Good Bug? Bad Bug?

An identification guide for pest and beneficial insects in summer pulses, soybeans, peanuts and chickpeas

Hugh Brier
Joe Wessels
Kate Charleston

GRDC
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This guide aims to help growers and consultants correctly identify pest and beneficial insects in summer pulses (mungbeans, navy beans, adzuki beans, cowpeas and pigeon peas), soybeans, peanuts and chickpeas. The '**good bugs**' are predators and parasitoids of the '**bad bugs**', which are pests of these crops.

This publication is supported by

Note that the term 'bug' in the title is used colloquially. Strictly speaking, the only insects that should be referred to as 'bugs' are the true bugs (Order Hemiptera) which include major pests such as the green vegetable bug and mirids, and major predators such as the spined predatory bug and damsel bugs.

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Good bug?
Bad bug?

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Hugh Brier[1], Joe Wessels[1] and Kate Charleston[2]

DAFF Queensland (Primary Industries)
[1]Kingaroy and [2]Toowoomba

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Note:

Insect sizes provided on photographs in this guide refer to the body length only (or wingspan if specified). They do not include antennae, legs, or other protruding body parts.

Insect information is shaded to indicate pest or beneficial status - good bugs (beneficials) in blue and bad bugs (pests) in orange. Major pests are highlighted with a warning symbol.

Very small insects (adults less than 3 mm) or eggs are indicated with a magnifying glass

GOOD BUG

BAD BUG

MAJOR PEST

Commonly encountered insects

Pests

Helicoverpa

Helicoverpa (*H. armigera* and *H. punctigera*) is a very damaging pulse pest, attacking all plant parts including leaves, terminals, buds, flowers and pods. In summer pulses in Northern Australia, the more difficult to control *H. armigera* is the dominant species. While crops can compensate for low to moderate early helicoverpa damage, very high populations in younger crops can destroy terminals, buds, flowers, and young pods, and have a major impact on yield and harvest maturity. Damage to well-developed pods directly affects yield and can reduce seed quality. It is important to accurately identify larvae so that the correct pesticides can be applied. *H. armigera* has resistance to many older pesticides and helicoverpa virus biopesticides (e.g. VivusMax® and Gemstar®) have no impact on non-helicoverpa caterpillars, e.g. loopers.

Loopers and other leaf-feeders

Cluster caterpillar (*Spodoptera litura*) is most common in the tropics and coastal regions. As well as feeding on leaves, it attacks flowers and pods, although not as voraciously as helicoverpa. However, in peanuts it sometimes causes significant damage to the pegs and any pods near the soil surface. Caterpillars can reach over 40 mm long and have smooth fat bodies with distinctive black half moons along the back and sides. They have 4 pairs of ventral prolegs.

The most common large leaf-eating caterpillars are the **soybean, vegetable and tobacco loopers**. These are easily differentiated from helicoverpa by their tapering bodies (towards the head end) and because they have 2 pairs of ventral prolegs. In Queensland's tropical and coastal regions, a number of **brown loopers** are encountered, the most abundant being the **bean looper** (*Mocis alterna*), other *Mocis* sp., and *Pantydia* sp. (no common name). Brown loopers have elongated parallel (non-tapering) bodies with 2-3 pairs of ventral prolegs. All loopers move with a looping action. While predominantly foliage feeders, they also attack mungbean flowers. Loopers are readily controlled with Bt-based biopesticides such as Dipel®.

The **grass blue butterfly's** slug-like larvae feed on soybean leaves but also damage vegetative terminals. Severe terminal damage (>25%) can have a significant impact on yield. Hoverfly larvae (important aphid predators) also have a slug-like appearance, and are often misidentified as grass blue butterfly larvae. Grass blue larvae have proper legs whereas hoverfly larvae are maggots and have no legs.

Leaf miners and webbers

All are small to medium caterpillars that feed inside (mine) leaves, or roll or web leaves together to form sheltered feeding sites. The most common species are **soybean moth** (*Aproaerema simplexella*), which feeds inside leaves and spasmodically occurs in plague numbers, and the larger **legume webspinner** (*Omiodes diemenalis*), which is common in coastal crops, but usually not in sufficient numbers to inflict economic damage. The **beet webworm** (*Spoladea recurvalis*) is rarely if ever an economic pest in summer pulses, but the adult stage (moth) is very often confused with that of the very damaging bean podborer (*Maruca vitrata*). Large populations of beet webworms often develop on more favoured weed hosts such as black pigweed.

Pod boring caterpillars

Bean podborer (*Maruca vitrata*) is a major pest of adzukis, mungbeans, navy beans and pigeon pea, but not soybeans and peanuts. It is most prevalent in coastal and tropical regions where populations of 20-30 per square metre are frequently encountered. The distinctive pale black-spotted larvae initially feed in flowers before moving to the pods. Early detection is critical (look for the webbing of flowers) as larvae are very difficult to control once they are inside the pods.

Etiella (*Etiella behrii*) is a major pest of dryland peanuts, particularly in end-of-season droughts. It is a lesser pest of soybeans, mungbeans and adzukis. In peanuts, larvae are able to reach and infest the below ground pods and once inside, are impossible to control. Etiella damage greatly increases the risk and level of aflatoxin contamination in peanuts. Irrigation reduces the risk of infestation, and early harvest reduces the level of aflatoxin.

Stem boring beetles

Lucerne crown borer (*Zygrita diva*) is a common stem boring beetle in soybeans. The distinctive orange beetles lay eggs in young plant stems, and the larvae tunnel inside the plant feeding on the pith. Pith feeding has no impact on yield, but larvae girdling (ringbarking) of the stem prior to pupation has a major impact if (a) it occurs before the completion of podfill, or (b) girdled plants lodge prior to harvest. This pest is of increasing concern in the NSW Northern Rivers district.

Stem boring flies

Stem boring flies can also inflict significant damage. **Beanfly** (*Ophiomyia phaseoli*) is a major pest in seedling navybeans, and **soybean stemfly** (*Melanagromyza sojae*) has caused serious damage to soybeans in the Mackay region. The early indicator of infestations are numerous pale oviposition stings on the leaves (look like pinpricks of light when leaves are held up to the sun).

Podsucking bugs

Podsucking bugs (PSB) include **green vegetable bug or GVB** (*Nezara viridula*), **redbanded shield bug** (*Piezodorus oceanicus*), **brown shield bug** (*Dictyotus caenosus*) and **brown bean bug** (*Melanacanthus* and *Riptortus* sp.). PSB are major pests of all summer pulses except peanuts. They can infest crops from flowering onwards, but crops are at greatest risk from early podfill to late pod ripening. Damage at early podfill can potentially reduce yield, but crops are often able to compensate for even moderate early damage. Damage at mid to late podfill has a severe impact on seed quality and podsucking bug thresholds are consequently very low. GVB is the most common species, but others can predominate or contribute to overall PSB pressure. The brown bean bugs (large and small) are as damaging as GVB. While not as damaging as GVB, the redbanded shield bug (= 0.75 GVB) and the brown shield bug (= 0.2 GVB) are more difficult to control. Deltamethrin alone gives zero control of either species but up to 66% control can be achieved with the addition of a 0.5% salt (NaCl) adjuvant. See page 40 for more information on converting to GVB equivalents.

Mirids

Green and brown mirids (*Creontiades* sp.) are small elongated bugs that feed on buds and flowers. Populations typically increase throughout budding and flowering and crops are consequently exposed to increasing and sustained pressure for 21-28 days. Summer pulses at greatest risk are mungbeans, adzukis and navy beans and thresholds are very low. Peanuts and soybeans are less susceptible to attack. Populations of up to 5 mirids per square metre (nymphs plus adults) can be tolerated in soybeans with no impact on yield.

Aphids

Small soft-bodied sap-sucking bugs. **Soybean aphids** (*Aphis glycines*) are bright green and restricted to soybeans. Now widespread in Queensland and coastal NSW, they are often kept in check by predators, especially ladybirds. Damaging outbreaks are more likely in cooler seasons or where predators are disrupted by non selective pesticides. Soybean aphid can have a severe impact on yield and evenness of crop maturity. Dark grey to black **cowpea aphids** are an occasional pest of mungbeans, peanuts and pigeon pea.

Silverleaf whitefly

Silverleaf whitefly or SLW (*Bemisia tabaci type B*) is an ever-present threat to soybeans and navy beans in Queensland and northern NSW. Peanuts are a less preferred host and SLW is not a problem in mungbeans or pigeon pea. The key IPM strategy is to delay spraying non-selective pesticides for as long as possible, particularly in the vegetative/flowering stages. Biopesticides are effective against small helicoverpa larvae and medium loopers, and mirid populations of up to 5 per m^2 can be tolerated in soybeans with no yield impact. Delay spraying for podsucking bugs with deltamethrin until the start of podfill. Minimising disruptive pesticide use maximises the effectiveness of one of SLW's natural enemies, the introduced small parasitic wasp, *Eretmocerus hayati*.

Soil insects and slugs

Soil insect problems are often related to soil type and stubble management. **Peanut scarabs** such as *Heteronyx piceus* are most prevalent in red volcanic soils of the South Burnett, whereas blacksoil **earwigs** are most active in heavy cracking soils. **Field crickets** are classed as soil insects but will attack soybean and mungbean pods, the damage being very similar to mouse damage. **Slugs** are an increasing problem in higher rainfall years where zero till is practiced and where there is increased stubble retention on the soil surface.

Mites

Two-spotted or red spider mites (*Tetranychus* sp.) can be a problem where a crop is in close proximity to earlier-maturing hosts such as cotton and maize. The risk of mite attack is greatly increased in regions where non-selective pesticides are widely used. Two-spotted mites are usually light green with two dark spots, but overwintering mites are red all over. Mite-damaged leaves are silvery with fine webbing. **Peanut mites** (*Paraplonobia* sp.) are a minor peanut pest and are dark green and much larger than two spotted mite.

Beneficials - predators

Predatory bugs

Two species of **large predatory shield bugs** are commonly found in summer pulses and attack helicoverpa and other caterpillars. The **spined predatory bug** (*Oechalia schellenbergii*) has distinctive spines on its shoulder. Its nymphs lack spines but have a distinctive red or orange ring on their backs. The **glossy shield bug** (*Cermatulus nasalis*) is larger and a more glossy brown than the pod-feeding brown stink bug (*Dictyotus caenosus*), which is a more 'dusty' brown. *Cermatulus* nymphs are dark with four red or orange spots on their backs. Eggs of both predatory bug species are laid in rafts similar in size to GVB rafts, but are dark and are fringed on top with spines. *Oechalia* eggs have longer spines than *Cermatulus* eggs.

Assassin bugs are more common in tropical regions, the best known is the large *Pristhesancus* sp. Assassin bug adults have concave abdomens (when viewed from above), and prominent recurved "beaks" to pierce their prey (and unwary fingers!). Assassin bugs are commonly mistaken for brown bean bugs.

A number of **small predatory bugs** attack small caterpillars and eggs. The **damsel bug** (*Nabis kingbergii*) is a small slender assassin type bug while the **bigeyed bug** (*Geocorris lubra*) is stout with prominent eyes. Being small, both species are often overlooked when scouting. Predatory mirids commonly seen in soybeans include the **apple dimpling bug** (or yellow mirid) (*Campylomma liebknechti*) and the **brown smudge bug** (*Deraeocoris signatus*). Nymphs of the latter are maroon in colour and look like aphids but have only one tube-like projection from their abdomen (as opposed to three for aphids).

Predatory beetles

Ladybirds are the most common predatory beetles. Large numbers of the highly visible bright orange adults indicate a crop is infested with aphids or silverleaf whitefly. Common species include the transverse and striped ladybirds, and the newly arrived white-collared ladybird (*Hippodamia variegata*). Other predatory beetles attack moth eggs and small caterpillars and include **red and blue beetles**, **carabs** and **soldier beetles**.

Other important predators include **ants**, **lacewings**, **predatory wasps**, **hoverfly larvae**, **wireworm larvae**, **spiders**, **frogs** and **birds**.

Beneficials - parasitoids

Parasitoids of podsucking bugs

The introduced green vegetable bug (GVB) parasitoid ***Trichopoda giacomellii*** attacks large nymphs and adult GVB, laying large off-white eggs, usually on the bug's back or thorax. Green vegetable bug eggs are also frequently parasitised by the tiny wasp ***Trissolcus basalis***. Parasitised GVB eggs turn black and are easily distinguished from the dark eggs of predatory bugs, as they lack the peripheral dorsal spines of the latter.

Parasitoids of caterpillars

Helicoverpa eggs are frequently parasitised by very small ***Trichogramma sp***. wasps. Parasitised eggs turn black before the tiny wasps emerge. Helicoverpa larvae are parasitised by a number of wasps and tachinid fly species. The most common wasps include the **two-toned caterpillar parasite** (*Heteropelma scaposum*) and *Microplitis demolitor* (no common name). Larvae of the former don't complete their development until helicoverpa pupate but *Microplitis* larvae emerge from mid-sized helicoverpa larvae and pupate beside their victim. Looper larvae and armyworms are commonly parasitised by small wasps *Apanteles*, *Coetesia* and *Litomastix* sp., which lay large numbers of eggs in each host. Hundreds of parasites can emerge from a single larva.

Parasitoids of silverleaf whitefly

Silverleaf whitefly are parasitised by tiny wasps in the genera ***Encarsia*** and ***Eretmocerus*** including the imported *Eretmocerus hayati*.

NOTE: Unnecessary spraying results in the needless death of predators and parasitoids and can flare helicoverpa, whitefly, mites and aphids.

Large caterpillars (when fully grown), attacking leaves, buds, flowers and/or pods

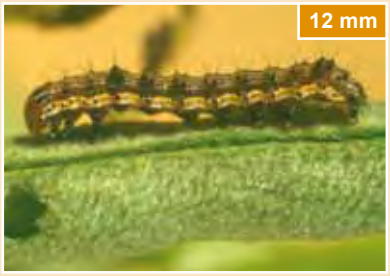
Helicoverpa

Helicoverpa armigera and H. punctigera

MAJOR PEST of leaves, buds, terminals, flowers and pods

Large *H. armigera* larva - dark colour variant with yellow side stripe - note parallel body and four pairs of ventral prolegs

Large (late 5th instar) *H. armigera* larva - green variant - note white hairs and wide pale side (lateral) stripe



Medium *H. armigera* larva - note four pairs of ventral prolegs and dark saddle behind front legs

Small *H. armigera* larva in soybean terminal

Medium (4th instar) larvae attacking mungbean buds

Medium (4th instar) *H. punctigera* larva - dark hairs and lack of dark saddle

Cluster caterpillar

Spodoptera litura

Moderate PEST of leaves/pods

Note fat body, rows of large dark half moon spots and yellow stripes, and 4 pairs of ventral prolegs. More common in coastal and tropical regions. Heavy infestations are damaging due to this species' large size.

Large larva

Medium larva (dark form)

Newly hatched from egg mass

Irrorated tabby

Anticarsia irrorata

Minor PEST of leaves

Note pale bands between body segments and 4 pairs of ventral prolegs.
Red-striped variant often has an 'irrorated' appearance – sprinkled with fine dark sand.

White-striped form

Red-striped variant

Medium larvae

Use for comparison of actual size:

mm 10 20 30 40 50

Leaf feeding caterpillars (Loopers)

Soybean looper

Thysanoplusia orichalcea

Moderate PEST

Larvae have a pronounced looping movement, tapered body, and 2 pairs of ventral prolegs.

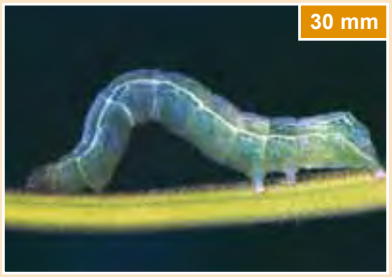
Large larvae

Medium larvae - note colour and stripes

Tobacco looper

Chrysodeixis argentifera

Moderate PEST



Two pairs of ventral prolegs

Bean looper

Mocis alterna

Moderate PEST

Long thin body with forward sloping head and two pairs of ventral prolegs. Very variable in colour.

Typical colour variant

Striped variant

Orange variant

Three barred moth

Mocis trifassiata

Minor PEST mostly coastal

Sloping head, 2 pairs of ventral prolegs

Pantydia capistrata

Minor PEST mostly coastal

Two pairs of ventral prolegs

Pantydia metaspila

Minor PEST mostly coastal

Three pairs of ventral prolegs

Castor oil looper

Achaea janata

Minor PEST

Large very variable looper. Three pairs of functional ventral prolegs. Rarely occurs in damaging numbers.

Purple variant

Orange variant

Twig caterpillar

Scopula perlata

Minor PEST (infrequent)

One pair of ventral prolegs - too small and infrequent to ever pose a threat

Small to medium caterpillars - leaf feeders, miners, webbers and flower feeders

Grass blue butterfly
Zizina labradus
Moderate PEST

Attacks leaves and terminals; slug like - head tucked underneath

Crotalaria moth
Utethesia lotrix
Minor PEST

Hairy body – rarely in damaging numbers

Nodaria externalis
Minor PEST - mostly coastal

Reticulated pattern and four pairs of ventral prolegs

Pea blue butterfly
Lampides boeticus
Minor PEST of flowers

Attacks flowers; slug like - head protruding in this specimen

Tiger looper
Gymnoscelis lophopus
Minor PEST of flowers

Often striped (hence the common name), rough skin

Plume moth
Sphenarchus sp
Minor PEST of flowers

Covered in short spines

Cotton webspinner
Achyra affinitalis
Minor PEST of seedling soybeans

Dark head, grey body; wriggles violently

Legume webspinner
Omiodes diemenalis
Minor PEST of coastal crops

Look for frass and webbed leaves; may have dark head when young

Beet webworm
Spoladea recurvalis
Minor PEST

Rarely if ever present in damaging numbers

Soybean moth
Aproaerema simplexella
SPASMODIC MAJOR PEST soybeans

Major pest only if in large numbers; only feed on soybeans

Soybean leafminer
Lithocolletis aglaozona
Minor PEST

Larvae and damage - larvae are widest just behind the head

Hydrilloides lentalis
Minor PEST of peanut leaves

Rough skin; often found at base of plants

Use for comparison of actual size:

mm 10 20 30 40 50

Caterpillars & other larvae - pod and stem borers

Bean podborer

Maruca vitrata

MAJOR PEST (adzuki, navy & mung)

Medium larva (note prominent spots) - feeds in flowers before moving to pods

Etiella

Etiella behrii

MAJOR PEST of peanuts

Pale green or cream with pink stripes with red band behind head.

Larva damaging young peanut pod

Larvae reach pods through cracks in soil

Sorghum head caterpillar

Cryptoblabes adoceta

Minor PEST

Larva (cream with brown stripe) and damage; very low incidence

Endotricha punclicotalis

Minor PEST

Dark larva are common under peanut bushes but little if any pod damage

Eublemma dimidialis

Minor PEST in the tropics

Larva in mungbean pod

Helicoverpa

Helicoverpa armigera

MAJOR PEST

The most damaging podboring pest in terms of damage and abundance

Sugarcane wireworm

Agrypnus variabilis

Moderate PEST of tropical peanuts

Small larva in peanut pod

Lucerne crown borer

Zygrita diva

MAJOR PEST in some regions

Larva in soybean stem - note the brown discolouration of the pith

Whitefringed weevil

Graphognathus leucoloma

MAJOR PEST of peanuts

Larva and damage to peanut taproot

Soybean stemfly

Melanagromyza sojae

Minor PEST in the tropics

Larva and damage

Beanfly pupa

Ophiomyia phaseoli

MAJOR PEST (navy bean seedlings)

Pupae and damage in mungbean

Larval predators, parasitoids and diseases

Common hoverfly

Simosyrphus grandicornis

MAJOR PREDATOR of aphids and whitefly

Larva - note maggoty body tapering towards the head

Larva attacking cowpea aphids

Braconid wasp

Agathis sp.

MAJOR PARASITOID of etiella

Larvae emerging from Etiella host

Insert: Adult wasp

Litomastix sp.

MAJOR PARASITOID

Soybean looper full of *Litomastix* pupae

Wasp pupae visibe under caterpillar skin

Orange caterpillar parasite

Netelia producta

MAJOR PARASITOID

Egg laid near head of *H. punctigera* larva

Microplitis demolitor

MAJOR PARASITOID

(Image Nat Parker)

Microplitis pupa beside helicoverpa host

(Image David Murray)

Microplitis larva squeezed from helicoverpa

Tachinid fly

Carcelia sp.

PARASITOID

Note the white egg behind the caterpillar's head

Apanteles sp.

MAJOR PARASITOID

Characteristic fluffy white wasp pupal cocoons covering armyworm larva

NPV - Nucleopolyhedrovirus

PATHOGEN (VIRUS) of helicoverpa

Helicoverpa larvae killed by NPV (note how larvae has liquified) - commercial formulations of NPV are specific to helicoverpa

Beauvaria

PATHOGEN (FUNGUS)

Noticable in wet (La Nina) years

Helicoverpa larva killed by fungus

GOOD BUG

BAD BUG

MAJOR PEST

Use for comparison of actual size:

mm 10 20 30 40 50

(W) = wingspan

Moths - large

Helicoverpa

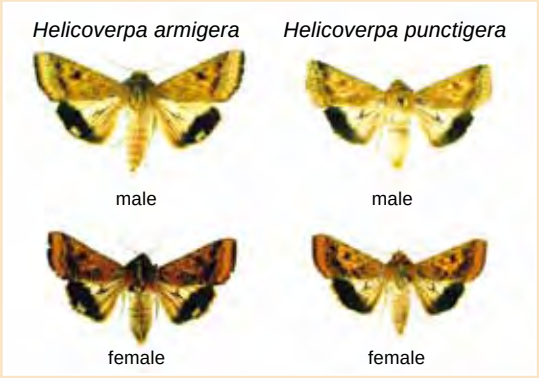
Helicoverpa spp.

MAJOR PEST

The small pale spots in the hind wing inner margins are indicative of *H. armigera,* and not present in *H. punctigera.* Note the forewings are brown in the female and cream in the male.

H. armigera female

H. armigera male



Pinned moths showing wing patterns

Tobacco looper

Chrysodeixis argentifera

Moderate PEST

Silver markings on forewings

Soybean looper

Thysanoplusia orichalcea

Moderate PEST

Large golden patch on forewings

Pinned moth showing wing patterns

Vegetable looper

Chrysodeixis eriosoma

Moderate PEST

Similar to tobacco looper but with a gap between the silver wing spots

Sugarcane armyworm

Leucania stenographa

Minor PEST in coastal regions

Cluster caterpillar

Spodoptera litura

Moderate PEST

Note the distinctive criss-cross pattern

Bean looper

Mocis alterna

Moderate PEST

Grey wings with dark markings

Three barred moth

Mocis trifassiata

Moderate PEST

Note the distinctive brown bands

Pantydia metaspila

Minor PEST

Common in coastal crops

Moths - large and medium

(W) = wingspan

Pantydia capistrata
Minor PEST mostly coastal

Similar size to helicoverpa but has different wing patterns

Castor oil looper
Achaea janata
Minor PEST

Very large but uncommon looper. Note the distinctive pattern on the hindwing of the pinned specimen.

Adult at rest - note large size

Pinned moth - note pattern on hindwing

Bean podborer
Maruca vitrata
MAJOR PEST

Normal resting pose - outspread wings and body raised at head end

Irrorated tabby
Anticarsia irrorata
Minor PEST of leaves

Note the distinctive fine line from wingtip to wingtip. Looks very similar to the moth of a major soybean pest in the Americas, the velvet bean caterpillar *Anticarsia gemmatalis.*

Brown form

Dark form

Beet webworm
Spoladea recurvalis
Minor PEST

Often confused with bean podborer moths but hindwings are predominantly brown

Crotalaria moth
Utethesia lotrix
Minor PEST

Very distinctive red and black spots

Nodaria externalis
Very minor PEST

Eublemma dimidialis
Minor PEST in the tropics

(Image M. Shepard)

Cotton webspinner
Achyra affinitalis
Minor PEST

Mainly a seedling pest

Twig caterpillar
Scopula perlata
Minor PEST

Wings spread out at rest – typical for this moth family

Use for comparison of actual size:

mm 10 20 30 40 50

(W) = wingspan

Butterflies and small moths

Grass blue butterfly

Zizina labradus

Moderate PEST

Note - no eye spots or tails on wings.

Wings closed at rest.

Pinned specimen showing blue wings

Etiella

Etiella behrii

MAJOR PEST of peanuts

Prominent snout; orange bands and white streak on forewing folded back over body

Pea blue butterfly

Lampides boeticus

Minor PEST

Note prominent white bands under wings, eye spots and small tails.

Wings closed at rest

Pinned specimen showing blue wings

Soybean moth

Aproaerema simplexella

SPASMODIC MAJOR PEST soybeans

Small, dark with white band; very jumpy - moth swarms 1st sign of a major outbreak

Plume moth

Sphenarchus sp.

Minor PEST

Normal resting pose - note very narrow feathery outspread wings

Legume webspinner

Omiodes diemenalis

Minor PEST

Very distinctive brown/yellow colouration

Soybean leafminer

Lithocolletis aglaozona

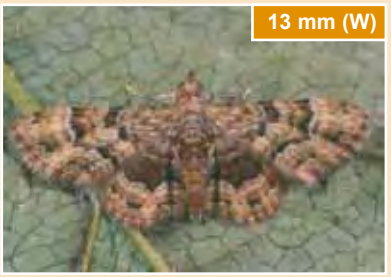
Minor PEST

Smaller and more brightly coloured than soybean moth

Tiger looper

Gymnoscelis lophopus

Minor PEST



Wings outspread at rest showing lovely cryptic colouration

Endotricha punclicotalis

Minor PEST

Distinctive purple brown and cream bands

Sorghum head caterpillar

Cryptoblabes adoceta

Minor PEST

Drab little moth with wings folded over body

Eggs - single or small groups

Helicoverpa
Helicoverpa sp.
MAJOR PEST

Left to right - fresh white, brown ring, and black larval head in nearly hatching eggs

Soybean looper
Thysanoplusia orichalcae
Moderate PEST

Slightly flattened (about 0.4 mm high)

Grass blue butterfly
Zizina labradus
Moderate PEST

Note marked central depression and bluish tinge

Trichogramma
Trichogramma pretiosum
MAJOR PARASITOID of helicoverpa

Adult wasp on helicoverpa egg (left) and unparasitised egg (top) vs parasitised

Bean looper
Mocis alterna
Moderate PEST

Slightly larger and more globular than helicoverpa eggs

Twig caterpillar
Scopula perlata
Minor PEST

Looks similar to lacewing egg but is vase shaped (i.e. not elliptical)

Large brown bean bug
Riptortus serripes
MAJOR PEST

Usually laid singly

Small brown bean bug
Melanacanthus scutellaris
MAJOR PEST

Laid singly or in small clusters

Soybean moth
Aproaerema simplexella
Minor PEST

Elongated (0.2 mm diameter)

Bean podborer
Maruca vitrata
MAJOR PEST

Eggs laid on flower bud - very hard to see

Etiella
Etiella behrii
MAJOR PEST of peanuts

Flattened eggs on peanut leaf petioles

Cluster caterpillar
Spodoptera litura
Moderate PEST

Egg cluster (left) and close up of eggs

Use for comparison of actual size:

mm 10 20 30 40 50

Eggs - rafts

Green vegetable bug (GVB)

Nezara viridula

MAJOR PEST

The freshly-laid pale egg raft contains 66 eggs, the orange raft contains 123 eggs. Individual eggs are 0.75 mm wide x 1 mm tall.

Freshly-laid egg raft

Egg raft ready to hatch - note orange colour

Young GVB nymphs emerging from eggs

Trissolcus basalis

MAJOR PARASITOID of GVB

Wasp emerging from GVB egg

Redbanded shield bug

Piezodorus oceanicus

MAJOR PEST

Distinctive dark eggs (elliptical in cross section) in twin-row rafts - hatching nymphs

Brown shield bug

Dictyotus caenosus

Moderate PEST

Twin row rafts - note pale colour

Green stink bug

Plautia affinis

Minor PEST

Note small raft size and olive green colour

Spined predatory bug

Oechalia schellenbergii

PREDATOR

Note dark colour and long perimeter spines

Glossy shield bug

Cermatulus nasalis

PREDATOR

Note dark colour and short perimeter spines

Ladybird

various species

MAJOR PREDATOR

Note elongated football shape

Assassin bug

Pristhesancus sp.

PREDATOR

Note tall, vase-like shape

Green lacewing

Mallada signatus

MAJOR PREDATOR

Elliptical eggs on distinctive long stalks

Shield bugs - adults (fully developed wings)

Green vegetable bug (GVB)

Nezara viridula

MAJOR PEST

Normal summer green form (top view) showing shield shape

Normal summer green form (side view) - note piercing/sucking mouth tube folded underneath the body

Overwintering form - usually purple to brown in colour

Uncommon orange summer form - often confused with an orange cockroach (see commonly confused insects section)

Brown shield bug

Dictyotus caenosus

Moderate PEST

Smaller than GVB - often confused with glossy shield bug

Green stink bug

Plautia affinis

Minor PEST

Note brown on wings

Redbanded shield bug

Piezodorus oceanicus

MAJOR PEST

Male (pale cream band)

Female (red/pink band)

Trichopoda eggs

Trichopoda giacomellii

PARASITOID

Eggs (4) laid on GVB adult

Spined predatory bug

Oechalia schellenbergii

PREDATOR

(Image K. Knight)

Attacking a GVB nymph

Large spined predatory bug

Andrallus spinidens

PREDATOR

Less common than *Oechalia* sp

Glossy shield bug

Cermatulus nasalis

PREDATOR

Attacking a cluster caterpillar; darker and larger than brown shield bug

Use for comparison of actual size:

mm 10 20 30 40 50

Shield bugs - nymphs, and leafhoppers

Green vegetable bug (GVB)

Nezara viridula

MAJOR PEST

Nymphs can be green or black with numerous white, orange and red spots.

Fifth instar nymph

Fourth instar nymphs - dark form

Third instar nymph

Redbanded shield bug

Piezodorus oceanicus

MAJOR PEST

Nymphs lack the spotting that is typical of green vegetable bug.

Fifth instar nymph

Fourth instar nymph

Second instar nymph

Glossy shield bug

Cermatulus nasalis

PREDATOR

Fifth instar nymph - note the 4 orange spots

Spined predatory bug

Oechalia schellenbergii

PREDATOR

Note distinctive ‘ring of fire’

Brown shield bug

Dictyotus caenosus

Moderate PEST

Fourth instar nymphs

Green stink bug

Plautia affinis

Minor PEST

Fifth instar nymph

Lucerne leafhopper adult

Austroasca alfalfae

Moderate PEST

Note yellow-green colour, rounded head and short antennae

Vegetable jassid adult

Austroasca viridigrisea

Minor PEST

Bright green jassids and ‘stipling’ damage - note the rounded head and short antennae

Elongated bugs

Large brown bean bug
Riptortus serripes
MAJOR PEST

Adults are flighty with muscley hind legs and a yellow band along each side. Nymphs look like ants.

Adult female

Adult male

Fourth instar nymph

Small brown bean bug
Melanacanthus scutellaris
MAJOR PEST

Similar to but less robust than the large brown bean bug and with a cream band on each side. Brown bean bug nymphs are easily confused with ants (see right). Bugs have a thicker waist and piercing/suking mouthparts (tucked under the body).

Adult

Fourth instar nymph

Third instar nymph

First instar nymph

Pacific damsel bug
Nabis kingbergii
MAJOR PREDATOR

Narrower than brown mirids with which it is sometimes confused, and with strongly recurved mouthparts.

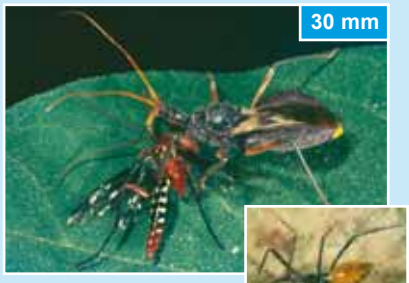
Adult

Nymph

Ant
various species
PREDATOR

Narrow waist and biting mouthparts.; ants are vastly underrated predators

Assassin bug
various species
PREDATOR




Adult *Pristhesancus plagipennis* attacking a wasp. **Insert:** nymph (7 mm). Note thick concave abdomen, narrow head and recurved mouthparts. An agressive species; avoid handling

Coranus trabeatus adult

Use for comparison of actual size:

mm 10 20 30 40 50

Mirid-like bugs

Brown mirid

Creontiades pacificus

MAJOR PEST

Elongated delicate sapsucking bugs with long antennae.
All nymph instars have banded antennae (see third instar below right).

Adult - brown form (brown all over)

Adult - green form (lime green with purple triangle at base of wings)

Third instar nymph - elliptical body with long banded antennae

Broken backed bug

Taylorilygus pallidulus

Minor PEST - low incidence in pulses

Shorter than green mirid; mainly green with brown wing tips - adult (left), nymph (right)

Green mirid

Creontiades dilutus

MAJOR PEST

Elongated delicate sapsucking bugs with long antennae. Nymphs have no bands on the antennae, unlike brown mirids.

Adult

Second instar nymph

Australian crop mirid

Sidnia kingbergi

Minor PEST - low incidence in pulses

Adult (left) and final instar nymph (right); shorter than the brown mirid

Chinese black mirid

Tytthus chinensis

PREDATOR

Very small mirid; adult (left) and nymph (right)

Bigeyed bug

Geocorris lubra

MAJOR PREDATOR

Note how far apart the eyes are

Apple dimpling bug

Campylomma liebknechti

MAJOR PREDATOR of helicoverpa

Adult (attacks eggs & small larvae)

Brown smudge bug

Deraeocoris signatus

MAJOR PREDATOR of aphids and whitefly

Adults have a broken back appearance. Nymphs are maroon to brown in colour

Adult - often confused with broken backed bug, but are brown all over

Large nymph - look like aphids, but lack the aphid's honey tubes

Beetles (adults)

Redshouldered leaf beetle
Monolepta sp.
Moderate PEST of coastal crops

Attacks leaves and flowers - severe defoliation if in plague numbers

Peanut scarab
Heteronyx piceus
MAJOR PEST of peanuts in red soil

Adult beetles are often found laying eggs under peanut seedlings

Lucerne crown borer
Zygrita diva
MAJOR PEST in some regions

Adults lay eggs in soybean stems

Staphylinid or rove beetle
Paederus sp.
PREDATOR

Can cause severe skin irritation

Soldier beetle
Chauliognathus pulchellus
PREDATOR

Other species in this genus have red markings

Corrhenes stigmatica
Minor PEST of soybeans

Not as common as *Zygrita*

White collared ladybird
Hippodamia variegata
MAJOR PREDATOR of aphids & SLW

Striped ladybirds
Micraspis frenata
MAJOR PREDATOR of aphids & SLW

Red and blue beetle
Dicranolaius bellulus
PREDATOR

Three-banded ladybird
Harmonia octomaculata
MAJOR PREDATOR of aphids & SLW

Mealybug ladybird
Cryptolaemus montrouzieri
MAJOR PREDATOR of mealybug

Carab beetle
Gnathophanus pulcher
PREDATOR

(Image M. Shepard)

GOOD BUG
BAD BUG
MAJOR PEST

Use for comparison of actual size:

mm 10 20 30 40 50

Beetles (weevils), flies, and wasps

Whitefringed weevil
Graphognathus leucoloma
MAJOR PEST of peanuts

Pod weevil
Apion sp.
Minor PEST of flowers/small pods

Note the short globular body and long snout typical of this group of weevils

Amnemus weevil
Amnemus sp.
Minor PEST of soybeans

(Image P. Desborough)

Adult and damage

Tachinid fly
Carcelia sp.
PARASITOID of helicoverpa

Adult

Common hoverfly
Simosyrphus grandicornis
MAJOR PREDATOR of aphids & SLW

Adult

Trichopoda giacomellii
PARASITOID of green vegetable bug

Adult male (orange body) - females have similar wings but a black body

Beanfly
Ophiomyia phaseoli
MAJOR PEST of seedlings

Crops at greatest risk (decreasing order) are navy beans, adzukis and mungbeans

Microplitis demolitor
MAJOR PARASITOID of helicoverpa

Pupa and adult wasp

Banded caterpillar parasite
Ichneumon prommissorius
MAJOR PARASITOID of pupae

Orchid dupe
Lissopimpla excelsa
MAJOR PARASITOID of caterpillars

(Image Keith Power)

Two-toned caterpillar parasite
Heteropelma scaposum
MAJOR PARASITOID of caterpillars

(Image P. Reid)

Orange caterpillar parasite
Netelia producta
MAJOR PARASITOID of caterpillars

(Image Keith Power)

Mealybugs, beetle larvae, and lacewings

Peanut, pink or hibiscus mealybug

Maconellicoccus hirsutus

Minor PEST

Adult mealybug - look for pink exudate when squeezed

Colony massed on soybean stem

Mealybug ladybird

Cryptolaemus montrouzieri

MAJOR PREDATOR of mealybug

Larva (right) attacking mealybug on cotton

Ladybird larvae

various species

MAJOR PREDATOR of aphids & SLW

Often with distinctive black and yellow bands. Have three pairs of true legs but no prolegs.

Carab beetle larvae

Gnathophanus pulcher

PREDATOR

Larva on soybean leaf

Larva killing a cluster caterpillar

Brown lacewing

Micromus sp.

MAJOR PREDATOR of aphids

Adult with delicate lace-like wings

Larva

Soldier beetle larva

Chauliognathus pulchellus

PREDATOR

Green lacewing

Mallada signatus

MAJOR PREDATOR

Adult with delicate lace-like wings

Larva using prey remnants as camoflage

Use for comparison of actual size:

mm 10 20 30 40 50

Pupae

Helicoverpa

Helicoverpa sp.

MAJOR PEST

Pupae are found in soil underneath host crop. Healthy (un-parasitised) pupae wriggle violently when touched; parasitised ones don't. Helicoverpa species can be distinguished by the distance between the pupal tail spines (see below).

Helicoverpa punctigera pupa

H. armigera (left) and *H. punctigera* (right)

Castor oil looper

Achaea janata

Minor PEST

Note white coating on pupa

Vegetable looper

Chrysodeixis eriosoma

Moderate PEST

Pupa in loose cocoon on soybean leaf

Plume moth

Sphenarchus sp.

Minor PEST of flowers

Note spiny appearance

Grass blue butterfly

Zizina labradus

Moderate PEST

Note constriction and wing mouldings

Bean podborer

Maruca vitrata

MAJOR PEST (adzuki, navy & mung)

Note leg and wing 'mouldings' and dark eye of developing moth

Soybean moth

Aproaerema simplexella

MAJOR PEST if in plague numbers

Bottom: soybean moth pre-pupa (left), pupa (right), and parasitoid pupa (top)

Common hoverfly

Simosyrphus grandicornis

MAJOR PREDATOR of aphids & SLW

Note - tear drop shape and no constriction or wing mouldings

Ladybird pupae

various species

MAJOR PREDATOR of aphids & SLW

Usually highly visible and stuck to the leaves

Beanfly pupa

Ophiomyia phaseoli

MAJOR PEST (navy bean seedlings)

Crops at greatest risk (decreasing order) are navy beans, adzukis and mungbeans

Microplitis demolitor

MAJOR PARASITOID

Cocoon beside dying cluster caterpillar host

Whiteflies, aphids, thrips and mites

Silverleaf whitefly (SLW)

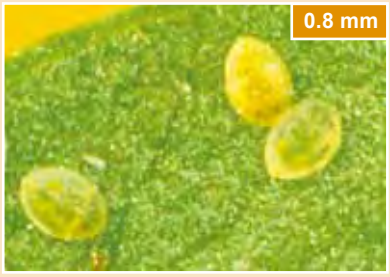
Bemisia tabaci type B

MAJOR PEST

When folded, the wings don't quite touch revealing the pale orange body underneath. In contrast the folded wings of the green house whitefly touch (no gap). SLW nymphs also have a clean outline whereas GHW nymphs have long filaments.

(Image Richard Lloyd)

Adults



SLW 4th instar nymphs, also known as redeye pupa (not true pupae)

Adults under soybean leaf

Healthy 4th instar whitefly nymph showing wing bud development

SLW Parasitoid wasps

Eretmocerus hayati

Encarsia sp.

MAJOR PARASITOID of SLW

(Image Paul de Barro)

Adult wasps *Eretmocerus* (left) and *Encarsia* (right)

Examples of parasitised SLW nymphs

Soybean aphid

Aphis glycines

Moderate PEST

A bright green aphid - mostly minor pest, but high populations have maked impact on yield and crop maturity; outbreaks more likely in cooler years

Two-spotted mite

Tetranychus urticae

MAJOR PEST

Green summer and red overwintering forms

Cowpea aphid

Aphis craccivora

Minor PEST

Note the paired honey tubes at the aphid's rear, typical of all aphids

Adults (black) and nymphs (grey)

Cowpea aphid colony on mungbean pod

Thrips

various species

PEST of seedlings and flowers

Adult - note narrow feathery wings (2 pairs) folded back against small elongated body

Use for comparison of actual size:

mm 10 20 30 40 50

Soil insects and slugs

Sugarcane armyworm
Leucania stenographa
Minor PEST of coastal soybeans

Pest where cane stubble is present

Common armyworm
Leucania convecta
Minor PEST

4 pairs of ventral prolegs. Older larvae have distinctive colouration; young are often pale

Black cutworm
Agrotis ipsilon
Minor PEST of seedlings

Larvae and damage

Etiella
Etiella behrii
MAJOR PEST of peanuts

In soil under peanut bush

Peanut scarab
Heteronyx piceus
MAJOR PEST of peanuts

Major pest in volcanic red soils - note typical C shape of larvae when disturbed

Peanut mealybug
Maconellicoccus hirsutus
Minor PEST

On soybean taproot

Sugarcane wireworm
Agrypnus variabilis
Moderate PEST of tropical peanuts

Small larva in peanut pod

Sugarcane wireworm
Agrypnus variabilis
Can also be a PREDATOR

Large larva found attacking helicoverpa pupae under mungbean crop

Black field cricket
Teleogryllus sp.
Minor PEST

Black field earwig
Nala lividipes
MAJOR PEST in cracking soils

Smaller and darker than the predatory earwig

Predatory earwig
Labidura truncata
PREDATOR

Attacking a helicoverpa pupa

Slug
various species
Increasing PEST in zero till

Best managed pre-planting with baits

Damage symptoms

Beanfly
Ophiomyia phaseoli

MAJOR SEEDLING PEST (in decreasing order) of navy beans, adzukis and mungbeans.

Navybean seedlings killed by beanfly larvae - look for pupating larvae and pupae at the base of the stems

Beanfly oviposition stings on navy bean leaf

Cotton seedling thrips
Thrips tabaci

Damage to mungbean seedlings (did not impact yield or time to flowering/harvest)

Two-spotted mite
Tetranychus urticae

Damage in peanuts - major pest where non-selective pesticides are widely used

Damage in mungbeans - note silvering of leaves

Cluster caterpillar
Spodoptera litura

Windowing by small larvae; helicoverpa and grass blue butterfly also cause this

Peanut mite
Paraplonobia sp.

Damage in peanuts showing bleached leaves - mites are very large with a dark body and pale legs (minor pest)

Close up showing very fine leaf stippling; peanut mites quickly drop off plant when disturbed

Soybean aphid
Aphis glycines

Early symptoms include cupped distorted leaves covered in sticky honey dew; ladybirds are also a good aphid indicator.

Lucerne leafhopper
Austroasca alfalfae

Hopper burn in peanuts - typical symptoms are yellowing and death from the leaf tip

Sooty mould

(Image Natalie Moore)

Severe symptoms in soybeans heavily infested with silverleaf whitefly

Tomato spotted wilt virus

Stunting and yellowing of peanuts in plants infested by western flower thrip

GOOD BUG
BAD BUG
MAJOR PEST

Use for comparison of actual size:

mm 10 20 30 40 50

Damage symptoms

Soybean moth
Aproaerema simplexella

Early symptoms showing leaf mines containing individual larvae

Severe leaf damage caused by heavy infestations (8-12 larvae per leaf)

Severe damage with many leaves killed outright

Soybean looper
Thysanoplusia orichalcea

Damage to soybean leaves - holes are more angular than helicoverpa (right)

Helicoverpa
Helicoverpa sp.

Below threshold damage to soybean leaves - holes are more rounded than looper (left)

Redshouldered leaf beetle
Monolepta sp.

Shredding of leaves caused by monolepta beetle swarm - often occurs after rain

Bean podborer
Maruca vitrata

Damage to mungbean flowers - look for chewing, webbing and frass (poo)

Flower thrips
various species

Flower thrips damage to mungbean pods - curling makes pods difficult to harvest

Cluster caterpillar
Spodoptera litura

Damage to soybean pods

Silverleaf whitefly
Bemisia tabaci type B

Damage to soybean pods

Field cricket
Teleogryllus sp.

Damage to soybean pods - very similar to mouse damage

Lucerne crown borer
Zygrita diva

Stem ‘girdling’ by lucerne crown borer larva that has killed the plant above the girdle

Damage symptoms (seed and post-harvest)

Podsucking bugs
various species

GVB damage to soybean seeds during early podfill (left) and late podfill (right)

GVB sting marks on mungbean seeds. Will downgrade crop if >2% of seeds are stung

Damage to navy bean seeds (left) compared with undamaged seed (right) - **staining attracts a price penalty**

Helicoverpa
Helicoverpa sp.

Damage to mungbean pods (similar to bean podborer, but more holes and less frass)

Medium larva inside chickpea pod

Etiella
Etiella behrii

Damage to harvested and shelled peanuts - note the small pinholes in the seeds; **etiella damage greatly increases aflatoxin risk**

Damage to soybean pod - note frass inside pod and exit hole

Peanut scarab
Heteronyx piceus

Damage is usually a single large hole at the distal end - note scarification around the hole

Sugarcane wireworm
Agrypnus variabilis

Damage to peanuts - note numerous small holes

Post harvest pests

Cowpea bruchid
Callosobruchus maculatus
MAJOR PEST of stored mungbean

Adult and eggs on mungbean seed - also called cowpea weevil, but not a true weevil

Bean bruchid
Acanthoscelides obtectus
MAJOR PEST of stored navybean

Adult on navy bean seed - also called bean weevil, but not a true weevil

Bruchidius mackenziei
MAJOR PEST of stored soybean

Adult on soybean seed

Use for comparison of actual size:

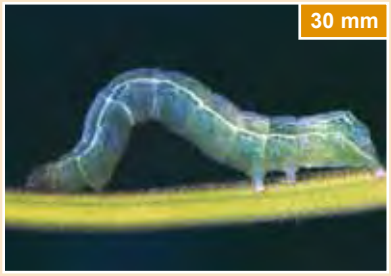
mm 10 20 30 40 50

Commonly confused insects - larvae

Large green caterpillars

Helicoverpa (green variant) has wide paie lateral stripe and 4 pairs of prolegs

Soybean looper has a tapered body and 2 pairs of prolegs



Tobacco looper has less pronounced striping than the soybean looper

Large striped caterpillars

Helicoverpa (striped variant) has 4 pairs of prolegs, prominent side strip, parallel body and obvious body hairs

Common armyworm has 4 pairs of prolegs but is smoother and fatter, with more coloured bands than helicoverpa

Bean looper has only 2 pairs of prolegs, slender smooth body, bottom of head is angled forwards

Medium (10mm) **helicoverpa** (top) and **cluster caterpillar** (bottom); cluster caterpillars have a slight 'hump' behind the head and a smoother plumper appearance

Small fat green larvae

Grass blue butterfly head capsule and true legs evident if turned over

Common hoverfly has no head capsule or true legs and body tapers to head end; moves like a maggot because it is one!

Small mining and boring caterpillars

Soybean moth larvae are small with a grey green body and a dark head; they feed (mine) inside the leaves

Legume webspinner is larger, pale green, pale head and no spots; produce copious quantities of frass

Bean podborer has a dark head, numerous dark spots on cream body

Commonly confused insects - bugs

Brown shield-shaped bugs

Brown shield bug (adult) is smaller and lighter brown than the predatory glossy shield bug

Overwintering **green vegetable bug** - larger than the others, and normally a purple or greenish brown - look for 3 pale spots across the middle of the shoulders

Glossy shield bug (adult) is larger and a darker brown than the brown shield bug (if unsure, feed it a small caterpillar and watch what happens!)

Small bugs with 'broken' backs

Broken backed bug adult– mostly green with wing ends brown

Brown smudge bug adult – brown all over

Mirids versus leafhoppers (small green elongated bugs)

Green mirids –have long antennae and long legs

Jassids/leafhoppers – short antennae, rounded head and relatively shorter legs

Small thin brown bugs

Brown mirid – similar to green mirid but brown or green/purple in colour

Pacific damsel bug – longer thinner head than brown mirid and with strongly recurved mouth parts

Large thin brown bugs

Brown bean bugs (large BBB pictured) – a yellow or cream band on each side, large muscley hind legs

Rice or Paddy bug – hind legs long and thin – ***not a pest of pulses or grain legumes***

Assassin bugs - hind legs long and thin, strongly concave body and recurved proboscis – savage predators

NEITHER PEST NOR BENEFICIAL | GOOD BUG | BAD BUG | ⚠ MAJOR PEST

Use for comparison of actual size:

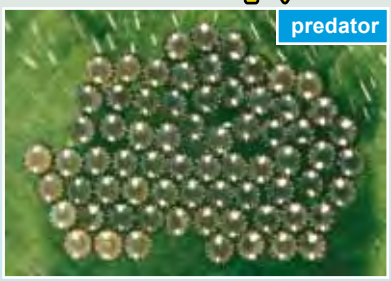
mm 10 20 30 40 50

Commonly confused insects

Bug egg rafts

Green vegetable bug freshly-laid pale egg raft - 66 eggs

Redbanded shield bug - distinctive dark eggs (elliptical in cross section) in twin-row rafts



Glossy shield bug - note dark colour and short perimeter spines

Spined predatory bug - note dark colour and long perimeter spines

Flat orange insects

Uncommon orange variant of the **green vegetable bug** - classic shield shape, with sucking mouthparts (hidden underneath)

Orange **cockroach** (*Ellipsidion* sp.) - elliptical outline, long wavy antennae, and chewing mouthparts – **not a pest**

White patterend moths: bean podborer vs beet webworm

Bean podborer - outspread wings, body raised at head end, hindwings mostly translucent

Beet webworm – wings not as outspread, hindwings are predominantly brown with white band

Brown bean bug nymphs versus ants

Brown bean bug nymph - note the sucking mouthparts. Waist not as constricted as an ant's waist

Ant – biting mouthparts, very narrow constricted waist

Mealybug vs cryptolaemus ladybird larvae

Peanut mealybug – sedentary on host plant, oval outline, shorter filaments

Cryptolaemus ladybird larva – mobile, body tapers towards rear end, very long filaments

Smudge bug nymph versus aphids

Smudge bug nymph- look like aphids, but lack the aphid's paired honey tubes

Aphids (cowpea aphids illustrated) – note the paired honey tubes at the aphid's rear, typical of all aphids

Insect sampling - use a beat sheet

Sample insects with a 'standard' beat sheet, 1.3-1.5m wide x 1.8-2m deep. Butt one side of the sheet against the base of plants in the row to be sampled, and drape the sheet over the plants in the opposite row. Beat (shake) plants in the central 1m of row with a 1m long beat stick.

Sample 5 sites throughout the crop and take 5 one-metre (1m) long samples at each site to get an accurate estimate of pest pressure in your crop. Compare your pest population to the relevant pest threshold to determine if spraying is required, *i.e. if the pest is above threshold*.

Thresholds quoted are standardized as pests per square metre, so you need to convert your counts to pests per square metre as follows:

1. Record the number of insects for each 1m long sample taken at each sample site
2. Total counts at each sample site and calculate the average per site
3. Divide each sample site average by your row spacing in metres For example, if helicoverpa are averaging 2.25 larvae per row metre in a crop with 0.75 m row spacing, you have 2.25/0.75 = 3.0 helicoverpa per square metre
4. Compare pest numbers from all sampled sites to determine if only a portion of the crops needs spraying, e.g. if pests are above threshold only along one edge

How to make your own beat sheet

Use a sheet of white or yellow poly tarp (do not use cotton as it absorbs water and gets too dirty). Note that white sheets are a bit glary in bright sunlight (so wear sun glasses) and that some (yellowish) insects are harder to see on a yellow sheet..

Cut to a finished size of 1.3-1.5 m wide x 1.8-2.0 m deep. Use the larger size if you have large (tall) plants. Allow enough material for a folded re-enforcing hem on the longer sides and a sleeve to take an 18 mm dowel (or poly pipe) on the shorter side.

Dowels make the sheet more rigid, allow the sheet to butt firmly against the plants to be sampled, and hold the sheet in place when it is draped over plants in the row opposite to that being sampled.

You also need a 1m long length of dowel or poly pipe to beat (shake) the bushes.

Determine the 'size' (number of seeds per square metre) of your crop to determine its susceptibility to podsucking bug damage.

- As podsucking bug thresholds are based on likely % seed damage, the number of seeds per square metre (seeds/m^2) in your crop must be estimated to determine the threshold for your size crop.
- This is easily done as follows:
  Seeds/m^2 = seeds per pod x pods per plant x plants per row metre/row spacing in metres.

Determine the damage potential of mixed pod-sucking bug populations in your crop.

- Many podding pulse crops are infested with more than one species of podsucking bug.
- To determine the overall damage potential of your bug population, convert counts of species other than green vegetable bug (GVB) to GVB equivalents as follows; 1 brown bean bug (large or small) = 1GVB, 1 redbanded shield bug = 0.75GVB, 1 brown shield bug = 0.2GVB.
- Total the converted species counts (bugs per m^2) to determine the population's overall damage potential.

See page 40 for more information on converting to GVB equivalents.

Example BUG CHECK SHEET

Take 5 one-metre samples per site & 5-6 sites per crop

FARM/LOCATION:			DATE:		TIME:	
BLOCK:		**SITE:**		**CROP/STAGE:**		
Pests	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Average**
Helicoverpa <3 mm						
Helicoverpa 3-7 mm						
Helicoverpa 1-13 mm						
Helicoverpa 13-23 mm						
Helicoverpa >23 mm						
Loopers <13 mm						
Loopers 13-23 mm						
Loopers >23 mm						
Legume webspinner						
Bean podborer (look in flowers)						
GVB small nymph						
GVB medium nymph						
GVB large nymph						
GVB adult						
Redband shield bug small						
Redband shield bug medium						
Redband shield bug large						
Redband shield bug adult						
Brown bean bug nymph						
Brown bean bug adult						
Mirid nymph						
Mirid adult						
Thrips (in flowers)						
Soybean aphid						
Silverleaf whitefly						
Mites						
Other						
Comments:						
Beneficials	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Average**
Apple dimpling bug						
Damsel bug						
Bigeyed bug						
Spined predatory bug						
Glossy shield bug						
Brown smudge bug						
Lacewings						
Ladybirds						
Red and blue beetle						
Hoverfly						
Spiders						
Parasitic wasps						
Other						
Comments:						

IPM in summer pulses – an overview

The basic IPM strategy for legumes is to avoid non-selective pesticides for as long as possible in order to foster a build-up of predators and parasites, i.e. '**GO SOFT EARLY**'. This helps keep early pests in check and buffer the crop against pest attack during later crop stages. **This is particularly important for soybeans because of the silverleaf whitefly risk**.

However, intervention may be required during podding, especially against podsucking bug populations which peak during late podfill. Podsucking bugs cannot be ignored as they can drastically reduce seed quality, as well as yield. Over 90% of seeds can be damaged if bugs are left unchecked and crop value can be reduced by over $500/ha.

Regular monitoring of pest numbers is critical in soybeans and other pulse crops, especially with the onset of flowering and throughout podding, when crops become attractive to podsucking bugs, helicoverpa and other pests. While other legumes share many of the same pests as soybeans, some pest species are restricted to specific crops.

Comparing crops

From an insect management point of view, peanuts are easier to manage than soybeans whereas mungbeans, navy beans and adzuki beans (listed in order of increasing difficulty) are more challenging than soybeans.

Pest activity and IPM strategies for grain legume/pulse crops

Grain legume/pulse crops grouped by similarity in pest management requirements are:

- Soybeans
- Mungbeans, adzuki beans and navy beans
- Peanuts
- Chickpeas

Soybeans

Major pests in soybeans are podsucking bugs, helicoverpa (heliothis), and potentially silverleaf whitefly. Other frequent pests include loopers, cluster caterpillar, soybean moth, soybean aphid, monolepta beetle and mirids.

Soybean leaves are more attractive to foliage-feeding pests (e.g. loopers and leaf miners) than leaves of the other summer pulses and their greater hairiness makes them more attractive to many ovipositing (egg-laying) moths than the leaves of other summer pulses.

While soybeans can be attacked by **helicoverpa** at any stage from seedlings onwards, the crop is most susceptible from flowering onwards. Soybeans can compensate for considerable insect damage during early podding because they set a large number of 'reserve pods'. In addition, soybeans have thicker, hairier and less succulent pods than mungbeans, adzukis and navy beans and are therefore not attractive to loopers and bean podborer.

Podsucking bugs are major soybean pests. The most abundant species in order of damage potential are:

- green vegetable bug (*Nezara viridula*)
- brown bean bugs (*Riptortus* and *Melanacanthus* sp.)
- redbanded shield bug (*Piezodorus oceanicus*).

While many cultivars can compensate for yield loss caused by moderate bug populations, seed quality is adversely affected, particularly for edible soybeans where processors have very low damage tolerances (e.g. maximum of 2% damaged seed).

Silverleaf whitefly (SLW) poses a major threat to soybeans in tropical and subtropical regions. However the recently released SLW parasite *Eretmocerus hayati*, together with native parasites and predators, can reasonably be expected to stabilise whitefly populations, provided they are not disrupted by the overuse of non-selective pesticides.

A coastal pest that can suddenly appear in large numbers is **monolepta beetle**. DEEDI trials have helped secure a recent label extension for Steward® (indoxacarb) against monolepta in soybeans.

In a typical soybean crop, budget for one pyrethroid (e.g. Decis®) spray for podsucking bugs, and expect that you will probably have to apply at least one helicoverpa spray after flowering (preferably Steward® EC). Also prepare for infestations of leaf feeding caterpillars

(and monolepta in coastal crops). For caterpillars, use NPV+Aminofeed® for helicoverpa alone. Use Bt+Aminofeed for loopers or Bt+NPV+Aminofeed for mixed looper/helicoverpa populations.

Mungbeans, adzukis and navy beans

These crops have a similar pest spectrum to soybeans, however navy beans in particular are far more susceptible to **beanfly** attack during the seedling stage. Flowers and small pods are also more susceptible to looper damage, as they are larger and more succulent than soybean flowers and pods.

Large flowers and indeterminate growth (overlapping in time of flowering and podding) make these crops, and particularly adzukis, very attractive hosts to **bean podborer** (*Maruca vitrata*), a caterpillar pest which initially feeds inside flowers before moving into pods. Indeterminate flowering also makes these crops susceptible to mirid damage. **Mirids** attack the buds and flowers, which results in reduced pod-set. These crops are attacked by the same **podsucking bugs** as soybeans.

Navy beans are susceptible to SLW, but **mungbeans and adzukis are not suitable SLW hosts**. While adult SLW are often seen, very few SLW nymphs develop in these crops.

Mungbean seed can be infested in the field by **bruchids** but this is often not detected until 3 or more months post harvest. Bagged planting seed kept for any length of time out of cold storage is at particular risk of bruchid attack.

In a typical crop, you would budget for 1-2 dimethoate[1] sprays against mirids and/or bean fly, one helicoverpa spray (most likely using Steward® or Larvin®), and the possibility of a pyrethroid spray for podsucking bugs.

Peanuts

Peanuts are less attractive to insect pests than other summer pulses. **Helicoverpa** and **cluster caterpillars** can attack peanut foliage, flowers and pegs (the pegs connect to the pods). In loose soils, cluster caterpillars can also reach the underground pods. Helicoverpa larvae in peanuts are frequently killed by naturally-occurring helicoverpa virus epidemics.

Peanuts are at risk from **soil dwelling pests** such as peanut scarabs (and possibly cane grubs) and whitefringed weevil. Whitefringed weevil can largely be avoided by not rotating peanuts with alternate weevil hosts which include other legumes, root crops (e.g. potatoes), and lucerne.

In dry seasons, pods can be attacked by **etiella** (*Etiella behrii*) larvae, which are able to reach the underground pods but only in dry soil. Etiella damage is a major risk factor for aflatoxin (a carcinogenic toxin produced by *Aspergillus* fungi), which gains entry through holes made by etiella larvae exiting pods to pupate in the soil.

Peanuts are not a favoured **silverleaf whitefly** host, and are only at risk in extreme SLW years or if growing close to early maturing SLW hosts.

Lucerne jassids are a problem in some regions, their feeding resulting in hopper burn (yellowing and death of leaf tips). Lucerne jassids are yellow green and should not be confused with the more common and bright green **vegetable jassid** which rarely if ever causes economic damage.

In a typical peanut crop, you would budget for one spray but hope to spray only every 2nd year. NPV would be the IPM product of choice for helicoverpa, **provided larvae are small (<12 mm)**.

Chickpeas

The only significant insect pest of chickpeas is **helicoverpa**, though cane grubs have been known to cause damage in some cane areas. Acidic leaf secretions produced by chickpeas repel most other pests as well as beneficials.

To control helicoverpa target small-very small larvae (<7 mm) in podding chickpeas with a single, well-timed spray. Recommended thresholds are between 2-4 grubs per metre. Higher thresholds are only recommended in crops with adequate moisture where chickpeas can compensate for damage without suffering yield loss. Lower thresholds are often used for stressed crops late in the season (i.e. suffering terminal drought), but may also be appropriate for larger seeded kabuli-type chickpeas, such as Macarena.

A typical chickpea crop will require at least one helicoverpa spray. Steward® EC (indoxacarb) is a commonly recommended insecticide for helicoverpa control in chickpeas, and provides good residual control.

1 Please note: previous registrations of dimethoate were suspended in October 2011. Current use is as per APVMA permit 13155 (valid to 5-10-13).

Summer pulse pest thresholds

Soybeans

Table 1. Soybean yield loss thresholds by crop stage

Crop stage	Pest	Threshold	Comments
Seedling/early vegetative	Helicoverpa & grass blue butterfly	25% terminal loss	Terminal loss more likely if crops are moisture stressed
Mid-late vegetative	Helicoverpa	6/m^{2+*}	Lower threshold in early vegetative crops or take action if terminal loss exceeds 25%
Vegetative	Spodoptera, loopers & grass blue butterfly	33% defoliation or 25% terminal loss	Refer to defoliation figure on page 39; terminal loss most likely if grass blue larvae present
Budding, flowering	Thrips	4-6 per flower	Open and inspect flowers
Budding, flowering & early podding	Mirids	5/m^{2+}	Trials show no yield loss for mirid populations up to 5/m^2
Budding to podding	Spodoptera	3/m^{2+}	Not as damaging as helicoverpa
	Loopers	15-20% defoliation	Refer to defoliation figure on page 39
	Soybean aphids	250 aphids per plant	Visual - check upper leaves & stem
Budding to late pod fill	HELICOVERPA	See Table 2	Based on yield loss model below; inspect flowers and terminals for small larvae
Early to late podfill	PODSUCKING BUGS	See Table 3	Thresholds for crushing are double those for edible beans

Note: **+** Thresholds are based on beat sheet sampling and are expressed in pests/m^2.
* Replaces 33% defoliation threshold which still applies for other caterpillar species.

Table 2. Economic yield thresholds* for helicoverpa in podding soybeans

Control cost ($/ha)	Helicoverpa thresholds* (larvae/m^2) at soybean crop values listed below ($/t)									
	$350	$400	$450	$500	$550	$600	$650	$700	$750	$800
$15	1.1	0.9	0.8	0.8	0.7	0.6	0.6	0.5	0.5	0.5
$20	1.4	1.3	1.1	1.0	0.9	0.8	0.8	0.7	0.7	0.6
$25	1.8	1.6	1.4	1.3	1.1	1.0	1.0	0.9	0.8	0.8
$30	2.1	1.9	1.7	1.5	1.4	1.3	1.2	1.1	1.0	0.9
$35	2.5	2.2	1.9	1.8	1.6	1.5	1.3	1.3	1.2	1.1
$40	2.9	2.5	2.2	2.0	1.8	1.7	1.5	1.4	1.3	1.3
$45	3.2	2.8	2.5	2.3	2.0	1.9	1.7	1.6	1.5	1.4
$50	3.6	3.1	2.8	2.5	2.3	2.1	1.9	1.8	1.7	1.6
$55	3.9	3.4	3.1	2.8	2.5	2.3	2.1	2.0	1.8	1.7
$60	4.3	3.8	3.3	3.0	2.7	2.5	2.3	2.1	2.0	1.9

* Threshold based on a measured yield loss of 40 kg/ha for every larva per square metre. Cross-reference the cost of control versus the crop value to determine the economic threshold (ET), e.g. if the cost of control = $35/ha and the crop value =$450/t, the ET = 1.9. **Spray helicoverpa only if they exceed the threshold which is the break even point.**

Table 3. Economic quality threshold* for green vegetable bug (GVBAEQ) in edible soybeans

Potential yield (t/ha)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Nato soybeans	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Normal soybeans	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.6

*Threshold based on a rate of damage of approximately 80 harvestable seeds per adult bug per square metre. Spray bugs at the 2% action threshold, before the critical 3% damage level is reached. This allows for other insect damage not caused by posdsucking bugs. Note that thresholds increase in 'larger' crops as more bugs are required to inflict a given percentage (%) of damage. When mixed bug populations are present (adults & nymphs) convert their damage potential to green vegetable bug adult equivalents (GVBAEQ) as per page 40.

Mungbeans, adzuki and navy bean

Table 4. Mungbeans, adzuki and navy bean thresholds by crop stage

Crop stage	Pest	Threshold	Comments
Seedling	Seedling thrips	none	Spring mungbeans only rarely sprayed
	Beanfly	1 larval tunnel/plant	May need respray in 7 days
Vegetative	Helicoverpa	25% terminal loss or 33% defoliation or provisionally* 4-5/m^{2+}	Refer to defoliation figure on page 39 The provisional 4-5/m^2 is for mid to late vegetative crops
	Loopers	33% defoliation	Refer to defoliation figure on page 39
Budding, flowering	Thrips	4-6 per flower	Open and inspect flowers
Budding, flowering & early podding	MIRIDS	See Table 7	Values are for ground and aerially sprayed crops respectively
Budding to podding	HELICOVERPA	See Table 5	New threshold model. Inspect flowers and terminals for small larvae
	Spodoptera and loopers	3/m^{2+}	A nominal threshold
Flowering to podding	BEAN PODBORER	7/m^2 (visual) 1.5/m^2 (beatsheet)	Major pest in coastal crops; look for young larvae in flowers - control before they attack pods
Early to late podfill	PODSUCKING BUGS	See Table 6	Thresholds for processing are double those for sprouting

Note: **+** Thresholds are based on beat sheet sampling and are expressed in pests/m^2.
* Extrapolated from revised Helicoverpa thresholds in soybeans. Lower than the soybean threshold because mungbean plants are smaller than soybean plants. Needs to be verified in field trials.

Table 5. Economic yield loss thresholds* for helicoverpa in podding mungbeans

Control cost ($/ha)	Helicoverpa thresholds* (larvae/m^2) at mungbean crop values listed below ($/t)									
	$400	$450	$500	$550	$600	$650	$700	$750	$800	$850
$15	1.1	1.0	0.9	0.8	0.7	0.7	0.6	0.6	0.5	0.5
$20	1.4	1.3	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.7
$25	1.8	1.6	1.4	1.3	1.2	1.1	1.0	1.0	0.9	0.8
$30	2.1	1.9	1.7	1.6	1.4	1.3	1.2	1.1	1.1	1.0
$35	2.5	2.2	2.0	1.8	1.7	1.5	1.4	1.3	1.3	1.2
$40	2.9	2.5	2.3	2.1	1.9	1.8	1.6	1.5	1.4	1.3
$45	3.2	2.9	2.6	2.3	2.1	2.0	1.8	1.5	1.6	1.5
$50	3.6	3.2	2.9	2.6	2.4	2.2	2.0	1.9	1.8	1.7
$55	3.9	3.5	3.1	2.9	2.6	2.4	2.2	2.1	2.0	1.8
$60	4.3	3.8	3.4	3.1	2.9	2.6	2.4	2.3	2.1	2.0

* Thresholds based on a measured yield loss of 35 kg/ha for every larva per square metre. Cross-reference the cost of control versus the crop value to determine the economic threshold (ET), e.g. if cost of control = $35/ha and crop value =$450/t, the ET = 2.2.
Spray helicoverpa only if they exceed the threshold which is the break even point.

Please note: *Mirid thresholds in crop stage tables 1, 4 and 8 are based on the cost of dimethoate. Previous registrations of dimethoate were suspended in October 2011. Current use is as per APVMA permit 13155 (valid to 5-10-13).*

Table 6. Economic quality threshold* for green vegetable bug/m² in mungbeans

Potential yield (t/ha)	0.25	0.5	1.0	1.5	2.0	2.5	3.0
GVBAEQ to damage 1.4% of seeds	0.1	0.2	0.5	0.8	1.1	1.4	1.7

*Threshold based on a rate of damage of approximately 50 harvestable seeds per adult bug per square metre. Spray bugs at the 1.4% action threshold, before the critical 2% damage level is reached. This allows for other insect damage not caused by posdsucking bugs. Note that thresholds increase in 'larger' crops as more bugs are required to inflict a given percentage (%) of damage. When mixed bug populations are present (adults & nymphs) convert their damage potential to green vegetable bug adult equivalents (GVBAEQ) as per page 40.

Table 7. Economic threshold chart for mirids (*Creontiades* spp.) in mungbeans

Control cost ($/ha)	Mirid thresholds* (adults + nymphs/m²) at mungbean crop values listed below ($/t)									
	$400	$450	$500	$550	$600	$650	$700	$750	$800	$850
$10	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2
$15	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3
$20	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.4
$25	1.0	0.9	0.8	0.8	0.7	0.6	0.6	0.6	0.5	0.5
$30	1.3	1.1	1.0	0.9	0.8	0.8	0.7	0.7	0.6	0.6
$35	1.46	1.3	1.2	1.1	1.0	0.9	0.8	0.8	0.7	0.7
$40	1.7	1.5	1.3	1.2	1.1	1.0	1.0	0.9	0.8	0.8

*Table based on a measured yield loss of 60 kg/ha for every mirid per square metre inflicted over a 28 day period. There is therefore no need to spray low mirid populations immediately at early flowering. Delaying sprays for low mirid populations by up to 7 days for low mirid populations will have no impact on yield, will reduce the risk of flaring helicoverpa and may mean you only have to apply 1 mirid spray
Cross-reference the cost of control versus the crop value to determine the economic threshold (ET), e.g. if cost of control = $15/ha and crop value =$600/t, the ET = 0.42. The higher the cost of control, and the lower the crop value, the higher the threshold.
Note that if dimethoate[1] is phased out, the higher cost of the replacement thresholds will raise the thresholds considerably - e.g. x 2 or more.

Table 8. Economic threshold chart for helicoverpa in podding navy beans

Control cost ($/ha)	Helicoverpa thresholds* (larvae/m²) at navy bean crop values listed below ($/t)									
	$400	$500	$600	$700	$800	$900	$1000	$1100	$1200	$1300
$15	0.6	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2
$20	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.2
$25	0.9	0.7	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.3
$30	1.1	0.9	0.7	0.6	0.6	0.5	0.4	0.4	0.4	0.3
$35	1.3	1.0	0.9	0.7	0.7	0.6	0.5	0.5	0.4	0.4
$40	1.5	1.2	1.0	0.9	0.7	0.7	0.6	0.5	0.5	0.5
$45	1.7	1.3	1.1	1.0	0.8	0.7	0.7	0.6	0.6	0.5
$50	1.9	1.5	1.2	1.1	0.9	0.8	0.7	0.7	0.6	0.6
$55	2.1	1.6	1.4	1.2	1.0	0.9	0.8	0.7	0.7	0.6
$60	2.2	1.8	1.5	1.3	1.1	1.0	0.9	0.8	0.7	0.7

* Table based on a measured yield loss of 67 kg/ha for every larva per square metre. Cross-reference the cost of control versus the crop value to determine the economic threshold (ET), e.g. if cost of control = $35/ha and crop value =$1000/t, the ET = 0.5.

** Spray helicoverpa only if they exceed the threshold which is the break even point. The higher the const of control, and the lower the crop value, the higher the threshold

1 Please note: Previous registrations of dimethoate were suspended in October 2011. Current use is as per APVMA permit 13155 (valid to 5-10-13).

Peanuts

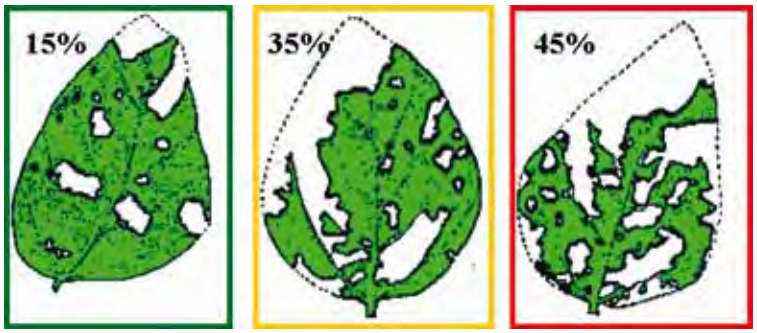
Table 9. Thresholds by crop stage

Crop stage	Pest	Threshold	Comments
Vegetative	Helicoverpa	33% defoliation	Refer to defoliation figure on page 39
Budding, flowering	Thrips	4-6 per flower	Open and inspect flowers
Budding, flowering & early podding	Mirids	5/m^{2+}	Trials show no yield loss for mirid populations up to 5/m^2
Budding to podding	Spodoptera	3/m^{2+}	May chew through pegs
Flowering to podding	HELICOVERPA	4-5/m^{2+}	A nominal threshold. Inspect flowers and terminals for small larvae
Any stage	Lucerne leafhopper	20% of leaves with hopper burn	Burnt leaves start yellowing and dying from the tip

Note: **+** Thresholds are based on beat sheet sampling and are expressed in pests/m^2.

Defoliation thresholds

Different levels (%) of defoliation are shown. Note that the measured defoliation seems to be less than suggested by the observer's eye. Note also that the defoliation threshold is based on crop's overall level of defoliation, and not just that of the most severely damaged leaves.



Converting pod sucking bugs to Green Vegetable Bug Equivalent (GVBEQ) and Green Vegetable Bug Adult Equivalents (GVBAEQ)

Green vegetable bug equivalents

Green vegetable bugs (GVB) and brown bean bugs (BBB) are equally damaging to pulse crops but green vegetable bugs (GVB) are considered a more important pest due to their abundance, widespread distribution and rate of reproduction. The damage potential of other pod sucking pests is not as great as GVB but they can cause severe damage when present in large numbers. To determine the damage potential of pod sucking bugs they must be converted to GVBEQ as shown in the table at the bottom of this page (*Damage potential of pod sucking bug species relative to GVB*):

For each bug stage (nymphs and adults) of each species, convert to GVBEQ by multiplying by the relevant conversion factor.

Green vegetable bug adult equivalents

Using the previous example - if you find that the three GVB and one RBSB are 2nd instars instead of adults and the two BSB are 4th instars - an additional calculation is required to convert these instars into adult equivalents. This is because bug nymphs are less damaging than adults.

The table below provides the conversion factors to convert instars to green vegetable bug adult equivalents. The example above shows 3.75 GVB equivalents as 2nd instars and 0.4 GVB equivalents as 4th instars.

Damage potential of nymphs in green vegetable bug adult equivalents (GVBAEQ) from 1-6 weeeks prior to harvest

Days to harvest maturity	Small nymphs (I-II)	Medium nymphs (III-IV)	Large nymphs (V) and adults
7	0.1	0.5	1.0
14	0.2	0.6	1.0
21	0.2	0.7	1.0
28	0.3	0.8	1.0
35	0.4	0.8	1.0
42	0.4	0.8	1.0

Each instar group is multiplied by the conversion factor and then added together to obtain the total damage potential. This can be calculated for days to harvest.

Damage potential of pod sucking bug species relative to GVB

Pod sucking bug species	Conversion to GVBEQ
Green vegetable bug (GVB) *Nezara viridula* 	1.00
Brown bean bugs (BBB) *Riptortus* & *Melanacanthus* sp.  	1.00
Redbanded shield bug (RBSB) *Piezodorus oceanicus* 	0.75
Brown shield bug (BSB) *Dictyotus caenosus* 	0.20

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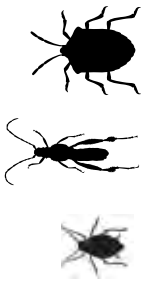
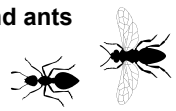
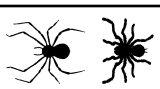
Identifying insects - general shape* and distinguishing features

Insect type	Key identifying features
Immature stages: Larvae 	Look nothing like the adults. Usually elongated with/without legs. Pass through a pupal stage before reaching adulthood. • **Moth larvae or caterpillars:** Proper legs at front and fleshy prolegs at the rear, chewing mouthparts. • **Beetle larvae:** Front legs only, chewing mouthparts. • **Fly and wasp parasitoid larvae:** are maggots with no legs nor obvious mouthparts. • **Lacewing larvae:** similar to beetle larvae.
Immature stages: Pupae 	Intermediate stage between larvae and adults. Immobile, no external legs or wings. Found in soil or on host plants. Sometimes in a protective silken cocoon (some caterpillars) or exposed (e.g. helicoverpa and ladybirds).
Immature stages: Nymphs 	Reasonably similar to the adults but lack wings. • **Bug nymphs:** Look for sucking mouth parts, and distinctive colour patterns for each species.
Bugs 	All have sucking mouthparts and if winged, 2 pairs of wings. • **Shield bugs:** Shield shape, beetle like outline, only inner forewings are hardened, outer forewings and rear wings are membranous. • **Mirids, bean bugs, assassin bugs:** Elongated, long antennae, only inner part of forewings are hardened., outer forewings and rear wings are membranous. • **Jassids, leafhoppers:** Elongated, short antennae, rounded head, forewings of uniform hardness, jump/hop when disturbed. • **Aphids:** Globular, pair of honey tubes at rear, wings if present are clear and not hardened. Usually present in colonies. Sooty mould may also be present. • **Mealybugs:** Fluffy, sedentary on plant host.
Beetles 	Can be rounded (ladybirds) or elongated (lucerne crown borer). Chewing mouthparts, forewings hardened into protective cover. Some like ladybirds are brightly coloured. Weevils have an elongated 'snout'.
Moths and butterflies 	Two pairs of scale-covered wings that are large relative to their body. Butterflies more brightly coloured than moths, have clubbed antennae and often rest with wings folded vertically. Moths rest with wings folded over body or outspread.
Flies 	Most pest and parasitic flies are house-fly shaped. Sponging mouthparts, one pair of wings. Relatively large eyes.
Wasps and ants 	Narrow waisted and biting mouthparts. • **Wasps:** 2 pairs of wings, often with ovipositor at rear. • **Ants:** Usually wingless, often in large numbers.
Crickets 	Similar to grasshoppers but fatter. Chewing mouthparts, large jumping hind legs.
Earwigs 	Elongated body. Large rear pincers, chewing mouthparts.
Lacewings 	Delicate body, long antennae, 2 pairs large delicately-veined clear wings, chewing mouthparts.
Cockroaches 	Flattened wide body. Chewing mouth parts, long wavy antennae.
Mites 	Very small rounded body with eight legs, webbing on leaf. Usually present in colonies.
Thrips 	Small narrow body. Adults with 2 pairs of narrow feathery wings. Usually found inside leaf terminals, buds or flowers.
Spiders 	Variety of body shapes, eight legs, multiple eyes.

*Note that the shapes provided are examples only and are not necessarily a true representation of either the actual appearance or the relative sizes of these arthropods

This guide is designed to help growers and consultants to correctly identify pest and beneficial insects in their summer pulses (soybeans, mungbeans, navy beans, adzukis and peanuts), and chickpeas. The 'good bugs' are predators and parasites (parasitoids) of the 'bad bugs', which are pests of summer pulses and chickpeas. Note that many of the minor pests rarely if ever cause economic damage because of their small size and/or (normally) very low abundance. In many instances, minor pests actually perform a useful role because they attract beneficial insects into crops.

The photographic 'montage' format is client-driven and largely follows that developed by Maureen McCarthy (Childers) for the very popular *Isis Landcare Bug Book*. Images of similar-looking good bugs and bad bugs are placed side by side to allow for a rapid diagnosis and comparison. The guide also contains photographs of damage, and a 'commonly confused' section for quick reference. Brief captions list key characteristics of all illustrated insects, as well as their status (e.g. MAJOR PEST or Minor PEST). Included are many caterpillar pests mostly found in new coastal cane/grain farming systems. Note that many of the minor pests illustrated have no common names.

Also included are outlines of the key pests and beneficials likely to be encountered in summer pulses, an example Bug Check Sheet (for readers to copy), and sampling guidelines and threshold tables for the most common pests in summer pulses and chickpeas.

Glossy shield bug (good) attacking cluster caterpillar (bad)