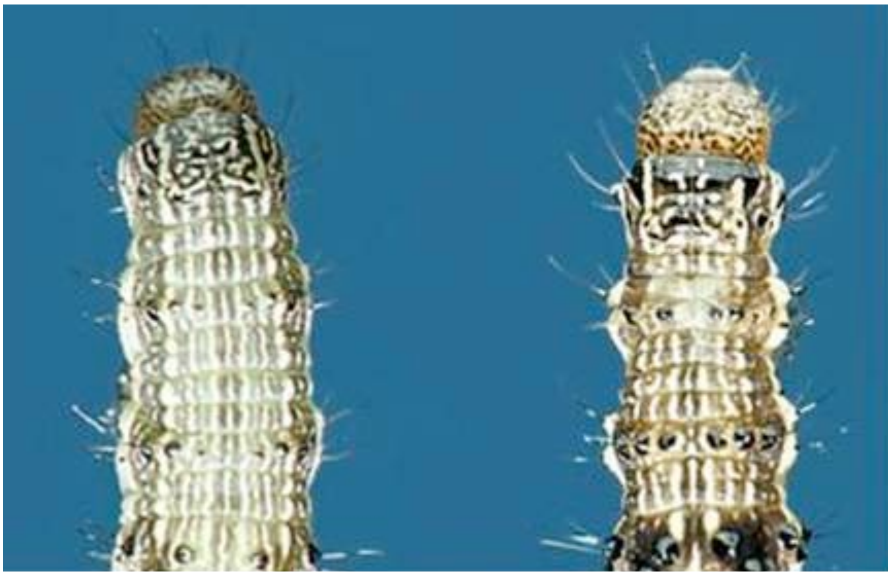

Photo 3: *H. punctigera with black hairs from head (left) and H. armigera with white hairs and 'saddle' on fourth abdominal segment (right).*

Photo: L Turton & M Cahill

Distinguishing ***Helicoverpa*** spp. from other caterpillars

Helicoverpa spp. larvae can be easily identified, despite the colour variation, by a broad yellow stripe along the body.[22] Young larvae (<10 mm) prefer to feed on foliage; older larvae prefer to feed on pods.

In southern Australia, other larvae that look like native budworm may be found in a pulse crop, e.g. southern armyworm and pink cutworm. These are primarily grass feeders and rarely do any damage to pulses.[23]

H. punctigera larvae have black hairs around the head, no dark 'saddle' and light-coloured legs. In contrast, medium larvae of *H. armigera* have white hairs around the head, a dark 'saddle' on the fourth segment back from the head and dark-coloured legs. Pupae of *H. armigera* are readily separated from *H. punctigera* which have spines that are close together.

Medium and large larvae, pupae and adult of *Helicoverpa* spp. can be distinguished visually. Both species of *Helicoverpa* larvae have a group of four pairs of 'legs' in the back half of the body; loopers can have a group of two, three or four pairs of legs at the rear and loop when walking. *Helicoverpa* spp. larvae do not taper noticeably towards the head, as do loopers.

Armyworm larvae can be distinguished by the lack of hairs and by bodies that taper at both ends.

Medium *H. armigera* larvae may also be confused with cluster caterpillar (*Spodoptera litura*) but are more hairy and lack the cluster caterpillar's distinctive spots and hump behind the head. To view images of cluster caterpillar, visit: www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/cluster-caterpillar.

Helicoverpa eggs are paler than looper eggs, which have a green tinge and are squatter.[24,25]

22 GRDC (2014) Northern faba bean GrowNotes™. https://grdc.com.au/Resources/GrowNotes™

23 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

24 H Brier (2008) Break crop IPM short course manual. Southern Region IPM Workshop Training Manual: Soybeans and Winter Pulses, 11 March 2008, Griffith and Coleambally, NSW, 82pp.

25 GRDC (2013) Insect ID: The Ute Guide, iOs app, Version 1.1, 14 October 2013. https://grdc.com.au/Resources/Ute-Guides/Insects

Identification of *Helicoverpa* spp. moths

Helicoverpa spp. moths have a 30–45 mm wingspan with stout bodies. Moths are a dull light brown with dark markings.

Adult moths of *H. punctigera* are usually active during the evening and night and are rarely seen during the day. For native budworm (*H. punctigera*), the forewings are buff-olive to red-brown with numerous dark spots and blotches. The hind wings are pale grey with dark veins and a dark band along the lower edge. The hind wings have a dark, broad band on the outer margin.

Photo 4: Helicoverpa punctigera *(native budworm) moths, showing female (left) and male (right).*

Photo: SARDI

H. armigera has a small light or pale patch in the dark section of the hindwing while the dark section is uniform in *H. punctigera*.[26 27 28 29 30]

26 H Brier (2008) Break crop IPM short course manual. Southern Region IPM Workshop Training Manual: Soybeans and Winter Pulses, 11 March 2008, Griffith and Coleambally, NSW, 82pp.

27 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

28 G McDonald (1995) Native budworm. Agnote Ag0417. Agriculture Victoria, June 1995, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/pest-insects-and-mites/native-budworm

29 D Hopkins, M Miles (1998) Insects: the Ute Guide, Southern Region. Primary Industries and Resources SA.

30 GRDC (2013) Insect ID: The Ute Guide, iOs app, Version 1.1, 14 October 2013. https://grdc.com.au/Resources/Ute-Guides/Insects

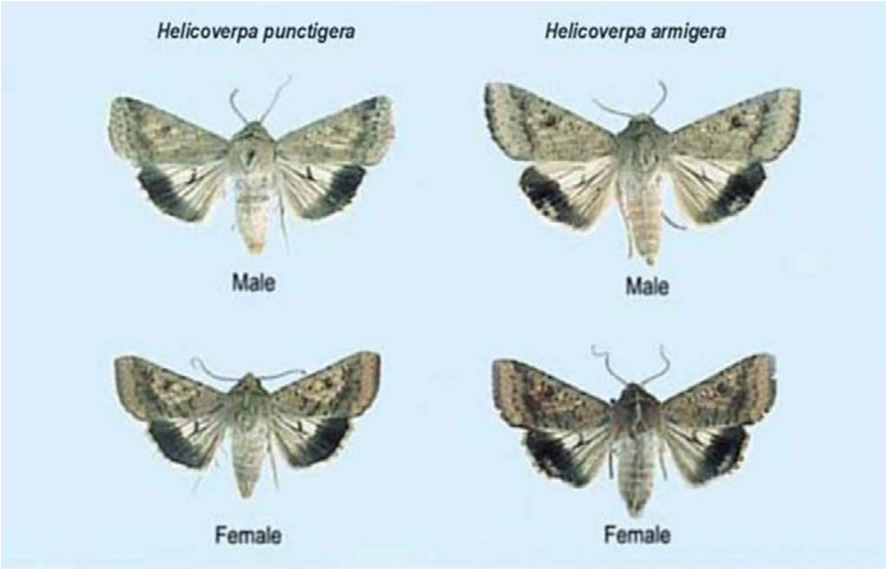

Photo 5: *Helicoverpa punctigera (native budworm) and H. armigera moths. The two species are distinguished by the presence of a pale patch in the margin of the hindwing of H. armigera. Most Helicoverpa in southern Australia from September to early November will be H. punctigera.*

Source: Pulse Australia (2016), Southern faba and broad bean management practices training course 2016. Pulse Australia

Life cycle of *Helicoverpa* spp.

Each female *helicoverpa* can lay more than 1,000 eggs. In southern Australia, native budworm may produce up to five generations a year. The eggs hatch 1–2 weeks after laying in spring (or 2–6 days in summer) and the larvae feed in crops for 4–6 weeks.

Once larvae are fully grown, they crawl to the base of the plant, tunnel into the soil and form a chamber in which they pupate. During spring, summer and early autumn, the pupae develop quickly and a new generation of moths emerges after about two weeks. As with all insect development, the duration of pupation is determined by temperature, taking longer in spring and autumn. Diapausing pupae take much longer to emerge.

The moth emerges, feeds, mates and is then ready to begin the cycle of egg laying and larval development.

Native budworm eggs and holes on soursob (oxalis) petals are signs of native budworm activity in the area.

The spring generation causes the most damage, especially to pulse crops.

During winter, native budworm enters a resting period as a pupa in the soil. Adult moths emerge from these over-wintering pupae in August and September and live for about 2–4 weeks.[31 32 33]

Diapause in *Helicoverpa* spp.

Both species of *Helicoverpa* survive winter as pupae in the soil, when host plants and thus food sources are scarce. *H. punctigera* are capable of over-wintering in southern cropping regions, but only a few are ever found. By contrast, substantial numbers of over-wintering *H. armigera* pupae can be found under late summer crops, particularly when *Helicoverpa* activity has been high late into March.

31 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

32 H Brier (2008) Break crop IPM short course manual. Southern Region IPM Workshop Training Manual: Soybeans and Winter Pulses, 11 March 2008, Griffith and Coleambally, NSW, 82pp.

33 GRDC (2014) Northern faba bean GrowNotes™. https://grdc.com.au/Resources/GrowNotes™

Not all pupae that form in late summer go into diapause; a proportion continue to develop, perhaps emerging during winter, or early in spring.

Over-wintering pupae can be killed without use of chemicals. Pupae in the soil are susceptible to soil disturbance and disruption of the emergence tunnel. Cultivation is enough to create this disturbance.[34]

Damage by *Helicoverpa* spp.

Helicoverpa spp. attack most major field crops as well as many horticultural crops.1 They attack all above-ground plant parts. Once crops reach flowering, larvae focus on buds, flowers and pods.

Native budworm (*H. punctigera*) larvae bore into the faba bean pods and usually destroy several seeds in each pod. A single larva may attack 4–5 pods before reaching maturity. The amount of damage to each seed varies considerably, but the damaged area has jagged edges.

Helicoverpa spp. cause most damage from pod-set to maturity, and can reduce grain yield and quality. Whilst important, insect damage does not constitute the majority of defective faba bean grain.

It is important to control larvae while they are still very small (<7 mm). Ninety per cent of all feeding (and therefore damage) by *Helicoverpa* is done by larvae from the third instar (small–medium larva that are 8–13 mm long) onwards. Large *Helicoverpa* larvae (>24 mm) are the most damaging stage, since larvae consume about 80% of their diet in the fifth and sixth instars.

Photo 6: *Native budworm on faba bean. Helicoverpa spp. attack all above-ground parts of plants.*

Photo: Wayne Hawthorne, formerly Pulse Australia

Photo 7: *Native budworm damage to faba bean pods. Helicoverpa spp. larvae focus on buds, flowers and pods once the crop has reached flowering.*

Photo: Landmark

34 GRDC (2014) Northern faba bean GrowNotes™. https://grdc.com.au/Resources/GrowNotes™

Photo 8: *Native budworm damage to faba bean grain downgrades its quality. Affected grains are classified as defective.*

Photo: Landmark

While the feeding behaviour of *H. armigera* and *H. punctigera* are expected to be the same, no research has been undertaken to assess this.

No studies have compared the behaviour of larvae in drought-stressed crops compared with crops with adequate moisture. Consequently there is no certainty about whether there is more, or earlier, flower and pod feeding when foliage appears to be less attractive.[35,36,37,38]

Monitoring *Helicoverpa* spp. larvae

Regularly monitor the faba bean crop for insect pests and/or damage to make timely decisions on control. It is important to target small larvae.

Begin monitoring crops for *Helicoverpa* larvae when crops start flowering and continue until late maturity. One recommendation is to inspect crops weekly for before pod-set, then 2 or 3 times a week until late podding. Another recommendation is to monitor crops every 3 or 4 days from the beginning of flowering. Moth flight activity can provide an early warning for egg laying and potential future larval activity in the crop, and also signals the time to start monitoring crops for larvae.

Growers also need to take into account beneficial species and populations, as there may be a very high predation rate in faba bean. See Section 8.7 Beneficial species.

Experienced agronomists suggest that *Helicoverpa* numbers alone do not always give an accurate assessment of damage. In some situations (for example, if the crop is severely moisture stressed), monitoring crop damage will assist in assessing the accumulating yield loss.

While the quickest and easiest method of sampling most crops is to use a 38 cm diameter sweep net, it may be less efficient in tall, dense crops of faba bean. Repeat the sweeping process of 10 sweeps in at least 12 places throughout the paddock to obtain an average caterpillar density. For more details, see Section 8.1.7 Monitoring methods.

Sweep-net sampling of faba bean severely underestimates the density of larvae, and particularly the smaller larvae. A visual inspection of faba bean terminals, flowers and buds is very important for smaller larvae estimates.

35 GRDC (2014) Northern faba bean GrowNotes™, https://grdc.com.au/Resources/GrowNotes™

36 H Brier (2008) Break crop IPM short course manual. Southern Region IPM Workshop Training Manual: Soybeans and Winter Pulses, 11 March 2008, Griffith and Coleambally, NSW, 82pp.

37 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

38 M Miles, P Grundy, A Quade and R Lloyd (2015) Insect management in fababeans and canola recent research. GRDC Update Paper, 25 February 2015, https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2015/02/insect-management-in-fababeans-and-canola-recent-research

VIDEO

For more information in beat sheet sampling, watch: GCTV16: IPM beatsheet demo. Mung bean, https://www.youtube.com/watch?v=MwtqG6IC49E

Beat sheet sampling is the preferred sampling method for medium to large *Helicoverpa* larvae. The beat sheet sampling method is providing a better estimate of larval density than sweep nets, but is still poor overall, as it markedly underestimates larva density in faba bean, particularly smaller larvae. Scout for small larvae by opening vegetative terminals, buds and flowers. Sample 6 widely spaced locations per paddock and take five 1-metre long samples at each site with a standard beat sheet. Convert larval counts per metre to larvae per square metre by dividing the counts by the row spacing, in metres.[39 40 41]

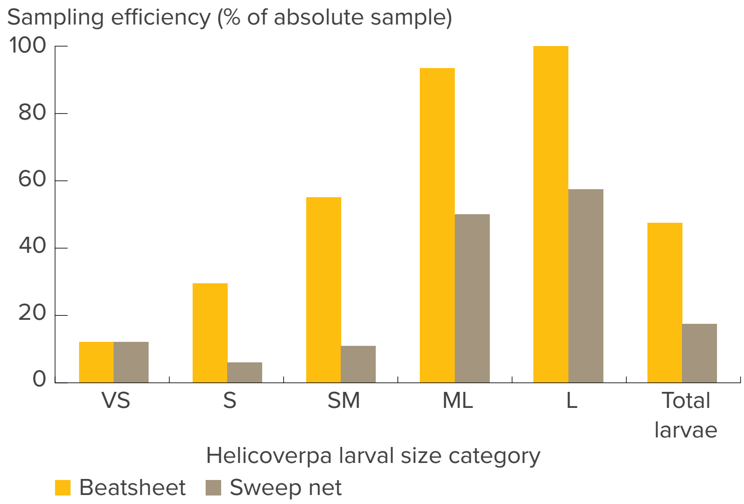

Figure 3: *A simple conversion from sweep-net sampling to beat-sheet sampling is not currently possible because the two methods are not equally effective at collecting different larval sizes. Larger larvae are more easily dislodged with both methods, but smaller larvae are more difficult to assess accurately.*

Source: Miles *et al* (2015) [42]

A basic approach to monitoring is to sample each of 10 widely separated sites, by laying a 0.5 m^2 piece of white fertiliser bag between the rows. Beat the plants on each side over the bag and count the number of 4–9 mm long larvae that fall.

Helicoverpa eggs are difficult to see, so egg counts are an unreliable indicator of control thresholds. Egg survival to larvae can also be highly variable. If an egg count is taken, use it as an indication of an egg-lay event and determine the potential development rate of the *Helicoverpa*. Rates of native budworm (*H. punctigera*) development have been estimated for South Australia, based on meteorological data (Table 2); eggs laid on 20 August will take about 3 weeks to hatch, while eggs laid 1 month later will take 13 days. In some seasons, a second spray is needed.

39 H Brier (2008) Break crop IPM short course manual. Southern Region IPM Workshop Training Manual: Soybeans and Winter Pulses, 11 March 2008, Griffith and Coleambally, NSW, 82pp.

40 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

41 D Lush (2013) Time to watch for native budworm. Grains Research and Development Corporation, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-106-Sept-Oct-2013/Time-to-watch-for-native-budworm

42 M Miles, P Grundy, A Quade and R Lloyd (2015) Insect management in fababeans and canola recent research. GRDC Update Paper, 25 February 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02

Table 2: Estimated developmental rate (number of days between stages) for native budworm in South Australia. Development is faster in spring than winter. In some years, a second spray is required. Based on former Victorian Department of Primary Industries estimates using DARABUG software using moth counts, larvae developmental stages and weather pattern information. These are a guide only.

Stage	August 20	August 30	September 10	September 20	September 30
Egg laying to egg hatch	21	18	16	13	13
Egg hatch to larvae 7–10 mm	32	30	28	27	24
Egg laying to larvae 7–10 mm	53	48	44	40	37

Source: Budworm Watch program – more than monitoring, (2003), www.regional.org.au/au/apen/2003/abstracts/p-37.htm

It is difficult to estimate the number of very small larvae hatched in the previous 24 hours. Often they are low in the canopy. When using a beat sheet, they often remain on leaflets, making them very difficult to see and count. Very small larvae do no economic damage to the crop, their feeding confined to leaves. Early research on *Helicoverpa* has shown high mortality of very small larvae; their value in monitoring is potential activity of larger larvae in a week or two.

In studies of *Helicoverpa* larval feeding behaviour in soybean, large larvae were found to cause the majority of damage, in the order of 80%, with medium larvae contributing about 15% and other instars, the remainder.[43 44 45 46]

Monitoring *Helicoverpa punctigera* (native budworm) moth flights

Helicoverpa punctigera (native budworm) moths migrate to southern Australia from breeding grounds in the northern pastoral and desert areas after winter rainfall.

Large numbers of native budworm moths usually fly into cropping areas during late winter and spring, with infestations commencing in the northern cropping areas.

Moths are attracted to traps containing a chemical sex-attractant (pheromone), specific to the species so only the *Helicoverpa* is caught.

Photo 9: *Pheromone traps can be used as a guide to identifying and monitoring moth numbers.*

Photo: Unknown

43 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

44 Matthews, P. and Marcellos, H. (2003) Faba bean. AgFact P4.2.7 Second Edition, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/157729/faba-bean-pt1.pdf www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/157732/faba-bean-pt2.pdf

45 GRDC (2014) Northern faba bean GrowNotes™. https://grdc.com.au/Resources/GrowNotes™

46 L Breen (2003) Budworm Watch program – more than monitoring. Australasia Pacific Extension Network 2003 Forum, Hobart, 26-28 November 2003, www.regional.org.au/au/apen/2003/abstracts/p-37.htm

Take note of news of *Helicoverpa* moth flights and inspect crops for the presence of caterpillars when crops are flowering and podding.

Growers should begin monitoring crops when moths are detected in their region. However, as there is no established relationship between the numbers of moths trapped and the resulting caterpillar population in nearby crops, growers cannot determine the need for sprays by the moth traps.[47]

Control thresholds for ***Helicoverpa*** spp.

An economic control threshold is the number of caterpillars that will cause more financial loss than the cost of spraying. Further research is needed into control thresholds for *Helicoverpa* in faba bean.

The thresholds used for *Helicoverpa* are based on yield loss rather than quality; however, in faba bean, the quality threshold (defective grain) is probably reached before significant yield loss. Even in low numbers, *Helicoverpa* can affect the marketability of grain while not economically affecting yield, meaning that control measures may be needed before economic thresholds are reached. For large grains such as faba bean, growers should consider treating the moment any budworm larvae are detected.

The control thresholds used in the southern region are those developed for Western Australia. This threshold is the only one used in Australia that may be derived from research, rather than 'best guesses', and assumes 90 kg/ha yield loss per larva in 10 sweeps (Table 3). In southern Australia, the original threshold was two larvae per 10 sweeps.

In New South Wales, a threshold for spraying is determined when the average number of small larvae (<10 mm) exceeds 2–4 larvae/m^2, but if the crop is used for human consumption, a lower threshold of 1 larvae/m^2 is advised.[48 49 50]

Note that the Western Australian thresholds are only a guide for the southern region. To calculate the threshold, use the formula:

Economic threshold for grubs in 10 sweeps = C ÷ (K x P)

Where:

C = control cost ($/ha), i.e. chemical plus application costs per hectare

K = 90 kg/ha faba bean grain eaten for every one caterpillar netted in 10 sweeps or per square metre

P = price of grain per kg, i.e. price per tonne ÷ 1,000

For example, with faba bean:

P = $280/t, (i.e. $0.28/kg) Therefore: ET = 10 ÷ (90 x 0.28)

C = $10/ha

K = 90 kg/ha

47 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

48 P Mangano, S Micic (2016) Management and economic thresholds for native budworm control. Department of Agriculture and Food, Western Australia, www.agric.wa.gov.au/grains/management-and-economic-thresholds-native-budworm

49 M Miles, P Grundy, A Quade and R Lloyd (2015) Insect management in fababeans and canola recent research. GRDC Update Paper, 25 February 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/02

50 D Lush (2013) Time to watch for native budworm. Grains Research and Development Corporation, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-106-Sept-Oct-2013/Time-to-watch-for-native-budworm

Table 3: Examples of economic thresholds for native budworm control in faba bean for Western Australia.

	P	C	K	Economic thresholds	
Grain price per tonne ($)	Grain price per kg ($)	Control costs including application ($/ha)	Loss per grub in each of 10 sweeps (kg/ha/grub)	Grubs in 10 sweeps	Grubs in 5 lots of 10 sweeps (5x previous column)
280	0.28	10	90	0.4	2
560	0.56	10	90	0.2	1

Note: These thresholds are a guide only, as no thresholds have been developed for south-eastern Australia.[51] They are based on yield loss only, not loss of quality. Source: P Mangano, S Micic (2016) Management and economic thresholds for native budworm control. Department of Agriculture and Food, Western Australia, www.agric.wa.gov.au/grains/management-and-economic-thresholds-native-budworm

Helicoverpa punctigera (native budworm) control

Few control options are currently available other than the use of chemical insecticides or biopesticides for above-threshold populations of larvae in a crop.

Spray promptly once the threshold are exceeded. *Helicoverpa punctigera* (native budworm) larvae are easily killed by all registered products, including products to which *H. armigera* is resistant.

Because *H. punctigera* moths migrate annually into eastern Australian cropping regions, any resistance that might be selected for, because of exposure to insecticides in crops, is lost among the larger susceptible population. In other words, as new *H. punctigera* moths appear each year, insecticide resistance is unlikely to be a threat to pulse production in southern and western regions of Australia.

Commonly used insecticides registered for use on native budworm are shown in Table 7 with details in Table 8 .

Aim to control larvae less than 10 mm long, because bigger larvae require higher rates of insecticides. The larvae must be sprayed before they burrow into the seed pods or they will be shielded from insecticides and will continue to damage seed.[52,53]

Helicoverpa armigera control

H. armigera has developed resistance to synthetic pyrethroids, organophosphates and carbamates. Unlike *H. punctigera*, populations tend to remain local, so their resistance to insecticides is maintained in the population from season to season.

If *H. armigera* is the dominant species, spray with carbamates or pyrethroids may fail because of resistance. The biopesticides Helicoverpa nucleopolyhedrovirus (NPV) and *Bacillus thuringiensis* (*Bt*) currently have no known resistance problems.

Before flowering, biopesticides are recommended in preference to chemical insecticides in all pulses, particularly older, less selective products, for integrated pest management.

After flowering, control is recommended only for small larvae 5–7 mm long, depending on the product and if resistance levels are within acceptable limits for the region.

If using a product that is effective only against early-instar larvae, another spray may be necessary during flowering to prevent large larvae damage at pod-set.

Where newer, more selective pesticides, such as spinosad and indoxacarb, are used for *H. armigera*, the number of spray applications per crop is restricted (usually to one) for resistance management. Because of this, and because they are often more

51 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited

52 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

53 GRDC (2014) Northern faba bean GrowNotes™. https://grdc.com.au/Resources/GrowNotes™

FEEDBACK

MORE INFORMATION

GRDC Fact Sheet: Snail management, www.grdc.com.au/GRDC-FS-SnailManagement

Comprehensive information on snail management is available in the publications:

- Snail Bait Application: GRDC Fact Sheet, https://grdc.com.au/Resources/Factsheets/2015/01/Snail-Bait-Application
- *Bash 'Em, Burn 'Em, Bait 'Em: Integrated snail management in crops and pastures*, www.grdc.com.au/GRDC-Snails-BashBurnBait
- *Snail Identification and Control: The Back Pocket Guide*, www.grdc.com.au/BPG-SnailIdentificationAndControl

expensive, new chemical pesticides are best reserved for 'at risk' flowering and podding stages.

For best results, all 'ingestion' products (including biopesticides) require thorough plant coverage. The addition of Amino Feed® or equivalent is strongly recommended for biopesticides.[54 55]

8.3.2 Snails

While snail populations do not build up as readily under faba bean as under field pea, they can still be a problem. Snails climb onto faba bean plants and standing cereal stubble. They can enter the grain sample at harvest with or without having climbed onto the faba bean plant. Snail numbers can explode in seasons with wet springs, summers and autumns.[56 57] **Particular attention must be paid to slugs under no-till and stubble retention**.[58]

White snails or round snails (*Cernuella virgata* and *Theba pisana*)

Two species of white (or round) snails exist: the vineyard or common white snail (*Cernuella virgata*) and the white Italian snail (*Theba pisana*). They are found throughout the agricultural districts of South Australia, and the Victorian Mallee and Wimmera. They also occur in Western Australia, New South Wales and Tasmania.

Both species have similar shapes: white coiled shells up to 20 mm diameter, which may have brown bands around the spiral. The common white snail has an open umbilicus whereas the umbilicus of the Italian snail is partly closed. The umbilicus of a white snail is the hollow space on the underside of the shell.

Photo 10: *Vineyard or common white snail. Note the umbilicus (hollow space) is open.*

Photos: SARDI

54 GRDC (2014) Northern faba bean GrowNotes™. https://grdc.com.au/Resources/GrowNotes™

55 H Brier (2008) Break crop IPM short course manual. Southern Region IPM Workshop Training Manual: Soybeans and Winter Pulses, 11 March 2008, Griffith and Coleambally, NSW, 82pp.

56 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

57 GRDC (2012) Snail Management: All-year-round attack on snails required. Southern and Western Region Fact Sheet. Grains Research and Development Corporation, www.grdc.com.au/GRDC-FS-SnailManagement

58 J Kirkegaard (2017) Opportunities and challenges for continuous cropping systems, GRDC Update Paper, https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2017/02/opportunities-and-challenges-for-continuous-cropping-systems

Photo 11: *White Italian snail. Note the umbilicus (hollow space) is partly closed.*

Photos: SARDI

Conical snails or pointed snails or (*Cochlicella acuta* and *Cochlicella barbara*)

Two species of conical snails exist: conical snails (*Cochlicella acuta*) and small conical snails (*C. barbara*).

Conical snails are also known as pointed snails. They have fawn, grey or brown shells. Mature conical snails have shells 12–18 mm long whereas the shells on the small conical snails are 8–10 mm long.

Highest numbers of conical snails (*C. acuta*) are found on the Yorke Peninsula in South Australia. Isolated populations are also present in other parts of SA, Victoria, NSW and Western Australia.

The small conical snail, *C. barbara*, occurs throughout SA, but is most abundant in higher-rainfall areas (>500 mm). It is also widely spread in Victoria, NSW and WA.

The ratio of shell length to base diameter is always greater than two for conical snails and less than two for small conical snails.[59 60 61]

59 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

60 GRDC (2011) Snail Identification and Control: The Backpocket Guide. www.grdc.com.au/BPG-SnailIdentificationAndControl

61 GRDC (2015) Snail Bait Application: Lessons from the Yorke Peninsula to improve snail baiting effectiveness. Fact heet. Grains Research and Development Corporation, https://grdc.com.au/Resources/Factsheets/2015/01/Snail-Bait-Application

Photo 12: *Conical snail, also known as pointed snail. The shell length is always more than double the base diameter. Mature conical snail shells are 12–18 mm long.*

Photo: SARDI

Photo 13: *Small conical snail, also known as small pointed snail. The shell length is always less than double the base diameter. Mature small conical snail shells are 8–10 mm long.*

Photo: SARDI

Damage by snails

White snails mainly damage crops during establishment and harvest. Both common white and Italian snails may feed on young crops and destroy substantial areas, which then need re-sowing. In late spring, snails climb plants. The juveniles, in particular, contaminate the grain at harvest.

Conical snails, *Cochlicella acuta*, contaminate grain at harvest, especially cereals and canola. They feed mostly on decaying plant material but can damage cereal and canola seedlings.

The small conical snail, *C. barbara*, feeds on growing plants and can contaminate grain. Lucerne is a favoured plant.

The contaminated grain may be downgraded or rejected and live snails in grain pose a threat to exports. Grain will be rejection if more than half a dead or one live snail is found in a 0.5 L wheat sample or 200 g pulse sample (Grain Trade Australia). Check with your buyers for specific regulations or visit: www.pulseaus.com.au/marketing/receival-trading-standards

Crushed snails clog up machinery causing delays during harvest. Modify headers and clean grain to eliminate snail contamination of grain. For more details see Section 12.9 Managing snails.

Life cycle of snails

Snails appear to build up most rapidly in canola, field pea and faba bean. However, they can feed and multiply in all crops and pastures. White snails are dormant in summer. Young snails hatch about 2 weeks after eggs are laid. They feed and grow through the winter and spring and then climb fence posts or plants in late spring or summer where they go into summer dormancy. Snails live for 1–2 years, and move only short distances. They are spread in hay, grain, machinery or by vehicles.

Conical snails have a similar life cycle to white snails. Conical snails may over-summer under stones as well as on posts and plants.

Small conical snails over-summer on the ground in the leaf litter and under stones and stumps.[62 63 64]

Monitoring snails

Monitor snails regularly to establish their numbers, types and activity, as well as success of controls. Monitoring and early baiting before eggs are laid is critical for snail control.

Look for snails early morning or in the evening when conditions are cooler and snails are more active.

The key times to monitor snail populations are:

- summer to pre-sowing – check numbers in stubble before and after rolling, slashing or cabling;
- 3–4 weeks before harvest, to assess need for harvester modifications and cleaning; and
- after summer rains: check if snails are moving from resting sites.

A wide range of snail sizes in an area indicates that snails are breeding there; if most snails are the same size, snails are moving in from other areas. Size range of snails is important as juveniles don't take baits.

Various monitoring techniques are recommended for snails. Methods include:

- Sampling with 10 x 10 cm quadrats at 50 locations across the paddock. Take samples from the perimeter to the interior of the paddock and note density in different areas.
- Sampling with a 0.1 m^2 (32 x 32 cm) quadrat. Place the quadrat on the ground and count all live snails within it. Take five counts along the fence at approximately 10 m apart, then five counts into the paddock every 10 m.
- Sampling with a 30 x 30 cm quadrat at 50 locations across the paddock.

When sampling at 50 locations, take five sampling transects in each paddock. One transect is taken at 90 degrees to each fence line, and the fifth transect runs across the centre of the paddock. Take five samples (counts), 10 m apart along each transect. Record the size and number of the snails in each sample. Average the counts for each transect and multiply this figure by 10 to calculate the number of snails per square metre in that area of the paddock.

If two snails groups are present (round and conical), record the number of each group separately.

62 GRDC (2015) Snail Bait Application: Lessons from the Yorke Peninsula to improve snail baiting effectiveness. Fact Sheet. Grains Research and Development Corporation, https://grdc.com.au/Resources/Factsheets/2015/01/Snail-Bait-Application

63 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

64 GRDC (2012) Snail Management: All-year-round attack on snails required. Southern and Western Region Fact Sheet. Grains Research and Development Corporation, www.grdc.com.au/GRDC-FS-SnailManagement

Place the snails in a simple sieve box and shake gently to separate into larger snails and those smaller than 7 mm. Round snails and small conical snails (<7 mm) are unlikely to be controlled by bait. Record two size groups (juveniles <7 mm and adults >7 mm). Sieve boxes can be constructed from two stackable containers, such as sandwich boxes. Remove the bottom from one and replace by a punch hole screen. Suggested screen size is 7 mm round or hexagonal.

When looking for snails, check under weeds, and shake and thresh samples of mature crops onto a small tarp or sack, to see if snails are in the portion of crop that will enter the harvester.

Record live snails before and seven days after baiting or the paddock operation and calculate the reduction in numbers.

Snail control

To control snails, you will need to apply a combination of treatments throughout the year.

The keys to snail management and control are:

- Stubble management:
    - cabling or rolling in summer;
    - slashing in summer; and
    - burning in autumn.
- Summer weed control.
- Baiting in autumn.
- Harvest and delivery:
    - reducing snail intake during harvest (windrowing, brushes, bars);
    - header settings; and
    - cleaning after harvest.

Snail control starts in the summer before sowing. Stop baiting 8 weeks before harvest to avoid bait contamination in grain. Juvenile snails (<7 mm) cannot be controlled after sowing. If pulse crops have more than 5 snails/m^2, growers are likely have grain contamination at harvest.

While control measures for conical snails are the same as those used on white snails, they are generally less effective as conical snails can shelter in cracks in the ground or under stones. Dragging harrows or a cable before burning improves the control of conical snails by exposing more snails to burning.

The best control is achieved by stubble management on hot days or burning, followed by baiting in autumn before egg laying.

Rolling, harrowing or dragging a cable over stubble on hot days reduces snail numbers by knocking snails to the ground to die in the heat (air temperature >35°C). Some snails may also be crushed by rollers.

Burning in autumn can reduce snail numbers by up to 95%, provided there is sufficient stubble for a hot and even burn. Note that wind or water erosion become a risk on burnt stubble.

It is important to understand the factors that determine baiting efficacy. Bait in autumn when snails have commenced activity following rain and must be done before egg laying. Baiting may be necessary to reduce damage to young crops. Fence line baiting can also be vital to prevent re-infestation of the paddock. Do not bait within 2 months of harvest.

Timing and choice of controls will depend on the season. Three bait types are available for snail control: methiocarb, metaldehyde and iron chelates, which are similar in efficacy. (However, methiocarb is not registered for use in faba bean.) The metaldehyde rate used depends on the product used.

MORE INFORMATION

For more information on managing snails at harvest, see Section 12.9 Managing snails.

Most spreaders are designed for fertiliser. A trial has shown that snail and slug bait is not spread as widely as expected and can become fragmented. Ute spreaders give uneven coverage. For optimal coverage, calibrate spreaders especially for snail bait.[65]

Windrowing can reduce white snail numbers harvested. Snails are knocked from the crops during windrowing, and most re-climb the stalks between the windrows rather than in the windrow.

Biological controls are not yet available for white snails. Native nematode species have shown promise against the four pest snail species but commercially trialled with limited success.[66]

Grain can be cleaned on-farm where snail contamination is so high that grain will be downgraded or rejected.[67 68 69]

8.3.3 Slugs (*Deroceras reticulatum*, *Milax gagates* and others)

Slugs are a growing problem in the high-rainfall zones with zero-till and stubble retention. Faba bean tolerates slug damage better than many other crops.

Although slugs reproduce very poorly on faba bean in laboratory trials, this is not observed in paddocks. This may be due to the microhabitat in faba bean crops favouring slug populations. This is possibly related to soil moisture relative to other crops that dry out the soil more. No single control method will provide complete protection; an integrated approach is best. Slug populations are regulated by moisture. Cool, wet summers and heavy stubble provide ideal conditions for slugs, as they need moisture and shelter to thrive.

MORE INFORMATION

Details of other species can be found in *Slugs in Crops: the Back Pocket Guide*, www.grdc.com.au/GRDC-BPG-Slug

A slug identikit is available at Ground Cover™ Radio, go to https://grdc.com.au/Media-Centre/Hot-Topics/Slugging-slugs/Details

Slug species identification

The two main pest species are the grey field (or reticulated) slug (*Deroceras reticulatum*) and the black keeled slug (*Milax gagates*). The grey field slug is the most common slug species in southern Australia. Brown field slugs (*D. invadens* or *D. laeve*) can also pose a serious threat.

Adult grey field slugs are usually grey and about 2–5 cm long. They may have dark brown mottling and range from light grey to fawn. The black keeled slug is uniform black to grey, with a ridge down its back, and 4–6 cm long. The brown field slug is 25–35 mm long, and usually brown all over with no distinct markings.

The brown field slug is mainly surface active but can burrow to shallow depths.

Grey field slugs are mainly active on the surface while the black keeled slug can burrow up to 20 cm underground to escape the heat. For this reason, black keeled slugs may become active in emerging crops later than grey field slugs, as the autumn break develops. This means the optimal timing of control will differ for the two species.

As black keeled slugs are a burrowing species, they are considered better suited to drier environments.

65 GRDC (2015) Snail Bait Application: Lessons from the Yorke Peninsula to improve snail baiting effectiveness. Fact Sheet. Grains Research and Development Corporation, https://grdc.com.au/Resources/Factsheets/2015/01/Snail-Bait-Application

66 M Nash (2013) Slug control – new insight. GRDC Update paper. https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Slug-control-new-insights

67 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

68 GRDC (2012) Snail Management: All-year-round attack on snails required. Southern and Western Region Fact Sheet. Grains Research and Development Corporation, www.grdc.com.au/GRDC-FS-SnailManagement

69 Queensland Department of Agriculture and Fisheries (2016) http://ipmguidelinesforgrains.com.au/pests/slugs-and-snails/snails-in-seedling-crops/

Photo 14: *The two main slug species in southern Australia are the grey field slug (Deroceras reticulatum) (top) and the black keeled slug (Milax gagates) (bottom).*

Photo: Peter Mangano, DPIRD

Damage by slugs

Slugs will attack all plant parts. Seedlings are the most vulnerable and can suffer major economic damage. Faba bean is more tolerant of slug damage than many other crops.

Slugs can be underestimated as pests because they are nocturnal and shelter during dry conditions.

Although slugs can cause major damage to emerging pulse, canola and wheat crops in high rainfall areas, they have also caused damage in lower-rainfall areas in wetter years. Damage is usually greater in cracking clay soils.

Photo 15: *Slug damage on a faba bean seedling.*

Photo: Wayne Hawthorne, formerly Pulse Australia

Life cycle of slugs

Slugs are hermaphrodites, that is, individuals are both male and female. Slugs will breed whenever moisture and temperature conditions are suitable – generally from mid-autumn to late spring. Both individuals of a mating pair lay eggs in batches. Each individual can lay about 100 eggs; some species can produce about 1,000 eggs per year.

Eggs are laid in moist soils and will hatch within 3–6 weeks, depending on temperature. Juveniles look like smaller versions of the adult.

Moisture is essential for slug survival and some species, such as the black keeled slug, may move down the soil to depths of 20 cm or more in dry periods and reappear when conditions improve.

Photo 16: *Slug eggs hatch within 3–6 weeks of laying. Some species can produce up to 1,000 eggs per year.*

Photo: Michael Nash

Monitoring of slugs

Use surface refuges, such as 30 x 30 cm pavers, to monitor slugs. This represents approximately 1 m^2 for slugs. Ideally, use a minimum of 10 tiles per 10 ha placed evenly across the entire paddock.

Growers can also use either a tile, hessian bag or slug trap left in the paddock over night to count snail or slug numbers. There are many types of slug traps available for home garden use. Use surface traps baited with layer's mash and check them early in the morning, as slugs move out of the traps as the day starts to warm up.

Slug control

When slugs are actively breeding, no current control measure will reduce populations below established thresholds. Particular attention must be paid to slugs under no-till and stubble retention.[70]

Cultivation and rolling, and burning stubble after weed control will reduce slug populations. Rolling the soil immediately after sowing can also markedly reduce slug damage. Shallow discing may reduce populations of grey field slugs by 40–50%. While burning may help control surface active species, it will not control the burrowing black keeled slugs.

If anticipating crop damage from slugs, bait after sowing, before crop emergence. Differences in biology between species can affect control options and chemical efficacy.

Always use the highest possible label rates or adjust the rate to the perceived size of the slug population. Bait is commonly applied at 4–5 kg/ha, but be aware that the density of bait points needs to be at about 25–30 bait points/m^2 for a paddock population of 20 slugs/m^2, giving 80% chance of slugs encountering the baits. Spreading bait with fertiliser spreaders can lead to poor distribution of bait.[71]

Preliminary trials found the effective bait life is between 2–3 weeks. More than one bait application may be necessary, particularly with wet winters. Cheaper options give similar results if baiting occurs monthly.

Buried bait is less effective than bait on the soil surface.

MORE INFORMATION

GRDC Fact Sheet: Slug identification and management, see www.grdc.com.au/GRDC-FS-SlugControl

70 J Kirkegaard (2017) Opportunities and challenges for continuous cropping systems. GRDC Update Paper, https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2017/02/opportunities-and-challenges-for-continuous-cropping-systems

71 GRDC (2015) Snail Bait Application: Lessons from the Yorke Peninsula to improve snail baiting effectiveness. Fact Sheet. Grains Research and Development Corporation, https://grdc.com.au/Resources/Factsheets/2015/01/Snail-Bait-Application

Three types of baits are registered for the control of slugs. They are based on:

- metaldehyde;
- methiocarb (Mesurol®) (although this is not registered for us in faba bean); and
- iron EDTA (iron chelate) complex (Multiguard®).

Metaldehyde and iron chelates are considered by some as the most effective baits. Metaldehyde damages the mucous-producing cells, so it is less affected by cold and wet conditions. Rates of up to 10 kg/ha may be necessary. Baiting will generally only kill half of the slug population at any one time. Details of slug baits are shown in Table 4.

Table 4: Notes on the three groups of slug baits for use in crops in southern Australia.

Bait base	Product	Notes
Metaldehyde	Many products	• Some products are registered for all slugs and some for grey field slugs only • Black keeled and brown slugs appear more tolerant of baits containing metaldehyde • Highly toxic to birds and mammals • Spread evenly to avoid off-target damage
Methiocarb	Mesurol®	• Highly toxic to carabid beetles, one of the few predators of slugs
Iron EDTA complex	Multiguard®	• Registered for grey field slugs only • Snail and slug-specific • Low toxicity to mammals and birds • No impact on predatory insects • The recommended IPM option in Europe

Source: GRDC (2013) Slug control: Slug identification and management Fact Sheet. Grains Research and Development Corporation, www.grdc.com.au/GRDC-FS-SlugControl

Consider placing baits with the seed when sowing when black keeled slugs are present.

For grey field slugs, broadcasting baits is more effective.

Predators may provide some regulation of slug populations. The carabid or ground beetle, *Notonomus gravis*, reduces grey field slug numbers but not below damage thresholds.[72 73 74 75 76]

72 M Nash, H Brier, P Horne, J Page, S Micic, G Ash, A Wang (2013) Slug control: Slug identification and management Fact Sheet. Grains Research and Development Corporation, www.grdc.com.au/GRDC-FS-SlugControl

73 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

74 M Nash, M Richards, H De Graff, G Baker (2016) New insights into slug and snail control. GRDC Update Paper, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/New-insights-into-slug-and-snail-control GRDC (2014) Slugging Slugs: findings from recent GRDC High Rainfall Zone (HRZ) trials. Grains Research and Development Corporation, https://grdc.com.au/Media-Centre/Hot-Topics/Slugging-slugs/Details

75 GRDC (2014) Slugging Slugs: findings from recent GRDC High Rainfall Zone (HRZ) trials. Grains Research and Development Corporation, https://grdc.com.au/Media-Centre/Hot-Topics/Slugging-slugs/Details

76 M Nash (2013) Slug control – new insight. GRDC Update paper. https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Slug-control-new-insights

MORE INFORMATION

GRDC Fact Sheet: Aphids and viruses in pulse crops, www.grdc.com.au/GRDC-FS-AphidsandVirusesinPulses

IPM guidelines for grains website: http://ipmguidelinesforgrains.com.au/

8.3.4 Aphids

Aphids are a pest of faba bean chiefly because they spread viruses during feeding, which can reduce crop yields, especially when infection is extensive in early crop stages. A few aphids can cause substantial damage if they are spreading viruses, especially early in the season.

It takes large numbers of aphids to damage crops by direct feeding. This happens in hot spots, where aphids are concentrated at the growing tips of plants, causing wilting stunting and, sometimes, tip death.

Aphids and virus transmission

Viruses are a problem in faba bean crops in some seasons. Viruses such as Pea seed-borne mosaic (PSbMV), Bean leaf roll virus (BLRV) and Beet western yellows virus (BWYV) are not seed-transmitted but become established after aphid-vector activity.

Different aphid species transmit different viruses to particular crop types; species identification is important because management strategies can vary.

Aphids, and the viruses they spread, have alternative hosts between growing seasons. Summer rain and early autumn breaks favour the early build-up in aphids, as well as the volunteer plants that host viruses. It is important to use integrated management practices to control aphid populations early in the season.

Aphids can spread viruses persistently or non-persistently (Table 5). Once an aphid has picked up a persistently transmitted virus, it carries the virus for life, infecting every plant where it feeds. Aphids carrying non-persistently transmitted viruses, carry the virus temporarily and only infect new plants in the first one or two probes.

For more information on viruses, refer to Section 9 Diseases.

Table 5: Examples of transmission of some persistent and non-persistent viruses by four aphid species affecting pulse crops.[77]

Aphid	Cucumber mosaic virus (CMV)	Pea seed-borne mosaic virus (PSbMV)	Beet western yellows virus (BWYV)
	non-persistent	non-persistent	persistent
Green peach aphid	Yes	Yes	Yes
Pea aphid	Yes	Yes	No
Cowpea aphid	Yes	Yes	Yes
Bluegreen aphid	Yes	No	No

Source: Pulse Australia (2016) Faba bean: integrated disease management. Australian Pulse Bulletin. Pulse Australia, www.pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/idm-strategies

Persistent viruses can be transmitted while visiting faba bean crops, so it is important to protect crops against aphid invading from surrounding areas.[78 79 80]

77 GRDC (2010) Aphids and viruses in pulse crops. Fact Sheet. Grains Research and Development Corporation, www.grdc.com.au/GRDC-FS-AphidsandVirusesinPulses

78 GRDC (2014) Northern faba bean GrowNotes™. https://grdc.com.au/Resources/GrowNotes™

79 GRDC (2010) Aphids and viruses in pulse crops, Fact Sheet. Grains Research and Development Corporation, www.grdc.com.au/GRDC-FS-AphidsandVirusesinPulses

80 Pulse Australia (2016) Faba bean: integrated disease management, Australian Pulse Bulletin, 15 January 2016, Pulse Australia, www.pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/idm-strategies

MORE INFORMATION

PestNotes Southern has more details on cowpea aphids, please see http://www.pir.sa.gov.au/__data/assets/pdf_file/0003/275826/Cowpea_Aphid.pdf

Cowpea aphid (*Aphis craccivora*)

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

Cowpea aphid is the only black aphid. All stages have black and white legs. Adults are shiny black, up to 2.5 mm long and may have wings. Nymphs are slate grey.

Superficially, nymphs of the brown smudge bug look like cowpea aphid nymphs.

Photo 17: *Cowpea aphids can transmit a number of viruses to faba bean crops. Note the different aphid ages: the older aphids are shiny black. The white cast is a skin, shed as the aphid grows.*

Photo: SARDI.

Photo 18: *Cowpea aphid colony damaging a faba bean plant.*

Photo: Gordon Cumming, formerly Pulse Australia

FEEDBACK

The cowpea aphid is the most common species to infest faba bean. Before they colonise a faba bean crop, cowpea aphids can transmit viruses (Table 6).

Table 6: Some persistent and non-persistent viruses spread by cowpea aphid that affect faba bean. This list is not exhaustive and the viruses may be spread by other aphid species.

Persistent	Non-persistent
Bean leaf roll virus (BLRV)	Pea seed-borne mosaic virus (PSbMV)
Sub clover red leaf virus (SCRLV)	Bean yellow mosaic virus (BYMV)
Sub clover stunt virus (SCSV)	Cucumber mosaic virus (CMV)
Beet western yellows virus (BWYV)	Alfalfa mosaic virus (AMV)

Source: Southern Faba Bean Best Management Practices Training Course Manual, (2016), Pulse Australia

A cowpea aphid infestation is generally patchy at first but will spread through the crop if the weather is fine and warm.

Infestations start when winged females colonise a few plants in a crop and give birth to wingless nymphs that live in colonies. This may occur from early winter onwards. As the plant deteriorates, the aphids move to neighbouring plants, increasing the area of infested patches within the crop.[81 82 83]

MORE INFORMATION

Details on bluegreen aphids can be found in PestNotes Southern, please see http://www.pir.sa.gov.au/__data/assets/pdf_file/0011/275492/Bluegreen_Aphid.pdf

Bluegreen aphid (*Acyrthosiphon kondoi*)

Adult bluegreen aphids grow up to 3 mm, may have wings and vary from matte blue-green to grey-green. They are oval, with long legs and antennae. They have two large cornicles (tubes) that extend beyond the base of the abdomen. Nymphs are similar to adults but smaller.

Photo 19: *Bluegreen aphid.*

Photo: Grain Legume Handbook

81 P Umina, S Hangartner (2015) Cowpea aphid, Pest Notes Southern, cesar and the South Australian Research and Development Institute, www.pir.sa.gov.au/__data/assets/pdf_file/0003/275826/Cowpea_Aphid.pdf

82 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

83 T Yeatman, W Hawthorne, J Paull, J Bellati, J Egan, K Henry, R Kimber, M Seymour, J van Leur, K Lindbeck, P Matthews, I Rose (2009) Faba Beans: The Ute Guide. Primary Industries and Resources South Australia, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide/

Photo 20: *Bluegreen aphids of various ages. The brown insects are dead bluegreen aphids which have been parasitised by wasps.*

Photo: Grain Legume Handbook

Bluegreen aphids can colonise faba bean plants and transmit important viruses including the non-persistent viruses Cucumber mosaic virus (CMV) and Bean yellow mosaic virus (BYMV).

Bluegreen aphids do not transmit Pea seed-borne mosaic virus (PSbMV).

Bluegreen aphids cause feeding damage to upper leaves, stems and terminal buds of host plants. Heavy infestations can cause damage to plants by direct removal of nutrients. In general, aphids have the greatest impact on crops when soil moisture is limited.

Bluegreen aphids prefer cooler weather (10°C–18°C) for breeding. Females produce **up to 100 young at a rate of approximately 7 per day**. Winged aphids develop when infestations become crowded; they fly or are blown by wind to start new infestations elsewhere.

Natural enemies are: hoverfly larvae, aphid parasites, green lacewing larvae, brown lacewing, ladybirds.[84 85 86]

Monitoring aphids

Aphids invade faba bean crops from adjacent crops and pastures.

The literature varies in recommendations for aphid monitoring early in the season.

One method is to inspect faba bean crops and sample leaves for winged aphids from early winter onwards. A second source encourages monitoring faba bean and surrounding crops and pastures at all crop stages, including frequent monitoring of seedlings and establishing plants to detect rapid increases of aphid populations.

In contrast, other literature states that the early monitoring of aphids in faba bean crops for virus control has limited benefits. This is firstly because non-colonising aphids may be found. Secondly, even when colonising aphids are found, the virus may have already spread by the time they are observed.

In spring and early summer, inspect faba bean crops for aphid colonies Monitor crops and neighbouring areas regularly and identify the species of aphid present and their numbers.

Branch samples may give useful estimates of aphid density for bluegreen aphid.

84 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia

85 T Yeatman, W Hawthorne, J Paull, J Bellati, J Egan, K Henry, R Kimber, M Seymour, J van Leur, K Lindbeck, P Matthews, I Rose (2009) Faba Beans: The Ute Guide. Primary Industries and Resources South Australia, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide/

86 P Umina, W Kimber (2015) Bluegreen aphid, Pest Notes Southern. cesar and the South Australian Research and Development Institute, http://www.pir.sa.gov.au/__data/assets/pdf_file/0011/275492/Bluegreen_Aphid.pdf

VIDEO

For more information of insecticide resistance and management of green peach aphid and TuYV (formerly BWYV), watch: www.youtube.com/watch?v=1MIRtsfydkc

Sticky traps might assist in identifying early aphid activity, as well as the presence of beneficial insects including hoverflies, lacewings, ladybirds and parasitic wasps. These species will attack aphids.

Beneficial insects can help reduce virus spread and spring feeding damage, but some virus spread will have occurred before aphid numbers subside.

Aphid control for viruses

Control the aphids if virus spread and direct feeding damage is of concern.

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

While no specific thresholds are available for cowpea aphid, in the southern region growers are encouraged to treat low levels of cowpea aphids in faba bean to prevent virus transmission early in the season.

Monitor faba bean and surrounding crops and pastures from early winter, and spray if plants with cowpea aphid can be found easily.

Use an integrated management approach to reduce the risk of virus transmission by aphids. **Particular attention must be paid to pests that develop resistance to available pesticides, such as green peach aphid.**[87]

The best protection against aphid infestation and virus spread in faba bean is to preventing aphids landing in the crop.

While beneficial insects can help reduce virus spread (and spring feeding damage), some virus spread will have occurred before aphid numbers subside.

The risk of non-persistently transmitted viruses can be reduced before sowing using a range of management measures, as follows:

- Eliminate summer weeds and volunteer pulses (the 'green bridge') that host viruses and provide refuge for aphids.
- Monitoring in nearby crops and pastures early in the season.
- Sow directly into cereal stubbles, (preferably standing) and encourage rapid canopy cover through early planting and high planting density as bare soil is more attractive to some aphid species. Minimum-tillage with inter-row sowing is ideal to discourage aphid landings.
- Consider using seed-applied insecticide dressings; Gaucho 600 Red Flowable® is now registered and when applied as seed treatment will help protect faba bean seedlings from early season aphid attack and reduce spread of the persistently transmitted viruses BLRV and BWYV early in the season, as well as Subterranean clover red leaf virus (SCRLV), Subterranean clover stunt virus (SCSV) and Beet western yellows virus (BWYV).
- Possibly use foliar insecticides soon after crop emergence to help control persistently transmitted viruses. These are of little benefit against non-persistently transmitted viruses. A prophylactic insecticide spray is not desirable. Several insecticides for aphid control are highly toxic to bees and should not be applied while bees are foraging or pollinating faba beans.
- Possibly use an aphicide to reduce aphid numbers; e.g. pirimicarb targets aphids but leaves beneficial insects unharmed. Pirimicarb is registered for faba bean in Victoria and Tasmania.
- Rotate pulse crops with cereals to reduce virus and vector sources and, where possible, avoid close proximity to perennial pastures (such as lucerne) or other crops that host viruses and aphid vectors.
- Purchase virus-tested seed or have farmer seed virus-tested. Sow tested seed with less than 0.1% virus infection.

87 J Kirkegaard (2017) Opportunities and challenges for continuous cropping systems. GRDC Update Paper, https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2017/02/opportunities-and-challenges-for-continuous-cropping-systems

Foliar application of synthetic pyrethroids (SP) for aphids is under debate. It is recommended to prevent BLRV transmission by preventing early colonising of crops by pea aphids. However, discouraging colonisation may increase the spread of aphids and, potentially, virus through a crop.

Synthetic pyrethroid (SP) insecticides should not be used to control green peach aphid, an important vector of BWYV, as most populations are resistant to SPs.

A commonly used insecticide registered for use on bluegreen aphid is shown in Table 7 with details in Table 8 (see Section 8.8 Registered insecticides, commonly used).

Pulse Breeding Australia (PBA) is increasing its emphasis on developing pulse crop lines with increased virus resistance. Faba bean lines with resistance to BLRV and field pea with resistance to BLRV and PSbMV have been identified and should be commercially available in the future.

Aphid control for direct feeding damage

Limited threshold information on aphid numbers is available, to determine whether it is economically worthwhile to apply insecticides to prevent damage caused by feeding.

For bluegreen aphid, the economic control threshold in faba bean in Victoria is 10% of plants infested.

When determining economic thresholds for aphids, it is critical to consider several other factors before making a decision. The availability of moisture and the incidence of predators and parasitoids will affect the decision to control aphids. 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.

When damage is evident, it may be necessary to control bluegreen aphid. Faba bean suffers some mechanical damage from this pest.

For bluegreen aphid, spray with insecticide only where damage to growing points is obvious. Broad-spectrum insecticides should be avoided to assist with conservation of natural enemies.

If bluegreen aphid is the predominant pest, use insecticides that do not kill aphid parasites and predators; for mixed infestations, systemic chemicals that control aphids and mites should be used.

Routine spraying of SP insecticides should be avoided as repeated applications of these insecticides can result in resistance developing in other aphid species and will also kill many natural insect predators.

A border spray can provide sufficient control earlier in the season when aphids move into crop edges.

A 'soft' insecticide such as pirimicarb is an option for controlling direct feeding damage when aphid populations are increasing.[88 89 90 91 92 93]

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88 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

89 GRDC (2014) Northern faba bean GrowNotes™. https://grdc.com.au/Resources/GrowNotes

90 GRDC (2010) Aphids and viruses in pulse crops, Fact Sheet. Grains Research and Development Corporation, www.grdc.com.au/GRDC-FS-AphidsandVirusesinPulses

91 P Umina, W Kimber (2015) Bluegreen aphid, Pest Notes Southern. cesar and the South Australian Research and Development Institute, http://www.pir.sa.gov.au/__data/assets/pdf_file/0011/275492/Bluegreen_Aphid.pdf

92 Pulse Australia (2015) Managing viruses in pulses. Australian Pulse Bulletin, 20 November 2015, Pulse Australia, www.pulseaus.com.au/growing-pulses/publications/manage-viruses

93 T Yeatman, W Hawthorne, J Paull, J Bellati, J Egan, K Henry, R Kimber, M Seymour, J van Leur, K Lindbeck, P Matthews, I Rose (2009) Faba Beans: The Ute Guide. Primary Industries and Resources South Australia, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide/

8.4 Other pests of faba bean

A range of other pests are also potentially major pests in some pulses, including faba bean. These should not be ignored in crop monitoring and management of faba bean.

Pests like lucerne flea compete for food and resources with other agricultural pests such as redlegged earth mite and blue oat mite. Control strategies that only target one species may not necessarily reduce the overall pest pressure because other pests can fill any gaps. It is important to assess the complex of pests before deciding on the most appropriate control strategy.

To avoid developing multiple pesticide resistance, rotate chemical classes across generations rather than within a generation of a pest.[94]

8.4.1 Redlegged earth mite (*Halotydeus destructor*)

RLEM identification

Redlegged earthmites (RLEM) are active from autumn to late spring and are found in southern Australia.

Adults and nymphs of RLEM have a 'velvety' black body. Adult RLEM are 1 mm long with eight red-orange legs. Newly hatched mites are only 0.2 mm long and pinkish-orange with only six legs.[95 96]

Photo 21: *Redlegged earth mite (RLEM) close up.*

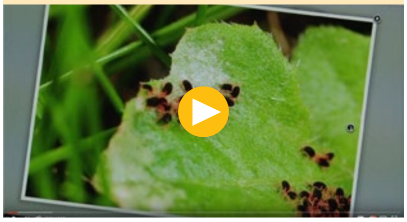
Photo: Grain Legume Handbook

MORE INFORMATION

For more information on redlegged earthmites, please see the Agnote, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/pest-insects-and-mites/redlegged-earth-mite

VIDEO

Or watch GRDC (2012) GCTV9: https://www.youtube.com/watch?v=tMnUVGOUXu8



94 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

95 GRDC (2013) Insect ID: The Ute Guide, iOs app, Version 1.1, 14 October 2013. https://grdc.com.au/Resources/Ute-Guides/Insects

96 T Yeatman, W Hawthorne, J Paull, J Bellati, J Egan, K Henry, R Kimber, M Seymour, J van Leur, K Lindbeck, P Matthews, I Rose (2009) Faba Beans: The Ute Guide. Primary Industries and Resources South Australia, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide/

Photo 22: *RLEM feeding causes leaves to first turn silvery, then brown and shrivelled, so that the plants look scorched.*

Photo: Grain Legume Handbook

RLEM damage

RLEM feed on the foliage for short periods and then move around. Other mites are attracted to compounds released from damaged leaves.

Typical RLEM damage appears as 'silvering' or 'whitening' of the attacked foliage. RLEM are most damaging to emerging crops, greatly reducing seedling survival and development.

In severe cases, entire crops may need re-sowing following RLEM attack. RLEM feed on a wide range of plant species.[97]

Photo 23: *RLEM damage on a faba bean seedling.*

Photo: Wayne Hawthorne, formerly Pulse Australia

97 P Umina (2007) Redlegged earthmite. Agnote AG0414, January 2007, Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/pest-insects-and-mites/redlegged-earth-mite

Photo 24: *Damage to a faba bean crop from RLEM spreading from an adjacent pasture.*

Photo: Wayne Hawthorne, formerly Pulse Australia

RLEM life cycle

RLEM are usually active between April and November. During this period, RLEM may pass through 2–3 generations, with each generation surviving 6–8 weeks. Long, wet springs favour the production of over-summering eggs.

Autumn rains trigger hatching in 3–9 days. False autumn breaks can cause large losses in mite numbers. Mites take 20–25 days from hatching to mature and start laying eggs.

RLEM monitoring

Inspect faba bean crops from autumn to spring for mites and their damage, particularly in the first few weeks after sowing.

Mites feed on the leaves in the morning or on overcast days. In the warmer part of the day RLEM tend to gather at the base of plants, sheltering in leaf sheaths and under debris. They crawl into cracks in the soil to avoid heat and cold. When disturbed during feeding they will drop to the ground and seek shelter.

RLEM control and insecticide resistance management

Control strategies that only target RLEM may not entirely remove pest pressure. Other pests can fill the gap, and this is particularly evident after chemical applications, which are generally more effective against RLEM than other mite pests.

Non-chemical options are becoming increasingly important due to evidence of resistance in RLEM populations and concern about long-term sustainability. If using a chemical spray, choose one that has least environmental impact and aim to reduce the number of chemical applications. Pesticide groups exist with low to moderate impacts on many natural enemies, such as cyclodienes.

Insecticide resistance in RLEM is presently confined to Western Australia. High levels of resistance to pyrethroids exist within WA populations. Resistance to organophosphates has also evolved. A strategy to manage insecticide resistance in RLEM populations is available for use by grain growers and their advisers.

Chemical control of RLEM

While insecticides are registered for control of active RLEM, none currently registered are effective against RLEM eggs. Commonly used insecticides registered for use on RLEM are shown in Section 8.8 Registered insecticides, commonly used.

Four chemical sub-groups are registered to control RLEM in grain crops: organophosphates (Group 1B); synthetic pyrethroids (Group 3A); phenylpyrazoles

MORE INFORMATION

GRDC Fact Sheet: Resistance management strategy for the redlegged earth mite, https://grdc.com.au/FS-RLEM-Resistance-strategy-South

(Group 2B); and neonicotinoids (Group 4A). The latter two are registered only for use as seed treatments.

If spraying in autumn, control the first generation of mites before they lay eggs. Pesticides used at or after sowing should be applied within three weeks of the first appearance of mites, before adults begin to lay eggs. Rotate products with different modes of action, to reduce the risk of insecticide resistance.

Autumn insecticide application includes:

- Pesticides with persistent residual activity used as bare earth treatments to protect seedlings.
- Foliage sprays applied after crop emergence, which and are generally an effective control.
- Systemic pesticides applied as seed dressings, which act by maintaining the pesticide at toxic levels within the seedling. Note, if mite numbers are high, plants may suffer significant damage before the pesticide has much effect.

A correctly timed spray in spring can reduce populations of RLEM the following autumn. Use climatic variables, and tools such as Timerite® to determine the optimum date for spraying. While Timerite® has less relevance in pulse cropping, it has an important role in pastures and RLEM population management. Research in southern Australia has shown the use of a Timerite® spring spray effective in reducing RLEM populations by 93%.

Users need to be mindful of its limitations and the issues around repeated insecticide applications according to this approach.

Spring RLEM sprays will generally not be effective against other pest mites.

MORE INFORMATION

Details on Timerite® can be found at https://www.wool.com/globalassets/start/woolgrower-tools/timerite/timeriteinformationpackage.pdf

Biological control of RLEM

At least 19 predators and one pathogen are known to attack earthmites in eastern Australia, particularly other mites, although small beetles, spiders and ants also play a role. Benefits of a predatory mite (*Anystis wallacei*) that has been released are yet to be demonstrated.

Natural enemies of RLEM residing in windbreaks and roadside vegetation need to be protected also, so avoid pesticides with residual activity applied as border sprays to prevent mites moving into a crop or pasture.

Cultural control of RLEM

Cultural control measures include:

- rotating crops or pastures with non-host crops, such as cereals;
- cultivating, which can also help reduce RLEM populations;
- clean fallowing and controlling weeds around crop and pasture perimeters; and
- controlling weeds, especially thistles and capeweed, to remove breeding sites for RLEM.[98 99 100 101 102]

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98 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

99 P Umina (2007) Redlegged earthmite. Agnote AG0414, January 2007, Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/pest-insects-and-mites/redlegged-earth-mite

100 GRDC (2016) Resistance management strategy for the redlegged earth mite in Australian grains and pastures in New South Wales, South Australia, Tasmania and Victoria, Fact Sheet.. Grains Research and Development Corporation, https://grdc.com.au/FS-RLEM-Resistance-strategy-South

101 T Yeatman, W Hawthorne, J Paull, J Bellati, J Egan, K Henry, R Kimber, M Seymour, J van Leur, K Lindbeck, P Matthews, I Rose (2009) Faba Beans: The Ute Guide. Primary Industries and Resources South Australia, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide/

102 TJ Ridsdill-Smith, C Pavri (2015) Controlling redlegged earth mite, Halotydeus destructor (Acari: Penthaleidae), with a spring spray in legume pastures. Crop and Pasture Sci., 66: 938–946.

8.4.2 Lucerne flea (*Sminthurus viridis*)

Lucerne flea is mostly found on loam or clay soils and can damage a wide range of crops.

Lucerne flea identification

Lucerne flea springs off plants when disturbed. It is yellow-green and may have dark markings. Adults are plump and wingless and approximately 2–3 mm long, often with mottled darker patches over the body. Newly hatched nymphs are pale yellow and 0.5–0.75 mm long, and resemble adults as they grow, but are smaller.

The lucerne flea is a springtail; this group has six or fewer abdominal segments and a forked tubular appendage 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.

Photo 25: *Lucerne flea with eggs. Adults are yellow-green and may have black or brown markings.*

Photo: Grain Legume Handbook

Lucerne flea damage

Faba bean is susceptible to lucerne flea, in contrast to chickpea. In addition to pulses, the insect can damage pastures, lucerne, oilseeds and cereals.

Lucerne flea is present in autumn to spring. Crops are most susceptible to damage immediately following seedling emergence. Numbers tend to peak in spring.

Although a serious pest of young crops, lucerne flea can also damage older crops. They move up plants from the soil level, leaving a distinctive transparent 'window' on leaves. A severe infestation may remove all green material.[103 104 105]

103 D Hopkins, M Miles (1998) Insects: the Ute Guide, Southern Region. Primary Industries and Resources SA.

104 T Yeatman, W Hawthorne, J Paull, J Bellati, J Egan, K Henry, R Kimber, M Seymour, J van Leur, K Lindbeck, P Matthews, I Rose (2009) Faba Beans: The Ute Guide. Primary Industries and Resources South Australia, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide/

105 www.cesaraustralia.com/sustainable-agriculture/identify-an-insect/

Photo 26: *Leaf damage caused by lucerne flea feeding, resulting in a distinctive transparent 'window' appearance.*

Photo: Grain Legume Handbook

Lucerne flea life cycle

They are favoured by high humidity and moisture, a mild autumn and winter.

Long wet springs favour lucerne flea, often causing more serious outbreaks in the following autumn. It requires cool, moist conditions.

Lucerne flea will produce up to five generations in most years. Activity stops in late spring when dry conditions lead to the production of over-summering eggs by the final generation of females.

Over-summering eggs hatch the following autumn, usually soon after opening rains in southern Australia, when the right combination of temperature and moisture occurs.

Monitoring

Regularly monitor for damage from autumn to spring. Importantly, faba bean crops should be inspected frequently at emergence and during establishment, when they are most susceptible to damage.

Lucerne flea is often concentrated in localised patches or 'hot spots' so it is important to have a good spread of monitoring sites within each paddock.

Examine foliage for the characteristic damage and check the soil surface, where insects may be sheltering. Monitoring usually involves working on hands and knees.

Monitoring lucerne flea populations for growth stage as well as numbers can also be important for accurate timing of some sprays.

Chemical control of lucerne flea

In southern Australia, lucerne flea hatching starts after the first significant autumn rain. If damage warrants control, treat the infested area with an insecticide 3 weeks after lucerne flea first emerges. This will allow for the further hatching of over-summering eggs but will be before they reach maturity and begin to lay winter eggs

While insecticides provide the most effective means of control, lucerne flea has a high natural tolerance to synthetic pyrethroids and should not be treated with this class of insecticide. In paddocks where damage is likely, a border spray may be sufficient to prevent movement of lucerne flea into the crop from neighbouring paddocks. Lucerne flea is often patchily distributed within crops, so spot spraying may be sufficient. Do not blanket spray unless the infestation warrants it.

Control lucerne flea control in the paddock in the season before sowing susceptible crops like faba bean. Spring spraying can reduce the number of insects in the following autumn by preventing the laying over-summering eggs. A planned program of timely spring and autumn sprays with effective chemicals over 2–3 years can reduce populations to very low levels.

There are no formal spray thresholds for lucerne flea damage in crops. However, the key is early control because of the impact of seedling vigour on crop performance. Damage levels can be used to determine whether or not spraying is necessary.

It is important to assess the complex of pests present before deciding on the most appropriate control strategy.

When both lucerne flea and redlegged earth mite are present, control strategies should consider both pests.

Avoid 'insurance sprays' where insecticide is added to other sprays just in case an outbreak occurs. Spray decisions should be based on monitoring of the pest numbers across several weeks, and where an increase in numbers can be seen causing crop damage. If numbers are static or declining, it can mean that natural enemies are having an effect on the pest population. Overuse of chemicals when pest numbers are low or not causing economic damage will select for insecticide resistance in the long term. Timing sprays to have the most impact and rotating insecticide groups will help to avoid resistance developing.

Spray immature lucerne fleas before they have a chance to reproduce. Organophosphates (OPs) are recommended for lucerne flea and *Bryobia* mite control.

If spraying, use an organophosphate insecticide, e.g. omethoate. A border spray may be sufficient to stop invasion from neighbouring pastures or crops. Spot spraying, rather than blanket spraying, may be all that is required.

If warranted, treat the infested area approximately 3 weeks after lucerne flea has been observed on a newly emerged crop. This will allow for the further hatching of over-summering eggs but will be before lucerne flea reaches maturity and begins to lay winter eggs.

Biological and cultural control of lucerne flea

Several predatory mites, for example, snout mites, various ground beetles and spiders prey on lucerne flea.

Clean fallows and control of weeds within crops and around pasture perimeters, especially of capeweed, helps reduce lucerne flea numbers.

Cultivation using trap, border crops and mixed cropping can help reduce the overall infestation levels, particularly when used in conjunction with other measures. Grasses and cereals are less favourable to lucerne flea and as such can be useful for crop borders.[106 107 108 109]

106 www.cesaraustralia.com/sustainable-agriculture/identify-an-insect/

107 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

108 T Yeatman, W Hawthorne, J Paull, J Bellati, J Egan, K Henry, R Kimber, M Seymour, J van Leur, K Lindbeck, P Matthews, I Rose (2009) Faba Beans: The Ute Guide. Primary Industries and Resources South Australia, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide/

109 G Jennings (2002) Knowledge, timing, key to lucerne flea control. Grains Research Advice, November 2002, Grains Research and Development Corporation,

FEEDBACK

MORE INFORMATION

More information on Blue oat mite, please see PestNotes Southern at http://www.pir.sa.gov.au/__data/assets/pdf_file/0004/274090/Blue_oat_mite.pdf

8.4.3 Blue oat mite (*Penthaleus* spp.)

Blue oat mite identification

Adult blue oat mites (BOM) are 1 mm long, with eight red-orange legs. They have a dark blue-black body with an oval red/orange spot on their back, which distinguished them from redlegged earthmite (RLEM). Mites generally feed singularly. They share similar life cycles with RLEM.

Three pest species of BOM exist in Australia, which complicates identification and control. These are *Penthaleus major*, *P. falcatus* and *P. tectus*.

Photo 27: *Blue oat mite has a blue-black or deep purple body with a distinct red to orange spot on its back, which distinguishes it from redlegged earth mite.*

Photo: Gordon Cumming, formerly Pulse Australia

Blue oat mite damage

The BOM species are predicted to be found on faba bean and cause feeding damage, although this has not been researched to date. Blue oat mite attack most crops and pastures, but cereals, canola and lucerne are most susceptible.

Blue oat mite life cycle

BOM are active from April to late October, and over-summer as eggs. Autumn rains trigger hatching within 3–9 days. False breaks in the season can cause large losses in mite numbers. Mites take 20–25 days from hatching to mature and start laying eggs.

Blue oat mite monitoring

It is important to monitor germinating pulse crops. Check paddocks before sowing in autumn and throughout winter.

Examine plants for damage and search for mites on leaves and the ground, especially in late-sown crops.

BOM spend most of their time on the soil surface, rather than on the foliage. They are most active during the cooler parts of the day, feeding in the mornings and in cloudy weather. They seek protection during the warmer part of the day on moist soil surfaces or under foliage, and may even dig into the soil under extreme conditions.

Chemical control

Each species differ in their distribution, pesticide tolerance and crop plant preferences. BOM is often misidentified as RLEM but some BOM species are more tolerant than RLEM to a range of synthetic pyrethroid and organophosphate insecticides.

All current pesticides are only effective against the active stages of mites, and do not kill mite eggs. Commonly used insecticides registered for use on BOM are shown in Table 7 with details in Table 8. See Section 8.8 Registered insecticides, commonly used.

P. falcatus has a high natural tolerance to a range of pesticides registered for use against earth mites. The other BOM species have a lower level of tolerance to pesticides and are generally easier to control with chemicals.

Control first generation mites before they can lay eggs to avoid a second spray. Pesticides used at or after sowing should be applied within 3 weeks of first appearance of mites, as adults will then begin laying eggs.

Spraying in spring is not a recommended strategy with BOM.

Pesticides with persistent residual effects can be used as bare-earth treatments. If applied by sowing, these treatments can protect the plants throughout their seedling stage.

Systemic pesticides applied as seed dressings can help minimise crop damage during establishment, however, if mite numbers are high, significant damage may still occur before the pesticide has much effect. (No systemic pesticides are registered for use in faba bean.)

Biological & cultural control

A number of predator species are known to attack earth mites in Australia. Leaving shelterbelts or refuges between paddocks will help maintain natural enemy populations.

Preserving natural enemies when using chemicals is often difficult for growers because the pesticides generally used are broad spectrum and kill beneficial species with the pests.

Cultural controls such as rotating crops or pastures with non-host crops can reduce pest colonisation, reproduction and survival, decreasing the need for chemical control. Non-preferred crops are:

- *P. major* – canola;
- *P. tectus* – chickpea; and
- *P. falcatus* – wheat, barley.

Faba bean should be considered as vulnerable, and should not be considered a useful rotational crop to help control BOM species.

Pre- and post-sowing weed management (particularly broadleaf weeds) is important.[110] [111] [112] [113]

110 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

111 D Hopkins, M Miles (1998) Insects: the Ute Guide, Southern Region. Primary Industries and Resources SA.

112 T Yeatman, W Hawthorne, J Paull, J Bellati, J Egan, K Henry, R Kimber, M Seymour, J van Leur, K Lindbeck, P Matthews, I Rose (2009) Faba Beans: The Ute Guide. Primary Industries and Resources South Australia, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide/

113 P Umina, S Hangartner (2015) Blue oat mite, Pest Notes Southern. cesar and the South Australian Research and Development Institute, http://www.pir.sa.gov.au/__data/assets/pdf_file/0004/274090/Blue_oat_mite.pdf

FEEDBACK

MORE INFORMATION

GRDC Fact Sheet: Plague locust control, https://grdc.com.au/Resources/Factsheets/2010/08/Plague-Locust-Control-Factsheet

8.4.4 Australian plague locust (*Chortoicetes terminifera*)

Australian plague locust identification

Adults of the Australian plague locust have a characteristic black spot on the tip of the hind wing. Nymphs or hoppers are more difficult to identify. If swarming in a large band, then it is likely to be the Australian plague locust.

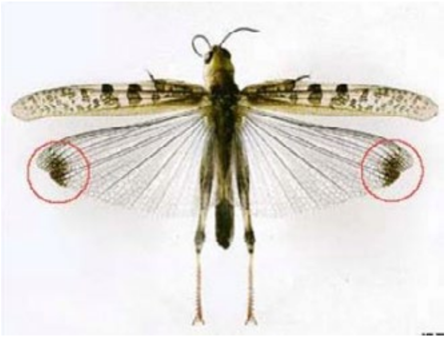

Photo 28: *Australian plague locust. Note the black spot at the tip of the hind wing.*

Photo: APLC via PIRSA

Australian plague locust damage

Locusts and grasshoppers will cause damage to faba bean in the same way that they will damage any green material when in plague numbers.

Faba bean seedlings may be less vulnerable in the stages compared with lupin and lentil but crops may still be significantly damaged.

Pulses are susceptible to attack while they remain green and susceptibility of drying pulse crops is unknown. Rejection at grain delivery can occur if adult locusts or parts of them are present in the sample, or objectionable stains and odours exist.

Australian plague locust life cycle

Most locust plagues originate in south-west Queensland and adjacent areas of South Australia, New South Wales and the Northern Territory. Populations develop following rainfall in this area.

With suitable conditions, autumn swarms may migrate 200–500 km into pastoral and adjacent agricultural areas. On arrival they lay millions of eggs in bare ground which can produce the spring outbreak.

Comprehensive details and government responses to plague locust threats can be found at the Australian Plague Locust Commission website (http://www.agriculture.gov.au/pests-diseases-weeds/locusts/about/australia).

Control

The Australian Plague Locust Commission (APLC) undertakes surveillance threat assessments, forecasting and control measures when locust populations in outbreak areas have the potential to cross into agricultural locations.

In the event of a plague, local government may undertake some spraying operations within their own area. Where significant problems are expected, government agencies may undertake large-scale control in pastoral and adjacent agricultural areas.

Effective locust suppression can only be achieved by landowners, local government and government agencies working cooperatively, together with ongoing APLC activities.

Cultivating egg beds will destroy the eggs. Use approved insecticides to target the bands of nymphs before they take flight. Advice on timings and chemicals can be obtained from state government departments or local chemical resellers. Often Australian Pesticides and Veterinary Medicines Authority (APVMA) Permits are required for chemical use.[114 115]

8.5 Occasional pests of faba bean

The pests listed below are seldom seen in faba bean crops, but have been known to occur over the years and under ideal conditions may occasionally represent an economic threat. See more specific publications for full details.[116,117]

8.5.1 Cutworms: Common cutworm or Bogong moth, black cutworm, brown or pink cutworm and herringbone cutworm (*Agrotis infusa*, *Agrotis ipsilon*, *Agrotis munda* and other *Agrotis* species)

Cutworm identification and life cycle

Cutworm larvae are hairless with dark heads and usually dark bodies. They live in the soil and grow to 50 mm long. They curl up and remain still if disturbed.

Female moths lay eggs in soil in lightly vegetated or bare areas. Larvae have six growth stages (instars).

Cutworm monitoring, damage and control

Cutworm is a sporadic emergence pest. It attacks all crops and pastures including faba bean and broad bean.

Large larvae (20–40 mm long) ringbark or cut off seedlings at ground level; the final sixth stage larvae eat 86% of food.

Check crops from emergence to establishment. Damage is often patchy. Larvae are usually just beneath the surface; check the base of healthy or recently damaged plants adjoining damaged, bare or thin areas.

Control by selective spraying. Treat affected patches with a standard insecticide (synthetic pyrethroid). Commonly used insecticides registered for use on cutworm are shown in Table 8 with details in Table 9. Section 8.8 Registered insecticides, commonly used.

Biological controls include a number of parasites, disease and spiders.

MORE INFORMATION

For more details on identification, see Insects: the Ute Guide.
https://grdc.com.au/Resources/Ute-Guides/Insects/Moths-butterflies-caterpillars/West/Cutworms-Bogong-Moth-Black-Cutworm-Pink-Cutworm-And-Herringbone-Cutworm

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114 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

115 GRDC (2010) Plague locust control: a coordinated approach to control plague locusts. Fact Sheet. September 2010, Grains Research and Development Corporation and Australian Plague Locust Commission, https://grdc.com.au/Resources/Factsheets/2010/08/Plague-Locust-Control-Factsheet

116 T Yeatman, W Hawthorne, J Paull, J Bellati, J Egan, K Henry, R Kimber, M Seymour, J van Leur, K Lindbeck, P Matthews, I Rose (2009) Faba Beans: The Ute Guide. Primary Industries and Resources South Australia, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide/

117 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia

Photo 29: *Cutworm damage to faba bean plant at soil level.*

Photo: Wayne Hawthorne, formerly Pulse Australia

8.5.2 Balaustium mite (*Balaustium medicagoense*)

Balaustium mite identification and life cycle

Correct identification is critical for control. *Balaustium* mite adults grow to 2 mm long, may be variable in colour but are mainly dark red to brown. They are slow moving and have characteristic short hairs covering the body. They also have a 'pad'-like structure on the forelegs. Newly hatched nymphs have six bright orange legs, while adults have eight red legs.

Balaustium mite activity is from March to November in a Mediterranean climate. The mite requires autumn rainfall for over-summered eggs to hatch.

Balaustium mite monitoring, damage and control

Check crops throughout the growing season, particularly in paddocks with a history of chemical treatments for redlegged earth mite (RLEM).

Most synthetic pyrethroids are not effective on *Balaustium*, lucerne flea or *Bryobia* mites.

(Also, there are no insecticides registered for *Balaustium* in pulses.)

Balaustium mite is also more tolerant of organophosphate insecticides than RLEM.

MORE INFORMATION

For more details on identification, see Insects: the Ute Guide, https://grdc.com.au/Resources/Ute-Guides/Insects/Mites/South/Balaustium-Mite

Crop Mites: The Back Pocket Guide https://grdc.com.au/resources-and-publications/all-publications/publications/2012/06/bpg-cropmites

8.5.3 Clover mite or Bryobia mite (*Bryobia* spp.)

Bryobia mite identification and life cycle

Adults are 0.75–1 mm long with pale orange legs with a dark grey-brown to fawn-orange body, which is oval and flattened. Their front legs are 1.5 times their body length. *Bryobia* mite leave distinct feeding trails.

Bryobia mite is highly active during warm conditions in autumn, spring and early summer. They are found in low numbers in winter when they are unlikely to cause problems. Summer rains followed by a warm autumn increases their survival.

Bryobia mite monitoring, damage and control

Control summer weeds early in paddocks to be cropped. Before sowing, look for damage and their presence on clover and *Brassica* weeds.

Monitor during crop establishment. Mites are difficult to find in wet conditions; check during the warmer part of the day.

MORE INFORMATION

For more details on identification, see Insects: the Ute Guide, https://grdc.com.au/Resources/Ute-Guides/Insects/Mites/South/Clover-Mite

MORE INFORMATION

For more details on identification, see Insects: the Ute Guide, https://grdc.com.au/Resources/Ute-Guides/Insects/Earwigs/South/European-Earwig-and-Native-Earwig

For information on management, see GRDC European earwigs Fact Sheet, https://grdc.com.au/Resources/Factsheets/2013/11/European-Earwigs-Fact-Sheet

For more details on identification, see Insects: the Ute Guide, https://grdc.com.au/Resources/Ute-Guides/Insects/Beetles-larvae/South/Mandalotus-Weevil

For more details on identification, see Insects: the Ute Guide, https://grdc.com.au/Resources/Ute-Guides/Insects/Thrips/South/Onion-Thrips-Plague-Thrips-and-Western-Flower-Thrips

Crop Weevils: The Back Pocket Guide https://grdc.com.au/resources-and-publications/all-publications/publications/2013/05/grdc-bpg-cropweevils

Spray only when necessary – avoid insurance sprays and rotate insecticide groups to reduce the risk of insecticide resistance. Faba bean is not a good break crop against *Bryobia* mite.

Most synthetic pyrethroids are not effective on *Bryobia* mites, lucerne flea or *Balaustium* (and there are no insecticides registered for *Balaustium* in pulses). Organophosphates are recommended for *Bryobia* mites and lucerne flea. Insecticide rate commonly used for redlegged earth mite are generally ineffective against *Bryobia* mite.

8.5.4 Other occasional pests of faba bean

Other occasional pests of faba bean are:

Earwigs

European earwig and native earwig (*Forficulina auricularia* and *Labidura truncata* plus other species)

Mandalotus weevil

(*Mandalotus* spp.)

Onion thrips, plague thrips, & western flower thrips

(*Thrips tabaci*, *Thrips imaginis* and *Frankliniella occidenttalis*)

Photo 30: *Thrip damage on the underside of faba bean leaves.*

Photo: Wayne Hawthorne, formerly Pulse Australia

Photo 31: *Thrip damage on the upper side of faba bean leaves.*

Photo: Wayne Hawthorne, formerly Pulse Australia

Brown pasture looper

(*Ciampa arietaria*)

Looper caterpillar

(*Chrysodiexis* spp.)

Bronze field beetle

(*Adelium brevicorne*)

False wireworm

(*Gonocephalum misellum*)

Onion seedling maggot

(*Delia platura*)

MORE INFORMATION

For more details on identification, see Insects: the Ute Guide, https://grdc.com.au/Resources/Ute-Guides/Insects/Moths-butterflies-caterpillars/South/Brown-Pasture-Looper

For more details on identification, see: Insects the Ute Guide. https://grdc.com.au/Resources/Ute-Guides/Insects/Moths-butterflies-caterpillars/South/Looper-Caterpillar

For more details on identification, see Insects: the Ute Guide, https://grdc.com.au/Resources/Ute-Guides/Insects/Beetles-larvae/South/Bronzed-Field-Beetle

For more details on identification, see Insects: the Ute Guide, https://grdc.com.au/Resources/Ute-Guides/Insects/Beetles-larvae/South/False-Wireworms

For more details on identification, see Insects: the Ute Guide, https://grdc.com.au/Resources/Ute-Guides/Insects/Flies/South/Onion-Maggot

MORE INFORMATION

Plant Heath Australia has a fact sheet on Exotic bruchids, please see http://www.planthealthaustralia.com.au/wp-content/uploads/2014/02/Exotic-Bruchids-FS.pdf

Plant Health Australia has produced a fact sheet on Exotic leafminers, see www.planthealthaustralia.com.au/wp-content/uploads/2014/02/Exotic-leaf-miners-FS-Grains.pdf

8.6 Exotic faba bean insects – biosecurity threats

8.6.1 Exotic seed beetles/bruchids (*Coleoptera*: Family: *Chrysomelidae*, sub-family: *Bruchinae*)

Seed beetles, also known as bruchids, are a group of relatively small beetles that attack ripe or ripening seeds, especially legumes. There are over 200 species of bruchids worldwide from several genera that are important primary pests with significant economic impact to pulses.

Several pest bruchid species occur in Australia, however, very few bruchid species in Australia attack faba bean. There is potential for other exotic bruchids that do attack faba bean being introduced and establishing in Australia. The host range for these may be quite specific, while other species can attack a wide range of pulse crops. Early detection of new bruchids in faba bean may have consequences across a range of crops.

The presence of damaged seed (round holes) in stored grain is an indication of bruchids. The general form of bruchids and their association with pulses make it unlikely to be confused with other beetle pests associated with stored product. It is suggested that any bruchids found in faba bean, in the field or in storage, should be sent in for further identification. **Call the Exotic Plant Pest Hotline, 1800 084 881**.

8.6.2 Exotic leafminers (*Diptera*: family *Agromyzidae*)

The Agromyzidae are a group of small flies whose larvae feed internally on living plant tissue, often as leaf and stem miners. Key exotic Agromyzid species for faba bean include the American serpentine leafminer (*Liriomyza trifolii*) and pea leafminers (*Chromatomyia horticola*, *Liriomyza huidobrensis*).

Leaf-mining (tunnelling) is the most obvious symptom that can be seen and surveyed for in the field. Leaf mining damage caused by exotic Agromyzidae species can be confused with native leaf miner species and moth larvae. Any suspect mining should be sent in for identification. **Call the Exotic Plant Pest Hotline, 1800 084 881**.

Control of *Liriomyza* is difficult. Economic impacts could be highly significant in most crops and across most cropping regions if eradication is not achieved.

MORE INFORMATION

See Beneficial Insects:The Back Pocket Guide for Southern and Western Regions https://grdc.com.au/resources-and-publications/all-publications/publications/2013/05/grdc-bpg-cropweevils

8.7 Beneficial species

All pest populations are regulated to some degree by the direct effects of other living organisms. Beneficial organisms include a range of wasps, flies, bugs, mites, lacewings, beetles and spiders that can reduce insect pest populations through predation and parasitisation. Virus and fungal diseases also provide control.

A wide range of beneficial organisms can be grouped into three categories:

- *Parasites* – organisms that feed on or in the body of another host. Most eventually kill their host and are free living as an adult (parasitoids) for example, aphid wasp parasites.
- *Predators* – mainly free-living insects that consume a large number of prey during their lifetime for example, shield bugs, lacewings, hoverflies, spiders, predatory mites and predatory beetles.
- *Insect diseases* – include bacterial, fungal and viral infections of insects.

Inappropriate use of an insecticide that reduces the number of beneficial species can result in a more rapid build-up of insect populations and reliance on further use of insecticide.

MORE INFORMATION

For more details and photographs of beneficial organisms in insect management see: CESAR website, http://www.cesaraustralia.com/sustainable-agriculture/identify-an-insect/

GRDC Insect ID: the Ute Guide, https://grdc.com.au/resources-and-publications/app

Faba beans: the Ute Guide, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/11/faba-beans-the-ute-guide

Integrated pest management (IPM) in its simplest form is a management strategy in which a variety of biological, chemical and cultural control practices are combined to provide stable, long-term pest control.[118]

Photo 32: *A pea aphid being consumed by the seven-spotted lady beetle (Coccinella septempunctata).*

Photo: Brad Stokes, University of Idaho

A list of some beneficial organisms is provided below.

Beetles

- Carabid beetle (*Notonomous gravis*), https://grdc.com.au/Resources/Ute-Guides/Insects/Predators/South/Carabid-Beetles
- Transverse ladybird and common ladybird, https://grdc.com.au/Resources/Ute-Guides/Insects/Predators/South/Predatory-Ladybird-Beetles-Transverse-Ladybird-Common-Spotted-Ladybird-Minute-TwoSpotted-Ladybird-And-Others

Bugs

- Damsel bug (Family: *Nabidae*), https://grdc.com.au/Resources/Ute-Guides/Insects/Predators/South/Damsel-Bug
- Assassin bug, https://grdc.com.au/Resources/Ute-Guides/Insects/Predators/South/Assassin-Bugs
- Glossy shield bug, https://grdc.com.au/Resources/Ute-Guides/Insects/Predators/South/Glossy-Shield-Bug
- Spined predatory shield bug (*Oechalia schellenbergii*), https://grdc.com.au/Resources/Ute-Guides/Insects/Predators/South/Spined-Predatory-Shield-Bug

Flies

- Hoverfly (Family: *Syrphidae*)
- Tachinid fly, https://grdc.com.au/Resources/Ute-Guides/Insects/Parasites/South/Tachinid-Calliphorid-and-Sarcophagid-Flies

Lacewings

- Green lacewing (Family: *Chrysopidae*), https://grdc.com.au/Resources/Ute-Guides/Insects/Predators/South/Green-Lacewings
- Brown lacewing (Family: Hemerobiidae), https://grdc.com.au/Resources/Ute-Guides/Insects/Predators/South/Brown-Lacewings

Mites

- Pasture snout mite (*Bdellodes lapidaria*), https://grdc.com.au/Resources/Ute-Guides/Insects/Predators/South/Snout-Mites-Pasture-Snout-Mite-And-Spiny-Snout-Mite
- French anystis mite, https://grdc.com.au/Resources/Ute-Guides/Insects/Predators/South/French-Anystis-Mite

118 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

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Caterpillar wasps

- Orange caterpillar parasite wasp, https://grdc.com.au/Resources/Ute-Guides/Insects/Parasites/South/Orange-Caterpillar-Parasite
- Two-toned caterpillar wasp
- Banded caterpillar wasp, https://grdc.com.au/Resources/Ute-Guides/Insects/Parasites/North/Banded-Caterpillar-Parasite
- *Telenomus* wasp and *Trichogramma* wasp, https://grdc.com.au/Resources/Ute-Guides/Insects/Parasites/South/Caterpillar-Egg-Parasites
- Orchid dupe, https://grdc.com.au/Resources/Ute-Guides/Insects/Parasites/South/Orchid-Dupe
- Braconid wasp (*Microplitis demolitor*), https://grdc.com.au/Resources/Ute-Guides/Insects/Parasites/North/Microplitis-demolitor

Aphid wasps

- *Aphidius ervi* and *Trioxys complanatus* wasps, https://grdc.com.au/Resources/Ute-Guides/Insects/Parasites/South/Aphid-Parasites

Spiders

Wolf spider (Family: *Lycosidae*)

Jumping spider (Family: *Salticidae*)

Insect diseases – viral & fungal

Bacillus thuringiensis (*Bt*)

Nuclear polyhedrosis virus (NPV)

FEEDBACK

8.8 Registered insecticides, commonly used

Table 7: Registered insecticides commonly used in pulse crops in Australia.[119] Adhere to registered rates and withholding periods.

Active ingredient Example trade name	Redlegged earth mite	Blue oat mite	Lucerne flea	Bluegreen aphid	Native budworm	Brown pasture looper	Cutworm	Locust	Withholding period (days)	
									Harvest	Grazing
alphacypermethrin DOMINEX®	NSW ACT Vic TAS SA WA	NSW ACT Vic TAS SA WA			NSW ACT Vic SA WA		NSW ACT Vic TAS SA WA	P	21	35
beta-cyfluthrin BULLDOCK®	All states				Qld NSW Vic SA WA				14	7
chlorpyrifos LORSBAN®	All states	NSW								2
cypermethrin SCUD®, SONIC®					NSW Vic TAS SA WA			P	21	35
deltamethrin DECIS® OPTIONS				All States			NSW WA		7	
dimethoate Various	Vic Tas SA		WA							14
endosulfan* Various	All states	NSW WA							Nil	49 days
esfenvalerate SUMI-ALPHA FLEX®	All states	All states			All states				14	2
gamma-cyhalothrin TROJAN®	NSW Vic Tas SA WA				Sth NSW, WA, Vic, SA			P	7	7
lambda-cyhalothrin KARATE® ZEON	NSW Vic Tas SA WA				NSW Vic SA WA			P	7	7
Maldison FYFANON®	All states									
omethoate LE-MAT®	NSW Vic Tas SA WA	Qld NSW								1
metarhizium anisopliae GREEN GUARD®								All states		

Source: Pulse Australia (2016) and updated by GRDC (2017)

Registered for use in the indicated states. (shaded cells)

* Endosulfan not permitted post-emergence in pulses.
P = Permit only so check if still applicable and which crops are listed on the permit.

119 Pulse Australia (2016) Agronomy. Southern Faba Bean Best Management Practices Training Course Manual 2016, Pulse Australia Limited.

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8.8.1 Comments on insecticides

Registrations and use details may differ between states. Always read the label for specific details and information on registration status and insects controlled. Check the APVMA website for labels (http://apvma.gov.au/).

Table 8: Comments on insecticides.

Insecticide & trade name	Remarks
alphacypermethrin DOMINEX®	Best results if sprayed at egg hatching of native budworm. Apply when damaging numbers first appear in the crop. Use higher rate if native budworm larvae are >10 mm. Use higher rate if native budworm are >20 mm for Fastac®. Can be used post-emergence for redlegged earth mite control in field pea.
beta-cyfluthrin BULLDOCK®	Use higher rate if native budworm larvae are >10 mm. Bulldock® Duo can also be mixed with mineral oil and applied at ULV rates.
chlorpyrifos LORSBAN®	Active against a wide range of insect pests. Not systemic. Rainfast within 4 hours. Toxic to fish.
cypermethrin SCUD®, SONIC®	Use higher rate if native budworm larvae are >10 mm. Control of larvae >20 mm is unreliable at this rate.
deltamethrin DECIS® OPTIONS	Apply as soon as infestation occurs. Use lower rates only when infestation is low and most larvae are <5 mm long. Longer larvae not readily controlled. Use higher rate for pea weevil under high infestation and for chickpea, faba bean and lentil.
dimethoate Various	Apply to the emerged crop, not to bare ground. Has contact and systemic activity. Rain within 24 hours may reduce effectiveness. Can also be used as a seed treatment at 150 ml in 1 L water/ 100 kg seed, but not mixed with rhizobia.
endosulfan* Various	For redlegged earth mite use 0.5 L/ha for broad area spraying of bare earth after sowing. Use 1 .0 L/ha for perimeter spray to prevent reinvasion. Do not use post-emergence on any crop.
esfenvalerate SUMI-ALPHA FLEX®	Use 130 ml/ha for native budworm larvae <10 mm, 200 ml/ha if 10–20 mm long and 330 ml/ha for >20 mm long.
gamma-cyhalothrin TROJAN®	For native budworm use higher rate if larvae are >10 mm or the crop is dense. Rainfast within 30 minutes. S5 poison schedule.
lambda-cyhalothrin KARATE® ZEON	For control of native budworm apply at hatching or soon after when the larvae are small. Use the higher rate if larvae are >10 mm or if the crop is dense.
omethoate LE-MAT®	Spray crop 2–5 weeks after opening rains and before serious damage occurs. Rainfast in 1 hour. Application in spring (according to Timerite®) will reduce redlegged earth mite the following year.
metarhizium anisopliae GREEN GUARD®	Biological control agent. Apply in 75–225 L/ha of water for best results when locusts and grasshoppers are at the nymph stage. Do not apply in gusty conditions with winds >8 m/sec or rainfall imminent in next 6 hours. Surfactant and oil required.

* Endosulfan not permitted post-emergence in pulses.

Source: Pulse Australia (2016) and updated by GRDC (2017)