Insect control

Sorghum is susceptible to insect pests from emergence to late grainfill. Early sorghum pests include armyworms and soil insects. These pests are normally present in a grain sorghum crop in low numbers where their damage can be tolerated. However, seasonal conditions can sometimes stimulate the buildup of a large population of one or more of these, and they can cause significant damage.

Seed dressings to combat soil insects are commonly available and may be the most effective control as well as the least disruptive to natural enemies.

Choosing open-headed type sorghum hybrids can deter pests such as aphids and Rutherglen bugs. These insects prefer compact or closed panicle types, on which they are hard to control because of the difficulty of achieving spray penetration.

It is now possible to adopt an integrated pest management (IPM) strategy to control *Helicoverpa* and midge (Figure 1) on sorghum with a nuclear polyhedrosis virus (NPV) that is selective for *Helicoverpa*, and by planting of midge-tolerant hybrids. Such a strategy eliminates any impact on natural enemies that naturally attack both midge and *Helicoverpa*. [1]

Figure 1: *Sorghum midge is a serious pest of sorghum crops.*

Photo: QDAF

7.1 Sorghum pests at a glance

A summary of information about sorghum pests is presented in Table 1.

1 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

Table 1: *Sorghum pests.* [2]

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	Do not cause yield loss unless populations are extreme. Dryland crops under moisture stress most severely affected	Just before head emergence, flowering up to harvest	Reduce head emergence, seed set and quality. Honeydew interferes with harvest	Rarely economic to spray. Aphids usually controlled by natural enemies before stickiness occurs. Rain will reduce stickiness. A pre-harvest spray with a knockdown herbicide will usually avoid the harvest problems caused by aphids	Annual
Armyworms	No established threshold. Use defoliation as guide to potential impact. Consider stage of growth and potential damage	Feed on leaves of young plants, through to head emergence and flowering	Feed on leaves in funnels or throats of plants. In rare instances, or outbreaks of Day-feeding Armyworm can cause significant defoliation. Severe leaf area loss at flowering can reduce yields	Feeding during evening and night. Caterpillars hide near ground during day. Day-feeding armyworm active during the day	Rarely
Black field earwigs	Usually in large numbers. Examine soil before sowing for nymphs and adults	Attack germinating seed and roots of young seedling and tap roots of older plants	Destroy roots and cause plants to fall over in wind	Populations regulated by soil moisture, favoured by moist soils and organic matter. Sow treated seed and band spray in situations of high risk. Damage reduced by shallow sowing into moist warm soils using press-wheels	Rarely
Cutworms	At first sign of damage. Usually in large numbers in patches or moving in from edges	Seedling	Cut off leaves and stems at ground level, causing plant death. Most feeding in evening and night. Caterpillars hide in soil during day	Inspect crops late evening or night for presence of large, dark grey-green caterpillars. Spot treatment may be effective. Cutworm build up in weedy fallows and field edges. Weed control can force them onto seedling crops	Rarely
False wireworms	Treat seed or soil if ≥3 larvae/m row	Newly emerged seedling. Can attack dry sown seed. More damage when emergence and growth delayed by dry weather	Feed on dry seed and eat into the stems of young plants just above ground level	Check at junction of loose cultivated soil and undisturbed soil before sowing. Vary from 8–40 mm in length. Often feed on decaying vegetable matter. Use germinating seed baits to assess population pre-sowing. Warm soil and press wheels can reduce damage	Intermittent
Helicoverpa caterpillars	Economic thresholds (ET) can be calculated using the following formula: ET = (C × R) ÷ (V × N × 2.4), where C is cost of control ($/ha), R is row spacing (cm), V is value of crop ($/t), N is number of heads/m row, 2.4 is damage (g/larva)	Infestations on vegetative plants do not cause economic damage. Eggs are laid on heads just prior to flowering from December to March	Small caterpillars (<10 mm) eat flower spikelets, larger caterpillars eat developing seed reducing yields and allow entry of fungal pathogens. Each larva destroys ~2.4 g of grain	To determine heads per m row, count 10 m of row at 10 sites. Sample larvae by shaking sorghum heads into a bucket. Compact-headed varieties suffer more serious damage than open-headed types. Cultivation of stubble over winter reduces pupae survival. Threshold calculators are available at www.thebeatsheet.com.au/economic-threshold-calculators	Annual

2 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

MORE INFORMATION

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/284576/Insect-and-mite-control-in-field-crops-2013.pdf

http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/insect-mite-crops

http://thebeatsheet.com.au/economic-threshold-calculators/

7.2 *Helicoverpa (Helicoverpa armigera)*

Helicoverpa do little economic damage as foliage feeders. Eggs laid on heads just before flowering produce larvae that cause economic damage. Sorghum is most at risk from *Helicoverpa* from head emergence to early grainfill. Larvae of *Helicoverpa* can be confused with sorghum head caterpillar and yellow peach moth. [3]

Figure 2: Helicoverpa armigera *caterpillar.*

All *Helicoverpa* caterpillars on sorghum are *H. armigera* (Figure 2). [4]

7.2.1 Damage

Helicoverpa can attack sorghum in both the vegetative and reproductive phases. It is only when they attack developing grain that control may be warranted. [5]

- Small larvae (<10 mm long) feed on the pollen sacs in the flower head where they cause little damage.
- Larger *Helicoverpa* larvae feed on developing seed; 80% of damage is done in by the final larval instar.
- Each larva destroys ~2.4 g of grain in its lifetime.

Monitoring

- Monitor weekly from head emergence through to early grain.
- Determine *Helicoverpa* numbers by rotating five head stalks into a bucket.
- Count larvae in the bucket and work out an average per head.
- Determine larval sizes (important for control decisions).
- Repeat sampling at a minimum of six sites throughout the paddock. [6]

3 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

4 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

5 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

6 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

7.2.2 Thresholds

Action levels vary with factors such as grain prices and cost of control. The critical number of insects per head is the number of insects that can eat a greater monetary value of grain than the cost of spraying. Control is recommended when insect numbers are at or above the critical threshold level.

The critical *Helicoverpa* larvae number can be calculated with the following formula:

(C (cost of control) × R (row spacing)) ÷ (V (value of crop in $) × N (no. of heads/m row) × 2.4)

7.2.3 Monitoring and control

Checking for *Helicoverpa* should be done very early in the morning or very late in the evening twice a week. Aim to control larvae before they reach 7 mm in length, because larger larvae cause more damage and are harder to control. Eggs are laid between head emergence and flowering. [7]

The best product to use for control of *Helicoverpa* is a naturally occurring virus that targets this pest (Figure 3). NPV is regarded as a highly successful, alternative control option when used under the right conditions. The use of NPV will reduce selection for resistance and is therefore the preferred control option. Note that NPV often works more slowly than conventional chemistry in terms of killing larvae; however, the larvae do not feed for a few days prior to dying. [8]

- NPV is most effective against small larvae (<7 mm). Avoid targeting larvae >3 mm.
- Crop coverage is critical because this is an ingestion product.
- Spray NPV when ~50% of the sorghum panicles have completed flowering (see label for instructions).
- Spray when larvae are actively feeding, at temperatures between 25°C and 35°C.
- NPV is harmless to wildlife and natural enemies of *Helicoverpa*. [9]

7 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

8 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

9 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

Figure 3: *NPV infected, and killed,* Helicoverpa *larva.*

Photo: QDAF

MORE INFORMATION

http://www.pestgenie.com.au/

www.apvma.gov.au

Helicoverpa armigera is highly resistant to pyrethroids, organophosphates and carbamates. The effectiveness of these products depends on the percentage of resistant *Helicoverpa*, but their use cannot be relied on for control, particularly under high pest pressure.

There are other chemical means of controlling *Helicoverpa*; however, these chemicals severely disrupt natural enemies. For current chemical control options, see Pest Genie or the Australian Pesticides and Veterinary Medicines Authority (APVMA). [10]

7.2.4 Natural enemies

The combined action of natural enemies can have a significant impact on potentially damaging *Helicoverpa* populations. It is therefore desirable to conserve as many natural enemies as possible. Natural enemies of *Helicoverpa* include predators of eggs, larvae and pupae, parasites of eggs, and larvae and caterpillar diseases.

Predatory bugs and beetles that attack *Helicoverpa* eggs and larvae include:

- spined predatory bugs
- glossy shield bugs
- damsel bugs
- big-eyed bugs
- apple dimpling bugs
- assassin bugs
- red and blue beetles
- predatory ladybird beetles
- ants
- spiders
- lacewings

10 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

Parasites include:

- *Trichogramma* spp.—tiny egg parasite wasps
- *Microplitis* and *Netelia* (wasps)—caterpillar parasites
- Species of tachinid flies—caterpillar parasites

With the exception of *Trichogramma* and *Microplitis*, most parasites do not kill *Helicoverpa* until they reach the pupal stage. Predatory earwigs and wireworm larvae are significant predators of *Helicoverpa* pupae. [11]

7.3 Sorghum midge (*Stenodiplosis sorghicola*)

Sorghum midge is a serious pest of sorghum that may require several insecticide applications during flowering, particularly for late-planted crops (Figure 4). Management is now centred on growing midge resistant hybrids that not only simplify management and decreases cost, but provide greater midge control. [12]

MORE INFORMATION

http://ipmguidelinesforgrains.com.au/pests/sorghum-midge/

http://espace.library.uq.edu.au/view/UQ:106771

http://www.publish.csiro.au/paper/EA9930193.htm

http://groundcover.realviewdigital.com/?iid=83218&startpage=page0000043#folio=42

Figure 4: *Severe damage caused by sorghum midge to sorghum head.*

Photo: QDAF

Sorghum midge rating scheme

In 1993, Department of Agriculture, Fisheries and Forestry Queensland (QDAF), in partnership with Grains Research and Development Corporation (GRDC) and the commercial sorghum breeding companies, developed a protocol for measuring the midge resistance (MR) levels in grain sorghum hybrids and assigning official MR ratings to all the commercially released lines.

The rating number is a measure of: amount of grain lost per visiting female midge per day. It ranges from 1 (nil resistance) through to 8+ ('practical field immunity' under most conditions and maximum commercially available resistance). In practical terms, this means that a 7-rated hybrid, when exposed to the same midge pressures as a 1-rated hybrid, will sustain 7 times less damage.

11 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

12 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

MORE INFORMATION

https://www.grdc.com.au/Research-and-Development/Major-Initiatives/The-Sorghum-Midge-Tested-Scheme

MORE INFORMATION

http://thebeatsheet.com.au/sorghum/helicoverpa-and-midge-management-in-sorghum/

MORE INFORMATION

http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-107-NovDec-2013/Cost-effective-control-of-sorghum-midge

http://www.grdc.com.au/GRDC-FS-SorghumMidgeEconomicThresholds

http://www.ausgrain.com.au/Back%20Issues/175jfgrn08/Niv_Cost.pdf

http://www.ausgrain.com.au/Back%20Issues/185jfgrn09/27_Thresholds.pdf

The testing protocol, carried out by QDAF, involves planting an annual trial in a semi-controlled environment (ideal for sorghum and midge) and subjecting the plants to high midge pressures. The resulting midge damage per head is then assessed for all entries.

For evaluation purposes, the test (pre-commercial) hybrids are grown alongside standard/control lines of known MR ratings. After statistical analysis of the results, official MR ratings are then assigned for each hybrid. This testing regime provides a measure of quality assurance for growers in that hybrids are independently assessed in a precise and consistent manner every time, and the ratings and accompanying logo are issued only to hybrids assessed by the scheme. [13]

7.3.1 Damage

Sorghum midge can severely reduce yields, especially in late-sown crops:

- Midge eggs hatch into transparent white larvae that feed on immature seed.
- Feeding creates a depression in the developing seed and prevents seed kernel development.
- High populations of midge can destroy the crop.
- The progeny of each egg-laying adult can destroy 1.4 g of grain.
- Sorghum midge activity is evident by white pupal cases that stick out of the tips of glumes.

The midge lifecycle varies from 2 to 4 weeks, depending on temperatures. This allows many generations to occur in one season and accounts for the rapid build-up of extremely high midge densities, especially where the flowering period of sorghum is extended by successive plantings. [14]

7.3.2 Monitoring

Count adult midge on flowering heads at mid-morning. Repeat daily. [15]

Weekly trap catch data for *H. punctigera* and *H. armigera* from locations across all states can now be viewed online. The adjustable bar below the map allows selection of a time period (1 wk, 2 wks, 1 mth, etc). https://jamesmaino.shinyapps.io/MothTrapVis/

7.3.3 Thresholds

Thresholds vary with the resistance levels of the hybrids as well as commodity prices and the cost of insecticides. Threshold levels can be calculated using the factor of 1.4 g of grain destroyed per one egg-laying adult. On susceptible hybrids, this level is usually about one adult per head. [16]

The sorghum midge economic threshold calculator

The calculator helps growers decide whether to apply an insecticide by asking the question: is the number of midge high enough to justify insecticide and application expenses, or is the number too low to affect the crop yield?

The tool uses your specific farming conditions to provide tailored advice.

It is available online, along with information on how to collect the pest data used by the calculator, at: http://thebeatsheet.com.au/economic-threshold-calculators/. [17]

13 GRDC. The sorghum midge tested scheme. GRDC Major Initiative, https://www.grdc.com.au/Research-and-Development/Major-Initiatives/The-Sorghum-Midge-Tested-Scheme

14 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

15 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

16 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

17 GRDC (2013) Cost and benefit of treating sorghum midge. GRDC Sorghum Midge Spray Calculator Fact Sheet, http://www.grdc.com.au/GRDC-FS-SorghumMidgeEconomicThresholds

Alternatively, midge thresholds for a particular crop can be calculated by using the following formula. For more detailed information, seek advice from your agronomist.

Control midge when:

NM/R is greater than (C × W × CB)/(1.4 × V × RD)

where:

NM is number of midge/m row

R is midge rating of hybrid used

C is cost of control ($/ha)

W is row spacing width (cm)

CB is cost benefit ratio

1.4 is weight of sorghum (grams) lost per midge

V is value of crop ($/t)

RD is residual life of chemical used (days)

Example calculation: NM/R = 4/3 =1.33 and (C × W × CB)/(1.4 × V × RD) = (17 × 100 × 2)/(1.4 × 155 × 4) = 3.92

As 1.33 < 3.92, do not spray at this stage. [18]

7.3.4 Control

The most common means of controlling sorghum midge is by planting resistant hybrids. Since 1993, all commercial sorghum hybrids have been assigned official midge resistant (MR) ratings from 1 to 7.

Hybrids with a rating 7, when exposed to the same midge density as the susceptible hybrid (rating 1), sustain 7 times less damage. In 2002, the rating system was extended to a new 'open-ended' rating of 8+. Trials have shown that some 8+ hybrids contain levels of resistance that approach 'practical field immunity'. Note that for 8+ varieties, some are just a little better than 7, whereas others are 'practically immune'.

Today, >99% of grain sorghum in Australia has some level of midge resistance, with most commercial hybrids rating 4–6. The high level of adoption of MR cultivars and the elimination of low-rated MR hybrids means that spraying for midge is now very rare, with <5% of crops treated, in contrast to the mid-1990s when 30–40% of the crops were sprayed. The use of resistant hybrids also means that natural enemies are conserved.

Producers are recommended to use resistant sorghum hybrids to combat sorghum midge, particularly for later plantings when midge pressure is highest. See the current variety ratings.

Insecticides are still available for the control of midge, but these chemicals will severely disrupt natural enemies. For current chemical control options, consult Pest Genie or APVMA. [19]

During head emergence and flowering, crops should be checked daily about 3–4 h after sunrise. Midge are very mobile, so re-infestation of crops is common. Crops should be sprayed when the economic thresholds in Table 2 are reached (based on $17/ha spray cost, grain at $120/t and a benefit : cost ratio of 2 : 1). Because insecticides are only 60–80% effective, a cost : benefit ratio of 2 : 1 is appropriate in most situations.

18 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

19 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

MORE INFORMATION

http://www.pestgenie.com.au/

www.apvma.gov.au

http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/sorghum/planting-information

Table 2: *Sorghum midge per head warranting control in hybrids with different levels of midge resistance.* [20]

Hybrid midge resistance (tested rating)	Flowering (no. of heads/ha)		
	20,000	40,000	60,000
Susceptible (1)	2.5	1.2	0.8
Low (2)	5.0	2.5	1.7
Moderate (4)	10.0	5.0	3.3
High (6)	15.0	7.5	5.0

7.3.5 Natural enemies

Three small, black wasp parasitoids play a role in the control of sorghum midge populations, but they do not reduce levels of crop damage. They are *Eupelmus* sp., *Tetrastichus* sp. and *Aprostocetus* sp. Their presence in sorghum crops may be recognised by their small, round emergence holes in the spikelet. [21]

7.4 Minor pests

MORE INFORMATION

GRDC Update Paper: Emerging insect threats in northern grain crops

7.4.1 Soil insects

These include false wireworms *Pterohelaeus* spp. (eastern false wireworm, striate false wireworm) and *Gonocephalum* spp. (small false wireworm, southern false wireworm, northern false wireworm); also earwigs, cockroaches, and field crickets (black field crickets or brown field crickets).

Damage

- Larvae feed on decaying vegetable and crop residues in the soil.
- They also feed on newly germinating seed and the growing points of seedlings, which results in patchy stands.
- Damage is most common in early-planted crops where crop residue has become scarce.
- During summer, adults may damage young plants, by surface feeding or cutting of the plant at or near soil level.
- Damage by both larvae and adults may necessitate re-planting.

PODCAST

Melina Miles QDAF discusses soil dwelling insect pests and describes germinating seed bait technique for checking populations prior to sowing. GRDC Podcast: 104 Thrips worrying early summer crops

Risk period

The risk from adults is highest in summer. With larvae, the risk is highest for early-planted (September–October) crops. Damage may occur if early plant growth is slowed by cool, damp weather allowing larvae to remain in the moist root-zone. As soil dries, larvae retreat below the root-zone.

Monitoring and thresholds

Soil insects are often difficult to detect as they hide under trash or in the soil. Immature insects such as false wireworm larvae are usually found at the moist/dry soil interface. [22]

Most soil insects are active at night or very averse to bright sunny conditions so using germinating seed baits [23] to check for insects before the crop goes is recommended.

20 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

21 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

22 QDAF (2011) How to recognise and monitor soil insects, Department of Agriculture, Fisheries and Forestry, https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/help-pages/recognising-and-monitoring-soil-insects

23 GRDC Podcast 3 Nov 2015, 104 Thrips worrying early summer crops, https://grdc.com.au/Media-Centre/GRDC-Podcasts/Northern-Weekly-Update/2015/11/104-north

Management

High mortality of false wireworms can be caused by cool wet weather from autumn to spring. False wireworm beetles are more damaging to seedlings where stubble is buried by cultivation than in crops that are directly drilled into the surface retained stubble. This is because the surface-feeding beetles remain feeding on the stubble and not the crop.

- Prepare ground for even and rapid germination.
- Use of press-wheels at planting provides some protection.
- Clean cultivation during summer dries out topsoil and eliminates weeds that provide food for adults.
- Larvae can be controlled by insecticide applications at planting or insecticide-treated seed.
- Control of adults is obtained by baiting with insecticide-treated cracked grain broadcast evenly over the surface at or immediately after planting.
- Where broadcasting is not possible, the bait may be laid in trials spaced ≤2 m apart. For current chemical control options, see Pest Genie or APVMA.

Natural enemies provide little control. [24]

7.4.2 Cutworms (*Agrostis* spp.)

These include brown cutworm (*Agrotis munda*), Bogong moth (*Agrotis infusa)*, black cutworm (*Agrotis ipsilon*) and variable cutworm (*Agrotis prophyricollis*).

The common name of cutworm is derived from the larval habit of severing the stems of young seedlings at or near ground level, causing the collapse of the plant. Cutworm larvae typically shelter in the soil during the day. They curl into a 'C' shape when disturbed (Figure 5).

Figure 5: *Cutworm larvae on the soil surface.*

Photo: J Wessels, QDAF

Damage

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

24 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

- Risk period is spring and summer—one generation per crop.
- Weedy fallow prior to sowing can lead to cutworm infestation.

Monitoring and thresholds

- Inspect emerging seedlings twice per week.
- Treat seedlings when there is a rapidly increasing area or proportion of crop damage (>10% seedling loss).
- Treat older plants if >90% of plants are infested or >50% of plants have ≥75% leaf tissue loss.

Control

- Cutworms are attacked by a range of natural enemies such as parasitoids, predators and diseases that also affect *Helicoverpa*.
- Controlling weeds in the field and field edges prior to planting will reduce cutworm populations that may have built up on these weeds. Spraying or cultivation of weeds just before or after crop emergence may force cutworm larvae onto the seedling crop.
- Insecticides are used when damage warrants their use. For current chemical control options, see Pest Genie or APVMA.
- Spot-spraying of identified patches may suffice. For best results, spray late in the afternoon, close to feeding time. [25]

7.4.3 Black field earwig (*Nala lividipes*)

Black field earwigs are a sporadic pest of sorghum, usually in areas with heavy, black soils.

Damage

- Eat newly sown and germinating seed and the roots of crops belowground, resulting in poor establishment.
- Chew the stems of newly emerged seedlings aboveground.

Monitoring and control

- Monitor crops after planting until establishment.
- Use germinating seed baits or digging and sieving to detect adults and nymphs prior to planting.
- Control if >50 earwigs are present in 20 germinating seed baits.
- Grain baits containing insecticide applied at sowing offer best protection.
- Insecticide seed dressings provide some protection.
- In-furrow sprays are not effective in protecting against dense populations.
- Earwigs prefer cultivated soils rather than undisturbed soil (no-till).
- Use press-wheels at sowing.
- For current chemical control options, see Pest Genie or APVMA. [26]

7.4.4 Armyworms

These include northern armyworm (*Leucania separate*), common armyworm (*Leucania convecta*) and day-feeding armyworm (*Spodoptera exempta*).

Armyworm is the caterpillar stage of certain moths and can occur in large numbers, especially after good rain following a dry period (Figure 6). During the day, armyworms shelter in the throats of plants or in the soil and emerge after sunset to

25 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

26 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

feed. The adults of the common and northern armyworms may be confused. Genitalia dissection by a specialist is required to separate the species. The larval stages likely to be encountered in cereals are all similar in appearance.

Figure 6: *Armyworm.*

Photo: QDAF

Damage

- Small infestations are usual in vegetative sorghum, causing little damage other than 'shot holes' in the leaves.
- Young plants may be defoliated or killed by heavy infestations, particularly of day-feeding armyworm .
- Older plants can outgrow damage, but seed yield may be reduced.
- Signs of damage include chewed leaf margins and faecal pellets at the base of young plants or in the throats of older plants.
- The northern and common armyworm feed at night and hide in vegetation during the day.
- Day-feeding armyworms feed during the day.

Monitoring

- Visually monitor during the early growth stage and again during head emergence and flowering.
- Egg lays are often associated with heavy rainfall, so check for larvae several weeks after rainfall events.
- Since armyworms (except day-feeding armyworm) hide during the day, look under clods of soil, under vegetation and at the base of plants. Also look for dark green-brown faecal pellets.

Thresholds

Treatment decisions should be made on the extent of defoliation and whether the crop can compensate for damage, the prevalence of natural enemies, the value of the crop and the cost of treatment.

Control

- Many chemicals will control armyworms. Their effectiveness is often dependent on good penetration into the crop to achieve contact with the caterpillars.

- Control may be more difficult in high-yielding thick canopy crops, particularly when larvae are resting under leaf litter at the base of plants.
- Because larvae are most active at night, spraying in the afternoon or evening may produce the best results. For current chemical control options, see Pest Genie or APVMA.

Natural enemies

Armyworm larvae are attacked by a number of parasitoids that may be important in reducing the intensity of outbreaks. When armyworms are in numbers likely to cause damage, parasitoids are unlikely to give timely control.

Predators include those that attack *Helicoverpa*, and green scarab beetles, predatory shield bugs and perhaps common brown earwigs. Viral and fungal diseases are recorded as causing mortality of armyworm. [27]

7.5 Corn aphid *(Rhopalosiphum maidis)*

Aphids frequently infest sorghum heads towards the end of grainfill; however, there is usually minimal economic damage, even when conditions are dry. Under extremely high populations, they may affect yield and quality. [28]

Damage

- Adults and nymphs suck sap and produce honeydew, which causes blockages and breakdowns of harvesters and can delay or extend harvest.
- High numbers can cause plants to turn yellow and appear unthrifty.
- High populations on heads produce sticky grain, which can clog harvesters.
- Water-stressed dryland crops loose yield.

Monitoring

- Estimate the percentage of plants infested and the percentage of leaf area covered by aphids.
- Check for the presence of predators and parasitoids. Record changes in aphid and natural enemy populations over successive checks.

Thresholds

The action level in the vegetative stage 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.

Control

- Control is rarely warranted as natural enemies tend to control aphids before they start to cause stickiness in heads. Rainfall prior to harvest will reduce stickiness.
- Choosing hybrids with open heads can reduce aphid numbers, as these are generally less infested than tight-headed hybrids. [29]
- A pre-harvest spray with a knockdown herbicide will avoid the harvest problems caused by aphids. In severe cases, chlorpyrifos is a registered option for corn aphids. [30]

27 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

28 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

29 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

30 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

- Chemical control options are cost-effective but all insecticides that control aphids impact on natural enemies. For current chemical control options, see Pest Genie or APVMA. [31]

Natural enemies

A range of parasitoids and predators will help reduce aphid populations. Predators of aphids include:

- ladybird larvae
- damsel bugs
- big-eyed bugs
- larvae of green lacewings
- larvae of hoverflies
- wasp parasitoids such as *Lysiphlebus testaceipes, which* mummify and kill aphids [32]

PODCAST

Melina Miles QDAF discusses Rutherglen bug. GRDC Podcast: 106 Safe seed storage strategy

7.5.1 Rutherglen bug (*Nysius vinitor)* and grey cluster bug (*N. clevelandensis*)

Rutherglen bugs (RGB) can cause damage when present in very high numbers, by sucking sap from the plant leaves, stems and heads, thereby reducing yield and/or quality. [33]

Damage

- Seed heads may be damaged by feeding, resulting in reduced yield and quality.
- Affected seed is red and spotty and hollowed out.
- Grain will be small and shrivelled and does not continue to fill beyond the point it was damaged.
- Damaged seed is subject to fungal and bacterial attack.
- Seedling crops can be damaged by nymphs moving from nearby canola stubbles.

Monitoring

- Monitoring for RGB can be done at the same time as for *Helicoverpa*.
- Monitor by beating sorghum heads into a bucket and counting the number of RGB adults and nymphs.
- Because the impact on seed-set by RGB is greatest during flowering and early seed development, monitoring should start at early flowering.
- Distribution is typically patchy across the field, which means that random sampling, and the more samples taken, the greater the level of confidence in the overall infestation.

Thresholds

Rutherglen bug populations within a head can increase rapidly. Preliminary indications suggest at flowering a threshold of 20–25 bugs/head; increasing to 30–35 bugs/head at the soft-dough stage. By the hard-dough stage through to harvest, no damage occurs. [34]

31 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

32 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

33 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

34 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

MORE INFORMATION

http://thebeatsheet.com.au/sorghum/management-of-rutherglen-bug-in-seedling-crops-sorghum-and-sunflower/

http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2008/09/RUTHERGLEN-BUG-SORGHUM-MIDGE-AND-DIAGNOSING-POOR-SEED-SET-IN-GRAIN-SORGHUM

Control

- If the threshold is exceeded, control of RGB should occur from flowering to soft dough. Although large populations often occur close to harvest, there is no impact on yield from RGB activity post physiological maturity. The RGB are feeding on the plant, not on the seed.
- There are no soft chemical options for the control of RGB. Repeated influxes of migrating adults can make repeat applications necessary.
- Control of the adults is generally recommended because of the rapid population build-up as well as the difficulty of controlling nymphs hidden within the sorghum head. Carbaryl and maldison are registered for their control. [35]
- For details on current chemical control options, see Pest Genie or APVMA. [36]

Natural enemies

Egg parasitoids are the most commonly recorded natural enemy of RGB. Their potential contribution to population control will be limited in seasons when there are large influxes of adults. Predation has rarely been recorded, but spiders may play a role. [37]

7.5.2 Sorghum head caterpillar (*Cryptoblabes adoceta*)

This pest in more prevalent in tropical and sub-coastal areas of north-eastern Australia. It may be confused with *Helicoverpa* and yellow peach moth.

Damage

- Larvae feed on developing seed, each larva destroys ~0.5 g of grain.
- They web clusters of seed together.

Monitoring

- Presence of caterpillars is indicated by webbing of seed clusters, webbing of whole heads and presence of small white–pink excreta.
- Count larvae on heads by dislodging them from sorghum heads into a bucket.

Thresholds

- Action levels vary with commodity prices and the cost of insecticides.
- The threshold level can be calculated using the factor of 0.5 g of grain destroyed by the larva.
- The threshold is usually in the range of 5–10 larvae/head.

Control

- Open-headed sorghum varieties are generally less infested that tight-headed varieties and also allow better penetration of insecticides.
- There are currently no registered products against sorghum head caterpillar but chemicals targeting *Helicoverpa* are likely to be effective.
- For chemical control options, consult Pest Genie or APVMA.

Natural enemies

- Parasitic wasps provide some biological control, but are unlikely to control populations above 10/m^2.

35 N Moore, L Serafin, L Jenkins (2014) Grain sorghum. Summer crop production guide 2014, pp. 5–16, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/303485/Summer-crop-production-guide-2014.pdf

36 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

37 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

- The avoidance of broad-spectrum pesticides prior to flowering (e.g. for aphids or armyworm) will help conserve natural enemies. [38]

7.5.3 Yellow peach moth (*Conogethes punctiferalis*)

This pest may be confused with *Helicoverpa* and sorghum head caterpillar.

Damage

Larvae feed on developing seed. Each larva destroys ~1 g of grain.

Monitoring

Count larvae during milky dough stage and by dislodging them from heads into a bucket.

Thresholds

The level varies with factors such as commodity price and cost of insecticide. The level can be calculated using the factor of 1 g of grain destroyed per larva. The threshold usually works out to be 2–5 larvae/head.

Control

- Open-headed sorghum varieties are generally less infested than tight-headed varieties because they allow better penetration of insecticides.
- Chemical control is cost-effective. For current control options, see Pest Genie or APVMA.

Natural enemies

The avoidance of broad-spectrum pesticides prior to flowering will help conserve natural enemies. Parasitic wasps provide some biological control. [39]

MORE INFORMATION

http://www.grdc.com.au/Resources/Ute-Guides

38 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum

39 QDAF (2012) Insect pest management in sorghum. Department of Agriculture, Fisheries and Forestry Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/insect-pest-management-in-sorghum