NSW GOVERNMENT | Department of Primary Industries

Orchard plant protection guide

for deciduous fruits in NSW **2018–19**

NSW DPI MANAGEMENT GUIDE

Kevin Dodds and Bruce Browne

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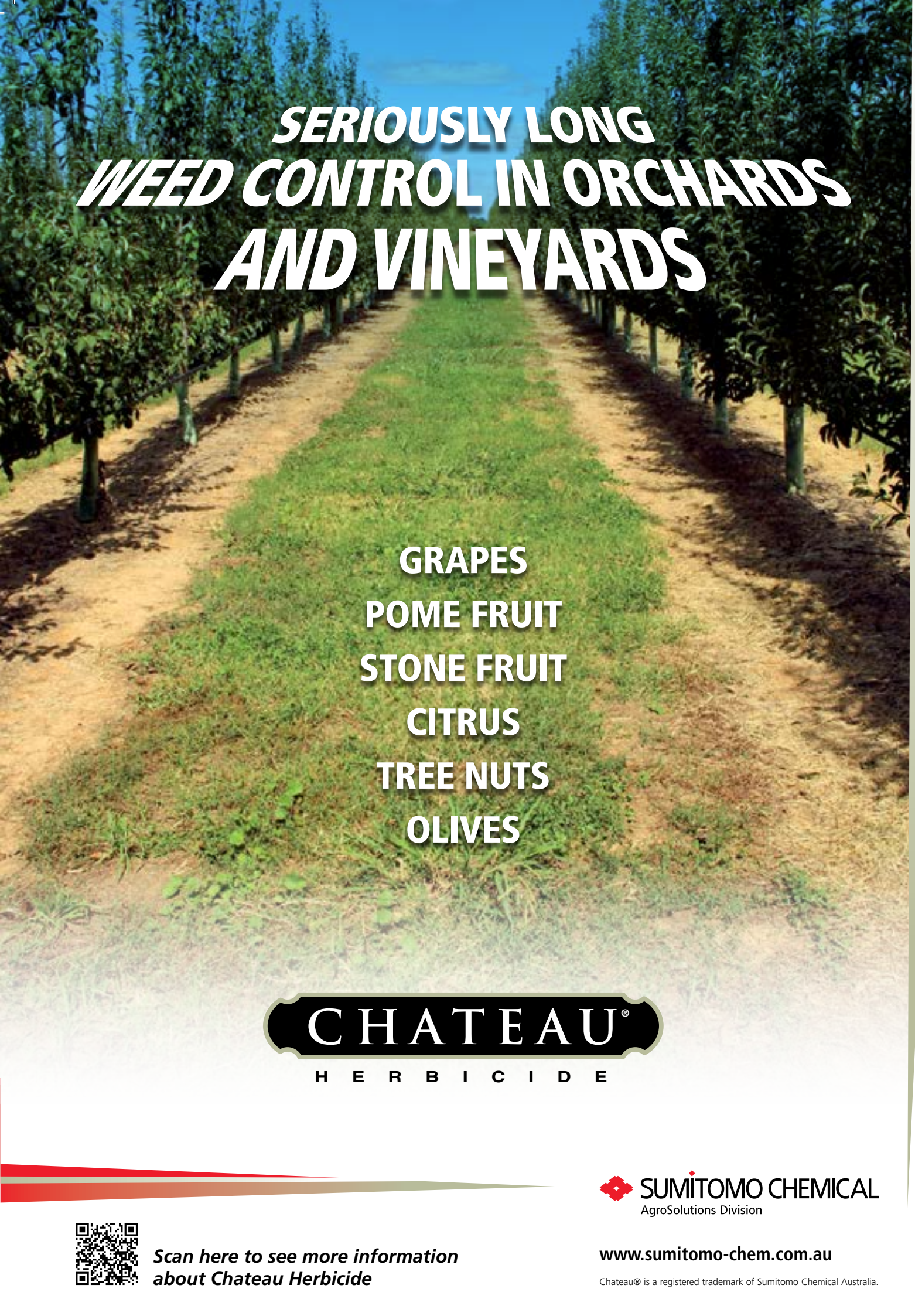

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Orchard plant protection guide for deciduous fruits in NSW 2018–19

Kevin Dodds
Development Officer Temperate Fruits
Department of Primary Industries | Plant Systems
Tumut District Office
PO Box 3 TUMUT NSW 2720
M: 0427 918 315
P: 02 6941 1405
F: 02 6947 4149
E: kevin.dodds@dpi.nsw.gov.au
W: www.dpi.nsw.gov.au

Bruce Browne
Farm Chemicals Officer
Department of Primary Industries | Plant Biosecurity and Product Integrity
Head Office
161 Kite Street ORANGE NSW 2800
P: 02 6391 3154
E: bruce.browne@dpi.nsw.gov.au
W: 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 (August 2018). 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 NSW Department of Industry 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.

® Registered trade name.

™ Trade name with registration pending, or unregistered.

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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.

Permits

Some of the chemical use patterns quoted in this publication are approved under permits issued by the Australian Pesticides and Veterinary Medicines Authority (APVMA) and in force at the time the publication was prepared. Persons wishing to use a chemical in a manner approved under permit should obtain a copy of the relevant permit and approved use pattern from the supplier of the product at point of sale and must read all the details, conditions and limitations relevant to that permit, and must comply with the details, conditions and limitations prior to and during use.

Cover photos

Main photo: Orchard, Alf Manciagli, NSW DPI.

Inset one: Codling moth, Entomart.

Inset two: Mastrus ridens wasp, Plant and Food Research NZ.

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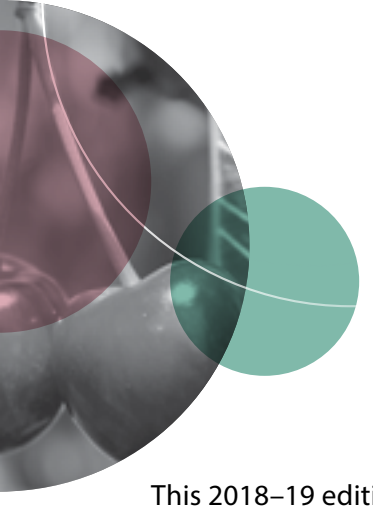


About this guide

This 2018–19 edition of the *Orchard plant protection guide for deciduous fruits in NSW* is the latest in a series of similar publications which have served industry for over 57 years. It provides up-to-date information on all aspects of protecting your orchard from pests and diseases.

Feature articles

David Williams, a Principal Research Scientist with Agriculture Victoria, is well known in the temperate fruit industries for his many years of work researching the behaviour and management of pome and stone fruit pests. In this edition, David outlines progress on the testing and release of a new codling moth parasitic wasp, *Mastrus ridens*.

The article *Improving market access protocols for mainland fruit* by Lloyd Kingham, details progress made for NSW cherry market access to domestic and international markets. This article also introduces CSIRO's new Horticultural Engagement Officer, Kate Fiedler.

Dr Manu Saunders provides an interesting insight into research findings regarding *Pollinators, predators and parasites in pome fruit orchards*.

The Biosecurity Act 2015 came into effect from 1 July 2017. Included in this edition of the guide is a factsheet outlining how landholders can minimise the biosecurity risks from visitors to their farm.

Distribution

The guide aims to provide commercial orchardists with up-to-date technical information on all aspects of crop protection and is available free of charge (pick-up only) to fruit growers in NSW. Copies can be collected from NSW Local Land Services offices or through their grower co-operative/state organisation and selected rural retail stores across NSW.

This guide is also available through the NSW DPI website at www.dpi.nsw.gov.au/agriculture/horticulture/pests-diseases-hort/information-for-multiple-crops/orchard-plant-protection-guide.

Pesticides

We do not list every pesticide that is registered for a specific use but rather guide growers in their choice of chemicals.

It is our policy to use common chemical names or active ingredients, not trade names, when referring to pesticides, crop regulation compounds and nutrient sprays in the body of the guide. Some users find this inconvenient because the chemical name is often in small print on product labels compared with the prominence given to the trade name. Unfortunately this practice is necessary because there can be many product names for the same active ingredient and it would be impossible to list them all at each mention in the guide.

Under the pesticides registration system administered by the Australian Pesticides and Veterinary Medicines Authority (APVMA), individual products are registered for use in or on specific crops for specific weeds, pests or diseases. Also, there can be variations in use recommendations between states for the same crop, even differences in times of application or treatment intervals.

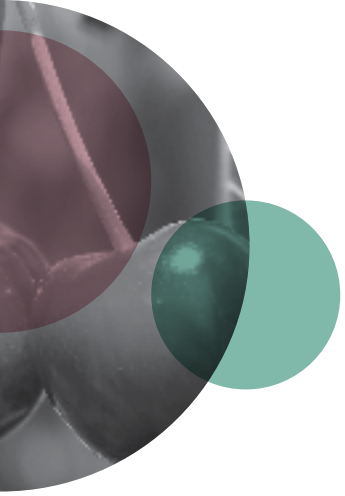
Our use of common chemical names in recommendations in the guide is intended to simplify the advice. It does mean that at least one product containing that active ingredient is registered for the purpose given. The onus is on the user of a pesticide product to ensure that the use of that product is consistent with the label or permit issued by the APVMA.

Use of pesticides is under constant scrutiny through residue surveys and reviews. It is imperative that these valuable tools for fruit production are not misused.

Acknowledgments

We thank the officers of the NSW Department of Primary Industries and other organisations who have helped to revise this issue of the guide. Once again, agricultural chemical companies have provided information on their products and helpful suggestions and we thank them for their involvement and interest.

We welcome suggestions, comments and ideas from growers and technical people alike which may improve the usefulness and relevance of the guide.



What's new?

New products

Several new active ingredients and new uses achieved registration for deciduous fruits in New South Wales since our last edition. These new chemicals and use patterns are included in the relevant crop pesticide tables and calendars. The new registrations included in this edition of the guide are:

Seguris Flexi® (isopyrazam) is a new group 7 fungicide registered for the control of black spot and powdery mildew in apples and black spot in pears.

Problad Plus® (BLAD) is a group BM01 fungicide registered for the suppression of brown rot and blossom blight in stone fruit.

Sharpen® WG Herbicide (saflufenacil) is a new group G herbicide registered for use in established pome fruit orchards for the control of a range of broadleaf and grass weeds.

Existing products with new uses

Fyfanon® 440EW (maldison), a group 1B insecticide, now includes label registration as a cover spray for the control of fruit fly in various deciduous fruit crops including apples, pears, stone fruits and persimmons.

Cormoran® (novaluron + acetamiprid), a group 15/4A insecticide, now includes label registration for San José Scale and Woolly Aphid in apples and pears. It also now includes a range of uses in stone fruits including Black and Green Peach Aphids, Oriental Fruit Moth and suppression of Queensland Fruit Fly.

Reviews, suspensions and cancellations

Active ingredients with common uses in deciduous fruit that remain 'In Progress' on the APVMA review list include diquat, chlorpyrifos, fipronil, maldison, methidathion, paraquat and procymidone. Anyone wishing to learn more about the details of APVMA chemical reviews can find more information and review reports at www.apvma.gov.au

APVMA permits relevant to deciduous fruits

The APVMA administers a permits scheme that allows for the legal use of chemicals in certain ways that are contrary to the label instructions or, in certain circumstances, allows for the limited use of an unregistered chemical product. Table 1 lists key permits currently related to deciduous fruit crops in NSW, including persimmons. Permits for the control of fruit flies are not included in this table. A list of permits relevant to Queensland fruit fly (QFF), and fruit flies generally, is provided in the article entitled 'Queensland fruit fly – registered and permitted chemicals for use in NSW deciduous fruits (as at 1 August 2018)' on page 4.

Readers are advised to source a copy of the full permit document from the APVMA website and understand and comply with its contents and those on the product label.

For more information on the legal requirements associated with use of chemical permits, refer to the article entitled 'Legal responsibilities in applying pesticides' on page 115. APVMA permits can be searched and accessed via this organisations website by following this link https://portal.apvma.gov.au/permits

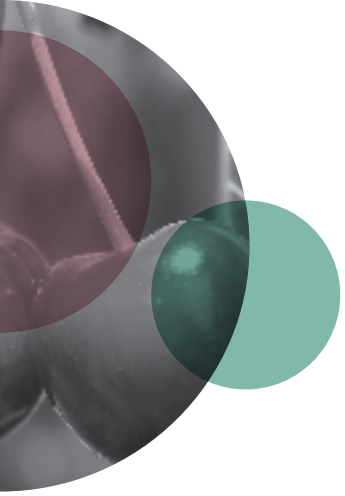
Feedback please

The authors of this guide wish to make sure that the information we are providing is what you need to help your business grow. We would like to receive any feedback that you care to offer – good, bad or indifferent. This will help us to make future editions even more useful. Please contact me with your suggestions via any of the below methods:

Kevin Dodds, Development Officer Temperate Fruits
NSW Department of Primary industries
PO Box 3 TUMUT NSW 2720
Telephone 02 6941 1405
Fax 02 6947 4149
Mobile 0427 918 315
Email kevin.dodds@dpi.nsw.gov.au
Web: www.dpi.nsw.gov.au/agriculture/horticulture

Table 1. Current APVMA chemical permits related to deciduous fruit crops in NSW (as at 1st August 2018).

Crops	Key Pest/Disease	Chemical	Permit No.	Expiry
All fruit fly host crops	Fruit fly	Dimethoate (only after completion of harvest)	PER13859	31 July 2024
Apples	Alternaria	Metiram (e.g. Polyram® DF)	PER12864	30 June 2020
Apricots	Oriental fruit moth	Clothianidin (Samurai®)	PER13527	30 June 2023
Apricots, peaches, nectarines and plums	Phytophthora trunk/collar rot	Fosetyl (e.g. Aliette®)	PER85273	30 April 2023
Cherries	Carpophilus beetle	Bifenthrin	PER82062	31 October 2018
Cherries	European earwig	Indoxacarb (e.g. Avatar®)	PER11002	31 March 2020
Monitoring and mass trapping	Fruit fly	Various lures, attractants, pheromones and toxicants	PER13785	30 April 2019
Persimmons	Cercospora leaf spot	Chlorothalonil	PER13445	30 September 2020
Persimmons	Cercospora leaf spot	Mancozeb	PER12488	31 March 2020
Persimmons	Certain leafrollers and orange fruitborer	Methoxyfenozide (e.g. Prodigy®)	PER12591	30 September 2021
Persimmons	Clearwing borer	Shin-Etsu MD Carmenta® Pheromone	PER13176	30 September 2020
Persimmons	Cluster grub	Chlorpyrifos	PER13932	31 March 2023
Persimmons	Fruit fly	Alpha-cypermethrin	PER85550	30 June 2023
Persimmons	Mealybug	Chlorpyrifos	PER14547	30 June 2019
Persimmons	Mealybug	Clothianidin (Samurai®)	PER14779	30 April 2023
Persimmons	Mealybug	Sulfoxaflor (Transform®)	PER80378	31 March 2020
Persimmons	Queensland fruit fly	Trichlorfon	PER12450	31 January 2021
Persimmons	Scale insects	Petroleum oil	PER13933	30 November 2022
Persimmons	Various pests	Beta-cyfluthrin	PER80374	31 August 2022
Persimmons	Various pests	Methidathion	PER13694	30 September 2022
Persimmons	Various pests	Trichlorfon	PER14743	30 June 2020
Pome and stone fruits	Queensland fruit fly	Spinetoram (e.g. Delegate®)	PER12590	31 May 2019
Prunes	Rust	Copper hydroxide	PER12594	31 January 2021
Stone fruits	Fruit fly	Alpha-cypermethrin	PER14875	31 October 2021
Stone fruits	Western flower thrips	Spirotetramat (Movento®)	PER84804	31 January 2021
Stone fruits (except cherries)	Western flower thrips (suppression only)	Abamectin and chlorantraniliprole (Voliam Targo®)	PER85380	30 November 2020



Queensland fruit fly – registered and permitted chemicals for use in NSW deciduous fruits (as at 1 August 2018)

Kevin Dodds
Development Officer Temperate Fruits
NSW Department of Primary Industries

Background

The chemicals fenthion and dimethoate were mainstay products used for the control of Queensland fruit fly (QFF) in orchards until recently. However, following extensive reviews by the APVMA, fenthion (Lebaycid®) can no longer be used or supplied in Australia and dimethoate (e.g. Rogor®) is only permitted (Permit 13859) as a QFF clean up spray following the completion of harvest in fruit fly host crops. The loss of these chemical applications has left growers wondering what options remain for managing QFF. This brief article is intended to provide growers of deciduous fruit in NSW with an overview of registered chemicals and permits that can be used to manage QFF.

The information presented in this document relates to products registered or permitted for use in NSW. Producers outside NSW must check the registration or permit status of products for their respective state or territory.

IMPORTANT: Always refer to the product label or APVMA permit for rates, application method and other important use and safety information.

Chemicals with registration for spraying certain deciduous crops in NSW

There are currently four active ingredients registered as cover sprays for application to certain deciduous fruit crops in NSW:

Clothianidin (Samurai®) has label registration in NSW for use as a cover spray for QFF in pome fruit, stone fruit and persimmon. This product is recommended as a three spray program at 7-day intervals when monitoring indicates fruit fly action.

Maldison (Fyfanon® 440EW) has label registration in NSW as a fruit fly cover spray in pome fruit, stone fruit and persimmons. The recommendation is to apply it when fruit fly activity is initially observed as determined by monitoring and trapping.

Novaluron + acetamiprid (e.g. Cormoran®) has label registration for 'suppression only' in stone fruit when used as part of a broader program involving other products.

Trichlorfon (e.g. Lepidex® 500) has label registration in NSW for use as a cover spray in stone fruit and pome fruit to be used from the start of stinging. This product can be applied every 7–10 days; the withholding period is 2 days in edible fruit crops. Refer to the product label for rates and other instructions.

Chemicals with registration for use in trapping and baiting in NSW

Currently there are a number of active ingredients with label registration for use in traps and baits for QFF in NSW deciduous fruit orchards including:

Chlorpyrifos (Lorsban® 750WG and Pyrigran Insecticide®) have label registration in NSW stone fruit (except cherries) for use in combination with yeast hydrolysate as a bait.

Dichlorvos (BioTrap® DDVP cubes) has label registration for use in conjunction with available traps containing a suitable lure for QFF monitoring.

Fipronil (Amulet Gel® and Amulet Cue-Lure®) has label registration for use as a bait spray on stone fruit trees (except cherries) and non-fruiting refuge vegetation. Fipronil is also included as the active ingredient in the Amulet® Cue-Lure fruit fly stations.

Hydroxyphenylbutanone acetate (e.g. Wild May® fruit fly attractant) has label registration as a pesticide-free lure for attracting and killing male QFF.

Maldison (Hy-Mal®) has label registration for use in combination with yeast hydrolysate as a bait to control or eradicate fruit fly species. Maldison is also included as the active insecticide in several trap systems and/or replacement wicks including the Q Fly Wick®, eco-lure® male fruit fly wick and the dak·pot® lure and insecticide trap.

Spinosad (e.g. eco-naturalure®) has label registration as a premixed fruit fly bait concentrate for use on fruit trees.

Trichlorfon (e.g. Lepidex® 500) has label registration in NSW for use as a bait in combination with yeast hydrolysate.

Current APVMA permits allowing use of certain chemicals in NSW for fruit fly/Queensland fruit fly control

Table 2 contains the current list of APVMA permits with applications relevant to QFF control, trapping or baiting in certain deciduous fruits in NSW (current as at 1 August 2018).

Readers are advised to source a copy of the full permit document from the APVMA website and understand and comply with its contents.

Suggested management program

To suppress the QFF population, it is key to continue to bait spray, use male annihilation technique (MAT) blocks and follow good hygiene practices throughout the year, not just when the crop is susceptible. This will assist in suppressing QFF populations, reducing the risk of population build-up and increased fruit fly pressure the following year. MAT blocks are typically placed out (as per label rate) every 3–4 months, and bait sprays can be less frequent during the cooler months. Starting bait sprays early, i.e. August or early September, is key to reducing the risk of population build-up as the weather warms up. The more growers in your region that follow these basics, and the longer a program is implemented, the greater chance you have of reducing QFF pressure.

Bugs for Bugs (Dan Papacek) and NSW DPI (Dr Olivia Reynolds) have teamed-up to develop a simple three-step action plan to manage QFF. It features baiting, MAT blocks and sanitation. A copy of the action plan can be found on the following pages.

Information sources for growers

APVMA: www.apvma.gov.au

Infopest: www.infopest.com.au

Bugs for Bugs: www.bugsforbugs.com.au

NSW DPI information Resources on QFF: https://www.dpi.nsw.gov.au/biosecurity/insect-pests/qff.

Table 2. Current APVMA permits allowing use of certain chemicals in NSW for fruit fly/QFF control.

Crops	Chemical	Permit No.	Expiry
Fruit fly host crops (postharvest only)	Dimethoate	PER13859	31 July 2024
Persimmons	Alpha-cypermethrin (e.g. Alpha-scud®)	PER85550	30 June 2023
Pome and stone fruit (suppression only)	Spinetoram (Delegate®)	PER12590	31 May 2019
Stone fruit (except cherries)	Alpha-cypermethrin (e.g. Alpha-scud®)	PER14875	31 October 2021
Various	Various lures, attractants, pheromones and certain toxicants in traps	PER13785	30 April 2019

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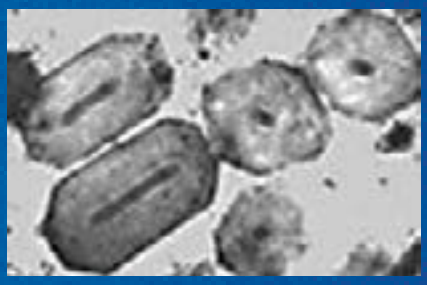
Cyd-X applied at low rates in conjunction with insecticides and/or mating disruption helps reduce and maintain low codling moth populations.

Insecticidal virus for control of Codling Moth larvae.



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Codling Moth larvae

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MANAGE QUEENSLAND FRUIT FLY

IT'S YOUR RESPONSIBILITY

...and it's as easy as A B C

A ATTRACT AND KILL WITH PROTEIN BAIT SPRAYS

B REDUCE MALES WITH MALE ANNIHILATION TECHNIQUE (MAT)

C PRACTISE GOOD SANITATION

Hort Innovation

NSW Department of Primary Industries

BUGS FOR BUGS

Olivia Reynolds (NSW DPI) Dan Papacek (Bugs for Bugs)

MANAGE QUEENSLAND FRUIT FLY

IT'S Y

A PROTEIN BAIT SPRAYS

WHY

- A protein + toxicant attracts and kills flies
- Fruit flies require protein before they can sting fruit

HOW

- Mix protein lure with toxicant at the recommended rate
- Apply as a spot or band to the host trees

WHEN

- Start early and apply weekly until at least 3 weeks after harvest
- Apply more often if you see signs of fruit fly damage or increased activity

ALSO

- Protein may cause fruit burn – test before use – minimise fruit contact
- Treating larger areas including non-fruiting blocks and surrounds will improve results

YOUR RESPONSIBILITY ...and it's as easy as A B C

B MALE ANNIHILATION

WHY

- Reducing the male population will help improve fruit fly control

HOW

- Place MATs throughout your orchard at 10 – 20 per hectare

WHEN

- Apply three times per year
- Leave individual MAT out for a full 12 months

ALSO

- Use MAT as well as protein baiting (not instead of)
- Works best when used over large areas leading to improved control over time

C SANITATION

WHY

- Surviving flies from last year are major contributors to spring populations
- Minimise fruit fly breeding for best results

HOW

- Remove unwanted hosts including feral and neglected trees
- Remove all residual fruit following harvest
- Destroy any fallen fruit if damaged by fruit fly

MONITORING

- Fruit fly traps monitor male population trends
- Replace wicks every three months
- Treat trap counts as a guide only
- Do not rely on trap counts to decide whether or not to apply protein bait sprays and MAT
- Regularly inspect your crop for any sign of fruit fly damage

All photos: Dan Papacek

For more information go to: www.dpi.nsw.gov.au or www.bugsforbugs.com.au

A new biocontrol agent and mass trapping of codling moth

David Williams
Agriculture Victoria Research Division
Department of Economic Development, Jobs, Transport and Resources
david.williams@ecodev.vic.gov.au

Introduction

Changes to the types of pesticides available for use in fruit production, and the progress of research into biological control of major insect pests, is providing fruit growers with safer, cost-effective and environmentally friendly options to incorporate into their pest management systems.

Codling moth (Figure 1) is the most serious pest of pome fruit worldwide and the most damaging pest of commercial apple, pear, quince and nashi orchards in Australia. It is widely distributed in all Australian states except Western Australia and Northern Territory. In the past, codling moth was controlled by multiple applications of organophosphate insecticides until the pest developed resistance to those pesticides. Newer pesticides with lower human toxicity are more specific and more expensive than the organophosphate pesticides they replaced, but also require more attention to timing of spray applications and adherence to resistance management strategies.

Figure 1. Codling moth. Photo: Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org.

Codling moth overwinters on pome fruit trees as hibernating mature caterpillars in cocoons in sheltered areas such as under bark scales on the trunk. In spring, as day length and temperature increase, the caterpillars emerge from hibernation, enter pupation and eventually emerge as adult moths ready to mate and lay eggs. Mating disruption is designed to reduce or delay mating so that fewer eggs are laid. Although application of sex pheromone mediated mating disruption (MD) can be an effective alternative to the use of pesticides for control of low to moderate population levels of codling moth, control of moderate to high population densities is more problematic. Several consecutive seasons of area-wide MD treatments are needed to control higher pest population levels. The aim of MD is to prevent, or at least significantly reduce, mating between the moths. However, if there are enough female moths present then mating can still occur. It is therefore important that fruit growers have access to a number of tools that can help reduce the number of female moths in their orchards.

A new biocontrol agent

A wasp called *Mastrus ridens* (Figure 2), that targets codling moth has been introduced into Australia. The wasps were confined in quarantine until, after 5 years of host-specificity testing, approval was granted to release them into orchards (Figure 3). The first release was into an organic orchard in the Goulburn Valley in 2014 to establish a nursery site and to provide a field site in which establishment issues such as dispersal, predation and hyper-parasitism could be studied. Since then the research team has been releasing *Mastrus* into sites in Queensland, New South Wales, South Australia, Tasmania and Southern Victoria. The team has also been investigating the effects on wasp survival of commonly used orchard pesticides.

Mastrus ridens seeks out hibernating codling moth caterpillars and lays eggs in the cocoon. When the wasp eggs hatch, the wasp larvae feed on the codling moth caterpillars. Codling moth larvae

consumed by *Mastrus* are easily distinguished from those that have been consumed by predators because in the latter case there are generally only scattered remains. The research team confirmed parasitism by *Mastrus*, but there was also considerable predation by earwigs and ants. An added bonus was detection of another wasp, suspected to be *Gotra pomonellae,* which was also attacking codling moth pupae.

Figure 2. An adult *Mastrus ridens* wasp.

To release *Mastrus* in orchards, parasitised codling moth larvae in corrugated cardboard bands are chilled, transported in eskies, transferred into modified fruit fly traps which are suspended from lower limbs of fruit trees (Figure 4), and then left until the adult wasps emerge and disperse. The location of these release sites were recorded for future reference (Figure 5). Between 8,000 and 20,000 *Mastrus* were released at each site and *Mastrus* adults were seen searching the trees for codling moth larvae for about 7 days after release.

Until recently it has been difficult to catch female codling moths in traps. A chemical ester isolated from pears and added to pheromone traps changed that situation in apple orchards, but did not perform so well in pear orchards, probably because of competition from the pears themselves. Addition of an extra plant volatile to the pheromone pear-ester mixture increased the capture of male and female codling moths in pear orchards treated with mating disruption. Mass trapping using the enhanced lure in pear orchards under mating disruption gave excellent control of codling moths. By enhancing the potential for pheromone-mediated mating disruption to maintain codling moth populations and resultant fruit damage at low levels, mass trapping will complement biological control of codling moth. It also reduces the risk of exposure to pesticides that may be toxic to the *Mastrus ridens* wasp. Table 3 indicates the risk of some common pesticides and of their direct and indirect effects, such as fertility of surviving adults and their offspring.

Figure 3. *Mastrus ridens* project leader David Williams (Agriculture Victoria) explains the release process with Batlow orchardist, Greg Mouat.

Figure 4. A modified Lindfield trap used to deploy *Mastrus ridens* in commercial orchards across Australia.

Figure 5. *Mastrus ridens* release sites are GPS located and monitored.

Conclusion

The release of the codling moth parasitoid, *Mastrus ridens*, combined with mass trapping of codling moth females and the use of mating disruption, will potentially avoid the over use of insecticide cover sprays and provide effective biocontrol of codling moth in pome fruit.

Acknowledgements

This research into mass trapping was funded by Hort Innovation using the apple and pear R&D levy, nashi industry contributions and contributions from participating orchardists, plus funding from the Australian Government.

The introduction of *Mastrus ridens* was funded through the Hort Innovation Apple and Pear Fund, using the apple and pear R&D levy, contributions from Plant and Food Research Limited New Zealand and funding from the Australian Government.

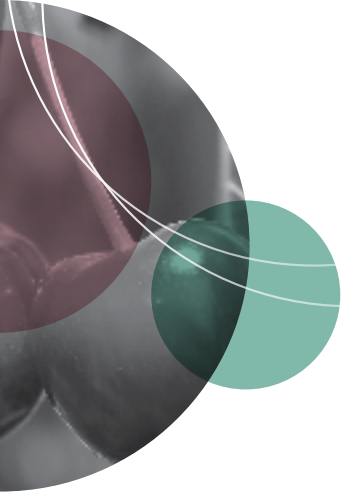
The distribution and establishment of *Mastrus ridens* is funded through the Hort Innovation Apple and Pear Fund using the industry levy and government contributions.

In each of the above projects the Victorian Government provided additional funds, not managed by Hort Innovation, through the Agriculture Victoria Research Division of its Department of Economic Development, Jobs, Transport and Resources.

Table 3. The risk of some common pesticides and of their direct and indirect effects, such as fertility of surviving adults and their offspring.

Pesticides		Direct toxicity	Fertility of survivors	Fertility of offspring from survivours
Fungicides	Cyprodinil			
	Fenarimol			
	Mancozeb			
	Ziram			
Miticide	Abamectin			
Insecticides	Acetamiprid + novaluron			
	Clorantraniliprole			
	Clothianidin		No survivors	No survivors
	Indoxacarb		No survivors	No survivors

Low	
Moderate	
High	



Improving market access protocols for mainland fruit

Lloyd Kingham, Plant Biosecurity Officer
NSW DPI

Introduction

The NSW Department of Primary Industries (DPI) is contributing to a new national systems approach project to help open domestic and export market opportunities for NSW deciduous fruit producers. This new approach builds on the successful cherry protocols developed for Asian markets funded through the Federal Government's PASE (Package Assisting Small Exporters) program. The four-year, $5 million scheme to strengthen evidence of pest control measures aims to develop new protocols which will help prevent risks across the supply chain, and to give growers more options to meet domestic market access requirements. The project has been funded by Hort Innovation, NSW DPI and project leader CSIRO. Also involved are the Western Australian Department of Primary Industries and Regional Development and Agriculture Victoria, as well as cherry, citrus and apple industry groups and growers.

New markets have been opened

The Queensland fruit fly (QFF) seasonal pest absence and postharvest irradiation project achieved its goal of providing market access for fresh, early season Australian mainland cherries into valuable South East Asian markets such as Indonesia and Vietnam. The importance of maintaining low fruit temperatures and improving road and airfreight logistics in both Australia and Asia were critical lessons learnt from this project. The acceptance of fruit treated with irradiation and methyl bromide by importers and consumers provided the data required by Cherry Growers Australia and the Australian Government Department of Agriculture and Water Resources (DAWR) for market access negotiations with Vietnam and China.

Exports of NSW cherries to Indonesia grew from 3 ton in 2016 to 16 ton in 2017. Vietnam accepted NSW irradiated cherries, with 26 ton exported in 2017 after no exports in 2016. Victorian producers also made use of the trade channels developed by the project, exporting 366 ton of irradiated cherries to Vietnam. Consequently the Victorian producers are now supporting the new systems approach project. The China market also opened to mainland cherries being treated with methyl bromide, in part convinced by Indonesia accepting 4 ton of NSW cherries treated by methyl bromide in 2016.

The methodology for the seasonal pest absence protocol was refined, providing monitoring data and assurance that fruit was QFF free. This presented an opportunity to enhance domestic arrangements. NSW cherries have now been permitted to move under trial conditions into both South Australia and Western Australia, including 3000 kilograms of cherries to WA in the 2017 season.

Cherry Growers Australia (CGA) have added new components to the Cherry export manual and biosecurity management program (Figure 6) for producers wishing to use irradiation or methyl bromide as an end point treatment. If you intend to export to Indonesia, Vietnam or China in the coming season, this manual provides detailed market access requirements. Contact CGA on data@cherrygrowers.org.au for more information, to obtain a copy of the manual or to enquire about registration for export.

Postharvest quality trials

To demonstrate the effects of low dose irradiation on fruit quality, Dr John Golding from the NSW DPI conducted four fruit storage trials across 2016–17 and 2017–18 on batches of NSW cherries destined for export. Following commercial treatment, fruit were assessed for quality (external and internal) and shelf life at four different storage times. While increased storage time

negatively affected final fruit quality, low dose irradiation did not. These results reinforce the confidence of industry, exporters and importers in using irradiation as a safe, practical and cost-effective market access treatment for the export of NSW cherries.

Improving market access protocols

The ability to trade quality mainland fruit into South East Asian markets remains a priority for mainland horticulture and DAWR. However, the work does not end once one trade pathway is developed. The new systems approach project aims to provide further options for mainland industries. For example, if the seasonal pest absence systems approach has been providing fruit free of QFF, then how much further refinement of the system is required before the fruit can bypass irradiation or methyl bromide treatment entirely, and be traded fresh into South East Asia? Other exciting and practical questions which the systems approach project aims to answer include:

- Are there other quarantine pests of concern which require an end point treatment that are currently managed on-farm with integrated pest management?
- Can we gather data to develop a systems approach for these pests as well?
- Within existing market access protocols, can we accept that automated optical fruit sorting and grading in packing sheds is equivalent or better than visual inspection of the final packed product?

National support for systems approach and market access

Dr Kathryn Fiedler is the new Horticultural Engagement Officer employed with CSIRO Health and Biosecurity. Kate is working in the area of systems approach, market access and related pest management activities for Australian growers. Her role is to develop and deepen relationships across the horticultural supply chain which will help develop and deliver effective biosecurity-related R&D services. She is the CSIRO individual that provides the day-to-day interface between CSIRO scientists, the regulatory and scientific staff within each state, and horticultural industry bodies. Kate is a plant pathologist originally from the United States, and brings her experience from California, Pacific Islands, South and Southeast Asia to this project. She is located at the CSIRO office within the EcoSciences Precinct, Brisbane, QLD.

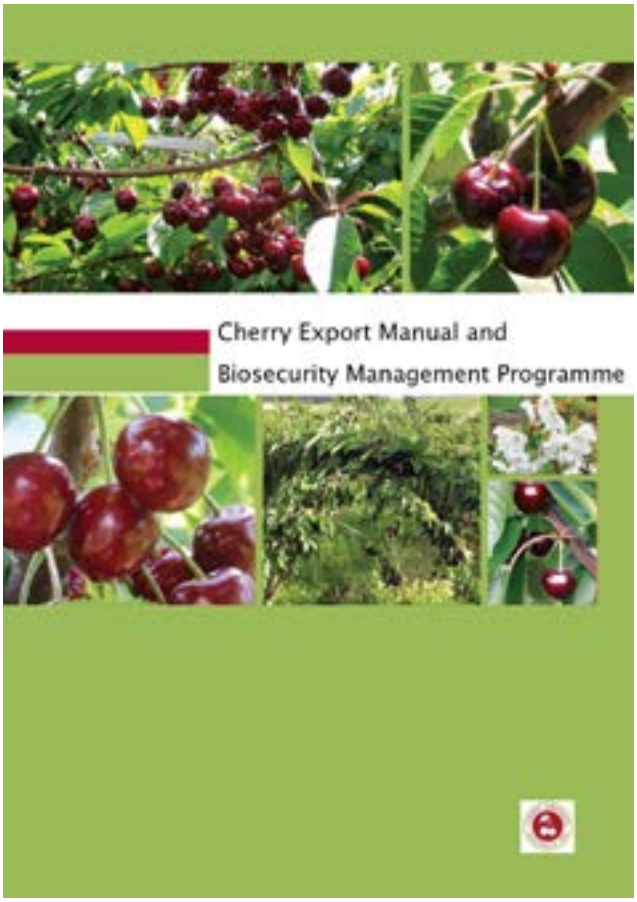


Figure 6. The Cherry Export Manual and Biosecurity Management Program is maintained and distributed by Cherry Growers Australia.

Contact details

Lloyd Kingham
Phone: 02 6938 1654
Email: lloyd.kingham@dpi.nsw.gov.au

Kathryn Fiedler
Phone: 07 3833 5950
Email: Kathryn.fiedler@csiro.au

Pollinators, predators and parasitoids: promoting beneficial arthropods in pome fruit orchards

Dr Manu Saunders
Ecologist, University of New England

Yield in temperate fruit crops is enhanced by the activities of a variety of beneficial arthropods. Most of these arthropods are already working for free in orchards around the country, pollinating flowers and controlling pest outbreaks. Studying their ecology and life histories helps understand how to manage orchards to ensure that populations of these beneficial species persist and grow.

Flowers of most temperate fruit crops require cross-pollination to set fruit, and insects are the best agents for this. Renting European honey bee hives to provide pollination services is an easy option, but this can become expensive and may not be the most cost-effective approach. Many crops, including apple, produce higher or better quality yields when there are multiple types of insects, not just one bee species, active in the orchard to pollinate flowers. This is because different insects have different traits and foraging behaviours that mean their effectiveness at delivering the right pollen at the right time varies. For example, research from North American apple orchards found that wild native species of bees were more effective apple pollinators than honey bees.

In most Australian orchards, there are hundreds of wild insect species, including native bees (Figure 7), wasps, flies (Figure 8), butterflies, moths and beetles that visit crop flowers and can be efficient pollinators, even in unfavourable weather conditions. For example, flies are more tolerant of cold weather than bees, so can be important pollinators in cooler regions or on poor weather days. Moths and beetles are often more active at night, when day-flying insects are resting. In apple, due to the staggered opening times of different cultivars, or of king blossoms compared to their surrounding blossoms, having multiple pollinators active throughout the entire bloom period can help buffer the effects of different flower opening times under different weather conditions.

Pollinators are not the only type of arthropod that benefits fruit production. Maintaining populations of predators and parasitoids can be more important for producing high-quality marketable fruit in apple orchards. Relying on pesticides to control pests is rarely an effective long-term solution. Not only is it expensive, but some insect pests can develop resistance, new pests can present themselves under changing environmental conditions, and many pesticides also affect beneficial non-target insects and other wildlife.

Figure 7. Native halictid bee pollinating an apple flower. Photo: Manu Saunders, UNE.

Luckily, there are plenty of arthropods that provide the same outcome as pesticide application at no cost to growers, and with fewer long-term effects. Spiders, earwigs, dragonflies, and some beetles, flies and wasps are valuable predators that specifically prey on damaging

pests in pome fruit orchards. Many insect groups, like flies and wasps, are double agents: they pollinate flowers during bloom and also control pests and remove wastes throughout the fruit development stage. For example, large-bodied parasitoid wasps are also pollinators (Figure 9), and the larvae of some syrphid fly species (also called hoverflies, family Syrphidae) hunt and eat aphids, while the adults feed only pollen and nectar. Predatory flies, like robber flies (Asilidae) and long-legged flies (Dolichopodidae), have diverse tastes: they are predators of smaller insects, including pest species, but they also visit flowers for nectar and pollen. Blowflies, bush flies, March flies and tachinid flies (families Calliphoridae, Muscidae, Tabanidae, Tachinidae) are also common pollinators, and provide other services by parasitising pest insects, or removing organic wastes that may increase disease risk from the system.

Figure 8. Native syrphid fly pollinating an apple flower. Photo: Manu Saunders, UNE.

Our research in apple orchards in Batlow, Shepparton and Harcourt found that these beneficial arthropods are most abundant in orchards where there is ample weedy ground cover, as well as in areas adjacent to non-crop vegetation, like remnant woodland or grassy meadows. This is because beneficial insects need floral resources throughout the year as well as undisturbed nesting habitats, like dead wood, leaf litter, small water bodies, and small patches of bare sandy soil to burrow nest holes into.

Most of these insects also do not travel very far unless they have to, usually only up to a few hundred metres. So it is the conditions within and immediately around orchards that determine what beneficials are available throughout the year, especially at important times such as the bloom period.

Figure 9. Native flower wasps mating in an apple orchard (females of this species are wingless). These wasps are both pollinators and predators of fruit pests. Photo: Manu Saunders, UNE.

Maintaining living ground cover (i.e. grasses and flowering weedy plants) is particularly important for keeping beneficial insects around, particularly in centres of orchards that are far from non-crop vegetation adjacent to orchards. Ground cover does not just enhance fruit production by providing habitat for beneficial arthropods. It also provides many other benefits, including reducing soil erosion and dust, and improving soil health and water infiltration.

Weedy ground cover (Figure 10) and longer grass in orchards is often thought to promote pest abundance. However, our research using vertebrate exclusion experiments to test the complementary effects of insects and birds on

apple yields, found that tall grass and diverse flowering ground cover may only increase pest abundance in the absence of biological pest control. Because plant diversity boosts the number of beneficial animals, where insectivorous birds and insect natural enemies provide complementary pest control services, any increase in pests will be counteracted by the enhanced biological control services. More research is needed to tease out these factors.

Figure 10. Weedy flowering ground cover in orchards can sustain beneficials (like this native bee) long-term, even after bloom ceases. Photo: Manu Saunders, UNE.

Another important factor to consider when managing orchards to enhance beneficial insects is the landscape context of an orchard. We found that the ratio of pest to beneficial arthropods was much higher in Shepparton: there were approximately twice as many pests as beneficials in our Shepparton study orchards, compared to Harcourt and Batlow sites. This included a mix of organic and conventional orchards, so the landscape effect was overriding any benefits of organic management. Similar effects have been found in the Shepparton region for other wildlife (e.g. native birds) and it is likely that the long history of intensive agriculture and vegetation clearing in this region has effected populations of beneficial species.

Maintaining inter-row ground cover vegetation, as well as establishing 'nursery' areas of native flowering plants and trees, or grassy meadows around orchard blocks, are some relatively easy, cost-effective measures that growers can use to support beneficial arthropods that enhance fruit production.

Contact details

Dr Manu Saunders
Phone: 02 6773 1794
Email: manu.saunders@une.edu.au

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University of New England

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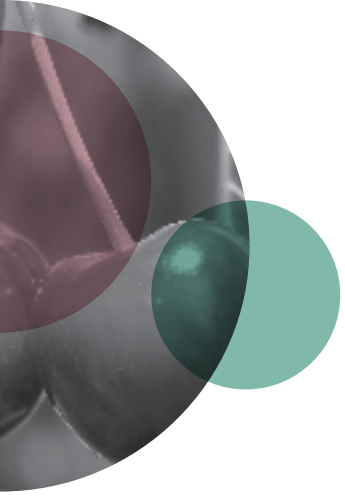


Good management to control common diseases, pests and disorders

This guide provides orchardists with suggestions for the management of their major pests and diseases through the responsible use of pesticides (page 115). Pesticide use can be moderated even further through good orchard management.

Weather influences the pests and diseases that will affect temperate fruit orchards. By observing the weather, fruit growers can predict the occurrence and severity of pest and disease outbreaks and only spray when a threat exists. Watching the weather and knowing your pests is the key.

There are a number of other ways to reduce the risks posed by a broad range of pests and diseases including:

- pruning opens tree canopies to allow better spray penetration and allows leaves to dry more quickly, reducing the threat from many diseases
- overhead irrigation should be avoided or managed in such a way as to avoid creating favourable conditions for disease infections unless the reasons against it are compelling (i.e. frost management or mitigating heat stress)
- good hygiene, including appropriate disposal of unwanted fruit, also reduces the threat posed by many insect pests and diseases
- timing weed control to reduce the likelihood of pests finding alternative sites to survive the winter when fruit trees are unsuitable
- destruction of feral fruit trees and neglected orchards.

The following section provides specific details on weather conducive to disease or pest outbreaks and on non-pesticide management options where applicable. Orchardists should always keep in mind that exclusive use of pesticides or alternative management will rarely produce satisfactory fruit quality. Each management strategy supplements the other.

Diseases

Alternaria leaf blotch and fruit spot

Alternaria leaf blotch is characterised by irregular red–brown coloured lesions on the leaves (Figure 11). The lesions might expand under favourable conditions, followed by yellowing of the leaves and then defoliation of the trees. Leaf lesions often exhibit blackish-purple borders. Alternaria leaf blotch is distinguished by the fact that in favourable weather conditions the blotches will continue to grow, and when the leaf is half covered by lesions, it will tend to drop prematurely from the tree.

Figure 11. Alternaria leaf blotch. Photo: NSW DPI.

Alternaria fruit spot is characterised by small, slightly sunken, light to medium brown spots appearing on the lenticels of the fruit, often surrounded by a black border. Symptoms appear after warm weather and usually no earlier than 42 days before harvest (Figure 12).

Non-pesticide management. Due to the similarity of Alternaria leaf blotch and fruit spot symptoms to those caused by other problems (e.g. fungal

diseases and physical damage), it is important to have symptoms assessed by an expert, especially if you are considering applying fungicides (or other treatments) to combat these symptoms.

Be particularly vigilant with apple varieties that are susceptible to Alternaria leaf blotch and fruit spot including Fuji, Gala, Pink Lady and Red Delicious.

The proposed management approach for Alternaria leaf blotch and fruit spot includes the removal or breakdown of leaf residue, in particular when leaf disease occurred in the previous season.

Figure 12. Alternaria fruit spot. Photo: NSW DPI.

Apple and pear scab

For apple or pear scab (Figure 13) to occur, the leaves or fruit must remain wet over a long enough period to allow germination of the fungal spores that cause the disease. Warm, wet conditions between 17–20 °C are ideal for infection.

Non-pesticide management. Orchard sanitation, particularly during autumn, helps to reduce scab carry over. The first infections of the new season are caused by spores which overwinter on infected leaves on the orchard floor. Anything which reduces the number of leaves also reduces the pressure intensity of early disease. Treat leaves on the tree just before leaf fall with a nitrogenous fertiliser to hasten leaf breakdown. Mulch the leaf litter after leaf fall by sweeping and then using a mechanical shredder, slasher or flail mower to chop leaves into small pieces which then break down more rapidly. Combine leaf mulching with a ground application of a nitrogenous fertiliser.

Figure 13. Apple scab. Photo: The University of Georgia, Plant Pathology.

Bacterial blossom blast and leaf spotting

Pseudomonas syringae pv *syringae* (Pss) occurs naturally on a wide range of plant species. It overwinters in orchards on bud scales and leaf scars, then in spring the populations increase and are spread to developing plant tissues by rain splash, overhead irrigation and insects. Pss is the causal organism for bacterial blossom blast (Figure 14) in pears and more recently spring leaf spotting of apples (Figure 15) and cherries. Pss is also the cause of bacterial canker in stone fruit (see section on bacterial canker).

Figure 14. Blossom blast. Photo: J. Pscheidt, Orgeon State University.

Figure 15. Bacterial leaf spot on an apple leaf. Photo: Kevin Dodds, NSW DPI.

A number of copper-based fungicides are registered for the control of bacterial canker (bacterial gummosis) in apricots and cherries. In both these crops, applications are timed to coincide with first bud movement in spring and again postharvest to coincide with leaf fall.

There are currently no chemicals registered for the control of Pss in apples and pears. Copper fungicides applied for the management of scab during the dormant phase and at green tip might have a supplementary effect on Pss.

Non-pesticide management. Plant tissues that are injured by frost are more exposed to infection by Pss as the injury sites are readily colonised by the bacteria. Therefore, any measure taken to avoid or prevent frost damage will also reduce the potential for infections. When planning new orchards, avoid planting susceptible species in frost prone areas, such as poorly drained gullies and known frost pockets.

Overhead irrigation systems and wind machines have been shown to be effective in reducing the risk of frost. Maintaining a weed-free strip of bare soil under the trees also reduces frost potential.

Bacterial canker

Bacterial canker (Figure 16) is favoured by wet, windy conditions in autumn and early winter before and during leaf fall. Damage to trees and limbs from pruning, hail or wind during the early dormancy period increases the risk of the disease. Rain during the growing season ensures the disease is spread throughout the orchard.

Non-pesticide management. In severely infected blocks, avoid pruning in winter; prune after harvest or as close to budburst as possible. Prune areas of the orchard with canker problems last and paint large pruning wounds with white acrylic paint. As canker can be particularly severe on young plantings it is important to maintain a complete disease control schedule. Young plantings seldom recover full vigour after severe infections and can be a source of inoculum for older, more productive trees. Consider removal and replanting in severe cases. Avoid damage to trees, particularly during winter. Control wildlife such as rabbits, hares and macropods which will chew young green bark, creating disease entry sites.

Figure 16. Bacterial canker. Photo: NSW DPI.

Bacterial spot

While bacterial spot (Figure 17) is more common on susceptible varieties grown in coastal areas, it is also becoming a problem in inland production areas. Wet conditions between blossom and petal fall favours both leaf and fruit infection on peaches and nectarines. Windy, wet conditions and heavy dews during the growing season will also favour secondary infections. Exposed blocks are more vulnerable.

Figure 17. Bacterial spot on a plum. Photo: NSW DPI.

Non-pesticide management. Trees under nutrient stress or stress from other pests and diseases are more likely to be infected by bacterial spot. Maintain high soil fertility and a good pest management program. Destroy nearby feral or neglected prunus as they can act as a reservoir for the disease. Do not prune during wet weather.

Bitter rot

Bitter rot (Figure 18) is usually seen in warmer coastal districts after November. It is favoured by warm, humid and wet conditions during the growing season and is spread by rain splash. Spores germinate in water and infection can occur within 5 hours at optimum temperature (26 °C). Infection can occur during, or just after blossom but is more common in mid to late season.

Figure 18. Bitter rot in apple. Photo: Clemson University, USDA Cooperative Extension Slide Series, Bugwood.org.

Brown rot

The incidence of brown rot (Figure 19) and blossom blight is related to temperature and duration of wetness. As little as 3–5 hours of wetting at 20 °C may lead to significant infection. Within 24 hours of wetting, severe blossom infection may occur regardless of temperature.

Optimum conditions for blossom infection of peach and cherry is 20–25 °C with showery conditions and cool nights. Temperatures above or below the optimum range may delay infection but not prevent it. Frequent rain periods and warm conditions at or near harvest lead to fruit infection within 48 hours.

Non-pesticide management. Control of the disease without the use of fungicides is usually not possible. However, measures can be taken to reduce the amount of the disease in the current and subsequent seasons. In particular, it is important to collect and destroy any diseased fruit or flowers whether they are still attached to the tree or have fallen. Mummies are diseased fruit which have dried. The spores on mummies provide inoculum for infection in the subsequent season. Consistent collection and destruction of mummies reduces the amount of disease present in orchards.

Control insect pests that spread the disease. Brown rot spores need a wet surface to germinate and infect tissue, and injury can provide a surface wet with sap or fruit juice. Control insect pests that cause fruit injury, such as the oriental fruit moth (*Grapholita molesta*), the light brown apple moth (*Epiphyas postvittana*) and dried fruit beetles (*Carpophilus* spp.). Good insect pest control is essential for successful brown rot control.

Figure 19. Brown rot on stone fruit. Photo: NSW DPI.

Peach leaf curl

Peach leaf curl (Figure 20) is favoured by a cool and wet spring around budswell followed by warm, humid conditions, which bring about rapid growth. The optimum temperature for fungal growth is 20–26 °C.

Non-pesticide management. Thorough control of this disease requires a timely pesticide application. A number of other measures can be taken to make management more effective. Where leaf curl has been a serious problem it is important to put more effort into maintaining tree vigour. Thin more fruit than usual, ensure adequate irrigation and apply extra nitrogen fertiliser.

Figure 20. Peach leaf curl. Photo: NSW DPI.

Powdery mildew

Powdery mildew (Figure 21) outbreaks are most likely to occur in spring and early summer and again in autumn if new growth occurs. Relatively humid, mild conditions (10–25 °C) without rain favour this disease. The white growth (mycelium) on the surface of leaves can withstand hot, dry conditions and produce spores when favourable conditions return. The spores are spread by wind but are quickly killed by high temperatures.

Figure 21. Powdery mildew on an apple. Photo: NSW DPI.

Rust

Rust (Figure 22) is favoured by warm weather with periods of rain and heavy dews. Wet periods of 4 hours or more with an optimum temperature range of 13–26 °C is adequate for spore germination and subsequent leaf infection. Dry, windy conditions help to spread the rust spores, while rain can splash them onto young leaves.

Non-pesticide management. Control of rust requires application of pesticides in response to weather that is conducive to the disease. Good orchard hygiene will moderate the severity of infections. Where possible orchardists should remove all diseased wood and leaves during pruning and remove all fallen leaves from branches and crotches. Trees often carry small numbers of green leaves through the winter. These should be removed and destroyed.

Figure 22. Rust on a plum leaf. Photo: NSW DPI.

Shot hole

Wet conditions in late winter to early spring can activate shot hole spores that have remained dormant in bud scales and twig lesions during the previous season. Both fruit (Figure 23) and leaves (Figure 24) can be affected. Infection requires at least 24 hours of continuous wetness and spores can germinate in temperatures as low as 1 °C. Rain during budswell helps to spread the disease.

Figure 23. Shot hole infection on a peach. Photo: NSW DPI.

Figure 24. Shot hole infection on apricot leaves. Photo: NSW DPI.

Non-pesticide management. A fungicide program is usually necessary to control shot hole but a number of other measures can help management. Be careful that irrigation does not wet the leaves. Where practical, prune out infected wood and burn the prunings. Hastening leaf fall will reduce the amount of inoculum that builds up during autumn.

Sooty blotch

The sooty blotch fungus survives from one season to the next on infected twigs. The spores are dispersed during rain in spring and early summer. The optimum temperature for fungal growth is 18–27 °C with humidity greater than 90%. It is found more often in the shady parts of fruit blocks (Figure 25). In coastal districts it is more troublesome later in the season.

Figure 25. Sooty blotch on an apple. Photo: Clemson University.

Summer trunk canker

Summer trunk canker (Figure 26 and Figure 27) is more common during prolonged wet, windy spring and summer seasons on soils that are poorly drained. Optimum soil temperatures for infection occur from October to March. Over-watering favours the disease. Staking young trees to reduce trunk movement and infection at ground level is recommended.

Non-pesticide management. Avoid over-irrigation, especially during spring and autumn as this is when soil temperatures are most suitable for disease development. The disease can spread in contaminated water, therefore orchardists should be careful to use clean water where possible for irrigation.

Figure 26. Summer trunk canker. Photo: NSW DPI.

Figure 27. Summer trunk canker. Photo: NSW DPI.

Pests

Apple dimpling bug

The main danger posed by the apple dimpling bug (Figure 28 and Figure 29) occurs between early pink and petal fall. The danger is particularly acute if fruit tree flowering coincides with the flowering of native trees in surrounding bush. In particular be aware of wattle, tree lucerne and Geraldton wax.

Non-pesticide management. Orchardists need to maintain vigilance on blocks or rows which neighbour native trees and shrubs. Where possible, removal of native vegetation is recommended.

Figure 28. Apple dimpling bug. Photo: NSW DPI.

Figure 29. Apple dimpling bug damage to an apple. Photo: NSW DPI.

Carpophilus beetle

Carpophilus is a pest of pre and postharvest stone fruit. *Carpophilus* beetles are small (2–3 mm long), black or brown (Figure 30). Their wing covers are short and they have clubbed antennae. The larvae are yellowish, about 5 mm long when fully grown and have a brown head and forked tail.

Adults lay eggs in rotting and damaged fruit on the orchard floor. Mature larvae emerge from the fruit and pupate in the ground. Adults overwinter on the tree under bark or in mummified fruit. Adult beetles burrow into stone fruit near the stem, through splits or mechanical damage.

The adult can fly several kilometres in search of hosts. Summer rains and rotting fruit are ideal conditions for breeding. Carpophilus adults are a major vector of brown rot, transmitting spores are they move across the fruit.

Non-pesticide management. This is best achieved by weekly monitoring between stone hardening and harvest, orchard hygiene and good fruit fly control. Traps are available from retail rural suppliers. Orchard hygiene can be improved by removal and destruction of waste fruit from orchards. Controlling Queensland fruit fly will decrease the amount of fallen fruit.

Figure 30. Carphophilus beetle. Photo: NSW DPI.

Codling moth

The codling moth (Figure 31) is favoured by warm, dry growing conditions between spring and autumn. Eggs are laid around dusk when the temperature is 16°C or higher and the air is calm. A warm spring speeds up the development of eggs and larvae. The number of generations (2 or 3 in New South Wales) depends on the temperature during the season. Warm autumn conditions increase the risk of late infestation. A tell-tale sign of codling moth presence is frass (sawdust like material) at the point where the moths have entered the fruit (Figure 32).

Figure 31. Adult codling moth. Photo: NSW DPI.

Figure 32. Frass at the entry point of the codling moth. Photo: NSW DPI.

Non-pesticide management. Various measures can be taken to improve management of codling moth. The effectiveness of these measures depends on the size of the orchard block. For larger blocks or where area-wide management is being practised, mating disruption is a good alternative. This technique uses commercial dispensers to emit massive amounts of pheromones into the orchard air. This confuses male moths which are then unable to find female moths with which to mate. For smaller or isolated blocks (or to supplement mating disruption), other management strategies may be effective, although often time-consuming.

Thorough monitoring of the orchard every second week, beginning at 42–56 days after bloom, allows for removal and destruction of any infested fruit. Fallen fruit should be picked up and destroyed as soon as possible, or alternatively fallen fruit should be thrown into the centre of the row for mulching. Scraping loose bark from trees removes overwintering sites. Although natural predators of codling moth are not totally effective in controlling populations, they should be encouraged by the use of 'soft' sprays where possible.

Green peach aphid

Outbreaks of the green peach aphid (Figure 33) in spring are usually associated with good growing conditions. Aphid populations can be reduced by hot, dry winds and conditions which harden tree growth.

Non-pesticide management. A number of biological control agents can reduce aphid populations and should be encouraged. Avoid using pesticides which will kill these biological control agents. Avoid excessive amounts of nitrogen fertilisers which promote growth of soft plant tissue and prune out water shoots. Control weeds around the orchard as these act as reservoirs for migrating aphids.

Figure 33. Green peach aphid. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org.

Harlequin bug

The harlequin bug (*Dindymus versicolor*) is a native Australian plant bug. The adult bug is about 12 mm in length and is very conspicuous (Figure 34). Mating adults can be seen moving in pairs joined at the abdomen and facing in opposite directions. The harlequin bug is a sap sucker which uses a proboscis (needle-like mouthpart) to pierce the epidermis of the host plant tissue. In apples, this feeding damage occurs on the fruit and results in slight depressions on the skin of the apple and is associated with a browning of the underlying flesh (Figure 35). Visual symptoms on apples could easily be confused with symptoms typical of boron cork disorder.

Non-pesticide management. As there are presently no chemicals registered for the control of harlequin bug in orchards in Australia, management of the pest is dependent on the adoption of cultural practices.

The severity of damage in some orchards seems to be associated with bugs having easy access to the trees either by weed growth within the tree row and/or canopy, low growing branches, a nearby trellis post, wires and irrigation tubes.

Due to its association with certain weed species, good weed control in the orchard is key to reducing the likelihood and intensity of infestations. Particular attention should be given to the removal and/or control of common orchard weeds in the *Malva* (marshmallow) and *Rumex* (dock) genera. Management of *Polygonum erectum* (wireweed) is also considered important. Maintenance of a weed-free strip under the effective tree canopy will help control associated weeds and will reduce available shelter and protected access to the trees.

Removal of sheltering sites such as timber stacks and other rubbish from within the orchard should also help reduce bug numbers in the orchard.

Figure 34. Adult harlequin bug. Photo: Kevin Dodds, NSW DPI.

Figure 35. Mid season feeding damage on Cripps Pink (Pink Lady) caused by harlequin bug. Photo: Kevin Dodds, NSW DPI.

Light brown apple moth

Light brown apple moth (LBAM; Figure 36) can be a problem when cool conditions in spring extend into summer. Under these conditions, LBAM may breed through summer into autumn. There is generally an increase in moth action and egg laying in autumn when spraying for other pests has ended. The onset of hot, dry conditions can help reduce the risk. LBAM seem to favour varieties that bear in clusters as the overlapping fruit provide a safe shelter for feeding (Figure 37).

Non-pesticide management. Thorough thinning of fruit reduces the number of sheltered sites where this pest can spin webs and pupate. Thin to singles if it is an option. The insect uses weeds such as dock, capeweed and mallow (*Rumex*, *Arctotheca calendula* and *Malva*, respectively) to survive during the winter. Reducing the number of these weeds in your orchard before budswell reduces the overwintering population. Clean up all fruit left hanging in trees. Mating disruption agents are available for LBAM management. These products perform better when applied to large blocks thereby minimising any edge or dilution effect.

Figure 36. Light brown apple moth. Photo: Department of Primary Industries and Water, Tasmania, Bugwood.org.

Figure 37. Light brown apple moth feeding damage on a pear. Photo: NSW DPI.

Oriental fruit moth

Warm, moist conditions that favour tree growth and brown rot also favour the oriental fruit moth (OFM; Figure 38). Hot, dry, windy conditions are unfavourable for the moth and can reduce heavy infestations in spring. Cold winters can reduce the carry over population. OFM is usually found in stone fruit, but has become a problem in pears and apples in Victoria. OFM damage appears as black wilted tube tips (Figure 39).

Figure 38. Adult oriental fruit moth. Photo: Eric LaGasa, Washington State Department of Agriculture, Bugwood.org.

Figure 39. Shoot tip damage caused by oriental fruit moth. Photo: NSW DPI.

Non-pesticide management. Mating disruption may replace the need for pesticide application for OFM. Mating disruption works best for orchards:

- that are isolated from other pome fruit or stone fruit orchards
- that are part of an area-wide management scheme
- where migration and internal sources of OFM can be controlled
- where OFM numbers are low but cause sufficient damage to warrant investment in mating disruption.

Good orchard management can help with OFM control. Smooth-barked, calm, well-managed trees will generally only support lower populations of OFM, so reduce tree vigour where this is practical. Disinfect wooden storage bins before moths emerge in spring. Destroy large prunings and remove all fruit from trees that is left after harvest. Any trees that have been bulldozed should be burnt. Encourage neighbours to clean up neglected orchards.

Plague thrips

A wet autumn followed by a mild winter allows thrips to survive (Figure 40). If the following spring is dry with sunny days and heavy weed flowering, then a thrips infestation can be expected. If spring is a mixture of warm and cool periods, then numbers of thrips may be reduced. Also, heavy rainfall or cold periods during flowering can reduce thrips numbers.

Non-pesticide management. Careful management of orchard weeds is required during the critical periods of blossom and in the lead up to fruit maturity. As for other thrips species, reducing the number of flowering broadleaved weeds present at these times may be helpful. Do not mow at these times as it will force thrips into the trees.

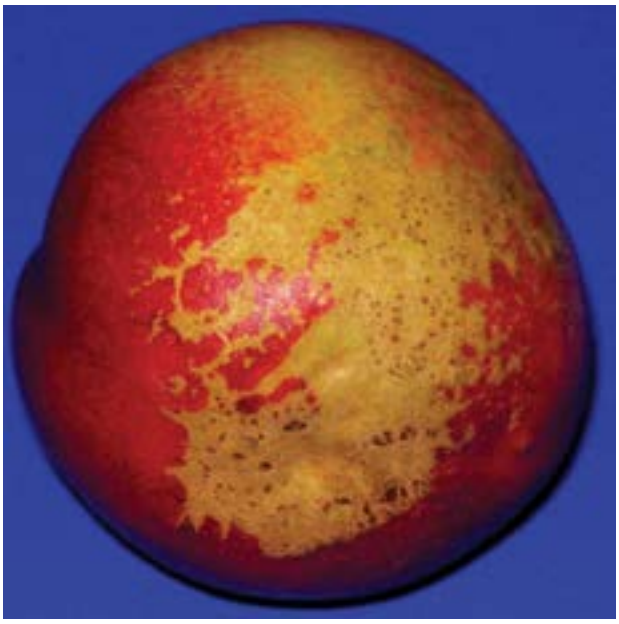


Figure 40. Plague thrips damage on a nectarine. Photo: NSW DPI.

Queensland fruit fly

Queensland fruit fly (Figure 41) is widely distributed in warm, moist growing areas, usually along the coast. It is not often found in the cooler growing areas because the overwintering pupae in the ground are killed by cold temperatures. The fly can be active in the Central and South Western

Slopes, especially where irrigation is used, and can survive the winter. It is active all year round in the warmer, northern coastal areas.

Non-pesticide management. Observe restrictions on the movement of fruit into quarantine zones. Remove unwanted fruit trees from around sheds, houses, along boundary fences and irrigation channels. Practice good packing shed hygiene, with thorough inspection to remove any infested fruit. Properly dispose of reject fruit by burning, boiling or soaking in water with a surface layer of kerosene for 3 days. Do not bury fruit, as fruit flies have a soil-inhabiting phase in their lifecycle and burial will help them to survive. Remove all late hanging and fallen fruit missed during harvest.

Figure 41. Queensland fruit fly. Photo: Andrew Jessup.

Two-spotted mite

The two-spotted mite (Figure 42) is more likely to be a problem in warm to hot, dry summer conditions. In cooler areas feeding stops in autumn with the fall in temperature and the orange coloured non-feeding form appears. In warmer coastal areas the mite can continue to live and feed throughout the winter on weeds and legumes, such as clovers, then reinfest new growth on pome fruit (Figure 43) and stone fruit.

Non-pesticide management. In many cases orchardists can establish sufficient populations of biological control agents to eliminate the need for spraying for two-spotted mites for many seasons. Application of 'hard' pesticides for control of other pests (e.g. codling moth) often leads to outbreaks of two-spotted mite because of the elimination of biological control agents. It is extremely useful to monitor populations of both two-spotted mites and their biological control agents and delay making a miticide application until it is necessary. It may be useful to employ a professional consultant to help with this decision. Other orchard management techniques likely to reduce the chance of two-spotted mite outbreaks include measures to reduce dust and ensuring adequate irrigation.

Figure 42. Adult two-spotted mites. Photo: NSW DPI.

Figure 43. Two-spotted mite damage on apple leaves. Photo: Anne Mooney.

Western flower thrips

Western flower thrips (WFT; Figure 44) have established themselves as pests of stone fruit during the last decade, particularly in the Sydney Basin, Central Coast and North Coast areas. Of major concern is the damage caused to nectarines. More recently, WFT have caused problems in inland regions and have begun to cause significant losses in apple crops. At 30 °C the life cycle takes around 15 days but as temperatures fall, the life cycle takes longer: at 15 °C it can take up to 45 days. In warmer areas of Australia, all stages of WFT are present throughout the year. In apples, WFT damage appears as flower shaped blemishes known as pansy spot (Figure 45).

Non-pesticide management. Control of established WFT populations will require timely pesticide application. However, a number of management practices will reduce pest numbers and minimise damage. As broadleaved weeds (particularly clover) are an alternative host of WFT, keep ground covers mown short throughout the year to prevent flowering, but do not mow when fruit trees are in blossom. Choose pesticides which are less harmful to beneficial insects to encourage their presence and survival.

Figure 44. Western flower thrip. Photo: Sandra Hardy, NSW DPI.

Figure 45. Pansy spot caused by western flower thrip. Photo: Sandra Hardy, NSW DPI.

Woolly aphid

Vigorous trees with shady interiors or located next to shaded windbreaks are often the first trees to be infested with woolly aphids (Figure 46), because of the higher humidity. Low humidity, temperatures above 25 °C and direct sunlight reduce the rate of woolly aphid development within trees.

Non-pesticide management. Pay extra attention to pruning vigorous trees. It is important to maintain an open canopy.

Woolly apple aphid (WAA; Figure 47) is also prone to attack by the parasitic wasp *Aphelinus mali*.

Note: If careful observation of WAA colonies shows that there are many black bodies, and small wasps are observed in the surrounding foliage, delay spraying pesticides. The biological control agent is likely to provide sufficient control.

Figure 46. Woolly aphid. Photo: Jim Baker, North Carolina State University, Bugwood.org.

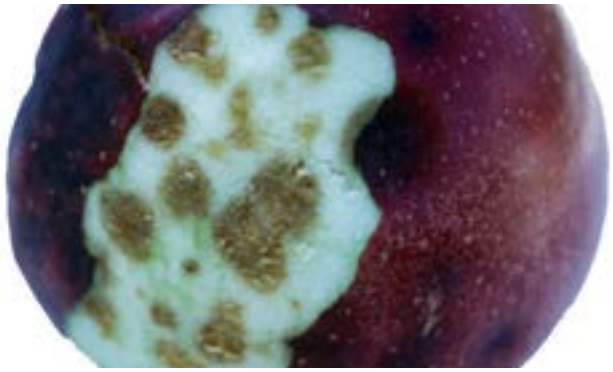


Figure 47. Woolly apple aphid. Photo: University of Georgia Plant Pathology, University of Georgia, Bugwood.org.

Disorders

Internal cork

Often known as corky pit, internal cork is a physiological disorder usually caused by low soil boron level, heavy liming, heavy crops and drought. It causes fruit stunting and distortion in both apples (Figure 48) and pears. Cork disorders can be rectified by application of soluble boron compounds, both foliar and soil dressing (see apples section).

Figure 48. Internal cork in an apple. Photo: NSW DPI.

Sunburn

Sunburn can be a significant cause of physical damage to deciduous fruit, particularly apples (Figure 49) and pears. Losses due to sunburn can be as high as 50% in some varieties and situations where protection methods are not employed. In apples, damage is most likely when shaded air temperature exceeds 30 °C and fruit surface temperature is above 45 °C.

Poorly timed shoot and fruit thinning, pruning, or limb training can suddenly expose unconditioned fruit to direct sunlight increasing the risk of sunburn damage. The risk of sunburn damage can be reduced by employing a range of management tools including:

- planting tolerant varieties
- timely irrigation to reduce tree stress
- avoid thinning, pruning, limb training or shoot thinning during and in the lead up to expected heatwaves
- maintenance of a green sward
- improving air flow in the orchard
- netting
- spray-on coatings.

For more detailed information on sunburn in orchards, visit www.depi.vic.gov.au/agriculture-and-food/horticulture/fruit-and-nuts/pome-fruit/sunburn-protection-for-apples.

Figure 49. Sunburn damage to apples. Photo: NSW DPI.

Superficial scald

Superficial scald (scald) is one of the major physiological disorders that occur during cold storage of apples and pears. Scald is characterised by brown irregular patches that appear on the skin during long-term cold storage (Figure 50). These areas become sunken and turn deeper brown as the disorder develops. Although the damage is only superficial (Figure 51), this amount of damage greatly downgrades fruit quality and grower returns.

Scald is a postharvest storage disorder of some important apple varieties, particularly Red Delicious and Granny Smith, and is essentially a long-term storage disorder. It can be seen within 3 months of harvest and increases with time in storage. Scald symptoms develop only slowly in cold storage but they rapidly increase in severity within a few days at normal air temperatures.

Treatment

1-methylcyclopropene (1-MCP) is a registered treatment in Australia for inhibiting superficial scald while maintaining apple quality during storage. It is registered in Australia for use in apples to:

- reduce incidence of superficial scald and peel greasiness
- maintain firmness
- maintain titratable acidity
- reduce incidence of mealiness.

Scald can be effectively controlled with diphenylamine (DPA) as a postharvest dip or drench. This treatment should be applied as soon as possible after harvest – delaying treatment by 14 days or more greatly reduces the effectiveness of DPA.

Figure 50. Superficial scald on apple. Photo: NSW DPI.

Figure 51. Superficial scald on a Granny Smith apple with the peel removed from a scalded and non-scalded region showing the superficial nature of the disorder. Photo: NSW DPI.

NSW GOVERNMENT | Department of Primary Industries

Plant Health Diagnostic Service

Helping to improve the health and profitability of your orchard

■ DIAGNOSIS ■ IDENTIFICATION ■ SURVEILLANCE

The **Plant Health Diagnostic Service (PHDS)** provides an essential link in protecting the health and improving the profitability of crops, pastures and nursery enterprises. Our laboratories are staffed by specialist pathologists, mycologists and entomologists – experts in a wide range of crop, pasture and horticultural pests and diseases – who can provide plant pathogen and insect identification.

Our specialist plant pathologists and entomologists have the backing of the **Agricultural Scientific Collections Unit**, which houses Australia's largest collection of agriculturally significant insects, fungi, plant bacteria and viruses.

Our Plant Health Diagnostic Services staff are supported by the Department of Primary Industries development officers and Local Land Services advisory staff, providing a complete plant health package for your business.

Available services

Key functions of PHDS include:

- identification and diagnosis of bacterial, fungal and viral diseases including but not limited to fruit rots, fruit tree borers, thrips and woody trunk diseases
- identification of insect and mite problems
- active surveillance for emerging and exotic diseases
- timely and efficient delivery of results to the client.

We can assist you to:

- save expenditure on unnecessary or incorrect chemical usage
- ensure your produce achieves best quality and, therefore, best market price
- implement best practice pest and disease control.

Diagnostic and Analytical Services

Elizabeth Macarthur Agricultural Institute (Menangle)
Phone: (02) 4640 6327
Private Bag 4008
NARELLAN NSW 2567
Email: emai.phds@industry.nsw.gov.au

Orange Agricultural Institute
Phone (02) 6391 3980
1447 Forest Road
ORANGE NSW 2800
Email: orangeai.phds@industry.nsw.gov.au

For more information, you can contact our Customer Service Unit on 1800 675 623 or visit our website at: www.dpi.nsw.gov.au/aboutus/services/laboratory-services

NATA

BIOSECURITY ACT 2015

Biosecurity Regulation 2017

Visitors to your farm & the general biosecurity duty

Minimising biosecurity risks is a shared responsibility

Anyone entering your property has the potential to spread pests, diseases and weeds. Minimising these risks is a shared responsibility between you and visitors to your property.

The general biosecurity duty means that anyone who knows or ought to know about a biosecurity risk has a duty to prevent, eradicate or minimise such a risk

As the land manager, you should never assume visitors to your property are aware of potential biosecurity risks. You need to be proactive and take your own steps to reduce these risks.

Due to the nature of many farms, the size of a farming enterprise can mean that farmers are unaware of entry from the public or company employees (such as utility companies, contractors, or the government, such as DPI or LLS officers, etc.).

How can you manage the risk?

Development and implementation of an on-farm biosecurity plan for your property will go a long way to making it clear to potential visitors what their biosecurity responsibilities are in relation to your property and business. Make sure your visitors are aware of your plan and what they can do to help protect the property from biosecurity risks.

Signs to inform visitors

Signs both on the property and at the boundaries are an effective way to advise visitors of their biosecurity responsibilities before coming onto your property. Signs can inform visitors of your biosecurity status and advise what they need to do before and during the visit.

Never assume that visitors know the appropriate biosecurity measures for your property.

Example of signs that can be placed around property.

Limiting access

By limiting and restricting access to your property, you can reduce the risk of pests, diseases and weeds establishing and spreading.

Proactive activities can include the following:

- Minimising the number of vehicles entering the property by arranging pick up from a gate or designated parking spot. Restricting entry into areas of high risk on the property.
- Use designated "on-farm only" vehicles.
- Ensuring visitors stick to designated roads and paths.

For more information about the Act, visit our website or contact us:

W www.dpi.nsw.gov.au/biosecurityact

E biosecuritylegislation@dpi.nsw.gov.au

Biosecurity Regulation 2017

"Come clean, go clean"

Ensuring people and vehicles are not carrying any unwanted pests, diseases and weeds is a simple yet highly effective way of minimising the risk.

You can implement a "come clean, go clean" strategy by:

- providing on farm vehicle wash down facilities that;
    - are readily accessible
    - have a sealed or packed gravel surface
    - have access to high pressure water, wash down product and power
    - are away from production and other sensitive areas and
    - do not drain into waterways or cropping areas.
- providing facilities to scrub and wash down boots before entering or leaving production areas.

People

Asking visitors some simple biosecurity questions can uncover other potential risks they might not be aware of. Ask your visitors the following questions:

- Have you visited any other farms within the last 48 hours?
- Have you been in contact with any stock that you suspect might have been sick in the past 48 hours?
- Have your boots and clothes been washed since you last entered a farm or came in contact with stock?
- You might consider providing fresh clothes or boots, or perhaps disposable overalls or booties to visitors who may carry potential risks.

On farm equipment

It may be practical to assign equipment only for use on the farm. This could include tools, clothing, footwear and vehicles. This way you can be confident the equipment used is clean, know its history and significantly minimise the risk of spreading pests, diseases and weeds.

Biosecurity breaches

If you feel someone's actions are posing a biosecurity risk to your property, remind them of your on-farm biosecurity plan and if necessary ask them to leave the property. If the problem persists, contact NSW DPI Biosecurity & Food Safety on 02 9741 4790 or report online via DPI's biosecurity website at http://www.dpi.nsw.gov.au/biosecurity/biosecurity-legislation

For more information about the Act, visit our website or contact us:

W www.dpi.nsw.gov.au/biosecurityact

E biosecuritylegislation@dpi.nsw.gov.au

Development stages for apple blossom

Figure 52. Dormant.

Figure 53. Green tip.

Figure 54. Spurburst.

Figure 55. Pink.

Figure 56. King bloom.

Figure 57. Full bloom.

Photos by Shane Hetherington, NSW DPI.

Development stages for stone fruit blossom

Figure 58. Dormant.

Figure 59. Budswell.

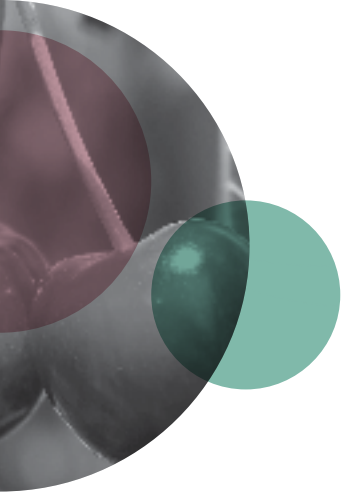
Figure 60. Budbreak.

Figure 61. Full bloom.

Figure 62. Petal fall.

Figure 63. Shuckfall.

Photos by Shane Hetherington, NSW DPI.



Orchard management

This section of the guide contains information directly related to managing pests, diseases, weeds, crop size and nutritional disorders in deciduous fruit crops. Information appears in the following order:

- apples
- pears
- pome fruit (harvested)
- apricots
- cherries
- plums and prunes
- peaches and nectarines (early and late)
- non-bearing trees
- nutrient sprays, with advice on correcting nutrient deficiencies
- weed management, including information on herbicides and their uses.

Pest and disease management

Only pests and diseases likely to occur are listed. Those not included appear rarely or in localised areas.

Not all pesticides registered for a particular condition are necessarily mentioned. Each group of chemicals is in alphabetical order and is intended to show those compounds recommended for that situation. The list is not in order of effectiveness.

Recommendations are intended to be consistent with the registered labels of products. If there is a difference, follow the directions on the label.

No information on rates (quantity of product in the spray mix) is given in this guide. This information appears on the product label. Check the product label for specific instructions and warnings.

Timing of treatments is mainly for tablelands districts. Warmer districts can be 14–25 days earlier than the tablelands.

Use of chemical names

The information given is intended as a guide for fruit growers and sometimes it is necessarily general. Using chemical names (active ingredients) in the recommendations is to simplify the entries. Such use implies that at least one product (trade name) containing that chemical is registered for that use. However, it should not be assumed that all products containing that active ingredient are registered for the same use. It is the pesticide user's responsibility to check the product label to ensure that the proposed use is legal and that all directions (e.g. rates, timing and warnings) are complied with.

Guide to chemical groups

The number and/or letter in brackets that appears after a chemical name (e.g. copper hydroxide (M1)) refers to its mode of action (MOA) chemical group. This is to help users quickly identify chemical groups to manage resistance (see article 'Avoiding resistance to pesticides', page 126).

Non-bearing trees

Young trees that are not bearing fruit do not need the same intensive pest and disease management as bearing trees. See page 106 for guidance on reducing sprays on non-bearing trees.

Colour coding for pesticides

Trade names (in brackets) are included where only one product is registered for that common name. Coloured dots before the chemical common name denote that chemical's compatibility with integrated pest management (IPM). They are coded as follows:

1. indicates that, when used with care, a chemical will have very little effect on beneficials and is recommended in an IPM program
2. indicates that this pesticide can be used with caution in an IPM program, but the beneficials present and the chemical's likely effect should be assessed before application
3. indicates that this chemical is likely to have a negative off-target effect including affecting beneficial arthropods.

Apples

Pesticides

Table 4. Chemicals registered[1] for the management of apple pests and crop regulation in NSW.

To manage ...	Code	Pesticide common name (trade name)[2]	Comment[3]
Alternaria leaf blotch and fruit spot	1	Boscalid + pyraclostrobin (Pristine®)	fungicide mixture of two actives, both with protective action
	1	Dithianon (Dragon®)	fungicide with protective action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action (suppression only)
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with curative and protective action (suppression only)
Apple dimpling bug	3	Bifenthrin	insecticide, acaricide with contact and stomach action
	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
	3	Tau-fluvalinate	insecticide and acaricide with contact and stomach action
	2	Thiacloprid (Calypso®)	systemic insecticide with contact and stomach action
Apple leaf hopper	3	Maldison	insecticide with contact, stomach and respiratory action
Apple scab	1	Boscalid + pyraclostrobin (Pristine®)	fungicide mixture of two actives, both with protective action
	1	Captan	protective fungicide
	1	Copper (as ammonium acetate)	protective fungicide and bactericide
	1	Copper (as ammonium complex Copperguard®)	protective fungicide and bactericide
	1	Copper (as tribasic copper sulfate) (Tribase Blue®)	protective fungicide and bactericide
	1	Copper cuprous oxide	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Cyprodinil	protective fungicide
	1	Difenoconazole (Bogard®)	systemic fungicide with protective and curative action
	1	Dithianon	fungicide with protective action
	1	Dodine (Syllit®)	fungicide with protective and some curative action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	1	Hexaconazole	systemic fungicide with protective and curative action
	ID	Isopyrazam (Seguris Flexi®)	protective fungicide
	1	Kresoxim-methyl	systemic fungicide with protective and curative action
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	non-systemic foliar fungicide with protective action
	1	Myclobutanil	systemic fungicide with protective and curative action
	1	Penconazole	systemic fungicide with protective and curative action
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	3	Sulfur	protective fungicide
	1	Thiram	protective fungicide

To manage ...	Code	Pesticide common name (trade name)[2]	Comment[3]
Apple scab (continued)	1	Trifloxystrobin (Flint®)	systemic fungicide with protective and curative action
	1	Triforine (Saprol®)	systemic fungicide with protective action
	1	Zineb (Barmac Zineb®)	protective fungicide
	2	Ziram	protective fungicide
Bitter rot	1	Copper oxychloride	protective fungicide and bactericide
	1	Dithianon	fungicide with protective action
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	non-systemic foliar fungicide with protective action
	2	Ziram	protective fungicide
Blue mould (postharvest)	1	Fludioxonil	protective fungicide with contact action
	1	Imazalil	systemic fungicide with protective and curative action
	1	Iprodione	contact fungicide with protective and curative action
	1	Thiabendazole	systemic fungicide with protective and curative action
Bud dormancy regulation	ID	Cyanamide	plant growth regulator
	ID	Methyl esters of fatty acids (Waiken®)	plant growth regulator
Budworms (*Helicoverpa* spp.)	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	3	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	3	Chlorantraniliprole + abamectin (Voliam Targo®)	insecticide and acaricide combination
	1	*Helicoverpa nucleopolyhedrovirus* (NPV)	biological insecticide with stomach action
	1	Indoxacarb	insecticide with contact and stomach action
	2	Spinetoram (Delegate®)	insecticide with contact action
Codling moth	3	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	3	Chlorantraniliprole + abamectin (Voliam Targo®)	insecticide and acaricide combination
	3	Clothianidin (Samurai®)	systemic insecticide
	1	*Cydia pomonella granulosis* virus	biological insecticide with stomach action
	1	Fenoxycarb (Insegar®)	insect growth regulator insecticide with ovicidal action
	1	Indoxacarb	insecticide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
	1	Mating disruption agent	codling moth sex pheromone
	3	Methidathion	non-systemic insecticide, acaricide with contact and stomach action
	3	Methomyl	systemic insecticide, acaricide with contact and stomach action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spinetoram (Delegate®)	insecticide with contact action
	2	Thiacloprid	systemic insecticide with contact and stomach action
Fly speck	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	non-systemic foliar fungicide with protective action
Grey mould (postharvest)	1	Fludioxonil	protective fungicide with contact action
	1	Iprodione	contact fungicide with protective and curative action
	1	Thiabendazole	systemic fungicide with protective and curative action
Light brown apple moth (LBAM)	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	3	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	3	Chlorantraniliprole + abamectin (Voliam Targo®)	insecticide and acaricide combination
	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	1	Fenoxycarb (Insegar®)	insect growth regulator insecticide with ovicidal action
	1	Indoxacarb (Avatar®)	insecticide with contact and stomach action
	1	Mating disruption agent	insect sex pheromone
	3	Methidathion	non-systemic insecticide, acaricide with contact and stomach action

To manage ...	Code	Pesticide common name (trade name)[2]	Comment[3]
Light brown apple moth (LBAM) (continued)	3	Methomyl	systemic insecticide, acaricide with contact and stomach action
	1	Methoxyfenozide (Prodigy®)	insecticide that lethally accelerates the moulting process
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spinetoram (Delegate®)	insecticide with contact action
Loopers	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	1	Methoxyfenozide (Prodigy®)	insecticide that lethally accelerates the moulting process
	2	Spinetoram (Delegate®)	insecticide with contact action
Mealybugs	3	Clothianidin (Samurai®)	systemic insecticide
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spirotetramat (Movento®)	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Mites	3	Abamectin	acaricide with stomach action, some translaminar movement (two-spotted and European red mites only)
	3	Abamectin + chlorantraniliprole (Voliam Targo®)	acaricide and insecticide combination
	1	Bifenazate	acaricide with contact and residual action against motile stages
	3	Etoxazole (Paramite®)	acaricide with contact and residual action against motile stages (two-spotted and European red mites only)
	1	Fenbutatin oxide	acaricide with contact and stomach action, controls motile stages
	1	Hexythiazox (Calibre®)	non-systemic acaricide with contact and stomach action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	3	Maldison	insecticide with contact, stomach and respiratory action
	3	Methidathion	insecticide with contact and stomach action
	3	Milbemectin (Milbeknock®)	acaricide with contact and stomach action
	2	Propargite	acaricide with contact action against active stages
	3	Tebufenpyrad (Pyranica®)	acaricide with contact action (two-spotted and European red mites only)
Oriental fruit moth (OFM)	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	3	Chlorantraniliprole + abamectin (Voliam Targo®)	insecticide and acaricide combination
	1	*Cydia pomonella granulosis* virus	biological insecticide with stomach action
	1	OFM mating disruptant	insect sex pheromone
	2	Spinetoram (Delegate®)	insecticide with contact action
	2	Thiacloprid	systemic insecticide with contact and stomach action
Oystershell scale	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
Phytophthora	1	Fosetyl	systemic fungicide with protective and curative action
Plague locust	3	Fenitrothion	non-systemic insecticide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
Plague thrips	3	Bifenthrin	insecticide, acaricide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	3	Tau-fluvalinate	insecticide and acaricide with contact and stomach action
Plant/crop regulation	ID	1-naphthylacetic acid (NAA)	plant growth regulator
	ID	Ammonium thiosulfate	blossom desiccant
	ID	Aviglycine (Retain®)	plant growth regulator
	ID	Benzyladenine	plant growth regulator
	ID	Benzyladenine + Gibberallins (A4 and A7) (Cytolin®)	plant growth regulator
	3	Carbaryl	contact insecticide with stomach action and fruit thinning effect
	ID	Ethephon	plant growth regulator
	ID	Paclobutrazol	plant growth regulator, taken up into the xylem through the leaves, stems or roots, and translocated to growing sub-apical meristems
	ID	Prohexadione-calcium (Regalis® Plus)	plant growth regulator and retardant

To manage ...	Code	Pesticide common name (trade name)[2]	Comment[3]
Powdery mildew	1	Boscalid + pyraclostrobin (Pristine®)	fungicide mixture of two actives, both with protective action
	1	Bupirimate (Nimrod®)	systemic fungicide with protective and curative action
	1	Difenoconazole (Bogard®)	systemic fungicide with protective and curative action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	1	Hexaconazole	systemic fungicide with protective and curative action
	ID	Isopyrazam (Seguris Flexi®)	protective fungicide
	1	Kresoxim-methyl	systemic fungicide with protective and curative action
	3	Mancozeb + wettable sulfur	fungicide mixture of two actives, both with protective action
	1	Myclobutanil	systemic fungicide with protective and curative action
	1	Penconazole	systemic fungicide with protective and curative action
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	3	Sulfur	fungicide with protective action
	1	Trifloxystrobin (Flint®)	systemic fungicide with protective and curative action
	1	Triforine (Saprol®)	systemic fungicide with protective action
Queensland fruit fly (QFF). For a complete list of permits refer to page 4	3	Clothianidin (Samurai®)	systemic insecticide
	1	Fipronil (Amulet Cue-Lure®)	bait/lure
	3	Maldison (Fyfanon® 440EW)	insecticide with contact, stomach and respiratory action
	1	Spinosad (Naturalure™)	bait/lure
	3	Trichlorfon	insecticide and acaricide with contact and stomach action
Ripe fruit spot (target spot)	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Iprodione (dip only)	contact fungicide with protective and curative action
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	non-systemic foliar fungicide with protective action
	1	Thiabendazole	systemic fungicide with protective and curative action
	1	Thiram	protective fungicide
Rutherglen bug	3	Trichlorfon	insecticide with contact and stomach action
San José scale	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	3	Diazinon	non-systemic insecticide, acaricide with contact, stomach and respiratory action
	1	Fenoxycarb (Insegar®)	insect growth regulator insecticide with ovicidal action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	3	Methidathion	non-systemic insecticide, acaricide with contact and stomach action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spirotetramat (Movento®)	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Silver leaf	1	Cyproconazole + iodocarb (Garrison®)	pruning wound sealer containing curative and protective fungicides
	1	Tebuconazole (Greenseal®)	pruning wound sealer containing fungicide
Sooty blotch	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	non-systemic foliar fungicide with protective action
	1	Zineb (Barmac Zineb®)	protective fungicide
Storage quality	NA	1-methylcyclopropene (1-MCP)	postharvest treatment
Storage rots (blue and/or grey moulds. Check species on label)	1	Fludioxonil	protective fungicide with contact action
	1	Imazalil	systemic fungicide with protective and curative action
	1	Iprodione	contact fungicide with protective and curative action
	1	Thiabendazole	systemic fungicide with protective and curative action
Superficial scald	ID	1-methylcyclopropene (1-MCP)	postharvest treatment
	ID	Diphenylamine	anti-scald compound
Tuber mealybug	3	Clothianidin (Samurai®)	systemic insecticide
	1	Flonicamid (Mainman®)	systemic insecticide with translaminar action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action

To manage ...	Code	Pesticide common name (trade name)[2]	Comment[3]
Tuber mealybug (continued)	2	Spirotetramat (Movento®)	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Weevils	3	Alpha-cypermethrin	non-systemic insecticide with contact and stomach action
	1	Indoxacarb	insecticide with contact and stomach action
Western flower thrips	2	Spinetoram (Delegate®)	insecticide with contact action
Wingless grasshoppers	3	Carbaryl	contact insecticide with stomach action
	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	3	Fenitrothion	non-systemic insecticide with contact and stomach action
	1	Indoxacarb	insecticide with contact and stomach action
Woolly aphid	3	Chlorpyrifos	contact insecticide with stomach and respiratory
	3	Clothianidin (Samurai®)	systemic insecticide
	3	Diazinon	non-systemic insecticide, acaricide with contact, stomach and respiratory action
	1	Flonicamid (Mainman®)	systemic insecticide with translaminar action
	2	Imidacloprid	contact and stomach insecticide when used as a foliar spray
	3	Maldison	insecticide with contact, stomach and respiratory action
	3	Methidathion	non-systemic insecticide, acaricide with contact and stomach action
	2	Novaluron + acetamiprid (Cormoran®) (suppression only)	insect growth regulator and contact insecticide with multiple modes of action
	1	Pirimicarb	selective systemic aphicide with contact, respiratory and stomach action
	2	Spirotetramat (Movento®)	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action

[1]Source: InfoPest http://infopest.com.au and APVMA Pubcris https://portal.apvma.gov.au/pubcris

[2]Trade names (in brackets) are included where only one product is registered for that common name. Coloured dots before the chemical common name denote that chemical's compatibility with IPM.

[3]Adapted from The Pesticide Manual, 14th Edition, British Crop Protection Council 2006.

1 indicates that, when used with care, a chemical will have very little effect on beneficials and is recommended in an IPM program.

2 indicates that this pesticide can be used with caution in an IPM program, but the chemical's effect on beneficials present should be assessed before application.

3 indicates that this chemical is likely to have a negative off-target effect including on beneficial arthropods.

ID indicates that there is insufficient data for a rating to be given.

Further information

See page 38 for details on the chemical names used and other information about these tables.

For information on non-bearing trees, see page 106.

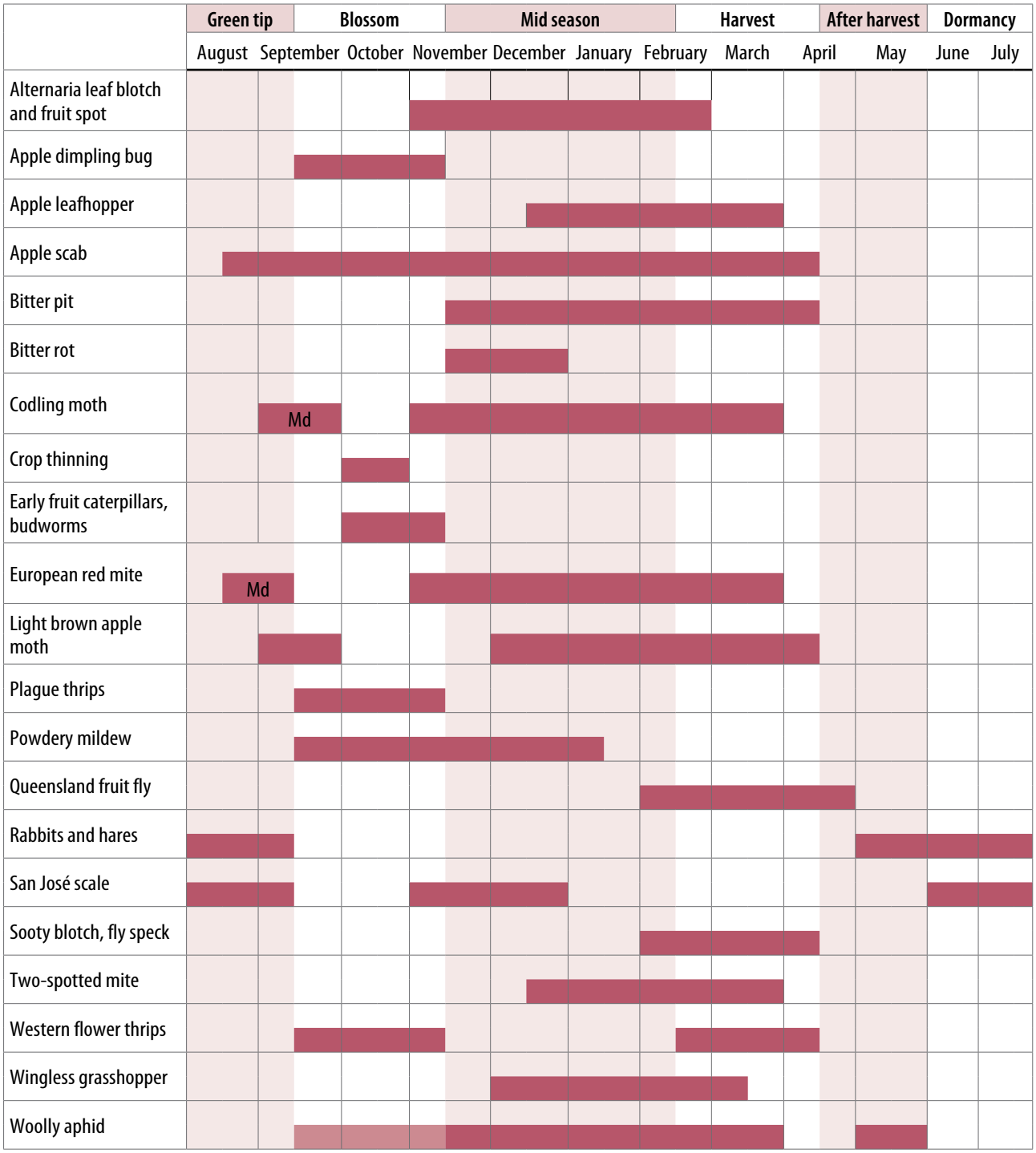
These free Agfacts/Primefacts provide more detail on some problems in apples. They are available in the Agriculture section of the NSW Department of Primary Industries website as a portable document file (pdf) at www.dpi.nsw.gov.au/content/agriculture/horticulture/pomes

- Apple and pear nutrition: Primefact 85
- Apple and pear scab: H4.AB.4
- Bitter pit in apples: H4.AC.1
- Bitter rot of apple: H4.AB.3
- Boron deficiency (cork) in pome fruits: H4.AC.2
- Powdery mildew of apples: H4.AB.8
- Queensland fruit fly: Primefact 1186
- Watercore of apples: Primefact 49.

See page 130 for other useful publications.

Pests and growing periods in apples

Table 5. Apples – pests and growing periods.



Note: This is a guide only. The status and treatment time for each problem varies across districts. Monitoring is critical to avoid unnecessary or poorly-timed sprays.

Likely timing for monitoring and treatment.

Soil treatment

MD — mating disruption.

Management calendar for apples

Table 6. Apples – calendar.

Month	Reason	Treatment	Remarks
GREEN TIP			
September	Scab	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR copper oxychloride (M1) OR tribasic copper sulfate OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	Apply at green tip. This is the first application of a spray schedule based on the protective method of control that involves maintaining a protective fungicide cover on newly exposed leaves and later on blossoms, foliage and fruit, until harvest. Do not use copper sprays after green tip as russetting can occur. Apply a proprietary mixture of mancozeb + copper hydroxide no later than green tip where target spot, sooty blotch or fly speck have been a problem in previous seasons. This product is toxic to *Galendromus pyri* and cannot be used in conjunction with integrated mite control.
	Bitter rot	Copper oxychloride (M1)	Apply at green tip and spur burst (where necessary)
	European red mite (ERM) and San José scale	Etoxazole (10B) OR horticultural mineral oil (HMO)	Etoxazole provides adequate protection against eggs and nymphs. Adult mite suppression is minimal. European red mite eggs on spurs, laterals and main limbs are most susceptible to oil the closer the eggs are to hatching. This usually occurs around flowering. Most spray oil products are registered for use only up to green tip, generally at 2%. A small number of HMO products can be used later at 1%. The preferred timing is just after full bloom when the spray will be a valuable component of the resistance management strategy for ERM (see 'Avoiding resistance to pesticides', page 126). Do not apply oil sprays at both green tip and just after full bloom. Thorough coverage is essential at green tip to control both ERM and scale.
PRE-BLOOM			
September	Scab	Protective treatment – scab fungicides: captan (M4) OR cyprodinil (9) OR difenoconazole (3) OR dithianon (M9) OR dodine (M7) OR hexaconazole (3) OR isopyrazam (7) OR kresoxim-methyl (11) OR mancozeb (M3 OR metiram (M3) OR myclobutanil (3) OR penconazole (3) OR penthiopyrad (7) OR thiram (M3) OR trifloxystrobin (11) OR zineb (M3) OR ziram (M3) OR a proprietary mixture of boscalid (7) + pyraclostrobin (11)	Apply one of these fungicides as the second protective fungicide application at spurburst in mid to late September. Do not use cyprodinil after petal fall. See label for using protective with difenoconazole. Do not use dithianon after the beginning of December on apples to be cool stored. This restriction does not apply to apples intended for controlled atmosphere (CA) storage. Do not apply kresoxim-methyl to apples where there is a risk of drift to cherries. Mancozeb, metiram and ziram are toxic to *Galendromus pyri* (but not *Galendromus occidentalis*). See table on page 123. Penconazole should be mixed with a protective chemical to increase the length of protective period. Note restrictions on the number of applications of some products – see labels.

Month	Reason	Treatment	Remarks
September (continued)	Scab	Curative treatment – 'after infection' control: difenoconazole (3) OR dodine (M7) OR hexaconazole (3) OR myclobutanil (3) OR penconazole (3) OR penthiopyrad (7) OR triforine (3)	The curative or 'after infection' method of control involves spraying only after an infection period has taken place in the spring. It is recommended as a supplement to protective spraying where the interval between sprays has become undesirably long. Curative sprays, to be effective, must be applied as soon as possible after infection has occurred. The effective periods for the fungicides recommended here are up to: 1.5 days: dodine 3 days: penthiopyrad, triforine 4 days: hexaconazole, penconazole 5 days: difenoconazole, fluquinconazole, myclobutanil Do not apply triforine to Golden Delicious or Cox's Orange Pippin. See manufacturers' labels for advice on mixing with protective sprays and restrictions on the number of applications. Neglecting scab on non-bearing trees can, in seasons favouring its development, cause leaf drop, reduced growth and eventually reduced cropping. The curative or after infection method of control can be used to save unnecessary protective applications on young trees. Spray after infection periods from September to early December.
	Codling moth	Mating disruption agent	Apply dispensers within the top 30 cm of the tree, before any adult codling moth action starts. Do not use on blocks of less than 3 ha or irregularly shaped blocks. No other codling moth control should be needed if infestation in the previous season was less than 0.3%. If more than 0.3%, partial or full supplementation with insecticide is recommended. Seek advice from reseller or consultant. Monitoring for codling moth action throughout the season is important.
	Light brown apple moth (LBAM)	Mating disruption agent	Apply dispenser in top third of tree before first moth emergence in spring. Do not use in orchards less than 3 ha.
BLOSSOMING (PINK TO PETAL FALL)			
September–October	Scab and powdery mildew	Scab fungicide (see September) + mildew fungicide: bupirimate (8) isopyrazam (7) OR kresoxim-methyl (11) OR myclobutanil (3) OR penconazole (3) OR trifloxystrobin (11) OR triforine (3) OR a proprietary mixture of boscalid (7) + pyraclostrobin (11) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Apply a mildew fungicide on susceptible varieties. Include a wetting agent when recommended by manufacturer. Powdery mildew can be very damaging to non-bearing trees. A protective schedule should be followed as outlined in the section on bearing apples. However, in blocks of young trees where spraying can be thorough and observations frequent, it is often possible to reduce the number of applications below that usually required for older and larger trees. Controlling powdery mildew with chemicals is particularly important with young trees that are being trained as central leader or palmette types where lateral tipping is undesirable. See labels for restrictions on the number of applications for some products and instructions for mixing with a protective fungicide. Do not apply kresoxim-methyl to apples where there is a risk of drift to cherries. **Warnings**: • check compatibilities of scab fungicides with mildew fungicides • do not use dodine at temperatures below 4 °C from pink stage on, otherwise fruit russetting might occur • dodine can cause russet on yellow varieties such as Golden Delicious • do not use triforine on Golden Delicious or Cox's Orange Pippin • Mancozeb, metiram and ziram are toxic to *G. pyri.*
	Woolly aphid	Clothianidin (4) OR imidacloprid (4)	Spray at the first sign of aphids. Apply to soil around the base of trees identified as infested the previous autumn. See label for details.

Month	Reason	Treatment	Remarks
September–October (continued)	Apple dimpling bug	Bifenthrin (3A) OR chlorpyrifos (1B) (WG or WP formulation) OR sulfoxaflor (4C) OR tau-fluvalinate (3A) OR thiacloprid (4) OR a proprietary mixture of novaluron (15) + acetamiprid (4A)	Apply at late pink to protect flowers from infestation. Chlorpyrifos is very toxic to bees. Three days should elapse between spraying and bee action starting. Do not apply to trees in flower. Do not apply more than two sprays of sulfoxaflor per season. Highly toxic to bees while spray is wet. Do not apply while bees are foraging in the crop. Apply tau-fluvalinate from pink stage to 20% bloom. Do not apply after 20% bloom. Will disturb integrated mite control. Do not apply Cormoran® during flowering. Will kill bees foraging in the crop to be treated or in hives which are over-sprayed or reached by spray drift.
	Plague thrips	Bifenthrin (3A) OR maldison (1B) OR tau-fluvalinate (3A)	All varieties can be affected, but Granny Smith and Golden Delicious are most readily damaged and should be kept under close observation. Spray all varieties as soon as thrips numbers reach 6–8 per blossom, following warm, dry weather during the pink to full bloom period. Thrips occasionally occur in plagues and many invade flower buds as early as spurburst or early pink, causing serious damage. If thrips are seen in large numbers in weed flowers and in early-flowering fruit varieties, be prepared to spray apples. NOTE: All the chemicals listed here to control plague thrips are considered harmful to IPM programs.
	Western flower thrips (WFT)	Spinetoram (5)	WFT action can occur during flowering. Make three consecutive applications of spinetoram at either 3–5-day intervals when temperatures are greater than 20 °C or at 6–12-day intervals when temperatures are less than 20 °C.
	Loopers	Methoxyfenozide (18) OR spinetoram (5)	Best control is achieved using a program of three sprays in spring.
	Budworms (*Helicoverpa* spp.)	*Bacillus thuringiensis* (Bt)(11) OR carbaryl (1A) OR chlorantraniliprole (28) OR indoxacarb (22A) OR spinetoram (5) OR	A program of sprays for either codling moth or LBAM starting at petal fall will help to manage budworms.
		a proprietary mixture of chlorantraniliprole (28) + abamectin (6)	Do not make more than one application of Voliam Targo® per season. Highly toxic to bees. Do not spray while bees are actively foraging. Do not allow spray drift to flowering weeds or flowering crops in the vicinity of the treatment area.
October	Scab and powdery mildew	Scab fungicide OR scab/mildew fungicide (see September–October)	Warning: In October, the danger of scab infection is very high. Income for the year can depend upon efficiently operating spray machinery and maintaining a close schedule of sprays throughout the month. Aim to apply protective sprays every 10 days through October, or at even closer intervals if the weather is favourable for scab. Apply the fourth protective spray 10 days after pink. This will be at approximately full bloom. Apply the fifth protective spray 10 days later. Include a mildew fungicide with the scab spray on susceptible varieties at each application. Take care not to exceed the total number of sprays for each group of fungicides as recommended on the labels. See 'Avoiding resistance to fungicides', page 126. Include a wetting agent for mildew control when recommended by the manufacturer.

Month	Reason	Treatment	Remarks
October (continued)	Elongation of Red Delicious	Commercial mixture of gibberellins + benzyladenine (Cytolin®, Swell®) + wetting agent	Apply as a fine mist. Spray when wind is calm in early morning or late evening under slow drying conditions. For best response, spray when the temperature is above 7 °C, the foliage and flowers are free from surface rain droplets and rain is unlikely for at least 6 hours. Warnings: • do not apply 1-naphthylacetic acid (NAA) within 14 days of application of Cytolin® or Swell® • do not apply a mixture of carbaryl + NAA following application of Cytolin® or Swell®.
	European red mite	Horticultural mineral oil (HMO)	Apply 1% spray at high volume just after full bloom. Use only those formulations specifically registered for use at this time. See September section.
	Crop regulation (thinning)	Ammonium thiosulfate	Apply one to two diluted sprays starting at 80% full bloom once sufficient flowers have been pollinated to ensure an adequate crop.
		Carbaryl (1A)	Apply 7–28 days after full bloom. Warning: Carbaryl is toxic to *G. occidentalis* and bees.
		Commercial mixture of gibberellins + benzyladenine (Cytolin®, Swell®) + wetting agent	Apply 10–22 days after full bloom depending on variety. Apply as part of a program followed by carbaryl or NAA according to label recommendations.
		1-naphthylacetic acid (NAA)	Apply 10–14 days after full bloom to the top 2/3 of the tree.
PETAL FALL			
October–November	Alternaria leaf blotch and fruit spot	Boscalid + pyraclostrobin (11) OR dithianon (M9) OR penthiopyrad (7) (suppression only) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11) (suppression only)	A problem mostly in the Bilpin and Picton regions. Incidence of leaf blotch appears to be increasing in the major producing regions of Batlow and Orange. Spray applications to control Alternaria leaf blotch should begin after blossom and during early fruit development. Do not apply more than three applications per season. Export produce: consult apal.com.au or NuFarm for export MRLs. See 'Alternaria leaf blotch and fruit spot of apple', page 20. NOTE: fluopyram + trifloxystrobin (Luna® Sensation) and penthiopyrad (Fontelis®) have label registration for 'suppression only' of Alternaria leaf blotch in apples.
	Budworms (*Helicoverpa* spp.)	*Bacillus thuringiensis* (Bt)(11) OR carbaryl (1A) OR chlorantraniliprole (28) OR indoxacarb (22A) OR spinetoram (5)	Apply Bt at the first sign of action. Bt is best used as a routine program. It is not suitable for emergency treatment. Applying the codling moth program of indoxacarb from petal fall will also control budworms.
	Codling moth and light brown apple moth (LBAM)	Chlorantraniliprole (28) OR	A maximum of three applications of Altacor® are to be applied at 14–21-day intervals commencing at petal fall or apply at 140 degree days after LBAM is detected in traps.
		fenoxycarb (7B) (20 g/100 L) OR	Use the commercial codling moth management service (Batlow and Orange) to help time the first spray. Otherwise, apply the first application 7–10 days after complete petal fall. Thorough coverage is important. Follow with two further sprays at intervals of 7 days.
		indoxacarb (22A) OR	Use for the first half of the season only. See label for details of timing sprays.
		a proprietary mixture of chlorantraniliprole (28) + abamectin (6) OR	Do not make more than one application of Voliam Targo® per season. Highly toxic to bees. Do not spray while bees are actively foraging. Do not allow spray drift to flowering weeds or flowering crops in the vicinity of the treatment area.
		a proprietary mixture of novaluron (15) + acetamiprid (4A)	Do not apply more than one application of Cormoran® per season in apples. Target the first generation of codling moth just before egg hatch. Apply against LBAM, after petal fall, around 140 degree days from biofix. Do not apply during flowering. Toxic to bees.

Month	Reason	Treatment	Remarks
October–November (continued)	Codling moth	Chlorantraniliprole (28) OR	Maximum three applications 14–21 days apart, starting at petal fall (or before 110 degree days after codling moth detected in traps) until late December. Program also useful to control budworm, OFM and LBAM.
		clothianidin (4) OR	Apply two sprays 14 days apart once pest monitoring indicates egg hatch. Follow with different chemical group.
		spinetoram (5) OR	Target sprays against mature eggs and newly hatched larvae. Use higher rate in adverse weather conditions or high population pressure.
		thiacloprid (4)	Apply the first spray by the time 110 degree days after biofix has been reached. Continue applications (maximum of four) at 14-day intervals until four sprays have been used.
	To retard vegetative growth and stimulate cropping	Ethephon	May be applied to strongly growing young trees where there is difficulty settling these into crop. Ethephon can also be used on mature, vigorous trees to reduce growth and promote return bloom. Apply from full bloom to 42 days after full bloom. As a guide, about 21 days after petal fall when shoots are approximately 13 cm long is a good time to use ethephon. Ensure thorough coverage. Trees should be large enough to support an increased crop load before being treated. Use the higher rate of ethephon to maximise thinning and stimulate bloom during the following season. Warnings: • do not apply to weak trees or trees stressed by drought, waterlogging, high temperatures, poor fertility or disease • do not apply if harvesting fruit in the same season, as flowers or fruitlets will be partially or completely thinned • application should be avoided under conditions that favour rapid drying. A 12-hour rain-free period is required.
	To retard vegetative growth	Prohexadione-calcium	Apply in two to three sprays starting when terminal shoots are 3–5 cm long. Repeat at 21–35-day intervals. Use higher rates on vigorous trees.
MID SEASON (FROM PETAL FALL TO DECEMBER)			
November	Bitter rot	Dithianon (M9) OR mancozeb (M3) OR metiram (M3) OR ziram (M3)	Bitter rot is normally troublesome only at Bilpin and Oakdale. Apply the first spray for its control in the first week of November. Continue sprays at intervals of 14 days during periods of warm, humid weather. These sprays also control scab. Examine trees regularly. Remove infected fruits and burn or bury them. Warning: Mancozeb, metiram and ziram are toxic to *G. pyri*.
	Scab and powdery mildew	See September	Apply a sixth protective fungicide spray 10–14 days after fifth. See also bitter rot, above. Apply a seventh protective fungicide spray 14 days after the sixth. At this time include mildew fungicide only on highly susceptible varieties, but ensure choice of mildew fungicide does not exceed the maximum number of sprays for that group (see Fungicide groups, page 126, and fungicide labels).
	Codling moth and light brown apple moth (LBAM)	Chlorantraniliprole (28) OR	Maximum three applications 14–21 days apart, starting at petal fall (or before 110 degree days after codling moth detected in traps) until late December. Program also useful to control budworm and OFM.
		fenoxycarb (7B) (20 g/100 L) OR	See October–November. A total of four applications at 7-day intervals is required, the first three at 20 g/100 L and the fourth at 40 g/100 L (see November–December).
		indoxacarb (22A)	Continue applications at 10-day intervals.
	Codling moth	Clothianidin (4) OR thiacloprid (4)	See October–November. Continue applications at 14-day intervals.

Month	Reason	Treatment	Remarks
November (continued)	To reduce vegetative growth (Red Delicious and Granny Smith)	Paclobutrazol	Apply initial application 28 days (Red Delicious) and 35 days (Granny Smith) after full bloom. Use higher rate recommended on vigorous or heavily pruned trees. Apply sufficient volume to provide good coverage of new green stem tissue. It is important to use a recommended wetting agent. Additional treatments follow at 21-day intervals, but do not apply more than 4 L/ha in a season. Refer to product label for other restraints.
	Cork disorders (boron deficiency)	Borax OR soluble boron	Apply single spray 14 days after petal fall. See 'Nutrient sprays', page 108 for rate. See label for alternative application rate, timing and warnings. Warning: Excessive applications of boron can cause toxicity. Recommended dosage rates should not be exceeded. Do not use spraying and soil dressing method in the one season.
	Bitter pit	Calcium chloride OR calcium nitrate + wetting agent	Apply up to six sprays throughout the season. Calcium nitrate is recommended until the end of December and also provides nitrogen. Calcium chloride is recommended from January to harvest. Warning: Avoid spraying when the temperature exceeds 28 °C and under slow drying conditions, as foliage and fruit injury can occur. The risk increases with the number of sprays.
November–December	Powdery mildew	Remove infected growth	Promptly removing infected growth is most helpful in checking the disease. It should be seen as a valuable supplement to applying mildew sprays.
	Codling moth and light brown apple moth (LBAM)	Fenoxycarb (7B) (40 g/100 L) OR	When the three 20 g/100 L applications have been completed (see October– November), apply a fourth spray 7 days later at 40 g/100 L.
		indoxacarb (22A)	Maintain schedule – see November, but stop after six applications.
	Codling moth	Chlorantraniliprole (28) OR clothianidin (4) OR thiacloprid (4)	Maximum three applications 14–21 days apart, starting at petal fall (or before 110 degree days after codling moth detected in traps) until late December. Program also useful to control budworm, OFM and LBAM. Do not apply more than two sprays of clothianidin or four sprays of thiacloprid in one season. For the remainder of the season, use a different chemical as required.
	San José scale	Chlorpyrifos (1B) OR novaluron (15) + acetamiprid (4A) OR spirotetramat (23) OR sulfoxaflor (4C)	Apply thoroughly, especially to the tops of trees when crawlers are active. Will also give short-term control of woolly aphid. Apply novaluron + acetamiprid to control crawlers from petal fall in rotation with insecticides from alternative mode of action groups. Do not re-apply spirotetramat within 14 days. Do not make more than two applications of sulfoxaflor per crop. Fenoxycarb used for codling moth will suppress San José scale.
	European red mite (ERM) and two-spotted mite (TSM)	Abamectin (6) OR bifenazate (UN) OR etoxazole (10B) OR milbemectin (6B) OR propargite (12C) OR tebufenpyrad (21A) OR a proprietary mixture of abamectin (6) + chlorantraniliprole (28)	If ERM or TSM is a problem early (rare under integrated mite control), apply abamectin within 42 days of petal fall. This must be mixed with HMO to assist leaf penetration. Follow the directions on the label. Milbemectin can be used in a similar way as abamectin for early control of overwintering populations as they hatch from eggs. Do not apply more than one application per season. Warnings: • avoid applying abamectin and dithianon within 7–10 days of each other as some fruit russetting can occur. Check product labels for specific warnings • bifenazate and propargite should be applied thoroughly • resistance to tebufenpyrad in both ERM and TSM has been diagnosed • etoxazole provides effective control of eggs and nymphs but minimal protection of adult mites.

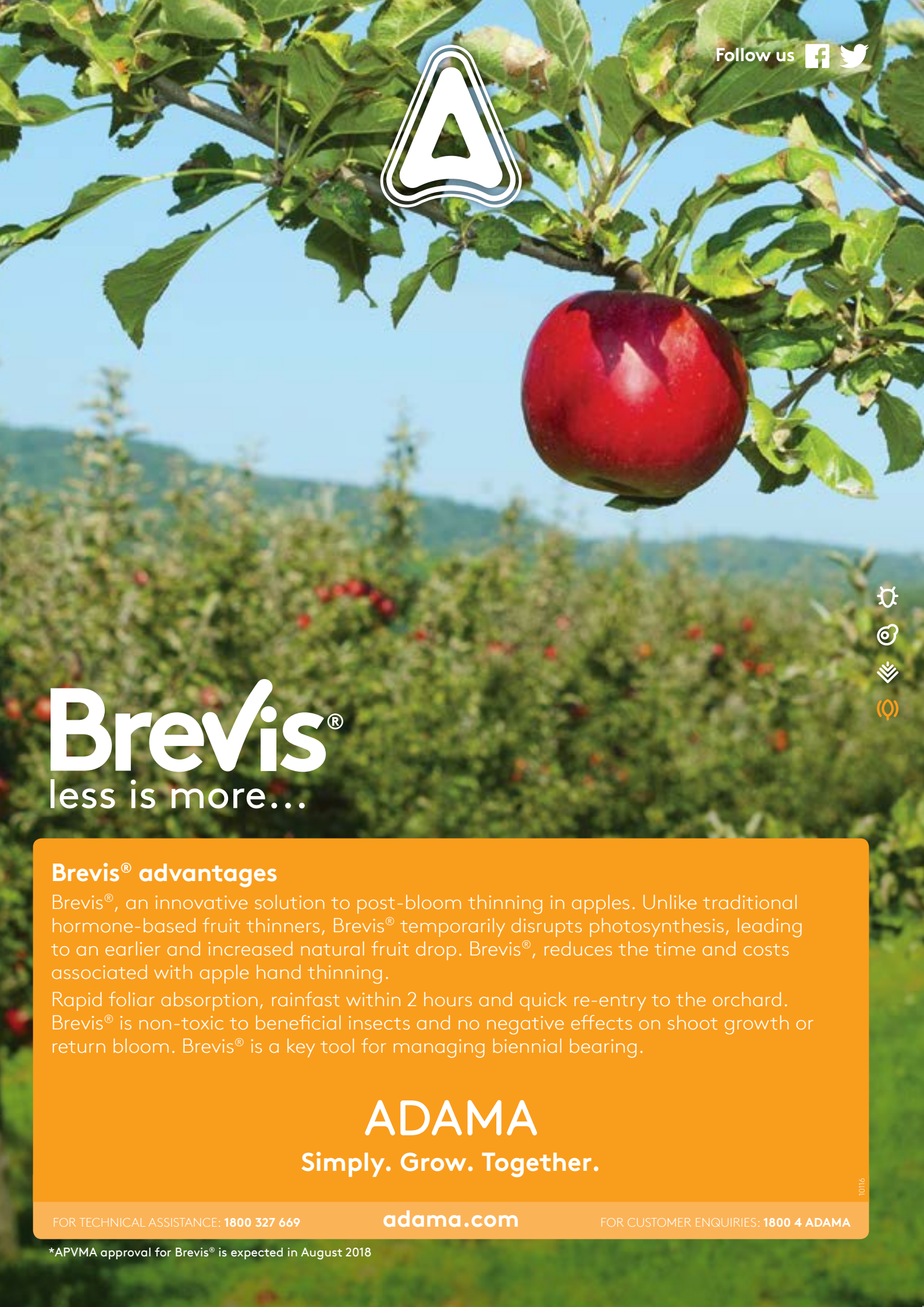
Month	Reason	Treatment	Remarks
November–December (continued)	European red mite (ERM) and two-spotted mite (TSM) (continued)		Use only one application of abamectin, bifenazate and tebufenpyrad in a season. Consecutive applications between seasons must also be avoided. See 'Avoiding resistance to miticides', page 126. Use of a commercial mite monitoring service will assist choice and timing of treatment.
	Magnesium deficiency	Foliar treatment: magnesium sulfate + wetting agent Soil treatment: materials and rates according to soil test analysis. Seek advice	Non-bearing trees often express magnesium deficiency symptoms. Symptoms occur in January/February. Preventative sprays should be applied in December. See 'Nutrient sprays', page 108 for rate. Highly susceptible varieties such as Fuji might require soil treatments to overcome deficiencies. Warning: Avoid spraying russet sensitive varieties.
	Light brown apple moth (LBAM)	Chlorpyrifos (1B) (WG or WP formulation) OR spinetoram (5)	Where mating disruption alone is used for codling moth, fruit will be unprotected from LBAM. Check blocks regularly for infestation and apply treatment only if necessary. Chlorantraniliprole program for codling moth will help to control LBAM. Target sprays of spinetoram against mature eggs and newly hatched larvae.
LATE SEASON (DECEMBER TO HARVEST)			
December	Scab	Scab fungicide (see September)	Apply an eighth protective fungicide spray 21 days after the seventh. Length of this and subsequent spray intervals for scab control will depend on the weather and if any infection on either fruit or foliage has developed. A shorter interval will be required on infected trees. Warnings: • do not use dithianon after early December on clear-skinned varieties or on any apples to be cool stored because of possible adverse effects on fruit finish. This restriction does not apply to apples intended for controlled atmosphere (CA) storage • some of the recommended fungicides have export harvest intervals of up to 70 days. It is best to avoid these chemicals if fruit is intended for export. Always read the label and if unsure of the chemical's export harvest interval, contact your reseller.
	To reduce vegetative growth	Paclobutrazol	Apply second application 21 days after the first and subsequent treatments at 21-day intervals. These are applied at the lower rate recommended. Final application no later than 21 days before harvest.
	Bitter rot	See November	See November.
	Powdery mildew	See September–October	Protect new growth until terminal bud has formed and leaves have hardened off. No further spraying for powdery mildew should be necessary until autumn. A late November spray should give adequate protection until mildew action diminishes about mid-December. Highly susceptible varieties might benefit, however, from a further spray during summer. Care should be taken to protect young trees so that tree training is not affected by mildew.
	Codling moth and light brown apple moth (LBAM)	Fenoxycarb (7B) (40 g/100 L) OR	See November–December. The fifth application should be made 28–42 days after the fourth. Use sex pheromone traps to help time sprays.
		indoxacarb (22A)	Change to an alternative product after six applications.
	Codling moth	Chlorantraniliprole (28) OR	Limit to three applications then continue with different mode of action.
		thiacloprid (4)	See November–December.
	Light brown apple moth (LBAM)	Chlorpyrifos (1B) OR spinetoram (5)	See November–December. See spinetoram label for restrictions on the number of sprays.

Month	Reason	Treatment	Remarks
December (continued)	Two-spotted mite	Bifenazate (UN) OR etoxazole (10B) OR propargite (12C) OR tebufenpyrad (21A)	Start regularly checking foliage, particularly in tree centres for mites and predators. Using an 8–10× hand lens is recommended. Use a commercial mite monitoring service. Tebufenpyrad is not as effective against TSM as against ERM. Use only one application of bifenazate, etoxazole or tebufenpyrad in a season and avoid consecutive sprays between seasons. See 'Avoiding resistance to miticides', page 126.
December–March	Wingless grasshopper	Chlorpyrifos (1B) OR indoxacarb (22A)	Blocks of young non-bearing trees can be severely attacked in some localities as herbage dries out. Infestation can occur from early December onwards, depending on the district and nature of season. Infestation can continue until February. In moist seasons, where there is ample green herbage, grasshoppers should not be a problem. Regularly mow grass both within and surrounding the block to reduce host plants and help keep grasshoppers away from trees. For ground spraying use chlorpyrifos: 500 mL of 500 g/L product/ha. Warning: Stock should not be allowed to graze herbage for 14 days after it has been sprayed.
	Control of preharvest drop	1-naphthylacetic acid (NAA)	Apply a few days before anticipated fruit drop. NAA is effective for about 14 days but two applications might be required if harvesting is delayed.
January	Woolly aphid	Chlorpyrifos (1B) OR	Infestation of new season's lateral growth might not appear until January.
		Fflonicamid (9C) OR	A minimum re-treatment interval of 14 days must be observed. Do not apply more than three applications.
		sulfoxaflor (4C)	Do not apply more than two sprays per season. Highly toxic to bees while spray is wet. Do not apply while bees are foraging in the crop.
	Bitter pit	See November	See November.
	Scab	See September	Spray at 28–42-day intervals depending on the weather and if any infection on either fruit or foliage has developed. Jonathans might not need to be sprayed provided no leaf or fruit infection can be found on careful examination.
	Codling moth and light brown apple moth (LBAM)	Fenoxycarb (7B) (40 g/100 L)	Apply a sixth application 28–42 days after the fifth.
	Light brown apple moth (LBAM)	Chlorpyrifos (1B) OR spinetoram (5)	See November–December. See spinetoram label for restrictions on the number of sprays.
	Bitter rot	See November	See November.
	To reduce vegetative growth	Paclobutrazol	Apply 21 days after previous application at lower rate recommended. Do not treat later than 21 days before harvest. See other comments November.
January–February	European red mite	Bifenazate (UN) OR propargite (12C) OR tebufenpyrad (21A)	Maintain monitoring service or keep trees under observation. Depending on the effectiveness of earlier spray, a further one might be necessary. Use only one application of bifenazate or tebufenpyrad in a season and avoid consecutive sprays between seasons. There is resistance to tebufenpyrad in some districts. See 'Avoiding resistance to miticides', page 126.
	Two-spotted mite	See December	See December.

Month	Reason	Treatment	Remarks
January–April	Queensland fruit fly (QFF). For a complete list of permits refer to page 4	1. Hang male lures in orchard as indicator of fly presence 2. apply baits 3. spray with trichlorfon (1B) OR acetoxyphenylbutanone (Amulet® Cue-Lure)	1. In seasons of good summer rains, QFF can be present from January at Bilpin and February in other susceptible districts. Three-quarter-developed fruit may be attacked. 2. see article on page 4. 3. trichlorfon, start spraying at the first sign of stings, use 500 mL/100 L then weekly at 250 mL/100 L. Sprays may be substituted for, or complement, baiting and should only be necessary in warmer districts. In the interests of IPM, avoid sprays if possible. Trichlorfon is very toxic to *Phytoseiulus persimilis*. The effect on other predators is unknown. A grid system of 16 Amulet® (fipronil) fly lures per hectare has been reported to give effective control when used in conjunction with monitoring traps and good crop hygiene.
		Clothianidin (4A) OR maldison	Apply three consecutive foliar sprays of clothianidin 7 days apart when monitoring indicates fruit fly action. Do not apply if bees are foraging in the orchard. Apply a maximum of four maldison applications per season with a minimum of 7 days between consecutive sprays.
	Improve harvest management, fruit quality and enhance storage potential	Aviglycine	Apply 21–28 days before harvest. Check label for varieties.
February	Scab	See September	Spray at 28–42-day intervals depending on the weather and if any infection on either fruit or foliage has developed. Jonathans might not need to be sprayed provided no leaf or fruit infection can be found on careful examination.
	Bitter rot and bitter pit	See November	See November.
	Codling moth and light brown apple moth (LBAM)	Fenoxycarb (7B)	Apply seventh spray 28–42 days after the sixth on later maturing varieties. See January.
	Light brown apple moth (LBAM)	Chlorpyrifos (1B) OR spinetoram (5)	See November–December. See spinetoram label for restrictions on the number of sprays.
February–March	To hasten maturity, improve colour of Jonathan and Delicious	Ethephon + 1-naphthylacetic acid (NAA) + wetting agent	Applying 14–21 days before normal harvesting date will advance maturity by 7–10 days. Temperature changes following application will influence ripening rate. The NAA has a 'stop drop' effect. Fruit will grow little after treatment, so do not spray underdeveloped fruit. Take care not to delay harvesting. Store fruit for a short time only. Warning: Do not apply to weak trees or those stressed by heat, drought, waterlogging or disease.
February–April	Woolly aphid	Pirimicarb (1A) OR chlorpyrifos (1B) OR	Infestation is most likely to occur in the centres of dense vigorous trees and might not appear until late summer or early autumn. Keep very close watch for this because woolly aphid should not be allowed to build up on bearing trees. Observe withholding periods.
		flonicamid (9C) OR	Note: 21 day withholding period.
		sulfoxaflor (4C)	Do not apply more than two sprays per season. Highly toxic to bees while spray is wet. Do not apply while bees are foraging in the crop.
	Sooty blotch and fly speck	Mancozeb (M3)	These diseases are troublesome in damp, humid areas, especially in coastal districts. The diseases become apparent as fruit approaches maturity. Orchards where a minimum of cover sprays are applied for black spot control are more susceptible. In affected orchards apply sprays at 21-day intervals starting in early February. This fungicide will also control scab and bitter rot. Mancozeb is toxic to *G. pyri*. See table, page 126.

Month	Reason	Treatment	Remarks
February–May	Postharvest disorders	See 'Pome fruit – harvested fruit', page 65	See 'Pome fruit – harvested fruit', page 65.
March	Scab and powdery mildew	Scab fungicide + mildew fungicide (see September)	Spray for scab at intervals not exceeding 21 days during March and April. Longer intervals can lead to late scab development either on the tree or in store. Include mildew sprays only on varieties highly susceptible to mildew, but do not exceed the number of sprays recommended for each group.
	Bitter rot	See November	See November.
	Light brown apple moth (LBAM)	Chlorpyrifos (1B)	If required and if the codling moth schedule has stopped.
	Control of preharvest drop	See December–March	See December–March.
	Bitter pit	See November	See November.
	Scab and storage rots	Scab fungicide (see September)	Spray intervals longer than 21 days could allow late scab to develop either on the tree or in store.
March–May	Bitter rot	See November	Continue spraying late varieties at intervals of 21 days in districts where bitter rot has caused losses at this time in past seasons. These fungicides will also control scab.
	Sooty blotch and fly speck	Mancozeb (M3)	Spray late maturing varieties in districts where infection is common. Mancozeb is toxic to *G. pyri*. See table, page 126.
POSTHARVEST TO PRE-LEAF FALL			
April–May	Scab	Urea	This postharvest treatment is recommended for reducing the primary spore population which overwinters in leaves. It is a valuable supplement to scab control and should be used annually, but is especially valuable after a bad scab year. Urea has some nutritive value. Apply after picking but not before the end of April. It is essential to thoroughly cover lower surfaces of leaves. If necessary, apply a light ground spray to contact all fallen leaves – no special attention to a ground spray will be necessary where dilute sprays by air-blast are used. Better results can be expected if the orchard floor is clean at the time of spraying. Any treatment such as mowing and mulching that hastens leaf breakdown will help to reduce overwintering scab. Warnings: • some damage by urea to spurs and laterals has occurred in very dry seasons • care should be taken to avoid over-spraying with urea. This is most likely to occur on headland trees.
May	Woolly aphid	Chlorpyrifos (1B) OR imidacloprid (4)	Mark infested trees in late summer or autumn to help identify trees to be treated with imidacloprid in the following spring, but read product label for restrictions. Alternatively, apply chlorpyrifos as a postharvest spray when a lot of leaves have fallen. Monitor for ongoing infestations in the following spring
May–August	Rabbits and hares	Protect trees with sound netting fence	Young trees can be severely damaged from early May through to late August. It is also helpful to place apple or plum prunings around headlands – these are very attractive to the pests and help to divert them from trees. Scatter fresh prunings every 14–21 days.
	Sunscald	Paint trunk	Paint tree butts with white acrylic paint for sunscald protection.
	Rabbits, hares and sunscald	Cover with insulating paper	Cover the trunks with aluminium-coated paper. Staple the paper around the tree, foil side out. Plastic guards are also available commercially.

Month	Reason	Treatment	Remarks
DORMANCY			
June–July	Zinc deficiency	Zinc sulfate	Apply when fully dormant before pruning. If symptoms are mild, the dosage can be halved.
June–August	Powdery mildew	Remove infected buds when pruning	Removing infected material when pruning is most important for good mildew control. It is particularly important to tip-prune infected buds from Jonathans.
	Bitter rot	Remove and burn mummified fruits and dead wood when pruning	Remove all 'mummies' that failed to set, but which are still attached to trees. In areas where bitter rot occurs, most of these will be infected.
	Apple scab, alternaria leaf spot and fruit blotch	Sweep and mulch leaf matter	The destruction of overwintering leaves from the previous season will help to reduce disease pressure and inoculum levels in spring.
	San José scale	Horticultural mineral oil (HMO)	In orchards where scale is known to be present, apply oil at 2–3 L/100 L at any time between mid-June and mid-August when trees are dormant. Spraying before pruning is preferable as scale can survive on prunings on the ground. In districts where this pest is a problem, an annual oil spray might be necessary. Elsewhere, an oil spray every second year is advisable, even if scale is not apparent, because once scale becomes established on trees, it is difficult to control. Sprays for San José scale control should be applied dilute and very thoroughly, taking care to thoroughly wet trunks, limbs and twigs, and penetrate cracks and crevices in the bark. Warning: Only one full strength oil spray (3 L/100 L) should be applied in a season. An interval of at least 28 days between a full-strength oil spray and green tip application is desirable.
		Sanitation: spray with oil as above OR cut down and burn	Scale can build up heavily on neglected fruit tree seedlings around orchard areas, on many ornamental trees and shrubs related to the apple and on several non-related hosts, e.g. tree lucerne, osage orange and willow. Wind and birds can spread scale from these to apples. Such sources of infestation should not be overlooked in areas where scale is a problem. Infested deciduous ornamentals should be sprayed with oil. Neglected apple trees and other hosts should be cut down and burnt.
	Cork disorders (boron deficiency)	Borax (soil dressing)	Apply at any convenient time in winter or early spring. Use 80 g of 11% granules around small trees increasing to 300 g for large trees. Distribute evenly around each tree beneath the canopy. Apply every fourth or fifth year or when symptoms appear. Soil analysis is recommended on a 3-year basis.
	Magnesium deficiency	Dolomite OR magnesium carbonate OR magnesium oxide OR magnesium sulfate	The treatment product and rate should be based on a soil test. A deficiency can take 2–3 years to be corrected. Seasonal foliar sprays might be required during this period.
August	Control bud break	Methyl esters of fatty acids OR	Apply 35–50 days before normal bud break to advance bud break. Apply 20 days before normal bud break to delay bud break (some flower bud thinning can also occur). Test on a small number of trees when first using and compare with similar untreated trees. Keep records of all treatments and conditions. Variety responses could vary.
		cyanamide	Apply at 30–45 days before expected budburst (50% green tip) of apples to advance budburst and flowering.



Brevis® advantages

Brevis®, an innovative solution to post-bloom thinning in apples. Unlike traditional hormone-based fruit thinners, Brevis® temporarily disrupts photosynthesis, leading to an earlier and increased natural fruit drop. Brevis®, reduces the time and costs associated with apple hand thinning.

Rapid foliar absorption, rainfast within 2 hours and quick re-entry to the orchard. Brevis® is non-toxic to beneficial insects and no negative effects on shoot growth or return bloom. Brevis® is a key tool for managing biennial bearing.

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*APVMA approval for Brevis® is expected in August 2018

Pears

Pesticides

Table 7. Chemicals registered[1] for the management of pear pests and crop regulation in NSW.

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Apple leaf hopper	3	Maldison	insecticide with contact, stomach and respiratory action
Apple weevil	3	Alpha-cypermethrin	non-systemic insecticide with contact and stomach action
	1	Indoxacarb	insecticide with contact and stomach action
Bitter rot	1	Copper oxychloride	protective fungicide and bactericide
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	non-systemic foliar fungicide with protective action
	1	Zineb (Zineb®)	protective fungicide
Blue mould	1	Fludioxonil	protective fungicide with contact action
	1	Imazalil	systemic fungicide with protective and curative action
	1	Iprodione	contact fungicide with protective and curative action
	1	Thiabendazole	systemic fungicide with protective and curative action
Bryobia mite	1	Bifenazate	acaricide with contact and residual action against motile stages
	1	Clofentezine (Apollo®)	acaricide with contact action, and long residual action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	1	Fenbutatin oxide (Torque®)	acaricide with contact and stomach action, controls motile stages
Budworms (*Helicoverpa* spp.)	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	3	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	3	Chlorantraniliprole + abamectin (Voliam Targo®)	acaricide and insecticide combination
	1	*Helicoverpa* NPV	biological insecticide with stomach action
	1	Indoxacarb	insecticide with contact and stomach action
	2	Spinetoram (Delegate®)	insecticide with contact and stomach action
Codling moth	3	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	3	Chlorantraniliprole + abamectin (Voliam Targo®)	insecticide and acaricide combination
	3	Clothianidin (Samurai®)	systemic insecticide
	1	Codling moth mating disruptant	insect sex pheromone
	1	*Cydia pomonella granulosis* virus	biological insecticide with stomach action
	1	Fenoxycarb (Insegar®)	insect growth regulator insecticide with ovicidal action
	1	Indoxacarb	insecticide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
	3	Methidathion	non-systemic insecticide, acaricide with contact and stomach action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spinetoram (Delegate®)	insecticide with contact action
	2	Thiacloprid (Calypso®)	systemic insecticide with contact and stomach action
Drop prevention/ reduction	ID	1-naphthylacetic acid	plant growth regulator

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
European red mite	3	Abamectin	acaricide with stomach action, some translaminar movement
	3	Abamectin + chlorantraniliprole (Voliam Targo®)	acaricide and insecticide combination
	1	Bifenazate	acaricide with contact and residual action against motile stages
	1	Clofentezine (Apollo®)	acaricide with contact action, and long residual action
	3	Etoxazole (Paramite®)	acaricide with contact and residual action against motile stages
	1	Fenbutatin oxide (Torque®)	acaricide with contact and stomach action, controls motile stages
	1	Hexythiazox (Calibre®)	non-systemic acaricide with contact and stomach action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	3	Milbemectin (Milbeknock®)	acaricide with contact and stomach action
	2	Tebufenpyrad (Pyranica®)	acaricide with contact action
Fly speck	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	non-systemic foliar fungicide with protective action
Fruit thinning	ID	1-naphthylacetic acid (NAA)	plant growth regulator
	3	Carbaryl	contact insecticide with stomach action
Fullers rose weevil	1	Indoxacarb	insecticide with contact and stomach action
	3	Alpha-cypermethrin	non-systemic insecticide with contact and stomach action
	1	Indoxacarb	insecticide with contact and stomach action
Light brown apple moth (LBAM)	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	2	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	3	Chlorantraniliprole + abamectin (Voliam Targo®)	acaricide and insecticide combination
	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	1	Fenoxycarb (Insegar®)	insect growth regulator insecticide with ovicidal action
	1	Indoxacarb	insecticide with contact and stomach action
	3	Methidathion	non-systemic insecticide, acaricide with contact and stomach action
	1	Methoxyfenozide (Prodigy®)	insecticide that lethally accelerates the moulting process
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spinetoram (Delegate®)	insecticide with contact action
Longtail mealybug	1	Buprofezin	persistent insecticide and acaricide with contact and stomach action
	3	Clothianidin (Samurai®)	systemic insecticide
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spirotetramat (Movento®)	systemic insecticide with stomach action
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Loopers	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	1	Methoxyfenozide (Prodigy®)	insecticide that lethally accelerates the moulting process
	2	Spinetoram (Delegate®)	insecticide with contact and stomach action
Oriental fruit moth (OFM)	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	3	Chlorantraniliprole + abamectin (Voliam Targo®)	acaricide and insecticide combination
	1	*Cydia pomonella granulosis* virus	biological insecticide with stomach action
	1	OFM mating disruptant	insect sex pheromone
	2	Spinetoram (Delegate®)	insecticide with contact action
	2	Thiacloprid (Calypso®)	systemic insecticide with contact and stomach action
Oystershell scale	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
Pear and cherry slug	3	Carbaryl	contact insecticide with stomach action
	2	Spinetoram (Delegate®)	insecticide with contact action
Pear leaf blister mite	3	Carbaryl	contact insecticide with stomach action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	3	Sulfur as polysulfide (lime sulfur)	fungicide/insecticide/acaricide with contact and vapour action

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Pear scab and black spot	1	Boscalid + pyraclostrobin (Pristine®)	fungicide mixture of two actives, both with protective action
	1	Captan	protective fungicide
	1	Copper (as ammonium acetate)	protective fungicide and bactericide
	1	Copper (as tribasic copper sulfate) (Tribase Blue®)	protective fungicide and bactericide
	1	Copper cuprous oxide	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Cyprodinil (Chorus®)	protective fungicide
	1	Difenoconazole (Bogard®)	systemic fungicide with protective and curative action
	1	Dithianon	fungicide with protective action
	1	Dodine (Syllit®)	fungicide with protective and some curative action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	1	Hexaconazole	systemic fungicide with protective and curative action
	ID	Isopyrazam (Seguris Flexi®)	protective fungicide
	1	Kresoxim-methyl	systemic fungicide with protective and curative action
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	protective fungicide
	1	Myclobutanil	systemic fungicide with protective and curative action
	1	Penconazole	systemic fungicide with protective and curative action
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	3	Sulfur as polysulfide (lime sulfur)	fungicide/insecticide/acaricide with contact and vapour action
	1	Thiram	protective fungicide
	1	Trifloxystrobin (Flint®)	systemic fungicide with protective and curative action
	1	Zineb (Zineb®)	protective fungicide
	2	Ziram	protective fungicide
Queensland fruit fly (QFF). For a complete list of permits refer to page 4	3	Clothianidin (Samurai®)	systemic insecticide
	1	Fipronil (Amulet Cue-Lure®)	bait/lure
	3	Maldison (Fyfanon® 440EW)	insecticide with contact, stomach and respiratory action
	1	Spinosad (Naturalure™)	bait/lure
	3	Trichlorfon	insecticide and acaricide with contact and stomach action
Ripe fruit spot (target spot)	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Iprodione (dip only)	contact fungicide with protective and curative action
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	protective fungicide
Rutherglen bug	3	Trichlorfon	insecticide and acaricide with contact and stomach action
San José scale	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	3	Diazinon	non-systemic insecticide and acaricide with contact, stomach and respiratory action
	1	Fenoxycarb (Insegar®)	insect growth regulator insecticide with ovicidal action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	3	Methidathion	non-systemic insecticide and acaricide with contact and stomach action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spirotetramat (Movento®)	systemic insecticide with stomach action
Sooty blotch	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	protective fungicide

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
	1	Zineb (Zineb®)	protective fungicide
Storage quality improvement	NA	1-methylcyclopropene (1-MCP)	postharvest treatment
Storage rot (blue and/or grey moulds. Check species on label)	1	Fludioxonil	protective fungicide with contact action
	1	Imazalil	systemic fungicide with protective and curative action
	1	Iprodione	contact fungicide with protective and curative action
	1	Thiabendazole	systemic fungicide with protective and curative action
Superficial scald	ID	1-methylcyclopropene (1-MCP)	postharvest treatment
	ID	Diphenylamine	anti-scald compound
Thrips	3	Maldison	insecticide with contact, stomach and respiratory action
Tuber mealybug	3	Clothianidin (Samurai®)	systemic insecticide
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spirotetramat (Movento®)	systemic insecticide with stomach action
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Two-spotted mite (TSM)	3	Abamectin	acaricide with stomach action, some translaminar movement
	3	Abamectin + chlorantraniliprole (Voliam Targo®)	acaricide and insecticide combination
	1	Bifenazate	acaricide with contact and residual action against motile stages
	1	Clofentezine (Apollo®)	acaricide with contact action, and long residual action
	3	Etoxazole (Paramite®)	acaricide with contact and residual action against motile stages
	1	Fenbutatin oxide (Torque®)	acaricide with contact and stomach action, controls motile stages
	1	Hexythiazox (Calibre®)	non-systemic acaricide with contact and stomach action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	3	Methidathion	non-systemic insecticide, acaricide with contact and stomach action
	3	Milbemectin (Milbeknock®)	acaricide with contact and stomach action
	2	Propargite	acaricide with contact action against active stages
	2	Tebufenpyrad (Pyranica®)	acaricide with contact action
Western flower thrips (WFT)	2	Spinetoram (Delegate®)	insecticide with contact and stomach action
Wingless grasshopper	2	Carbaryl	contact insecticide with stomach action
	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	1	Indoxacarb	insecticide with contact and stomach action
Woolly aphid	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	3	Maldison	insecticide with contact, stomach and respiratory action
	3	Methidathion	non-systemic insecticide and acaricide with contact and stomach action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spirotetramat (Movento®) (suppression only)	systemic insecticide with stomach action
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action

[1]Source: InfoPest http://infopest.com.au and APVMA Pubcris https://portal.apvma.gov.au/pubcris

[2]Trade names (in brackets) are included where only one product is registered for that common name. Coloured dots before the chemical common name denote that chemical's compatibility with IPM.

[3]Adapted from The Pesticide Manual, 14th Edition, British Crop Protection Council 2006.

1 indicates that – when used with care – a chemical will have very little effect on beneficials and is recommended in an IPM program.

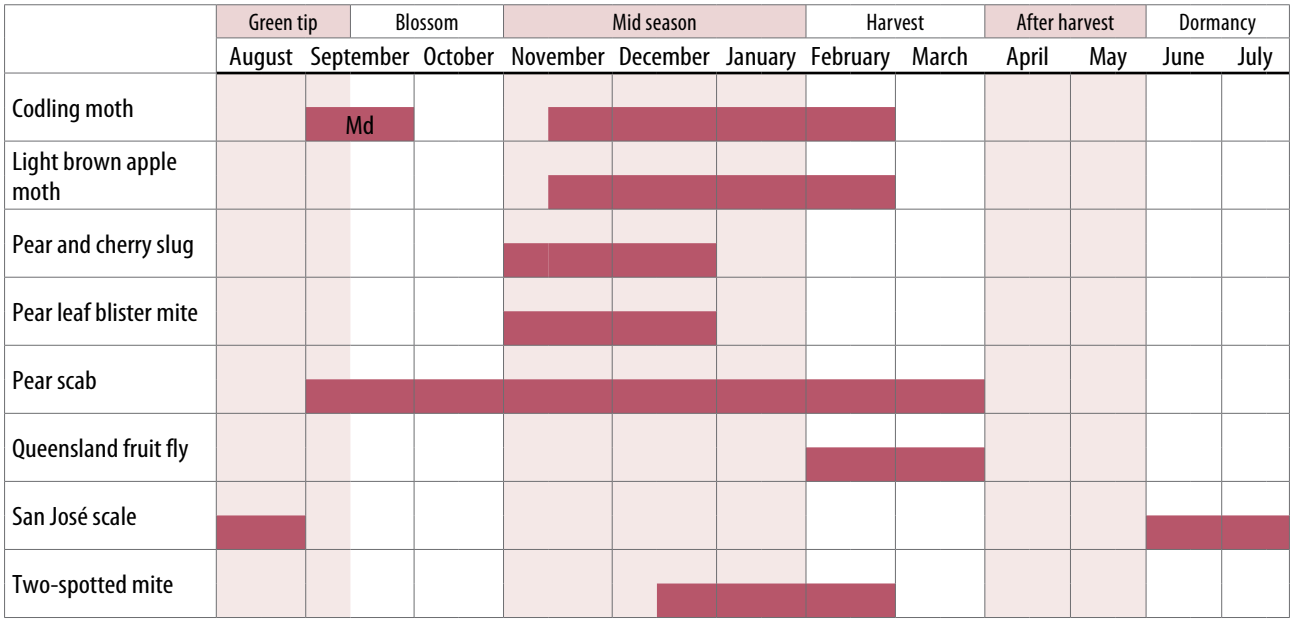
2 indicates that this pesticide can be used with caution in an IPM program, but the chemical's effect on beneficials present should be assessed before application.

3 indicates that this chemical is likely to have a negative off-target effect including on beneficial arthropods.

ID indicates that there is insufficient data for a rating to be given.

Pests and growing periods in pears

Table 8. Pears – pests and growing periods.



Note: This is a guide only. The status and treatment time for each problem varies across districts. Monitoring is critical to avoid unnecessary or poorly-timed sprays.

Likely timing for monitoring and treatment.

Soil treatment

MD — mating disruption.

Further information

See page 38 for details on the chemical names used and other information about these tables.

For information on non-bearing trees, see page 106.

These free Agfacts/Primefacts provide more detail on some problems in pears. They are available in the Agriculture section of the NSW Department of Primary Industries website as a portable document file (pdf) at www.dpi.nsw.gov.au/content/agriculture/horticulture/pomes

- Apple and pear nutrition: Primefact 85
- Apple and pear scab: H4.AB.4
- Boron deficiency (cork) in pome fruits: H4.AC.2.

See page 130 for other useful publications.

Management calendar for pears

Table 9. Pears – calendar.

Month	Reason	Treatment	Remarks
GREEN TIP			
August–September	Scab	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR copper oxychloride (M1) OR tribasic copper sulfate (M1)	Apply first spray at green tip stage, late August to early September. Winter Cole and Josephine pears can be damaged by copper sprays.
		Captan (M4) OR cyprodinil (9) OR difenoconazole (3) OR dithianon (M9) OR dodine (M7) OR hexaconazole (3) OR isopyrazam (7) OR kresoxim-methyl (11) OR mancozeb (M3) OR metiram (M3) OR myclobutanil (3) OR penthiopyrad (7) OR thiram (M3) OR trifloxystrobin (11) OR ziram (M3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Apply one of these fungicides at spurburst and again 10 days later at approximately white bud stage, except difenoconazole which is applied 10 days after spurburst. Note restrictions on the number of applications of some products and the need to mix some with protectives. Neglecting scab on non-bearing trees can, in seasons favourable to its development, cause leaf drop, reduced growth and eventually reduced cropping. The curative or 'after infection' method of control can be employed to save unnecessary protective applications on young trees. Do not apply kresoxim-methyl to pears where there is a risk of drift to cherries. Curative sprays, to be effective, must be applied as soon as possible after infection has occurred. The effective periods for the fungicides recommended here are: 1.5 days: dodine 4 days: hexaconazole 5 days: difenoconazole, myclobutanil See manufacturers' labels for advice on mixing with protective sprays. Note restrictions on the number of sprays for each fungicide group. See product labels and article on fungicide resistance on page 126. Warnings: • do not use cyprodinil after petal fall • do not use dodine at temperatures close to freezing from white stage on as fruit russetting can occur.
PRE-BLOOM			
September	Codling moth	Mating disruption	Apply dispensers within the top 30 cm of the tree, before any adult codling moth action commences. Do not use on blocks of less than 3 ha or irregular shaped blocks. No other codling moth control should be needed if infestation in the previous season was less than 0.3%. If more than 0.3%, partial or full supplementation with insecticide is recommended. Seek advice from reseller or consultant. Monitoring for codling moth action throughout the season is important.
BLOSSOMING			
October	Scab	See list above	Warning: In October the danger of scab infection is very high. Income for the year can depend upon efficiently operating spray machinery and maintaining a close schedule of sprays throughout the month. Aim to spray every 10 days through October.
MID SEASON – AFTER PETAL FALL TO HARVEST			
November	Cork disorders	Boron	Proceed as for apples.
	Scab	See September	Spray intervals can be lengthened to 14 days.
	Codling moth and light brown apple moth (LBAM)	Fenoxycarb (7B) (20 g/100 L) OR	See Apples, October–November. Apply three applications at 7-day intervals, commencing 7–10 days after complete petal fall.
		indoxacarb (22A) OR	Use in November–December only, maximum of six applications. See label for details on timing sprays.

Month	Reason	Treatment	Remarks
November (continued)	Codling moth and light brown apple moth (LBAM) (continued)	a proprietary mixture of novaluron (15) + acetamiprid (4A) OR	Target the first generation of codling moth just before egg hatch. Apply against LBAM, after petal fall, around 140 degree days from biofix. Do not apply during flowering. Toxic to bees.
		a proprietary mixture of chlorantraniliprole (28) + abamectin (6)	Do not make more than one application of Voliam Targo® per season. Highly toxic to bees. Do not spray while bees are actively foraging. Do not allow spray drift to flowering weeds or flowering crops in the vicinity of the treatment area.
	Codling moth	Chlorantraniliprole (28) OR	Maximum three applications 14–21 days apart, starting at petal fall (or before 110 degree days after codling moth detected in traps) until late December. Program also useful for controlling budworm, OFM and LBAM.
		clothianidin (4) OR thiacloprid (4)	Apply the first spray by the time 110 degree days after biofix has been reached. Continue applications (maximum of four) at 14-day intervals until four sprays have been used.
November–December	Pear and cherry slug	Carbaryl (1A) OR spinetoram (5)	Apply as soon as infestation noticed.
	Pearleaf blister mite	Carbaryl (1A)	Apply only if infestation evident. Carbaryl is toxic to *Galendromus occidentalis*.
	San José scale	Novaluron (4A) + acetamiprid (15) OR spirotetramat (23)	Apply novaluron + acetamiprid to control crawlers from petal fall in rotation with insecticides from alternative mode of action groups. Do not apply spirotetramat before before fruitlets reach 10 mm diameter. Continue monitoring and apply further applications when new generations appear. Do not reapply within 14 days of a previous application of spirotetramat.
November–February	Two-spotted mite	Abamectin (6) OR bifenazate (UN) OR fenbutatin oxide (12B) OR milbemectin (6B) OR tebufenpyrad (21A)	Two-spotted mite can cause severe scorching and leaf drop in periods of hot, dry weather, particularly in shallow soils with poor moisture holding capacity. This effect can be produced by relatively few mites. Keep foliage under observation, particularly in the centres of the trees (use an 8–10× hand lens). If mites appear in moderate numbers and predators are scarce, thoroughly applying one of the listed treatments is recommended. Abamectin must be mixed with a horticultural mineral oil to assist leaf penetration. See label for details. It is not as necessary to apply abamectin to pears within the first 42 days after petal fall as it is for apples. See warning, Apples, November–December. Milbemectin can be used in much the same way as abamectin for early control of overwintering populations as they hatch from eggs. Refer to the product label for specific information on timing of spray. Do not apply more than one application per season. Provided predators are present, no further application should be necessary, but continue to keep trees under observation. Using bifenazate and tebufenpyrad is restricted to one application in a season. Avoid consecutive applications between seasons. See 'Avoiding resistance to pesticides', page 126. Warnings: Resistance to tebufenpyrad in two-spotted mite has been diagnosed in some districts.
	European red mite	Abamectin (6) OR bifenazate (UN) OR fenbutatin oxide (12B) OR milbemectin (6B) OR tebufenpyrad (21A)	European red mite rarely occurs on pears. Fenbutatin oxide (at full rate) will control a moderate infestation. Alternatively use abamectin (see TSM) or bifenazate or tebufenpyrad but only one application of any of these should be used in a season, regardless of the pest and consecutive applications of any of these miticides between seasons must be avoided. See 'Avoiding resistance to pesticides', page 126. Milbemectin can be used in much the same way as abamectin for early control of overwintering populations as they hatch from eggs. Do not apply more than one application per season.
December–February	Codling moth and light brown apple moth (LBAM)	Fenoxycarb (7B) (40 g/100 L)	Continue applications to late January or early February. Keep trees under observation after last spray in case of late season infestation. Watch interval between spraying and harvest (14 days) with early-maturing varieties. Fourth and subsequent applications at this rate. See Apples section for timing.
	Codling moth	Thiacloprid (4)	Continue applications at 14-day intervals. Do not apply more than four sprays in one season. For the remainder of the season, use a different chemical as required.

Month	Reason	Treatment	Remarks
December–February (continued)	Scab	See August–September	Frequency of application will depend on seasonal conditions and amount of infection already present. Generally, monthly or even longer intervals will be satisfactory in clean orchards. However, if infection occurred in spring, a spraying interval of 21 days should be maintained. Some of the recommended fungicides have export harvest intervals of up to 70 days. It is best to avoid these chemicals if fruit is intended for export. Always read the label and if unsure of the chemical's export harvest interval contact your reseller.
January–February	Control of preharvest drop	1-naphthylacetic acid (NAA)	Should be applied a few days before anticipated fruit drop on susceptible varieties. Effective for about 14 days. Two applications might be required if harvesting is delayed.
February–March	Queensland fruit fly (QFF)	See Apples	See Apples.
March	Scab	See December–February	On later maturing varieties, apply spray approximately 21 days before picking is due to start.
POSTHARVEST TO LEAF FALL			
February–April	Postharvest scald and rots	See Pome fruit – harvested fruit	See Pome fruit – harvested fruit.
	Two-spotted mite	Propargite (12C)	Apply immediately after harvest if required. Use high volume. Continue to monitor for predators.
April	Scab	Urea	See Apples.
DORMANCY			
June	Zinc deficiency	Zinc sulfate	Apply during dormant period, before pruning. If symptoms are mild, dosage may be halved. See 'Nutrient sprays for deciduous fruits', page 108, for rates.
June–August	San José scale	Horticultural mineral oil and sanitation	See Apples.
July–August	Cork disorders	Boron	Proceed as for apples.

Pome fruit – harvested fruit

Preparing postharvest treatments for apples and pears

Compatibility

Diphenylamine (DPA) is compatible with some postharvest fungicides and calcium chloride. Check labels to see which products are compatible.

Mixing

Premix DPA in a small amount of water and then add to the tank. Add fungicide(s) individually to the tank mix (if required). If calcium is required, it should be added to the dip last, but must be dissolved in water before being added.

Thoroughly mix the dip before treating fruit (run pump and agitator for at least 5 minutes).

Other postharvest treatments

The active constituent 1-methylcyclopropene (1-MCP) is registered in Australia for postharvest apple and pear treatments. It was developed to help apples maintain their fresh picked qualities (e.g. crunchiness, taste and juice content) and to control superficial scald. It works with the natural ripening process to temporarily stop fruit from producing ethylene, and from responding to outside sources of ethylene. The negative effects associated with ripening are delayed and quality can be maintained.

Management calendar for pome fruit

Table 10. Pome fruit – calendar.

Month	Reason	Treatment	Remarks
February–May	Superficial scald: • apples and pears • pome fruit	Diphenylamine dip (DPA) OR 1-methylcyclopropene (1-MCP) Refer to next page	See labels for recommended varieties, concentrations and compatible fungicides. The uptake rate of DPA varies with variety. Apply at the recommended rate and avoid treating fruit for too long. Do not use on export fruit unless permitted by the importing country. Effectiveness • DPA should be applied as soon as possible after harvest (preferably within 24 hours). Fruit should not be stored for more than 28 days before dipping • dust or water and chlorine from pre-washed fruit dilute and degrade the dip. If pre-washing, allow fruit sufficient time to drain before dipping in DPA • check that dip and fruit temperatures are within the stipulated range (15–30 °C). Treatment outside this range can result in poor scald control (low temperatures), excessive DPA uptake (high temperatures) or fruit damage.
			Mixing Refer to 'Preparing postharvest treatments' above. Application Follow the manufacturer's recommendations regarding discard and replacement times for dips. In drench systems, DPA is stable under pumping for up to 200 minutes. Agitate drench before use. Ensure that dipping/drenching time is not too long, 10–30 seconds is ideal. Drain fruit and allow it to dry before placing in storage. Test dip strength after 50 bins. Accurately measure top up volume. Do not top up more than three times. Note: dip tanks can provide a source of contamination for storage rot organisms; consider adding a fungicide to control postharvest rots. See 'Postharvest rots' in this table. See also 'Superficial scald', page 32.

Month	Reason	Treatment	Remarks
February–May (continued)	Postharvest rots in apples and pears	Fludioxonil (12) OR imazalil (3) OR iprodione (2) OR thiabendazole (1)	Refer to the label for compatibility with DPA and calcium chloride. Do not use these treatments where fruit is to be exported unless permitted by the importing country. See general note on 'Preparing postharvest treatments' at the start of this section. Refer to product labels for details of the diseases controlled and resistance management strategy.
	Postharvest control of breakdown and bitter pit in apples	Calcium chloride (commercial grade flaked or liquid)	Calcium application can reduce the incidence of disorders such as bitter pit and breakdown and helps to maintain quality during storage. Check variety tolerance to calcium application, as some varieties are more susceptible to injury, for example lenticel spotting in Jonathans. Fruit from older and low-vigour trees are also more sensitive to lenticel spotting. For these, commercial grade calcium chloride treatment should not exceed a rate of 2.5 kg/100 L. Treatment is corrosive to metals. Do not use rusty dip tanks. Drain fruit thoroughly after dipping and immediately place into cool storage. Refer to general note on 'Preparing postharvest treatments' at the start of this section.
	Maintain firmness and titratable acidity, to reduce mealiness in apples and pears. Prevent superficial scald and reduce incidence of greasiness in apples.	1-methylcyclopropene (1-MCP)	1-methylcyclopropene (1-MCP) is a one-time, 24-hour application undertaken in a sealed room directly after harvest. It is applied using a registered applicator. The product comes as specially formulated tablets or powder which, when dissolved in water, releases the active ingredient into the air of the sealed storage room. 1-MCP must be used in airtight treatment areas as leakage will reduce effectiveness. It should be applied within 7 days of harvest and before the climacteric respiration peak. It should not be applied to fruit that have been stressed (poor fertility, heat, drought or sun-scald) or to fruit that have had a preharvest application of ethephon. For best results for long-term storage, fruit should be harvested at optimum maturity for long-term storage, pre-cooled and stored appropriately in either refrigerated air or controlled atmosphere. Refer to the product label further details.
February–January (Storage, sorting and packing season)	Control bacterial growth in process water	Bromochlorodimethyl-hydantoin (Nylate®) OR chlorine-based products OR iodine (AIS Iodine Granules®) OR peroxyacetic acid	Use spray or dip equipment. For use in all water washing systems. Use only (chlorine) products registered for use in fruit and vegetables and processing. Check label for registration and directions for use. AIS Iodine Granules to be used only in conjunction with the AIS® or Isan systems®. Refer to the product label for further information.

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- The Pearl formulation is well proven and has been the standard overseas for Penconazole more than a decade.

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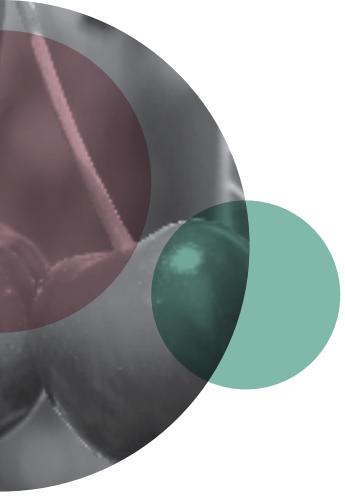


Apricots

Pesticides

Table 11. Chemicals registered[1] for the management of apricot pests and crop regulation in NSW.

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Apple weevil	2	Indoxacarb	insecticide with contact and stomach action
Bacterial canker/ gummosis	1	Copper (as ammonium acetate)	protective fungicide and bactericide
	1	Copper cuprous oxide	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Copper oxychloride and copper hydroxide	protective fungiciade/bactercide
	1	Tribasic copper sulfate	protective fungicide
Bacterial spot	1	Copper oxychloride	protective fungicide and bactericide
Black peach aphid	3	Imidacloprid	contact and stomach insecticide as a foliar spray
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Pirimicarb	systemic aphicide with contact, respiratory and stomach action
	1	Pymetrozine	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
	2	Spirotetramat (Movento®)	systemic insecticide
Blossom blight	1	BLAD (Problad Plus®) (suppression only)	biological fungicide with multiple modes of action
	1	Chlorothalonil	protective fungicide
	1	Copper oxychloride	protective fungicide and bactericide
	2	Cyprodinil	protective fungicide
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	1	Iprodione	contact fungicide with protective and curative action
	1	Mandestrobin (Intuity®)	translaminar fungicide with curative and protective action
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	1	Procymidone	systemic fungicide with protective and curative action
	1	Propiconazole	systemic fungicide with protective and curative action
	1	Triforine (Saprol®)	systemic fungicide with protective action
Brown rot	1	BLAD (Problad Plus®) (suppression only)	biological fungicide with multiple modes of action
	1	Chlorothalonil	protective fungicide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Cyprodinil	protective fungicide
	1	Dithianon	fungicide with protective action
	1	Fludioxonil (postharvest only)	fungicide with long residual action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	1	Iprodione	contact fungicide with protective and curative action
	2	Mancozeb	protective fungicide
	1	Mandestrobin (Intuity®)	translaminar fungicide with curative and protective action

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Brown rot (continued)	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	1	Propiconazole	systemic fungicide with protective and curative action
	1	Thiram	protective fungicide
	1	Triforine (Saprol®)	systemic fungicide with protective action
Bryobia mite	1	Bifenazate	acaricide with contact and residual action against motile stages
	1	Clofentezine	contact acaricide with long residual action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
Budworm (*Helicoverpa* spp.)	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	3	Carbaryl	contact insecticide with stomach action
	2	Indoxacarb	insecticide with contact and stomach action
Carpophilus beetles	3	Bifenthrin	contact insecticide
	1	Carpophilus Catcha Trap	insect trapping system
Cherry aphid	3	Diazinon	insecticide with contact, stomach and respiratory action
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Pirimicarb	stomach action
	2	Spirotetramat (Movento®)	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Crop load and thinning	1	Gibberellic acid	plant growth regulator
Crown gall	2	*Agrobacterium radiobacter* var. *radiobacter* (Nogall™)	antagonistic bacterium (see also, 'Biological control', page 123)
European earwig	3	Carbaryl	contact insecticide with stomach action
	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
Freckle	1	Chlorothalonil	protective fungicide
	1	Copper (as ammonium acetate)	protective fungicide and bactericide
	1	Copper cuprous oxide	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Dithianon	fungicide with protective action
	2	Mancozeb	protective fungicide
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	1	Thiram	protective fungicide
	1	Tribasic copper sulfate	protective fungicide
Fruit maturation and harvest management	ID	Aviglycine (Retain®)	plant growth regulator
Fruit tree borer	3	Carbaryl	contact insecticide with stomach action
Fullers rose weevil	2	Indoxacarb	insecticide with contact and stomach action
Green looper	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
Green peach aphid	3	Diazinon	insecticide with contact, stomach and respiratory action
	3	Imidacloprid	contact and stomach insecticide when used as a foliar spray
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Pirimicarb	stomach action
	1	Pymetrozine	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Green treehopper	3	Carbaryl	contact insecticide with stomach action
Light brown apple moth (LBAM)	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	3	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	2	Indoxacarb	insecticide with contact and stomach action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spinetoram (Delegate®)	insecticide with contact action

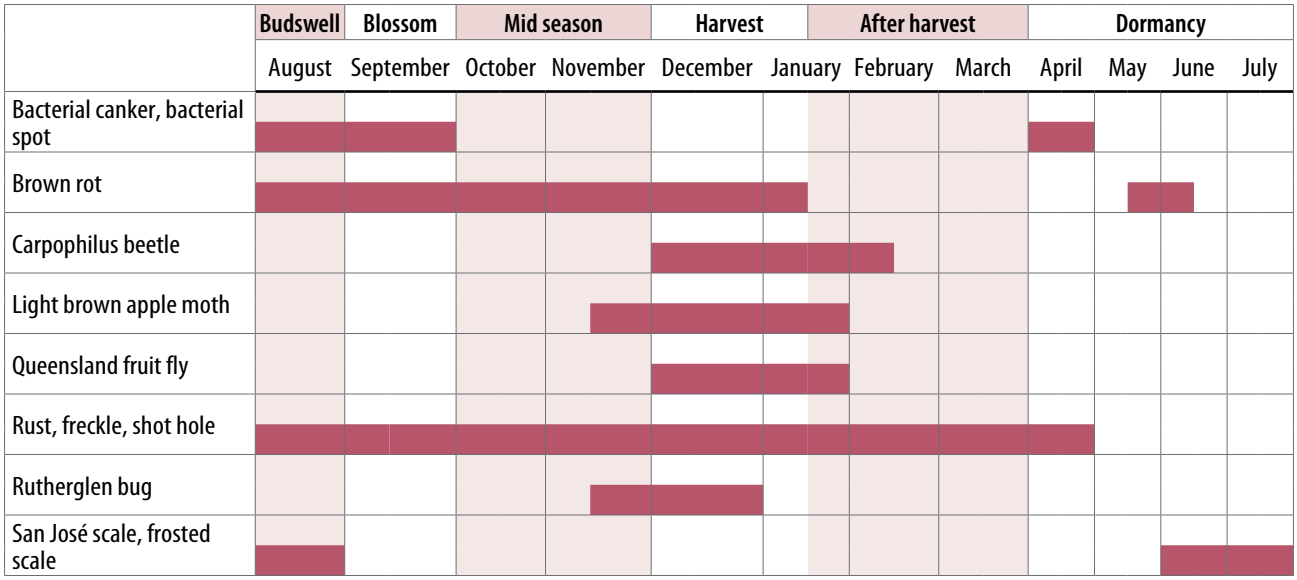
To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Mites (check labels for mite species controlled)	1	Bifenazate	acaricide with contact and residual action against motile stages
	1	Clofentezine	contact acaricide with long residual action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	1	Hexythiazox	acaricide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
	3	Milbemectin (Milbeknock®)	acaricide with contact and stomach action
	2	Propargite	acaricide with contact action against active stages
Oriental fruit moth (OFM)	3	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	1	*Cydia pomonella granulosis* virus	biological insecticide with stomach action
	2	Indoxacarb	insecticide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	1	OFM mating disruptant	insect sex pheromone
	2	Spinetoram (Delegate®)	insecticide with contact action
	2	Thiacloprid	systemic insecticide with contact and stomach action
Oystershell scale	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
Pear and cherry slug	3	Carbaryl	contact insecticide with stomach action
	2	Spinetoram (Delegate®)	insecticide with contact action
Plague locust	3	Maldison	insecticide with contact, stomach and respiratory action
Queensland fruit fly (QFF). For a complete list of permits refer to page 4	3	Chlorpyrifos (bait only)	contact insecticide with stomach and respiratory action
	3	Clothianidin (Samurai®)	systemic insecticide
	1	Fipronil (Amulet Cue-Lure®)	bait/lure
	3	Maldison (Fyfanon® 440EW)	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®) (suppression only)	insect growth regulator and contact insecticide with multiple modes of action
	1	Spinosad (Naturalure™)	bait/lure
	3	Trichlorfon	insecticide and acaricide with contact and stomach action
Rust	1	Chlorothalonil	protective fungicide
	1	Copper oxychloride	protective fungicide and bactericide
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	protective fungicide
Rutherglen bug	3	Maldison	insecticide with contact, stomach and respiratory action
	3	Trichlorfon	insecticide and acaricide with contact and stomach action
San José scale	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	3	Diazinon	insecticide with contact, stomach and respiratory action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	2	Novaluron + acetamiprid (Cormoran®) (suppression only)	insect growth regulator and contact insecticide with multiple modes of action
Shot hole	1	Chlorothalonil	protective fungicide
	1	Copper (as ammonium acetate)	protective fungicide and bactericide
	1	Copper cuprous oxide	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Dithianon	fungicide with protective action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	protective fungicide
	1	Thiram	protective fungicide
	1	Tribasic copper sulfate	protective fungicide

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Silver leaf	1	Cyproconazole + iodocarb (Garrison®)	pruning wound sealer containing curative and protective fungicides
Transit rot	1	Chlorothalonil	protective fungicide
	1	Fludioxonil (postharvest only)	protective fungicide with contact action
	1	Iprodione (postharvest only)	contact fungicide with protective and curative action
Vegetative growth	1	Paclobutrazol	plant growth regulator
Western flower thrips	2	Spinetoram (Delegate®)	insecticide with contact action
Wingless grasshoppers	3	Carbaryl	contact insecticide with stomach action
	2	Indoxacarb	insecticide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action

[1]Source: InfoPest http://infopest.com.au and APVMA Pubcris https://portal.apvma.gov.au/pubcris
[2]Trade names (in brackets) are included where only one product is registered for that common name. Coloured dots before the chemical common name denote that chemical's compatibility with IPM.
[3]Adapted from The Pesticide Manual, 14th Edition, British Crop Protection Council 2006.
1 indicates that – when used with care – a chemical will have very little effect on beneficials and is recommended in an IPM program.
2 indicates that this pesticide can be used with caution in an IPM program, but the chemical's effect on beneficials present should be assessed before application.
3 indicates that this chemical is likely to have a negative off-target effect including on beneficial arthropods.
ID indicates that there is insufficient data for a rating to be given.

Pests and growing periods in apricots

Table 12. Apricots – pests and growing periods.



Note: This is a guide only. The status and treatment time for each problem varies across fruit-growing districts.
Likely timing for monitoring and treatment
Monitoring is critical to avoid unnecessary or poorly-timed sprays.

Further information

See page 38 for details on the chemical names used and other information about these tables.

For information on non-bearing trees, see page 106.

These free Agfacts/Primefacts provide more detail on some problems in stone fruit. They are available in the Agriculture section of the NSW Department of Primary Industries website as a portable document file (pdf) at www.dpi.nsw.gov.au/content/agriculture/horticulture/stone-fruit

- Bacterial canker of stone fruit: Primefact 77
- Bacterial spot of stone fruit: Primefact 76
- Rust of stone fruit: Primefact 78.

See page 130 for other useful publications.

Management calendar for apricots

Table 13. Apricots – calendar.

Month	Reason	Treatment	Remarks
BUDSWELL			
August	Bacterial canker	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR tribasic copper sulfate (M1) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	Apply at first sign of bud movement. Repeat application 7–10 days later. Note label rate. Apply in mid-winter.
	Freckle and shot hole	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR copper oxychloride (M1) OR tribasic copper sulfate (M1)	Spray copper based fungicides at budswell before earliest signs of leaf/bud movement.
	Shot hole	Chlorothalonil (M5) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	Treatment should begin before disease infection. Spray at budswell before earliest signs of leaf/bud movement. Do not apply chlorothalonil later than 35 days before harvest as may cause skin blemishes.
	San José scale and frosted scale	Novaluron + acetamiprid (15) (4A) OR	Apply novaluron + acetamiprid from petal fall to control San José scale, targeting crawlers when they become active in the canopy. Up to two applications can be applied for San José scale control as part of a spray program in rotation with registered insecticides from alternative mode of action groups, using a minimum spray interval of 14 days.
		Petroleum oil OR	Apply when buds are well swollen, but before much pink of petals shows, mid to late August. Very thorough dilute spraying is essential. Scales are not usually troublesome in tableland areas. Spraying with oil every second year might be sufficient to prevent infestation developing in these areas. Do not use more than one full-strength (3 L/100 L) spray in any one year.
		Spirotetramat (23)	Do not apply more than three applications per crop, with no more than two applications made later than 21 days after shuck fall and with a minimum 14 days between applications. Do not harvest for 21 days after application.
August–September	To reduce vegetative growth	Paclobutrazol	Apply any time between 14 days before budburst and full bloom by one of the following methods: 1. beneath each trickle or drip point 2. through trickle irrigation system (with care) 3. collar drench around base of trunk. Re-apply in the season following that in which normal growth resumes. Refer to product label for rates of use and other restraints.
BLOSSOMING			
August–September	Bacterial canker	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR copper oxychloride (M1)	Apply 7 days after petal fall. Repeat application 7–10 days later. This schedule of sprays controls the high leaf population of the bacteria in mid–late spring.

Month	Reason	Treatment	Remarks
August–September (continued)	Brown rot (blossom blight)	Chlorothalonil (M5) OR dithianon (M9) OR ioprodione (2) OR mancozeb (M3) OR mandestrobin (11) OR penthiopyrad (7) OR procymidone (2) OR propiconazole (3) OR triforine (3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Apply at mid to full bloom (50–100%) and at petal fall. Warning: do not use a fungicide for the last field spray from the same group as that to be used as a postharvest dip. Mandestrobin: apply at 20% and again at 90% flowering. Procymidone can only be used before shuck fall to control blossom blight.
MID SEASON – SHUCK FALL TO FRUIT RIPENING			
September–November	Brown rot	Chlorothalonil (M5) OR dithianon (M9) OR mancozeb (M3) OR penthiopyrad (7) OR thiram (M3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Apply chlorothalonil or mancozeb at shuck fall and again 14 days later, or dithianon at shuck fall and 28 days later. Check labels for withholding periods.
	Freckle	Chlorothalonil (M5) OR dithianon (M9) OR mancozeb (M3) OR penthiopyrad (7) OR thiram (M3)	Apply chlorothalonil or mancozeb at shuck fall and again 14 days later, or dithianon at shuck fall and 28 days later. Check labels for withholding periods.
	Rust	Chlorothalonil (M5) OR mancozeb (M3) OR	Apply chlorothalonil or mancozeb at shuck fall and again 14 days later, or dithianon at shuck fall and 28 days later. Check labels for withholding periods.
	Shot hole	Chlorothalonil (M5) OR dithianon (M9) OR mancozeb (M3) OR thiram (M3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Apply chlorothalonil or mancozeb at shuck fall and again 14 days later, or dithianon at shuck fall and 28 days later. Check labels for withholding periods.
	Rutherglen bug	Maldison OR pyrethrins OR trichlorfon	Spray when bugs swarm onto trees.
	Light brown apple moth (LBAM)	*Bacillus thuringiensis* (Bt) (11) OR	Spray with Bt when caterpillars are first noticed. Thorough coverage is essential. Repeat at 10–14-day intervals if required. Not suitable as an emergency treatment.
		Chlorantraniliprole (28) OR	Maximum three applications 14–21 days apart, starting at petal fall (or before 110 degree days after codling moth detected in traps) until late December. Program also useful for controlling budworm and OFM.
		Novaluron + acetamiprid (15) (4A)	Apply novaluron + acetamiprid after petal fall or 140 degree days after LBAM are detected in traps. If required, apply a second application after a 14-day interval.
	Magnesium deficiency	Magnesium sulfate	See 'Nutrient sprays for deciduous fruits', page 108, for rates.

Month	Reason	Treatment	Remarks
RIPENING TO HARVEST			
December–January	Brown rot	Iprodione (2) OR propiconazole (3) OR triforine (3)	Apply 21 days and again 7 days before picking is due to start. Remove infected fruit and destroy. Observe withholding periods between spraying and picking. If shot hole or freckle are major problems, use one of the fungicides listed for those diseases.
	Brown rot, rust and shot hole	Dithianon (M9) OR mancozeb (M3) OR mandestrobin (11) OR thiram (M3)	Dithianon and thiram are not registered for rust. Brown rot: apply mandestrobin at 21 days and then 7 days pre harvest, with a minimum of a 14-day interval.
	Queensland fruit fly (QFF). For a complete list of permits refer to page 4	1. Hang male lures in orchard as indicator of fly presence 2. apply baits 3. spray with trichlorfon (1B) 4. fipronil lures	1. Lures will detect fly presence. Fruit stinging can commence in August 2. when flies are detected, start a baiting program and repeat weekly using yeast autolysate with either maldison, fipronil or spinosad in the mix as a contact insecticide 3. trichlorfon has a 2 day withholding period 4. a grid system of 16 Amulet® fly lures per hectare has been reported to give effective control when used in conjunction with monitoring traps, baiting with a yeast chemical mixture and good crop hygiene. If treated produce is to be exported, follow label instructions regarding residue definition and residue limits/import tolerances of importing countries. Residues must not exceed requirements of the importing country.
	Carpophilus beetles	1. Monitor 2. sanitation 3. bifenthrin (3A)	1. Regularly inspect fruit for beetle action, especially as fruit ripens 2. pick up fallen fruit which can attract beetles into the orchard and spread brown rot 3. only when beetles invade. Bifenthrin (3A) is toxic to beneficial insects and mites.
	Light brown apple moth (LBAM)	See November	See November.
	Brown rot and rhizopus rot	Postharvest dip: fludioxonil (12) OR iprodione (2)	Include a wetting agent in the dip. Immerse fruit for 30–60 seconds (to ensure thorough wetting) as soon as possible after harvest. Iprodione controls brown rot and suppresses rhizopus rot.
January–April	Rust	Chlorothalonil (M5) OR mancozeb (M3)	Examine undersides of young leaves frequently and spray as soon as any rust is observed.
	Enhance firmness over harvest and storage	Aviglycine	Apply 7–14 days before harvest. Will delay maturity by up to 5 days depending on variety.
DORMANCY			
April	Shot hole	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR copper oxychloride (M1) OR tribasic copper sulfate (M1) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	Apply a postharvest application.
	Bacterial canker	copper cuprous oxide (M1) OR copper hydroxide (M1) OR tribasic copper sulfate (M1)	Apply when leaves are falling freely and again mid-winter.
June–August	Brown rot	Sanitation	Remove all mummies, cankers and dead shoots from trees and destroy by burning.
	San José scale and frosted scale	Petroleum oil	Watch for infestation and treat with oil if necessary while trees are dormant. Warning: use only one full strength oil spray (3 L/100 L) in any one winter.
	Magnesium deficiency	Magnesium sulfate	See Apples, June–August.

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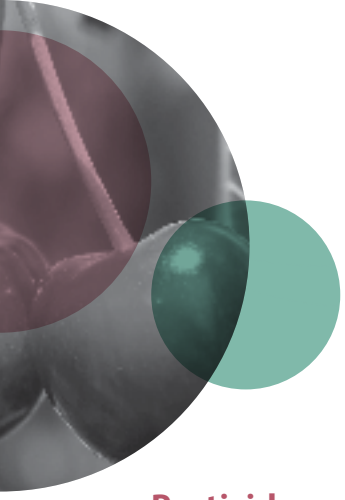


Cherries

Pesticides

Table 14. Chemicals registered[1] for the management of cherry pests and crop regulation in NSW.

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Bacterial canker/ gummosis	1	Copper (as ammonium acetate)	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Copper cuprous oxide	protective fungicide and bactericide
	1	Tribasic copper sulfate	protective fungicide
Black peach aphid	3	Imidacloprid	contact and stomach insecticide when used as a foliar spray
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Pirimicarb	selective systemic aphicide with contact, respiratory and stomach action
	1	Pymetrozine	systemic insecticide
	2	Spirotetramat (Movento®)	systemic insecticide with stomach action
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Brown rot/blossom blight (*Monilinia* spp.) Check product label for species controlled (i.e. *Monilinia laxa* or *Monilinia fructicola*)	1	BLAD (Problad Plus®) (suppression only)	biological fungicide with multiple modes of action
	1	Captan	protective fungicide
	1	Chlorothalonil	protective fungicide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Dithianon	fungicide with protective action
	1	Fludioxonil (dip only)	postharvest fungicide with long residual action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	1	Iprodione	contact fungicide with protective and curative action
	2	Mancozeb	protective fungicide
	1	Mandestrobin (Intuity®)	translaminar fungicide with curative and protective action
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	2	Procymidone	systemic fungicide with protective and curative action
	1	Propiconazole	systemic fungicide with protective and curative action
	1	Thiram	protective fungicide
	1	Ziram	protective fungicide
Bryobia mite	1	Clofentezine	contact acaricide with long residual action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
Bud dormancy	ID	Methyl esters of fatty acids (Waiken)	crop load, initiating dormancy break
Budworms (*Helicoverpa* spp.)	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
Cherry aphid	3	Diazinon	insecticide with contact, stomach and respiratory action
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Pirimicarb	selective systemic aphicide with contact, respiratory and stomach action
	2	Spirotetramat (Movento®)	systemic insecticide with stomach action
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Fruit size and quality improvement	ID	Gibberellic acid (ProGibb®)	plant growth regulator
Crown gall	1	*Agrobacterium radiobacter* var. *radiobacter* (Nogall™)	antagonistic bacterium (see also, 'Biological control', page 123)
European earwig	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
European red mite	1	Clofentezine	contact acaricide with long residual action
	1	Hexythiazox	acaricide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	2	Propargite	acaricide with contact action against active stages
Freckle	1	Copper hydroxide	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
	2	Mancozeb	protective fungicide
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	1	Thiram	protective fungicide
	1	Ziram	protective fungicide
Green peach aphid	3	Diazinon	insecticide with contact, stomach and respiratory action
	2	Imidacloprid	contact and stomach insecticide when used as a foliar spray
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Pirimicarb	selective systemic aphicide with contact, respiratory and stomach action
	1	Pymetrozine	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Light brown apple moth (LBAM)	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spinetoram (Delegate®)	insecticide with contact action
Mites	1	Horticultural mineral oil (HMO)	acaricide with ovicidal action
	2	Propargite	acaricide with contact action against active stages
Oriental fruit moth (OFM)	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	1	*Cydia pomonella granulosis* virus	biological insecticide with stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	1	OFM mating disruptant	insect sex pheromone
	2	Spinetoram (Delegate®)	insecticide with contact action
	2	Thiacloprid (Calypso®)	systemic insecticide with contact and stomach action
Oystershell scale	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
Pear and cherry slug	2	Spinetoram (Delegate®)	insecticide with contact action
Plague locust	3	Fenitrothion	non-systemic insecticide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
Plague thrips	3	Tau-fluvalinate	insecticide and acaricide with contact and stomach action
Queensland fruit fly (QFF). For a complete list of permits refer to page 4	3	Chlorpyrifos (bait only)	contact insecticide with stomach and respiratory action
	3	Clothianidin (Samurai®)	systemic insecticide
	1	Fipronil (Amulet Cue-Lure®)	bait/lure
	3	Maldison (Fyfanon® 440EW)	insecticide with contact, stomach and respiratory action
	1	Spinosad (Naturalure™)	bait/lure
Rust	1	Chlorothalonil	protective fungicide
	1	Copper oxychloride	protective fungicide and bactericide
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	protective fungicide
Rutherglen bug	3	Maldison	insecticide with contact, stomach and respiratory action
	3	Trichlorfon	insecticide and acaricide with contact and stomach action

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
San José scale	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	3	Diazinon	insecticide with contact, stomach and respiratory action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spirotetramat (Movento®)	systemic insecticide with stomach action
Shoot growth regulation	ID	Benzyladenine + Gibberallins (A4 and A7) (Cytolin®)	plant growth regulator
	ID	Prohexadione-calcium (Regalis® Plus)	plant growth regulator
Shot hole	1	Chlorothalonil	protective fungicide
	1	Copper (as ammonium acetate)	protective fungicide and bactericide
	1	Copper cuprous oxide	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Dithianon	fungicide with protective action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	protective fungicide
	1	Thiram	protective fungicide
	1	Tribasic copper sulfate	protective fungicide
	1	Ziram	protective fungicide
Transit rot	1	Chlorothalonil	protective fungicide
	1	Fludioxonil (postharvest dip only)	postharvest fungicide with long residual action
	1	Iprodione (postharvest dip only)	contact fungicide with protective and curative action
Two-spotted mite	1	Clofentezine	contact acaricide with long residual action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	1	Hexythiazox	acaricide with contact and stomach action
	3	Milbemectin (Milbeknock®)	acaricide with contact and stomach action
	2	Propargite	acaricide with contact action against active stages
Vegetative growth	ID	Paclobutrazol	plant growth regulator
Western flower thrips	2	Spinetoram (Delegate®)	insecticide with contact action
Wingless grasshoppers	3	Maldison	insecticide with contact, stomach and respiratory action

[1]Source: InfoPest http://infopest.com.au and APVMA Pubcris https://portal.apvma.gov.au/pubcris

[2]Trade names (in brackets) are included where only one product is registered for that common name. Coloured dots before the chemical common name denote that chemical's compatibility with IPM.

[3]Adapted from The Pesticide Manual, 14th Edition, British Crop Protection Council 2006.

1 indicates that – when used with care – a chemical will have very little effect on beneficials and is recommended in an IPM program.

2 indicates that this pesticide can be used with caution in an IPM program, but the chemical's effect on beneficials present should be assessed before application.

3 indicates that this chemical is likely to have a negative off-target effect including on beneficial arthropods.

ID indicates that there is insufficient data for a rating to be given.

Pests and growing periods in cherries

Table 15. Cherries – pests and growing periods.

	Budswell		Blossom		Mid season		Harvest		After harvest			Dormancy			
	August	September	October	November	December	January	February	March	April	May	June	July			
Bacterial canker															
Brown rot															
Cherry aphid, green peach aphid															
European earwig															
Pear and cherry slug															
Plague thrips															
Queensland fruit fly															
Rabbits and hares															
San José scale															
Shot hole															
Western flower thrips															

Note: This is a guide only. The status and treatment time for each problem varies across fruit-growing districts. Monitoring is critical to avoid unnecessary or poorly-timed sprays.

Likely timing for monitoring and treatment.

Further information

See page 38 for details on the chemical names used and other information about these tables.

For information on non-bearing trees, see page 106.

These free Agfacts/Primefacts provide more detail on some problems in stone fruit. They are available in the Agriculture section of the NSW Department of Primary Industries website as a portable document file (pdf) at www.dpi.nsw.gov.au/content/agriculture/horticulture/stone-fruit

- Bacterial canker of stone fruit: Primefact 77
- Bacterial spot of stone fruit: Primefact 76
- Rust of stone fruit: Primefact 78

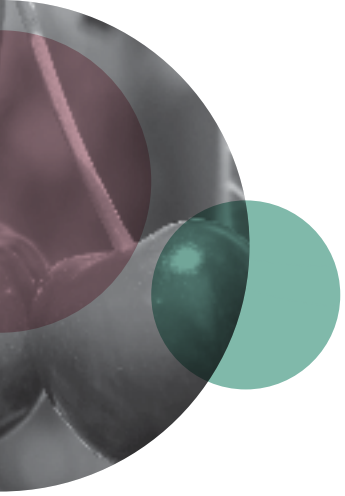
See page 130 for other useful publications.

Management calendar for cherries

Table 16. Cherries – calendar.

Month	Reason	Treatment	Remarks
BUDSWELL			
August	Bryobia mite eggs and San José scale	Horticultural mineral oil (HMO)	See June–August.
	Control bud break	Methyl esters of fatty acids	Apply 35–50 days before normal bud break to advance bud break. Apply 20 days before normal bud break to delay bud break (some flower bud thinning can also occur). Test on a small number of trees when first using and compare with similar untreated trees. Keep records of all treatments and conditions. Variety responses may vary.
September	Shot hole and bacterial canker	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR copper oxychloride (M1) OR tribasic copper sulfate (M1) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	Apply at bud movement. See labels for rates and details of timing.
	Brown rot	Copper oxychloride (M1)	Apply at bud movement. See labels for rates and details of timing.
BLOSSOMING TO HARVEST			
September–October	To reduce vegetative growth and increase yield	Paclobutrazol	See Apricots. Excessive growth retardation has been experienced on some cherry cultivars on the lighter soils in the Tablelands.
	Boron deficiency (fruit pitting)	Borax OR soluble boron	Commencing at petal fall, apply three sprays at intervals of 14 days. The first spray must be applied at petal fall for maximum control of pitting. See 'Nutrient sprays for deciduous fruits', page 108, for rates.
	European earwig	Chlorpyrifos (1B)	Spray: Apply in spring if required. Bait: Use 5 kg of bait/ha in spring. See product label for preparation.
September–December	Brown rot (blossom blight and fruit rot)	Captan (M4) OR chlorothalonil (M5) OR dithianon (M9) OR iprodione (2) OR mandestrobin (11) OR procymidone (2) OR propiconazole (3) OR thiram (M3) OR ziram (M3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Apply at early white to early blossom (1–10% blossom), mid to late September. Repeat at full bloom (50–100% blossom) in early October and at petal fall to shuck fall (mid to late October). Further sprays may be required if season is wet or disease incidence requires it. Where shot hole is troublesome, use chlorothalonil or dithianon as the shuck fall spray. Follow with chlorothalonil 14 days after shuck fall, or dithianon 28 days after shuck fall. Use one of the fungicides listed except dithianon and procymidone (withholding periods 21 days and 9 days respectively) to spray early-maturing varieties 7 days before harvest. For late maturing varieties, apply the fungicide 21 days and again 7 days before harvest starts. If weather conditions are favourable for the disease, it might be necessary to apply further sprays during harvest. Warnings: • do not use a fungicide for the last field spray from the same group as that to be used as a postharvest dip. See 'Avoiding fungicide resistance', page 126, and warnings on labels • procymidone can only be used before shuck fall to control blossom blight • observe withholding periods between spraying and picking.
	Shot hole and brown rot	Chlorothalonil (M5) OR dithianon (M9) OR thiram (M3) OR ziram (M3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	
October	Magnesium deficiency	Magnesium sulfate + wetting agent	Non-bearing cherry trees often show symptoms of magnesium deficiency. Symptoms appear in January–February. Apply preventative sprays in October. See 'Nutrient sprays for deciduous fruits', page 108, for rates. In severe cases soil applications may be required. See rates for Apples, November–December.

Month	Reason	Treatment	Remarks
October–December	Cherry aphid and green peach aphid (GPA)	Pirimicarb (1A) OR sulfoxaflor (4C)	Infestation may appear from late October. See 'Avoiding resistance to insecticides', page 126. Spray only if necessary. Do not apply more than two sprays per season. Highly toxic to bees while spray is wet. Do not apply while bees are foraging in the crop.
	Cherry aphid and black peach aphid	Spirotetramat (23)	Monitor crops following petal fall. Start applications at the onset of crawler emergence or when pest numbers reach an economic threshold. To ensure sufficient foliage for product uptake. Do not apply before shuck fall. Do not apply more than two applications per crop for cherries with a minimum of 14 days between applications.
	Green peach aphid (GPA)	Imidacloprid (4)	If GPA only is infesting cherries and biological control (e.g. ladybirds) is not imminent, apply imidacloprid once only and thoroughly. Note withholding period.
	Light brown apple moth (LBAM)	*Bacillus thuringiensis* (Bt) (11) OR novaluron + acetamiprid (Cormoran®) OR spinetoram (5)	If caterpillars are observed, start a program of sprays at 7–10-day intervals. Bt is not effective as an emergency treatment. Apply novaluron + acetamiprid after petal fall or 140 degree days after LBAM are detected in traps. If required, apply a second application after a 14-day interval.
	European earwig	Chlorpyrifos (1B)	Apply if required. These treatments will also control LBAM.
	Carpophilus beetles	1. Monitor 2. sanitation	1. Regularly inspect fruit for beetle action, especially as fruit ripens 2. pick up and destroy fallen fruit. This will help to reduce breeding sites and the spread of carpophilus beetles, which also spread brown rot.
	Queensland fruit fly (QFF)	See Apricots	Might occasionally be a problem in later varieties.
	Pear and cherry slug	Spinetoram (5)	Slug appears in late November – early December. Reinfestation may occur so repeat spraying might be necessary. Following treatment with spinosad, the insect will stop feeding but may take a few days to die.
POSTHARVEST (FRUIT)			
November–January	Brown rot and rhizopus rot	Postharvest dip: fludioxonil (12) OR iprodione (2)	Include a wetting agent in the dip. Immerse fruit for 30–60 seconds (to ensure thorough wetting) as soon as possible after harvest. Iprodione controls brown rot and suppresses rhizopus rot. See warnings on resistance in September–December.
AFTER HARVEST			
December–February	Two-spotted mite	Propargite (12C)	Not an important pest on cherries but may occasionally cause severe leaf mottling. If infestations occur apply miticide after picking in late December or early January.
January–February	Bacterial canker	Prune young trees now, mature trees if necessary	This is an opportune time to carry out any pruning which may be necessary and is a period when trees are least susceptible to canker infection. Large cuts should be treated with a protective paint.
	Brown rot	Sanitation	Remove cankers and dead shoots from trees and destroy by burning.
DORMANCY			
April–August	Bacterial canker	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR tribasic copper sulfate (M1) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	This time of year is critical for bacterial canker infection. Apply when leaves are beginning to fall and again at mid to complete leaf fall. Apply one or more sprays during winter. Aim to maintain a very thorough coverage throughout dormancy for badly infected trees.
	Shot hole	Copper oxychloride (M1)	Apply as leaves fall.
June–August	Rabbits and hares	See Apples	See Apples.
	San José scale and Bryobia mite eggs	Horticultural mineral oil (HMO)	Watch for scale and mite eggs while pruning and if infestation is seen, apply oil while trees are dormant. If Bryobia eggs are numerous the spray is best delayed until budswell as eggs are more easily killed then. Thorough application is essential. Warning: Apply only one full-strength oil spray (3 L/100 L) in any one winter.



Plums and prunes

Pesticides

Table 17. Chemicals registered[1] for the management of plum and prune pests and crop regulation in NSW.

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Aphids	1	Horticultural mineral oil (HMO)	insecticide with ovicidal action
Apple weevil	2	Indoxacarb	insecticide with contact and stomach action
Bacterial canker/ gummosis	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
Black peach aphid	3	Imidacloprid	contact and stomach insecticide when used as a foliar spray
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Pirimicarb	stomach action
	1	Pymetrozine	systemic insecticide
	2	Spirotetramat (Movento®)	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Blossom blight	1	BLAD (Problad Plus®) (suppression only)	biological fungicide with multiple modes of action
	1	Captan	protective fungicide
	1	Chlorothalonil	protective fungicide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Cyprodinil (Chorus®)	protective fungicide
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	1	Iprodione	fungicide with protective and curative action
	1	Mandestrobin (Intuity®)	translaminar fungicide with curative and protective action
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	2	Procymidone	systemic fungicide with protective and curative action
	1	Propiconazole	systemic fungicide with curative action
	1	Triforine (Saprol®)	systemic fungicide with protective action
	1	Ziram	protective fungicide
Blossom thinning	ID	Ammonium thiosulfate	plant growth regulator
	ID	AFAP (Armothin®) (some varieties only)	plant growth regulator
Brown rot	1	BLAD (Problad Plus®) (suppression only)	biological fungicide with multiple modes of action
	1	Captan	protective fungicide
	1	Chlorothalonil	protective fungicide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Cyprodinil (Chorus®)	protective fungicide
	1	Dithianon	fungicide with protective and some curative action
	1	Fludioxonil (dip only)	fungicide with long residual action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	1	Iprodione	fungicide with protective and curative action

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Brown rot (continued)	2	Mancozeb	protective fungicide
	1	Mandestrobin (Intuity®)	translaminar fungicide with curative and protective action
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	1	Propiconazole	systemic fungicide with curative action
	1	Thiram	protective fungicide
	1	Triforine (Saprol®)	systemic fungicide with protective action
	1	Ziram	protective fungicide
Bryobia mite	1	Bifenazate	acaricide with contact and residual action against motile stages
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
Budworms (*Helicoverpa* spp.)	3	Carbaryl	contact insecticide with stomach action
	1	Indoxacarb	insecticide with contact and stomach action
	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
Carpophilus beetles	3	Bifenthrin	contact insecticide
	1	Carpophilus Catcha Trap	insect trapping system
Cherry aphid	3	Diazinon	insecticide with contact, stomach and respiratory action
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Pirimicarb	stomach action
	2	Spirotetramat (Movento®)	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Crown gall	1	*Agrobacterium radiobacter* var. *radiobacter* (Nogall™)	antagonistic bacterium
European earwig	3	Carbaryl	contact insecticide with stomach action
	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
European red mite	1	Bifenazate	acaricide with contact and residual action against motile stages
	1	Clofentezine	contact acaricide with long residual action
	3	Etoxazole (Paramite®)	acaricide with contact and residual action against motile stages
	1	Hexythiazox	acaricide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	2	Propargite	acaricide with contact action against active stages
Freckle	1	Copper oxychloride	protective fungicide and bactericide
	3	Mancozeb	protective fungicide
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	1	Ziram	protective fungicide
Fruit maturation	ID	Aviglycine (Retain®)	plant growth regulator
Fruit tree borer	3	Carbaryl (Bugmaster®)	contact insecticide with stomach action
Fruit maturity management	ID	Gibberellic acid	plant growth regulator
Fullers rose weevil	1	Indoxacarb	insecticide with contact and stomach action
Garden weevil	1	Indoxacarb	insecticide with contact and stomach action
Green looper	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
Green peach aphid	3	Diazinon	insecticide with contact, stomach and respiratory action
	3	Imidacloprid	contact and stomach insecticide when used as a foliar spray
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Pirimicarb	stomach action
	1	Pymetrozine	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Green treehopper	3	Carbaryl	contact insecticide with stomach action

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Light brown apple moth (LBAM)	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	3	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide with muscle action
	1	Indoxacarb	insecticide with contact and stomach action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spinetoram (Delegate®)	insecticide with contact action
Mites	1	Horticultural mineral oil (HMO)	acaricide with ovicidal action
	2	Propargite	acaricide with contact action against active stages
Oriental fruit moth (OFM)	3	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	1	*Cydia pomonella granulosis* virus	biological insecticide
	1	Indoxacarb	insecticide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	1	OFM mating disruptant	insect sex pheromone
	2	Spinetoram (Delegate®)	insecticide with contact action
	2	Thiacloprid	systemic insecticide with contact and stomach action
Oystershell scale	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
Pear and cherry slug	3	Carbaryl	contact insecticide with stomach action
	2	Spinetoram (Delegate®)	insecticide with contact action
Phytophthora stem canker	1	Copper (as ammonium acetate)	protective fungicide and bactericide
	1	Copper cuprous oxide	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	1	Tribasic copper sulfate	protective fungicide
Plague locust	3	Maldison	insecticide with contact, stomach and respiratory action
Plague thrips	3	Tau-fluvalinate	insecticide and acaricide with contact and stomach action
Queensland fruit fly (QFF). For a complete list of permits refer to page 4	3	Trichlorfon	insecticide and acaricide with contact and stomach action
	3	Chlorpyrifos (bait only)	contact insecticide with stomach and respiratory action
	3	Clothianidin (Samurai®)	systemic insecticide
	1	Fipronil (Amulet Cue-Lure®)	bait/lure
	3	Maldison (Fyfanon® 440EW)	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®) (suppression only)	insect growth regulator and contact insecticide with multiple modes of action
	1	Spinosad (Naturalure™)	bait/lure
Rust	1	Chlorothalonil	protective fungicide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Dithianon	fungicide with protective action
	2	Mancozeb	protective fungicide (except Wilson plums)
	2	Metiram (Polyram®)	protective fungicide
	1	Propiconazole (prunes)	systemic fungicide with curative action
	1	Zineb	protective fungicide (not early plums)
Rutherglen bug	3	Trichlorfon	insecticide and acaricide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action
San José scale	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	3	Diazinon	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	2	Spirotetramat (Movento®)	systemic insecticide

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Shot hole	1	Chlorothalonil	protective fungicide
	1	Copper (as ammonium acetate)	protective fungicide and bactericide
	2	Copper cuprous oxide	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Copper oxychloride + copper hydroxide	protective fungicide and bactericide
	1	Dithianon	fungicide with protective action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	protective fungicide
	1	Thiram	protective fungicide
	1	Tribasic copper sulfate	protective fungicide
	1	Ziram	protective fungicide
Silver leaf	1	Cyproconazole + iodocarb (Garrison®)	pruning wound sealer containing curative and protective fungicides
Storage quality	ID	1-methylcyclopropene (1-MCP)	postharvest treatment
Transit rot	1	Iprodione (postharvest)	contact fungicide with protective and curative action
Two-spotted mite	1	Bifenazate	acaricide with contact and residual action against motile stages
	1	Clofentezine	contact acaricide with long residual action
	3	Etoxazole (Paramite®)	acaricide with contact and residual action against motile stages
	1	Hexythiazox	acaricide with contact and stomach action
	3	Milbemectin (Milbeknock®)	acaricide with contact and stomach action
	1	Horticultural mineral oil (HMO)	acaricide with ovicidal action
	2	Propargite	acaricide with contact action against active stages
Vegetative growth	ID	Paclobutrazol	plant growth regulator
Western flower thrips	2	Spinetoram (Delegate®)	insecticide with contact action
Wingless grasshoppers	3	Carbaryl	contact insecticide with stomach action
	1	Indoxacarb	insecticide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action

[1]Source: InfoPest http://infopest.com.au and APVMA Pubcris https://portal.apvma.gov.au/pubcris

[2]Trade names (in brackets) are included where only one product is registered for that common name. Coloured dots before the chemical common name denote that chemical's compatibility with IPM.

[3]Adapted from The Pesticide Manual, 14th Edition, British Crop Protection Council 2006.

1 indicates that – when used with care – a chemical will have very little effect on beneficials and is recommended in an IPM program.

2 indicates that this pesticide can be used with caution in an IPM program, but the chemical's effect on beneficials present should be assessed before application.

3 indicates that this chemical is likely to have a negative off-target effect including on beneficial arthropods.

ID indicates that there is insufficient data for a rating to be given.

Pests and growing periods in plums and prunes

Table 18. Plums and prunes – pests and growing periods.

	Budswell	Blossom		Mid season		Harvest		After harvest		Dormancy		
	August	September	October	November	December	January	February	March	April	May	June	July
Apple leafhopper												
Bacterial canker, bacterial spot												
Black peach aphid												
Brown rot												
Bryobia mite												
Carpophilus beetle												
European earwig												
Light brown apple moth												
Pear and cherry slug												
Plague thrips												
Plum rust mite												
Queensland fruit fly												
Rust, freckle, shot hole												
Rutherglen bug												
San José scale, frosted scale												
Two-spotted mite												
Wingless grasshopper												

Note: This is a guide only. The status and treatment time for each problem varies across fruit-growing districts.

Likely timing for monitoring and treatment.

Monitoring is critical to avoid unnecessary or poorly timed sprays.

Management calendar for plums and prunes

Table 19. Plums and prunes – calendar.

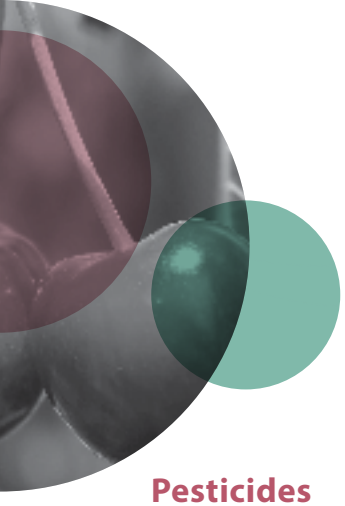
Month	Reason	Treatment	Remarks
BUDSWELL			
August–September	San José scale	Chlorpyrifos (1B) OR	Apply at budswell. Horticultural mineral oil (2 L/100 L spray) may be added for control of Bryobia mite eggs and frosted scale.
		spirotetramat (23)	Do not apply more than three applications per crop, with no more than two applications made later than 21 days after shuck fall and with a minimum of 14 days between applications.
	Bryobia mite eggs, San José scale and frosted scale	Horticultural mineral oil (HMO)	Apply at early white stage if oil has not already been applied, early to mid-September. Apply if scales are present or mite eggs are very plentiful; otherwise, an oil spray is advisable every second year to prevent San José scale build-up.
	Shot hole, brown rot and rust	Chlorothalonil (M5) OR copper oxychloride (M1)	Do not mix spraying oils or wetting agents with chlorothalonil. Spray copper based fungicides to control shot hole when buds are swelling but before and within 7 days of bud opening.
	Shot hole	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR tribasic copper sulfate (M1) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	
	Magnesium deficiency	See Apples, June–August	See Apples, June–August.
BLOSSOMING			
September	Blossom thinning	AFAP (Armothin®) OR ammonium thiosulfate	Apply close to full bloom. Use spray volume of at least 1,500 L/ha. Uniform flowering will improve results. Overspray may occur between rows. Always test on a small number of trees initially, leaving unsprayed check trees, and keep records of conditions and responses. Check with label for variety recommendations.
September–October	Brown rot (blossom blight)	Captan (M4) OR chlorothalonil (M5) OR dithianon (M9) OR iprodione (2) OR mancozeb (M3) OR propiconazole (3) OR triforine (3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Apply at mid to full bloom (50–100% blossom) in mid to late September and again at petal fall to shuck fall in late September or early October. Warning: See 'Avoiding fungicide resistance' warnings on labels.
	Shot hole, rust and brown rot (blossom blight)	Chlorothalonil (M5) OR dithianon (M9) OR mancozeb (M3) OR thiram (M3)	If these diseases are troublesome, use one of these fungicides as the petal fall to shuck fall spray. For rust control apply chlorothalonil or mancozeb at 14-day intervals; or dithianon or zineb at 28-day intervals. Thiram is not registered for rust. A full schedule of protective sprays before shuckfall is essential for rust control. The first sprays for rust should be applied no later than mid-October. 'White oil' is recommended on the zineb label. If unavailable use horticultural mineral oil. Warnings: • zineb can injure Wickson, Wilson and early plums • mancozeb can injure Wilson plums.
	Rust	Zineb (M3) + horticultural mineral oil (HMO)	

Month	Reason	Treatment	Remarks
September–October (continued)	Black peach aphid	Imidacloprid (4) OR novaluron (15) + acetamiprid (4A) OR pymetrozine (9B) OR spirotetramat (23) OR sulfoxaflor (4C)	Mainly a problem in Japanese plums. Infestation can appear any time in September or October. Spray as soon as this is seen. One application should be sufficient. Apply novaluron + acetamiprid when monitoring indicates aphid numbers are above the economic threshold. Aphids that are within curled leaves may not be adequately controlled. Do not apply any of these insecticides in consecutive sprays. Do not apply more than three applications of spirotetramat per crop, with no more than two applications made later than 21 days after shuck fall and with a minimum of 14 days between applications.
	European earwig	Carbaryl (1A) OR chlorpyrifos (1B)	Can be a problem at Young. See Cherries, September–October.
	Plague thrips	Tau-fluvalinate (3A)	Plague thrips can cause severe fruit blemish on Narrabeen plums. Apply only if necessary. Tau-fluvalinate will disrupt integrated pest management programs.
October	Bryobia mite	Bifenazate (UN) OR clofentezine (10A)	Mites can become a problem from about mid-October if oil spray is not applied at the early white stage. Predatory mites should control Bryobia mites in most situations. Note: use only one application of clofentezine per season.
	Light brown apple moth (LBAM)	*Bacillus thuringiensis* (Bt) (11) OR	Apply at first sign of action. Bt is best used as a program. It is not suitable for an emergency treatment.
		Chlorantraniliprole (28) OR	Maximum of three applications of chlorantraniliprole 14–21 days apart, starting at petal fall (or before 110 degree days after LBAM detected in traps) until late December. Program also useful to control budworm and oriental fruit moth.
		Novaluron (15) + acetamiprid (4A)	Apply novaluron + acetamiprid after petal fall or 140 degree days after LBAM are detected in traps.
MID SEASON – AFTER BLOSSOMING TO RIPENING			
November	Magnesium deficiency	Magnesium sulfate	See 'Nutrient sprays for deciduous fruits', page 108, for rates.
	Zinc deficiency	Zinc sulfate + fresh hydrated lime	If symptoms are present, apply in early November. Apply as a separate spray. Do not use a spreader. Warning: Zinc sulfate–lime mixture defoliates Narrabeen plums and can injure other Japanese plums. In such cases, substitute winter spray of zinc sulfate before pruning, as for apples.
	Rust and shot hole	Chlorothalonil (M5) OR dithianon (M9) OR mancozeb (M3)	Apply last few days of November or very early December. Do not delay if season is wet. Prunes should be sprayed for rust by the middle of November. Shorten the interval between sprays to 21 days if many infections are observed. White oil is recommended on the zineb label. If unavailable use horticultural mineral oil.
	Rust	Zineb (M3) + horticultural mineral oil (HMO)	
	Bryobia mite	Bifenazate (UN) OR clofentezine (10A)	See October.
	Two-spotted mite	Bifenazate (UN) OR milbemectin (6B) OR propargite (12C)	Mites could be a problem in the MIA at this time if predatory mites are absent. Thorough application is essential. Do not apply more than one application of milbemectin per season.

Month	Reason	Treatment	Remarks
November–December	Rust (prunes)	Zineb (M3) + horticultural mineral oil (HMO)	Spray with mancozeb or zineb/oil mixture until the end of December. Make sure that the interval between sprays is no more than 21 days. Monitor your orchard for rust infection periods. The number of infection periods can be reduced by: • pruning to allow air flow • having younger trees • drip irrigation (where irrigation is used) • orchard floor management to reduce humidity. Infection periods are more common: • in hot weather, particularly if humid • where humidity is trapped in valleys (particularly around Young). If the season is shaping up to be a bad one for rust, adding propiconazole to mancozeb could be advisable. Propiconazole is a curative fungicide and should be mixed with a protective fungicide such as mancozeb or zineb.
		Chlorothalonil (M5) OR mancozeb (M3) OR propiconazole (3) in a tank mix with mancozeb (M3) OR zineb (M3)	
November–February	Pear and cherry slug	Carbaryl (1A) OR spinetoram (5)	Slug appears in late November–early December. Reinfestation can occur so repeat spraying could be necessary.
December	Rutherglen bug	Trichlorfon (1B)	Spray when bugs occur on trees and fruit.
	Two-spotted mite	Bifenazate (UN) OR propargite (12C)	In the Tablelands, mites are most likely to be troublesome in trees beside blocks of apples or pears that are being sprayed regularly for codling moth control. Examine trees from mid-December and apply when mites are noticed. One thorough application should be sufficient. On prunes at Young and in the MIA, check for predatory mites. In most seasons they will control two-spotted mite without the need to spray, provided disruptive pesticides are avoided.
	Plum rust mite		See October–November.
	Light brown apple moth (LBAM)	*Bacillus thuringiensis* (Bt) (11) OR	Maintain program if LBAM is a problem. Bt is not suitable as an emergency treatment.
		Carbaryl (1A) OR indoxacarb (22A) OR	Apply if infestation warrants. Carbaryl will also control pear and cherry slug on plums and European earwig on prunes, but will disrupt mite control by predatory mites. Thorough spray coverage is required. Up to three consecutive applications of indoxacarb will give best results.
		Chlorantraniliprole (28)	Maximum three applications 14–21 days apart, starting at petal fall (or before 110 degree days after LBAM detected in traps) until late December. Program also useful to control budworm and oriental fruit moth.
	Rust and shot hole	Dithianon (M9) OR mancozeb (M3)	Continue rust sprays at intervals recommended by the manufacturer, especially if season is wet.
	Rust	Zineb (M3) + horticultural mineral oil (0.5 L/100 L) spray	See October.
January–February	Light brown apple moth (LBAM)		Pest might not appear until January or February. Spray when infestation is noticed.
	Two-spotted mite	See December	See December.
	To delay fruit maturity and reduce fruit drop (prunes)	Gibberellic acid (GA)	Apply when soluble solids level is between 14–18%. GA gives better results in a dry growing season. It improves fruit quality; prunes are slightly larger, firmer and because of the delayed maturity have higher sugar content when harvested.
	Pear and cherry slug	Carbaryl (1A) OR spinetoram (5)	Spray only if infestation appears.

Month	Reason	Treatment	Remarks
January–February (continued)	Wingless grasshopper	Indoxacarb (22A)	Grasshoppers invade orchards as herbage dries off. Severe damage can be caused to young trees, especially at Young. Trees around orchard margins are most liable to injury. Repeat sprays might be necessary. Treat pasture around orchard to provide a barrier. See Peaches and Nectarines, December.
	Rust (prunes)	Mancozeb (M3) OR propiconazole (3) in a tank mix with mancozeb (M3) OR zineb (M3) OR zineb (M3) + horticultural mineral oil (HMO)	Continue sprays until harvest time (2–3 applications) at intervals not exceeding 21 days. Propiconazole added to mancozeb will help in a bad rust year. See September–October.
RIPENING TO HARVEST			
January–March	Brown rot	Captan (M4) OR dithianon (M9) OR iprodione (2) OR mancozeb (M3) OR propiconazole (3) OR triforine (3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Apply 21 days and again 7 days before picking is due to begin. Remove and destroy infected fruit. If weather conditions are favourable for brown rot, it might be necessary to apply a further spray during the picking period. Observe withholding periods between spraying and picking. Warning: Do not use a fungicide for the last field spray from the same group as that to be used as a postharvest dip.
	Brown rot, shot hole and rust	Dithianon (M9) OR mancozeb (M3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Apply at intervals recommended by the manufacturer if rust or shot hole is troublesome. In some cases, where the weather is dry and infection periods do not occur, it might not be necessary to spray. Monitor infection periods carefully. See factors contributing to rust infection periods November–December. NOTE: Fluopyram + trifloxystrobin is not registered for rust control.
	Queensland fruit fly (QFF). For a complete list of permits refer to page 4	1. Trapping 2. baiting	1. Fruit fly can be a problem in the more susceptible districts. 2. Amulet® lures can be useful as part of a control program. If treated produce is to be exported, note the residue definition and residue limits/import tolerances of importing countries. Ensure that any residues do not exceed those requirements of the importing country.
	Carpophilus beetles	1. Monitor 2. sanitation 3. bifenthrin (3A)	See peaches and nectarines.
	Brown rot and rhizopus rot	Postharvest dip: fludioxonil (12) OR iprodione (2)	Include a wetting agent in the dip. Immerse fruit for 30–60 seconds (to ensure thorough wetting) as soon as possible after harvest. Iprodione controls brown rot and suppresses rhizopus rot.

Month	Reason	Treatment	Remarks
AFTER HARVEST			
February–March	Rust (prunes)	See January–February	At least one rust spray after harvest is desirable to keep leaves on the trees until normal leaf fall time in May.
April	Shot hole	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR copper oxychloride (M1) OR tribasic copper sulfate (M1) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	Apply when leaves are falling freely.
	Bacterial canker and bacterial spot		Copper sprays used for shot hole will also help control bacterial diseases.
April–July	Black peach aphid	Maldison (1B) OR spirotetramat (23)	Mainly a problem in Japanese plums. Lateral growth can become infested in autumn. If this becomes severe, it will be necessary to spray, otherwise considerable damage to buds, with premature budburst, can result. Do not apply more than three applications of spirotetramat per crop, with no more than two applications made later than 21 days after shuck fall and with a minimum of 14 days between applications
DORMANCY			
May–August	Fruit-tree borer	Scrape away sawdust and destroy young larvae feeding on bark	In first-year workings, bark is cracked and raised, with fine sawdust protruding through the cracked bark. Remove sawdust and destroy small caterpillars feeding on bark. If plum trees are carefully scrutinised and all workings destroyed, there should be far less trouble in succeeding years. Keep trees healthy.
	Rabbits and hares	See Apples	See Apples.
June–August	Brown rot	Sanitation	Remove all mummies, cankers and dead shoots from trees and destroy by burning.
June–September	San José scale, frosted scale and Bryobia mite eggs	Petroleum oil	Watch for infestation while pruning and apply oil if necessary while trees are dormant and up to budswell, early September. If Bryobia eggs are numerous the spray is best delayed until budswell as eggs are more easily killed then. Only one full-strength oil spray (3 L/100 L) should be used in any one year. Warning: Damage to prunes in the MIA has been observed following oil applied at this time. Apply a registered product at a maximum 2 L/100 L but only if needed.
	San José scale	Spirotetramat (23)	Do not apply more than three applications per crop, with no more than two applications made later than 21 days after shuck fall and with a minimum 14 days between applications.
	Magnesium deficiency	Magnesium sulfate	See Apples, June–August.



Peaches and nectarines

Pesticides

Table 20. Chemicals registered[1] for the management of peach and nectarine pests and crop regulation in NSW.

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Aphids	1	Horticultural mineral oil (HMO)	insecticide with ovicidal action
Apple weevil	1	Indoxacarb	insecticide with contact and stomach action, mainly against larvae
Bacterial canker/ gummosis	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
Bacterial spot	1	Copper oxychloride	protective fungicide and bactericide
Black peach aphid	2	Imidacloprid	contact and stomach insecticide as a foliar spray
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Pirimicarb	stomach action
	2	Spirotetramat (Movento®)	systemic insecticide
	1	Pymetrozine	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Blossom blight	1	BLAD (Problad Plus®) (suppression only)	biological fungicide with multiple modes of action
	1	Captan	protective fungicide
	1	Chlorothalonil	protective fungicide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Cyprodinil	protective fungicide
	1	Dodine (Syllit®)	fungicide with protective and some curative action
	1	Iprodione	contact fungicide with protective and curative action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	1	Mandestrobin (Intuity®)	translaminar fungicide with curative and protective action
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	2	Procymidone	systemic fungicide with protective and curative action
	1	Propiconazole	systemic fungicide with protective and curative action
	1	Triforine (Saprol®)	systemic fungicide with protective action
	1	Ziram	protective fungicide
Blossom thinning	ID	Ammonium thiosulfate	plant growth regulator (certain varieties of peaches only)
	ID	AFAP (Armothin®)	plant growth regulator (certain varieties)
Brown rot	1	BLAD (Problad Plus®) (suppression only)	biological fungicide with multiple modes of action
	1	Captan	protective fungicide
	1	Chlorothalonil	protective fungicide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Cyprodinil	protective fungicide
	1	Dithianon	fungicide with protective action
	1	Fenbuconazole (Indar®) nectarines only	systemic fungicide with protective and curative action
	1	Fludioxonil (postharvest dip only)	fungicide with long residual action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Brown rot (continued)	1	Iprodione	contact fungicide with protective and curative action
	2	Mancozeb	protective fungicide
	1	Mandestrobin (Intuity®)	translaminar fungicide with curative and protective action
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	1	Propiconazole	systemic fungicide with protective and curative action
	1	Thiram	protective fungicide
	1	Triforine (Saprol®)	systemic fungicide with protective action
	1	Ziram	protective fungicide
Bryobia mite	1	Bifenazate	acaricide with contact and residual action against motile stages
	1	Clofentezine	contact acaricide with long residual action
	3	Etoxazole (Paramite®)	acaricide with contact and residual action against motile stages
	1	Fenbutatin oxide (Torque®)	acaricide with contact and stomach action, controls motile stages
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
Budworms (*Helicoverpa* spp.)	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	3	Carbaryl	contact insecticide with stomach action
	1	Indoxacarb	insecticide with contact and stomach action, mainly against larvae
Carpophilus beetles	3	Bifenthrin	contact insecticide
	ID	Carpophilus Catcha Trap	insect trapping system
Cherry aphid	3	Diazinon	insecticide with contact, stomach and respiratory action
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Pirimicarb	stomach action
	2	Spirotetramat (Movento®)	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Crown gall	1	*Agrobacterium radiobacter* var. *radiobacter* (Nogall™)	antagonistic bacterium (see also, 'Biological control', page 123)
European earwig	3	Carbaryl	contact insecticide with stomach action
	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
European red mite	1	Bifenazate	acaricide with contact and residual action against motile stages
	1	Clofentezine	contact acaricide with long residual action
	3	Etoxazole (Paramite®)	acaricide with contact and residual action against motile stages
	1	Fenbutatin oxide (Torque®)	acaricide with contact and stomach action, controls motile stages
	1	Hexythiazox	acaricide with contact and stomach action
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Tebufenpyrad (Pyranica®)	acaricide with contact action (peaches only)
Freckle	1	Copper oxychloride	protective fungicide and bactericide
	1	Dithianon	fungicide with protective action
	2	Mancozeb	protective fungicide
	1	Penthiopyrad (Fontelis®)	locally systemic fungicide with protective and curative action
	1	Thiram	protective fungicide
	1	Ziram	protective fungicide
Fruit maturity management	ID	Gibberellic acid	plant growth regulator
Fruit quality	ID	Aviglycine (Retain®)	plant growth regulator
Fruit tree borer	3	Carbaryl	contact insecticide with stomach action
Fullers rose weevil	1	Indoxacarb	insecticide with both contact and stomach action, mainly against larvae
Green looper	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
Green peach aphid	3	Clothianidin (Samurai®)	systemic insecticide
	3	Diazinon	insecticide with contact, stomach and respiratory action
	2	Imidacloprid	contact and stomach insecticide as a foliar spray
	3	Maldison	insecticide with contact, stomach and respiratory action
	3	Methomyl	systemic insecticide with contact and stomach action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Green peach aphid (continued)	2	Pirimicarb	stomach action
	1	Pymetrozine	systemic insecticide
	2	Sulfoxaflor (Transform®)	systemic insecticide with contact and stomach action
Green treehopper	3	Carbaryl	contact insecticide with stomach action
Leaf curl	1	Chlorothalonil	protective fungicide
	1	Copper (as ammonium acetate)	protective fungicide and bactericide
	1	Copper cuprous oxide	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Copper as octanoate (Tricop)	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Dithianon	fungicide with protective action
	1	Dodine (Syllit®)	fungicide with protective and some curative action
	1	Tribasic copper sulfate	protective fungicide
	1	Ziram	protective fungicide
Light brown apple moth (LBAM)	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
	3	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	1	Indoxacarb	insecticide with both contact and stomach action, mainly against larvae
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	2	Spinetoram (Delegate®)	insecticide with contact action
Mites	1	Horticultural mineral oil (HMO)	acaricide with ovicidal action
	2	Propargite	acaricide with contact action against active stages
Oriental fruit moth (OFM)	3	Carbaryl	contact insecticide with stomach action
	1	Chlorantraniliprole (Altacor®)	insecticide interrupts normal muscle contractions
	3	Clothianidin (Samurai®)	systemic insecticide
	1	*Cydia pomonella granulosis* virus	biological insecticide
	1	Indoxacarb	insecticide with both contact and stomach action, mainly against larvae
	3	Maldison	insecticide with contact, stomach and respiratory action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
	1	OFM mating disruptant	insect sex pheromone
	2	Spinetoram (Delegate®)	insecticide with contact action
	2	Thiacloprid (Calypso®)	systemic insecticide with contact and stomach action
Oystershell scale	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
Pear and cherry slug	3	Carbaryl	contact insecticide with stomach action
	2	Spinetoram (Delegate®)	insecticide with contact action
Pear looper	1	*Bacillus thuringiensis* (Bt)	biological pesticide (see also, 'Biological control', page 123)
Phytophthora stem canker (rot)	1	Copper as ammonium acetate	protective fungicide and bactericide
	1	Copper cuprous oxide	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	1	Fosetyl-aluminium (peaches only)	systemic fungicide with protective and curative action
	1	Tribasic copper sulfate	protective fungicide
Plague locust	3	Maldison	insecticide with contact, stomach and respiratory action
Plague thrips	3	Tau-fluvalinate	insecticide and acaricide with contact and stomach action
Queensland fruit fly (QFF). For a complete list of permits refer to page 4	3	Chlorpyrifos (bait only)	contact insecticide with stomach and respiratory action
	3	Clothianidin (Samurai®)	systemic insecticide
	1	Fipronil (Amulet Cue-Lure®)	bait/lure
	3	Maldison (Fyfanon® 440EW)	insecticide with contact, stomach and respiratory action
	1	Spinosad (Naturalure™)	bait/lure
	3	Trichlorfon	insecticide and acaricide with contact and stomach action

To manage…	Code	Pesticide common name (trade name)[2]	Comment[3]
Rust	1	Chlorothalonil	protective fungicide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Dithianon	fungicide with protective action
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	protective fungicide
	1	Zineb (Barmac®)	protective fungicide
Rutherglen bug	3	Maldison	insecticide with contact, stomach and respiratory action
	3	Trichlorfon	insecticide and acaricide with contact and stomach action
San José scale	3	Chlorpyrifos	contact insecticide with stomach and respiratory action
	3	Diazinon	insecticide with contact, stomach and respiratory action
	2	Spirotetramat (Movento®)	systemic insecticide
	1	Horticultural mineral oil (HMO)	insecticide and acaricide with ovicidal action
	3	Methidathion	non-systemic insecticide, acaricide with contact and stomach action
	2	Novaluron + acetamiprid (Cormoran®)	insect growth regulator and contact insecticide with multiple modes of action
Shot hole	1	Chlorothalonil	protective fungicide
	1	Copper (as ammonium acetate)	protective fungicide and bactericide
	1	Copper cuprous oxide	protective fungicide and bactericide
	1	Copper hydroxide	protective fungicide and bactericide
	2	Copper hydroxide + mancozeb (Mankocide®)	protective fungicide and bactericide
	1	Copper oxychloride	protective fungicide and bactericide
	1	Dithianon	fungicide with protective action
	1	Fluopyram + trifloxystrobin (Luna® Sensation)	translaminar fungicide with curative and protective action
	2	Mancozeb	protective fungicide
	2	Metiram (Polyram®)	protective fungicide
	1	Thiram	protective fungicide
	1	Tribasic copper sulfate	protective fungicide
	1	Ziram	protective fungicide
Silver leaf	1	Cyproconazole + iodocarb (Garrison®)	pruning wound sealer containing curative and protective fungicides
Transit rot	1	Fludioxonil (postharvest)	fungicide with long residual action
	1	Iprodione (postharvest)	contact fungicide with protective and curative action
Two-spotted mite	1	Bifenazate	acaricide with contact and residual action against motile stages
	1	Clofentezine	contact acaricide with long residual action
	3	Etoxazole (Paramite®)	acaricide with contact and residual action against motile stages
	1	Fenbutatin oxide (Torque®)	acaricide with contact and stomach action, controls motile stages
	1	Hexythiazox	acaricide with contact and stomach action
	1	Horticultural mineral oil (HMO)	acaricide with ovicidal action
	3	Milbemectin (Milbeknock®)	acaricide with contact and stomach action
	2	Propargite	acaricide with contact action against active stages
	2	Tebufenpyrad (Pyranica®)	acaricide with contact action (peaches only)
Vegetative growth	ID	Paclobutrazol	plant growth regulator
Western flower thrips	2	Spinetoram (Delegate®)	insecticide with contact action
Wingless grasshoppers	3	Carbaryl	contact insecticide with stomach action
	1	Indoxacarb	insecticide with contact and stomach action
	3	Maldison	insecticide with contact, stomach and respiratory action

[1]Source: InfoPest http://infopest.com.au and APVMA Pubcris https://portal.apvma.gov.au/pubcris

[2]Trade names (in brackets) are included where only one product is registered for that common name. Coloured dots before the chemical common name denote that chemical's compatibility with IPM.

[3]Adapted from The Pesticide Manual, 14th Edition, British Crop Protection Council 2006.

1 indicates that – when used with care – a chemical will have very little effect on beneficials and is recommended in an IPM program.

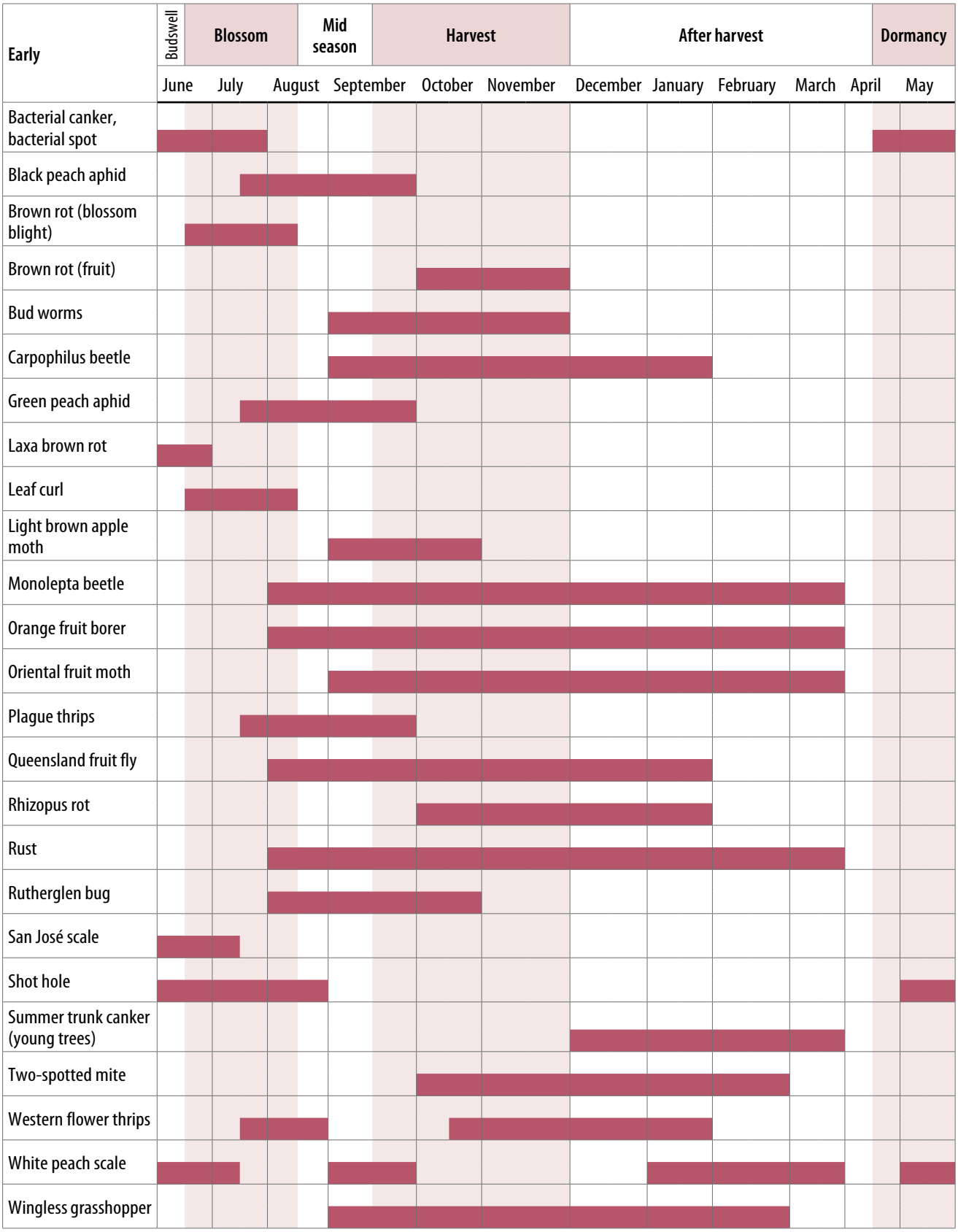
2 indicates that this pesticide can be used with caution in an IPM program, but the chemical's effect on beneficials present should be assessed before application.

3 indicates that this chemical is likely to have a negative off-target effect including on beneficial arthropods.

ID indicates that there is insufficient data for a rating to be given.

Pests and growing periods in peaches and nectarines

Table 21. Peaches and nectarines – pests and growing periods (early).



Note: This is a guide only. The status and treatment time for each problem varies across fruit-growing districts.

Likely timing for monitoring and treatment.

Monitoring is critical to avoid unnecessary or poorly timed sprays.

Table 22. Peaches and nectarines – pests and growing periods (late).

Late	Dormant			Mid season			Harvest					Dormancy
	Budswell/Blossom						Postharvest					
	June	July	August	September	October	November	December	January	February	March	April	May
Bacterial canker, bacterial spot	■	■										■
Black peach aphid			■	■								
Brown rot (blossom blight)		■	■									
Brown rot (fruit)				■	■	■	■	■	■			
Bud worms				■	■	■	■	■	■			
Carpophilus beetle				■	■	■	■	■	■			
European earwig							■	■	■			
Green peach aphid			■	■	■							
Laxa brown rot	■	■	■									
Leaf curl	■	■	■									■
Light brown apple moth					■	■	■	■				
Monolepta beetle			■	■	■	■	■	■	■	■		
Oriental fruit moth					■	■	■	■	■	■		
Plague thrips		■	■	■	■							
Queensland fruit fly				■	■	■	■	■	■			
Rhizopus rot					■	■	■	■	■			
Rust, freckle			■	■	■	■	■	■	■	■		
Rutherglen bug			■	■	■	■	■	■				
San José scale	■	■	■						■	■	■	
Shot hole	■	■	■									■
Summer trunk canker (young trees)										■	■	
Two-spotted mite									■	■		
Western flower thrips		■	■				■	■	■			
White peach scale	■	■	■	■					■	■		
Wingless grasshopper						■	■	■	■			

Note: This is a guide only. The status and treatment time for each problem varies across fruit-growing districts.

■ Likely timing for monitoring and treatment.

Monitoring is critical to avoid unnecessary or poorly timed sprays.

Management calendar for peaches and nectarines

Table 23. Peaches and nectarines – calendar.

Month	Reason	Treatment	Remarks
EARLY BUDSWELL TO EARLY PINK–EARLY WHITE			
EARLY June–July LATE July–September	Leaf curl	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR copper octanoate (M1) OR dithianon (M9) OR dodine (M7) OR tribasic copper sulfate (M1) OR zineb (M3) OR ziram (M3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	Spraying newly planted trees should not be overlooked. Where there is a range of rates for copper oxychloride, use the highest permitted rate. Dodine for peaches and nectarines. Do not apply after petal fall. Copper sprays used to control leaf curl, shot hole and rust will help to control bacterial diseases.
	Rust	Dithianon (M9) OR zineb (M3)	Spraying newly planted trees should not be overlooked. Where there is a range of rates for copper oxychloride, use the highest permitted rate. Copper sprays used to control leaf curl, shot hole and rust will help to control bacterial diseases.
	Shot hole	Chlorothalonil (M5) OR copper cuprous oxide (M1) OR copper hydroxide (M1) OR tribasic copper sulfate (M1) OR ziram (M3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	Spraying newly planted trees should not be overlooked. Where there is a range of rates for copper oxychloride, use the highest permitted rate. Copper sprays used to control leaf curl, shot hole and rust will help to control bacterial diseases.
	Bacterial spot and bacterial canker	Copper oxychloride (M1) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	Copper sprays used to control leaf curl, shot hole and rust will help to control bacterial diseases.
	Green peach aphid, black peach aphid and San José scale	Horticultural mineral oil (HMO)	Apply thoroughly at early budswell. May be combined, if necessary, with copper oxychloride. This treatment, followed by the action of aphid predators in spring, is an important component of the resistance management strategy for green peach aphid.
	Oriental fruit moth (OFM)	Mating disruption	Attach Disrupt-OFM or Isomate OFM Rosso dispensers to trees at 270/ha to give an even distribution through the orchard. Apply before the end of August. See product instructions for more information.
	To reduce vegetative growth	Paclobutrazol	See Apricots. Apply 14 days before budburst and full bloom.
	Brown rot and freckle	Copper oxychloride (M1) OR dithianon (M9)	Apply at early bud movement.

Month	Reason	Treatment	Remarks
MID PINK–MID WHITE TO SHUCK FALL			
EARLY June–July LATE July–September	Brown rot	Captan (M4) OR chlorothalonil (M5) OR dithianon (M9) OR iprodione (2) OR mandestrobin (11) OR penthiopyrad (7) OR propiconazole (3) OR triforine (3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	If rain is forecast and blossom blight infection is likely, apply at early bloom (1–10%) and at mid to full bloom. Apply at early to mid-budswell as a 'clean up' spray if the previous season was a bad year for brown rot. This treatment will minimise the risk of blossom blight. Additional sprays might be required at petal to shuck fall where this disease is a problem.
	Plague thrips	Tau-fluvalinate (3A)	Spray during flowering only if thrips are numerous. Tau-fluvalinate is toxic to predatory mites, so if present, this could result in a two-spotted mite problem later.
	Western flower thrips (WFT)	Spinetoram (5)	WFT action can occur during flowering but is more likely to be a problem closer to harvest. Do not confuse WFT with other thrips that also infest blossoms – the control measures are different.
	Light brown apple moth (LBAM)	*Bacillus thuringiensis* (Bt) (11)	Apply at first sign of action. Bt is best used as a routine program. It is not suitable for emergency treatment.
	Blossom thinning	AFAP (Armothin®) OR ammonium thiosulfate	Apply close to full bloom. Use spray volume of at least 1,500 L/ha. Extended blossom periods will reduce effectiveness. Treatments that compress blossoming will help. Always test on a small number of trees initially, leaving unsprayed check trees, and keep records of conditions and responses. Check with label for variety recommendations.
	Oriental fruit moth (OFM)	Indoxacarb (22A) OR thiacloprid (4)	Pheromone dispensers are the preferred treatment. Apply up to three applications of indoxacarb at 10-day intervals. See label for details of timing. Monitoring by traps is required for timing. Apply in a series of three sprays of thiacloprid (maximum) at 14-day intervals, starting at egg hatch of a generational peak as indicated by monitoring. Apply thoroughly to ensure complete coverage. For the remainder of the season, continue to use other control measures. Thiacloprid will also reduce green peach aphid in treated blocks. See August.
		Chlorantraniliprole (28)	Maximum of three applications 14–21 days apart, starting at petal fall (or before 110 degree days after codling moth detected in traps) until late December. Program is also useful to control budworm and LBAM.
	Freckle, rust and shot hole	Dithianon (M9) OR mancozeb (M3) OR thiram (M3)	Apply one of these fungicides at petal fall to shuck fall where these diseases are troublesome. Thiram is only registered for shot hole.
	Brown rot (blossom blight) and shot hole	Chlorothalonil (M5) OR dithianon (M9) OR dodine (Syllit®)(M7) OR mandestrobin (11) OR penthiopyrad (7) OR thiram (M3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Dodine is not registered for shot hole.

Month	Reason	Treatment	Remarks
EARLY June–July LATE July–September	Green peach aphid	Clothianidin (4) OR imidacloprid (4) OR novaluron (15) + acetamiprid (4A) OR pirimicarb (1A) OR pymetrozine (9) OR sulfoxaflor (4C)	The budswell oil spray and subsequent predator action should give control, but if this spray was missed or infestation is severe, a spray might be necessary. Apply novaluron + acetamiprid when monitoring indicates aphid numbers are above the economic threshold. Aphids that are within curled leaves may not be adequately controlled. Delay using insecticide for as long as possible as part of the resistance management strategy. Do not apply consecutive applications of any of these insecticides. Resistance to pirimicarb is already known. All three insecticides will also control black peach aphid.
	European earwig	Carbaryl OR chlorpyrifos (1B)	Can damage fruit in some districts and some seasons. Bait: Prepare according to product label. Apply bait at 5 kg/ha in spring. Spray: Apply in spring. Avoid contact with bees.
EARLY LEAFING TO FRUIT RIPENING			
EARLY July–December LATE September–February	Rust and shot hole	Chlorothalonil (M5) OR dithianon (M9) OR mancozeb (M3) OR thiram (M3) OR zineb (M3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Rust sprays should start with early leaf development and should continue throughout the season. This fungicide program aims to protect the leaf from infection and is the key to rust control. When rust becomes established in an orchard it is difficult to control. Chlorothalonil is not registered for rust on nectarines. Fluopyram + trifloxystrobin is registered for shot hole only. Thiram is not registered for rust. Zineb is registered for rust only. Warning: Do not apply chlorothalonil later than 35 days before harvest because of possible phytotoxicity.
	Rutherglen bug	Maldison (1B) OR trichlorfon (1B)	Spray when bugs occur on trees and fruit. Treat infested weeds in and around the orchard. Remove weeds that are a host for the bugs. These sprays will not prevent reinfestation from outside the orchard. Both insecticides will also provide some control of QFF.
	Budworms (*Helicoverpa* spp.)	Carbaryl	Apply at first sign of pest action and repeat as necessary. Budworms bore into the side of the fruit. Check orchard for larval action especially after periods of westerly winds which carry moths to the coast.
	Queensland fruit fly (QFF)	1. Trapping 2. baiting acetoxy phenyl butanone OR clothianidin (4A) OR trichlorfon (1B)	1. Hang male lures in the orchard to detect fly presence. Fruit stinging can start in August 2. when flies are detected, start a baiting program and repeat weekly using yeast autolysate with either maldison, fipronil or spinosad in the mix as a contact insecticide. Cothianidin has a 7-day withholding period. Trichlorfon has a 2-day withholding period. Apply at start of stinging. A grid system of 16 Amulet® fly lures per hectare has been reported to give effective control when used in conjunction with monitoring traps, baiting with a yeast chemical mixture and good crop hygiene. For a full list of current permits for QFF, refer to page 2. If treated produce is to be exported, note the residue definition and residue limits/import tolerances of importing countries. Ensure that any residues do not exceed those requirements of the importing country.

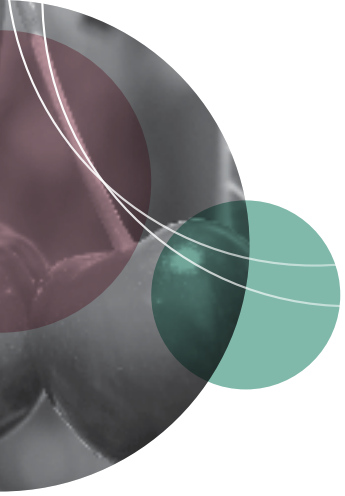
Month	Reason	Treatment	Remarks
EARLY July–December LATE September–February	Oriental fruit moth (OFM)	Chlorantraniliprole (28) OR clothianidin (4) OR indoxacarb (22A) OR mating disruption (Central Coast) OR novaluron (15) + acetamiprid (4A) OR thiacloprid (4)	Apply if damage to young lateral tips of peaches or nectarines is obvious and/or fruit damage was severe last season. Apply up to three applications of indoxacarb at 10-day intervals. See label for details on timing. Using OFM mating disruption has not been successful on the North Coast because of attack by orange fruit borer in the absence of insecticides for OFM. If targeting the first generation, apply novaluron + acetamiprid before 110 degree days after OFM are detected in traps. Apply thiacloprid in a series of three sprays (maximum) at 14-day intervals, starting at egg hatch of a generational peak as indicated by monitoring. Apply thoroughly to ensure complete coverage. For the remainder of the season use other control measures.
	Light brown apple moth (LBAM)	*Bacillus thuringiensis* (Bt) (11) OR chlorantraniliprole (28) OR indoxacarb (22A) OR novaluron (15) + acetamiprid (4A)	Examine trees regularly, beginning in mid-September. Inspect the stem end of fruit in the centres of the trees. Biological control using Bt might not be effective under high pest pressure. Thorough application of indoxacarb is essential, using up to three sprays. Apply novaluron + acetamiprid after petal fall or 140 degree days after LBAM are detected in traps. If required, apply a second application after a 14-day interval.
	Orange fruit borer	Carbaryl	Attacks peaches and nectarines around the stem end and occasionally bores into tips of young shoots causing damage similar to OFM.
	Monolepta beetle (red-shouldered leaf beetle)	Carbaryl	Damage can occur when fruitlets are very small. Check orchard and windbreak trees after rain for insect action and spot treat if present. Early detection is essential as beetle numbers can increase quickly. Monolepta beetle not only damages green and ripening fruit but can severely damage foliage of young trees.
	Western flower thrips (WFT)	Spinetoram (5)	Monitor for thrips presence. WFT is likely to be a problem in the 14–21 days before harvest, especially on nectarines. If the pest is detected, apply spinetoram.
	Carpophilus beetles	1. Monitor 2. sanitation 3. bifenthrin (3A)	Beetles can be a serious problem. Follow the three-stage management strategy: 1. Regularly inspect fruit for beetle action, especially as fruit ripens. 2. pick up and destroy fallen fruit. This will help to reduce breeding sites and the spread of carpophilus beetles, which also spread brown rot. 3. spray only when beetles invade. Bifenthrin is toxic to beneficial insects and mites.
	Green peach aphid (GPA)	Imidacloprid (4) OR pirimicarb (1A) OR pymetrozine (9B) OR sulfoxaflor (4C)	See page 126, especially the need to rotate insecticide groups.
	Katydid (long-horned grasshopper, green treehopper)	Carbaryl	Could be a problem in the MIA when OFM is controlled by pheromones. Using carbaryl can result in a two-spotted mite problem.
	Black peach aphid (BPA)	Imidacloprid (4) OR pirimicarb(1A) OR pymetrozine (9B) OR spirotetramat (23) OR sulfoxaflor (4C)	Thorough budswell spraying often gives control for the season. Reinfestation from the roots may occur in October. When spraying GPA and/or BPA do not use consecutive applications of the same insecticide. Note the need to rotate insecticide groups to avoid resistance. Do not apply more than three applications of spirotetramat per crop, with no more than two applications made later than 21 days after shuck fall and with a minimum of 14 days between applications.

Month	Reason	Treatment	Remarks
EARLY July–December LATE September–February	Magnesium deficiency	Magnesium sulfate	See 'Nutrient sprays for deciduous fruits', page 108.
	Zinc deficiency	Zinc sulfate + fresh hydrated lime	If symptoms present, spray early when observed – apply as a separate spray. See 'Nutrient sprays for deciduous fruits', page 108 for mixing rates. Do not use a wetting agent.
	San José scale	Chlorpyrifos (1B) OR novaluronn (15) + acetamiprid (4A) OR spirotetramat (23)	Apply when crawlers are active. This treatment could cause fruit marking especially on white fleshed peaches, when applied under hot, dry conditions. Apply novaluron + acetamiprid to control crawlers from petal fall in rotation with insecticides from alternative mode of action groups. Do not apply more than three applications of spirotetramat per crop, with no more than two applications made later than 21 days after shuck fall and with a minimum 14 days between applications.
	European earwig	Carbaryl OR chlorpyrifos (1B) (EC formulation)	Apply if required.
	Wingless grasshopper	Maldison (1B)	Might invade orchards in Tablelands districts as herbage dries out, from about mid-December, and cause damage to fruit and foliage. Spray infested herbage around trees and also the trees themselves if the pests have already infested these.
		Carbaryl	If large numbers of grasshoppers are in the pasture land surrounding the orchard, it is advisable to spray a strip at least 10 m wide round the margins of the block, especially if the grasshoppers have not yet invaded the block. Observe withholding period for grazing animals (2 days). Keep trees under observation and treat the pasture buffer when any reinfestation of the area is seen.
FRUIT RIPENING TO HARVEST			
EARLY September–December LATE October–January	Queensland fruit fly (QFF)	See 'Early leafing – fruit ripening'	See 'Early leafing – fruit ripening'.
	Two-spotted mite	Bifenazate (UN) OR fenbutatin oxide (12B) OR milbemectin (6B) OR predatory mites OR propargite (12C) OR tebufenpyrad (21A) (peaches only)	Two-spotted mite is only likely to be a problem if azinphos-methyl or carbaryl is used extensively during the season, or postharvest after bifenthrin. Examine the centres of the trees from mid-November onwards and spray when a build-up is noticed. One thorough application should be sufficient, but watch for reinfestation after 21–35 days. Do not rely on one chemical group. Rotate between groups to prevent resistance developing. Use one application only in any one season of bifenazate, tebufenpyrad or milbemectin and avoid consecutive sprays between seasons. Predatory mites are an alternative treatment to miticides: *Amblyseius victoriensis* in the MIA, *Galendromus occidentalis* in the tablelands and *Phytoseiulus persimilis* on the coast. Some pesticides are toxic to predatory mites and must be avoided for best results. Refer to advice provided by the mite supplier.
	San José scale	Chlorpyrifos (1B) OR spirotetramat (23)	A preharvest treatment will only be required if crawlers are active. Observe withholding periods. This treatment could cause fruit marking especially on white fleshed peaches when applied under hot, dry conditions. In subtropical areas this treatment is normally undertaken after harvest is completed. Do not apply more than three applications of spirotetramat per crop, with no more than two applications made later than 21 days after shuck fall and with a minimum of 14 days between applications.

Month	Reason	Treatment	Remarks
EARLY September–December LATE October–January	Brown rot	Captan (M4) OR dithianon (M9) OR fludioxonil (12) OR iprodione (2) OR mancozeb (M3) OR propiconazole (3) OR triforine (3) OR a proprietary mixture of fluopyram (7) + trifloxystrobin (11)	Apply 21 days and again 7 days before picking. If weather conditions are favourable for brown rot it might be necessary to apply further sprays during the harvest period. Remove infected fruit and destroy. Warnings: • postharvest dipping will not yield good results if brown rot control has been poor in the orchard. An adequate spray program in conjunction with orchard and packing shed sanitation is very important. This applies especially to late maturing nectarines • observe withholding periods between spraying and picking • do not use a fungicide for the last field spray from the same group as that to be used as a postharvest dip. Avoid using fludioxonil in the field as it is UV sensitive. Best as postharvest dip. See 'Avoiding fungicide resistance' on product label • carpophilus beetle damage can lead to increased incidence of brown rot infection in fruit. Good management of this pest is vital.
	Rust and shot hole	Chlorothalonil (M5) OR dithianon (M9) OR mancozeb (M3) OR thiram (M3) OR zineb (M3)	Refer to Mid pink/Mid white to shuck fall. Thiram is not registered for rust. Zineb is registered for rust only.
	Western flower thrips (WFT)	Spinetoram (5)	The danger period for inland districts is 14–21 days before harvest. Monitoring is advisable. If presence of WFT is suspected or confirmed, apply spinetoram at the rate for WFT on the label.
	Carpophilus beetles	1. Monitor 2. sanitation 3. bifenthrin (3A)	1. Regularly inspect fruit for beetle action, especially as fruit ripens 2. pick up and destroy fallen fruit. This will help to reduce breeding sites and the spread of carpophilus beetle, which also spread brown rot 3. spray only when beetles invade. Bifenthrin is toxic to beneficial insects and mites.
	Enhance firmness over harvest and storage	Aviglycine	Apply 7–14 days before harvest. Can delay maturity by up to 5 days.
	Oriental fruit moth (OFM)	See early leafing	See early leafing.
	Light brown apple moth (LBAM)	See early leafing	Keep trees under observation.
	Zinc deficiency	Zinc sulfate + fresh hydrated lime	Apply if zinc deficiency symptoms appear. See 'Nutrient sprays for deciduous fruits', page 108.
	Rutherglen bug	Maldison (1B) OR trichlorfon (1B)	Troublesome in some seasons during dry weather following haying-off weed growth. Infested weed growth in and beside the orchard should also be sprayed. Respraying might be necessary within a few days during a plague. Both insecticides will control QFF.
	Wingless grasshopper	Maldison (1B)	Observe withholding period.
HARVEST AND POSTHARVEST (FRUIT)			
EARLY October–June LATE December–February	Brown rot and rhizopus rot	Postharvest dip: fludioxonil (12) OR iprodione (2)	Include a wetting agent in the dip. Immerse fruit for 30–60 seconds (to ensure thorough wetting) as soon as possible after harvest. Do not use a fungicide for the last field spray from the same group as that to be used as a postharvest dip. Avoid using fludioxonil in the field as it is UV sensitive. Best as postharvest dip. Iprodione controls brown rot and suppresses rhizopus rot. See warnings on resistance.
	Skin rub or browning (peaches)	Harvest fruit at the correct maturity. Grade fruit when it is 10–20 °C and then cool to 0–2 °C.	This injury is more common in volume-filled containers and fruit that is picked while still immature. Defuzzing equipment for peaches may increase the problem. Fruit pre-cooled to less than 5 °C will suffer mechanical damage more readily than fruit above this temperature.

Month	Reason	Treatment	Remarks
EARLY October–June LATE December–February	Skin discolouration (SD) or inking (peaches and nectarines)	Use clean picking bags and boxes as dirt and dust increases the problem. Pick fruit with care and handle gently	SD symptoms can appear after dipping. Small areas of skin tissue become dark brown to black, tending to concentrate on the red areas of the skin tissue. Damage does not extend into the flesh. SD has been observed primarily on highly coloured varieties, either dipped immediately after harvest, before fruit has been cooled, or in fruit dipped after cooling. Vibrations from picking platforms can cause compression injury on fruit, causing SD. Non-abrasive handling and picking into small containers could reduce the problem. Inspect packing equipment for abrasive surfaces and replace if necessary. Other factors can contribute to the disorder, such as iron in water. Check pH of the dip water, which should not exceed 6.5 to 7.
	Enhance firmness over harvest and storage	Aviglycine	Apply 7–14 days before to harvest. Can delay maturity for up to 5 days.
	Phytophthora root rot	Fosetyl (33)	Autumn foliar spray should be applied in sufficient time to be taken up by active leaves. Chemical remains in wood and confers medium-term protection (peaches only). Use only where disease has been detected in the block.
	Leaf curl and shot hole	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR copper oxychloride (M1) OR tribasic copper sulfate (M1) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	Some formulations can be applied when leaves are falling freely. Check label before use.
	Bacterial canker and bacterial spot		Copper sprays for leaf curl or shot hole will also help to control bacterial diseases.
AFTER HARVEST (TREES)			
EARLY October–April LATE December–April	Rust and shot hole	Chlorothalonil (M5) OR dithianon (M9) OR mancozeb (M3) OR thiram (M3) OR zineb (M3)	Continue a rust prevention program after harvest to prevent premature leaf fall leading to early blossoming in autumn. Early leaf fall in mid-summer exposes scaffold limbs to sunscald, killing the bark. Wood rotting bracket fungi colonise the dead wood. Tree health and longevity of the orchard is reduced. Spray interval is dependent on rainfall. If dry, spray every 21 days; if wet, reduce spray interval to 10–14 days. Good spray coverage on the underside of the leaves is essential. Thiram is not registered for rust. Zineb is registered for rust only.
	Summer trunk canker (*Phytophthora cinnamomi*)	Stake trees chlorination of nursery water	Normally this disease is a problem only in newly planted trees. Do not plant peach rootstock in soils prone to waterlogging. Purchase disease-free trees grown in a well-drained, soil-less potting mix. In windy areas, stake newly planted trees to prevent tree movement and bark damage that might result in disease entry at ground level. The first sign of the disease is an orange-red resin or gum exuding from the trunk. Other symptoms are a wilting appearance, leaf yellowing, leaf rolling and leaf drop. Nursery irrigation water might need chlorination.
	Wood rots	Grafting mastic OR water-based paint OR wound sealant	Prune back limbs to healthy wood and paint large cuts during summer and winter pruning. Limbs affected by sunscald following a severe summer pruning are major infection sites. Do not over-prune and leave sufficient leaf cover to protect the upper side of the limb.

Month	Reason	Treatment	Remarks
EARLY October–April LATE December–April	San José scale	Chlorpyrifos (1B) OR spirotetramat (23)	Apply when crawlers are active. In some seasons, scale populations can rise dramatically causing significant limb dieback and tree death. High volume application using hand wands is recommended to ensure good spray coverage. Do not apply more than three applications of spirotetramat per crop, with no more than two applications made later than 21 days after shuck fall and with a minimum of 14 days between applications.
	Oriental fruit moth (OFM)	Carbaryl OR thiacloprid (4)	Maintain treatment of peaches and nectarines if damage to lateral tips continues. See 'Early leafing–fruit ripening'. Maximum of three sprays of thiacloprid.
	Two-spotted mite	Bifenazate (UN) OR fenbutatin oxide (12B) OR milbemectin (6B) OR predatory mites OR propargite (12C) OR tebufenpyrad (21A) (peaches only)	Mites can become a problem after harvest. See 'Fruit ripening to harvest'.
	Peach tree fungal gummosis (*Botryosphaeria dothidea*)	No fungicide control program has been established for this disease	Oozing resin or gum appears on branches or trunks and from swollen lenticels. Multiple infections result in extensive cankers. Bark takes on a black and crusty appearance. Often the branches are girdled, and if complete, leads to limb or tree decline and death. Do not leave pruning stubs as they can be an entry point for the disease. Remove winter prunings from the orchard to reduce carry over inoculum. Avoid moisture stress after harvest and maintain tree health with adequate nutrition.
LEAF FALL			
EARLY April–May LATE April–May	Leaf curl and shot hole	Copper cuprous oxide (M1) OR copper hydroxide (M1) OR copper oxychloride (M1) OR tribasic copper sulfate (M1) OR a proprietary mixture of mancozeb (M3) + copper hydroxide (M1)	Using copper sprays is often required to hasten leaf fall. Apply four sprays at 7-day intervals during the leaf fall period. Delay leaf defoliation if the season is wet during April as early flowering can occur if temperatures are mild during May. In these seasons, start defoliation in late May or early June (1st week). Copper hydroxide is not registered for shot hole on nectarines.
	Bacterial spot and bacterial canker		Copper sprays will also help to control bacterial diseases.
DORMANCY			
EARLY May–June LATE June–July	Black peach aphid	Maldison (1B)	Infestation of lateral growth can occur in autumn. If this becomes severe, it will be necessary to spray, otherwise considerable damage to buds, with premature budburst, can result.
	Crown gall	*Agrobacterium radiobacter* var. *radiobacter*	Inoculate trees at planting.
	Brown rot	Sanitation	Remove all mummies, cankers and dead shoots from trees and destroy by burning.
	San José scale	Horticultural mineral oil (HMO)	See also under August – Green peach aphid control. Warning: Apply only one full-strength oil spray (3 L/100 L) in any one winter.
		Sanitation	See under Apples.
	Green peach aphid	Horticultural mineral oil (HMO)	For white peach scale, the maximum registered rate is 2 L/100 L. Apply thoroughly. Scale control during dormancy should be routine because of the rapid population build-up during summer.



Non-bearing trees

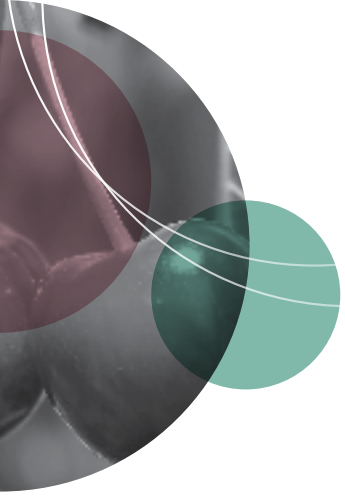
Young trees that are not bearing fruit do not need the same intensive spray schedule as bearing trees. Below are the types of problems most likely to be encountered with apples and pears (Table 24) and stone fruit (Table 25). However, prevention is the cheapest route to healthy trees. Source new trees from reputable nurseries. Choose varieties with known pest and disease resistance. Avoid stressing young trees by supplying good nutrition, sufficient water and preventing weed growth close to young trees.

Table 24. Apples and pears.

Pest or disease	Damage	Control
Apple scab	Can cause severe setback to young tree development. Scab infections of leaves will result in reduced growth and premature leaf drop.	The curative fungicides listed in the apple section are recommended as they reduce the amount of spraying required. The treatment should be applied when weather conditions have favoured scab infection.
Pear and cherry slug	Slug attack can cause leaf damage leading to premature defoliation.	Young trees should be inspected periodically and action taken if required.
Powdery mildew	Can be very damaging to young trees and can result in problems with tree training. Particular care needs to be taken with susceptible varieties such as Cripps Pink.	A protective schedule is required, but can be minimal if frequent observations are made and infected shoots are pruned out as soon as they are seen. Note that some fungicides will control both scab and mildew.
Rabbits and hares	Tree growth is reduced and the tree might die from ring barking of the trunk.	Protecting trees with trunk guards and/or wire netting fence is the most reliable means of preventing attack.
Wingless grasshoppers	Tree growth is reduced and tree training problems might occur because of reduced leaf area.	A protective treatment might be necessary when grasshoppers are numerous.
Woolly aphid and San José scale	The growth of the young tree can be reduced and in some cases lead to tree death.	Make sure that trees are free from infestation before delivery from the nursery. A pre-planting treatment is advised if these insects are noticed on nursery stock.

Table 25. Stone fruit.

Pest or disease	Damage	Control
Bacterial canker	Can cause severe gumming of limbs and trunks leading to reduced tree growth and sometimes death if severely cankered.	A protective spray schedule based on copper fungicides is advised between leaf fall and early budswell period.
Cherry aphid and black peach aphid	Aphids can infest lateral growth of stone fruit in autumn and become a problem in spring.	Closely observe trees for the presence of insects and take action if warranted.
Crown gall	This bacterial disease can cause significant losses in stone fruit trees by infection of the crown root.	Treating seeds, rootstock seedlings and bare rooted trees before planting with a biocontrol agent is advised. See 'Biological control', page 123.
Leaf curl	This disease causes leaf fall and marked or misshapen fruit. Heavy leaf fall can lead to fruit drop and small fruit. It affects mainly peaches, nectarines and, to a lesser extent, apricots.	A protective spray schedule based on copper fungicides is advised between leaf fall and the early budswell period. In coastal districts, regularly monitor young trees in late winter and early spring (August–September) and spray if necessary.
Plague thrips	Thrips laying eggs causes leaf damage to the expanding foliage of the stone fruit.	Closely observe trees for insect presence and take action if warranted.
Rabbits and hares	Tree growth is reduced and the tree can die from ring barking of the trunk.	Protecting trees with trunk guards and/or wire netting fence is the most reliable means of preventing attack.
Rust	A severe infection causes premature leaf fall, exposing limbs to sun scald and wood-rotting fungi.	Apply a protective fungicide program during the growing season.
Scale insects	San José and white peach scale infestations can lead to unthrifty trees and tree death.	Make sure that trees are free from infestation before delivery from the nursery. A pre-planting treatment is advised if these insects are noticed on nursery stock.
Shot hole	The disease causes leaf shot hole, leaf yellowing, premature leaf fall, twig death and even branch gumming.	A protective spray schedule based on copper fungicides is advised between leaf fall and early budswell period.
Summer trunk canker	This is a potentially serious disease affecting stone fruit on peach rootstock in wet soils. Severely infected trees may die.	Staking of trees to prevent movement during periods of rain and windy weather will reduce the incidence of the disease. Orchard mounding and using fungicide treatments can help.



Nutrient sprays for deciduous fruits

Healthy, unstressed trees are more able to resist attack from pests and diseases. Therefore, maintaining good plant nutrition is an important component of any crop protection strategy.

Good plant nutrition in the deciduous fruit orchard begins before planting. Site preparation should include a complete soil test. This needs to be done with enough lead time to permit fertilisers and remedial treatments to be applied and incorporated into the soil where necessary.

Once the orchard is established, soil and plant tissue tests, along with nutrient budgets, can be used to help plan your annual fertiliser program.

Nutrient sprays can be an important component of an orchard fertiliser program, but should be seen as supplementing soil applied fertilisers; not as a substitute for them.

Table 26 lists the most common nutrient deficiencies of deciduous fruit trees and when to treat for them using foliar sprays. There are numerous proprietary brands available of either single nutrient products or products containing combinations of nutrients. Consult the product labels and your supplier for rates and directions for use.

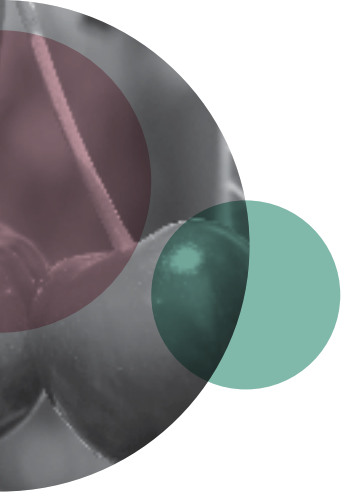
Table 26. Key nutrients, symptoms of deficiency, and treatments for deciduous fruit trees.

Key nutrients	Symptoms of deficiency	Timing of spray	Nutrient source and rate
Boron	Internal cork. Small brown spongy lesions in the fruit flesh. Also important in flowering and pollination.	Use in late spring when there is ample foliage to absorb the nutrients. Do not use when fruit is small and tender. Boron can also be applied postharvest but should be applied while leaves are still green. Apply in early morning or late evening to maximise leaf absorption. Do not combine polyborate powder with other foliar sprays. If deficiency persists, apply borax as a soil application.	Polyborate powder (20.5%) (soluble boron) 125 g/100 L
Calcium	Bitter pit and storage pit. Indentations on the fruit skin that become brown spots in the flesh and on the skin.	Calcium sprays are applied to apples from fruit set until just before harvest. Calcium nitrate is used until early December as it also provides some nitrogen. Calcium chloride is recommended from January as extra nitrogen is not desirable in the lead-up to fruit maturity. Ensure good fruit coverage. Do not use concentrate calcium sprays. Calcium dip postharvest before storage can reduce the incidence of storage pit. Refer to section 'Pome fruit harvested fruit'.	Calcium chloride 500 g/100 L Calcium nitrate 500 g/100 L
Copper	Not common. Can be associated with shoot-tip die back.	Copper fungicides applied at the dormant or green-tip stage usually supply sufficient copper.	Dormant copper fungicides (various). See label for application rate

Key nutrients	Symptoms of deficiency	Timing of spray	Nutrient source and rate
Iron	Interveinal yellowing with distinctive green veins. Not common. Primarily a problem in high pH (alkaline) soils or heavily limed soils.	Apply in spring when there is ample foliage to absorb nutrients. More than one application might be needed. Best applied early in the morning for maximum uptake.	Iron sulfate or iron chelate 100 g/100 L Multiple applications might be necessary
Magnesium	Interveinal yellowing particularly along leaf margins. Midrib and main veins of leaf remain green.	Apply in spring when there is ample foliage to absorb nutrients. Magnesium can be applied postharvest when leaves are still green. If deficiency persists, apply dolomite to soil, based on soil analysis.	Magnesium sulfate 2 kg/100 L + wetting agent
Manganese	Deficiency is uncommon. Toxicity (bark measles) can be a problem in Red Delicious apples and is associated with low soil pH.	Mancozeb sprays used for fungal disease control will often supply sufficient manganese to correct a mild deficiency.	If mancozeb sprays are not being used and deficiency occurs, use manganese sulfate on stone fruit (100 g/100 L) and pome fruit (200 g/100 L)
Nitrogen	Leaves pale green. Restricted new growth. Severe deficiency in peaches and nectarines can result in reddening of leaves.	Postharvest foliar nitrogen can help build reserves in dormant plant tissues for early spring growth and strong flowering. For prunes in the Young district, apply supplementary soil-applied nitrogen in years of heavy fruit set or to trees with root damage, particularly older trees.	Urea (only use low biuret spray grade, 0.4%) Prunes: 1 kg/100 L + 100 ml of non-ionic wetter
Zinc	Small narrow leaves and rosette foliage and delayed spring growth are the most common symptoms of zinc deficiency.	Some zinc formulations can be applied in season or postharvest when leaves are still green. Zinc sulfate should be applied when trees are fully dormant and before pruning. Bark or bud damage can occur if trees are not fully dormant.	Zinc sulfate heptahydrate (23% Zn), use on stone fruit in early summer (1 kg + 500 g hydrated lime) and pome fruit when dormant (2.5–5 kg/100 L)

IMPORTANT NOTE: Decisions regarding foliar fertilisation should be determined in conjunction with soil and tissue analysis. There are very few situations where routine foliar fertiliser can be justified without testing first. One exception to this rule is applying calcium sprays to reduce the incidence of bitter pit in apples.

Reference: Weir, RG and Cresswell, GC, 1993, '*Plant nutrient disorders 1 – Temperate and subtropical fruit and nut crops*'.



Weed management

Why manage weeds?

Rapid canopy establishment and early cropping are keys to profitability in any orchard block, particularly modern capital-intensive systems. Weeds compete with trees for moisture and nutrients and can also create a microclimate that is favourable for pests and disease.

Research shows that competition from weeds in young, developing orchards can result in slower canopy establishment and delayed productivity. In high density orchards, the risks from weed competition are heightened due to shallow-rooted dwarfing rootstocks that place tree roots in direct competition with weeds. A poor weed management strategy will also have a negative effect on yields in established orchards.

Having an effective weed management strategy in place will help growers to achieve their goals for orchard establishment, early yields and hygiene.

Hygiene comes first

Good orchard hygiene should be the first step in any weed management strategy. Establishing new weed species and movement of weeds on and throughout your property are largely determined by the degree of weed hygiene employed.

Be aware of new weeds appearing on your property. Have them identified if necessary, and put a plan in place to eradicate them or reduce their spread. Moving machinery from non-crop areas to the orchard and between blocks is the most likely method for spreading new weeds.

Periodically cleaning orchard equipment is a useful practice to help reduce the spread of new weeds.

Management strategies and control options

The most appropriate weed management strategy will vary from site to site and will depend on factors including the size of the orchard, tree age, weed spectrum and density, soil type, available moisture and choice of under-tree management (i.e. bare earth, mulched or sod culture). Over time, strategies need to respond to changes in the weed spectrum and growing conditions. Methods of weed management can be grouped as either physical or chemical; or can incorporate elements of both.

Physical weed control methods

Physical methods of weed control include cultivation, thermal weeding, grazing and mulching.

Cultivation

Cultivation was once a common commercial practice in orchards and does reduce competition from weeds, but at some cost. Disturbing top soil is now known to have a negative effect on soil structure and organic matter levels. It can also result in some root damage to trees, especially in blocks on dwarf stocks. Cultivation also increases erosion risk.

Spot cultivation using a hoe is very labour intensive, but might be an option for smaller orchards as an alternative to broad scale cultivation or spot spraying.

Thermal weeding

Research shows that flame or thermal weeding using propane burners, hot air or hot water can be effective on small seedlings, but is less effective against larger annuals or perennial weeds. There are also occupational health and safety as well as fire hazards associated with these methods. Do not use thermal weeding near trees less than three years old, as severe crop damage can occur.

Grazing animals

Grazing with animals such as sheep, geese and fowls can be used to suppress weed growth and reduce seed load in the orchard. Geese are heavy feeders of weeds such as grasses and they also help to clean up windfall fruit. Sheep can cause damage to trees if other feed is scarce.

If orchard-grazing animals are intended for sale, be aware of chemical residue issues. Consult chemical labels for information on stock withholding periods.

Mulching

Mulching, if done correctly, represents the most effective alternative to chemical weed control. Mulching the under-tree row with large quantities of organic materials such as straw, old hay or bark chips has multiple benefits including:

- moisture retention
- soil temperature regulation
- organic matter and soil microbe build-up
- weed control.

Side-cast mowers deposit slashings along the tree row, which can aid with weed suppression and organic matter build-up, but experience has shown that this is not effective as a stand alone mulch treatment if the aim is to achieve a weed-free strip.

To be effective as a weed control, mulch must be applied at sufficient thickness to act as a physical barrier to sunlight and weed growth; this will depend on the type of mulch being applied.

Growers should also be aware of the possibility of nitrogen drawdown effect when using some raw, non-composted mulches.

Chemical weed control

Chemical herbicides have been the mainstay of weed management in orchards since the mid 1940s. Using herbicides remains the most cost-effective and reliable approach to managing weeds in commercial orchards.

Types of herbicide and when to spray?

Orchard herbicides can be grouped into three broad categories:

1. pre-emergent residual herbicides (Table 27)
2. post-emergent selective grass herbicides (Table 28)
3. post-emergent non-selective knockdown herbicides (Table 29).

Generally, the best time to spray for weeds in the orchard is either just before (pre-emergent) or just after germination (post-emergent). Most weeds germinate in either spring or autumn. Small weeds are easier to control than older, more mature weeds.

Pre-emergent residual herbicides are designed to perform best if applied to bare soil that is totally weed- and trash-free. Any material that prevents the pre-emergent herbicide from contacting and incorporating into the soil surface will reduce the level of control over germinating weeds. Most pre-emergent herbicides will give effective control of a wide range of annual broadleaf weeds and grasses if applied correctly. Best results are achieved when applied to bare soil. Established perennials such as paspalum will not be controlled without using a post-emergent herbicide.

Post-emergent selective grass herbicides are useful where the predominant weed species present is a grass. The three active ingredients with registrations for use in NSW as selective grass herbicides are all members of the Group A herbicide mode of action (MOA). This means they are considered highly prone to developing resistance and should be used in accordance with resistance-management principles.

Post-emergent non-selective herbicides (knockdowns) perform best when applied to young, actively growing broadleaf weeds and some grasses. Due to their non-selective nature, many herbicides in this group can be very harmful to fruit trees. Young trees are particularly prone to injury if not protected from knockdown herbicides. Consult product labels for specific recommendations.

The tables entitled 'Herbicides and their uses' (page 113) provide a summary of information on the range of active ingredients available for use in deciduous fruit orchards.

IMPORTANT: Please read the product label thoroughly before applying any herbicide in your orchard. Failure to do so could result in a poor product performance or even damage to your trees.

Should I be concerned about resistance?

The short answer is Yes!

Glyphosate-resistant ryegrass is present in orchards and vineyards across Australia due to an over-reliance on Group M herbicides. Some useful tips on how to avoid resistance in your orchard can be found at www.glyphosateresistance.org.au

Herbicides work by interfering with specific processes in plants. This is known as the mode of action (MOA). All herbicides have been classified into groups from A to Z according to their MOA. Some groups are more likely to develop resistance and are considered high risk. The earlier the group is in the alphabet, the higher the likely susceptibility to resistance.

Refer to the section 'Herbicides and their uses' (page 113) or the product label to determine the MOA group.

To minimise the risk of herbicide resistance developing in your orchard:

- know your herbicide groups and do not rely on chemicals from the same group for every spray
- use a lower risk herbicide in preference to a high risk one. For example, never use a group A herbicide when an L or M group herbicide will do the job
- look for surviving weeds after spraying and prevent these from setting seed
- use as many weed control techniques as practical and do not rely solely on herbicides.

Herbicide sprayer setup

A properly configured and well-calibrated sprayer is essential to ensure your herbicides are applied in accordance with label recommendations and that you achieve the weed control result that you are hoping for. Some important points to consider are:

- always ensure effective agitation, especially when using dry flowable (DF), suspension concentrate (SC), water dispersible granule (WG) and wettable powder (WP) formulations
- ensure the pressure gauge is in accurate working order
- use the correct (specified) pressure range for the nozzles being used
- flat fan nozzles have traditionally been the popular choice for herbicide spraying, but these are no longer appropriate when it comes to reducing spray drift. For more information refer to the section on 'Managing herbicide spray drift' below
- always use a low drift type nozzle wherever possible, such as an air induction (AI) nozzle
- select the correct nozzle size from the manufacturer's chart once you have decided on a safe ground speed and the recommended application volume for the herbicide being used
- ensure a 'double overlap' of the spray fans at the top of the target, not ground level. Too low will result in uneven application of herbicide, while too high will increase the risk of off-target damage
- if individual nozzle output (litres per minute) varies by more than 5% of the manufacturer's specifications, replace these nozzles
- ensure all equipment is properly calibrated before use
- herbicide labels can include mandatory advice on droplet spectrum, e.g. medium coarse. If so, be sure to choose the right nozzle and operating pressure.

Simple and easy calibration

The most common procedure for calibrating herbicide spray equipment is:

1. select the tractor engine rpm and gear to give a satisfactory ground speed in the orchard and the correct pump pressure
2. fill the spray tank with water and note the exact level reached
3. measure a 100 m strip and spray over it with water
4. measure the width of the sprayed strip
5. return the rig to the exact position where it was filled the first time and measure how much water it takes to refill the tank to exactly the same level as before.

The area covered by a full tank can then be calculated using the following:

Assume:

Length of sprayed area [**L**] = 100 m

Width of sprayed area [**W**] = 1.5 m

Tank capacity [**T**] = 500 L

Volume of water used in test spray [**V**] = 10 L

Rate of application of commercial product [**R**] = 3.75 kg/ha

Then:

Area covered by full tank is

L × W × T ÷ V

In our example, the area covered is

100 m × 1.5 m × 500 L ÷ 10 L = 7,500 m^2 or 0.75 ha

(there are 10,000 m^2 per hectare)

Herbicide required in a full tank

= area covered by a full tank × rate of application [**R**]

In our example the amount of herbicide required

= 0.75 ha × 3.75 kg/ha = 2.8 kg

Managing herbicide spray drift

Herbicide application nozzle selection by Peter Alexander from TeeJet

Selecting nozzles to apply herbicides should primarily focus on reducing the risk of spray drift without compromising efficacy. Drift (or loss) is a significant issue facing the industry and applicators of herbicides not only have a moral, but also a legal obligation, to adopt current best practise.

Although there remains confusion among some growers regarding nozzle selection, the industry in general, backed largely by several years of trials on application rates, nozzle designs and travel speeds, generally agree (and recommend) that growers can apply most herbicides with coarser spray quality without any detrimental effect on efficacy.

How coarse still depends on the herbicide, the target and the conditions at the time of spraying, and growers need to be prepared to adjust either application rate or nozzle design appropriately.

For example, if using very coarse droplets, higher water volumes might be required to maintain high levels of efficacy, particularly when targeting fine leaf grasses with grass selective (Group A) products.

Consult your spray equipment supplier for appropriate nozzle types and configuration.

Herbicides and their uses

Table 27. Pre-emergent residual herbicides.

Active ingredient	Example trade name(s)	Herbicide group	Crop	Weeds controlled	Remarks
Dichlobenil	Casoron® G, Sierraron®	K	Orchards	Annual grasses and broadleaf weeds	Remove existing weeds before spreading granules.
Flumioxazin	Chateau®	G	Pome and stone fruit	Active against a wide range of grass and broadleaf weeds	Requires at least 15 mm of rain or irrigation to activate. Applied postharvest to budbreak, add a knockdown for weeds greater than 10 cm.
Isoxaben	Gallery® 750	O	Orchards	Certain broadleaf weeds	Requires incorporation by at least 12.5 mm rainfall or sprinkler irrigation within 21 days of application.
Napropamide	Devrinol™ WG	K	Stone fruit	Annual grasses and some broadleaf weeds	Incorporate to a depth of 2–5 cm.
Norflurazon	Zoliar® 800 DF	F	Apples, pears and stone fruit	Active against a wide range of annual broadleaf weeds and grasses	Do not use more than 4.2 kg product/ha in any one season. Do not apply to trees younger than 18 months.
Oryzalin	Cameo™ 500, Surflan™ 500, Oryzalin flowable	D	Apples, pear and stone fruit	Active against a wide range of annual broadleaf weeds and grasses	Use lower rate for short term (up to 4 months) and higher rate for longer term (6–8 months) control. Activated by moisture.
Oxyfluorfen	Goal®	G	Apples, pears, apricots, plums and peaches	Active against a wide range of annual broadleaf weeds and grasses	For pre-emergent or early stage seedling control, apply 3–4 L/ha. Do not apply once budswell has occurred. For post-emergent spike, use at 75 mL/ha with a glyophosate product or 250 mL/ha with a paraquat or diquat/paraquat product. Do not use on apples or pears if they are less than 3 years old.
Pendimethalin	Stomp 440®	D	Deciduous fruits	Active against a wide range of annual broadleaf weeds and grasses	Requires moisture for incorporation.
Simazine	Gesatop®	C	Pome fruit	Active against a range of broadleaf weeds	Do not use on trees younger than 2 years old. Use higher rate for medium to heavy textured soils.
Terbacil	Sinbar®	C	Apples and peaches	Annual weeds and perennial grasses	Do not apply to trees less than 3 years old. Do not apply on sandy or gravelly soils. Sorrel can become predominant after repeated applications of terbacil.

Table 28. Post-emergent selective grass herbicides.

Active ingredient	Example trade name(s)	Herbicide group	Crop	Weeds controlled	Remarks
Clethodim	Status®	A	Non-bearing fruit trees	Generally annual grasses	Apply to 2-leaf to fully tillered grasses.
Fluazifop-P-butyl	Fusilade® Forte	A	Apples, pears, stone fruit	Only controls annual and perennial grasses	Withholding period not required on these crops when used as directed.
Haloxyfop	Verdict®	A	Apples, pears, stone fruit	Annual and perennial grasses	Apply to small, actively growing grasses.

Table 29. Post-emergent non-selective knockdown herbicides.

Active ingredient	Example trade name(s)	Herbicide group	Crop	Weeds controlled	Remarks
Amitrole + ammonium thiocyanate	Amitrole T	Q	Orchards	Broad-spectrum. More active against broadleaf weeds (including marshmallow) and sedges	Trees should be at least three years old. Do not apply within 56 days from harvest. Wet weeds thoroughly. Use higher rate for marshmallow.
Amitrole + paraquat	Alliance®	L+Q	Orchards	Various	Spray young weeds in late-winter for spring–summer. Use higher rate in spring.
Asulam	Asulox®, Rattler® 400, Asulam® 400	R	Apples	Dock	Apply to actively growing docks in spring when leaves are fully expanded but before flower shoots emerge.
Carfentrazone-ethyl	Spotlight Plus®	G	Young or established orchards	Small flowered mallow and certain other annual broadleaf weeds	Tank mix with a knockdown herbicide to assist weed control. Hammer® no longer has registration for orchards or vineyards.
Diquat	Reglone®	L	Orchards	Capeweed	Avoid spray drift onto plant parts with green pigments. Spray only actively growing weeds (5–10 cm high). Wet thoroughly (add wetter).
Glufosinate ammonium	Basta®	N	Pome and stone fruit orchards	Broad-spectrum herbicide that controls a wide range of grass and broadleaf weeds including willow herb	Do not use around trees less than two years old, unless they are effectively shielded from spray and spray drift. Ensure thorough spray coverage. Works best in warm/humid conditions. Do not harvest for 21 days following application.
Glyphosate	Roundup®	M	Apples, pears and stone fruit	Control of a wide range of annual and perennial weeds	Do not allow spray or spray drift to contact green bark, suckers, fresh wounds, foliage or fruit. Do not use near trees less than three years old unless they are properly protected from spray and drift.
Glyphosate + carfentrazone-ethyl	Broadway®	M+G	Pome and stone fruit orchards	Broadleaf weeds including marshmallow	Do not allow spray or drift to contact green bark, stems, foliage or fruit.
Paraquat	Gramoxone®	L	Orchards	Most annual grasses and some broadleaf weeds. Add diquat to control capeweed	Avoid spray drift onto plant parts with green pigment. Spray only actively growing weeds (5–10 cm high). Wet thoroughly.
Paraquat + diquat	Spray.Seed®	L	All fruit crops	Broad-spectrum	Avoid spray drift onto plant parts with green pigment. Spray only actively growing weeds (5–10 cm high). Wet thoroughly.
Saflufenacil	Sharpen®	G	Pome fruit orchards	Control of a range of broadleaf weeds and grasses	Do not apply as a spray near trees less than three years old unless they are effectively shielded from spray and spray drift.

Legal responsibilities in applying pesticides

Bruce Browne
Farm Chemicals Officer, Plant Biosecurity
NSW DPI

The main national and NSW government agencies involved in legislation related to pesticides are the Australian Pesticides and Veterinary Medicines Authority (APVMA), NSW Environment Protection Authority (EPA) and Safe Work NSW.

The Australian Pesticides and Veterinary Medicines Authority

Pesticides are controlled in Australia through an inter-governmental arrangement known as the National Registration Scheme for Agricultural and Veterinary Chemicals. Under this scheme, the APVMA is the Commonwealth agency responsible for assessment and registration of pesticides in Australia and their regulation up to and including the point of sale under the *Agricultural and Veterinary Chemicals Code Act 1994*.

The states and territories are responsible for controlling the use of pesticides beyond the point of sale, that is, their use, handling, storage and disposal.

Before registering a product, the APVMA is required to conduct an assessment of the potential effects of the pesticide on the environment, human health and trade, and of the likely effectiveness of the pesticide for its proposed uses. When a pesticide contains an active constituent not previously used in Australia, the APVMA must seek public comment before registering the product.

Only registered pesticides can be used in NSW. Registration includes approval of label directions for each pesticide product. Label directions specify how, and under what circumstances, the pesticide may be used to treat the relevant target pest or pests. Labels also give directions on clean up, storage, disposal, personal and environmental safety.

The APVMA's Chemical Review Program reviews the registration of existing agricultural and veterinary chemicals if new information regarding a higher risk to human health, the environment or trade becomes available. The public, the Office of Chemical Safety and the Australian Department of Environment can report problems known as 'adverse events' regarding specific chemicals or products to the APVMA. The new and existing information is reviewed by the Office of Chemical Safety, the Department of Environment and the APVMA. The APVMA also invites public comment for chemicals under review as part of the process.

Permits for off-label use

Special provisions exist under legislation administered by the APVMA to allow people to use pesticides in a way that is not described on the approved label. The APVMA can approve off-label use of the pesticide by issuing a minor use permit. In NSW off-label use is not allowed unless a permit has been issued. A permit is similar to a label in that all instructions must be strictly followed.

Permits

A permit is issued for a limited use over a specified period of time if the Australian Pesticides and Veterinary Medicines Authority (APVMA) are convinced that such a use is justified. Justification is usually on the grounds that a suitable registered alternative is not available, it is required as part of an emergency management response program or to manage a pest or resistance management strategy.

In addition the pesticide:

- will not cause undue hazard to the safety of people exposed to it, during handling the pesticide or anything containing its residues
- should not have an unintended effect that is harmful to animals, plants or the environment
- will not unduly prejudice export trade
- will be effective against the intended pest.

Permits may be granted during the 2018-19 season, consult the APVMA for information about new permits. Growers wishing to use a chemical in the manner approved under a permit should obtain a copy of the relevant permit from the APVMA and must read and comply with all the details, conditions and limitations on the permit. Current permit and registration details are available on the APVMA web site: http://apvma.gov.au/

Industry bodies, organisations and corporations can apply for permits for off-label use. Inquiries should be made to the APVMA at:

PO Box 6182 Kingston ACT 2604
Phone: 02 6210 4700
Web: http://apvma.gov.au/

The Environmental Protection Authority

The Pesticides Act 1999 and Pesticides Regulation 2017

The Pesticides Act 1999 and Regulation 2017 are two of the primary legislative instruments controlling the use of pesticides after the point of sale in NSW. They aim to reduce the risks associated with the use of pesticides to human health, the environment, property, industry and trade. They also aim to promote collaborative and integrated policies for the use of pesticides. The EPA enforces the proper use of all pesticides in NSW.

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.

The Act and Regulation require all commercial pesticide users to:

- only use pesticides registered or permitted by the APVMA
- obtain an APVMA permit if they wish to use a pesticide in a way not covered by the label
- read the approved label and/or APVMA permit for the pesticide product (or have the label/permit read to them) and strictly follow the directions on the label
- only keep registered pesticides in containers bearing an approved label
- prevent injury to people, damage to property and harm to non-target plants and animals, the environment and trade through the use of a pesticide
- undertake approved training in pesticide application and renew this qualification every 5 years
- keep records of their pesticide application.

Compulsory training in pesticide use

Since 1 September 2003 training in the use of pesticides has been compulsory in NSW. If you use pesticides in your job or business you must achieve and maintain a specific level of competency in pesticide use.

There is a range of training available to suit all types of pesticide users. In most cases the training involves a 2-day course, based on competencies from the Agriculture, Horticulture and Conservation and Land Management Training Package (AHC10). You can also become qualified by demonstrating to a registered training organisation that you know how to use pesticides in your job or business.

The minimum prescribed training qualification is the AQF2 unit of competency, 'Apply chemicals under supervision'. 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'.

Note: the lower level AQF2 competency will provide a minimum qualification that satisfies the Regulation. For more information on training in pesticide use refer to the EPA website.

These training requirements do not apply where the pesticide is all of the below:

- ordinarily used in the home or garden
- widely available to the general public at retail outlets
- being applied by hand or using hand-held equipment only
- being used in small quantities:
  - for outdoor use in quantities of no more than 5 litres/5 kilograms of concentrated product or 20 litres/20 kilograms of the ready-to-use product
  - for indoor use in quantities of no more than 1 litre/1 kilogram of concentrated product or 5 litres/5 kilograms of the ready-to-use product.

Pesticide record keeping

The EPA's Pesticides Regulation makes it compulsory for all people who use pesticides for commercial or occupational purposes to make a record of their pesticide use. Pesticides include herbicides, fungicides, insecticides, fumigants, nematicides, defoliants, desiccants, bactericides and vertebrate pest poisons. A small use exemption, similar to that for training, applies to record keeping.

To comply with the record keeping rules set out in the Regulation you must record the following within 24 hours of applying the pesticide:

- date, start and finish time
- the operator details – name, address and contact information
- the crop you treated e.g. apples
- the property address and a clear delineation of the area where the pesticide was applied
- type of equipment used to apply the pesticide e.g. knapsack, air blast sprayer, tractor mounted boom spray
- the full product name of the pesticide applied (e.g. Bayfidan 250 EC Fungicide® – not just 'Bayfidan'). If you mixed two pesticides together, record both
- the total amount of concentrate product used
- the total amount of water, oil or other products mixed in the tank with the concentrate
- size of block sprayed
- order blocks were treated
- an estimate of the wind speed and direction at the start of spraying. You can use a wind meter (anemometer) or the Beaufort scale to help estimate the wind speed. (Beaufort scale is available from the Bureau of Meteorology at www.bom. gov.au/lam/glossary/beaufort. shtml)
- if other weather conditions are specified on the label as relevant to the proper use of that pesticide (such as temperature, humidity, rainfall), you must record these weather conditions at the start of the application
- if wind and weather conditions change significantly while you are spraying, you need to record these changes
- records must be made in English.

If you already keep records for other purposes (e.g. for the packing shed you are supplying), you can simply add to that record any of the requirements listed above that are not already in that record.

Records must be kept for 3 years. If you are the owner or the person who has the management or control of the property on which you, your employees or a contractor applied the pesticide, you are responsible for keeping the records.

Note: If you applied the pesticide yourself, then it is your responsibility to make the record. You can get someone else to write it down for you but it is up to you to make sure the record is made and that it is accurate. If you employed someone to apply the pesticide then that person must record their name as well as your name, address and contact details as their employer. If the pesticide was applied by a contractor, the contractor must record their own name, address and contact details, the name, address and contact details of the owner or the person who has the management or control of the land where the pesticide was applied. You only have to record this additional information if the person who owns or manages the property and the person who applied the pesticide are different.

See Figure 64 for the EPA's example record keeping form.

Dangerous goods and hazardous substances (chemicals)

Many hazardous substances are also classified as dangerous goods. These are substances, mixtures or articles that, because of their physical, chemical (physicochemical) or acute toxicity properties, present an immediate hazard to people, property or the environment. Types of substances classified as dangerous goods include explosives, flammable liquids and gases, corrosives, chemically reactive or acutely (highly) toxic substances.

The criteria used to determine whether substances are classified as dangerous goods are contained in the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code). The ADG Code contains a list of substances classified as dangerous goods.

Hazardous substances (chemicals) are those that, following exposure, can have an adverse effect on health. Examples of hazardous substances include poisons, substances that cause burns or skin and eye irritation and substances that may cause cancer.

A substance is deemed to be hazardous if it meets the classification criteria specified in the Approved Criteria for Classifying Hazardous Substances [NOHSC:1008 (2004)] (Approved Criteria).

Substances that have been classified according to the approved criteria are provided in the online database called the Hazardous Substances Information System (HSIS).

Safe Work NSW

Under the Work Health and Safety Act 2011 (WHS Act), Safe Work NSW seeks to protect workers in the workplace. Regulations under the WHS Act control the use of hazardous substances including most pesticides. The Work Health and Safety Regulation 2011 is the most recent and important of these. It covers identification of hazardous substances in the workplace and the assessment and control of risks associated with their use. A copy of the *Work Health and Safety Act 2011* is available at this link: https://www.legislation.nsw.gov.au/#/view/act/2011/10.

The Act and accompanying Regulation are intended to protect workers from both the short and long-term health effects of exposure to hazardous chemicals 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 chemicals and a Safety Data Sheet (SDS) for each hazardous chemical)
- consultation with workers
- training of workers
- minimising the risks arising from hazardous chemicals exposure
- health surveillance (if organophosphates are used).

To help industries implement the Act and Regulation, Safe Work NSW developed a code of practice: Safe Use and Storage of Chemicals (Including Pesticides and Herbicides) In Agriculture 2006. This does not replace the WHS laws, but can help you understand what you have to do.

Note: this code of practice is the 2006 edition. The Pesticides Regulation 2017 and the Work Health and Safety Act and Regulation 2011 have been enacted after this code of practice was published. Safe Work's statement on this issue is:

> "*These codes of practice were developed based on the Occupational Health and Safety Act and Regulation (or older laws) which were replaced with the* Work Health and Safety Act and Regulation in NSW *from 1 January 2012. These codes are taken to have been made under the Work Health and Safety Act, which means they are current and can still be used to help you meet your WHS requirements, however to ensure you comply with your legal obligations you must refer to the appropriate legislation*."

For further guidance see Managing risks of hazardous chemicals in the workplace July 2014.

The WHS Regulations (2011) include specific responsibilities of a person conducting a business or managing risks to health and safety associated with handling and storing hazardous chemicals at a workplace. These include:

- correct labelling of containers, using warning placards and displaying of safety signs
- maintaining a register and manifest (where relevant) of hazardous chemicals and providing notification to the regulator of manifest quantities if required
- identifying risk of physical or chemical reaction of hazardous chemicals and ensuring the stability of hazardous chemicals
- ensuring that exposure standards are not exceeded
- provision of health monitoring to workers
- provision of information, training, instruction and supervision to workers
- provision of spill containment system for hazardous chemicals if necessary
- obtaining the current SDS from the manufacturer, importer or supplier of the chemical
- controlling ignition sources and accumulation of flammable and combustible substances
- provision and availability of fire protection, firefighting equipment, emergency and safety equipment
- preparing an emergency plan if the quantity of a class of hazardous chemical at a workplace exceeds the manifest quantity for that hazardous chemical
- stability and support for containers of bulk hazardous chemicals including pipework and attachments
- decommissioning underground storage and handling systems
- notifying the regulator of abandoned tanks in certain circumstances.

NSW dangerous goods and hazardous substances transport legislation

Not all pesticides are dangerous goods or hazardous substances but many are. If a pesticide is a dangerous good or hazardous substance, it will be noted on the label and the SDS.

Before the implementation of the Work Health and Safety Regulations 2011, workplace storage, handling and use of hazardous chemicals were regulated under separate instruments for hazardous substances and for dangerous goods.

The new WHS Regulations cover workplace hazardous substances and dangerous goods under a single framework for hazardous chemicals. It also introduces a new hazard classification and hazard communication system based on the United Nations' Globally Harmonised System of Classification and Labelling of Chemicals (GHS). The specific requirements of the ADG code for the transport of dangerous goods do not usually apply to the transport of farm chemicals because they are normally in small quantities.

Large operations should check the amounts for which marking of the vehicle and other special conditions are required by the ADG code.

The following rules apply to small quantities of pesticides being transported in **unopened** containers:

- keep them in a compartment of the vehicle separate from persons or foodstuffs
- the vehicle must be locked to prevent public access to chemicals when parked near a public road
- do not leave your loaded vehicle unlocked or unattended
- protect the load from weather
- do not accept or load damaged or leaking containers
- secure the load and limit its movement.

The following rules apply to small quantities of pesticides being transported in **opened** containers:

- keep in a separate airtight compartment, or on the rear section of an open vehicle (ute, truck or trailer)
- all other items carried (e.g. personal protective equipment, a change of clothes, food and drink) should be carried in clean containers preventing contact with any chemical pest control equipment and chemicals carried on the vehicle should not be in contact with porous surfaces
- the internal and external surfaces of the vehicle, chemical containers and spray equipment should be kept clean
- protect the load from weather
- do not leave your loaded vehicle unlocked or unattended
- do not load damaged or leaking containers
- secure the load and limit its movement.

Some critical elements of the label

Re-entry intervals

The re-entry interval is the time which must elapse between applying the pesticide and re-entry into the sprayed crop, unless the person is wearing the personal protective equipment specified for re-entry on the label. The reason for setting a re-entry interval is that pesticides sometimes remain on crops in the form of foliar aerosol particles. Residues can be dislodged by contact with the crop and absorbed through the skin by those working in the crop.

Re-entry intervals only appear on the label of a small number of products (both new and old) that have recently been reviewed by the APVMA. If there is no re-entry period on the label, the general rule is to wait 24 hours after application or until the crop is dry, whichever is longer.

Crops should not be re-entered when wet from dew or light rain within the re-entry period unless appropriate personal protective equipment, as described on the label is worn.

Pesticides and the environment

Many 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.

Protecting the aquatic environment

The risk to aquatic organisms can be managed by following label instructions.

Protecting bees

Many pesticides are toxic to bees, however this risk can be reduced by following label instructions. The label provides the following statement:

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

Protecting birds

Organophosphate and carbamate insecticides can be toxic to birds, especially in granular formulations. See the label for details on how to minimise the danger to birds.

Managing residues resulting from pesticide application

Withholding periods (WHPs)

The withholding period (WHP) is the minimum time which must elapse between the last application of a pesticide and harvest. The purpose of the WHP is to avoid residues in raw agricultural commodities and in foods for human and animal consumption.

- 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 product specific
- harvest WHPs may vary with formulation (e.g. ultra low volume or extra concentrated), rate (which may vary with the pest controlled), and whether or not the crop can be harvested green or dry
- not all labels include all registered use patterns for a particular active ingredient. Consequently, not all labels carry the same information on WHPs. 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, it will carry a statement to the effect that no WHP is necessary if label directions are followed
- where appropriate, growers are advised to contact the chemical manufacturer or the packing shed they are supplying for advice on managing chemical residues in the crop or in stock.

Export requirements

Some export markets have a lower maximum residue limit (MRL) than Australia or no MRL. Contact your packing shed to determine their requirements.

Managing spray drift

Spray drift is the airborne movement of agricultural chemicals onto a non-target area. There may be a risk of injury or damage to humans, plants, animals, the environment or property. If you are responsible for spray drift that causes off-target damage you may be fined or required to pay compensation.

Buffer zones

Buffer zones assist in minimising drift into sensitive and non-target areas. A buffer zone may consist of fallow, pasture, a non-sprayed strip of the crop or purpose planted vegetation such as a crop or wind break. Vegetative buffer zones should be sufficiently open to allow the spray to penetrate and of sufficient depth to trap the bulk of any drift.

Analytical laboratories

In some situations a chemical analysis of fruit may be required. Listed below are some laboratories which undertake this type of work:

Agrisearch Analytical
Level 1, 48 Victoria Road
Rozelle NSW 2039
Phone 02 9810 3666
Fax 02 9810 3866
E-mail: contact@agrisearchanalytical.com.au

National Measurement Institute
36 Bradfield Road
Lindfield NSW 2070
Phone 02 8467 3600
Fax 02 8467 3610
Email: info@measurement.gov.au

National Association of Testing Authorities
PO Box 7507
Silverwater NSW 2128
Phone 02 9736 8222
Fax 02 9743 5311

More laboratories can be found at the National Association of Testing Authorities.

Poison Schedules

Pesticides are classified into four categories in the Poisons Schedule (Table 30) 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, generally above the brand name on the front of the label.

Note: Some active ingredients can appear under more than one schedule, generally because the carrier is more hazardous than the active ingredient or due to the concentration of the active ingredient. For example, parathion is a schedule 6 poison if the concentration of the active ingredient is 45% or less of the total formulation. Penncap-M, which contains 240 g/L parathion, is schedule 6, whereas Folidol M500, which contains 500 g/L parathion, is a schedule 7.

The safety directions specify the personal protective equipment that 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.

Note: Before opening and using any farm chemical, consult the label and the SDS for specific safety directions.

Applying pesticides by aircraft

Additional legal obligations apply if the pesticide is to be applied by aircraft. More information on the legal requirements for aerial application is available on the EPA website: www.epa.nsw.gov.au/pesticides/aerialapplicators.htm

Acknowledgements

Brian McKinnon, Non Graduate Lecturer Farm Mechanisation

Natalie O'Leary, Profarm Trainer.

Information sources

APVMA: www.apvma.gov.au

Australian Code for the transport of dangerous goods by road and rail: www.ntc.gov.au/heavy-vehicles/safety/australian-dangerous-goods-code/

Bureau of meteorology: www.bom.gov.au

Environment protection authority: www.epa.nsw.gov.au/

Hazardous substances information system: hcis.safeworkaustralia.gov.au/

Managing risks of hazardous chemicals in the workplace: www.safeworkaustralia.gov.au/

National association of testing authorities: www.nata.com.au/

NSW DPI resources on QFF: www.dpi.nsw.gov.au/biosecurity/insect-pests/qff.

Safe use and storage of chemicals in agriculture: www.safework.nsw.gov.au/health-and-safety/safety-topics-a-z/hazardous-chemical

Work Health and Safety Act 2011: www.legislation.gov.au/Details/C2017C00305

Work Health and Safety Regulation 2011: www.legislation.gov.au/Details/F2011L02664

Table 30. The poisons schedule.

Schedule 1	This Schedule is intentionally blank.
Schedule 2	Pharmacy Medicine – substances, the safe use of which may require advice from a pharmacist and which should be available from a pharmacy or, where a pharmacy service is not available, from a licensed person.
Schedule 3	Pharmacist Only Medicine – substances, the safe use of which requires professional advice but which should be available to the public from a pharmacist without a prescription.
Schedule 4	Prescription Only Medicine or Prescription Animal Remedy – substances, the use or supply of which should be by or on the order of persons permitted by State or Territory legislation to prescribe and should be available from a pharmacist on prescription.
Schedule 5	Caution – substances with a low potential for causing harm, the extent of which can be reduced through the use of appropriate packaging with simple warnings and safety directions on the label.
Schedule 6	Poison – substances with a moderate potential for causing harm, the extent of which can be reduced through the use of distinctive packaging with strong warnings and safety directions on the label.
Schedule 7	Dangerous Poison – substances with a high potential for causing harm at low exposure and which require special precautions during manufacture, handling or use. These poisons should be available only to specialised or authorised users who have the skills necessary to handle them safely. Special regulations restricting their availability, possession, storage or use may apply.
Schedule 8	Controlled Drug – substances which should be available for use but require restriction of manufacture, supply, distribution, possession and use to reduce abuse, misuse and physical or psychological dependence.
Schedule 9	Prohibited Substance – substances which may be abused or misused, the manufacture, possession, sale or use of which should be prohibited by law except when required for medical or scientific research, or for analytical, teaching or training purposes with approval of Commonwealth and/or State or Territory Health Authorities.
Schedule 10	Substances of such danger to health as to warrant prohibition of sale, supply and use – substances which are prohibited for the purpose or purposes listed for each poison.

For more information see https://www.tga.gov.au/publication/poisons-standard-susmp.

Pesticides: Example record keeping form

Note: It is not compulsory to use this format. If you use a short name for something in filling out this form, you must write the full name somewhere else such as a book or farm diary.

Pesticides application record sheet. Record the name, address and contact details of the owner or occupier of the land where the pesticide was applied:											
Date, start and finish time 	**Operator details** 	**Crop or place where pesticide was applied** 	**Type of equipment used** 	**Name of pesticide used** 	**Amount of concentrated product used** 	**Total quantity applied** 	**Size of block sprayed** 	**Order blocks were treated** 	**Estimated wind speed and direction** 		**Other weather details** 
	Name, address and contact details	*Also record spraying of fallow and any pesticides used in and around crops**		*Record all the pesticides you used.*	*If you mixed two Pesticides together, you can record both on the same form.*	*Total amount of water, oil or other things mixed with concentrated product.*	*Refer to your farm map***	*Write which block was sprayed first, second, third, etc.*	*If these conditions change significantly during spraying then also record the changes.*		*Only if they are specified on label the label or APVMA permit*
									Speed	Direction	

* It is not compulsory to record the pest or disease but it is recommended as part of good operating practices.

** A farm map is recommended because it would make recording this information easier.

(Records must be in English)

Form reproduced with the permission of NSW EPA

Figure 64. An example pesticide record keeping form.

Biological control

Growers are moving away from the 'sledgehammer' approach of using broad-spectrum pesticides due to environmental and occupational health problems. Over the last 5–10 years, growers have adopted a more integrated pest and disease management (IPDM) approach.

Biological control plays an important role in the success of IPDM. Biological control agents are the natural enemies of orchard pests. They include insect predators and parasites, predatory mites and bacterial pesticides.

It is important to use biological control agents in the right way. Growers often become disillusioned when biological control agents fail to control a pest outbreak, but what they need to remember is that, biological control agents are very good at maintaining pest populations at low levels that do not cause serious damage to your crop. They are rarely useful in an emergency. Orchardists should do all they can to encourage populations of biological control agents.

Beneficial insects and mites

When predatory insects and mites are allowed to increase in numbers, they can perform very effective roles in balancing the ecology in deciduous fruit orchards. Some examples include:

- Ladybird beetles (adult and larvae) are predators of aphids, mealybugs, scale insects and pest mites (Figure 65)
- Lacewing (larvae) will control mealybugs, aphids, whitefly, scale, pest mites and moth eggs (Figure 66)
- Parasitic wasps (including *Trichogramma* spp.) lay their eggs in aphids, mealybugs, heliothis, borer moths, codling moth, light brown apple moth, oriental fruit moth and looper caterpillars (Figure 67)
- Predatory mites (Figure 68) can be native or introduced. They prey on pest mites (including two-spotted mite, European red mite) and thrips (including Western flower thrips).

Figure 65. Ladybird beetle. Photo: David Cappaert, Michigan State University, www.msu.edu.

Figure 66. Lacewing larvae. Photo: Joseph Berger, www.forestryimages.org.

Figure 67. Parasitic wasp. Photo: Scott Bauer, USDA Agricultural Research Service, www.forestryimages.org.

Figure 68. Predatory mite. Photo: NSW DPI.

As growers introduce softer chemicals into their orchards, there will be greater opportunity for beneficial insects and mites to survive.

When a pest problem arises, always consider all the control options available. If it is necessary to apply a pesticide, consider the range of effective options and choose the one that will least affect biological control agents living in your orchard.

Longer term, consider which management strategies will help you boost the numbers of beneficials and rebalance the ecology of your orchard.

Bacterial insecticides

Bacillus thuringiensis (Bt) is a bacterium that is the active component of Dipel® and similar products. The bacterium is one that affects the caterpillar stage of certain insects.

Bt is recommended in this guide to control light brown apple moth (LBAM). If applied before infestation becomes established, it will provide LBAM control that is non-disruptive to other beneficials.

Controlling crown gall

Crown gall is a bacterial disease in many woody plants. It is described as a plant cancer caused by the soil inhabiting bacterium *Agrobacterium tumefaciens*.

Infected plants are usually weakened and unproductive due to their damaged root system and can die.

The pathogenic *A. tumefaciens* is believed to be present in most soils and can be spread by water, cultivation, insects and tools used in propagation.

Wounds on a susceptible tree can be colonised and infected by the pathogen. This initiates the formation of tumours or galls. Once infected, nothing can be done to the tree to control the disease.

NOGALL™ is a product based on a specific strain of another species of bacterium, *Agrobacterium radiobacter*. This organism, *A. radiobacter* var. *radiobacter*, is not disease causing, but was found to be antagonistic on the bacterium that causes crown gall. When *A. radiobacter* gets to a wound first, it inhibits the development of crown gall caused by *A. tumefaciens*.

As with many examples of biological control, when used as a preventative treatment, Nogall is part of an integrated disease management (IDM) strategy for crown gall. Other components include:

- good site selection to avoid waterlogging
- avoiding unnecessary damage to the roots of young stone fruit trees
- disinfecting pruning and propagating equipment frequently
- avoiding nursery soils known to have pathogenic agrobacterium or heavy nematode infestation
- careful choice of rootstock.

Protecting biological control agents

1. know your orchard pests and beneficial insects and mites and be able to recognise them. Reference material is available in *The good bug book:* bugsforbugs.com.au/product/good-bug-book-cd/
2. monitor your orchard pests, beneficial insects and predatory mites to effectively time sprays.
3. use chemicals less toxic to beneficials (Table 31). Consult the chemical label or The good bug website: www.goodbugs.org.au/ for chemical toxicity.
4. modify the orchard environment to encourage beneficials. Many predatory species rely on pollen from grasses, native flowers and herbs to tide them over while waiting for prey.

For further resources visit www.goodbugs.org.au

Suppliers of beneficial insects and mites can be found at www.goodbugs.org.au/suppliers.html.

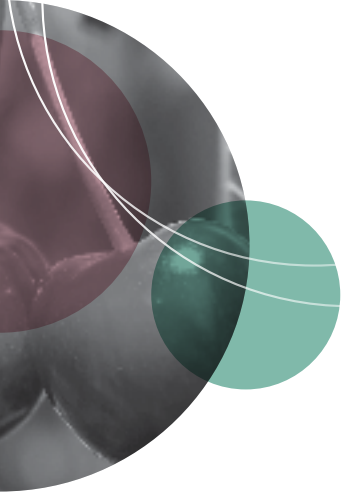
Table 31. Pesticides toxic to predatory mites, ladybirds and lacewings.

Pesticides	*Phytoseiulus persimilis*	*Galendromus occidentalis*	*Galendromus pyri*	Ladybirds	Lacewings
Insecticides					
Azinphos-methyl	X	0	0	XX	XX
Bifenthrin	XX	XX	XX	–	–
Carbaryl	0	X	0	XX	XX
Chlorpyrifos	X	X	0	XX	XX
Maldison	X	X	X	XX	XX
Methidathion	XX	XX	XX	XX	XX
Methomyl	XX	X	XX	X	X
Tau-fluvalvinate	XX	XX	XX	–	–
Trichlorfon	XX	0	?	–	–
Miticides					
Abamectin	X	X	X	X	XX
Tebufenpyrad	XX	0	0	–	–
Fungicides					
Mancozeb	X	0	XX	X	X
Metiram	X	0	X	–	–
Ziram	0	0	X	–	–

Toxicity rating: XX – very harmful; X – harmful; 0 – nil or minor effect

Only those recommended in this guide are included.

For more extensive information on chemicals visit www.goodbugs.org.au/chemicals.html.



Avoiding resistance to pesticides

Resistance in an insect, mite or disease to a specific chemical has occurred when the chemical no longer provides the control it did previously.

Populations of pests and diseases that are repeatedly sprayed with a particular chemical can develop resistance to that chemical. All populations contain a very small number of individuals that are resistant to a given pesticide. Continuing to use the pesticide kills susceptible individuals, but in doing so selects a strain that is increasingly composed of resistant forms. Once resistant forms reach a critical proportion of a population, lack of control ultimately renders the chemical useless.

Resistance management

Managing resistance for all pesticides is now an important consideration when choosing a control strategy. One strategy used in resistance management is to rotate chemical groups so that the weed, fungus, insect or mite is not being continually treated by the same type of chemical.

Repeated treatment could lead to the organism developing resistance to that chemical group.

In the past, it has often been difficult for growers to distinguish between chemical groups and their different modes of action, a factor important in successful rotation. An identification scheme was set up for both herbicides (see page 113) and fungicides (Table 32).

In 1999, the CropLife Australia Insecticide Resistance Action Committee completed a similar list for insecticides and miticides (Table 33).

Since July 2001, all registered pesticides have had an action group identification symbol on the label. This helps growers to choose a product from a different chemical action group when seeking to rotate chemicals in a program.

Product labels incorporate a Resistance Warning and many include crop-specific instructions relating to the number of applications permitted for use in that crop. Users of agricultural chemical products must always read the label and any permit before using the product and strictly comply with the conditions as directed. Complying with resistance management instructions will help to minimise the risk of developing resistance.

Table 32. Fungicide groups[1,2].

Group	Chemical class	Common name	Example trade name*
1	Benzimidazole	Thiabendazole	Tecto Flowable®
2	Dicarboximide	Iprodione	Rovral®
		Procymidone	Sumisclex®
3	Imidazole	Imazalil	Fungaflor®
	Piperazine	Triforine	Saprol®
	Triazole	Difenoconazole	Bogard®
		Hexaconazole	Viva®
		Myclobutanil	Systhane®
		Penconazole	Topas®
		Propiconazole	Tilt®
7	Pyrazole carboxamide	Penthiopyrad	Fontelis®
		Isopyrazam	Seguris® Flexi
	Pyridine carboxamides	Boscalid + pyraclostrobin (11)	Pristine®
	Pyridinyl-ethyl-benzamides	Fluopyram + trifloxystrobin (11)	Luna® Sensation
8	Hydroxypyrimidine	Bupirimate	Nimrod®
9	Anilinopyrimidine	Cyprodinil	Chorus®
11	Strobilurin	Kresoxim-methyl	Stroby®
		Trifloxystrobin	Flint®
		Mandestrobin	Intuity®
12	Phenylpyrrole	Fludioxonil	Scholar®
33	Ethyl phosphonate	Fosetyl	Aliette®
M1	Inorganic	Copper fungicides	Kocide®
M2	Inorganic	Sulfur as polysulfide	Lime sulfur
		Sulfur (elemental)	Thiovit®
M3	Dithiocarbonate	Mancozeb	Dithane®
		Metiram	Polyram®
		Thiram	Thiragranz®
		Zineb	Zineb
		Ziram	Ziragranz®
M4	Phthalimide	Captan	Orthocide®
M5	Chloronitrile	Chlorothalonil	Bravo®
M9	Quinone	Dithianon	Dragon®

Table 33. Insecticide and miticide groups[1,2].

Group	Chemical class	Common name	Example trade name*
1A	Carbamate	Carbaryl	Bugmaster Flowable®
		Methomyl	Lannate L®
		Pirimicarb	Aphidex®
1B	Organophosphate	Chlorpyrifos	Lorsban™
		Diazinon	Diazol®
		Maldison	Fyfanon®
		Methidathion	Suprathion®
		Omethoate	Folimat®
		Trichlorfon	Dipterex®
2	GABA-gated chlorine channel blockers		
2B	Phenylpyrazoles (fiproles)		Fipronil®
3	Pyrethroid	Alpha-cypermethrin	Fastac Duo®
		Bifenthrin	Talstar®
		Tau-fluvalinate	Mavrik Aquaflow®
4A	Neonicotinoid	Imidacloprid	Confidor®
		Thiacloprid	Calypso®
		Acetamiprid	Cormoran®
4C	Sulfoximine	Sulfoxaflor	Transform®

Group	Chemical class	Common name	Example trade name*
5	Spinosyn	Spinosad	Eco-naturalure®
		Spinetoram	Delegate®
6	Avermectin	Abamectin	Vertimec®
	Milbemycin	Milbemectin	Milbeknock®
7B	Juvenile hormone mimic	Fenoxycarb	Insegar®
9B	Feeding blocker	Pymetrozine	Chess®
9C		Flonicamid	Mainman®
10A	Tetrazine	Clofentezine	Apollo®
	Thiazolodine	Hexythiazox	Calibre®
10B		Etoxazole	Paramite®
11	Microbial	*Bacillus thuringiensis*	DiPel®
12B	Organotin	Fenbutatin oxide	Torque®
12C		Propargite	Betamite®
13A	Chlorfenapyr	Chlorfenapyr	Secure®
15	Benzoylureas	Novaluron	Cormoran®
16	Thiadiazine	Buprofezin	Applaud®
18	Diacylhydrazine	Methoxyfenozide	Prodigy®
20D		Bifenazate	Acramite®
21A	Mite growth inhibitor	Tebufenpyrad	Pyranica®
22A	Oxadiazine	Indoxacarb	Avatar®
23		Spirotetramat	Movento®
28	Diamide	Chlorantraniliprole	Altacor®

[1]Trade names that include the common chemical name are not listed. Source: CropLife Australia.

[2]The information in the table shows fungicide groups based on mode of action only. For a chemical's compatibility with IPM please see the individual crop tables.

*Example only. Other products registered.

Useful conversions

Most pesticide labels quote use rates in mL or g of product per 100 L of water. Exceptions do occur, such as the rates of chemical thinners and diphenylamine (DPA), which are commonly expressed in terms of parts per million (ppm). If the dosage required is incorrectly calculated, costly mistakes can be made in the orchard or packing shed. Dipping rates for postharvest treatment for Queensland fruit fly (QFF) are quoted as milligrams per litre (mg/L), the equivalent of ppm.

Standard formula – amount per 100 L

To calculate the amount of product (in litres or kilograms) per 100 L of spray or dip, given the rate or concentration in ppm or mg/L, use the following formula:

Required amount of product for 100 L

$$= \frac{\text{dip strength (ppm or mg/L)}}{\text{product strength (g/L or g/kg)} \times 10}$$

For a tankful

Multiply the figure obtained from your standard formula (above) by your tank size and ÷ 100.

Some examples

Spraying thinners

How much carbaryl product (product strength 500 g/L) is required per 100 L of water if the concentration rate for Granny Smith apples is 1000 ppm (or mg/L)?

Required amount of product (in L)

$$= \frac{1{,}000 \text{ ppm or mg/L}}{500 \text{ g/L} \times 10}$$

$$= 0.2 \text{ L/100 L}$$

To convert L to mL, multiply by 1,000. In this case the amount of product is 200 mL/100 L.

Fruit dipping – DPA (diphenylamine)

A grower needs to dip Red Delicious apples at 2,000 ppm using a 310 g/L DPA product in an 1,100 L dipping tank. The quantity (in litres) of DPA needed to give the required dip concentration is:

Required amount of product (in L)

$$= \frac{2{,}000 \text{ ppm or mg/L}}{310 \text{ g/L} \times 10} \times \frac{1{,}100 \text{ L}}{100}$$

= 7 L of DPA product per tankful.

Field spraying for QFF

Dilute

An orchardist needs to spray orchard trees for QFF using product A. The label rate is 75 mL of product A per 100 L. The spray is to be made up in a 1,500 L vat.

Required amount of product A (in L)

$$= \frac{75 \text{ mL} \times 1{,}500 \text{ L}}{100 \text{ L}}$$

= 1,125 mL (1.125 L) product in the vat.

This is the dilute spray mix.

Concentrate

If the same grower, using the same equipment but correctly set up for concentrate spraying wanted to control fruit fly, then the calculation is given below.

For this example, the sprayer puts out 2,000 L/ha dilute to wet the trees 'to the point of run off'. Re-nozzled and adjusted for concentrate spraying, the 1,500 L sprayer vat now applies 500 L/ha. The concentration factor in this example is therefore 2,000 ÷ 500 or 4×.

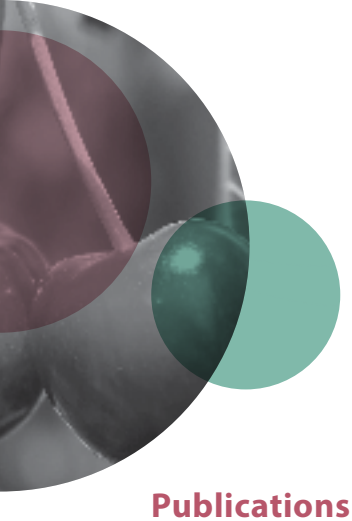
The spray unit set up for concentrate spraying now covers four times the area that it did when set up for dilute spraying.

Required amount of product A (in L)

$$= \frac{75 \text{ mL} \times 1{,}500 \text{ L} \times 4}{100 \text{ L}}$$

= 4,500 mL (4.5 L) product in the vat.

Additional information on concentrate spraying might be available on the label.



Useful resources for fruit growers

Publications

Some books and several leaflets, Agfacts and Primefacts are mentioned in this guide. These are available from various sources, some of which are outlined below:

Primefacts/Agfacts usually contain illustrations of the pest or disease the Primefact/Agfact describes. These are available free from NSW Department of Primary Industries website: www.dpi.nsw.gov.au/agriculture/horticulture

Integrated pest management for Australian apples and pears is a practical guide for pome fruit orchardists wanting to implement IPM. This is available free from the website: www.dpi.nsw.gov.au/content/agriculture/horticulture/pomes/ipm-apples-pears

Integrated pest and disease management for Australian summerfruit is a practical guide for summer fruit orchardists wanting to implement IPDM. This is available free from the website: www.dpi.nsw.gov.au/content/agriculture/horticulture/stone-fruit/summerfruit-ipdm

Spray Sense is a publication providing information on pesticide issues, which has recently been expanded and upgraded. Topics covered include sprayer calibration, testing for residues, storing pesticides, disposal of empty containers, how to read a label and a number of other topics. Spray Sense can be downloaded free from the NSW DPI website: www.dpi.nsw.gov.au/content/agriculture/farm/chemicals/general/spray-sense-leaflet-series

Crop regulation of pome fruit in Australia is a useful manual published by the Tasmanian Institute of Agricultural Research. ISBN 1-86295-027-X.

The good bug book (second edition) is a valuable reference for the beneficial organisms commercially available for biological control in Australia. It includes illustrations as well as tables of information on their susceptibility to pesticides. It is published by Integrated Pest Management Pty Ltd for the Australasian Biological Control Association Inc. It can be purchased from the website: bugsforbugs.com.au/product/good-bug-book-cd/

Internet sites

Name	Website
Pesticides – use and disposal	
Australian Pesticides and Veterinary Medicines Authority	www.apvma.gov.au
ChemClear	www.chemclear.com.au
drumMuster	www.drummuster.com.au
InfoPest	www.infopest.com.au
Agricultural industry organisations	
Apple and Pear Australia Ltd	www.apal.org.au
Cherry Growers Australia	www.cherrygrowers.org.au
Hort Innovation	www.horticulture.com.au
National Farmers' Federation	www.nff.org.au
NSW Farmers' Association	www.nswfarmers.org.au
Persimmons Australia	www.persimmonsaustralia.com.au
Summerfruit Australia Ltd	www.summerfruit.com.au
State government	
NSW Department of Primary Industries	www.dpi.nsw.gov.au
NSW Rural Assistance Authority	www.raa.nsw.gov.au
Local Land Services	www.lls.nsw.gov.au

Name	Website
Office of Environment and Heritage NSW	www.environment.nsw.gov.au
SafeWork NSW	www.safework.nsw.gov.au
Department of Economic Development, Jobs, Transport and Resources, Victoria	www.economicdevelopment.vic.gov.au
Department of Agriculture and Food, Western Australia	www.agric.wa.gov.au
Department of Primary Industries and Regions SA	www.pir.sa.gov.au
Department of Agriculture, Fisheries and Forestry	www.daff.qld.gov.au
Department of Primary Industries, Parks, Water and Environment	www.dpipwe.tas.gov.au
Rural assistance	
Department of Human Services	www.humanservices.gov.au
Health NSW	www.health.nsw.gov.au
NSW Rural Assistance Authority	www.raa.nsw.gov.au
Rural Skills Australia	www.ruralskills.com.au
Federal government	
ABC Rural Department	www.abc.net.au/rural
Australian Trade Commission	www.austrade.gov.au
Department of Agriculture	www.agriculture.gov.au
Plant Health Australia	www.planthealthaustralia.com.au
Climate	
Commonwealth Bureau of Meteorology	www.bom.gov.au
Environment	
Office of Environment and Heritage NSW	www.environment.nsw.gov.au
Department of the Environment	www.environment.gov.au
NSW Environment Protection Authority	www.epa.nsw.gov.au
Alternative systems (organics)	
Australian Organic	www.austorganic.com
Organic Federation of Australia	www.ofa.org.au
Economic information	
Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)	www.agriculture.gov.au/abares
Export and import support	
Biosecurity Import Conditions Database (BICON)	www.agriculture.gov.au/import/online-services/bicon
Codex – International Food Standards	www.agriculture.gov.au/ag-farm-food/food/codex
Manual of Importing Country Requirements (MICoR)	https://micor.agriculture.gov.au/Pages/default.aspx
Market price information	
Market Information Services	www.marketinfo.com.au
Technical production information	
Agencies and universities	
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	www.csiro.au
South Australia Research and Development Institute	www.pir.sa.gov.au/research
Tasmanian Institute of Agriculture	www.utas.edu.au/tia
New Zealand Ministry for Primary Industries	www.mpi.govt.nz
United Kingdom Department for Environment, Food and Rural Affairs	www.gov.uk/defra
United States Department of Agriculture (USDA)	www.usda.gov
Fruit and Nut Research and Information Centre, University of California	http://fruitsandnuts.ucdavis.edu
Tree Fruit Research and Extension Center, Washington State University	www.tfrec.wsu.edu
Integrated pest management	
Australasian Biological Control Association Inc.	www.goodbugs.org.au
Quality assurance	
Freshcare Australia	www.freshcare.com.au
Nurseries	
ANFIC (Australian Nurserymen's Fruit Improvement Company)	www.anfic.com.au
Fleming's Nurseries	www.flemings.com.au

Pesticide application record sheet

(To be completed within 24 hours of spraying and kept for 3 years)

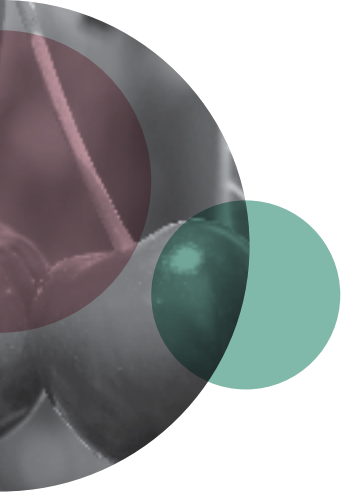
General information		
Operator (See note at bottom of sheet)*:		
Date of application:	Start time:	Finish time:
Crop Details		
Crop sprayed:	Block/Area name and address:	Size of block sprayed:
Product/Application Details		
Product used:		
Pest/disease targeted:	Equipment used:	
Amount of concentrate used (indicate either the label rate or the total amount used):	Total quantity of spray applied (L):	Total area of application (ha):
Weather Conditions		
Wind speed:	Wind direction:	
Did weather conditions change during spraying? ☐ No ☐ Yes (Give details)		
Other comments:		

*Operator: If it is the property owner you need to record name, address and contact details. For an employee you need to record name and employer details and for a contractor you need name, address and contact detalis. On this record you can record the name only, as long as you have the other details recorded elsewhere.

Orchard sprayer calibration record

Spray unit		
Nozzle set up		
Operating pressure		
Tractor		
Operating speed and gear		
Air calibration		
Air inlet area (m^2)		
Air speed at intake (m/s)		
Air volume (m^3/h)		
Tree dimensions (m)	Canopy width:	Canopy height:
Optimum tractor speed (km/h)		
Water calibration		
Actual tractor speed (km/h)		
Total nozzle input (L/min)		
Row spacing (m)		
Application volume (L/ha)		

Calibrated by	Date



Agriculture NSW – Horticulture Leaders and Development Officers

Director Horticulture

Dr Shane Hetherington
e: shane.hetherington@dpi.nsw.gov.au
p: 02 6391 3860 m: 0409 314 894 f: 02 6391 3605
Orange Agricultural Institute
1447 Forest Road ORANGE NSW 2800

Leader Northern Horticulture

Mark Hickey
e: mark.hickey@dpi.nsw.gov.au
p: 02 6626 1277 m: 0427 401 474 f: 02 6628 1744
Wollongbar Primary Industries Institute
1243 Bruxner Highway WOLLONGBAR NSW 2477

Leader Southern Horticulture

Myles Parker
e: myles.parker@dpi.nsw.gov.au
p: 02 6391 3155 m: 0419 217 553 f: 02 6363 7878
Orange Agricultural Institute
1447 Forest Road ORANGE NSW 2800

Blueberries

Melinda Simpson
e: melinda.simpson@dpi.nsw.gov.au
p: 02 6626 1350 m: 0447 081 765 f: 02 6628 1744
Wollongbar Primary Industries Institute
1243 Bruxner Highway WOLLONGBAR NSW 2477

Citrus

Andrew Creek
e: andrew.creek@dpi.nsw.gov.au
p: 02 6951 2522 m: 0428 934 952 f: 02 6951 2692
Yanco Agricultural Institute
Trunk Road 80 YANCO NSW 2522

Steven Falivene
e: steven.falivene@dpi.nsw.gov.au
p: 03 5019 8405 m: 0427 208 611 f: 03 5027 4319
Dareton Primary Industries Institute
Silver City Highway DARETON NSW 2717

Macadamias

Jeremy Bright
e: jeremy.bright@dpi.nsw.gov.au
p: 02 6626 1346 m: 0427 213 059 f: 02 6628 1744
Wollongbar Primary Industries Institute
1243 Bruxner Highway WOLLONGBAR NSW 2477

Sub-tropical Bananas

Matt Weinert
e: matt.weinert@dpi.nsw.gov.au
p: 02 6626 1352 m: 0438 644 136 f: 02 6628 1744
Wollongbar Primary Industries Institute
1243 Bruxner Highway WOLLONGBAR NSW 2477

Temperate Fruits

Kevin Dodds
e: kevin.dodds@dpi.nsw.gov.au
p: 02 6941 1400 m: 0427 918 315 f: 02 6947 4149
Tumut District Office
64 Fitzroy Street TUMUT NSW 2720

Viticulture

Adrian Englefield
e: adrian.englefield@dpi.nsw.gov.au
p: 02 6933 2720 m: 0428 324 099
National Wine and Grape Industry Centre
Locked Bag 588 WAGGA WAGGA NSW 2678

Darren Fahey
e: darren.fahey@dpi.nsw.gov.au
m: 0457 842 874
Orange Agricultural Institute
1447 Forest Road ORANGE NSW 2800

Information Delivery

Dr Amanda Warren-Smith
e: amanda.warren-smith@dpi.nsw.gov.au
p: 02 6391 3953
Orange Agricultural Institute
1447 Forest Road ORANGE NSW 2800

NSW Local Land Services (Horticulture)

Local Land Services (LLS), launched in January 2014, delivers quality, customer-focussed services to farmers, landholders and the community across rural and regional New South Wales. LLS bring together agricultural production advice, biosecurity, natural resource management and emergency management into a single organisation. LLS horticulture officers help producers address the challenges they face today and take advantage of future opportunities, to achieve improvements in crop yields, orchard management and market access.

Biosecurity NSW and regulatory services

Biosecurity NSW is the contact point in this state for anyone who requires advice on intrastate or interstate movement of fruit or plants and other issues of a biosecurity nature. In previous editions of this guide, we published contact details for regulatory officers at various locations across New South Wales. The method of contacting Biosecurity NSW has changed, and all enquiries should now be directed via Plant Health Australia's Domestic Quarantine Line 1800 084 881. This phone number will connect you with an automated system to allow you to choose the state or territory that your report or enquiry relates to.

Producers can contact their nearest LLS office by phoning 1300 795 299.

COMPATIBILITY CHART

Formulation (formulation in brackets indicates other formulations for active ingredient)	Compatible with	Product	Active ingredient	abamectin	AVG	Bt	bifenthrin	bupirimate	captan	carbaryl	chlorantraniliprole	chlorothalonil	chlorpyrifos	copper hydroxide	copper hydroxide + mancozeb
emulsifiable concentrate	summer spray oils and most insecticides and fungicides	Vertimec	abamectin												
soluble powder		Retain	AVG			c									
water dispersible granule (wettable powder)	most insecticides and fungicides	DiPel DF	Bt		c										
suspension concentrate (emulsifiable concentrate)	most fungicides	Talstar 80 SC	bifenthrin									c		c	
emulsifiable concentrate	only with listed	Nimrod	bupirimate						n						
water dispersible granule	wettable powder and suspension concentrate insecticides and fungicides not ECs	Captan WG	captan					n		c	c		n		
suspension concentrate		Bugmaster Flowable	carbaryl						c				c		
water dispersible granule		Altacor	chlorantraniliprole												
suspension concentrate	wettable powder and suspension concentrate insecticides and fungicides not ECs and oils	Bravo	chlorothalonil				c						c		
emulsifiable concentrate (water dispersible granule)		Lorsban 500 EC	chlorpyrifos						n	c		c		n	n
wettable powder	most insecticides	Kocide Blue Xtra	copper hydroxide				c						n		
water dispersible granule (suspension concentrate, wettable powder)	most fungicides and insecticides	Mancozide DF	copper hydroxide + mancozeb										n		
water dispersible granule (wettable powder)	most insecticides, including emulsions and spraying oils	Oxydul DF	copper oxychloride							c			n		
suspension concentrate (wettable powder)	spray oils, most insecticides, fungicides, miticides	Nordox 500	cuprous oxide										n		
water dispersible granule		Chorus	cyprodinil			c							c		
water dispersible granule		Bogard 100 WG	difenoconazole			c				c			c		
emulsifiable concentrate		DPA 310 Scald Inhibitor	diphenylamine												
water dispersible granule		Delan 700 WG	dithianon								c		n (EC)		
suspension concentrate	most insecticides and fungicides; may need ionic surfactant for ECs	Syllit 400 SC	dodine												
emulsifiable concentrate		Ulvapron	dormant oil						n			n		c	
suspension concentrate	most insecticides and fungicides	Rubigan 120 SC	fenarimol												
emulsifiable concentrate		Torque	fenbutatin oxide										c	c	
wettable powder		Insegar 250 W	fenoxycarb			c			c				c		
suspension concentrate		Vision 250 SC	fluquinconazole + pyrimethanil												
water dispersible granule		Aliette WG	fosetyl							c			c		
emulsifiable concentrate	no info	D-C-Tron Plus	horticultural mineral oil	c					n	c		n			
emulsifiable concentrate (water dispersible granule, water soluble granule, soluble powder)	most fungicides	Imazagard 800 EC	imazalil												
suspension concentrate		Confidor 200 SC	imidacloprid						c						
water dispersible granule		Avatar	indoxacarb						c						
emulsifiable concentrate (water dispersible granule, suspension concentrate)		Rovral Liquid	iprodione							c			c		
water dispersible granule		Stroby WG	kresoxim-methyl							c					
emulsifiable concentrate		Hy-Mal	maldison						c				c		
water dispersible granule (wettable powder)	most insecticides and fungicides	Dithane DF	mancozeb				c							c	
water dispersible granule	most insecticides and fungicides	Polyram DF	metiram								c				
water dispersible granule	most insecticides and fungicides	Systhane 400 WP	myclobutanil						c		c				
soluble concentrate	no info	NAA	naphthylacetic acid												
suspension concentrate		Cut-Back	paclobutrazol					c							
emulsifiable concentrate		Topas 100 EC	penconazole			c				c		c	c		
suspension concentrate		Fontelis	penthiopyrad						n		c				
water dispersible granule		Pirimor WG	pirimicarb					c	c						
suspension concentrate		Spiral Aquaflo	procymidone												
wettable powder	no info	Omite 300 W	propargite					c	n pears		c				
emulsifiable concentrate		Tilt 250 EC	propiconazole									c			
suspension concentrate	most commonly used insecticides and miticides	Vision	pyrimethanil + fluquinconazole												
suspension concentrate	no info	Mavrik Aquaflow	tau-fluvalinate						c						
wettable powder	many insecticides and fungicides	Pyranica	tebufenpyrad						c						
water dispersible granule	no info	Thiragranz	thiram										c		
suspension concentrate (water dispersible granule)	most insecticides	Tri-Base Blue	tribasic copper sulfate										n		
soluble concentrate	most insecticides and fungicides	Dipterex 500 SL	trichlorfon										c		
emulsifiable concentrate		Saprol	triforine												
wettable powder	no info	Zineb	zineb										c		
water dispersible granule		Ziragranz	ziram										c	n	n

[1] Adding oils to Torque will reduce speed of action. [2] Hold-on treatment for pears. [3] NOT apples and plums. DO NOT tank mix more than two products. Compatibilities are only for formulations shown. Read both product labels and check formulation details and compatibility sections. If one label says 'compatible

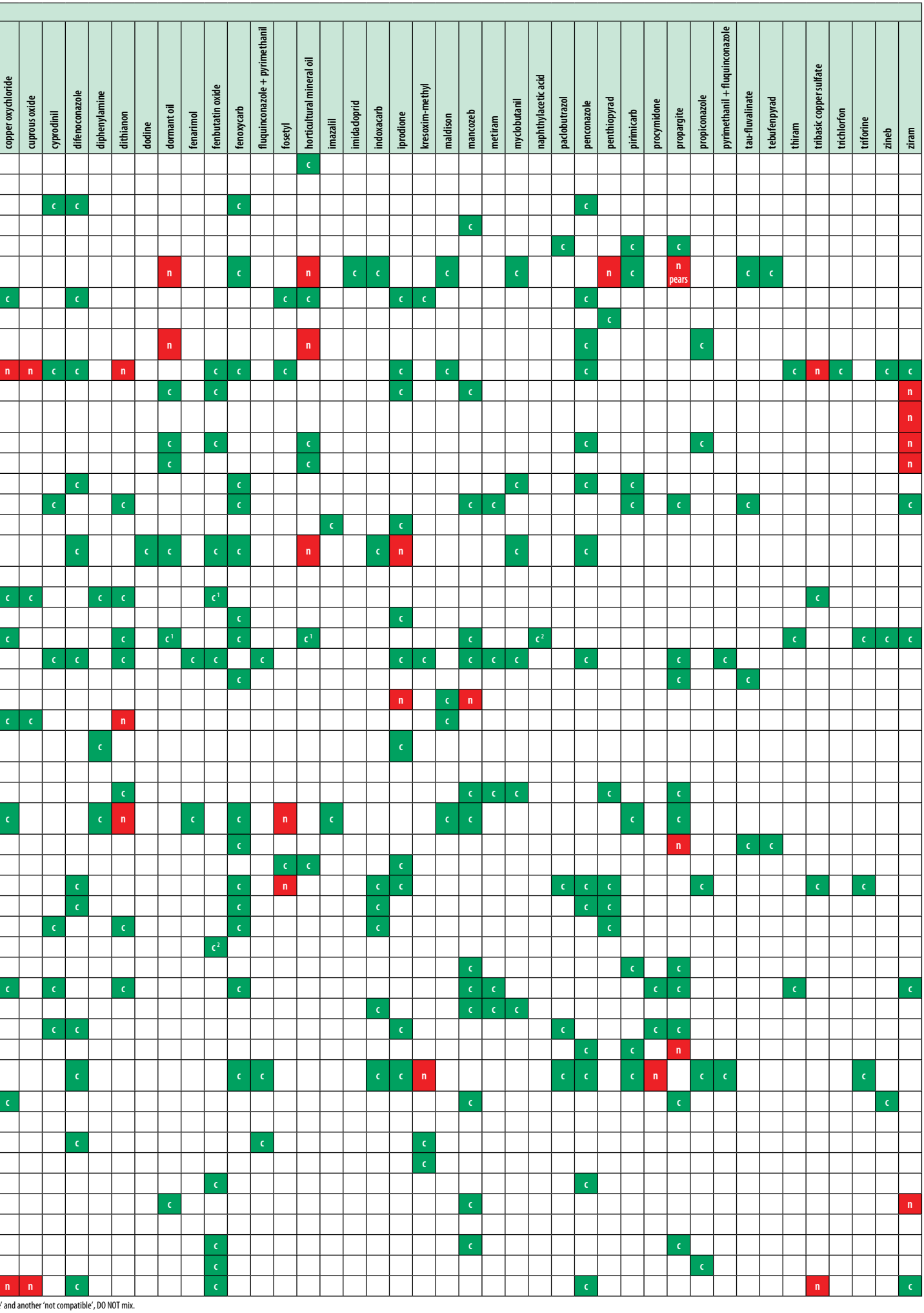
The following were excluded as no specific information on compatibility was included:

AFPA (Armothin – soluble concentrate)
ammonium thiosulphate (Biothin – soluble concentrate)
bifenazate (Acramite – suspension concentrate)
ethephon (Ethrel – soluble concentrate)
gibberellic acid (ProGibb – water soluble granules; also water dispersible granules and soluble concentrate)
hexaconazole (Viva – suspension concentrate)
methyl esters of fatty acids (Waiken – emulsifiable concentrate)
pymetrozine (Chess – water dispersible granule; also wettable powder)
spinosad (Success – suspension concentrate; also wettable powder)
thiabendazole (Tecto – suspension concentrate)
thiacloprid (Calypso – suspension concentrate)
trifloxystrobin (Flint – water dispersible granule)

The following were excluded as mixing with other products was prohibited:

benzyladenine (Cylex)
benzyladenine and gibberellins (Cytolin)

c Compatible n Not Compatible



' and another 'not compatible', DO NOT mix.

Altacor® Hort now registered in Almonds to control Carob moth.

Realise the difference. Spray early.

To produce wonderful Pome and Stone fruit, it pays to start early with Altacor® Hort insecticide. By targeting the first generation of Oriental fruit moth and Codling moth, it gets on top of the problem – before it gets on top of you. Altacor® Hort works to control Codling moth in the egg, as they hatch and any larvae that emerge, while remaining friendly to key beneficials.

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www.fmc[illegible].au

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'We obviously use ReTain so we can get the best quality and consistency.'

'We also use it to help with storage. Actually, everything we store gets "ReTained" so we can keep them longer while maintaining the quality.'

James Gaffney
Apple grower
Bon View Orchards
Pakenham Vic

James also sees ReTain as a useful tool for delaying harvests to increase fruit size.

'If I'm struggling for size, say I want 5-7 mil extra in my fruit – to get more money for a premium size – I can hold it back for a couple of weeks, depending on the variety.'

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