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GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

FABA BEAN

SECTION 7

INSECT CONTROL

KEY INSECT PESTS OF FABA BEAN | OTHER INSECT PESTS | IDENTIFICATION RESOURCES ARE USEFUL FOR CHECKING WHETHER INSECTS ARE FRIEND OR FOE | THE PEST MANAGEMENT PROCESS | MONITORING FABA BEAN FOR INSECT PESTS | LEGAL CONSIDERATIONS FOR PESTICIDE USE | REGISTRATION | REFERENCES AND FURTHER READING

Insect control

Insect pest management in pulses is more than just chemical control. Correct identification of the pest or beneficial is critical. An integrated approach rather than a prophylactic approach is required. Insect pest management in faba beans lends itself to an integrated pest management (IPM) program because the crop hosts a wide range of beneficial insects throughout the growing season.

There are two key insect pests of faba beans in the northern grains region: *Helicoverpa* spp. (Figure 1), which cause yield loss and damage grain quality; and aphids (Figure 2), which are a pest chiefly because they spread viruses. Other pests occur in faba beans, but they are sporadic, minor of uncertain pest status. These include the green mirid, loopers, beet armyworm and podsucking bugs.

Figure 1: Helicoverpa *larva damaging a maturing pod.*

Photo: Melina Miles, QDAF

Figure 2: *Faba bean plant heavily infested with cowpea aphid.*

Photo: Melina Miles, QDAF

7.1 Key insect pests of faba bean

This section covers the incidence of insect pests in faba beans, and the period of crop susceptibility to damage from these pests (Table 1).

Table 1: *The incidence of insect pests in faba beans, and the period of crop susceptibility to damage from these pests. Present—present in crop but generally not damaging. Damaging—crop susceptible to damage and loss.*

Pest	Crop stage				
	Emergence/ seedling	Vegetative	Flowering	Podding	Grainfill
Blue oat mites	Damaging	Present	Present		
Cutworms	Damaging				
Slugs	Damaging	Damaging			
Aphids (virus vectors)	Transmission of virus	Damaging Transmission of virus	Present	Present	
Helicoverpa spp. Native budworm Cotton bollworm		Present	Damaging?	Damaging	Damaging
Loopers		Present	Present		
Beet armyworm	Damaging	Damaging			
Green mirid		Present	Present	Damaging?	Damaging?
Podsucking bugs			Present	Damaging?	Damaging?
Thrips	Present Damaging?	Present	Present	Damaging?	

Source: IPM guidelines, http://ipmguidelinesforgrains.com.au/crops/winter-pulses/faba-bean/

7.1.1 *Helicoverpa*

Helicoverpa armigera (cotton bollworm)

Helicoverpa punctigera (native budworm)

To manage *Helicoverpa* well, it is important to be able to sample and identify the different larval instars (very small, small, medium–large, large). Familiarity with these different life stages is critical to determining the likelihood of damage occurring and optimising timing of control.

There are two species of *Helicoverpa*, *Helicoverpa armigera* and *H. punctigera* that may occur in faba beans in the northern region. *H. armigera* is resistant to some insecticide groups (particularly the synthetic pyrethroids), whilst *H. punctigera* is susceptible to all products. While it is not always possible to do so, identifying which species is present, or knowing which predominate in your area, may help you avoid products that may not give good control. It will also help you plan to minimise selection pressure from overuse of key products, and avoid the rapid development of insecticide resistance. There are some tools that can help you make this determination.

CASE STUDY

Managing Helicoverpa in faba beans—an interim management strategy

To avoid incurring excessive damage caused by a failure to detect *Helicoverpa* in the crop before they cause damage (a sampling issue), or because the threshold is too high and more damage is done than is currently expected the following management strategy is suggested.

Start sampling for *Helicoverpa* when the crop starts flowering. Be aware of the limitations of both the beat sheet and sweep net in detecting low densities, and smaller larvae.

Use a visual sample to detect small larvae in the terminal leaves, buds and flowers before they reach medium size.

Aim to treat the crop before larvae reach medium larval size and are capable of damaging pods

Consider including a low rate of NPV (*Helicoverpa* virus) with fungicide applications to assist with the control of early instar larvae. Repeated applications of low rate NPV are likely to be more effective than single higher rate applications. (see Section 7.5.7 Control options for Helicoverpa in faba beans for discussion on NPV use in winter–spring). The use of NPV to suppress potentially damaging populations during flowering will have considerable benefits over the use of broad-spectrum insecticides (e.g. synthetic pyrethroids) by not disrupting bees (pollination) and natural enemies.

Identifying Helicoverpa

Determining which species of *Helicoverpa* are present in the crop is essential, principally because of the differing susceptibility of the two species to synthetic pyrethroids and carbamates.

Visual identification of the different species is sometimes possible from examination of larvae, however, it can be difficult and unreliable for small larvae about the size when control decisions have to be made. A hand lens, microscope or USB microscope is critical for examining small larvae.

Small *H. armigera* larvae (3rd instar) have a saddle on the fourth segment and *H. punctigera* do not (Figure 3). This is often difficult to see in the field and this method is not 100% accurate, but may be used as a guide.

In larger (5th and 6th instar) larvae, hair colour on the segment immediately behind the head is a good species indicator (Figure 4). These hairs are white for *H. armigera* and black for *H. punctigera*.

H. punctigera and *H. armigera* moths are distinguished by the presence of a pale patch in the hindwing of *H. armigera* (Figure 5).

Figure 3: *Medium* Helicoverpa armigera *(12 mm) showing the distinctive 'saddle' on fourth and fifth body segments (top), and* H. punctigera *without saddle (bottom).*

Figure 4: *Large* Helicoverpa punctigera *(left) and* H. armigera *(right) larvae showing the distinguishing dark and pale hairs behind their heads.*

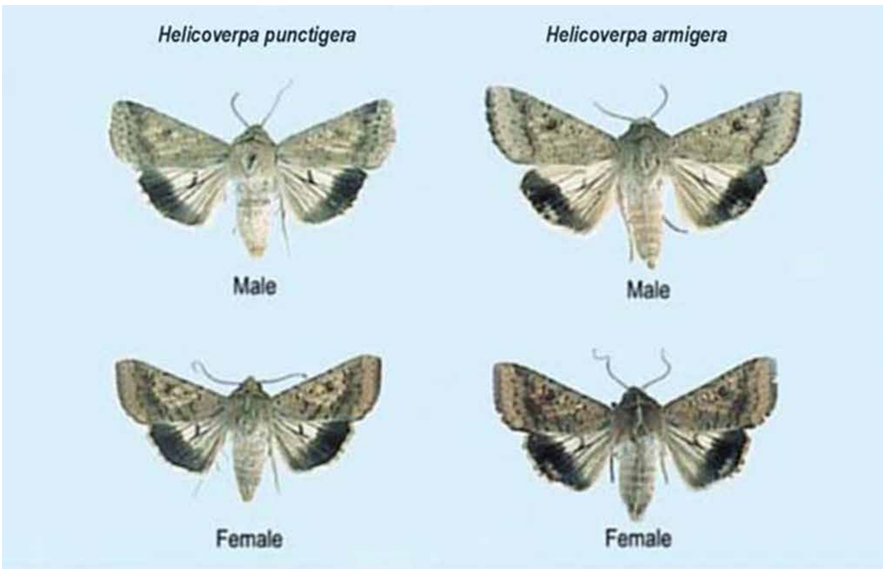


Figure 5: H. punctigera *and* H. armigera *moths are distinguished by the presence of a pale patch in the hindwing of* H. armigera.

Source: QDAF

Helicoverpa species composition can vary between seasons and regions

Species composition in the crop will be influenced by a number of factors:

- Winter rainfall in inland Australia that drives populations of *H. punctigera*; and the occurrence and timing of wind systems that carry *H. punctigera* from inland Australia to eastern cropping regions,
- Winter rainfall in eastern cropping regions which drives the abundance of local populations of *H. armigera* through the generation of spring hosts. In regions where chickpea is grown, chickpea may serve as a significant spring host for *H. armigera* emerging from diapause, if these populations are not controlled (e.g. subthreshold populations across large areas of poorly managed summer crops).
- Relative timing of flowering—podding (attractive and susceptible) stages and the immigration of *H. punctigera* and emergence of *H. armigera* from overwintering diapause. Note: in Central Queensland, *H. armigera* does not enter winter diapause and will be the predominant species in faba beans.
- Geographic location. In temperate regions (southern Queensland and further south) the majority of the *H. armigera* population over-winter from mid-March onwards and emerge during September/October. *Helicoverpa punctigera* is usually the dominant species through September when moths are migrating into eastern cropping regions. Seasonal variation can lead to *H. armigera*-dominant early infestations in some years, particularly in more northern districts. Pheromone trap catches can be used as an indication of the species present in a region. Note that pheromone traps are cannot be used to predict the size of an egg lay within a crop.

Life-cycle and development of Helicoverpa

Adult moths are active at night, but may be disturbed when sampling or walking through the crop during the day. Moths vary in colour from grey–green to pale cream and have a wing span of 3–4.5 cm (Figure 6).

Figure 6: *Native budworm (*Helicoverpa*) moths, showing male (right) and female (left). Note the buff colouring.*

Photo: SARDI

The female moths lay round eggs (0.5 mm in diameter) singly on the host plant. The eggs are white but turn brown just before hatching (Figure 7). In the spring, eggs hatch within 7–10 days (depending on temperature) and larva feed for 4–6 weeks.

The larvae can grow to 5 cm in length and vary in colour from green, yellow pink and reddish brown to almost black (Figure 8).

Figure 7: *Left to right: fresh white eggs, brown ring and black larval head visible in the eggs close to hatching.*

Source: QDAF

Larvae develop through 5–6 instars. Categorising larval size can be done in terms of instar, or more commonly, a size category (see Figure 8). Very small (1st instar), small (2nd instar), medium (3rd–4th instar) and large (5–6th instar).

Actual larval size	Larval length (mm)	Size category
	1-3	very small
	4-7	small
	8-23	medium
	24-30+	large

Figure 8: Helicoverpa *laval size categories and actual sizes.*

Once fully developed, larvae leave the plant and tunnel down up to 10 cm into the soil and form a chamber in which they pupate (Figure 9).

Pupae will normally develop to produce a moth in 2–3 weeks. The moth emerges, feeds, mates and is then ready to begin the cycle of egg laying and larval development. As with all insect development, the duration of pupation is determined by temperature, taking around 2 weeks in summer and up to 6 weeks in spring and autumn.

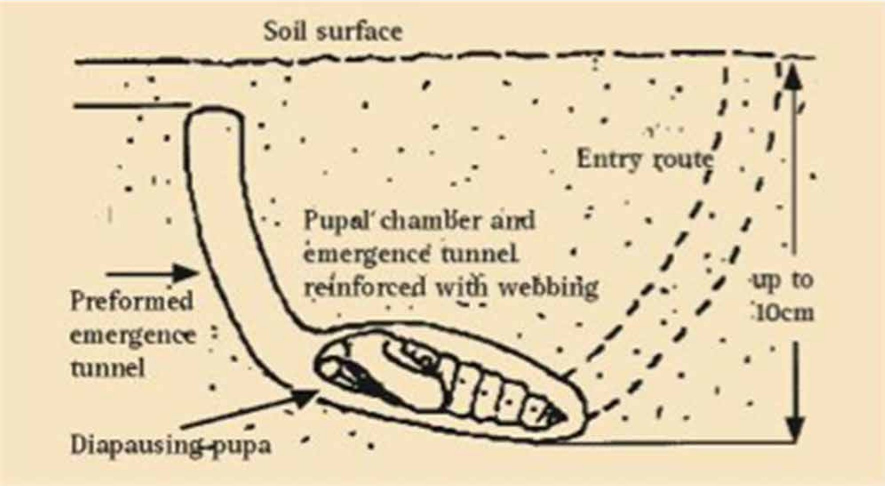


Figure 9: Helicoverpa *pupa in pupal channel, with the entry and exit tunnels that are excavated before the larva pupates.*

Source: http://www.daff.qld.gov.au/__data/assets/pdf_file/0005/72689/Insects-Helicoverpa-ecology-biology.pdf

Ninety per cent of all feeding (and therefore damage) by *Helicoverpa* is done by larva 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 overall diet in the fifth and sixth instars. This highlights the importance of controlling the larvae while they are still very small to small (<7 mm).

Full-grown, sixth instar larvae are up to 40 mm long with considerable variation in colours and markings (Figure 10).

Figure 10: Helicoverpa *larval colour is very variable.*

Source: QDAF

7.1.2 Aphids

Identification

Although several aphid species may infest faba beans, the cowpea aphid (*Aphis craccivora*) is the most commonly observed because it forms very visible dark colonies. Other species are known to infest faba beans in other growing regions (pea aphid, blue green aphid; Figure 11), but a survey of which other species occur in faba beans in the north has not been conducted.

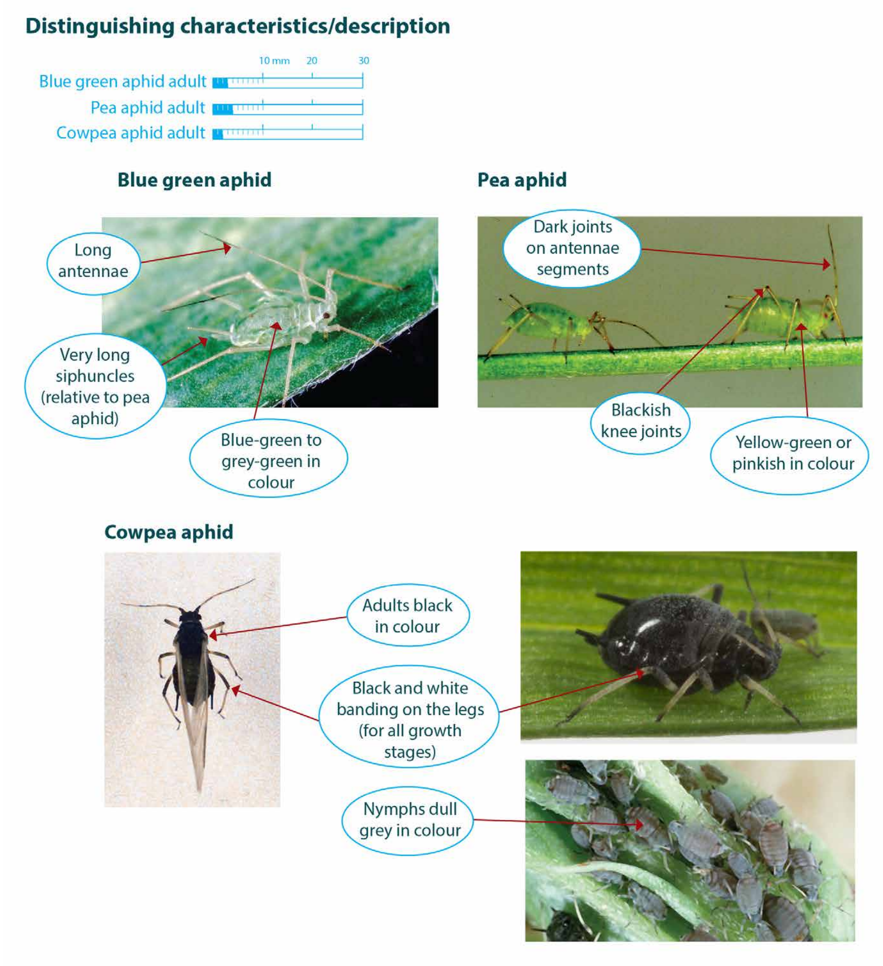


Figure 11: *Distinguishing characteristics of aphids of faba bean.*

Source: I SPY manual https://grdc.com.au/i-spy-manual

Cowpea aphid (Aphis craccivora)

Cowpea aphid is the only black-coloured aphid (Figure 12). Brown smudge bug nymphs superficially look like cowpea aphid nymphs, but cowpea aphid is unlikely to be confused with other aphids of pulses, as it is the only black aphid numerous on these crops. Adults are small (up to 2.5 mm long) and are shiny black, whereas the nymphs are slate grey (Figure 13).

The cowpea aphid is the major BLRV vector, as well as the most efficient SCSV vector and a vector of CMV.

Figure 12: *Cowpea aphid (*Aphis craccivora*). Note the different aphid ages—young to old. The older aphids are shiny black. All life stages have black and white banded legs. The white cast is a skin, shed as the aphid grows.*

Photo: Grain Legume Handbook

Figure 13: *Shiny black cowpea aphids and grey nymphs.*

Photo: Z. Ludgate, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/aphid-overview/cowpea-aphid

Cowpea aphid may be confused with the brown sowthistle aphid (*Uroleucon sonchi*) which may also be present in winter pulse crops on sowthistle (Figure 14). The brown sowthistle aphid does not colonise winter pulses.

Figure 14: *Brown sowthistle aphid (*Uroleucon sonchi*) can be confused with cowpea aphid. Its primary host is sowthistle, which can be common in winter pulses. Brown sowthistle aphid does not colonise winter pulses, but is able to transmit CMV.*

Photos: G. Cumming, Pulse Australia (left); Melina Miles, QDAF (right)

Life-cycle

In Australia, most pest aphid species only produce females, which may be winged (alates) or wingless (apterae), and these give birth to live young. In other countries some aphid species have different (or altered) life-cycle phases (e.g. sexual/asexual) that are initiated by host-insect interactions and/or environmental conditions. Many aphids are plant host (crop) specific. Aphids require specific host plants for their survival. Aphid populations usually decline over summer, as most species are adapted to cooler environments (introduced from the northern hemisphere). The availability of suitable host plants (e.g. specific weed families on roadsides and verges) allows populations to survive and increase. It is also possible that aphids breed up outside cropping regions, perhaps in the cooler, moister areas east of the Great Divide, and migrate into cropping regions in autumn and/or spring. This was the likely scenario for the widespread and sudden influx of cowpea aphid in the northern region in the autumn of 2014. Winged aphids move into crops in autumn and aphid numbers will usually start to build up along crop edges. Where mild autumn conditions persist, aphid populations can build quickly, but generally decline as temperatures drop in winter. The formation of winged aphids and aphid movement generally increases when host plants are dying or when overcrowding occurs with high populations. Nymphs go through several growth stages, moulting at each stage into a larger individual. Sometimes the delicate pale aphid skins or casts (the exoskeleton they have shed) can be seen. Nymphs do not have wings. Spring often triggers a rapid increase in aphid numbers as increasing temperatures and flowering crops provide favourable breeding conditions. Most aphids form dense colonies before winged aphids are produced. These move onto surrounding plants further into the crop creating hot spots. Rain, and the activity of natural enemies can impact significantly on aphid survival and population growth.

In some seasons, aphids form large colonies and heavy infestations may produce large amounts of a sticky secretion (honeydew). Faba bean leaf reaction to the honeydew and/or the fungi that grow on the honeydew can be seen on leaves below heavy aphid infestations (Figure 15).

Figure 15: *Spotting on lower leaves associated with dense aphid infestations and the production of honeydew and associated fungi.*

Photo: Melina Miles, QDAF

Direct feeding damage

Aphids damage plants by direct feeding, although generally causing minimal damage unless they are in extremely high numbers. Direct feeding damage is typically seen in hot spots, often along the margins of a paddock where the aphids have colonised the crop first. Cowpea aphid will colonise the plant terminal and gradually spread lower on the plant if densities are high.

Figure 16: *A moderate infestation of cowpea aphid in the terminal of a vegetative faba bean plant. Some distortion of the leaves is evident as a result of aphid feeding.*

Photo: Melina Miles, QDAF

The impact of direct aphid feeding is not well understood, although in most instances the crop grows out of the symptoms. The main concern with aphids is their capacity to act as vectors, carrying and transferring virus diseases (Figure 16) during feeding/sucking.

Aphids as vectors of viruses

Viruses have become a major concern to faba bean producers in the northern grain region since the mid-1990s (Table 2). Two virus disease symptoms are seen: virus mosaic (dark and light green areas on leaves), usually accompanied by leaf roughness or distortion; and virus yellowing accompanied usually by leaf stiffness or rolling, stunting, and root blackening.

Table 2: *Aphids known to transmit viruses in pulse crops.*

Aphid Species	Common name	Cucumber mosaic virus (CMV)	Pea Seed-borne mo-saic virus (PSbMV)	Beet western yellows virus (BWYV)
Acyrthosiphon pisum	Pea ahid	✓	✓ 50%	
Aphis craccivora	Cowpea aphid	✓ 9 .4%	✓	✓
Acyrthosiphon kondoi	Blue green aphid	✓ 6 .1%		
Myzus persicae	Green peach aphid	✓ 10 .8%	✓	✓ 96%
Lipaphis erysimi	turnip aphid	✓ 3 .9%		
Macrosiphum euphorbiae	Potato aphid		✓	✓ 14%
Aphis gossypii	Melon or cotton aphid	✓	✓	
Aulacorthum solani	Foxglove aphid	✓	✓	✓
Brachycaudus helichrysi	leafcurl plum aphid			✓
Brevicoryne brassicae	Cabbage aphid	✓	✓	✓
Hypermyzus lactucae	Sowthistle aphid	✓		
Myzus ascalonicus	Shallot aphid			✓
Myzus ornatus	Ornate aphid	✓		✓
Rhopalosiphum maidis	Corn aphid	✓ (in glasshouse)		
Rhopalosiphum padi	Oat aphid	✓ (in glasshouse)	✓	
Therioaphis trifolii	Spotted alfalfa aphid	✓		
Uroleucon sonchi	Brown sowthistle aphid	✓		

Note that many more vectors are listed for PsbMV and/or CMV.

% is the virus transmission rate for various species

Source: I SPY manual https://grdc.com.au/i-spy-manual

Both types of viruses are carried into crops by aphids during autumn or late winter. Both reduce yields, but virus yellowing is more severe (sometimes lethal) and widespread. Virus species causing mosaic symptoms include Bean yellow mosaic virus (BYMV) and Broad bean wilt virus (BBWV) (Figure 17). Virus species that cause yellowing (also referred to as luteoviruses or luteo-type viruses) include Alfalfa mosaic virus (AMV), Bean leaf roll virus (BLRV), Beet western yellows virus (BWYV), Subterranean clover red leaf virus (SCRLV), and subterranean clover stunt virus (SCSV), of which BLRV (often in mixed infection with SCRLV) has been most severe and widespread.

Two of the major viruses in the northern grains region are BLRV and BYMV. Both viruses survive summer on green legume plants (such as lucerne), and can infect only through aphid vectors. Chemical control may prevent infection of BLRV, as the aphid needs a relatively long period to feed on the plant and transmit the virus. Chemical control will not have any effect on the rapidly transmitted BYMV. There are no current guidelines for the application of aphicides on faba bean to control virus. Early sowing (while maximising yield) will increase the exposure of crops to aphid flights, potentially resulting in more virus infection.

Cultural controls are the first options to be implemented. These include:

- Sow even plant stands into standing stubble.
- Control weeds that host aphids, including around perimeter and in neighbouring paddocks. Although keep in mind that aphids may migrate long distances into crops, and local weed control may not always prevent aphid infestation. However, local weed control will contribute to minimizing the persistence of virus resevoirs.
- Avoid sowing faba beans in paddocks adjacent to legume pastures/forages.
- Avoid stresses that reduce crop vigour (e.g. late sowing into cold soils, excessive herbicide application, poor nutrition).
- Block faba bean paddocks together and limit aphid entry points into paddocks.

The faba bean breeding program has several lines that have higher resistance to viruses than Doza⒫ and Cairo⒫. These breeding lines are classified as 'resistant' to viruses rather than 'immune', so cultural control will still be important.

Figure 17: *Bean seed showing Pea seed-borne mosaic virus (PSbMV) markings (SARDI).*

Source: http://www.pulseaus.com.au/pdf/Faba%20bean%20disease%20management%20strategy%20Southern%20region.pdf p. 5

How aphids transmit viruses

Aphids can spread viruses persistently or non-persistently. Once an aphid has picked up a persistently transmitted virus—for example, Beet western yellows virus (BWYV)—it carries the virus for life, infecting every plant where it feeds on phloem. Aphids carrying non-persistently transmitted viruses, such as Cucumber mosaic virus (CMV), carry the virus temporarily and only infect new plants in the first one or two probes (Figure 18). [1]

1 GRDC (2010), Aphids and viruses in pulse crops, GRDC Fact Sheet, http://www.grdc.com.au/GRDC-FS-AphidsandVirusesinPulses

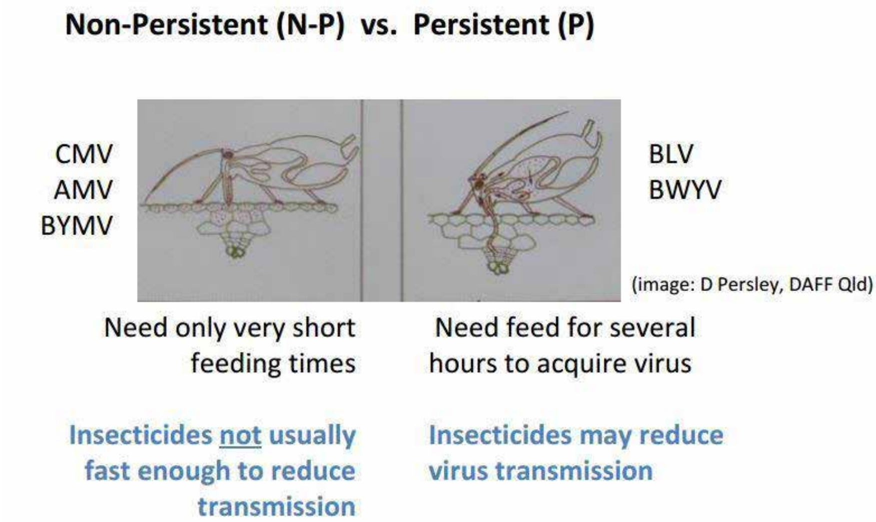
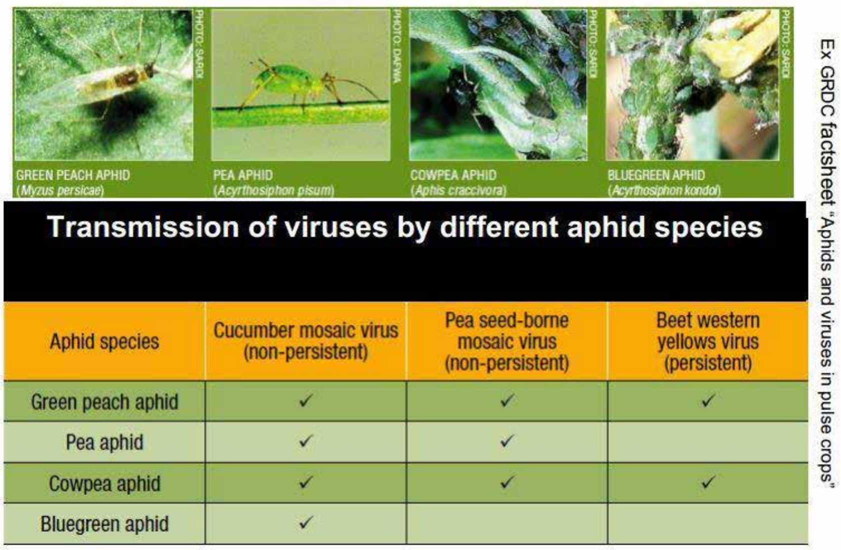


Figure 18: *Transmission of viruses by aphids.*

Source: D. Persley, QDAF

Persistent transmission

Persistent transmission means that when an insect vector feeds on an infected plant, the virus has to pass through the body of its vector and lodge in its salivary glands before it can be transmitted to a healthy plant, a process that takes >1 day. Once the insect is infectious, it remains so for the rest of its life. Very few aphid species are vectors of this kind of virus in pulses. These species of aphids tend to colonise their hosts. The pea and green peach aphids are important as vectors of luteoviruses in pulses. Because acquisition of the virus is slow, insecticides that kill aphids work well (except in the case of insecticide-resistant green peach aphid) in suppressing spread of these viruses (Figure 19), including Bean leaf roll virus (BLRV), Bean yellow mosaic virus (BYMV), Subterranean clover red leaf virus (SCRLV) and subterranean clover stunt virus (SCSV).



Transmission of viruses by different aphid species

Aphid species	Cucumber mosaic virus (non-persistent)	Pea seed-borne mosaic virus (non-persistent)	Beet western yellows virus (persistent)
Green peach aphid	✓	✓	✓
Pea aphid	✓	✓	
Cowpea aphid	✓	✓	✓
Bluegreen aphid	✓		

Figure 19: *Transmission of viruses by different aphid species.*

Source: GRDC Fact Sheet https://grdc.com.au/GRDC-FS-AphidsandVirusesinPulses

Non-persistent transmission

Non-persistent transmission means that the insect vector can land on a virus-infected plant, make a brief probe, acquire the virus on its mouthparts within seconds, and then transmit it immediately when probing on a healthy plant. The aphid loses the virus after it probes a healthy plant one or two times. After this, the insect does not infect further plants. The whole process is so fast that insecticides do not act quickly enough to prevent transmission, and can exacerbate the situation by making the aphids hyperactive, flitting from plant to plant (Figure 20). Many aphid species are vectors of this type of virus, including ones that do not colonise legumes but just land and probe pulse crops while searching for their preferred hosts, such as oat and turnip aphids. Such viruses include: Alfalfa mosaic virus (AMV), Bean yellow mosaic virus (BYMV), Cucumber mosaic virus (CMV) and Pea seed-borne mosaic virus (PSbMV).

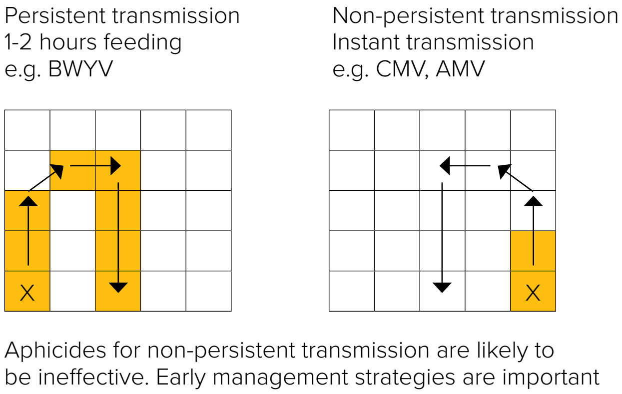


Figure 20: *Differences in the progression of infection within a field of persistent and non-persistent viruses vectored by aphids.*

Source: I SPY manual https://grdc.com.au/i-spy-manual

7.2 Other insect pests

There is a suite of other insect pests that may occur in faba beans in the northern grains region. Significant impact is either poorly understood, or sporadic. Nevertheless, it is worthwhile to be aware of their damage potential, and be able to identify them in the event of an outbreak.

MORE INFORMATION

Spotting green mirid damage on faba beans

7.2.1 Green mirid (*Creontiades dilutus*)

Green mirid adults are 7 mm long, pale green, with antennae nearly as long as the body; and often with red markings on legs (Figure 21). Wings are clear and folded flat over the back. Green mirid nymphs have a pear-shaped body and the tips of the antennae are reddish brown. Newly hatched nymphs are 1–2 mm in length. Late instar nymphs (4–5th instar) are up to 7 mm long and have dark wingbuds. All nymphs have red-tipped antennae.

Figure 21: *Green mirid adult (left) and nymph (right).*

Photo: QDAF

Green mirid adults may be confused with the Broken-backed bug (*Taylorilygus pallidulus*) and the Crop mirid (*Sidnia kinbergi*) (Figure 22). Both these other species are smaller than the green mirid.

Figure 22: *Broken-back bug adult (left) and late instar nymph (second from left). Wingbuds clearly visible on the nymph indicating it is 4–5th instar. Crop mirid nymph (far right) and adult (second from right).*

Photos: J Wessels, QDAF

For images and descriptions of mirids and mirid-like species see the *Good Bug, Bad Bug* book (http://thebeatsheet.com.au/resources/).

Life-cycle

Green mirid adults move into crops, typically in spring, from local weed hosts and/or migrate into cropping areas from inland Australia. Females insert the 1.5 mm, banana-shaped eggs into the plant stems. Females can live for 3+ weeks and lay up to 80 eggs over this period. Eggs cannot be scouted in the field. Eggs hatch in 4–5 days in summer, longer under cooler temperatures, possibly up to 10 days. There are 5 nymphal stages (instars). Development from egg to adult takes around 2 weeks in summer, longer under cooler conditions.

Damage

Adults and nymphs pierce plant tissue and release a chemical (pectinase) that destroys cells in the feeding zone. Medium and large nymphs (3rd–5th instar) are as damaging as adults. In summer pulse crops (mungbeans, adzuki beans), mirids feed on buds, flowers, and developing pods causing them to shed. When mirids feed on maturing pods, they can damage the seed without causing the pods to shed. It is this type of damage that is thought to have been caused by mirids in faba bean crops in 2014. Further research is required to validate the preliminary trial work, and to understand the impact of mirids on buds, flowers and pods/seed at different stages of development.

In preliminary trial work (M. Miles, QDAF 2014), maturing pods were caged with mirid adults for seven days (Figure 23). Control pods were caged without mirids. After seven days, half the pods were harvested, still green, and examined for damage. The remaining pods were left on the plants until maturity and then harvested. Examination of green pods and seeds showed no sign of damage (no necrosis, no spotting). The seed from the late harvested pods showed clear evidence of spotting, consistent with feeding damage caused by mirids in other crops. The impact of mirid feeding, whilst requiring further validation, is a seed quality/appearance issue.

Figure 23: *Cage used to confine green mirid adults on maturing faba bean pods to assess damage potential (left). Seed from pods not exposed to green mirids (centre). Seed from pods exposed to adult mirids for 7 days (right).*

Photos: Melina Miles, QDAF

Monitoring and thresholds

Mirids can be monitored in faba beans using a sweep net or beat sheet—in conjunction with *Helicoverpa* sampling perhaps.

There are no thresholds yet established for mirids in faba beans. It is also unclear what stages of budding—grain development and maturity are susceptible to mirids. We know from experience in summer pulses and cotton that crops are able to compensate for loss of buds and flowers. However, damage to seed quality during pod filling is more problematic.

Management

No definite management strategy has yet been devised for mirids in faba beans. However, the disruptiveness of insecticide options that will control mirids means that a considered approach is required. Some suppression of mirids may be achieved if indoxacarb is used to control *Helicoverpa*.

7.2.2 Cutworms (*Agrotis* spp.)

Several species of cutworms, including *Agrostis munda* (brown cutworm), *A. infusa* (Bogong moth; Figure 24), *A. ipsilon* (black cutworm) and *A. prophyricollis* (variable cutworm) attack a wide range of crops in the northern cropping zone. The common name cutworm is derived from the larval habit of severing the stems of young seedlings at or near ground level, causing the collapse of the plant.

Identification

Larvae are up to 50 mm long, hairless with dark heads and usually darkish coloured bodies, often with longitudinal lines and/or dark spots (Figure 25). Larvae curl up into a C-shape and remain still if picked up. Moths are a dull brown-black colour. Cutworms may be confused with armyworms and *Helicoverpa* larvae. Moths are a dull brown-black colour.

Visit the QDAF website for identification information (https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/soil-insects/cutworm).

Damage

Cutworm larvae can sever stems of young seedlings at or near ground level, thereby causing collapse of the plant. Sometimes the young plant is partially dragged into the soil where the larvae feed on it. Larvae may also climb plants and browse on or cut off leaves. Crop areas attacked by cutworms tend to be patchy and the destruction of seedlings in one area may cause cutworms to migrate to adjacent fields. Risk period is summer and spring—one generation per crop.

Monitoring and thresholds

Inspect emerging seedlings twice per week and plants up to budding stage once per week. Check 1 m of row at a number of locations. Check along the plant row, at the base of seedlings under the soil surface and stubble. Placement of a hessian bag on the soil surface may draw cutworms to the surface. Check for their presence in the morning. Treat seedlings when there is a rapidly increasing area or proportion of crop damage. Treat older plants if 90% (9 out of 10) checks have cutworm present, or if defoliation exceeds 75%.

Management

- Controlling weeds prior to planting will reduce the risk of cutworm infestations. Moths will lay on weeds, and large larvae move from the weeds to establishing crops when weeds are sprayed, cultivated or senesce.
- A late-afternoon spray, close to the time when feeding commences, gives best results.
- Spot spraying of infested patches may suffice.
- Cutworms are killed by a number of natural enemies such as parasitoids, predators and diseases.

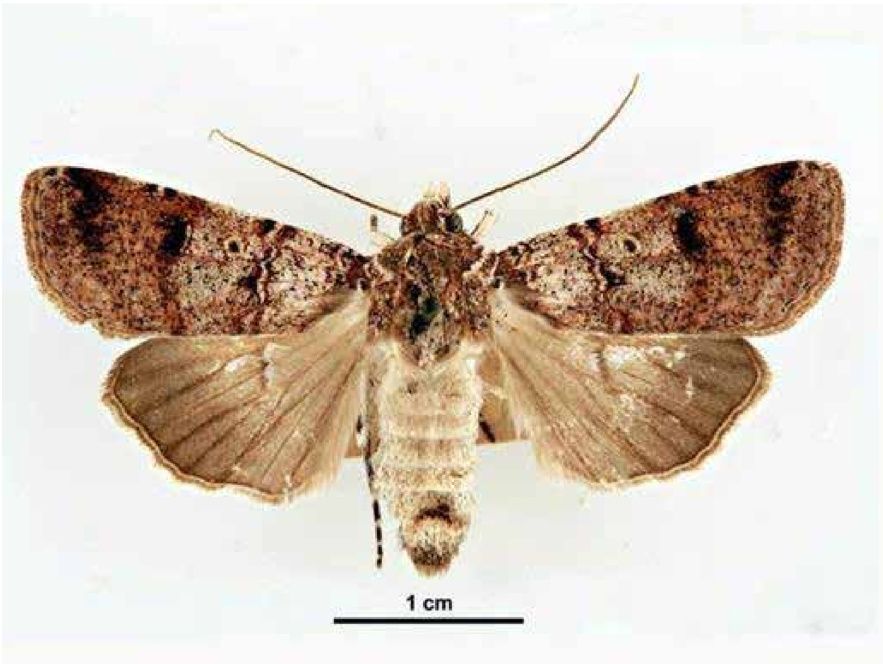


Figure 24: *Bogong moth.*

Source: Lucinda Gibson and Ken Walker Museum Victoria; http://wwwpadil.gov.au/pests-and-diseases/pest/main/136308/5837

Figure 25: *Cutworm. The common name is derived from the larval habit of severing the stems of young seedlings at or near ground level. 40 mm.*

Photo: P. Room, http://www.cottoncrc.org.au/industry/Publications/Pests_and_Beneficials/Cotton_Insect_Pest_and_Beneficial_Guide/Pests_by_common_name/Cutworms

7.2.3 Thrips

Several species of thrips can damage faba bean crops, but little is known of their economic impact. Leaf feeding damage to seedlings can occur. In seedlings, thrips cause distortion of the emerging and expanding leaves. Unless the thrip pressure is extreme, and the crop emergence compromised by limited moisture or cold, plants will grow out of the damage and it is considered cosmetic rather than damaging.

More commonly, thrips are observed in flowers. Thrips feed on the pollen in flowers and it is speculated that they affect the development of small pods. However, the link between thrips and pod damage is not well established. Thrip numbers almost always exceed the nominal threshold of 4–6 per flower. [2]

Onion thrips (*Thrips tabaci*), plague thrips (*T. imaginis*), tomato thrips (*Frankliniella schultzei*; Figure 26) and Western flower thrip (*Frankliniella occidentalis*) are all likely to be present in faba beans.

Damage

Damaged leaves and older pods are marked with silvery brown blotches. Unless excessive, (for example, on seedlings where growth has slowed because of cool, wet or dry conditions) plants will grow through this damage. Thrips can transmit Tomato spotted wilt virus (TSWV), which is often mistaken for chocolate spot (Figure 27).

Monitoring and thresholds

Seedling thrip infestation can be monitored by gently pulling up seedlings to examine for the presence of thrips (using a hand lens if necessary). In budding and flowering plants, beat the growing points and flowers onto your hand (or white paper) to dislodge the thrips.

2 NSW DPI (2013) Insect and mite control in field crops 2013. NSW DPI management guide, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/284576/Insect-and-mite-control-in-field-crops-2013.pdf

Figure 26: *Adult tomato thrips (*Frankliniella schultzei*).*

Photo: L. Wilson, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/thrips-overview/tomato-thrips,-plague-thrips

Figure 27: *Tomato spotted wilt virus (TSWV), which can be transmitted by thrips and is often mistaken for chocolate spot.*

Photo: Drew Penberthy, Penagcon

Figure 28: *Oedema on faba bean pods are not a result of insect feeding.*

Photo: Melina Miles, QDAF

Oedema on the surface of faba bean pods are not caused by insect feeding (Figure 28). This damage is often assumed to be caused by thrips; this is incorrect. Oedema is a physiological condition that causes surface 'blisters' on leaves and pods. Oedema occurs typically when the soil is warm and moist, and the night air is cool and humid, and a thick crop canopy further reduces air movement. As a result, plant transpiration is lower than water uptake. When the blisters rupture, the oedema dry leaving a warty or scaly 'scab'.

7.2.4 Loopers

Tobacco looper Chrysodeixis argentifera

Vegetable looper Chrysodeixis eriosome

Soybean looper Thysanoplusia orichalcea

Loopers are occasional seen in faba beans, and it is possible that any of the three species above could be present. Loopers can be distinguished from *Helicoverpa* by their 'looping' action when walking—visit the Beat Sheet on YouTube to see looper and *Helicoverpa* larvae movements (http://www.youtube.com/user/TheBeatsheet).

Other distinguishing features of loopers:

- their body tapers to the head; and

- they have only two pairs of hind legs, as opposed to four for *Helicoverpa*.

Identification

Eggs are pale yellow-green, ribbed and are flatter than *Helicoverpa* eggs. Looper eggs hatch in 3–6 days. There are six larval stages. Larvae take 2–3 weeks to develop. Larval colour can vary considerably. Large larvae are usually green with white stripes. Larvae can reach 50 mm in length. Looper larvae usually pupate under leaves in a thin silken cocoon. Pupae are dark above and pale underneath.

Figure 29: *Soybean looper showing characteristic irregular feeding damage (left) and looping action (right).*

Photos: Melina Miles, QDAF

Damage

Larvae feed on leaves. Eighty per cent of defoliation is done by medium–large larvae. Looper damage is characterized by large irregular shaped holes in the leaves, usually coinciding with the appearance of large larvae (Figure 29). In contrast, *Helicoverpa* leaf feeding results in rounded holes.

Loopers have the potential to cause significant defoliation in crops, but this level of damage has not been recorded in faba beans.

Monitoring and thresholds

Be alert to the presence of small looper larvae, and the likelihood that the visible level of defoliation will accelerate as larvae reach late instar stage (40–50 mm in length).

Larvae will be dislodged with beat sheet and sweep net sampling. The presence of plants with evident leaf feeding should trigger sampling specifically for loopers.

There is no threshold established for loopers in faba beans.

Management

Looper eggs and larvae are attacked by the same predators and parasitoids as other lepidopteran pests e.g. predatory beetles, predatory bugs and parasitoid wasps. Should control be warranted, *Bacillus thuringiensis* var. *kurstaki* (Bt), a naturally occurring bacteria, is effective against small larvae, and most products applied for *Helicoverpa* control will incidentally control loopers.

7.2.5 Beet armyworm

Lesser (or beet) armyworm (*Spodoptera exigua*) has been recorded causing minor defoliation in vegetative faba beans in the northern region in the autumn of 2014.

Identification

Eggs are laid in ‘rafts’ of 10 to 30 and are covered by creamy brown scales by the female moth. Newly hatched larvae aggregate around the egg raft. Late instar larvae are 30–40 mm long. Mature larvae may be confused with *Helicoverpa* larvae but are green to brown, about half the length of a mature *Helicoverpa* larva, with a white stripe along each side of the back. The moth is about 10 mm in length with grey/brown, mottled forewings. The hindwing is of a pearly white.

For images of egg rafts, and moths see Pests and Beneficials in Australian Cotton Landscapes (http://www.cottoninfo.com.au/sites/default/files/documents/pandbsguideweb%20%281%29.pdf).

Life-cycle

In summer, the egg stage lasts for 3 days. The larval stage lasts for about 9–14 days and usually has six instars. Pupation occurs in the soil and lasts for about 10 days. In autumn and winter, these stages may take somewhat longer to progress through.

Damage

The young larvae remain near the egg raft and skeletonise the leaf (Figure 30). Larger larvae may infest seedling and cause defoliation.

Figure 30: *Beet armyworm (*Spodoptera exigua*) larva (left) and feeding damage to vegetative faba bean (right).*

Photos: Chris Teague, Landmark, Goondiwindi, 2014

7.2.6 Slugs

Slugs are not a widespread issue in the northern region, although there are some areas that have an ongoing problem with slugs. Faba beans are probably one of the more tolerant winter crops, generally growing out of slug damage without any adverse impact. Field slug (*Deroceras reticulatum*), Black keeled slug (*Milax gagates*) and the Marsh slug (*D. larvae*) have been recorded from the northern region (M. Nash, pers. comm.).

For a full description, see Identification and control of pest slugs and snails for broadacre crops in Western Australia (Micic et al. 2007).

Identification

The most common species in southern Australia is thought to be the reticulated or field slug, *Deroceras reticulatum* (Figure 31). Usually grey in colour the adult slugs range from about two to four centimetres long.

The black keeled slug, *Milax gagates* has also been found in canola and wheat paddocks. This slug is uniform black to grey and four to five centimetres long.

Figure 31: *Top: Field slug (*Deroceras reticulatum*). Bottom: Black keeled slug (*Milax gagates*).*

Photo: Peter Mangano, DAFWA

Life-cycle

Slugs are hermaphrodites (individuals are both male and female). Each individual can lay about 100 eggs.

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

Damage

Slugs have caused major damage in emerging canola, pulse and wheat crops especially in high rainfall areas but have also caused damage in lower rainfall areas in wetter years (Figure 32). The black-keeled slug will feed both above and below ground on germinating seedlings. Damage is usually greater in cracking clay soils which provide better habitat for slugs, because of the higher water-holding capacity of the soils.

Figure 32: *Slug damage in a faba bean seedling. Beans tolerate slug damage better than many other crops, particularly compared with lupin or canola.*

Photo: W. Hawthorne, Pulse Australia

Monitoring and thresholds

Monitoring has recently been shown to be an unreliable way to assess slug densities, and the need for control (Michael Nash, pers. comm.). This is principally because slug distribution across a field is highly variable, and they are only active under a narrow range of conditions.

Management

The effective management of slugs requires an integrated approach. Figure 33 shows a timeline for implementing a range of management strategies that will impact on a slug population.

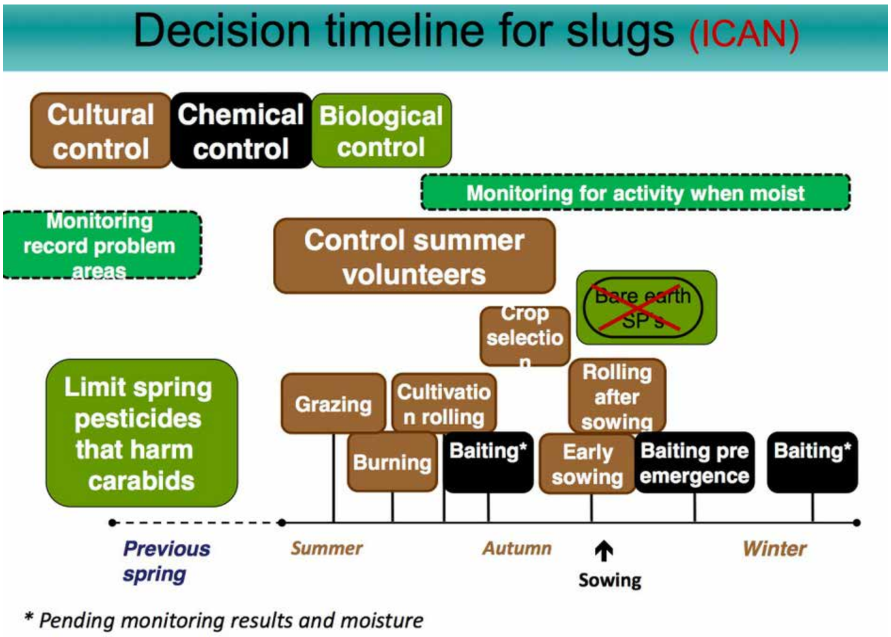


Figure 33: *Timeline for implementing slug management strategies.*

Source: Michael Nash, SARDI http://ipmguidelinesforgrains.com.au/wp-content/uploads/Apr2014-Snugs_SAVic.pdf

- Cultivation and rolling, and burning stubble after weeds are controlled will reduce slug populations.
- Rolling the soil after seeding can also reduce slug damage.
- Bait at sowing to protect seedlings as they emerge. Buried bait is less effective than bait on the soil surface.
- The most effective baits are metaldehyde and iron chelates. Metaldehyde damages the mucus producing cells and is therefore less affected by cold and wet conditions. Rates of up to 10 kg/ha may be necessary.
- Baiting will generally only kill 50% of the slug population at any one time, hence the need for a multi-pronged approach.
- Minimise the prophylactic use of synthetic pyrethroids ('just a bit in because we're going over the paddock anyway). SPs kill predatory beetles (carabids) that feed on slugs.

Further information on slug management and current research visit the Snug Blog maintained by slug researcher Michael Nash, SARDI (https://www.facebook.com/ASnugBlog or at https://asnugblog.wordpress.com).

7.3 Identification resources are useful for checking whether insects are friend or foe

7.3.1 Insect ID: The Ute Guide

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 34).

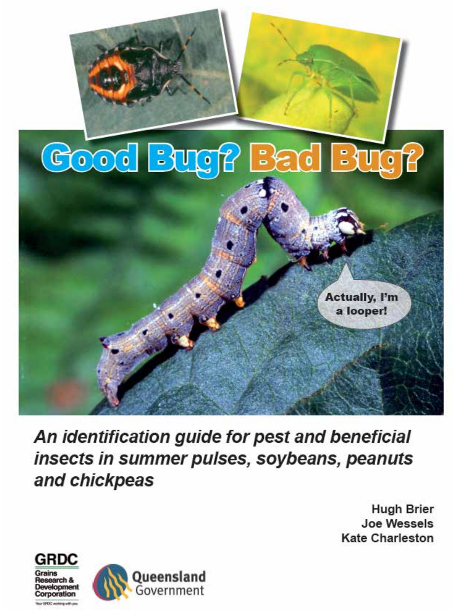
Insect ID is a comprehensive reference guide to insect pests commonly affecting broadacre crops and growers across Australia, and includes the beneficial insects that may help to control the pests. Photos have been provided for multiple life-cycle stages, and each insect is described in detail, with information on the crops they attack, how they can be monitored and other pests that they may be confused with. Use of this app should result in more confident identification of key pests and beneficial insects.

Not all insects found in field crops are listed in this app, so further advice may be required before making control or management decisions. Talk to your agronomist or state department of agriculture/primary industries for more complete information on identification, management and thresholds.

Figure 34: *Screenshots from the iOS edition of Insect ID: The Ute Guide.*

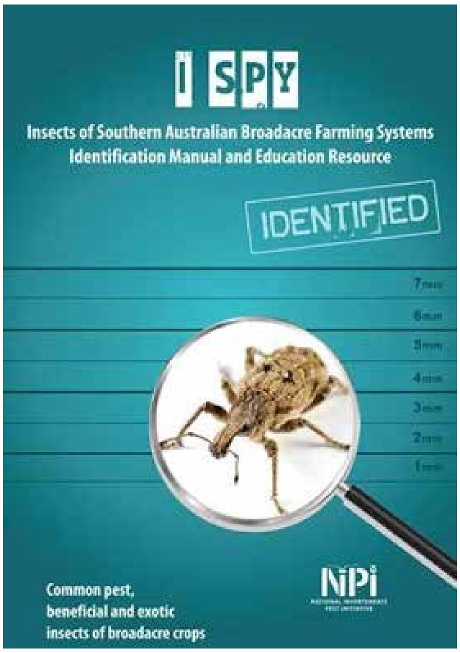
7.3.2 The Good Bug, Bad Bug book

The Good Bug, Bad Bug book (downloadable pdf from http://thebeatsheet.com.au/resources/)



7.3.3 I SPY manual

I SPY manual (downloadable pdf from http://www.grdc.com.au/i-spy-manual)



7.4 The pest management process

Figure 35 depicts the process of pest management. The components are considered below.

MORE INFORMATION

Insect pest management in faba beans

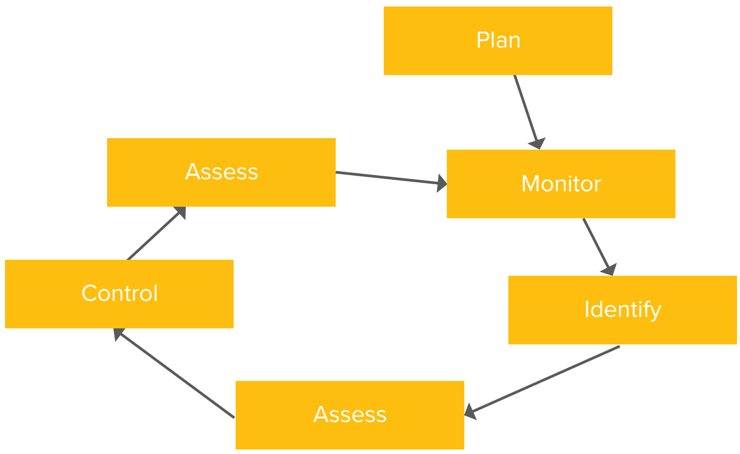


Figure 35: *Pest management process.*

Source: Southern/Western Faba and Broad Bean—Best Management Practices Training Course. Module 3—Varieties. 2013. Pulse Australia

7.4.1 Planning

- Be familiar with which pests are likely to attack the crop in your region, their damage symptoms, and when they may occur and cause crop loss.
- Discuss sampling protocols with your local agronomist and plan how you will cope with the logistics of sampling. Will the agronomist do all the sampling? Will the grower and agronomist share the responsibility?
- Have the appropriate sampling equipment available (sweep net and/ or beat sheet)
- Discuss what general approach you will be taking to managing the pests. For example:
- Will you act early, or follow current recommended thresholds? Will you use softer options, or cheaper broad spectrum options?
- What is the likely mix of *Helicoverpa* species in your district, and how might this affect your choices?
- How will you handle an outbreak of minor pests, or species that we don't know much about?

Be aware of the latest management options, pesticide permits and registrations in faba beans, and any use and withholding period restrictions.

7.4.2 Monitoring

- Scout crops regularly during 'at risk' periods (see Table 1), at least once per fortnight.
- Distinguish between the pest being present during a susceptible stage of crop development, and stages where they will cause no significant impact on the crop.
- Be familiar with which sampling method is appropriate for the pests that are likely at each stage of crop development. For example:
- Visual and ground searches for cutworm and aphids during the seedling stage.
- Baited shelter traps for slugs prior to sowing and at establishment
- Beat sheet for loopers, mirids, *Helicoverpa* from vegetative stages to maturity.

Record insect counts and other relevant information using a consistent method to allow comparisons over time. For example:

- For visual inspections do a set number of plants, or metres of row, or square metres (use a stick or quadrat for consistency
- For beat sheet sampling, use a standardized beat sheet (1.2 m wide) and stick (1.0 m in length), and a consistent number of beats/shakes per sample (10)
- Record crop stage, level of damage to leaves, buds, flowers and pods which will help determine the overall impact of some species (particularly relevant where there are no existing numerical thresholds to guide decisions)

Provide this information in a written form to the grower—or demand it from your agronomist.

7.4.3 Correct identification of insect species

It is not important to identify every insect present in your crop, but to be familiar enough with the key pest and beneficial species to recognize the different life stages before you start monitoring.

7.4.4 Assessing management options

Use the crop monitoring information to decide what control action (if any) is required.

Take into consideration other factors that may influence the approach you take. For example:

- Likely level of insecticide resistance in *Helicoverpa* (dependant on the abundance of *H. armigera* in the population)
- Rate of pest population growth over a series of visits. Rapidly increasing populations may need a different approach to a population that is static, or increasing slowly. The damage potential of the pest is also important in this context.
- The crop potential to compensate for insect damage
- Stage of development (greater potential to compensate for damage during vegetative–flowering). The later the damage (e.g. to pods) the less opportunity there is to compensate for loss.
- Available soil moisture, potential for adequate rainfall
- Temperatures that may limit flowering and pod set in late spring.

7.4.5 Control

Ensure that aerial operators and ground-rig spray equipment are calibrated and set up for best practice guidelines.

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.

7.4.6 Re-assess and document results

Re-assess pest populations in the crop within 3–7 days of spraying, depending on the product used and expectations of time to control the population. Be aware that some newer products act more slowly than older, broadspectrum knockdown products like synthetic pyrethroids (SPs) and organophosphates (OPs).

It is important to re-assess the field within the window of product efficacy, rather than waiting up to 2 weeks to re-assess. Delaying the post-treatment assessment beyond a week runs the risk of having re-infestation, or hatching of eggs post spray. These post-spray reinfestation events can be difficult to distinguish from a control failure if the post-treatment assessment is not made in the appropriate timeframe.

When making a post-treatment assessment look for and record:

- pest density
- life stages in the population may be important to record for some species, and will provide information on whether the treatment has performed as expected, or there is an issue with contact, resistance or re-infestation/emergence of juveniles
- if crop damage is ongoing, or has ceased.

Record the post-treatment data with the pre-treatment data.

7.5 Monitoring faba bean for insect pests

There are a number of sampling methods that can be used in faba beans, and the use of one or more of these methods when crop checking depends on the crop stage, which pests are likely.

It is likely that more than one method may be necessary to effectively estimate pest density. For example, when sampling for *Helicoverpa* a beat sheet or sweep net will not dislodge small larvae in terminals and flowers. A visual inspection of a number of plants is required in addition to sweep net or beat sheet sampling. Table 3 shows the recommended methods for each of the pest species at different stages of crop development.

Table 3: *Sampling methods recommended for specific pests at different stages of faba bean crop development.*

Pest	Sampling method			
	Emergence–seedling	Vegetative	Flowering–pod set	Pod fill–maturity
Blue oat mites	Visual			
Cutworms	Visual in crop or neighbouring weeds Quadrat	Visual in crop or neighbouring weeds Quadrat		
Slugs	Baited shelter trap Visual	Baited shelter trap Visual		
Aphids (virus vectors)	Visual (% plants infested, density)	Visual (% plants infested, density)		
Helicoverpa spp.			Beat sheet Sweep net Visual in terminals and flowers for small larvae	Beat sheet Sweep net Visual in terminals and flowers for small larvae
Loopers		Visual (look for feeding damage) Beat sheet to estimate density		

Pest	Sampling method			
	Emergence–seedling	Vegetative	Flowering–pod set	Pod fill–maturity
Beet armyworm		Visual (look for feeding damage) Beat sheet to estimate density		
Green mirid			Beat sheet	Beat sheet
Podsucking bugs			Beat sheet	Beat sheet
Thrips	Visual; look for typical damage symptoms on leaves and terminals			

MORE INFORMATION

[Insect management in fababeans and canola recent research](#)

[Recent insect pest management research findings](#)

7.5.1 Sampling strategy and technique

Usually economic thresholds are developed using a specific sampling technique, and it is important to use that technique in order to relate your density data to the threshold recommendations. At this point, the majority of threshold recommendations for faba beans are thought to be 'best bets' and they have not been derived experimentally using a specific sampling method. Refer to the sampling information for each specific pest (Table 3) to determine the most appropriate technique for detecting the species.

The sweep net is widely used in the south for sampling faba beans where the primary pest is *Helicoverpa punctigera*.

Preliminary research results on effective sampling methods for *Helicoverpa* (QDAF 2014; Figure 36), has shown that neither the sweep net and beat sheet are effective in sampling smaller larvae. Sampling small larvae is important in terms of identifying a potentially damaging population before larvae are too large to control, and before the larvae start causing damage to grain. In response to this finding, a visual inspection of terminals (leaves, flowers and buds) is recommended in conjunction with either sweep net or beat sheet sampling.

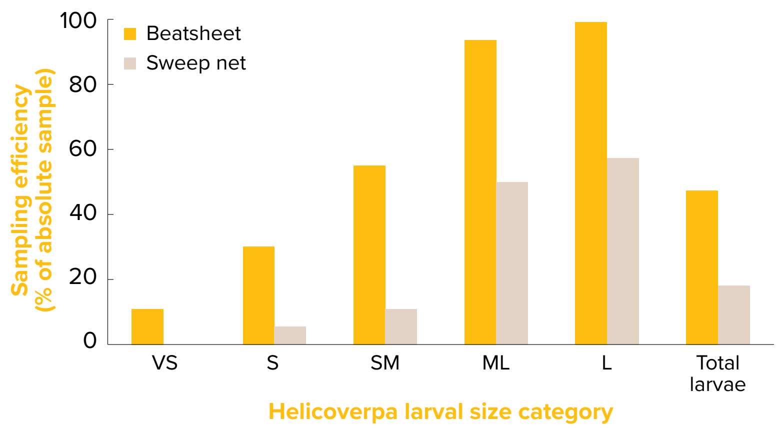


Figure 36: *The relative efficacy of sweep net and beat sheet sampling in detecting different sizes of* Helicoverpa *larvae in a flowering faba bean crop. Data is presented as a percentage of the known total (absolute) larval population in the section of crop sampled with each method*

Source: QDAF, 2014

Larger larvae are easily dislodged from the crop, but the smaller larvae are not, suggesting that they are feeding is protected, or more complex structures on the plant. Dissection of flowering plants to determine the distribution of larvae showed that larvae are in the buds and flowers, rather than on leaves. It also revealed that small larvae are predominantly located at the top of the plant in the terminal (Figures 37 and 38).

This data set has only been collected for flowering faba beans at this point. It is possible that the efficacy of the sampling methods may improve as the crop develops further, and particularly as there are fewer complex structures in which larvae can shelter. Research is ongoing to determine if the distribution of larvae changes during the development of the crop, and to finalise monitoring recommendations for *Helicoverpa*.

Figure 37: *Small larva feeding on a bud in the terminal of a faba bean plant. The larva was only visible after pulling open the terminal during a visual inspection of the plant.*

Photo: Melina Miles, QDAF

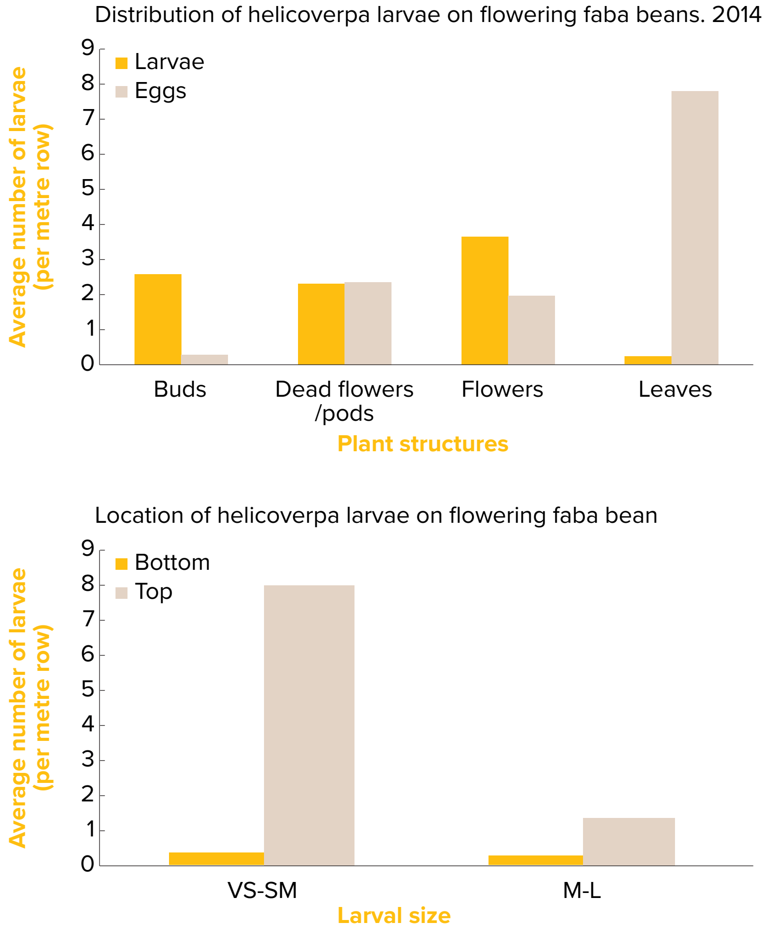


Figure 38: *Location of larvae, and specifically of small larvae, in the canopy of a flowering faba bean crop.*

Source: QDAF, 2014

How to use a beat sheet

The beat sheet is a useful method for sampling a number of pest species in faba beans. It is usually associated with *Helicoverpa* monitoring, but is equally useful for making an estimate of the density of loopers, armyworm, mirids, and podsucking bugs.

Place the beat sheet with one edge at the base of a row. On 1-m row spacing, spread the sheet out across the inter-row space and up against the base of the next row (Figure 39). Draping over the adjacent row may be useful for row spacing <1 m, or where there is canopy closure. It also minimises insects being thrown off the far side of the sheet.

Figure 39: *The beat sheet can be used between the rows as is done in chickpeas (left) or in larger crops, draped over the adjacent row to maximize capture of insects dislodged when sampling (right).*

Photos: GRDC, QDAF

Using a 1-m-long stick (dowel, heavy conduit), shake the row vigorously 10 times to dislodge larvae from the plants. Size and count larvae on the sheet.

A standard beat sheet is made from plastic or tarpaulin material with heavy dowel on each end to weigh the sheet down. The beat sheet is typically 1.3 m wide by 1.5 m long. The extra 0.15 m on each side catches insects thrown out sideways.

Watch a video on using a beat sheet in canola or chickpea at the Beat sheet YouTube channel (http://www.youtube.com/user/TheBeatsheet).

How to use the beat sheet to sample faba beans

Check crops regularly (at least once a week) with a beat sheet, from flowering through to harvest.

To avoid possible edge effects, start sampling at least 50 m into the field.

Each time you inspect, take 5–10 samples across the field. The number of samples should be influenced by what you find. Consistently high, or low, numbers of insects will require fewer samples be taken because the overall picture is clear. Where pests are patchy, and numbers are variable, more samples will be needed to be confident in averaging the counts to get an estimate of pest numbers.

An estimate of pest density is usually the average of all individual samples taken (e.g. 5+1+4+3+2+5+5=25, 25/7=3.6 per sampling unit).

In addition to larval counts, visual observation of crop growth stage, progress of flowering/podding, and the presence of natural enemies (beneficials) all provide useful information for making decisions.

When using a beat sheet, it is worth converting pest density estimates into standard units, generally the number per m^2. This conversion adjusts for the amount of crop (linear metres of row) at different row configurations.

To convert pest density to m^2, use the following formula:

Number per m^2 = average number of pests ÷ row spacing (in metres)

How to use a sweep net to sample faba beans

Where crops are sown on narrow row spacings and it is not possible to get a beat sheet between the rows, or you want to make a quick assessment of whether there are pests in the crop, a sweep net can be used to sample faba beans.

Watch a video on how to use a sweep net to sample for insects at The Beat Sheet YouTube channel (http://www.youtube.com/user/TheBeatsheet).

Hold the sweep net handle in both hands and sweep it across in front of your body in a 180° arc. Take a step with each sweep. Keep the head of the net upright so the bottom of the hoop travels through the canopy. Use sufficient force in the sweep to pass the hoop through the canopy and dislodge larvae.

To avoid possible edge effects, start sampling at least 50 m into the field.

Take 10 sweeps and then stop and check the net for insects. Taking too many sweeps in a sample will result in damage to the insects and make identification more difficult.

Each time you inspect, take 5–10 samples across the field. The number of samples should be influenced by what you find. Consistently high, or low, numbers of insects will require fewer samples be taken because the overall picture is clear. Where pests are patchy, and numbers are variable, more samples will be needed to be confident in averaging the counts to get an estimate of pest numbers. If the patchiness seems to be associated with different parts of the field, take samples at a range of locations around the field.

There may be opportunities to treat just a portion of the field, rather than the whole field, where pests infestations are restricted within a field. Cutworm, earth mites, aphids and *Helicoverpa* can all have limited distribution in a field, most commonly around edges, or on an edge closest to the source of infestation.

An estimate of pest density is usually the average of all individual samples taken (e.g. 5+1+4+3+2+5+5=25, 25/7=3.6 per sampling unit).

Because sweep nets penetrate only a proportion of the crop (the top section), understanding the distribution of the pests in the canopy will provide information on the relative usefulness of the sweep net and beat sheet for sampling a range of insect pests.

Recording monitoring data for decision-making

Keeping records is a routine part of crop checking. Successive records of crop inspections will show you whether pest numbers are increasing or decreasing, the progression towards damaging stages and densities, and provide evidence of pest mortality/beneficial impact. In conjunction with pest information, basic information on the crop stage, damage, crop growth and environmental conditions are relevant. This information is critical in deciding whether a control is necessary, and the appropriate timing.

Insect checking records should include as a minimum:

- date and time of day
- crop growth stage
- average number of pests detected, and their stage of development
- checking method used and number of samples taken
- management recommendation (economic threshold calculation)
- post-treatment counts.

7.5.2 What to be aware of when sampling for *Helicoverpa*

Eggs and very small larvae

Egg counts are an unreliable indicator of *Helicoverpa* larval densities, and potential crop damage. Eggs are difficult to find and count, and egg survival through to larvae is generally very low because eggs fall off plants in the wind/rain, and are eaten by predators. Counting eggs is not recommended, or required in estimating *Helicoverpa* larval densities.

MORE INFORMATION

Aphids – to spray or not to spray

Similarly, very small larvae (<3 mm) are difficult to find in the crop, and mortality in other crops is known to be high. Given the high level of beneficial insect activity in faba beans, we can assume that many eggs and very small larvae will be eaten by predators (predatory bugs, ladybeetles, red and blue beetles, lacewings).

Visible egg lays and moth activity in the crop are indicative of *Helicoverpa* pressure in the crop, and should be a sign that *Helicoverpa* needs to be monitored for in coming days/weeks.

Small, medium and large larvae

Exactly which larval stages have the capacity to cause damage in faba beans has not been researched. At this point we are assuming that *Helicoverpa* behaves similarly in faba beans to how it behaves in other pulses.

It is typically the medium–large larvae that cause the majority of crop loss in pulses. These larvae (>8 mm) will feed on buds, flowers, and penetrate pods to feed on developing seed. In general, *Helicoverpa* larvae consume 80% of their total lifetime consumption in the final two instars (large larvae). This is why it is important to implement control, if required, before larvae reach this stage.

The natural mortality of larger larvae is lower than for earlier stages, although there are a number of natural enemies that will attack medium–large larvae (e.g. *Microplitis* parasitoid, predatory bugs, *Netelia*, *Heteropelma*) (Figure 40).

Figure 40: *Microplitis cocoon beside a parasitized* Helicoverpa larva *(left). (right) Collection of predators caught in a sweep net (lady beetles, brown lacewing, damsel bug, green mirid visible).*

Photos: Melina Miles, QDAF

7.5.3 *Helicoverpa* damage in faba beans

Helicoverpa larvae will feed on leaves, buds, flowers and the developing grain in pods. It is not known if they have a preference for particular structures, but preliminary examination of in-plant distribution in flowering/podding faba beans has shown few larvae on leaves compared with the number on the reproductive structures.

Flowers and buds

Whilst the poor rate of conversion of flowers to pods in faba beans is acknowledged, there seems to be a general acceptance that the plant produces an excess of flowers and protecting these is not necessary. Observations during trial work (QDAF) have shown significant levels of damage to flowers can occur, resulting in non-viable flowers. The larvae feed directly on the pollen sacs or on the ovary of the flower (Figure 41). Whilst no threshold is currently proposed for *Helicoverpa* in flowering crops, it is suggested that monitoring for *Helicoverpa* commence prior to the first pods setting.

Figure 41: Helicoverpa *damage to flowers, damaging the pollen sacs (left) and the ovary (right).*

Photos: Melina Miles, QDAF

Pods and grain damage

Helicoverpa are very damaging to faba bean pods, making many more exploratory holes and partially consuming more grain than seen in other pulses.

The holes make the pods vulnerable to infection by fungi and bacteria, which may in turn increase the likelihood of weathered and discoloured grain (Figure 42). Investigation is required into how *Helicoverpa* feeding contributes to defective grain alone (insect damage) or in combination with 'weathering' impacts.

Figure 42: Helicoverpa *damage to faba bean pods. Multiple entry points in a pod and partially consumed grain are typical, allowing entry by fungi and bacteria that may contribute to increased levels of defective grain.*

Photos: Melina Miles, QDAF

7.5.4 Defective grain and the contribution of *Helicoverpa*

One of the concerns been raised repeatedly in terms of *Helicoverpa* management in faba beans is the issue of defective grain. To determine whether insect damage was the main cause of defective grain QDAF analysed the data from 80+ receival notes from faba bean deliveries in NSW between 2010 and 2012. The top ten contributing categories of defective grain are presented in Table 4. Whilst insect damage is not making the highest contribution to overall defective grain (1.3% on average), the overall impact of insect damage may be higher if weathering and poor colour are a result of insect damage. These quality aspects require further investigation.

Table 4: *Top ten contributing defective grain categories for NSW-delivered faba bean samples (2010–12), n=83 samples.*

Ranking	Defective grain category	Average of all seed (%)
1	Broken/damaged	2.0
2	Insect damage	1.3
3	Weathered	1.2
4	Shrivelled	1.1
5	Poor colour	0.8
6	Sprouted	0.53
7	<3.75 mm	0.41
8	Caked	0.32
9	Seed coat broken/split	0.31
10	Green/immature	0.13

Source: QDAF data

7.5.5 Thresholds

Insect pest thresholds provide a guide to what number of the pest is likely to cause significant economic loss if not controlled. Thresholds are a critical component of pest management, ensuring that treatments are only applied when the value of the crop loss is greater than the cost of controlling the pest.

Some economic thresholds are derived from extensive trial work that establishes a relationship between pest density and crop loss—accounting for crop compensation.

However, the majority of the thresholds available to guide decisions in faba beans are what is known as 'nominal or 'best bet' thresholds. These thresholds are not developed from trial work, but based on educated guesses and experience.

Helicoverpa thresholds for faba beans are nominal thresholds, and there is some variation in the recommendations made in the different growing regions/ states (Table 5).

Table 5: *Published thresholds for* Helicoverpa *in faba beans.*

Pest	Faba bean threshold
WA	Yield loss (/ha) estimated for every larva per 10 sweeps 90 kg (Mangano et al. 2006)
VIC/SA	4–8 larvae per m^2 (beating) 2–3 larvae per 10 sweeps (Insectopedia 2000)
NSW	2–4 larvae per m^2 (less than 10 mm) Human consumption 1 per m^2

It is not possible to extrapolate threshold data from chickpea, or summer pulses, to faba beans because the relationship between *Helicoverpa* and the crop may be very different. For example, the WA yield loss estimate for chickpea is 30 kg/ha; very different from the 90 kg/ha estimated for faba beans.

Yield and quality thresholds

The published thresholds for *Helicoverpa* in faba beans appear to be based on the economics of yield loss (loss of grain weight). However, given the low tolerance for defective grain in faba beans, it is probable that a loss in quality (and consequently downgrading) will occur before economically significant grain loss occurs.

Research is necessary to determine the impact of *Helicoverpa* feeding damage on yield loss, and quality.

When the DAFWA figure of 90 kg/ha is used to calculate the economic threshold (Table 6), the threshold is considerably lower than the nominal thresholds recommended.

Conversion of beat sheet samples and sweep net samples to a common unit (e.g. per metre squared) has is not yet possible. The equivalence has not been tested.

Table 6: *Faba bean yield loss-based ready reckoner for* Helicoverpa.

Cost of control ($/ha)	Grain price ($/t)		
	300	400	500
15	0.6	0.4	0.3
20	0.7	0.6	0.4
25	0.9	0.7	0.6
30	1.1	0.8	0.7
35	1.3	1.0	0.8
40	1.5	1.1	0.9

Base on DAFWA yield loss estimate of 90 kg/ha per larva per 10 sweeps.

7.5.6 Other considerations when making control decisions based on *Helicoverpa* larval densities are:

- environmental conditions and the health of the crop
- how quickly the crop is finishing, and how long it will be susceptible to damage
- how likely is wet weather than may exacerbate the *Helicoverpa* damage through weathering

- prevalence of natural control agents such as parasitic wasps, predatory shield bugs, ladybirds and diseases
- type and location of pest damage and whether it affects yield indirectly or directly
- stage in the life-cycle of the pest and the potential for damage—how long until the larvae are damaging, or pupated?
- crop stage and ability of the crop to compensate for damage
- value of the crop (high-value crops cannot sustain too much damage as a small loss in yield or quality could mean a large financial loss) versus the cost of the spraying and the likely yield or quality benefit gained from control. [3]

7.5.7 Control options for *Helicoverpa* in faba beans

Within the range of options available for pest control in faba beans, there is considerable variability in the impact they will have on beneficial insects (predators, parasitoids, bees) in the crop. It is worth being familiar with the relative impact of the softer, moderate and highly disruptive options (Table 7).

Table 7: *Relative selectivity (impact on beneficial insects) of a range of insecticides/ biopesticides registered for use in faba beans.*

Product	Overall ranking	Predatory beetles - Total	Predatory bugs - Total	Apple Dimplling bug	Lacewing adults	Spiders	Total (wasps)	Ants	Thrips
Bt	Very low	VL	VL	VL	VL	VL	VL	VL	VL
NPV (Vivus Max)	Very low	VL	VL	VL	VL	VL	VL	VL	VL
Pirimicarb (Pirimor)	Very low	VL	L	VL	VL	VL	VL	VL	L
Petroleum spray oil	Very low	VL	VL	VL	VL	L	VL	H	VL
Indoxacarb (Steward)	Low	L	VL	H	M	VL	VL	H	VL
Emamectin (Affirm)	Mod	L	H	H	L	M	M	VL	M
Dimethoate (200 mL/ha)	Mod	M	M	M	M	L	M	H	M
Dimethoate (500 mL/ha)	High	M	M	H	VH	M	H	VH	M
OP's	High	H	H	VH	L	M	H	VH	H
Pyrethroids	Very high	VH	VH	VH	VH	VH	VH	VH	VH

Source: www.ipmworkshops.com.au; Cotton pest management guide 2012–13 for more detailed information

Resistance management strategies

The capacity for *H. armigera* to develop resistance to widely used insecticides is well documented. One of the key factors leading to this has been prolonged exposure to certain chemical groups, both within and across seasons.

3 Southern/Western Faba & Broad Bean—Best Management Practices Training Course 2013. Pulse Australia.

Minimising the risk of poor control, and exacerbating resistance, can be achieved through the following strategies:

- Determine the likelihood of *H. armigera* being present in the crop before attempting to control a population of *Helicoverpa* with OPs, SPs. The use of pheromone traps for *H. armigera* and *H. punctigera* in the spring will provide useful information on the level of activity of the two species.
- Consider the impact of sprays on *Helicoverpa*, even if *Helicoverpa* is not the target. Every exposure contributes to selection for resistance to those products.
- Do not use the same chemical group in consecutive sprays. With the efficacy of some of the newer chemistry, it may be tempting to continue using it rather than rotating with another group. The more exposures *Helicoverpa* populations have to the same active ingredient, the more likely it is that resistance will develop.

The cotton and grains industries monitor levels of *Helicoverpa* resistance to key insecticide groups and the two Bt toxins deployed in genetically modified (GM) cotton and key grain crops (information available on the Cotton CRC website).

Spray smart

Timing and coverage are both critical to achieving good control of *Helicoverpa* larvae, whether using a chemical insecticide or a biopesticide (such as NPV or Bt).

A poor level of control from inappropriate timing risks crop loss and the costs of re-treating the field. Poor timing also increases the likelihood of insecticide resistance by exposing larvae to sub-lethal doses of insecticide. Regular crop scouting enables assessment of both the number of *Helicoverpa* larvae in the crop and the age structure of the population.

Ensure crops are being checked when they are susceptible to *Helicoverpa* damage. Early detection is critical to ensure effective timing of sprays.
Larvae that are feeding or moving in the open are more easily contacted by spray droplets. Target larvae before they move into protected feeding locations (e.g. flowers, pods).

Ensure larvae are at an appropriate size to control effectively with the intended product (Figure 43).
Very small (1–3 mm) to small (4–7 mm) larvae are the most susceptible stages and require a lower dose to kill. Larvae grow rapidly; if a spray application is delayed more than 2 days, the crop should be rechecked and reassessed

Assess if the larvae are doing economic damage. Only spray if the value of the crop saved is more than the cost of spraying. Vegetative feeding generally does not equate to significant yield loss.

Good coverage is increasingly important with the introduction of ingestion-active products because the larvae must actually feed on plant material covered with an adequate dose of the insecticide or biopesticide.

Attract-and-kill products such as Magnet® consist of a liquid moth lure based on floral volatiles mixed with an insecticide. Only a relatively small area needs to be treated (<2% of the total crop), minimising impact on natural enemies. Reducing the pest moth population decreases the number of eggs laid into a crop, which can lower subsequent pest pressure and delay the need for foliar insecticides.

Figure 43: Helicoverpa *larva killed by NPV.*

Photo: Melina Miles, QDAF

7.6 Legal considerations for pesticide use

Information on the registration status, rates of application and warnings related to withholding periods, occupational health and safety (OH&S), residues and off-target effects should be obtained before making decisions on which pesticide to use. This information is available from State Department Chemical Standards Branches, chemical resellers, Australian Pesticide and Veterinary Medicine Authority (APVMA) and the pesticide manufacturer.

Background to some of the legal issues surrounding insecticide usage is provided here, but it is by no means exhaustive. Specific questions should be followed up with the relevant staff from your local State Department.

7.7 Registration

Users should be aware that all pesticides go through a process called registration, where they are formally authorised (registered) by APVMA for use:

- against specific pests
- at specific rates of product
- in prescribed crops and situations
- where risk assessments have evaluated that these uses are:
- effective (against the pest, at that rate, in that crop or situation)
- safe (in terms of residues not exceeding the prescribed MRL (maximum residue level)
- not a trade risk.

Labels

A major outcome of the registration process is the approved product label—a legal document—that prescribes the pest and crop situation where a product can be legally used, and how.

MSDS

Material Safety Data Sheets are also essential reading. These document the hazards posed by the product, and the necessary and legally enforceable handling and storage safety protocols.

Permits

In some cases a product may not be fully registered but is available under a permit with conditions attached, which often require the generation of further data for eventual registration.

APVMA

The national body in charge of administering these processes is called the APVMA (the Australian Pesticides and Veterinary Medicines Authority) and is based in Canberra.

Always read the label

Apart from questions about the legality of such an action, the use of products for purposes or in manners not on the label involves risks. These risks include reduced efficacy, exceeded MRLs and litigation.

Be aware that pesticide-use guidelines on the label are there to protect product quality and Australian trade by keeping pesticide residues below specified MRLs. Residue limits in any crop are at risk of being exceeded or breached where pesticides:

- are applied at rates higher than the maximum specified
- are applied more frequently than the maximum number of times specified per crop
- are applied within the specified withholding period (i.e. within the shortest time before harvest that a product can be applied)
- are not registered for the crop in question.

PestGenie

Pest Genie® (http://www.pestgenie.com.au) is an easy-to-use, web-based system, which provides a full suite of tools to aid compliance with legal, OH&S and industry requirements related to the storage and use of chemicals, including pesticides and animal health products.

7.8 References and further reading

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Parasitoids: Natural enemies of helicoverpa

Understanding helicoverpa ecology and biology: Know the enemy to manage it better (PDF, 1.0MB)

Using NPV to manage helicoverpa in field crops (PDF, 446.1KB)