NORTHERN
SEPTEMBER 2018

GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

CEREAL RYE

SECTION 7

INSECT CONTROL

INTEGRATED PEST MANAGEMENT | RUSSIAN WHEAT APHID | HELICOVERPA SPP. | APHIDS | CUTWORM (AGROTIS SPP.) | ARMYWORM | MITES | SLATERS | SOIL INSECTS IN THE NORTHERN REGION

Insect control

Key messages:

- Cereal rye can attract armyworms. [1]
- An abundance of top growth (when rye is used for cover cropping) that is poorly incorporated may cause poor seed-to-soil contact in the subsequent crop and may attract armyworms or cutworms. [2]
- Cereal rye can attract significant numbers of beneficial insects such as lady beetles. [3]
- Insects are not usually a major problem in winter cereals but sometimes they build up to an extent that control may be warranted.
- Integrated pest management (IPM) strategies encompass chemical, cultural and biological control mechanisms to help improve pest control and limit damage to the environment.
- For current chemical control options refer to the Pest Genie or Australian Pesticides and Veterinary Medical Authority (APVMA).

7.1 Integrated pest management

Pest insects can have adverse and damaging impacts on agricultural production and market access, the natural environment, and our lifestyle. Pest insects may cause problems by damaging crops (Tables 1, 2 and 3) and food production, parasitising livestock, or being a nuisance and health hazard to humans. IPM Guidelines provide an extensive collection of tools and strategies to manage pests in grain cropping systems.

1 WS Curran, DD Lingenfelter, L Garling, P Wagoner (2006) Cover crops for conservation tillage systems. The Pennsylvania State University, http://extension.psu.edu/plants/crops/soil-management/conservation-tillage/cover-crops-for-conservation-tillage-systems

2 Manure $ense (2009) Cereal rye: manure and livestock's new best friend. Michigan State University February 2009

3 A Clark (ed.) 2007 Managing cover crops profitably. 3rd ed. SARE Outreach Handbook Series Book 9. National Agricultural Laboratory, http://www.sare.org/publications/covercrops.htm

Table 1: *Winter cereal pests affecting Northern Region crops.*

	Pre-season	Establishment	Winter	Spring
Aphids	Remove green bridge (weed and volunteer hosts)	High risk: • wet summer/autumn • history of virus If high risk, consider seed dressings. Targeted early control along crop edges or infested patches may delay build-up in the crop.	High risk: Warm conditions favour aphids. Monitor and record aphids and beneficials. Review to determine if populations increase/decrease or are stable. Rainfall >20 mm will reduce aphid populations. Consider delaying insecticide application if rain is forecast. If spray required, use a selective insecticide.	A warm, dry spring encourages population growth. No yield loss will occur if infestations occur later than milky grain. Monitor/record aphids and beneficials. Use suggested thresholds. If spray required, use a selective insecticide. Use of broad spectrum pesticides will kill beneficial insects and increase likelihood of aphid population resurgence.
Common Armyworm	• Control host weeds (especially ryegrass) • Ensure correct ID (armyworm vs *Helicoverpa*.)	Use traps to indicate moth activity (lures of 10% port, 15% raw sugar and 75% water)	High risk: good local rain following a dry period encourages egg laying. Monitoring: • Use traps to monitor for moth activity. • Monitor for larvae at dusk with a sweep net. • Ground search for larvae and droppings. • Look for scalloped leaf margins. Control larvae when small.	Increase monitoring as crop starts to dry down. Small larvae take 8–10 days to reach size capable of head lopping. Determine if crop will be susceptible (dry, except for green nodes) when larvae reach damaging size. Control late in the day when larvae are actively feeding. Use of SPs to control armyworm early can increase likelihood of *Helicoverpa* survival and damage by killing beneficials that would control them.
Helicoverpa armigera	If large numbers of *Helicoverpa* present in previous crop, pupae busting may reduce pest incidence.		• Monitor for larvae with sweep net (can be done when checking for armyworm), or with a beat sheet. • Control small larvae (<7 mm) with NPV	Monitor for larvae using a sweep net or beat sheet. • Large larvae are most damaging to developing grain. (Small larvae (<7 mm) can be controlled with NPV). • Be aware that *H. armigera* have resistance to SPs in all regions.

Source: IPM Guidelines

Table 2: *Insect pest risk for winter cereals in the Northern Region.*

High risk	Moderate risk	Low risk
Soil insects, slugs and snails		
• Some crop rotations increase the likelihood of soil insects: » cereal sown into a long-term pasture phase » high stubble loads » above average rainfall over summer-autumn. • History of soil insects, slugs and snails • Summer volunteers and brassica weeds will increase slug and snail numbers • Cold, wet establishment conditions expose crops to slugs and snails	• Information on pest numbers prior to sowing from soil sampling, trapping and/or baiting will inform management. • Implementation of integrated slug management strategy (burning stubble, cultivation, baiting) where history of slugs. • Increased sowing rate to compensate for seedling loss caused by establishment pests.	Slugs and snails are rare on sandy soils.
Earth mites		
• Cereals adjacent to long-term pastures may get mite movement into crop edges. • Dry or cool, wet conditions that slow crop growth increase crop susceptibility to damage. • History of high mite pressure.	Leaf curl mite populations (they transmit wheat streak mosaic virus) can be increased by grazing and mild wet summers.	Seed dressings provide some protection, except under extreme pest pressure.
Aphids		
Higher risk of BYDV disease transmission by aphids in higher rainfall areas where grass weeds are present prior to sowing. Wet summer and autumn promotes survival of aphids on weed and volunteer hosts.	Wet autumn and spring promotes the growth of weed hosts (aphids move into crops as weed hosts dry off). • Planting into standing stubble can deter aphids landing. • Use of seed dressings can reduce levels of virus transmission and delay aphid colonisation. • Use of SPs and OPs to control establishment pests can kill beneficial insects and increase the likelihood of aphid survival.	Low rainfall areas have a lower risk of BYDV infection. High beneficial activity (not effective for management of virus transmission).

High risk	Moderate risk	Low risk
Armyworm		
Large larvae present when the crop is at late ripening stage.	High beneficial insect activity (particularly parasitoids). Rapid crop dry down.	No armyworm present at vegetative and grain filling stages.

Source: IPM Guidelines

Table 3: *Impact of insect according to crop stage. * Snails are also a grain contaminant at harvest*

Pest	Crop stage			
	Emergence	Vegetative	Flowering	Grainfill
Wireworms	Damaging	Present		
Cutworm	Damaging			
Black headed cockchafer	Damaging	Present		
Earth mites	Damaging	Present		
Slugs, snails*	Damaging			
Brown wheat mite		Damaging		
Aphids	Present	Damaging	Present	Present
Armyworm		Present	Present	Damaging
Helicoverpa armigera				Damaging

Present	Present in crop but generally not damaging
Damaging	Crop susceptible to damage and loss

Source: IPM Guidelines

Integrated pest management is an approach that uses a combination of biological, cultural and chemical control methods to reduce insect pest populations. A key aim of IPM is to reduce reliance on insecticides as the sole and primary means of pest control. IPM can improve growers' profitability while reducing environmental damage and limiting the risk of on-farm pesticide exposure.

7.1.1 Key IPM strategies for winter cereals:

- Where the risk of establishment pest incidence is low (e.g. earth mites) regular monitoring can be substituted for the prophylactic use of seed dressings.
- Where establishment pests and aphid infestations are clearly a result of invasion from weed hosts around the field edges or neighbouring pasture—a border spray of the affected crop may be sufficient to control the infestation.

Insecticide choices:

- Redlegged earth mite (RLEM), blue oat mite (BOM) and other mite species can occur in mixed populations. Determine species composition before making decisions as they have different susceptibilities to chemicals.
- Establishment pests have differing susceptibilities to insecticides (SPs, OPs in particular). Be aware that the use of some pesticides may select for pests that are more tolerant.

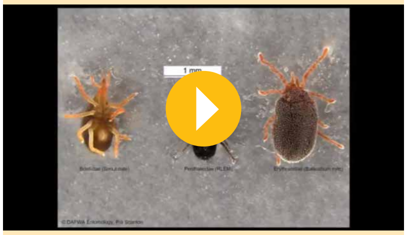
Insecticide resistance:

- RLEM has been found to have high levels of resistance to synthetic pyrethroids such as bifenthrin and alpha-cypermethrin.

VIDEOS

WATCH: GCTV2: Integrated pest management

WATCH: Over the Fence North: Vigilance needed for changing insect patterns.



WATCH: GCTV11: GRDC's Insect ID App

MORE INFORMATION

IPM Guidelines for grains

Emerging insect threats in northern grain crops.

IPM Guidelines website.

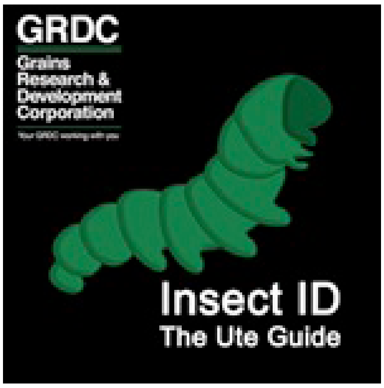
- *Helicoverpa armigera* has historically had high resistance to pyrethroids and the inclusion of nucleopolyhedrovirus (NPV) is effective where mixed populations of armyworm and *Helicoverpa* occur in maturing winter cereals. [4]

7.1.2 Emerging insect threats in Northern Region crops

Key points:

- Monitor crops frequently so as not to be caught out by new or existing pests.
- Look for and report any unusual pests/damage symptoms—photographs are good.
- Just because a pest is present in large numbers in one year does not mean it will necessarily be so next year—it may be the turn of another spasmodic pest; e.g. soybean moth, to make its presence felt.
- However, be aware of cultural practices that favour pests and rotate cops each year to minimise the build-up of pests and plant diseases.
- Agronomists and growers should monitor their crops and report the first signs of any suspicious activity. [5]

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



The Insect ID: The Ute Guide is a comprehensive reference guide for insect pests commonly affecting broadacre crops and growers across Australia, and includes the beneficial insects that may help to control them. Photos have been provided for multiple life cycle stages, and each insect is described in detail, with information on the crops they attack, how they can be monitored and other pests that they may be confused with. Use of this app should result in better management of pests, increased farm profitability and improved chemical usage. [6]

App features:

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

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

4 IPM Guidelines (2016) Winter cereals. GRDC and QDAF, http://ipmguidelinesforgrains.com.au/crops/winter-cereals/

5 H Brier, M Miles (2015) Emerging insect threats in northern grain crops. GRDC Update Paper, 31 July 2015, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/07/Emerging-insect-threats-in-northern-grain-crops

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

7.1.3 Insect sampling methods

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

Factors that contribute to quality monitoring:

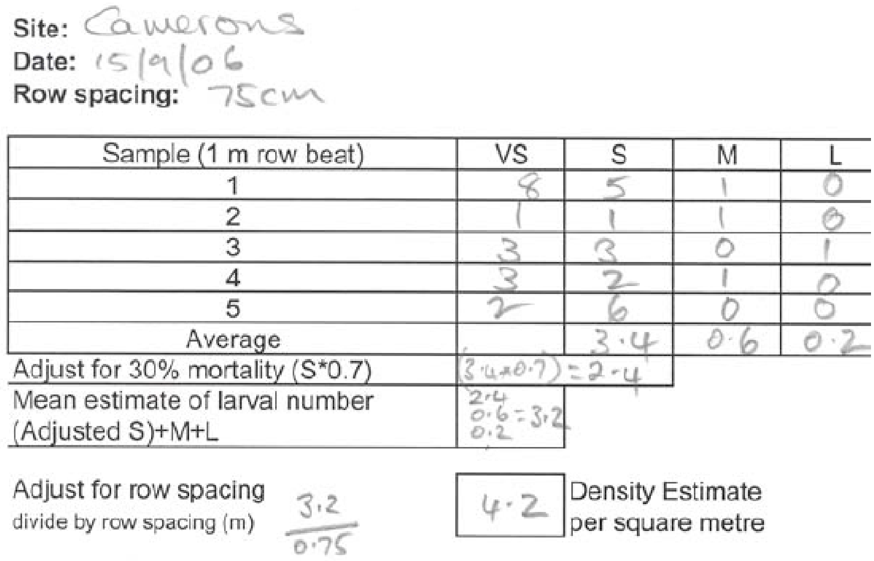
- Knowledge of likely pests/beneficials and their life cycles is essential when planning your monitoring program. As well as visual identification, you need to know where on the plant to look and what is the best time of day to get a representative sample.
- Monitoring frequency and pest focus should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

Keeping good records

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

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

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



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

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

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

4.2 Density Estimate per square metre

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

Source: QDAF

Records of spray operations should include:

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

Sampling methods

Beat sheet

A beat sheet is the main tool used to sample row crops for pests and beneficial insects (Photo 1). Beat sheets are particularly effective for sampling caterpillars, bugs, aphids and mites. A standard beat sheet is made from yellow or white tarpaulin material with heavy dowel on each end. Beat sheets are generally between 1.3–1.5 m wide by 1.5–-2.0 m deep (the larger dimensions are preferred for taller crops). The extra width on each side catches insects thrown out sideways when sampling and the sheet´s depth allows it to be draped over the adjacent plant row. This prevents insects being flung through or escaping through this row.

How to use the beat sheet:

- Place the beat sheet with one edge at the base of plants in the row to be sampled.
- Drape the other end of the beat sheet over the adjacent row. This may be difficult in crops with wide row spacing (one metre or more) and in this case spread the sheet across the inter-row space and up against the base of the next row.
- Using a one-metre stick, shake the plants in the sample row vigorously in the direction of the beat sheet 5–10 times. This will dislodge the insects from the sample row onto the beat sheet.
- Reducing the number of beat sheet shakes per site greatly reduces sampling precision. The use of smaller beat sheets, such as small fertiliser bags, reduces sampling efficiency by as much as 50%.

- Use the datasheets to record type, number and size of insects found on the beat sheet.
- One beat does not equal one sample. The standard sample unit is five non-consecutive one-metre long lengths of row, taken within a 20 m radius; i.e. 5 beats = 1 sample unit. This should be repeated at six locations in the field (i.e. 30 beats per field).
- The more samples that are taken, the more accurate is the assessment of pest activity, particularly for pests that are patchily distributed such as pod-sucking bug nymphs.

When to use the beat sheet:

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

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

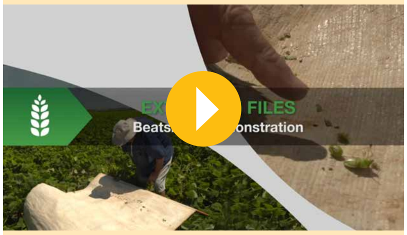
Most thresholds are expressed as pests per square metre (pests/m^2). Hence, insect counts in crops with row spacing less than one metre must be converted to pests/m^2. To do this, divide the 'average insect count per row metre' across all sites by the row spacing in metres. For example, in a crop with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

Other sampling methods:

- Visual checking is not recommended as the sole form of insect checking; however it has an important support role. Leaflets or flowers should be separated when looking for eggs or small larvae, and leaves checked for the presence of aphids and silverleaf whitefly. If required, dig below the soil surface to assess soil insect activity. Visual checking of plants in a crop is also important for estimating how the crop is going in terms of average growth stage, pod retention and other agronomic factors.
- Sweep net sampling is less efficient than beat sheet sampling and can underestimate the abundance of pest insects present in the crop. Sweep netting can be used for flighty insects and is the easiest method for sampling mirids in broadacre crops or crops with narrow row spacing (Photo 1). It is also useful if the field is wet. Sweep netting works best for smaller pests found in the tops of smaller crops (e.g. mirids in mungbeans), is less efficient against larger pests such as pod-sucking bugs, and it is not practical in tall crops with a dense canopy such as coastal or irrigated soybeans. At least 20 sweeps must be taken along a single 20 m row.
- Suction sampling is a quick and relatively easy way to sample for mirids. Its main drawbacks are unacceptably low sampling efficiency, a propensity to suck up flowers and bees, noisy operation, and high purchase cost of the suction machine.

VIDEOS

WATCH: GCTV16: Extension files—IPM beat sheet demo



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

MORE INFORMATION

IPM guidelines for monitoring tools and techniques.

- Monitoring with traps (pheromone, volatile, and light traps) can provide general evidence on pest activity and the timing of peak egg lay events for some species. However, it is no substitute for in-field monitoring of actual pest and beneficial numbers. [7]

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

Source: DAFWA and The Beatsheet

7.2 Russian wheat aphid

Russian wheat aphid (RWA) (*Diuraphis noxia*), a major pest of wheat and barley, poses a major threat to the Australian grains industry. The global distribution of RWA continues to expand, aided by the ease of international travel.

Russian wheat aphid has been confirmed to be present in NSW following detections in South Australia in May and Victoria in June 2016. Grain growers and consultants across NSW are urged to monitor cereal paddocks for signs of RWA, and report suspect aphids or symptoms to NSW DPI.

If not controlled RWA can cause up to 80 and 100% yield loss in wheat and barley respectively. RWA is also a minor pest of oats, rye, sorghum and triticale and a vector of barley yellow dwarf virus (BYDV), brome mosaic virus (BMV) and barley stripe mosaic virus. The RWA's host range also includes several non-crop grass species that occur in Australia.

Russian wheat aphid is adapted to semi-arid dryland climates where annual rainfall is usually less than 600 mm and therefore it is well suited to survive in Australian grain-growing regions. [8]

Secondary hosts are plants that support adults and final instars only. These hosts allow the aphid to survive but not to reproduce. Secondary hosts include rye, oat, and triticale.

Russian wheat aphid can spread by wind, movement of machinery and vehicles and on people's clothing. [9]

It appears that RWA is most often being found in early-sown crops or those sown into paddocks containing volunteer cereals. Early observations also suggest that it is most prevalent in stressed areas within the crop. Overseas data also indicate that RWA is susceptible to heavy winter rainfall so the combination of cold and wet weather may limit its build up over winter. Grass weeds and pasture hosts include barley grass, brome grass, fescue, ryegrass, wild oats, phalaris and couch grass. [10]

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

8 A Nicholas (2016) Exotic pest alert: Identification of Russian Wheat Aphid and associated crop damage. http://cwfs.org.au/wp-content/uploads/2016/06/Exotic-Pest-Alert-Russian-Wheat-Aphid-Identification-and-Associated-Damage.pdf

9 DPI NSW (2016) Russian wheat aphid. http://www.dpi.nsw.gov.au/content/biosecurity/plant/russian-wheat-aphid

10 M Pardy (2016). Riverine Plains Grower Bulletin Issue 2, July 2016

7.2.1 Identification

Russian wheat aphid is a small, (~2 mm) slender-bodied aphid that varies in colour from pale yellowish-green to grey-green and is usually covered in a waxy fine white powder coating (Photo 2). Winged RWAs have dark patches on the thorax and a slightly darker green abdomen than non-winged specimens.

The cornicles (tube-like structures at the rear of the abdomen) are very short, rounded, and although present can be very difficult to see and often appear to be absent.

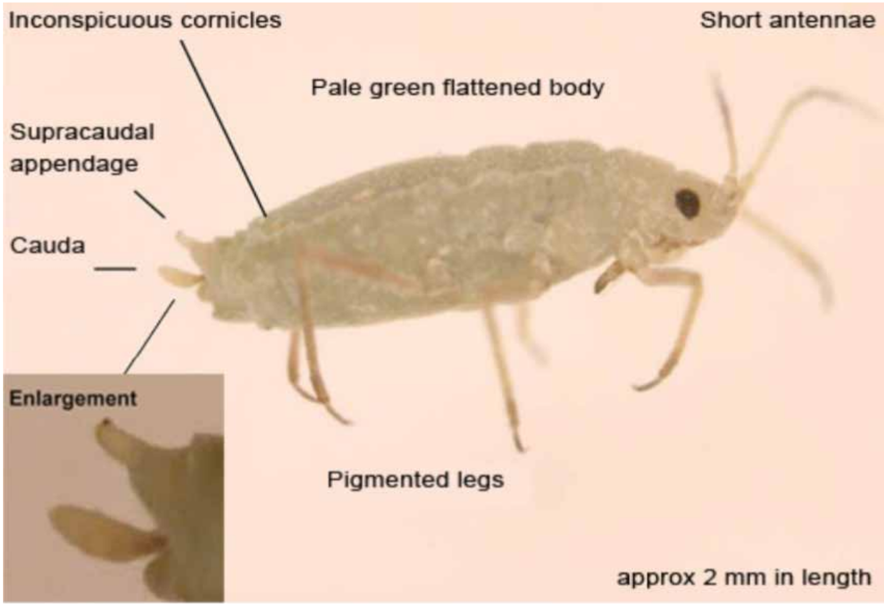


Photo 2: *Key identifying characteristics of RWA.*

Source: DPI NSW

The RWA's most distinguishing feature and what sets it apart from all other cereal aphids is an appendage above the cauda (tail), a supracauda, giving the aphid the appearance of having two tails.

The RWA's supracauda is large and conspicuous on the non-winged forms but shorter and knob-like on winged specimens (Photo 3). With care the supracauda can be seen with a hand lens. [11]

11 A Nicholas (2016) Exotic pest alert: Identification of Russian Wheat Aphid and associated crop damage. http://cwfs.org.au/wp-content/uploads/2016/06/Exotic-Pest-Alert-Russian-Wheat-Aphid-Identification-and-Associated-Damage.pdf

Photo 3: *Colony of RWAs (Diuraphis noxia) in a wheat leaf.*

Photo: Frank Peairs, Source: PIRSA

What to look for

Detection of RWA is most likely to occur with the observation of symptomatic plants. Scout for symptomatic tillers in host crops and inspect for aphids (Photo 4). RWA is very small (less than 2 mm) and a 10× magnification hand lens can be used to examine them.

Photo 4: *Feeding of RWA colonies causes striped discolouration of leaves.*

Source: DPI NSW

Russian wheat aphid may be present in mixed populations. If aphids which are commonly found in cereals are observed it should not be assumed these are the only ones present.

Symptoms associated with the presence of RWA include:

- stunted growth (Photo 5)
- leaves with white, yellowish and red streaks (Photo 6)
- leaf rolling along margins
- awns trapped by rolled flag leaves
- heads with a bleached appearance. [12]

Photo 5: *Stunted growth and leaf discolouration caused by RWA.*

Source: DPI NSW

Leaves infested with RWA develop continuous white, yellowish and red (sometimes described as purplish) streaks along the length of leaf (Photo 6). The occurrence and intensity of colouration varies, with the coloured streaks on young, lightly infested plants often restricted to the leaf edge. This can be difficult to detect and a hand lens is required.

12 DPI NSW (2016) Russian wheat aphid. http://www.dpi.nsw.gov.au/content/biosecurity/plant/russian-wheat-aphid

Figure 2: *Discolouration of wheat leaves caused by RWA.*

Source: DPI NSW

7.2.2 Varietal resistance or tolerance

Russian wheat aphid tends to prefer barley > durum wheat > bread wheat > triticale > cereal rye > oats.

7.2.3 Damage caused by pest

Russian wheat aphid is a major field pest of wheat and barley in many grain producing countries. Yield losses of up to 80% in wheat and 100% in barley have been reported overseas.

Russian wheat aphid injects toxins into the plant during feeding which stunts plant growth. Heavy infestations may kill plants. Toxins injected by the aphid during feeding destroy chlorophyll and prevent carbohydrate formation, with heavy infestations killing the plant. Initially RWA feeding causes a small light brown blotch that can be confused with damage by other insects and more problematically with symptoms caused by disease. [13]

Russian wheat aphid will infest the plant at any growth stage, preferring to feed within the new leaves while they are rolled up; i.e. before the leaf opens. This feeding can prevent the leaf from opening and gives the young plant an onion-leaf like appearance.

Feeding on open leaves causes the leaf to roll inwards around the aphid providing a suitable and protected microclimate. Infested flag leaves that remain unrolled trap the awns which prevents the wheat head from fully emerging and reduces grainfill (Photo 6).

According to SARDI cereal pathologist Dr Hugh Wallwork, RWA does not seem to be a good transmitter of viruses.

13 DPI NSW (2016) Russian wheat aphid. http://www.dpi.nsw.gov.au/content/biosecurity/plant/russian-wheat-aphid

Photo 6: *Wheat awns trapped by flag leaf damaged by RWA feeding*

Photo: Food and Agriculture Organisation, Source: DPI NSW

7.2.4 Thresholds for control

Economic thresholds for control still need to be determined for Australian conditions. However, as with most pests and diseases, spraying should be considered only where aphid levels are high enough to cause economic damage.

Current international advice suggests an economic threshold of 20% of plants infested up to the start of tillering and 10% of plants infested thereafter.

The lower thresholds post-tillering reflects the need to protect the major yield contributing leaves. [14]

7.2.5 Management of insect pest

Monitoring

An aphid sample may be required for accurate identification:

- Leave aphids on host leaves where possible to reduce damage to aphids during transportation.
- Sample suspect plants, ensuring they are infested with aphids. Remove roots and soil.
- Samples should be placed in sealed container, vial or plastic ziplock bag with triple packaging (e.g. vial with two layers of plastic ziplock bags).

14 M Pardy (2016). Riverine Plains Grower Bulletin Issue 2, July 2016

- All samples should be accompanied by an RWA diagnosis request form.
- Samples should be sent by express post.

Hygiene

It is important to put hygiene practices into place to reduce the risk of transporting pests and diseases on clothing, footwear, vehicles and machinery when moving between paddocks and farms.

If symptoms of suspected RWA are observed it is important to change clothing (including hats) and clean footwear and vehicles before entering another paddock or farm. People entering crops should consider wearing disposable coveralls and changing these between farms. Used coveralls should be bagged and securely disposed of. Clothing worn in a suspected infested crop should be bagged, sealed and washed before being worn again.

Chemical control

It is most important to control RWA from the start of stem elongation through flag leaf development and ear emergence.

If chemical control is required, APVMA has issued an emergency permit [#82792] for the control of RWA. The specific use of these chemicals, however, depends on the state in which the crop is grown, so growers will need to contact their local authorities for further information.

Chemical control should consider economic thresholds, insecticide resistance in other crop pests, natural pest enemies and beneficial insects as part of IPM. [15]

See the GRDC website for the latest nationally developed RWA management guidelines.

- Gloves are up in sustained FITE against RWA

VIDEOS

WATCH: Integrated Pest Management to combat the RWA

MORE INFORMATION

RWA surveillance reporting sheet

Exotic pest alert: Identification of RWA and associated damage

PIRSA RWA—Paddock decontamination protocol

RWA Distribution Map

7.3 *Helicoverpa* spp.

The name *Helicoverpa* refers to two species of moth, the larvae of which attack field crops in the Northern grains region of Australia. These two species are *Helicoverpa punctigera* and *H. armigera*. Together, they are the most economically damaging insect pests of field crops in Queensland and northern NSW, and are major pests of irrigated crops in southern NSW.

Helicoverpa armigera is generally regarded as the more serious pest because of its greater capacity to develop resistance to insecticides, its broader host range, and the fact that it persists in cropping areas from year to year, whereas *H. punctigera* numbers fluctuate from year to year based on conditions in its inland breeding areas.

Helicoverpa armigera attacks all crops but is less common in wheat and barley. In contrast, *H. punctigera* only attacks broadleaf crops and is not found on grass or cereal crops such as wheat, barley, sorghum or maize. As it is not unusual to find both *Helicoverpa* and armyworm in cereal crops, correct identification of the species present is important.

Lifecycles of *Helicoverpa* spp. takes 4–6 weeks from egg to adult in summer and 8-12 weeks in spring or autumn. The lifecycle stages are egg, larvae, pupa and adult (moth) (Figure 3).

15 DPI NSW (2016) Russian wheat aphid. http://www.dpi.nsw.gov.au/content/biosecurity/plant/russian-wheat-aphid

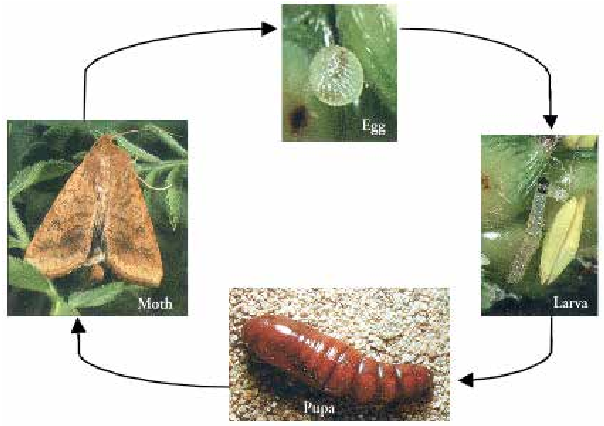


Figure 3: *Lifecycle of Helicoverpa.*

Source: Pulse Australia

Eggs are 0.5 mm in diameter and change from white to brown to a black head stage before hatching. Newly hatched larvae are light in colour with tiny dark spots and dark heads. As larvae develop they become darker and the darker spots become more obvious. Both species look the same at the egg and small larvae stages (Photo 7).

Photo 7: *Left to right: fresh white, brown ring and black larval head in nearly hatching eggs.*

Source: CropIT

Medium larvae develop lines and bands running the length of the body and are variable in colour (Figure 11). *H. armigera* have a saddle of darker pigment on the fourth segment and at the back of the head and dark-coloured legs. *H. punctigera* have no saddle and light-coloured legs.

Large larvae of *H. armigera* have white hairs around the head; *H. punctigera* have black hairs around the head.

Photo 8: *H. armigera* **larvae showing white hairs on head.**

Source: Cabi

Pupae are found in soil underneath the crop. Healthy pupae wriggle violently when touched. *H. armigera* pupal tail spines are more widely spaced than those of *H. punctigera*.

Moths are a dull light brown with dark markings and are 35 mm long. *H. armigera* has a small light or pale patch in the dark section of the hindwing (Photo 9) while the dark section is uniform in *H. punctigera*. Forewings are brown in the female and cream in the male.

Photo 9: *Adult moth of H. armigera.*

Source: Cabi

7.3.1 Varietal resistance or tolerance

Virtually all *Helicoverpa* present are *H. armigera*, which has developed resistance to many of the older insecticide groups. [16]

7.3.2 Damage caused by *Helicoverpa*

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 a low number of whole grains, thus increasing the potential losses.

16 QDAF (2012) Insect pest management in winter cereals. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-winter-cereals

Most (80–90%) of the feeding and crop damage is done by larger larva (the final two instars). [17]

7.3.3 Thresholds for control

While there are no thresholds developed for *Helicoverpa* in winter cereals, using a consumption rate determined for *Helicoverpa* feeding in sorghum (2.4 g/larva), one larvae per m^2 can cause 24 kg grain loss/ha (Table 4).

Table 4: *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 a 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

Source: QDAF

Based on the preceding information, a crop worth $250/tonne will incur a loss of $6/ha from each *Helicoverpa* larvae. 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. [18]

7.3.4 Management of *Helicoverpa*

The best approach to managing *Helicoverpa* is to use a combination of both chemical and non-chemical tools. By considering the ecology of *H. armigera* and *H. punctigera*, several key principles emerge that will assist in the successful and sustainable management of these pests.

Chemical control

Presently there are few control options other than the use of chemical insecticides (or biopesticides), for above threshold populations of larvae in a crop. Spraying should be carried out promptly once the threshold has been exceeded. Controlling *Helicoverpa* effectively with insecticides depends on knowing which species are present in the crop.

Helicoverpa punctigera is easily killed by all registered products, including products to which *H. armigera* is resistant (e.g. synthetic pyrethroids). Because *H. punctigera* moths migrate annually into eastern Australian cropping regions, they lose any resistance they might develop as a result of exposure to insecticides in crops. In contrast, *H. armigera* populations tend to remain local so their resistance to insecticides is maintained in the population from season to season. [19]

17 QDAF (2012) Insect pest management in winter cereals. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-winter-cereals

18 QDAF (2012) Insect pest management in winter cereals. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-winter-cereals

19 QDAF (2012) Key management principles of *Helicoverpa*. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/helicoverpa/helicoverpa-biology-and-ecology/key-management-principles

Helicoverpa armigera has historically had high resistance to pyrethroids and control of medium-large larvae using pyrethroids is not recommended.

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. [20]

Attract and kill technology

Attract and kill products consist of a liquid insect lure based on floral volatiles that is mixed with an insecticide. This lure plus insecticide mixture is then able to be easily applied to large crop areas.

When the adult (and preferably female) moths are attracted to the treated rows, they feed on the product and the added insecticide, causing their death before all eggs are laid.

Because the aim is to concentrate the feeding moths in the treated rows, a key advantage of the attract and kill approach is that not every row of crop needs to be treated (perhaps under 2% of the total crop area).

By reducing the pest moth population, the number of eggs laid into a crop can be significantly reduced. This reduction in egg lay can:

- delay the need for foliar insecticides
- reduce the subsequent pest pressure.

Because the insecticide applied using attract and kill is only confined to a small percentage of the crop area, another key advantage is that most natural enemies will be unaffected. Research to date suggests that these products generally only attract the target pest plus a range of other minor or non-pest moth species. [21]

For current chemical control options see Pest Genie or APVMA.

Spray smart

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

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

- Ensure crops are being checked when they are susceptible to Helicoverpa damage as early detection is critical to ensure effective timing of sprays. Larvae that are feeding or moving in the open are more easily contacted by spray droplets. Target larvae before they move into protected feeding locations (e.g. flowers, cobs, pods or bolls).
- Ensure larvae are at an appropriate size to control effectively with the intended product.
  Very small (1–3 mm) to small (4–7 mm) larvae are the most susceptible stages and require a lower dose to kill. Larvae grow rapidly—if a spray application is delayed more than two days, the crop should be rechecked and reassessed.
- Assess if the larvae are doing economic damage (i.e. only spray if the value of the crop saved is more than the cost of spraying). Vegetative feeding generally does not equate to significant yield loss.

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

20 QDAF (2012) Insect pest management in winter cereals. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-winter-cereals

21 QDAF (2011) Attract and kill technology for *Helicoverpa* management. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/helicoverpa/attract-and-kill

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

Note that due to the resistance that *Helicoverpa* has developed to major chemical groups, registered chemicals will not necessarily give adequate control in every situation. Local knowledge of which chemicals are working in a particular area should be sought from consultants and agronomists in your area to ensure you are not spraying unnecessarily or promoting the further development of resistance through your choice of insecticide.

Control without insecticides

While insecticides are an important tool for controlling and managing *Helicoverpa*, other management tools are also available.

- Be smart with your beneficials. Be aware of the presence of beneficial insects and pathogens in the crop, and factor their likely impact into any management decisions.
- Pupae busting remains an important, non-chemical tool to reduce both the size of overwintering *H. armigera* populations and the carryover of insecticide-resistant individuals from season to season. Cultivating to a depth of 10 cm before the end of August will kill a large proportion of overwintering pupae. Check fields that had larvae present after mid-March to assess pupal numbers.
- Weed management in and around crops can prevent the build-up of *Helicoverpa* and other insect pests.
- Spring trap crops have been successfully used as an area-wide management tool for reducing the size of the overall *Helicoverpa* population as it emerges from diapause in spring.

Natural enemies

A variety of predatory and parasitic insects, spiders, birds, bats, rodents and diseases attack *Helicoverpa* at different stages of its life cycle.

Predators

Some predators are relatively permanent residents in fields (e.g. ants), while others migrate from nearby fields or other vegetation. Many predators are opportunity feeders that also feed on prey other than *Helicoverpa*. Some predators found commonly in crops will not feed on *Helicoverpa* at all and some may only feed on certain stages (for example, larvae of a particular size, or only eggs). Knowing what predators eat is important when making management decisions.

Predators of *Helicoverpa* eggs and larvae include spined predatory shield bug, glossy shield bug, damsel bug and bigeyed bug.

The most common predators of *Helicoverpa* in field crops are:

- predatory bugs (e.g. spined predatory shield bug, assassin bug, and damsel bug)
- predatory beetles (e.g. ladybirds, red and blue beetle, carab beetle, and soldier beetle)
- spiders
- lacewings (green and brown)
- ants.

Parasitoids

Some wasps and flies attack *Helicoverpa* eggs, larvae and pupae. Parasitoids kill their host to complete their development. The parasitoids most active in field crops include:

- smaller wasp species such as Microplitis, Trichogramma and Telenomus

MORE INFORMATION

Important natural enemies of *Helicoverpa*: microplitis and ascovirus.

- relatively large parasitoid wasps (Netelia, Heteropelma, Ichneumon)
- flies (Carcelia and Chaetophthalmus)

Parasitoids that attack *Helicoverpa* larvae do not kill their hosts immediately (Figure 13). However, they do stop or slow down caterpillar feeding, which reduces the impact of the pest on the crop. When parasitoids attack late instar larvae or pupae, they stop moths developing and going on to produce further eggs and larvae.

Photo 10: *Normal Helicoverpa egg (left) and a black parasitised egg (right).*

Source: QDAF

Pathogens

Pathogens are viruses, fungi or bacteria that infect insects. Many naturally occurring diseases infect and kill *Helicoverpa* larvae, including NPV and fungal pathogens (Metarhizium, Nomuraea and Beauveria). Another disease—ascovirus— stunts larval development, and is spread by wasp parasitoids.

Two pathogens that affect *Helicoverpa* are available commercially as biopesticides:

- Helicoverpa NPV is a highly selective product that infects only *Helicoverpa* larvae and is harmless to humans, wildlife and beneficial insects.
- Bt is a bacterial toxin from Bacillus thuringiensis available as a selective spray that only kills moth larvae. Genes from the Bt organism have also been used to genetically modify cotton plants so that the toxin is expressed in the plant's tissues. When young *Helicoverpa* larvae feed on a Bt cotton plant, the toxin kills susceptible individuals.

Small larvae (less than 7 mm) can be controlled with biopesticides (e.g. NPV). Biopesticides are not effective on larger larvae. Larger larvae are more difficult to control than are small larvae, and NPV (*Helicoverpa* nucleopolyhedrovirus) is most effective when larvae less than 13 mm in length are targeted.

Conserving natural enemies

Natural enemies will rarely eradicate all eggs or larvae, but may reduce infestations to below economic threshold if predators and parasitoids are not disrupted by broad-spectrum insecticides. The amount of disruption that insecticides cause to natural enemy activity varies depending on which chemicals are used and which natural enemies are active.

Take a whole-farm or regional approach

There is no simple solution to *Helicoverpa* control in a farming system that provides a wide range of food sources throughout the year. The continuous availability of hosts potentially allows successive generations to build up in a cropping region throughout the year. A whole-farm approach to *Helicoverpa* involves managing the local population by:

- having a good knowledge of pest and life cycle
- checking crops regularly
- being familiar with the economic thresholds for different crops
- basing chemical choices on the latest Insecticide Resistance Management Strategy (IRMS)
- achieving appropriate timing and coverage of sprays
- conserving populations of predatory and parasitic insects
- using trap cropping if appropriate
- cultivating to destroy overwintering pupae
- destroying weed hosts within the crop and surrounding areas.

Area-wide management strategies are designed to manage *Helicoverpa* at a regional level rather than each farmer making *Helicoverpa* control actions in isolation. It requires a high level of communication and cooperation between farmers, consultants, and research/extension personnel. [22]

7.3.5 *Helicoverpa* and insecticide resistance

Insecticide Resistance Management Strategy (IRMS)

This strategy is developed each year in order to contain the increase in resistance of *H. armigera* to insecticides including pyrethroids, carbamates, organophosphates and endosulfan. In its present form it mainly applies to summer crops, especially cotton, but as more insecticides are registered in grain crops the IRMS is being expanded to a Farming Systems IRMS (FS-IRMS) that considers insecticide use in all broadacre crops throughout the year.

The FS-IRMS aims to ensure that there is a sufficient break, of at least one *Helicoverpa* generation, in the use of each insecticide group, across all crops.

Major FS-IRMS guidelines:

1. Currently there are no restrictions on the number of pyrethroid sprays that can be applied to non-cotton crops, but there are a number of considerations that apply to the use of pyrethroids in the farming systems.
2. It is strongly recommended that pyrethroids not be used on *Helicoverpa armigera*, as they are unreliable.
3. Pyrethroids should be targeted only on small larvae (i.e. less than 7 mm long) as application on larger resistant larvae will be ineffective and will increase levels of pyrethroid resistance. (Note: even for insecticide groups for which resistance is not established, small larvae are still more susceptible than larger larvae).
4. If you are intending to spray a population of *Helicoverpa*, consider where the moths that laid the eggs may have originated. If they are likely to be survivors from a crop that was previously sprayed (e.g. with a pyrethroid), spraying again with the same insecticide will exacerbate resistance.
5. Avoid using broad-spectrum sprays such as organophosphates or pyrethroids early in the season. They reduce the numbers of beneficial insects and increase the chances of aphid, mite and further *Helicoverpa* outbreaks.
6. Be aware that in 2005 there were major changes to the registration for endosulfan. Endosulfan has been withdrawn from use in grain crops, with a few exceptions for control of pests in seedling crops. Endosulfan can no longer be used in soybean, sunflower, mungbean or other summer grain crops.
7. The use of ovicides may be warranted in the event of high egg pressure—use methomyl before the black head egg stage.
8. Use recommended larval thresholds to minimise pesticide use and reduce resistance selection. Sprays should only be applied if the larvae are doing

22 QDAF (2012) Key management principles of *Helicoverpa*. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/helicoverpa/helicoverpa-biology-and-ecology/key-management-principles

economic damage (i.e. the value of the crop saved should exceed the cost of spraying).

9. Cultivate host-crop residues as soon as possible after harvest to destroy pupae. Cultivation must be completed no later than one month after large larvae were observed in the field, otherwise the moths will emerge and move elsewhere.
10. Do not respray an apparent failure with a product of the same chemistry.

Helicoverpa control on an area-wide basis

Farmers are faced with increasing problems of controlling resistant *Helicoverpa*. In response to this a *Helicoverpa* Regional Management Strategy (HRMS), or area-wide management (AWM) strategy, was formulated by producers, consultants, researchers and extension personnel and was implemented in two pilot study areas on the Darling Downs in 1998–2001.

The HRMS was designed to manage *Helicoverpa* at a regional level rather than each farmer making *Helicoverpa* control actions in isolation. The HRMS pilot trial resulted in a high level of communication and cooperation between farmers and consultants in an effort to better manage *Helicoverpa*.

The basic principles of the strategy involve a yearly cycle of management practices, which includes tactics that aim to reduce:

- the population of overwintering *Helicoverpa* pupae (March–June)
- the early season build-up of *Helicoverpa* on a regional/district scale (July–November)
- the mid-season population pressure on *Helicoverpa*-sensitive crops (December–March).

Key components of AWM include:

- crop checking
- pupae busting
- improved management for commercial crops
- trap crops
- using information from pheromone traps
- monitoring the contribution of beneficial insects
- insecticide management

Many areas outside the original pilot study areas are now implementing similar strategies. In the pilot study areas, many of the original HRMS/AWM groups continue to meet and discuss pest management issues. Contact your local extension officer, consultant or Department of Employment, Economic Development and Innovation IPM Development Extension Officer for information on existing groups in your region, or how to form a new group.

Control considerations

Presently there are few control options other than the use of chemical insecticides, or virus, for *Helicoverpa* larvae once in a crop. Spraying should be carried out promptly once the threshold for each insect has been reached.

Spray small or spray fail

Helicoverpa grow rapidly and a few days' delay in spraying can result in major crop damage and increased difficulty in control. If a spray application is delayed for more than 2 days, for any reason, the crop should be rechecked and reassessed.

Make sure that crops are being checked when they are susceptible to *Helicoverpa* damage. Early detection of infestation is critical to ensure the most effective timing of sprays.

Ensure *Helicoverpa* larvae in the crop are at an appropriate size to control effectively with the product you are intending to use. Spray only if the larvae are doing economic damage (i.e. the value of the crop saved should exceed the cost of spraying).

Seek professional advice to ensure you are NOT:

- spraying unnecessarily (i.e. below threshold)
- planning to use an insecticide to which the pest is likely to be resistant
- promoting the further development of resistance through your choice of insecticide.

Common insecticides and registered application rates can be found by individual crop. These are not complete lists of all products registered in winter crops and it is recommended that you check Infopest before applying a chemical. As always, read the label.

Due to the resistance that *Helicoverpa* has developed to major chemical groups, it is important to remember that registered chemicals will not necessarily give adequate control in each situation. Local knowledge of which chemicals are working in a particular area should be sought from consultants and agronomists in your area. [23]

MORE INFORMATION

Insect sampling methods

7.3.6 Monitoring

Check for larvae on the plant throughout the growing season (monitoring can be done in conjunction with sampling for armyworm). Using a sweep net, check a number of sites throughout the paddock.

7.4 Aphids

Aphids are usually regarded as a minor pest of winter cereals, but in some seasons they can build up to very high densities. Aphids are most prevalent on cereals in late winter and early spring. High numbers often occur in years when there is an early break in the season and mild weather in autumn and early winter provides favourable conditions for colonisation and multiplication.

Four different species of aphid can infest winter cereals:

1. Oat or wheat aphid
2. Corn aphid
3. Rose-grain aphid
4. Rice root aphid

7.4.1 Oat or wheat aphid

Oat or wheat aphid (*Rhopalosiphum padi*) is one of the most common aphid infesting winter cereals (Photo 11). Typically this species colonises the base and lower portions of the plant including the basal leaves, stems and back of ears of cereal plants (Table 5). [24] Oat aphids predominantly attack oats, wheat and barley but can occur on corn and all cereals and grasses. [25]

23 QDAF (2011) *Helicoverpa* and insecticide resistance. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/helicoverpa/insecticide-resistance

24 IPM Guidelines. (2016). Aphids in winter cereals. http://ipmguidelinesforgrains.com.au/pests/aphids/aphids-in-winter-cereals/

25 GRDC (2016). Crop Aphids, Back pocket guide. https://grdc.com.au/resources-and-publications/all-publications/publications/2016/11/crop-aphids-back-pocket-guide

Photo 11: *Apterous viviparous female and nymphs of oat or wheat aphid on grass leaf.*

Source: PBase

Table 5: *Oat or wheat aphid description and management information.*

Scientific name	*Rhopalosiphum padi*
Description	Adults are 2 mm long, olive-green to black with a red rust patch at the rear end and may have wings. Antennae extend to half the body length. Nymphs are similar but smaller. Wheat and oat aphids are very similar to corn aphids.
Distribution	An introduced species found in all states of Australia.
Crops attacked	Barley, wheat and oats.
Life cycle	A species that produces many generations through the growing season. Winged and non-winged forms occur.
Damage	Aphids feed directly on stems, leaves and heads, and in high densities cause yield losses and plants may appear generally unthrifty. This type of damage is rare throughout the grainbelt. Aphids can spread BYDV in wheat and barley.
Monitoring and action level	Aphids can affect any crop stage but are unlikely to cause economic damage to cereal crops expected to yield less than 3 t/ha. Consider treatment if there are 10–20+ aphids on 50% of the tillers.
Control	Chemical control: Apply a foliar insecticide in late winter or spring to avoid direct damage to tillers and heads. To prevent losses from BYDV in virus-prone areas, control aphids early in the cropping year. For current chemical control options see Pest Genie or APVMA. Cultural control: There are no known effective cultural control methods.
Host-plant resistance	In virus-prone areas, use resistant plant varieties to minimise losses due to BYDV.
Natural enemies	Predation by hoverflies, lacewings and ladybeetles and parasitism by wasps can reduce aphid populations, but this does not happen in every season. Heavy rain may reduce aphid populations significantly.

Source: QDAF

MORE INFORMATION

PestNotes: Oat aphid.

7.4.2 Corn aphid

Corn aphid (*Rhopalosiphum maidis*) is also a common species found in winter cereals (Photo 12). It generally colonises the upper parts of the plant, particularly the rolled up terminal leaf. It can be found inside the leaf whorl of the plant, with cast skins indicating their presence (Table 6). They rarely infest wheat or oats. [26] While corn aphids are most likely found in barley crops, they also occur in wheat, sorghum, maize and many grasses. [27]

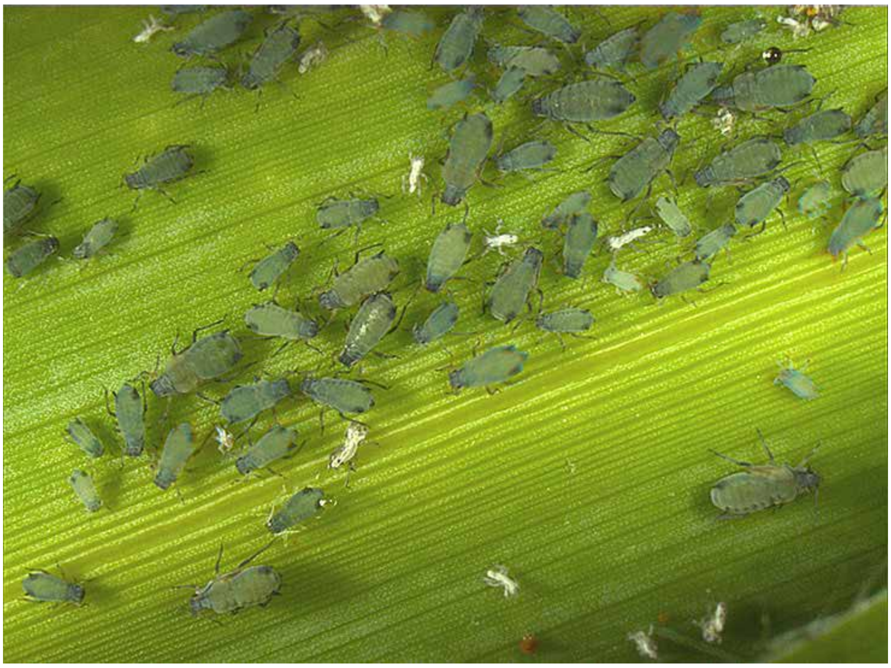


Photo 12: *Corn aphid: note dark legs and cornicles, relatively short antennae.*

Source: KSU

Table 6: *Corn aphid description and management.*

Scientific name	*Rhopalosiphum maidis*
Description	Up to 2 mm long, light to dark olive-green with a purple area at the base of small tube-like projections at the rear of the body. Adults are generally wingless. Antennae extend to about a third of body length. Nymphs are similar, but smaller in size.
Similar species	Other species of aphids.
Distribution	An introduced species, probably Asiatic in origin, found in all states of Australia.
Crops attacked	Sorghum, maize, winter cereals and many grasses.
	Life cycle on sorghum: Corn aphids breed throughout the summer on sorghum with a life cycle of about a week. There can be up to 13 generations on a sorghum crop and 30 generations a year.
	Life cycle on cereals: A parthenogenetic species that undergoes many generations through the growing season. Both winged and non-winged forms occur.

26 IPM Guidelines (2016) Aphids in winter cereals. http://ipmguidelinesforgrains.com.au/pests/aphids/aphids-in-winter-cereals/

27 GRDC (2016). Crop Aphids, Back pocket guide. https://grdc.com.au/resources-and-publications/all-publications/publications/2016/11/crop-aphids-back-pocket-guide

Damage	In sorghum: Adults and nymphs suck sap and produce honeydew. Very high numbers may turn plants yellow. High populations on heads produce sticky grain and clog harvesters. Rain will readily remove honeydew. Water-stressed dryland crops lose yield. In cereal: Aphids feed on stems, leaves and heads, and in high densities cause yield losses. However, this type of damage is uncommon throughout the cereal belt. Risk period In sorghum: All stages of the crop are attacked, but the most serious damage occurs when high populations infest heads. In cereals: Most prevalent on cereals in late winter and early spring. High numbers often occur in years when an early break in the season and mild weather in autumn and early winter provide favourable conditions for colonisation and multiplication.
Monitoring	Estimate percentage of plants infested and percentage of leaf area covered by aphids.
Action level	The action level in the vegetative stage of sorghum is 100% of plants with 80% of the leaf area covered by aphids. On the heads it is 75% of heads with 50% of the head covered by aphids. Aphids are unlikely to cause economic damage to cereal crops expected to yield less than 3 t/ha. To avoid direct-feeding damage, consider treatment if there are 10–20 or more aphids on 50% of the tillers.
Chemical control	Chemical control is cost-effective. See Pest Genie or APVMA for current control options. Conservation of natural enemies: A range of parasitoids and predators will help reduce aphid populations. Predators of aphids include: ladybird larvae, damsel bugs, bigeyed bugs and the larvae of green lacewings and hoverflies. Wasp parasitoids mummify and kill aphids
Host-plant resistance	In sorghum, hybrids with open heads are less infested than tight-headed hybrids

Source: QDAF

MORE INFORMATION

PestNotes: Corn aphid.

7.4.3 Rose-grain aphid

Rose-grain aphid (*Metopolophium dirhodum*) (Photo 13) generally colonises the undersides of the leaves, and moves upwards as these leaves die, high in the canopy (Table 7). [28] These aphids attack cereals and grasses including barley, oats, wheat and triticale. [29]

28 IPM Guidelines (2016) Aphids in winter cereals. http://ipmguidelinesforgrains.com.au/pests/aphids/aphids-in-winter-cereals/

29 GRDC (2016). Crop Aphids, Back pocket guide. https://grdc.com.au/resources-and-publications/all-publications/publications/2016/11/crop-aphids-back-pocket-guide

Photo 13: *Rose-grain aphid with nymphs.*

Source: BugGuide

Table 7: *Description and management of rose-grain aphids.*

Scientific name	Metopolophium dirhodum
Description	Adults are 3 mm long, green to yellow-green with long and pale siphunculi (tube-like projections on either side at the rear of the body) and may have wings. There is a dark green stripe down the middle of the back. Antennae reach beyond the base of the siphunculi. Nymphs are similar but smaller in size.
Similar species	Because of its distinctive colour, it is unlikely to be confused with other aphids.
Distribution	An introduced species that has been recorded from NSW, Queensland, South Australia, Tasmania and Victoria.
Crops attacked	Wheat, barley, triticale, oats.
Life cycle	Undergoes many generations during the growing season; winged and non-winged forms occur.
Damage	Adults and nymphs are sap-suckers. Under heavy infestations, plant may turn yellow and appear unthrifty. Can spread BYDV in wheat and barley.
Monitoring and action level	Can affect any crop stage; assess the potential for direct-feeding damage in late winter. Estimate the number of aphids per tiller. Aphids are unlikely to cause economic damage to cereal crops expected to yield less than 3 t/ha.
Control	Chemical control: Apply a foliar insecticide in late winter or spring to avoid damage to tillers. To prevent losses from BYDV in virus-prone areas, control aphids early in the cropping year. For current chemical control options see Pest Genie or APVMA. Cultural control: There are no known effective cultural control methods for this aphid.
Natural enemies	Predation by hoverflies, lacewings and ladybird beetles, parasitism by wasps and heavy rainfall can reduce aphid populations.

Source: QDAF

7.4.4 Rice root aphid

Rice root aphid (QLD) (*Rhopalosiphum rufiabdominalis*) (Photo 14) colonises the roots of the plants under the soil surface, and colonies may extend up from the roots to the base of the plant. Noticeable when the bases of plants are exposed—often during periods of moisture stress (Table 8). [30]

Photo 14: *Adult rice root aphid.*

Source: UCANR

Table 8: *Description and management of rice root aphids.*

Scientific name	*Rhopalosiphum rufiabdominalis*
Description	Fully grown aphids are 1.2–2.2 mm long and dark green to grey-brown in colour. Nymphs are lighter in colour with a reddish area at the tip of the abdomen.
Damage	Rice root aphids suck fluids from the plant roots, but only do so when the bases of plants are exposed.
Control	Rice root aphids cannot be controlled using contact insecticides because of their below-ground location on plants. Seed dressings may be effective.

Source: QDAF

Damage caused by aphids

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 ear, result in yield loss development, and aphid infestations during the grainfill period may result in low protein grain (Photo 15).

30 IPM Guidelines (2016) Aphids in winter cereals. http://ipmguidelinesforgrains.com.au/pests/aphids/aphids-in-winter-cereals/

Photo 15: *Corn aphids are found in furled leaves and tillers any time from seedling to head emergence.*

Source: cesar

As aphids may compete for nitrogen (N) with the crop, crops grown with marginal levels of N can be more susceptible to the impact of an aphid infestation. In barley, aphids can spread BYDV. While this can have a large effect on barley yield in some areas, it is not considered a major problem in Queensland in most seasons. In virus-prone areas, use resistant plant varieties to minimise losses due to BYDV.

Inspect for aphids throughout the growing season by monitoring leaves, stems and heads as well as exposed roots. Choose six widely spaced positions in the crop and at each position examine five consecutive plants in a row. Research is currently underway into damage thresholds and control options for cereal aphids. Some research indicates that aphid infestations can reduce yield by around 10% on average.

Adults and nymphs suck sap and produce honeydew. Very high numbers may cause stress in the plants (yellowing or wilting in extreme infestations). These symptoms are more common in moisture-stressed crops.

Direct-feeding damage may occur when colonies develop on stems, heads, leaves. Aphids can affect root development, the number of tillers, seed set and grain size.

Aphids can transmit BYDV. Significant yield losses occur when aphids transmit virus in the first 8–10 weeks after emergence.

Aphid infestations may initially be detected on crop edges. Winged aphids will disperse throughout the field and colonise, creating hotspots across the field. As populations grow, infestations will become more uniform across the field. [31]

7.4.5 Thresholds for control

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

- Early infestations (emergence to booting): When 20% of tillers have 10 or more aphids
- Later infestations (flag–soft dough): When 50% of tillers have 15 or more aphids

Aphid populations can decline rapidly, which may make control unnecessary. In many years aphid populations will not reach threshold levels. [32]

31 IPM Guidelines (2016) Aphids in winter cereals. http://ipmguidelinesforgrains.com.au/pests/aphids/aphids-in-winter-cereals/

32 IPM Guidelines (2016) Aphids in winter cereals. http://ipmguidelinesforgrains.com.au/pests/aphids/aphids-in-winter-cereals/

There are no specific control thresholds for infestations in cereal rye crops.

7.4.6 Management of aphids

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 cannot be effectively controlled by non-systemic foliar treatments.

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 aphid outbreak, as there are abundant alternative hosts to breed up on.

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. Delay chemical control if heavy rain is forecast. Heavy rain can reduce aphid populations.

Early control of infestations around the edge of the crop (using a border spray) may delay or prevent more widespread infestation of the crop.

Use aphid-selective products (e.g. pirimicarb) to preserve beneficial insects and potentially reduce the need for follow-up applications.

Seed treatments may be effective in minimising the spread of BYDV and delay the build-up of aphids in the crop. Be mindful of the relevant withholding periods when applying seed treatments close to harvest.

The prophylactic use of synthetic pyrethroids is not recommended as it encourages build-up of resistance in aphids and other non-target insects.

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. Broad-spectrum insecticides kill natural enemies and increase likelihood of subsequent aphid infestations later in the season. Refer to the beneficial impact table to identify products least likely to impact on non-target beneficials. Natural enemies can also be effective in suppressing aphid numbers that may survive post-treatment, preventing the need for subsequent treatments. [33]

Natural enemies

Beneficials include parasitic wasps, lacewings, hoverflies, ladybird beetles. They can exert effective control of small to moderate populations of aphids, however they may not arrive early enough to prevent the build-up of aphids to above threshold. They are useful in controlling individuals and small colonies that may survive an insecticide application. For this reason, the use of soft options (e.g. pirimicarb) for aphid control should be considered, particularly if the aphid infestation is being treated in the early stages of crop development (prior to grainfill) when there is the potential for aphid infestations to resurge.

The presence of bloated aphids with pale gold/bronze sheen (mummies) indicates parasitoid activity in the crop.

33 QDAF (2012) Insect pest management in winter cereals. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-winter-cereals

Aphid fungal diseases can cause a rapid reduction in aphid population in wetter seasons. Fungal infection is detected by the presence of white, fluffy growth on aphids, particularly on lower leaves and stems.

Cultural control

Control weeds and volunteers to minimise early infestation of crops. Aphids, and BYDV, survive over summer on self-sown cereal and perennial grasses.

In some seasons, aphid movement may occur over large distances and local weed management will have little impact.

Encourage beneficial populations through the preservation of native vegetation which provides a refuge for beneficials. [34]

7.4.7 Monitoring

Monitor all crop stages from seedling stage onwards. Look on leaf sheaths, stems, within whorls and heads, and record the number of large and small aphids (adults and juveniles), beneficials (including parasitised mummies), and the impact of the infestation on the crop.

Stem elongation to late flowering is the most vulnerable stage. Frequent monitoring is required to detect rapid increases of aphid populations.

Check regularly—at least five points in the field and sample 20 plants at each point. Populations may be patchy—densities at crop edges may not be representative of the whole field.

Average number of aphids per stem/tiller samples gives a useful measurement of their density. Repeated sampling will provide information on whether the population is increasing (lots of juveniles relative to adults), stable, or declining (lots of adults and winged adults). [35]

7.5 Cutworm (*Agrotis* spp.)

Several species of cutworms (*Agrotis* spp.) attack establishing cereal crops in Queensland and NSW. As their name suggests, cutworm larvae sever the stems of young seedlings at or near ground level, causing the collapse of the plant.

An abundance of top growth that is poorly incorporated may cause poor seed-to-soil contact in the subsequent crop and may attract armyworms or cutworms. [36]

Larvae are up to 50 mm long, hairless with dark heads and usually darkish coloured bodies, often with longitudinal lines and/or dark spots (Photo 16). Larvae curl up and remain still if picked up. Moths are dull brown-black colour. [37]

34 IPM Guidelines (2016) Aphids in winter cereals. http://ipmguidelinesforgrains.com.au/pests/aphids/aphids-in-winter-cereals/

35 IPM Guidelines (2016) Aphids in winter cereals. http://ipmguidelinesforgrains.com.au/pests/aphids/aphids-in-winter-cereals/

36 Manure $ense (2009) Cereal rye: manure and livestock's new best friend. Michigan State University February 2009

37 QDAF (2010) Cutworm. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/soil-insects/cutworm

Photo 16: *Common cutworm larva in typical curled position*

Source: cesar

7.5.1 Varietal resistance or tolerance

All field crops can be attacked. Crops are at most risk during seedling and early vegetative stages. [38]

7.5.2 Damage caused by pest

Damage usually shows up as general patchiness or as distinct bare areas in a very short time (Photo 17). Young caterpillars climb plants and skeletonise the leaves or eat small holes. The 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. They usually feed in the late afternoon or at night. By day they hide under debris or in the soil. [39]

38 QDAF (2010) Cutworm. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/soil-insects/cutworm

39 QDAF (2010) Cutworm. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/soil-insects/cutworm

Photo 17: *Pink cutworm damage.*

Source: cesar

7.5.3 Conditions favouring development

Usually a single generation during early vegetative stages. Moths prefer to lay their eggs in 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. [40]

7.5.4 Thresholds for control

Inspect crop twice weekly in seedling and early vegetative stage. Larvae feed late afternoons and evenings.

Chemical control is warranted when there is a rapidly increasing area or proportion of crop damage.

Chemical control may be warranted if larval numbers exceed 1 larva/ m^2 in emerging crops. [41]

7.5.5 Management of insect pest

Controlling weeds in the fallow prior to planting will assist in reducing cutworm population and reduce crop damage - at least 3–4 weeks prior to sowing.

The best time to monitor is late afternoons and evenings when larvae feed. During the day, scratch away soil around damaged plants to find larvae sheltering in the soil. For more information read how to recognise and monitor for soil insects. [42]

Chemical control: Insecticide application is cost-effective. The whole crop may not need to be sprayed if distribution is patchy; spot spraying may suffice. See Pest Genie or APVMA for current control options.

Cultural control: Control weeds 3–4 weeks prior to sowing.

Natural enemies: Cutworms are attacked by a number of predators, parasites and diseases.

MORE INFORMATION

PestNotes: Cutworm.

40 QDAF (2010) Cutworm. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/soil-insects/cutworm

41 QDAF (2010) Cutworm. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/soil-insects/cutworm

42 QDAF (2012) Insect pest management in winter cereals. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-winter-cereals

7.6 Armyworm

Armyworm is the caterpillar stage of certain moths and can occur in large numbers especially after good rain follows a dry period. During the day armyworms shelter in the throats of plants or in the soil and emerge after sunset to feed on the leaves of all winter cereals, particularly barley and oats, generally during September and October. They like to feed on young leaf tissue, giving the leaf margins a tattered appearance. Heavy feeding leaves only the midrib of the leaf. Control is rarely warranted except where large numbers attack small plants. [43]

Cereal rye can attract armyworms. [44] An abundance of top growth that is poorly incorporated may cause poor seed-to-soil contact in the subsequent crop and may attract armyworms or cutworms. [45]

Leafy cereal plants can tolerate considerable feeding and control in the vegetative stage is seldom warranted unless large numbers of armyworms are distributed throughout the crop or are moving in a 'front', destroying young seedlings or completely stripping older plants of leaf. The most serious damage occurs when larvae feed on the upper flag leaf and stem node as the crop matures, or in barley when the older larvae start feeding on the green stem just below the head as the crop matures.

The most common species are common and northern armyworm (*Leucania convecta* and *L. separata*) (Photo 18), and lawn armyworm (*Spodoptera mauritia*). Infestations are evident by the scalloping on margins of leaves caused by feeding of the older larvae.

Photo 18: *Common armyworm (Leucania convecta).*

Source: The Beatsheet

Check for larvae on the plant and in the soil litter under the plant. The best time to check is late in the day when armyworms are most active. Alternatively, check around the base of damaged plants where the larvae may be sheltering in the soil during the day. Using a sweep net (or swing a bucket), check a number of sites throughout the paddock. Sweep sampling is particularly useful early in an infestation when larvae

43 QDAF (2010) Armyworms in field crops. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/armyworm-overview

44 WS Curran, DD Lingenfelter, L Garling, P Wagoner (2006) Cover crops for conservation tillage systems. The Pennsylvania State University, http://extension.psu.edu/plants/crops/soil-management/conservation-tillage/cover-crops-for-conservation-tillage-systems

45 Manure $ense (2009) Cereal rye: manure and livestock's new best friend. Michigan State University February 2009

are small and actively feeding in the canopy. One full sweep with a net samples the equivalent to a square metre of crop.

Early recognition of the problem is vital as cereal crops can be almost destroyed by armyworm in just a few days. While large larvae do the head lopping, controlling smaller larvae that are still leaf feeding may be more achievable. Prior to chemical intervention consider how quickly the larvae will reach damaging size and the development stage of the crops. Small larvae take 8–10 days to reach a size capable of head lopping, so if small larvae are found in crops nearing full maturity/harvest no spray may be needed, whereas small larvae in late crops which are still green and at early seed fill may reach a damaging size in time to significantly reduce crop yield.

7.6.1 Damage caused by armyworm

Larvae target the stem node as the leaves become dry and unpalatable, and the stem is often the last part of the plant to dry.

A larva takes around 8–10 days to develop through the final, most damaging instars with crops susceptible to maximum damage for this period. One larva/m^2 can cause a loss of 70 kg/ha grain per day (Photo 19). The most serious damage results from the habit of the older larvae of feeding on the green stem just below the head of maturing cereal. The severed heads fall to the ground and cannot be harvested.

Photo 19: *Ragged flag and other leaves on a maturing cereal crop.*

Source: The Beatsheet

7.6.2 Thresholds for control

Table 9 shows the value of yield loss incurred by 1 and 2 larva/m^2 per day, based on approximate values for wheat and an estimated loss of 70 kg/ha per larva. Based on these figures, and the relatively low cost of controlling armyworm, populations in ripening crops in excess of 1 large larva/m^2 will warrant spraying.

Table 9: *Value of yield loss based on approximate values for wheat.*

Value of grain ($/t)	Value of yield loss ($) per day	
	1 larva/m^2	2 larva/m^2
$140	$9.80	$19.60
$160	$11.20	$22.40
$180	$12.60	$25.20
$200	$14.00	$28.00
$220	$15.40	$30.80
$250	$17.50	$35.00
$300	$21.00	$42.00
$350	$24.50	$49.00
$400	$28.00	$56.00

Source: QDAF

Control is warranted if the armyworm population distributed throughout the crop is likely to cause the loss of 7–15 heads per square metre (Photo 20).

Photo 20: *Armyworms feeding on grain heads.*

Source: World of Wheat

7.6.3 Management of armyworms

Many chemicals will control armyworms. However, their effectiveness is often dependent on good penetration into the crop to get contact with the caterpillars. Control may be more difficult in high-yielding thick canopy crops, particularly when larvae are resting under soil at the base of plants. As larvae are most active at night, spraying in the afternoon or evening may produce the best results. If applying sprays close to harvest, be aware of relevant withholding periods.

Biological control agents may be important in some years. These include parasitic flies and wasps, predatory beetles and diseases. *Helicoverpa* NPV is not effective against armyworm. [46]

MORE INFORMATION

PestNotes: Armyworm.

Armyworms in field crops

46 QDAF (2012) Insect pest management in winter cereals. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-winter-cereals

7.7 Mites

7.7.1 Brown wheat mite

Brown wheat mite (Petrobia latens) damage is only severe in dry seasons. The mature wheat mite is about the size of a pinhead, globe-shaped and brown (Photo 24). It has been a sporadic pest of winter cereals. Populations reach troublesome levels only under very dry conditions (Table 10). [47]

Photo 21: *Brown wheat mite on cereal leaf*

Photo: P Sloderbeck, Source: IPM Images

Table 10: *Description and management of brown wheat mite.*

Scientific name	*Petrobia latens*
Description	Adults are oval, up to 0.6 mm long and have 8 legs. The front legs are significantly longer than the others. The mite is brown and appears dark greenish-brown to black when on a green leaf. It is significantly smaller than, and has finer legs than, the BOM. Immature mites are smaller and orange-red.
Similar species	A very small mite that is unlikely to be confused with the blue oat mite or redlegged earth mite.
Crops attacked	Cereal rye, wheat, barley, triticale, oats, cotton and grasses. Crops are at risk during warm, dry periods.
Damage	Adults and nymphs pierce and suck on leaves, resulting in a mottled and 'drought-like' appearance. Crops with heavy infestations appear bronzed or yellowish and seedlings can die.
Monitor	Check from planting to early vegetative stage, particularly in dry seasons.
Action level	Spray if mottled patches appear throughout the crop and if conditions are dry.
Chemical control	Foliar treatments may sometimes be cost-effective. For current chemical control options see Pest Genie or APVMA.
Natural enemies	No natural enemies recorded.

Source: QDAF

47 QDAF (2010) Brown wheat mite. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/a-z-insect-pest-list/mites-overview/brown-wheat-mite

7.7.2 Blue oat mite

Blue oat mite (BOM) (*Penthaleus species*) are important pests of seedling winter cereals, but are generally restricted to cooler grain-growing regions (southern Queensland through eastern NSW, Victoria, South Australia and southern Western Australia) (Figure 4). The BOM is an important pest of seedling winter cereals. When infestations are severe, the leaf tips wither and eventually the seedlings die. Eggs laid in the soil hibernate over winter, allowing populations to build up over a number of years. This can cause severe damage if crop rotation is not practised (Table 11). Check from planting to early vegetative stage, particularly in dry seasons, monitoring a number of sites throughout the field. BOM are most easily seen in the cooler part of the day, or when it is cloudy. They shelter on the soil surface when conditions are warm and sunny. If pale-green or greyish irregular patches appear in the crop, check for the presence of BOM at the leaf base. [48]

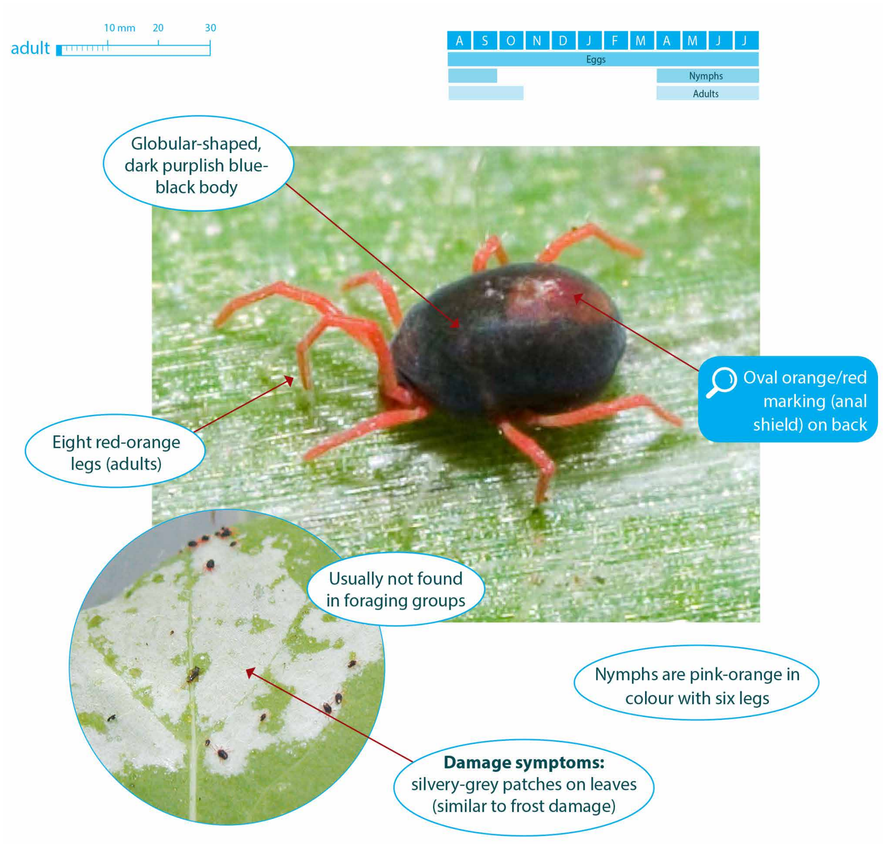


Figure 4: *Distinguishing characteristics and description of the BOM.*

Source: cesar

48 QDAF (2012) Insect pest management in winter cereals. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-winter-cereals

MORE INFORMATION

PestNotes: Blue oat mite.

Table 11: *Description and management of the BOM.*

Scientific name	*Penthaleus major*
Description	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 RLEM.
Similar species	Brown wheat mite Redlegged earth mite
Crops attacked	Mainly a pest of cereals and grass pastures, but will feed on pasture legumes and many weeds.
Damage	Adults and nymphs pierce and suck on leaves resulting in silvering of the leaf tips in cereals. When heavy infestations occur, the leaf tip withers and the seedling can die. In canola, leaves are mottled or whitened in appearance.
Monitor	Check from planting to early vegetative stage, particularly in dry seasons. Most easily seen in the late afternoon when they begin feeding on the leaves.
Control	Foliar applications of insecticides may be cost-effective if applied within 2–3 weeks of emergence in autumn. The use of control tactics solely in spring will not prevent the carryover of eggs into the following autumn. For current chemical control options see Pest Genie or APVMA.
Natural enemies	Thrips and ladybirds.

Source: QDAF

7.7.3 Damage caused by pest

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 lead to seedling death. Damage is most likely during dry seasons when mites in large numbers make moisture stress worse and control may be warranted in this situation. [49]

7.7.4 Thresholds for control

There are no economic thresholds established for this pest.

7.7.5 Management of insect pest

Where warranted, foliar application of registered insecticide may be cost-effective. Check with the most recent research to determine the likely susceptibility of BOM to the available registered products. Chemicals are the most common method of control against earth mites. Unfortunately, all currently registered pesticides are only effective against the active stages of mites; they do not kill mite eggs. For low–moderate mite populations, insecticide seed dressings are an effective method. Avoid prophylactic sprays; apply insecticides only if control is warranted and if you are sure of the mite identity. Pesticides used at or after sowing should be applied within three weeks of the first appearance of mites, before adults commence laying eggs.

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). Since eggs laid in the soil hibernate throughout the winter, populations of the mite can build up over a number of years

49 QDAF (2012) Insect pest management in winter cereals. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-winter-cereals

and cause severe damage if crop rotation is not practised. The use of control tactics solely in spring will not prevent the carryover of eggs into the following autumn.

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. [50]

7.8 Slaters

Slaters (also known as woodlice, sowbugs and pill bugs) are multi-legged, land-living crustaceans found all over Australia. Slaters are not generally regarded as a pest of broad acre agriculture and tend to feed on decaying vegetation and dead animal matter. Overall, they perform an important recycling role in the environment however on rare occasions they can also attack seedlings of broad acre crops. Recently damage from slaters has increased in the Northern region, with a number of reports of infestations in winter cereal crops in northern NSW and southern Qld.

The native slater species doing the damage to cereal crops is *Australiodillo bifrons*. This species has a light brown oval shaped and flattened body with a dark brown stripe in the middle of the back (Photo 22). This native slater is commonly found in low lying swampy regions and tends to be more active after rain periods. [51]

Photo 22: *Common slater (Porcellio scaber).*

Photo: J Douglas, Source: cesar.

Slaters are crustaceans related to the normally aquatic or marine crabs, lobsters and prawns but are adapted to living on land. Slaters are easily recognised by their heavily armoured, flattened bodies. They are oval, dull-grey and segmented, growing from 8-20 mm in length, depending on the species. They have 1 pair of prominent antennae, 1 pair of inconspicuous antennae and 7 pairs of legs (1 pair per segment).

There are three species of slaters found in broadacre situations, although they vary in their distribution. The common slater originally introduced from Europe, *Porcellio scaber*, is the most widespread species in Australia. This species is usually pale grey, although brown, yellow or orange variations are not uncommon, and can reach 20 mm in length. The Pill bug, *Armadillidium vulgare*, is also a European species and occurs commonly across Australia. It is characterised by its ability to roll into a ball when disturbed. It can grow to 18 mm and is dark brown to black in colour. The flood bug, *Australiodillo bifrons*, is a native slater that forms large swarms of tens of thousands of individuals. Flood bugs have recently been recorded attacking cereal crops. Populations of flood bugs have increased in parts of New South Wales

50 QDAF (2012) Insect pest management in winter cereals. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-winter-cereals

51 The Beatsheet. (2009). Slaters and other winter cereal establishment pests. http://thebeatsheet.com.au/slaters-and-other-winter-cereal-establishment-pests/

MORE INFORMATION

Slaters - cesar.

particularly those areas that are prone to flooding. *A. bifrons* is about 7-8 mm long and 4 mm wide with an oval-shaped and flattened body, light brown colour with darker irregular spots, and has a dark brown stripe down the middle of its back. It is a species adapted to low-land swampy soil or marshy environments. [52]

7.8.1 Damage caused by slaters

Although the reported incidence of slater damage to crops has grown in recent years, feeding damage on emerging crop seedlings is still relatively rare. When it does occur, slater feeding on plants results in an uneven rasping-type damage that can appear similar to slug and snail damage. They can chew the tops of emerging cotyledons or leaves of crop seedlings, leaving only the seedling stumps. Other damage includes ring-barking of stems and young branches. However, the presence of slaters in a paddock, even in high numbers, does not always mean crop damage will occur because the slaters will generally be feeding on decaying organic matter. It is not known what makes slaters suddenly shift from eating organic matter to seedlings. [53]

7.8.2 Thresholds for control

There are no economic thresholds established for slaters.

7.8.3 Managing Slaters

Biological:

There has been no research on natural enemies of slaters, although ground beetles (carabids) and some species of spiders are common predators in the United Kingdom.

Cultural:

Management options are limited after crop emergence so prevention is a key part of control.

Managing stubble is likely to be the most effective strategy to reduce slater numbers. Some growers have had success managing slaters ahead of canola rotations through burning crop residues.

Slater populations can be suppressed by reducing stubble loads, or disturbing stubble in summer, exposing insects to the hot soil.

Chemical:

There are no insecticides registered to control slaters in broadacre situations. Slaters are relatively unaffected by most foliar applications of synthetic pyrethroids and organophosphates to control other crop-establishment pests, even when applied at very high rates. Insecticides are probably ineffective because slaters hide under cover and thus avoid contact with insecticide sprays. There are chemical baits registered for use against slaters in horticulture, and there is evidence to suggest some success with chlorpyrifos baits in Western Australia. [54]

7.9 Soil insects in the Northern region

Key points:

- There are a number of soil insects that can damage establishing crops.
- The germinating grain bait technique is recommended for pest detection.
- Thresholds for control are different for summer and winter crops.
- Different soil insect pests occur under different cultivation systems.

52 Hangartner S, McDonald G. (2015). Slaters. cesar http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/slaters

53 Hangartner S, McDonald G. (2015). Slaters. cesar http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/slaters

54 Hangartner S, McDonald G. (2015). Slaters. cesar http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/slaters

- Weedy fallows and volunteer crops encourage soil insect build-up.
- Zero tillage encourages beneficial predatory insects and earthworms.

Soil-dwelling insect pests can seriously reduce plant establishment and populations, and subsequent yield potential. They are often difficult to detect as they hide under trash or in the soil. Fact sheets on the common soil insects are available:

- wingless cockroaches
- black field crickets
- black field earwigs
- black sunflower scarab beetles
- cutworms
- false wireworm
- true wireworm

Other soil insects are common, but do not damage crops.

- Centipedes are long, many-segmented animals with legs all along the body. They have long feelers and tail appendages and can move very quickly.
- Millipedes have a long, cylindrical, segmented body with an extremely high number of legs. They have short feelers, no tail appendages and move more slowly than centipedes. When disturbed, they coil up into a spiral.
- Isopods (woodlice or slaters) are small grey animals up to 7–10 mm long with long feelers and eight pairs of legs. They are usually found in groups under trash and in cracks in the soil.
- Earthworms are true soil animals, unlike centipedes, millipedes and isopods, which live on or near the soil surface. Earthworms are valuable in improving soil texture.
- Ants live in colonies which are mostly underground. The wingless workers gather food, particularly pasture seeds when available, for the colony.

Different soil insects occur under different cultivation systems and farm management can directly influence the type and number of these pests:

- Weedy fallows and volunteer crops encourage soil insect build-up.
- Insect numbers decline during a clean long fallow due to lack of food.
- Summer cereals followed by volunteer winter crops promote the build-up of earwigs and crickets.
- High stubble levels on the soil surface can promote some soil insects due to a food source but this can also mean that pests continue feeding on the stubble instead of germinating crops.
- Zero tillage encourages beneficial predatory insects and earthworms.
- Incorporating stubble promotes black field earwig populations.
- False wireworms are found under all intensities of cultivation but decline if stubble levels are very low.

Soil insect control measures are normally applied at sowing. Since different insects require different control measures, the species of soil insects must be identified before planting.

Monitoring for soil insects

1. Take a number of spade samples from random locations across the field.
2. Check that all spade samples are deep enough to take in the moist soil layer (this is essential).
3. Hand sort samples to determine type and number of soil insects.

Spade sampling is laborious, time consuming and difficult in heavy clay or wet soils.

Management—germinating seed bait technique

Immediately following planting rain:

1. Soak insecticide-free crop seed in water for at least two hours to initiate germination.
2. Bury a dessertspoon full of the seed under 1 cm of soil at each corner of a 5 m × 5 m square at 5 widely spaced sites per 100 ha.
3. Mark the position of the seed baits as high populations of soil insects can completely destroy the baits.
4. One day after seedling emergence, dig up the plants and count the insects.

Trials have shown that there is no difference in the type of seed used when it comes to attracting soil-dwelling insects. However, using the type of seed to be sown as a crop is likely to indicate the species of pests which could damage that crop.

The major disadvantage of the germinating grain bait method is the delay between the seed placement and assessment. [55]

55 QDAF (2011) How to recognise and monitor insect pests. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/help-pages/recognising-and-monitoring-soil-insects