INSECT PESTS
OF
FIELD CROPS

IN COLOUR

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Foreword

Insect pests are a major source of loss in field crops in Queensland. A most important first step towards controlling them is correct identification. This book has been designed to enable losses from insect attack to be minimized by proper identification of the pest and the application of proven control measures.

The book is intended for use by primary producers and agricultural extension officers and as a background for research workers. It should also be of interest and value to students of agriculture.

Text was contributed by officers of the Entomology Branch of my Department with Mr G. Swaine, Supervising Entomologist, being largely responsible for collating and editing the information. Mr D. A. Ironside, District Experimentalist, provided the majority of the colour photographs and Mr W. H. T. Yarrow, Entomologist, was responsible for the details concerning control. Information and Extension Training Branch prepared the copy for the printer and Mrs D. Mulder of that Branch was responsible for the cover art work. The Government Printer, Mr S. R. Hampson, and members of his staff gave much valuable advice on the preparation of the material.

Funds for the publication were provided in a special allocation from the Queensland Treasury Department.

The Director of the Entomology Branch, Mr T. Passlow, and staff of that Branch propose the production of a companion volume to cover insect pests of fruit and vegetable crops in the near future.

G. I. Alexander
Director-General
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Notes on the use of this book

The field crops in this book are dealt with in alphabetical order from cereal crops to tobacco. Sugar-cane is omitted as this major industry is the responsibility of the Bureau of Sugar Experiment Stations in Queensland. The major pests and other commonly occurring insects and mites and natural enemies are listed for each crop. Correct identification of the pest is essential for its control. Illustrations have therefore been chosen as an aid to the identification of that stage of the pest which causes damage, for example the caterpillar which feeds on the crop, rather than the adult moth which does not cause damage. In some cases the pest causes damage which is characteristic; since that damage can be used as an aid to identification of the pest itself appropriate illustrations of pest damage have also been selected. All illustrations are accompanied by descriptive notes on the insect and its biology in relation to the crop. It is important to preserve natural enemies wherever possible. To facilitate their identification, illustrations and accompanying notes of some of the more common natural enemies have been included.

A section on the more common pests of stored products has also been included. These have been dealt with in the same way as the pests of field crops.

The final section of the book is concerned with current recommendations for control and is presented in tabular form under crop headings arranged alphabetically. Since control measures are subject to change from time to time this section will be revised as necessary.

It has not been possible to illustrate and provide notes on all the insects listed or to include all pests that one may encounter. Where further advice is needed contact your local Department of Primary Industries office.

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CEREAL CROPS (wheat, barley, oats, millet, triticale)

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*Blue oat mite (*Penthaleus major* (Duges))
*Common army worm *(Pseudaletia convecta* (Walker))
Locusts:—see SORGHUM
Australian plague locust (*Chortoicetes terminifera* (Walker))
Migratory locust (*Locusta migratoria* (Linnaeus))
} —see SORGHUM

Minor pests

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Sugarcane armyworm *{Mythimna loreyimima* (Rungs))
* Brown wheat mite *(Petrobia latens* (Miiller))
Cutworms *(Agrotis* spp.)—see SUNFLOWER
*False wireworms:
False wireworm *(Pterohelaeus alternatus* Pascoe)
Southern false wireworm *{Gonocephalum macleayi* (Blackburn))
Tortoise beetle (*Pterohelaeus darlingensis* Carter)
Oat aphid (*Rhopalosiphum padi* (Linnaeus))
Seedharvesting ants—see PASTURES
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Pheidole anthracina Forel
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Nuclear polyhedrosis virus
Parasites of common armyworm:
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Cuphocera varia (Fabricius)
**Goniophthalmus australis* (Baranov)
} —tachinid flies

•Illustrated.

CEREAL CROPS

Blue oat mite *(Penthaleus major* (Duges))

Brown wheat mite (*Petrobia latens* (Muller))

Blue oat mite damage to oats

Wheat leaves damaged by blue oat mite (left) and brown wheat mite (right) x 3.5

The blue oat mite is an important pest of seedling winter cereals.

Adults are about 2 mm long and are readily recognized by their blue, oval-shaped bodies and bright red legs. The mites are seen most commonly during the late afternoon when they begin feeding on the leaves. This continues throughout the night and results in silvering of the leaf tips. When infestations are severe the leaf tips wither and eventually the seedlings die.

Since eggs laid in the soil hibernate throughout the winter, populations of the mite can build up over a number of years and cause severe damage if crop rotation is not practised.

The mature, brown wheat mite is about the size of a pinhead, roughly globular-shaped and brown. It has been a sporadic pest of winter cereals. Plague infestations occurred in 1963 but the mite was of minor importance until 1980 when wide-spread outbreaks occurred once more. Populations reach troublesome levels only under very dry conditions. Feeding causes a fine mottling of the leaves and the damage gives the appearance of drought effects. When heavily infested crops are viewed from a distance they have a bronzed or yellowish appearance.

CEREAL CROPS

Common armyworm *(Pseudaletia convecta* (Walker))

Common armyworm x 2.5

Head cutting damage to barley

The common armyworm is important in southern Queensland where it attacks winter cereals, particularly barley, in September and October. It appears in plague proportions at times but is only of local importance in the intervening years. Conditions leading to outbreaks are not fully understood.

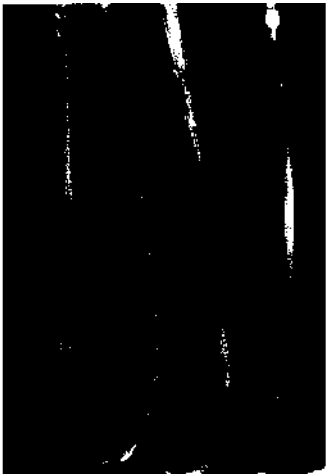
Infestations within paddocks are often patchy in distribution and more luxuriant stands of barley often have the biggest infestations, up to 60 or more armyworms per square metre.

Eggs are laid by the moth at night in the folds of leaves or inside leaf sheaths at the base of the plant. The larvae hide in the leaf debris at the base of the plant or in cracks in the soil and emerge at night to feed. Infestations are indicated by the eaten-out margins of leaves due to feeding of the older larvae and also by the faecal pellets around the base of the plant. The most serious damage results from the habit of the older larvae of feeding on the green stem just below the head of maturing barley. The severed heads fall to the ground and cannot be harvested. Larvae pupate in a specially prepared chamber in the soil. Adults of the next generation are produced after a life cycle which varies from 40 days in spring to 100 days in winter.

CEREAL CROPS

False wireworms (*Gonocephalum* spp., and *Pterohelaeus* spp.)

False wireworm adult and larva x 3



Wheat seedlings showing typical damage below soil level by false wireworm

Adult false wireworms emerge from the soil during spring and early summer. Eggs are laid singly into moist soil, usually under trash or low-growing weeds. They hatch within 7 to 14 days and the larvae burrow down to the top of the moist layer of the soil. As this moist layer moves up and down with wetting and drying out of the soil so do the larvae move. Larval development continues through autumn and winter into spring. When mature, the larva makes a cell in the soil in which it pupates. The adult emerges about 14 days later.

Larvae feed on decaying vegetable matter and crop residues in the soil. They also feed on newly germinated seeds, for example of cereals, cotton, soybeans, sunflower, tobacco and tomato. Both the seed and the growing point of the plant are damaged, resulting in 'patchy' stands. Damage is most common in late-planted winter crops and early-planted summer crops, especially where crop residues have become scarce. During summer adults may damage young plants, especially navy beans and sunflower, by ringbarking or cutting at or below ground level. Damage by both larvae and adults necessitates replanting in many cases.

Control of larvae is by chemical applied to the seed at planting. Paddocks should be sampled to determine wireworm numbers before planting, as a guide to seed treatment. Control of adults is not practicable.

Natural enemies of pests

Parasites of common armyworm:

Braconid wasp *(Apanteles ruficrus* Haiiday)

Tachinid fly *{Goniophthalmus australis* (Baranov))

White pupal cocoons and adult of *Apanteles ruficrus* x 13

Adult *Goniophthalmus australis* x 6.5

Apanteles ruficrus is an important parasite of several armyworm species in Australia. These include the common armyworm, a serious pest of winter cereals, and the northern armyworm. Adult wasps oviposit in small armyworm larvae less than 1 cm long. After approximately 12 days of internal feeding the wasp larvae emerge by burrowing through the skin of their host. Each wasp larva then spins a white, silken cocoon from which the adult wasp subsequently emerges. Up to 30 wasps may develop in a single armyworm larva.

Goniophthalmus australis is a common parasite of armyworms but little is really known of its importance. Large numbers of tiny eggs are laid by the fly on cereals and grasses on which armyworms feed. The eggs hatch in the gut of the armyworm and the resulting larvae feed on the host tissue. When mature the parasites leave the host, which usually dies soon after, and pupate in the soil. The life cycle of the parasite is probably 4 to 5 weeks in spring. In addition to armyworms many other species of moth larvae are parasitized.

COTTON

Major pests

Bollworms and budworms:
- *Corn earworm *(Heliothis armiger* (Hiibner))
- *Native budworm (*Heliothis punctiger* Waliengren)
- *Pinkspotted bollworm (*Pectinophora scutigera* (Holdaway))
- *Rough bollworm *(Farias huegeli* Rogenhofer)

Minor pests

Cluster caterpillar *(Spodoptera litura* (Fabricius))
*Cotton aphid *(Aphis gossypii* Glover)
Cotton harlequin bug *(Tectocoris diophthalmus* (Thunberg))
Cotton leafhopper *(Amrasca terraereginae* (Paoli))
Cotton leafperforator *(Bucculatrix gossypii* Turner)
*Cotton tipworm *(Crocidosema plebejana* Zeller)
Cotton webspinner *(Loxostege affinitalis* (Lederer))
Cutworms *(Agrotis* spp.)—see SUNFLOWER
Green mirid *(Creontiades dilutus* (Stal))
Green vegetable bug *(Nezara viridula* (Linnaeus))—see GRAIN LEGUMES
Loopers:
- Common cotton looper *(Anomis planalis* (Swinhoe))
- Cotton looper *(Anomis flava* (Fabricius))
- Tobacco looper *(Chrysodeixis argentifera* (Guenee))—see TOBACCO

Pale cotton stainer *(Dysdercus sidae* Montrouzier)
Redshouldered leaf beetle *(Monolepta australis* (Jacoby))
Spur-throated locust *(Austracris guttulosa* (Walker))—see SORGHUM
Thrips:
- *Cotton seedling thrips *(Thrips tabaci* Lindeman)—see ONIONS also
- Plague thrips *(Thrips imaginis* Bagnall)

*Twospotted mite *(Tetranychus urticae* Koch)
Yellow peach moth *(Dichocrocis punctiferalis* (Guenee))—see MAIZE

*Illustrated.

Natural enemies of pests

Disease of cotton looper:
- *Nuclear polyhedrosis virus

Parasites of budworms:

Egg parasites:
- *Telenomus* spp.
- **Trichogramma* spp

} —wasps

Larval parasites:
- **Microplitis demolitor* Wilkinson
- *Orange caterpillar parasite *(Netelia produaa* (Brulle))
- Orchid dupe (*Lissopimpla excelsa* (Costa))
- Twotoned caterpillar parasite (*Heteropelma scaposum* (Morley))

} —wasps

- **Carcelia* spp.
- *Chaetophthalmus* spp.
- *Exorista* spp.
- *Goniophthalmus australls* (Baranov)
- *Winthemia* spp.

} —tachinid flies

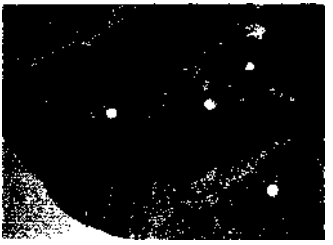
Predators:
- Assassin bug (*Coranus trabeatus* Horvath) —range of insects
- *Bigeyed bug *(Geocoris lubra* (Kirkaldy))—soft-bodied insects and mites
- Common brown earwig *(Labidura riparia iruncata* Kirby)—range of insects
- *Damsel bug *(Tropiconabis nigrolineqius* (Distant))—moth eggs and larvae
- Green lacewings *(Chrysopa* spp.)—eggs and soft-bodied insects
- *Poilen beetle *(Dicranolaius belhdus* (Guerin-Meneville))—range of insects
- Transverse ladybird *(Coccinella repanda* Thunberg)—cotton aphids —see LUCERNE
- Spiders:—budworm larvae
  - *Flower spiders *(Diaea* spp.)
  - *Wolf spiders *(Lycosa* spp.)
  - Yellow nightstalking sac spider *(Chiracanthiwn mordax* L. Koch)

* Illustrated

COTTON

Corn earworm (*Heliothis armiger* (Hiibner))

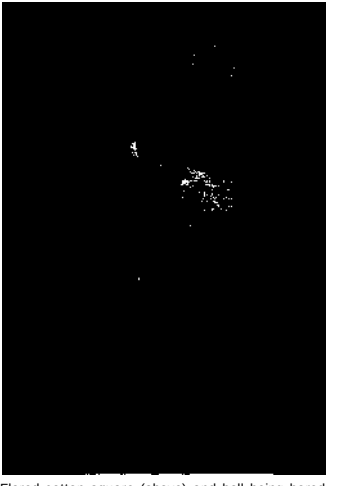
Native budworm (*Heliothis punctiger* Wallengren)



Eggs of budworms x 4

Moth of corn earworm (left) and native budworm (right) x 1.5

Variations in appearance of mature larvae of corn earworm x 1.5



Flared cotton square (above) and boll being bored by budworm larva (below)

COTTON

Corn earworm *(Heliothis armiger* (Hubner))

Native budworm *(Heliothis punctiger* Wallengren)

Corn earworm and native budworm are very similar in appearance, habits and life cycle. The pearly-white eggs of both species are alike and so are their young larvae. Large corn earworm larvae, up to 4 cm long when mature, vary in colour from light green to brown. Dark specimens have two pairs of distinctive black markings on the back above the front legs and a third pair at the tail. These markings are usually faint or absent in the native budworm and the larvae vary in colour from pale to dark green. The moths also differ in markings on the wings. Newly emerged corn earworm moths have a distinct kidney-shaped spot in the middle of the forewing, whereas this is diffuse in the native budworm. The dark bands on the hind wings are also distinctive: the corn earworm has a pale patch in the middle of this band towards the edge of the wing, whereas the native budworm does not.

Eggs hatch in 3 to 5 days in summer, the dark head capsule of the larvae becoming visible inside just before hatching. Larval development takes 14 to 21 days. Mature larvae pupate at a depth of 5 to 10 cm in the soil and moths emerge 15 to 20 days later. The moths feed on nectar before pairing and the females begin to lay eggs when 3 to 6 days old. As many as 1500 eggs may be laid by a female over a 14 day period, with peak egg laying at about 7 days.

In cotton the eggs are commonly laid near the tips of the plant. Young larvae feed at first on nearby leaves and then on the flower buds (squares). The bracts of damaged squares flare open after about 2 days. Older larvae bore into the young bolls and feed inside. Apart from direct damage this allows the entry of rots. Egg laying can occur throughout most of the growing season with populations of native budworm predominating prior to first flower.

COTTON

Pinkspotted bollworm *(Pectinophora scutigera* (Holdaway))

Pinkspotted bollworm larva in damaged cotton boll x 12

The moth flies at night and lays very small, cream-coloured eggs which hatch in about 3 days. The larvae bore into green bolls and to a lesser extent into squares. They mature and pupate in the bolls, the life cycle taking 4 to 6 weeks.

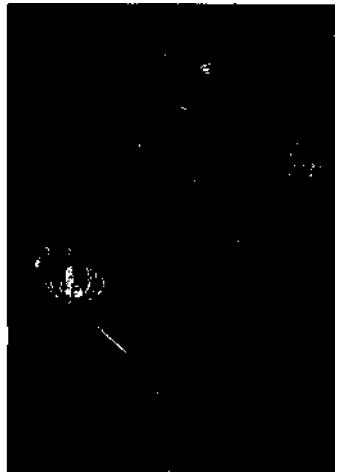
Pinkspotted bollworm only occurs in central Queensland and is a significant mid to late season pest. Cotton is the main host and the larvae overwinter in unharvested bolls and crop residues.

Cultural control methods such as the elimination of ratoon or standover cotton, the slashing and burial of crop residues during winter, followed by irrigation, greatly reduce the numbers of overwintering larvae. Careful scouting of green bolls is essential if insecticidal control is to be effective.

COTTON

Rough bollworm (*Earias huegeli* Rogenhofer)

Rough bollworm larva in damaged cotton boll x 3



Alternative host plant of rough bollworm, *Hibiscus trionum* x 0.5

Rough bollworms may attack cotton throughout the life of the crop. The most severe damage occurs when the larva penetrates the green boll. This results in the direct loss of *one* or two locules of cotton but, by allowing entry of bollrotting organisms, may also result in the total loss of the boll. When a square or young boll is attacked, the fruit form is invariably shed by the plant. Rough bollworms also bore into plant terminals and in young seedlings this damage may cause the death of the plant. Later damage to terminals causes the plant to branch and may delay crop maturity.

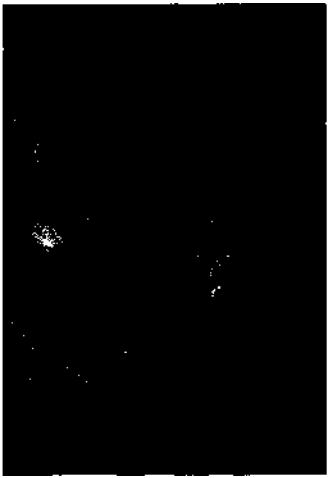
Rough bollworm can be particularly troublesome in cotton planted in recently-cleared bushland and newly-developed irrigation areas. The reason for this is the abundance of its wild host, the bladder ketmia *(Hibiscus trionum),* in these areas, which results in the development of large populations of the pest. Considerable reduction in numbers of rough bollworm can be achieved by cultural methods. These include destroying bladder ketmia in and around the crop, destroying volunteer cotton plants outside the crop area and disposing of crop residues by slashing and ploughing as soon as possible after harvest.

COTTON

Cotton aphid *(Aphis gossypii* Glover)

Cotton tipworm *(Crocidosema plebejana* Zeller)

Cotton plant covered in honeydew and sooty mould resulting from aphid infestation



Cotton tipworm (right); damaged tip (left) x 2

The cotton aphid is 1 to 2 mm long and varies in colour from pale to dark green. Adults are either winged or wingless. Winged forms invade cotton and establish colonies at any time during crop growth. The aphid can be troublesome during the seedling stage when its feeding may result in plants being stunted. At the boll-opening stage the honeydew produced by the insect and the associated fungal moulds can foul the cotton lint. In addition to lowering quality this later infestation results in difficulties in harvesting.

Cotton aphid has a number of predators such as ladybeetles and lacewings but these are usually eliminated in cotton by insecticide sprays applied to control pests.

The adult moth is grey-brown, 10 to 12 mm long, and lays eggs singly against the veins of the small terminal leaves. The larvae may kill seedling plants but more commonly the damage they cause to the terminal shoot results in secondary branching and consequent delay in maturation of the plant. This delay may be important on the Darling Downs and at St. George because the short growing season prevents compensation by the plant. It is not important under the warmer, extended crop growing conditions in central Queensland. Infested terminals usually have some webbing associated with the damage. The larval stage lasts 2 to 3 weeks and the pupa is formed in a silken shelter on the terminal shoot.

COTTON

Cotton seedling thrips *(Thrips tabaci* Lindeman)

Twospotted mite *(Tetranychus urticae* Koch)

Seedlings damaged by thrips x 0.7

Cotton leaves showing damage by twospotted mite

Cotton seedling thrips are the most common of a number of thrips species found on cotton. Infestations may occur at any stage of the crop but are only important on seedlings. Damage at this stage may result in loss of vigour or death of the terminal shoot followed by unwanted branching of the plant. Such damage is most severe when growth is slowed down by cold weather or dry conditions, but even then the seedlings rarely die. The infestations in seedling cotton result from thrips which have multiplied on numerous weeds during spring.

The insect is readily controlled in cotton by insecticide sprays.

Infestations of twospotted mites in cotton begin at the base of the main leaf veins and spread rapidly over the leaf. Sucking of the tissues results in leaf mottling and yellowing and in depressed growth of the plants. As the severity of the attack increases the leaves wilt and then die and fall. Early infestation results in loss of yield. Infestation when the crop is near maturity may be an advantage since the resulting defoliation facilitates harvesting.

The mite problem is often induced by excessive use of insecticides against other cotton pests since this kills natural enemies of twospotted mite and thereby allows its numbers to increase.

COTTON

Natural enemies of pests

General predator: Pollen beetle (*Dicranolaius bellulus* (Guerin—Meneville))

Disease of cotton looper: Nuclear polyhedrosis virus

Pollen beetle x 12

Cotton looper larva killed by nuclear polyhedrosis virus x 4

The pollen beetle is a small, red and blue insect which is well known as a general predator. All stages of the life cycle are found in the soil, although the adults are often seen actively searching over the plant by day. Apart from feeding on pollen, the adults are also carnivorous and will eat eggs and small caterpillars of budworms and feed on many other slow-moving pests. Numbers of the predator in cotton vary greatly.

Disease only breaks out if larvae are numerous. Normally, numbers of cotton looper larvae are kept at low levels because of regular spraying carried out on cotton against other insects.

Virus-infected larvae turn pale and subsequently die. They are frequently found on the foliage hanging by their pro-legs to form an inverted V. The skin has by this time darkened and become fragile and it readily ruptures to release the virus-laden fluid contents of the body. The disease spreads to other larvae when they eat contaminated foliage.

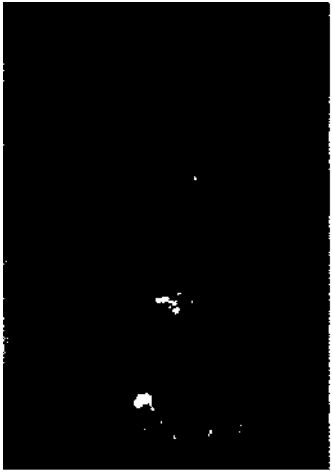
COTTON

Natural enemies of pests

Parasites of budworms:

Egg parasite: *Trichogramma* sp.

Larval parasite: Orange caterpillar parasite *(Netelia producta* (Brulle))



Trichogramma wasp on budworm egg x 100

Orange caterpillar parasite x 3

Trichogramma sp. is an egg parasite of several insect pests including budworms. Up to three parasite eggs may be laid in that of the host. The subsequent development of the immature stages of the parasite takes place in the egg of the host and the adults emerge after 8 to 12 days.

The natural incidence of this parasite and related species is often low in cotton and they are readily killed by insecticides. In unsprayed cotton mortality of budworm eggs from parasitism may be as high as 60 to 80%, but this is insufficient for control. Mass rearing and release programmes for *Trichogramma* have been tried both locally and overseas, but with limited success.

The orange caterpillar parasite occurs widely throughout Asia, Australia and New Zealand. The adult is about 18 mm long, red-brown and with a flattened abdomen and long legs. It is attracted to light at night, sometimes in large numbers.

The egg of the parasite is attached to the caterpillar host by a stalk and may be already hatched at the time of laying. The parasite larva attaches itself to the outside of the caterpillar but does not develop until after its victim has pupated.

The incidence of the parasite varies considerably in the crop and from one cotton season to another. It is severely affected by insecticides.

COTTON

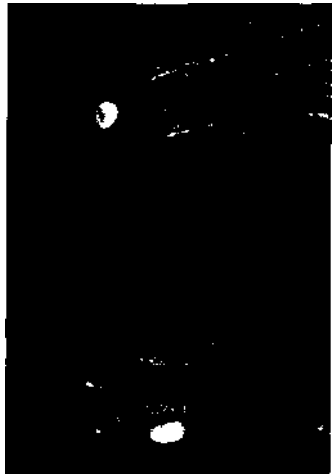
Natural enemies of pests

Parasites of budworm larvae:

Wasp *(Microplitis demolitor* Wilkinson)

Tachinid fly *(Carcelia* sp.)

Microplitis pupa and adult (centre and right), parasitized corn earworm larva (left) x 6



Eggs of tachinid fly on corn earworm larvae x 7

Microplitis demolitor is a relatively small wasp which lays its eggs in young larvae of budworms and several other noctuid pest species. The host larva usually stops feeding 6 days later and shortly after that a grey, slightly curved parasite larva, 5 mm long, will emerge from the side of the host, form a cocoon and pupate. The host larva will continue to live after the parasite has pupated but dies at about the same time as the adult parasite emerges one week after forming the cocoon. Wnen cooler temperatures prevail, the larval parasite may enter a resting stage (diapause) in the cocoon. Oviposition by the female wasp commences within 24 hours of emergence from the cocoon.

Usually, the parasite is not highly-active in cotton but it is very common in tobacco at Mareeba in north Queensland.

In general, levels of parasitism by tachinid flies are low. The eggs or newly hatched larvae are affixed to the body of the host caterpillar, usually on or near the head, the parasite larva subsequently entering the body of its host and feeding inside. When mature, the parasite larva pupates outside the host in a typical fly cocoon.

COTTON

Natural enemies of pests

Predators:

Bigeyed bug *(Geocoris lubra* (Kirkaldy))

Damsel bug *(Tropiconabis nigrolineatus* (Distant))

Bigeyed bug x 10

Damsel bug x 5

Bigeyed bugs range in length from 3 to 5 mm and are grey to dark tan and characterized by their large eyes. The cylindrical, white eggs are laid singly on the terminals and under leaves. The nymphs resemble the adults but are wingless and more robust. Both these stages move rapidly over the vegetation and will fall from the plant when disturbed.

This day-feeding species is an important predator of eggs and young larvae *of* budworms as well as of other soft-bodied insects and of mites. Numbers usually build up early in the season, reaching a peak in midsummer.

The cosmopolitan damsel bug ranges in length from 8 to 12 mm and is tan or grey. The slender body tapers towards the head which possesses a pronounced beak. Eggs are laid singly into the soft tissues of the plant and are marked by the flat, circular emergence cap which protrudes from the plant surface. Nymphs resemble adults but are smaller and lack wings.

Damsel bugs feed on a variety of hosts, including budworms, aphids, jassids and spider mites. They can generally be found in cotton and are most abundant in late summer, often in response to a build up of larvae in the crop.

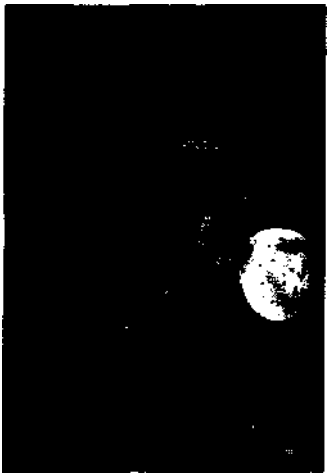
COTTON

Natural enemies of pests

Predators:

Flower spider *(Diaea* sp.)

Wolf spider *(Lycosa* sp.)



Flower spider x 8

Wolf spider x 2.3

Diaea spp. are the most common of several groups of flower spiders. They are brightly coloured, the abdomen being frequently cream or yellow and the thorax and legs green. The first two pairs of legs are bigger than the hind two pairs and are used to catch small insects attracted to the pollen and nectar of the flowers. *Diaea* spp. do not spin a web. The egg sac is found on the underside of the leaves and is usually covered by a silken shelter.

Wolf spiders are common and are small to medium-sized. They arc grey to brown and are often strikingly patterned in black, brown, grey or orange. The female carries the egg sac behind the abdomen, attached by silken threads to the spinnerets. When the spiderlings hatch, they ride for a time on the back of the female before assuming separate existence.

The group commonly found in cotton, *Lycosa* spp., make a burrow in the soil into which they can retreat. They are essentially ground foragers but will also attack caterpillars high on the cotton plant. *Lycosa* are most easily seen during crop growth before the cotton canopy closes over the ground.

DUBOISIA

Major pests

*Black scale *(Saissetia oleae* (Olivier))
*Duboisia leaf beetle (*Psylliodes parilis* Weise)
*Large leafeating ladybird *{Henosepilachna guttatopustulata* (Fabricius))
*Sandal-box hawk moth *(Coenotes eremophilae* (Lucas))

Minor pests

Cluster caterpillar *(Spodoptera litura* (Fabricius))—see TOBACCO
Cutworms *(Agrotis* spp.)—see SUNFLOWER
Painted apple moth *(Tela anartoides* Walker)

Natural enemies of pests

Parasite of black scale:
Scutellista cyanea Motschulsky—wasp
Parasites of large leafeating ladybird:
Pediobius sp.
Uga colliscutellum (Girault) } —wasps
Predator of large leafeating ladybird:
*Striped ladybird *{Micraspis frenata* (Erichson))

*Illustrated

DUBOISIA

Black scale *{Saissetia oleae* (Olivier))

Sandal-box hawk moth *(Coenotes eremophilae* (Lucas))

Black scale on stalk

Sandal-box hawk moth larvae on defoliated Duboisia x 0.7

Scale-infested trees become covered in sooty mould and twigs die. Scales of the first generation after winter mature in September and there are at least two generations during the course of the year. Parasites are effective in control, except where there is interference through the excessive use of insecticides to control Duboisia leaf beetle. Ants attending the scale for honeydew also tend to reduce control by parasites and are best excluded by a spray of residual insecticide to the lower trunk of the tree.

Moths lay their eggs on the foliage during March-April. Usually less than 5% of trees arc affected but large numbers of larvae can occur on individual trees. When this happens all the foliage and the young shoots are eaten.

DUBOISIA

Duboisia leaf beetle *{Psylliodes parilis* Weise)

Large leafeating ladybird *{Henosepilachna guttatopustulata* (Fabricius))

Duboisia leaf beetles on damaged leaf x 3

Adult and larvae of large leafeating ladybird and damage x 3

Adults feed on the foliage, peppering the leaves with numerous holes. Where the infestation is severe more than 20% of the leaf area can be destroyed. Damage is also caused to the growing points of the shoots. During summer the life cycle from egg to adult takes about 6 weeks. Eggs are laid singly or in small groups in the soil surface under the canopy of the tree. The larval and pupal stages are completed in the soil. Adults tend to emerge in waves and move up to feed on the young foliage. Most activity occurs in the warmer months but damage can also occur during winter.

Both adults and larvae eat the leaf surface leaving only a fine transparent skin between the lace-like pattern of veins. All the leaves on a tree are rapidly damaged if the infestation is heavy. The life cycle from egg to adult takes 5 to 8 weeks depending on the time of year. The yellow, spindle-shaped eggs are laid in clusters on the lower surface of the leaf. After moulting three times the larvae are full-grown and form dark brown pupae attached to the twigs or trunk. Worst infestations occur during summer and may require chemical control measures.

DUBOISIA

Natural enemies of pests

Parasite of black scale: Wasp {*Scutellista cyanea* Motschulsky)

Predator of large leafeating ladybird: Striped ladybird (*Micraspis frenata* (Erichson))

Black scale showing emergence holes of *Scutellista cyanea* x 2

Adults and larva of striped ladybird, predator of large leafeating ladybird x 9

The adult is a small blue wasp about 2 mm long. It lays its eggs beneath the scale covering of mature black scales and the parasite larvae feed on the eggs of the host. Sometimes several parasites develop in the one scale. The life cycle is complete after about 6 weeks and the adult parasite eats an exit hole in the top of the scale. Over 80% parasitism occurs and the parasite can exert satisfactory-control. However, excessive use of insecticides is detrimental. Ant populations must be reduced since they disturb the parasite during egg laying and reduce its effectiveness.

The adults and larvae feed on many insects including leafeating ladybirds and also on pollen. Partly because of this diversity of feeding they do not prevent damage by the large leafeating ladybird but they do help, together with other natural enemies, in keeping its numbers down.

Adult striped ladybirds survive unfavourable conditions, such as winter, in a dormant state. Before going into dormancy they often come together in large numbers in a small area, sometimes on a single tree. Colonies of the dormant ladybirds may be found in a variety of situations such as on sand dunes, in timbered areas or even in buildings.

GRAIN LEGUMES (navy beans, soybeans, mung beans, chickpeas, cowpeas, pigeon peas)

Major pests

*Bean fly *{Ophiomyia phaseoli* (Tryon))
*Bean podborer *{Maruca testulalis* (Geyer))
*Bean spider mite *{Tetranychus ludeni* Zacher)
Budworms:
*Corn earworm *{Heliothis armiger* (Hübner))
Native budworm *{Heliothis punctiger* Wallengren)
*Green vegetable bug *{Nezara viridula* (Linnaeus))

Minor pests

Jassids:
Lucerne leafhopper *(Austroasca alfalfae* (Evans))
Vegetable jassid *{Austroasca viridigrisea* (Paoli))
} —see LUCERNE
Loopers:
Green looper (*Chrysodeixis eriosoma* (Doubleday))
*Soybean looper *(Diachrysia orichalcea* (Fabricius))
*Lucerne crownborers:
Corrhenes stigmatica (Pascoe)
Zygrita diva Thomson
Lucerne seed web moth (*Etiella behrii* (Zeller))—see PEANUTS
*Podsucking bug *(Riptonus serripes* (Fabricius))
Redbanded shield bug *(Piezodorus hybneri* (Gmelin))
Soybean moth *(Stomopteryx simplexella* (Walker))
Spur-throated locust *(Austracris guttulosa* (Walker))—see SORGHUM

Natural enemies of pests

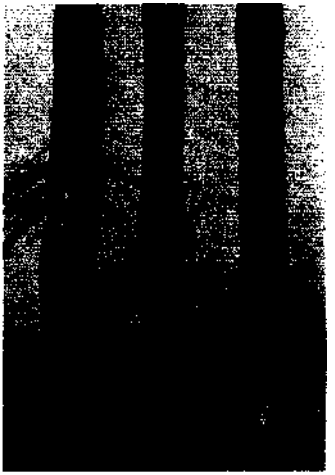
Diseases of corn earworm and loopers:
*Caterpillar fungus *(Nomuraea rileyi* (Farlow))
Nuclear polyhedrosis virus disease—see SORGHUM
Parasites of budworms—see COTTON
Parasite of green vegetable bug:
**Trissolcus basalis* (Wollaston)
Predators of moth eggs and caterpillars:
Predatory shield bugs:
Cermatulus nasalis (Westwood)
Oechalia schellenbergii (Guérin-Méneville)
Damsel bug *(Tropiconabis nigrolineatus* (Distant))
For additional predators see COTTON

* Illustrated

GRAIN LEGUMES

Bean fly *(Ophiomyia phaseoli* (Tryon))

Egg-laying punctures of bean fly on leaf x 3



Stems damaged by bean fly (centre and left); undamaged stem (right)

The bean fly is shiny black and about 2.5 mm long. The females lay very small eggs into the upper side of the leaf, the sites being marked by punctures. The maggot eats its way along the leaf tissues into the leaf stalk and down into the lower stem where it pupates near the surface layers. During warm weather the life cycle from egg to adult takes about 3 weeks.

A severe attack on young plants may cause them to wilt and die. On older plants the epidermis of the stem cracks open near ground level and adventitious roots can develop at or above the damaged section. The yield and vigour of the plant is reduced and affected plants are susceptible to lodging and mechanical or wind damage.

Bean fly is important only during summer months and when successive planting of susceptible crops in an area allows large populations to build up. In inland areas populations of bean fly die out during the winter and infestations in the main crop of navy beans and mung beans in those areas are normally not a problem. By contrast, in coastal areas bean fly survives the milder winter and infestations are more of a problem there, especially on cowpeas grown for seed. Soybeans are rarely infested. Chickpeas are not attacked. Bean fly is a major pest of many pasture legumes grown for seed in north Queensland.

GRAIN LEGUMES

Bean podborer *(Maruca testulalis* (Geyer))

Young podborer feeding on bean flower x 10

Podborer in damaged pod x 8

Adults of the bean podborer are slim-bodied moths with a wing span of approximately 25 mm. The forewings are yellowish-brown with several translucent spots while the hind wings are mostly devoid of scales except for the brownish fringes. Moths are active at night but shelter within the plant canopy during the day.

Crops are invaded at the beginning of flowering. The larvae feed on the buds and flowers and bore into the pods to eat the developing seeds. The flowers and pods are bound together by frass-covered web produced by the larva. Frass is frequently extruded as a plug from the hole made by the older larva when it bores into a pod. The larvae grow to 18 mm long and are yellowish-green with several rows of dark marks. Mung beans, cowpeas and pasture legume seed crops can be severely damaged. Navy beans and soybeans are two of the less preferred hosts but occasional serious outbreaks do occur.

GRAIN LEGUMES

Bean spider mite *(Tetranychus ludeni* Zacher)

Soybean looper *(Diachrysia orichalcea* (Fabricius))

Bean spider mites and eggs x 21

Soybean looper x 2.5

Adults are up to 0.5 mm long and their spider-like appearance can just be made out with the naked eye. The mites feed on the underside of the leaf and damage is seen as a mottling in the leaf colour. Severely affected leaves become yellow and fall from the plant. The life cycle is brief, about 11 days in summer. The rapid build up in numbers which occurs during periods of hot dry weather is accentuated when broad-spectrum insecticides are used as these destroy predators.

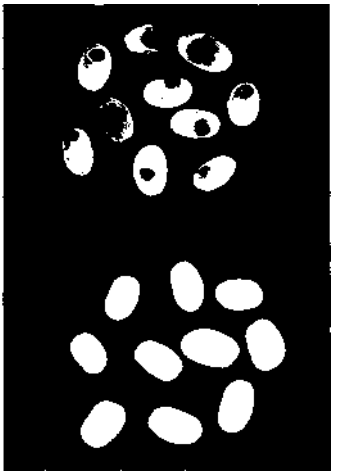
Mites are not a problem in inland navy bean and soybean areas but can be a problem in these crops when grown in the Lockyer Valley.

Soybean loopers are foliage feeders and are characterized by their 'looping' form of movement. The caterpillar is green with light-coloured stripes and grows to 38 mm long. The adults have a wing span of 35 mm and a shiny golden area on the forewings. The soybean looper can occur on both soybean's and navy beans. It caused major losses in soybeans when it first appeared in Australia in 1977 but has been a minor pest since that time. The plain green larvae of the green looper also occur in these crops but rarely cause economic damage.

GRAIN LEGUMES

Corn earworm *(Heliothis armiger* (Hübner))

Young corn earworm on navy bean flower x 6



Bean seeds damaged by corn earworm (above); undamaged seeds (below)

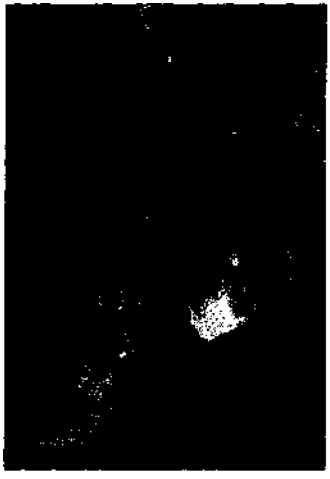
The corn earworm is an important pest of navy beans, soybeans and pigeon peas. Crops are invaded by adults at the commencement of flowering and the peak of egg laying usually coincides with peak flowering. White, spherical eggs are laid on terminals, buds, petioles, stems and leaves; the larvae feed on leaves, flowers and developing seeds in the pods. During summer the life cycle takes 5 to 7 weeks. Only one generation is usually completed in any one bean crop.

Damage to pods and seeds reduces yield. On navy beans good control of corn earworm is particularly important since high quality is demanded for canning. During a wet harvest water enters the feeding holes and stains undamaged seed.

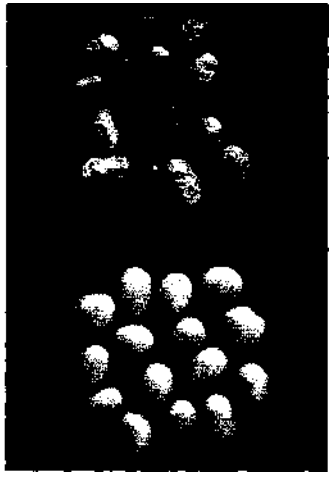
The closely related native budworm can infest soybean crops during the early growth stages. It feeds on terminals and leaves. The terminal damage can cause excessive branching which results in pod set being lower on the plant and consequent difficulties in harvesting. Chickpeas are attacked in the green-pod stage during early spring and spraying may be necessary to prevent loss of crop.

GRAIN LEGUMES

Green vegetable bug (*Nezara viridula* (Linnaeus))



Adults and nymphs of green vegetable bug on beans x 2



Damaged seed (above); undamaged seed (below)

The green vegetable bug is an important pest of summer-grown grain legumes. The females deposit rafts of 20 to 150 eggs on the lower surface of leaves. The nymphs are initially orange-brown. As they grow they develop black, yellow and red patterns but green predominates in later instars. The life cycle takes about 5 weeks in summer. Both the juvenile and adult stages feed by piercing and sucking the developing bean seeds. This causes young seeds to abort and partly grown seeds to shrivel. Fully expanded seed exhibits a black spot in a depressed area at the puncture point. Bug feeding reduces yield and quality. The loss of quality from bug infestation is particularly important in navy beans.

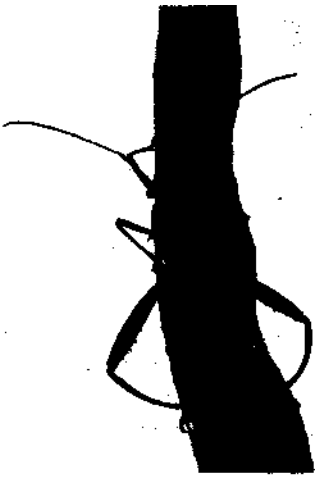
Bug populations are very patchy, so thorough crop inspections are important. A large proportion of bugs move to the top of the canopy and 'bask' in the sunlight between 7 a.m. and 9 a.m. Crop inspections are best done at that time.

GRAIN LEGUMES

Lucerne crownborers *{Corrhenes stigmatica* (Pascoe), and *Zygrita diva* Thomson)

Podsucking bug *(Riptortus serripes* (Fabricius))

Adults of two species of borer: *Corrhenes stigmatica* x 3 (above); *Zygrita diva* x 3.5 (below)



Adult podsucking bug x 3

Lucerne crownborers are the larvae of small longicorn beetles, characterized by long antennae. The most common species is *Zygrita diva*. The adult is about 14 mm long, coloured grey-brown to light orange and may or may not have black markings. It has long, black antennae. The larvae grow to 13 mm long and are white and elongate with deep constrictions between the body segments. There appears to be only one full generation per year on soybeans in southern Queensland. The adults lay eggs into soybean stems from early summer to midsummer. The larvae tunnel within the pithy sections of the stem. When full-grown they excavate an overwintering chamber in the stem just below ground level. As the larva excavates this chamber it can 'ring-bark' the stem from within, causing premature plant death.

The other grain legumes are not normally attacked.

Podsucking bugs are about 16 mm long with an elongate body and long legs. They are predominantly brown with a yellowish stripe along each side of the body. The podsucking bugs are very active in the crop, running and flying when disturbed. While the green vegetable bug is the main pest of grain legumes, the podsucking bug can occasionally occur in sufficient numbers to cause economic damage.

GRAIN LEGUMES

Natural enemies of pests

Caterpillar fungus *(Nomuraea rileyi* (Farlow))

Green vegetable bug parasite (*Trissolcus basalis* (Wollaston))

Corn earworm larvae affected by caterpillar fungus x 2.5

Adult *Trissolcus basalis* on egg raft of green vegetable bug x 40

Affected larvae become stiff and are anchored to the plant by fungal threads. Later, they are completely covered in white fungus which produces a velvety, green layer of spores under moist conditions. These spores infect other larvae and other species of insects by producing fungal threads which penetrate their bodies.

Moist conditions favour the fungus and it tends to be more effective on crops with dense leaf cover, such as soybeans. Apart from corn earworm, high mortality can be caused under these conditions to armyworms, cluster caterpillars and loopers in the crop.

Trissolcus basalis is an introduced parasite which has significantly reduced populations of the green vegetable bug in coastal areas of Queensland.

The female wasp lays its eggs into those of the green vegetable bug and during the subsequent development of the parasite the entire contents of the host eggs are consumed. The adult parasite bursts out of the top of the bug egg after a life cycle of about 12 days during warm weather. The short life cycle is of value to the parasite in suppressing green vegetable bug since it can complete almost three generations in the time taken by its host to complete one generation.

LINSEED

Major pests

*Native budworm *(Heliothis punctiger* Wallengren)

Minor pests

Corn earworm (*Heliothis armiger* (Hübner))—see COTTON
Cutworms:
Bogong moth (*Agrotis infusa* (Boisduval))
and other *Agrotis* spp.—see SUNFLOWER

Natural enemies of pests

Parasites of native budworm:
Heteropelma spp.
Microplitis spp.—see COTTON
Trichogramma spp.—see COTTON
—wasps
Carcelia spp.—see COTTON
Chaetophthalmus spp.
Exorista spp.
—tachinid flies

*Illustrated.

LINSEED

Native budworm *(Heliothis punctiger* Wallengren)

Heads of linseed damaged by native budworm larvae x 2.5

The native budworm is the important species of *Heliothis* damaging linseed in southern Queensland but another species, the corn earworm, also occurs on the crop. Since the larvae are very similar it is necessary to have the adult moths, which show clear differences, to be sure of the species involved.

Infestations in linseed begin in September with moths which emerge from overwintering pupae in the soil. These newly emerged moths are attracted to linseed crops at the time of flowering and lay their white, ribbed eggs on the flowers and developing fruit capsules. The newly emerged larvae feed mainly on the flowers and later on the linseed 'bolls', rarely causing damage to the leaves or stems. During its development one larva may feed on several 'bolls'. The larva may be readily recognized by its habit of partially burrowing into the fruit capsules leaving the hind part of its body exposed.

Regular inspection of the crop is recommended to detect infestation before extensive damage has occurred and to time insecticide application so as to obtain maximum benefit.

LUCERNE

Major pests

Aphids:
- *Bluegreen aphid *(Acyrthosiphon kondoi* Shinji)
- *Spotted alfalfa aphid (*Therioaphis trifolii* (Monell) f. *maculata)*

*Lucerne leafhopper *(Austroasca alfalfae* (Evans))

*Lucerne leafroller *(Merophyas divulsana* (Walker))

Minor pests

Cutworms *(Agrotis* spp.)—see SUNFLOWER

Pea blue butterfly *(Lampides boeticus* (Linnaeus))

Lucerne crownborer *(Zygrita diva* Thomson)—see GRAIN LEGUMES

Lucerne seed web moth *(Etiella behrii* (Zeller))—see PEANUTS

*Native budworm (*Heliothis punctiger* Wallengren)—see COTTON also

Twospotted mite *(Tetranychus urticae* Koch)—see COTTON

* Vegetable jassid (*Austroasca viridigrisea* (Paoli))

Whitefringed weevil *(Graphognathus leucoloma* (Boheman))—see PEANUTS

*Pea aphid *(Acyrthosiphon pisum* (Harris))

Natural enemies of pests

Disease of aphids:
- **Entomophthora* fungus

Disease of native budworm:
- Nuclear polyhedrosis virus

Parasite of spotted alfalfa aphid:
- **Trioxys complanatus* Quilis

Predators of aphids:
- *Brown lacewing *(Micromus tasmaniae* Walker)
- Common spotted ladybird *(Harmonia conformis* (Boisduval))
- Maculate ladybird *(Harmonia octomaculata* (Fabricius))
- Transverse ladybird *(Coccinella repanda* Thunberg)

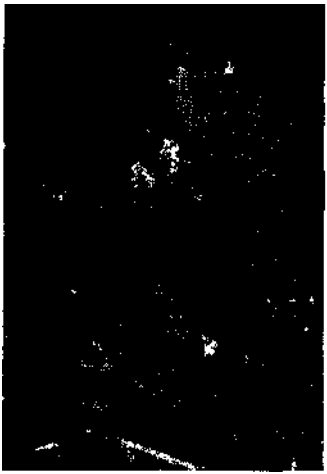
Predator of caterpillars:
- Damsel bug *(Tropiconahis nigrolineatus* (Distant))—see COTTON

* Illustrated

LUCERNE

Bluegreen aphid *(Acyrthosiphon kondoi* Shinji)

Lucerne leafroller *(Merophyas divulsana* (Walker))



Bluegreen aphid colony x 5

Lucerne leafroller damage to terminal leaves

The aphid varies from green-grey to green-blue and the adult is 2 to 3 mm long. Infestations are usually found on the upper part of the plant. Highest populations occur during autumn-winter and are reduced dramatically in spring.

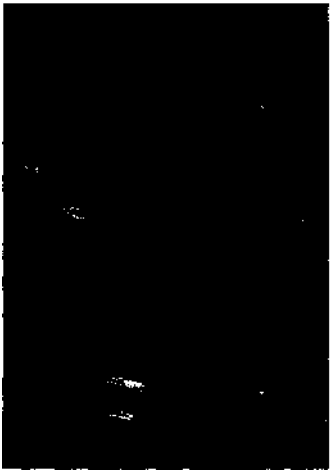
The insects suck sap from the plants and the symptoms of damage include misshapen and yellowed leaves and stunting of the plants. Regrowth is slowed down and continuing infestations eventually kill established plants. Seedlings are much more susceptible and are readily killed.

The adult leafroller is a small, yellowish moth which lays clusters of scale-like eggs on the upper surface of the leaf. The larvae are greenish with a black head. They web and roll the leaves at the tip of the shoot and skeletonize the leaves from within the roll. After 4 to 5 weeks the pupa is formed in the leaf roll and this stage lasts about 1 week in summer.

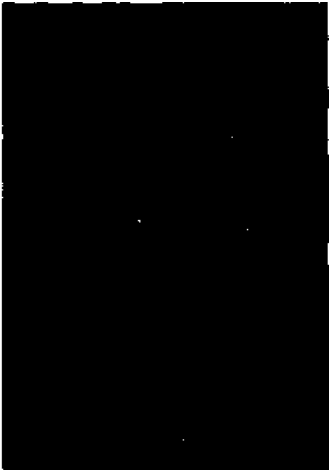
The insect can be a severe pest during warm dry conditions when the extended period between cutting allows populations to build up.

LUCERNE

Spotted alfalfa aphid *(Therioaphis trifolii* (Monell) f. *maculata)*



Spotted alfalfa aphid colony on leaf x 13



Veinal chlorosis of leaf caused by spotted alfalfa aphid

The spotted alfalfa aphid differs from the bluegreen aphid in being yellowish and having rows of spots across the body. It is normally found on the underside of the lower leaves, whereas the bluegreen aphid usually infests the upper part of the plant. Seedlings of susceptible lucerne varieties are killed rapidly by spotted alfalfa aphid which sucks the sap from the veins and injects a toxin into the plant. The first sign of damage is a yellowing or whitening of the leaf veins (veinal chlorosis). Populations can develop rapidly and as they increase the lower leaves yellow and fall. After a spotted alfalfa aphid attack, regrowth is retarded. Infestations thin stands, lower production and reduce root reserves. Stand life is further shortened by increased susceptibility to disease and to invasion by weeds. These aphids secrete a sticky honeydew making all aspects of harvesting difficult. Many lucerne varieties are available with a high level of resistance to the spotted alfalfa aphid. Native predators and an introduced parasitic wasp play an important part in the biological control of this aphid.

LUCERNE

Lucerne ieafhopper *(Austroasca alfalfae* (Evans))

Vegetable jassid *(Austroasca viridigrisea* (Paoli))

Adults of lucerne leafhopper x 9

Vegetable jassid leaf-stippling damage x 3

Adult lucerne leafhoppers are about 3 mm long and have the distinctive habit of jumping or moving sideways over the edge of the leaf when disturbed. Eggs are inserted into the plant. The life cycle takes 2 to 3 weeks in summer and the pest is generally most prevalent during the late summer-autumn period. The nymphs and adults feed on the sap-conducting system and also inject a toxin into the plant. The leaves become yellow and the plants are stunted. Conditions which favour lucerne leafhoppers are poor growing conditions for the crop, long intervals between harvests and spells of hot, dry weather.

The vegetable jassid is similar to the lucerne leafhopper but is slightly bigger and bright green. It also infests lucerne earlier in spring-summer. Feeding is by sucking the leaf cells which die leaving a white spot. Adjacent spots form the stipple pattern characteristic of vegetable jassid damage. In general, the insect cannot be regarded as economically important in lucerne since the crop can tolerate large numbers without loss of yield. Extremely high populations only occur during hot, dry weather when the crop is nearing harvest.

LUCERNE

Native budworm *(Heliothis punctiger* Wallengren)

Pea aphid *(Acyrthosiphon pisum* (Harris))

Plant damage with budworm larva feeding on the tip of the plant x 5

Pea aphid x 15

The native budworm generally attacks lucerne during spring and early summer. The larvae feed on the leaf but rarely cause serious damage since increasing populations are almost always wiped out by a nuclear polyhedrosis virus disease. Diseased larvae are soft and the fragile skin ruptures easily, releasing the fluid body contents over the plant. Outbreaks of the disease are common in spring and are readily recognized by the sticky body contents of affected larvae which stick to one's legs when walking through the crop.

The disease is spread rapidly as larvae eat parts of the plant contaminated by diseased individuals. Where the disease is evident chemical control is not warranted.

Pea aphid is about the same size as the bluegreen aphid and may be green, yellow or pink. It has long, conspicuous tubes (cornicles) on the abdomen and the antennae have dark bands. The adults may be winged or wingless and produce living young (nymphs) which are usually green.

Pea aphid causes damage which is similar to that of the bluegreen aphid. It differs from that pest in that it is more numerous in autumn and spring, rather than in autumn-winter. It also has a wider range of alternative host plants than does bluegreen aphid.

LUCERNE

Natural enemies of pests

Predators of aphids:

Brown lacewing (*Micromus tasmaniae* Walker)

Transverse ladybird *(Coccinella repanda* Thunberg)

Brown lacewing adult and larva feeding on aphid colony x 6.5

Adults and larva of transverse ladybird feeding on aphids x 6

The brown lacewing is an important aphid predator, but only one of a number in lucerne. During its development, which lasts about 1 week, the larva eats about 100 aphids, while the adult eats about three times that number in 10 days. The larvae feed by sucking the body contents of the aphid through large, curved jaws and the adults chew their prey.

The brown lacewing breeds at relatively low temperatures and can be found breeding readily in winter. Peak populations normally occur in spring.

Both the transverse ladybird and the maculate ladybird arc important predators of the bluegrccn and spotted alfalfa aphids. Transverse ladybird adults lay batches of bright yellow, spindle-shaped eggs near colonies of aphids. Both the larvae and the adults feed voraciously on these pests. When aphids are scarce in any locality, the ladybirds survive by eating other prey (for example the eggs and small larvae of budworms) and pollen, or they fly off in search of other aphid colonies. The adult transverse ladybird can be recognized by the V-shaped black mark on each wing cover, while the mature larvae have a yellow patch on each side just behind the head.

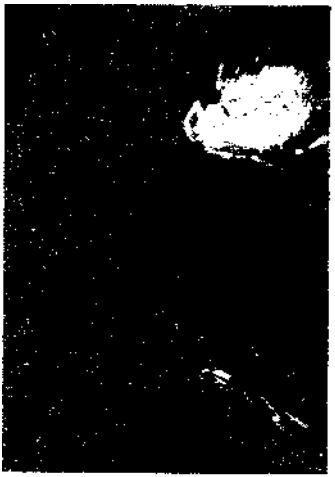
When the natural enemies do not control aphid numbers, insecticides should be used which do least damage to the ladybird populations.

LUCERNE

Natural enemies of pests

Parasite of spotted alfalfa aphid: *Trioxys complanatus* Quilis

Disease of aphids: *Entomophthora* Fungus



Parasitized mummy of spotted alfalfa aphid and adult *Trioxys complanatus* x 10

Bluegreen aphids affected by *Entomophthora* fungus x 5

This introduced wasp parasite is established in all areas of Queensland where the spotted alfalfa aphid is present and occurs even when host populations are low.

The adult wasp inserts an egg into the aphid and the parasite larva feeds on the body contents until they are consumed entirely. Pupation occurs in the expanded skin of the aphid (the mummy) and the adult wasp emerges by bursting this skin. The life cycle takes about 12 days.

Because of the value of this parasite in suppressing aphid populations care should be taken not to use insecticides which would seriously affect its numbers.

Infected aphids become swollen and discoloured and normally adhere to the underside of the leaves. They may be covered later with a velvety layer of fungal spores which are shot out and stick to other insects within range. The spores germinate and produce fungal threads which penetrate the body of the insect and thus repeat the cycle of infection.

Moist conditions resulting from rain, dew or irrigation, coupled with prolonged overcast cloud, favour the spread of the disease. Under these conditions heavy aphid populations can be reduced in as little as 2 weeks. The disease appears to be a major factor in the seasonal disappearance of bluegreen aphids in spring.

MAIZE

Major pests

Australian plague locust *(Chortoicetes termini/era* (Walker))—see SORGHUM
*Corn earworm *(Heliothis armiger* (Hubner))
*Dayfeeding armyworm *(Spodoptera exempta* (Walker))

Minor pests

*Black field earwig *(Nala lividipes* (Dufour))
Common armyworm *{Pseudaletia convecta* (Walker))—see CEREAL CROPS
Corn aphid *{Rhopalosiphum maidis* (Fitch))
Cutworms *(Agrotis* spp.)—see SUNFLOWER
False wireworms:—see CEREAL CROPS
Gonocephalum spp.
Pterohelaeus spp.
*Maize leafhopper *(Cicadulina bimaculata* (Evans))
Migratory locust *(Locusta migratoria* (Linnaeus))—see SORGHUM
Spur-throated locust *(Austracris guttulosa* (Walker))—see SORGHUM
*Yellow peach moth *(Dichocrocis punctiferalis* (Gucnce))

Natural enemies of pests

Diseases of army worms:
Entomophthora fungus—see LUCERNE
*NucIear polyhedrosis virus
Parasites:
Of common armyworm—see CEREAL CROPS
Of Australian plague locust:
Locust egg parasite *(Scelio* spp.)
Of corn earworm—see COTTON

"Illustrated

MAIZE

Corn earworm *(Heliothis armiger* (Hiibner))

Mature corn earworm inside damaged maize cob x 2.5

Egg-laying moths are attracted to the crop at the time of flowering and the eggs are laid mostly on the freshly-emerged silks of the cob. The eggs hatch in 3 to 4 days and the larvae move up the drying silk, through the throat and feed on the developing grains in the tip of the cob. Feeding is usually restricted to this tip area but occasionally larvae will move further down the cob before making their way out through the husk. Fully-grown larvae pupate in small cells about 3 cm below ground.

In general, chemical control measures are not required in maize but for sweet corn an extensive control programme is necessary in order to meet strict marketing standards.

MAIZE

Dayfeeding armyworm *(Spodoptera exempta* (Walker))

Maize plant with third instar larvae of dayfeeding armyworm causing damage x 1

Mature larva of dayfeeding armyworm killed by nuclear polyhedrosis virus x 3

The dayfeeding armyworm is important at times in north Queensland where it occurs between late December and March. Outbreaks follow good rains after a drought period and appear to be worse when the rains are late.

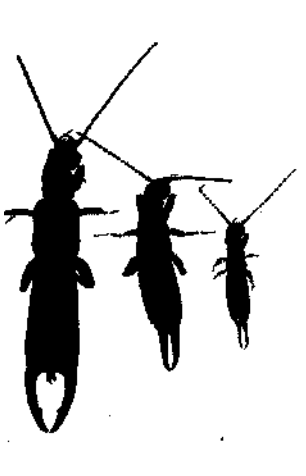
Eggs are laid by the night-flying moth in clusters of a few to about 400 eggs. The clusters are covered with the fawn-coloured hairs of the abdomen of the female and are found normally on the leaves of the young plants. Eggs hatch in about 3 days and the dark, striped larvae take about 3 weeks to mature. Damage to crops such as maize, sorghum and sugar-cane may not be noticed until the larvae are almost full-grown. Many grass species are attacked but couch seems to be especially favoured.

The larvae are subject to fungal and virus diseases. These normally become widespread only when large populations of larvae occur and they act too late to prevent serious damage by the pest. Larvae affected by nuclear polyhedrosis virus can be readily recognized. They hang in an inverted V from the plant and the skin is fragile and ruptures readily to release the body contents which have liquefied as a result of the disease.

Spraying is necessary on crops during outbreaks and effective control depends on early detection and prompt treatment.

MAIZE

Black field earwig (*Alala lividipes* (Dufour))



Black field earwig adult (left); nymphs (right) x 4.5

Black field earwig damage to maize seedlings

Earwigs are readily recognized by the pair of tough pincers at the end of the abdomen. Nymphs resemble adults but are wingless.

The pest lives in the soil and moves around in the upper few centimetres loosened by cultivation. The life cycle from egg to adult takes all summer. Numbers decrease during winter and surviving females lay their eggs in spring in batches of about 30 in the soil.

Black field earwig is a pest mainly in areas having heavy, black soils. It usually feeds on decaying stubble but also eats newly sown and germinating seed and the roots of crops. Control measures are indicated if the insect is seen in numbers at the time the land is being prepared for planting.

MAIZE

Maize leafhopper *{Cicadulina bimaculata* (Evans))

Leafhoppers on maize x 7

Wallaby ear of maize caused by maize leafhopper

Maize leafhoopers are small (3 mm), pale-coloured, active insects. They are common on maize, particularly in coastal districts, during late summer. When maize is not available they feed and multiply on various grasses. Eggs are laid into the host plant tissues and the young nymphs resemble the adults but have no wings. Leafhoppers feed by sucking sap.

In coastal areas heavy infestations (more than 15 insects per plant) produce wallaby ear symptoms in susceptible maize hybrids. Affected plants can be recognized by their dark green colour and the prominent thickening of the veins on the underside of the leaves. The severity of the disease in any one cultivar is proportional to the leafhopper population. It is not known whether the damage is caused by toxic saliva injected into the plant by the pest or whether a virus is involved. Sweet corn varieties are fairly tolerant to wallaby ear disease.

MAIZE

Yellow peach moth *(Dichocrocis punctiferalis* (Guenee))

Maize stem damaged by yellow peach moth larva x 0.8

Damaged maize cob with larva of yellow peach moth inside x 2.5

Sporadic infestations of yellow peach moth are more common in crops grown in central Queensland than elsewhere in the State. The most serious damage is destruction of grain in the ears, but the larvae also mine the stems. Characteristically, the larvae leave feeding tracks marked by webbing and excreta. As many as 30 larvae may occur in a single ear.

Although maize is a favoured host, severe damage can occur in sorghum, cotton, citrus, peach, custard apple, papaw and mango.

The very small eggs are laid on the host plant and the newly emerged larvae eat their way into the plant tissue. They become full-grown in about 3 weeks in summer, and are then greyish-white often distinctly tinged with pink. The head and four rows of spots down the length of the body are dark brown.

Infested maize crops should be ploughed under as soon as possible after harvest. Normally, chemical control is not necessary.

ONIONS

Major pest

*Onion thrips *(Thrips {abaci* Lindeman)

•"Illustrated

ONIONS

Onion thrips *{Thrips tabaci* Lindeman)

Onion thrips damage

Onion thrips adults and nymphs x 10

Thrips are most abundant in onion crops during a hot, dry spring following a mild, dry winter. The insect multiplies within the crop and both adults and nymphs feed on the leaves by rasping the surface tissues and sucking the exuded juices. The consequent white flecking is characteristic of onion thrips attack and indicates the insect is present. Populations greater than 50 thrips per plant may reduce the size of the bulb. Early-planted crops are usually harvested before damaging populations of the pest develop. It may be necessary to control infestations on later crops with insecticides.

PASTURES AND PASTURE SEED CROPS

Major pests

Bean fly *{Ophiomyia phaseoli* (Tryon))—see GRAIN LEGUMES
Bean podborer *{Maruca testulalis* (Geyer))—see GRAIN LEGUMES
*Buffel grass seed caterpillar *{Mampava rhodoneura* (Turner))
*Funnel ant *{Aphaenogaster pythia* Forel)
Locusts:
Australian plague locust *{Chortoicetes terminifera* (Walker))]
Migratory locust *{Locusta migratoria* (Linnaeus))]—see SORGHUM
Spur-throated locust *{Austracris guttulosa* (Walker))]
*Pasture webworms
Flatheaded pasture webworm *{Oncopera mitocera* (Turner))
Roundheaded pasture webworm *{Oncopera brachyphylla* Turner)
*Seedharvesting ants
Pheidole ampla Forel
Pheidole anthracina Forel
*Sod webworm *{Herpetogramma licarsisalis* (Walker))

Minor pests

*Amnemus weevils
Amnemus superciliaris (Pascoe)
Amnemus quadrituberculatus (Boheman)
Armyworms:
Dayfeeding armyworm *{Spodoptera exempta* (Walker))—see MAIZE
*Lawn armyworm *{Spodoptera mauritia* (Boisduval))
Blue oat mite *{Penthaleus major* Duges))—see CEREAL CROPS
Cluster caterpillar *{Spodoptera litura* (Fabricius))—see TOBACCO
Corn earworm *{Heliothis armiger* (Hubner))—see COTTON
Crabgrass leaf beetle *{Lema rufotincta* Clark)
Cutworms *{Agrotis* spp.}—see SUNFLOWER
Pangola grass aphid *{Schizaphis hypersiphonata* A. N. Basu)
*Pasture whitegrubs (e.g. *Rhopaea* spp.)
*Rough brown weevil *{Baryopadus corrugatus* Pascoe)
Strawberry spider mite (*Tetranychus Iambi* Pritchard and Baker)
Yellow-winged locust *{Gastrimargus musicus* (Fabricius))

Natural enemies of pests

Parasites:
Locust egg parasites *{Scelio* spp.)
*Orchid dupe *{Lissopimpla excelsa* (Costa))

*Illustrated

PASTURES AND PASTURE SEED CROPS

Buffel grass seed caterpillar *(Mampava rhodoneura* (Turner))

Funnel ant *{Aphaenogaster pythia* Forel)

Buffel grass seed caterpillar x 1

Funnel ant nests

This caterpillar was first noted as a pest of buffel grass seed in 1980. Biloela buffel grass is preferred, but other varieties can be attacked and infestations have also been recorded on *Setaria anceps.* The insect occurs widely throughout central Queensland.

The moth is white and lays very' small, white eggs in the developing seed head up to the flowering stage. The larva may reach 18 mm in length when mature and feeds on the developing seeds. Damage on green heads shows as a white, spiral tunnel; mature heads may be completely webbed up. One larva is sufficient to destroy the head, although more than one may be found in some cases. The larva pupates in the densely webbed head forming conspicuous silken cocoons. The complete life cycle takes 4 to 6 weeks.

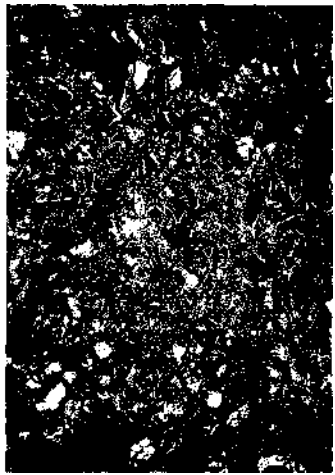
Soil-inhabiting funnel ants occur in many parts of Queensland and can be particularly troublesome on the Atherton Tableland. They are a problem in declining pastures on land once under rainforests. The effect of the ants is largely mechanical in that soil is removed from around the grass roots, thereby creating an artificial drought situation. Closely-cropped grass areas become covered with soil mounds made by the ants.

PASTURES AND PASTURE SEED CROPS

Pasture webworms *(Oncopera mitocera* (Turner), and *Oncopera brachyphylla* Turner)

Seedharvesting ants *(Pheidole ampla* Forel, and *Pheidole anthracina* Forel)

Entrances to ground burrows of pasture webworms



Entrance to nest of seedharvesting ants

Eggs are laid by the moths in pastures at dusk from February to May. The larvae live below ground in web-lined vertical burrows and come to the surface at night to feed on any vegetable matter near the burrow. Any species of pasture grass is readily eaten. The life cycle is such that at the beginning of the dry season (August) the larvae have reached a size where they cause serious damage. Larval size (maximum length 65 mm) and damage increase until November-December. The larvae pupate in the soil at a depth of 100 to 150 mm between November and March. One hundred webworms per square metre is a common infestation level. This has the same effect as one cow per hectare in reducing dry season pasture production by more than 800 kg per hectare. A single insecticide spray before mid-September will control the pest until the next dry season.

Several species of small ants harvest grass and legume seeds for food. The ants make nests in the ground and the entrances to these are ringed by heaps *of* discarded seeds. Seeds sown onto undisturbed soil surfaces, especially following burning, are vulnerable to attack. Plant stands of annual grasses especially can be severely reduced.

PASTURES AND PASTURE SEED CROPS

Pasture whitegrubs (e.g. *Rhopaea* sp.)

Sod webworm *(Herpetogramma licarsisalis* (Walker))

Upturned grass tussock—the roots have been eaten by pasture whitegrubs x 0.5

Sod webworm larvae x 4

Adults emerge from the soil during summer, usually after rain. Eggs are laid in cells in the soil and larvae hatch 2 to 3 weeks later. These pass through three stages which together last between 9 and 18 months, depending on the species of whitegrub involved. Larvae are usually found just under the soil surface feeding on plant roots, especially grasses. The plants are gradually weakened and the reduced ability to regenerate roots finally results in death. In the final stage of damage the grass tussocks are virtually sitting on the soil surface and may be pulled out by stock grazing in the paddock or by birds searching for insects. Severe damage results in bare areas on which weeds can establish.

The larvae feed at night, at first causing browning, then stunting and dying off. Usually only limited areas are affected and damage is most severe in late summer and autumn. The larvae can be found during the day between the roots of damaged plants, their presence being further indicated by the large faecal pellets at the base of the webbed leaves. Larvae will congregate beneath a wet bag left out overnight. The pupa is formed in a cocoon covered with soil particles. The moth is light greyish-brown with a wing span of about 2.5 cm. Large numbers of these moths come to light at night.

Amnemus weevils *(Amnemus superciliaris* (Pascoe), and *Amnemus quadrituberculatus* (Boheman))

Rough brown weevil *(Baryopadus corrugatus* Pascoe)

Desmodium roots damaged by larvae of Amnemus weevils x 1

Rough brown weevil larva and root damage x 3

Damage is caused by the larvae which feed on the tap roots of *Desmodium* spp. and other tropical legumes such as *Glycine* spp. from April until they pupate in early September. The adults emerge during September and feed on the plant foliage until March of the following year. Eggs are laid in hollow stems of the host or of grasses in the pasture. Chemical spraying is not considered necessary in mixed pastures and maintenance of favourable growing conditions enables the pasture to compensate for loss of plants through damage. Spraying of large populations of adults on seed stands of desmodium during summer may be warranted.

Rough brown weevil causes damage to legumes, especially desmodium, being grown for seed on the Atherton Tableland in north Queensland. Host plants include greenleaf and silverleaf desmodiums, siratro, cowpea, french bean, peanut, phasey bean, *Lablab purpureus* and *Macrutyloma axillare*. Complete loss of mature stands of these species may result from larval root feeding. Loss of roots results in reduction in plant growth, wilting, leaf yellowing and shedding, and death. The adults, which are unable to fly, all emerge from the soil after the first storm rains in spring. If the number of adults causes concern, spraying should be carried out promptly to prevent the development of a subsequent generation of the damaging larval stage in the soil.

PASTURES AND PASTURE SEED CROPS

Lawn armyworm *{Spodoptera mauritia* (Boisduval))

Lawn armyworm (above): and its parasite, the orchid dupe (below) x 2

Lawn armyworm damage to Kikuyu grass

Lawn armyworm outbreaks occur occasionally in fertilized pastures during the summer and can be severe locally. Clusters of eggs covered with fawn hairs are laid on the leaves by the night-flying moths. The main damage is caused by the maturing larvae which hide by day at the base of plants or in the soil under cow pads and feed on the grasses at night. Larvae can be recognized by the triangular black patch on either side of the back of each body segment. When mature, the larvae are about 4 cm long. The presence of lawn armyworm is indicated by defoliated patches appearing in an otherwise healthy pasture.

Another sign of lawn armyworm infestation is the conspicuously-coloured parasite, the orchid dupe. This can be seen flying low over infested pastures and laying its eggs through its long ovipositor into the young lawn armyworms in the soil. The resulting parasite larva feeds inside the caterpillar host but does not cause death until after the host has pupated.

PEANUTS

Major pests

*Lucerne seed web moth *(Etiella behrii* (Zeller))
*Whitefringed weevil *{Graphognathus leucoloma* (Boheman))
*Whitegrubs *(Heteronyx* spp.)

Minor pests

Budworms:
Corn earworm *{Heliothis armiger* (Hiibner))—see COTTON
*Native budworm *(Heliothis punctiger* Wallengren)
Green vegetable bug *{Nezara viridula* (Linnaeus))—see GRAIN LEGUMES
Jassids *(Austroasca* spp.)—see LUCERNF.
*Peanut mite *(Paraplonobia* sp.)
Pineapple mealybug *{Dysmicoccus brevipes* (Cockerel 1))

Natural enemies of pests

Nuclear polyhedrosis virus of budworms—see COTTON
Parasites and predators of budworms—see COTTON

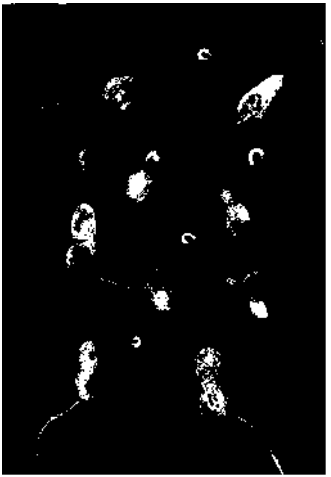
•Illustrated

PEANUTS

Lucerne seed web moth *{Etiella behrii* (Zeller))

Whitegrubs *{Heteronyx* spp.)

Lucerne seed web moth larva x 7



Whitegrubs and damaged shells

Lucerne seed web moth has a wide host range of native and cultivated legumes and is a pest of peanuts, mainly during dry seasons, in areas of light soil. The eggs are laid on the plant and the larvae subsequently tunnel in the soil and enter the developing pods during the latter part of the growing season. Considerable damage may be caused directly by the larvae chewing the seed and indirectly by allowing the entry of fungi such as *Aspergillus flavus* into the pod and consequent contamination of the seed. This damage is not obvious until the plants are pulled at harvest.

Whitegrubs are the soil-dwelling larvae of scarab beetles. The adults emerge from the soil after early summer rain to feed on vegetation and then return to the soil to lay eggs. The young larvae feed on soil humus and plant roots. Older larvae attack shells and kernels of peanuts, reducing both yield and quality. Early-planted crops tend to be more heavily infested than later ones.

PEANUTS

Whitefringed weevil *(Graphognathus leucoloma* (Boheman))

Adult whitefringed weevil x 5

Whitefringed weevil larvae and their damage x 2

This introduced weevil is present throughout the State. It has a wide host range which includes lucerne, peanuts, various legumes, maize, wild grasses, tobacco, vegetables and ornamentals.

The most important damage is caused by the white, legless, soil-dwelling larvae which chew into the taproot causing the plant to die or to be severely reduced in vigour. Infestations in a crop are usually patchy.

Adults, which are all females, emerge from the soil after the first heavy rains in December or January. They lay their eggs in small batches usually attached to plant stems, dead leaves or stones at the point of contact with the soil. Each female can lay up to 1500 eggs during its life of 2 to 3 months. The eggs hatch after 10 to 14 days and the larvae make their way into the soil where they feed on plant roots through autumn, winter and spring.

The adults are unable to fly. They feed on foliage but this damage is not important.

PEANUTS

Native budworm *{Heliothis punctiger* Wallengren)

Peanut mite *(Paraplonobia* sp.)

Native budworm larva x 2

Peanut mite damage

The native budworm is frequently present in peanut crops, particularly during the first half of the crop's growth. The larvae mainly attack the leaves, although they can also feed on the growing points. The caterpillars are predominantly green, but can vary from green to brown. Plants can survive considerable defoliation before yield losses occur. On well-grown plants 12 to 15 larvae per metre of row are required to cause yield reduction.

Economic losses from peanut mites are mainly associated with young crops during periods of dry weather.

The mites are characterized by their dark green to black, oval bodies, light amber legs and their habit of falling to the ground when the plant is disturbed.

Pest activity is usually first apparent as general yellowing and silvering of the leaves in patches of the crop. As the damage becomes more severe the lower leaves are shed and plants are killed.

Populations of the mites decline rapidly following rain.

POTATOES

Major pests

Aphids:
*Green peach aphid *(Myzus persicae* (Sulzer))
*Potato moth *{Phthorimaea operculella* (Zeller))

Minor pests

Crickets:
Black field cricket *(Teleogryllus commodus* (Walker))—see SUNFLOWER
*Mole crickets *(Gryllotalpa* spp.)
Cutworms *(Agrotis* spp.)—see SUNFLOWER
Rice root aphid *(Rhopalosiphum rujiabdominalis* (Sasaki))
Tomato aphid *{Macrosiphum euphorbiae* (Thomas))
*Twentysixspotted ladybird *{Henosepiiachna sparsa vigint isexpunciata* (Boisduval))
Vegetable jassid *(Austroasca viridigrisea* (Paoli))—see LUCERNE
Whiteflies *(Bemisia* spp.)
Whitefringed weevil *(Graphognathus leucoloma* (Boheman))—see PEANUTS
Whitegrubs (e.g. *Heteronyx* spp.)—see PEANUTS

Natural enemies of pests

Disease of green peach aphid *(Entomophthora* fungus)—see LUCERNE
Parasites of green peach aphid:
Aphidius colemani Viereck] -- wasps
Diaeretiella rapae (MTntosh)]
Parasites of potato moth:
Apanteles subandinus Blanchard]
**Copidosoma desantisi* Annecke and Mynhardt *]*—wasps
**Orgilus lepidus* Muesebeck]
Predator of green peach aphid:
*Brown smudge bug *(Deraeocoris signatus* (Distant))

*Illustrated

POTATOES

Green peach aphid *{Myzus persicae* (Sulzer))

Predator of green peach aphid: Brown smudge bug *(Deraeocoris signatus* (Distant))

Potato leaf infested with green peach aphids x 7

Adult brown smudge bug with prey x 10

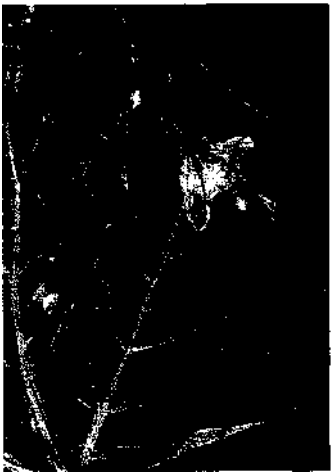
The green peach aphid is a small, pale green, whitish or pinkish insect which sometimes occurs in very large colonies on the undersides of the lower leaves of potatoes during autumn and winter. Numerous parasites and predators normally build up with the aphids and generally cause rapid population decline. When populations become very large most of the aphids produce wings and fly away. Fungal diseases may also break out in the aphid colonies, particularly under wet conditions. The aphids suck sap from the potato plants and very high populations may cause premature plant death. However, the aphid is most important as a carrier of potato leaf roll virus. Plants affected by this virus show leaf-rolling symptoms and if the virus occurs in the crop in the early stages of growth yield losses are considerable. Planting certified seed is the best method of overcoming some of the virus problem.

Although the green peach aphid on potatoes is attacked by many predators, probably the most important in south-east Queensland is the brown smudge bug. The bugs, which are usually found breeding in association with large aphid populations in autumn, require small amounts of plant sap for proper development. However, they have no harmful effect on the plant. In addition to potatoes, these predators are commonly seen in many other crops and on weeds.

Eggs are laid into the plant tissue and the small wingless nymphs which emerge are bright red. Older "nymphs are brown.

POTATOES

Potato moth *(Phthorimaea operculella* (Zeller))



Leaves mined by potato moth larvae

Potato tuber damaged by potato moth larvae

The minute eggs are laid most commonly on the soil at the base of plants. Larvae upon emerging from the eggs, tunnel directly into the plant tissue. Tunnelling between upper and lower leaf surfaces can soon be detected in the form of blotch mines which later become brittle, discoloured patches of dead tissue. Most serious damage occurs when larvae gain access to tubers, due to their being inadequately hilled or to the soil cracking. When full-grown, after about 2 weeks under warm conditions, the larvae pupate, generally under lumps of soil. The inconspicuous moths are greyish-brown with a wingspan of about 2 cm.

The tuber moth is a pest mainly of the spring and early autumn crops, particularly where the crop is sited near a recent potato crop. Careful hilling and attention to irrigation to prevent soil cracking are most effective cultural practices in minimizing tuber damage.

POTATOES

Mole crickets *{Gryllotalpa* spp.)

Twentysixspotted ladybird *(Henosepilachna sparsa vigintisexpunctata* (Boisduval))

Mole cricket x 2.5

Twentysixspotted ladybird adult and larva x 7

Mole crickets are generally minor pests which feed on a variety of plants. However, they do occasionally cause extensive damage to potatoes by burrowing through the tubers leaving large round holes. Tubers left in the ground for extended periods are most prone to damage.

The adults are big insects, with the front legs broadened and flattened for digging. The insect appears to be most common in wet soil along creek banks or in low-lying areas.

This is one of the few ladybirds which feed on plants. Elongate-oval, yellowish eggs are laid in clusters on the foliage. The larva eats narrow strips out of the underside of the leaf, but leaves a thin layer of the upper surface intact producing a very characteristic window effect.

The pest is uncommon in potato crops sprayed for insect control but is quite common on volunteer plants and in backyard gardens.

POTATOES

Natural enemies of pests

Parasites of potato moth:

Wasps *(Copidosoma desantisi* Annecke and Mynhardt, and *Orgilus lepidus* Muesebeck)

Copidosoma desantisi cocoons visible through skin of parasitized potato moth larvae x 8

Orgilus lepidus pupa and wasp x 8

Considerable biological control of the potato moth in Queensland is exercised by a few species of small parasitic wasps introduced from South America. These parasites are specific to potato moth and attack no other insect in Australia. *Copidosoma desantisi* lays its eggs in the eggs of the host while *Orgilus lepidus* lays eggs in the host larvae. Regardless of the stage chosen for egg laying the parasite larvae develop within the host larva and ultimately kill it. By this time the parasite larvae are full-grown. After a short period in the pupal stage, the wasps emerge to complete the life cycle.

While the parasites do not prevent damage by the potato moth larvae they do reduce the numbers of moths which would build up in a crop and carry over to the next one.

PUMPKINS

Major pests

*Plain pumpkin beetle *(Aulacophora ahdominalis* (Fabricius))
*Pumpkin beetle *{Aulacophora hilaris* (Boisduval))
*Twentyeightspotted ladybird *(Henosepilachna vigintioctopunctaia* (Fabricius))

*Illustrated

PUMPKINS

Pumpkin beetles *(Aulacophora abdominalis* (Fabricius), and *Aulacophora hilaris* (Boisduval))

Twentyeightspotted ladybird *(Henosepilachna vigintioctopunctata* (Fabricius))

Pumpkin beetles x 4

Twentyeightspotted ladybird (all stages) and its leaf damage x 4

The life histories and habits of these two insects are similar. Eggs are laid singly or in small groups on dead leaves or on clods under the food plant. Young larvae feed on the roots which become discoloured and misshapen and they may also penetrate fruit in contact with the ground.

Adult beetles cluster together when feeding. They are particularly damaging to the seedlings, flowers and small fruit of cucurbit crops. Spring plantings are often attacked shortly after germination and seedlings can be destroyed by a relatively small number of beetles on each plant. Damage is less severe after the plants have formed runners but even then the growth can be checked by the beetles. Feeding on flowers can interfere with fruit setting.

The adult is an oval-shaped, sluggish beetle which lays its eggs on the lower surface of leaves or on the young fruit. Larvae feed mainly on the underside of the leaves where they eat the green tissue and leave the veins linked together. Full-grown larvae pupate on the plant or in adjacent trash. Seedling damage is seldom as severe as with pumpkin beetles but severe defoliation of older plants can occur at times. This reduces yield and exposes the maturing fruit to the sun and thus induces scald. Migrations from weed hosts are often responsible for outbreaks in crops.

RICE

Major pests

*Brown planlhopper *{Nilaparvata lugens* (Stal))
•White rice stemborer *(Tryporyza innotata* (Walker))

Minor pests

*Brown rice stink bug *(Eysarcoris* sp.)
Common armyworm *{Pseudaletia convecia* (Walker))—see CEREAL CROPS
* Paddy bug *(Leptocorisa acuta* (Thunberg))

Natural enemies of pests

Parasite of white rice stemborer:
Telenomus rowani (Gahan)

*Illustrated

RICE

Brown planthopper *(Nilaparvata lugens* (Stal))

Brown planthoppers at base of stems x 4

Rice paddock showing burn damage due to brown planthopper

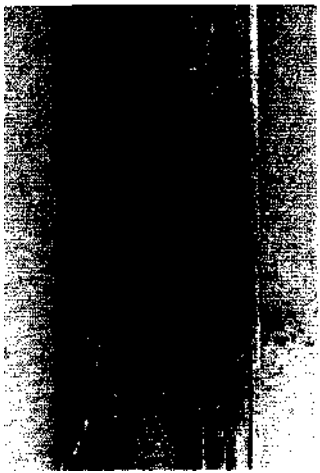
The brown planthopper has caused severe damage in the Burdekin river area on a number of occasions and has also been recorded from rice in the Mareeba district.

Moist, humid, calm conditions are favourable to migrations of the winged form into crops. While the crop is immature the wingless form predominates. Eggs are laid in the leaf tissue. Adults and nymphs feed by sucking the sap. In heavily-infested areas damage causes the lower leaves to turn yellow and plants may wither completely. Patches of hopper burn occur irregularly throughout the crop.

Cultural and biological control methods are not effective. Where symptoms of burn appear chemical control is the only method possible.

RICE

White rice stemborer *{Tryporyza innotata* (Walker))



Larvae of white rice stemborer in split stems x 2

Paddy rice showing white heads

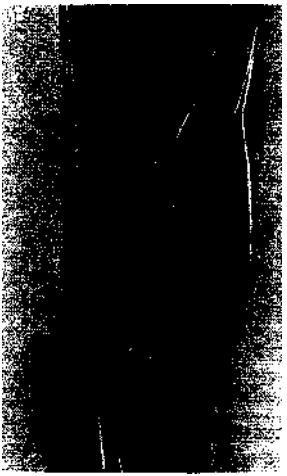
The white rice stemborer is a major pest of rice in the Mareeba district but has not so far been recorded from the Burdekin area.

Moths emerge from stubble about 2 weeks after storm rains or pre-plant flooding. Egg masses are laid on the leaves and the young larvae descend to water level where they enter the stem and feed inside. One larva can damage as many as 6 plants before reaching the pupal stage. Damage before panicle initiation results in the death of the heart of the plant and subsequent tillering. Later damage causes loss of the seed head, recognized as white heads, and the plant at this stage is unable to recover by tillering. Mature larvae hibernate in the stubble during the dry winter.

RICE

Brown rice stink bug *{Eysarcoris sp.)*

Paddy bug *(Leptocorisa acuta* (Thunberg))



Brown rice stink bugs x 3

Paddy bug on rice x 3

The brown rice stink bug normally lives on grasses and migrates into rice paddocks at the time of flowering. Both adults and nymphs feed upon the rice grains at the milk stage with the result that grains do not fill or are only partially filled. The brown bug emits a strong oily smell when disturbed and may impart an "off" flavour to the rice if present in large numbers.

The adult insect is long and slender, about 14 to 17 mm long and 3 to 4.5 mm wide. On sunny days the insects hide at the basal parts of the plant. The females fly from adjoining grassy areas into rice fields at the time of flowering and lay 200 to 300 eggs along the midrib on the upper surface of the leaf blade. Both the adults, and the nymphs which develop from the eggs, suck the sap of the developing rice grains, thereby reducing yield. Warm weather, frequent drizzle and overcast skies during flowering of the crop favour population buildup. Infested fields can often be detected from a distance as they emit a typical rice bug odour.

SAFFLOWER

Major pests

*Grey cluster bug (*Nysius clevelandensis* Evans)
*Rutherglen bug (*Nysius vinitor* Bergroth)

Minor pests

Cutworms (*Agrotis* spp.)—see SUNFLOWER
Native budworm (*Heliothis punctiger* Wallengren)—see COTTON
Southern false wireworm (*Gonocephalum macleayi* (Blackburn))
—see CEREAL CROPS
Spur-throated locust (*Austracris guttulosa* (Walker))—see SORGHUM
*Thistle aphid (*Capitophorus elaeagni* (del Guercio))

Natural enemies of pests

Predators of *Nysius* spp.:
Flower spiders:
Diaea spp.
Runcinia elongata (L. Koch) } —see COTTON
Predators of thistle aphid:
Transverse ladybird (*Coccinella repanda* Thunberg)—see LUCERNE
Predators of bugs, caterpillars and moths—see SUNFLOWER

SAFFLOWER

Grey cluster bug *{Nysius clevelandensis* Evans)

Rutherglen bug *{Nysius vinitor* Bergroth)

Thistle aphid *(Capitophorus elaeagni* (del Guercio))

Rutherglen bugs on safflower head >

Thistle aphid colony x 6

Adult insects fly into the crop from sowthistle and other weed hosts. The eggs are small, white and banana-shaped and are laid in the seed heads. Immature bugs are pink and globular and they and adults feed on terminals, buds and developing seeds. Small buds may be killed and seed quality affected. Continuous reinfestation of a crop from adjacent weedy areas is possible and a number of insecticide treatments may be required to maintain control and prevent excessive damage.

These aphids are green to grey and colonies may be found feeding on terminals or the underside of leaves. Heavy infestations on a crop suffering moisture stress can affect yield and treatment with an aphicide may be required. However, predators such as ladybirds, hover fly larvae and wasp parasites generally exert sufficient natural control so that insecticide applications are rarely warranted.

SORGHUM

Major pests

*Corn earworm (*Heliothis armiger* (Hübner))
Dayfeeding armyworm (*Spodoptera exempta* (Walker))—see MAIZE
Locusts:
*Australian plague locust (*Chortoicetes terminifera* (Walker))
*Migratory locust (*Locusta migratoria* (Linnaeus))
*Spur-throated locust (*Austracris guttulosa* (Walker))
*Sorghumhead caterpillar (*Cryptoblabes adoceta* Turner)
*Sorghumhead caterpillar (*Cryptoblabes adoceta* Turner)

Minor pests

Black field earwig (*Nala lividipes* (Dufour))—see MAIZE
Corn aphid (*Rhopalosiphum maidis* (Fitch))
Cutworms (*Agrotis* spp.)—see SUNFLOWER
False wireworms—see CEREAL CROPS
Gonocephalum spp. } —see CEREAL
Pterohelaeus spp. }
Green vegetable bug (*Nezara viridula* (Linnaeus))—see GRAIN LEGUMES
Northern armyworm (*Pseudaletia separata* (Walker))
Seedharvesting ants—see PASTURES
Pheidole ampla Forel
Pheidole anthracina Forel
Wireworms (Elateridae)
*Yellow peach moth (*Dichocrocis punctiferalis* (Guenée))
Yellow-winged locust (*Gastrimargus musicus* (Fabricius))

Natural enemies of pests

Diseases of armyworms—see MAIZE
*Diseases of corn earworm:
*Caterpillar fungus (*Nomuraea rileyi* (Farlow))
*Nuclear polyhedrosis virus—see MAIZE
Parasites:
Of corn earworm—see COTTON
Of locust eggs: *Scelio* spp. } —wasps
*Of sorghum midge: *Eupelmus* spp. }

SORGHUM

Corn earworm *(Heliothis armiger* (Hubner))

Corn earworm eggs and young larvae on sorghum head x 18

Close-up of sorghum head with mature corn earworm larvae x 1

Large corn earworm larva affected with nuclear polyhedrosis virus on sorghum head x 3

SORGHUM

Corn earworm *(Heliothis armiger* (Hubner))

Corn earworm appears regularly as a major pest of sorghum. Feeding by the larvae in the throat of the developing plant results in the leaves becoming ragged but does not affect yield. The major infestations occur between flowering and grain hardening, and economic damage is done by the larvae feeding on the developing grain at this time. Egg laying commonly coincides with flowering, the eggs being placed on the florets. The young larvae feed on the milk grains and the older larvae on the firmer seed. However, larvae cannot develop on hardened grain. Mature larvae leave the plant and pupate in the soil.

The natural mortality of corn earworm in sorghum heads can vary considerably. Epizootic diseases caused by a nuclear polyhedrosis virus especially, and by bacteria and fungi, are common on sorghum and can result in complete decimation of larval infestations. Of the predators commonly active against the larvae, spiders are considered to be the most important. Larval parasites occur in low numbers only, whereas high levels of egg parasitism have been recorded. Cannibalism between larvae is very common and is more significant when larval numbers per head are high.

Heavy infestations of larvae may be more common on compact-headed varieties of sorghum than on the more open types. The compact heads provide protection from adverse weather conditions, predators and parasites.

SORGHUM

Australian plague locust *(Chortoicetes terminifera* (Walker))

Australian plague locust female (above); male (below) x 2.7

Australian plague locust is a medium-sized migratory insect which occurs in eastern Australia and spreads during outbreak years into Victoria and South Australia. Outbreaks occur after successive seasons of good rain, in south-western Queensland and western New South Wales, which provide plenty of grasses for the young stages (hoppers) and the adults. The swarms of adults fly mostly during the day but some flights also take place at night.

Adult females lay eggs in bare ground mainly, in tunnels bored by the tip of the abdomen. The pod of 30 or more banana-shaped eggs is enclosed in a frothy substance which also plugs the tunnel above. Both males and females die at this time although some females survive long enough to lay several pods. Incubation of the eggs takes 2 to 3 weeks, except in autumn when most of them lie dormant until next spring. Nymphs (hoppers) work their way up through the froth plug and moult on emerging. They go through a number of stages, moulting between each. Bands of hoppers can be readily seen from the air as an advancing tidal front eating out the vegetation as they progress. The hopper stage lasts 5 to 6 weeks during summer. The newly-formed adult (fledgling) requires about 4 days before its wings have hardened sufficiently for sustained flight and is ready to lay eggs after about 2 weeks in summer.

Control is best implemented against hoppers and then only when they form a dense band. All outbreaks should be reported to the local shire council.

SORGHUM

Spur-throated locust *(Austracris guttulosa* (Walker))

Adult spur-throated locust x 1,3

Adult spur-throated locust from below showing the spur between the front legs x 3

Spur-throated locust is essentially a tropical species and causes greatest damage to sorghum and sunflower during outbreaks in the grain-growing areas of the Central Highlands and Western Port Curtis. Massive movements of immature adults occur with west to east moving weather fronts from far western areas of the State into cropping areas during September to January. The adults mature rapidly on arrival. Egg pods are laid throughout an area and not concentrated in egg beds. The subsequent hoppers do not form bands but can cause serious crop losses in addition to damage caused by the adults.

The adults are from 5 to 8 cm long and like the older hoppers have a prominent spur between the front legs. Other distinguishing features include colourless or bluish-tinged hind wings, hind legs with mauve shanks and black-tipped white spines and unhanded femurs. The hoppers are green on hatching, with a black stripe down the middle of the back. The colour may change to light brown as the hoppers mature.

Chemical control measures should be directed against the infestation within the crop and not against the insect on headlands and adjacent areas.

SORGHUM

Migratory locust *{Locusta migratoria* (Linnaeus))

Adult migratory locust x 1.5

Sorghum thinned and defoliated by migratory locust

The migratory locust is found in the same areas as the spur-throated locust but may also extend in numbers into coastal areas. It may be distinguished from the spur-throated locust in being slightly smaller (adults 4.5 to 6 cm long) and more plump and in not having a spur between the front legs. The hind wings are clear or faintly greenish-yellow and often smoky at the tip. The body is green to brown depending on population density. The shanks of the hind legs are pink or straw-coloured and the femur is often banded. Nymphs vary from grey-brown to dark brown or black depending on population density.

Eggs are laid in egg beds in the soil and hopper bands and adult swarms are formed when population densities are high. Sorghum and sugar are the main crops at risk. Cotton and sunflower are not attacked and planting of these is recommended where outbreaks of migratory locust are expected.

Chemical control may be required against infestations in the crop or against hopper bands to prevent them moving into the crop.

SORGHUM

Sorghumhead caterpillar *(Cryptoblabes adoceta* Turner)

Yellow peach moth *(Dichocrocis punctiferalis* Guenee)

Close-up of sorghum head showing larvae of sorhgumhead caterpillar and their webbing x 1

Sorghum head damaged by yellow peach moth larvae x 1.5

The sorghumhead caterpillar is a minor pest of sorghum in southern and central Queensland, the worst infestations occuring in humid coastal areas.

Open-headed varieties of sorghum are less prone to attack than compact-headed ones. A succession of sorghum crops should be avoided, to prevent build-up of the pest. Chemical control is of limited value and economic injury levels have not been determined.

Whilst less favoured than maize by yellow peach moth, grain sorghum can suffer severely at times. Infestation starts as the sorghum grains begin to mature and can develop rapidly. The larvae feed on the grain and when they are present in numbers the inside of the sorghum head becomes cluttered with their excreta and webbing. At times the whole head may be tightly bound together by the larval webbing. Stem tunnelling may also occur but is less common than in maize.

SORGHUM

Sorghum midge *(Contarinia sorghicola* (Coquillet))

Adult sorghum midge x 15

Adult sorghum midge parasite, *Eupelmus* sp. x 14

Midge-damaged head (left); undamaged head (right)

Close-up of grains with pupal cases of sorghum midge and emergence holes of its parasite x 33

SORGHUM

Sorghum midge *(Contarinia sorghicola* (Coquillet))

Sorghum midge is a small fragile fly, 1.5 mm long, and orange-red. The female lives only 1 or 2 days, and it lays up to 100 eggs inside the sorghum flowers. The eggs hatch in 2 days and the larvae feed on and shrivel the developing grain for 10 days before pupating inside the florets. After 4 days the adult flies emerge from the pupae, leaving the white pupal cases attached to the glumes. The life cycle takes 16 to 20 days in summer.

Sorghum crops are most susceptible to attack by midges during flowering, when yellow pollen is being shed. However, when midge populations are large, sorghum heads can be damaged before flowering. After flowering, when the anthers turn brown, the crop is unattractive to the midge.

The pest is well adapted to the climate and its host as it survives during winter and periods of drought as a resting stage or diapause larva in unharvested heads and sorghum trash. It can survive there for 3 to 5 years. With wet weather followed by warm, humid conditions in spring and summer, adult midges develop from the resting stage and infest any sorghum crops or volunteer sorghum crops which are flowering.

Cultural control methods help to reduce serious damage. Late-sown crops are usually more severely attacked than early ones if there is a succession of flowering. Crops which flower during the wet season are also prone to attack by large numbers of midges emerging from the resting stage. All factors which promote even growth and rapid, uniform flowering will reduce the build-up of midges and lessen the risk of damage. These include well-prepared seedbeds, good quality seed true to varietal type and avoidance of staggered plantings.

It is important to scout the crop carefully after head emergence and during flowering. The appropriate chemicals should be applied when there are two midges per head. Small black wasp parasites of the midge are often present and should not be confused with midges. The parasites do not prevent loss of grain to midges but they will reduce the numbers of adult midges which breed out. The most satisfactory results with insecticides are obtained when flowering is even.

SUNFLOWER

Major pests

*False wireworms—see CEREAL CROPS also
Gonocephalum spp.
Pterohelaeus spp.
*Grey cluster bug *{Nysius clevelandensis* Evans)
*Rutherglen bug *{Nysius vinitor* Bergroth)

Minor pests

Black field earwig *(Nala lividipes* (Dufour))—see MAIZE
Black scarab beetles *(Pseudoheteronyx* spp.)
Budworms:—see COTTON also
*Corn earworm *(Heliothis armiger* (Hiibner))
Native budworm *(Heliothis punctigcr* Wallengren)
*Cutworms *(Agrotis* spp.)
*Field crickets:
Teleogryllus com modus (Walker)
Teleogryllus lepidus (Walker)
Green looper *{Chrysodeixis eriosoma* (Doubleday))
Green vegetable bug *{Nezara viridula* (Linneaus))—see GRAIN LEGUMES
Soybean looper *(Diachrysia orichalcea* (Fabricius))—see GRAIN LEGUMES
Spur-throated locust *(Austracris guttulosa* (Walker))—see SORGHUM
Thrips:
Onion thrips *{Thrips tabaci* Lindeman)—see ONIONS
Tomato thrips *(Frankliniella schulizei* (Trybom))
Vegetable jassid *(Austroasca viridigrisea* (Paoli))—see LUCERNE
Whitefringed weevil *(Graphognathus leucoloma* (Boheman))—see PEANUTS
*Wingless cockroaches:
Cosmozosteria spp.
Desmozosteria spp.
*Wireworms (Elateridac)

Natural enemies of pests

Disease of corn earworm:
Nuclear polyhidrosis virus—see SORGHUM
Parasites of budworms—see COTTON
Predators of caterpillars:
Damsel bug *(Tropiconabis nigrolineatus* (Distant))—see COTTON
Pollen beetle *(Dicranolaius bellulus* (Guerin-Mencville))—see COTTON
Predatory shield bugs:
Cermatulus nasalis (Westwood)
Oechalia •schellenhergii (Guerin-Meneville)
Soldier beetle *(Chauliognathus pulchellus* (Macleay))
General predators:
Flower spiders *(Diaea* spp.)—see COTTON
*Lynx spiders *(Oxyopes* spp.)

Pollinator

*Honey bee *(Apis mellifera* Linnaeus)

""Illustrated

SUNFLOWER

False wireworms *{Gonocephalum* spp., and *Pterohelaeus* spp.)

Wingless cockroaches *(Cosmozosteria* spp., and *Desmozosteria* spp.)

Adult false wireworms, *Pterohelaeus* sp. (top); *Gonocephalum* sp. (bottom) x 3

Wingless cockroach adults x 1.5

Seedling sunflowers in central Queensland may be severely damaged by false wireworm beetles *(Pterohelaeus* and *Gonocephalum* spp.). Damage has been most severe in newly-cleared bushland areas planted to the crop, although some damage has also occurred in longer established areas.

The adults fly into the paddock during summer months. They feed mostly at night and shelter during the day under stones, crop trash or mature volunteer sunflower and sorghum plants. Plants may be eaten completely, cut off at ground level, ring-barked or so damaged otherwise as to retard or prevent growth.

Larvae may also damage seeds and seedlings.

Wingless cockroaches have caused damage to seedling sunflowers in central Queensland areas where the crop has been expanded by planting in newly cleared bushland. The adults are large, shiny brown insects with yellow stripes and margins. They are active crawlers and move into sunflower crops from surrounding scrub. Like the false wireworm beetles they are nocturnal, feeding at night and sheltering by day under trash.

SUNFLOWER

Budworms:

Corn earworm *{Heliothis armiger* (Hiibner))

Native budworm *{Heliothis punctiger* Waltengren)

Budworm eggs and larvae on bracts of flower bud x 8

Budworm larvae and their damage beneath the flower head

Although damage is obvious and appears serious it is considered that budworms are not of major economic importance in sunflower as the plant is able to tolerate large infestations and still produce a worthwhile yield.

Damage can occur at budding and is normally not important then since the plants can still form a productive head. When larval populations in the flower head are large, damage is obvious. Even then the plant is able to compensate and to produce a satisfactory crop.

Both species occur in sunflower, the proportion of each varying according to time of planting in any particular area and also from year to year. The habits of the two species are similar. Eggs are laid at the bud stage through to flowering, on the flower bracts and on the upper surface of leaves at the tip of the plant. After hatching, larvae often favour the underside of the head bracts as feeding sites. Small larvae may also be found among the florets, while larger ones feed on all parts of the flower head including florets, developing seeds, petals, bracts and the pithy tissue at the back of the flower head.

SUNFLOWER

Grey cluster bug *{Nysius clevelandensis* Evans)

Rutherglen bug *{Nysius vinitor* Bergroth)

Adults of grey cluster bug on back of sunflower head x 2.5

Withered flower head resulting from sucking by Rutherglen bug

Rutherglen bug and the similar grey cluster bug occur in all sunflower producing districts in Queensland. The Rutherglen bug is usually considered to be the more important of the two and attains major pest status at times.

Large numbers can build up on alternative annual weed hosts of the family Compositae, particularly when these hosts become abundant after mild wet winters. The adult bugs are very mobile and can fly from the weed hosts into the sunflower crop from the seedling stage to maturity. However, most of the invasion occurs from budding through to completion of flowering. Thereafter, breeding begins in the crop and banana-shaped eggs are laid among the florets and developing seed. Adults mainly suck developing seed, but will suck other parts of the plant when the infestation is heavy and may even kill it. The combined effect of nymphs and adults on the seed may reduce yield and oil quality and it is this damage which is of most concern to the grower. The complete life cycle from egg to adult in summer is about 30 days and there is only one generation in the crop.

SUNFLOWER

Cutworms (*Agrotis* spp.)

Cutworms and damage to sunflower seedlings x 2

Several species of cutworms attack a wide range of vegetable, field and cereal crops in Queensland. The common name of cutworm is derived from the larval habit of severing the stems of young seedlings at or near ground level, thereby causing collapse of the plant. Sometimes, the young plant is partially dragged into the soil, where it is fed upon by the cutworm larva. Crop areas attacked by cutworm tend to be patchy in nature, and destruction of available seedlings in a given area may force the cutworms to migrate to adjacent areas.

Cereal crops adjacent to permanent vegetation, or fields previously sown to grassy sod or legumes, are prone to cutworm attack, as arc crops which possess high weed populations. Consequently, farm practices often have a considerable bearing on cutworm incidence.

The adult cutworm is a dull, stout-bodied moth with a wingspan of about 4 cm. The small, pearly-white eggs are generally laid on soil under low growing plants such as dock, turnip weed, sowthistle and pigweed. Sometimes these eggs are deposited among organic material on the soil surface and one cutworm species is known to prefer moist soil for egglaying. The larvae, which emerge after a few days, feed at night and hide during the day in the soil. There are five larval stages, and full-grown larvae measure up to 5 cm long. Overall colour may be grey or brown, depending on the species, and the skin often has a roughened, granular texture. The larval stage usually lasts 4 to 6 weeks.

Mature larvae stop feeding and pupate in an earthern cell in the top 5 cm of soil, often under some object such as a piece of wood. The female moths are highly prolific, and can lay up to 2400 eggs. The life cycle from egg to adult takes about 2 months.

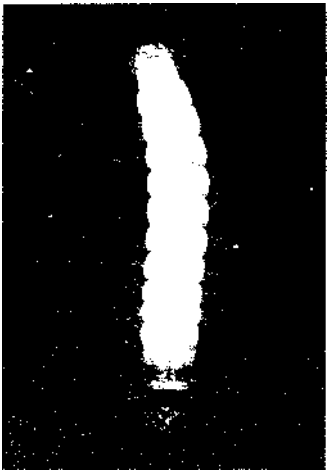
The degree of control by insecticides depends on a number of factors; including the size of the larvae, the penetrability of the soil by sprays, rainfall and the residual life of the chemical being used; but usually only one application is needed.

SUNFLOWER

Field crickets *(Teleogryllus* (Walker)) (Walker), and *Teleogryllus lepidus*

Wireworms (Elateridae)

Adult field cricket x 2.5



Wireworm larva x 3.5

The adults are black and have the head and mouthparts inclined downwards. Immature stages (nymphs) resemble adults in shape but are wingless and paler. Both adults and immatures shelter during the day in cracks in the soil or under trash. They come out at night and feed on weeds or grasses or on crops planted by the farmer. In sunflower the insect feeds on the seedlings, on the back of the flower heads and on the maturing seeds on the face of the head.

Control is not normally necessary and should only be considered where the area has a past history of field cricket problems.

Wireworms are the soil-dwelling larvae of click beetles. They are cream to yellow-brown and have a distinctly flattened body and wedge-shaped head. They are less common in sunflower paddocks than false wireworms, which are cylindrical and have a rounded head.

Both insects have similar feeding habits. The larvae feed on vegetable matter in the soil and also on the underground stems and roots of plants. Sunflower seedlings are damaged in the early stages of growth up to the four or five leaf stage.

Control measures are not worth while against wireworm but seed treatment may be of value against false wireworms on some paddocks.

SUNFLOWER

Natural enemies of pests

Lynx spiders *{Oxyopes* spp.)

Pollinator

Honey bee *{Apis melifera* Linnaeus)

Lynx spider x 7

Honey bee on sunflower x 1.3

Lynx spiders are small and have long, conspicuously spined legs which give them a silky appearance. The adults are usually light-green or yellow, with the abdomen often having stripes along the length. They are active predators, often searching for small caterpillars near the top *of* plants. They do not build webs but catch their prey by jumping on to it from a distance. The egg sacs, which are attached to leaves, are attended constantly by females. As with most spiders the young disperse in the wind, being held up by silk threads which they produce. Lynx spiders arrive this way in the early crop and they mature and produce eggs when the plants flower.

Sunflowers need insects for pollination, and honey bees are the only insects significant in this role. Adequate pollination of sunflowers grown in Queensland is usually carried out by feral bees and supplementary pollination by hive bees is not normally necessary. This is fortunate since beekeepers do not favour sunflower because of its low bee-breeding potential and small honey production.

Any spraying required on sunflowers should be done during late afternoon or early evening when most of the pollinating bees will have left the crop.

SWEET POTATO

Major pests

*Sweet potato weevil *{Cylas formicarius eleganiulus* (Summers))

Minor pests

African black beetle *{Heteronychus arator* (Fabricius))
Bean spider mite *{Tetranychus ludeni* Zacher)—sec GRAIN LEGUMES
Common brown leafhopper *{Orosius argentatus* (Evans))
Convolvulus hawk moth *{Agrius convo/vuli* (Linnaeus))
Mole crickets *(Gryllotalpa* spp.)—see POTATOES
Sweet potato leafminer *{Bedellia somnulentella* (Zeller))
Wireworms (Elateridac)—see SUNFLOWER

SWEET POTATO

Sweetpotato weevil *{Cylas formicarius elegantulus* (Summers))

Sweetpotato weevil infestation in stem and tuber x 4.5

The adults of this weevil attack the foliage, stalks and tubers of the sweet potato and their larvae feed in the stems and tubers. Tuber infestation is the most serious aspect of the attack of this pest with tubers rendered valueless when riddled by larval burrows. The insect is spread readily in infested stems if these are used for planting material.

The female lays very small, greyish-white, oval eggs in cavities gouged out for the purpose in the tuber or in the stem near ground level. The larvae on hatching, after an incubation period of 5 or 6 days, burrow into the tuber or stem. After 2 or 3 weeks, larval development is complete and larvae then pupate in oval cavities at the end of their burrows, usually close to the surface of the tuber. After a pupal period of about 1 week, the beetles emerge through irregularly-shaped holes in the surface of the tubers.

TOBACCO

Major pests

*Budworms:
- Corn earworm *{Heliothis armiger* (Hiibner))
- Native budworm *{Heliothis punctiger* Wallengren)

"Tobacco loopcr *{Chrysodeixis argentifera* (Guenee))

Minor pests

*Cluster caterpillar *{Spodoptera litura* (Fabricius))
False wireworms *{Gonocephalum* spp.)—see CEREAL CROPS
Green looper *{Chrysodeixis eriosoma* (Doubleday))
Tobacco leafminer *{Phthorimaea operculella* (Zeller))—see POTATOES
Tobacco stemborer *{Scrobipalpa heliopa* (Lower))
Wireworms (Elateridae)—see SUNFLOWER

Natural enemies of pests

Of budworms—see COTTON
Of loopers:
- *Entomophihora* fungus disease
- Wasp parasite *{Litomastix* sp.)

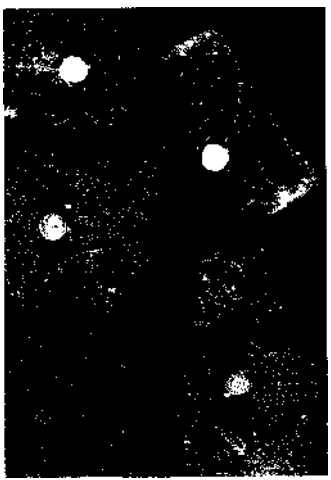
*Illustrated

TOBACCO

Budworms:

Corn earworm *{Heliothis armiger* (Hiibner))

Native budworm *(Heliothis punctiger* Wallengren)



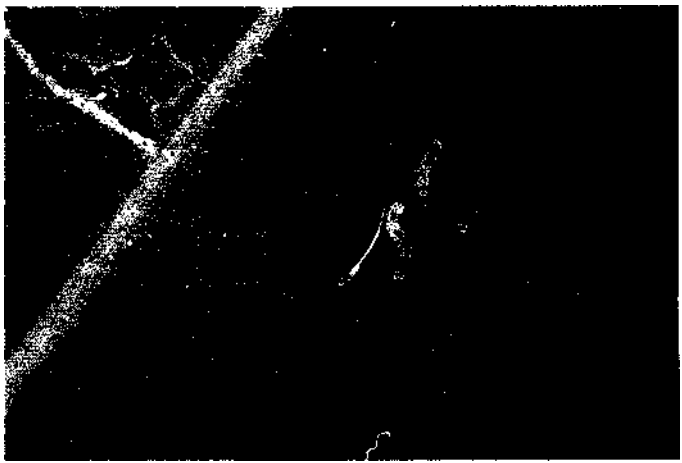
Budworm eggs and young larvae x 14

Budworm on the tip of the plant < *z* 5

The globular eggs of budworms are laid on the upper leaves of immature plants. They are at first pearly-white but a brown, circular band appears as the embryo develops inside. Damage by the larvae to the young leaves at the tip of the plant results in increasing loss of leaf tissue as the leaf expands. If the growing point is destroyed by the larvae the plant produces suckers and these must be removed as they appear, leaving only one to replace the former main stem. Most of the older larvae feed exposed on the leaves and larval development is complete after 2 to 3 weeks. The full-grown larva is about 4 cm long and is predominantly green, brown or black.

TOBACCO

Tobacco looper *{Chrysodeixis argentifera* (Guenee))



Small tobacco loopers and their damage (windows) x 6.5

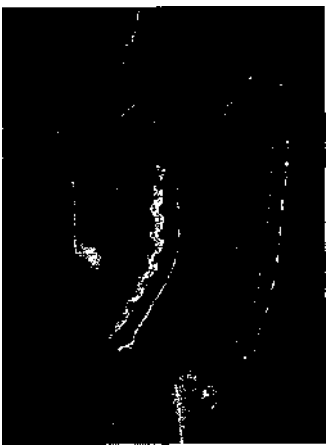
Tobacco loopers arch their bodies when walking and can be distinguished from other loopers on tobacco by having only two instead of four 'false' legs at the end of the body.

The slightly flattened white eggs are usually laid singly on the undersurface of the bigger leaves, mostly near the leaf edge. They gradually darken and after 5 days the larvae emerge. The green larvae move to the middle leaves of the plant where they will eat all the leaf tissue except the midrib if present in large numbers. Most of the damage is caused during the second week of larval development by the last two larval stages. After 2 weeks the larvae are mature and about 4 cm long. They pupate in silken cocoons attached to the undersurface of the leaves or under debris at ground level. The moth is predominantly bronze-brown with conspicuous silver markings on the forewings.

TOBACCO

Cluster caterpillar *{Spodoptera litura* (Fabricius))

Tobacco stemborer *(Scrobipalpa heliopa* (Lower))



Mature cluster caterpillars x 1.5

Stemborer mines in leaf x 2

Cluster caterpillar can develop on many cultivated plants and weeds. The night-flying moth lays large numbers of eggs in batches covered with light hairs on the plant or adjacent objects. Young larvae are gregarious (hence the name cluster caterpillar) and eat the leaf tissues, leaving only the veins. These young larvae are dark towards the front of the body. Older larvae are solitary and have conspicuous black triangles in a line along each side. Mature larvae pupate in the soil. The life cycle, egg to adult, takes about 30 days in warm weather.

All stages of growth of tobacco plants are susceptible to stemborer damage but seedlings and the newly-transplanted crop are the most vulnerable. In the Mareeba district stemborer is potentially the most important pest of seedbeds.

Symptoms of damage in seedlings and young plants include a stem gall, and stem discoloration, wilting and rosetting of the terminal leaves and suckering of the plant.

The pearly-white eggs are laid on the plant but are difficult to detect because of their small size. The larva usually bores into a vein and then onwards down the midrib and leaf stalk into the stem of the plant. Occasionally it will mine erratically in the leaf tissue, causing a windowing type of damage, before continuing onwards down the leaf into the stem. Full-grown larvae are formed after about 3 weeks and are creamy-white and up to 1.2 cm long. They pupate in the tissues beneath the outside of the stem. The small moth has brown, coppery-red wings with a span of about 1 cm.

STORED PRODUCTS

Pests

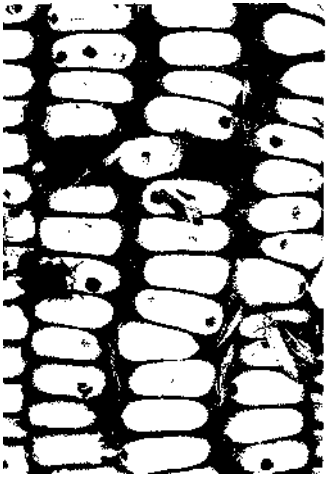
*Angoumois grain moth *(Sitotroga cerealel/a* (Olivier))
*Bean weevil *(Acanthoscelides obtectus* (Say))
*Cigarette beetle *(Lasioderma serricorne* (Fabricius))
Dried fruit beetle *(Carpophilus dimidiatus* (Fabricius))
*Flat grain beetles *(Cryptolestes* spp.)
Indian meal moth *(Plodia interpunctella* (Hiibner))
*Lesser grain borer *(Rhyzopertha dominica* (Fabricius))
Longheaded flour beetle *{Latheticus oryzae* Waterhouse)
Maize weevil *(Sitophilus zeamais* Motschulsky)
*Rice weevil *(Sitophilus oryzae* (Linnaeus))
*Rust-red flour beetle *(Triholium castaneum* (Herbst))
*Sawtoothed grain beetle *(Oryzaephilus surinamensis* (Linnaeus))
Spider beetles:
Mezium americanum (Laporte)
Ptinus clavipes Panzer
*Tropical warehouse moth *(Ephestia cautella* (Walker))

*Illustrated

STORED PRODUCTS

Angoumois grain moth *(Sitotroga cereailella* (Olivier))

Bean weevil *(Acanthoscelides obtectus* (Say))



Angoumois grain moths and larval damage x 2

Bean weevil adults and damage x 5.5

The Angoumois grain moth is the most common moth infesting grain, peanuts and oilseeds stored on farms. Sorghum and maize are frequently attacked. Infestations are prevalent in commodities with high moisture content. The moth infests maturing grain in the field, particularly in central and north Queensland. Adult moths are small, with a wingspan of 12 mm. They are yellow-brown with a few darker markings. The hind wings are characteristically pointed at the ends. The tiny white larvae, which hatch from eggs laid on or near the grain, eat their way into the grains and complete their development inside.

A generation may be completed in about 5 weeks, but development is considerably slower during winter.

The bean weevil is a pest of stored beans, peas, cowpeas and other legume seeds. It is not usually a problem on farms where legume seeds are held for only short periods, but can cause significant damage in seed stored for long periods. Minor infestations of ripening crops in the field by closely-related insects usually die out in storage. Infestation by the bean weevil and some other similar species is usually restricted to stored seed in Queensland. Presence of the insect may be recognized by circular Windows' or neat round holes about 2 mm in diameter in the seed. Development is completed inside the seed. The 'windows', which are left by larvae feeding close to the seed surface, are pushed out by the emerging adult beetles.

A generation takes about 4 weeks during summer. Development slows during winter and effectively stops at temperatures below 15°C.

STORED PRODUCTS

Cigarette beetle *(Lasioderma serricorne* (Fabricius))

Flat grain beetles *(Cryptolestes* spp.)

Cigarette beetle adult and larva x 1 7

Flat gram beetles x 1 7

The cigarette beetle is the only economic pest of stored tobacco. Infestation results in a loss of quality due to holing of the leaf and contamination by cocoons and frass. As larvae move away from light, infestations develop within the commodity rather than on the surface. Populations survive between seasons in remnants of leaf in and around the tobacco sheds. Newly-cured leaf is readily infested by adults which can fly from these sources. The cigarette beetle is also a minor pest of a wide range *of* stored produce including cereal products, seeds and spices.

A generation takes about 5 weeks during summer.

Flat grain beetles infest a wide range of grains, legumes and derived products. Infestation of grain or seed causes a reduction in germination. Damaged grain and grain dust, which usually result from mechanical harvesting, are necessary for survival. Heavy infestations are usually associated with the presence of other pests. Adults fly readily from infested grain or residues from previous harvests and can infest newly-harvested grain. The beetles are flat and about 2 mm long. Both adults and larvae feed externally on the germ of grains.

A generation takes about 4 weeks during summer. Development is much slower during winter and effectively stops at temperatures below 17.5°C. However, the beetles are cold-hardy and are not killed by normal winter temperatures.

STORED PRODUCTS

Lesser grain borer *(Rhyzopertha dominica* (Fabricius))

Rust-red flour beetle *(Tribolium castaneum* (Herbst))

Lesser grain borers x 10

Rust-red flour beetles x 17

The lesser grain borer is a very serious pest capable of infesting all grains and grain products. It is the most common cause of grain being rejected for export from Australia because of infestation. On farms heavy infestations in bagged or bulk-stored grain leave only husks and a flour-like residue. Adults fly readily from infested grain or grain residues and can infest newly-harvested grain. Adults are about 3 mm long, and are cylindrical with the head characteristically turned down. Larvae feed initially outside the grain but older larval stages and the adults feed internally.

A generation takes about 4 weeks during summer. Infestations may develop in grain too dry for other species, with survival even when the moisture content is as low as 8%.

The rust-red flour beetle is the most common pest in grains in central storage in Queensland and is present on almost all farms. It attacks grain and seeds causing reduced germination. Damaged grain and grain dust are necessary for survival, so these should be minimized at harvest. It also attacks grain products including stockfeeds and flour, oilseeds, peanuts, other nuts and dried fruits. Adults fly readily on warm evenings from infested grain or residual seed and feed, and can infest new, uninfested produce. The adults, which are 2 mm to 5 mm long, may live up to 2 years. Both adults and larvae feed externally on the germ of grains, or in grain dust or other grain-derived products.

A generation takes about 4 weeks during summer. Development is slower during winter and effectively ceases when the temperature of the produce falls below 20°C.

STORED PRODUCTS

Maize weevil *{Sitophilus zeamais* Motschulsky)

Rice weevil *(Sitophilus oryzae* (Linnaeus))

Rice weevil x 25

The rice weevil is a major pest and is the most common species in cereal grains stored on farms. It infests wheat, oats, barley, milled rice and sorghum. Heavy infestations in bagged and bulk-stored grain leave only husks together with frass. It is also prevalent in grain spills around farms. Infestations may be detected by bumping or otherwise disturbing the grain mass—this causes the adults to move up to the surface. The adults move readily by walking but do not fly. Field infestation by this species is rare. Adults are 2 to 3.5 mm long and have the characteristic snout of weevils. Generally they have four light-coloured areas on the back, two on each wing cover. Both adults and larvae feed internally in the grain. A generation takes about 4 weeks during summer. Development is slower during winter and effectively ceases at grain temperatures below 15"C, but the adults may survive at lower temperatures.

The maize weevil is the common pest of maize on Queensland farms. It flies readily and commonly infests maize in the field, especially those varieties with exposed cobs. The maize weevil also attacks sorghum which may be infested in the field during prolonged harvests. It destroys grain in the same way as the rice weevil. The maize weevil is virtually indistinguishable from the rice weevil, but is slightly larger. Its habits and life cycle are also similar, with both larvae and adults feeding internally in grains.

STORED PRODUCTS

Sawtoothed grain beetle *(Oryzaephilus surinamensis* (Linnaeus))

Tropical warehouse moth *(Ephestia cautella* (Walker))

Sawtoothed grain beetles x 9

Tropical warehouse moth (top;, pupa (right), and larva (bottom) x 5.5

The sawtoothed grain beetle infests a wide range of stored commodities including grain, stockfeeds, processed cereal products, peanuts and dried fruits. Infestations on farms may be heavy, but are localized and usually in grain residues or spills. Damaged grain or grain dust is necessary for establishment in stored grain. The beetles can move rapidly through the infested commodity and may fly under warm conditions. Adults are about 3 mm long and have characteristic tooth-like projections on either side of the thorax. Both adults and larvae feed externally on the germ of the grain.

A generation takes about 4 weeks during summer. Development slows during winter and effectively stops at temperatures below 17.5°C.

The tropical warehouse moth is the most common moth species infesting grain and grain products in bulk storage. It also attacks peanuts, oilseeds and dried fruits. Usually only the surface layers of grain are infested. Infestation is conspicuous because of silken webbing produced by the larvae which causes clumping of grains and may cover the surface of the bulk. The moths fly over the grain bulk at dusk to lay eggs. They have a wingspan of about 1 5 mm, with a conspicuous dark band across the middle of the forewing and a less conspicuous dark band near its outer edge. The cream-coloured larvae grow to about 10 mm.

A generation takes about 5 weeks during summer, but development slows during winter and effectively stops at temperatures below 15°C.

CURRENT RECOMMENDATIONS FOR CONTROL

In situations where a pest infestation has developed the grower has little alternative but to apply a pesticide. The following tabulations, based on crop headings, list Departmental recommendations for control in such instances. Pesticides are listed under their common names, together with information on rates of use of a specified concentration of the pesticide, on pest management, and on withholding periods for sprayed crops.

Excessive use of pesticides should be avoided since it not only wastes money but may cause plant damage or aggravate the pest situation. The pest management notes have been drawn up as a guide to the intelligent use of pesticides. For this, regular field inspection is necessary, especially at vulnerable stages of plant growth. Spraying should only be carried out if an infestation is causing concern or if numbers of a pest have reached the levels specified in some of the management notes. The rates of use recommended have been found in field trials to give economic control. If the recommended rates are exceeded problems may arise through excessive residues in the crop at harvest. The withholding periods specified are the number of days which should elapse between the final spray application and harvesting or grazing. These periods are required to ensure that undesirable residues are not retained in the produce when offered for sale, or in the case of grazing are not consumed by the animal to its detriment or the detriment of subsequent human food.

Where a particular product differs in concentration from the example in the list, the required rate per 100 litres or per hectare will also differ. Reference should be made to the directions on the label.

To assist those who may not recognize pesticides by their common names an appendix gives their registered trade names. Not all these formulations are registered for each of the uses of the pesticides recommended. It is important that users read the label to ensure that a particular product is registered for the crop-pest situation for which it is required.

Insecticides are poisonous compounds. Care should be taken in their use, particularly in handling concentrates. Avoid contact with the skin and minimize exposure to spray drift.

CEREAL CROPS

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per ha
ARMYWORMS *Pseudaietia* spp.	Check soil and dead leaves at base of plants for armyworms especially at crop ripening. Spray maturing barley plants if head loss is likely to be greater than 20 heads per m^2.	chlorpyrifos	10 (harvest) 2 (grazing)	700-900 raL of 500 g/L
		chlorpyrifos ULV	10 (harvest) 2 (grazing)	700-900 mL of 500 g/L
		diazinon		1.0-1.1 L of 800 g/L
		maldison ULV	7 (harvest)	700 mL of 1180 g/L
		methidathion	42 (harvest) 7 (grazing)	1.4 L of 400 g/L
		permethrin	~	100-200 mL of 500 g/L
		trichlorfon	14 (harvest)	900 mL of 6O0 g/L
BLUE OAT MITE *Penthaleus major*	If pale green to greyish irregular patches appear in the crop, check for the presence of blue oat mite at leaf base. Damage is most likely during dry seasons.	azinphos ethyl	30 (harvest) 14 (grazing)	90 mL of 400 g/L
		methidathion	42 (harvest) 7 (grazing)	90 mL of 400 g/L
BROWN WHEAT MITE *Petrobia latent*	Damage is only severe in dry seasons. Early damage appears as leaf mottling. Severe damage results in bronzing or yellowing which can be seen at a distance. If this more severe damage develops, spraying may be necessary. Crop rotation is beneficial in reducing the possibility of infestation.	dimethoate	28 (harvest)	90 mL of 400 g/L

COTTON

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per ha
BUDWORMS *Heliothis* spp.	Thorough sampling for small larvae during periods of oviposition is essential. Infestations are more significant during peak squaring. Treatment is necessary when 8-10% terminals are infested. In presquaring stage higher levels of infestation may be tolerated.	chlordimeform		1.0 L of 500 g/L
		cypermethrin	14	300-700 mL or 200 g/L
		cypermeth rin ULV	14	1.5-3.5 L of 40 g/L
		deltamethrin	7	500-700 mL of 25 g/L
		deltamethrin ULV	7	2.5-3.5 L of 5 g/L
		endosulfan	28	2.1 L of 350 g/L
		fenvalerate	7	300-700 mL of 200 g/L
		fenvalerate ULV	7	1.5-3.5 L of 40 g/L
		methomyl	—	1.8-2.4 L of 225 g/L or 0.5-1 0L for small larvae
		permethrin ULV	—	1.8-3.6 L of 50 g/L
		profenofos	28	1.5-2.0 L of 500 g/L
		sulprofos	14	1.0-1.4 L of 720 g/L
COTTON APHID *Aphis gossypii*	Heavy infestations (20-30% infested terminals) late in the season warrant control because they produce honeydew which stains the lint and interferes with harvesting.	dimethoate	14	650 mL of 300 g/L
		endosulfan		2.1 L of 350 g/L
		monocrotophos	21	900mL-1.2L of 400 g/L
		omethoate	21	700 mL of 800 g/L
		profenofos	28	1.0 L of 500 g/I-
COTTON LEAFHOPPER *Amrasca terraereginae*	Leafhopper attack is most prevalent during seedling stage. Treatment may be necessary if large populations occur, since they cause severe leaf stippling and retard growth of seedlings.	dimethoate	14	650 mL of 300 g/L
		endosulfan	28	2.1 L of 350 g/L
		monocrotophos	21	900mL-1.2L of 400 g/L
		omethoate	7	700 mL of 800 g/L
COTTON LOOPER *Anomis flava*	Cotton loopers are normally not a problem. They are also kept under control by sprays applied against budworms.	cypermethrin	14	400-500 mL of 250 g/L
		endosulfan	28	2.1 L of 350 g/L
		methomyl		1.4-1.8 L of 290 g/L
		monocrotophos	21	1.9-2.1 L of 400 g/L
COTTON SEEDLING THRIPS *Thrip.s (abaci*	Treatment is warranted when 70-80% of seedlings are infested. Populations develop rapidly and twice weekly inspections are recommended.	dimethoate	14	650 mL of 300 g/L
		monocrotophos	21	900 mL of 400 g/L
		omethoate	21	700 mL of 800 g/L
COTTON TIPWORM *Crocidosema plebejana*	Terminal damage induces secondary branching. This delays maturity which may be important on the Darling Downs and at St. George but is not important under the warmer conditions in central Queensland. Where necessary apply treatment when 40-50% terminals are infested.	endosulfan	28	2.1 L of 350 g/L
CUTWORMS *Agrolis* spp.	Feeding may severely reduce seedling stand. Larvae occur near the plants in top 3-5 cm of soil. Band spray over the rows.	chlorpyrifos		700 mL of 500 g/L
		endosulfan	28	2.1 L of 350 g/L
PINKSPOTTED BOLLWORM *Pectinophora sculigera*	Only a problem in the Dawson/Callide area of central Queensland. Cultural control by disposing of crop residues is most effective. When reliance is placed on scouting for control of budworms, resulting in a reduction in the number of sprays, sampling for pinkspotted boll worm is essential. Apply treatments when 3-5% bolls are infested. Several applications may be necessary.	deltamethrin	7	500-700 mL of 25 g/L
		(central Qld. only)	7	400 mL of 200 g/L
ROUGH BOLLWORM *Earias huegeli*	Similar to pinkspotted bollworm. Two applications at 4-7 day intervals are necessary to control infestations.	cypermethrin	14	300-400 mL of 250 g/L
		endosulfan	28	2.1 L of 350 g/L
		monocrotophos	21	1.9-2.1 L of 400 g/L
		permethrin ULV	7 —	550 mL-1 L of 500 g/L 1.8-3.6 L of 50 g/L
TWOSPOTTED MITE *Tetranychus urticae*	Populations can develop rapidly and treatment is warranted when 60-70% terminals are infested.	methidathion	3	1.4 L of 400 g/L
		monocrotophos	21	900 mL of 400 g/L
		profenofos	28	1.0 L of 500 g/L

FOOTNOTE: The terminal is the commonest sample unit used. Infestations should be assessed twice weekly by fixed sample (25 terminals) or by sequential sampling methods.

Scouting is essential for rational control of insect pests in cotton. Decision to spray is based on per cent terminals infested. The tolerable level of infestation depends on the stage of crop growth. If parasites and predators are common, endosulfan is preferred since it is least harmful to them. Repeated applications of synthetic pyrethroids (e.g. cypermethrin, deittmethrin, fenvalerate, permethrin) should be avoided since it has been shown that their use results in outbreaks of aphids and spider mites. This occurs because of the adverse effects of these chemicals on parasites and predators.

DUBOISIA

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per 100 L
BLACK SCALE *Saissetia oleae*	Spray with mineral oil if the infestation begins to cause dieback. Control attending ants with a 0.1% chlorpyrifos spray to the base of the trunk.	mineral oil	—	1 L miscible summer
CLUSTER CATERPILLAR *Spodoptera titura*	Spot spray young trees if clusters of larvae are evident and defoliation is occuring.	carbaryl methomyl	-	125 g of 800 g/kg 110 mL of 225 g/L
DUBOISIA LEAF BEETLE *Psyltiodes parilis*	Spray when more than 2 adults are evident on each terminal shoot. Spray may have to be repeated at 6-weekly intervals throughout the year.	carbaryl	-	125 g of 800 g/kg
LARGE LEAFEATING LADYBIRD *Henosepilachna guitatopustulata*	Spray trees if larval clusters are found or when leaf damage is first seen.	carbaryl promecarb	-	125 g of 800 g/kg 100 g of 490 g/kg
SANDAL-BOX HAWK MOTH *Coenotes eremophilae*	Spot spray trees if clusters of larvae are evident and defoliation is occuring.	carbaryl	-	125 g of 800 g/kg

GRAIN LEGUMES (navy beans, soybeans, chickpeas, cowpeas, pigeon peas)

Pest	Management notes	Pesticide	Withholding (day*)	Rate of specified commercial prepara-
BEAN FLY *Ophiomyia phase oh*	Sample daily from plant emergence. Only spray if 1 or more larval tunnels found per plant. A repeat spray may be needed after 7 days, based on results of continued monitoring.	diazinon dimethoate methomyl	-? -? -?	150mLof800g/L 800 mL of 400 g/L 1 L of 225 g/L
BEAN PODBORER *Maruca testulalis*	Spraying specifically against this insect is only required in navy beans. Spray if more than 3 larvae occur per metre of row. in other grain legumes it is normally controlled by sprays directed against corn	methomyl	1	1.5-2 L of 225 g/L
BEAN SPIDER MITE *Tetranychus ludeni*	Spray if numbers from 5 leaflets at each site average more than 10/cm^3 (navy beans) and	dimethoate monocrotophos propargite	7 5 7	800 mL of 400 g/L 900 mL of 400 g/L 1.1 kgof300g/kg
CORN EARWORM *lieliolhis armiger*	Monitor as in footnote. For soybeans, spray when average of 2 or more larvae occur per metre of row. For navy beans, spray when average is 1 or more per 2 metres of row.	fen valerate methomyl	21 (harvest) 7 (grazing) 1	400-500 mL of 200 g/L 1.5-2 L of 225 g/L
GREEN VEGETABLE BUG *Nezara viridula*	Monitor populations as per footnote between 7 and 9 a.m. when pests are exposed on the crop. Spray if average number over the 5 sites exceeds 20 of all stages of the bug (soybean) or 5 (navy bean).	dimethoate endosulfan methomyl monocrotophos	7 7 1 5	450 mL of 300 g/L 2.1 L of 350 g/L 1.5 L of 225 g/L 700 mL of 400 g/L
JASSIDS *Austroasca* spp.	On navy beans, vegetable jassids do not need controlling unless jassid stipple is clearly visible when standing in the field. For lucerne leaf hopper, if shaking the plant raises large numbers (20 or more jassids per large plant) spraying is warranted. Other crops are unlikely to require spraying for	dimethoate endosulfan	7 7	450 mL of 300 g/L 1.6 L of 450 g/L
NATIVE BL'DWORM *Heliothis punctiger*	Most damaging on chickpea. Examine the crop during the green-pod stage. Spray if larva! numbers cause concern.	endosulfan fenvalerate methomyl!	7 7(grazing) 21 (harvest) -?	1.6 L of 450 g/L 400-500 mL of 200 g/L 1.8-2.4 L of 225 g/L
SOYBEAN LOOPER Diachrysia orichalcea	Spray at pod-filling stage in soybeans or navy beans if necessary.	fenvalerate methomyl	7(grazing) 21 (harvest) 1	400-500 mL of 200 g/L 1.5 L of 225 g/L

FOOTNOTE: Inspect weekly from seedling stage to onset of flowering and twice weekly thereafter on at least 5 sites per 100 ha for soybeans and 5 sites per 20 ha for navy beans. At each site examine at least 4 metres of row for corn earworm and for all other pests except green vegetable bug. For that pest examine 20 metres of row at each site.

LINSEED

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per ha
NATIVE BUDWORM *Heliothis punctiger*	Check plants at and after flowering for eggs and small larvae. Spray when high populations of young larvae (less than 1 cm long) are present.	carbaryl endosulfan fenvalerate methomyl	3 28 14 1	1.4kgof800g/kg 2.1 Lof350g/L 400-500 mL of 200 g/L 1.5-2 L of 225 g/L

LUCERNE

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per ha
APHIDS				
BLUEGREEN APHID *Acyrihosiphon kondoi.*	Protect susceptible varieties of seedlings for 4-6 weeks with disulfoton drilled in with seed and/or spray when 2 aphids/plant are found during bi-weekly inspections.	demeton-s-methyl	3	150-300 mL of 250 g/L
		dimethoate	7	200 mL of 300 g/L
SPOTTED ALFALFA APHID *Therioaphis* (n/o/iiand		disulfoton	70	5 kg of 50 g/kg granule (see footnote)
PEA APHID *Acyrihosiphon pisum*	For young crops spray when there are more than 5 aphids/plant. For older, hay crops spray or harvest if there are more than 20 aphids/plant.	methidathion	7	750 mL of 400 g/L
		pirimicarb	3	100-150 gof 500 g/kg
		thiometon	7	150 mL of 245 g/L
CUTWORMS *Agroiis* **spp.**	seedling stands occur.	chlorpyrifos		700 mL of 500 g/L
		trichlorfon	2	900 mL of 600 g/L
JASSIDS				
LUCERNE LEAFHOPPER *Austroasca alfalfae and* **VEGETABLE JASSID** *Austroasca viridigrisea*	Spray for lucerne leafhopper if numbers exceed 200 per 10 sweeps of 350 mm diameter insect net. Spray for vegetable jassid only if stippling is excessive.	carbaryl	1	1.1-1.4 kg of 800 g/kg
		diazinon	14 (harvest) 2(grazing)	350 mL of 800 g/L
		dimethoate	7	450 mL of 300 g/l
LUCERNE LEAFROLLER *Merophyas divulsana*	Harvest or spray if 30% or more of terminals rolled.	carbaryl	1	1.1 kg of 800 g/kg
		chlorpyrifos	10 (harvest) 2 (grazing)	400 mL of 500 g/kg
		methidathion	7	850 mL of 400 g/L
NATIVE BUDWORM *Heliothis punctiger*	Spray if one or more medium to large healthy larvae are present per 10 stalks. Do not spray if larval disease is common.	carbaryl	1	1.1-1.4 kg of 800 g/kg
		methomyl	3	1.5-2 L of 225 g/L

FOOTNOTE: Only apply disulfoton by drilling in with the seed at time of planting.

MAIZE

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per ha
ARMYWORMS ***Pseudaletia convecia* and *Spodoptera exempla***	Spray seedling stands if large numbers of small larvae are found on or around the plants. Weekly inspections of maize crops (especially in north Queensland) are required as early detection is important.	chlorpyrifos	10 (harvest) 2 (grazing)	700-900 mL of 500 g/L
		diazinon	14 (harvest) 2(grazing)	1 L of 800 g/L
		maldison ULV	7	700 mL of 1180 g/L
		methidathion	42 (harvest) 7 (grazing)	1.4 L of 400 g/L
		methomyl	1	1.5 L of 225 g/L
		trichlorfon	14 (harvest) 2(grazing)	900 mL of 600 g/L
AUSTRALIAN PLAGUE LOCUST ***Ckorloiceles lermim/era***	Wherever possible d-rect treatment against small hoppers since that gives best control. Spraying against concentrations of adults should be done when thev are at rest, early in the morning or at dusk.	carbaryl	1	1.2-1.4 L of 500 g/L
		chlorpyrifos ULV	10 (harvest) 2(grazing)	560 mL of 500 g/L
		diazinon	14 (harvest) 2 (grazing)	700 mL of 800 g/L
		diazinon ULV	14 (harvest) 2 (grazing)	550-700 mL of 980 g/L
		fenitrothion	7(grazing)	325 mL of 1000 g/L
		maldison ULV	"	450-700 mL of 1180 g/L
CORN EARWORM *Hetiotkis armiger*	Spray every 2 to 3 days at green silk stage (sweet corn only).	fenvalerate	7	300-500 mL of 200 g/L
		methomyl	1 (harvest) 3(grazing)	1.5-2 L of 225 g/L
BLACK FIELD EARWIG *Na!a lividipes*	Control measures are required if present in numbers during land preparation for planting. Apply insecticide as an m-furrow spray at planting.	chlorpyrifos	—	1 mL of 500 g/L in 10 L water per 100 m of row.
CUTWORMS *Agrotis* **spp.**	Eliminate alternative weed hosts 4 to 6 weeks before planting. Look out for cutworm damage in seedlings (plants cut off at ground level). Spray immediately if losses are causing concern.	chlorpyrifos	10 (harvest) 2(grazing)	900 mL of 500 g/L
		diazinon	14 (harvest) 2(grazing)	I L of 800 g/L
CUTWORMS *Agroiis* spp.		trichlorfon	14 (harvest) 2 (grazing)	900 mL of 600 g/L
FALSE WIREWORMS *Gonocephalum macleayi. Pterohelaeus alternatus.* *Pterohelaeus darlingemis*	Sample soil.for larvae before planting. If present, use insecticide as a seed treatment. Also, use press wheels or rollers to reduce larval damage by promoting rapid germination and faster seedling growth. The insecticides, chlorpyrifos and lindane. are applied as a pre-plant seed treatment using the wettable powder formulation.	chlorpyrifos WP	—	!60gof250g/kg/ 100 kg seed
		lindane WP		250gof200g/kg/ 100 kg seed
MAIZE LEAFHOPPER *Cicadulina himaculam*	Associated with wallaby ear disease, especially in late planted coastal crops. Plant resistant varieties.	dimethoate	28	470 mL of 300 g/L
MIGRATORY LOCUST *Locusta migraloria*	As for Australian plague locust.	carbaryl	1	600-850 g of 800 g/kg
		chlorpyrifos ULV	10 (harvest) 2(grazing)	350 mL of 500 g/L
		diazinon	14 (harvest) 2(grazing)	700-850 mL of 800 g/L
		diazinon ULV	14 (harvest) 2(grazing)	580-720 mL of 980 g/L
		fenitrothion	7(grazing)	400-550 mL of 1000 g/L
		maldison ULV	~~nil~~	450-700 mL of 1180 g/L
		naled	1 (harvest) 2(grazing)	350-500 mL of 900 g/L
SPUR-THROATED LOCUST *guttutosa*	As for Australian plague locust.	chlorpyrifos ULV	10 (harvest) 2(grazing)	1.25-1.5 L of 500 g/L
		fenitrothion	7	400-550 mL of 1000 g/L
		monocrotophos	5	350-700 mL of 400 g/L
		naled	1 (harvest) 2 (grazing)	450-600 mL of 900 g/L

ONIONS

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial prepara-
ONION THRIPS *Tkrips*	**Spraying is not normally necessary on early planted crops. In later crops spray if large numbers (more then 50 per plant) of thrips occur.**	**dimethoate** **methidathion** **omethoate**	**7** **7** **7**	**800 mL of 400 g/L** **750 mL of 400 g/L** **700 mL of 800 g/L**

PASTURES AND PASTURE SEED CROPS

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per ha
BUFFEL GRASS SEED CATERPILLAR *Mampava rhodoneura*	After January, monitor moth activity. One week after peak activity inspect the field for larvae. Spray if the number of larvae causes concern.	methomyl	—	1.75L of 225g/L
FUNNEL ANT *Aphaenogaster pytMa*	Pasture renovation through cultivation may be necessary to establish a dense sward. Maintain a dense grass cover by controlled grazing to exclude	nil		
AUSTRALIAN PLAGUE LOCUST *Chortoketes lermin fera*	Spraying against hopper bands gives best results when the hoppers are small. Spraying against concentrations of adults should be done when they are at rest early in the morning or at dusk.	carbaryl chlorpyrifos ULV diazinon diazinon ULV fenitrothion fenitrothion ULV maldison ULV	1 (grazing) 14 (harvest) 2 (grazing) 14 (harvest) 2(grazing) 7(grazing) 7 (grazing) 1 (grazing)	600-850 g of 800 g/kg 560mL of 500g/L 700mL of 800g/L 550-700 mL of 980 g/L 650mL of 500g/L 300-400 mL of 1280 g/L 450-700 mL of 1180 g/L
MIGRATORY LOCUST *migratoria*	As for Australian plague locust.	carbaryl chlorpyrifos ULV diazinon diazinon ULV fenitrothion fenitrothion ULV maldison ULV naled	1 (grazing) 14 (harvest) 2(grazing) 14 (harvest) 2 (grazing) 7 (grazing) 7 (grazing) 1 (grazing) 1 (harvest) 2 (grazing)	600-850 g of 800 g/kg 350 mL of 500 g/L 700-850 mL of 800 g/L 580-720 mL of 980 g/L 800mL-i L of 500 g/L 300-400 mL of 1280 g/L 450-700 mL of 1180 g/L 350-500 mL of 900 g/L
SPUR-THROATED LOCUST *Austracris gutulosa*	As for Australian plague locust.	chlorpyrifos ULV diazinon fenitrothion fenitrothion ULV monocrotophos naled	— 7 (grazing) 7 (grazing) 7 1 (harvest) 2(grazing)	1.25-1.5 L of 500 g/L 580-720 mL of 980 g/L 800mL-l L of 500 g/L 300-400 mL of 1280 g/L 350-700 mL of 400 g/L 450-600 mL of 900 g/L
YELLOW-WINGED LOCUST *Gasmmargus*	As for Australian plague locust.	carbaryl maldison ULV	1 (grazing) 1 (grazing)	600-850 g of 800 g/kg 450-700 mL of II80 g/L
PASTURE WEBWORMS *Oncopera brachyphytla* *Oncopera mitocera*	In legume-based pastures in north Queensland spray in early September if webworm numbers exceed 9 per m².	chlorfenvinphos diazinon	7 14	550 mL of 500 g/L 700 mL of 800 g/L
ROUGH BROWN WEEVIL *Baryopadus corrugatus*	In areas where rough brown weevil is a problem avoid successive plantings of tropical seed legumes to prevent build up of weevil populations. Spray if adults appear in numbers after the first storm rains	azinphos-ethyl	14	1.4 L of 400 g/L
SEEDHARVESTING ANTS *Pheidole* spp.	Where the ants are known to be a problem in establishment of pastures, treat seed with insecticide before planting.	lindane WP	—	See footnote
SOD WEBWORM *Herpetogramma Ikarsisalis*	Protection of grass Tor grazing during winter is most important. In this connection look for signs of damage (brown patches) during late summer/early autumn. Spray if necessary.	trichlorfon	2(grazing)	900 mL of 600 g/L

FOOTNOTE: Seedharvesting ants *(Pheidole* spp.) are controlled by treating the seed before planting with lindane at the rate of 450 g of 200g/kg/l00kgofseed.

PEANUTS

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per ha
CORN EARWORM *Heliothis armiger* and NATIVE BUDWORM *Heliothis punctiger*	Infestations of native budworm are usually controlled by outbreaks of virus disease. Spraying for corn earworm should only be carried out if larval numbers at flowering exceed 1 per metre of	endosulfan methomyl	7 14	2.1 L of 350 g/L 1.S-2.0L of 225 g/L
LUCERNE SEED WEB MOTH *Elietla bthrii*	Where infestation is detected harvest early if possible.	nil		
PEANUT MITE *Paraphnobia* sp.	Infestations are most damaging in young crops during periods of drought. Populations of the mite decline rapidly following rain.	dimethoate	14	450 mL of 300 g/L
WHITEFRINGED WEEVIL *Graphognathus leucoloma*	Crop rotation is essential to prevent build up of weevil populations in the field. Also, remove all volunteer peanut plants to reduce adult weevil numbers in the soil.	nil		
WHITEGRUBS *Heteronyx* spp.	Crop rotation, together with deep ploughing, will reduce numbers of the pest. Destroy weeds in fallow by cultivation to prevent larval development. Early harvesting in infested areas is recommended.	nil		

POTATOES

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per 100 L
GREEN PEACH APHID *Myzus persicae*	This is the main vector of potato leaf roll virus. numbers low. Plant certified virus-free seed potatoes.	dimethoate methamidophos monocrotophos pirimicarb	7 7 3 2	100 mL of 300 g/L 50 mL of 580 g/L 1.0L of 400 g/L 50 g of 500 g/kg
POTATO MOTH *Phlhorimaea Operculetla*	Remove crop residues after harvest. Where possible, rotate cropping. Careful hilling and attention to prevent soil cracking are most effective cultural practices in minimizing tuber damage. If the number of small Jeaf mines increases, spray immediately. Repeated spraying may be required at 2 week intervals because of re-infestation from outside sources. Tubers held on farm for seed or for sale at a later date should be kept in cool storage or treated with den-is dust.	azinphos-ethyl carbaryl chlorfenvinphos methamidophos methomyl monocrotophos permethrin	3 14 3 1 1 3	65 g of 750 g/kg 125 mL of 400 g/L 1.4kg of 800 g/kg 50 mL of 500 g/L See footnote 65 mL of 580 g/L 1.5-2.0 L of 225 g/L 1.0 L of 400 g/L 150-200 mL of 500 g/L

FOOTNOTE: Apply 250 g of 7.5 g/kg rotenone per bag.

PUMPKINS

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per 100 L
PLAIN PUMPKIN-BEETLE ***Aulacophora abdominaiis*** **and PUMPKIN BEETLE** ***Aulacophora hilaris***	**Spray if beetles appear on seedlings. Further sprays may be required if beetles appear in large numbers on young leaves, flowers and young fruit.**	**carbaryl** **promecarb**	**3** **28**	**125gof800g/kg** **100gof490g/kg**
TWENTYEIGHT-SPOTTED LADYBIRD ***Henosepilachna vigintioctopunctata***	**Spray if ladybirds occur on young plants. Further sprays may be required if large numbers of adults and larvae occur on older plants.**	**carbaryl** **promecarb**	**3** **28**	**125gof800g/kg** **100gof490g/kg**

RICE

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial prepara-
BROWN PLANTHOPPER *Nilaparvata*	*Mareeba growers*—spray as indicated by the BROWN PLANTHOPPER MONITORING SERVICE. *Burdekin growers*—spray when planthoppers exceed 10 per stool or when hopper bum is seen. Carbofuran granules unlikely to be effective in	carbofuran diazinon	14 42 2	1.3kgof800g/kg 10 kg of lOOg/kg 350mLoflOOg/L
BROWN RICE STINK BUG *Eysarcoris* sp.	Destroy crop residues and ratoon rice as soon as possible after harvest. Keep headlands and banks clear of grass. Spray if pest numbers exceed 4 per	carbaryl	14	I.3kgof800g/kg
PADDY BUG *Lepiocorisa*	Destroy crop residues and ratoon rice as soon as possible after harvest. Keep headlands and banks clear of grass. Spray as necessary.	carbaryl	14	1.3kgof800g/kg
WHITE RICE STEMBORER *Tryporyza*	Destroy crop residues as soon as possible after harvest. Plant crops early in the season. Carbofuran granules unlikely to be effective in upland rice.	carbaryl carbofuran	14 42	1.3kgof800g/kg lOkgoflOOg/kg

SAFFLOWER

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial prepara-
GREY CLUSTER BUG ***Nysius clevelandensis*** **and**	**Inspect plants regularly from budding onwards. Spray if there are 1 5 adults or more per plant.**	**endosulfan maldison**	**28**	**2.1 L of 350 g/L 450-900 mL of !!80 g/L**
		methidathon	**3**	**1 L of 400 g/L**
RUTHERGLEN BUG		**trichlorfon**	**14**	**900 mL of 600 g/L**
NATIVE BUDWORM ***Heliothis puncliger***	**Inspect crops regularly from budding onwards. Spray when larvae are small (less than 1 cm long).**	**endosulfan**	**28**	**2.1 L of 350 g/L**
THISTLE APHID ***Capilophorus elaeagni***	**Check tips and undersurface of leaves. Spray only if aphids are present in large numbers.**	**endosulfan**	**28**	**2.1 L of 350 g/L**

Bees are important pollinators. Therefore, if spraying during flowering is unavoidable, spray in late evening when bees are least active. Use insecticides which are least harmful to bees such as endosulfan and trichlorfon.

SORGHUM

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per ha
AUSTRALIAN PLAGUE LOCUST *Chortoicetes termini/era*	Spraying against hopper bands gives best results when the hoppers are small. Spraying against concentrations of adults should be done when they are at rest early in the morning or at dusk.	carbaryl	1	750-850 g of 800 g/kg
		chlorpyrifos ULV	2	560 mL of 500 g/L
		diazinon	14 (harvest) 2 (grazing)	700 mL of 800 g/L
			14 (harvest) 2 (grazing)	550-700 mL of 980 g/L
		fenitrothion ULV	14 (harvest) 7(grazing)	650 mL of 500 g/L
		maldison ULV	~	450-700 mL of 1180 g/L
CORN EARWORM *Heliothis armiger*	Early detection of small larvae in the heads is essential for effective control. Spray when numbers exceed 2 per head.	endosulfan	28	1.6 L of 450 g/L
		fen vale rate	7	300-400 mL of 200 g/L
		methomyl	14	1.5-2 L of 225 g/L
CUTWORMS *Agrotis* spp.	Eliminate alternative weed hosts 4 to 6 weeks before planting, Look out for cutworm damage (plants cut off at ground level). Spray promptly if losses are causing concern.	chlorpyrifos	2 (harvest) 1 (grazing)	900 mL of 500 g/L
		trichlorfon	14 (harvest) 2 (grazing)	900 mL of 600 g/L
DAYFEEDING ARMYWORM *Spodoptera exempta*	Control if necessary in the seedling stage of plant growth. Do not apply chlorpyrifos, fenitrothion or trichlorfon to alpha or pioneer 848 varieties. Non-economic phytotoxicty may occur on other	chlorpyrifos	2	900 mL of 500 g/L
		methomyl		1.5 L of 225 g/L
		trichlorfon	14 (harvest) 2(grazing)	900 mL of 600 g/L
FALSE WIRE WORMS *Gonocephalum macleayi. Pterohetaeus alternants, Pterohelaeus darlingensis*	Sample soil for larvae before planting. If present, use insecticide as a seed treatment. Also, use press wheels or rollers to reduce larval damage by promoting rapid germination and faster seedling growth.	chlorpyrifos WP	—	See footnote
MIGRATORY LOCUST *migraloria*	As for Australian plague locust.	carbaryl	1	750-850 g of 800 g/kg
		chlorpyrifos ULV	2	350 mL of 500 g/L
		diazinon	14 (harvest) 2 (grazing)	700-850 mL of 800 g/L
		diazinon ULV	14 (harvest) 2 (grazing)	580-720 mL of 980 g/L
		fenitrothion	7 (grazing)	800 mL-l L of 500 g/L
		maldison ULV	—	450-700 mL of 1180 g/L
		naied	1 (harvest) 2(grazing)	350-500 mL of 900 g/L
SEEDHARVESTING ANT *Pheidole ampla*	Where the ants are known to be a problem use seed treatment. Also, use press wheels or rollers to accelerate germination and thereby minimize ant attack.	lindane WP	14 (harvest)	See footnote
SORGHUMHEAD CATERPILLAR *Cryptoblabes adocela*	This pest prefers compact-headed varieties. Practise crop rotation to avoid build up of pest numbers.	endosulfan	28	1.6 L of 450 g/L
		trichlorfon	14 (harvest) 2(grazing)	900 mL of 600 g/L
SORGHUM MIDGE *Contarinia sorghicola*	Use agronomic practices to minimize midge activity. These include eliminating volunteer sorghum and Johnson grass, avoiding flowering during expected rains and reducing the time spread of flowering. Scout carefully following head emergence and during flowering. Spray when there is an average of 2 midges per head.	carbaryl	1	2-2.5 L of 500 g/L
		chlorpyrifos	2	500 mL of 500 g/L
		chlorpyrifos ULV	2	500 mL of 500 g/L
		fen valerate		100 mL of 200 g/L
		fen valerate ULV	-	500 mL of 40 g/L
		maldison ULV		450 mL of 1180 g/L
		monocrotophos	5	500-700 mL of 400 g/L

FOOTNOTE: False wireworms are controlled by treating the seed with chlorpyrifos at the rate of 160 g of 250 g/kg/100 kg of seed before planting.

FOOTNOTE: Seedharvesting ant *(Pheidole ampla),* is controlled by treating the seed with lindane at the rate of 300 g of 200 g/L/100 kg of seed before planting.

SWEET POTATO

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial prepara-
SWEET POTATO WEEVIL *Cytas formicarius elegantulus*	Plant uninfested material into uninvested soil. Chemical control of existing infestation is not recommended. Where infestation occurs practice crop rotation.	nil		

TOBACCO

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation
CORN EARWORM *Heliothis armiger* and NATIVE BUDWORM *Heliolhn punctiger*	Spray seedlings and transplants 3 times at WEEKLY INTERVALS. Subsequently, spray untopped crops as recommended by the TOBACCO PEST PREDICTION SERVICE (north Queensland) OR spray untopped crops if budworm numbers exceed 1 per 27 plants.	acephate	14	1.3 kg of 750 g/kg per ha
		cypermethrin		75–100 mL of 100 g/L per 100 L
		deltamethrin	7	50 mL of 25 g/L per 100 L
		methomyl	3	200–250 mL of 350 g/L per 100 L 100–200 mL of 225 g/L per ha
		permethrin		100–200 mL of 500 g/L per ha
		sulprofos	7	2.50 mL–3.0 L of 720 g/L per ha
CLUSTER CATERPILLAR *Spodoplera luura*	Spray if damage to leaves is causing concern.	methomyl	3	100–200 mL of 225 g/L per ha
		permethrin	2	100–200 mL of 500 g/L per ha
TOBACCO LEAFMINER *Phthorimaea operculellti*	Destroy crop residues in the field and seedlings remaining in seedbed after transplanting is completed. Spray seedlings and transplants as for budworms. Particular attention should be paid to late planted crops in north Queensland.	methomyi	3	100 mL of 225 g/L per ha
		monocrotophos	5	150 mL of 400 g/L per 100 L
		sulprofos	7	70 mL of 720 g/L per ha
TOBACCO LOOPER *Chrywdeixis argenlifera*	Spray seedlings and transplants as for budworms. Subsequently, spray as recommended by the TOBACCO PEST PREDICTION SERVICE (north Queensland) OR spray if numbers of medium-sized loopers (1 cm long) exceed 3 per 4	acephate	14	1.3 kg of 750 g/kg per ha
		deltamethrin		50 mL of 25 g/L per 100 L
		endosulfan		200–250 mL of 350 g/L per 100 L
		methomyi	3	100 mL of 225 g/L per ha
		monocrotophos	5	150 mL of 400 g/L per 100 L
TOBACCO STEMBORER *Sirobipalpa heliopa*	Destroy crop residues in the field and seedlings remaining in the seedbed afler transplanting is completed. Spray seedlings and transplants weekly. Particular attention should be paid to late planted crops in north Queensland.	methomyi	3	100 mL of 225 g/L per ha
		monocrotophos	5	150 mL of 400 g/L per 100 L
		sulprofos	7	100 mL of 720 g/L per ha
		deltamethrin	—	50 mL of 25 g/L per 100 L

SORGHUM

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per ha
SPUR-THROATED LOCUST *guttulosa*	As for Australian plague locust.	chlorpyrifos chlorpyritos ULV fenitrothion fenitrothion ULV monocrotophos naled	- 7 (grazing) 7 (grazing) 1 (harvest) 2 (grazing)	1.25–1.5 L of 500 g/L 1.25–1.5 L of 500 g/L 500 mL–1 L of 500 g/L 800–400 mL of 1280 g/L 350–700 mL of 400 g/L 450–600 mL of 900 g/L
YELLOW-WINGED LOCUST *Gasirimargus musicus*	As for Australian plague locust.	carbaryl maldison ULV	1	1.2–1.4 L of 500 g/L 450–700 mL of 1180 g/L

SUNFLOWER

Pest	Management notes	Pesticide	Withholding (days)	Rate of specified commercial preparation per ha
BUDWORMS *Heliothis* spp.	Spray if large infestations occur.	cypermethrin endosulfan fenvalerate methomyl	28 14	300–400 mL of 250 g/L 2.1 L of 350 g/L 450–900 mL of 200 g/L 1.5 L of 225 g/L
CUTWORMS *Agrotis* spp.	Spray when losses to seedlings occur.	chlorpyrifos	–	900 mL of 500 g/L
FALSE WIREWORMS spp. and *Pterohelaeus* spp.	Against larvae in the soil: Apply treatment only if pre-plant sampling indicates larvae are present. Use procedures such as water injection and press wheels to reduce larval damage through rapid germination and seedling growth. Insecticide is applied as a seed treatment at planting.	chlorpyrifos WP	—	See footnote
	Against adults: If damage to seedlings is causing concern, use insecticide bait. Spraying is not effective as beetles hide by day and escape treatment.	chlorpyrifos		400 mL of 500 g/L + 250 mL sunflower oil to 4.5 kg cracked wheat
		methiocarb	"	2.5 kg of 20 g/kg pellets
GREEN VEGETABLE BUG *Nezara viridula*	Adults bask on plants in early morning. Spray when average number per plant is 2 or more.	dimethoate endosulfan methomyl	7 28 –	450 mL of 400 g/L 2.1 L of 350 g/L 1.5 L of 225 g/L
RUTHERGLEN GREY CLUSTER BUGS *Nysius* spp.	Preflowering Spray: if more than 25 adults per plant. Postflowering Spray: if more than 30 adults per head before heads turn down.	cypermethrin endosulfan maldison methidathion	28 3	300–400 mL of 250 g/L 2.1 L of 350 g/L 450–900 mL of 1000 g/L 1.1 L of 400 g/L
WINGLESS COCKROACHES *Cosmozosteria* spp. and *Desmozosteria* spp	If cockroaches are abundant at planting, use insecticide bait. Spraying is not effective as cockroaches hide by day and escape treatment.	chlorpyrifos methiocarb	—	300 mL of 500 g/L + 250 mL sunflower oil to 4.5 kg cracked wheat 2.5 kg of 20 g/kg pellets

FOOTNOTE: Treat seed against larvae of false wireworms (*Gonocephaium* spp. and *Pterohelaeus* spp), at the rate of 160g of 250g/L chlorpyrifos per 100 kg seed before planting.

Sunflowers are dependent on honey bees for pollination. Therefore, if spraying during flowering is unavoidable, sprav in late afternoon when bees are least active. Use insecticides which are least harmful to bees such as endosulfan or methomyl.

STORED GRAIN

Situation	Management notes	Pesticide	Rate of specified commercial preparation per m^3	Minimum
Disinfestation of infested	Jumigation must be carried out in a gas-tight enclosure to ensure complete control. Storage structures must be carefully sealed.* Fumigants are highly toxic and should be handled with care. Two fumigants—methyl bromide and phosphine—are effective against grain Dosage rates for fumigants are based on internal volume of the enclosure and apply equally to full, partly filled or empty enclosures. METHYL BROMIDE This should only be used by licensed operators. Additionally, it may reduce germination. PHOSPHINE However, the following rules must be observed. (a) Operators must leave the affected area within 2 hours of commencing placement of tablets. (b) Produce must be aired for 5 days following fumigation before it is handled. (c) Tablets or pellets should never be exposed to free water or placed in close-packed groups as these conditions could result in fire. Do not use phosphine when grain moisture content is less than 9%, or when grain temperature is less than 15°C.	bromide	32 g	24 h
(a) In a gas-tight enclosure.	In a structure which meets gas-tight standards under pressure test, such as a welded steel bin, a lower dosage rate may be used. A gas-tight enclosure will be insect-proof and prevent re-infestation, but may allow lethal concentrations of carbon dioxide to build up or lead to moisture migration problems with high moisture grain.	phosphine	1.5 tablets or 7.5 pellets	10 days at 15-25°C. 7 days above 25°C.
(b) In bolted metal or weld-mesh-hessian silo, or bag stack.	In a structure which does not meet gas-tight standards under pressure test, such as a bolted metal or weldmesh-hessian silo, or a bag stack, complete control by fumigation cannot be ensured, even at high-dosage rates.	phosphine	5 tablets or 25 pellets	10 days at 15-25°C. 7 days above 25°C.

*SEALING TECHNIQUES: Metal bins can be sealed by applying aluminium tape, silicone sealant, plastic sheeting or adhesive paint to wall-floor and wall-roof junctions, intake and outlet hatches, manhole covers, lap joints, and rivet and bolt holes. Weldmesh-hcssian silos or bag stacks should be covered with PVC sheets at least 0.25 mm thick or polythene sheets at least 0.13 mm thick. These sheets should be joined by tightly rolling together at least 50 cm of overlap and securing with bulldog clips. Weight the skirt formed by excess sheeting around the base with sand snakes or lengths of timber. Wooden floors and unpainted hardboard or fibreboard walls arc not gas tight. Bag stacks should be built on plastic sheeling to allow later fumigation.

TOBACCO LEAF

	Pesticide	Rate of specified preparation per *L*	Volume of diluted spray per 100 m^2
Thoroughly clean hulk sheds immediately after the crop has been sold and again before any new crop is put into it. Spray the building fabric with pesticide to kill any residual infestation.	carbaryl	20 mL of 500 g/L	5 L
Fumigate the bulk shed with phosphine after loading with the new crop and again immediately prior to the sale of the crop. Sheds should be welt sealed to retain the fumigant. (Detailed information on fumigation with phosphine is presented in the recommendations for stored grain.)	phosphine	Rate of specified commercial preparation per m^3 1.5 tablets or 7.5 pellets	

STORED PRODUCTS PEST CONTROL

GRAIN

Stored products pests may cause serious damage to a wide range of produce stored on farms. Direct weight loss of commodities results from insect feeding, and indirect losses are caused by contamination with faeces, frass, and bodies of dead insects. In bulk stored commodities pest infestation can cause heating and increased moisture. Infestation may result in a serious reduction in germination of seed. Control procedures are necessary to prevent such damage, and similar procedures are effective against all the stored products pests.

A very high standard of pest control is particularly necessary in cereal grains. Most of Australia's cereal grain production is exported, and a NIL tolerance of live insects is a requirement for export. Control measures are aimed at minimizing infestation throughout the handling chain, including deliveries from farms to the bulk handling authority.

WHERE ARE THE INSECTS ON FARMS:

Most pest infestation in stored products arises from insects already in other commodities on the farm. Residues from previous harvests in headers, augers and other harvesting machinery, and in storage areas are especially important—these residues are usually infested and come into direct contact with the new commodities. Seed grain, feed grain and other feed supplements which are stored for long periods may support large pest populations. Spilt produce may also be a source of pests. All pest insects walk, and many fly, from the sources into new uninfested products.

PREVENTION OF INFESTATIONS:

(a) Machinery and storage areas must be cleaned of all crop residues after use.

(b) Residues from machinery, spills on the ground, and old infested seed and feed stocks should be burned completely or deeply buried.

(c) Seed and feed stocks should be kept to a minimum.

(d) Machinery and storage areas should be treated with insecticides, but only after cleaning.

CONTROL OF INFESTATIONS:

(a) Development of pest populations is slowed down and insecticide activity is prolonged by cooling the commodity (aerating) or by drying it.

(b) Approved insecticides should be mixed with commodities for which the intended storage period on the farm is more than 6 weeks. The insecticide will kill any pests present and give protection against re-infestation.

(c) Infested produce may be disinfested by fumigation in a gas-tight enclosure. Fumigants have no residual action, so grain may be protected by insecticides or by putting it in an insect-proof enclosure after fumigation.

TOBACCO LEAF

Presence of the cigarette beetle or its damage may result in rejection of tobacco offered for sale. Control measures against this pest are essential.

Infestation of the new crop arises from populations of the insect breeding in tobacco leaf or leaf fragments left after the previous crop, or other infested materials on the farm. Thorough cleaning of bulk sheds after sale of the crop and before picking the new crop will reduce infestation. Pesticide sprays may be used to control the pest in tobacco sheds. Should tobacco become infested fumigation should be used to kill the pest.

STORED GRAIN

Situation	Management notes	Pesticide	Rate of specified commercial preparation per L	Volume of diluted spray per 100 m²
Both pre- and post-harvest	Clean all harvesting machinery, handling equipment, storage facilities and surrounds. Burn or bury residues from machinery and storage areas.	azamethiphos chlorpyrifos-methyl + carbaryl fenitrothion + carbaryl	10 g of 500 g/kg 20 mL of 500 g/L + 20 mL of 500 g/L 10 mL of 1 kg/L + 20 mL of 500 g/L	5 L
	Burn or bury old infested feedstocks and seed.	pirimiphos-methyl + carbaryl	20 mL of 500 g/L + 20 mL of 500 g/L	
	Treat surfaces of buildings, storage bins and handling equipment with pesticide.	fenitrothion + carbaryl dust (see footnote)	Lightly cover surfaces	
	Clean and treat the header immediately after harvest. Run the machine before harvesting to remove the insecticide dust.	fenitrothion + carbaryl dust (see footnote)	Lightly cover surfaces, applying the following quantities to the nominated areas: Drum and return auger —600 g Screen —200 g Straw-walkers, riddles, augers —400 g Front elevator —100 g Bin —400 g Outside the machine where residues may lodge —400 g	

FOOTNOTE: 12 g/kg fenitrothion + 8 g/kg carbaryl.

STORED GRAIN

Situation	Management notes	Pesticide	Rate of specified commercial preparation per 1.	Volume of diluted spray per ton:
Uninfested grain to be stored up to 6 weeks after harvest	Provided the storage bins and surrounds have been cleaned and treated no further control measures are necessary.	nil		
Live insects in grain for delivery to bulk handling authority	Fumigation is most effective (see later). Where this is undesirable or impracticable, grain may be sprayed with pesticide.	dichlorvos	5.3 mL of 1.14 kg/L	1 L
Grain to be stored 6 weeks to 3 months	Following cleaning and treating the storage bins and surrounds, treat the grain with approved pesticides prior to storage.	Either chlorpyrifos-methyl OR fenitrothion* OR pirimiphos-methyl PLUS EITHER bioresmethrin + piperonyl butoxide OR carbaryl OR pyrethrins + piperonyl butoxide ALTERNATIVELY fenitrothion/ carbaryl dust	10 mL of 500 g/L 6 mL of 1 kg/L 4.5 mL of 900 g/L 10 mL of 50 g/L + 400 g/L 10mL of 500 g/L 50 mL of 60 g/L + 528 g/L 500 g of 12 g/kg + 8 g/kg per tonne	1 L
Grain to be stored 3 months to 9 months	As for grain stored 6 weeks to 3 months.	Either chlorpyriphos-methyl OR fenithrothion* OR pirimiphos-methyl PLUS EITHER bioresmethrin + piperonyl butoxide OR carbaryl OR pyrethrins + piperonyl butoxide	20 mL of 500 g/L 12 mL of 1 kg/L 4.5 mL of 900 g/L 20 mL of 50 g/L + 400 g/L 16 mL of 500 g/L 50 mL of 60 g/L + 528 g/L	1 L
	Spray the surface of the grain bulk at 2 month intervals during storage.	chlorpyrifos-methyt fenitrothion* pirimiphos-methyl	20 mL of 500 g/L 10 mL of 1 kg/L 11.1 mL of 900 g/L	5L
	If moth infestation is apparent spray the surface of the grain bulk.	dichlorvos	4.4 mL of 1.14 kg/L	5L

*Some preparations of fenttrothion reduce germination of sorghum—CHECK THE LABEL.

TRADE NAMES OF RECOMMENDED PESTICIDES

PESTICIDE	PROPRIETARY NAMES
acephate	ICI Orthene 75 Soluble Powder Insecticide (750 g/kg) Schering Orthene 750SP Insecticide (750 g/kg)
azamethiphos	Ciba-Geigy Alfacron 50 Residual Insect Spray (500 g/kg)
azinphos-ethyl	Bayer Gusathion A Liquid Insecticide Spray (400 g/L) Lane Kilathion Insecticide (400 g/L)
bioresmethrin	Cooper's BRM 5/50 Grain Protectant (50 g/L bioresmethrin, 400 g/L piperonyl butoxide)
carbaryl	Barmac Carbene Liquid Insecticide (500 g/L) Chem-Air Carbaryl 80 Wettable Powder (800 g/kg) Chemspray Carbaryl Insecticide (800 g/kg) Crop King Agricultural Chemicals Carbaryl 80 Wettable Powder Insecticide (800 g/kg) ICI Septene 80 Dispersible Powder Insecticide (800 g/kg) ICI Septene Liquid Insecticide (500 g/L) Lane Bugmaster 80 Insecticide (800 g/kg) Nufarm Carbaryl SULV-25 Insecticide (250 g/L carbarvl) Schering Sevin 80VV Carbaryl Insecticide (800 g/kg)
carbofuran	Furadan 10G Insecticide/Nematicide (100 g'kg)
chlordimeform	CGS 500 Cotton Insecticide, Acaricide & Ovicide (500 g/L) CGS 800 SP Cotton Insecticide, Acaracide & Ovicide (818 g/kg)
chlorfenvinphos	Shell Birlane 50 Insecticide (500 g/L)
chlorpyrifos	Dow Lorsban 25W insecticide (250 g/kg) Dow Lorsban 50EC Insecticide (500 g/L) Dow Lorsban 50ULV Insecticide (500 g/L)
chlorpyrifos-methy!	Dow Reldan 50EC Insecticide (500g/L)
cypcrmethrin	Dow Nurellc 200EC Insecticide (200 g/L) Dow Nurellc 40ULV Insecticide (40 g/L) ICI Cymbush 250 Emulsifiable Concentrate Insecticide (250 g/L) ICI Cymbush 40ULV Insecticide for L'LV Application (40 g/L) Polyirin 200 Insecticide (200 g/L) Polytrin 30LLV Insecticide (30 g/L) Ripcord EC Insecticide Spray (200 g/L) Ripcord 40ULV Insecticide Spray (40 g/L) Roche-Maag Cypermcthrin 200 Insecticide (200 g/L) Roche-Maag Cypermethrin ULV Insecticide (40 g/L) Shell Ripcord 200 Insecticide (200g/L) Shell Ripcord ULV Insecticide (40 g/L) Decis 25 EC Insecticide (25 g/L) Dccis 5 ULV Insecticide (5 g/L)
demeton-s-methyl	Bayer Metasystox (i) Systemic Insecticide (250 g/L)
derris	Crop King Agricultural Chemicals Derris Dust Insecticide (7.5 g/kg roienone) Chem-Air Diazinon 80 Emulsifiable Concentrate Insecticide (800 g/L) Crop King Agricultural Chemicals Diazinon 80 Emulsifiable Concentrate Insecticide (800 g/L) Gesapon 80 Insecticide (800 g/L) Gesapon ULV 90 Insecticide (980 g/L) Lane Diazinon 80 Insecticide (800 g/L) Bayer Mafu 500 Insecticide (500 g/L) Lane DDVP 500 Insecticide (500 g/L) Lane DDVP 1140 Insecticide (1140 g/L) Nufarm dichlorvos 1 14 Insecticide (1 140 g/L)

dimethoate	Barmac Go-Mite Insecticide (400 g-'L) BASF Perfekthion E.C. 40 Systemic Insecticide (400 g/L) Chemspray Rogor Insecticide (300 g/L) fee Rogor 400 Insecticide (400 g/L) G.F. Thion E.C. 40 Systemic Insecticide (400 g/L) Lane Rogor Insecticide (300 g/L) Lane Rogor 40 Insecticide (400 g/L) Lane Dimethoate 40 Insecticide (400 g/L) Nufarm Dimethoate Systemic Insecticide (400 g/L) Rogor Diostop E.C. Insecticide Spray (400 g/L)
disulfoton	Bayer Disyston 5 Granular Insecticide (50g/kg) Shell Solvirex Granular Insecticide (50 g/kg)
endosulfan	Campbell Endosulfan E.C. Insecticide (350 g/L) Crop King Thiodan 35 E.C. Insecticide (350 g/L) Hoechst Thiodan Insecticide (350 g/L) ICI Endosan Emulsifiable Concentrate Insecticide (350 g/L) ICI Endosan 250ULV Insecticide (250 g/L) Lane Endosulfan Insecticide (350 g/L) Nufarm Endosulfan SULV-45 Insecticide (450 g/L) Nufarm Endosulfan 350EC Insecticide (350 g/L) Nufarm Endosulfan ULV 240 Insecticide (240 g/L) Roche-Maag Endosulfan ULV Insecticide (240 g/L) Thiodan ULV Insecticide (240 g/L) Vclsicol Endosulfan 350 Emulsifiable Concentrate Insecticide (350 g L)
fenitrothion	Bayer Folithion 50 Insecticide Spray (500 g/L) Baver Folithion 100 Insecticide Sprav (1 g/L) Bayer Folithion 500 Insecticide (500 g/L) Ciba-Geigy Sumithion 50 Emulsifiable Concentrate Insecticide (500 g/L) Ciba-Geigy Sumithion 100 Insecticide (1 kg/L) Ciba-Geigy Sumithion ULV Premium Grade Insecticide (1.28 kg/L) Cooper's Fenitrogard Liquid Insecticide (1 kg/L) Lane Fenitrothion 500 Insecticide (500 g/L) Lane Fenitrothion 1000 Insecticide (1 kg/L) Lane Fenitrothion Dust Grain Protectant Powder Insecticide (20 g/kg) Lane Fenitrothion ULV Insecticide (1.27 kg/L) Nufarm Fenitrothion 100 Insecticide (1 kg/L) Nufarm Fenitrothion Grain Protectant Powder Insecticide (20 g/kg)
fenitrothion/carbaryl	Bayer Folithion C Grain Dust Insecticide (12 g/kg fenitrothion + 8 g/kg carbaryl) Nufarm Fenitrocarb Grain Protectant Powder Insecticide (12 g/kg fenitrothion + 8 g/kg carbaryl)
fenvalerate	Shell Sumicidin 200 Insecticide (200 g/L) Shell Sumicidin ULV Insecticide (40 g/L) Shell Sumicidin ULV C50 Insecticide (40 g/L)
lindane	Lane Anti-Ant Seed Dressing (200 g/kg)
maldison	Crop King Agricultural Chemicals Malathion ULV Concentrate Insecticide (1180 g/L) Farmco Malathion ULV Ultra Low Volume Insecticide (1 180 g/L) ICI Malathion U.L.V. Concentrate Insecticide (1 180 g/L) Lane Maldison ULV Insecticide (1180 g/L) Malathion ULV Concentrate Insecticide (1180 g/L) Nufarm Maldison ULV Insecticide (1180 g/L) Shell Malathion ULV Insecticide (1180 g/L)
methamidophos	Bayer Nitofol Insecticide Spray (580 g/L) Lane Monitor Insecticide (290 g/L) Prefect Insecticide (580 g/L) Schering Monitor 580 Insecticide (580 g/L)
methidathion	Supracide 40 Emulsifiable Concentrate Insecticide (400 g/L)
methiocarb	Bayer Mesurol Snail and Slug Bait (20 g/kg)
methomyl	Du Pont Lannate L Insecticide Water Miscible Liquid (225 g/L) Du Pont Lannate LV Water Miscible Liquid (290 g/L) Shell Nudrin Insecticide (225 g/L) Union Carbide Klipp Methomyl Insecticide (225 g/L)
methyl bromide	CIG Agrigas M Methyl Bromide Fumigant (1 kg/kg) CIG Agrigas MC-2 Methyl Bromide Fumigant (980 g/kg methyl bromide + 20 g/kg chloropicrin) Methyl Bromide Penetrating Fumigant (Dow) (1 kg/kg)
monocrotophos	Nuvacron 40 Systemic Insecticide (400g/L) Shell Azodrin 400 Systemic Insecticide/Miticide (400 g/L)

naled	Lane Dibrom EC Insecticide (900 g/L) Lane Dibrom ULV Insecticide (1140 g/L)
omethoate	Bayer Folimat 80 Insecticide Spray (800 g/L)
parathion	Bayer E605 Folidol Fifty Insecticide Spray (500 g/L) Bayer Paramul 50 Insecticide Spray (500 g/L) Chem-Air Parathion 50 (500 g/L)
parathion-mcthyt	Crop King Agicultural Chemicals Methyl Parathion 50 Insecticide (500 g/L) ICI Phosfone 50M Parathion Methyl Miscible Oil Insecticide (500 g/L) Lane Parathion 50M insecticide (500 g/L) Shell Parathion M50 Insecticide (500 g/L)
permethrin	ICI Ambush Emulsifiable Concentrate Insecticide (500 g/L) ICI Ambush 250 Emulsifiable Concentrate Insecticide (250 g/L)
phosphine	Degesch Australia Pty. Limited Phosloxin Coated Fumigation Pellets—Prepac (560 g/kg aluminium phosphide developing 330 g/kg Phosphine PH3) Degesch Australia Pty. Limited Phostoxin Fumigation Pellets (560 g/kg aluminium phosphide developing 330 g/kg phosphine PH3) Degesch Australia Pty. Limited Phostoxin Fumigation Tablets (560 g/kg aluminium phosphide developing 330 g/kg phosphine PH3) Degesch Australia Pty. Limited Phostoxin Grain Fumigation Tablets (560 g/kg aluminium phosphide developing 33 g/kg phosphine PH3) Degesch Australia Ply. Limited Phostoxin Round Fumigation Tablets (560 g/kg aluminium phosphide developing 330 g/kg phosphine PH3) Detia Gas-Ex-B Fumigation Bags (570 g/kg aluminium phosphide developing 330 g/kg phosphine PH3) Detia Gas-Ex-T Fumigation Tablets (570 g/kg aluminium phosphide developing 330 g/kg phosphine PH3) Detia Phosphine Fumigation Pellets (570 g/kg aluminium phosphide developing 330 g/kg phosphine PH.i)
Pirimicarb	ICI Pirimor Wettable Powder Aphicide (500 g/kg)
pirimiphos-methyl	ICI Actellic 90SF Solvent Free Liquid Insecticide (900 g/L)
profenofos	CGS Curacron 500EC Insecticide (500 g/L) CGS Curacron 250 L'LV Insecticide (250 g/L)
promecarb	Carbamult 50 WP Insecticide Spray (490 g/kg)
propargite	ICI Omite 30W Wettable Powder Miticide (300 g/kg) Mitacron Miticide (300 g/kg)
pyrethrins-piperonyl butoxide	Hardi-Py-Far (60 g/L pyrethrins, 528 g/L pipcronyl butoxide)
sulprofos	Bayer Hclothion EC Insecticide Spray (720 g/L)
thiometon	Ekatin Systemic Insecticide (245 g/L)
trichlorfon	Bayer Dipterex Liquid Insecticide Spray (625 g/L) Bayer Dipterex SP80 Insecticide Spray (800 g/kg) Nufarm Lepidex Insecticide (600 g/L)

S. R. Hampson, Government Printer, Queensland