Winter cereals* insect pest management

Northern grains region

**Winter cereals include wheat, barley, oats, canary and triticale.*

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Department of **Agriculture, Fisheries and Forestry**

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Front cover photo by Melina Miles, DAFF Queensland. All other images are provided by DAFF staff unless otherwise indicated.

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Pest may be present in the crop
Crop susceptible to crop loss

Although a pest may be present in a crop, there are specific stages of crop growth that are more tolerant or vulnerable to significant crop loss. For example, minor feeding damage to vegetative and green barley crops by armyworm is noticeable, but will not result in yield loss. However, if armyworm is detected in barley during crop maturity when it is susceptible to head lopping, significant yield loss may occur.

Establishment pests

Earth mites

Blue oat mite or BOM (*Penthaleus* species) are important pests of seedling winter cereals, but are generally restricted to cooler grain-growing regions (southern Queensland through New South Wales). Redlegged earth mite *(Halotydeus destructor*) does not commonly occur in the northern grains region north of Dubbo.

Earth mites are active from autumn through to early summer, and then survive the summer as eggs in the soil. These oversummering eggs hatch in autumn when temperatures and rainfall conditions are right. There can be 2- 3 generations per season.

Identification

Adults are 1 mm long and have 8 legs. Adults and nymphs have a purplish-blue, rounded body with red legs. They move quickly when disturbed. The presence of a small red area on the back distinguishes it from the redlegged earth mite.

There are three species of blue oat mite (*P. major*, *P. falcatus* and *P. tectus*), all three may occur in northern NSW and southern Queensland. P. major is the most common species in the northern region, and *P. tectus* the least common. *P. major* and *P. tectus* are the species most frequently detected in cereals.

Correct species identification (at least distinguishing between redlegged earth mite and blue oat mite) is important because the different species have different tolerances for insecticides, with BOM species being more tolerant of insecticides than the redlegged earth mite. Determining which species of BOM is present can be relevant in the event of poor control or control failure. The three species can be distinguished under a microscope, by examining the pattern of hairs on the back of the mites.

The earth mites cause similar damage to brown wheat mite, but are much larger in size.

Damage

Adults and nymph mites pierce and suck leaves resulting in silvering of the leaf tips. Feeding causes a fine mottling of the leaves, similar to the effects of drought. Heavily infested crops may have a bronzed appearance and severe infestations cause leaf tips to wither and can heavy infestations at emergence can lead to seedling death.

Adult blue oat mite and 'mottling' on leaf characteristic of feeding damage. (Image A. Weeks, cesar)

Monitoring and thresholds

Check from planting to early vegetative stage, particularly in dry or wet seasons, when plant growth may be slow and damage accumulates faster than the plant can grow out of it.

Check a number of sites across the field, including edges close to pasture or weedy fallow. Using a quadrat, or checking a specific length of row (e.g. 50 cm) will assist with comparing mite densities across the field.

Also be alert to the timing of mite emergence from eggs that have survived over summer. Following a favourable season the year before, large numbers of hatching mites can cause significant damage to emerging crops in a short period of time.

Blue oat mites are most easily seen in the cooler part of the day, or when it is cloudy. They spend most of their time on the soil surface rather than on the plant. If pale-green or greyish irregular patches appear in the crop, check for the presence of blue oat mite at the leaf base.

Accurate thresholds are not available.

BOM density likely to result in economic crop loss = 50 mites/100 cm.

Plants growing under ideal conditions can tolerate higher numbers of mites.

Management and control

Paddock history, particularly crop and weed history, has a significant influence on mite numbers from one season to the next.

BOM has specific host preferences, and whilst they will feed on a range of crops, they may not reproduce on them. Higher numbers of BOM are likely following a grassy pasture or weedy fallow. Canola is a useful rotation with cereals where BOM is a problem.

Cultural control methods can contribute to the reduction in the size of the autumn mite population (e.g. cultivation, burning, controlling weed hosts in fallow, grazing and maintenance of predator populations).

Natural enemies

Predators of BOM include spiders, ants, predatory beetles and the predatory anystis mite and snout mite. BOM are also susceptible to infection by a fungal pathogen (*Neozygites acaracida*), particularly in wet seasons.

More detailed information on earth mite identification, management and control can be found at

- Department of Primary Industries Victoria Agnote 1300
- GRDC back pocket Guide “Crop Mites” (links to online pdf)
- The I-Spy manual

Cutworm (*Agrotis* spp.)

Brown cutworm - *Agrotis munda*, Bogong moth - *Agrotis infusa*, Black cutworm - *Agrotis ipsilon* and Variable cutworm - *Agrotis prophyricollis*

Several species of cutworms attack establishing cereal crops in the northern grains region. The common name of 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. Usually there is only a single generation during early vegetative stages. Moths prefer to lay their eggs in cracks in the soil in lightly vegetated (e.g. a weedy fallow) or bare areas. Early autumn egg-laying results in most damage to young cereals. Larvae hatch and feed on host plants right through to maturity. Mature larvae pupate in the soil. Under favourable conditions, the duration from egg-lay to adult emergence is 8-11 weeks, depending on the species.

Identification

Larvae curl into a 'C' shape when disturbed. Cutworm larvae are smooth skinned with a 'greasy' appearance. The absence of hairs and distinct lines along the body and behind the head (on the collar) distinguishes them from helicoverpa. The absence of distinct lines along the body distinguishes them from armyworm larvae.

For more detailed information on identification, see the I-Spy manual.

Damage

- Damage usually shows up as general patchiness or as distinct bare areas developing in a very short time.
- Young caterpillars climb plants and skeletonise the leaves or eat small holes. Older larvae may also climb to browse or cut off leaves, but commonly cut through stems at ground level and feed on the top growth of felled plants.
- Caterpillars that are almost fully grown often remain underground and chew into plants at or below ground level.
- 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 spring and summer - one generation per crop.
- Weedy fallow prior to sowing can lead to cutworm infestation.

Monitoring and thresholds

Inspect emerging seedlings twice per week. Larvae usually feed in the late afternoon or at night. By day they hide under debris or in the soil. Crop inspection needs to include examination of seedlings as well as of the soil along the crop row.

Pay particular attention to patches that appear to be emerging poorly, and field edges close to weedy fallows or weedy fencelines where cutworm may move from into the field.

A threshold of 1 larva per square metre is proposed for cutworm in emerging cereal crops.

Management and control

- Controlling weeds in the fallow prior to planting will assist in reducing cutworm population and reduce the risk of crop damage. Aim to control the weeds at least 3-4 weeks prior to sowing. Controlling weeds immediately before planting, or crop emergence may force large cutworm to relocate into the crop when their weed hosts die off.
- Spot spraying of identified patches of cutworm may suffice. This is particularly so when the source of the cutworm can be identified e.g. neighbouring fallow or weeds in the crop.
- For best results, spray late in the afternoon, close to the time when larvae emerge and feed.
- Cutworms are attacked by a range of natural enemies such as parasitoids, predators and diseases.

Slaters or flood bug (*Australiodillo bifrons*)

The native slater (*Australiodillo bifrons*) is an occasional pest of emerging winter crops. Outbreaks (or mass movements) of slaters have been recorded in May and June in southern Queensland and northern NSW. They have also been recorded in October in Central Queensland. The impact of slaters on emerging and establishing crops is highly dependant on the environmental conditions (how wet or dry) and the number of slaters.

Slaters are not generally regarded as a pest of broad acre agriculture, and are certainly not confined to agricultural areas. Slaters generally feed on decaying vegetation and dead animal matter. Overall they perform an important recycling role in the environment.

This native slater is commonly found in low lying swampy regions and tends to be more active after rain periods, which is typically when the swarming occurs. They need damp conditions and will die if exposed to open and dry situations.

Click the picture to watch a video of slaters swarming in a field near Moree, NSW (2006)

Identification

Slaters are crustaceans, not insects. They have a hard skeleton on the outside and many pairs of jointed legs. *Australiodillo bifrons* has a light brown oval shaped and flattened body with a dark brown stripe in the middle of the back. Both males and females have a characteristic split on the frontal plate. Males tend to be larger than females and can grow as large as 9 mm long and 6.5 mm wide.

Flood bug (*Australiodillo bifrons*). (Photo: Angelos Tsitsilas, cesar)

Damage

Slater damage to seedling wheat (Photo: Vic French).

Slaters are known to do damage to seedlings of wheat and oats and there is also evidence of slater activity in canola in western and southern Australia.

Slater damage looks similar to snail and slug damage with rasping and shredded appearance to leaves. Feeding damage can also appear as irregular patches removed from the leaves, resulting in distinctive 'windows' of transparent leaf membrane. Thousands of seedlings can be eaten in a short time by swarms of slaters.

Monitoring and threshold

Slaters can be observed whilst conducting crop inspections for other pests of establishing cereals, or weeds. Look for damage to seedlings consistent with rasping and windowing. If significant damage is found, a ground search along the affected row and neighbouring rows is warranted.

The damage caused by slaters is similar to that caused by slugs, so a ground search in combination with deployment of shelter traps may be useful in determining the cause. It is unlikely that small numbers of slaters will be present, but if crop inspections are irregular, then the 'swarm' may have passed through the crop between check leaving just damaged crop.

There is no threshold for slaters in winter cereals. The extent and rate of seedling loss will be a guide to whether significant crop loss is likely.

Management and control

Slaters are an agricultural pest in South Africa where they are generally controlled by cultivation. Changing farming practices such as minimum or non tillage seem to have increased the incidence of the slaters, especially if there is also a large amount of stubble present in fields.

There are no registered pesticides for the control of slaters in winter cereals.

Experience with slaters suggests that folia application of synthetic pyrethroids and organophosphates for other species has little impact on slaters. This low impact may be because slaters are largely protected from contact by soil and stubble. Insecticide baits are used in horticulture for slaters.

Non chemical approaches such as providing alternative habitats may decrease slater numbers in crops. Shelterbelts containing a complex understorey of vegetation and soil litter may be more attractive to slaters. Such environments also harbour many natural enemies of broad acre insect pests which can also keep slater populations in check.

Slugs

Reticulated slug (*Deroceras reticulatum*), Black keeled slug (*Milax gagates*)

Slugs are largely restricted to higher rainfall growing areas (> 500 mm per annum), and abundance is generally higher where stubble is retained. Stubble provides suitable shelter and moisture for slugs. Wet summer conditions promote slug numbers, increasing survival and reproduction. Cracking clays also favour slugs, as the slugs are able to shelter in the cracks over summer and take refuge during unsuitable conditions. Reduced tillage can also favour an increase in slug populations as cultivation will kill slugs and increase their exposure to desiccating conditions. Typically slugs are active at night, sheltering during the day under stubble and in the soil. Slugs tend to be more active when following rain, when the soil surface is moist.

Identification

The black keeled slug grows to 50 mm in length, is uniformly grey to black with a ridge or keel along the back (from the middle of the body to the tail). The reticulated slug is smaller, growing to 40 mm in length. These slugs are pale grey to light brown with dark mottling.

(Photo: D Paul) **(Photo: A. Weeks)**

Damage

Slugs have rasping mouthparts, and damage to seedling leaves is characteristically serrated or shredded in appearance. Damage to above ground parts of the plant is generally more severe when seedling growth is slow as a result of dry, or cool and wet conditions. Superficially, damage to seedlings can be confused with that caused by earth mites.

Slugs can also feed on seedlings before they emerge from the soil, resulting in poor or patchy establishment. The black keeled slug tends to feed below ground, and is associated with seedling loss prior to emergence. Patchy establishment may have a number of causes, and it is important to determine whether it is slugs, wireworm and false wireworm or earth mites that are responsible.

Monitoring and thresholds

Slugs are generally active at night. If sowing a particularly susceptible crop, or slug numbers are suspected to be high, monitoring prior to sowing is recommended. Prior to sowing, the presence of a slug population can be determined by the use of bait traps. A bait trap is a shelter trap (moist hessian bag, carpet tile, ceramic floor tile) placed in the field with several snail/slug baits underneath.

Place the traps in the field after rain and when the soil surface is moist. Place traps at a number of sites and leave for 24 – 48 hours before checking for slugs. The bait will help attract slugs. Alternatively, spread bait over a wider area and check for dead slugs.

If slug pressure is low, or slug damage is detected, you can monitor the emerging crop at night when the slugs will be active (when the crop is wet). Baiting is warranted if slugs are found under bait traps.

WA recommends the following thresholds for winter cereals:

- Black keeled slug 1-2/m^2*
- Reticulated slug 5 /m^2*

*To determine the density per m2 work out the area covered by the bait trap used and then correct to equal a m^2. For example, a trap 33 x 33 cm square = 0.1 m^2, so you would multiply the average slug catch by 10 to get the average per m^2.

Management and control

If conditions prevail that promote slug numbers, an integrated management approach will be required to effectively reduce slug numbers below damaging levels. Cultivation or baiting alone will not be sufficient to control large slug populations.

Carabid beetle adult, predator of slugs.

Predatory carabid beetles are known to feed on slugs, and are likely to make a valuable contribution to suppressing slug populations in most seasons.

Cultural control

Cultural practices which discourage slugs include cultivation (2 discings to 5 cm) to bury trash (shelter), kill slugs and slug eggs directly and through exposure. Whilst effective in reducing slug numbers, cultivation needs to be used in combination with baiting to effectively reduce slug numbers below damaging levels. Rolling restricts the movement of slugs in the seedbed.

The use of press wheels creates a humid furrow which may increase the likelihood of slug damage.

These strategies inconsistent with zero/minimum till and stubble retention practices aiming to conserve soil moisture. They are recommended as management tools to be implemented only when seasonal conditions (particularly a wet summer) have favoured slug build up.

Chemical control

Ideally, fallows should be bare so the only food source for slugs is the baits. The presence of plant material and shelter can reduce the effectiveness of baiting. For this reason, baits applied post-emergence are less effective than pre-emergent baits, as slugs often prefer the emerging seedlings. Aim to control mature slugs in autumn before they start breeding, and before they cause seedling loss.

Take action if there is significant slug activity in the pre-crop fallow, 2 weeks before planting. Two equally effective bait types are registered for slug control in field crops – those based on metaldehyde, and those based on an iron chelates (EDTA complex).

Metaldehyde based baits are highly toxic to mammals and birds (Schedule 5 poisons) and must be spread evenly to avoid heaping which might attract non target animals.

Iron chelate based baits are specific to slugs and snails (molluscs) and slaters (crustaceans) and have low toxicity to mammals and birds (no poison schedule). They have no impact on carab beetles which are key snail predators and hence are the preferred IPM option. Iron chelate based compounds are registered for use in the bare fallow prior to planting, and also in crop boundaries. While of low toxicity, iron chelate baits are attractive to some animals and birds.

Insecticide sprays targeting other soil pests, such as armyworms and cutworms, are ineffective against slugs. Where there is extreme slug pressure, baits alone will not bring slugs under control. For more information on slugs see the I-Spy Manual (p70).

White curl grubs: Scarab larvae

Black soil scarab (*Othnonius batesii*)

Scarab larvae are the juvenile stages of the scarab beetle. Larvae feed underground on the roots of a wide range of crop and pasture species, including winter cereals. Scarab damage to winter cereals is uncommon.

Adult beetles fly in early summer, laying eggs in suitable environments (crop and pasture). Scarabs may have a one or two year lifecycle, with noticeable damage to crops occurring when the larvae are nearing their maximum size in winter and spring.

Crops that follow a pasture phase are most at risk as the scarab larvae can carryover from the pasture to crop.

Scarab damage in barley crop at Jandowae, Darling Downs, Queensland. The severely damaged crop area on the right was under pasture prior to planting. The area on the left was previously cropped and cultivated. (Photo: Steve Henning)

Identification

White curl grubs are the juvenile (larval) stage of a scarab beetle.

Larvae have heavily sclerotised heads and strong mandibles (jaws). They have 6 legs on the thorax. The larvae grow up to 40 mm in length. The body of the larva is whitish, and they curl up into a C shape when uncovered and disturbed.

Third (and final) instar black soil scarab larva (30 mm) found under damaged barley plants at Jandowae, Darling Downs. Note the pale head capsule of this species. (Photo: Steve Henning).

Adult beetles are robust beetles up to 20 mm in length, typically with strong digging forelegs. They are generally brown to reddish brown, although the black soil scarab is a distinctive two-tone beetle with a dark head and light brown wing covers.

Black soil scarab adult (17 mm). Note the two-tone colour scheme – dark head and thorax, and light brown wing covers. Image by CSIRO.

Damage

Damage to crops can be significant when large larvae are present from crop establishment onwards. This occurs when the scarab has a 2 year larval life, as does the black soil scarab.

Small larvae do little damage to crops, but larger larvae feed on the roots of cereal plants, effectively reducing the capacity of the root system. As a result, affected plants are unthrifty, and more likely to become stressed and or die under moisture stress.

The scarab larvae feed on the below-ground parts of the cereal seedlings, limiting root growth or severing roots completely (left). As a result, seedling cereals are moisture stressed and unthrifty (right). (Photos: Steve Henning)

Monitoring and thresholds

Check for larvae in the soil prior to planting, particularly in high risk situations (e.g. going from pasture to crop). Larvae are generally in the top 50mm of soil and around the roots of plants, but may be deeper if soil moisture is low.

Use a shovel or auger to sample across the field. Sample to a depth of 10 cm and estimate the number of larvae per square metre. Using a quadrat may help in standardising the sampling.

The threshold for black soil scarab is two or more per square metre.

Management and control

Because scarab larvae live entirely below ground, once the crop is planted and the damage evident, there is no control option available to prevent further damage to the crop. It is simply impossible to contact the larvae with insecticide and large larvae would be difficult to control even if they could be contacted (e.g. a seed dressing will not deliver a large enough dose to kill large larvae).

Following a pasture (particularly several years of pasture) with crop, is the highest risk scenario for scarabs. Seasonal conditions (the onset of wetter than average seasons) may also contribute to an increased incidence of scarab damage.

Eggs are laid in pasture in spring/summer, and the small larvae develop whilst feeding on the roots of pasture grasses. By autumn/winter, the larvae are large (up to 30 mm), and feeding voraciously. If the pasture is removed and the winter cereal planted, the scarab larvae started feeding on the emerging cereal plants. At the time the cereal crop is emerging, larvae in the field are 10-12 months old and at the early 3rd instar stage. They will pupate in mid to late summer and emerge as adults in the spring.

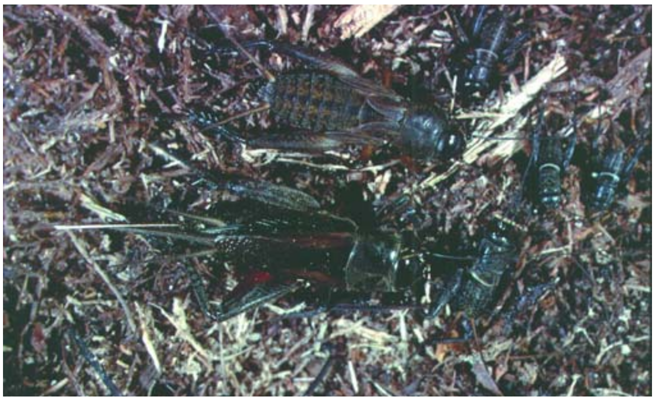
Black field cricket (*Teleogryllus commodus*)

Adult and nymph black field crickets feed on the leaves and stems of seedlings and may reduce a stand to the extent that replanting is necessary.

Both adults and nymphs shelter during the day in cracks in the soil or under trash. Black field cricket is most common in cracking soils where they can shelter in the cracks during the day. They come out at night and feed on weeds, grasses or crops.

Identification

Adults are up to 30 mm long, winged, black or brown and have the head and mouthparts inclined downwards. The hindlegs are large and modified for jumping like grasshoppers. Nymphs are similar in shape but are smaller, paler and wingless. Small nymphs can have a white band across their back.



Adult and nymphs of black field cricket. (Photo: D Ironside)

Damage

Crops can be attacked at any stage. Crops in heavier soils are at greatest risk. Most damage is caused by crickets already in the area at planting or by adults flying into crops.

Significant damage may be caused by adults and nymphs feeding on seedlings. When black field crickets are present in plague numbers, seedling crops can be thinned to the point where replanting is necessary.

Monitoring and threshold

Crickets feed at night, so inspect crops at dusk when crickets are most active.

Use germinating seed baits to estimate the size of the population. It is recommended that 20 GSB be placed in the field to make the assessment of pest density.

A threshold of 0.5 crickets per germinating grain bait is suggested.

Where crickets are just one of multiple surface active pests are detected, use the Soil Insect Rating to determine whether treatment is warranted.

Treatment is warranted if the SIR is greater than 6.

The Soil Insect Rating (SIR) is a means of deriving a threshold for multiple surface-active soil insect pests – which includes wingless cockroaches, FWW beetles and crickets. The number of each of these species is adjusted for the relative damage they cause (relative to that caused by the small FWW beetle).

SIR = (1xSW + 3.5xLW + 5xSR + 10xLR + 5xCR) / No. GSB examined

Where:

- SW = No. small FWW beetle
- LW = No. large FWW beetle
- SR = No. cockroaches < 20mm in length
- LR = No. cockroaches = or > 20 mm in length
- CR = No. crickets

Management and control

Cultural control: Weedy cultivation prior to planting may encourage crickets.

Chemical control: Field crickets are controlled using insecticide-treated cracked-grain baits.

Natural control agents, including diseases, parasitic insects, and predatory birds and insects, appear to have little effect.

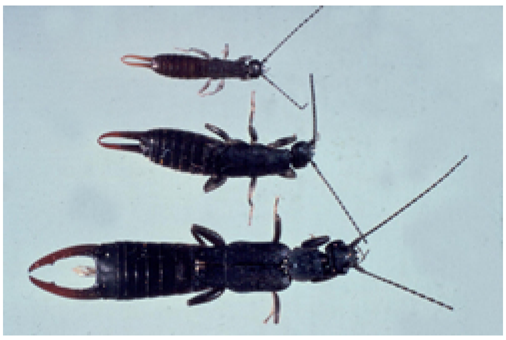
Black field earwig (*Nala lividipes*)

The black field earwig normally feeds on decaying stubble in cultivation but may attack germinating crops.

Identification

Adults are 15 mm long, shiny black with a flattened body and a pair of curved pincers at the end of the body. Nymphs resemble adults but are smaller, wingless and paler.

The black field earwig is similar to another earwig species, the common brown earwig (*Labidura truncata*). The common brown earwig is larger (growing to 24 mm), and is lighter in colour. The common brown earwig is a predator of caterpillar species and does not feed on plants.



Left: Black field earwig. Adult (bottom) and nymphs (Photo: D Ironside).
Right: Common brown earwig (*Labidura truncate*) is a predator of caterpillar larvae and pupae.

Damage

The black field earwig eats germinating seed and seedling roots, resulting in poor establishment. Feeding on secondary roots may cause the plants to fall over as they get larger.

Black field earwig cause damage to germinating seed and the roots of seedling plants, resulting in poor establishment (Photo: T Passlow).

Monitoring and threshold

Monitor crops from planting until establishment.

Use germinating seed baits or digging and sieving to detect adults and nymphs prior to planting.

Shelter traps can be used. Place damp hessian sacks on the ground and inspect underneath for earwigs after 1-2 days.

Control if more than 50 earwigs in 20 germinating seed baits or, control is warranted if one earwig is found in 20 spade samples.

Management and control

Cultural control: The black field earwig is mainly a pest in areas having heavy, black soils. Earwigs prefer cultivated soils rather than undisturbed soil (zero til). Use press wheels at sowing, which are set at 2-4 kg per cm width after planting rain, or 4-8 kg per cm in dry soil.

A history of black earwig incidence in a paddock is an indicator of increased risk of damage.

Chemical control: Grain baits containing insecticide applied at sowing offer best protection. Insecticide seed dressings provide some protection. In-furrow sprays are not effective in protecting against dense populations.

Vegetative - Flowering

Cereal aphids

Aphids are usually regarded as a minor pest of winter cereals, but in some seasons they can build up to very high densities. The incidence of Barley Yellow Dwarf Virus in the northern region is historically very low, and there is no recent data to determine the level of risk. Consequently, in discussing aphids in winter cereals the focus of aphid management is to minimise the impact of direct feeding damage.

Four species of aphid can infest winter cereals. The species in crops, and the relative abundance of the species can vary from season to season. So too can the timing of aphid arrival in a crop, and the activity of natural enemies that can influence the size of the population over time.

Identification

Commonly occurring species in the northern region are:

- **Oat or wheat aphid** (*Rhopalosiphum padi*) is one of the most common aphid-infesting winter cereals. Typically colonises the base and lower portions of the plant. The species has a preference for cool conditions, and is likely to be an annual migrant into crops from sources in cooler environments where it survives over summer.
  Dark green to black with a reddish area around the abdomen base extending from one cornicle to the other. Adults similar in size to *R. maidis* (2 mm), and have a 'boxy' shape.

Healthy (left) and parasitised oat aphids. (Photo from Southern Ute Guide)

- **Corn aphid** (*Rhopalosiphum maidis*) is also a common species found in winter cereals. It generally colonises the upper parts of the plant, particularly the whorl and rolled up terminal leaf. This species is more tolerant of warm conditions and it is likely that it over summers on grass hosts (weeds and cereal volunteers) in the cropping district. There is recent evidence that the *R. maidis* that colonises winter cereals is not the same type as those which colonise sorghum or maize. This means that there is not movement of aphids from sorghum to winter cereals, or vice versa.
  Light to dark green with two dark (reddish) areas around the base of the cornicles. Adults up to 2 mm long, pear shaped. Distinguish *R. maidis* from *R. padi* by the pattern of the colour on the abdomen, and the longer terminal process (segment) on the antennae.

Colony of corn aphid adults and nymphs. (Photo from Southern Ute Guide)

- **Rose-grain aphid** (*Metopolophium dirhodum*) generally colonises the undersides of the leaves, higher in the canopy. A cool season species, it is most likely an annual migrant into crops.
  Yellow-green species with a dark line down the midline of the body. Adults are relatively large, 1.5-3.5 mm long.

Rose-grain aphid adult and nymphs. (Photo from Southern Ute Guide)

- **Rice root aphid** (*Rhopalosiphum rufiabdominalis)* colonises the roots of the plants under the soil surface, although colonies may extend up from the roots to the base of the plant. This species is widespread, but is most often observed in seasons with a dry start. Reddish species, similar in size to the corn and oat aphid (2 mm). may be confused with *R. padi* because of the similarity in colour, size and location on the plant (around the base). Close examination is necessary to distinguish the two species. The rice root aphid has dense hairs, whilst *R. padi* does not. *R. padi* has 6-segmented antennae, rice root has 5 segmented antennae. (Photo: Melina Miles)

Rice root aphid adult. (Photo: Melina Miles)

For more information on identification of cereal aphids, see the I-Spy manual.

Damage

Aphids can impair growth in the early stages of crop and prolonged infestations can reduce tillering and result in earlier leaf senescence. Infestations during booting to milky dough stage, particularly where aphids are colonising the flag leaf, stem and head, can result in yield loss. Aphid infestations during grain fill may result in low protein grain as aphids compete for nitrogen (N) with the crop. Persistence of aphid populations through until maturity, particularly on the head, is uncommon.

Aphid feeding does not produce obvious symptoms in the plant. Comparison of the growth rate of infested and uninfested plants may show the impact of heavy infestations.

The Oat and Corn aphid are known vectors of Barley Yellow Dwarf Virus (BYDV). The impact of BYDV infection on yield is considerably higher than the impact of direct feeding by aphids. BYDV can impact on barley, wheat and oats. However, the incidence of BYDV in the northern region (NSW, Qld) is historically low. In virus-prone areas (particularly high rainfall areas where grass hosts are available all year round) resistant varieties are an important part of minimising losses caused by BYDV.

Monitoring and thresholds

Inspect for aphids from seedling to booting. Typically, aphid populations start to decline by the time the crop comes into head. The cause of the population decline is not well understood, but is probably a combination of changes in suitability for aphids and the impact of natural enemies.

Monitor individual plants at the seedling stage, tillers at later stages of growth.

As aphid infestations tend to develop from the edges of fields, take a representative sampling from across the field. Estimate the number of aphids on each plant or tiller, and average for the field. Because aphid infestations may be patchy, particularly during the early stages of colonisation, a random sampling strategy will be most effective.

Thresholds

Research is currently underway into damage thresholds and control options for cereal aphids. Some research indicates that aphid infestations (>10 aphids per tiller) can reduce yield by around 10% on average.

Current fixed thresholds suggest control is warranted when there are 10-20 or more aphids on 50% of the tillers.

Management and control

The decision to control aphids on winter cereals depends on both the size of the aphid population and the duration and timing of the infestation. Controlling aphids during early crop development generally results in a recovery of the rate of root and shoot development, but there can be a delay. Aphids are more readily controlled in seedling and pre-tillering crops which are less bulky than post-tillering crops. Corn aphids in the terminal leaf tend to disappear as crops come into head, and other species generally also decline in abundance about this time as natural enemy populations build up. Note that the rice root aphid feeds below ground and can not be effectively controlled by non-systemic foliar treatments.

Lacewing larvae (top) and wasp emerging from parasitised aphid. (Photos: Melina Miles)

Prophylactic seed dressings may be effective in delaying the build up of aphid populations in a crop, but because aphids are sporadic (not occurring every season), it can be difficult to decide if a seed dressing is warranted. A locally wet summer and autumn is generally a precursor to an outbreak of species that oversummer locally. For those species that migrate into the cropping areas, assessing the risk can be more difficult.

Delay any planned chemical control if rain is forecast and check again after rain as intense rainfalls can reduce aphid infestations by dislodging aphids from the plants. Foliar insecticides registered for aphid control are generally broad spectrum, meaning they kill natural enemies (beneficial insects such as ladybird beetles and larvae, hover fly larvae, lacewing larvae or parasitic wasps) as well as aphids. Preserving natural enemies is important in managing aphid populations long-term. Natural enemies can exert effective control on small to moderate aphid infestations. Large aphid populations can also be controlled, but often not until the crop is maturing, which may be too late to prevent impact on yield. Natural enemies can also be effective in suppressing aphid numbers that may survive post-treatment, preventing the need for subsequent treatments.

Brown wheat mite

Brown wheat mite (*Petrobia latens*) is an irregular pest, most often occurring in damaging numbers in dry seasons.

Brown wheat mite adult (approximately 0.6 mm in length) (Photo: M Miles)

Adults are oval, up to 0.6 mm long and have 8 legs. The front legs are significantly longer than the others. The adult mite is brown and appears dark greenish-brown to black when on a green leaf. Immature mites are smaller and orange-red.

The brown wheat mite is significantly smaller and has finer legs than the blue oat and redlegged earth mites. The blue oat mite, which is the other mite species occurring in the southern part of the northern grains region, has a dark, blue-black body and a red mark on the back.

At the beginning of summer, eggs are laid in the soil that will survive the summer. Rain and cooler temperatures in autumn and winter trigger hatching, but large populations only develop if conditions are warm and dry.

Damage

Wheat, barley, triticale, oats and grasses are hosts. Crops are at risk during warm, dry periods. Adults and nymph mites pierce the leaves, feeding on cells. Brown wheat mite has a preference for feeding on leaf tips, resulting in mottling, silvering and then dessication. Heavy infestations at establishment can result in seedling death. More commonly, infestations on vegetative crops cause silvering and bronzing and a crop that looks droughted with withered and brown leaf tips.

Left: Mottling on wheat leaf caused by feeding of brown wheat mite (Photo: M Miles)
Right: Wheat heavily infested with brown wheat mite, Westmar September 2012, showing bronzing as a result of browning of leaf tips (Photo: M Miles).

Monitoring and thresholds

Brown wheat mite feed actively during the day, but will move quickly and drop from the plant when disturbed by checking. This behaviour makes assessing density difficult.

Check from planting to early vegetative stage, particularly in dry seasons.

No threshold has been determined. Treatment of brown wheat mite is recommended if the crop is showing signs of damage (bronzing, yellowing, withered leaf tips) and dry conditions are persisting.

Management and control

Spray if mottled patches appear throughout the crop and if conditions are dry. Heavy rain can reduce brown wheat mite numbers significantly.

Fields that have had continuous wheat, or volunteer cereal or grass over summer and early autumn are thought to be at higher risk.

Nothing is known about biological control of brown wheat mite.

False wireworm

Eastern false wireworm (*Pterohelaeus* spp)
Southern false wireworm (*Gonocephalum* spp)

Adult false wireworms emerge from the soil during spring and early summer. In winter cereals, the damage caused by large larvae and adult beetles can be significant, although false wireworm are a minor and irregular pest.

Identification

Larvae are up to 30 mm long, shiny and cream, yellow or tan with three pairs of legs just behind the head. They are hard-bodied, cylindrical and segmented with a rounded head.

Adult beetles of *Pterohelaeus* spp. are 20 mm long and dark grey-black with a distinctive 'pie-dish' shape formed by flanges around the outline of the beetle.

Larva and adult of the eastern false wireworm (*Pterohelaeus* sp - left) and southern false wireworm (*Gonocephalum* sp - right) (Photos: D Ironside)

Adult beetles of *Gonocephalum* spp. are 9 mm long, dark grey-black and often covered in soil. There are flanges around the outline of the thorax (behind the head). Eggs are laid singly in moist soil, usually under trash or low-growing weeds.

Damage

Adults chew on seedlings at or above ground level, ring-barking or completely cutting the stem.

Larvae feed on decaying vegetable matter and crop residues in the soil, as well as on germinated seed. They usually have a single generation per year. Both the seeds and growing points are damaged, resulting in patchy stands.

Monitoring and thresholds

Assess larval and adult numbers using germinating seed baits (GSB):

- **Larvae**: more than 25 larvae in 20 germinating seed baits (GSB[*])
- **Adults**: apply bait to the whole field if the soil insect rating (SIR[†]) is more than six.

It is recommended that 20 GSB be placed in the field to make the assessment of pest density.

The Soil Insect Rating (SIR) is a means of deriving a threshold for multiple surface-active soil insect pests – which includes wingless cockroaches, FWW beetles and crickets. The number of each of these species is adjusted for the relative damage they cause (relative to that caused by the small FWW beetle).

SIR = (1xSW + 3.5xLW + 5xSR + 10xLR + 5xCR) / No. GSB examined

Where:

SW = small FWW beetle
LW = large FWW beetle
SR = cockroaches <20mm in length
LR = cockroaches = or >20 mm in length
CR = crickets

Management and control

Cultural control: the false wireworm is mainly a pest in areas having heavy, black soils. It prefers cultivated soils rather than zero til. However, adults can move some distance from where they emerge, so preventing damage from adults is not possible.

Chemical control: use cracked grain baits for adult beetles. Larvae can only be controlled if detected prior to planting and seed dressing or in-furrow treatment applied.

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[*] **Germinating seed baits.** GSBs are most effective when placed in the field after rain. Soak grain (wheat or barley) overnight in water to pre-shoot. Place GSB at 5 widely spaced sites throughout each 100 ha. At each site mark the corners of a 5m x 5m grid. At each corner place half a hand-full of pre-soaked grain on the moist soil layer and cover with 1cm of soil. One day after seedlings have emerged above ground from GSB, dig up the GSB and place the seed and surrounding soil on a tray or sheet to examine. Count the number of each soil pest.

[†] **Soil Insect Rating.** The SIR is a multispecies soil insect rating model and was originally developed for sunflower, but has been extrapolated to sorghum and winter cereals. It is used to provide a combined estimate of the damage potential of a number of surface active establishment pests e.g. false wireworm species, wingless cockroaches, black field earwigs and black field crickets. The multiplier applied to each species adjusts for the relative damage potential making them all equivalent (the higher the multiplier, the less damaging).

Grainfill – Harvest pests

Armyworms

Common armyworm larvae. (Photo: J Wessels)

Common armyworm (*Leucania convecta*), Northern armyworm (*Leucania separate*) Dayfeeding armyworm (*Spodoptera exempta*).

Armyworm best known for the damage they cause in spring when they lop seed heads in barley, oats and occasionally wheat. Common armyworm is active in autumn (feeding on seedlings at establishment) and both the common and northern armyworm are active in spring when they are most damaging, lopping heads of winter cereals as the crops dry down.

The northern and common armyworm feed exclusively on grasses, including cereal crops. Armyworm outbreaks typically occur after periods of drought, perhaps because natural enemies that would otherwise keep populations in check are depleted. It is possible that treating cereal crops for aphids in vegetative stages may also make them more vulnerable to armyworm damage because natural enemies have been killed.

During the day armyworms shelter in the soil or under stubble around the base of plants and emerge after sunset to feed.

Identification

Distinguishing armyworm larvae from *Helicoverpa armigera* larvae (which may also be present in wheat and barley) is important. If *H. armigera* is present in addition to armyworm, they may not be effectively controlled with synthetic pyrethroids, and the addition of helicoverpa nucleopolyhedrosis virus (NPV) will be beneficial.

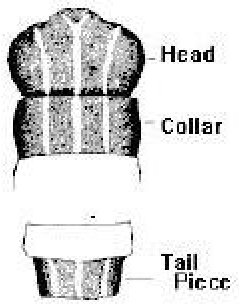


Illustration of a common armyworm larva showing the location of the collar where the distinguishing stripes can be found.

Armyworm caterpillars can be distinguished from other caterpillar species that may occur in winter cereals (e.g. cutworm and helicoverpa) by the three white lines that run the length of the body. These white lines are most distinct on the 'collar' just behind the head.

For more information on the identification of armyworm see the I-Spy manual.

Monitoring and thresholds

It is essential to recognise the problem early and be prepared to spray before economic damage occurs. Once head lopping starts, significant crop loss can occur in a matter of days. Whilst large larvae do the head lopping, controlling smaller larvae that are still leaf feeding may be more achievable.

Check for larvae on the plant and in the soil litter along the rows at the base of plants. Look for the presence of fecal pellets on the ground, and scalloping of leaves.

Barley crop with ragged (scalloped) leaves indicative of armyworm activity (Photo: M.Miles)

- Late in the day, when the larvae are becoming active, use a sweep net (or swing a bucket through the crop) to make a quick assessment of whether armyworm larvae are present in the crop. Watch a video of how to sample barley with a sweep net.
- Record the number and size of the larvae found. Size is important because this information will be useful in predicting whether larvae will reach a damaging size when the crop is susceptible. If the majority of larvae are 35-40 mm, then they have almost completed development and will be pupating soon; their damage potential is low.
- Infestations are often patchy, so check a number of sites across the field. Infestations are often first detectable in areas of the crop that are thickest, e.g. where double sown. Ensure representative areas of the crop are sampled.

A barley crop at the stage susceptible to armyworm damage; dry leaves and stems, and green nodes.

It is estimated that one large armyworm larva can lop up to 7 heads per day (armyworms are active mostly at night). At one larva per square metre, that equates to around 70 kg/ha of lost grain per day. A damaging larva may be active for up to 5 days before pupating, giving a total potential yield loss of 350 kg/ha.

Importantly, this calculation is determined on the number of large larvae in the crop when susceptible to head lopping. If a decision to treat the crop is made earlier, targeting smaller leaf feeding larvae, then an adjustment needs to be made for the likely mortality (death) of larvae from small to large. Mortality can include a range of causes including dislodgement from the plant by wind/rain; predation; disease. A mortality factor of 20% (small x 0.8 = medium-large) is proposed. Consequently, 4 small larvae = 3.2 medium – large larvae, for example.

Armyworm yield loss in barley & wheat ready-reckoner

The economic break-even point is reached when potential yield loss (if no action taken) equals the cost of control.

Grain price ($/t)	Economic value of yield loss ($/ha)*		
	0.5 large larva/m^2 (=0.6 small)	1 large larvae/m^2 (=1.25 small)	1.5 large larvae/m^2 (= 1.9 small)
100	18	35	53
150	26	53	79
200	35	70	105
250	44	88	131

* Yield loss estimate based on the consumption rate of 1 large larva per m^2 over 5 days = 70 kg/ha\day x 5 = 350kg/h total potential loss (loss of 1 head/m^2 = yield loss of 10kg/ha).

Treatment is warranted when the value of the yield loss ($/ha) exceeds the cost of control.

Armyworm Economic Threshold in barley & wheat ready-reckoner

From a crop monitoring perspective, it is useful to calculate an economic threshold as has been done in the ready-reckoner below.

Cost of control ($/ha)	Crop value ($/t)			
	100	150	200	250
20	0.6	0.4	0.3	0.2
25	0.7	0.5	0.4	0.3
30	0.9	0.6	0.4	0.3
35	1.0	0.7	0.5	0.4

The economic threshold (larvae/ m^2) based on a total potential yield loss per larva of 350 kg/ha.

Management and control

In addition to assessing larval number, to make a decision about if and when control is required, an estimate will need to be made of how quickly the larvae will reach damaging size and when this will occur in relation to the crop maturity and susceptibility to head lopping.

- **Scenario 1:** The crop is nearing full maturity/harvest, and the grubs are small. Small larvae take 8-10 days to reach a size capable of head lopping. The crop will not be susceptible to head lopping when the larvae reach medium – large. Treatment is not required.
- **Scenario 2:** The crop is nearing full maturity/harvest, and the grubs are small. Small larvae take 8-10 days to reach a size capable of head lopping. Under continuing dry, warm conditions the crop will not be susceptible to head lopping when the larvae reach medium – large. However, there is a period of cool, wet weather and the crop does not dry down as quickly as expected. It will be important to monitor the crop regularly to assess larval size and crop susceptibility.
- **Scenario 3:** A late crop that is still very green and at early seed fill with above threshold numbers of small larvae. Depending on the rate of crop dry down, it is likely that larvae will be large and most damaging when the crop is susceptible. Therefore the risk to yield is high.

The effectiveness of an insecticide application for armyworm is dependent on good penetration into the crop and good coverage to get contact with the caterpillars where they feed. Control may be more difficult in high-yielding thick canopy crops, particularly when larvae are feeding in the canopy. As larvae are most active at night, spraying in the afternoon or evening may produce the best results.

Cotton bollworm, corn earworm (*Helicoverpa armigera*)

Helicoverpa armigera is frequently found in winter cereals, usually at levels too low to warrant control, but occasionally numbers may be sufficiently high to cause economic damage. Virtually all helicoverpa present are *H. armigera*, which has developed resistance to many of the older insecticide groups. H. punctigera (native budworm) does not feed on grasses.

Identification

As it is not unusual to find both helicoverpa and armyworm in cereal crops, correct identification of the species present is important (see armyworm section above).

Helicoverpa armigera **larva showing the presence of white hairs just behind the head. The presence of hairs on the body, and the absence of distinct lines on the collar distinguish *H. armigera* from armyworm larvae.**

Damage

Helicoverpa do not cause the typical head-cutting damage of armyworms. Larvae tend to graze on the exposed tips of a large number of developing grains, rather than totally consuming whole grains, thus increasing the potential losses. Most (80-90%) of the feeding and crop damage is done by larger larva (the final two instars).

Monitoring and thresholds

Check for larvae on the plant as the crop starts to mature (monitoring can be done at the same time as sampling for armyworm). Using a sweep net sample a number of sites throughout the paddock. Watch a video of how to sample barley with a sweep net.

While there are no experimentally derived thresholds developed for helicoverpa in winter cereals, we can estimate likely yield loss using a consumption rate determined for helicoverpa feeding in sorghum.

At the rate of yield loss of 2.4 g/larva, one larvae per square metre can cause 24 kg grain loss/ha. Calculate the helicoverpa density in the crop using the following equation:

Density/m^2 = (number of larvae per m row/row spacing (m))

For example, at 30cm row spacing the number of larvae per square metre would be 3.3 (based on 1 larva per metre of row). Sweep net sampling has not been calibrated for winter cereals. Work on 10 sweeps = 1 m^2 sampled.

The following table shows the value of yield loss incurred by a range of larval densities, using the estimated consumption of 2.4 g/larvae and a range of grain values for wheat. Note that larval damage is irrespective of the crops yield potential (i.e. each larva will eat its fill whether it is 1 t/ha crop or a 3 t/ha crop).

Cereal price ($/t)	Value of crop loss ($/ha)			
	4 larvae/m^2	6 larvae/m^2	8 larvae/m^2	10 larvae/m^2
150	14.4	21.6	28.8	36
200	19.2	28.8	38.4	48
250	24.0	36.0	48.0	60
300	28.8	43.2	57.6	72
350	33.6	50.4	67.2	84
400	38.4	57.6	76.8	96
450	43.2	64.8	86.4	108

Based on the example above, a crop worth $250/tonne will incur a loss of $6/ha from each helicoverpa larvae per m^2. If chemical intervention costs $30/ha (chemical + application costs) the economic threshold or break-even point is 5 larvae/m^2. These parameters can be varied to suit individual costs, and can incorporate a working benefit:cost ratio. A common benefit:cost ratio of 1.5 means that the projected economic benefit of the spray will be 1.5 times the cost of that spray. Spraying at the break even point (benefit:cost ratio of 1) is not recommended.

Management and control

Small larvae (<7 mm) can be controlled with biopesticides (e.g. NPV). Biopesticides are not effective on larger larvae (>13 mm). *Helicoverpa armigera* has historically had high resistance to synthetic pyrethroids and control of medium-large larvae using pyrethroids is not recommended.

Broadleaf weeds in the crop may provide suitable hosts for helicoverpa larvae which can develop on these before they move to the winter cereal as medium – large larvae when the weed hosts dry off.

Natural enemies

Predators of helicoverpa eggs and larvae include Trichogramma wasps, green and brown lacewings, spined predatory bug, glossy shield bug, damsel bug and bigeyed bug.

Where winter cereals have previously been treated with broad spectrum insecticides to control aphids, fewer natural enemies may be present and survival of caterpillar pests could be greater than in an untreated field.

Stem borer (*Ephysteris silignitis*)

A regular but minor pest of wheat, with most records from Central Queensland, southern Queensland. Evidence of the activity of the stem borer is white heads in the crop. *E. silignitis* is a native species with a relative E. *promptella* recorded as a pest of sugarcane in Australia. *Ephysteris silignitis* occurs widely in Australia south to about 35 degrees south. Little is known about this species.

Damage

The damage is usually confined to a single tiller per plant at a relatively low incidence through fields. Infected tillers seem to flower normally, but soon after flowering the stem upwards from the last node (and including the head) dies and is white with no grain in the head. From a distance, these symptoms appear to be the same as those of crown rot. However, infected tillers are green and apparently healthy from the last node (including the flag leaf) down. On closer examination, a small entry hole about the size of a pinhead may be evident usually at or just below the first node up from the base of the plant. In some cases an exit hole is visible just above the last node.

Stem borer larva in wheat (Photo: Iain Macpherson)

Monitoring and threshold

Examine affected tillers by splitting the stem open. If there has been feeding by the larva, follow the feeding trail up the stem looking for a larva still feeing in the stem, or evidence of an exit hole at the last node.

There is no threshold for stem borer.

There are no recorded incidences where the 'white heads' caused by the stem borer have been significant enough to cause economic yield loss.

Management and control

There is no registered chemical control, and the control of stem boring species is particularly difficult with insecticides.

No other management information is available. It is likely that there are specific seasonal conditions that increase the likelihood of stem borer in crops, and result in outbreaks but at this point these are not known.

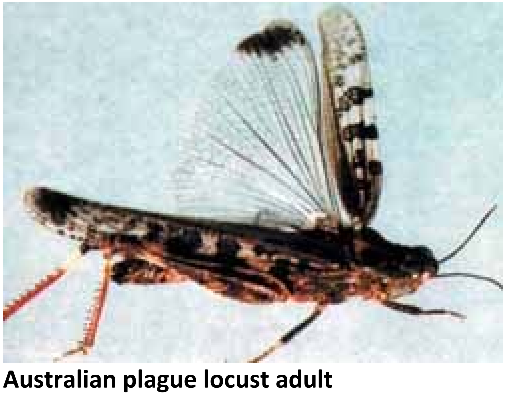
Locusts and grasshoppers

- Australian plague locust (*Chortoicetes terminifera*)
- Migratory Locust (*Locusta migratoria*)
- Spur throated Locust (*Austracris guttulosa*)

Three species of locust (Australian plague, migratory and spur throated) are most commonly associated with damage to crops in the northern grains region. Although plagues are infrequent when they occur, large numbers of locusts can move into crops overnight and cause significant damage.

Damage is characterised by removal of large pieces of leaves. In high numbers, locusts can rapidly defoliate a crop.

The Australian plague locust is the most important economically due to the extent and frequency of its outbreaks. Successful breeding occurs after good rains in inland areas and the locusts then migrate on prevailing weather systems, invading adjacent agricultural areas.



Australian plague locust adult

Migratory locust adults.

The migratory locust is large, heavily built, green or brown in the solitary form. Migratory locust is most frequently a pest in the Central Highlands of Queensland where there are frequent small outbreaks. This species feeds predominantly on grasses, including grass crops (wheat, barley, oats, sorghum, maize) and pasture.

The spur-throated locust is the least frequently damaging of the three species, however migrations can occur into cropping areas. The most significant recent spur throat locust outbreak was in central western Queensland in 2010. This species is most damaging in summer crops, but can cause losses in winter cereals in autumn and early summer.

It can be readily distinguished from other pest species of locusts and grasshoppers by its large size and the presence of a spur between the front legs.

Spur throated locust viewed from underneath with the characteristic 'spur' highlighted by the red circle.

For detailed information on locust and grasshopper identification, distribution and current levels of activity see

- DAFF website (http://www.daff.gov.au/animal-plant-health/locusts/about).
- Biosecurity Queensland locust factsheet (links to a pdf file)

Identification of locusts

The major difference between locusts and grasshoppers is that locusts have the ability to swarm. Grasshoppers do not. There are some 500 grasshopper species in Australia, some of which can develop large localised infestations without the risk of swarming.

It is therefore important that land managers can identify the four locust species and one grasshopper considered economically important pests in Queensland.

Life cycle

All locusts and grasshoppers have the same three-stage life cycle (egg ➞ hopper (nymph) ➞ adult) and require green vegetation (hence rainfall) for successful breeding.

Batches of eggs ('egg pods') are laid in the soil in holes up to 100 mm deep; holes are then filled with a froth plug. Some species lay in close proximity to each other, and these aggregations are known as 'egg beds'. Eggs need warmth and moisture to incubate in the soil. Under ideal conditions eggs hatch in 2–3 weeks, but may remain viable in the soil for up to 12 months.

The hatched locusts (nymphs or hoppers) are small, sexually immature, and flightless. They progress through a number of growth stages or 'instars' before 'fledging' into the adult form.

The number of instars varies between species (from 5–9), as does the time taken to reach maturity. Some species form dense aggregations of hoppers, known as 'bands', which can march across country in densities up to 5000 locusts/m^2.

Adults of all locust species are winged. New adults (fledglings) are sexually immature, and may remain in this state for as little as 14 days or for many months. Adults can form swarms covering several square kilometres which, under suitable climatic conditions, can migrate long distances to invade previously uninfested areas. For the Australian plague locust, migrations in excess of 500 km in a night are not unusual, and are associated with weather fronts (see Figure 1).

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Queensland Government