Department of Primary Industries

Insect and mite control in field crops 2013

NSW DPI MANAGEMENT GUIDE

Kathi Hertel, Karen Roberts and Phil Bowden

www.dpi.nsw.gov.au

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Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing (July 2013). However, because of advances in knowledge, users are reminded of the need to ensure that the information upon which they rely is up to date and to check the currency of the information with the appropriate officer of the Department of Trade and Investment, Regional Infrastructure and Services or the user's independent adviser.

The product trade names in this publication are supplied on the understanding that no preference between equivalent products is intended and that the inclusion of a product name does not imply endorsement by the department over any equivalent product from another manufacturer.

Recognising that some of the information in this document is provided by third parties, the State of New South Wales, the author and the publisher take no responsibility for the accuracy, currency, reliability and correctness of any information included in the document provided by third parties.

Always read the label

Users of agricultural chemical products must always read the label and any permit before using the product, and strictly comply with the directions on the label and the conditions of any permit. Users are not absolved from any compliance with the directions on the label or the conditions of the permit by reason of any statement made or omitted to be made in this publication.

Withholding periods

The withholding period (WHP) is the minimum time which must elapse between the last application of a pesticide and harvest for grain or forage, or for grazing. The purpose of the WHP is to avoid residues of agricultural chemicals and their metabolites which exceed maximum residue limits (MRLs) in raw agricultural commodities and in foods for consumption by humans and animals.

Pesticides used on crops may have WHPs for both harvest and grazing.

WHPs are specific to use patterns, i.e. to chemical, crop and pest. WHPs are also product specific.

Harvest WHPs may vary with formulation (e.g. ULV or EC), rate (which may vary with the pest controlled), and whether or not the crop can be harvested green or dry.

Grazing WHPs may vary depending upon whether or not the crop is grazed/cut for stock food pre-/post-harvest.

Not all labels pick up all registered use patterns. Consequently, not all labels contain the same information on WHPs. Different labels may have different WHPs for the same use pattern.

On some labels the WHP is contained within the tables giving Directions for Use; on other labels the WHP appears separately below the Directions for Use.

Where no WHP is given on the label, do not assume that the WHP is zero. If there is no WHP, the label will contain a statement to the effect that no WHP is necessary if label directions are followed.

Where a product has no grazing WHP, crops treated with the product should not be grazed prior to harvest. In these circumstances, it is uncertain whether stock that graze the stubble or are fed by-products of the treated crop will develop detectable residues of the chemical. Where appropriate, growers are advised to contact the chemical manufacturer for advice on managing chemical residues in the crop or in stock.

Locust control

The following are registered for the control of plague and spur throated locusts: fipronil (Regent®), diazinon, metarhizium (Green Guard®), and fenitrothion. In addition, there are several permits (see page 34) which allow the use of chlorpyrifos and synthetic pyrethroids. Read the label and permit for specific crops, rates, and withholding periods.

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Further information

A range of publications on managing insects and crop damage are available from the NSW DPI Bookshop or the NSW DPI website at www.dpi.nsw.gov.au

Useful books

Good Bug? Bad bug?
Crop Insects: *Northern Grain Belt: The Ute Guide*
Crop Insects: *Southern Gran Belt: The Ute Guide*
Insects: *Southern Region: The Ute Guide*
A Field Guide to Insects in Australia
The Good Bug Book
Pests of field crops and pastures: identification and control
Integrated pest management for crops and pastures

Useful internet sites

Government

NSW Department of Primary Industries
www.dpi.nsw.gov.au
Department of Agriculture, Fisheries and Forestry, Queensland
www.dpi.qld.gov.au
South Australian Research and Development Institute
www.sardi.sa.gov.au
Department of Agriculture and Food Western Australia
www.agric.wa.gov.au
Department of Primary Industries, Victoria
www.dpi.vic.gov.au
Department of Primary Industries, Parks, Water and Environment, Tasmania
www.dpipwe.tas.gov.au
Department of Primary Industry and Fisheries, Northern Territory
www.nt.gov.au/d/Primary_Industry
Australian Plague Locust Commission (DAFF)
www.daff.gov.au/animal-plant-health/locusts
CSIRO Entomology
www.csiro.au/ento
Australian Museum
australianmuseum.net.au/insects

Pest updates

Pest Facts – South Eastern
www.cesaraustralia.com/sustainable-agriculture/pestfacts-south-eastern
Pest Facts – Western Vic and SA
www.sardi.sa.gov.au/pestsdiseases/publications/pestfacts2
The Beat Sheet (Queensland DAFF)
www.thebeatsheet.com.au

Industry organisations and information

GRDC
www.grdc.com.au
Cotton CRC
www.cottoncrc.org.au/content/Industry/Publications/Pests_and_Beneficials.aspx
Australian Entomological Society
www.austentsoc.org.au
International Working Group for Diamondback Moth
www.nysaes.cornell.edu/ent/dbm
Kondinin Group – Farming Ahead
www.farmingahead.com.au
Pulse Australia
www.pulseaus.com.au
Australian Entomology Supplies
www.entosupplies.com.au
PestIQ
www.pestiq.com.au

Beneficial insects and IPM

Bugs for Bugs
www.bugsforbugs.com.au
Australasian Biological Control
www.goodbugs.org.au
Biological Services
www.biologicalservices.com.au
Bio Resources
www.bioresources.com.au
Ecogrow
www.ecogrow.com.au
(Turf and horticultural IPM products)

Insect identification and collection

NSW Department of Primary Industries
www.dpi.nsw.gov.au/aboutus/services/das/plant-pests-diseases
Australian National Insect Collection
www.csiro.au/places/ANIC
What bug is that? CSIRO
http://anic.ento.csiro.au/insectfamilies
Pest and disease image library
www.padil.gov.au

Chemical searches

Australian Pesticides and Veterinary Medicines Authority (APVMA)
www.apvma.gov.au
Pest Genie
www.pestgenie.com.au

Smartphone and tablet apps – Apple

Pest Genie
APVMA
Pestbook (Dupont)
Field guide to Victorian fauna
Sipcam Australia

Smartphone and tablet apps – Android

Pest Genie
Sipcam Australia

Insect and mite control

This publication contains information on how to control the more important insect and mite pests of azuki bean, canola, chickpea, cowpea, faba bean, field pea, linseed, lucerne, lupin, maize, millet, mungbean, navy bean, pigeon pea, safflower, sorghum, soybean, sunflower and winter cereal crops. Brief descriptions of some major pests and their damage are given to help you recognise them. It is important to check crops regularly for pest and beneficial insects and to get accurate identification of insects and mites in crops. Most insects are not pests and there are many beneficials often present in crops that help keep a range of pests under control as well as performing other ecosystem services such as pollination and nutrient cycling. These are often destroyed by use of broad spectrum chemicals. Included is a section on Integrated Pest Management (IPM) and Pest Management in Organic Systems that are using sound environmental principles to achieve economic control of pests and reduction of chemical use at the same time. These systems require a holistic approach to the farming system to be successful, but are based on having a dynamic agroecosystem.

Managing your legal responsibilities in applying pesticides

Pesticides Act and Regulations

The *Pesticides Act 1999* is the primary legislative instrument controlling the use of pesticides in NSW and is administered by the Environment Protection Authority (EPA). The underlying principle of the Pesticides Act is that pesticides must only be used for the purpose described on the product label and all the instructions on the label must be followed. Consequently, all label directions must be read by or explained to the user prior to each use of the pesticide.

All pesticide users should take reasonable care to protect their own health and the health of others when using a pesticide. They should also make every reasonable attempt to prevent damage occurring from the use of a pesticide, such as off-target drift onto sensitive areas or harm to endangered and protected species.

A regulation was gazetted on 14 December 2001 requiring all commercial pesticide users, i.e. all farmers and spray contractors to keep records of their pesticide application (Records Regulation). There was a six month phase-in period, with the regulation coming into effect from 31 July 2002.

While no set form has to be used, records must include the following:

- full product name,
- description of the crop or situation,
- rate of application and quantity applied,
- description of the equipment used,
- address of the property, identification of the area treated and order of paddocks treated,
- date and time of the application (including start and finish),
- name, address, and contact details of the applicator and of the employer or owner if an employee or contractor is the applicator,
- estimated wind speed and direction (including any significant changes during application),
- other weather conditions specified on label as being relevant (e.g. temperature, rainfall, relative humidity).

A form that captures all the information required by the Records Regulation, together with notes on how to fill it in, is included in this guide. The form and notes can also be downloaded from the Department's website. A self-carboning record book is available from Murrumbidgee Rural Studies Centre, PMB Yanco, 2703 NSW. Phone 1800 138 351 or SMARTtrain.

Records must be made within 24 hours of application, be made in legible English, and kept for 3 years.

A second regulation (User Training Regulation) commenced on 1 September 2003. This regulation requires all commercial pesticide users to be trained in pesticide application. **The phase-in period ended on 1 September 2005.** All previous training, e.g. FarmCare/ChemCert and SMARTtrain, will be recognised for a period of five years from the time when the training was completed.

The training of aerial applicators, pest control operators and fumigators is recognised as satisfying

the requirements of the Regulation. Apart from these groups, all commercial users must have a prescribed qualification. Only domestic use, such as home gardens, is excluded, provided the pesticide is a specific domestic/home garden product. Covered by the Regulation is pest control by/on:

- public authorities, e.g. State Rail,
- golf courses, sporting fields and bowling greens,
- agricultural, horticultural, aquacultural and forestry operations,
- businesses, educational institutions, and hospitals.

The minimum prescribed training qualification is the AQF2 unit of competency, 'Apply chemicals under supervision', although owner-applicators are encouraged to train and be assessed in the two higher AQF3 competencies, 'Prepare and apply chemicals' and 'Transport, handle and store chemicals'.

Growers are recommended to undertake the SMARTtrain course, Chemical Application, or the standard ChemCert course, both of which cover the higher AQF3 competencies. For growers with literacy and/or numeracy difficulties, the lower level AQF2 competency will provide a minimum qualification that satisfies the Regulation.

The Office of Environment and Heritage introduced a Notification and Miscellaneous Regulation under the Pesticides Act, with a phase-in period which ended 1 February 2007. This Regulation affects public authorities controlling weeds on public places.

Hazardous Substances legislation

Many registered pesticides are classified as hazardous substances and most of those that are not pose some risk to the health of those who use them or are exposed to them.

The *Occupational Health and Safety Act 2000,* and the *Hazardous Substances section of the Occupational Health and Safety Regulation 2001*, detail legal requirements of suppliers, employers and employees in the workplace for hazardous substances management. The Act and accompanying Regulation are intended to protect workers from both the short and long term health effects of exposure to hazardous substances and to improve current health and safety practices by:

- provision of health and safety information to workers (including a list or register of all hazardous substances and a Material Safety Data Sheet (MSDS) for each hazardous substance),
- consultation with workers,
- training of workers,
- assessment of the risks arising from hazardous substances exposure,
- control of the risks, and
- recording of the risk assessment and control measures implemented, training of both those applying and exposed to hazardous substances, and health surveillance (if warranted by the risk assessment in respect of organophosphates).

Both storage and use are covered by the OHS legislation. Records of training and risk assessments have to be kept for 5 years.

Dangerous Goods Regulation

Dangerous Goods legislation has been revised to bring it in line with Hazardous Substances legislation. The new requirements came into force after a phase-in period ending 1 September 2006. The main requirements include:

- provision of MSDSs,
- carrying out and documenting risk assessments, and
- keeping a register of Dangerous Goods.

All these requirements already apply to hazardous substances. In practice, the only change will be to add to existing management and record systems any Dangerous Goods that are not also hazardous substances.

Storage limits have changed. Premises storing large quantities require placarding of both the storage shed and the entrances to the premises. If very large quantities are stored – which would be rare on-farm, a manifest, site plan and written emergency plan are required. Consult your local WorkCover office for advice.

Farm chemicals are registered pesticides, and many are either Hazardous Substances or Dangerous Goods or both. As different legislation applies to each category, farmers must ensure their pesticide use complies with all relevant legislation.

WorkCover NSW's *Code of practice for the safe use and storage of chemicals (including pesticides and herbicides) in agriculture* is an approved industry code of practice and provides practical guidance for farm chemical users to comply with the legislation. This has been recently revised to reflect the new Dangerous Goods requirements. Copies can be obtained from your local WorkCover office, by download from the WorkCover website – www.workcover.nsw.gov.au – or by phoning 1300 799 003.

How to fill out your pesticide application record

The form on page 9 includes more than the Records Regulation requires, so **compulsory** information is described below in *italics*.

Self-carboning record books, with records consecutively numbered to satisfy Quality Assurance (QA), can be purchased by phoning 1800 138 351.

Property/holding

Fill in the residential address. Attach a detailed property map (for instance, line drawing), showing adjoining sensitive areas, with paddocks and other features clearly identified.

Applicator details

The applicator, or person applying the pesticide, must fill in their contact details. If the applicator is not the owner for instance, a contractor or employee, then the owner's details also have to be filled in. In the case of a contractor, one copy of the record should be kept by the applicator and another given to the owner.

Sensitive area identification

If there are sensitive areas, either on the property or on land adjoining, these should be identified in advance, and marked on the sensitive areas diagram, together with any precautions or special instructions. When using a contractor or giving the job to an employee, this section should be filled in and given to the person doing the application BEFORE the job starts. The property map with sensitive areas marked should be shown to them and the job fully discussed.

Paddock identification

Identify the paddocks/blocks and order of treatment (if there is more than one) in the 'paddock' section of the form. This should be filled in prior to the start of application, along with the residential address. If using a contractor or employee, this information should also be given to them BEFORE they start the job. Applicators using Global Positioning Systems (GPS) could include a GPS co-ordinate in addition to the paddock number/name.

Crop/pest identification

The left-hand side of the table is for crops, pastures and plants including non-crop, bushland and fallow areas, the right hand side for animals. *As a minimum, identify the host (crop/situation) and the pest.* It would be helpful to provide as much detail about the pest as possible, for instance, 4-leaf, if a weed, or size of larvae e.g. less than 10 mm, if a pest. Addition of details such as crop variety and growth stage are often important for QA schemes, but may also be necessary to positively identify the area treated as required by the regulation.

Product details

The product name and rate/dose should be transcribed from the label. For tank mixes, include all products in the mixture.

If the use pattern is on-permit, include the permit number and expiry date as well as the label details. The permit rate/dose may vary from that on the label. Don't forget to include the label product name.

The water rate may come from the label or from your standard practice or as a result of your calibration. If additives or wetters are included in the mixture, note these.

The total L/ha can be calculated when the application is finished.

If the label has a withholding period (WHP) of for example, 7 days, note this down. To calculate the date when treated produce can be harvested or slaughtered, add 7 full (24 hour) days to the time when you finished applying the chemical. If you want to harvest or slaughter earlier in the day than that time, you will have to wait until the eighth day.

Equipment details

As a minimum, you have to fill in what equipment you used. Positive identification can be assisted by

If you suspect a poisoning, contact:

- **Poisons Information Centre, emergency phone (24 hr) 131 126**

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No.

Location, Applicator, Date of Application

Property/Holding: (residential address)					Date:
Applicator's Full Name:			Owner (if not applicator):		
Address:			Address:		
		Phone:			Phone:
Mobile:	Fax:	E-mail:	Mobile:	Fax:	E-mail:
Sensitive Areas (including distances, buffers):			Comments (including risk control measures for sensitive areas):		

	N	
W	Treated Area	E
	S	

Host/Pest

Paddock Number/Name:	Paddock Area:	Order of Paddocks Sprayed:
Crop/Situation:	Type of Animals:	
Crop/Pasture Variety:	Age/Growth Stage:	
Growth Stage:	Mob/Paddock/Shed:	
Pest/Disease/Weed:	Animals – Number Treated:	
	Pest Density/Incidence: Heavy ❑ Medium ❑ Light ❑	

Application Data

Full Label Product Name:		Rate/Dose:	Water Rate @ L/ha:	
Permit No.:	Expiry Date:	Additives/Wetters:		
Total L or kg:	WHP:	ESI:	Date Suitable for Sale:	
Equipment Type:		Nozzle Type:	Nozzle Angle:	Pressure:
Date Last Calibrated:	Water Quality (pH or description):			

Weather

Showers ❑ Overcast ❑ Light Cloud ❑ Clear Sky ❑					
Rainfall (24 hours before and after)					
Before:	mm	During:	mm	After:	mm
Time (show time in this column	Temperature °C	Relative Humidity (%)	Wind Speed	Direction	Variability (e.g. gusting)
Start					
Finish					
Comments:					

specifying the settings used for the application, for instance, nozzle type and angle, pressure. The nozzle type will usually include the angle. With pressure, the reading should be as close to the nozzle as possible. Other details are useful as a reminder for future use, or as a check on your set-up should you have a treatment failure, for instance, date of calibration and water quality. Water quality is important for herbicide efficacy. At the most basic level, water quality can be described in terms of its source, for instance, rainwater, dam water or bore water.

Weather

As a minimum, you have to record wind speed and direction. This is better measured with instruments than estimated. Record any changes during application.

Poisons Schedules

Pesticides are classified into four categories in the Poisons Schedules based on the acute health hazard to the user of the pesticide. Each Schedule has a corresponding signal heading which appears in large contrasting lettering on the label of the pesticide product.

Poisons Schedules

Unscheduled	Very low toxicity	**No heading required**
Schedule 5	Slightly toxic	**Caution**
Schedule 6	Moderately toxic	**Poison**
Schedule 7	Highly toxic	**Dangerous Poison**

The Poisons Schedules will largely determine the **Safety Directions** and **First Aid Instructions** which appear on the label. The Safety Directions specify what personal protective equipment should be worn, and what safety precautions should be taken, e.g. do not inhale spray mist. The First Aid Instructions specify what action should be taken in the event of a poisoning. Safety Directions and First Aid Instructions may be different for different formulations of the same pesticides.

NB. Before opening and using any farm chemical, consult the label and Material Safety Data Sheet (MSDS) for specific Safety Directions. The *Hazardous Substances* chapter of the *Occupational Health and Safety Regulation 2001* requires resellers to provide end users with an MSDS.

You must also record the time of day when you started and the time when you finished.

Weather records have to be made for all equipment that distributes pesticide through the air.

Rainfall should be recorded for the 24 hours before and the 24 hours after application, unless a different figure is given in the restraints or critical comments sections of the label. Rainfall before or after application can affect pesticide efficacy.

Temperature and relative humidity should also be recorded, particularly if either or both are referred to in the restraints or critical comments sections of the label. Temperature and relative humidity can affect efficacy, increase the risk of off-target drift or may damage the host (phytotoxicity) or a combination of all three.

Pesticides and worker safety

Pesticides can have both immediate (acute) effects and chronic (long term) effects on the health of people who are exposed to them.

Acute toxicity

The acute or immediate toxicity of a farm chemical is reflected in the Poisons Schedules or poison warnings which appear on the label of a pesticide product. The acute toxicity is assessed in terms of the potential of the active ingredient of the chemical to poison an individual by the route of exposure which is most lethal, e.g. oral ingestion.

Chronic toxicity

The effects of long-term exposure to small doses of chemical is referred to as chronic toxicity. Some of these chronic toxicity effects include:

- neurotoxic effects – on the brain and central nervous system;
- reproductive;
- carcinogenic – cancer causing, and
- endocrine disruption.

The best way to manage any long term risks of chronic pesticide effects is to reduce exposure by following all the directions on pesticide labels.

Insecticide modes of action

Group	Activity group	Chemical grouping	Active constituent	Trade name
1A	*Acetylcholine esterase inhibitors* Inhibition of the enzyme acetylcholinesterase, interrupting the transmission of nerve impulses. Contact and stomach poisons. Some systemic (S). (Rd) stands for strong residual activity. (Re) stands for 'respiratory' – volatile insecticide which kills insects as they breathe vapour.	Carbamates	aldicarb (S)	Temik®
			bendiocarb	Ficam®
			carbaryl	Carbaryl®
			carbofuran	Furadan®
			carbosulfan (S)	Marshal®
			methomyl (S)	Lannate®
			methiocarb	Mesurol®
			oxamyl (S)	Vydate L®
			pirimicarb (S) (Re)	Pirimor®
			propoxur (Rd)	Blattanex®
			thiodicarb	Larvin®
1B		Organophosphates	acephate (S) (Rd)	Orthene Xtra®
			azamethiphos (Rd)	Alfacron®
			azinphos-methyl	Gusathion®
			cadusafos	Rugby®
			chlorfenvinphos (Rd)	Birlane®, Barricade S®
			chlorpyrifos (Re)	Lorsban®
			chlorpyrifos-methyl	Reldan®
			diazinon (Re)	Diazinon 800®, Di-Jet®
			dichlorvos (Re)	Dichlorvos®
			dimethoate (S)	Rogor®
			disulfoton (S)	Disulfoton®
			ethion	Mustang®
			fenamiphos	Nemacur®
			fenitrothion	Sumithion®
			fenthion (Re)	Lebaycid®
			maldison/malathion (Re)	HyMal®
			methamidophos (S)	Nitofol®
			methidathion	Suprathion®
			mevinphos (S) (Rd)	Phosdrin®
			omethoate (S)	Le-mat®
			parathion-methyl (Re)	Folidol®
			phorate (S)	Thimet®
			phosmet	Imidan®, Poron®
			primiphos-methyl	Actellic®
			prothiofos	Tokuthion®
			profenofos	Curacron®
			temephos	Abate®
			terbufos (Rd)	Counter®
			trichlorfon	Dipterex®, Neguvon®
2A	*GABA-gated chloride channel antagonists* Interferes with GABA receptors of insect neurons, leading to repetitive nervous discharges. Contact and stomach poisons. Some systemic (S). (Rd) stands for strong residual activity.	Cyclodienes	endosulfan	Endosan®
2B		Phenylpyrazoles (fiproles)	fipronil (S) (Rd)	Regent®

Insecticide modes of action (continued)

Group	Activity group	Chemical grouping	Active constituent	Trade name
3	*Sodium channel modulators* Acts as an axonic poison by interfering with the sodium channels of both the peripheral and central nervous system stimulating repetitive nervous discharges, leading to paralysis. Non-systemic contact and stomach poisons. (Rd) stands for strong residual activity. (Re) stands for 'respiratory' – volatile insecticide which kills insects as they breathe vapour.	Pyrethroids	allethrin (Re)	Roach Tox®
			alpha-cypermethrin	Fastac®, Vanquish®
			beta-cyfluthrin (Rd)	Bulldock®
			bifenthrin	Talstar®
			cyfluthrin (Rd)	Tugon®
			cypermethrin (Rd)	Scud®, Outflank®
			deltamethrin	Decis®, Coopafly®
			esfenvalerate	Hallmark®, Outlaw®
			fenvalerate	Sumifly®
			lambda-cyhalothrin (Rd)	Karate®
			flumethrin	Bayticol®
			gamma-cyhalothrin	Trojan®
			permethrin	Ambush®, Permoxin®
			resmethrin	Reslin®
			tau-fluvalinate	Mavrik®
			tetramethrin	Raid®
			zeta-cypermethrin	Python®
		Pyrethrins	pyrethrins	Mortein®
4	*Nicotinic acetylcholine receptor agonists/ antagonists* Binds to nicotinic acetylcholine receptor, disrupting nerve transmission. Systemic, contact and stomach poisons.	Neonicotinoids	imidacloprid	Confidor®
			acetamipirid	Supreme®
			thiacloprid	Calypso®
			thiamethoxam	Cruiser®
			clothianidin	Samurai®
5	*Nicotinic acetylcholine receptor modulators* Induces acetylcholine like activity. Contact poisons.	Spinosyns	spinosad spinetoram	Success®, Extinosad®, Delegate®
6	*Chloride channel activators* Interferes with the GABA nerve receptor of insects. Translaminar contact and stomach poisons.	Avermectin	abamectin	Agrimec®, Virbamec®
			emamectin benzoate	Proclaim®
		Milbemycin	milbemycin/milbemectin	Interceptor®
7A	*Juvenile hormone mimics*	Juvenile hormone mimics	methoprene	Grain-Star®
7B			fenoxycarb	Insegar®
7C	IGR – Mimic juvenile hormones which prevent moulting from the larval to the adult stage.		pyriproxifen	Sumilarv®
8A	*Miscellaneous non-specific (multisite) inhibitors* Unknown or non-specific target site	Alkyl halides	methyl bromide	Methyl Bromide®
8B			chloropicrin	Larvacide®
8C			sulfuryl fluoride	Profume®
9B	Selective feeding blockers/disrupters	Feeding blockers/ disrupters	pymetrozine	Chess®

Insecticide modes of action (continued)

Group	Activity group	Chemical grouping	Active constituent	Trade name
10A	*Mite growth inhibitors* Contact and stomach poisons that inhibit different growth stages. Some have translaminar activity. (Rd) stands for strong residual activity.	Tetrazine	clofentezine (Rd)	Apollo®
		Thiazolidine	hexythiazox	Calibre®
10B			etoxazole	Paramite®
11	*Microbial disrupters of insect midgut membranes* Organism has protein inclusions that are released in the gut of the target pest resulting in gut paralysis and a cessation of feeding. Includes transgenic crops expressing Bt.	Bt microbials (biological insecticide/larvicide – dipteran specific)	Bt israelensis	Vectobac®
			Bt kurstaki	Dipel®
			Bt aizawai	Xentari®
12A	*Inhibition of mitochondrial ATP synthase* Non-systemic contact and stomach poisons.	Thiourea	diafenthiuron	Pegasus®
12B		Organotin miticides	fenbutatin oxide	Torque®
12C			propargite	Omite®
12D			tetradifon	Masta-Mite®
13	*Uncoupler of oxidative phosphorylation via disruption of H proton gradient* Translaminar contact and stomach poison.	Pyrrole compound	chlorfenapyr	Intrepid®
15	*Chitin biosynthesis inhibitors, Lepidopteran* IGR – inhibits moulting.	Benzoylureas	triflumuron	Zapp®
			diflubenzuron	Fleececare®
16	*Chitin biosynthesis inhibitors, Homopteran* IGR – inhibits moulting.	Thiadiazine	buprofezin	Applaud®
17	*Inhibit chitin bioysnthesis type 2 – Dipteran* IGR – systemic, interferes with pupation and moulting.	Triazine	cyromazine	Vetrazin®
18	*Ecdysone agonists* IGR – disrupts moulting by antagonising the insect hormone ecdysone.	Diacylhydrazines	tebufenozide	Mimic®
			methoxyfenozide	Prodigy®
19	*Octopaminergic agonist* Non-systemic with contact and respiratory action.	Triazapentadiene	amitraz	Taktic®
20A	*Mitochondrial complex II electron transport inhibitors* Non-systemic with stomach action.		hydramethylnon	Amdro®
21A	*Mitochondrial complex I electron transport inhibitors* Contact and stomach poison.	Mite growth inhibitors	fenpyroximate	Acaban®
			pyridaben	Sanmite®
			tebufenpyrad	Pyranica®
21B		Botanical	rotenone	Derris®
22A	*Voltage dependent sodium channel blockers* Contact and stomach poison.	Oxadiazine	indoxacarb	Avatar®
24A	*Mitochondrial complex IV electron transport inhibitors*	Fumigants	phosphine	Eco2Fume®
			aluminium phosphide	Fostoxin®
			magnesium phosphide	Pestex®

Insecticide modes of action (continued)

Group	Activity group	Chemical grouping	Active constituent	Trade name
28	*Ryanodine receptor modulators* Interruption of normal muscle contraction.	Diamide	chlorantraniliprole	Altacor®
			flubendiamide	Belt®
UN	*Unknown mode of action*		azadirachtin	Neemazal®
			bifenazate	Acramite®
			dicofol	Miti-Fol®

Source: CropLife Australia and CropLife International.
Notes on how poisons act from *The Pesticide Manual*, 12th edition.
– 'Contact' means contact with the pest.
– 'Stomach' means the pesticide on the plant has to be eaten.
– 'Systemic' means taken up by the plant. 'Systemic' is NOT the same as 'residual'. Systemic insecticides may have short or long term (residual) activity. Where only some insecticides in a group are systemic, they are marked with '(S)'.
– '(Rd)' stands for strong residual activity.
– '(Re)' stands for 'respiratory' – volatile insecticide which kills insects as they breathe vapour.
– 'Translaminar' means absorbed by the leaf.

Dimethoate update

Dimethoate has been registered for use as an insecticide and acaricide (ticks and mites) in Australia for over 30 years. In 2004, the APVMA began a review of dimethoate because of potential human health concerns related its usage. It included toxicology data and data related to occupational exposure, all previously submitted registration data and relevant published data for detailed assessment.

In January 2011 the Human Health Risk Assessment of Dimethoate – Toxicology component was published. The Dimethoate Residues and Dietary Risk Assessment Report (August 2011) found that dimethoate use on many crops could exceed the recommended public health standard (the Acute Reference Dose). In response, on 6 October 2011, the APVMA suspended the use of dimethoate on a number of food crops due to potential dietary risks.

The Exposure and Risk Assessment component (PDF, 1.7MB) | (DOC, 1.2MB) of the Human Health Risk Assessment of Dimethoate was published on 7 March 2013. Prepared by the Office of Chemical Safety (OCS), this assessment included the occupational health and safety risks associated with the use of dimethoate. Following this, on 25 September 2012 most dimethoate products were suspended.

The suspension period has now been extended to 5 October 2013. Associated permits will be extended to 5 October 2013. The suspension prohibits:

- use of dimethoate on certain horticultural crops
- use on all food producing plants in the home garden
- supply and possession of dimethoate products unless they carry the new instructions for use.

The use of dimethoate in field crops is now under Permit only – PER13155 (see page 35 for details) or click on http://permits.apvma.gov.au/PER13155.PDF. Note this permit is valid until 5 October 2013.

Crops where existing label directions may continue to be followed.

Vegetable crops: Existing labels include pre-harvest uses only.

Seed dressings (vetches, lupins, peas, lucerne, clover, linseed, canola).

Crops that are subject to additional restrictions/variations to their existing approved use patterns

Crop	Additional use restrictions
Cereals, (including maize, sorghum)	DO NOT harvest for 4 weeks after application DO NOT graze or cut for stock food for 14 days after application
Oilseeds, Pulses (grain legumes)	DO NOT harvest for 14 days after application DO NOT graze or cut for stock food for 14 days after application
Pastures, forage crops and leucaena	DO NOT graze or cut for stock food for 14 days after application
Cereals, (including maize, sorghum)	DO NOT harvest for 4 weeks after application DO NOT graze or cut for stock food for 14 days after application
Pastures, forage crops and leucaena	DO NOT graze or cut for stock food for 14 days after application

Pesticides and the environment

Most insecticides are toxic to aquatic organisms, bees and birds. Fungicides and herbicides are relatively safe to bees in terms of their active ingredients, but their carriers and surfactants may be toxic. The risks that a particular product poses to the environment are reflected in statements on the label under headings like 'Protecting wildlife, fish, crustacea and the environment'.

Protecting the aquatic environment

The risk to aquatic organisms can be managed by:

- preventing drift into surface waters during application;
- locating mixing/loading and decontaminating facilities away from surface waters and providing such facilities with bunding and sumps to prevent movement of either concentrate or rinsate into surface waters;
- installing valves which prevent back-flow when filling spray tanks from surface waters and in suction lines for chemigation systems which draw directly from surface waters;
- avoiding aerially applying spray onto fields under irrigation;
- building sufficient on-farm storage capacity (including provision for storm run-off) to contain pesticide contaminated tailwater from irrigation;
- spraying in an upstream direction, when it is necessary to spray near surface waters, to reduce the maximum concentration at any one point in the watercourse;
- using only registered products to control aquatic weeds, e.g. Roundup Biactive® rather than Roundup®; and
- avoiding disposal of used containers in surface waters and on flood plains and river catchments.

Protecting bees

Many pesticides are toxic to bees and can damage the productivity of hives if bees or the hives are contaminated. Some pesticides are particularly toxic to bees and are identified as such with the following special statement on the label.

Dangerous to bees.
DO NOT spray any plants in flower while bees are foraging.

The pesticide risk to bees can be reduced by:

- applying pesticides toxic to bees early in the morning or in the evening when bees are not foraging;
- notifying the apiarist to allow the removal of hives from the vicinity of the crop before spraying;
- where possible, use EC and granular formulations in preference to wettable powders which are particularly hazardous to bees. Note that micro-encapsulated formulations such as that used for methyl parathion are particularly hazardous to bees because of their persistence in the environment and because bees transport the micro-capsules back to the hive along with the pollen.
- using ground rigs in preference to aerial application to minimise drift, especially when crops and adjacent plants are flowering; and
- avoiding drift and contamination of surface waters where bees may drink (see advice on risk management for aquatic organisms).

Protecting birds

The organophosphate and carbamate insecticides can be particularly toxic to birds, especially in granular formulations. Bird kills from diazinon has been well documented in Australia and overseas. Insecticidal seed dressings can pose similar risks. Just a few treated seeds and pesticide granules can be lethal to birds. Spillages can be very hazardous to birds as they can easily ingest a toxic dose from a small area.

Risks to birds from granular products can be managed by:

- ensuring complete incorporation beneath the soil surface, particularly at row ends where spillage may occur; and
- immediate clean up of spillage, however small.

Bait materials for control of rodents or soil insect pests can also be hazardous to birds, either through direct consumption of the bait or from feeding on bait affected animals or pests. The risks to birds from baits can be managed by:

- ensuring even bait distribution, with no locally high concentrations;
- not baiting over bare ground or in more open situations, such as near crop perimeters, where birds may see the baits;

- not baiting near bird habitat such as remnant native vegetation;
- use of bait stations which prevent access by birds, particularly near bird habitat;
- only baiting where pest pressure is high;
- baiting late in the evening when birds have finished feeding;
- prompt collection and burial of rodent carcasses where these occur in open situations; and
- immediate clean up of spillage, however small.

Insecticide sprays can also be hazardous to birds, either because of direct contact with the sprayed chemical, or by feeding on sprayed insect pests or crops. Even where birds are not killed, they may be sufficiently affected to make them more vulnerable to predation. Contaminated seed and insects collected from sprayed fields by parent birds can also be lethal to young chicks still in the nest. Risks to feeding and nesting birds can be managed by:

- minimising drift into remnant vegetation, wildlife corridors, nesting sites, or other bird habitats;
- actively discouraging birds from feeding in crops which are to be sprayed;
- spraying late in the day when birds have finished feeding; and
- using only low toxicity chemicals when large concentrations of birds are nesting nearby.

The best way to manage any long term adverse environmental risks is to follow the protection statements on labels, minimise spray drift, and to dispose of chemical containers and waste in accordance with label directions and codes of practice.

Insecticide resistance management

Resistance is the term used when a pest species has developed a strain which is no longer adequately controlled by a chemical that previously provided satisfactory control. The level of resistance can vary markedly between species and also between strains or populations of the same species. Resistance may be localised or general.

In cases where the level of resistance is high, pest populations can be unaffected by many times the normal rate of application. All resistance has a basis in genetic changes within the population.

Genetic resistance occurs naturally within any population, and can be transferred from one generation to the next. Continued use of a single pesticide or pesticide group with a common mode of action over several generations will select for resistance. While most pests will be killed, a small minority will survive and multiply, their proportion increasing with each generation.

The main consideration with resistance in insects and other pest organisms is the huge numbers in any population and the brief lifespan of the generations measured against cropping seasons. Because of the vast numbers that can proliferate in favourable conditions, even small percentages that are resistant can be economically destructive. For example, a 5% resistance level in a population of 1000/m^2 under 'normal' conditions would only amount to 50 individuals, which probably would not cause serious damage. If favourable conditions increased the population to 10 000/m^2, the same 5% would amount to 500 individuals at which point the damage may become serious.

Similarly, selection pressure will see the proportion of resistant individuals compounding from generation to generation. If there were 3 generations of an insect in a growing season this would give 15 generations in 5 years. With a treatment regime reliant upon a single chemical or group of chemicals, the original 5% would compound dramatically over the 5 years (commonly by a factor of more than 10), creating a substantial proportion of resistant organisms ($10 \times 5\% = 50\%$).

This explains why resistance can develop surprisingly quickly following the introduction of a new chemical. At first, the chemical works like magic, achieving an apparent 100% kill. Because it is so effective, the farmer uses nothing else. As the chemical begins losing its effectiveness, the farmer either increases the rate of application or the frequency of application or both. While a natural response, this is the worst thing to do. All this achieves is to make the pests more resistant more quickly and increase the number of resistant pests.

The population of resistant pests in the field, e.g. insects on crops, can be diluted by the migration of susceptible (i.e. non-resistant) individuals from

other areas. In other words, the resistant and non-resistant populations can mix. Unsprayed refuges are planted for exactly this purpose.

With highly resistant organisms, it is critical to kill as many as possible in the one treatment. For this reason, timing and rate are very important when using chemicals, to target the most susceptible stage of development. Alternative controls at susceptible life cycle stages need to be considered as well.

To delay the development of resistance when using chemicals in either rotation or combination, it is important that the two chemicals complement one another. If the pests are resistant to the first chemical, the second chemical must be capable of killing the survivors. If there is resistance to the second chemical also, then it will only select for a highly-resistant population of survivors, thereby not solving the problem but making it worse. Source: *SMARTtrain Chemical Risk Management Reference Manual.*

Integrated Pest Management

Integrated Pest Management (IPM) is a pest management system that uses a range of control tactics to keep pest numbers below the level where they are causing economic damage. It is primarily based around biological control of pests by either encouraging natural enemies or release of biocontrols. Other methods of control support these biological controls and can include:

- Cultural methods include farm hygiene, weed control, strategic cultivation (pupae busting) physical barriers, quarantine areas, different planting times, crop rotations, trap crops, use of attractants for beneficials or repellants for pests and keeping plants healthy so they resist attack.
- Host plant resistance like genetically resistant varieties or physical features that repel pests.
- Genetic control measures such as release of sterile male insects.
- Pheromones to confuse mating or aggregation.
- Use of microbial pesticides such as Bt, Nuclear Polyhedrosis Virus (NPV) or metarhizium.
- Manipulation of micro-environmental conditions to make it less suitable for pests or more suitable for beneficials (planting density, row spacing, row orientation).
- Use chemicals as a last resort. Use 'soft' chemicals or pest specific chemicals in preference to broad spectrum pesticides, especially early in the growing season when it is important to preserve beneficials.

IPM relies on monitoring the crop regularly, having pests and beneficial insects correctly identified and strategic control decisions made according to established damage thresholds.

Area wide management

Area wide management (AWM) is basically IPM that operates over a broad region and attacks the pest when and where it is ecologically weakest without regard to economic thresholds. It is a system currently used in managing resistance in *Helicoverpa armigera* in cotton. AWM co-ordinates farmers in implementing management strategies on their own farms to control local populations of *H. armigera* and prevent high numbers building up later in the season. AWM strategies involve a detailed understanding of the biology and life cycle of the pest and how the pest moves around in a region. Strategies can include the co-ordinated timing of operations like pupae busting, sowing and destroying of trap crops and spraying of certain chemical types including 'soft' or biological insecticides.

Biological control

Biological control can simply be defined as the use of natural enemies to control pest outbreaks, where the pest is not usually eradicated, but brought down to levels where it is not causing economic damage. Success with biological control has been varied in many situations. Complete success where the pests do not exceed the economic thresholds have only occurred in 19% of cases. Many releases of biocontrol agents have had no significant effect. There have been more successes in long term agro-ecosystems such as orchards and forests where pest and natural enemy populations are more stable. In annual cropping systems maintaining resources that favour the build up of natural enemies, such as greater biodiversity of plants, retaining stubble and groundcover and limiting use of broad spectrum insecticides will help in keeping pests in check.

Types of biological control

1. *Natural.* An already existing control agent is encouraged to control pests. This means avoiding the use of chemicals that may destroy these control agents.
2. *Single release (classical).* The control agent is released with the aim of establishing it as a permanent part of the ecosystem. This is usually carried out for introduced pests.
3. *Multiple release.* Here the control agent is not usually perfectly adapted to the environment (e.g. drought or frost intolerant) and so needs to be re-released. This may occur as a 'top-up' after unfavourable conditions, as a regular seasonal release, or as an inundative release where the control agent does not survive well. In this case, the agent is used as a living insecticide that is released in large numbers to reduce pest numbers before it dies.

Biological control agents for insect pests can include:

1. *Predators.* These actively capture their prey. Beetles, lacewings, bugs, flies, spiders and vertebrates are predators.
2. *Parasitoids.* These are host specific and need only one host to complete their life cycle. They lay eggs in their host and insects emerge after using the host as a food source. The host is nearly always killed. They differ from parasites which will co-exist with the host. Parasitoids include wasps such as the parasitic wasp which will lay eggs inside lucerne aphids, white cabbage moth caterpillars and scarab larvae, and flies, such as the technid fly.
3. *Pathogens.* These include bacteria, viruses, fungi, protozoa and nematodes. A few of these organisms can enter and multiply rapidly within the host, e.g. metarhizium, Bt, NPV.

Parasite control agents are usually more successful than predators because they are more host specific.

Trichogramma wasps

Trichogramma pretiosum wasps prey on the eggs of *Helicoverpa* spp., loopers, cabbage moths and others and are suitable for use in minimally sprayed field crops, sweet corn, vegetables and for heliothis in fruit crops. They are less than 0.5 mm in size and lay their eggs into moth eggs. The wasp larvae develop into a fully formed wasp inside the moth egg, in the process killing the developing caterpillar. *Trichogramma* are supplied as parasitised moth eggs in capsules that are distributed around the crop and can be applied with water.

Examples of biological control

Pest targeted	Biological Control
Heliothis	*Trichogramma pretiosum* *Bacillis thuringiensis* Nuclear Polyhedrosis Virus
Diamondback moth	Egg and larval parasitoids
Other moth species	Predatory bugs and beetles Green lacewings
Loopers	*Trichogramma pretiosum*
Aphids	Green lacewings *Mallada signata* Aphid parasitoides Ladybeetles Hoverflies
Green vegetable bug	*Trissolcus basalis* *Trichopoda* Predatory bugs
Two spotted mite	*Phytoseiulus persimilis* Predatory mites *Stethorus* beetles

Nuclear Polyhedrosis Virus (NPV)

Insect viruses are naturally occurring insect specific pathogens that have been part of the environment for millions of years and play an important role in the natural control of insect populations.

Insects consume the virus from the leaves. The virus then moves through the gut wall and invades the body of the insect, causing the insect to stop feeding and die within 5 days due to the breakdown of its internal organs. The body ruptures after death, releasing virus particles that infect other caterpillars.

Gemstar® and Vivus Gold® are commercial products that control *Helicoverpa punctigera* and *H. amigera* with a liquid concentration of virus particles in cotton and selected crops. Typically they provide 60–90% control of larvae. Both products fit best within an IPM program using natural enemies such as ladybeetles and parasites, but can be alternated with synthetic insecticides.

As a biological insecticide, efficacy is dependant on environmental conditions for good performance. It needs to be ingested so coverage of the target area is essential.

Bacillus thuringiensis (Bt)

The Bt bacteria produce proteins that are characterised by their potency and specificity to certain species, most of which are agronomically important pests. Mixtures of crystals and spores have been sprayed like a chemical pesticide for many years in horticultural industries but with variable success in broadacre field crops, Full-Bac® WDG being a notable exception. Full-Bac® WDG is a dry flowable, more suited to application by boomspray than previous formulations.

The caterpillar ingests the protein which then attacks the gut wall, causing holes in the gut and the insect to stop feeding. The bacterial spores contained in the protein then leak through the gut wall and cause a bacterial infection. The insect will die either from this bacterial infection or starvation. This is the process which makes the Bt protein highly specific and environmentally desirable.

The insertion of the Bt gene into cotton plants has taken many years to develop and there is continued breeding of plants that express higher levels of the Bt toxin.

Resistance to Bt is being managed carefully with the development of management programs and new research on multiple insect resistance genes.

Novel strains of Bt are being isolated for a wide range of pest families including beetles, flies and locusts.

Insect and mite monitoring

Crops should be checked frequently throughout the growing season. Infestation can occur at any time, but crops are most susceptible to serious damage during emergence-establishment and from budding-flowering or head emergence until harvest maturity. Heavy insect attack during the pre-flowering or pre-heading period may also reduce yield significantly.

The incidence of major pests varies from year to year and locality to locality so you will not have to contend with all of them every year. Occasionally, one or more of the minor pests may become numerous and cause serious damage. Pest control must be a planned part of the successful management of field crops. The growth stage or condition of the plant, or both, may determine whether treatment is justified. Growers who regularly inspect crops for pest activity will be better able to decide if and when treatment is needed. Usually crops are most at risk at establishment and during the flowering or grain fill period, but the damage caused is not always directly related to pest abundance. Other factors such as weather, seedbed conditions and sowing depth may also influence germination rate and seedling emergence, and therefore the ability of young plants to outgrow damage caused by pests.

The cause of crop damage must be correctly identified for effective control and to avoid killing harmless or beneficial insects. Collect specimens of suspect pests and damaged plants and ask your local agronomist or adviser to identify them and suggest appropriate control strategies.

Sampling insect and mite populations

All insect population samplings are subject to error. The reliability of the sampling results depends on two factors:

- *The extent of other effects.* For example, wireworms and false wireworms move up and down in the soil in response to changes in soil moisture and temperature; the distribution of wind-borne pests, such as bugs and thrips, in the sheltered zone on the leeward side of a windbreak, and the sheltering effect of trees on aphids.
- *The number of samples taken.* A large number of small samples will provide a more reliable result than a small number of large samples. However, you must be prepared (and able) to let the sampling continue long enough to reduce the risk of error to a level you are prepared to accept.

You should continue sampling until a decision can be made by careful judgment rather than by guesswork. If, when sampling, you find that the pests are restricted to only a small section of a paddock you may wish to sample that area more intensively to see whether it should receive special treatment.

Monitoring and scouting techniques

There are a variety of monitoring techniques that are used to check pest and beneficial numbers in different crops:

- Sweep nets used in pastures and in standing crops that you can easily walk through
- Sticky traps for small flying insects
- Pitfall traps for mobile ground dwelling insects and spiders
- Suction samplers for small mites and insects on plants or soil
- Delta traps (pheromone) to attract specific pests e.g. codling moth or lightbrown apple moth (LBAM)
- Light traps for nocturnal flying insects
- Beat sheets for standing crops hard to walk through (cotton, canola and soybeans)
- Fruit fly traps (with different attractants)

There are a variety of recording sheets that can be used as well as some designed specifically for particular crops. A diary note may also be a useful way of recording these pest monitoring results.

Insect control thresholds

Insect control thresholds provide guidelines to allow timely decisions for crop spraying. This can reduce unnecessary spraying and keep populations from reaching a level where damage is high.

The most common threshold used is an economic threshold, which involves control at the density that will prevent the pest numbers from reaching an economically damaging population.

The aim of pest management is to keep pest populations below this economic threshold.

Guideline thresholds based on research exist for some pests but most thresholds fluctuate depending upon a number of factors. Monitoring and sampling of crops is essential to determine these factors and their influence on where the threshold lies. Farmers who maintain a close watch on pest activity through regular crop inspections and thorough sampling, are in a better position to decide if and when treatment is needed.

The following factors should be monitored and considered when using thresholds and making spray decisions:

- Environmental conditions and the condition of the crop
- Extent and severity of the infestation and how quickly the population increases
- Prevalence of natural control agents such as parasitic wasps, predatory shield bugs, ladybirds and diseases
- Type and location of pest damage and whether it affects yield indirectly or directly
- Stage in the life cycle of the pest and the potential for damage
- Crop stage and ability of the crop to compensate for damage
- Amount of damage which has already occurred and the additional damage that will occur if the crop is not sprayed
- Value of the crop (high value crops cannot sustain too much damage as a small loss in yield or quality could mean a large financial loss), the cost of the spray and its application and the likely yield or quality benefit gained from control.

'PestFacts'

PestFacts is a free electronic service designed to keep consultants, growers and researchers informed about pest outbreaks, effective controls and current information about relevant research findings as they emerge during the growing season.

The PestFact services draw on the field observations of consultants, growers and industry specialists across the southern grain belt region, with an on-line observational reporting proforma which has been developed to assist with reporting and to track pest occurrences, distribution and insect pressures over time.

The information generated by PestFacts can also be used to gain an idea of the occurrence and location of pest problems. This provides an opportunity for awareness, discussion and ongoing evaluation of changing pest importance.

Through feedback from the diagnostic services and the insect identification workshops that have been conducted in the past, a training manual

has been developed to complement identification workshops.

Each PestFacts addition is now available as a podcast. Freely download the podcast from www.sardi.sa.gov.au/pestsdiseases/publications/pestfacts, To subscribe contact Kym Perry: (08) 8303 9370 or email kym.perry@sa.gov.au and Helen DeGraaf: (08) 8303 9543 or email helen.degraaf@sa.gov.au

Useful references

PestFacts South-Eastern
www.cesaraustralia.com/sustainable-agriculture/latest-news/pestfacts-south-eastern-is-underway-for-the-2012-winter-season

Crop insects: The Ute Guide (Southern Grain belt edition)
www.grdc.com.au/Resources/Bookshop/2008/01/Crop-Insects-The-Ute-Guide-Southern-Region-Grain-Belt-edition

Special issue in *Australian Journal of Experimental Agriculture*: Invertebrate pests of grain crops and integrated management: current practice and prospects for the future, www.publish.csiro.au/nid/73/issue/4062.htm

Organic pest management

Organic standards prohibit the use of synthetic insecticides and, whilst some organic (naturally derived) products are permitted, direct substitution of 'organic' with 'synthetic' pest control products is discouraged. Under the standards a more holistic approach needs to be adopted, which essentially comes down to an 'integrated' pest management strategy, but without the aid of chemicals. Instead of using synthetic pesticides, organic farmers adopt a system design and cultural practices that encourage healthy plant growth and the presence of natural enemies.

Of fundamental importance when creating an organic pest management strategy is to determine which pests may become a threat and to gain a thorough knowledge of their ecology and dispersal characteristics and how they are likely to affect the crop. It is also essential to determine if any beneficial species are present (as well as their ecology and dispersal characteristics) and how they can be encouraged to have the greatest impact in controlling the pest or disease.

Some of these key features of organic pest management systems are discussed below.

Cropping system design

The cropping system design and its relationship with other natural features on and adjoining the farm will influence the ability to effectively manage pests, weeds and diseases organically. A number of aspects of design should be considered when designing cropping layouts:

- *Site selection* – producing a crop in an area where pests and diseases are known to be endemic or where vast monocultures of the same crop are located can make organic pest and disease management more problematic.
- *The crop rotation sequence* – where the choice of crops and their relationship with one another can interrupt the pest or disease lifecycle.
- *The layout within a rotation*, i.e. row spacing, sowing density, intercrop spacing and interplanting with other species can influence the occurrence and dispersal of pests and their natural enemies. For example, to limit the spread of aphid-transmitted virus, crops planted later can be planted upwind of fields planted beforehand. Some planting layouts can also confuse pests and thus reduce egg laying or dispersal.
- *The relationship of the crop to other natural features on the farm*. For example, the location and design of shelter belts and insectaries planted as a border surrounding the main crop to encourage the build-up of natural enemies. Research has shown that substantial numbers of beneficial insects can move up to 113 m from insectary hedgerows into adjacent crops. In New Zealand and United Kingdom beetle banks have been successfully used around crops to prevent pests moving into the crops. Incorporating a wetland or areas with native understorey plantings into the farm design can encourage pest eating bird species such as ibis, wrens and silvereyes which consume large numbers of insects each day.

Crop monitoring

Ongoing monitoring of crops and surrounding vegetation is essential to determine the presence of both pests and predators, and when, if any, intervention is required to keep pests at an acceptable level or, if feasible, boost predator numbers by introducing them into the system.

Cultural and mechanical controls

A range of cultural and mechanical control options are utilised by organic producers both as preventative and interventionary pest management strategies.

Choice and variety of crop

Among the crop features that will give an organic crop an advantage are inherited disease and pest resistance, seedling vigour, and other physiological features such as hard seed coats that deter pests. Varieties selected on the basis of their maturity can be planted to avoid periods of high pest and disease incidence. Note that genetically modified (transgenic) varieties / crops are **not** permitted in organic systems.

Timing of planting. Crops can be planted to avoid periods of high pest and disease incidence. If there is a choice over planting times, choose times when pest pressure is likely to be lowest.

Water and nutrition management. Plants growing with optimum water and nutrition tend to be less susceptible to pest attack and may better compensate for damage. Over or under provision of water or nutrients will stress the plant and increase its vulnerability.

Trap crops. Secondary crops strategically used within the main crop can deter or act as trap crops for pests or can attract predatory species. For example pigeon peas (*Cajanus cajan*) have been used as an effective trap crop for heliothis (*Helicoverpa armigera*) in soybeans.

Insectary crops. Given that many beneficial insects require nectar or pollen as alternate food sources, the provision of a neighbouring flowering crop to act as an insectary crop can help increase the numbers of beneficials working the main crop. Other insectary crops may be crops that host a related non-pest species, such as a species of aphid that can then support the establishment of aphid parasitoids and predators which may move into the main crop if aphids become established there.

Inter-cropping. Alternating rows of different crops has been used as a means of reducing pest pressure. Inter-cropping, *per se*, does not reduce pest pressure, but some combinations of crops work well together and result in less pest pressure.

Sanitation. Many key pests have many host plants. If those host plants are weeds on your property or are volunteers, then you may be contributing to supporting the pest population on your property. Controlling weeds, particularly flowering weeds, is crucial for the successful management of, for example, Western Flower Thrips (*Franklienella occidentalis*). Mites are often spread through properties or from crop to crop by machinery or on the clothes of people walking the paddocks.

Cultivation. Burying crop refuse can help to prevent carryover of some pests and diseases. Pupae busting is the term used for cultivation of soil to destroy the exit holes for heliothis (*Helicoverpa armigera)* moths after pupation. Normally it is done post-harvest and before the over-wintering larvae or pupae are due to emerge as moths. Cultivation to a depth of 10 cm is sufficient. Although some pupae may be physically destroyed the main purpose is to destroy the exit tunnels. Pupae busting is essential to keep the number of spring emerging heliothis to a minimum.

Light or bait traps. Moths and some beetles are attracted to black light and thus may be caught in a 'light trap'. These traps are not very selective so a large number of non-pest and possibly beneficial insects may also be trapped. Pest specific pheromones can greatly enhance the attractiveness of the trap to the target pest.

Biological control

Biological control uses beneficials, habitat manipulation and/or products derived from natural organisms to control pests. Natural enemies, also known as 'beneficials', are organisms that feed on or otherwise kill the target pest. These may be predatory insects (including ladybirds, lacewings, spiders and mites), parasitoids, fungi, bacteria, viruses, nematodes, or animals (e.g. insect feeding birds). Biological control is often best used as a preventative method but some components of biological control are useful as direct intervention. These include:

Introducing beneficials. Predators or parasitoids of a specific pest may be released into the problem area. Perhaps they are absent because they are not naturally occurring in your area, for some reason they have been killed, or their populations are not sufficiently high to adequately control the pest. Some predator and parasitoid species are available from commercial 'insectaries' to release into a crop to control a specific pest outbreak.

Habitat manipulation. Although this is normally a preventative method, slashing neighbouring insectary crops may encourage beneficials to move across into the target crop and, hopefully, control the pest. Yeast sprays may encourage lacewings and some other predatory bugs into a crop area to control a specific pest.

Autocidal control. Mass reared pest insects are released following sterilisation by radiation or chemosterilants. When the sterilised males mate with 'wild' females, no progeny is produced. This is a tool being used in fruit fly control.

Semiochemical control. Synthetically produced chemicals imitate sex or aggregation (grouping) pheromones to disrupt the behaviour of the pest or prevent mating and reduce the number of pest offspring being produced. Both sex and aggregation pheromones can lure pests into a sticky or pesticide trap. This is commonly used in orchards as a preventative method.

Biocidal control. Natural products or organisms have a toxic or lethal effect on the target pest. These include products derived from plants, such as Neem or natural pyrethrum, and pathogens, bacteria, viruses, protozoa, fungi, nematodes, and animals. Biocidal control can really only be used as a direct control method once pest numbers have reached damaging levels as the kill rate is generally high, but the carry-over effect is low.

Table 1: Registered organic plant protection products

Active ingredient	Registered trade names	Comments
ammonium chloride	Path-X	Sanitiser
amorphous silica	Abrade Abrasive Barrier Insecticide Absorba-cide	IGR, abrades insect cuticle
azadirachtin (Neem extract)	Azamax	IGR, relatively non-toxic, good IPM fit
botanical oil	EcoOil Synetrol Horti Oil	For use in fruit and vegetable crops
Bt	Dipel	Wide use pattern
canola oil	Nexus Spray Adjuvant	Claims to be a wetter, sticker, spreader; more likely a penetrant
diatomaceous earth	Perma-Guard D10	Desiccant
esters of vegetable oil	Hasten	Penetrant with non-ionic surfactant added
fatty acid ethoxylates	Deluge 600 Wetting agent	Non-ionic surfactant
metarhizium	Green Guard	Fungal spores to control locusts in organic crops; toxic to bees
paraffinic oil	SK Enspray 99	Combination insecticide & fungicide
petroleum oil	Summer Spray Oil Winter Spray Oil Vicol Summer Oil Insecticide	Wide use pattern
pheromone	Wild May Fruit Fly Attractant	Attracts and kills in a 'wet' trap, i.e. fruit flies drown in attractant (pheromone products containing an insecticide not certified)
pine oil	BioWeed Control	Suppresses rather than controls
potassium bicarbonate	EcoCarb EcoRose	Limited to small scale, i.e. non-commercial, operations
potassium salts	Hitman Soap Insecticide	Wide use pattern
pyrethrins	Pyganic Organic Insecticide	Broad spectrum (including beneficials), short residual (breaks down quickly in sunlight)
rotenone	Derris Dust	Toxic to people and fish
spinosad	EcoNaturalure Entrust Naturalyte	Wide use pattern; resistance can be an issue if too heavily used

Source: Pesticides and Veterinary Medicines in Organic Farming, *SMARTtrain Chemical Notes 5.*
Note: There is not a single organic standard. Products acceptable under one standard may not be acceptable under another. Check with your organic certifier before using any product.

Chemical control

'Chemical control' is usually associated with synthetically derived poisons, which are not allowed under organic standards. However, some chemicals are allowed under organic standards, and these tend to be biologically derived products and some inorganic products or minerals. It should be noted that even if the product is acceptable under the organic standards it may not be safe or legal for you to use. The use of any pesticide whether it is biologically based or not is regulated by the Australian Pesticide and Veterinary Medicines Authority (APVMA) and regulations covering the safe use and application of pesticides should be adhered to.

Pest management in an organic system uses many of the same principles that are used for Integrated Pest Management (IPM) in conventional farming systems. Monitoring pests and beneficial species, correct identification of species present and a thorough knowledge of the control methods that can be used are essential to maintain adequate pest control to give marketable produce. An holistic approach must be taken that involves sound ecological principles so that the system is in balance.

Application technology

To achieve full benefit from insecticides, it is essential that they be applied properly. This will ensure minimum side effects and maximum control, safety to the user and return for the pesticide investment.

The aim of applying insecticides is to effectively distribute the correct amount of product to the target. This will give the required results and minimise contamination of non-target areas.

This can only be achieved by using efficient and properly calibrated equipment.

Getting the spray rig set up before the start of the season is critical in achieving results through timely spraying and saves money.

The first step is to read, fully understand and accurately follow the label instructions. The instructions will include recommended application rates, nozzle information and details on recommended pressure and flow rates.

Droplet size

Most insecticides are contact chemicals rather than systemics (like most herbicides) and therefore it is more important to have complete coverage of the target. This means small droplet sizes are necessary. Larger droplets tend to strike an object in their path because of their momentum, whilst smaller and lighter droplets tend to flow around the object with the airstream, particularly at low airflow rates. This increases their chances of striking an object deeper into the canopy, or landing on the reverse side of the target. Small droplets are necessary if a uniform, complete coverage is required. They are however more subject to drift, the consequences being poor target coverage, and possible environmental damage. Chemical users will often need to compromise between coverage and reducing spray drift, particularly when weather conditions are less than ideal.

The best droplet size required for the target is produced by a careful selection of spray nozzle and operating pressure. Most insecticide spraying should be carried out using a medium droplet spectrum. Labels will sometimes specify the droplet size along with water volumes.

Insecticides should not be applied using flat fan nozzles. Air induction/inclusion or venturi nozzles should be used, or special low-drift flat fan nozzles.

When choosing a nozzle size, farmers need to decide on the application rate or water rate, and determine what speed or speed range is required. Applications rates and speeds vary considerably depending on the type of chemicals used, availability and condition of water, weather and field conditions and the type of sprayer used.

Water volume rates

Water volumes nominated on the label are a good guide. They can range from 30–200 L/ha, depending on the chemical and the way it is being used. Rates between 50–100 L/ha are the most common. Applying high rates results in a significant amount of time being lost in refilling. When spray is applied at low volumes significant savings in time carting and mixing are achieved. However there are problems with applying chemicals at low volumes. Nozzles must be in good condition, finer filters may be needed for the smaller orifices, drift can be more of a problem and good tank agitation is essential because the concentration of the mix is higher.

Coverage/Volume

As the droplet size is reduced many more droplets can be produced from the same volume of spray. When using large droplets the total spray volume must be increased to maintain acceptable target coverage. With smaller droplets, the opposite is the case.

Boomspray height

Matching boomspray height with nozzle angle will ensure the spray overlap between nozzles is correct, allowing spray coverage to be maximised and remain even. If the boom height is set too low only the area beneath each nozzle is sprayed which means there will be unsprayed gaps due to insufficient overlap. Bouncing when the boom is too low will cause the same uneven coverage. Less problems occur when the boom is too high as the pattern evens out, however drift and evaporation losses can be a problem. Nozzle tips should be angled at 10°–15° to the boom.

Nozzle manufacturers specify a suitable height, depending on the angle of the resulting spray fan. Most agricultural nozzles have spray fans in the 80°–110° range – the proportion of fine droplets increases with the angle of the fan.

Drift potential

Very fine droplets (< 95 µm) pose the highest risk of spray drift. Under normal spraying conditions large droplets will only be moved short distances by the prevailing wind. Small droplets can get caught up in turbulence and be carried a considerable distance from the target.

The following influence the potential of spray droplets to drift:

- *Height of spray release.* The greater the height above the canopy, the higher the risk of drift as there is more time for the droplets to be exposed to air currents. There is also more time for evaporation to reduce droplet size.
- *Droplet size and behaviour.*
- *Chemical formulations.* ULV formulations and other formulations can affect the size of the droplet produced and hence its drift potential. Insecticides are more prone to drift than herbicides because of the smaller droplet size required.

BCPC/ASAE nozzle ratings

Category	Nozzle size flat fan	Pressure (bar)	Volume mean diameter (microns)	Typical uses in crops
Very fine	11001	4.5	< 100	Greatest drift risk
Fine	11002	3.5	100–200	Insecticides Fungicides Herbicides (grass weeds)
Medium	11004	2.5	200–300	Insecticides Fungicides Herbicides (broadleaf weeds)
Coarse	11008	2	> 300	Soil-applied herbicides

Note: 'Volume mean diameter' or VMD means that 50% of the droplets are less than the stated size and 50% greater.
Source: *Spray Drift Management: Principles, Strategies and Supporting Information and Pesticide Application Methods*, third edition.

Nozzle outputs and ISO colour coding

Nozzle	Output at 3 bar in litres/minute	ISO colour
01	0.4	orange
015	0.6	green
02	0.8	yellow
03	1.2	blue
04	1.6	red
05	2.0	brown
06	2.4	grey

Source: *Pesticide Application Methods*, third edition.

- *Weather conditions.* Temperature, wind speed, wind direction and humidity determine the extent of drift that is likely to occur. Stable atmospheric conditions are best for minimising drift potential, but no spraying should be undertaken in the presence of an inversion layer as this can move the spray a long distance from the target. This effect can be seen when smoke gets trapped and moves horizontally. Spraying is best carried out between wind speeds of 3–15 km/hr. High humidity is also preferred to reduce evaporation and drift of water-based sprays.

Speed

High speeds can be used provided boom bounce is not a problem and, with ground driven sprayers, pressure is not higher than is acceptable for the nozzles fitted. At speed, air flow over the boom can assist in forcing droplets into the spray canopy, but air turbulence can add to drift. For large booms, e.g. > 30 m, speeds over 25 km/hr will result in boom bounce. Speeds over 25 km/hr also increase the drift risk. It is essential that forward speed does not vary from that used for calibration when sprayers are fitted with PTO or engine driven pumps. Any change in speed will result in overdosing (going slower) or underdosing (going faster).

Evaporation risk

Small water based droplets will evaporate rapidly under hot conditions and can cause considerable losses of spray volume.

Compatibility

See page 96 for information on compatibility of insecticides with herbicides.

Adjuvants

An adjuvant is an approved product which is added to a spray formulation to improve its properties, e.g. better spreading, sticking or penetration. It can also be used to reduce application rates by improving activity or improving product performance in adverse conditions. If an adjuvant is needed the manufacturers label will generally mention the type and rate of adjuvant.

Generally, oils increase viscosity and produce a coarser droplet size. Common surfactants and wetters produce smaller droplets because the liquid surface tension is reduced.

Water quality

The quality of water used as a carrier for chemicals can have significant effects on the level of chemical effectiveness. It is always advisable to use rain water but this is not always possible. Rain water stored in concrete tanks will be alkaline and can reduce efficacy.

Muddy water, hard water, alkaline water, salty water and water containing organic matter such as algae can cause blockages and reduce the effectiveness of some groups of chemicals. Water temperature can also have a significant effect on the properties of some chemicals. There are a number of solutions for problem water. See Agfact AC.2 *Farm water quality and treatment* for details.

Tank mixing pesticides

Where there is no such prohibition on the label, growers may utilise whatever tank mix they believe appropriate, provided they can comply with the instructions on each of the product labels which are the components of the mix. This means that each component of the tank mix must be used at or below the rate which appears on its label as if it was being used on its own. All tank mixes, other than those mentioned on the product label, are at the user's risk.

Conservation farming and emerging pest challenges

Insect pests and stubble retention

Over the last 20 years many farmers in cropping areas across Australia have adopted conservation farming systems that include minimum tillage practices that retain stubbles. This has resulted in a change in the arthropod pest spectrum, with farmers having to deal with a different range of pests that are associated with higher levels of organic matter on the surface of cropping paddocks.

Many of these arthropods are commonly found around the farm but the more favourable conditions created by minimum tillage and stubble retention, have emerged as significant pests. Research on their life cycles and control is continuing. Some examples of emerging pests include:

Slugs

Slugs are a significant pest of crops during the crop emergence and establishment phases. Being

opportunistic breeders and the more favourable conditions created by minimum soil disturbance and stubble retention, the extent and level of slug damage is continuing to increase.

Two species responsible for major damage are the Grey field slug (*Deroceras reticulatum*) and the Black keeled slug (*Limax cinereaniger*). It is important for growers and consultants to monitor population dynamics (species and age distribution) and numbers at key times throughout the season. This information is critical in determining the most effective approach to manage slugs and forms the basis for decision-making crop sowing options.

Research and development is on-going, assessing the effectiveness of a integrated management strategies including cultural practices like stubble rolling and tillage; and tactical baiting strategies.

Snails

The distribution of snails continues to extend across the High Rainfall Zones (HRZ). The management of this pest is generally well understood and integrated snail management has been widely adopted. However, the small pointed conical snails (*Prietocella barbara*) cannot be effectively managed and thus causes significant crop damage and grain contamination.

Baiting is often ineffective as the juveniles will not take baits. In the HRZ it is often not possible to control the late spring hatchings of this species which then go on to become a contaminant of grain. The small pointed conical snail is well adapted to environment of the HRZ where climatic conditions and the presence of perennial pasture and weed species increase the rate of survival and breeding opportunities.

Wireworms

True wireworms (*Agrypnus* spp.) and false wireworms (*Orondina* spp.) attack cereals, oilseeds and grain legumes. Wireworm problems are often associated with stubble retention and trash from previous crops, which provide a refuge that favours survival and breeding.

Early detection of true and false wireworms is important. Once feeding damage has become obvious it is often too late to implement effective control.

Foliar applications can be used for partial control of some species of false wireworms that feed above ground. In paddocks with a history of wireworm problems, cultivation before seeding may reduce pest pressure. Rotations, including continuous cropping or short pasture phases will often limit population increases.

Slaters

Slaters can attack broad-acre crops, and in some instances can cause serious damage. There have been reports of slaters causing damage to cereals, canola, lentils and pastures in New South Wales and Victoria. However, the presence of slaters within a paddock (even in high numbers) does not necessarily mean a pest issue.

Slaters typically feed on decaying organic matter and only rarely feed on emerging crop seedlings. Feeding results in uneven rasping-type damage that often appears as 'windows' of transparent leaf membrane.

There appears to be a strong correlation with minimum tillage and stubble retention. Stubble provides a cool, moist refuge that facilitates survival and population development. Slaters need damp conditions and will die if exposed to open and dry situations. Crumbly clay soil surfaces and cracking clays also seem to favour their survival.

Major pests

Wireworms and false wireworms

Description

Wireworms (*Agrypnus* spp.) are the soil-dwelling larvae of some beetles of the family Elateridae.

These beetles, when laid on their backs, can leap into the air and land on their feet. This action is often accompanied by a clicking sound – hence their popular name 'click beetles'.

Wireworm larvae have soft, semi-flattened, smooth, creamy white or pale bodies with darker, wedge-shaped heads and forked, tooth-edged tails. They are 15–25 mm long when fully grown.

Do not mistake soil dwelling predaceous larvae of beetles of the Family Carabidae and Family Staphylinidae for wireworms. They can be distinguished from wireworms by a prominent pair

of slender, fleshy processes on the rear of the body. Carabid and Staphylinid larvae are slender and semi-flattened with large dark brown or black heads, white or pale yellow bodies and three pairs of short legs. They are up to about 20 mm long when fully grown.

The soil-dwelling larvae of another family of beetles, the Tenebrionidae, are known as false wireworms because of their similarity in appearance and habits to some wireworms.

False wireworm larvae have hard, round, smooth, yellow-brown or brown-black bodies. They have pointed, upturned tails or a pair of raised spine-like processes at the rear end. They are about 40 mm long when fully grown.

Occurrence and damage

Infestations of both wireworms and false wireworms often occur together but wireworm damage occurs more commonly in southern areas while false wireworms are most troublesome in northern districts. Wireworms generally favour low-lying, poorly-drained paddocks while false wireworms prefer light, dry soils with a high organic matter content.

Wireworms and false wireworms cause similar damage. The larvae attack germinating seed and eat the contents. They also chew into the underground stems of seedlings and young plants, so that they wither and die. Affected crops may be thinned or, in heavy infestations, so badly damaged that resowing is necessary.

Wireworm damage is usually most serious when the germination and establishment of newly sown crops is impaired by cold, wet conditions. Damage by false wireworm is normally most severe when crops are sown into dry seedbeds and germination is delayed by continued dry weather.

Treatment

Check the soil for wireworms and false wireworms before sowing because treatment after sowing is not practical. Sampling the soil and determining the populations of these pests is difficult. A suggested method is to closely examine a number of areas in the paddock, each 200 mm × 200 mm × 50–300 mm deep (deeper when soil is colder or drier, shallower when soil is warmer and wetter). As a guide take 20 samples in a 4 ha paddock, ranging up to 200 samples in a 100 ha paddock.

The use of press wheels where appropriate (at pressures of 4–6 kg/cm width of press wheel) may improve establishment where populations of wireworm and false wireworm larvae are low. Banded, in-furrow pesticide at sowing will control wireworms but may be less effective against false wireworms, particularly if populations are very high. Correct placement of the pesticide relative to the seed is critical to its success. Contact your advisor for information on pesticides and application techniques.

Redlegged earth mite, blue oat mite and bryobia mite

Redlegged earth mite (*Halotydeus destructor*) and blue oat mite (*Penthaleus major*) are two soil-dwelling mites that damage crops in autumn, winter and spring. They are primarily pests of seedlings but can also seriously injure older plants. Winter crops at establishment may be severely damaged, particularly if growth during and following emergence is slow. Damaged plants die or remain stunted and weak. Sometimes seedlings are killed before they emerge.

Both mites prefer light, sandy or loamy, well drained soils and often occur together in crops on the tablelands, slopes and plains of New South Wales.

Feeding

Mites feed by rasping the surface of the cotyledons and leaves and by sucking up the sap. Feeding is normally from late afternoon until early morning, but continues through the day in calm, cloudy weather. Mites are very active and if disturbed on a plant will drop or descend to the ground and disperse to find shelter. Redlegged earth mites usually remain clustered together on the soil or on parts of the leaves during the day. Blue oat mites generally hide by day in the soil beneath damaged plants or under plant debris on the ground.

Redlegged earth mite (RLEM)

The redlegged earth mite is mainly a pest on the southern and central tablelands, slopes and plains. It is native to southern Africa and capeweed is its preferred host plant. Other hosts include prickly paddy melon, wild turnip, common sowthistle, Paterson's curse and chickweed (weeds); and canola, lupin, field pea and linseed (field crops). Sometimes mites may move into young winter cereals from a

fence line or adjoining pasture and cause damage along one or more of the crop edges.

Description

Adult mites are eight-legged and about 1 mm long with oval, flattened black bodies and pinkish-orange legs and mouthparts.

Seasonal development

Three overlapping generations usually occur between mid-autumn and spring and adult populations are normally highest in May–June and September–October. Redlegged earth mites oversummer as unlaid aestivating eggs in the dead bodies of spring generation adult mites lying on or near the soil surface. The aestivating eggs are highly resistant to desiccation and usually do not begin to develop until late summer–early autumn. They hatch when favourable conditions of soil temperature and moisture occur in the following mid autumn to early winter.

TimeRite® for redlegged earth mite management

TimeRite® is an information package that provides individual farmers with the optimum spray date on their farm to control redlegged earth mites during spring.

Developed by CSIRO and Australian Wool Innovation, TimeRite® predicts the optimum date in spring to control redlegged earth mites just after they have ceased laying normal winter eggs on pasture and just before diapause. (Diapause is when adult redlegged earth mites produce eggs that are retained in the body of the adult female and are therefore protected from the effects of insecticide applications.)

The single strategic spray has a two-fold effect, controlling redlegged earth mites in spring and decreasing the summer population that emerge in the following autumn. The package may form part of an integrated management strategy to control redlegged earth mites.

Close attention should be paid to individual pesticide labels when controlling earth mites. Application rates vary with situations e.g. bare earth or post-crop/pasture emergence. Correct identification of earth mite species is essential. Registrations sometimes include redlegged earth mites only, but not blue oat mites or bryobia mites. Application rates may vary with earth mite species. READ THE LABEL.

This strategic approach has little effect on non-target invertebrates, both pest and beneficial during the following autumn.

Farmers need to identify the location to be sprayed. This can be done by a local feature e.g. town, mountain etc or the longitude and latitude of the area. This is used to find the optimum date from the package. The spray date for each farm is the same date each year.

For information phone Australian Wool Innovation toll free on 1800 070 099 or visit the website www.timerite.com.au

Blue oat mite

Blue oat mites are often confused with redlegged earth mites. There are currently four recognised species of blue oat mites in Australia, *Penthaleus major, P. falcatus, P. minor* and *P. tectus*. Accurate identification of the species requires examination by an entomologist.

The four species vary in their geographical distribution in Australia. With the exception of *P. minor*, all species have been found in NSW, in some instances, in mixed populations.

Damage to crop and pastures is incurred in the establishment phase. Host plant preferences vary with the species, as do their life cycles and tolerances to various pesticides. Host plants include black thistle, chickweed, curled dock, dandelion, dead-nettle, prickly lettuce, shepherds purse, variegated thistle and wild oat. Cultivated field crop hosts include wheat, barley, oats, rye, canola, field pea, lupin and linseed.

Description

Adult mites have eight legs and are about 1 mm long with oval, rounded, dark brown to black bodies, bright red or pinkish red legs and mouthparts and a red spot or streak towards the hind end of the back.

Seasonal development

Overlapping generations of the blue oat mite usually occur between mid autumn and late spring. It oversummers as aestivating eggs laid in mid-late spring by the second generation adults. These aestivating eggs are highly resistant to desiccation. They do not begin to develop until late summer-early autumn and they do not hatch until favourable conditions of temperature and moisture occur in the following mid autumn to early winter.

Bryobia mite

When in high numbers, bryobia mites have caused severe damage to emerging canola and lupin crops in autumn. Mites feed on the tops of leaves producing whitish grey spots that give the leaves a wilted, stippled look.

Summer rains followed by a warm mild autumn give bryobia mites the best conditions for survival and increase. They do not tolerate cold wet weather but can persist into June following warm autumn conditions. Crops planted into paddocks with a history of summer/early autumn weeds, and warm dry conditions after crop emergence are most at risk. The use of minimum tillage and earlier sowing times has led to the increased importance of this pest.

Summer weeds present in paddocks prior to cropping should be checked to determine the numbers of bryobia mites present. Mites can be controlled by cleaning infested weeds from the fallow at least one month before sowing, using a combination of herbicide and miticide, by sowing miticide treated seed, or by applying miticide during crop growth.

Rates of insecticides commonly used to control redlegged earth mites and lucerne flea are not effective against bryobia mites.

Description

The adult is less than 1 mm long and is dark grey with eight pale red to orange legs. The front pair of legs on bryobia mites are very long and held out in front of the body like a pair of feelers. Bryobia mites are easily confused with redlegged earth mites but are often present in the late summer to early autumn, before RLEM appear. The body of the mites is rounded and plump.

Life cycle

Adult bryobia mites are active in late spring, summer and autumn. Eggs are present during winter and hatch as conditions dry and warm up in spring and early summer. Newly hatched nymphs have six legs and are bright red, but turn dark-grey in a few days. A month between hatching and a young adult is usual. There are several generations per year.

Heliothis caterpillars

Corn earworm (*Helicoverpa armigera*) and native budworm (*H. punctigera*) are the two heliothis caterpillar pests of field crops that may be present from mid September onward. Corn earworm is likely to predominate between February and May. There are a number of other differences between the two pests and these are summarised in the table on page 31.

Seasonal biology

There are generally three or four overlapping generations of caterpillars of the native budworm and corn earworm between September and May in southern NSW, and four or five in northern NSW.

Scout crops regularly

The amount of damage by native budworm and corn earworm varies considerably from year to year. Moth activity alone cannot be taken as a guide for spraying. In some years when moths are common, egg and caterpillar numbers are often limited by adverse cool or cold wet weather, parasitoids, predators and diseases, and damage may be restricted or insignificant. In other years a relatively small moth population may produce many caterpillars and cause significant damage.

Periodic outbreaks of caterpillars of both pests in summer are often associated with heavy rainfall. You should check your crops at least a week after heavy rainfall for moths, eggs and very small caterpillars, and treat if necessary.

Spraying threshold figures are unlikely to ever be more than guidelines for timing sprays. Examine your crops at least twice a week during the various heliothis danger periods. Before deciding to spray, consider the:

- likely extent and severity of the infestation,
- ability of the crop to either tolerate caterpillar damage without any significant loss or to replace leaves or fruiting parts lost to the caterpillars,
- value or likely loss if the crop is left untreated, and
- cost of treatment.

Spray eggs and very small caterpillars, particularly of the corn earworm

Corn earworm has developed resistance to many of the pesticides used against it, but the eggs and very small caterpillars (up to 5 mm long) can still be killed provided the correct rate of pesticide is used. However larger caterpillars are not likely to be controlled.

Corn earworm

In New South Wales corn earworm is largely restricted to within about 150 km of the coast and to inland irrigated summer crop production areas.

Unlike native budworm it mainly overwinters locally as pupae in the soil. These pupae are the source of the moths which produce the spring and summer generations of caterpillars. The moths are not strong fliers, but can be carried for long distances by wind. They usually initiate infestations locally – within about 100 km of where they developed as caterpillars.

During summer, corn earworm moths may be carried by wind into southern NSW from areas to the north (or into northern NSW from southern Queensland) and initiate infestations in crops over a wide area. Pheromone traps or lights do not always attract moths. There may be no forewarning of a probable corn earworm outbreak unless growers regularly inspect crops to detect moths.

Native budworm

Native budworm is widely distributed throughout mainland Australia and during winter breeds in semi-arid parts of Western Australia, South Australia and south-west Queensland. These vast inland areas are the sources of the moths which produce the spring-generation of caterpillars in New South Wales (local overwintering pupae in the ground are of little concern). The moths are strong fliers and may also be carried for very long distances by wind to initiate infestations in localities far from where they developed as caterpillars.

Descriptions of corn earworm and native budworm eggs and caterpillars

Eggs

Newly laid eggs are white or yellowish white, dome-shaped, flattened at the base, ribbed and 0.5 mm in diameter. Not all eggs are fertile. Fertile and infertile eggs are laid at the same time, and sometimes all eggs laid are infertile. Fertile eggs change to greenish yellow with an irregular brown or reddish-brown ring around the middle. Before hatching the blackish head and grey body of the caterpillar shows through. They hatch in 3–5 days in warm weather and 6–16 days in cooler weather. Infertile eggs become slightly cylindrical (within about 12 hours of being laid) and then shrivel to a pyramid shape.

Caterpillars

Newly hatched caterpillars are 1–1.5 mm long with dark heads and dark spotted white bodies. Young

	Corn earworm	Native budworm
Insecticide resistance	■ Moderate to high levels of resistance to many insecticides, but: – very small caterpillars (up to 5 mm long) can still be controlled – larger caterpillars are unlikely to be controlled	■ No resistance ■ Large caterpillars (more than 5 mm long) can be controlled provided the correct rate is used
Crops attacked	■ Azuki bean, chickpea, cotton, maize, millet, navy bean, sorghum, soybean and sunflower	■ Canola, chickpea, cotton, faba bean, field pea, linseed, lupin, safflower, soybean, sunflower, and winter cereals ■ Lucerne ■ Azuki and navy bean occasionally
Seasonal behaviour	■ Found in all irrigation areas ■ Main activity is in summer and autumn ■ Local overwintering pupae are main source of new infestations each year	■ Found in all irrigation areas ■ Main activity is in spring and early summer ■ Spring infestations originate from moths blown in from semi-arid inland areas ■ Local overwintering pupae are of little importance

Crop	Egg laying sites
Azuki bean and navy bean	Mainly on the upper leaves and on the flowers
Lucerne	Upper leaves, flower buds and flowers
Maize	Upper two-thirds of the plants – on the stems, leaves (both sides), but predominantly on tassels, silks and husks
Millet and sorghum	Upper leaves and stems but predominantly on flower heads
Soybean	The terminals at budding and flowering stages, flower buds and flowers
Sunflower	On the leaves and bracteoles surrounding and close to the developing flower head

caterpillars up to about 15 mm long, have dark heads and pale yellow, greenish or brownish bodies with conspicuous upper body hairs in dark bases and, often narrow dark stripes down the back and along each side. Older caterpillars up to 50 mm long vary greatly in colour from yellow to almost black, often have a broad pale stripe along each side, and their upper body hairs are usually on raised processes.

Egg laying

Egg laying is usually confined to the period from flower bud formation (or head emergence/tasselling) until flowering ends. When moths are exceptionally abundant, infestation can be expected before the commencement of flowering.

Eggs are laid, usually singly, on the upper parts of plants – vegetative or floral growing points, young tender leaves, stems and flower buds, flowers and fruits. The moths prefer the more advanced and succulent portions of crops for egg laying and usually avoid poorly grown areas. Eggs may not be obvious to the untrained eye because of their minuteness. However, moderate to heavy egg lays should be obvious to trained observers in many pulse crops, including mungbeans, and are often found on terminals or on the tops of young leaves at the top of the canopy. Egg scouting in chickpeas can be very difficult.

Heliothis resistance management strategy

Corn earworm (*Helicoverpa armigera*) has developed resistance to the pyrethoid chemical group (e.g. decis options®, Karate®), and the carbamate group (e.g. Lannate L®). However, very small caterpillars (up to 5 mm long) can still be controlled with these and other pesticides. New chemical groups are now available for the control of *H. armigera*, but often control is slower.

Corn earworm caterpillars are found in all irrigation areas. Their main activity is in summer and autumn. Local overwintering pupae are the main source of new infestations each year. The following strategies are recommended across all cotton and grain industries.

Destroying the overwintering pesticide-resistant pupae

- Corn earworm overwinters as pupae in the soil under crop stubble and moths emerge from the pupae in the following spring.
- Insecticide resistance is carried over between seasons in the pupae.
- Where large heliothis caterpillars are present in crops during March there is a risk of carryover of resistance to the next season. Cultivate these paddocks to destroy the pupae as soon after harvest as possible and complete by the end of August.
- Check no-till late season crops for pupae. Consider busting if detectable numbers (one pupae per 10 m^2) are present.
- Ensure cultivation creates full disturbance to at least 10 cm deep as follows:
  – on hills: to 10 cm each side of the plant line
  – on beds: right across the bed to 20 cm beyond the outside rows
  – on the flat: the whole area.

Scout crops regularly

- Monitor crops twice weekly during heliothis danger periods to detect eggs and very small (up to 5 mm long) caterpillars. Infestations are often associated with heavy rainfall.
- Use advisors for monitoring because moth activity alone cannot be taken as a guide for spraying and eggs are not readily seen with the naked eye because they are small and often hidden.
- Pay closer attention to late season *H. armigera* activity on susceptible crops (cotton, summer pulses, late sorghum and late sunflowers).

Spray eggs and very small caterpillars

- Spray to control the eggs and very small (up to 5 mm long) caterpillars. It is important that the chemical contacts the eggs and caterpillars.
- Egg laying is usually confined to the period from flower bud formation (or head-emergence/tasselling) until flowering ends. At 25°C it takes 8–10 days from egg lay to 5 mm long caterpillars.

Pesticide management

- Conserve beneficials by using the most selective pesticide available, including appropriate use of Nuclear Polyhedrosis Virus (NPV) products (e.g. Vivus Gold®).

- Monitor natural enemies and be aware that their activity varies in crop types. For example, they are not very active in chickpeas.
- Delay the use of disruptive pesticides (pyrethroids, carbamates and organophosphates) in all crops for as long as possible. Review spraying threshold figures as a guide to spray timing.
- Where *Helicoverpa* populations are present and above threshold, control them within the limits of insect resistance and available registrations. Ensure spray applications are accurate and timely. Do not spray in the heat of the day. Use a NPV product e.g. Vivus Gold® where appropriate to reduce selection for insecticide resistance but caterpillars must be small (5–10 mm), it must be applied in the evening, and there should be no rainfall within 24 hours. Apply NPV as high volume spray (with a wetting agent) at 30 L/ha aerially and 100 L/ha by a ground rig.
- Biopesticides have an increasingly important role to play in the management of *Helicoverpa* spp. in grain crops. NPV and *Bacillus thuringiensis* (Bt) can be effective pesticides but are often not robust enough to handle high density infestations, large range of larval sizes and persistent egg lays.

  Milk powder additives such as Denkavit® at 1 kg/ha improve the performance of NPV and Bt on chickpeas and other crops. Bio assays on mungbeans and cotton have shown that Amino-feed®, a liquid additive is the equivalent of milk powder additives and gives fewer problems with mixing and blocked nozzles.
- Rotate chemical groups when spraying crops. If you have to spray more than once use a pesticide from each of the three available groups (organochlorines, synthetic pyrethroids and carbamates) in rotation. Never apply two consecutive sprays from the same chemical group. For example, if a pyrethroid is used to control sorghum midge do not use a pyrethroid to control heliothis.
- Remove all farm vegetation likely to encourage the breeding of insect pests. For example, destroy failed or abandoned crops by cultivation or by using herbicides immediately the decision to abandon has been made. Avoid sowing commercial chickpea crops after June. Late flowering crops are a known host for the next generation of *H. armigera*.
- Use ovicide rates of pesticides only where crops are monitored regularly for eggs and larvae and where eggs are targeted.
- Use larvicide (highest) rates where there is no regular crop monitoring and where larvae are targeted.

Use information from pheromone traps

- During August, September and October pheromone traps will be in place in some districts. Information gained will indicate whether more detailed sampling of spring host crops (e.g. winter cereals, pulses and weeds) is necessary.
- Advisors or growers wanting assurance on the numbers of corn earworm moths laying eggs in their crops should catch moths in a sweep net and determine their identity. (Moths collected in pheromone traps are a poor indicator of which species of larvae will predominate in crops.) As a guide, catch a total of at least 30 heliothis moths at random throughout the crop and on flowering weeds in the paddock (ignore the other moths – such as tobacco loopers, brown cutworms and common armyworms – that may fly in company with the native budworms).

Permits

Some of the chemical use patterns quoted in this publication are approved under Permits issued by the APVMA and are in force at the time the publication was prepared. Persons wishing to use a chemical in a manner approved under a Permit should obtain a copy of the relevant Permit from the APVMA and must read all the details, conditions and limitations relevant to that Permit, and must comply with the details, conditions and limitations prior to use.

Table 2. Permits as at July 2013

Active ingredient	Registered trade names	Permit number	Date	Crops	Pests	Rate (per ha)
chlorpyrifos 500 g/L	Lorsban 500 EC Nufarm Chlorpyrifos 500 EC Cyren 500 EC	PER8522	9 March 2006 to 9 March 2016	Pulse crops and grain legumes including: azuki beans, cowpeas, mung beans, faba beans, lentils & navy beans	Wireworm (*Agrypnus variabilis*), black field earwig (*Nala lividipes*), field crickets (*Teleogryllus commodus*), and false wireworm (*Isopteron punctatissimu*, *Gonocephalum macleayi* and *Pterohelaeus* spp).	100 mL product plus 125 mL sunflower oil per 2.5 kg cracked sorghum or wheat seed per hectare.
250 g/L lambda-cyhalothrin	Karate (Zeon Tech) plus other registered products containing 250 g/L lambda-cyhalothrin	PER10927	24 February 2012 to 30 June 2015	Crops & situations specified on the labels of the products listed under conditions of use	Australian plague locust (*Chortoicetes terminfera*) and Spur throated locust nymph (*Austracris guttulosa*)	lambda-cyhalothrin: 250 g/L Zeon: 24–36 mL/ha
150 g/L gamma-cyhalothrin	Trojan plus other registered products containing 150 g/L gamma-cyhalothrin					gamma-cyhalothrin: 150 g/L EC: 20–30 mL/ha
25 g/L betacyfluthrin	Bulldock Duo, Bulldock 25 EC plus other registered products containing 25 g/L betacyfluthrin					betacyfluthrin: 25 g/L EC: 200–400 mL/ha
100 g/L alpha-cypermethrin	Dominex Duo plus other registered products containing 100 g/L alpha-cypermethrin					alpha-cypermethrin: 100 g/L EC: 160–200 mL/ha
16 g/L alpha-cypermethrin	Dominex ULV plus other registered products containing 16 g/L alpha-cypermethrin					alpha-cypermethrin: 16 g/L UL: 1.0–1.25 L/ha
250 g/L alpha-cyfluthrin	Googly Alpha-Duo 250 SC plus other registered products containing 250 g/L alpha-cyfluthrin.					alpha-cypermethrin: 250 g/L SC: 64–80 mL/ha
200 g/L cypermethrin	Sonic 200 EC plus other registered products containing 200 g/L cypermethrin as their only active ingredient	PER10928	24 February 2012 to 30 June 2015		Australian plague locust (*Chortoicetes terminfera*) and Spur throated locust nymph (*Austracris guttulosa*)	200 g/L EC: 160–200 mL/ha
250 g/L cypermethrin	Cyrux 250 EC plus other registered products containing 250 g/L cypermethrin as their only active ingredient					250 g/L EC: 120–200 mL/ha
260 g/L cypermethrin	4Farmers Cypermethrin 260 EC plus other registered products containing 260 g/L cypermethrin as their only active ingredient					260 g/L EC: 120–200 mL/ha
40 g/L cypermethrin	Farmoz Scud 40 ULV plus other registered products containing 40 g/L cypermethrin as their only active ingredient	PER10928	24 February 2012 to 30 June 2015		Australian plague locust (*Chortoicetes terminfera*) and Spur throated locust nymph (*Austracris guttulosa*)	40 g/L ULV: 1–1.25 L/ha
27.5 g/L deltamethrin 5.5 g/L deltamethrin	Farmoz Ballistic Elite, Akodelthrin and other registered products. Farmoz Ballistic ULV, Decis Forte ULV and other registered products.	PER11624	24 August 2009 to 31 August 2014	Safflower (*Carthamus tinctorius*)	Rutherglen bug (*Nysius vinitor*)	27.5 g/L EC products: Apply at a rate of 500 mL product per hectare. 5.5 g/L ULV products: Apply at a rate of 2.5 L product per hectare.

Table 2. Permits as at July 2013 (continued)

Active ingredient	Registered trade names	Permit number	Date	Crops	Pests	Rate (per ha)
18 g/L abamectin	All registered products	PER12904	17 February 2012 to 31 March 2014	maize	Two-spotted mite (*Tetranchus urticae*)	300 mL/ha
18 g/L abamectin	Farmoz Wizard 18 Miticide plus other registered products	PER13293	7 May 2012 to 30 April 2015	azuki bean, mung bean and navy bean	Two-spotted mite (*Tetranchus urticae*) and bean or onion thrips (Thrips tabaci)	300 mL/ha
240 g/L spirotetramat	Movento 240 SC	PER13403	1 June to 30 June 2015	Seed production crops: Maize and sorghum	green peach aphid (*Myzus persicae*) and maize thrips (*Frankliniella williams*)	GPA – 200–300 mL product / ha MT – 300–400 mL product / ha
500 g/L pirimicarb	Pirimor WG plus other registered products	PER13451	20 December to 31 March 2016	azuki bean, mung bean and soybean	Cowpea aphid (*Aphis craccivora*) and Soya bean aphid (*Aphis glycines*)	250–300 g/ha
225 g/L methomyl	Farmoz Electra 225 plus other registered products.	PER13606	19 November 2012 to 31 March 2015	Mung beans (*Vigna radiata*)	Bean pod borer (*Maruca vitrata*)	1.5 to 2.L/ha Add 25 mL/100 L of a non-ionic wetting agent

Dimethoate

The Permit applies to the following 400 g/L agricultural products bearing suspended labels:

Product No.	Product Name	Registrant	Suspended Label Approval No.
32962	Nufarm Dimethoate Systemic Insecticide	Nufarm Australia Limited	32962/0401, 32962/0402, 32962/0701, 32962/0998, 32962/1299, 32962/0704, 32962/0104, 32962/1203, 32962/1006, 32962/53189
39239	Farmoz Dimethoate 400 Systemic Insecticide	Farmoz Pty Limited	39239/0402, 39239/0897, 39239/4252, 39239/0708, 39239/0809, 39239/0108, 39239/0405
49600	Saboteur Systemic Insecticide	Crop Care Australasia Pty Ltd	49600/01, 49600/0100, 49600/0702, 49600/1107, 49600/0306, 49600/53186
51545	Chemag Dimethoate Insecticide	Imtrade Australia Pty Ltd	51545/0203, 51545/1100
55441	4 Farmers Dimethoate 400 Systemic Insecticide	4 Farmers Pty Ltd	55441/0402
55495	Superway Dimethoate 400 Systemic Insecticide	Superway Garden Ag & Pest Products Pty Ltd	55495/0103
55704	Conquest Dimethoate 400 Systemic Insecticide	Conquest Crop Protection Pty Ltd	55704/0502
56454	Danadim Insecticide	Ospray Pty Limited	56454/0903, 56454/0909, 56454/1109, 56454/0306
56887	United Farmers Unidime 400 Insecticide	Ravensdown Fertiliser Co-Operative Limited	56887/0303
57860	Halley Dimethoate 400 Systemic Insecticide	Halley International Enterprise (Australia) Pty Ltd	57860/0603
58374	Cropro Stalk Insecticide	PCT Holdings Pty Ltd	58374/0504
59469	AW Dimethoate 400 Systemic Insecticide	Agri West Pty Limited	59469/0105 59469/0609
62511	Titan Dimethoate 400 Systemic Insecticide	Titan Ag Pty Ltd	62511/0108 62511/0808
63470	Country Dimethoate 400 Systemic Insecticide	Accensi Pty Ltd	63470/1208
64309	Farmalinx Dimetholinx Insecticide	Farmalinx Pty Ltd	64309/0809
65259	Rover Systemic Insecticide	Sipcam Pacific Australia Pty Ltd	65259/0810
65260	Rogor Upgrade Insecticide	Ospray Pty Ltd	65260/50541
66538	ACP Dimethoate 400 Systemic Insecticide	Australis Crop Protection Pty Ltd	66538/53836

Abbreviations used in the tables

CS	capsule suspension	ULV	ultra-low volume	SP	soluble powder
FL or F	flowable concentrate	EC	emulsifiable concentrate	WP	wettable powder
LC	liquid concentrate	G (GR)	granular	WG	water dispersible granule
P	pellet	OL	oil miscible liquid		
SL	soluble concentrate	SC	suspension concentrate		

Table 3. Azuki bean, cowpea and pigeon pea – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	Consider control when colonies are large.	Flowering and podding usually under hot dry conditions.	Distort and stunt leaves. Reduce pod set.	Control rarely necessary. Look for presence of predators. Honey dew could attract heliothis moths.	Intermittent
Cutworms	At first sign of damage. Usually in large numbers in patches or moving in from edges of crop.	Seedling. Check for presence when sowing crop and at emergence (particularly on weedy fallows).	Eat leaves and cut stems at or below ground level killing plants. Remain in the soil during the day and feed at night.	Inspect crops late in evening or night for presence of large dark grey-green caterpillars. Caterpillars hide in soil during the day. Spot treatment of affected patches only may be necessary. Favour light soils.	Intermittent
Podsuckers – rated in terms of GVB equivalents. Green vegetable bugs (GVB) = 1 GVB Redbanded shield bugs = 0.75 GVB Brown bean bugs = 1 GVB	Threshold will depend on damage allowed by market and crop potential. For azukis: 0.1 bugs/m^2 in a poor yielding crop, 0.7–0.8 bugs/m^2 in a high yielding crop.	Flowering to harvest.	Suck pods and seeds. Damage developing seeds. Reduce seed quality.	Nymphal green vegetable bugs are distinctly different in colour to adults. Treat early morning when bugs are near top of plant. GVB and BBB are the biggest problem.	Intermittent
Heliothis caterpillars	40% defoliation pre-flowering. 1 larvae up to 5 mm long per m^2 post-flowering. Apply Nuclear Polyhedrosis Virus (NPV) (e.g. Vivus Gold) at sub-threshold levels of 0.3–0.5 per m^2. Seed for human consumption should not be damaged.	Budding, flowering and podding.	Small caterpillars < 10 mm long feed on leaves, flower buds, flowers and young pods. Caterpillars > 10 mm make holes in seeds or pods.	Presume caterpillars are corn earworm (*H. armigera*) and potentially resistant. Check crop twice weekly during flowering/podding. Control by spraying eggs and caterpillars up to 5 mm long. Aphid honeydew attracts moths to lay eggs in crops. Pupae bust azuki bean fields after harvest.	Annual
Loopers	40% leaf area loss pre-flowering. 3 per m^2 after flowering.	Early growth stages, damage often moving in from edges of crop.	Defoliate plants.	Caterpillars have a distinct looping action distinguishing them from heliothis. Bt will control small to medium loopers.	Problem mainly for coastal areas and QLD
Lucerne seed web moths (Inland districts only)	None validated. Should be moth based not larvae based. No specific control measures. Treatments for heliothis, pod sucking bugs and thrips give some control.	Flowering and podding.	Small caterpillars bore into pods. Small pods wither. Caterpillars develop inside large pods, chew out grain, fill pod with excrement and webbing.	Damage may not be noticed until pods are discoloured by excrement. Favoured by hot dry weather, often in proximity to lucerne stands. Adequate irrigation reduces caterpillar entry into pods.	Rarely
Mirids	0.3–1.3 per m^2 depending on chemical choice application method and cost.	Budding/flowering stage.	Damage buds and flowers causing them to abort. Poor seed set.	Large numbers suspected of causing crop failure. Use a sweep net to monitor.	Annual
Thrips (onion, plague and tomato)	Lack of data on flower damage. Current QDAFF threshold in mungbeans is 4–6 per flower.	Budding and flowering stages. Moisture stressed crops more vulnerable.	Feed on young buds and flowers. Reduces pod set and distorts pods.	Shake flowers into white container to dislodge thrips or open and inspect flowers.	Annual
Two spotted mites	None established.	Late vegetative, flowering and pod setting. Worse under hot dry conditions.	Form fine web on the underside of the leaf. Cause premature maturity and reduce seed size and yield by rasping and sucking action.	Move in from maturing maize and broadleaf perimeter vegetation. Avoid synthetic pyrethroids or carbamates on nearby maize early in the season. Avoid planting next to earlier maturing hosts.	Intermittent

All thresholds based on beat sheet method. See *Azuki beans: Irrigated planting guide* for more detailed information.

Table 4. Azuki bean, cowpea and pigeon pea – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Green vegetable bugs	Heliothis	Loopers	Mirids	Thrips
Bacillus thuringiensis sub-species *kurstkai*	BioCrystal (azuki beans and pigeon peas only)		0.5–2.0	0.5–2.0		
	DiPel SC (azuki beans and pigeon peas only)		1.0–4.0	1.0–4.0		
deltamethrin* 27.5 g/L EC	Crop D-Sect EC	0.5	0.5	0.5		
	decis options	0.5	0.5	0.5		
esfenvalerate 50 g/L EC	Sumi-Alpha Flex (pigeon peas only)		0.13–0.33 ❶❸			0.13 ❸
indoxacarb (25:75) 150 g/L EC	Steward EC (azuki beans only)		0.4		0.4	
methomyl 225 g/L SL	Electra 225	1.5 ❷	1.5 or 2.0 ❷			
	Lannate L	1.5 ❷	1.5–2.0 ❷	1.5 ❸		1.0 ❸
	Marlin 225	1.5 ❷	1.5 or 2.1 ❷			
	Methomyl 225	1.5 ❷	1.5 or 2.0 ❷			
	Nudrin 225	1.5 ❷	1.5–2.0 ❷	1.5 ❹		1.0 ❹
nuclear polyhedrosis virus (NPV) 2 thousand million/mL (Obs)	Gemstar LC		0.375			
	Vivus Gold		0.375			
	Vivus Max		0.15			
thiodicarb 375 g/L SC	Larvin 375 (pigeon pea only)		0.5 or 0.75			
	Showdown 375 (pigeon pea only)		0.5 or 0.75			
800 g/kg WG	Confront 800 WG (pigeon pea only)		0.235 or 0.35 kg			
	Mission T 800 WG (pigeon pea only)		0.235 or 0.35 kg			

* **Numerous other generic products are also registered.**
❶ Registered for native budworms (*Helicoverpa punctigera)* only.
❷ Also registered as an ovicide at 0.5–1.0 L/ha.
❸ Registered for cowpeas and pigeon peas only.
❹ Registered for pigeon peas only.

Table 5. Canola – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	> 50% of plants with clusters 25 mm long on stem or 4–5 stems per m^2 with clusters 50 mm long on stems.	Flowering/early pod set.	Prevent pod set. Dry out stem. Can attract heliothis moths.	Check for presence of predators e.g. ladybird larvae, hoverfly larvae, fungal diseases. Heavy rain can wash aphids off plants. Infestations most likely in hot, dry weather.	Intermittent
Blue oat mites (BOM) and redlegged earth mites (RLEM)	Newly emerged seedling can be killed by low numbers of mites. Preventative treatment is recommended.	Germinating seeds/seedling to 4 leaf stage. Mites oversummer as an egg in bodies of dead adults.	Mottle and whiten cotyledons and leaves by rasping and sucking. May stunt and kill seedlings. RLEM more common in southern NSW.	Most feeding during cooler part of day/night. Can kill seedlings as they germinate. Bare earth treatment after sowing is most effective. BOM and RLEM have different tolerances to some pesticides.	Annual
Cutworms	Usually in patches in a crop. Treat at first sign of damage. Treat while feeding.	Seedling 2–8 leaves.	Eat leaves and cut stems near ground level.	Inspect crops late evening or night for presence of large dark grey-green caterpillars.	Rarely
Diamondback moths (Cabbage moths)	Using cone or beat sheet. Foliage to mid-flowering: 8–12 larvae per 10 plants Mid to late flowering: 17–23 larvae per 10 plants Pod maturation: 43 to 57 larvae per 10 plants Thresholds are conservative.	Vegetative/flowering/pod set/pod filling.	Make clear membranous windows in leaves and graze stems and pods.	Threshold measures 3–4th instars (5–6 mm larvae) for visibility reasons. Sample 10 plants in three locations. Tables are available to assist spray decisions. Sweep nets are not suitable to sample dense crops. Rainfall > 5–8 mm in 24 hours often reduce larvae density and re-sampling may be necessary before deciding to spray.	Intermittent
False wireworms	No determined threshold. Paddocks should be inspected the spring prior to sowing as there is no post-sowing control.	Newly emerged seedling.	Ringbark and sever the hypocotyl of seedlings below soil surface.	Most common in soils high in organic matter but may feed on seedlings if soils and organic matter dry out. Inspect in spring.	Intermittent
Heliothis caterpillars	5 or more 10 mm long larvae per m^2 (mid podding). At first pod damage.	Late flowering and early pod set, up to windrowing.	Caterpillars < 10 mm eat foliage. Caterpillars > 10 mm chew pods and eat seeds. Assess caterpillar size and crop maturity.	Observe crop for presence of moths during late flowering. *H. punctigera* most common in spring. *H. armigera* in low numbers within 30 km of summer irrigation.	Annual
Lucerne fleas	Treat if 50% of leaf area is likely to be damaged.	Seedling/early vegetative growth.	Eat leaves, leaving clear membranous windows in foliage.	Eliminate weeds on headlands. Lucerne fleas 'hop' when disturbed.	Intermittent
Rutherglen bugs	10 adults or 20 nymphs per plant.	Flowering. Pod filling and windrowed crops.	Suck sap reducing pod set, pod fill, oil quantity and seed viability.	Infestations most likely in hot, dry weather. Adults 5 mm long narrow grey-brown. Nymph reddish-brown, pear shaped, wingless. Infestations may be confined to the edge of crop. Check for 15–20 m into crop.	Intermittent
Slugs	Bait at first sign of damage. Species determines damage and bait effectiveness.	Newly emerged seedling.	Chew off seedlings. Leaf damage may look like hail.	Damage starts in damp areas of paddock. Check presence by setting wet hessian or tile traps. Combined control strategies of burning, cultivation, weed control and baiting are most effective.	Intermittent
Wireworms	None available. No after sowing treatment.	Germination/seedling.	Attack the germinating seed or the underground stem causing plants to wither and die shortly after emergence.	Press wheels reduce crop damage. Wireworms are present in the top 50 mm of moist soil.	Rarely
Weevils (sitona and vegetable)	No threshold established.	Seedling.	Adults and larvae feed on foliage, giving them a serrated appearance and can eat plants down to the ground.	Capeweed is a host (vegetable) and medic and lucerne (sitona). Damage is usually most severe on crop edges so a border spray at crop emergence is often sufficient.	Intermittent

Table 6. Canola – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Aphids	Blue oat mites	Cutworms	Diamondback moths	Heliothis	Lucerne fleas	Redlegged earth mites	Rutherglen bugs	Vegetable weevils
alpha-cypermethrin*										
100 g/L EC	Alpha-Scud Elite❷		50 mL		0.4	0.2 or 0.3❶		50 mL❸		0.4
	Astound Duo❷		50 mL		0.4	0.2 or 0.3❶		50 mL❸		0.4
	Dictate Duo❷		50 mL		0.4	0.2 or 0.3❶		50 mL❸		0.4
	Dominex Duo❷		50 mL		0.4	0.2 or 0.3❶		50 mL❸		0.4
	Fastac Duo❷		50 mL		0.4	0.2 or 0.3❶		50 mL❸		0.4
250 g/L SC	Alpha Forte 250 SC		20 mL		2.5	80 or 120 mL❶		40 mL		0.16
Bacillus thuringiensis										
sub-species *kurstkai*	BioCrystal				0.5–2.0 kg	0.5–2.0 kg				
	Delfin WG				25–100 g	25–100 g				
	DiPel SC				1.0–4.0 kg	1.0–4.0 kg				
	DiPel DF				0.5–2.0 kg	0.5–2.0 kg				
	Full-Bac WDG				0.5–2.0 kg	0.5–2.0 kg				
sub-species *aizawai* strain GC-91	Bacchus WG				1.0–4.0 kg	1.0–4.0 kg				
beta-cyfluthrin										
25 g/L EC	Bulldock Duo		0.2			0.2 or 0.4❹		0.2		
bifenthrin										
100 g/L EC	Arrow 100 EC❺		0.1					50–100 mL		0.1–0.2
	Bifenthrin 100 EC❺		0.1					50–100 mL		0.1–0.2
	Ospray Bifenthrin 100 EC❺		0.1					50–100 mL		0.1–0.2
	Talstar 100 EC❺		0.1					50–100 mL		0.1–0.2
250 g/L EC	Talstar 250 EC❻		40 mL					20–40 mL		40–80 mL
chlorpyrifos*										
500 g/L EC	Conquest Chlorpyrifos 500		0.14–0.3	0.9				0.14–0.3		
	Cyren 500 EC		0.14–0.3	0.9				0.14–0.3		
	Lorsban 500 EC		0.14–0.3	0.9				0.14–0.3		
	Strike-Out 500 EC		0.14–0.3	0.9				0.14–0.3		
cypermethrin*										
200 g/L EC	Scud Elite					200–250 mL❼		50–75 mL❽		
	Titan Cypermethrin 200					200–250 mL❼		50–75 mL❽		

* **Numerous other generic products are also registered.**

❶ Registered for native budworms (*Helicoverpa punctigera*) only. Use the higher rate if larvae longer than 10 mm are present. Do NOT apply more than a total of 400 mL/ha per season to any one crop.

❷ Also registered for loopers (*Chrysodeixis argentifera*) at 0.2 or 0.3 L/ha.

❸ Registered at 100 mL/ha prior to crop emergence. Apply by ground rig only when soil is moist. Do not apply as a ULV application.

❹ Do not use on larvae longer than 5 mm if *Helicoverpa armigera* are present.

❺ Also registered for bryobia mites at 0.2 L/ha. Apply to bare earth. Brown pasture loopers (*Cismpa arietaria*) at 50–100 mL/ha and pasture webworms (*Hednota* spp.) at 100 mL/ha.

❻ Also registered for bryobia mites at 80 mL/ha and pasture webworms (*Hednota* spp.) at 40 mL/ha.

❼ Registered for native budworms (*Helicoverpa punctigera*) only.

❽ Spray post seedling emergence (1–5 leaf stage). Do NOT apply as bare earth treatment.

Table 6. Canola – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Blue oat mites	Cutworms	Diamondback moths	Heliothis	Lucerne fleas	Redlegged earth mites	Rutherglen bugs	Vegetable weevils
deltamethrin*										
27.5 g/L EC	Ballistic Elite[9]			0.2		0.5				
	D-Sect EC[9]			0.2		0.5				
	decis options[9]			0.2		0.5				
5.5 g/L ULV	Deltaguard ULV[10]			1.0		2.5				
esfenvalerate										
50 g/L EC	Sumi-Alpha Flex		50–70 mL[12]			0.13–0.33[11]		50–70 mL[12]		0.4–0.5[13]
gamma-cyhalothrin										
150 g/L	Trojan[14]				20 mL	20 or 30 mL[16]		8 mL[17]	30 mL	
lambda-cyhalothrin										
250 g/L CS	Karate (Zeon Tech)				24 mL	24 or 36 mL[15]		9 mL[16]	36 mL	
	Kung Fu 250				24 mL	24 or 36 mL[15]		9 mL[16]	36 mL	
	Flipper 250 CS				24 m	24 or 36 mL[15]		9 mL[16]	36 mL	
	Matador (Zeon Tech)				24 mL	24 or 36 mL[15]		9 mL[16]	36 mL	
maldison										
500 g/L EC	Nufarm Maldison 500								1.1	
methidathion										
400 g/L EC	Suprathion 400 EC[17]		0.2				0.2	0.2		

* **Numerous other generic products are also registered.**
[9] Also registered for green vegetable bugs (*Nezara viridula*) and loopers at 0.5 L/ha.
[10] Also registered for green vegetable bugs (*Nezara viridula*) and loopers at 2.5 L/ha.
[11] Registered for *Helicoverpa punctigera* in southern NSW only.
[12] Also registered at 400 mL/ha for bare earth pre-emergent application.
[13] Registered for southern NSW only.
[14] Also registered for cabbage white butterfly (*Pieris rapae*) at 20 mL/ha and grey cluster bugs (*Nysius* spp.) at 30 mL/ha.
[15] Registered for native budworms (*H. punctigera*) only.
[16] Registered rate may be less effective against blue oat mites (*Penthaleus major*).
[17] Registered as a bare earth treatment.

Table 6. Canola – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Blue oat mites	Cutworms	Diamondback moths	Heliothis	Lucerne fleas	Redlegged earth mites	Rutherglen bugs	Vegetable weevils
methomyl										
225 g/L SL	Electra 225					1.0 or 2.0				
	Lannate L					1.5–2.0[18]				
	Marlin					1.5–2.0[19]				
	Methomyl 225					1.5–2.0[19]				
	Nudrin 225					1.5–2.0				
nuclear polyhedrosis										
virus (NPV)	Gemstar					0.375				
2 thousand million/mL	Vivus Gold					0.375				
(Obs)	Vivus Max					0.15				
omethoate*										
290 g/L SL	All-Mitey 290 SL[20]		0.1				0.1	0.1[21]		
	Le-mat 290 SL[20]		0.1				0.1	0.1[21]		
	Mite Master 290[20]		0.1				0.1	0.1[21]		
	Omen 290[20]		0.1				0.1	0.1[21]		
	Omethoate 290 SL[20]		0.1				0.1	0.1[21]		
permethrin 40:60										
500 g/L EC	Permerid 500 EC			25 mL						
pirimicarb*										
500 g/kg WP	Aphidex 500 WP	0.5 or 1.0 kg								
	Pirimicarb 500 WP	0.5 or 1.0 kg								
500g/kg WG	Atlas 500 WG	0.5 or 1.0 kg								
	Pirimicarb 500 WG	0.5 or 1.0 kg								
	Piricarb WG	0.5 or 1.0 kg								
	Pirimor WG	0.5 or 1.0 kg								

* **Numerous other generic products are also registered.**

[18] Registered for native budworms (*H. punctigera*) only.

[19] Also registered as an ovicide 0.5–1.0 L/ha.

[20] Also registered for bryobia mites at 0.12 L/ha.

[21] Registered as a bare earth treatment. Apply immediately prior to seedling emergence.

Table 7. Chickpea – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	No threshold established.	All growth stages especially seedling.	No damage observed. Suck sap and transmit virus.	Aphids do not breed on chickpeas due to malic acid in leaves. Retained cereal stubble repels aphids. Species that transfer virus are unknown.	Rarely
Armyworms	Usually present in large numbers. Most active late afternoon and night.	Later vegetative stages and pod filling.	Defoliate and causes pod drop.	Rarely a problem in chickpeas. Buildup often occurs after heavy rain.	Rarely
Blue oat mites and redlegged earth mites	Chickpeas normally repel these insects due to malic acid in leaf glands.	Most susceptible just as seedling emerges if large numbers present.	Mottle and whiten leaves and suppress seedling emergence.	Chickpea is the least susceptible crop to these insects. Treatment rarely necessary.	Rarely
Cutworms	Usually present in crop in large numbers in patches.	Early plant growth stages. Often present as sowing.	Chew leaves and stems. May cut plants off at ground level.	Feed evening and night, hide during day. Check and spray late evening. Rarely a problem.	Rarely
Green vegetable bugs	Not normally a problem in chickpeas as bug numbers do not build up until summer months. (See information on summer pulse crops.)				
Heliothis caterpillars	1–4/m^2 (beat sheet) or 5/m^2 (sweep net). Use formula to fine tune threshold. Yield loss ($/ha) = $\frac{\text{Average number of larvae per m}^2 \times 2.0 \times \text{chickpea price (\$/t)}}{100}$ Refer to Qld QDAFF publication *Helicoverpa Management in Chickpea*	Flowering to pod filling. Examine crops twice per week.	Caterpillars < 10 mm eat foliage and flowers. Large caterpillars eat seed in pods.	Most damage done by caterpillars > 20 mm. *H. punctigera* most common in spring. *H. armigera* in low numbers within 30 km of summer irrigation. Threshold calculators are available at www.thebeatsheet.com.au/sampling-2	Annual
Loopers	Rarely a problem. Move in from edge of crop.	Early plant growth stages.	Defoliate plants.	Capeweed is the preferred host. Caterpillars have distinct looping motion.	Rarely
Lucerne fleas	Rarely a problem in chickpeas.	Early plant growth stages.	Eat leaves, leaving clear membranous windows in foliage.	Eliminate weed growth on headlands. Lucerne fleas hop when disturbed. Liming reduces numbers on acid soils.	Rarely
Thrips	1–2 thrips per flower.	Flowering.	Feed on young buds and flowers. Reduce pod set and distort pods.	Shake flowers into white container to dislodge thrips or open and inspect flowers.	Rarely

Table 8. Chickpea – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Blue oat mites	Cutworms	Green vegetable bugs	Heliothis	Loopers	Lucerne fleas	Redlegged earth mites	Thrips
alpha-cypermethrin*									
100 g/L EC	Alpha-Scud Elite	50 mL	75 mL		0.2 or 0.3❶			50 mL❷	
	Astound Duo	50 mL	75 mL		0.2 or 0.3❶			50 mL❷	
	Dominex Duo	50 mL	75 mL		0.2 or 0.3❶			50 mL❷	
	Fastac Duo	50 mL	75 mL		0.2 or 0.3❶			50 mL❷	
Bacillus thuringiensis									
sub-species *kurstkai*	BioCrystal				0.5–2.0	0.5–2.0			
	DiPel SC				1.0–4.0	1.0–4.0			
beta-cyfluthrin									
25 g/L EC	Bulldock Duo				0.2 or 0.4				
chlorpyrifos*									
500 g/L EC	Conquest Chlorpyrifos 500 EC	0.14–0.3						0.14–0.3	
	Cyren 500 EC	0.14–0.3						0.14–0.3	
	Lorsban 500 EC	0.14–0.3						0.14–0.3	
	Strike-Out 500 EC	0.14–0.3						0.14–0.3	
cypermethrin*									
200 g/L EC	Cypershield 200				0.2–0.25❶				
	Scud Elite				0.2–0.25❶				
	Titan Cypermethrin 200				0.2–0.25❶				
deltamethrin*									
27.5 g/L EC	Ballistic Elite		0.2	0.5	0.5	0.5			
	D-Sect EC		0.2	0.5	0.5	0.5			
	decis options		0.2	0.5	0.5	0.5			
5.5 g/L ULV	Deltaguard ULV		1.0	2.5	2.5	2.5			
indoxacarb (25:75)									
150 g/L EC	Steward EC				0.3				
esfenvalerate									
50 g/L EC	Sumi-Alpha Flex	50–70 mL❸			0.13–0.33 ❹❺			50–70 mL❸	0.13❹
gamma-cyhalothrin									
150 g/L CS	Trojan				50 or 60 mL❻			8 mL❼	

* **Numerous other generic products are also registered.**
❶ Registered for native budworms (*Helicoverpa punctigera*) only.
❷ Registered at 100 mL/ha prior to crop emergence. Apply when soil is moist. Do not apply as a ULV application.
❸ Also registered at 100 mL/ha as a bare earch pre-emergent application.
❹ Registered for southern NSW only.
❺ Registered for native budworms (*Helicoverpa punctigera*) only.
❻ Northern NSW rate only. Registered for native budworm (*Helicoverpa punctigera*) only in southern NSW at 20 or 30 mL/ha.
❼ Registered rate may be less effective against blue oat mites (*Penthaleus major*).

Table 8. Chickpea – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Blue oat mites	Cutworms	Green vegetable bugs	Heliothis	Loopers	Lucerne fleas	Redlegged earth mites	Thrips
lambda-cyhalothrin 250 g/L CS	Flipper 250 CS				24 or 36 mL[8]			9 mL[9]	
	Karate (Zeon Tech)				24 or 36 mL[8]			9 mL[9]	
	Kung Fu 250				24 or 36 mL[8]			9 mL[9]	
	Matador (Zeon Tech)				24 or 36 mL[8]			9 mL[9]	
maldison 1169 g/L ULV	Fyfanon ULV						0.225	0.225	
methomyl* 225 g/L SL	Electra 225			1.5	1.5–2.0				
	Lannate L				1.5–2.0	1.5			1.0
	Methomyl 225				1.5–2.0[10]	1.5			1.0
	Nudrin 225				1.5–2.0[10]	1.5			1.0
nuclear polyhedrosis virus (NPV) 2 thousand million/mL (Obs)	Gemstar				0.375				
	Heliocide				0.375				
	Vivus				0.375				
	Vivus Gold				0.375				
	Vivus Max				75 mL–0.15				
omethoate* 290 g/L SL	All-Mitey 290 SL[11]	0.1					0.1	0.1[12]	
	Le-mat 290 SL[11]	0.1					0.1	0.1[12]	
	Mite Master 290[11]	0.1					0.1	0.1[12]	
	Omen 290[11]	0.1					0.1	0.1[12]	
	Omethoate 290 SL[11]	0.1					0.1	0.1[12]	
thiodicarb 375 g/L SC	Larvin 375				0.5 or 0.75				
	Showdown 375				0.5 or 0.75				
800 g/kg	Confront 800 WG				0.235 or 0.35 kg				
	Mission T 800 WG				0.235 or 0.35 kg				

* **Numerous other generic products are also registered.**
8 Registered for native budworms (*Helicoverpa punctigera*) only.
9 Registered rate may be less effective against blue oat mites (*Penthaleus major*).
10 Also registered as an ovicide at 0.5 to 1.0 L/ha.
11 Also registered for bryobia mites at 0.12 L/ha.
12 Also registered as a barrier spray for redlegged earth mites (*Halotydeus destructor*) at 0.3 L/ha.

Table 9. Faba bean – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	Treat low levels of aphids to prevent virus transmission.	Seedling to flowering.	Suck sap, stunt plants and transmit virus.	Retained cereal stubble repels aphids. Check for natural predators such as ladybirds, hover flies and lacewings.	Rarely
Armyworms	Usually present in large numbers. Most active late afternoon and night.	Later vegetative stages and pod filling.	Defoliate and cause pod drop.	Rarely a problem in faba bean. Buildup often occurs after heavy rain.	Rarely
Blue oat mites and redlegged earth mites	Normally large numbers require treatment.	Seedling (can prevent emergence).	Mottle and whiten cotyledons and leaves by rasping and sucking. May stunt and kill seedlings.	Bare earth spraying preferred in high risk paddocks.	Intermittent
Cutworms	Usually present in large numbers in patches of the crop.	Seedling to 6 leaf stage.	Eat leaves, cut stems at ground level or just below.	Check for presence in late evening or night. Eliminate weeds from paddock perimeter.	Rarely
Green vegetable bugs	1–2 bugs per m^2.	Flowering to maturity.	Suck sap, distort pods, destroy seeds, cause pod drop.	Rarely a problem as they develop in late spring and summer.	Rarely
Heliothis caterpillars	2–4 larvae per m^2 (less than 10 mm long) or 1 per m^2 for human consumption.	Flowering to pod setting.	Prevent pod set, bore into pods and destroy seeds.	Inspect crops twice per week. Spray caterpillars while small. *H. punctigera* most common in spring. *H. armigera* in low numbers within 30 km of summer irrigation.	Annual
Loopers	Usually present in large numbers. Move on a front into a crop.	Seedling and vegetative stages.	Defoliate plants.	Usually occur in patches. Spot or perimeter spraying effective. Characteristic looping movement.	Rarely
Lucerne fleas	Control may be necessary in southern NSW. Spray if seedling leaf area is likely to be reduced by 50%.	Early plant growth stages.	Eat leaves, leaving clear membranous windows in foliage.	Eliminate weed growth on headlands. Lucerne fleas hop when disturbed. Liming reduces numbers on acid soils.	Intermittent
Thrips	4–6 thrips per flower.	Pre-flowering to early pod filling.	Feed on young buds and flowers. This reduces pod set and distorts pods.	Shake flowers to dislodge thrips into a white container. Slender-bodied feathery-winged insect 1–1.5 mm long.	Rarely

Table 10. Faba bean – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Aphids	Blue oat mites	Cutworms	Green vegetable bugs	Heliothis	Loopers	Lucerne fleas	Redlegged earth mites
alpha-cypermethrin*									
100 g/L EC	Alpha-Scud Elite		50 mL	75 mL		0.2 or 0.3❶			50 mL❷
	Astound Duo		50 mL	75 mL		0.2 or 0.3❶			50 mL❷
	Dominex Duo		50 mL	75 mL		0.2 or 0.3❶			50 mL❷
	Fastac Duo		50 mL	75 mL		0.2 or 0.3❶			50 mL❷
Bacillus thuringiensis									
sub-species *kurstkai*	BioCrystal					0.5–2.0	0.5–2.0		
	DiPel SC					1.0–4.0	1.0–4.0		
beta-cyfluthrin									
25 g/L EC	Bulldock Duo		0.2						0.2
bifenthrin									
100 g/L EC	Arrow 100 EC❸		0.1				50–100 mL		50–100 mL
	Bifenthrin 100 EC❸		0.1				50–100 mL		50–100 mL
	Ospray Bifenthrin 100 EC❸		0.1				50–100 mL		50–100 mL
	Talstar 100 EC❸		0.1				50–100 mL		50–100 mL
250 g/L EC	Talstar 250 EC❹		40 mL				20–40 mL		20–40 mL
chlorpyrifos*									
500 g/L EC	Conquest Chlorpyrifos 500 EC		0.14–0.3						0.14–0.3
	Cyren 500 EC		0.14–0.3						0.14–0.3
	Lorsban 500 EC		0.14–0.3						0.14–0.3
	Strike-Out 500 EC		0.14–0.3						0.14–0.3
deltamethrin*									
27.5 g/L EC	Ballistic Elite			0.2	0.5	0.5	0.5		
	D-Sect EC			0.2	0.5	0.5	0.5		
	decis options			0.2	0.5	0.5	0.5		
5.5 g/L ULV	Deltaguard ULV			1.0	2.5	2.5	2.5		

* **Numerous other generic products are also registered.**

❶ Registered for native budworms (*Helicoverpa punctigera*) only. Use the higher rate if larvae larger than 10 mm are present.

❷ Registered at 100 mL/ha prior to crop emergence. Apply when soil is moist.

❸ Also registered for bryobia mites at 0.2 L/ha. Apply to bare earth. Also registered for brown pasture loopers (*Ciampa arietaria*) at 50–100 mL/ha and pasture web worms (*Hednota* spp.) at 100 mL/ha.

❹ Also registered for bryobia mites at 80 mL/ha and pasture web worms (*Hednota* spp.) at 40 mL/ha.

Table 10. Faba bean – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Blue oat mites	Cutworms	Green vegetable bugs	Heliothis	Loopers	Lucerne fleas	Redlegged earth mites
esfenvalerate 50 g/L EC	Sumi-Alpha Flex[5]		50–70 mL			0.13–0.33[6]			50–70 mL
gamma-cyhalothrin 150 g/L CS	Trojan					50 or 60 mL[7]			8 mL[8]
indoxacarb 150 g/L EC	Steward EC					0.3			
lambda-cyhalothrin 250 g/L CS	Flipper 250 CS					24 or 36 mL[9]			9 mL[8]
	Karate (Zeon Tech)					24 or 36 mL[9]			9 mL[8]
	Kung Fu 250					24 or 36 mL[9]			9 mL[8]
	Matador (Zeon Tech)					24 or 36 mL[9]			9 mL[8]
maldison 1169 g/L ULV	Fyfanon ULV							0.225	0.225
nuclear polyhedrosis virus (NPV) 2 thousand million/mL (Obs)	Gemstar LC					0.375			
	Vivus Gold					0.375			
	Vivus Max					0.15			
omethoate 290 g/L SL	All-Mitey 290 SL[10]	0.1 or 0.2[11]	0.1					0.1	0.1[12]
	Le-mat 290 SL[10]	0.1 or 0.2[11]	0.1					0.1	0.1[12]
	Mite Master 290[10]	0.1 or 0.2[11]	0.1					0.1	0.1[12]
	Omen 290 SL[10]	0.1 or 0.2[11]	0.1					0.1	0.1[12]
	Omethoate 290 SL[10]	0.1 or 0.2[11]	0.1					0.1	0.1[12]

[5] Also registered as a bare earth pre-emergent application at 100 mL/ha.
[6] Registered in southern NSW for native budworm (*Helicoverpa punctigera*) only.
[7] Northern NSW rate only. Registered for native budworm (*Helicoverpa punctigera*) only in southern NSW at 20 or 30 mL/ha.
[8] Registered rate may be less effective against blue oat mites (*Penthaleus major*).
[9] Registered for native budworms (*Helicoverpa punctigera*) only.
[10] Also registered for bryobia mites at 0.12 L/ha.
[11] Registered for blue green aphids (*Acyrthosiphon kondoi*) at 0.1 or 0.2 L/ha and cowpea aphids at 0.2 L/ha.
[12] Also registered as a barrier spray for redlegged earth mites (*Halotydeus destructor*) at 0.3 L/ha.

Table 11. Field pea – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	None established. Number of plants infected rather than numbers of aphids is important for control.	Before flowering.	Suck sap, stunt plants and transmit virus.	Direct crop damage unlikely. Check for predators. Retain cereal stubbles. Rarely seen in large numbers.	Rarely
Blue oat mites (BOM) and redlegged earth mites (RLEM)	Check seedlings for presence of mites after the autumn break. Spray if growth is retarded.	Seedling emergence to 4 nodes. Pea emergence can be suppressed.	Mottle and whiten cotyledons and leaves by rasping and sucking. May stunt and kill seedlings. RLEM more common in southern NSW.	Most feeding during cooler part of day/night. Often present under clods or underside of weeds such as capeweed/saffron thistles during day. Higher numbers after pasture.	Intermittent
Cutworms	Usually in large numbers in patches in crop. Treat at first sign of damage. Late afternoon preferred.	Seedling up to 4 nodes.	Eat leaves and cut stems at or below ground level. Remain in soil during the day.	Inspect crops late evening or night for presence of large dark grey-green caterpillars. Consider over-row spraying (night) or treat patches only.	Rarely
Heliothis caterpillars	Four or more 4–9 mm larvae per 10 sweeps for stock feed. 1–2 larvae (4–9 mm) per 10 sweeps for human consumption. Larvae over 10 mm may enter pods and not be controlled.	Flowering and pod filling.	Prevent pod formation. Bore into pods, eat and damage seeds.	Observe crop for presence of moths during flowering. *H. punctigera* most common in spring. *H. armigera* in low numbers within 30 km of summer irrigation.	Annual
Loopers	Rarely a problem in field peas. Move in from edge of crop.	Early plant growth stages.	Defoliate plants.	Capeweed preferred food plant. Caterpillars have distinct looping motion.	Rarely
Lucerne fleas	Control may be necessary in southern NSW. Spray if seedling leaf area is likely to be reduced by 50%.	Seedling up to 4 nodes. Crops on heavy acidic soils most prone to damage.	Eat leaves, leaving clear membranous windows in foliage.	Eliminate weeds on headlands. Lucerne fleas hop when disturbed. Liming reduces flea numbers on acidic soils.	Intermittent
Lucerne seed web moths	At the first sign of damage. Treatments applied against heliothis caterpillars or pea weevils will give some control.	Flowering and podding.	Small caterpillars bore into seeds, leave webbing and excrement on pods.	Attack may go unnoticed until damage has occurred. No recommended treatment.	Rarely
Pea weevils	Take 25 sweeps at each of 6 sites on crop edges. Border spray if there is average of 2 or more weevils per site.	First flowers onwards.	Larvae bore into pods, enter seeds, reduce seed weight by 25%. Reduce germination by 75%.	Fumigate all purchased seed in gas tight silo for 21 days with phosphine. Spray adults in crop before egg laying commences.	Annual
Thrips	Rarely a problem in field peas. 4–6 thrips per flower.	Budding to flowering.	Feed on young buds and flowers. Reduces pod set and distort pods.	Shake flowers into white container to dislodge thrips or open and inspect flowers.	Rarely

Table 12. Field pea – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Aphids	Blue oat mites	Cutworms	Green vegetable bugs	Heliothis	Loopers	Lucerne fleas	Pea weevils	Redlegged earth mites	Thrips
alpha-cypermethrin*											
100 g/L EC	Alpha-Scud Elite		50 mL	75 mL		0.16–0.3 ❶			0.16 or 0.2	50 mL ❷	
	Astound Duo		50 mL	75 mL		0.2 or 0.3 ❶			0.16 or 0.2	50 mL ❷	
	Dictate Duo		50 mL	75 mL		0.2 or 0.3 ❶			0.16 or 0.2	50 mL ❷	
	Dominex Duo		50 mL	75 mL		0.16–0.3 ❶			0.16 or 0.2	50 mL ❷	
	Fastac Duo		50 mL	75 mL		0.2 or 0.3 ❶			0.16 or 0.2	50 mL ❷	
250 g/L SC	Alpha Forte 250 SC		20 mL	30 mL		80 or 120 mL			64 or 80 mL	40 mL	
Bacillus thuringiensis sub-species *kurstkai*	BioCrystal					0.5–2.0	0.5–2.0				
	DiPel SC					1.0–4.0	1.0–4.0				
beta-cyfluthrin											
25 g/L EC	Bulldock Duo		0.2			0.4 or 0.5			0.4	0.2	
bifenthrin											
100 g/L EC	Arrow 100 EC ❸		0.1				50–100 mL			50–100 mL	
	Bifenthrin 100 EC ❸		0.1				50–100 mL			50–100 mL	
	Ospray 100 EC ❸		0.1				50–100 mL			50–100 mL	
	Talstar 100 EC ❸		0.1				50–100 mL			50–100 mL	
250 g/L EC	Talstar 250 EC ❹		40 mL				20–40 mL			20–40 mL	
chlorpyrifos*											
500 g/L EC	Conquest Chlorpyrifos 500 EC		0.14–0.3							0.14–0.3	
	Cyren 500 EC		0.14–0.3							0.14–0.3	
	Lorsban 500 EC		0.14–0.3							0.14–0.3	
	Strike-Out 500 EC		0.14–0.3							0.14–0.3	
cypermethrin*											
200 g/L EC	Cypershield 200					0.2 –0.25 ❺			0.2		
	Scud Elite					0.2 –0.25 ❺			0.16 or 0.2		
250 g/L EC	Cypermethrin 250 EC					0.16–0.2 ❺			0.16		
260 g/L EC	Cypermethrin 260 EC					0.155–0.208 ❺			0.155		
deltamethrin*											
27.5 g/L EC	Ballistic Elite			0.2		0.25–0.5			0.4–0.5		
	D-Sect EC			0.2		0.25–0.5			0.4–0.5		
	decis options			0.2		0.25–0.5			0.4–0.5		
5.5 g/L ULV	Deltaguard ULV			1.0		1.25–2.5			2.0–2.5		

* **Numerous other generic products are also registered.**
❶ Registered for native budworms (*Helicoverpa punctigera*) only. Use the higher rate if larvae larger than 10 mm are present.
❷ Registered at 100 mL/ha prior to crop emergence. Apply by ground rig only when soil is moist. Do not apply as a ULV application.
❸ Also registered for bryobia mites at 0.2 L/ha. Apply to bare soil.
❹ Also registered for bryobia mites at 80 mL/ha. Apply to bare soil.
❺ Registered for native budworms (*Helicoverpa punctigera*) only.

Table 12. Field pea – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Blue oat mites	Cutworms	Green vegetable bugs	Heliothis	Loopers	Lucerne fleas	Pea weevils	Redlegged earth mites	Thrips
esfenvalerate 50 g/L EC	Sumi-Alpha Flex					0.13–0.33 ❻❼					0.13❼
gamma-cyhalothrin 150 g/L CS	Trojan					20 or 30 mL❻			20 mL	8 mL❼	
lambda-cyhalothrin 250 g/L CS	Flipper 250 CS					24 or 36 mL❻			24 mL	9 mL❽	
	Karate (Zeon Tech)					24 or 36 mL❻			24 mL	9 mL❽	
	Kung Fu 250					24 or 36 mL❻			24 mL	9 mL❽	
	Matador (Zeon Tech)					24 or 36 mL❻			24 mL	9 mL❽	
maldison 1169 g/L ULV	Fyfanon ULV							0.225		0.225	
methomyl* 225 g/L SL	Electra 225					1.5 or 2.0					
	Lannate-L					1.5 or 2.0	1.5				1.0
	Methomyl 225					1.5–2.0❾	1.5				1.0
	Nudrin 225					1.5–2.0❾	1.5				1.0
nuclear polyhedrosis virus (NPV) 2 thousand million/mL (Obs)	Gemstar					0.375					
	Vivus Gold					0.375					
	Vivus Max					0.15					
omethoate* 290 g/L SL	All-Mitey 290 SL		0.1					0.1		0.1❶❶	
	Le-mat 290 SL❿		0.1					0.1		0.1❶❶	
	Mite Master 290		0.1					0.1		0.1❶❶	
	Omen 290❿		0.1					0.1		0.1❶❶	
	Omethoate 290 SL❿		0.1					0.1		0.1❶❶	
permethrin 40:60 500 g/L EC	Axe					0.15–0.25					
	CropPro Pounce					0.15–0.25					

* **Numerous other generic products are also registered.**
❻ Registered for native budworms (*Helicoverpa punctigera*) only.
❼ Registered for southern NSW only.
❽ Registered rate may be less effective against blue oat mites (*Penthaleus major*).
❾ Also registered as an ovicide at 0.5–1.0 L/ha.
❿ Also registered for bryobia mites at 0.12 L/ha.
❶❶ Also registered as a barrier spray for redlegged earth mites (*Halotydeus destructor*) at 0.3 L/ha.

Table 13. Linseed – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	Rarely a problem in linseed. Not known to transmit any virus diseases.	Flowering and boll filling.	Suck sap, stunt plants and transmit virus.	If aphids present check for predators before spraying.	Rarely
Armyworms	Usually present in large numbers. Most active afternoon and night.	Boll filling.	Chew off sections of head.	Rarely a problem in linseed. Heavy rain precedes development.	Rarely
Blue oat mites (BOM) and redlegged earth mites (RLEM)	Check seedlings for presence of mites after autumn break. Spray if growth is retarded.	Seedling emergence until 4 leaf stage. Seedling emergence can be prevented.	Mottle and whiten cotyledons and leaves by rasping and sucking. May stunt and kill seedlings. RLEM common in south, BOM in north.	Most feeding done during cooler part of the day and night. Often present under clods or undersides of weeds such as capeweed, Paterson's curse and saffron thistle during day.	Annual
Cutworms	Usually in large numbers in patches in crop.	Early plant growth stages. Often present at sowing.	Chew leaves and stems. May cut plants off at or below ground level.	Feed evening and night. Hide in soil during day. Check and spray late afternoon. Spot spraying may be sufficient.	Rarely
Heliothis caterpillars	Consider spraying if there has been a big egg lay or if there are more than 2–4 larvae less than 8 mm long per m^2.	Late flowering and boll formation.	Destroy flower buds, eat holes in or destroy developing bolls.	Linseed very susceptible to attack, sometimes two sprays necessary. *H. punctigera* most common in spring. *H. armigera* in low numbers within 30 km of summer irrigation. Crops need to be inspected up until bolls have ripened.	Annual
Lucerne fleas	Control may be necessary in southern NSW. Spray if seedling leaf area is likely to be reduced by 50%.	Seedling up to 4–6 leaf stage. Crops on heavy acidic soils most prone to damage.	Eat leaves, leaving clear membranous windows in foliage.	Eliminate weeds on headlands. Lucerne fleas hop when disturbed. Liming reduces flea numbers. Most likely on acid soils.	Intermittent
Thrips	Rarely a problem in linseed. 1–2 thrips per flower.	Budding to flowering.	Feed on yound buds and flowers. This reduces boll set and distorts bolls.	Shake flowers into white container to dislodge thrips or open and inspect flowers.	Rarely

Table 14. Linseed – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Armyworms	Blue oat mites	Cutworms	Green vegetable bugs	Heliothis	Lucerne fleas	Redlegged earth mites
alpha-cypermethrin*								
100 g/L EC	Alpha-Scud Elite			75 mL		0.2 or 0.3 ❶		
	Astound Duo			75 mL		0.2 or 0.3 ❶		
	Dictate Duo			75 mL		0.2 or 0.3 ❶		
	Dominex Duo			75 mL		0.2 or 0.3 ❶		
	Fastac Duo			75 mL		0.2 or 0.3 ❶		
250 g/L SC	Alpha Forte 250 SC			30 mL		80 or 120 mL ❶		
Bacillus thuringiensis								
sub-species *kurstkai*	BioCrystal	0.5–2.0 kg				0.5–2.0 kg		
	Delfin WG	0.5–2.0 kg				0.5–2.0 kg		
	Dipel SC	1.0–4.0 kg				1.0–4.0 kg		
	DiPel DF	0.5–2.0 kg				0.5–2.0 kg		
	Full-Bac WDG	0.5–2.0 kg				0.5–2.0 kg		
sub-species *aizawai* strain GC-91	Bacchus WG	1.0–4.0 kg				1.0–4.0 kg		
chlorpyrifos*								
500 g/L EC	Conquest Chlorpyrifos 500 EC		0.14–0.3	0.9				0.14–0.3
	Cyren 500 EC		0.14–0.3	0.9				0.14–0.3
	Lorsban 500 EC		0.14–0.3	0.9				0.14–0.3
	Strike-Out 500 EC		0.14–0.3	0.9				0.14–0.3
deltamethrin*								
27.5 g/L EC	Ballistic Elite ❷			0.2	0.5	0.5		
	D-Sect EC ❷			0.2	0.5	0.5		
	decis options ❷			0.2	0.5	0.5		
5.5 g/L ULV	Deltaguard ULV ❸			1.0	2.5	2.5		
methidathion								
400 g/L EC	Suprathion 400 EC ❹		0.2				0.2	0.2
nuclear polyhedrosis virus (NPV) 2 thousand million/mL (Obs)	Gemstar LC					0.375		
	Vivus Gold					0.375		
	Vivus Max					0.15		

* **Numerous other generic products are also registered.**
❶ Registered for native budworms (*Helicoverpa punctigera*) only. Use the higher rate if larvae larger than 10 mm are present.
❷ Also registered for loopers at 0.5 L/ha.
❸ Also registered for loopers at 2.5 L/ha.
❹ Registered as a bare earth treatment only. Apply immediately prior to seedling emergence.

Table 14. Linseed – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Armyworms	Blue oat mites	Cutworms	Green vegetable bugs	Heliothis	Lucerne fleas	Redlegged earth mites
omethoate* 290 g/L SL	All-Mitey 290 SL ❺❻		0.1				0.1	0.1 ❺
	Le-mat 290 SL ❺❻		0.1				0.1	0.1 ❺
	Omen 290 ❺❻		0.1				0.1	0.1 ❺
	Omethoate 290 SL ❺❻		0.1				0.1	0.1 ❺
permethrin 40:60 500 g/L EC	Axe					0.2–0.3		
	Permerid 500 EC			25 mL				
trichlorfon 500 g/L SL	Dipterex 500 SL	1.2						
	Lepidex 500	1.2						

* **Numerous other generic products are also registered.**
❺ Also registered for bryobia mites at 0.12 L/ha.
❻ Also registered as a barrier spray for redlegged earth mites (*Halotydeus destructor*) at 0.3 L/ha.

Table 15. Lucerne – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids (Spotted alfalfa aphids, pea aphids, blue-green aphids)	For low resistance varieties: 2 aphids per plant for seedlings, 5 aphids per stem for plants >10 cm prior to first harvest, 20 aphids per stem after first harvest.	All growth stages	Suck sap, stunt plants and transmit virus.	Active in autumn, winter and spring. Sow resistant varieties. Parasites are very effective. Graze/cut if crop is less than half grown.	Annual
Armyworms	Usually present in large numbers. Consider stage of growth and potential damage. Treat in late afternoon.	Young plants most susceptible.	Can kill young plants. Plants defoliated.	Heavy rain precedes development. Caterpillars hide near ground during day, feeding mainly at night.	Rarely
Black-headed pasture cockchafers	Examine pastures in April–May. Control if average young larvae density exceeds 300 per m^2.	All growth stages.	Plants cut off at ground level. Heavy infestations can eat out large areas. The casts make the pasture unattractive to stock.	Larvae forage at night when soil surface is moist following rain. Spray late evening.	Intermittent
Blue oat mites and redlegged earth mites	Newly emerged seedlings can be killed by low numbers of mites. Preventative treatment is recommended, such as seed treatment or bare earth sprays.	Most severe on young seedling. Seedling emergence can be prevented.	Cause greyish and silver streaks by rasping and sucking sap.	Weedy fallows promote mite survival. Look for mites early morning or late evening. Often present under clods or undersides of weeds such as capeweed, Paterson's curse and saffron thistle during the day.	Annual
Cutworms	Usually present in large numbers in patches in the paddock.	Early plant growth stages.	Chew leaves and stems. May cut plants off at ground level.	Feed evening and night. Check and spray late evening.	Rarely
Heliothis caterpillars	Monitor activity during flower bud development and flowering for caterpillars.	Late budding to flowering and pod fill. Spring pest of hay crops.	Destroys developing buds and flowers. Eats holes in and destroys seed pods.	Early cutting or grazing may induce movement into nearby crops. Can affect seed crops at any stage during flowering.	Annual
Lucerne fleas	Inspect at weekly intervals after autumn break and spray as soon as flea numbers begin to increase.	Seedling and young plants most commonly affected but can also damage established plants.	Eat leaves, leaving clear membranous windows in foliage.	Lucerne fleas 'hop' when disturbed. Clean fallows and eliminate weeds from around the paddock perimeter at least 4 weeks prior to sowing to reduce flea numbers.	Intermittent
Lucerne leaf-rollers	Control when 25–30% of terminals are rolled in haymaking or grazing stands. Less if a seed crop.	All growth stages. Shortly before and during flowering but more important in seed crops.	Caterpillars feed on terminal leaves and flowering stems. Fertilisation and pod set may be severely reduced.	Damage is most often important in moisture stressed, dryland stands. Graze/cut in preference to spraying if lucerne stand is approaching maturity.	Intermittent
Sitona weevils	Spray established stands if weevils are numerous and damage is noticeably worsening and causing excessive leaf loss. Early season sprays can reduce subsequent numbers.	Young plants most susceptible. Older plants may appear pale and unthrifty.	Adults make scallop-shaped notches along leaf margins and also chew stems. Early stage larvae can cause more serious damage through feeding on roots and root nodules.	Damage is generally most serious in spring and autumn, but adults may feed actively during warm weather in winter.	Intermittent
Thrips (onion, plague and tomato)	At least 2 thrips per flower in seed crops.	Budding to flowering.	Feed on young buds and flowers. This prevents seed set.	Shake flowers into white container to dislodge thrips or open and inspect flowers.	Intermittent

Table 16. Lucerne – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Aphids	Army-worms	Blue oat mites	Cutworms	Green mirids	Heliothis	Lucerne leaf-rollers	Lucerne fleas	Redlegged earth mites	Sitona weevils	Thrips	Webspinner caterpillars
alpha-cypermethrin*													
100 g/L EC	Alpha-Scud Elite			50 mL		0.16	0.16❶			50 mL❸			
	Astound Duo			50 mL		0.16	0.16❶			50 mL❸			
	Dictate Duo			50 mL		0.16	0.16❶			50 mL❸			
	Dominex Duo			50 mL		0.16	0.16❶			50 mL❸			
	Fastac Duo			50 mL		0.16	0.16❶			50 mL❸			
250 g/L SC	Alpha Forte 250 SC			20 mL		64 mL	64 mL❶			20–40 mL			
Bacillus thuringiensis sub-species *kurstkai*	BioCrystal		0.5–2.0				0.5–2.0						
	DiPel SC		1.0–4.0				1.0–4.0						
beta-cyfluthrin													
25 g/L EC	Bulldock Duo			0.2						0.2			
bifenthrin*❹													
100 g/L EC	Arrow 100 EC❺❻			0.1			0.4–0.6❶			50–100 mL			
	Bifenthrin 100 EC❻			0.1			0.4–0.6❶			50–100 mL			
	Talstar 100 EC❺❻			0.1			0.4–0.6❶			50–100 mL			
Talstar 250 g/L EC	Talstar 250 EC❷			40 mL			0.16–0.24❶			20–40 mL			
carbaryl													
500 g/L SC	Bugmaster Flowable❼						2.2	1.7–1.8	0.5		1.8		
	Carbaryl 500 Flowable						2.2	1.7–1.8	0.5		1.8		
chlorpyrifos*													
500 g/L EC	Conquest Chlorpyrifos 500	0.2–0.3	0.7–0.9	0.14–0.3	0.9			0.3–0.4	70 mL	0.14–0.3	0.35		0.7
	Cyren 500 EC	0.2–0.3		0.14–0.3	0.9			0.3–0.4	70 mL	0.14–0.3	0.35		0.7
	Lorsban 500 EC	0.2–0.3	0.7–0.9	0.14–0.3	0.9			0.3 or 0.4	70 mL	0.14–0.3	0.35		0.7
	Strike-Out 500 EC	0.2–0.3	0.7–0.9	0.14–0.3	0.9			0.3 or 0.4	70 mL	0.14–0.3	0.35		0.7
diazinon													
800 g/L EC	Barmac Diazinon	0.5❽											
	Country Diazinon	0.5❽											
	David Gray's Diazinon 800	0.5❽											
	Diazol 800	0.5❽											

* **Numerous other generic products are also registered.**
❶ Registered for native budworm (*Helicoverpa punctigera*) only.
❷ Also registered for brown pasture looper at 20–40 mL/ha, pasture web worm at 40 mL/ha and bryobia mites at 80 mL/ha.
❸ Registered for bare earth treatment for control of redlegged earth mites (*Halotydeus destructor*) at 0.1 L/ha.
❹ Apply to bare earth.
❺ Registered for control of pasture webworms (*Hednota* spp.) at 0.1 L/ha and bryobia mites (*Bryobia* spp.) at 0.2 L/ha.
❻ Also registered for bryobia mites at 0.2 L/ha and brown pasture loopers at 50–100 mL/ha. Apply to bare soil.
❼ Registered for control of jassids at 2.2 L/ha.
❽ Registered for spotted alfalfa aphids (*Therioaphis trifolii* f. *maculata*) only.

Table 16. Lucerne – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Army-worms	Blue oat mites	Cutworms	Green mirids	Heliothis	Lucerne leaf-rollers	Lucerne fleas	Redlegged earth mites	Sitona weevils	Thrips	Webspinner caterpillars
esfenvalerate													
50 g/L EC	Sumi-Alpha Flex	100 mL[9]		50–70 mL[10]			0.13–0.33[11]			50–70 mL[10]		0.13[12]	
fenitrothion*													
1000 g/L EC	David Gray's Fenitrothion 1000										0.65		
	Farmoz Fenitrothion 1000										0.65		
	Nufarm Fenitrothion 1000										0.65		
gamma-cyhalothrin													
150 g/L CS	Trojan[13]	20 mL[14]					20 or 30 mL[15]	20 or 30 mL		8 mL[16]			
lambda-cyhalothrin													
250 g/L CS	Flipper 250 CS	24 mL[14]					24 or 36 mL[15]	24 or 36 mL		9 mL[16]			
	Karate (Zeon Tech)	24 mL[14]					24 or 36 mL[15]	24 or 36 mL		9 mL[16]			
	Kung Fu 250	24 mL[14]					24 or 36 mL[15]	24 or 36 mL		9 mL[16]			
	Matador (Zeon Tech)	24 mL[14]					24 or 36 mL[15]	24 or 36 mL		9 mL[16]			
maldison													
440 g/L EW	Fyfanon 440 EW	1.25[17]							0.16–0.34				
500 g/L EC	Nufarm Maldison 500	1.1[17]							0.14–0.3				
1150 g/L EC	Hy-Mal	0.5[17]							60–130 mL				
1169 g/L ULV	Fyfanon ULV	0.45[17]	0.7						0.225	0.225			
methidathion													
400 g/L EC	Suprathion 400 EC	0.75	1.4	90 mL[18]				0.85	90 mL[18]	90 mL[18]	1.4		
methomyl*													
225 g/L SL	Electra 225						1.5–2.0[19]						
	Lannate-L						1.5–2.0[19]						
	Marlin						1.5–2.0						
	Methomyl 225						1.5–2.0						
	Nudrin 225						1.5–2.0						

* **Numerous other generic products are also registered.**
[9] Registered for southern NSW for blue-green aphids (*Acyrthosiphon kondoi*) only.
[10] Also registered for bare earth and pre-emergent applications at 100 mL/ha.
[11] Registered for native budworm (*Helicoverpa punctigera*) in southern NSW only. Rates vary with size of larvae.
[12] Registered in southern NSW only.
[13] Also registered for blackhead pasture cockchafers (*Aphodius tasmaniae*) at 17 or 35 mL/ha. Do not use ULV application for this pest.
[14] Registered for pea aphids (*Acyrthosiphon pisum*) only.
[15] Registered for native budworm (*Helicoverpa punctigera*) only.
[16] Registered rate may be less effective against blue oat mites (*Penthaleus major*).
[17] Registered for spotted alfalfa aphids (*Therioaphis trifolii* f. *maculata*) and blue green aphids (*Acyrthosiphon kondoi*) only.
[18] Registered as a bare earth treatment. Apply at 0.2 L/ha immediately prior to seedling emergence.
[19] Registered for native budworm (*Helicoverpa punctigera*) only.

Table 16. Lucerne – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Army-worms	Blue oat mites	Cutworms	Green mirids	Heliothis	Lucerne leaf-rollers	Lucerne fleas	Redlegged earth mites	Sitona weevils	Thrips	Webspinner caterpillars
nuclear polyhedrosis virus (NPV) 2 thousand million/mL (Obs)	Vivus Max						0.15						
omethoate* 290 g/L SL	All-Mitey[20]	0.1 or 0.2[21]		0.1					0.1	0.1[22]			
	Le-mat 290 SL[20]	0.1 or 0.2[21]		0.1					0.1	0.1[22]			
	Mite Master 290[20]	0.1 or 0.2[21]		0.1					0.1	0.1[22]			
	Omen[20]	0.1 or 0.2[21]		0.1					0.1	0.1[22]			
	Omethoate 290 SL[20]	0.1 or 0.2[21]		0.1					0.1	0.1[22]			
phosmet 150 g/L EC	Imidan			0.25–0.35						0.25–0.35			
pirimicarb 500 g/kg WP	Aphidex 500 WP	0.1 or 0.15 kg[23]											
	Pirimicarb 500	0.1 or 0.15 kg[23]											
500 g/kg WG	Aphidex WG	0.1 or 0.15 kg[23]											
	Atlas 500 WG	0.1 or 0.15 kg[23]											
	Primicarb 500 WG	0.1 or 0.15 kg[23]											
	Pirimor WG	0.1 or 0.15 kg[23]											

* **Numerous other generic products are also registered.**

[20] Also registered for pasture mites (*Bryobia* spp.) at 0.12 L/ha.

[21] Registered for blue green aphids (*Acyrthosiphon kondoi*) at 0.1 or 0.2 L/ha and cowpea aphids at 0.2 L/ha

[22] Registered as a barrier spray at 0.2 L/ha.

[23] In 200–300 L water.

Table 17. Lupin – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	Treat at first sign of virus infected plants or appearance of aphid clusters on flowering spikes.	Late vegetative, budding and flowering.	Reduce pod set and transmit viruses. Cause stunted plants.	Eliminate weeds such as hexham scent, fumitory and stagger weed. Retained cereal stubble repels aphids from crop. Treatment of aphids has not always prevented virus transmission.	Intermittent
Armyworms	Usually present in large numbers. Most active in afternoon/night.	Pod filling.	Chew off pods which drop on ground.	Rarely a problem in lupins. Prefer winter cereals, especially barley. Buildup often occurs after heavy rain.	Rarely
Blue oat mites (BOM) and redlegged earth mites (RLEM)	Check seedlings for presence of mites after the autumn break. Spray if growth is retarded.	Seedling emergence to 4 leaf stage. Look for damage to cotyledons. Can kill seedling.	Mottle and whiten cotyledons and leaves by rasping and sucking. May stunt and kill seedlings. RLEM more common in southern NSW.	Most feeding during cooler part of day/night. Often present under clods or underside of weeds such as capeweed/saffron thistle during day.	Annual
Cutworms	Usually in large numbers in patches in a crop. Treat at first sign of damage preferably in late afternoon.	Early plant growth stages.	Eat leaves and cut stems at or below ground level. Remain in soil during the day.	Inspect crop late afternoon or night for presence of large dark grey-green caterpillars. Over the row band spraying (night) or spot treatment.	Rarely
Heliothis caterpillars	Depends on value of lupins and stage of pod filling. Albus lupins more susceptible. 1–2 larvae per m^2 less than 5 mm long for human consumption. 1–2 larvae per 10 sweeps for stock feed.	Can cause flower and pod abortion at early flowering. More commonly present late flowering and pod filling.	Small caterpillars feed inside flowers (1–5 mm). Large caterpillars (25 mm) eat holes in pods and seeds.	Examine crops weekly during flowering. Seed for stock feed can tolerate some damage. *H. punctigera* most common in spring. *H. armigera* in low numbers within 30 km of summer irrigation.	Annual
Loopers	Rarely a problem in lupins. Move in from edge of crop.	Early plant growth stages.	Defoliate plants.	Capeweed is the preferred host. Caterpillars have a distinct looping motion.	Rarely
Lucerne fleas	Control may be necessary in southern NSW. Spray if seedling leaf area is likely to be reduced by 50%.	Seedling up to 4 leaf stage. Crop on heavy acidic soils most prone to damage.	Eat leaves, leaving clear membranous windows in foliage.	Eliminate weeds on headlands. Lucerne fleas hop when disturbed. Liming reduces flea numbers on acidic soils.	Intermittent
Lucerne seed web moths	At the first sign of damage. Treatments for heliothis will give some control.	Flowering and podding.	Small caterpillars bore into seeds, leave webbing and excrement on pods.	Attack may go unnoticed until damage has occurred. No recommended control measure.	Rarely
Thrips	Rarely a problem in lupins. Check for presence in flowers. 1–2 thrips per flower.	Budding and flowering.	Reduce flowering and cause pod abortions.	Shake flowers into white container to dislodge thrips or open and inspect flowers.	Rarely

Table 18. Lupin – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Aphids	Armyworms	Blue oat mites	Cutworms	Green vegetable bugs	Heliothis	Loopers	Lucerne fleas	Redlegged earth mites	Thrips
alpha-cypermethrin*											
100 g/L EC	Alpha-Scud Elite		0.24	50 mL	75 mL		0.2 or 0.3❶			50 mL❷	
	Astound Duo		0.24	50 mL	75 mL		0.2 or 0.3❶			50 mL❷	
	Dictate 100		0.24	50 mL	75 mL		0.2 or 0.3❶			50 mL❷	
	Dominex Duo		0.24	50 mL	75 mL		0.2 or 0.3❶			50 mL❷	
	Fastac Duo		0.24	50 mL	75 mL		0.2 or 0.3❶			50 mL❷	
250 g/L SC	Alpha Forte 250 SC		96 mL	20 mL	30 mL		80 or 120 mL			40 mL	
Bacillus thuringiensis sub-species *kurstkai*	BioCrystal		0.5–2.0				0.5–2.0	0.5–2.0			
	DiPel SC		1.0–4.0				1.0–4.0	1.0–4.0			
beta-cyfluthrin 25 g/L EC	Bulldock Duo			0.2	0.2 or 0.4		0.2 or 0.4❶			0.2	
bifenthrin 100 g/L EC	Arrow 100 EC❸			0.1				50–100 mL		50–100 mL	
	Bifenthrin 100 EC❸			0.1				50–100 mL		50–100 mL	
	Ospray Bifenthrin 100 EC❸			0.1				50–100 mL		50–100 mL	
	Talstar 100 EC❸			0.1				50–100 mL		50–100 mL	
chlorpyrifos* 500 g/L EC	Conquest Chlorpyrifos 500			0.14–0.3						0.14–0.3	
	Cyren 500 EC			0.14–0.3						0.14–0.3	
	Lorsban 500 EC			0.14–0.3						0.14–0.3	
	Strike-Out 500 EC			0.14–0.3						0.14–0.3	
cypermethrin* 200 g/L EC	Cypershield 200						0.2 or 0.3❶				
	Scud Elite				75 mL		0.2–0.3❶				
	Titan Cypermethrin 200						0.2–0.3❶				
deltamethrin* 27.5 g/L EC	Ballistic Elite				0.2	0.5	0.2–0.5❹	0.5			
	D-Sect EC				0.2	0.5	0.5	0.5			
	decis options				0.2	0.5	0.2–0.5❹	0.5			
5.5 g/L ULV	Deltaguard ULV				1.0	2.5	2.5	2.5			

* **Numerous other generic products are also registered.**
❶ Registered for native budworms (*Helicoverpa punctigera*) only.
❷ Registered at 100 mL/ha prior to emergence. Apply by ground rig only to moist soil. Do not use as a ULV application.
❸ Registered for bryobia mites at 0.2 L/ha. Apply to bare soil.
❹ Registered for corn earworms (*Helicoverpa armigera*) at 0.5 L/ha.

Table 18. Lupin – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Armyworms	Blue oat mites	Cutworms	Green vegetable bugs	Heliothis	Loopers	Lucerne fleas	Redlegged earth mites	Thrips
esfenvalerate 50 g/L EC	Sumi-Alpha Flex			50–70 mL❺			0.13–0.33❻❼			50–70 mL❺	0.13❻
gamma-cyhalothrin 150 g/L CS	Trojan						20 mL❼			8 mL❾	
lambda-cyhalothrin 250 g/L CS	Flipper 250 CS						24 mL❼	12 mL		9 mL❽	
	Karate (Zeon Tech)						24 mL❼	12 mL		9 mL❽	
	Kung Fu 250						24 mL❼	12 mL		9 mL❽	
	Matador (Zeon Tech)						24 mL❼	12 mL		9 mL❽	
maldison 1169 g/L ULV	Fyfanon ULV								0.225	0.225	

❺ Also registered at 100 mL/ha for bare earth, pre-emergent application.
❻ Registered in southern NSW only.
❼ Registered for native budworms (*Helicoverpa punctigera*) only.
❽ Registered rate may be less effective against blue oat mites (*Penthaleus major*).

Table 18. Lupin – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Armyworms	Blue oat mites	Cutworms	Green vegetable bugs	Heliothis	Loopers	Lucerne fleas	Redlegged earth mites	Thrips
methomyl											
225 g/L SL	Electra 225						1.5–2.0[10]				
	Lannate L						1.5–2.0[10]				
	Marlin						1.5 or 2.0				
	Methomyl 225						1.5 or 2.0[11]				
	Nudrin 225						1.5–2.0[11]				
nuclear polyhedrosis virus (NPV) 2 thousand million/mL (Obs)	Gemstar LC						0.375				
	Vivus Gold						0.375				
	Vivus Max						0.15				
omethoate*											
290 g/L SL	All-Mitey 290 SL[12]			0.1					0.1	0.1[13]	
	Le-mat 290 SL[12]			0.1					0.1	0.1[13]	
	Mite Master 290[12]			0.1					0.1	0.1[13]	
	Omen 290[12]			0.1					0.1	0.1[13]	
	Omethoate 290 SL[12]			0.1					0.1	0.1[13]	
pirimicarb											
500 g/kg WP	Aphidex 500 WP	0.25 kg[14]									
	Pirimicarb 500	0.25 kg[14]									
500 g/kg WG	Aphidex WG	0.25 kg[14]									
	Atlas 500 WG	0.25 kg[14]									
	Pirimicarb 500 WG	0.25 kg[14]									
	Pirimor WG	0.25 kg[14]									
trichlorfon											
500 g/L SL	Dipterex 500 SL		1.2								
	Lepidex 500		1.2								

* **Numerous other generic products are also registered.**
[10] Registered for native budworm (*Helicoverpa punctigera*) only.
[11] Also registered as an ovicide for heliothis at 0.5–1.0 L/ha.
[12] Also registered for bryobia mites at 0.12 L/ha.
[13] Also registered as a barrier spray for redlegged earth mites (*Halotydeus destructor*) at 0.3 L/ha.
[14] Registered for green peach aphids (*Myzus persicae*) and cowpea aphids (*Aphis craccivora*) only.

Table 19. Maize – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
African black beetles	When adult beetles are detected in springtime before sowing. Spraying is effective up to 5 beetles per m^2. If beetle numbers are >10/m^2 damage will occur in spite of spraying.	Normally early growth stages. Sometimes large numbers of beetles will 'fell' mature plants. Most severe attacks in spring and on old pasture land.	Chew roots and underground stems killing growing point. Surviving plants are weak and stunted and may lodge.	Dry conditions favour beetle attacks. Plague numbers after 2 dry springs/summers in a row. Treatment necessary at planting. Beetle barriers and delayed sowings can reduce attacks.	Intermittent (coastal)
Aphids	When large colonies form in the crop.	Tasselling to grain filling.	Suck sap from leaves, stems and cobs. Reduce seed set. Honeydew attracts heliothis moths.	Control rarely necessary. Predators such as ladybird larvae, hoverfly larvae, lacewings and parasitoids control aphid numbers.	Intermittent
Armyworms	Cause problems when present in large numbers. Consider stage of growth and potential damage.	Attacks seedling through to tasselling and silking.	Feed on leaves in the funnels of growing point. Plants defoliated, stunted or killed. Severe leaf area loss at silking reduces cob size and seed yield.	Feeding during evening and night. Caterpillars hide near ground during day. Build up often occurs after heavy rain. Broadspectrum sprays will disrupt the activity of natural enemies.	Rarely
Black field earwigs	Cause damage when present in large numbers. Examine soil before sowing for nymphs and adults. A number of species including black field earwigs can be beneficial predators as well as pests.	Attack germinating seed and roots of young seedling and tap roots of older plants.	Destroy roots and cause plants to fall over in wind.	Populations regulated by soil moisture, favoured by moist soils. Sow treated seed and band spray. Reduce damage with shallow direct drilling into moist warm soils using press wheels.	Intermittent (coastal)
Cutworms	At first sign of damage. Usually in large numbers in patches or moving in from crop edges.	Seedling.	Eat leaves and cut stems at or below ground level killing plants. Remain in the soil during the day and feed at night.	Inspect crops late evening or night for presence of large dark grey-green caterpillars. Spot treatment may be effective.	Rarely
False wireworms	Check at junction of loose cultivated soil and undisturbed soil underneath before sowing. Treat seed or soil if 3 or more larvae present per metre of row. (90 cm row spacing)	Newly emerged seedling. Can attack dry sown seed. More damage when emergence is delayed by dry weather.	Larvae chew seed and seedling roots and shoots, resulting in patchy stands. Adults chew seedlings at or above ground level, ring-barking or cutting the stem.	Often feed on decaying plant matter. Warm soils, zero till and press wheels reduce damage.	Intermittent

Table 19. Maize – pests (continued)

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Heliothis caterpillars	Hybrid maize seed crops 1–2 sprays at tasselling and silking. Processing maize 0–1 sprays during silking. Spraying is unlikely to be economic.	Foliage damage before tasselling does not warrant control. Main damage occurs to the cobs and tassels during tasselling and silking.	Eat holes in leaves, often in the funnels of the plants. Attack the tassels, move to the cobs, attack silks which prevents pollination, eat tops out of cobs. Allow entry of other insects and moulds.	Early sowing can reduce damage. Maize crops tolerate some damage and tight husk cover helps prevent caterpillar entry. Usually not worth spraying in commercial crops. Pupae bust during winter to reduce survival.	Annual
Redshouldered leaf beetles (*Monolepta*) (North Coast)	Usually swarm in large numbers creating hot spots.	Tasselling and silking crops.	Feed on foliage, tassels and silks, open husks at top of cobs, Impair seed set.	Allow entry of other insects and diseases into cobs. Spot spraying may be sufficient.	Intermittent (coastal)
Sugar cane and maize stem borer	None available.	Larvae enters maize stem through lower internodes during vegetative stages.	Eats internal structures of stem causing lodging. If infestation occurs early in crop development it can reduce grain weight. Generally occurs on edge of crops.	Native insect which can cause minor damage in other crops such as wheat or rice. No control possible. Insect may favour softer stem varieties.	Rarely
Two spotted mites	None established as there are no effective chemicals registered. First seen as webbing on undersides of leaves.	Tasselling and silking crops.	Suck sap, leaves lose colour, reduce plant vigour, cob size and seed development. Promote lodging and premature death.	Avoid use of synthetic pyrethroids and carbamates on other insects as they 'flare' two-spotted mites.	Intermittent
Wireworms	Presence of larvae before sowing. Treat if more than 1 larvae per metre of row. No post-sowing treatment.	Larvae feed on germinating seed and bore into stem of young seedling. Larvae are 15–25 mm long.	Kill seedlings by destroying growing point. Damage more severe under cool and wet conditions when growth is retarded. Damage stops when top 50 mm of soil dries out and warms up.	Wireworm numbers can be reduced by clean cultivation. Later sowing using press wheels into warm moist soils reduces damage. Many farmers apply routine control measures at sowing. The common brown earwig is a natural enemy.	Intermittent

Table 20. Maize – pesticide use (litres per ha)

Chemical formulation	Registered trade names	African blackbeetles (1 m row)	Armyworms	Cutworms	Heliothis	Rutherglen bugs	Wireworms (1 m row)
alpha-cypermethrin*							
100 g/L EC	Alpha-Scud Elite				0.3 or 0.4		
	Astound Duo				0.3 or 0.4		
	Dictate Duo				0.3 or 0.4		
	Dominex Duo				0.3 or 0.4		
	Fastac Duo				0.3 or 0.4❶		
250 g/L SC	Alpha Forte 250 SC				0.12 or 0.16		
Bacillus thuringiensis							
sub-species *kurstkai*	Delfin WG		25–100 g		25–100 g		
	Dipel DF		0.5–2.0 kg		0.5–2.0 kg		
sub-species	Full-Bac WDG		0.5–2.0 kg		0.5–2.0 kg		
aizawai strain GC-91	Bacchus WG		1.0–4.0 kg		50–200 g		
carbaryl							
500 g/L SC	Bugmaster Flowable		1.8–2.2	1.8–2.2	1.8–2.2	1.8–2.2	
	Carbaryl 500 Flowable		1.8–2.2	1.8–2.2	1.8–2.2	1.8–2.2	
chlorpyrifos*							
500 g/L EC	Conquest Chlorpyrifos 500	2.0	0.7 or 0.9	0.9			0.5–1.5
	Cyren 500 EC	2.0	0.7 or 0.9	0.9			0.5–1.5
	Lorsban 500 EC	2.0	0.7 or 0.9	0.9			0.5–1.5
	Strike-Out 500 EC	2.0	0.7–0.9	0.7–0.9			0.5–1.5
cypermethrin*							
200 g/L EC	Cypershield 200				0.38 or 0.5❷		
	Scud Elite				0.3 or 0.4❷		
	Titan Cypermethrin 200				0.3 or 0.4❷		
250 g/L EC	Conquest Cypermethrin 250				0.3 or 0.4❷		
260 g/L EC	Cypermethrin 260 EC				0.29 or 0.385❷		
40 g/L ULV	Cypershield ULV 40				1.9–2.5❷		
deltamethrin*							
27.5 g/L EC	Ballistic Elite		0.5	0.2	0.5		
	D-Sect EC		0.5	0.2	0.5		
	decis options		0.5	0.2	0.5		
	Delta-Duo				0.5		
5.5 g/L ULV	Deltaguard ULV		2.0–2.5	1.0	2.5		

* **Numerous other generic products are also registered.**
❶ Use higher rate if larvae is longer than 10 mm.
❷ Registered for corn earworm (*Helicoverpa armigera*) only.

Table 20. Maize – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	African blackbeetles (1 m row)	Armyworms	Cutworms	Heliothis	Rutherglen bugs	Wireworms (1 m row)
diazinon 800 g/L LC	Barmac Diazinon		1.0	1.0			
	Country Diazinon 800		1.0	1.0			
	David Gray's Diazinon 800		1.0	1.0			
	Diazol 800		1.0	1.0			
esfenvalerate 50 g/L EC	Sumi-Alpha Flex				0.5❸		
maldison 1169 g/L ULV	Fyfanon ULV		0.7				
methomyl* 225 g/L SL	Electra 225		1.5		1.5–2.0❹		
	Lannate L		1.5		1.5–2.0❸		
	Marlin		1.5		1.5–2.0		
	Methomyl 225		1.5		1.5–2.0❹		
	Nudrin 225		1.5		1.5–2.0❹		
nuclear polyhedrosis virus (NPV) 2 thousand million/mL (Obs)	Gemstar LC				0.375		
	Vivus Gold				0.375		
	Vivus Max				0.15		
terbufos 150 g/kg GR	Counter B 150 G						1.7–2.0 kg❺
	Hunter 150 G						1.7–2.0 kg❺
thiodicarb 375 g/L SC	Larvin 375				1.5–2.0❸		
	Showdown 375				1.5–2.0❸		
800 g/kg	Confront 800 WG				0.7–0.94 kg❸		
	Mission Thiodicarb 800 WG				0.7–0.94 kg❸		

* **Numerous other generic products are also registered.**
❸ Registered for corn earworm (*Helicoverpa armigera*) only.
❹ Also registered as an ovicide at 1.0 L/ha.
❺ Use higher rate in areas known to have a regular wireworm problem. Adjust the application rate for other row spacing using 17–20 g granules per 100 m of row.

Table 21. Millet – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Armyworms	Usually present in large numbers. Consider stage of growth and potential damage. Treat in late afternoon.	Usually young plants before head emergence.	Defoliate plants. Feed on leaves in the funnels or throats of plants. Severe leaf area loss reduces yields.	Inspect crops regularly during early growth and at head emergence for armyworms. Build up normally occurs after wet weather. Feeding mainly at night.	Rarely
Cutworms	At first sign of damage. Usually in large numbers in patches or moving in from edges.	Seedling.	Eat leaves and cut stems at or below ground level killing plants. Remain in the soil during the day and feed at night.	Inspect crops late evening or night for presence of large dark grey-green caterpillars to 50 mm long. Often spot spraying is sufficient.	Rarely
Heliothis caterpillars	Damage before flowering not normally severe. Treat if 10 or more 5 mm larvae per m^2 at flowering.	Before flowering feed like armyworms on foliage. Most severe damage during flowering and grain filling.	Eat holes in leaves (early). At flowering small caterpillars feed on spikelets. Larger caterpillars eat seed in head and reduce yields.	Damage to the seed can cause severe losses. Cultivate crop stubble over winter to reduce pupae survival.	Annual

Table 22. Millet – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Aphids	Armyworms	Cutworms	Heliothis	Rutherglen bugs
Bacillus thuringiensis						
sub-species *kurstkai*	Delfin WG		25–100 g		25–100 g	
	Dipel DF		0.5–2.0 kg		0.5–2.0 kg	
	Full-Bac WDG		0.5–2.0 kg		0.5–2.0 kg	
sub-species *aizawai*						
strain GC-91	Bacchus WG		1.0–4.0 kg		1.0–4.0 kg	
carbaryl						
500 g/L SC	Bugmaster Flowable		1.8–2.2	1.8–2.2	1.8–2.2	1.8–2.2
	Carbaryl 500 Flowable		1.8–2.2	1.8–2.2	1.8–2.2	1.8–2.2
chlorpyrifos*						
500 g/L EC	Conquest Chlorpyrifos 500		0.7–0.9	0.9		
	Cyren 500 EC		0.7 or 0.9	0.9		
	Lorsban 500 EC		0.7 or 0.9	0.9		
	Nufarm Chlorpyrifos 500 EC		0.7 or 0.9	0.9		
	Strike-Out 500		0.7–0.9	0.9		
deltamethrin*						
27.5 g/L EC	Ballistic Elite		0.5	0.2	0.5	
	D-Sect EC		0.5	0.2	0.5	
	decis options		0.5	0.2	0.5	
	Deltamethrin Duo		0.5	0.2	0.5	
	Deltashield 27.5		0.5	0.2	0.5	
5.5 g/L ULV	Deltaguard ULV		2.0–2.5	1.0	2.5	
methidathion						
400 g/L EC	Supracide 400		1.4			
	Suprathion 400 EC		1.4			

*** Numerous other generic products are also registered.**

Table 23. Mungbean – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Bean flies	Seedling: spray if more than 1 tunnel per plant is detected.	Emergence to mid-vegetative.	Larvae hatch from eggs on leaves and burrow down through the stem of the plants to just below ground level or to nodes in older plants.	Early infestations can destroy seedling crops. Check crops particularly after emergence. Check for presence of flies, larvae tunnels and egg laying marks in leaves.	Rarely. Intermittent in coastal crops
Cutworms	Large numbers in patches in crop. Treat at the first sign of damage.	Seedling up to 4 leaf stage.	Eat leaves and cut stems at or below ground level killing plants. Remain in the soil during the day and feed at night.	Inspect crop late in evening or night for presence of large dark grey-green caterpillars. Over-the-row band spraying may be effective.	Rarely
Pod suckers – rated in terms of GVB equivalents. Green vegetable bugs (GVB) = 1 GVB and brown bean bugs (BBB) = 1 GVB	0.3–0.8 GVB adult equivalents (AEq) per m^2. Refer to QDAFF threshold tables.	Just before flowering through to harvest maturity.	Suck sap from pods and damage seeds in pods. Reduce seed yield, quality and viability.	Bugs present on upper leaves early in morning. Best time for spraying. Instars different colour to adults. Economic thresholds reflect changes in seed damage penalties.	Intermittent
Heliothis caterpillars	Refer to QDAFF threshold tables. 0.5–3 larvae/m^2 from budding to podding.	Normally during flowering and podding. Attack prior to flowering can cause leaf area loss and stunting of growing points.	Caterpillars feed on the leaves, flower bugs, flowers, young pods and seeds in pods. Reduce pod set, seed quality and yield.	Presume caterpillars are corn earworm (*H. armigera*). Control by spraying eggs and small caterpillars up to 5 mm long. 1–2 sprays may be necessary.	Annual
Jassids	Spray if the plants are young and stressed and there are more than 20 jassids/plant (vegetable jassids). More than 22% of leaves in the top half of the canopy have hopper burn (lucerne jassids).	Any stage but particularly slow growing seedling crops or stressed crops.	Cause white spots on leaves (vegetable jassids) or yellowing leaves from the tip ('hopper burn') from injected toxins (lucerne jassids).	Older plants tolerate larger numbers of vegetable jassids. Large numbers are needed to justify spraying as it will decrease the populations of beneficial insects.	Rarely
Loopers	None established. Look for foliage damage. Legumes tolerate 30–40% leaf loss pre-flowering, but only 16% during pod fill.	Early growth stages. Often moving in from edges from crop.	Defoliate plants.	Caterpillars have a distinct looping movement distinguishing them from heliothis.	Rarely
Mirids	When using indoxacarb, the threshold is 1.1–1.3 mirids/m^2 for ground and aerial applications respectively. Indoxacarb is **not** recommended when more than 2 mirids/m^2 are present. Refer to QDAFF threshold tables for thresholds if using dimethoate. **Check if permit is currently valid.**	Budding/flowering.	Mirids damage buds and flowers causing them to abort resulting in uneven crop maturity and reduced pod set.	Sample with beat sheet prior to 9 am. Large populations may cause crop failure but pod/flower shedding also likely in heat wave conditions. Spraying with the full rate of broadspectrum insecticide for mirids predisposes the crop to heliothis attack – two low rate sprays 5–10 days apart could be used instead.	Intermittent
Thrips (onion and tomato)	When more than 4 thrips per flower are seen. Examine crops twice weekly budding-flowering.	Budding to flowering. Moisture stressed crops more susceptible.	Feed on leaves, flower buds, flowers and young pods. Reduce flowering and pod setting, distort pods.	Shake flowers into white container to dislodge thrips or open and inspect flowers. First treatment pre-flowering may be necessary.	Intermittent

Silverleaf whitefly are not considered to be an economic pest of mungbean and there is no need to apply insecticides for silverleaf whitefly control in mungbeans.

Table 24. Mungbean – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Green vegetable bugs	Heliothis	Loopers	Mirids	Thrips
alpha-cypermethrin*						
100 g/L EC	Alpha Scud Elite		0.3 or 0.4			
	Astound Duo		0.3 or 0.4			
	Dictate Duo		0.3 or 0.4			
	Dominex Duo		0.3 or 0.4			
	Fastac Duo		0.3 or 0.4			
250 g/L SC	Alpha Forte 250 SC		0.12 or 0.16			
Bacillus thuringiensis						
sub-species *kurstkai*	BioCrystal		0.5–2.0	0.5–2.0		
	DiPel SC		1.0–4.0	1.0–4.0		
cypermethrin*						
200 g/L EC	Cypershield 200		0.38–0.5	0.38–0.5 ❶		
	Scud Elite		0.3 or 0.4	0.3 or 0.4 ❶		
250 g/L EC	Cypermethrin 250		0.3 or 0.4	0.3 or 0.4 ❶		
260 g/L EC	Cypermethrin 260 EC		0.29–0.385	0.29–0.385 ❶		
40 g/L ULV	Cypershield ULV 40		1.9–2.5	1.9–2.5 ❶		
deltamethrin*						
27.5 g/L EC	Ballistic Elite	0.5	0.5	0.5		
	D-Sect EC	0.5	0.5	0.5		
	decis options	0.5	0.5	0.5		
	Delta-Duo	0.5	0.5	0.5		
5.5 g/L ULV	Deltaguard ULV	2.5	2.5	2.5		
indoxacarb (25:75)						
150 g/L EC	Steward EC		0.4	0.2 ❷	0.4	
gamma-cyhalothrin						
150 g/L CS	Trojan		50 or 60 mL ❸			
lambda-cyhalothrin						
250 g/L CS	Flipper 250 CS		60 or 70 mL			
	Karate (Zeon Tech)		60 or 70 mL			
	Kung Fu 250		60 or 70 mL			
	Matador (Zeon Tech)		60 or 70 mL			

* **Numerous other generic products are also registered.**
❶ For control of soybean loopers (*Diachrysia orichalcea*).
❷ Registered for soybean loopers only (*Thysanoplusia orichalcea*) only.
❸ Registered for northern NSW only.

Table 24. Mungbean – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Green vegetable bugs	Heliothis	Loopers	Mirids	Thrips
methomyl*						
225 g/L SL	Electra 225	1.5	1.5–2.0			
	Lannate-L	1.5	1.5–2.0			
	Marlin	1.5	1.5 or 2.0			
	Methomyl 225	1.5	1.5–2.0			
	Nudrin 225	1.5	1.5–2.0			
nuclear polyhedrosis						
virus (NPV)	Gemstar LC		0.375			
2 thousand million/mL	Vivus Gold		0.375			
(Obs)	Vivus Max		0.15			
thiodicarb						
375 g/L SC	Larvin 375		0.5 or 0.75			
	Showdown 375		0.5 or 0.75			
800 g/kg WG	Confront 800 WG		0.235 or 0.35 kg			
	Mission Thiodicarb 800 WG		0.235 or 0.35 kg			

*** Numerous other generic products are also registered.**

Table 25. Navy bean – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Cutworms	Usually in patches in a crop. Treat at first sign of damage.	Seedling.	Eat leaves and cut stems at or below ground level killing plants. Remain in the soil during the day and feed at night.	Inspect crops late evening or night for presence of large dark grey-green caterpillars. Use over-the row band spraying (night) or spray patches.	Rarely
Green vegetable bugs (GVB) brown bean bugs (BBB) and red banded shield bugs (RBSB)	0.33–1 GVB adult or late stage nymph per m^2 (sprouting and processing respectively), 1.5 BBB per m^2. 3 RBSB adults per m^2.	Just before flowering through to harvest maturity.	Suck sap from pods and damage seed in pods. Reduce seed yield, quality and viability.	Spray in early morning when bugs are on the upper leaves. Economic threshold reflects changes in seed damage penalties. Scout crops with a beat cloth twice weekly.	Intermittent
Heliothis caterpillars	Before flowering 33% leaf damage can be tolerated. Refer to QDAFF threshold tables. 0.5–3 larvae/m^2 from budding to podding.	Flowering, podding.	Early leaf chewing does little damage. Prevent pod set, bore into pods and eat seeds.	Check crop at least twice a week during flowering and podding. Presume caterpillars are corn earworm (*H. armigera*). 1 or 2 sprays may be necessary.	Annual
Mirids	0.5–1.5 larvae/m^2 between early podding to maturity.	Budding/flowering.	Mirids damage buds and flowers causing them to abort resulting in uneven crop maturity and reduced pod set.	Check twice weekly from bud initiation onwards.	Intermittent
Thrips (onion and tomato)	4–6 thrips per flower. Sometimes treatment necessary at budding.	Flowering. Stressed crops more susceptible.	Feed in flowers and reduce pod set and distort pods.	Shake flowers into white container to dislodge thrips or open and inspect flowers.	Intermittent
Wireworms	Presence of larvae before sowing. Treat soil if 2 or more larvae per metre of row at sowing.	Larvae feed on germinating seed. Bore into stem of young seedling.	Kills seed growing point. Damage is more severe under cool and wet conditions when growth is retarded.	Reduce numbers by clean cultivation. Press wheels reduce crop damage. Damage stops when the top 50 mm of soil dries and warms up.	Intermittent

Table 26. Navy bean – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Aphids	Bean flies	Green vegetable bugs	Heliothis	Loopers	Mirid bugs	Thrips
alpha-cypermethrin*								
100 g/L EC	Alpha-Scud Elite				0.3 or 0.4			
	Astound Duo				0.3 or 0.4			
	Dictate Duo				0.3 or 0.4			
	Dominex Duo				0.3 or 0.4			
	Fastac Duo				0.3 or 0.4			
250 g/L SC	Alpha Forte 250 SC				0.12 or 0.16			
Bacillus thuringiensis sub-species *kurstkai*	BioCrystal				0.5–2.0	0.5–2.0		
	DiPel SC				1.0–4.0	1.0–4.0		
beta-cyfluthrin 25 g/L EC	Bulldock Duo				0.6 or 0.8 ❶			
bifenthrin*								
100 g/L EC	Arrow 100 EC				0.6–0.8			
	Bifenthrin 100 EC				0.6–0.8			
	Ospray Bifenthrin 100 EC				0.6–0.8			
	Talstar 100 EC				0.6–0.8			
250 g/L EC	Talstar 250 EC				0.24–0.32			
cypermethrin*								
200 g/L EC	Cypershield 200				0.38–0.5	0.38–0.5 ❷		
	Scud Elite				0.3 or 0.4	0.3–0.4 ❷		
250 g/L EC	Cypermethrin 250				0.3 or 0.4	0.3 or 0.4 ❷		
260 g/L EC	Cypermethrin 260 EC				0.29–0.385	0.29–0.385 ❷		
40 g/L ULV	Cypershield ULV 40				1.9–2.5	1.9–2.5 ❷		
deltamethrin*								
27.5 g/L EC	Ballistic Elite			0.5	0.5	0.5		
	D-Sect EC			0.5	0.5	0.5		
	decis options			0.5	0.5	0.5		
	Deltamethrin Duo			0.5	0.5	0.5		
	Deltashield 27.5			0.5	0.5	0.5		
	Delta-Duo			0.5	0.5	0.5		
5.5 g/L ULV	Deltaguard ULV			2.5	2.5	2.5		
esfenvalerate 50 g/L EC	Sumi-Alpha Flex				0.4–0.5 ❸			
gamma-cyhalothrin 150 g/L CS	Trojan				50 or 60 mL ❹			

* **Numerous other generic products are also registered.**
❶ Do not use on larvae larger than 5 mm if *H. armigera* are present.
❷ For control of soybean loopers (*Diachrysta orichalcea*) only.
❸ Use higher rate to control corn earworms (*Helicoverpa armigera*).
❹ Registered for northern NSW only.

Table 26. Navy bean – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Bean flies	Green vegetable bugs	Heliothis	Loopers	Mirid bugs	Thrips
lambda-cyhalothrin								
250 g/L CS	Flipper 250 CS				60 or 70 mL			
	Karate (Zeon Tech)				60 or 70 mL			
	Kung Fu 250				60 or 70 mL			
	Matador (Zeon Tech)				60 or 70 mL			
methomyl*								
225 g/L SL	Electra 225		1.5–2.0	1.5	1.5 or 2.0 ❻	1.5		1.5–2.0
	Lannate L		1.5–2.0	1.5	1.5–2.0 ❻	1.5		1.5–2.0
	Marlin		1.5–2.0	1.5	1.5 or 2.0 ❻	1.5		1.5–2.0
	Methomyl 225		1.5–2.0	1.5	1.5 or 2.0 ❻	1.5		1.5–2.0
	Nudrin 225		1.5–2.0	1.5	1.5–2.0 ❻	1.5		1.5–2.0
nuclear polyhedrosis								
virus (NPV)	Gemstar				0.375			
2 thousand million/mL	Vivus Gold				0.375			
(Obs)	Vivus Max				0.15			
thiodicarb								
375 g/L SC	Larvin 375				0.5 or 0.75			
	Showdown 375				0.5 or 0.75			
800 g/L WG	Confront 800 WG				0.235–0.35 kg			
	Mission Thiodicarb 800 WG				0.235–0.35 kg			

❻ Also registered as an ovicide at 0.5–1.0 L/ha.

Table 27. Safflower – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	20% plants with 20 or more aphids per growing point, bud or flower head. Check for predators.	Most common during budding and flowering. Can also infest seedling.	Feed on growing points, buds and flower heads. Cause mottled appearance, distortion and shrivelling of heads.	Most commonly green peach, leaf curl and plum aphids. Check for presence of predators.	Intermittent
Blue oat mites (BOM) and redlegged earth mites (RLEM)	Usually present in large numbers. Later sowing allows time for control before planting.	Seedling emergence to 4 leaf stage. Look for damage to cotyledons.	Mottle and whiten cotyledons and leaves by rasping and sucking. May stunt and kill seedlings. RLEM more common in southern NSW.	Most feeding during cooler part of day and night. Often present under clods or underside of weed leaves such as capeweed and saffron thistles.	Intermittent
Cutworms	Usually in large numbers in patches in a crop. Treat at first sign of damage, preferably in late afternoon.	Early growth stages, spot spraying may be sufficient.	Eat leaves and cut stems at or below ground level killing plants. Remain in the soil during the day and feed at night.	Inspect crop in late afternoon or night for presence of large dark grey-green caterpillars. Spot spraying may be effective.	Rarely
False wireworms	Presence of larvae before sowing. No after sowing treatment.	Newly emerged seedling.	Larvae chew seed and seedling roots and shoots, resulting in patchy stands. Adults chew seedlings at or above ground level, ring-barking or cutting the stem.	Vary from 8–40 mm in length. Check at junction of loose cultivated soil and undisturbed soil prior to sowing..	Intermittent
Rutherglen bugs (RGB) and grey cluster bugs	Damage worse under moisture stress and hot conditions. Well grown crops can tolerate up to 40% bud loss.	Budding and flowering. Invasion from outside crop.	Suck sap from buds, flowers and stems. Cause wilting and death of heads. Nymphs feed on developing seeds.	Reduce oil content. Adults 5 mm long, narrow bodied grey colour. Nymphs reddish brown and pear-shaped.	Intermittent
Heliothis caterpillars	4–8 larvae 5–7 mm long per m^2. Only damage to flower buds. Well grown crops can tolerate up to 40% damage to buds and developing flower heads before flowering.	Budding and flowering.	Caterpillars chew flower buds and flowers, prevent seed set.	Check to identify if *H. punctigera* or *H. armigera*. Later in season greater possibility of *H. armigera* also within 30 km of summer irrigation.	Annual
Lucerne fleas	Rarely a problem in safflower as sown later and most on higher pH soils. (See details for canola.)				
Thrips	1–2 thrips per flower or 25% buds killed. Well grown plants may tolerate greater losses.	Budding and flowering. Buds become bronzed and die.	Kill buds, cause flower abortions. Greater damage under dry conditions.	Shake flowers into white container to dislodge slender-bodied, feathery-winged 1–1.5 mm long insect.	Intermittent

Table 28. Safflower – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Blue oat mites	Cutworms	Heliothis	Lucerne fleas	Redlegged earth mites
Bacillus thuringiensis						
sub-species *kurstkai*	BioCrystal			0.5–2.0		
	Delfin WG			25–100 g		
	DiPel DF			0.5–2.0 kg		
	DiPel SC			1.0–4.0		
	Full-Bac WDG			0.5–2.0 kg		
sub-species *aizawai*						
strain GC-91	Bacchus WG			1.0–4.0 kg		
chlorpyrifos*						
500 g/L EC	Conquest Chlorpyrifos 500 EC	0.14–0.3	0.9			0.14–0.3
	Cyren 500 EC	0.14–0.3	0.9			0.14–0.3
	Lorsban 500 EC	0.14–0.3	0.9			0.14 or 0.3
	Nufarm Chlorpyrifos 500 EC	0.14 or 0.3	0.9			0.14–0.3
	Strike-Out 500 EC	0.14–0.3	0.9			0.14–0.3
deltamethrin*						
27.5 g/L EC	Ballistic Elite		0.2	0.5		
	D-Sect EC		0.2	0.5		
	decis options❶		0.2	0.5		
5.5 g/L ULV	Deltaguard ULV❷		1.0	2.5		
esfenvalerate						
50 g/L EC	Sumi-Alpha Flex	50–70 mL❸		0.13–0.33❹		50–70 mL❸
methidathion						
400 g/L EC	Suprathion 400 EC❺	0.2			0.2	0.2
nuclear polyhedrosis virus (NPV) 2 thousand million/mL (Obs)	Gemstar			0.375		
	Vivus Gold			0.375		
	Vivus Max			0.15		

* **Numerous other generic products are also registered.**
❶ Also registered for green vegetable bugs (*Nezara viridula*) and loopers at 0.5 L/ha.
❷ Also registered for green vegetable bugs (*Nezara viridula*) and loopers at 2.5 L/ha.
❸ Registered at 100 mL/ha as a bare earth treatment. Apply prior to crop emergence.
❹ Registered for the control of native budworm (*Helicoverpa punctigera*) in southern NSW only.
❺ Registered as a bare earth treatment only. Apply immediately prior to seedling emergence.

Table 28. Safflower – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Blue oat mites	Cutworms	Heliothis	Lucerne fleas	Redlegged earth mites
omethoate 290 g/L SL	All-Mitey 290 SL ❻	0.1			0.1	0.1 ❼
	Le-mat 290 SL ❻	0.1			0.1	0.1 ❼
	Mite Master 290 ❻	0.1			0.1	0.1 ❼
	Omen 290 ❻	0.1			0.1	0.1 ❼
	Omethoate 290 SL ❻	0.1			0.1	0.1 ❼

❻ Also registered for bryobia mites at 0.12 L/ha.
❼ Also registered as a barrier spray for redlegged earth mites (*Halotydeus destructor*) at 0.3 L/ha.

Table 29. Sorghum – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	None established. Dryland crops under moisture stress most severely affected.	Just before head emergence, flowering up to harvest.	Reduce head emergence, seed set and quality. Honeydew interferes with harvest.	Rarely economic to spray. Aphids can encourage natural predators to build up. A pre-harvest spray with a knockdown herbicide will usually avoid the harvest problems caused by aphids.	Annual
Armyworms	Usually present in large numbers. Consider stage of growth and potential damage.	Attack young plants, through to head emergence and flowering.	Feed on leaves in funnels or throats of plants. Can kill young plants. Severe leaf area loss at flowering can reduce yields.	Feeding during evening and night. Caterpillars hide near ground during day. Build up often occurs after heavy rain.	Rarely
Black field earwigs	Usually in large numbers. Examine soil before sowing for nymphs and adults.	Attack germinating seed and roots of young seedling and tap roots of older plants.	Destroy roots and cause plants to fall over in wind.	Populations regulated by soil moisture, favoured by moist soils. Sow treated seed and band spray. Damage reduced by shallow sowing into moist warm soils using press wheels.	Rarely
Cutworms	At first sign of damage. Usually in large numbers in patches or moving in from edges.	Seedling.	Cut off leaves and stems at ground level, causing plant death. Most feeding in evening and night. Caterpillars hide in soil during day.	Inspect crops late evening or night for presence of large dark grey-green caterpillars. Spot treatment may be effective.	Rarely
False wireworms	Treat seed or soil if 3 or more larvae per metre row.	Newly emerged seedling. Can attack dry sown seed. More damage when emergence delayed by dry weather.	Feed on dry seed and eat into the stems of young plants just above ground level.	Check at junction of loose cultivated soil and undisturbed soil before sowing. Vary from 8–40 mm in length. Often feed on decaying vegetable matter. Warm soil and press wheels can reduce damage.	Intermittent
Heliothis caterpillars	Economic thresholds (ET) can be calculated using the following formula: $ET = \frac{C \times R}{V \times N \times 2.4}$ where C = cost of control ($/ha); R = row spacing (cm); V = value of crop ($/t); N = number of heads/m row; 2.4 = damage (g/larva)	Infestations on vegetative plants do not cause economic damage. Eggs are laid on heads just prior to flowering from December to March.	Small caterpillars (< 10 mm) eat flower spikelets, larger caterpillars eat developing seed reducing yields and allowing fungal entry. Each larvae destroys about 2.4 g of grain.	To determine heads per m row, count 10 m of row at 10 sites. Sample larvae by shaking sorghum heads into a bucket. Compact headed varieties suffer more serious damage than open headed types. Cultivation of stubble over winter reduces pupae survival. Threshold calculators are available at www.thebeatsheet.com.au/sampling-2	Annual

Table 29. Sorghum – pests (continued)

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Rutherglen bugs (RGB) and grey cluster bugs	Undetermined. For RGB the provisional threshold is 20–25 bugs/head at flowering to soft dough stage. No yield loss post hard-dough to physiological maturity.	Head emergence, flowering and grain filling.	Suck sap from leaves, stems, heads and grain, reducing yield and quality.	Attacks are rarely a problem and confined to small areas. Monitor from booting to milky dough stage by shaking 10 heads into a bucket and averaging RGB present. Spot spraying may be necessary. RGB is very mobile in front of storms. Attacks more common in hot, dry weather.	Intermittent
Sorghum midges	Midge thresholds for a crop can be calculated by using the following formula: **Spray for midge when:** $\frac{NM}{R}$ **is greater than** $\frac{C \times W \times CB}{1.4 \times V \times RD}$ where NM = number of midge per m row R = midge rating of hybrid used* C = cost of control ($/ha) W = row spacing width (cm) CB = cost benefit ratio 1.4 = constant V = value of crop ($/t) RD = residual life of chemical used (days) **Example** $\frac{NM}{R} = \frac{4}{3} = 1.33$ $= \frac{C \times W \times CB}{1.4 \times V \times RD} = \frac{17 \times 100 \times 2}{1.4 \times 155 \times 4}$ $= \frac{3400}{868}$ $= 3.92$ **As 1.33 < 3.92, do not spray at this stage.** (*See resistance rating in *Summer crop production guide*).	Head emergence and flowering.	Midge larvae suck fluid from developing seed, shrivel seed and reduce yields.	Check crops early in the day for newly emerged midges. Spraying could be necessary every 3–4 days under severe conditions. Maximum midge numbers occur 10 am–12 noon. Threshold calculators are available at www.thebeatsheet.com.au/sampling-2	Annual
Wireworms	Treat before sowing if more than 2 larvae per metre of row	Larvae feed on germinating seed and bore into stem of young seedling. Larvae are 15–25 mm long.	Kill seedling by destroying growing point. Damage is more severe under cool and wet conditions when growth is retarded. Damage stops when top 50 mm of soil dries out and warms up.	Wireworm numbers can be reduced by clean cultivation. Later sowing using press wheels into warm moist soils reduces damage. Use treated seed.	Intermittent

Table 30. Sorghum – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Aphids	Armyworms	Cutworms	Heliothis	Rutherglen bugs	Sorghum midges	Wireworms and false wireworms (1 m rows)
alpha-cypermethrin*								
100 g/L EC	Alpha-Scud Elite				0.3 or 0.4		0.1 or 0.2	
	Astound Duo				0.3 or 0.4		0.1 or 0.2	
	Dictate Duo				0.3 or 0.4		0.1 or 0.2	
	Dominex Duo				0.3 or 0.4		0.1 or 0.2	
	Fastac Duo				0.3 or 0.4		0.1 or 0.2	
250 g/L SC	Alpha Forte 250 SC				0.12 or 0.16		40 or 80 mL	
Bacillus thuringiensis								
sub-species *kurstkai*	BioCrystal		0.5–2.0		0.5–2.0			
	Delfin WG		25–100 g		25–100 g			
	DiPel SC		1.0–4.0 kg		1.0–4.0			
	DiPel DF		0.5–2.0 kg		0.5–2.0 kg			
	Full-Bac WDG		0.5–2.0 kg		0.5–2.0 kg			
sub-species *aizawai* strain GC-91	Bacchus WG		1.0–4.0 kg		1.0–4.0 kg			
beta-cyfluthrin								
25 g/L EC	Bulldock Duo				0.6		0.3	
carbaryl								
500 g/L SC	Bugmaster Flowable		1.8–2.2	1.8–2.2	1.8–2.2	1.8–2.2		
500 g/L EC	Carbaryl 500 Flowable		1.8–2.2	1.8–2.2	1.8–2.2	1.8–2.2		
chlorpyrifos*								
500 g/L EC	Conquest Chlorpyrifos 500 [1]	0.5 [2]	0.7–0.9	0.9			0.5	0.5–1.5
	Cyren 500 EC	0.5 [2]	0.7–0.9	0.9			0.5	0.5–1.5
	Lorsban 500 EC [1]	0.5 [2]	0.7 or 0.9	0.9			0.5	0.5–1.5
	Strike-Out 500 EC [1]	0.5 [2]	0.7–0.9	0.9			0.5	0.5–1.5
cypermethrin								
200 g/L EC	Cypershield 200				0.3–0.5 [3]		0.19–0.38	
	Titan Cypermethrin 200				0.3–0.5 [3]		0.19–0.38	
250 g/L EC	Cypermethrin 250				0.24 or 0.4 [3]		0.15 or 0.3	
260 g/L EC	Cypermethrin 260 EC				0.3 or 0.385 [3]		0.145–0.29	
40 g/L ULV	Cypershield ULV 40				1.5–2.0 [3]		0.9–1.9	
deltamethrin								
27.5 g/L EC	Ballistic Elite		0.5	0.2	0.5		0.2–0.4	
	D-Sect EC		0.5	0.2	0.5		0.2–0.4	
	decis options		0.5	0.2	0.5		0.2–0.4	
	Delta-Duo		0.5	0.2	0.5		0.2–0.4	
5.5 g/L ULV	Deltaguard ULV		2.0–2.5	1.0	2.5		1.0–2.0	

*** Numerous other generic products are also registered**

[1] Do not use on Sugar Drip or Alpha Sorghum. Check new varieties before applying to entire crop. [2] Registered for corn aphids (*Rhopalosiphum maidis*) only. [3] Registered for corn earworm (*Helicoverpa armigera*) only.

Table 30. Sorghum – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Armyworms	Cutworms	Heliothis	Rutherglen bugs	Sorghum midges	Wireworms and false wireworms (1 m rows)
diazinon 800 g/L LC	Barmac Diazinon		1.0	1.0			0.35–0.7	
	Country Diazinon 800		1.0	1.0			0.35–0.7	
	David Gray's Diazinon 800		1.0	1.0			0.35–0.7	
	Diazol 800		1.0	1.0			0.35–0.7	
esfenvalerate 50 g/L EC	Sumi-Alpha Flex				0.45❸		0.1–0.3	
gamma-cyhalothrin 150 g/L EC	Trojan				50 or 60 mL❸		15 or 30 mL	
lambda-cyhalothrin 250 g/L CS	Flipper 250 CS				60 or 70 mL❸		18 or 36 mL	
	Karate (Zeon Tech)				60 or 70 mL❸		18 or 36 mL	
	Kung Fu 250				60 or 70 mL❸		18 or 36 mL	
	Matador (Zeon Tech)				60 or 70 mL❸		18 or 36 mL	
maldison 1169 g/L ULV	Fyfanon ULV		0.7			0.45–0.9	0.45	
methomyl* 225 g/L SL	Electra 225		1.5		1.5–2.0❹			
	Lannate-L		1.5		1.5–2.0❹			
	Marlin		1.5		1.5 or 2.0❹			
	Methomyl 225		1.5		1.5–2.0❹			
	Nudrin 225		1.5		1.5–2.0❸❹			
nuclear polyhedrosis virus (NPV)❺ 2 thousand million/mL (Obs)	Gemstar LC				0.2–0.375			
	Heliocide				0.375			
	Vivus				0.375			
	Vivus Gold				0.375			
	Vivus Max				0.15			
terbufos 150 g/kg GR	Counter B 150 G							1.7–2.0 kg❻
	Hunter 150 G							1.7–2.0 kg❻

* **Numerous other generic products are also registered.**
❸ Registered for corn earworm (*Helicoverpa armigera*) only.
❹ Also registered as an ovicide at 0.5 to 1.0 L/ha
❺ Biological insecticide. Apply 3 days after 50% of panicles have reached 100% flowering.
❻ Use higher rate in areas known to have a regular wireworm problem. Adjust the application rate for other row spacing using 17–20 g granules per 100 m of row.

Table 31. Soybean – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	250 aphids per plant during budding to podding.	Before flowering. Thick clusters on stems.	Suck sap, stunt plants and transmit virus.	Check for predators before spraying.	Rarely
Cluster caterpillars (North Coast only)	None established. Look at amount of damage to foliage. Most legumes can tolerate 33% leaf area loss. During early pod fill only 15% leaf area loss is tolerable. Once pods are filled leaf area loss is of no consequence.	Most common during flowering and podding, sometimes earlier infestations can occur.	Young caterpillars feed on underside of leaves. Skeletonise leaves. Older caterpillars eat holes in leaves, may also eat flowers and pods. Can defoliate plants.	Only present on the North Coast. Can migrate from adjacent pastures.	Rarely
Cutworms	Usually large numbers in patches in crop. Treat at first sign of damage.	Seedling.	Eat leaves and cut stems at or below ground level killing plants. Remain in the soil during the day and feed at night.	Inspect crops late evening or night for presence of large darkish coloured caterpillars. Treat in late afternoon. Spot spraying may be effective.	Rarely
Grass blue butterflies	Before flowering 33% leaf area loss, 10–25% growing points lost. Flowering onwards 15% leaf area loss.	Can damage crop from early vegetative through to pod filling. Irrigation reduces damage.	Chew off growing points of plants. Eat leaves, flowers and young pods and damage seeds in pods.	Distinct small grey-blue butterfly produces caterpillar with slug-like appearance which grow to 10 mm long. Inspect crop twice weekly for damage.	Intermittent
Green vegetable bugs (GVB), brown bean bugs (BBB) and red banded shield bugs (RBSB)	For GVB, 1 GVB or GVB equivalent/m^2 (crushing) or 0.3/m^2 (seed or human consumption). For BBB, 1.5 GVBEQ/m^2 (crushing) or 0.5/m^2 (human consumption). For RBSB, 3 GVBEQ/m^2 (crushing) or 1/m^2 (human consumption).	From just prior to flowering until harvest. Examine crop twice weekly for bugs during early morning (7–9 am).	Adults and late stage nymphs suck sap from pods and seeds, cause new pods to shed. Damage seeds, shrivel, discolour, reducing size and viability.	A number of different bug species can be present in crops. Examine seeds in pods for damage during pod fill. Yield loss worst during early pod fill. Quality requirements for edible type much higher.	Annual
Heliothis caterpillars	Vegetative threshold is 6 larvae/m^2. Check twice per week during pod setting and treat if 6 or more (Riverina), 2 or more (North Coast) 5 mm long larvae per m^2.	Most damage during flowering, pod setting. Before flowering will defoliate the crop.	Defoliate plants. (Do not confuse with common armyworms). Eat flowers, young pods and seeds in pods. Cause pod shedding.	Refer to QDAFF threshold tables. Assume caterpillars are corn earworm (*H. armigera*). Control by spraying eggs and caterpillars up to 5 mm long. Larger caterpillars difficult to control.	Annual
Lesser armyworms (inland districts only)	Spray if plants likely to lose 33% or more of leaf area.	Early vegetative stages before flowering.	Defoliate plants, cause stunting and retarding of growth. Skeletonise leaves.	Caterpillars vary in colour from green to dark brown or blackish with yellowish lines along centre and sides of back.	Rarely

Table 31. Soybean – pests (continued)

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Loopers (tobacco, green and soybean)	None established. Assess amount of damage to foliage. Most legumes can tolerate 33% leaf area loss before flowering, less than 20% budding to podding.	All growth stages, often moving in from edges of crop. Can attack flowering crops.	Defoliate plants.	Caterpillars have a distinct looping movement, distinguishing them from heliothis.	Rarely
Mirids	Trials indicate there is little yield loss for populations up to 5 mirids/m^2.	Flowering to podding. Plant is less able to compensate damage at late flowering to mid podfill.	Cause buds, flowers and small pods to abort. On larger pods, severe damage results in brown and distorted pods with reduced seed size and seed staining.	Indoxacarb is not recommended where there is > 2 mirids/m^2 as it has less residual activity on hatching nymphs. Shortening flowering periods can reduce the risk of mirid damage. Sample with beat sheets at five 1 m lengths at six sites.	Intermittent
Lucerne seed web moths (inland districts only)	None established. No registered pesticides.	Vegetative stages from flowering to pod filling.	Kill growing points, tunnel into stems, bore into pods, cause small pods to shrivel and die. Caterpillars develop inside larger pods, chew out grain, fill pod with excrement and webbing.	Pods can appear normal until caterpillars mature when discolouration and excrement seen. More likely in hot dry weather, often in proximity to lucerne stands. Adequate irrigation of crops reduces caterpillar entry into pods.	Intermittent
Silverleaf whiteflies (B-biotype) (SLWF) (North Coast)	Don't spray! SLWF is moderately to highly resistant to all commonly used pesticides. Spraying will **promote** the development of further resistance in SLWF. IPM options are currently under development.	Can damage crops from seedling/ early vegetative through to pod filling.	Crop damage is the result of both direct sap-sucking insects and secondary losses from the develoment of sooty mould that develops on the 'honey dew' secreted by SLWF. Sooty mould reduces photosynthesis.	SLWF are found on the underside of leaves. Accurate identification is essential to avoid confusion with greenhouse whitefly. Adults have a distinctive gap between their powdery white wings. Adults are smaller (about 1.5 mm long) than greenhouse whitefly.	Annual
Soybean moths	No registered pesticides. > 33% total leaf area during vegetative stages or > 15% total leaf area loss during flowering/pod formation and pod filling.	Infestations can occur from seedling stage until maturity. Attack during vegetative stages most severe.	Initially caterpillars mine leaves (blisters). Leaves cup and fold together to form cocoons for pupation. Leaflets shrivel and die.	Sometimes parasitic wasps reduce infestations. Attacks more likely in hot dry weather, lighter soils and moisture stress.	Intermittent
Spider mites (tetranychid mites) and two spotted mites	An average 5 mites per cm^2 of leaf undersurface of leaves. Select 60 random leaves from crop, during flowering pod formation and filling.	Flowering, pod formation and filling.	Mites form a fine web on the underside of leaves. Suck sap, cause leaves to discolour and eventually die. Hasten plant maturity, reduce yield and seed size.	Mites are very small and may not be detected with naked eye. Damage often starts on edge of crop favoured by hot, dry conditions. Pyrethroids and carbamates encourage buildup by killing natural predators.	Intermittent (Annual in cotton areas)

Table 32. Soybean – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Green vegetable bugs	Heliothis	Jassids	Loopers	Mirids	Two-spotted mites
abamectin							
18 g/L EC	Wizard 18						0.3
alpha-cypermethrin*							
100 g/L EC	Alpha-Scud Elite		0.3 or 0.4				
	Astound Duo		0.3 or 0.4				
	Dictate Duo		0.3 or 0.4				
	Dominex Duo		0.3 or 0.4				
	Fastac Duo		0.3 or 0.4				
250 g/L SC	Alpha Forte 250 SC		0.12 or 0.16				
Bacillus thuringiensis							
sub-species *kurstkai*	BioCrystal		0.5–2.0		0.5–2.0		
	DiPel SC		1.0–4.0		1.0–4.0		
cypermethrin*							
200 g/L EC	Cypershield 200		0.38–0.5		0.38–0.5❶		
	Scud Elite		0.3 or 0.4		0.3 or 0.4❶		
250 g/L EC	Cypermethrin 250 EC		0.3 or 0.4		0.3 or 0.4❶		
260 g/L EC	Cypermethrin 260 EC		0.29–0.385		0.29–0.385❶		
40 g/L ULV	Cypershield 40 ULV		1.9–2.5		1.9–2.5❶		
deltamethrin*							
27.5 g/L EC	Ballistic Elite	0.5	0.5		0.5		
	D-Sect EC	0.5	0.5		0.5		
	decis options	0.5	0.5		0.5		
	Delta Duo	0.5	0.5		0.5		
5.5 g/L ULV	Deltaguard ULV	2.5	2.5		2.5		
esfenvalerate							
250 g/L EC	Sumi-Alpha Flex		0.13–0.33❷				
gamma-cyhalothrin							
150 g/L CS	Trojan		50 or 60 mL❸				
indoxacarb (25:75)							
150 g/L EC	Steward EC		0.4		0.2	0.4	
lambda-cyhalothrin							
250 g/L CS	Flipper 250 CS		60 or 70 mL				
	Karate (Zeon Tech)		60 or 70 mL				
	Kung Fu 250		60 or 70 mL				
	Matador (Zeon Tech)		60 or 70 mL				

* **Numerous other generic products are also registered.**
❶ Registered for soybean loopers (*Thysanoplusia orichalcea*) only.
❷ Registered in southern NSW only for native budworms (*Heliothis punctigera*). In northern NSW apply 0.4–0.5 L/ha. Apply higher rate for corn earworms (*Helicoverpa armigera*).
❸ Use the higher rate if pest numbers are high.

Table 32. Soybean – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Green vegetable bugs	Heliothis	Jassids	Loopers	Mirids	Two-spotted mites
methomyl*							
225 g/L SL	Electra 225	1.5	1.5–2.0 ❹				
	Lannate L	1.5	1.5–2.0 ❹				
	Marlin	1.5	1.5 or 2.0 ❹				
	Methomyl 225	1.5	1.5–2.0 ❹				
	Nudrin 225	1.5	1.5–2.0 ❹				
nuclear polyhedrosis							
virus (NPV)	Gemstar LC		0.375				
2 thousand	Vivus Gold		0.375				
million/mL (Obs)	Vivus Max		0.15				
thiodicarb							
375 g/L SC	Larvin 375		0.5 or 0.75				
	Showdown 375		0.5 or 0.75				
800 g/L WG	Confront 800 WG		0.235 or 0.35				
	Mission Thiodicarb 800 WG		0.235 or 0.35				
trichlorfon							
500 g/L SL	Dipterex 500 SL	1.25					
	Lepidex 500	1.2					

* **Numerous other generic products are also registered.**
❹ Also registered as an ovicide at 0.5 to 1.0 L/ha.

Table 33. Sunflower – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids	No registered pesticides.	Seedling to before flowering.	Suck sap from stem, reduce head size and stunt growth.	Check for presence of predators. Honeydew on plants can attract heliothis moths.	Rarely
Cutworms	Treat seedlings when crop damage rapidly increases (more than 10% seedling loss). Treat older plants if more than 90% of plants are infested or more than 50% of plants have 75% or more leaf tissue loss.	Seedling up to 4 weeks after emergence. Severe damage if present in soil at sowing.	Eat leaves and cut stems at or below ground level killing plants. Remain in the soil during the day and feed at night.	Inspect crops late evening or night for presence of large dark grey-green caterpillars. Spot treatment can be effective.	Rarely
False wireworms	Treat seed if 3 larvae per m row before sowing.	Newly emerged seedling. Can attack dry sown seed. More damage when emergence delayed by dry weather.	Larvae chew seed and seedling roots and shoots, resulting in patchy stands. Adults chew seedlings at or above ground level, ring-barking or cutting the stem.	Vary from 8–40 mm in length. Check at junction of loose cultivated soil and undisturbed soil prior to sowing.	Intermittent
Green vegetable bugs	One or more late stage nymphs or mature bugs per plant.	Budding, flowering and seed filling.	Suck sap from stem close to developing flower buds, causing heads to wilt and shrivel.	May also feed on developing seeds. Treat early in the morning when bugs are on the upper leaves.	Rarely
Heliothis caterpillars	Treat when 2 or more 5 mm long larvae per plant at early budding. At flowering to grain fill stage, the plant is able to tolerate higher densities (more than 20 per head).	Budding, flowering and seed filling.	Eat foliage, buds, petals, head bracts and seed. Chew holes in back of heads allowing entry of head rot fungi.	Presume caterpillars are corn earworm (*H. armigera*) and follow resistance management strategy. Control by spraying eggs and caterpillars up to 5 mm. Check crops twice weekly from budding onwards.	Annual
Rutherglen bugs and grey cluster bugs	**Early (spring)** – budding 10 bugs/head, flowering to seed fill: 20–25 bugs/head. **Late (Jan–April)** – budding: 20–25 bugs/head, flowering to seed fill: 50 bugs/head.	Budding, flowering and seed filling.	Suck sap from stem under buds causing wilting, reduced head size or death. Reduce yield, oil content and seed viability.	Yield losses range 10% (irrigation) to 30% (dryland) depending on moisture content. Several sprays may be needed under severe conditions.	Annual
Wireworms	Presence of larvae before sowing. No after-sowing treatment. Treat seed if 2 larvae per metre of row at sowing. Use treated seed.	Larvae feed on germinating seed. Bore into stem of young seedling.	Kill seedlings by destroying growing point. Damage more severe under cool and wet conditions when growth is retarded.	Wireworm numbers can be reduced by clean cultivation. Press wheels reduce crop damage. Damage stops when top 50 mm of soil dries out and warms up.	Intermittent

Table 34. Sunflower – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Armyworms	Cutworms	Green vegetable bugs	Heliothis	Jassids	Rutherglen bugs	Grey cluster bugs	Wireworms and false wireworms (1 m rows)
alpha-cypermethrin*									
100 g/L EC	Alpha-Scud Elite❶				0.3 or 0.4		0.3 or 0.4	0.3 or 0.4	
	Astound Duo❶				0.3 or 0.4		0.3 or 0.4	0.3 or 0.4	
	Dictate Duo				0.3 or 0.4		0.3 or 0.4	0.3 or 0.4	
	Dominex Duo				0.3 or 0.4		0.3 or 0.4	0.3 or 0.4	
	Fastac Duo❶				0.3 or 0.4		0.3 or 0.4	0.3 or 0.4	
250 g/L SC	Alpha Forte 250 SC❶				0.12 or 0.16		0.12 or 0.16	0.12 or 0.16	
Bacillus thuringiensis									
sub-species *kurstkai*	BioCrystal	0.5–2.0 kg			0.5–2.0 kg				
	Delfin WG	0.5–2.0 kg			0.5–2.0 kg				
	DiPel SC	1.0–4.0 kg			1.0–4.0 kg				
	DiPel DF	0.5–2.0 kg			0.5–2.0 kg				
	Full-Bac WDG	0.5–2.0 kg			0.5–2.0 kg				
sub-species *aizawai* strain GC-91	Bacchus WG	1.0–4.0 kg			1.0–4.0 kg				
carbaryl									
500 g/L SC	Bugmaster Flowable	1.8–2.2	1.8–2.2		1.8–2.2		1.8–2.2		
	Carbaryl 500 Flowable	1.8–2.2	1.8–2.2		1.8–2.2		1.8–2.2		
chlorpyrifos*									
500 g/L EC	Conquest Chlorpyrifos 500 EC		0.9						0.5–1.5
	Cyren 500 EC		0.9						0.5–1.5
	Lorsban 500 EC		0.9						0.5–1.5
	Strike-Out 500 EC		0.9						0.5–1.5
cypermethrin*									
200 g/L EC	Cypershield 200				0.38 or 0.5		0.38 or 0.5	0.38 or 0.5	
	Scud Elite				0.38–0.5		0.38–0.5	0.38–0.5	
	Titan Cypermethrin 200				0.38 or 0.5		0.38 or 0.5	0.38 or 0.5	
250 g/L EC	Cypermethrin 250 EC				0.3 or 0.4		0.3 or 0.4	0.3 or 0.4	
260 g/L EC	Cypermethrin 260 EC				0.29–0.385		0.29–0.385	0.29–0.385	
40 g/L ULV	Cypershield ULV 40				1.9–2.5		1.9–2.5	1.9–2.5	
deltamethrin*									
27.5 g/L EC	Ballistic Elite				0.5	0.5	0.5		
	D-Sect EC				0.5	0.5	0.5		
	decis options				0.5	0.5	0.5		
	Delta Duo				0.5	0.5	0.5		
5.5 g/L ULV	Deltaguard ULV❷				2.5	2.5	2.5		

* **Numerous other generic products are also registered.**
❶ To protect bees and ensure adequate pollination, application during flowering should be avoided. If application is necessary at flowering, apply early morning or late afternoon when bees are not actively foraging.
❷ Also registered for loopers at 2.5 L/ha

Table 34. Sunflower – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Armyworms	Cutworms	Green vegetable bugs	Heliothis	Jassids	Rutherglen bugs	Grey cluster bugs	Wireworms and false wireworms (1 m rows)
esfenvalerate 250 g/L EC	Sumi-Alpha Flex				0.13–0.33❸				
gamma-cyhalothrin 150 g/L CS	Trojan				60 or 70 mL❹		30 mL	30 mL	
lamda-cyhalothrin 250 g/L CS	Flipper 250 CS				60 or 70 mL❺		36 mL	36 mL	
	Karate (Zeon Tech)				60 or 70 mL❺		36 mL	36 mL	
	Kung Fu 250				60 or 70 mL❺		36 mL	36 mL	
	Matador (Zeon Tech)				60 or 70 mL❺		36 mL	36 mL	
methidathion 400 g/L EC	Suprathion 400 EC						1.0	1.0	
methomyl 225 g/L SL	Electra 225			1.5–2.0	1.5–2.0❻				
	Lannate-L			1.5–2.0	1.5–2.0❻				
	Marlin			1.5–2.0	1.5 or 2.0❻				
	Methomyl 225			1.5–2.0	1.5–2.0❻				
	Nudrin 225			1.5–2.0	1.5–2.0❻				
nuclear polyhedrosis virus (NPV) 2 thousand million/mL (Obs)	Gemstar LC				0.375				
	Vivus Gold				0.375				
	Vivus Max				0.15				
trichlorfon 500 g/L SL	Dipterex 500 SL	1.2					1.1		
	Lepidex 500	1.1–1.3	1.2				1.1		
terbufos 150 g/kg GR	Counter 150 G								1.7–2.0 kg❼

* **Numerous other generic products are also registered.**

❸ Registered for southern NSW for *Helicoverpa punctigera* only. Registered for northern NSW at 0.4–0.5 L/ha. Use higher rate for corn earworm (*Helicoverpa armigera)*.

❹ Northern NSW rate for *H. punctigera*. Apply 40 or 50 mL/ha for corn earworms (*H. armigera*) in southern NSW.

❺ Northern NSW rate. Karate is registered in southern NSW at 48 or 60 mL/ha.

❻ Registered as an ovicide at 0.5–1.0 L/ha.

❼ Rate per 100 m of row. Use the higher rate in areas known to have regular wireworm problems. Adjust the application rate for other row spacings using 17–20 g per 100 m of row.

Table 35. Winter cereals – pests

Insect	Threshold	Crop growth stage	Crop damage	Comments	Frequency
Aphids (corn aphids, oat aphids)	More than 15 aphids per tiller on 50% of tillers if the expected yield will exceed 3 t/ha.	Varies from 2–3 leaf stage through to heading. Potential for damage is higher if present during tillering than after booting.	Divert carbohydrates and transmit *Barley yellow dwarf virus*. Hot spots of high aphid numbers are seen in winter months.	Look for infestations in leaf sheath of young plants. Aphids move in from surrounding pasture areas. Aphids are attracted to early sown crops. Look for presence of predators.	Intermittent
Armyworms	2–3 caterpillars per m^2.	Normally attack ripening crops but can defoliate plants during earlier growth stages.	Initially eat lower leaves on plant. Move to heads when ripe. Chew through parts of head which drop onto ground. Prefer oats and barley.	Look for presence of caterpillars during evening or at night. More numerous in heavy areas of crop. Larvae size in relation to crop stage should be considered before spraying. Spray late afternoon or evening for best results.	Barley–Annual Wheat–Intermittent
Australian plague locusts	Presence of locusts in or near crops.	Seedling through to maturity.	Eat young seedlings in autumn and chew off ripening heads in spring.	If locusts are seen, contact your local Livestock Health and Pest Authority.	Rarely
Blue oat mites (BOM) and redlegged earth mites (RLEM)	Oats more susceptible than barley or wheat. Spray if growth is retarded.	1–5 leaf stage. Most severe on newly emerged crops.	Cause greyish and silvery streaks by rasping and sucking sap. Tips of leaves turn brown.	BOM cause more severe damage to cereals. Crop damage usually observed from 10–14 days after autumn break.	Annual
Brown wheat mites	Treat before damage becomes severe. Damage occurs during abnormally dry/warm conditions in autumn/spring.	From seedling to flowering.	Pierce leaves, suck sap. Leaves have bronzed or yellowish appearance.	Control does not always produce economic improvements in yield. Mature mites are 0.5–0.7 mm long. Immature mites are orange/red colour.	Rarely
Curculionid larvae	Usually patchy in occurrence. Treatment after sowing not effective.	Seedling.	Larvae feed on germinating seed. Bore into underground stems, kill growing points.	Examine soil before sowing. Use treated seed if present.	Rarely
Cutworms	Usually in large numbers in patches moving in from edges. Treat at first sign of damage.	1–2 leaf stage through plant tillering.	Eat leaves and stems, cut off plants at ground level or underground. Most feeding evening and night. Caterpillars hide in soil during day.	Inspect crops in late evening or night for presence of large dark grey-green caterpillar. Spray late in afternoon. Caterpillars hide in soil during the day.	Rarely
False wireworms	Presence of caterpillars before sowing. No after-sowing treatment.	Newly emerged seedling.	Feed on seed and underground stems and roots of young plants. Plants wither and die.	Vary from 8–40 mm in length. Check at junction of loose cultivated soil and undisturbed soil.	Rarely
Spur-throated locusts	Presence of locusts in or near crops.	Seedling through to maturity.	Eat young seedlings in autumn and winter and chew off ripening heads in spring.	If locusts are seen, contact your local Livestock Health and Pest Authority.	Rarely
White curl grubs (scarab grubs)	No after sowing treatment. Treat if 2–5 larvae per m^2. Treat seed before sowing.	Seedling from 2–5 leaves.	Feed on roots and underground stems. Often appear moisture stressed and unthrifty. Cause stunting and death of seedlings. Often seen as bare patches around trees.	Larvae curl up in semi-circle 20–60 mm long. Treat seed or fertiliser before sowing. Check near trees in paddocks. More common after pasture and in wetter seasons.	Intermittent
Wireworms	Presence of larvae before sowing. No post-sowing treatment.	Larvae feed on germinating seed. Bore into stem of young seedling.	Kills seedling by destroying growing points. Damage is more severe under dry cool growing conditions.	Wireworm numbers can be reduced by clean cultivation in summer and autumn. Wireworms are present in the top 50 mm of moist soil. Treat seed prior to sowing.	Rarely

Table 36. Winter cereals – pesticide use (litres per ha)

Chemical formulation	Registered trade names	Aphids	Armyworms	Blue oat mites	Cutworms	Heliothis	Lucerne fleas	Pasture webworms	Redlegged earth mites	Rutherglen bugs
alpha-cypermethrin*										
100 g/L EC	Alpha-Scud Elite	0.125	0.24	50 mL	75 or 150 mL			75 mL	50 mL❶	
	Astound Duo	0.125	0.24	50 mL	75 or 150 mL			75 mL	50 mL❶	
	Dictate Duo	0.125	0.24	50 mL	75 mL			75 mL	50 mL❶	
	Dominex Duo	0.125	0.24	50 mL	75 mL or 150 mL			75 mL	50 mL❶	
	Fastac Duo	0.125	0.24	50 mL	75 mL or 150 mL			75 mL	50 mL❶	
250 g/L SC	Alpha Forte 250 SC	50 mL	96 mL	20 mL	30 mL			30 mL	20–40 mL	
Bacillus thuringiensis										
sub-species *kurstkai*	Delfin WG		25–100 g			25–100 g				
	DiPel DF		0.5–2.0 kg			0.5–2.0 kg				
	Full-Bac WDG		0.5–2.0 kg			0.5–2.0 kg				
sub-species *aizawai* strain GC-91	Bacchus WG		1.0–4.0 kg			1.0–4.0 kg				
beta-cyfluthrin*										
25 g/L EC	Bulldock Duo	0.5–1.0	0.4	0.2				0.1 or 0.2	0.2	
bifenthrin										
100 g/L EC	Arrow 100 EC❷❸			0.1				0.1	50–100 mL	
	Ospray Bifenthrin 100 EC❷❸			0.1				0.1	50–100 mL	
	Talstar 100 EC❷❸			0.1				0.1	50–100 mL	
250 g/L EC	Talstar 250 EC❹			40 mL				40 mL	20–40 mL	
carbaryl										
500 g/L SC	Bugmaster Flowable		1.8–2.2		1.8–2.2	1.8–2.2				1.8–2.2
	Carbaryl 500 Flowable		1.8–2.2		1.8–2.2	1.8–2.2				1.8–2.2
chlorpyrifos*										
500 g/L EC	Conquest Chlorpyrifos 500 EC		0.7–0.9	0.7–0.14	0.9		70 mL	0.7	0.7–0.14	
	Cyren 500 EC		0.7–0.9	0.14–0.3	0.9		70 mL	0.7	0.14–0.3	
	Lorsban 500 EC		0.7 or 0.9	0.14–0.3	0.9		70 mL	0.7	0.14–0.3	
	Strike-Out 500 EC		0.7–0.9	0.14–0.3	0.9		70 mL	0.7	0.14–0.3	
cypermethrin*										
200 g/L EC	Cypershield 200		0.17	50–75 mL	75 mL				50–75 mL	
	Scud Elite		0.17	50–75 mL	75 mL				50–75 mL	
	Titan Cypermethrin 200		0.17							
260 g/L EC	Cypermethrin 260 EC				60 mL					

* **Numerous other generic products are also registered.**
❶ Registered at 100 mL/ha for infested paddocks prior to crop emergence. Apply by ground rig only to moist soil. Do not apply as a ULV application.
❷ Registered for wheat and barley only.
❸ Also registered for bryobia mites at 0.2 L/ha. Apply to bare soil. Also registered for brown pasture loopers (*Ciampa arietaria*) at 50–100 mL/ha.
❹ Also registered for bryobia mites at 80 mL/ha. Apply to bare soil. Also registered for brown pasture loopers (*Ciampa arietaria*) at 20–40 mL/ha.

Table 36. Winter cereals – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Armyworms	Blue oat mites	Cutworms	Heliothis	Lucerne fleas	Pasture webworms	Redlegged earth mites	Rutherglen bugs
deltamethrin										
27.5 g/L EC	Ballistic Elite		0.5		0.2	0.5				
	D-Sect EC		0.5		0.2	0.5				
	decis options EC		0.5		0.2	0.5				
5.5 g/L ULV	Deltaguard ULV		2.0–2.5		1.0	2.5				
diazinon										
800 g/L EC	Barmac Diazinon		1.0		1.0					
	Country Diazinon 800		1.0		1.0					
	David Gray's Diazinon 800		1.0		1.0					
esfenvalerate										
50 g/L EC	Sumi-Alpha Flex	0.1–0.3		50–70 mL❺		0.13–0.3❻			50–70 mL❺	
gamma-cyhalothrin										
150 g/L CS	Trojan❼	10 or 15 mL			10 or 15 mL				8 mL❽	
lambda-cyhalothrin										
250 g/L EC	Flipper 250 CS❾				12 or 18 mL			12 mL	9 mL	
	Karate (Zeon Tech)❾	12 or 18 mL			12 or 18 mL			12 mL	9 mL	
	Kung-Fu 250❾	12 or 18 mL			12 or 18 mL			12 mL	9 mL	
	Matador (Zeon Tech)❾	12 or 18 mL			12 or 18 mL			12 mL	9 mL	
maldison										
1169 g/L ULV	Fyfanon ULV		0.7				0.225		0.225	
methidathion										
400 g/L EC	Suprathion 400 EC		1.4	90 mL❿			90 mL❿		90 mL❿	

* Numerous other generic products are also registered.
❺ Also registered at 100 mL/ha as a bare earth application. Apply prior to crop emergence.
❻ Registered for native budworm (*Helicoverpa punctigera*) in southern NSW only.
❼ Registered for wheat and barley only. Also registered for pasture webworm at 10 mL/ha applied pre-seeding or post-crop emergence. See label for details.
❽ Registered rate may not control blue oat mites.
❾ Registered for wheat and barley only. Also registered for blackheaded pasture cockchafers (*Aphodius tasmaniae*) at 20 or 40 mL/ha and aphids (*Rhopalosiphum* spp.) at 12 or 18 mL/ha.
❿ Also registered at 0.2 L/ha as a ground spray immediately prior to seedling emergence.

Table 36. Winter cereals – pesticide use (litres per ha) (continued)

Chemical formulation	Registered trade names	Aphids	Armyworms	Blue oat mites	Cutworms	Heliothis	Lucerne fleas	Pasture webworms	Redlegged earth mites	Rutherglen bugs
methomyl*										
225 g/L SL	Electra 225		1.0 or 1.5			1.5–2.0				
	Lannate-L		1.0–1.5			1.5–2.0				
	Marlin		1.0 or 1.5			1.5–2.0				
	Methomyl 225		1.0 or 1.5			1.5–2.0				
	Nudrin 225		1.0–1.5			1.5–2.0				
omethoate*										
290 g/L SL	All-Mitey 290 SL[12]			0.1			0.1		0.1[13]	
	Le-mat 290 SL[12]			0.1			0.1		0.1[13]	
	Mite Master 290[12]			0.1			0.1		0.1[13]	
	Omen 290[12]			0.1			0.1		0.1[13]	
	Omethoate 290 SL[12]			0.1			0.1		0.1[13]	
permethrin (40:60)										
500 g/L EC	Ambush[14]		0.1–0.2							
	Axe[14]		0.1–0.2							
	Hellfire 500 EC[14]		0.1–0.2							
	Permekil 500 EC[14]		0.1–0.2							
	Permerid 500 EC[14]		0.1–0.2							
	CropPro Pounce[14]		0.1–0.2							
	Stakeout EC[14]		0.1–0.2							
phosmet										
150 g/L	Imidan								0.25–0.35	
pirimicarb*										
500 g/kg WP	Aphidex 500 WP	0.15 kg[15]								
	Pirimicarb 500	0.15 kg[15]								
500 g/kg WG	Aphidex WG	0.15 kg[15]								
	Atlas WG	0.15 kg[15]								
	Pirimor 500 WG	0.15 kg[15]								
trichlorfon										
500 g/L SL	Dipterex 500 SL		1.2							
	Lepidex 500		1.2							

* **Numerous other generic products are also registered.**
[12] Also registered for bryobia mites at 0.12 L/ha.
[13] Also registered as a barrier spray for redlegged earth mites (*Halotydeus destructor*) at 0.3 L/ha.
[14] Registered for control of barley grubs (*Persectania ewingii*) at 0.1–0.2 L/ha.
[15] Registered for control of corn aphids (*Rhopalosiphum maidis*).

Table 37. Seed dressings for insect and mite control 2013

Example seed treatment trade name and manufacturer #	Active ingredient	Group	Rate to apply to each 100 kg of seed*	Approx cost to treat 100 kg ($) ##	Faba beans/ Lentils	Lupin	Field Pea	Canola	Linseed	Lucerne	Cereals	Sorghum	Sunflowers	Maize
Cosmos® – Cropcare	fipronil (500 g/L)	2C	400 mL (canola) 150 mL (sorghum, sunflowers)	336.60 126.30				Redlegged earth mite				False wireworm. Protection from black field earwig	False wireworm. Protection from black field earwig	
Senator® 600 Red – Cropcare Gaucho® 600 – Bayer CropScience	imidacloprid (600 g/L)	4A	400 mL (canola, lucerne) 300 mL (lupin) 120–240 mL (cereals) 1.4 mL/1000 seeds (maize) 430 mL (sorghum, sunflower, sweetcorn)	22.00 16.50 6.60–13.20 0.10/1000 seeds 23.70		Redlegged earth mite, blue oat mite		Redlegged earth mite, blue oat mite, aphids		Redlegged earth mite, blue oat mite	Feeding damage caused by wheat and corn aphid. Spread of BYDV	True wireworm (*Agrypnus variabilis*), eastern and southern false wireworm, striate false wireworm, black field earwig, wingless cockroach, field cricket, black sunflower scarab	True wireworm (*Agrypnus variabilis*), eastern and southern false wireworm, striate false wireworm, black field earwig, wingless cockroach, field cricket, black sunflower scarab	True wireworm (*Agrypnus variabilis*), eastern and southern false wireworm, striate false wireworm, black field earwig, wingless cockroach, field cricket, black sunflower scarab
Imidacloprid 600 – TitanAg	imidacloprid (600 g/L)	4A	400 mL (canola, lucerne) 300 mL (lupin) 120 or 240 mL (cereals) 1.4 mL/1000seeds (maize) 430 mL (sorghum, sunflower, sweetcorn)	34.50 25.90 13.20–26.35 0.12/1000 seeds 37.10		Redlegged earth mite, blue oat mite		Aphids		Redlegged earth mite, blue oat mite	Feeding damage caused by wheat and corn aphid. Spread of BYDV	True wireworm (*Agrypnus variabilis*), eastern and southern false wireworm, striate false wireworm, black field earwig, wingless cockroach, field cricket, black sunflower scarab	True wireworm (*Agrypnus variabilis*), eastern and southern false wireworm, striate false wireworm, black field earwig, wingless cockroach, field cricket, black sunflower scarab	True wireworm (*Agrypnus variabilis*), eastern and southern false wireworm, striate false wireworm, black field earwig, wingless cockroach, field cricket, black sunflower scarab
Gaucho 350® – Bayer Crop Science	imidacloprid (350 g/L)	4A	200 mL (fababeans) 400 mL (lentils) 100 mL (fieldpeas) 500 mL (lupins) 200–400 mL (cereals)	7.00 14.00 3.50 17.45 8.49–16.98	Aphids	Redlegged earthmite, blue oat mite	Aphids				Feeding damage caused by wheat and corn aphid. Spread of BYDV			
Zorro® – Bayer Crop Science	imidacloprid + triadimenol	4A	400 mL	11.45							Feeding damage caused by wheat and corn aphid. Spread of BYDV			
Hombre® – Bayer Crop Science	imidacloprid 180 g/L + tebuconazole 6.25 g/L	4A	400 mL	8.83							Feeding damage caused by wheat and corn aphid. Spread of BYDV			
Hombre® Ultra – Bayer CropScience	imidacloprid 360g/L + tebuconazole 12.5 g/L	4A	200 mL	9.00							Feeding damage caused by wheat and corn aphid. Spread of BYDV			
Veteran® Plus – Crop Care	imidacloprid 180 g/L + flutriafol 6.25 g/L	4A	400 mL	8.35							Feeding damage caused by wheat and corn aphid. Spread of BYDV			
Arrow® Plus – Crop Care	imidacloprid 180 g/L + flutriafol 25 g/L	4A	400 mL	12.00							Barley only. Feeding damage caused by wheat and corn aphid. Spread of BYDV			
Tri-Power® – Crop Care	imidacloprid 180 g/L + flutriafol 6.25 g/L + metalaxyl 30 g/L	4A	400 mL	12.92							Feeding damage caused by wheat and corn aphid. Spread of BYDV			

Table 37. Seed dressings for insect and mite control 2013 (continued)

Example seed treatment trade name and manufacturer #	Active ingredient	Group	Rate to apply to each 100 kg of seed*	Approx cost to treat 100 kg ($) ##	Faba beans/ Lentils	Lupin	Field Pea	Canola	Linseed	Lucerne	Cereals	Sorghum	Sunflowers	Maize
Cruiser 350 FS® – Syngenta	thiamethoxam (350 g/L)	4A	400 mL (sorghum) 260–400 mL (sorghum – corn aphids) 1.4 mL/1000 seeds (maize and sweetcorn) 0.31 mL/1000 seeds (sunflower)									Eastern and southern false wireworm, corn aphids. Protection from black field earwig and true wireworm (*Agrypnus variabilis*)	Eastern and southern false wireworm, true wireworm (*Agrypnus variabilis*)	Eastern, southern and striate false wireworm. Protection from true wireworm (*Agrypnus variabilis*)
Cruiser 600 FS® – Syngenta**	thiamethoxam (600 g/L)	4A	230 mL (sorghum) 0.18 mL/1000 seeds (sunflower) 0.82 mL/1000 seeds (maize and sweetcorn)	NA								Eastern and southern false wireworm. Protection from black field earwig and true wireworm (*Agrypnus variabilis*)	Eastern and southern false wireworm, true wireworm (*Agrypnus variabilis*)	Eastern, southern and striate false wireworm. Protection from true wireworm (*Agrypnus variabilis*)

* Check water rates on the label as they may vary.
** Only available to accredited applicators. Price is included in seed costs.
# Major products readily available in NSW. Other trade names may also be available.
Prices quoted are GST inclusive at January 2011 and approximate only. Prices will vary depending on product, pack size purchased, seed treatment services i.e. imidaclorprid + fluquinconazole, and special marketing arrangements
Caution: Observe stock witholding periods on crops produced from treated seed.

Table 38. Withholding periods (days)

Insecticides	Azuki beans	Canola	Chickpeas	Cowpeas	Faba beans	Field peas	Linseed	Lucerne*	Lupins	Maize	Millet	Mung-beans	Navy beans	Pigeon peas	Safflower	Sorghum	Soybeans	Sunflower	Winter cereals
4Farmers Dimethoate 400	14H	14H		14H 1G			14H	7H 7G	14H			14H	14H	14H 1G			7H	14H 1G	28H 1G
All-Mitey 290 SL		1H 1G	1H 1G		1H 1G	1H 1G	1H 1G	1H 1G	1H 1G										1H 1G
Alpha Forte 250 EC		21H 21G				28H	14H	14H 14G	28H	7H		7H	7H			7H	7H	21H	7H 14G
Alpha-Scud Elite		21H 21G	21H 35G		28H 35G	28H	14H	See label	28H	7H		7H	7H			7H	7H	21H	7H 14G
Ambush																			3H
Aphidex 500		14H 14G						3G	42H 42G										42H 42G
Arrow 100 EC		28G			28G	28G		28H 28G	28G				14H 14G						28G
Astound Duo		21H 21G	21H 35G		28H 35G	28H	14H	See label	28H	7H		7H	7H			7H	7H	21H	7H 14G
Axe						2H	7H												3H
Ballistic Elite	7H	7H	7H	7H	7H	7H	7H		7H	7H	7H	7H	7H	7H	7H	7H	7H	7H	7H
Barmac Diazinon								14H 2G		14H 2G						14H 2G			14H 2G
Bifenthrin 100 EC		28G			28G	28G		28G	28G				14H 14G						28G
BioCrystal	Withholding period not required when used as directed. When tank mixed, observe the withholding period of the other product.																		
Bugmaster Flowable								1G			1G					1G		1G	1G
Bulldock Duo		14H 14G	14H 7G		14H 7G	7H 7G		3H 3G	14H 7G				21H 14G			14H 14G			14H 7G
Carbaryl 500 Flowable								1G		1G	1G					1G		1G	1G
Carbaryl WP								1H 1G											
Chemag Dimethoate	See label																		
Confront 800 WG			21H 21G		21H 21G	21H 21G			21H 21G	7H 7G		21H 21G	21H 21G	21H 21G			21H 21G		
Chlorpyrifos 500		2G	2G		2G	2G	2G	2H 2G	2G	10H 2G					2G	2H 2G		See label	10H 2G
Conquest Dimethoate	See label	14G		See label	14H		14H	See label				7H	7H	See label	14H		7H	14H	28H 1G
Counter 150 G	Withholding period not required when used as directed.																		
Country Diazinon 800		14H 14G					14H 14G	14H 14G		14H 14G					14H 14G	14H 14G			14H 14G
Cypermethrin 250 EC						28H 28G				7H		7H	7H			14H	7H	21H	7H 49G
Cypermethrin 260 EC						28H 28G				7H		7H	7H			14H	7H	21H	7H 49G
Cypermethrin 40 ULV												7H	7H			7H	7H	21H	
Cypershield 200						28H				7H		7H	7H			14H	7H	14H	
Cypershield ULV 40										21H		7H	7H			14H	7H	21H	
Cyren 500 EC		See label	See label		See label	See label		2G	See label	10H 2G	10H 2G					2H 2G			10H 2G
Danadim	7H	14H		7H		7H	14H	See label		28H		7H	7H	14H	14H		7H	14H	28H 1G
David Gray's Diazinon 800								14H 14G		14H 14G						14H 14G			14H 14G
D-Sect EC		7H	7H		7H	7H	7H		7H			7H	7H		7H	7H	7H	7H	7H
decis options	7H	7H	7H	7H	7H	7H	7H		7H	7H	7H	7H	7H	7H	7H	7H	7H	7H	7H
Delta-Duo										7H		7H	7H			7H		7H	
Deltaguard ULV		7H	7H		7H	7H	7H		7H	7H	7H	7H	7H		7H	7H	7H	7H	7H
Diazinon								14H 2G		14H 2G						14H 2G			
Diazol 800								14H 2G		14H 2G									
Dictate Duo		21H				28H	14H	See label	28H	7H		7H	7H			7H	7H	21H	21H
DiPel SC	Withholding period not required when used as directed. When tank mixed, observe the withholding period of the other product.																		
DiPel DF	Withholding period not required when used as directed. When tank mixed, observe the withholding period of the other product.																		
Dipterex 500 SL							2H		2H								2H	2H	2H
Disulfoton 50								70H 70 G											
Dominex Duo		21H 21G	21H 35G		28H 35G	28H	14H	See label	28H	7H		7H	7H			7H	7H	21H	7H 14G
DuPont Steward			28H 28G									28H 28G					28H 28G		

Maximum withholding periods are expressed where withholding periods vary due to targeted pest and application rates. Check label. Some labels do not specify withholding periods for either grazing or harvest. Check with manufacturer for details.
* Lucerne withholding period may vary with: (a) Its role as seed crop or hay production. (b) Pesticide application rate. Check label. ** Do not graze or cut for stockfeed. H – Harvest. G – Grazing. NR – Not required when used as directed.
If the crop is to be cut for stockfeed do not sell any stock that have been fed cut material for export slaughter until the Export Slaughter Interval (ESI) has been observed. The ESI is the minimum period that must elapse between the removal of grazing livestock to clean pasture or clean feed and slaughter.

Table 38. Withholding periods (days) (continued)

Insecticides	Azuki beans	Canola	Chickpeas	Cowpeas	Faba beans	Field peas	Linseed	Lucerne*	Lupins	Maize	Millet	Mung-beans	Navy beans	Pigeon peas	Safflower	Sorghum	Soybeans	Sunflower	Winter cereals
Electra 225	7H	7H		7H		7H		3H	7H	14H		7H	1H			14H 14G	7H	7H	14H 14G
Fastac Duo		21H 21G	21H 35G		28H 35G	28H	14H	See label	28H	7H		7H	7H			7H	7H	21H	7H 14G
Flipper 250 CS		7H 7G	7H 7G		7H 7G	7H 7G		14H 14G	14H 14G			See label	See label			14H 14G	21H	28H	14H 14G
Full-Bac WDG	Withholding period not required when used as directed. When tank mixed, observe the withholding period of the other product.																		
Fyfanon 440 EW								1H											
Fyfanon ULV			1H		1H	1H		1H	1H	1H						1H			1H
Gemstar LC	Withholding period not required when used as directed. When tank mixed, observe the withholding period of the other product.																		
Hellfire 500 EC																			3H
Hunter	Withholding period not required when used as directed.																		
Imidan								2G											7G
Karate (Zeon Tech)		7H 7G	7H 7G		7H 7G	7H 7G		14H 14G	14H 14G			See label	See label			14H 14G	21H 21G	28H	14H 14G
Larvin 375			21H 21G							7H 7G		21H 21G	21H 21G	21H 21G			21H 21G		
Larvin 800 WG		7H 21G	21H 21G							7H 7G		21H 21G	21H 21G	21H 21G			21H 21G		
Le-mat 290 SL		1H 1G	1H 1G		1H 1G	1H 1G	1H 1G	1H 1G	1H 1G						1H 1G				1H 1G
Lepidex 500							2H		2H						2H		2H	2H	2H
Lorsban 500 EC		10H 2G	2H 2G		2H 2G	2H 2G	10H 2G	2H 2G	2H 2G						10H 2G	2H			10H 2G
Marlin	7H	7H		7H		7H		3G	7H			7H				14H 14G	7H	7H	14H 14G
Matador (Zeon Tech)		7H 7G	7H 7G		7H 7G	7H 7G		14H 14G	14H 14G			See label	See label			14H 14G	21H 21G	28H	14H 14G
Mite Master 290		1H 1G	1H 1G		1H 1G	1H 1G	1H 1G	1H 1G	1H 1G										1H 1G
Monitor								42H 42 G											
Nudrin 225	7H	7H	7H	7H		7H		3G	7H	14H 14G		7H		7H		14H 14G	7H	7H	14H 14G
Nufarm Chlorpyrifos 500 EC		10H 2G	10H 2G		10H 2G	10H 2G	10H 2G	2H 2G	10H 2G	10H	10H 2G				10H 2G	2H 2G		10H 2G	10H 2G
Nufarm Dimethoate	14H			14H			14H	1G				14H	7H	14H	14H			14H	28H 1G
Nufarm Maldison								1H 1G											1H 1G
Omen 290		1H 1G	1H 1G		1H 1G	1H 1G	1H 1G	1H 1G	1H 1G						1H 1G				1H 1G
Permekil EC																			3H
Permerid 500 EC		14H					7H												3H
Permethrin 500																			3H
Pirimicarb 500		14H 14G						3G	42H 42G										42H 42G
Pirimor WG		14H 14G						3G	42H 42G										42H 42G
Pounce																			3H
Saboteur		14H		14H			14H	1G 1H				14H	See label		14H		7H	14H	28H 1G
Scud Elite		See label	21H 35G			28H			28H	7H		7H	7H			14H	7H	21H	21H 35G
Showdown 375			21H 21G							7H 7G		21H 21G	21H 21G	21H 21G			21H 21G		
Stakeout EC																			3H
Steward EC	21H 21G		21H 21G		21H 21G							21H 21G					21H 21G		
Strike-Out 500 EC		10H 2G	10H 2G		10H 2G	10H 2G	See label	See label		10H 2G					10H 2G	2H 2G		See label	10H 2G
Sumi-Alpha Flex		14H 7G	14H 7G			14H 7G	14H 7G	7G	14H 7G	7H 7G			14H 7G	14H 7G	14H 7G	7H 7G	14H 7G	14H 7G	7H 7G
Summit Chlorpyrifos 500 EC		10H 2G					10H 2G	10H							10H 2G				See label
Suprathion 400 EC		7H					7H	See label							7H			See label	See label
Talstar 100 EC		28G			28G	28G		28H 28G	28G				14H 14G						28G
Trojan		2H 7G	2H 7G		2H 7G	2H 7G		14H 14G	7H 14G			7H 14G	7H 14G			7H 14G	21H 21G	28H	7H 14G
Vivus Gold	Withholding period not required when used as directed.																		
Wizard 18 EC																	28H 28G		

Maximum withholding periods are expressed where withholding periods vary due to targeted pest and application rates. Check label. Some labels do not specify withholding periods for either grazing or harvest. Check with manufacturer for details.
* Lucerne withholding period may vary with: (a) Its role as seed crop or hay production. (b) Pesticide application rate. Check label. ** Do not graze or cut for stockfeed. H – Harvest. G – Grazing. NR – Not required when used as directed.
If the crop is to be cut for stockfeed do not sell any stock that have been fed cut material for export slaughter until the Export Slaughter Interval (ESI) has been observed. The ESI is the minimum period that must elapse between the removal of grazing livestock to clean pasture or clean feed and slaughter.

Table 39. Winter crop herbicide/insecticide compatibilities

This chart is a guide only. Read both product labels if using a mixture

FORMULATION	ACTIVE	PRODUCT	ACHIEVE®	ALLY®	ALPHA CYPERMETHERIN	AMICIDE® 625	ATLANTIS®	AVADEX®	AXIAL®	BASAGRAN	BIFENTHRIN	BLADEX®	BRAVO®	BROADSTRIKE™	BRODAL®	BROMICIDE® 200	BROMICIDE® MA	BUCTRIL® MA	BUTRESS®	CADENCE®	CHEETAH® GOLD	CHLORPYRIFOS	CONCLUDE™	CORRECT®	CRUSADER™	DECISION®	DELTAMETHRIN	DITHANE™	DIURON
water dispersible granule	tralkoxydim	Achieve® Herbicide		N											C		C			N									
suspension concentrate	terbutryn + MCPA as K salt	Agtryne® MA	N	C																									
water dispersible granule	metsulfuron-methyl	Ally® Herbicide	N											C		C	C			C			C		C				C
soluble concentrate	2,4-D as dea/dma	Amicide® 625																											C
suspension concentrate	mesosulfuron-methyl + mefenpyr-diethyl	Atlantis® OD																C				N							
emulsifiable concentrates	tri-allate	Avadex® Xtra																											
emulsifiable concentrates	pinoxaden + cloquintocet-mexyl	Axial®																											
water dispersible granule	isoxaflutole	Balance® 750 Herbicide																											C
water dispersible granule	cyanazine	Bladex® 900 Herbicide																											
emulsifiable concentrates	prosulfocarb +S-metolachlor	Boxer Gold®		C	C	C					C											C							
suspension concentrate	chlorothalonil	Bravo® Fungicide																											
water dispersible granule	flumetsulam	Broadstrike™ Herbicide		C											C	C	C		C										C
suspension concentrate	diflufenican	Brodal® Options Herbicide	C											C		C													
emulsifiable concentrate	bromoxynil noe	Bromicide® 200 Herbicide		C										C	C								C		C				
emulsifiable concentrate	bromoxynil + MCPA noe	Bromicide® MA Herbicide	C	C										C									C	N	C				
soluble concentrate	2,4-DB dma (amine)**	Buttress®												C										N					C
water dispersible granule	dicamba as Na salt**	Cadence® Herbicide	N	C																			C		N				C
emulsifiable concentrates	diclofop-methyl + sethoxydim +fenoxaprop-P-ethyl + others	Cheetah® Gold												C				C											
suspension emulsion	florasulam + MCPA	Conclude™		C												C	C	C		C									
emulsifiable concentrate	propaquizafop	Correct®/Shogun® 100 Herbicide															N		N										
oil dispersible liquid	cloquintocet-mexyl + pyroxsulam	Crusader™		C												C	C			N		N							
emulsifiable concentrates	diclofop-methyl + sethoxydim + mefenpyr-diethyl	Decision®	N	N																									
wettable powder	mancozeb**	Dithane™ M-45® Fungicide																											
suspension concentrate	diuron*	Diuron Liquid Herbicide		C										C					C	C									
emulsifiable concentrates	S-metolachlor	Dual Gold®								C																			
emulsifiable concentrate	oryzalin + trifluralin	Duet® 250 Herbicide																											
water dispersible granule	metosulam	Eclipse® Herbicide	C	C											C	C	C			C	C								C
suspension concentrate	pyraflufen-ethyl	Ecopar®	N	C																									
emulsifiable concentrate	alpha-cypermethrin	Fastac Duo® Insecticide	C												C				C									C	
soluble concentrate	imazapic as ammonium	Flame®		C		C														N									
emulsifiable concentrate	picolinafen + bromoxynil + MCPA	Flight® EC		C												C													
emulsifiable concentrate	fluazifop*	Fusilade® Herbicide																											
emulsifiable concentrate	triclopyr	Garlon™ 600																											
suspension concentrate	atrazine*	Gesaprim® 600 Herbicide																		C									C
suspension concentrate	simazine*	Gesatop® 600 Herbicide												C	C														C
wettable powder	chlorsulfuron	Glean® Herbicide		N				C								C	C			C									C
emulsifiable concentrate	oxyfluorfen	Goal® Herbicide																											
soluble concentrate	paraquat	Gramoxone® 250 Herbicide						C						C															C
emulsifiable concentrate	triclopyr + picloram + aminopyralid	Grazon™ Extra Herbicide		C																									
emulsifiable concentrates	carfentrazone-ethyl	Hammer®				C																							
water dispersible granule	thifensulfuron-methyl + metsulfuron-methyl	Harmony® M Herbicide	N																										
emulsifiable concentrate	diclofop	Hoegrass® 500 Herbicide		N										C		C	C	C											
emulsifiable concentrates	aminopyralid as tipa +fluroxypyr as mhe	Hotshot™		C																					C				
water dispersable granules	iodosulfuron-methyl-Na +mefenpyr-diethyl	Hussar®		N			N							N			N	N				N							
suspension concentrate	terbutryn	Igran® 500 Herbicide		C										C						C					N				
emulsifiable concentrate	phosmet	Imidan® Insecticide	C																C										
soluble concentrate	imazamox as ammonium +imazapyr as ammonium	Intervix®																											
emulsifiable concentrate	bromoxynil octanoate	Jaguar® Herbicide		C		N	C							C					C	C				N					

C = Compatible. N = Not compatible. Where there is a blank compatibility is not known, contact the manufacturer. Compatibility is dependent upon use pattern (both crop and weeds), rate, surfactant/compatibility agent and temperature. Water quality also affects compatibility. Mixtures generally require greater agitation. Mixing more than two chemicals affects compatibility and is not recommended. This chart only indicates which chemicals are compatible in mixtures at the time of compilation (4/13). Read the compatibility and crop safety sections of both labels before mixing. Mixing chemicals is at the user's own risk. * WG formulations also available; check labels for compatibilities. ** Other formulations also available; check labels for compatibilities. *** DO NOT mix with selective grass herbicides. **** Check label for compatible mixing rates and effect on weeds.

Table 39. Winter crop herbicide/insecticide compatibilities (continued)

PRODUCT	ECLIPSE®	FASTAC DUO®	FUSILADE®	TORDON™	GESAPRIM®	GESATOP®	GLEAN®	GOAL®	GRAMOXONE®	GRAZON™	HAMMER®	HARMONY®	HOEGRASS®	HOTSHOT™	HUSSAR® OD	IGRAN®	IMIDAN®	JAGUAR®	KAMBA® 500	KAMBA® M	KARATE®	LE-MAT®	LOGRAN®	LOGRAN® B-POWER	LONTREL™	LORSBAN™	LVE MCPA	MATAVEN®	MCPA 500	MONZA®	OMETHOATE	ONDUTY®	PARAGON®	PROMETRYN 900DF	RAPTOR®	ROUNDUP® CT	ROUNDUP® DRY	ROUNDUP POWERMAX™	SELECT®	SENCOR®	SERTIN®	SNIPER®	SPINNAKER®	SPRAYSEED®	STARANE™	STOMP®	SUPRACIDE®	SURPASS®	TALSTAR®	TARGA®	TERBYNE®	TIGREX®	TOPIK®	TORDON™ 242	TORDON™ 750	TREFLAN™	TRISTAR® ADVANCE	VERDICT™ 520	WILDCAT®
Achieve® Herbicide	C	C										N					C		N	N					C		C		N																	N				C		N	N				
Agtryne® MA													N																																													
Ally® Herbicide	C						N			C			N	C		C		C	C	C		C			C	C	C	N	C				C			C	C	C						C	C			C				C	C	C	C		N		C
Amicide® 625							C												C																									C															
Atlantis® OD																		C				C			C		C																								C								
Avadex® Xtra																														C						C		C																					
Axial®																																																											
Balance® 750 Herbicide						C			C																														C				C	C											N			
Bladex® 900 Herbicide																																				C	C	C				C	C		C										C			
Boxer® Gold											C										C		C	C											C		C						C			C									C			
Bravo® Fungicide																										C																						C											
Broadstrike™ Herbicide						C			C				C			C		C				C			C	C	C		C												N		C		C	C			C				C	C		C	C	C	C
Brodal® Options Herbicide	C	C				C																C							C										N	C	C		C						C	C			C					N	
Bromicide® 200 Herbicide	C						C						C						C			C	C			C	C		C							C	C	C										C				C							
Bromicide® MA Herbicide	C						C						C						C			C			C	N			C												N																N	N	N
Buttress®		C															C	C				C			C																				C						C								
Cadence® Herbicide	C				C		C									C		C					C			N	C		C							C	C	C						C				C				C							
Cheetah® Gold	C																	C				C			C		C		N																						C							
Conclude™																				C					C		C		C		N														C													
Correct® 100 Herbicide																				N		C					N		N				N						C	N	C							N				N		N	N				
Crusader™														C		N			N	N					C	N	C		N																													
Decision®															N												C																								C							
Dithane™ M-45® Fungicide		C																																													C										C	
Diuron Liquid Herbicide	C				C	C	C		C										C						C	C	C		C														C	C		C		C					N			C			
Dual Gold®					C																		C													C								C															
Duet® 250 Herbicide									C																											C	C	C						C															
Eclipse® Herbicide													C	C		C		C							C		C		C									C				C			C			C				C	C	C	C		C		C
Ecopar®													N										C						C																							N				N		N	
Fastac Duo® Insecticide						C			C									C	C							C	C		C			C	C		C	C	C	C	C			C	C	C				C				C							
Flame®				C	C				C										N																	C		C						C		C													
Flight® EC		C					C						C										C		C		C																									C				C		C
Fusilade® Herbicide																	C	C																					C		C										C							
Tordon™ 600 Herbicide					C																				C	C										C	C	C							C			C										
Gesaprim® 600 Herbicide				C					C										C							C										C	C	C						C	C	C		C							C			C	
Gesatop® 600 Herbicide		C							C									C																C	C	C	C	C				C	C			C		C				C				C		C	
Glean® Herbicide									C				N	C				C	C	C		C			C	C	C	C	C				C			C	C	C						C				C	C			C			C	N		N
Goal® Herbicide									C																											C		C						C															
Gramoxone® 250 Herbicide		C			C	C	C	C								C		C	C	C					C	C			C															C		C		C			C	C			C			
Grazon™ DS Herbicide																																				C								C			C											
Hammer®																							C													C		C						C		C										C			
Harmony® M Herbicide																												N																															C
Hoegrass® 500 Herbicide	C						N										C	C				C			C	C	C				C		C												C						C	C	C					C
Hotshot™	C						C																				C									C		C						C									C						
Hussar®	N						N									N							N	N	C		N			N		N													C						N								
Igran® 500 Herbicide	C																		C	C			C		C		C		C												N							C	C										
Imidan® Insecticide			C						C				C																C				C			C		C						C				C											
Intervix®		C																				C			C														C																				
Jaguar® Herbicide	C	C	C			C	C		C				C					N				C			C	C	C																					N	C	C			C				C	N	C

Table 39. Winter crop herbicide/insecticide compatibilities

This chart is a guide only. Read both product labels if using a mixture

FORMULATION	ACTIVE	PRODUCT	ACHIEVE®	ALLY®	ALPHA CYPERMETHERIN	AMICIDE® 625	ATLANTIS® OD	AVADEX®	AXIAL®	BASAGRAN	BIFENTHRIN	BLADEX®	BRAVO®	BROADSTRIKE™	BRODAL®	BROMICIDE® 200	BROMICIDE® MA	BUCTRIL® MA	BUTRESS®	CADENCE®	CHEETAH® GOLD	CHLORPYRIFOS	CONCLUDE™	CORRECT®	CRUSADER™	DECISION®	DELTAMETHERIN		DITHANE™	DIURON
soluble concentrate	dicamba dma	Kamba® 500 Herbicide	N	C												C	C						C		N					C
soluble concentrate	dicamba dma + MCPA dma	Kamba® M Herbicide	N	C																				N	N					
soluble concentrate	omethoate	Le-Mat® 290 Insecticide		C										C	C	C	C		C					C						
water dispersible granule	triasulfuron	Logran® 750 Herbicide		C				C								C				C										
water dispersable granules	butafenacil + triasulfuron	Logran® B Power																												
soluble concentrate	clopyralid**	Lontrel™ Herbicide	C	C										C		C	C						C		C					C
emulsifiable concentrate	chlorpyrifos*	Lorsban™ 300/500 Insecticide		C									C	C		C	N			N			C		N			C		C
emulsifiable concentrate	MCPA ioe (ester)**	LVE MCPA	C	C										C		C				C			C	N	C					C
emulsifiable concentrates	2,4-D as ehe	LV Ester 600		C																										
emulsifiable concentrate	flamprop-M-methyl	Mataven® 90 Herbicide		N																										
soluble concentrate	MCPA dma (amine)**	MCPA 500 Herbicide	N	C										C	C	C	C			C			C	N	N			C		C
emulsifiable concentrates	MCPA + Imazapic + Imazapyr	Midas®																										C		
water dispersable granules	sulfosulfuron	Monza®	N					C												N								N		
emulsifiable concentrate	picolinafen + MCPA ehe (ester)	Paragon® Herbicide		C																				N				C		
emulsifiable concentrates	pyrasulfotole +MCPA as 2-ehe +mefenpyr-diethyl	Precept® 300	C	C		N	C		C												C				C	C		C		
water dispersible granule	prometryn	Prometryn 900DF																												
water dispersible granule	imazamox***	Raptor® Herbicide																										C		
soluble concentrate	glyphosate dual salt**	Roundup® DST® Herbicide		C												C				C								C		
water soluble granules	glyphosate mas**	Roundup® Dry Herbicide		C												C				C								C		
soluble concentrate	glyphosate as K salt**	Roundup® Attack™ Herbicide		C				C								C				C								C		
water soluble granules	pyroxasulfone	Sakura®		C				C												C										C
emulsifiable concentrate	clethodim	Status® Herbicide													N									C						
suspension concentrate	metribuzin*	Sencor® 480 Herbicide													C									N						
water dispersible granule	picolinafen	Sniper® Herbicide																										C		
water dispersible granule	imazethapyr***	Spinnaker® 700 Herbicide										C		C	C													C		C
soluble concentrate	paraquat + diquat	Spray.Seed® 250 Herbicide		C				C												C										C
emulsifiable concentrate	fluroxypyr	Starane™ Herbicide		C										C					C				C							
emulsifiable concentrate	pendimethalin**	Stomp® 330 Herbicide						C						C																C
emulsifiable concentrate	methidathion	Supracide® 400 Insecticide																												
soluble concentrate	2,4-D ipa (amine)**	Surpass® 300 Herbicide	N	C												C				C				N				C		C
emulsifiable concentrate	bifenthrin**	Talstar® 100 Insecticide											C	C	C														C	
emulsifiable concentrate	quizalofop**	Targa® Herbicide													C													C		
water dispersible granule	terbuthylazine	Terbyne®																												
emulsifiable concentrate	diflufenican + MCPA ehe (ester)	Tigrex® Herbicide	C	C			C									C			C	C	C	C		N				C		
emulsifiable concentrate	clodinafop	Topik® 240 Herbicide		C										C	C									N						N
soluble concentrate	MCPA + picloram as K salts	Tordon™ 242 Herbicide	N	C										C										N				C		
soluble concentrate	2,4-D + picloram as tipa (amine)	Tordon™ 75D Herbicide	N	C										C										N						
suspension concentrate	clopyralid as mea + florasulam	Torpedo™		C												C	C	C												
emulsifiable concentrate	trifluralin	Treflan™ Herbicide						C				C		C																C
emulsifiable concentrate	diclofop + fenoxaprop	Tristar® Advance Herbicide		N										C														C		
water dispersible granule	flumioxazin	Valor®																												
emulsifiable concentrate	bromoxynil + pyrasulfotole	Velocity® ****		C			C		C												C					C				
emulsifiable concentrate	haloxyfop	Verdict™ 520 Herbicide												C			N											C	C	
emulsifiable concentrate	fenoxaprop + mefanpyr-diethyl	Wildcat® Herbicide		C										C			N	N												

C = Compatible. N = Not compatible. Where there is a blank compatibility is not known, contact the manufacturer. Compatibility is dependent upon use pattern (both crop and weeds), rate, surfactant/compatibility agent and temperature. Water quality also affects compatibility. Mixtures generally require greater agitation. Mixing more than two chemicals affects compatibility and is not recommended. This chart only indicates which chemicals are compatible in mixtures at the time of compilation (4/13). Read the compatibility and crop safety sections of both labels before mixing. Mixing chemicals is at the user's own risk. * WG formulations also available; check labels for compatibilities. ** Other formulations also available; check labels for compatibilities. *** DO NOT mix with selective grass herbicides. **** Check label for compatible mixing rates and effect on weeds.

Table 39. Winter crop herbicide/insecticide compatibilities (continued)

PRODUCT	ECLIPSE®	FASTAC DUO®	FUSILADE®	TORDON™	GESAPRIM®	GESATOP®	GLEAN®	GOAL®	GRAMOXONE®	GRAZON™	HAMMER®	HARMONY®	HOEGRASS®	HOTSHOT™	HUSSAR®	IGRAN®	IMIDAN®	JAGUAR®	KAMBA® 500	KAMBA® M	KARATE®	LE-MAT®	LOGRAN®	LOGRAN® B-POWER	LONTREL™	LORSBAN™	LVE MCPA	MATAVEN®	MCPA 500	MONZA®	OMETHOATE	ONDUTY®	PARAGON®	PROMETRYN 900DF	RAPTOR®	ROUNDUP® CT	ROUNDUP® DRY	ROUNDUP POWERMAX™	SELECT®	SENCOR®	SERTIN®	SNIPER®	Spinnaker®	Spray.seed	Starane™	Stomp®	Supracide®	Surpass®	Talstar®	Targa®	Terbyne®	Tigrex®	Topik®	Tordon™ 242	Tordon™ 75D	Treflan™	Tristar® Advance	Verdict™ 520	Wildcat®
Kamba® 500 Herbicide		C			C		C		C							C										N	C		C							C	C	C							C				C											
Kamba® M Herbicide							C		C							C										N																			C															
Le-Mat® 290 Insecticide							C						C					C											C			C			C	C	C	C	C	C	C		C	C				C		C				C				C	
Logran® 750 Herbicide																C										C	C						C			C	C	C						C				C	C			C	N			C			
Logran® B Power																																				C		C						C															
Lontrel™ Herbicide	C			C			C		C				C			C		C									C		C				C			C	C	C			C			C	C			C		C		C		C			C	C	C
Lorsban™ 300/500 Insecticide		C		C	C		C		C				C					C	N	N			C				N		N				N			C	C	C						C	C		C	N				C		N	N	C		C	
LVE MCPA	C	C					C						C	C		C		C	C				C		C	N						C			C	C	C	C			N	C		C	C						C	C				N	C	C
LV Ester 600							C												C				C													C		C						C															
Mataven® 90 Herbicide							C					N																																															
MCPA 500 Herbicide	C	C					C			C						C	C		C			C	C			N									C						N			C	C							C	C	C	C			N	
Midas®		C																													C																												
Monza®													N			N			N			N			C		C									C		C						C								C								
Paragon® Herbicide		C					C						C										C		C	N															N												C				C		C
Precept® 300		C											C		C							C			C					C																						C				C		C
Prometryn 900DF						C																																								C									C			
Raptor® Herbicide		C				C											C					C					C		C																														
Roundup® DST® Herbicide				C	C	C	C	C		C				C			C		C			C	C		C	C	C																C			C	C		C			C				C			
Roundup® Dry Herbicide				C	C	C	C							C			C		C			C	C		C	C	C																C			C					C				C			
Roundup® Attack™ Herbicide	C			C	C	C	C	C						C			C		C			C	C		C	C	C																C			C	C		C			C				C	C		
Sakura®		C					C	C	C			C										C	C	C					C					C		C								C			C									C			
Select® Herbicide		C	C																			C																		C	C								C								C		
Sencor® 480 Herbicide																						C																		N	C	C						C							C			
Sniper® Herbicide	C	C	C			C																C					C												C	C								C										
Spinnaker® 700 Herbicide		C				C																C														C	C	C		C				C		C			C							C			
Spray.Seed® 250 Herbicide		C			C		C	C	C								C		C			C	C		C	C	C		C														C			C		C	C		C					C			
Starane™ Herbicide	C			C	C					C			C	C									C		C	C	C		C							C		C										C					C	C	C			C	C
Stomp® 330 Herbicide					C	C			C														C											C		C	C	C					C	C					C											
Supracide® 400 Insecticide																C										C																											C						
Surpass® 300 Herbicide	C	C		C	C	C	C		C	C						C	C		C			C	C		C	N									C	C								C	C							C	N	C	C			N	
Talstar® 100 Insecticide							C											C					C																	C		C	C	C		C						C							
Targa® Herbicide																		C				C			C													C		C											C								
Terbyne®									C																											C	C	C						C											C			
Tigrex® Herbicide	C	C	C			C	C		C				C		N								C		C	C	C		C												N							C	C	C			C		C		C		C
Topik® 240 Herbicide	C												C	C				C					N										C												C		C	N				C		C	N				
Tordon™ 242 Herbicide	C												C									C			C	N	C		C												N				C			C					C						
Tordon™ 75D Herbicide	C				C																					N			C							C	C	C							C			C				C	N					N	
Torpedo™																											C		C																													
Treflan™ Herbicide						C	C		C														C			C								C						C			C	C							C							
Tristar® Advance Herbicide	C			N														C							C		N						C																		C							
Valor®																																				C		C						C															
Velocity® ****																									C		C																									C				C		C
Verdict™ 520 Herbicide					C	C																C			C	C	C		N										C		C				C			N							N				
Wildcat® Herbicide	C						N					C	C	N				C							C		C						C												C							C							

Compatibility

Occasionally it may be an advantage to mix two or more compatible chemicals and apply them at the same time to save time and money, or to increase the range of pests being targeted.

If you are contemplating using an untried mixture you should ask the manufacturers about the compatibility of the chemicals. If no clear guidelines are available, do a preliminary test by mixing the different products in small accurate proportions to simulate a spray tank mix.

There are no registration requirements for mixtures made on-farm, unless directions about mixing are given on the product labels. If there are no mixing directions on the labels, check with the manufacturers. Use of mixtures not recommended on the label is at the applicators own risk.

Wettable powders (WP), dry flowables (DF) and emulsifiable concentrates (EC) are least likely to be compatible when mixed together, because of interaction between the surfactants in each. Liquid formulations (LC and SL) are usually physically compatible with either wettable powders or emulsifiable concentrates.

Table 40. Scientific names

Scientific name	Common name	Scientific name	Common name
Acyrthosiphon kondoi	blue-green aphid	*Listroderes difficilis*	vegetable weevil
Acyrthosiphon pisum	pea aphid	*Melanacanthus scutellaris*	brown bean bug
Agrotis spp.	cutworm	*Merophyas divulsana*	lucerne leaf roller
Agrypnus variabilis	sugarcane wireworm	*Myzus persicae*	green peach aphid
Anoplognathus spp.	christmas beetle	*Nala lividipes*	black field earwig
Aphis craccivora	cowpea aphid	*Mythimna convector*	common armyworm
Aphodius tasmaniae	blackheaded pasture cockchafer	*Nezara viridula*	green vegetable bug
Austracris guttulosa	spur-throated locust	*Nysius vinitor*	Rutherglen bug
Austroasca alfalfae	lucerne leaf hopper	*Nysius clevelandensis*	grey cluster bug
Bathytricha truncata	sugarcane and maize stemborer	*Oncopera rufobrunnea*	underground grass grub
Bemisia tabaci	whitefly	*Orondina* spp.	false wireworm
Brachycaudus helichrysi	leaf curl plum aphid	*Othnonius batesi*	black soil scarab
Brevicoryne brassicae	cabbage aphid	*Penthaleus major*	blue oat mite
Bruchophagus roddi	lucerne seed wasp	*Persectania ewingii*	southern armyworm
Bruchus pisorum	pea weevil	*Petrobia latens*	brown wheat mite
Bryobia spp.	bryobia mite	*Pieris rapae*	cabbage white butterfly
Ciampa arietaria	brown pasture looper	*Piezodorus hybneri*	redbanded shield bug
Chortoicetes terminifera	Australian plague locust	*Plutella xylostella*	cabbage moth/diamondback moth
Chrysodeitis angentifena	tobacco looper	*Rhopalosiphum maidis*	corn aphid
Chrysodeitis eriosoma	green looper	*Sericesthis* spp.	small brown cockchafer
Contarinia sorghicola	sorghum midge	*Sitona discoideus*	sitona weevil
Deroceras spp.	slug	*Sminthurus viridis*	lucerne flea
Diachrysia oricalcea	soybean looper	*Spodoptera exigua*	lesser armyworm
Etiella behrii	lucerne seed-web moth	*Spodoptera letura*	cluster caterpillar
Frankliniella schultzei	tomato thrips	*Spodoptera mauritia*	lawn armyworm
Graphognathus leucoloma	white fringed weevil	*Stomopteryx simplexella*	soybean moth
Halotydeus destructor	redlegged earth mite	*Tetranychus ludeni*	bean spider mite
Hednota pedionoma	pasture webworm	*Tetranychus urticae*	two spotted mite
Helicoverpa armigera	corn earworm	*Therioaphis trifolii f. maculata*	spotted alfalfa aphid
Helicoverpa punctigera	native budworm	*Thrips tabaci*	onion thrips
Helix spp.	snails	*Thrips imaginis*	plague thrips
Heteronychus arator	African black beetle	*Zizina labradus*	grass blue butterfly
Leucania convecta	common armyworm	*Zygrita diva*	lucerne crown borer
Lipaphis erysimi	turnip aphid		

Table 41. Directory of pesticide manufacturers/distributors

Distributor / Manufacturer	Contact Details	Website / Email Contact	Phone Contact
4Farmers Pty Ltd	Unit 1, 70 McDowell Street, Welshpool WA 6106 Ph. (08) 9356 3445 Fax (08) 9356 3447	Web: www.4farmers.com.au Email: tech@4farmers.com.au	1800 038 445
Agbitech Pty Ltd	PO Box 537, Richmond NSW 2753 Ph. (02) 4588 5709 Fax (02) 4588 5704	Web: www.agbiotech.com.au	1800 242 519
Bayer CropScience Pty Ltd	PO Box 903, 875 Pacific Highway, Pymble NSW 2073 Ph. (02) 9391 6000 Fax (02) 9988 3311	Web: www.bayercropscience.com.au Email: enquiries.australia@bayer.com	**Technical enquiries** 1800 804 479
Imtrade Australia Pty Ltd	Suite 12, 11 Preston Street, Como WA 6142 Ph (08) 9368 7444 Fax (08) 9368 7445	Web: www.imtrade.com.au	**0407 559 401**
Conquest Agrochemicals Pty Ltd	76 Walters Drive, Osborne Park WA 6017 Ph (08) 9347 0500 Fax (08) 9347 0551	Email: support@conquestag.com.au	**(08) 9347 0500**
Crop Care Australasia Pty Ltd	Portal North – 15/16 Metraplex Avenue, Murarrie QLD 4172 PO Box 84 Morningside QLD 4170 Ph. (07) 3909 2000 Fax (07) 3909 2010	Web: www.cropcare.com.au	1800 111 454
David Gray & Company Pty Ltd	PO Box 2084, Palmyra DC WA 6961 Ph. (08) 9337 4933 Fax (08) 9337 8316	Web: www.davidgray.com.au Email: tradecentre@davidgray.com.au	(08) 9337 4933
Dow AgroSciences	Locked Bag 502, Frenchs Forest NSW 1640 Ph. (02) 9776 3400 Fax (02) 9776 3435	Web: www.dowagrosciences.com.au Email: austcustomerservice@dow.com	**Customer Service** 1800 700 096
Farmoz Pty Ltd	PO Box 302, St Leonards NSW 1590 Suite 4, Level 4, Building B 207 Pacific Highway, St Leonards NSW 2065 Ph. (02) 9431 7800 Fax (02) 9431 7700	Web: www.farmoz.com.au	Northern NSW: 0437 226 884 Southern NSW: 0428 414 506
Nufarm Australia Ltd	30 Pritchard Street, Lytton QLD 4178 Ph. (07) 3909 2060 Fax (07) 3909 2099	Web: www.nufarm.com.au	**Technical Support** 1800 639 899
Sipcam Pacific Australia Pty Ltd	Level 1, 191 Malop Street, Geelong VIC 3220 Ph (03) 5223 3746 Fax (03) 5223 3756	Web: www.sipcam.com.au Email: apepperell@sipcam.com.au	
Sumitomo Chemical Australia Pty Ltd	PO Box 60, Epping NSW 1710 Level 5, 51 Rawson Street, Epping NSW 2121 Ph. (02) 8752 9000 Fax (02) 8752 9099	Email: phil.glover@sumitomo-chem.com.au charles.mcclintock@sumitomo-chem.com.au	**Technical Support** Phil Glover (North) 0418 668 586 Charles McClintock (South) 0429 004 290
Syngenta Australia Ltd	Level 1, 2–4 Lyon Park Road, North Ryde NSW 2113 PO Box 886 North Ryde NSW 1670 Ph. (02) 8876 8444 Fax (02) 8876 8446	Web: www.syngenta.com.au	(02) 8876 8444
United Phosphorus Ltd	Suite 416, Level 4, 14 Lexington Drive, Norwest Business Park, Bella Vista NSW 2153 PO Box 8150, Baulkham Hills BC NSW 2153 Ph. (02) 8824 7277 Fax (02) 8814 6469	Web: www.uplonline.com Email: johnr@uniphos.com	1800 610 150

Table 42. A guide to the retail prices of insecticides

Product name	Company name	Chemical name	Price ($/L or $/kg)	Average Price ($/L or $/kg)	Comonly used rate (L/ha)	Cost ($/ha)
Thiodan	Bayer	endosulfan	9.43	9.43	2.1	19.80
Sumi-Alpha Flex	Sumitomo	esfenvalerate	10.665	10.665	0.33	3.51945
Nudrin 225	BASF	methomyl granules	10.78	10.78	1.0	10.78
Larvin 375	Bayer	thiodicarb	28.88	28.88	0.5	14.44
Fastac Duo	Nufarm	alpha-cypermethrin	11.00	11.00	0.3	3.30
Bulldock Duo	Bayer	beta-cyfluthrin	15.57	15.57	0.4	6.23
Talstar 100 EC	FMC	bifenthrin	36.50	36.50	0.1	3.65
Lorsban 500 EC	Dow Agrosciences	chlorpyrifos	13.90	13.90	0.3	4.17
decis options	Bayer	deltamethrin	13.19	13.19	0.5	6.59
Karate	Syngenta	lambda-cyhalothrin	138.00	138.00	0.09	12.42
Maldison	Nufarm	maldison	10.14	10.14	–	0.00
Supracide 400	Syngenta	methidathion	30.44	30.44	0.2	6.09
Le-mat 290 SL	Arysta LifeSciences	omethoate	34.00	34.00	0.1	3.40
Aphidex 500 WP	Farmoz	pirimicarb	37.10	37.10	0.25	9.28
Matador	CropCare	lambda-cyhalothrin	135.50	135.50	0.09	12.20
Lannate L	CropCare	methomyl	10.75	10.75	2.0	21.50
Gemstar	Bayer	NVP	51.25	51.25	0.375	19.22
Larvin 800 WG	Bayer	thiodicarb	58.98	58.98	0.235	13.86
Strike-Out 500 EC	Farmoz	chlorpyrifos	8.27	8.27	0.3	2.48
Suprathion 400 EC	Farmoz	methidathion	29.15	29.15	0.2	5.83
Fenitrothion 1000	Nufarm	fenitrothion	35.50	35.50	0.65	23.08
Imidan	CropCare	phosmet	17.57	17.57	0.35	6.15
Steward	Dupont	indoxacarb	71.75	71.75	0.3	21.53
Electra 225	Farmoz	methomyl	10.35	10.35	1.5	15.53
Pririmor WG	Syngenta	pirimicarb	45.00	45.00	0.15	6.75
Lepidex 500	Nufarm	trichlorfon	25.95	25.95	1.2	31.13
Bugmaster Flowable	Bayer	Bt (k)	15.08	15.08	2.0	30.15
Dipel SC	Valent Bioscience	Bt (k)	11.33	11.33	2.0	22.65
Entrust Naturalyte	Dow Agrosciences	spinosad	1650.00	1650.00	0.09	148.50
Axe		permethrin	53.68	53.68	0.25	13.42
Trojan	Dow AgroSciences	gamma-cyhalothrin	167.855	167.86	0.06	10.07
Vivus Max	AgBiotech	NPV	124	124.00	0.15	18.60
Fyfanon ULV	Ospray	maldison	9.2	9.20	0.45	4.14

NSW GOVERNMENT | Department of Primary Industries

Insect and mite control in field crops – Feedback 2013

1. **Your role in the grains industry (Please tick)**

   ☐ Government advisor ☐ Retail advisor ☐ Agribusiness ☐ Education
   ☐ Grower ☐ Researcher ☐ Student ☐ Other

2. **Your postcode? .....**

3. **Overall value of book (Scale 1–5: 1 = poor and 5 = excellent)** ☐

4. **How often do you consult the booklet? (Please tick)**

   ☐ Frequently (> 5 times a year) ☐ Occasionally (2–4 times a year)
   ☐ Rarely (once a year) ☐ Never

5. **Please rate (1–4) each section of the book by circling the most appropriate option.**

	Not much use	Useful	Very useful	Extremely useful
☐ Further information*, page <?>	1	2	3	4
☐ Useful websites, page <?>	1	2	3	4
☐ Legal responsibilities, page <?>	1	2	3	4
☐ Pesticide application record, page <?>	1	2	3	4
☐ Pesticides and worker safety, page <?>	1	2	3	4
☐ Pesticides and the environment, page <?>	1	2	3	4
☐ Insecticide resistance management, page <?>	1	2	3	4
☐ Integrated pest management, page <?>	1	2	3	4
☐ Insect and mite monitoring, page <?>	1	2	3	4
☐ 'PestFacts', page <?>	1	2	3	4
☐ Organic pest management, page <?>	1	2	3	4
☐ Application technology, page <?>	1	2	3	4
☐ Major pests, page <?>	1	2	3	4
☐ Current permits, page <?>	1	2	3	4
☐ Crops – Registered pesticides, page <?>	1	2	3	4
☐ Withholding periods, page <?>	1	2	3	4
☐ Compatibility with herbicides, page 96	1	2	3	4
☐ Scientific names, page 100	1	2	3	4
☐ Directory of pesticide manufacturers / distributors, page 101	1	2	3	4
☐ Guide to retail prices, page 102	1	2	3	4

* (Agfacts, other sources of information, useful internet sites, pest updates, industry organisations and information, beneficial insects and IPM, insect identification & collection, chemical searches).

6. **Does the book provide information that will assist you or your clients to adopt new practices or improve on-farm management?' (Please tick)**

   ☐ yes ☐ no ☐ maybe

7. **'Insect and Mite Control in Field Crops' is currently updated every 2 years**

   Your preference? (Please tick) ☐ Annual ☐ Biennial (every 2 years) ☐ 3 years +

8. **Format**

   'Insect and Mite Control in Field Crops' is currently available in hardcopy and electronic form.
   Your preference? (Please tick one)

   ☐ Hardcopy (booklet) ☐ Electronic (NSW DPI website)

9. **Suggested improvements** .....

   .....

   .....

Please return to: Kathi Hertel, Locked Bag 1000, Narrabri NSW 2390. Fax: (02) 6799 1503. Email: kathi.hertel@dpi.nsw.gov.au

LOCUSTS

» LOOK » REPORT » TREAT

Insect and mite control in field crops 2013

Australian Plague Locust

Spur Throated Locust

Locusts can be a devastating pest to agriculture, causing significant damage to crops, pastures and other sectors.

In NSW, three species of locust are declared pest insects under the *Rural Lands Protection Act 1998*. These are:

- Australian Plague Locust
- Migratory Locust
- Spur Throated Locust

The most common threat in NSW is from the Australian Plague Locust, with Spur Throated Locusts occasionally reaching damaging numbers.

Landholders are at the frontline in identifying, reporting and controlling locusts on their properties, supported by the NSW Department of Primary Industries and Livestock Health and Pest Authorities (LHPA). Local Land Services from 1 January 2014.

It is important that landholders remain vigilant and look for any signs of locust activity throughout the entire season. Landholders need to report all locust activity and should discuss control measures with their local LHPA. Reporting provides valuable data that allows effective control campaigns to be planned in a timely manner.

Further information on locusts is available at www.dpi.nsw.gov.au or www.lhpa.org.au

NSW GOVERNMENT | Department of Primary Industries

LIVESTOCK HEALTH AND PEST AUTHORITIES LHPA Safeguarding Agriculture in NSW

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