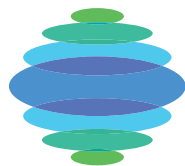


Orchard plant protection guide for deciduous fruits in NSW 2025–26

NSW PRIMARY INDUSTRIES MANAGEMENT GUIDE



Jessica Fearnley and Aphrika Gregson



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Orchard plant protection guide for deciduous fruit in NSW 2025–26

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Pesticide use is administered by the Australian Pesticides and Veterinary Medicines Authority (APVMA). The Environment Protection Authority administers the *Pesticides Act 1999* and Pesticides Regulation 2017, which controls pesticide use in NSW. The primary principle of the *Pesticides Act 1999* is that pesticides must only be used for the purpose described on the product label and label instructions must be followed. A summary of the important points is on [page 147](#).

Permits

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Acknowledgements

We thank the officers of the NSW DPIRD and other organisations who have helped to revise this issue of the guide. We would also like to thank Trevor Klein, Farm Chemicals Officer, for reviewing the pesticide recommendations, and Dr Amanda Warren-Smith for her guidance and editorial skills. Once again, agricultural chemical companies have provided information on their products and helpful suggestions, and we thank them for their involvement and interest.

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About this guide

The 2025–26 edition of the *Orchard plant protection guide for deciduous fruit in NSW* is the latest in a series of annual publications that have supported the pest and disease management decisions of generations of NSW temperate fruit producers for over 60 years. The guide is recognised as a respected and valuable reference for temperate fruit industries.

Feature articles

This year's feature articles are aimed at showcasing research undertaken by NSW DPIRD and their project teams. Jess Fearnley-Pattison introduces the new NSW DPIRD-led Hort Innovation project, Optimising protected cherry production (CY24004; [page 7](#)), which aims to enhance cherry production under protective cropping systems. She also shares insights from a recent study tour to Washington State, USA, where researchers shared the challenges associated with little cherry virus, offering valuable lessons for Australian growers ([page 9](#)).

Aphrika Gregson, Farm Chemicals Officer at NSW DPIRD, provides an update on APVMA chemical reviews relevant to deciduous fruit production in NSW ([page 13](#)). She also outlines critical information for growers on the brown marmorated stink bug, a significant biosecurity threat ([page 11](#)).

The NSW DPIRD Vulnerability Assessment Team presents the latest climate vulnerability results for Lapins cherry in NSW, highlighting key risks and adaptation strategies for growers ([page 16](#)).

The authors would like to acknowledge Dr Sally Bound for her contribution to the section [Chemical thinners for pome and stone fruit on page 132](#).

Distribution

This guide aims to provide commercial orchardists with up-to-date technical information on all aspects of crop protection. The guide is available free to commercial fruit growers and is distributed to rural retailers and key industry bodies in pome and stone fruit growing regions. For a full list of these locations, refer to the [NSW DPIRD website](#) (<https://www.dpird.nsw.gov.au/agriculture/horticulture/pests-diseases-hort/information-for-multiple-crops/orchard-plant-protection-guide>).

Additional copies can be obtained through [NSW DPIRD Tocal bookshop](#) (https://shop.regional.nsw.gov.au/products/orchard-plant-protection-guide?_pos=1&_psq=orcha&_ss=e&_v=1.0).

How to use this guide

Finding the information you need is as easy as 1–2–3.

Step 1: go to [Table 5](#) or [Table 6](#) and find the pest or disease you are interested in. These are listed alphabetically in the column titled Common name.

Step 2: check to see if the pest or disease is considered a major problem in your crop ([Figure 1](#)). If there is a red cross (✗) in the cells intersected by the pest or disease and the crop, then that crop is not likely to be affected. If there is a green tick (✓) in the cells intersected by the pest or disease and the crop, then the crop is likely to be affected and control strategies are recommended.

Step 3: scan across the table to find the relevant page number for the pest or disease.

Alternatively, see the contents table ([page iii](#)) and search for the pest or disease there. The contents table also includes details of other important plant protection articles covering subjects including crop regulation, postharvest diseases and responsible use of pesticides.

This guide provides orchardists with suggestions for managing the main pests and diseases through responsible pesticide use ([page 147](#)). Pesticide use can be moderated even further with good orchard management and implementing practices such as integrated pest, disease and weed management (IPDWM).

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

Additional ways to reduce the risks posed by a broad range of pests and diseases include:

- pruning to open tree canopies will allow better spray penetration, and help leaves to dry more quickly, reducing the threat of many diseases
- avoiding or managing overhead irrigation to prevent creating favourable conditions for disease infections unless the reasons against it are compelling (i.e. frost management or mitigating heat stress)
- practising good hygiene, including appropriately disposing of unwanted fruit, to reduce the threats posed by many insect pests and diseases
- timing weed control to reduce the likelihood of pests finding alternative sites to survive over winter
- destroying feral fruit trees and neglected orchards
- encouraging predatory and parasitic insects by not using disruptive chemicals.

The sections on pests (from [page 26](#)) and diseases (from [page 96](#)) provide specific details on weather conducive to pest or disease outbreaks and on non-pesticide management options where applicable. Orchardists should always keep in mind that using only pesticides or alternative management will rarely produce satisfactory fruit quality. Each management strategy supplements the other.

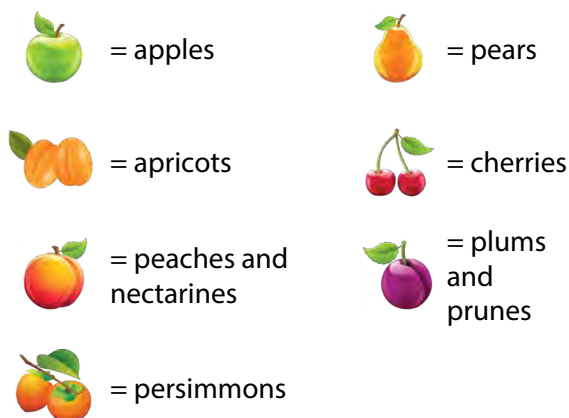


Figure 1. The icons used to identify the crops included in this guide. Source: [Vector Graphics Blog](https://www.tumblr.com/vectorgraphics-blog) (<https://www.tumblr.com/vectorgraphics-blog>); persimmon icon, [PNG images](https://pngimg.com/) (<https://pngimg.com/>).

Communication and extension for the Australian cherry industry – update

Jess Fearnley-Pattison, Development Officer – Temperate Fruit, NSW DPIRD

The Hort Innovation-funded project, 'Communication and extension for the Australian cherry industry' (CY22002), led by NSW DPIRD, is in its third year. The project aims to increase communication and extension activities for the Australian cherry industry. The latest production videos, fact sheets and case studies generated by the project team are on the [project page on the Cherry Growers Australia website](https://www.cherrygrowers.org.au/extension-and-communication-for-the-australian-cherry-industry-cy22002/) (<https://www.cherrygrowers.org.au/extension-and-communication-for-the-australian-cherry-industry-cy22002/>; Figure 2). On the [Cherry Growers Australia YouTube page](https://www.youtube.com/@CherryGrowersAustralia) (Figure 3) at <https://www.youtube.com/@CherryGrowersAustralia>, you can find all the project's videos and catch up on the latest workshops and in-field discussions, including those with our international guests, Dr Greg Lang and Ronald Vermeulen.

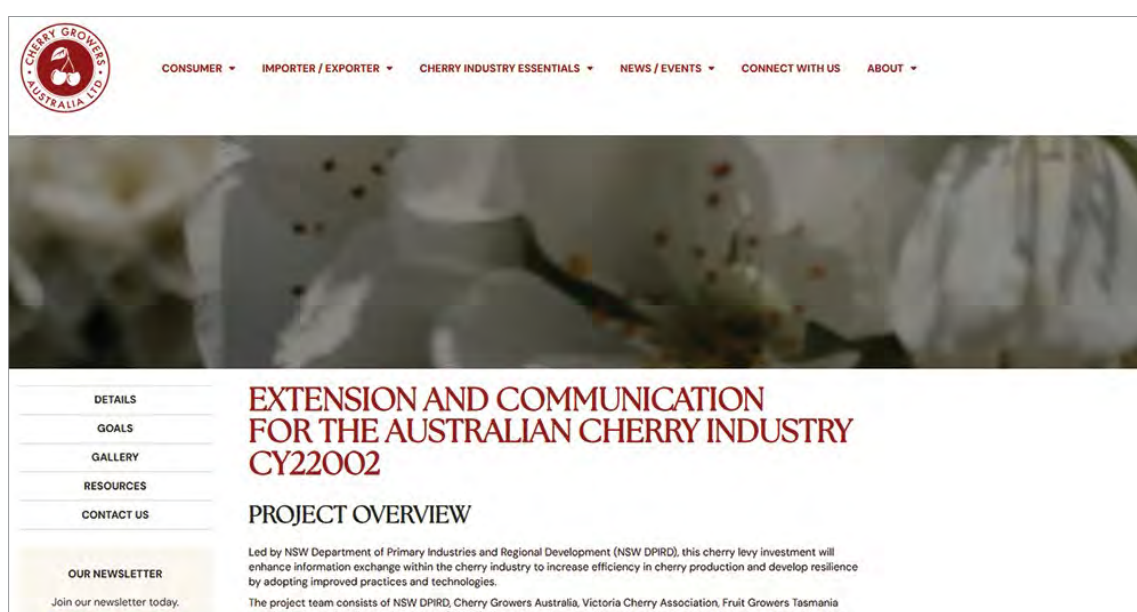


Figure 2. A screenshot of the project page on the Cherry Growers Australia website.

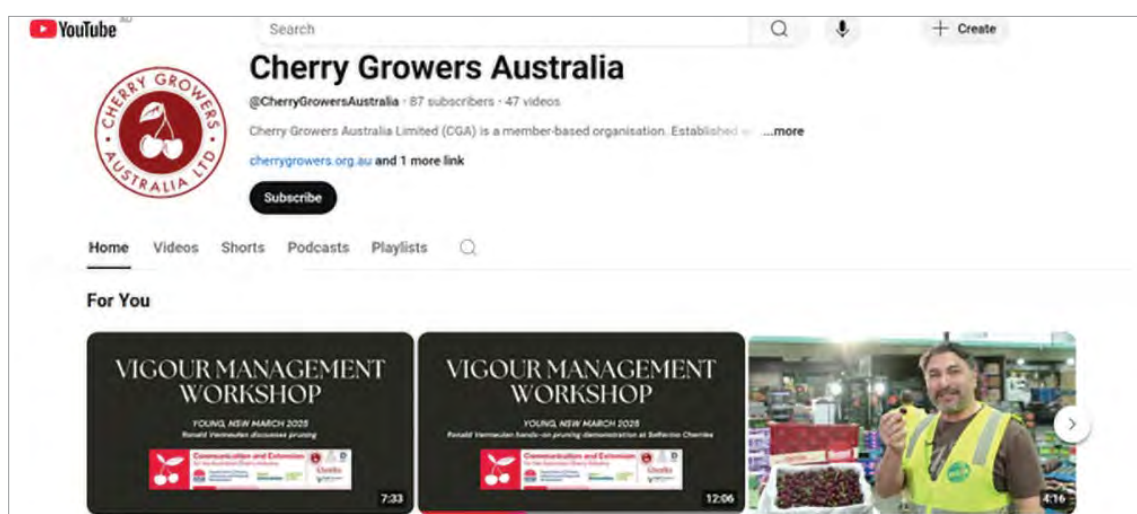


Figure 3. A screenshot of the Cherry Growers Australia YouTube page.

Acknowledgement

This project is funded by Hort Innovation using the cherry research and development levy, and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.



Optimising protected cherry production

Jess Fearnley-Pattison, Development Officer – Temperate Fruit, NSW DPIRD
Summer Song, Project Officer – Digital Agriculture, NSW DPIRD

NSW DPIRD is excited to announce a new Hort Innovation cherry R&D levy-funded project 'Optimising protected cherry production' (CY24004). Led by NSW DPIRD and supported by the Tasmanian Institute of Agriculture (TIA), the project will help Australian cherry growers make informed decisions about investing in and managing protected cropping systems (PCS), such as rain covers and netting. These systems can protect fruit from adverse weather, but their adoption on mainland Australia remains limited due to uncertainty with costs, benefits, and effects on fruit quality. Additionally, there is limited research on the best management practices with PCS for growers who use this technology.

This three-year project will deliver key outcomes for the cherry industry, including improved:

- understanding of the costs, benefits, and lifespans of different PCS
- grower confidence in PCS investment decisions
- knowledge of optimal management strategies for producing premium cherries under PCS
- resilience of the cherry industry to climate change
- resource use efficiency in cherry orchards.

To achieve these outcomes, the project team will produce the following outputs:

- an investment tool that will allow growers to evaluate investment decisions
- fact sheets and industry articles outlining how PCS influence orchard microclimate, fruit production and management recommendations
- videos showcasing growers' experiences with PCS
- regional workshops and orchard walks.

Replicated research trials will be conducted in the main cherry-growing regions in Australia, supported by grower-led case studies, to explore how PCS influence light, temperature, humidity, and soil moisture, and how these changes might affect cherry yield and quality. The project team will also identify best management practices for the canopy, irrigation, nutrition, and the use of growth regulators under PCS.

Extension activities will be coordinated with the Communication and extension for the Australian cherry industry project (CY22002), and materials will be distributed via Cherry Growers Australia and other industry platforms. By the end of the project, growers will have access to knowledge and tools to enhance their confidence in investing in PCS and managing their orchards for high-quality cherry production. To receive updates about this project and others, sign up for the [industry newsletter](https://mailchi.mp/cherrygrowers/newsletter-sign-up) (<https://mailchi.mp/cherrygrowers/newsletter-sign-up>).



Figure 4. An orchard with structured and draped hail netting in Batlow, NSW.



Have you seen our *Bushfire in orchards: a guide to preparedness, response and recovery* guide?

The 2024–25 Christmas season marked 5 years since the Black Summer Bushfires of 2019–20. These fires caused extensive damage to the region's apple industry with trees, netting, irrigation systems, machinery, and farm structures all severely affected.

In the aftermath, it was discovered that the critical information apple growers needed to make informed decisions about orchard recovery or removal did not exist. It quickly became clear that there was both a need and an opportunity for research to capture vital knowledge that would help growers make informed decisions about orchard recovery or removal.

In late 2020, a five-year collaborative research program was launched, involving NSW DPIRD, Hort Innovation, and Primary Industries and Regions South Australia (PIRSA).

Over the past 5 years, the project team conducted a series of trials and observational studies in orchards at Batlow and the Adelaide Hills. An outcome from this project is the guide titled *Bushfires in orchards: a guide to preparedness, response, and recovery*, which outlines the effects of bushfires on orchards, recommends methods for damage assessment, offers decision-making tools, and provides practical advice for preparing for fires.

The guide can be downloaded from the [NSW DPIRD website](https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/1592665/Bushfire-recovery-guide-web.pdf) (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/1592665/Bushfire-recovery-guide-web.pdf).



Acknowledgement

This project was funded through Hort Innovation Frontiers with co-investment from NSW DPIRD, PIRSA and contributions from the Australian Government.



Spotlight on little cherry virus in America

Jessica Fearnley-Pattison, Development Officer – Temperate Fruit, NSW DPIRD

NSW DPIRD facilitated a study tour for the 2025 Emerging Cherry Leaders cohort to Washington State, USA, in June 2025. During the trip, the group was surprised at the amount of little cherry virus (LCV) that had spread throughout Washington State. Almost all the growers visited had incidences of LCV within their orchards, causing reduced yield and quality. In the Pacific Northwest growing regions of the United States, little cherry virus is one of the most devastating diseases.

What is little cherry virus?

Little cherry virus causes fruit to be small, underdeveloped and have low Brix levels. Fruit colour development will be slow and uneven throughout the tree. This causes significant problems with fruit quality and results in reduced pack-outs.

Once a tree is infected, there is no way to eradicate the disease. For growers, the effect of LCV is both immediate and long-term. Infected trees are never as productive as healthy trees and the longer the tree is infected, the worse the symptoms become. Infected trees should be removed. The best removal method involves cutting trees at the stump and applying poison to kill the remaining root system.

Symptoms of little cherry virus

- Small, undersized fruit that fail to mature properly (Figure 5).
- Poor colour development, the skin can appear pale or blotchy.
- Cherries with low Brix and lacking flavour.
- Uneven ripening within fruit clusters or throughout the tree.
- Shrivelled, small leaves (Figure 6).



Figure 5. Little cherry virus causes small, unripe fruit. Photo: L Kunze, Biologische Bundesanstalt für Land-und Forstwirtschaft, Bugwood.org.



Figure 6. In Washington State, trees with little cherry virus have shrivelled leaves and small fruit.

How is little cherry virus spread?

LCV is primarily spread through infected propagation material, such as rootstock, and insect vectors. In the Pacific Northwest growing regions of America, the primary vectors are the apple mealybug (*Phenacoccus aceris*) and grape mealybug (*Pseudococcus martinus*; Figure 7), which spread the virus between trees and blocks, compounding the problem. Currently, these mealybugs are not found in Australia, so the virus can only be spread through infected propagation material.



Figure 7. Grape mealybug (not present in Australia) is the primary vector of little cherry virus in America. Photo: Eugene E Nelson, Bugwood.org.

What can we do in Australia?

LVC has been in Australia for over 35 years and is thought to be in several cherry-growing regions. While the exact incidence rates are not publicly documented, symptoms will often go unnoticed until just before harvest, when fruit might appear smaller, discoloured, and lack flavour, leading to potential economic losses for growers. Given the virus is in Australia, and we know the devastating effects it can have when it is widespread, growers are advised to implement rigorous monitoring and biosecurity measures to manage and mitigate its damage.

As Australia does not have the primary insect vectors that transmit LCV, the only way it can be transmitted is through infected material. Therefore, propagation material should be of high health status and certified as known virus tested. Growers can also:

- regularly inspect blocks, especially in the 2–3 weeks before harvest
- submit suspect fruit or tissue samples for laboratory testing
- remove and destroy infected trees quickly.

More information

Ag Victoria (2022) [Little cherry virus](https://agriculture.vic.gov.au/biosecurity/plant-diseases/fruit-and-nut-diseases/stone-fruits/little-cherry-virus#:~:text=Little%20cherry%20virus%20%20(LChV2,since%20been%20found%20in%20Victoria.), [https://agriculture.vic.gov.au/biosecurity/plant-diseases/fruit-and-nut-diseases/stone-fruits/little-cherry-virus#:~:text=Little%20cherry%20virus%20%20\(LChV2,since%20been%20found%20in%20Victoria.](https://agriculture.vic.gov.au/biosecurity/plant-diseases/fruit-and-nut-diseases/stone-fruits/little-cherry-virus#:~:text=Little%20cherry%20virus%20%20(LChV2,since%20been%20found%20in%20Victoria.)

DuPont T, Harper S, Bixby Brosi A and Beers B (2020) [Little cherry virus](https://treefruit.wsu.edu/crop-protection/disease-management/little-cherry-disease/), Washington State University, <https://treefruit.wsu.edu/crop-protection/disease-management/little-cherry-disease/>.

NSW DPIRD (2015) [Little cherry disease](https://www.dpi.nsw.gov.au/biosecurity/plant/insect-pests-and-plant-diseases/little-cherry-disease.), <https://www.dpi.nsw.gov.au/biosecurity/plant/insect-pests-and-plant-diseases/little-cherry-disease.>

Acknowledgement

The Emerging Cherry Industry Leaders Program is part of the Hort Innovation-funded Communication and extension for the Australian cherry industry project (CY22002).



Brown marmorated stink bug: a critical threat to orchard crops

Aphrika Gregson, Farm Chemicals Officer, NSW DPIRD

What growers need to know

The brown marmorated stink bug (*Halyomorpha halys*; [Figure 8](#)) is an exotic pest posing a serious threat to Australia's fruit-growing industries. Brown marmorated stink bug (BMSB) feeds on a wide range of fruit crops, including temperate tree crops, causing cosmetic and internal damage that renders fruit unmarketable. BMSB is native to Asia and is found in China, Japan, Taiwan and Korea. It was introduced to the USA, where it rapidly spread and has been detected in more than 40 states. It is also now throughout Europe.

For growers and the broader Australian horticulture sector, this pest could have devastating consequences if it becomes established in our growing regions. The high-risk period for BMSB is usually from 1 September to 30 April. There was an increased level of BMSB interceptions at Australian ports during 2024 and 2025. As a result, all states and territories conducted enhanced surveillance activities at detection sites and surrounding areas, as well as high-risk facilities. The increased surveillance included trapping, visual monitoring and in some cases, pesticide applications. Brown marmorated stink bug is a hitchhiker pest, known to stow away inside shipping containers, vehicles, machinery and other goods brought into Australia, including mail and passenger luggage. They become active when they arrive in Australia, with the warmer weather and longer day length breaking their dormancy and encouraging feeding.

From overseas observations on temperate horticulture

- **Apples and pears** are very susceptible to feeding injury from petal fall onwards, with the most significant effects seen on late-season fruit.
- **Peaches** are considered a preferred and highly vulnerable host ([Figure 9](#)). Rather than typical plant-hopping behaviour, BMSB can complete their entire life cycle on peach hosts alone.
- **Nectarines** are similarly vulnerable, cherries are less so, and the damage potential on apricots is currently unknown.
- In Korea, stink bugs, including BMSB, are the most significant pest of **persimmon** orchards.

Chemical control for BMSB requires frequent (weekly or fortnightly) pesticide applications, and careful selection of chemistries with high knockdown and low recovery rates. Some pyrethroids and neonicotinoid products deliver inadequate control, with some dying adults returning to full foraging activity. Effective control relies on using broad-spectrum formulations such as carbamates and organophosphates, which are largely incompatible with IPM systems.

Horticulture growers need to stay vigilant with seasonal biosecurity measures and report anything unusual.



Figure 8. Adult brown marmorated stink bug. Photo: Kristie Graham, USDA ARS, Bugwood.org.



Figure 9. Adult brown marmorated stink bugs on a peach. Photo: Gary Bernon, USDA APHIS, Bugwood.org.

Monitoring and identifying brown marmorated stink bug

As an exotic hitchhiker pest, the most likely entry points into Australia are freight and passenger ports. In NSW, these are Sydney and Newcastle. All horticultural producers in these regions must be vigilant with seasonal biosecurity and familiarise themselves with BMSB identification and what to do with suspect insects or suspect fruit damage. Adult BMSB are strong fliers and have been recorded flying up to 2 kilometres in one flight. They are highly mobile pests, moving from host to host during spring and summer, usually from early ripening fruit to plants with later ripening fruit.

Monitoring for brown marmorated stink bug in the orchard

- Target the orchard perimeter for BMSB monitoring; overseas observations have shown BMSB is a perimeter-driven threat, entering orchards from neighbouring vegetation repeatedly throughout the season.
- Adults are shield-shaped, mottled brown, and 12–17 mm long. Look for distinct white bands on antennae and legs (Figure 8).
- Nymphs start yellowish–brown with black and red markings, darkening as they mature.
- Eggs are light green, barrel-shaped, and laid in clusters of 20–30 on the underside of leaves (Figure 10).



Figure 10. Brown marmorated stink bug eggs and freshly hatched nymphs. Photo: Gary Bernon, USDA APHIS, Bugwood.org.

Brown marmorated stink bug feeding causes:

- dimpling and pitting on fruit surfaces
- internal corking and rot
- cat-facing (distortion and depressions on the fruit surface; Figure 11)
- gummosis in stone fruit such as peaches and nectarines
- depending on the timing of feeding, damage symptoms might take days (peaches) or weeks (apples) to show, and might worsen in cold-stored fruit.

The economic loss from unmarketable fruit can be severe, especially in apples and pears, where international losses have been significant.



Figure 11. Brown marmorated stink bug feeding causes cat-facing. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org.

What growers should do

1. Stay vigilant
 - Monitor orchards, packing sheds, and equipment regularly.
 - Inspect imported goods, bins, and pallets, especially during the high-risk season.
2. Know the signs
 - Learn to identify BMSB at all life stages.
 - Watch for unusual damage patterns on fruit and leaves.
3. Practice good biosecurity
 - Maintain strict hygiene protocols for incoming goods.
 - Quarantine new equipment or materials before use.
4. Report it immediately if you suspect BMSB:
 - Catch it in a sealed container.
 - Report it via:
 - Exotic Plant Pest Hotline: 1800 084 881
 - Email: biosecurity@dpi.nsw.gov.au (include photos and contact details).
 - [Online reporting form](https://forms.bfs.dpi.nsw.gov.au/forms/9247) (<https://forms.bfs.dpi.nsw.gov.au/forms/9247>).

BMSB is a notifiable pest in NSW; reporting is mandatory within one working day.



2025 update on Australian Pesticides and Veterinary Medicines Authority chemical reviews

Aphrika Gregson, Farm Chemicals Officer, NSW DPIRD

After an active constituent has been approved or a product has been registered, new information might emerge that suggests a change in risk/s to human health, the environment, animal or crop safety, or trade. New information might also be generated that suggests product ineffectiveness. The Australian Pesticide and Veterinary Medicines Authority (APVMA) reviews and changes use patterns where appropriate.

In August of 2023, the APVMA prioritised the completion of 8 ongoing chemical reconsiderations (reviews). Those relevant to horticultural production are in [Table 1](#). The APVMA have also nominated neonicotinoid active constituents, product registrations and label approvals for review, along with anticoagulant rodenticides.

Table 1. Ongoing Australian Pesticide and Veterinary Medicines Authority (APVMA) chemical reconsiderations relevant to horticultural production.

Chemical name	Proposed regulatory decision	Public consultation period concludes	Final regulatory decision
Malathion	Completed 22 November 2022	Closed 23 February 2023	Published 30 April 2024
Diazinon	Completed 12 March 2024	Closed 11 June 2024	Published 10 September 2024
Chlorpyrifos	Completed 12 December 2023	Closed 11 March 2024	Published 3 October 2024
Fenitrothion	Completed 9 April 2024	Closed 8 July 2024	Published 19 August 2025
Diquat	Completed 30 July 2024	Closed 29 October 2024	December 2025
Paraquat	Completed 30 July 2024	Closed 29 October 2024	December 2025
Fipronil (Ag)	April 2026	July 2026	December 2026

Summary of regulatory decisions on finalised agricultural chemical review

The APVMA has made several determinations about the use of the following agrochemical products in horticulture:

- **Chlorpyrifos:** based on its final regulatory assessment, the APVMA determined that chlorpyrifos use patterns in horticulture pose unacceptable occupational exposure risks to operators and re-entry workers, which could not be adequately mitigated through existing PPE or engineering controls. As a result, these use patterns are no longer supported.
- **Diazinon:** following the 2024 review, all food uses of diazinon were removed from approved labels. This decision was based on outdated residue data that no longer met current regulatory standards, preventing the APVMA from establishing safe dietary exposure levels.
- **Malathion:** in 2024, the APVMA affirmed approvals for malathion products with significant label variations, including new PPE and re-entry requirements, restricted application methods, and updated spray drift and storage controls. Concurrently, the TGA proposed up-scheduling products with >10% malathion from Schedule 5 to Schedule 6, affecting all horticultural use patterns.
- **Fenitrothion:** following the recently published final decision, fenitrothion is no longer supported in horticulture due to concerns related to environmental safety, residue levels, and international trade.

Following a high volume of submissions during public consultation, the APVMA has extended the timeline for its final decision on paraquat and diquat from the second quarter of 2025 to December. The proposed decision on fipronil products has also been delayed, with publication now expected in April 2026.

All information related to the chemical review process, including technical reports, preliminary and final regulatory decisions, can be accessed on the [APVMA website](http://www.apvma.gov.au) at www.apvma.gov.au.

Managing product phase-out: guidance on using cancelled agricultural chemicals

Agrochemical reviews conducted by the Australian Pesticides and Veterinary Medicines Authority (APVMA) might result in the cancellation of specific use patterns or, more broadly, the cancellation of pesticide products or active ingredients. However, if no immediate risk to safety, efficacy, or trade is identified, the APVMA implements a phase-out period. This phase-out is enabled by a 'deemed permit', which legally authorises the possession, custody, use, and supply of the cancelled agricultural and veterinary (AgVet) products for one year from the date of cancellation (*Agricultural and Veterinary Chemicals Code Act 1994 s45B*).

Table 2. Active ingredients relevant to temperate horticulture affected by the APVMA chemical review.

Active constituent	Final report	Fate of products	Deemed permit expiry
Chlorpyrifos	Gazetted 3 October 2024	Varied, affirmed and cancelled	4 October 2025
Diazinon	Gazetted 10 September 2024	Cancelled and affirmed	11 September 2025
Fenitrothion	Gazetted 19 August 2025	Varied and cancelled	20 August 2026
Malathion	Gazetted 2 May 2024	Varied and affirmed	1 May 2026*

* The APVMA has determined that products bearing previous labels can continue to be supplied for 2 years from the date of the final regulatory decision, under section 81(3) of the AgVet Code.

Navigating label changes: old vs new

A common outcome of APVMA reviews is variations to product labels. These changes can range from minor adjustments to significant alterations. Label variations might include updated personal protective equipment (PPE) requirements, new health warnings, the removal of target crops or application methods, or the introduction of revised withholding periods affecting residues in food or livestock production.

Under the NSW *Pesticides Act 1999*, it is not an offence to follow the label instructions attached to a container, even if these have been subsequently cancelled or modified following a review.

A deemed permit, issued by the APVMA, allows use according to the **current** label instructions, including any conditions related to shelf life or expiry date, or a period of one year from the date of cancellation (refer to [Table 1](#)). However, continuing to use older labels could introduce risks to both your personal safety and your business operations.

The most up-to-date approved label can always be accessed via the APVMA's product database. This resource is essential for identifying changes. If not in contravention of the current label, users might also choose to implement updated label instructions detailed in the APVMA's final review.

Checking the currency of a label

The APVMA assigns both a product number and a label approval number to every approved agricultural and veterinary product. This will be on the label, often near the barcode ([Figure 12](#)) or storage directions. The APVMA's public chemical registration information system search (PubCRIS) provides comprehensive details on all currently approved, cancelled, and expired AgVet chemical products. By locating a product in PubCRIS, you can readily access its most current approved label.



Figure 12. NuFarm's Hy-Mal® was not cancelled due to the APVMA's malathion review. Instead, the registrant voluntarily requested its cancellation. Hy-Mal is no longer registered and cannot be sold or used. Alternative malathion products remain registered and available for sale.

Chemical disposal through ChemClear

Following an APVMA review, producers with cancelled or obsolete agrochemical products can access a free disposal service through ChemClear, Agsafe's national collection program. ChemClear operates statewide every 2–3 years.

To qualify for free collection, chemical products must meet specific criteria. If a product does not meet these criteria, it might still be collected, but a disposal fee will apply, which should be quoted before scheduling a collection.

Table 3. Eligibility criteria for free or fee-incurring disposal of chemical products.

Eligible for free collection	Incurs a disposal fee
In original containers with intact labels	No longer registered for use (over 2 years from deregistration)
Manufactured by participating drumMUSTER companies	Unknown chemicals
Registered or deregistered within the last 2 years	Unlabelled chemicals
Within two years of the chemical's expiry date	Expired (over 2 years from expiration date)
Not held by distributors or AgVet stores as unwanted inventory	Mixed AgVet chemicals
–	Chemicals from manufacturers not participating in drumMUSTER
–	No longer registered for use (over 2 years from deregistration)

Managing obsolete or deregistered product stores on-farm

We recommend the following steps as good practice for managing obsolete or deregistered chemical products on your property:

- **Segregate:** immediately separate deregistered products awaiting disposal to prevent accidental use.
- **Register for collection:** register these products for collection with ChemClear ([Figure 13](#)) by phoning 1800 008 182 or through their [online portal](https://www.agsafe.org.au/chemclear-registration-form) (<https://www.agsafe.org.au/chemclear-registration-form>). Be prepared to provide the manufacturer's name, product name, product registration number, container size (volume), an estimation of the remaining quantity, and the container's condition.
- **Apply storage stickers:** ChemClear will issue storage stickers displaying your registration reference number. Apply these to the containers awaiting disposal.
- **Retain safety data sheets (SDS):** maintain a current SDS for each product awaiting collection. These can be sourced from:
 - The product manufacturer's website.
 - Safe Work Australia's [Hazardous Chemical Information System](https://hcis.safeworkaustralia.gov.au/) (HCIS, <https://hcis.safeworkaustralia.gov.au/>).
 - Your chemical reseller.
- **Maintain records:** as part of your chemical inventory, retain detailed records of your ChemClear disposal lodgement, including the date, product name, active ingredient(s), and the volume awaiting disposal.



Figure 13. Dispose of your unwanted AgVet chemicals safely in ChemClear collections in NSW.



Growing cherries (Lapins) in NSW: preparing for a changing climate

Jane Kelley, Bethany Ellis, James Lawson, Joanna Pardoe, David Allingham and Jessica Fearnley-Pattison, NSW DPIRD

Climate change is altering the growing conditions for many agricultural commodities. Primary producers need evidence-based information about the changing climate and the risks and opportunities it could bring. Through its Vulnerability Assessment Project, NSW DPIRD is providing information to help the sector better plan for, and respond to, climate change. The project team has determined the effects of climate change for many commodities, including horticulture, and important biosecurity risks. This article includes the results for cherries (Lapins) grown in the NSW Central Tablelands (Figure 14).

Cherries in NSW

NSW is Australia's third-largest producer of sweet cherries. There are approximately 420,000 cherry trees in NSW, and over 5,500 tonnes of cherries were produced in the 2020–21 season (Australian Bureau of Statistics). The Central Tablelands region of NSW, particularly around Orange, is a key cherry-growing area. This region has a cool climate, high elevation, rich soil, reliable rainfall, mild summers for fruit growth, and cold winters to provide winter chill. However, the region can also get frost during vulnerable stages such as flowering, and rain or heat near harvest, which can lead to fruit cracking or reduced yields. To reduce these risks, orchards are starting to adopt protective strategies such as rain covers, frost protection and improving irrigation efficiency to maintain fruit quality and ensure consistent yields.

Effects of climate change on cherries

To investigate how conditions in 2050 might change for cherry production in NSW, Climate Change in Australia's application-ready data were used, which comprises projections from 8 global climate models, each presenting a plausible future climate scenario. Intermediate and high emissions scenarios were used in the assessments (RCP4.5 and RCP8.5). The models differ in their projections, generating uncertainty in the modelling, which is reflected in the confidence statements given in brackets in the text. Care should be taken when interpreting these results.

'Climate suitability' is used to describe the extent to which climate conditions will be appropriate for the trees and fruit production. A very high climate suitability reflects optimum conditions, and a very low suitability reflects very poor conditions.

As the future is uncertain, 'confidence' is used to describe the likelihood of the projected change, ranging from low to medium to high. For example, there is high confidence that warmer temperatures will affect cherries during harvest.

Cherry growing regions in NSW will continue to have high to very high climate suitability for growing cherries by 2050 under a changing climate. The risks to the NSW cherry industry will affect the cherry growth stages in different ways (Table 4).

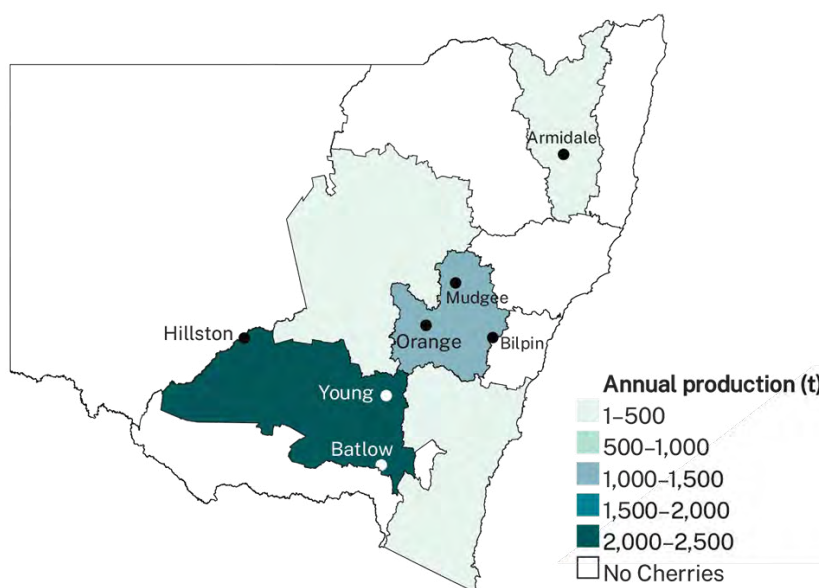


Figure 14. The main cherry-growing regions in NSW. Darker colours represent greater cherry production.

Cherry quality

Cherry firmness is a key measure of fruit quality, directly linked to freshness. Due to projected temperature rises, without adaptation, climate suitability is likely to be low in Hillston for optimal cherry firmness by 2050. Reductions in cherry firmness are also likely in Young, Mudgee and Bilpin (moderate to high confidence).

Irrigation water requirements

Irrigation water requirements are expected to increase for cherry growing regions, particularly under the high emissions scenario, where temperatures are projected to be higher. This is likely to be more pronounced around the Cowra growing areas.

Table 4. The projected effects of climate change on cherry growth stages.

Growth stage	Why is this growth stage important?	How will the projected changes in climate affect cherries in 2050?	What does this mean for cherry growers?
Dormancy End of leaf fall to bud scales opening 1 Apr to 31 Jul	Chill accumulation in winter sets the tree up for optimal flowering and fruit development.	Climate suitability is expected to remain very high for dormancy in the Orange region (high confidence).	There could be a minimal to moderate reduction in chill accumulation in Cowra and Mudgee (high confidence).
Bud swell to bud burst Bud burst to full shoot growth 1 Aug to 7 Sep	Bud swell and bud burst are when leaf shoot and flower bud development occur, which will determine the yield potential for the coming season.	Climate suitability is expected to increase slightly due to reduced frost in all growing areas in the Central Tablelands (high confidence).	Many of the current management strategies are likely to remain effective through to 2050. Having windbreaks can help support pollinator numbers during windy weather, enhance pollination success and reduce bruising when ripe fruit is on the tree.
Flowering Inflorescence to hard berry development 8 Sep to 7 Oct	Any factors that damage flowers, such as high wind or frost, reduce the season's yield potential.	Climate suitability is likely to remain high in the Central Tablelands growing areas due to reduced frost and a warmer climate (high confidence).	
Cell division Berry softening to berry colouring 8 Oct to 30 Nov	Poor conditions during this phase can lead to small fruit size and poor quality attributes such as doubling or cracking.	Climate suitability is likely to remain high to very high in all Central Tablelands growing areas (high confidence).	
Harvest Berries ripe to harvest 1 Dec to 31 Dec	Rainfall and heat can cause cracking or significantly affect the firmness of cherries and their quality.	Temperature increases are likely to result in minimal reductions in cherry firmness at Mudgee and Cowra (moderate to high confidence). Climate suitability is likely to remain very high in the Orange region (moderate to high confidence).	With the increased number of days with a temperature over 33 °C, strategies to protect cherries from heat stress might be required.
Postharvest To the end of leaf fall 1 Jan to 31 Mar	High temperatures can affect bud initiation, potentially increasing the risk of fruit doubling.	Climate suitability is likely to remain high to very high in all the Central Tablelands growing areas (high confidence).	Many of the current management strategies are likely to remain effective for this growth stage through to 2050.

How to adapt

Adapting to extreme heat

Shade netting can protect fruit from sunburn and reduce skin temperature. NSW apple growers already use shade netting to cool fruit and are successfully preventing quality downgrades in hotter areas. Netting can also reduce damage to fruit from wind, hail, birds and bats, and decrease water loss through evaporation.

Using overhead sprinklers or micro-sprays to cool cherries during harvest and postharvest periods is another viable adaptation strategy. This could also reduce evaporation and water demand. However, more research is needed to learn how to manage increased humidity in the canopy to avoid increased disease and rot.

Adapting to varied rainfall patterns

Rainfall near harvest can induce cherry cracking, which will downgrade the fruit to be unsaleable. Using protective rain covers in cherry orchards has not been widely adopted in NSW because of the cost of installation, perceived effect on quality and the extra time needed to manage the covers.

Early trials by NSW DPIRD suggest that orchards under covers had slightly higher minimum and maximum temperatures, reduced maximum humidity, increased minimum humidity, lower wind speeds and improved cherry quality. As the climate becomes more unpredictable and extreme weather becomes more common, protective rain covers appear to be a promising option for growers to protect their crops against these climatic factors.

Adapting to insufficient accumulated chill

Planting low-chill cherry varieties might be beneficial in regions with declining accumulated chill. These low-chill cherry varieties might provide opportunities to grow cherries in new areas.

Acknowledgement

This work has been produced by the NSW Primary Industries Climate Change Research Strategy, funded by the NSW Climate Change Fund.

For more information, please email vulnerability.assessment@dpiird.nsw.gov.au

A broader view of protection.

A little perspective can transform our understanding.

Bogard, Chorus, Topas and Seguris Flexi are four individually proven products with remarkable dependability against key pome fruit diseases. Step back and that view widens. Working across three modes of action, what we now see is a comprehensively superior program for the management of black spot and powdery mildew at every production milestone. With different modes of action, our products make it easy to manage the risk of fungicide resistance.

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Pests

Table 5. Key pests affecting pome fruit, stone fruit and persimmons in NSW.

Common name	Scientific name	Which crops are primarily affected?							Where to look
		Apples 	Pears 	Apricots 	Cherries 	Peaches/ nectarines 	Plums/ Prunes 	Persimmons 	
Ants	<i>Pheidole megacephala</i> and <i>Ochetellus glaber</i>	✗	✗	✗	✗	✗	✗	✓	page 26
Apple dimpling bug	<i>Campylomma liebknechti</i>	✓	✗	✗	✗	✗	✗	✗	page 28
Apple leafhopper	<i>Edwardsiana froggatti</i>	✓	✓	✗	✗	✗	✗	✗	page 30
Australian plague locust	<i>Chortoicetes terminifera</i>	✓	✓	✓	✓	✓	✓	✓	page 32
Black peach aphid and green peach aphid	<i>Brachycaudus persicae</i> and <i>Myzus persicae</i>	✗	✗	✓	✓	✓	✓	✗	page 33
Bryobia mite	<i>Bryobia rubrioculus</i>	✓	✓	✓	✓	✓	✓	✗	page 35
Budworms (<i>Heliothis</i>)	<i>Helicoverpa</i> species	✓	✓	✓	✓	✓	✓	✗	page 37
Carpophilus beetle (dried fruit beetle)	<i>Carpophilus</i> species	✗	✗	✓	✓	✓	✓	✗	page 39
Cherry aphid	<i>Myzus cerasi</i>	✗	✗	✓	✓	✓	✓	✗	page 41
Clearwing moth	<i>Ichneumenoptera chrysophanes</i>	✗	✗	✗	✗	✗	✗	✓	page 43
Codling moth	<i>Cydia pomonella</i>	✓	✓	✗	✗	✗	✗	✗	page 45
European earwig	<i>Forficula auricularia</i>	✗	✗	✓	✓	✓	✓	✗	page 48
European red mite	<i>Panonychus ulmi</i>	✓	✓	✓	✓	✓	✓	✗	page 50
Fruit tree borer	<i>Maroga melanostigma</i>	✗	✗	✓	✓	✓	✓	✗	page 53
Harlequin bug	<i>Dindymus versicolor</i>	✓	✗	✗	✗	✗	✗	✗	page 54
Light brown apple moth	<i>Epiphyas postvittana</i>	✓	✓	✓	✓	✓	✓	✓	page 56
Loopers including green loopers	Various species	✓	✓	✓	✓	✓	✓	✓	page 59

Table 5. Key pests affecting pome fruit, stone fruit and persimmons in NSW, page 2 of 2.

Common name	Scientific name	Which crops are primarily affected?							Where to look
		Apples 	Pears 	Apricots 	Cherries 	Peaches/ nectarines 	Plums/ Prunes 	Persimmons 	
Mealybugs including long-tailed mealybug	Various species	✓	✓	✗	✗	✗	✗	✓	page 61
Oriental fruit moth	<i>Grapholita molesta</i>	✓	✓	✓	✓	✓	✓	✗	page 63
Oystershell scale	<i>Diaspidiotus ostreaeformis</i>	✓	✓	✓	✓	✓	✓	✗	page 65
Pear and cherry slug	<i>Caliroa cerasi</i>	✗	✓	✗	✓	✗	✗	✗	page 66
Pear leaf blister mite	<i>Eriophyes pyri</i>	✗	✓	✗	✗	✗	✗	✗	page 67
Plague thrips	<i>Thrips imaginis</i>	✓	✓	✓	✓	✓	✓	✗	page 68
Queensland fruit fly	<i>Bactrocera tryoni</i>	✓	✓	✓	✓	✓	✓	✓	page 70
Rutherglen bug	<i>Nysius vinitor</i>	✓	✓	✓	✓	✓	✓	✗	page 78
San José scale	<i>Diaspidiotus perniciosus</i>	✓	✓	✓	✓	✓	✓	✗	page 79
Two-spotted mite	<i>Tetranychus urticae</i>	✓	✓	✓	✓	✓	✓	✗	page 81
Weevils	Various species	✓	✓	✓	✓	✓	✓	✗	page 84
Western flower thrips	<i>Frankliniella occidentalis</i>	✓	✓	✓	✓	✓	✓	✓	page 87
Wingless grasshoppers	<i>Phaulacridium vittatum</i>	✓	✓	✓	✓	✓	✓	✗	page 89
Woolly apple aphid	<i>Eriosoma lanigerum</i>	✓	✓	✗	✗	✗	✗	✗	page 90



Diseases

Table 6. Key diseases affecting pome fruit, stone fruit and persimmons in NSW.

Common name	Scientific name	Which crops are primarily affected?							Where to look
		Apples 	Pears 	Apricots 	Cherries 	Peaches/ Nectarines 	Plums/ Prunes 	Persimmons 	
Alternaria leaf blotch and fruit spot	<i>Alternaria</i> species	✓	✗	✗	✗	✗	✗	✗	page 96
Angular leaf spot	<i>Cercospora</i> species and <i>Pseudocercospora</i> species	✗	✗	✗	✗	✗	✗	✓	page 98
Apple scab and pear scab	<i>Venturia inaequalis</i> and <i>Venturia pirina</i>	✓	✓	✗	✗	✗	✗	✗	page100
Bacterial canker	<i>Pseudomonas syringae</i> pv. <i>syringae</i>	✗	✗	✓	✓	✓	✓	✗	page102
Bacterial spot	<i>Xanthomonas arboricola</i> pv. <i>pruni</i>	✗	✗	✓	✗	✓	✓	✗	page104
Bitter rot	<i>Glomerella cingulata</i> (anamorph: <i>Colletotrichum gloeosporioides</i>)	✓	✓	✗	✗	✗	✗	✗	page105
Blossom blight and brown rot	<i>Monilinia</i> species	✗	✗	✓	✓	✓	✓	✗	page106
Circular leaf spot	<i>Mycosphaerella</i> species	✗	✗	✗	✗	✗	✗	✓	page109
Crown gall	<i>Agrobacterium tumefaciens</i>	✗	✗	✓	✓	✓	✓	✗	page110
Fly speck	<i>Schizothyrium pomi</i>	✓	✓	✗	✗	✗	✗	✗	page111
Freckle	<i>Venturia carpophilum</i>	✗	✗	✓	✓	✓	✓	✗	page112
Peach leaf curl	<i>Taphrina deformans</i>	✗	✗	✗	✗	✓	✗	✗	page113
Phytophthora root and collar rot	<i>Phytophthora</i> species	✓	✓	✓	✓	✓	✓	✗	page115
Powdery mildew	<i>Podosphaera leucotricha</i>	✓	✓	✗	✗	✗	✗	✗	page117
Rust	<i>Tranzschelia discolor</i>	✗	✗	✓	✓	✓	✓	✗	page119
Shot hole	<i>Stigmata carpophila</i>	✗	✗	✓	✓	✓	✓	✗	page121
Silver leaf	<i>Chondrostereum purpureum</i>	✓	✗	✓	✓	✓	✓	✗	page123
Sooty blotch	<i>Gloeodes pomigena</i>	✓	✓	✗	✗	✗	✗	✗	page124



Apple blossom development stages

Photos by Shane Hetherington, NSW DPIRD.



Figure 15. Dormant.



Figure 16. Green tip.

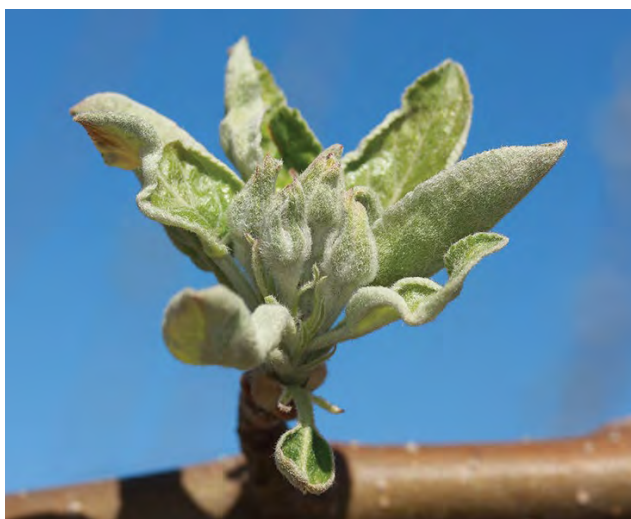


Figure 17. Spur burst.



Figure 18. Pink.



Figure 19. King bloom.



Figure 20. Full bloom.



Stone fruit blossom development stages

Photos by Shane Hetherington, NSW DPIRD.



Figure 21. Dormant.



Figure 22. Bud swell.



Figure 23. Bud break.



Figure 24. Full bloom.



Figure 25. Petal fall.



Figure 26. Shuck fall.



Persimmon development stages

Photos from García-Carbonell S, Yagüe B, Bleiholder H, Hack H, Meier U and Agustí M (2002) Phenological growth stages of the persimmon tree (*Diospyros kaki*). *Annals of Applied Biology*, 141: 73–76, <https://onlinelibrary.wiley.com/doi/10.1111/j.1744-7348.2002.tb00197.x>

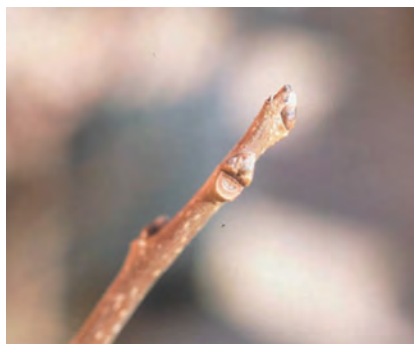


Figure 27. Late dormancy.

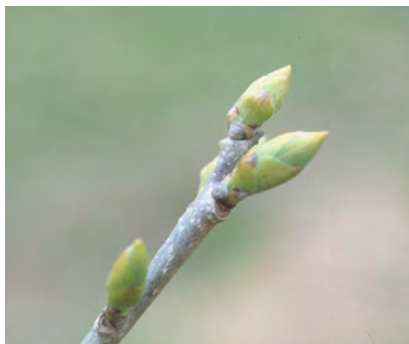


Figure 28. Green leaf tips.



Figure 29. First leaves unfolded.



Figure 30. Flower bud develops on new growth.



Figure 31. Flower sepals begin to separate.



Figure 32. Full flowering (50% open).



Figure 33. Flowers fading.

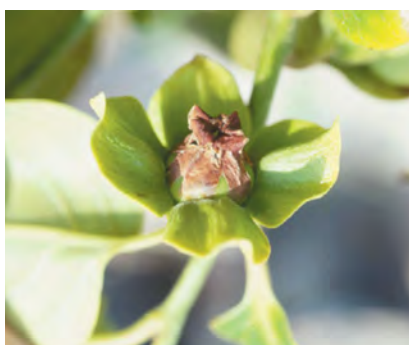


Figure 34. Fruit set, petals browning.

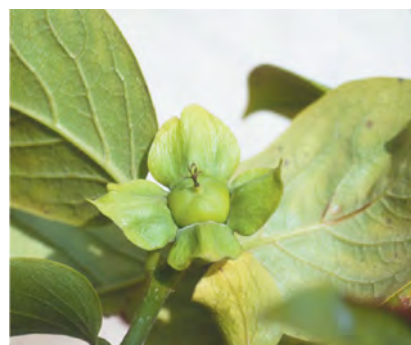


Figure 35. Early fruit development.



Figure 36. Late fruit development.



Figure 37. Start of fruit colouration.



Figure 38. Fruit ripe.



Pests

Ants



Various species

Ants are not a direct pest of persimmons, but they farm and protect mealybugs ([page 61](#)) and scale insects ([page 65](#) and [page 79](#)). Their risk period is, therefore, associated with those pests.

Risk period

Table 7. The peak risk period for ants in persimmon orchards.

Bud swell/ green tip	Shoot extension	Flowering and fruit development	Harvest	Postharvest	Dormancy

Pest identification

Many ant species are recorded in Australia, both native and introduced. Those most commonly associated with persimmons are the coastal brown ant (*Pheidole megacephala*; [Figure 39](#)) and the black house ant (*Ochetellus glaber*; [Figure 40](#)). Coastal brown ant workers are 1.5–2.5 mm long and the soldiers are 3.5–4.5 mm. They are shiny, light-yellow, brown or dark brown. Black house ants are 2–3 mm long and black to brown.

Damage

Ants do not damage persimmons directly, but they are usually associated with the presence of mealybugs or scale insects that excrete honeydew, which ants feed on. When searching the persimmon canopy for honeydew, ants will interfere with the predators and parasites of mealybugs and scale insects, defending the honeydew-producing pests from their natural predators.

Sooty mould is a black fungus that grows on honeydew and is another indirect effect of ants protecting mealybug and scale. Sooty mould results in a superficial black coating on fruit and leaves that can affect fruit colour development and the fruit cleaning process in the packing shed, increasing processing costs.

Monitoring

Monitoring for ants can be done while checking the canopy for other pests, including mealybug and scale. Monitor throughout the growing season from flowering to early postharvest. As ant activity is usually driven by warmth, monitoring during the warmer part of the day is recommended. Action should be considered when ants are found on 50% or more of the inspected shoots.



Figure 39. Coastal brown ants (*Pheidole megacephala*).
Photo: Australian Environmental Pest Managers Association 2021.



Figure 40. Black house ant (*Ochetellus glaber*).
Photo: Australian Environmental Pest Managers Association 2021.

Management

Cultural and physical: cultural controls for ants can include:

- destroying ant nests within or near the orchard
- skirting (removing low-hanging branches and weeds growing into the canopy) to reduce pathways for ants into the trees
- applying a sticky product on the lower tree trunk to make a physical barrier to ants.

Biological: there are currently no biological control agents effective against ants.

Chemical: the chemical options for controlling ants are listed in [Table 8](#).

Table 8. Registered or permitted products for ants in NSW persimmon orchards.

Active constituent (example trade name)	Insecticide group	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Pyrethrins + piperonyl butoxide (Py-Bo)	3A	1	High	All fruit crops ³
Pyriproxyfen (Distance® Plus)	7C	Not required when used as directed	Low	Orchards; bait application

¹ WHP = withholding period. ² Always refer to the label. ³ All crops = apples, pears, apricots, cherries, nectarines, peaches, plums and persimmons.

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Apple dimpling bug



Campylomma liebknechti

Commonly known as the apple dimpling bug (ADB) on mainland Australia, *Campylomma liebknechti* is primarily a pest of apples.

Risk period

Table 9. The peak risk period for apple dimpling bug.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult ADBs are greenish-brown and about 3 mm long. They have spiny legs, shield-shaped wing covers and dark bands at the base of the antennae (Figure 41).

Damage

Apple dimpling bugs feed by inserting their needle-like sucking mouthpart (proboscis) into the developing ovary of the flower or fruitlet and sucking the sap. The scarring at the feeding site fails to grow as the surrounding flesh expands, resulting in a typical dimple (Figure 42), restricting fruit sale.



Figure 41. Apple dimpling bug adult.



Figure 42. Dimpling on an apple caused by apple dimpling bug feeding during bloom.

Monitoring

The main risk period for ADB is between early pink and petal fall. The danger is increased if fruit tree flowering coincides with, or immediately follows, the flowering of native trees in the surrounding bush, especially tree lucerne (Figure 43), wattle (Figure 44) and Geraldton wax. Monitoring ADB activity in these species in the lead-up to apple flowering can indicate the likely level of seasonal risk.

Monitor ADB numbers at least twice weekly from late spur burst through to complete petal fall by tapping bud and flower clusters over a 4 L white ice cream container (or equivalent). The bugs are very active so the container needs to be inspected quickly to see the bugs before they escape. For most of the risk period (until 100% petal fall), the potential for significant ADB damage is high, even if bugs are present in only low numbers (i.e. 2 to 5 bugs per 250 flower clusters). Be aware that population numbers can quickly escalate to significant levels with weather changes. Experience has shown that ADB numbers often increase following the arrival of warm, northerly winds.



Figure 43. Tree lucerne is an apple dimpling bug host.

Management

Cultural and physical: maintain vigilance on blocks or rows that neighbour native trees and shrubs. Consider removing nearby host species, particularly lucerne and wattle trees.

Hand-thinning for crop load from late November to early December is a good opportunity to remove any apples with signs of dimpling damage. Some damaged fruit will drop naturally between petal fall and harvest.

Biological: there are no known biological control agents for ADB. Interestingly, after complete petal fall, ADB might actually be a beneficial insect in the orchard, feeding on *Helicoverpa* spp. moth eggs and pest mites.

Chemical: the chemical options for controlling apple dimpling bug are listed in [Table 10](#).

Table 10. Registered or permitted products for apple dimpling bug in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Acetamiprid + novaluron (Cormoran®)	4A + 15	70	Medium	Apples
Bifenthrin (Talstar® 80 SC)	3A	0	High	Apples
Sulfoxaflor (Transform® Isoclast™)	4C	7	Medium	Pome fruit, stone fruit
Tau-fluvalinate (Mavrik® Aquaflow)	3A	Not required when used as directed	High	Apples
Thiacloprid (Calypso®)	4A	21	Medium	Apples

¹ WHP = withholding period. ² Always refer to the label.



Figure 44. Wattle is an apple dimpling bug host.

Apple leafhopper

Edwardsiana froggatti



The apple leafhopper is an occasional pest in commercial apple and pear orchards. Infestation tends to be worse during dry years and in orchards where few insecticides are used, such as in organic systems.

Risk period

Table 11. The peak risk period for apple leafhopper.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult apple leafhoppers are 3–4 mm long and are pale to bright yellow (Figure 45). Nymphs are small, wingless and whitish-green. They are usually found on the underside of older leaves.

Damage

Apple leafhoppers can cause leaf distortion and mottling (Figure 46). If the infestation is severe, apple leafhopper can cause premature leaf drop.



Figure 45. Apple leafhopper adult.



Figure 46. Apple leafhopper feeding damage. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org.

Monitoring

Monitor for apple leafhopper if the weather forecast is for a dry season or if the insect was a problem in previous seasons.

Management

Cultural and physical: good orchard weed management will help reduce the potential for apple leafhopper infestations.

Biological: the introduced parasitoid, *Anagrus armatus*, has been effective as a biocontrol agent for apple leafhopper in Tasmania. However, its status on mainland Australia is unknown.

Chemical: the chemical option for controlling apple leafhopper is listed in Table 12.

Table 12. Registered or permitted product for apple leafhopper in NSW.

Active constituent (example trade name)	Insecticide group	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Malathion ³ (Fyfanon® 440 EW)	1B	3	High	Apples and pears

¹ WHP = withholding period. ² Always refer to the label. ³ Use pattern might be affected by APVMA review outcomes, refer to the [2025 update on Australian Pesticides and Veterinary Medicines Authority chemical reviews on page 13](#).

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Australian plague locust



Chortoicetes terminifera

Australian plague locusts usually prefer to feed on grasses and cereal crops such as wheat. However, they will attack a wide range of plants including horticulture crops. When locusts are present in large swarms, all crops are at risk.

Risk period

Table 13. The peak risk period for Australian plague locust.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Australian plague locusts can be green or brown (Figure 47), have a dark spot on the end of their wings and a dark 'X' mark on top of their thorax. When numbers are high, Australian plague locusts will form swarms.



Figure 47. Australian plague locust adult.

Damage

Australian plague locust swarms can severely damage crops; a large swarm can cause up to 100% crop loss. Often the swarm will land overnight and by morning, the entire crop will be eaten. In orchards, the foliage will receive more damage than fruit as the locusts will feed on green material first.

Monitoring

Australian plague locusts usually begin hatching in late August and early September and will be flying by November. Both the hopper stage and the flying adult locusts feed on green plant material. Monitoring paddocks adjacent to orchard areas for hopper emergence and observing trees for infestation and/or damage will give early indications of Australian plague locust activity.

It is important that any locust activity be reported as soon as possible. A toll-free call to the Australian Plague Locust Commission hotline can be made on 1800 635 962.

Management

Cultural and physical: Australian plague locust eggs can be reduced by cultivating egg beds, however, this is generally ineffective in orchards as the locust swarms are transient. Management should focus on regular monitoring and applying sprays when locusts are in a concentrated band.

Chemical: the chemical option for controlling the Australian plague locust is listed in Table 14. There are no registered or permitted products to control this pest in persimmons.

Table 14. Registered or permitted product for Australian plague locust in NSW.

Active constituent (example trade name)	Insecticide group	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Fenitrothion ³ (Sumithion® ULV)	1B	14	High	Apples, cherries
Alpha-cypermethrin (PER10927 , expires 30.6.30)	3A	14	High	Pome fruit, apricots, nectarines, peaches, plums, prunes

¹ WHP = withholding period. ² Always refer to the label. ³ Use pattern might be affected by APVMA review outcomes, refer to the [2025 update on Australian Pesticides and Veterinary Medicines Authority chemical reviews on page 13](#).

Black peach aphid and green peach aphid



Brachycaudus persicae and *Myzus persicae*

Aphids can be significant pests of stone fruit, attacking leaves and shoots, reducing crop potential and causing fruit quality issues.

Risk period

Table 15. The peak risk period for black peach aphids and green peach aphids.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult black peach aphids (BPA) can be winged or wingless, are shiny, black and about 2 mm long. Nymphs are reddish-brown (Figure 48).

Green peach aphid (GPA) nymphs are pale yellowish-green and have 3 dark lines on the back of the abdomen. Mature aphids are pale green or pinkish and about 2 mm long (Figure 49).

Damage

GPA is a particular concern because of its role in transmitting plant viruses. Aphid infestation can cause leaf and shoot tip distortion. Aphids feed on the leaves, extracting sap and causing leaves to turn yellow and drop. Honeydew produced by a heavy infestation during the growing season can result in sooty mould developing on the tree and fruit.

Monitoring

Check leaves and new growth for BPA and GPA infestation weekly from bud swell to ripening. Aphid numbers can increase quickly, making regular inspections important.



Figure 48. Various life stages of the black peach aphid. Source: adapted from Zeck (1965).



Figure 49. Wingless adult female and nymph stage green peach aphids.

Management

Cultural and physical: avoid excessive amounts of nitrogen fertilisers as these promote soft plant tissue growth that is favoured by aphids. Prune out water shoots and control weeds around the orchard as these can act as a reservoir for migrating aphids.

Biological: natural biological predators of the aphids include lacewings (Figure 50) and lady beetles. The activity and efficiency of biological control agents will be influenced by the absence of insecticides that are likely to be toxic to them. To maximise the effect of beneficial insects, avoid using broad-spectrum insecticides, particularly in spring and summer. In cool growing regions, GPA can overwinter as eggs around the buds. In the lead-up to bud burst, eggs and newly hatched nymphs are susceptible to oil sprays applied to control San José scale (page 79).

Chemical: in Australia, green peach aphid populations have developed high levels of resistance to synthetic pyrethroids and carbamates, and low-level resistance to organophosphates, neonicotinoids, sulfoxaflor, and recently spirotetramat.

CroLife Australia provides an [online insecticide resistance management](https://www.croplife.org.au/resources/programs/resistance-management/insecticide-resistance-management-strategies/) (IRM) plan to help preserve insecticide efficacy. Preventing resistance is easier than reversing it (<https://www.croplife.org.au/resources/programs/resistance-management/insecticide-resistance-management-strategies/>).

The chemical options for controlling BPA and GPA are in Table 16.



Figure 50. Lacewing larvae are important natural predators of aphids.

Table 16. Registered or permitted products for black peach aphids (BPA) and green peach aphids (GPA) in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Acetamiprid + novaluron (Cormoran®)	4A + 15	7	Medium	Stone fruit, BPA and GPA
Clothianidin (Samurai®)	4A	7	High	Peaches and nectarines, GPA only
Imidacloprid (Nuprid® 350SC)	4A	21	Medium	Stone fruit
Malathion (Fyfanon® 1000 EC)	1B	3	High	Stone fruit, BPA and GPA
Methomyl (Methomyl 225)	1A	1	High	Stone fruit, GPA only
Pirimicarb (Pirimor®)	1A	2	Medium	Stone fruit, BPA and GPA
Pymetrozine (Chess®)	9B	28	Low	Stone fruit, BPA and GPA
Spirotetramat (Movento®)	23	21	Medium	Stone fruit, BPA only
Sulfoxaflor (Transform® Isoclast™)	4C	7	Medium	Stone fruit, BPA and GPA

¹ WHP = withholding period. ² Always refer to the label.

Note: in addition to the above chemicals, the active constituent thiacloprid (e.g. Calypso®), although not registered for controlling GPA, the product label does claim that when used as directed for oriental fruit moth control, sprays for GPA will not be required.

Bryobia mite

Bryobia rubrioculus



Bryobia mites feed on fruit tree leaves by puncturing the leaf tissue with their sucking mouthparts. Bryobia mites have become more prevalent in recent years as integrated pest and disease management programs have moved away from broad-spectrum chemicals. Therefore, growers need to regularly monitor their crops to identify the incidence of these pests early.

Risk period

Table 17. The peak risk period for bryobia mite.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult mites are broad and flat, approximately 0.5 mm long and deep reddish-brown. Their front legs are as long as their body (Figure 51). They are often seen pressed flat against the leaf surface or as masses of red eggs on branches and stems (Figure 52). Without a microscope or a good hand lens, bryobia mite can be confused with European red mite.

Damage

Bryobia mites damage the leaves by sucking sap, generally feeding on the upper surface. Damage from this feeding will appear as whitish-grey spots, giving the leaf a stippled appearance. Heavily infested leaves will become pale and can prematurely fall, but fruit growth is rarely affected.

There are several ways to quantify the risk posed by mite populations, including counts, presence or absence, percentage of leaves infested and cumulative leaf-infested days (CLIDs). Your local IPM consultant should be able to assist with more advice on applying these methods in your orchard.

Monitoring

Monitor for bryobia mites fortnightly from late spring to the end of summer. More frequent monitoring might be needed if conditions are hot and dry as this accelerates pest development. Inspecting leaves throughout the orchard using a hand lens can be a good way to detect early mite activity. Collect leaf samples and inspect them using a microscope to determine the number of eggs, active mites, predatory mites and other beneficial insects present. Commercial mite monitoring services exist in some growing regions.



Figure 51. Bryobia mite adult.



Figure 52. Bryobia mite eggs are laid in large groups on branches and stems. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org.

Management

Cultural and physical: a dusty environment will favour pest mite activity. If weather conditions are hot and dry, orchard traffic should be limited and operators should drive slowly to limit the dust on trees. Maintaining green ground cover can reduce dust while also providing an attractive alternative habitat for beneficial predatory insects. Take particular care to control tall or climbing weeds that provide a bridge between other mite hosts and trees.

Biological: bryobia mites can be controlled by predatory mites including *Galendromus pyri*. Other naturally occurring biological control agents of pest mites include lacewings and *Stethorus* spp. beetles. Careful selection of IPM-friendly insecticides and fungicides will help to encourage predatory mites and other beneficials. Consult your chemical supplier for the least disruptive options.

Chemical: an effective chemical control program (Table 18) for pest mites usually includes a winter (dormant) or early spring (bud swell, green-tip) oil spray to control overwintering eggs, followed by targeted miticide application(s) during the growing season as determined by monitoring.

Table 18. Registered or permitted products for bryobia mite in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Bifenazate (Acramite®)	20D	Apricots, plums, nectarines, peaches 3; pome fruit 7	Low	Pome fruit, apricots, nectarines, peaches, plums
Clofentezine (Apollo®)	10A	21	Low	Pome fruit, stone fruit
Cyflumetofen (Danisaraba®)	25A	7	Low	Pome fruit
Etoxazole (Paramite®)	10B	7	High	Pome fruit, stone fruit except cherries
Fenbutatin oxide (Talk Miticide)	12B	Apples, pears 2; peaches, nectarines 14	Low	Apples, pears, peaches, nectarines
Horticultural mineral oil (various)	Paraffinic oil and petroleum oil	1	Low	Pome fruit, stone fruit
Sulfur as polysulfide sulfur (7 Worlds Ag Lime Sulphur)	M2	Not required when used as directed	Medium	Pears, apricots, nectarines, peaches, plums, prunes; stone fruit dormant to bud swell spray only

¹ WHP = withholding period. ² Always refer to the label.

Budworms



Helicoverpa species

Helicoverpa species (previously known as *Heliothis* and commonly known as budworms) are becoming more common in all Australian growing regions. The cotton bollworm, *Helicoverpa armigera*, and the native budworm, *Helicoverpa punctigera*, are the main insect pests of many agricultural and horticultural crops in Australia. The moth larvae can cause extensive feeding damage and also create entry points for secondary pests and diseases.

Risk period

Table 19. The peak risk period for budworms.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Helicoverpa spp. larvae are cream with dark-brown heads. As they mature, the larvae will become darker and develop stripes running along their bodies (Figure 53). These will then develop into the identifying characteristics between species. Female moths (Figure 54) generally have brown forewings, while males are usually cream.

Damage

Helicoverpa spp. larvae will bore into developing fruitlets (Figure 55), causing them to either fall or become deformed. Fruit damage usually appears as clean, isolated holes in the fruit surface, 5–10 mm deep and around 5 mm wide. These develop a russet lump or depression as the fruit matures. Larvae can also feed on the leaves and buds.

Monitoring

During spring and early summer, the undersides of damaged leaves should be carefully monitored for young caterpillars. *Helicoverpa* spp. damage can also occur in early autumn and around harvest, making this a good time to monitor trees.

Management

Cultural and physical: *Helicoverpa* spp. will lay eggs on a wide range of plants, including weeds. Managing weeds, particularly during dormancy, can help reduce the resident population.

Biological: protecting beneficials by using 'softer', more selective insecticides will help with biological control of *Helicoverpa* spp. Pathogen-based insecticides are commercially available, including *Bacillus thuringiensis* (Bt) and *nucleopolyhedrovirus* (NPV).



Figure 53. *Helicoverpa* spp. caterpillars.



Figure 54. Female *Helicoverpa* spp. adult.



Figure 55. *Helicoverpa* spp. damage to an apple.

Chemical: budworms and other early season caterpillars can damage fruit before spray programs for other key moth pests have started. Early spring monitoring can help to determine if early season chemical intervention is needed ([Table 20](#)).

Table 20. Registered or permitted products for budworms in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Abamectin + chlorantraniliprole (Voliam Targo®)	6 + 28	7	High	Pome fruit
<i>Bacillus thuringiensis</i> subsp. <i>Aizawai</i> (Bacchus® WG)	11C	Not required when used as directed	Low	All crops ³
<i>Bacillus thuringiensis</i> subsp. <i>Kurstaki</i> (DiPel®)	11	Not required when used as directed	Low	All crops
Carbaryl (Bugmaster®)	1A	Pome fruit 77; stone fruit 35	High	Pome fruit, stone fruit; do not use on cherries
Chlorantraniliprole (Altacor® Hort)	28	14	Low	Apples, pears
Indoxacarb (Avatar® eVo)	22A	Stone fruit (except cherries) 7; pome fruit and cherries 14	Low	Pome fruit, stone fruit
Methomyl (Nufarm Methomyl)	1A	1	High	Stone fruit
Nucleopolyhedrovirus (Vivus® Max)	31	Not required when used as directed	Low	Pome fruit
Spinetoram (Delegate®)	5	7	Medium	Pome fruit
Spinosad (Entrust® Organic)	5	3	Medium	Pome fruit

¹ WHP = withholding period. ² Always refer to the label. ³ All crops = apples, pears, apricots, cherries, nectarines, peaches, plums and persimmons.

Carpophilus beetle (dried fruit beetle)



Carpophilus species

Carpophilus beetle is an economically significant pest of stone fruit. It can cause serious damage to fruit on the tree and postharvest, especially when temperatures exceed 20 °C after wet weather and when the fruit is ripening.

Risk period

Table 21. The peak risk period for carpophilus beetle.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Carpophilus beetles are small (2–3 mm long) and black or brown (Figure 56 and Figure 57). Their wing covers are short and they have clubbed antennae. The larvae are yellowish, about 5 mm long when fully grown, have a brown head and a forked tail.

Damage

Most commercial damage is done to ripening stone fruit on the tree as beetles burrow into the fruit, particularly near the stem end suture line. In other fruit, such as apples, only fallen fruit is damaged and the pest is not considered economically important. 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.

The adult can fly several kilometres in search of hosts. Summer rain and rotting fruit are ideal conditions for breeding. Carpophilus beetle adults are a major vector of brown rot (page 106).

Monitoring

Using pheromone traps early in the season will indicate carpophilus beetle arrival or emergence, helping with early control and management. Weekly fruit inspections leading up to harvest might help identify the start of fruit infestation.

Management

Cultural and physical: the most important management strategy for carpophilus beetle is good orchard hygiene, which is improved by removing and destroying waste fruit from orchards. Controlling Queensland fruit fly will decrease the amount of fallen fruit and reduce the potential for infestation.



Figure 56. Chewing damage on a nectarine and carpophilus beetle (inset image).



Figure 57. Carpophilus beetle. Photo: Pest and Diseases Image Library, Bugwood.org.

A combination of weekly monitoring and/or mass trapping between stone hardening and harvest, orchard hygiene and good fruit fly control will give the best result. Traps are available from rural retailers.

Biological: an attract-and-kill system using synthetic aggregation pheromones plus food-attractant provides effective protection of ripening crops when deployed at least 4 weeks before harvest. Continuing to mass-trap through harvest and for an additional 2 weeks will help reduce the resident pest population. Placing traps ([Figure 58](#)) upwind on the outside edges of the orchard will ensure maximum pheromone spread.

Chemical: the chemical options for controlling carpophilus beetle are listed in [Table 22](#).



Figure 58. Carpophilus pheromone trap. Photo: Dan Papacek, Bugs for Bugs.

Table 22. Registered or permitted products for carpophilus beetle in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Bifenthrin (Bifenthrin® 250 EC)	3A	1	High	Stone fruit except cherries
Bifenthrin (PER82062 , expires 31.10.28)	3A	1	High	Cherries
Carpophilus Trapping Systems	Pheromone	0	Low	Pome fruit, stone fruit
Clothianidin (Samurai®)	4A	7	High	Stone fruit
Tetraniliprole (Vayego® 200 SC)	28	3	Low	Stone fruit; suppression only

¹ WHP = withholding period. ² Always refer to the label.

Cherry aphid

Myzus cerasi

Cherry aphids can be a major pest in all stone fruit, feeding on leaves and shoots, which can result in reduced and deformed growth.



Risk period

Table 23. The peak risk period for cherry aphid.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult cherry aphids are dark (Figure 59) and approximately 2 mm long. The adult population consists of winged and wingless individuals (Figure 60). The nymphs are dark brown to black. Cherry aphid eggs are shiny, oval and usually found on the underside of leaves.



Figure 59. Cherry aphids. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org.



Figure 60. Various stages of the cherry aphid life cycle. Source: adapted from Zeck (1965).

Damage

Aphids will often inhabit terminal leaf shoots, particularly young leaves. Infested leaves will curl, providing a protected space for aphids to continue feeding. Honeydew secreted by the aphids can result in sooty mould growth on the fruit, making it unmarketable. If the infestation is severe, leaves might turn brown and drop.

Monitoring

Examine trees regularly during and shortly after bud break for aphids (Figure 61). Particular attention should be paid to the terminal shoot tips. Continued monitoring each fortnight until harvest is recommended.



Figure 61. Cherry aphids on a bud. Photo: Mariusz Sobieski, Bugwood.org.

Management

Cultural and physical: high levels of nitrogen can promote soft new growth and this is favoured by aphids. Using smaller, more targeted amounts of fertiliser throughout the growing season can help moderate vegetative growth and reduce aphid infestation. Good weed management can reduce potential harbours and reduce migrating aphid populations.

Biological: fortunately good aphid control can be achieved using naturally occurring biological agents. Lacewings are aggressive general predators that will feed on aphids and can provide useful control. Lady beetles can be important aphid predators as both the adults and larvae feed on aphids (Figure 62).

Chemical: the chemical options for controlling cherry aphid are listed in Table 24.



Figure 62. Lady beetle adult, eggs and larvae.

Table 24. Registered or permitted products for cherry aphid in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Malathion ³ (Fyfanon® 1000 EC)	1B	3	High	Stone fruit
Paraffinic Oil (CropCover®)	Paraffinic oil and petroleum oil	0	Low	Peaches, nectarines
Pirimicarb (Pirimor®)	1A	2	Medium	Stone fruit
Spirotetramat (Movento®)	23	21	Medium	Stone fruit
Sulfoxaflor (Transform® Isoclast™)	4C	7	Medium	Stone fruit

¹ WHP = withholding period. ² Always refer to the label. ³ Use pattern might be affected by APVMA review outcomes, refer to the [2025 update on Australian Pesticides and Veterinary Medicines Authority chemical reviews on page 13](#).

Clearwing borer

Ichneumenoptera chrysophanes



The predominant species of clearwing borer found in NSW and Qld persimmon orchards is *Ichneumenoptera chrysophanes* (formerly *Carmenta chrysophanes*). Early spring is a critical time for monitoring and applying controls, although clearwing borers can be present all season, particularly in warmer regions of Northern NSW.

Risk period

Table 25. The peak risk period for clearwing borer in persimmon orchards.

Bud swell/ green tip	Shoot extension	Flowering and fruit development	Harvest	Postharvest	Dormancy

Pest identification

The adult borers look similar to wasps, with clear wings and narrow bodies. Males are usually black with bands of yellow hair (Figure 63), while the females are black with bands of orange (Figure 63). The forewings are usually 7–10 mm long. The larval stage is a borer 10–15 mm long, creamy-white caterpillar with a brown head capsule (Figure 64).

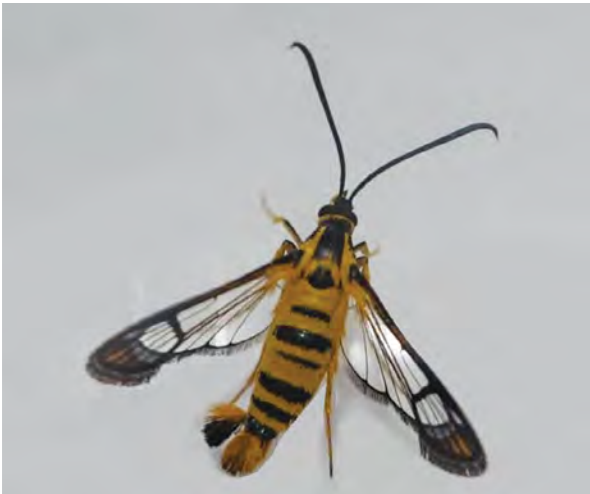


Figure 63. Male (left) and female (right) clearwing borers. Photo: George et al. (2017).

Damage

The larval stage of the clearwing borer damages persimmon trees by tunnelling under the bark, but unlike other fruit tree borers, they do not bore into the heartwood. Their feeding sites (usually covered in sawdust-like frass) can cause significant damage to the tree's conductive tissues (Figure 65). In severe cases, branches will be girdled, become weakened and break off. Sustained feeding over several borer generations can result in tree death.

Monitoring

Adult borer populations and flights can be monitored using pheromone traps. Usually, these traps will detect significant activity in early spring, indicating the need for control measures to be implemented early.



Figure 64. Clearwing borer larvae. Photo: George et al. (2017).

Warm coastal districts can have up to 4 peaks of adult borer activity in the growing season. If using pheromone dispensers to control this pest, it is important to note that traps can also be disrupted and borer catch suppressed, making it difficult to interpret the numbers.

Management

Cultural and physical: cultural methods for managing clearwing borer are limited. Some growers have reported success using a high-pressure handheld spray directed at the feeding sites during crop dormancy. This approach is usually employed to reduce overwintering pest numbers and to complement pheromone mating disruption.

Biological: Braconid wasps can be an effective biological control, parasitising a high percentage of clearwing borer larvae in south-east Qld. The wasps are active in late spring but might not be present in sufficient numbers to prevent some damage from occurring.

Trials using the parasitic nematode *Steinernema feltiae* sprayed onto persimmon trees in August achieved up to 20–30% clearwing larvae mortality.

Chemical: pheromone mating disruption of clearwing borer involves applying dispensers (Figure 66) throughout the orchard just before the first-generation emerges. These dispensers flood the orchard with female pheromones, confusing the male borers, preventing mating and subsequent egg-lay. Grower experience suggests that 2 applications per season might be necessary to achieve satisfactory control. Mating disruption for borer pests is usually most effective in large contiguous areas of the orchard, where the edge-to-area ratio of the block is low. For orchards smaller than 3 ha, consider placing pheromone dispensers in the adjacent bush to extend the coverage area.

The pheromone mating disruption product currently permitted for managing clearwing borer in NSW persimmon orchards is listed in Table 26. There are currently no registrations or permits for chemical sprays for this pest in persimmons.

Table 26. Registered or permitted product for managing clearwing borer in persimmons in NSW.

Active constituent (example trade name)	Insecticide group	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
inSense mating disruption agent (PER88722 , expires 31.5.28)	Pheromone	0	Nil	Persimmons

¹ WHP = withholding period. ² Always refer to the label.



Figure 65. Clearwing borer feeding damage and associated frass covering. Photo: George et al. (2017).



Figure 66. Clearwing borer pheromone mating disruption dispenser.

Codling moth

Cydia pomonella



Codling moth is one of the most damaging pests of apple and pears in Australia. Other hosts susceptible to codling moth include crab apple, some stone fruit, walnut and quince.

Risk period

Table 27. The peak risk period for codling moth.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult codling moths are approximately 9 mm long with a wingspan of 12–19 mm. Wings are mottled grey, with a brown and gold band at the tip. When the moth is at rest, its wings are held in a tent-like structure over its body (Figure 67). Larvae are white to light pink with a dark brown head. They appear worm-like and are 15–19 mm long. Larvae are most commonly seen when damaged fruit is cut open for inspection (Figure 68).



Figure 67. Codling moth larvae (left) and adult (right).



Figure 68. Codling moth larvae inside an apple.

Damage

A tell-tale sign of codling moth presence is frass (sawdust-like material) at the point where the larvae have entered the fruit (Figure 69). Young codling moth larvae will initially feed just below the skin of the fruit, creating what looks like a small sting on the surface (Figure 70). Most of the damage occurs as the moth tunnels into the fruit and feeds on the flesh and seeds. Bacteria often break down the flesh around the tunnels, causing more internal damage, which can lead to premature ripening and fruit drop. Codling moth larvae feed on the internal parts of the fruit and can damage almost an entire crop if not discovered and controlled.



Figure 69. Sawdust-like frass covering the area where codling moth larvae entered an apple.



Figure 70. Sting marks on the apple surface. Photo: Eugene E Nelson, Bugwood.org.

Management

Cultural and physical: where possible, infested fruit (either in the tree or fallen) should be removed from the orchard and destroyed. It can also be moved to the inter-row and mulched.

Scraping loose bark from trees removes overwintering sites. Take preventative action by burning old tree stacks during re-establishment and before moths emerge in spring. Timber fruit bins can also harbour overwintering codling moth pupae and are a source of infestation and transfer between orchards. Store bins away from orchard blocks if possible.

Biological: various biological measures help with managing codling moth and the effectiveness of these depends on the size of the orchard block. For larger blocks or where area-wide management is being practised, mating disruption can be a good alternative to spraying. This technique uses commercial dispensers to emit massive amounts of female moth pheromones into the orchard. This confuses male moths, which are then unable to find female moths to mate with. For smaller blocks (or to supplement mating disruption), other management strategies might be effective. Pheromone traps (Figure 71) and mating disruption dispensers must be deployed before full bloom.

Although natural codling moth predators are not totally effective in controlling populations, they should be encouraged by using softer chemicals where possible.

The parasitic wasp *Mastrus ridens* (Figure 72) was recently released in limited locations in the key apple-growing regions of Australia. The performance of this new biological control agent for codling moth will be assessed over the coming seasons and further releases are planned. It is likely that *M. ridens* will work best as part of an integrated control program using mating disruption and avoiding broad-spectrum chemicals.



Figure 71. A delta trap with sticky inserts and a pheromone lure to monitor adult codling moth activity.



Figure 72. An adult parasitic wasp (*Mastrus ridens*). Photo: Plant and Food Research, New Zealand.

Chemical: codling moth control is achieved by using pheromone mating disruption (PMD) or a chemical spray program. In very high pressure situations, a combination of PMD and insecticide (Table 28) might be necessary to reduce a large resident population.

Table 28. Registered or permitted products for codling moth in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Abamectin + chlorantraniliprole (Voliam Targo®)	6 + 28	7	High	Pome fruit
Acetamiprid + novaluron (Cormoran®)	4A + 15	Apples 70; pears 35	Medium	Apples, pears
Carbaryl (Bugmaster®)	1A	77	High	Pome fruit

Table 28. Registered or permitted products for codling moth in NSW, page 2 of 2.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Chlorantraniliprole (Altacor® Hort)	28	14	Low	Pome fruit
Clothianidin (Samurai®)	4A	7	High	Apples, pears
Cyclaniliprole (Teppan®)	28	28	Medium	Apples
Cydia pomonella granulosis virus (CYD-X®)	Biological insecticide	Not required when used as directed	Low	Apples, pears
Fenoxycarb (Insegar®)	7B	14	Low	Apples, pears
Indoxacarb (Avatar® eVo)	22A	14	Low	Apples, pears
Malathion (Fyfanon® 440 EW)	1B	3	High	Apples, pears
Mating disruption agent (Isomate®)	Pheromone	Not required when used as directed	Low	Apples, pears
Methomyl (Methomyl 225)	1A	1	High	Apples
Spinetoram (Delegate®)	5	7	Medium	Pome fruit
Tebufenozide (Ecdypro 700 WP)	18	21	Low	Apples, pears
Tetraniliprole (Vayego® 200 SC)	28	7	Low	Pome fruit
Thiacloprid (Calypso®)	4A	21	Medium	Pome fruit

¹ WHP = withholding period. ² Always refer to the label.

European earwig



Forficula auricularia

European earwig has a very broad host range, feeding on a variety of horticultural and broadacre crops. Earwigs can be particularly damaging in stone fruit crops, including cherries, where they feed on stems and fruit. In apples, earwigs do not generally attack the crop and are considered an important beneficial insect.

Risk period

Table 29. The peak risk period for European earwigs.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

European earwig adults are dark brown with yellow-brown legs and shoulders. They are 12–24 mm long and have thin, segmented antennae with a pair of pincers at the rear of the body. European earwig males have longer curved pincers and females have straight pincers (Figure 73).

Damage

European earwigs will feed on foliage, leaving irregularly shaped holes. In fruit trees, most economic loss occurs from the earwigs feeding on the fruit, causing shallow depressions (Figure 74) that can be the perfect host for brown rot (page 106). In cherries, significant damage can occur when earwigs feed on the stems of developing fruitlets (Figure 75).



Figure 73. Adult European earwigs, male (left) and female (right).



Figure 74. European earwig feeding damage on ripening cherries.



Figure 75. European earwig feeding damage on young cherry stems.

Monitoring

Monitoring for European earwigs can include physically inspecting the fruit and leaves as well as trapping. When inspecting fruit, look closely among fruit clusters as the adult earwigs will use these areas as shelter, particularly during daylight.

Earwig activity can also be monitored by placing sections of rolled corrugated cardboard in the tree canopy and checking once or twice a week for the pest. Adult earwigs will use the cardboard rolls as shelter, making them easy to find. Monitoring pest activity can help with the timing of spraying and/or baiting programs.

Management

Cultural and physical: practising good farm hygiene will prevent the introduction and spread of European earwig. Generally, European earwig will seek shelter during the day within the tree canopy and among fruit clusters, so keeping canopies open and thinning fruit to singles (where appropriate) will help reduce the potential for fruit damage. Removing pruned branches from around the base of trees will remove alternative nesting sites. Removing drooping branches that

are touching the ground will prevent earwigs from accessing the trees. Reducing the height of weeds in the inter-row will reduce shelter options for the earwigs.

Biological: currently there are no known natural predators of the European earwig. Some birds and lizards will feed on earwigs, but this is unlikely to significantly reduce populations. In apple and pear orchards, European earwig is considered a beneficial insect because it preys on woolly apple aphids.

Chemical: the chemical options for controlling European earwig are listed in [Table 30](#).

Table 30. Registered or permitted products for European earwig in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Carbaryl (Bugmaster®)	1A	35	High	Stone fruit except cherries
Fipronil ³ (Albatross® 200SC)	2B	Do not graze treated area	High	Cherries; single ground spray only
Indoxacarb (Avatar® eVo)	22A	Stone fruit 7; cherries 14	Low	Stone fruit
Pyrethrins + piperonyl butoxide (Py-Bo)	3A	1	High	Fruit crops

¹ WHP = withholding period. ² Always refer to the label. ³ Use pattern might be affected by APVMA review outcomes, refer to the [2025 update on Australian Pesticides and Veterinary Medicines Authority chemical reviews on page 13](#).

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European red mite

Panonychus ulmi



European red mite (ERM) is a serious pest of apple and pear foliage. Severe infestations can result in defoliation, particularly in pears. The pest is also found in stone fruit trees, but this is less common.

Risk period

Table 31. The peak risk period for European red mite.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult ERM females are about 0.4 mm long and rounded. They are dark maroon with prominent white spines on their body ([Figure 76](#)). In contrast, adult males are smaller than females and lighter coloured. They have a less rounded body and a pointed, angular abdomen. ERM eggs are light red, round and have a slight depression on the top. When infestations are heavy, eggs will be found clustered in hundreds around branch angles and buds ([Figure 77](#)).

Damage

ERM feeding will cause mottling on the upper leaf surface. Heavy infestations result in leaf bronzing and premature leaf fall, leading to reduced photosynthesis. Prolonged feeding can affect fruit size and colour and might affect bud development for the following season.

There are several ways to quantify the risk posed by mite populations including counts, presence or absence, percentage of leaves infested and cumulative leaf-infested days (CLIDs). Your local IPM consultant should be able to assist with more advice on applying these methods in your orchard.

Monitoring

During the growing season, and particularly as spring and summer temperatures increase, monitor the undersides of leaves for ERM and their eggs. The presence of webbing can also indicate that mite populations are in the canopy, although this is more common with two-spotted mite ([page 81](#)). Scouting the orchard for plant damage, such as bronzed or yellowed leaves, can be a quick way to identify pest mite hotspots.

Monitor for ERM fortnightly using a hand lens or by taking a random sample to the office or laboratory for closer inspection under a light microscope. Commercial mite monitoring services might be available in some districts.



Figure 76. A female European red mite.

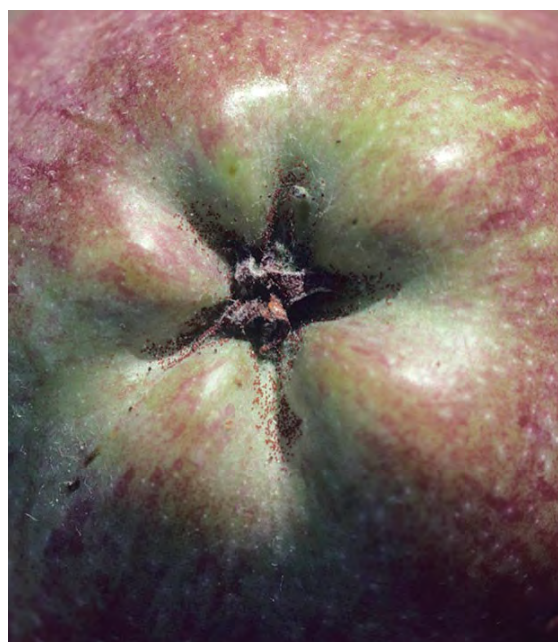


Figure 77. European red mite eggs on an apple.

When monitoring, record both pest and beneficial insect activity found on the leaves. It is a good idea to record both mites and predators as a percentage of leaves infested. This way, from sample to sample, you will know if the infestation is getting worse or if the beneficials, such as predatory mites, are maintaining control. For more information, refer to the article titled [Protecting beneficial insects on page 94](#).

Look for ERM eggs among the branches while pruning, especially in winter. This can help identify potential pest pressure and hotspots for the next season.

Management

Cultural and physical: physical management of ERM can include measures to reduce heat and dust in the orchard and ensure adequate soil moisture, thereby minimising any tree stress.

Biological: the predatory mite *Galendromus pyri* (formerly *Thyphlodromus pyri*) can be a very effective biological control agent for ERM. *G. pyri* adults are about the same size as adult ERM but have a pear-shaped body. When combined with the effects of other beneficial insects, including lacewings and *Stethorus* beetles, and with a soft (selective) insecticide program, full biological control of ERM is possible.

Predatory mites ([Figure 78](#)) are often found on the underside of leaves close to the mid-vein. Before feeding on pest mites, the adults are an opaque white or cream, similar to their oval-shaped eggs. After feeding, the gut of the predatory mites takes on the colour of their prey and they become more visible.

If predatory mite numbers are low or absent from an orchard, they can be seeded by transferring leaves and shoots from a block known to have a good population.

Chemical: European red mite is a high-profile pest, and there are resistant populations to several key insecticidal groups. CropLife Australia maintains an insecticide resistance management (IRM) plan for European red mite, two-spotted mite and green peach aphid, [available online](#). IRM is essential to maintain the efficacy of valuable insecticides. Preventing resistance from occurring is easier than trying to regain susceptibility.

Early season sprays should use chemistry with a low effect on beneficial insects to conserve predatory mite populations. In contrast, broad-spectrum insecticides or those with a high impact on beneficial insect populations have the potential to flare up mite populations.

Regular monitoring for both predatory insects and pest mite populations to inform spray decisions is critical. Wherever possible, make no more than one application from each registered miticide group per season. Effective mite control spray programs usually incorporate a single horticultural mineral oil during winter or just before bud burst. Consider also chemical rotation and insecticide mode of action to control other pests of pome fruit, such as codling moth, light brown apple moth and woolly aphid. These sprays can promote chemical resistance in mite pests.

The chemical options for controlling European red mite are listed in [Table 32](#).

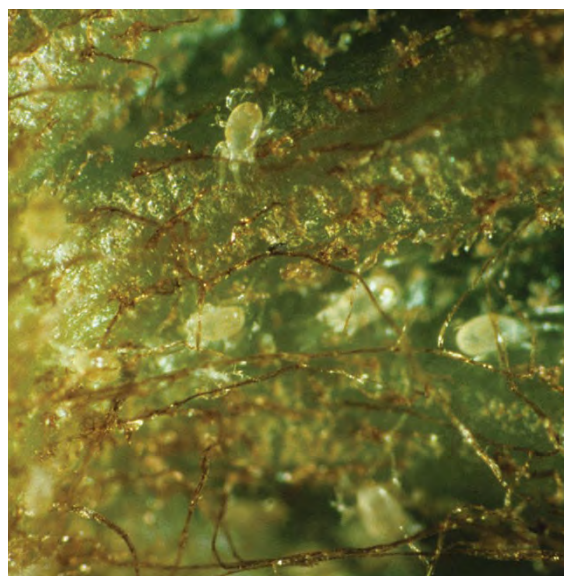


Figure 78. Adult predatory mites on an apple leaf.

Table 32. Registered or permitted products for European red mite in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Abamectin (Vertimec®)	6A	14	High	Apples, pears
Abamectin + chlorantraniliprole (Voliam Targo®)	6 + 28	7	High	Pome fruit

Table 32. Registered or permitted products for European red mite in NSW, page 2 of 2.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Bifenazate (Acramite®)	20D	Apricots, nectarines, peaches, plums 3; pome fruit 7	Low	Apples, pears, apricots, nectarines, peaches, plums
Cyflumetofen (Danisaraba®)	25A	7	Low	Pome fruit
Etoxazole (Paramite®)	10B	7	High	Pome fruit, stone fruit except cherries
Fenbutatin oxide (Talk Miticide)	12B	Apples, pears 2; peaches, nectarines 14	Low	Apples, pears, peaches, nectarines
Hexythiazox (Calibre®)	10A	3	Low	Apples, pears, stone fruit
Horticultural mineral oil (various)	Paraffinic oil and petroleum oil	1	Low	Pome fruit, stone fruit
Malathion (Fyfanon® 440 EW)	1B	3	High	Stone fruit
Milbemectin (Milbeknock®)	6	14	High	Pome fruit
Propargite (Omite®)	12C	7	Medium	Apples, stone fruit
Tebufenpyrad (Pyranica®)	21A	14	Medium	Apples, pears, peaches

¹ WHP = withholding period. ² Always refer to the label.

Fruit tree borer



Maroga melanostigma

The fruit tree borer is the larval stage of *Maroga melanostigma*, an Australian native moth that will affect a wide range of tree species, however, stone fruit (*Prunus*) are more susceptible.

Risk period

Table 33. The peak risk period for fruit tree borer.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Usually the first sign of fruit tree borers will be webbed sawdust material on scaffold branches or on the trunk where major branches intersect. Adult moths are cream-white with a black and orange abdomen, about 20 to 25 mm long, with a wingspan of about 40 mm. The forewings each have one small black dot on their surface. The larvae are cream with a dark head (Figure 79).

Damage

Fruit tree borers damage stone fruit trees when the larvae (caterpillars) chew the bark and tunnel into the stem or trunk. This damage often results in a complete ring-barking of the branch or trunk. When severe, it can lead to tree decline and eventual death. In young trees, the damage can cause the loss of a leader branch, affecting tree training and shape.

Monitoring

Inspect structural limbs and tree trunks for tell-tale sawdust patches (Figure 80).

Management

Cultural and physical: physical management is labour-intensive as it involves scraping away the sawdust and destroying the larvae found under the bark or in its tunnel. A fine wire can be used to penetrate the feeding tunnel and kill the larvae.

Biological: *Trichogramma* species wasps will parasitise fruit tree borer eggs, but it is unknown if this will provide commercial level control.

Chemical: for effective larvae control, use the registered chemical carbaryl (Table 34), expose and saturate feeding sites with the spray, ensuring that some insecticide penetrates the borer tunnels.



Figure 79. Fruit tree borer larva.



Figure 80. Sawdust patch on a borer-infested tree.

Table 34. Registered or permitted product for fruit tree borer in NSW.

Active constituent (example trade name)	Insecticide group	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Carbaryl (Bugmaster®)	1A	35	High	Stone fruit except cherries

¹ WHP = withholding period. ² Always refer to the label.

Harlequin bug



Dindymus versicolor

The harlequin bug, *Dindymus versicolor*, is a native Australian plant bug. It was documented as a pest of pome and stone fruit in the 1950s. However, between then and the 1990s, the use of synthetic insecticides might have suppressed harlequin bug numbers to the point where it was no longer considered a significant pest. Since the mid-1990s, orchardists have reported increasing harlequin bug activity. This is likely due to changes in crop protection chemistry and pest management strategies.

Risk period

Table 35. The peak risk period for the harlequin bug.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

The adult harlequin bug is about 12 mm long and is very conspicuous ([Figure 81](#)). The head, and inner margins and tips of the forewings are black, the thorax and base of the forewings are reddish-orange. The underside of the body is tinged with yellow or green and has some red and black markings.

The harlequin bug develops through 5 immature stages (instars) and is often found swarming in large numbers on native tree trunks, trellises, hail netting posts and in sheds. Mating adults can be seen moving in pairs, joined at the abdomen and facing in opposite directions.

Damage

The harlequin bug is a sap-sucker that uses a proboscis (needle-like mouthpart) to pierce the skin of the host plant tissue. On fruit, this feeding results in slight depressions on the skin of the apple and is associated with the browning of the underlying flesh ([Figure 82](#)). The damage could be easily confused with that of boron deficiency (cork disorder).

Monitoring

Common orchard weeds such as *Malva* spp. (marshmallow), *Rumex* spp. (dock) and *Polygonum aviculare* (wire weed) are known hosts and should be the focus of monitoring and weed control programs. Inspect weeds, timber stacks, trellises, netting structures and nearby native bush for harlequin bug colonies ([Figure 83](#)).

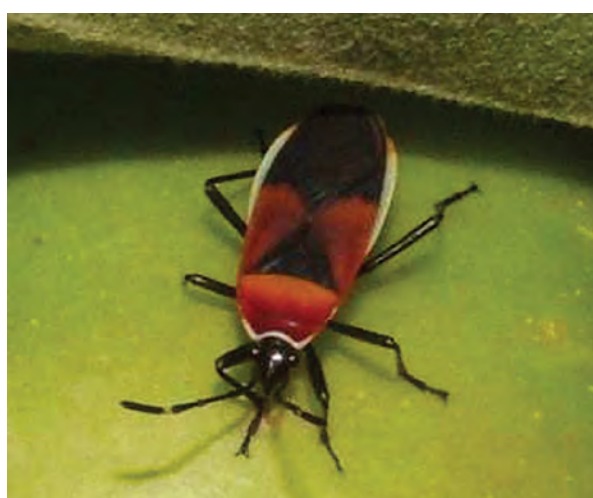


Figure 81. Adult harlequin bug.



Figure 82. Mid-season harlequin bug feeding damage to Cripps Pink apples.



Figure 83. Harlequin bug juveniles are often found swarming on tree trunks and timber posts in or near the orchard.

Management

Cultural and physical: the severity of damage in some orchards seems to be associated with the bugs having easy access to the trees via weed growth within the tree row and/or canopy, low-growing branches, nearby trellis posts or wires and irrigation tubes.

Due to the harlequin bug's association with certain weed species, controlling weeds in the orchard will help reduce the likelihood and intensity of infestations. Particular attention should be given to removing and controlling common orchard weeds in the *Malva* (marshmallow; [Figure 84](#)), *Rumex* (dock; [Figure 85](#)) and *Polygonum* (wireweed; [Figure 86](#)) genera.

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

Biological: there are no known biological control agents for the harlequin bug.

Chemical: as there are no chemicals registered for controlling harlequin bug in orchards in Australia, managing this pest is dependent on using cultural practices.



Figure 84. Marshmallow (*Malva parviflora*).



Figure 85. Dock (*Rumex crispus*).



Figure 86. Wireweed (*Polygonum erectum*).

Light brown apple moth



Epiphyas postvittana

The light brown apple moth (LBAM) is a native Australian leaf roller with a wide host range including fruit crops, broadleaf pastures and weed species. It can cause significant damage to temperate fruit crops, particularly in cool climate growing regions.

Risk period

Table 36. The peak risk period for light brown apple moth.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult moths are pale brown (Figure 87) and about 10 mm long. Caterpillars start yellow and become green with a brown head. Pupae are 10–12 mm long and turn from green to brown. Egg masses can be green to yellow–brown. LBAM do not survive well at high temperatures and are more likely in cooler areas with mild summers. Feeding and pupating sites in fruit are usually accompanied by webbing.



Figure 87. Light brown apple moth adult.

Damage

Larvae (or caterpillars) feed between fruit or under leaves webbed to the fruit, chewing the fruit surface (Figure 88). This damage results in fruit being downgraded during sorting and packing.

Monitoring

Monitor for LBAM using pheromone traps (Figure 89), starting before flowering. Use trap catches to determine a biofix date (first sustained flight; refer to [Calculating degree days for temperate fruit moth pests on page 92](#)).

Start fruit inspections in mid to late spring, especially among fruit clusters and under leaves as LBAM usually feeds in sheltered sites. To identify the timing of LBAM egg lay, inspect foliage, bearing in mind that egg masses can be hard to spot.

Management

Cultural and physical: reduce broadleaf weeds such as capeweed (*Arctotheca calendula*) and dock (*Rumex* spp.) as LBAM can overwinter in these. Thinning fruit to singles where practical (while maintaining an appropriate crop load) will reduce the number of suitable feeding sites for LBAM.



Figure 88. Light brown apple moth caterpillar with typical surface feeding damage on apple.

Biological: *Trichogramma carverae* is a commercially available parasitic wasp for LBAM control. Other biological controls include other parasitic wasps, lacewings, spiders and predatory shield bugs.

Bacillus thuringiensis (Bt) is a naturally occurring bacterium that is toxic to LBAM larvae when consumed, making it an effective biological control method.

Pheromone ties (Figure 90) placed in the orchard at a rate of 500–600/ha can be an effective non-chemical management tool. They flood the orchard with pheromones to confuse the male moths, disrupting mating and subsequent egg laying.

Chemical: the chemical options for controlling light brown apple moth are listed in Table 37.



Figure 89. Monitor pheromone traps weekly from early bud burst. Photo: Evergreen Growers Supply.



Figure 90. Pheromone mating disruption is a non-chemical management option. Photo: Peaceful Valley Farm Supply.

Table 37. Registered or permitted products for light brown apple moth in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Abamectin + chlorantraniliprole (Voliam Targo®)	6 + 28	7	High	Pome fruit; do not apply more than 1 spray per season
Acetamiprid + novaluron (Cormoran®)	4A + 15	Apples 70; pears 35; stone fruit 7	Medium	Apples, pears, stone fruit; do not apply during flowering
Acetamiprid + pyriproxyfen (Trivor®, PER89943, expires 30.11.25)	4A + 7C	28	Unknown	Persimmons
<i>Bacillus thuringiensis</i> (various)	11 and 11C	0	Low	All crops ³
Carbaryl (Bugmaster®)	1A	Pome fruit 77; stone fruit 35	High	Pome fruit, stone fruit; do not use on cherries
Chlorantraniliprole (Altacor® Hort)	28	14	Low	Pome fruit, stone fruit
Fenoxycarb (Insegar®)	7B	14	Low	Apples, pears
Indoxacarb (Avatar® eVo)	22A	Pome fruit, cherries 14; stone fruit 7	Low	Pome fruit, stone fruit
Mating disruption agent (various)	Pheromone	Not required when used as directed	Low	Apples

Table 37. Registered or permitted products for light brown apple moth in NSW, page 2 of 2.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Methomyl (Methomyl 225)	1A	1	High	Apples
Methoxyfenozide (Prodigy®)	18	14	Low	Pome fruit
Methoxyfenozide (Venturi® Max)	18	7	Low	Persimmons
Spinetoram (Delegate®)	5	Pome fruit 7; stone fruit 3	Medium	Apples, pears, apricots, cherries, nectarines, peaches, plums. Target mature eggs and newly hatched larvae
Spinosad (Entrust® Organic)	5	Apples, pears and stone fruit (except peaches) 3; peaches 7	Low	Pome fruit, stone fruit
Tebufenozide (Ecdypro 700 WP)	18	21	Low	Apples, pears
Tetraniliprole (Vayego® 200 SC)	28	7	Low	Pome fruit

¹ WHP = withholding period. ² Always refer to the label. ³ All crops = apples, pears, apricots, cherries, nectarines, peaches, plums and persimmons.

Loopers



Various species

Several different looper species can damage apples and pears, including apple looper (*Phrissogonus laticostata*); pome loopers (*Chloroclystis testulata* and *C. approximata*) and green looper (*Chrysodeixis eriosoma*). They are in all growing regions in NSW.

Risk period

Table 38. The peak risk period for loopers.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Looper larvae are greyish-white, green or pale brown and can be mottled or striped. Some loopers will have green larvae with faint white lines running along their body (Figure 91). Most looper larvae will grow to about 40 mm long and move with the characteristic looping of the body.



Figure 91. A green looper caterpillar.

Damage

Loopers feed on the fruit surface, causing superficial damage that usually develops into a russet scab or lump, which is similar to, but smaller than, the damage caused by budworms (*Helicoverpa* spp., page 37).

Monitoring

Adult looper moths begin to emerge from late September to October. Monitoring should occur then, paying particular attention to the foliage and young fruitlets. Feeding will usually occur early morning and late afternoon. This time is ideal for monitoring loopers.

Management

Cultural and physical: controlling broadleaf weeds in the orchard might help reduce the potential for looper infestation.

Biological: *Bacillus thuringiensis* (Bt) is a bacterium for effective biological control of loopers, affecting the caterpillar stage.

Chemical: the chemical options for controlling loopers are listed in Table 39.

Table 39. Registered or permitted products for loopers in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
<i>Bacillus thuringiensis</i> subsp. <i>Aizawai</i> (Bacchus® WG)	11C	Not required when used as directed	Low	All crops ³
<i>Bacillus thuringiensis</i> subsp. <i>Kurstaki</i> (DiPel®)	11	Not required when used as directed	Low	All crops
Methoxyfenozide (Prodigy®)	18	14	Low	Pome fruit
Spinetoram (Delegate®)	5	7	Medium	Pome fruit

Table 39. Registered or permitted products for loopers in NSW, page 2 of 2.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Spinetoram (Success® Neo)	5	7	Medium	Persimmons
Spinosad (Entrust® Organic)	5	Pome fruit 3; persimmon, not required when used as directed	Medium	Pome fruit, persimmons
Tebufenozide (Ecdypro 700 WP)	18	21	Low	Pears
Trichlorfon (PER14743 , expires 28.2.30)	1B	7	High	Persimmons

¹ WHP = withholding period. ² Always refer to the label. ³ All crops = apples, pears, apricots, cherries, nectarines, peaches, plums and persimmons.

Mealybugs



Various species

Mealybugs are sap-sucking insects that feed on a wide range of tree crops. They can shelter in the calyx of pome fruit and persimmons and are a pest of concern for export markets.

Risk period

Table 40. The peak risk period for mealybugs.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Female adult mealybugs are about 3 mm long, oval and usually covered in a white waxy coating (Figure 92). Males are usually small aphid-like winged insects. When squashed, mealybugs secrete a pale yellow liquid. Nymphs hatch from eggs within the female and are born live. They are small and orange-brown. Long-tailed mealybugs can be distinguished by their long tail filaments that can be as long as, or longer than, their body (Figure 93).



Figure 92. Adult female and juvenile mealybugs. Photo: Peggy Greb, USDA Agricultural Research Service, Bugwood.org.



Figure 93. Adult long-tailed mealybug. Photo: David Cappaert, Bugwood.org.

Damage

Mealybugs cause damage by inserting their mouthparts directly into the plants. Infested plant parts might be spotted, curled or wilted. Mealybugs also secrete a honeydew sap that encourages sooty mould growth, downgrading fruit quality. In severe infestations, tree health can be greatly reduced. Mealybugs can act as virus vectors and should be removed.

Monitoring

Monitor at least fortnightly during the growing season. Look in the calyx of the developing fruit weekly during harvest and record any mealybug presence. During dormancy, check under bark or other sheltered places for overwintering larvae or adults.

While monitoring for mealybugs, look for ant activity to determine if additional management measures are required. If ants are present, try to identify the location of their nests. Physically destroying ant nests in the orchard will reduce the number of ants that are protecting and spreading the mealybugs, rendering them more vulnerable to predation by beneficial insects. For more information on the role of ants in orchards and their association with temperate fruit pests, refer to [page 26](#).

Management

Cultural and physical: good orchard hygiene is critical for mealybug control. Infested material should be removed from the orchard and destroyed; do not use it as mulch. Mealybug infestations are worse on dusty trees, so avoid vehicle movement near trees on the windward side of infested blocks, and where possible, wet tracks down regularly.

Biological: a range of biological controls is available for mealybugs including various lady beetles, lacewings (Figure 94 and Figure 95) and specific parasitic wasps (Figure 96). Wasps can be extremely effective as they are highly mobile and efficient at seeking out their prey.

Chemical: the chemical options for controlling mealybugs are listed in Table 41.



Figure 94. Brown lacewing.



Figure 95. Green lacewing.



Figure 96. Parasitic wasp.

Table 41. Registered or permitted products for mealybugs in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Acetamiprid + pyriproxyfen (Trivor®, PER89943 , expires 30.11.25)	4A + 7C	28	Unknown	Persimmons
Acetamiprid + novaluron (Cormoran®)	4A + 15	Apples 70; pears 35	Medium	Apples, pears
Buprofezin (Strident®)	16	Pears 56; persimmons 28	High	Pears (long-tailed mealybug only), persimmon
Clothianidin (Samurai®)	4A	7	High	Apples, pears
Clothianidin (Samurai®, PER14779 , expires 31.1.26)	4A	Not required when used as directed	High	Persimmons
Flonicamid (Mainman®)	29	21	Low	Apples (tuber mealybug), pears (long-tailed mealybug)
Flonicamid (Mainman®, PER89215 , expires 31.5.28)	29	21	Low	Persimmons
Potassium salts of fatty acids (Hitman®)	Bio-pesticide	Not required when used as directed	Unknown	Fruit trees
Prothiofos (Tokuthion®)	1B	56	Medium	Pears
Spirotetramat (Movento®)	23	21	Medium	Pome fruit, stone fruit
Sulfoxaflor (Transform® Isoclast™)	4C	7	Medium	Pome fruit

¹ WHP = withholding period. ² Always refer to the label.

Oriental fruit moth

Grapholita molesta

Introduced to Australia at the beginning of the 20th century, the oriental fruit moth (OFM) is primarily a pest of stone fruit but can occasionally infest apples and pears.



Risk period

Table 42. The peak risk period for oriental fruit moth.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Oriental fruit moths are small, grey-brown and approximately 5–7 mm long (Figure 97). Although rarely seen in the orchard during the day, they might be seen near the tree tops in the late afternoon when temperatures are above 18 °C. OFM eggs are cream, small, round and approximately 0.7 mm in diameter. Larvae are creamy white and overwinter as pupae under bark or in tree wounds, particularly around the lower tree trunk.



Figure 97. Adult oriental fruit moth. Photo: Eric LaGasa, Washington State Department of Agriculture, Bugwood.org.

Damage

Warm, moist conditions favourable for tree growth and brown rot also favour the OFM. Hot, dry, windy conditions can reduce heavy infestations in spring. Cold winters with multiple frosts can reduce the carry-over population.

During spring, the newly hatched larvae will burrow into the young shoot tips to feed for up to 4 weeks. This causes the young shoots to wilt and collapse (Figure 98). The second generation can attack shoots and green or ripening fruit. Peaches and nectarines can be damaged early in the season by larvae after they leave the shoots. Fruit damage is first noticeable as a gummy exudate that might include some sawdust-like frass (Figure 99).

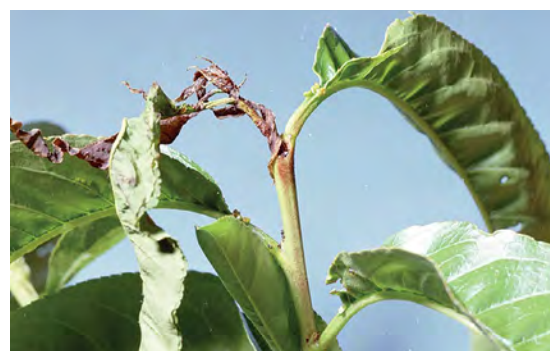


Figure 98. Wilted stone fruit shoot caused by burrowing oriental fruit moth larvae. Photo: Clemson University, USDA Cooperative Extension Slide Series, Bugwood.org.

Monitoring

Pheromone traps can indicate when moths are active and provide an estimation of population levels, but are not an effective monitoring tool where mating disruption is used, as the pheromone cloud will interfere with the traps. In sprayed orchards, pheromone traps deployed early in the season (around bloom) will help determine a biofix date as the basis for calculating degree days and predicting first-generation egg hatch. For more information, refer to [Calculating degree days for temperate fruit moth pests on page 92](#).

Regularly inspecting shoots and fruit will help identify early stages of OFM infestations. Look for dying shoot tips and/or gummy exudate on fruit.



Figure 99. Oriental fruit moth larvae damage on young peach showing typical gummosis and frass. Photo: Jonas Janner Hamann, Universidade Federal de Santa Maria (UFSM), Bugwood.org.

Management

Cultural and physical: good orchard management will help with OFM control. Smooth-barked, calm, well-managed trees will generally only support lower populations of OFM, so reduce tree vigour where practical. Disinfect wooden storage bins before moths emerge in spring. Destroy large prunings and remove all fruit remaining after harvest from the tree. Any trees that have been bulldozed should be destroyed by chipping or burning so they are not a source of infestation in the following season.

Biological: mating disruption might replace the need for pesticide application for OFM and 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.



Figure 100. *Trichogramma* spp. wasps can parasitise oriental fruit moth eggs.

The native parasitic wasp *Glabridorsum stokesii* is a natural OFM predator. Avoiding insecticides should help encourage beneficial insects. Introducing the commercially available parasitic wasp *Trichogramma carverae* is another biological control option (Figure 100).

Chemical: the chemical options for controlling oriental fruit moth are listed in Table 43.

Table 43. Registered or permitted products for oriental fruit moth in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Abamectin + chlorantraniliprole (Voliam Targo®)	6 + 28	7	High	Pome fruit
Acetamiprid + novaluron (Cormoran®)	4A + 15	7	Medium	Stone fruit
Carbaryl (Bugmaster®)	1A	35	High	Apricots, nectarines, peaches, plums, prunes; do not use on cherries
Chlorantraniliprole (Altacor® Hort)	28	14	Low	Pome fruit, stone fruit
Clothianidin (Samurai®)	4A	7	High	Nectarines, peaches
Clothianidin (Samurai®, PER13527 , expires 30.6.26)	4A	21	High	Apricots
Cydia pomonella granulosis virus (Grandex®)	Biological insecticide	0	Low	All crops ³
Indoxacarb (Avatar® eVo)	22A	7	Low	Apricots, nectarines, peaches, plums
Malathion ⁴ (Fyfanon® 1000 EC)	1B	3	High	Stone fruit
OFM mating disruptant	Pheromone	Not required when used as directed	Low	Various (check labels)
Spinetoram (Delegate®)	5	Pome fruit 7; stone fruit 3	Medium	Pome fruit, stone fruit
Spinosad (Entrust® Organic)	5	Stone fruit 3; peaches 7	Low	Stone fruit
Tetraniliprole (Vayego® 200 SC)	28	3	Low	Stone fruit
Thiacloprid (Calypso®)	4A	Stone fruit except peaches 14; pome fruit and peaches 21	Medium	Pome fruit, stone fruit

¹ WHP = withholding period. ² Always refer to the label. ³ All crops = apples, pears, apricots, cherries, nectarines, peaches, plums and persimmons. ⁴ Use pattern might be affected by APVMA review outcomes, refer to the [2025 update on Australian Pesticides and Veterinary Medicines Authority chemical reviews on page 13](#).

Oystershell scale

Diaspidiotus ostreaeformis



Oystershell scale is a small insect that attaches itself to bark and causes damage by feeding on the trunk and branches of fruit trees. This is a relatively uncommon pest in NSW temperate fruit orchards.

Risk period

Table 44. The peak risk period for oystershell scale.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

The covering of the female oystershell scale is usually around 4 mm long, elongated and tapers to a point. They are often slightly curved, resembling an oyster shell (Figure 101). They are usually brown with waxy scales that are cream on the underside. They have short antennae but no eyes or legs.

Damage

Oystershell scale feed on the trunks and branches of fruit trees, killing the areas at the feeding site. Heavy infestations will reduce growth, cause foliage yellowing and bark cracking, and can lead to plant death.

Monitoring

Monitor branches for oystershell-shaped bumps and yellowing leaves to determine the correct timing for control, which will reduce oystershell scale populations.

Management

Cultural and physical: strong, healthy plant growth can reduce the likelihood of scale infestations. On young trees, old scale covering and eggs can be destroyed by scrubbing the bark. Heavily infested branches should be pruned.

Biological: oystershell scale has very few natural predators for control. Parasitic wasps and predatory mites have been observed to feed on overwintering eggs, but control levels are minimal.

Chemical: horticultural mineral oils registered for use against oystershell scale (Table 45) vary in their suitability for use as a summer or winter treatment. Discuss product choice and correct time of use with your chemical supplier and always consult the product label.



Figure 101. Oystershell scale infestation. Photo: Rosa Henderson, New Zealand Biosecurity.

Table 45. Registered or permitted product for oystershell scale in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Horticultural mineral oil (various)	Paraffinic oil and petroleum oil	1	Low	Pome fruit, stone fruit

¹ WHP = withholding period. ² Always refer to the label.

Pear and cherry slug

Caliroa cerasi



The pear and cherry slug is the larval stage of the sawfly *Caliroa cerasi*. As its name suggests, it is a pest of pear and cherry trees.

Risk period

Table 46. The peak risk period for pear and cherry slug.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Pear and cherry slugs are easily identified in the field as dark-brown to black slug or leech-like larvae (Figure 102), approximately 5–10 mm long.

Damage

The larvae damage pear and cherry trees by feeding on the upper surfaces of leaves, giving them a skeletonised appearance. Severe infestations will deplete the trees' photosynthetic capacity, affecting shoot and fruit growth.

Pear and cherry slug infestations are common throughout the growing season, but can also accelerate after harvest (particularly in cherry orchards) when the tree canopy can turn brown prematurely.



Figure 102. Pear and cherry slug on a leaf, showing typical feeding damage.

Monitoring

Look for pear and cherry slug activity while working in the orchard throughout the season. Early detection can help prevent serious leaf damage.

Management

Cultural and physical: cultural controls for this pest in the commercial-scale orchard are limited, particularly if slugs are present throughout the orchard. However, if found on only a small number of trees and in low numbers, slugs can be physically removed or washed off with a jet of water.

Biological: pear and cherry slugs are often controlled by naturally occurring predators. Encouraging biological control agents such as hoverflies and lacewings in the orchard will help control.

Chemical: the chemical options for controlling pear and cherry slug are listed in Table 47.

Table 47. Registered or permitted products for pear and cherry slug in NSW.

Active constituent (example trade name)	Insecticide group	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Carbaryl (Bugmaster®)	1A	Pome fruit 77; stone fruit 35	High	Pome fruit, stone fruit except cherries; do not use on cherries
Indoxacarb (Avatar® eVo)	22A	Stone fruit 7; cherries 14	Low	Apricots, cherries, nectarines, peaches, plums
Piperonyl butoxide + chilli + garlic extract + pyrethrins (Richgro Beat-A-Bug®)	3A	1	Low	Fruit trees
Spinetoram (Delegate®)	5	Pome fruit 7; stone fruit 3	Medium	Pome fruit, stone fruit including cherries
Spinosad (Entrust® Organic)	5	Pome fruit, stone fruit 3; peaches 7	Low	Pome fruit, stone fruit

¹ WHP = withholding period. ² Always refer to the label.

Pear leaf blister mite

Eriophyes pyri

The pear leaf blister mite is a problem mostly in pears but can occasionally affect apples.



Risk period

Table 48. The peak risk period for pear leaf blister mite.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Pear leaf blister mites are significantly smaller than most other pest mite species and are difficult to see in the field using a standard hand lens. Pear leaf blister mites can be identified by their white or pinkish appearance. Their abdomen is ringed and elongated and they have 2 pairs of legs next to their head.

Damage

Pear leaf blister mite damage can occur on leaves, fruit and stems. It is most noticeable on the leaves and appears as small, green pimples on the underside, which then develop into blisters. These blisters take on a reddish appearance (Figure 103), eventually becoming brown, dead spots (Figure 104). Infested fruit will have depressed, russeted spots.

Monitoring

Monitoring for pear leaf blister mites fortnightly is recommended, although in hot and dry conditions, more frequent monitoring might be required.

Management

Cultural and physical: when trees are dusty, mite infestations can worsen. If weather conditions are hot and dry, orchard traffic should be limited and operators should drive slowly to limit dust on trees. Maintaining a green ground cover can reduce dust while also providing an attractive alternative habitat for mites.

Biological: predatory mites could be useful for controlling pear leaf blister mites.

Chemical: decisions to spray (Table 49) for pear leaf blister mite should be based on the results of regular mite monitoring.

Table 49. Registered or permitted products for pear leaf blister mite in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Carbaryl (Bugmaster®)	1A	77	High	Pome fruit
Horticultural mineral oil (various)	Paraffinic oil and petroleum oil	1	Low	Pears
Sulfur as polysulfide sulfur (Kendon Lime Sulphur)	M2	Not required when used as directed	Medium	Pome fruit

¹ WHP = withholding period. ² Always refer to the label.



Figure 103. Pear leaf blister mite on a pear tree. Photo: L Giunchedi, Università di Bologna, Bugwood.org.



Figure 104. Pear leaf blister mite on leaves. Photo: Adobe Stock.

Plague thrips



Thrips imaginis

Plague thrips are a native insect that are primarily a concern when present in large numbers from pink bud to early fruit set. They can damage both pome and stone fruit.

Risk period

Table 50. The peak risk period for plague thrips.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult plague thrips are visible to the naked eye and can be seen during flowering, crawling on petals and around the reproductive parts of the flowers (Figure 105). They are usually brown, narrow-bodied and about 1.0–1.3 mm long.

Damage

Plague thrips can damage temperate fruit crops in 2 main ways. Firstly, when they are present in very large numbers, their feeding on flowers results in damage to the stamens and stigmas, thereby affecting pollination and fruit set. Secondly, feeding on the developing fruitlet surface causes a russet to develop that becomes unsightly as the fruit grows, making it unmarketable (Figure 106).

Monitoring

Monitor for plague thrips using yellow sticky traps (Figure 107) placed throughout the orchard from bud burst to shuck fall. The traps can indicate thrips activity levels and can also be used to obtain a formal identification of the pest species.



Figure 105. Plague thrips adult on a flower stamen.

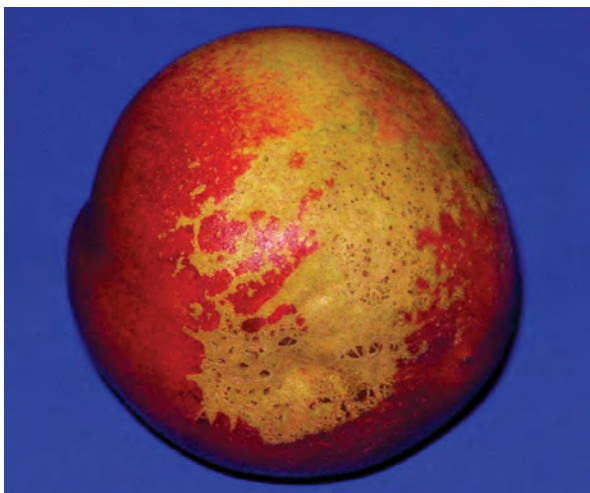


Figure 106. Fruit russet caused by early thrips feeding on the fruitlet.



Figure 107. Sticky traps are a useful monitoring tool.

Monitor plague thrips activity by tapping flower clusters over a white ice cream container (or similar). Inspecting individual flowers can also help determine a measurable population size (i.e. thrips/flower) and damage, which will appear as brown spots on the stamens and stigmas. Plague thrips are known to migrate in large numbers on the wind and can invade an orchard very quickly. Regular monitoring will help to identify any sudden increases in thrips numbers.

Management

Cultural and physical: avoid mowing orchard inter-rows and adjacent pastures at or just before bloom as this might drive thrips into the crop.

Biological: there are several natural plague thrips predators including predatory mites, bugs, lacewings, predatory thrips, lady beetles and parasitic wasps. However, these are unlikely to provide complete control of plague thrips, particularly during periods of rapid pest influx.

Chemical: an effective control program for plague thrips will be based on strategic spraying (Table 51) that is informed by monitoring and observation. When spraying at or around bloom, be particularly aware of any label warnings and recommendations for protecting bees and other off-target species.

Table 51. Registered or permitted products for plague thrips in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Acetamiprid + novaluron (Cormoran®)	4A + 15	70	Medium	Apples
Bifenthrin (Talstar® 80 SC)	3A	0	High	Apples
Flonicamid (Mainman®, PER89215 , expires 31.5.28)	29	21	Low	Persimmons; suppression only
Malathion (Fyfanon® 440 EW)	1B	3	High	Apples, pears
Methomyl (Methomyl 225)	1A	1	High	Stone fruit
Methomyl (PER14548 , expires 31.5.28)	1A	Not required when used as directed	High	Persimmons
Potassium salts of fatty acids (Hitman®)	Bio-pesticide	Not required when used as directed	Unknown	Fruit trees
Pyrethrins + piperonyl butoxide (Py-Bo)	3A	1	High	All crops ³
Tau-fluvalinate (Mavrik® Aquaflo)	3A	Not required when used as directed	High	Apples, cherries, nectarines, peaches, plums

¹ WHP = withholding period. ² Always refer to the label. ³ All crops = apples, pears, apricots, cherries, nectarines, peaches, plums and persimmons.

Queensland fruit fly



Bactrocera tryoni

Queensland fruit fly (QFF) is a significant pest of temperate fruit crops in northern and eastern Australia, including coastal and warm inland districts. It is an important quarantine pest of concern to most importing countries, and often requires end-point treatment control to trade.

Risk period

Table 52. The peak risk period for Queensland fruit fly.

Bud swell/ green tip	Blossom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult QFF are about 6–8 mm long and reddish-brown with yellow markings (Figure 108). Queensland fruit flies are most active in warm, humid conditions and after rain. Adult flies might be seen walking on the undersides of leaves or on maturing fruit, but will take flight if disturbed.

Damage

Queensland fruit flies damage the fruit by inserting their ovipositor and laying their eggs into the skin of the developing fruit (most commonly as the fruit approaches maturity). This is referred to as stinging the fruit and results in a mark on the skin about the size of a match head. In severe infestations, there can be multiple sting marks on each fruit (Figure 109).

When the eggs hatch, the developing larvae burrow into the fruit, causing the flesh to decay (Figure 110). In many instances, the affected fruit can look intact from the outside.



Figure 108. Dorsal view of an adult Queensland fruit fly.



Figure 109. Multiple Queensland fruit fly stings to an apple.



Figure 110. Queensland fruit fly larvae (maggots) and feeding damage in an apple.

Monitoring

Monitor QFF activity in and around the orchard using a combination of adult fly trapping and visual fruit inspections. Trapping serves as a warning system to indicate when flies are active in the orchard and when to start control treatments. Several types of traps are available including the Lynfield trap (Figure 111), Bugs for Bugs, Bio-Trap, Eco-Lure, Probodelt Cone and McPhail traps.

Lures are available to attract male or female flies depending on the attractant used. There are also registered and permitted options for making your own chemical lures (Table 54). Consult your trap supplier for further advice.



Figure 111. A Lynfield trap.

Management

Cultural and physical: Queensland fruit fly pupate in the soil under infested trees, making orchard hygiene an important part of managing QFF. Removing and destroying fallen and/or infested fruit from the orchard will help break the cycle and limit the available host material. Fruit fly barrier netting can be used to exclude flies from the crop, but this is not a practical option in commercial-scale orchards.

Mass trapping and male annihilation technique (MAT) cups (Figure 112) are also available as non-spray tools to manage adult QFF numbers.

Biological: Queensland fruit fly has several natural predators including the parasitoid *Diachasmimorpha tryoni*.

Sterile insect technique (SIT) involves mass rearing and sterilising fruit flies that are then released as part of an area-wide management program. Commercial-scale SIT is currently being developed.

Grazing chickens or ducks in the orchard can help reduce pest pressure, but this might only be practical on a small scale.

Chemical: an effective integrated chemical management program for QFF will include trap monitoring, protein bait sprays, male annihilation, orchard hygiene and cover spraying as required (Table 53 and Table 54).



Figure 112. Male annihilation technique (MAT) cups include a lure and pesticide wick and can be placed inside a trap for monitoring or deployed separately in larger numbers to attract and kill. Photo: Bugs For Bugs (<https://bugsforbugs.com.au/product/mat-cup/>).

Table 53. Registered or permitted **sprays** for Queensland fruit fly in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Acetamiprid + novaluron (Cormoran®)	4A + 15	7	Medium	Stone fruit; suppression only
Acetamiprid + pyriproxyfen (Trivor®, PER89943, expires 30.9.27)	4A + 7C	28	Unknown	Persimmons; suppression only
Alpha-cypermethrin (PER91059, expires 30.6.27)	3A	7	High	Stone fruit except cherries
Alpha-cypermethrin (PER96678, expires 30.9.30)	3A	14	High	Persimmons
Clothianidin (Samurai®)	4A	7	High	Pome fruit, stone fruit, persimmons
Dimethoate (PER13859, expires 31.5.30)	1B	Do not harvest sprayed fruit	High	Fruit fly host plants; postharvest use only
Etofenprox (Trebon®)	3A	3	High	Stone fruit except cherries
Malathion (Fyfanon® 440 EW)	1B	3	High	Apples, pears, stone fruit, persimmons
Pyrethrins (Pyganic®)	3A	Stone fruit 0; cherries 1	High	Stone fruit including cherries; preharvest clean-up spray only
Spinetoram (PER12590, expires 31.5.29)	5	Pome fruit 7; stone fruit 3	Medium	Pome fruit, stone fruit; suppression only
Trichlorfon (Lepidex®)	1B	2	High	Pome fruit, stone fruit
Trichlorfon (PER12450, expires 31.8.30)	1B	2	High	Persimmons

¹ WHP = withholding period. ² Always refer to the label.

Table 54. Registered or permitted **baits and lures** for Queensland fruit fly in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Dichlorvos (Biotrap DDVP Cubes)	1B	Not required when used as directed	Low	For use in traps with a suitable attractant
Fipronil ³ + 4-(p-acetoxyphenyl)-2-butanone (Amulet Cue-Lure®)	2B	Not required when used as directed	Low when used as bait	Male attract and kill
Hydroxyphenylbutanone acetate (Fly Bye®)	Lure	Not required when used as directed	Low	Male lure only for traps
Lures, attractants, pheromones and toxicants in traps (PER13785, expires 30.6.26)	Various	Not required when used as directed	Low	Various
Malathion (Fyfanon® 440 EW)	1B	Not required when used as directed	Low when used with bait for trapping	Poison for fruit fly trap trapping
Malathion + 4-(p-acetoxyphenyl)-2-butanone (Eco-Lure®)	1B	Not required when used as directed	Low when used as bait	Male attract and kill
Spinosad (Naturalure®)	5	Not required when used as directed	Low	Fruit crops; attract and kill bait

¹ WHP = withholding period. ² Always refer to the label.

Useful resources for managing Queensland fruit fly

Managing Queensland fruit fly in NSW temperate fruit orchards is critical due to the rising populations over recent seasons. This, coupled with an expected earlier population increase in the growing regions, highlights the need for proactive and integrated management strategies, including monitoring, baiting, exclusion techniques, and community-wide collaboration.

As a widespread and priority pest, the [Area-wide management website](https://area-wide-management.com.au/) (https://area-wide-management.com.au/ for QFF is available free for growers (Figure 113).

Area-wide management (AWM) is a proven, effective management approach for mobile pests around the world. AWM is used in a well-defined area or region, including all pest habitats within that area, to reduce the total pest population. This reduces the likelihood of that pest moving into farms and orchards from habitats such as gardens and/or native hosts. AWM provides opportunities to incorporate sterile insect techniques.

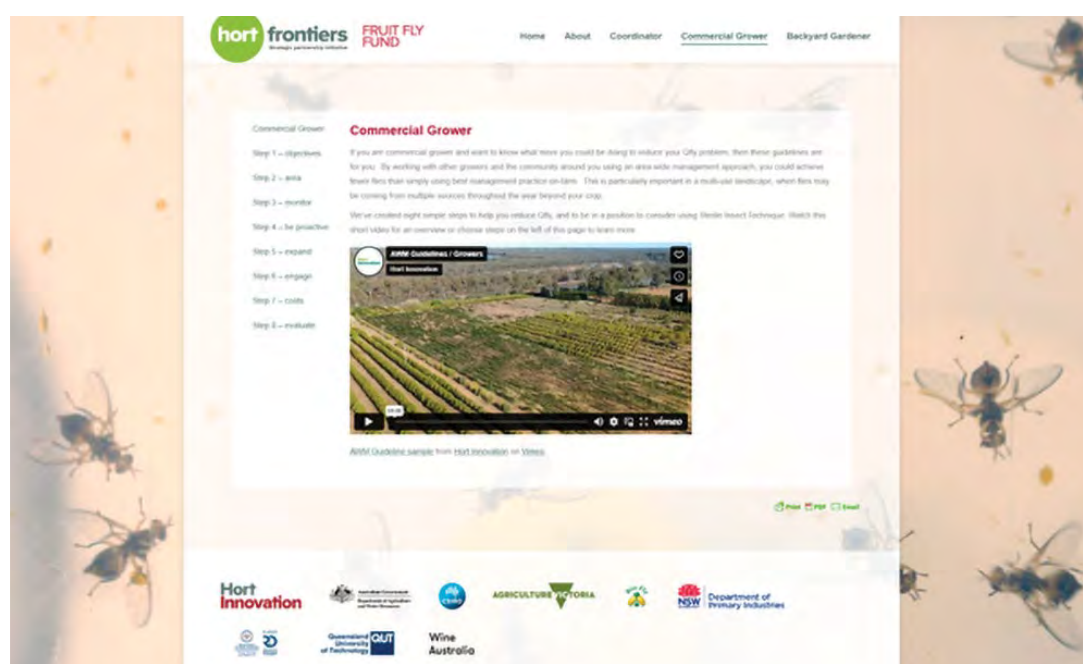


Figure 113. A screenshot of the area-wide management website.

Cherry-picked podcast: climate change and the Queensland fruit fly

In this episode of the cherry-picked podcast (Figure 114), NSW DPIRD discuss the climate vulnerability assessment (CVA) results for the Queensland fruit fly. Climate change is projected to affect its distribution, life cycle, and timing in NSW. The episode (Figure 115) highlights key findings from the CVA modelling, including seasonal shifts in climate suitability, potential expansion of fruit fly populations, and what this means for growers, exporters, and biosecurity planning.



Figure 114. The cherry-picked podcast logo.



Figure 115. Scan the QR code to listen to the podcast.

Other useful links for QFF resources

Ekman J (2019) [Implementing brown sugar flotation for ensuring freedom from fruit fly](https://www.vegkit.com.au/globalassets/laserfiche/assets/project-reports/cy16011/cy16011---final-report-complete.pdf). Final report to Hort Innovation, <https://www.vegkit.com.au/globalassets/laserfiche/assets/project-reports/cy16011/cy16011---final-report-complete.pdf>.

NSW DPIRD (2010) [Queensland fruit fly: an increasing biosecurity risk under a changing climate](https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/1499814/Climate-Vulnerability-Assessment-Factsheet-Queensland-fruit-fly.pdf), https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/1499814/Climate-Vulnerability-Assessment-Factsheet-Queensland-fruit-fly.pdf.

NSW DPIRD (2023) [Queensland fruit fly](https://www.dpi.nsw.gov.au/dpi/climate/climate-vulnerability-assessment/commodity-pages/queensland-fruit-fly), <https://www.dpi.nsw.gov.au/dpi/climate/climate-vulnerability-assessment/commodity-pages/queensland-fruit-fly>.

NSW DPIRD (2025) [Climate vulnerability assessment Queensland fruit fly results report](https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/1602549/Climate-Vulnerability-Assessment-Queensland-Fruit-Fly-Results-Report.pdf), https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/1602549/Climate-Vulnerability-Assessment-Queensland-Fruit-Fly-Results-Report.pdf.

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Your Fruit Fly Toolkit



BUGS
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Fruit fly is a difficult but manageable pest.
There is no silver bullet.
You need to use a systems approach to get the best results.

What are the essentials of a systems approach?

1. **Protein baits** - Attract and kill female flies
2. **Male annihilation technique (MAT)** - Attract and kill male flies
3. **Monitoring** - Inspect crops regularly and use male traps
4. **Sanitation** - Remove residual fruit after harvest and destroy neglected fruit trees

When combined and maintained rigorously, these strategies can provide excellent control. In certain high-risk crops, additional tools such as female traps, may also be of value and insecticide cover sprays are sometimes necessary. Currently registered insecticides are very toxic to beneficial insects and are not compatible with integrated pest management. Cover sprays should only be used as a last resort.

We encourage all fruit growers to think of fruit fly as a seasonal pest that needs to be managed all year round - even when susceptible fruit are not necessarily present.

Bugs for Bugs has been helping growers manage fruit fly for more than 40 years. We supply a comprehensive range of fruit fly management products including protein baits, MAT cups and traps.

This fruit fly toolkit provides a practical guide to using our fruit fly management products. For more information about [fruit fly management](#), visit our website.



Fruit Fly Lure

protein bait



Fruit Fly Lure is an Australian-made, easy-to-mix, autolysed protein. It is highly attractive to Queensland fruit fly and other fruit fly species. When mixed with a toxicant, it can be used to attract and kill adult fruit flies.

How does it work?

- The protein plus toxicant attracts and kills adult flies
- Female fruit flies must feed on protein before they can sting fruit

How to mix our protein bait

- Mix Fruit Fly Lure with water at 2 L per 100 L of water
- Add the toxicant at the label rate

How to apply

- Apply fresh on the day of mixing
- Use 15 L of mixture per ha
- Apply as a spot or band to the host plants or a suitable substrate
- Note: this is not a cover spray

When to apply

- Start early (before fruit becomes susceptible) and continue for at least 3 weeks after harvest
- Apply every 5-7 days (more often if you see any signs of damage or increased fruit fly activity)
- Re-apply after rain

Tips for best results

- Start early (at least 2 weeks before fruit becomes susceptible)
- Apply regularly and do not miss a treatment
- Increase frequency during high-risk periods
- Apply mixture to foliage or trunk of host plant (not on ground or grass)
- On some varieties, protein might cause fruit burn (test before use and minimise fruit contact)
- Treating larger areas, including non-fruiting blocks and surrounds, will improve results
- For improved longevity and rainfastness, use with our Fruit Fly Lure Thickener



MAT cups for male annihilation



MAT cups are designed to reduce the male fruit fly population. They are a powerful management tool, however they should only be used in addition to (not instead of) protein baiting.

We offer two styles of MAT cup

- An impregnated cotton wick in a plastic housing
- A cardboard cup with an impregnated corrugated cardboard inner
- Both MAT cup styles are designed to protect the ingredients from rain and UV degradation. We have developed the cardboard version as a biodegradable option.

How does it work?

- MAT is a targeted attract and kill strategy for male Queensland fruit flies
- MAT cups contain a powerful male sex attractant (cue lure) and a toxicant
- Male Queensland fruit flies are attracted to the cups and die as a result of ingesting the toxicant
- MAT cups are most effective when used over large areas or entire cropping regions to achieve area wide management
- MAT cups can significantly reduce the local fruit fly population when used over successive seasons

How many do I need?

- Apply 10-20 MAT cups per hectare, depending on crop sensitivity and local fruit fly pressure
- Apply new cups three times per year (in Spring, Summer and Autumn)
- Leave each MAT cup in the field for a full 12 months (biodegradable cups can be left in the field indefinitely)

How does MAT affect male fruit fly monitoring?

MAT cups compete with male fruit fly traps. It is important to take this into account when using male trap counts to assess fruit fly activity.



Fruit Fly Trap Pro for monitoring



Monitoring fruit fly populations helps us understand fruit fly activity in an area, and we can use this information to fine tune control programs. The Fruit Fly Trap Pro specifically attracts male Queensland fruit flies.

We offer two colour variations

- Clear base with yellow lid
- Yellow base with clear lid

How does it work?

- The trap contains a cotton wick impregnated with a powerful male sex attractant (cue lure) and an insecticide
- Male Queensland fruit flies are attracted from distances of up to 400 meters and collect in the trap where they can be counted

How many traps do I need?

1 trap per 5-10 ha (minimum 3 traps per farm)

How to assemble the Fruit Fly Trap Pro

- Wear gloves (to avoid contact with the pheromone wick)
- Push the hook through the lid into the pheromone wick holder
- Insert 4 plastic entry ports into the side of the trap (align tab at top of hole)

How to deploy the Fruit Fly Trap Pro

- Place traps in areas where fruit fly is likely to be active (e.g. along borders and rivers/waterways)
- Hang at head height in the host tree/crop shaded from direct sunlight
- Empty traps and record fly catches at least weekly
- Replace the pheromone wick every three months
- Replacement Q Fly Wicks are available from Bugs for Bugs

How to interpret your trap counts

Male traps are a useful tool for monitoring population trends but trap counts must be interpreted carefully. It is important to note that:

- These traps only catch male fruit flies
- Trap counts are not a good indication of potential for fruit fly damage in the crop (your monitoring program should include regular crop inspections, looking for adult flies and evidence of stinging)
- Fruit fly traps do not control fruit fly



Contact us for more information about fruit fly management

Phone: 07 4646 2628 E-mail: info@bugsforbugs.com.au Website: www.bugsforbugs.com.au

Rutherglen bug



Nysius vinitor

Rutherglen bug is a native insect that affects many field crops, and in some seasons, is a particular problem in stone fruit. In years of heavy infestation, it can also affect pome fruit.

Risk period

Table 55. The peak risk period for Rutherglen bug.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult Rutherglen bugs are grey-brown with clear wings. They are 4 mm long with a narrow body and prominent eyes (Figure 116). They are highly mobile and often swarm over the fruit and shoot surfaces in the hundreds (Figure 117).

Damage

Rutherglen bugs damage the fruit by sucking sap. Damage in peaches can be identified by thin strings of clear gum hanging down from green fruit. In other temperate fruit, the damage will appear as multiple small feeding marks on the skin. Rutherglen bug can also feed on young foliage, causing leaves and fruit to shrivel.

Monitoring

Monitor for Rutherglen bug during spring and summer. If canola or sorghum in surrounding areas is infested, increase monitoring.

Management

Cultural and physical: Rutherglen bugs will use nearby weeds as stepping stones into the orchard trees. Manage weeds in and around the orchard to reduce potential hosts (refer to [Managing weeds on page 136](#)).

Biological: birds and spiders might provide some predation of Rutherglen bug, but this will not control large populations.

Chemical: the chemical options for controlling Rutherglen bug are listed in [Table 56](#).

Table 56. Registered or permitted products for Rutherglen bug in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Malathion (Fyfanon® ULV)	1B	3	High	Stone fruit
Pyrethrins (Pyganic®)	3A	Cherries 1; apricots, nectarines, peaches, plums, prunes 0	High	Apricots, nectarines, peaches, plums, prunes (fresh)
Trichlorfon (Dipterex®)	1B	2	High	Pome fruit, stone fruit

¹ WHP = withholding period. ² Always refer to the label.



Figure 116. Adult Rutherglen bug.



Figure 117. Rutherglen bug swarm on an apple.

San José scale

Diaspidiotus perniciosus



San José scale (SJS) is an extremely important pest of pome and stone fruit. It is a sucking insect that injects a toxin into the plant as it feeds, causing localised discolouration, resulting in fruit being downgraded during processing and packing.

Risk period

Table 57. When to monitor and manage for San José scale.

Bud swell/ green tip	Blossom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

San José scale adult females are yellow with rounded dark grey scales (Figure 118). They are wingless and legless, about 2.5 mm in diameter. Males have a dark band across their back, long antennae, legs and wings. Crawlers are approximately 0.25 mm long and bright yellow.

Damage

San José scale sucks the sap and juice out of the tree and fruit while also injecting a toxin. This causes loss of tree vigour, stunted growth and limb death. On fruit, SJS feeding will cause slight depressions with a red–purple halo (Figure 119). If populations are low, the damage will be concentrated on the bottom of the fruit.



Figure 118. San José scale adult. Photo: United States National Collection of Scale Insects Photographs, USDA Agricultural Research Service, Bugwood.org.

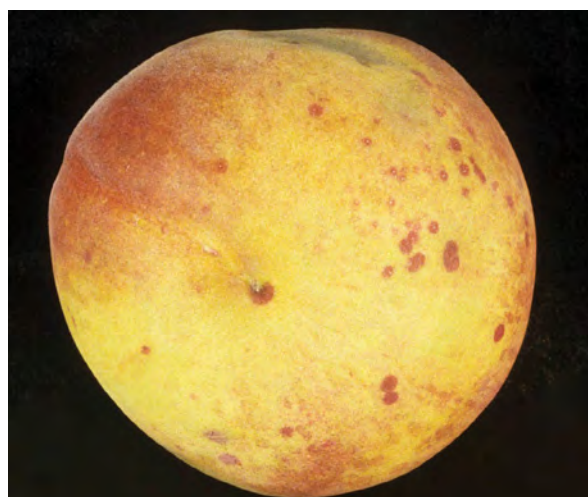


Figure 119. San José scale on a peach.

Monitoring

During the growing season, monitor fruit for signs of the red–purple halos caused by the feeding scale insect. Be sure to look closely around the calyx end of the fruit.

Crawlers can be monitored 4–6 weeks after bloom using double-sided tape with a thin layer of petroleum jelly around infested tree limbs. Monitoring during winter should focus on identifying scale colonies on the branches.

Management

San José scale overwinter as immature scale. In spring, the winged males emerge and mate with the wingless females. Approximately 1 month after the first male flight, the first crawlers can be seen. Understanding this life cycle helps target control and management. Dormant season treatments are the most effective.

Cultural and physical: the most effective cultural control is to prune out infested branches. This will reduce scale insect numbers and open up the tree canopy, improving spray penetration and coverage. Control ant populations (refer to [page 26](#)) as they spread the scale insect crawlers and protect them from natural predators.

Healthy trees supplied with appropriate nutrition and irrigation will be more likely to resist SJS infestation. Good weed management will help ensure minimal competition for resources.

Biological: several natural predators can be used to control SJS. The most common predatory insects and naturally occurring parasitoid wasps include *Cryptolaemus* (*Cryptolaemus montrouzieri*), green lacewings (*Mallada signata*) and Chilocorus beetles (*Chilocorus circumdatus*). Several fungi and bacteria are available that can infect and kill scale insects, however, these are less likely to reduce populations unless they become abundant. It should be noted that almost all pesticides for SJS control will harm beneficial insect populations.

Chemical: the chemical options for controlling SJS are listed in [Table 58](#).

Table 58. Registered or permitted products for San José scale in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Acetamiprid + novaluron (Cormoran®)	4A + 15	Apples 70; pears 35; stone fruit 7	Medium	Apples, pears, stone fruit
Fenoxycarb (Insegar®)	7B	14	Low	Apples, pears
Horticultural mineral oil (various)	Paraffinic oil and petroleum oil	1	Low	Pome fruit, stone fruit
Spirotetramat (Movento®)	23	21	Medium	Pome fruit, stone fruit
Sulfoxaflor (Transform® Isoclast™)	4C	7	Medium	Pome fruit
Sulfur as polysulfide sulfur (7 Worlds Ag Lime Sulphur)	M2	Not required when used as directed	Medium	Pears, apricots, nectarines, peaches, plums, prunes; stone fruit dormant to bud swell spray only

¹ WHP = withholding period. ² Always refer to the label.

Two-spotted mite

Tetranychus urticae



Two-spotted mite (TSM) is the most common pest mite species affecting all temperate fruit. It is more likely to become a problem in warm to hot, dry summers and when sprays for other pests and diseases disrupt predatory insects.

Risk period

Table 59. The peak risk period for two-spotted mite.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult female TSM are approximately 0.6 mm long and, while they can be seen with the naked eye, are best viewed with a 10× hand lens or light microscope. They are opaque, cream, and have 2 distinctive dark patches (spots) on either side of the upper and forward part of the body (Figure 120). Adult males are smaller and less distinctive than females. Eggs are also opaque, cream and very small, about 0.1 mm (Figure 121). TSM activity is often associated with webbing over the affected foliage.



Figure 120. Two-spotted mite adults.



Figure 121. Juvenile two-spotted mites with eggs on an apple leaf.

Damage

TSM damages crops by feeding mostly on the underside of leaves, causing cells to turn yellow–white and lose their photosynthetic capacity. Heavy feeding causes severe speckling of the foliage, giving the trees a bronzed look. Leaf bronzing can significantly affect normal tree function and can lead to premature leaf drop, negatively affecting fruit development and colouring in red fruit varieties. With TSM, this feeding damage is usually first noticed in the inner and lower third of the tree canopy.

Monitoring

During the growing season, and particularly as spring and summer temperatures increase, monitor the undersides of leaves for TSM and their eggs. Webbing can indicate that mite populations are in the canopy. TSM should not be confused with other orchard pest mites such as European red mite (page 50) or Bryobia mite (page 35). Scouting for plant damage, such as bronzed or yellowed leaves, can be a quick way to identify pest mite hotspots. There are several ways to quantify the risk from mite populations, including mite counts, presence or absence, percentage of leaves infested and cumulative leaf-infested days (CLIDs). Your local IPM consultant should be able to help with applying these methods.

Management

Cultural and physical: similar to most mite pests, TSM seems to prefer dusty conditions and often thrives in orchard trees adjacent to unsealed roads. Any method that reduces dust arising from such sources will help decrease TSM activity. Maintaining good soil moisture and minimising tree stress, particularly through the hottest part of the season, will help trees resist damage and recover from mite attack.

Biological: the predatory mites *Galendromus occidentalis* (formerly *Typhlodromus occidentalis*), *Phytoseiulus persimilis* (Figure 122) and *Neoseiulus californicus* can be effective biological control agents for TSM if seasonal conditions and crop protection chemical selection are favourable. *G. occidentalis* is established in the key apple-growing regions and can be effectively seeded into blocks via leaves and cuttings. *P. persimilis* is reared commercially for purchase and release.

There are many other naturally occurring predators of TSM including lacewings and *Stethorus* beetles, which will help control TSM populations, provided they are not killed off by sprays used for other orchard pests.

Chemical: two-spotted mite is a high-profile pest, and there are resistant populations to several key insecticidal groups. CropLife Australia maintains an [insecticide resistance management](https://www.croplife.org.au/resources/programs/resistance-management/insecticide-resistance-management-strategies/) (IRM, <https://www.croplife.org.au/resources/programs/resistance-management/insecticide-resistance-management-strategies/>) plan for European red mite, two-spotted mite and green peach aphid, available online. IRM is essential to maintain the efficacy of valuable insecticides. Preventing resistance from occurring is easier than trying to regain susceptibility.

Early season sprays should use chemistry with a low effect on beneficial insects to conserve predatory mite populations. In contrast, broad-spectrum insecticides or those with a high impact on beneficial insect populations have the potential to flare up mite populations.

Regular monitoring for both predatory insects and pest mite populations to inform spray decisions is critical. Wherever possible, make no more than one application from each registered miticide group per season. Effective mite control spray programs usually incorporate a single horticultural mineral oil during winter or just before bud burst. Consider also chemical rotation and insecticide mode of action to control other pests of pome fruit, such as codling moth, light brown apple moth and woolly aphid. These sprays can promote chemical resistance in mite pests. The chemical options for controlling TSM are listed in Table 60.



Figure 122. The predatory mite, *Phytoseiulus persimilis*, attacking two-spotted mites.

Table 60. Registered or permitted products for two-spotted mite in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Abamectin (Vertimec®)	6A	14	High	Apples, pears
Abamectin + chlorantraniliprole (Voliam Targo®)	6 + 28	7	High	Pome fruit
Acequinocyl (Kanemite®)	20B	14	Low	Pome fruit, stone fruit including cherries
Bifenazate (Acramite®)	20D	Apricots, nectarines, peaches, plums 3; pome fruit 7	Low	Apples, pears, apricots, nectarines, peaches, plums
Clofentezine (Apollo®)	10A	21	Low	Pome fruit, stone fruit
Cyflumetofen (Danisaraba®)	25A	7	Low	Pome fruit

Table 60. Registered or permitted products for two-spotted mite in NSW, page 2 of 2.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Etoxazole (Paramite®)	10B	7	High	Pome fruit, stone fruit except cherries
Fenbutatin oxide (Talk Miticide)	12B	Apples, pears 2; peaches, nectarines 14	Low	Apples, pears, nectarines, peaches
Hexythiazox (Calibre®)	10A	3	Low	Apples, pears, stone fruit
Horticultural mineral oil (various)	Paraffinic oil and petroleum oil	1	Low	Pome fruit, stone fruit
Milbemectin (Milbeknock®)	6	14	High	Pome fruit, stone fruit
Potassium salts of fatty acids (Hitman®)	Bio-pesticide	Not required when used as directed	Unknown	Fruit trees
Propargite (Omite®)	12C	7	Medium	Apples, stone fruit
Spiromesifen (Interrupt®)	23	14	High	Pome fruit, stone fruit
Tebufenpyrad (Pyranica®)	21A	14	Medium	Apples, pears, peaches

¹ WHP = withholding period. ² Always refer to the label.



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Weevils



Various species

Many weevil species can affect pome and stone fruit but they are relatively uncommon in conventionally sprayed orchards in NSW. Weevils can be a significant problem in organic orchards and some weevil species are high-priority pests in export markets.

Risk period

Table 61. The peak risk period for weevils.

Bud swell/ green tip	Blossom	Mid season	Harvest	Postharvest	Dormancy

The most potentially damaging weevils are:

- Apple weevil (*Otiorynchus cribricollis*)
- Eucalyptus weevil (*Goniapterus scutellatus*; [Figure 123](#))
- Fuller's rose weevil (*Asynonychus cervinus*; [Figure 124](#))
- Fruit tree root weevil (*Leptopius robustus*; [Figure 125](#))
- Garden weevil (*Phlyctinus callosus*; [Figure 126](#))

Pest identification

Weevils are small beetles that have snouts, a set of antennae, a rounded thorax, 6 legs and are usually coloured dark brown to red-brown. Different weevil species can be distinguished by the markings on their back.



Figure 123. Eucalyptus weevil. Photo: William M. Ciesla, Forest Health Management International, Bugwood.org.



Figure 124. Fuller's rose weevil.



Figure 125. Fruit tree root weevil. Photo: Pest and Diseases Image Library, Bugwood.org.



Figure 126. Garden weevil. Photo: Pest and Diseases Image Library, Bugwood.org.



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- Translaminar movement for full leaf coverage
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*Reduced fecundity of adult females.

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Damage

Weevils damage the fruit, leaves and roots of fruit trees (Figure 127). Feeding on fruit causes scarring, making it unsuitable for the fresh market. Weevils feeding on leaves deposit excreta around the stem end of the fruit, which results in downgrading. Some weevils cause partial or complete ringbarking on the fruit stalks, resulting in reduced fruit size or abortion. The Eucalyptus weevil is a quarantine pest that can contaminate export consignments.

Monitoring

Monitor for weevils from late October to late December, depending on the species. Weevil infestations tend to be localised to one area of the orchard and infestation is likely to recur in these areas. Trunk banding with a sticky coating, such as polybutenes and wax, or using a fibrous material can be a useful way to monitor for weevil activity.

Management

Cultural and physical: good orchard hygiene will prevent weevil populations from establishing. Carefully inspect any equipment, including ladders and bins being moved from one area of the orchard to another, and always work on clean blocks before moving to infested blocks. Weeds and rubbish on the orchard floor can act as hosts for weevils to lay eggs and provide an alternative feeding site. Maintaining a clean weed strip and having a mown inter-row (Figure 128) will reduce the number of weevils in the orchard.



Figure 127. Fuller's rose weevil damage to apple leaves.



Figure 128. A mown inter-row will reduce the number of weevils in the orchard.

Biological: weevils can be eaten by small birds and preyed upon by parasitic wasps. Avoid using harmful pesticides to increase the population of parasitic wasps, which will help control the number of weevils in the orchard.

Chemical: the chemical options for controlling weevils are listed in Table 62.

Table 62. Registered or permitted products for weevils in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Indoxacarb (Avatar® eVo)	22A	Pome fruit, cherries 14; stone fruit 7	Low	Pome fruit and stone fruit for apple weevil, Fuller's rose weevil and garden weevil
Tetraniliprole (Vayego® 200 SC)	28	Pome fruit 7; stone fruit 3	Low	Pome fruit, stone fruit

¹ WHP = withholding period. ² Always refer to the label.

Western flower thrips



Frankliniella occidentalis

Western flower thrips (WFT) are a pest of all the main temperate tree fruit crops. They are known to be particularly damaging to nectarines.

Risk period

Table 63. The peak risk period for western flower thrips.

Bud swell/ green tip	Blossom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Adult western flower thrips (WFT) are pale brown to yellow, with narrow bodies (Figure 129) and are about 1–2 mm long. Western flower thrips are hard to identify in the field and inspection under a light microscope will usually be required to differentiate them from other pest species such as plague thrips and onion thrips.

Damage

WFT damages the skin of certain temperate fruit, including apples and nectarines, by feeding on the fruit surface. As the damaged skin cells grow, the injury develops into a russet (Figure 130), or in apples, the fruit develops an unusual pansy flower-shaped spot (Figure 131).



Figure 129. Adult western flower thrips.



Figure 130. Western flower thrips feeding damage on a nectarine.



Figure 131. Pansy spot caused by western flower thrips.

Monitoring

Monitor for thrips species using yellow sticky traps (Figure 132) hung throughout the orchard from bud burst to harvest. The traps will indicate thrips activity and can also be sent to a laboratory to obtain a formal identification of the pest species.

Management

Cultural and physical: controlling established WFT populations will require timely pesticide application. However, several management practices will reduce pest numbers and minimise damage. As broadleaved weeds (particularly clover) are an alternative host for WFT, keep ground cover mown short throughout the year to prevent flowering, but do not mow when fruit trees are in blossom. Choose pesticides that are less harmful to beneficial insects to encourage their presence and survival. Where practical, thin fruit to singles or aim to keep clusters open, as this will make the environment around the fruit less attractive to thrips.

Biological: there are several natural predators of thrips including predatory mites, bugs, lacewings, predatory thrips, lady beetles and parasitic wasps. However, these are unlikely to provide complete control of WFT.

Chemical: registered or permitted chemical options for controlling WFT (Table 64) are limited and differ from those used to manage plague thrips (page 68), therefore, correctly identifying the pest thrips species is vital.



Figure 132. Use sticky traps to monitor for various thrips species.

Table 64. Registered or permitted products for western flower thrips in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Flonicamid (Mainman®, PER89215, expires 31.5.28)	29	21	Low	Persimmons; suppression only
Spinetoram (Delegate®)	5	Pome fruit 7; stone fruit 3	Medium	Apples, pears, apricots, cherries, nectarines, peaches, plums
Spinosad (Entrust® Organic)	5	Apples, pears, apricots, cherries, nectarines, plums 3; peaches 7	Low	Apples, pears, apricots, cherries, nectarines, peaches, plums
Spirotetramat (PER84804, expires 31.12.28)	23	21	Medium	Stone fruit

¹ WHP = withholding period. ² Always refer to the label.

Wingless grasshoppers

Phaulacridium vittatum



Wingless grasshoppers are native to Australia and can be a problem in most temperate fruit crops in all growing regions.

Risk period

Table 65. The peak risk period for wingless grasshoppers.

Bud swell/ green tip	Blossom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Wingless grasshoppers develop through a series of growth stages. Newly emerged wingless grasshoppers are dark grey and less than 2 mm long. Adults grow to about 10–20 mm long and have white stripes along both sides of the upper body (Figure 133). Most grasshoppers have short, non-functional wings, but a small proportion of the population is capable of flight and, therefore, wider dispersal. Unlike Australian plague locusts (page 32), wingless grasshopper populations are usually localised and do not form large migratory swarms.



Figure 133. Adult wingless grasshopper. Photo: Harvey Perkins, Canberra Nature Map.

Damage

Wingless grasshoppers feed on leaves and young shoots and can cause substantial defoliation.

Monitoring

Monitor for grasshoppers from September to November when the newly hatched grasshoppers are emerging. Look for hopper activity and signs of foliage and shoot feeding.

Management

Cultural and physical: weeds in the orchard should be removed as these can provide shelter for emerging and developing grasshopper nymphs.

Biological: wingless grasshoppers are prey for several predators. Parasites, including nematodes and *Scelio* spp., can have a substantial effect on egg survival. Poultry, such as chickens, can also be an effective option for control.

Chemical: the chemical options for controlling wingless grasshoppers are listed in Table 66.

Table 66. Registered or permitted products for wingless grasshoppers in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Carbaryl (Bugmaster®)	1A	Pome fruit 77; stone fruit 35	High	Pome fruit, stone fruit; do not use on cherries
Fenitrothion (Sumithion® ULV)	1B	14	High	Apples, cherries
Indoxacarb (Avatar® eVo)	22A	Apricots, nectarines, peaches, plums 7; apples, pears, cherries 14	Low	Apples, pears, apricots, nectarines, peaches, plums
Malathion (Fyfanon® ULV)	1B	3	High	Pome fruit, stone fruit

¹ WHP = withholding period. ² Always refer to the label.

Woolly apple aphid



Eriosoma lanigerum

Woolly apple aphids (WAA) are a serious pest of apple and pear trees.

Risk period

Table 67. The peak risk period for woolly apple aphid.

Bud swell/ green tip	Blossom	Mid season	Harvest	Postharvest	Dormancy

Pest identification

Woolly apple aphids are most noticeable during the growing season when they cluster in white woolly colonies on young green shoots (Figure 134) and around pruning cuts.

Woolly apple aphids survive through winter as an early-stage nymph called a crawler, which is oblong, flattened and grey to brown. Crawlers find sheltered positions in cracks and crevices in the bark, although most disperse to the base of the tree and infest the roots.

Damage

Galls (lumps) occur on shoots and roots when aphid feeding induces swelling of the surrounding plant tissue. Galls in leaf axils can interfere with fruit and vegetative bud development, reducing normal tree growth and potential yield. Damage to root systems (particularly on young trees) can be extensive and result in reduced tree growth and root death.

Heavy infestations will produce sticky honeydew that can land on fruit and lead to unsightly sooty mould developing.

Monitoring

The results of regular pest monitoring should guide woolly apple aphid management. This can be carried out in conjunction with other routine activities in the orchard.

Woolly apple aphids can enter the orchard on young nursery stock; always check nursery trees at delivery and before planting for infestations, particularly on the young root systems.

In mature and developing orchards, check the tree canopy for aerial colonies from late spring through to postharvest. This can be a random visual inspection of trees throughout a block, but make sure to check different varieties within a block as rootstocks and varieties can differ in their susceptibility and likelihood of infestation.

During in-season inspections, keep an eye out for signs of parasitism (Figure 135).



Figure 134. Woolly apple aphid colonies on an apple tree.



Figure 135. Woolly apple aphid adult. Photo: Jeffrey W Lotz, Florida Department of Agriculture and Consumer Services, Bugwood.org.

Management

Cultural and physical: woolly apple aphids prefer to colonise sheltered sites within the tree, so pruning to maintain an open canopy will help make the tree less attractive to them. Paint large pruning cuts to deter WAA.

Rootstocks vary in susceptibility to colonisation by WAA. Some of the main dwarfing rootstocks currently used in Australia are susceptible to WAA, including M26 (moderately susceptible) and M9 (very susceptible). The semi-dwarfing rootstock MM106 is considered resistant but is less suited to modern high-density production systems in most regions.

Biological: lady beetles (Figure 136) and lacewing larvae (refer to [Protecting beneficial insects on page 94](#)) are useful natural WAA predators and should be encouraged in the orchard by maintaining a diverse plant species mix in the tree inter-row and by avoiding disruptive insecticides. *Aphelinus mali* is an effective parasitic wasp of WAA; it lays eggs in the live aphids, causing them to stop producing wool and turn black. Check for *A. mali* parasitism when monitoring. When mature, the wasp inside the aphid's body will emerge by chewing a circular hole in the aphid's abdomen.

European earwigs (*Forficula auricularia*) can be an important predator of WAA. Studies in apple orchards showed that when present in high numbers early in the growing season, European earwigs (particularly in combination with the parasitic wasp *A. mali*) can control WAA.

Chemical: a chemical control strategy will focus firstly on controlling the root colonies (using a soil or collar drench) in early spring before they become a major problem in the tree canopy. Controlling aerial colonies during late spring to summer should seek to maximise the effects of *A. mali* and other beneficial insects. Avoid chemicals likely to harm any beneficial insects, or use with caution and only when absolutely necessary (Table 68).



Figure 136. Lady beetles feeding on woolly apple aphid and galls caused by the aphids.

Table 68. Registered or permitted products for woolly apple aphid in NSW.

Active constituent (example trade name)	Insecticide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Acetamiprid + novaluron (Cormoran®)	4A + 15	Apples 70; pears 35	Medium	Apples, pears; suppression only
Clothianidin (Samurai®)	4A	7	High	Apples; foliar spray or soil drench
Flonicamid (Mainman®)	29	21	Low	Apples
Imidacloprid (Confidant 200SC)	4A	Not required when used as directed	Medium	Apples
Malathion (Fyfanon® 440 EW)	1B	3	High	Apples, pears
Pirimicarb (Pirimor®)	1A	2	Medium	Apples
Spirotetramat (Movento®)	23	21	Medium	Pome fruit; suppression only
Sulfoxaflor (Transform® Isoclast™)	4C	7	Medium	Pome fruit

¹ WHP = withholding period. ² Always refer to the label.

Note: Thiacloprid (e.g. Calypso®) is not registered for WAA, but if used to control codling moth as indicated, early-season sprays for WAA might not be required.



Calculating degree days for temperate fruit moth pests

What are degree days?

Degree days (DD) are a measure of temperature over time and are used to predict the timing of life stages of certain insect pests. A degree day model counts the total time the temperature is above the minimum required for the pest to develop (lower developmental threshold).

There are established DD models for codling moth (CM), light brown apple moth (LBAM) and oriental fruit moth (OFM). These are best at predicting the first-generation of activity and usually become less reliable with subsequent generations as the season progresses. For this reason, some insecticide labels for these key pests include DD recommendations for the timing of the first sprays. Knowing how to calculate DD will help growers time their first sprays effectively.

What do you need?

To use DD for your first spray timing, you will need:

- pheromone traps to determine biofix
- thermometer (max-min or weather station)
- calculator or spreadsheet

What is biofix?

Biofix is the date of the first sustained flight of adult moths recorded in pheromone traps. It is used as a starting point for the accumulation of degree days and to guide the timing of the first spray.

How to determine biofix

Deploy traps at a density of about one per hectare, ensuring coverage of the warmest part of the orchard and any known hotspots where damage occurred in the previous season(s). Establish traps at least 1 week before bloom for CM and OFM, but bud break for LBAM. The aim is to record at least 2 weeks with no moths in the traps before the first flights begin. This will increase confidence in determining the biofix when moths emerge from their overwintering pupation sites and fly into the canopy.

Checking traps daily until the first sustained moth flight is recorded will increase the accuracy of the biofix date that you set.

Calculating and accumulating degree days from biofix

A simple formula for calculating DD using daily maximum and minimum temperatures and the lower developmental threshold for the pest is:

$$\text{Degree days} = \frac{(\text{max temp } ^\circ\text{C} + \text{min temp } ^\circ\text{C})}{2} - \text{lower developmental threshold } ^\circ\text{C}$$

Example calculation

For codling moth (with a lower developmental threshold of 10 °C; [Table 69](#)) on a day where the daily maximum temperature was 18 °C and the minimum was 7 °C, the DD for that day would be 2.5, calculated as follows:

$$\text{Degree days} = \frac{(18\text{ }^\circ\text{C} + 7\text{ }^\circ\text{C})}{2} - 10$$

$$\text{DD} = 25 \div 2 - 10$$

$$\text{DD} = 12.5 - 10$$

$$\text{DD} = 2.5$$

The lower developmental thresholds for CM, LBAM and OFM are listed in [Table 69](#).

DDs are calculated daily from biofix and added together to give cumulative degree days (CDD).

If using a max-min thermometer, this is best housed in a Stevenson screen (Figure 137) to ensure accurate measurement of ambient temperature, which can be recorded in a spreadsheet or on paper. Some weather stations with inbuilt models will track DD accumulation and predict first spray timing. Table 70 provides an example of how to accumulate degree days in a spreadsheet format.

Label recommendations for spray timing

Most insecticides for CM, OFM and LBAM target the start of egg hatch (i.e. larval stages). The active ingredient fenoxycarb (e.g. Insegar®) is a notable exception that only controls newly laid eggs. Codling moth and OFM egg hatch occur on average at approximately 110 CDD from biofix, while LBAM egg hatch occurs around 140 CDD. Refer to product labels for recommendations on timing applications based on cumulative degree days.

Table 69. Lower developmental thresholds for 3 key moth pests.

Moth pest	Lower developmental threshold (°C)
Codling moth	10.0
Light brown apple moth	7.0
Oriental fruit moth	7.5

Table 70. An example of a codling moth DD record sheet showing degree days (DD) and cumulative degree days (CDD).

Date of temperature recording	Maximum temperature (°C)	Minimum temperature (°C)	Degree days	Cumulative degree days
3.10.19 Biofix	12	5	0.0	0.0
4.10.19	22	6	4.0	4.0
5.10.19	25	10	7.5	11.5
6.10.19	19	8	3.5	15.0
7.10.19	27	12	9.5	24.5
8.10.19	24	10	7.0	31.5



Figure 137. A Stevenson screen is the recommended housing for temperature recording in the orchard.



Protecting beneficial insects

Modern orchard crop protection programs employ an integrated pest and disease management (IPDM) approach, using a combination of available tools. This includes biological control agents and beneficial insects as well as synthetic chemicals to manage the target pest or disease. Concerns about the environment and occupational health and safety mean that biological controls and beneficial insects are becoming increasingly important.

Orchard IPDM programs should minimise synthetic chemical use by only using them when necessary, accurately targeting their use and using the least disruptive chemical that will do the job. Choosing IPDM-friendly chemistry in a program will help optimise beneficial insect numbers in the orchard, allowing nature to make a useful contribution to controlling the target pest or disease. Important beneficial insects found in temperate fruit orchards include lady beetles, lacewings, parasitic wasps, predatory mites, *Stethorus* spp. beetles and European earwigs.

Some examples include:

- lady beetles (adult and larvae; [Figure 138](#)) are predators of aphids, mealybugs, scale insects and pest mites
- lacewing ([Figure 139](#)) larvae will control mealybugs, aphids, whitefly, scale, pest mites and moth eggs
- parasitic wasps (including *Trichogramma* spp.) lay their eggs in aphids, mealybugs, *Helicoverpa*, borer moths, codling moths, light brown apple moths, oriental fruit moths and looper caterpillars ([Figure 140](#))
- predatory mites ([Figure 141](#)), either native or introduced, prey on pest mites (including Bryobia mite, two-spotted mite and European red mite) and thrips (including WFT).



Figure 138. Lady beetle. Photo: David Cappaert, Michigan State University, www.msu.edu.



Figure 139. Lacewing adult. Photo: Joseph Berger, www.forestryimages.org.



Figure 140. Parasitic wasp. Photo: Scott Bauer, USDA Agricultural Research Service, www.forestryimages.org.



Figure 141. Predatory mite.

Monitoring pest and beneficial populations throughout the growing season is an important component of any IPDM program. Knowing the current status of any pest or beneficial population can greatly improve the ability to run an effective IPDM strategy in the orchard. When a pest problem arises that requires a chemical input, always consider all the control options available and choose the one that will have the least effect on biological control agents living in the orchard.

Protecting biological control agents

1. Be able to recognise orchard pests, beneficial insects and mites. Reference material is available online through [Bugs For Bugs](#), [Cesar Australia](#), and the [Good Bug website](#).
2. Monitor orchard pests, beneficial insects and predatory mites to effectively time sprays.
3. Use chemicals with the least toxicity to beneficials ([Table 71](#)). 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 while waiting for prey.

For further resources and [suppliers](#) of beneficial insects and mites, visit the [Good Bug website](#) (www.goodbugs.org.au/ and www.goodbugs.org.au/suppliers.html).

Table 71. Pesticides toxic to predatory mites, lady beetles and lacewings.

Pesticides	<i>Phytoseiulus persimilis</i>	<i>Galendromus occidentalis</i>	<i>Galendromus pyri</i>	Lady beetles	Lacewings
Insecticides					
Bifenthrin	XX	XX	XX	–	–
Carbaryl	0	X	0	XX	XX
Malathion	X	X	X	XX	XX
Methomyl	XX	X	XX	X	X
Tau-fluvalinate	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; ? = unknown.

This list is not exhaustive, other chemistries might be available.

For more extensive information on chemicals, refer to the [Good Bug website](#) (www.goodbugs.org.au/chemicals.html).



Diseases

Alternaria leaf blotch and fruit spot

Alternaria species

Alternaria leaf blotch and fruit spot mainly affect apples, and can be particularly damaging in warm growing regions with high summer rainfall.



Risk period

Table 72. The peak risk period for alternaria leaf blotch and fruit spot.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Alternaria **leaf blotch** is characterised by irregular red–brown lesions on the leaves that often exhibit blackish-purple borders (Figure 142). Typically, leaf blotch first appears from late spring to early summer and can increase in severity through to harvest.

Alternaria **fruit spot** is characterised by small, slightly sunken, light to medium brown spots appearing on the lenticels of the fruit (Figure 143), often surrounded by a black border. Fruit spotting is commonly observed in late summer through to harvest.



Figure 142. Alternaria leaf blotch on apple leaves.



Figure 143. Alternaria fruit spot on an apple.

Damage

In favourable weather conditions, the alternaria leaf blotches will continue to grow, and when the leaf is half covered by lesions, it will turn yellow (Figure 144) and drop prematurely from the tree. Fruit spotting symptoms appear after warm weather and usually no earlier than 42 days before harvest.

Monitoring

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 considering



Figure 144. Leaf yellowing from alternaria leaf blotch.

applying fungicides (or other treatments) to combat this disease.

The presence of leaf blotch in mid-summer can be an early warning for the likely appearance of fruit spotting later in the season and the need for preventative sprays. Scout the orchard from late spring to look for symptoms of leaf blotch and again for fruit spot in late summer.

Be particularly vigilant with susceptible apple varieties including Fuji, Gala, Cripps Pink and Red Delicious.

Management

Cultural and physical: managing alternaria leaf blotch and fruit spot includes removing or breaking down all leaf and pruning residue during winter (after leaf fall), especially if there was leaf disease last season. In very small orchards, this is done manually by raking and removing leaf litter. In larger orchards, mechanised sweeping (Figure 145) and mulching are more cost-effective at hastening the breakdown of last season's leaf matter.

Biological: there are no known biological controls for alternaria leaf blotch and fruit spot in apples.

Chemical: the chemical options for controlling alternaria leaf blotch and fruit spot are listed in Table 73.



Figure 145. The Sadie sweeper moves leaf and pruning residue to the centre of the row for mulching. Photo: Crendon Machinery.

Table 73. Registered or permitted products for alternaria leaf blotch and fruit spot in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Boscalid + pyraclostrobin (Pristine®)	7 + 11	14	Low	Apples
Cyprodinil + fludioxonil (Switch®)	9 + 12	14	Low	Apples; suppression only
Dithianon (Dinon 700 WG)	M9	21	Low	Apples
Fluopyram + trifloxystrobin (Luna® Sensation)	7 + 11	14	Low	Apples; suppression only
Fluxapyroxad (Sercadis®)	7	0	Low	Apples
Mefentrifluconazole (Belanty®)	3	7	Low	Apples; suppression only
Metiram (Fruitcote)	M3	14	Medium	Apples
Penthiopyrad (Fontelis®)	7	28	Low	Apples; suppression only
Polyoxin D zinc salt (Intervene® WG)	19	Not required when used as directed	Low	Apples

¹ WHP = withholding period. ² Always refer to the label.

Angular leaf spot



Cercospora species and *Pseudocercospora* species

Risk period

Table 74. The peak risk period for angular leaf spot in persimmons.

Bud swell/ green tip	Shoot extension	Flowering and fruit development	Harvest	Postharvest	Dormancy

Disease identification

Angular leaf spot will show as straight-edged leaf spots that are found on infected persimmon foliage (Figure 146). Spots range in size up to 7 mm, with dead tissue in the centre and a green halo. The spots sometimes merge as the disease progresses, forming large necrotic areas. The shape of the leaf spots can be used to differentiate angular leaf spot infections from another key pathogen in persimmons, *Mycosphaerella* spp. (page 109) which results in similar leaf spots but with round margins.



Figure 146. Angular leaf spot on persimmon leaves, showing characteristic angular lesions. Photo: George et al. (2017).

Damage

The disease is favoured by wet growing seasons, especially in Qld and NSW. Differences in varietal susceptibility have been reported, with the Izu cultivar being particularly vulnerable. Severe leaf infections can lead to yellowing, premature leaf fall and lost photosynthetic capacity, affecting fruit growth and carbohydrate reserves for the following season.

Monitoring

Start random leaf inspections in early spring and continue weekly throughout the season. Inspect all varieties to ensure any varietal differences are seen. Identifying the infection early will help target treatments before it becomes too severe.

Management

Cultural and physical: *Cercospora* spores survive over winter on infected leaves and leaf stalks for 5–6 months and are a source of inoculum for infections in the following season. Therefore, good orchard hygiene to remove or destroy fallen leaves through mulching thoroughly will help reduce the disease potential. The fungus is spread by rainfall and is thought to be favoured by dense canopies and high humidity.

Pruning trees to encourage an open canopy will speed up drying, reduce humidity and allow for good spray penetration and coverage.

Chemical: the chemicals currently registered or permitted for managing angular leaf spot in NSW persimmon orchards are listed in [Table 75](#).

Table 75. Registered or permitted products for angular leaf spot in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Chlorothalonil (PER13445 , expires 30.4.30)	M5	7	Low	Persimmons
Difenoconazole (PER87599 , expires 31.3.29)	3	28	Low	Persimmons
Mancozeb (PER12488 , expires 30.11.29)	M3	14	Medium	Persimmons

¹ WHP = withholding period. ² Always refer to the label.

Apple black spot/scab fungicide resistance project

Black spot, or apple scab, is a persistent disease in Australian apple orchards. Most cultivars grown are susceptible to infection. Therefore, control is often based on fungicide application, which, depending on the weather, can differ in frequency per season. This can pose a challenge, because the fungus causing black spot, *Venturia inaequalis*, is classified as a high risk for developing resistance to the various fungicides applied.

A project investigating the management of black spot/apple scab in Australian apple orchards has started. Western Australia's Department of Primary Industries and Regional Development has partnered with Curtin University, with funding through the SAAFE CRC, to investigate fungicide resistance in Australian production regions. The 4-year project aims to collect samples of blackspot from all the major apple growing regions in Australia and test them against the commonly used fungicides, to determine if these remain effective. The fungicide groups to be tested include 3, 7, 11 and U12. The project is also conducting testing on pear black spot, caused by a related fungus, *Venturia pirina*.

To determine if there is any fungicide resistance in the different growing regions in Australia, we require samples of black spot for testing. Infected leaves and fruit are suitable.

How to get involved

To assist in the sampling process, sample packs are available, which provide all the information required and return postage. Testing conducted during the project is free. Organic orchards are also encouraged to participate.

If you would like to participate in the project by requesting a sample pack or for further information on the project, please email applescab@dpird.wa.gov.au.

All samples collected in the project are deidentified for reporting; however, results will be sent back to each sampler to assist in individual management decisions.

Find out more information on the project [SAAFE Management of apple scab](https://www.crcsaafe.com.au/research/projects/management-of-apple-scab) (<https://www.crcsaafe.com.au/research/projects/management-of-apple-scab>).



Apple scab and pear scab



Venturia inaequalis and *Venturia pirina*

Apple scab (or black spot) is one of the most serious diseases in apples and pears and is found in all NSW growing regions. The fungus that infects apples (*V. inaequalis*) cannot infect pears, nor can the pear fungus (*V. pirina*) infect apples.

Risk period

Table 76. The peak risk period for apple scab and pear scab.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy
	Primary infection		Secondary infection		

Disease identification

Scab infection results in small, olive green–brown irregularly shaped lesions on the leaves (Figure 147) that become larger as they mature. Symptoms on the fruit are similar to those on the leaves but tend to have well-defined margins. As fruit lesions mature, they become brown to black and appear dry (Figure 148 and Figure 149).



Figure 147. Primary scab infection on an apple leaf.

Damage

Primary infections occur on leaves and fruit when overwintering spores (mostly from last season's leaf litter) land on wet foliage and germinate. Once mature, primary infections can lead to secondary infections when spores are splashed through the canopy by rain.

Growth around the lesions becomes distorted as the fruit expands, giving it an uneven shape. Fruit lesions are superficial and the fungus does not extend into the flesh, but scabbed fruit is considered unsuitable for wholesale and retail fresh markets.



Figure 148. Scab lesions on an apple. Photo: Andrew Taylor, WA DPIRD.

Monitoring

For apple or pear scab to occur, the host plant must remain wet long enough for the fungal spores that cause the disease to germinate. Warm (17–20 °C), wet conditions are ideal for infection. Disease models using rainfall, temperature and period of wetness to predict the likelihood of infection are available. Infection warning services operate in some regions. Alternatively, growers can establish weather station(s) and monitor infection risk in their orchards.

Inspect foliage and fruit closely when the primary infection period is over (around the end of November to the start of December).



Figure 149. Scab lesions on a pear. Photo: Bruce Watt, University of Maine, Bugwood.org.

Management

Cultural and physical: good orchard hygiene, especially during autumn and winter, helps to reduce scab carry-over and disease pressure in spring. A postharvest foliar nitrogen spray (usually Lo-biuret urea at 500 g/100 L of spray) at early leaf fall will encourage microbial action to break down fallen leaves. Any action that removes or helps break down fallen leaves will be beneficial. This includes raking, removing or sweeping and slashing to chop leaves into small pieces.

Biological: there are currently no biological control agents available for apple and pear scab. Growing scab-resistant varieties can reduce or negate the need for intensive fungicide spray programs for this disease. Consult your fruit nursery supplier for information on resistant varieties.

Chemical: spray programs (Table 77) for scab should focus on achieving thorough control during the spring primary infection period (from green-tip to the end of spring). If controlled well then, the potential for secondary infections through the rest of the growing season is dramatically reduced.

Table 77. Registered or permitted products for apple scab and pear scab in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Boscalid + pyraclostrobin (Pristine®)	7 + 11	14	Low	Apples, pears
Captan (Captan®)	M4	7	Low	Apples, pears
Copper-based fungicides (various)	M1	1	Low	Apples, pears
Cyprodinil (Chorus®)	9	Not required when used as directed	Low	Apples, pears
Difenoconazole (Bogard®)	3	28	Low	Apples, pears
Dithianon (Dinon 700 WG)	M9	21	Low	Apples, pears
Dodine (Syllit®)	U12	5	Low	Apples, pears
Fluopyram + trifloxystrobin (Luna® Sensation)	7 + 11	14	Low	Apples, pears
Fluxapyroxad (Sercadis®)	7	0	Low	Apples
Hexaconazole (Hostile 50SC)	3	Apples 7; Pears 14	Low	Apples, pears
Ipflufenquin (Migiwa® Kinoprol®)	52	42	Unknown	Apples
Isopyrazam (Seguris Flexi®)	7	21	Low	Apples, pears
Kresoxim-methyl (Stroby®)	11	42	Low	Apples, pears
Mancozeb (Dithane® Rainshield® NeoTec®)	M3	14	Medium	Pome fruit
Mefentrifluconazole (Belanty®)	3	7	Low	Apples
Metiram (Polyram®)	M3	14	Medium	Pome fruit
Myclobutanil (Myclonil)	3	21	Low	Apples, pears
Penconazole (Topas®)	3	14	Low	Apples, pears
Penthiopyrad (Fontelis®)	7	28	Low	Pome fruit
Potassium bicarbonate + potassium silicate (Ecocarb® Plus)	M2	Not required when used as directed	Low	Apples
Sulfur as polysulfide sulfur (7 Worlds Ag Lime Sulphur)	M2	Not required when used as directed	Medium	Apples, pears; do not apply to Delicious or Cox's Orange Pippin
Thiram (Thiram WG)	M3	7	Low	Apples, pears
Trifloxystrobin (Flint®)	11	35	Low	Apples, pears
Triforine (Saprol®)	3	1	Low	Apples; do not apply to Golden Delicious or Cox's Orange Pippin
Zineb (Barmac Zineb)	M3	14	Low	Pome fruit
Ziram (Ziram WG)	M3	7	Medium	Apples, pears

¹ WHP = withholding period. ² Always refer to the label.

Bacterial canker

Pseudomonas syringae pv. *syringae*

Bacterial canker can affect all parts of stone fruit trees, with cherries and apricots the most susceptible.



Risk period

Table 78. The peak risk period for bacterial canker.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Trees infected with bacterial canker will have dead bark and when this is removed, the underlying tissue will be orange–brown (Figure 150). Large amounts of gum can exude from the trunk and bark cankers (Figure 151). The infection first appears on the leaves as water-soaked spots, which can turn brown and fall out as the leaves age (Figure 152). Leaves can also have a yellowing, rolled appearance. Bacterial canker can be identified on the fruit by sunken spots with dark centres and occasionally with underlying gum pockets. Growers should be careful when pruning and performing other management activities to not damage the bark of trees during winter, as this can encourage bacterial canker infection.



Figure 150. Bacterial canker on a cherry tree.

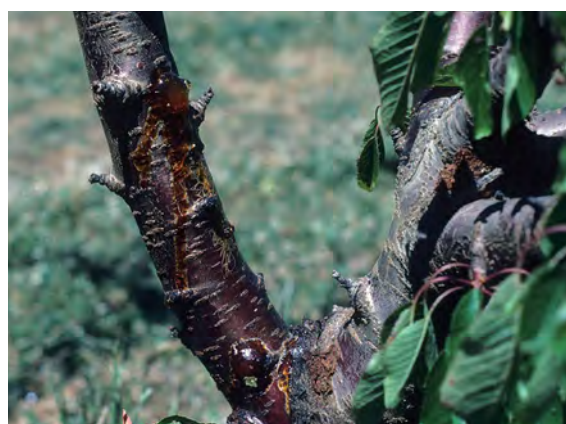


Figure 151. Bacterial canker on a cherry tree.

Damage

Bacterial canker is favoured by wet, windy conditions in autumn and early winter before and during leaf fall. Damage to trees and limbs from pruning and hail or wind during early dormancy increases disease risk. Rain during the growing season will encourage the disease to spread throughout the orchard. Bacterial canker will cause economic loss through a reduced fruit yield and branches or whole trees dying.

Monitoring

Inspect orchard trees regularly throughout the growing season for signs of dieback and/or gum-producing cankers. Severely infected trees should be promptly removed.

Management

Cultural and physical: it is good practice to avoid pruning stone fruit trees in winter. Prune soon after harvest or as close to bud burst as possible. Prune areas of the orchard with canker problems last and paint large pruning wounds with white acrylic paint or a proprietary tree wound dressing. As canker can be particularly severe in young plantings, it is important to maintain a complete disease control schedule.



Figure 152. Bacterial canker on cherry leaves.

Control wildlife such as rabbits, hares and macropods that will chew young green bark, creating disease entry sites.

Cherries and apricots are more susceptible than nectarines, peaches and plums. Therefore, in orchards prone to bacterial canker infection, avoid planting cherries and apricots.

Biological: there are currently no biological controls available for controlling bacterial canker in stone fruit.

Chemical: the chemical options for controlling bacterial canker are listed in [Table 79](#).

Table 79. Registered or permitted products for bacterial canker in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
<i>Bacillus amyloliquefaciens</i> (Serenade® Opti Biofungicide, PER88559 , expires 30.6.29)	44	Not required when used as directed	Low	Cherries; suppression only
Copper-based fungicides (various)	M1	1	Low	Apricots, cherries, stone fruit

¹ WHP = withholding period. ² Always refer to the label.

Bacterial spot

Xanthomonas arboricola pv. *pruni*

Bacterial spot is a disease that causes spotting on plum, apricot and peach leaves and fruit.



Risk period

Table 80. The peak risk period for bacterial spot.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Fruit infected with bacterial spot will have small circular, greasy spots that will sink and darken as the fruit enlarges (Figure 153). These spots often crack, providing entry points for secondary diseases. Similar greasy or water-soaked spots can be seen on the leaves of infected trees (Figure 154).

Damage

Up to half the fruit can become unsaleable due to cosmetic damage. Extensive leaf spotting results in ripping and tattering of foliage, reducing photosynthetic capacity.

Monitoring

Monitor leaves and fruit throughout the season to ensure early detection as the infection is difficult to control once established. Wet conditions between blossom and petal fall favour infection on peach and nectarine leaves and fruit. Windy, wet conditions and heavy dew during the growing season will also favour secondary infections. Extra caution is recommended during these conditions.

Management

Cultural and physical: trees suffering from other pests and diseases are more susceptible to bacterial spot. Maintain soil fertility and good pest management. Destroy any nearby neglected trees as they can act as a source of inoculum for the disease. Do not prune during wet weather.

Biological: there are currently no known biological control agents for bacterial spot.

Chemical: control options for bacterial spot in NSW are limited (Table 81). However, applying a full control schedule for leaf curl, shot hole and rust, which includes an early-season copper application, should help control bacterial spot.

Table 81. Registered or permitted products for bacterial spot in NSW.

Active constituent (example trade name)	Fungicide group	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
<i>Bacillus amyloliquefaciens</i> (Serenade® Opti Biofungicide, PER88559, expires 30.6.29)	44	Not required when used as directed	Low	Cherries
Copper oxychloride (Coppox®)	M1	1	Low	Stone fruit

¹ WHP = withholding period. ² Always refer to the label.



Figure 153. Bacterial spot on plums.



Figure 154. Bacterial spot on leaves. Photo: University of Georgia Plant Pathology, Bugwood.org.

Bitter rot

Glomerella cingulata (anamorph: *Colletotrichum gloeosporioides*)



Bitter rot is a fruit rotting disease of apples and pears that is more common in orchards with minimal fungicide spray programs.

Risk period

Table 82. The peak risk period for bitter rot.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Bitter rot symptoms will usually appear as small, light brown circular spots when the fruit is almost full size (Figure 155). These spots can enlarge rapidly and become sunken. If left untreated, the rot can penetrate deep into the flesh. Occasionally, if disease pressure is high, leaves of infected trees might show small, red flecks on the surface.



Figure 155. Bitter rot in an apple. Photo: University of Georgia Plant Pathology, Bugwood.org.

Damage

Infection on fruit makes it unsaleable and prone to decay. Fruit infection is less common in orchards that receive a full protective spray program for apple or pear scab.

Monitoring

Bitter rot is usually seen in warmer coastal districts after November, particularly in the Sydney basin. It is favoured by warm, humid and wet conditions during the growing season. Careful monitoring of susceptible areas is recommended from 3 weeks after petal fall until harvest.

Management

Cultural and physical: good orchard hygiene is critical for bitter rot control. The disease can survive over winter on mummified fruit and dead wood; this must be removed and destroyed. All prunings should be removed from the orchard floor or mulched.

Biological: there are currently no biological controls available for controlling bitter rot in pome fruit.

Chemical: the chemical options for controlling bitter rot are listed in Table 83.

Table 83. Registered or permitted products for bitter rot in NSW.

Active constituent (example trade name)	Fungicide group	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Copper oxychloride (Coppox®)	M1	1	Low	Pome fruit
Dithianon (Dinon 700 WG)	M9	21	Low	Apples
Mancozeb (Dithane® Rainshield® NeoTec®)	M3	14	Medium	Pome fruit
Metiram (Polyram®)	M3	14	Medium	Pome fruit
Zineb (Barmac Zineb)	M3	14	Low	Pome fruit
Ziram (Ziram WG)	M3	7	Medium	Apples

¹ WHP = withholding period. ² Always refer to the label.

Blossom blight and brown rot



Monilinia species

Blossom blight and brown rot are the most important diseases of stone fruit. The causal fungi are the 2 related pathogens, *Monilinia fructicola* and *Monilinia laxa*.

Risk period

Table 84. The peak risk period for blossom blight and brown rot.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy
	Blossom blight		Brown rot		

Disease identification

Blossom blight results in brown, shrivelled, dead flowers (Figure 156) and some dieback of the associated shoot growth. Brown rot infection appears as a soft brown decay of the developing fruit, which exhibits profuse brown–grey spores over the surface of the infection as it matures (Figure 157 and Figure 158). Infected fruit will sometimes shrivel and hang on the tree. These mummified (or mummy) fruit (Figure 159) and infected shoots are a major source of spores for the next season and should be removed from the orchard.

The first blossoms on cherry trees are the first susceptible tissue for infection at the start of the growing season (Figure 160). Conidia (spores produced asexually by various fungi), inoculum from mummified fruit, infected peduncles (the stalk bearing a flower or fruit) and cankers can be disseminated by splashing or wind-blown rain early in the season (Dowling et al. 2019).

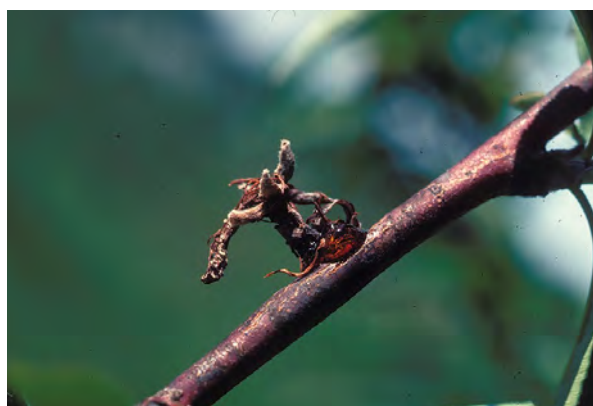


Figure 156. A peach flower infected by blossom blight. Photo: University of Georgia Plant Pathology, University of Georgia, Bugwood.org.



Figure 157. Peach fruit showing typical brown rot infection. Photo: Rebecca A Melanson, Mississippi State University Extension, Bugwood.org.



Figure 158. Brown rot on cherries.



Figure 159. Mummified fruit. Photo: Clemson University, USDA Cooperative Extension Slide Series, Bugwood.org.

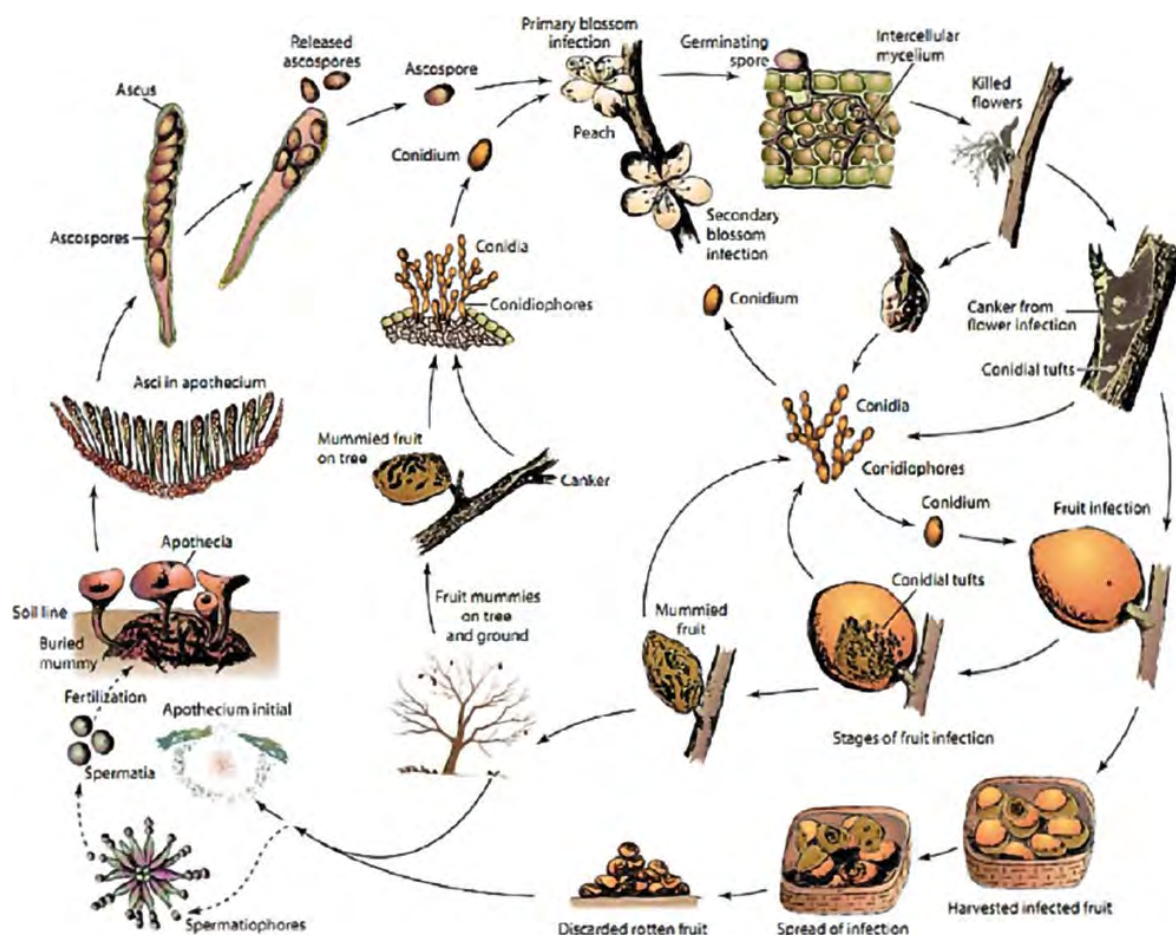


Figure 160. Life cycle of *Monilinia* species. Reprinted with permission from Plant Pathology, Elsevier Limited.

Damage

Blossom blight and brown rot can cause significant flower, shoot and crop loss if not carefully managed. Blossom blight reduces the number of viable flowers and damages fruiting shoots, which can result in poor pollination and fruit set. Brown rot makes fruit unsaleable and late-season infections can lead to fruit breakdown during postharvest storage, handling and marketing.

Monitoring

Blossom and/or fruit infection is likely if the disease was present in the previous season, and with warm conditions (around 20 °C or greater) combined with moisture from heavy dew or rainfall. Due to the high potential for losses, particularly in warm, wet seasons, it is worth monitoring for these diseases regularly. Check flowers, shoots and developing fruit for signs of rot at least weekly, and particularly following favourable weather conditions.

Management

Cultural and physical: remove and destroy infected shoots and mummified fruit as soon as they are noticed. Doing this early in the season will reduce the potential for the infection to spread to healthy fruit later in the season. Winter pruning is a good time for a final check to ensure all mummified fruit and infected shoots are removed before the start of the new season.

Biological: research into potential biocontrol agents for *Monilinia* species in stone fruit is ongoing. The plant protein-based biological fungicide, Problad® Verde, has label registration for suppression of brown rot and blossom blight in stone fruit (Table 85).

Chemical: an effective spray program for blossom blight and brown rot will include a combined approach of protective cover sprays and curative fungicides as needed from bud burst through flowering and to harvest, depending on weather conditions and disease pressure. Postharvest chemical options are also included in Table 85. For more information on managing storage rots, including brown rot, refer to [Managing postharvest diseases and disorders on page 127](#).

Table 85. Registered or permitted products for blossom blight and brown rot in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in ² ...
<i>Bacillus amyloliquefaciens</i> (Serenade® Opti Biofungicide, PER88559 , expires 30.6.29)	44	Not required when used as directed	Low	Cherries; suppression only
BLAD (ProBlad® Verde)	BM01	Not required when used as directed	Low	Stone fruit; suppression only
Captan (Captan®)	M4	7	Low	Stone fruit except apricots
Chlorothalonil (Bravo Weather Stik®)	M5	Apricots, cherries, nectarines, peaches 7; plums 1	Low	Apricots, cherries, nectarines, peaches, plums
Copper oxychloride (Coppox®)	M1	1	Low	Stone fruit
Cyprodinil (Chorus®)	9	Not required when used as directed	Low	Apricots, nectarines, peaches, plums
Dithianon (Dinon 700 WG)	M9	21; canning peaches 1	Low	Apricots, cherries, nectarines, peaches, plums, prunes
Dodine (Syllit®)	U12	Not required when used as directed	Low	Nectarines, peaches; do not apply after petal fall
Fludioxonil (Starling)	12	Not required when used as directed	Low	Stone fruit
Fluopyram + trifloxystrobin (Luna® Sensation)	7 + 11	1	Low	Stone fruit
Iprodione 250 g/L (Rovral Liquid®)	2	0	Low	Stone fruit; orchard spray only
Iprodione 500 g/L (Rovral Aquaflo®)	2	0	Low	Stone fruit; orchard spray and postharvest dip
Mancozeb (Dithane® Rainshield® NeoTec®)	M3	14	Medium	Stone fruit
Mandestrobin (Intuity™)	11	7	Low	Stone fruit
Penthiopyrad (Fontelis®)	7	Not required when used as directed	Low	Stone fruit
Potassium bicarbonate + potassium silicate (Ecocarb® Plus)	M2	Not required when used as directed	Low	Nectarines
Procymidone (Sumiscler® 500)	2	9	Low	Stone fruit
Propiconazole (Tilt® 500 EC)	3	1	Low	Stone fruit; blossom and fruit phases only
Pyraclostrobin + fluxapyroxad (Merivon®)	11 + 7	2	Low	Cherries
Sulfur as polysulfide sulfur (7 Worlds Ag Lime Sulphur)	M2	Not required when used as directed	Medium	Stone fruit (dormant to bud swell spray only)
Sulfur (Thiovit Jet®)	M2	Not required when used as directed	Medium	Nectarines, peaches, plums
Thiram (Thiram WG)	M3	7	Low	Stone fruit
Triforine (Saprol®)	3	0	Low	Apricots, nectarines, peaches, plums, prunes; orchard spray and postharvest dip
Ziram (Ziram WG)	M3	7	Low	Cherries, nectarines, peaches

¹ WHP = withholding period. ² Always refer to the label.

*Note: some of the chemicals listed have label claims for both blossom blight and brown rot, while others are only registered for one of these diseases. Always check the product label to ensure the correct product choice.

Circular leaf spot



Mycosphaerella species

Circular leaf spot was first identified in persimmons by NSW DPIRD in 2003. As the symptoms are similar, this leaf disease is often confused with angular leaf spot, which is also found in persimmons ([page 98](#)).

Risk period

Table 86. The peak risk period for circular leaf spot in persimmons.

Bud swell/ green tip	Shoot extension	Flowering and fruit development	Harvest	Postharvest	Dormancy

Disease identification

Infected persimmon foliage will have large circular spots with green halos ([Figure 161](#)). However, the lesions are generally larger and more rounded (i.e. not constrained by the leaf cell or vein structures) than with angular leaf spot.

Damage

Circular leaf spot is a major problem, especially in wet seasons, and particularly in northern NSW and the Sydney basin growing regions. It can lead to reduced photosynthetic capacity and premature leaf drop, which can affect fruit size in the current season and carbohydrate accumulation for the following season.

Monitoring

Start random leaf inspections in early spring and continue checking weekly throughout the season. Make sure all varieties are included to ensure any varietal differences are captured. Identifying the infection early will help to target treatments before it becomes too severe.

Management

Cultural and physical: circular leaf spot spores survive over winter on infected leaves and leaf stalks for 5–6 months and are a source of inoculum for infections in the following season. Therefore, good orchard hygiene to remove and destroy fallen leaves will help reduce the disease potential. The fungus is spread by rainfall and is thought to be favoured by dense canopies and high humidity. Pruning trees to encourage an open canopy will speed up drying, reduce humidity and allow for good spray penetration and coverage.

Biological: there are currently no biological control treatments available for circular leaf spot.

Chemical: there are currently no chemicals registered or permitted to control circular leaf spot in persimmons. However, spray programs targeting angular leaf spot ([page 98](#)) might reduce the incidence of this disease.



Figure 161. Circular leaf spot (*Mycosphaerella* spp.) symptoms on a persimmon leaf. Photo: George et al. (2017).

Crown gall

Agrobacterium tumefaciens

Crown gall is caused by the bacterium *Agrobacterium tumefaciens*. It occurs mostly on stone fruit and some ornamentals, for example roses, but less commonly on pome fruit, grapes and olives.



Risk period

Table 87. The peak risk period for crown gall.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Crown gall can be identified by galls on the crown of the plant (the point at the soil line where the main roots join the stem) and on the roots. They can also form on the main stem above the soil level or on branches. An example of a severe gall infection at the upper crown area on the roots of a peach seedling is shown in [Figure 162](#). There might not be any visible effect on the plant other than the galls. If infection is severe and many galls are present, plants, particularly young ones, can be stunted and unthrifty and can die if they are stressed by dry conditions. However, these symptoms are not diagnostic for crown gall; the presence of galls identifies the disease.



Figure 162. Crown gall on a peach seedling. Illustration: Margaret Senior.

Damage

Galls first appear as small, pale, roughened lumps of tissue. They enlarge, darken and become convoluted. The galls can be 25–50 mm in diameter on nursery plants and up to 300 mm on trees in the field.

Crown gall causes the greatest financial loss in the nursery; up to 80% of plants can be lost, with the symptoms only being noticed when the plants are dug up for sale. Suppliers are legally required to reject all infected plants before sale.

Monitoring

Check nursery stock and new trees for galls on receipt and before planting; notify the nursery supplier if crown gall is suspected. Young trees that look weak or stunted can be dug up and the crown area can be inspected for galls.

Management

Cultural and physical: the disease can be transferred between trees on pruning and grafting equipment; frequently disinfecting tools will help prevent this. Avoid unnecessary damage to the root system. The bacterium is thought to spread in water, so selecting a well-drained orchard site for establishment might help minimise the risk. Resistant rootstocks might also have a role in preventing crown gall in some tree crops. Speak with the nursery supplier to enquire about rootstock choices for your crop.

Biological: the only effective biological treatment for crown gall is listed in [Table 88](#).

Table 88. Registered treatment for crown gall in NSW.

Active constituent (example trade name)	Treatment type	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Rhizobium rhizogenes strain K1026 (Nogall®)	Biological	0	Low	Stone fruit

¹ WHP = withholding period. ² Always refer to the label.

Fly speck

Schizothyrium pomi



Fly speck is a fungal disease that causes surface blemishes on apples and pears, usually late in summer. It is rare in modern commercial orchards where disease management incorporates foliar fungicide sprays.

Risk period

Table 89. The peak risk period for fly speck.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Fly speck is identified by clusters of black, shiny specks on the fruit surface (Figure 163). These specks are round to irregular, and although fly speck can appear separately, it is commonly found in the same conditions that suit sooty blotch development (refer to page 124).

Damage

Fly speck can shorten the storage life of the fruit due to increased water loss. The saleability of the fruit is reduced due to its unacceptable appearance. In wet years, infected areas can suffer up to 25% loss.

Monitoring

Fly speck can survive from one season to the next on infected branches. The spores are then dispersed during rain in spring and early summer. Monitoring for fly speck should occur when conditions are favourable, i.e. when temperatures are between 18 °C and 27 °C with humidity greater than 90%.

Management

Cultural and physical: this disease can be managed with good orchard maintenance. Pruning to open the canopy will increase light and airflow, reducing the incidence of fly speck.

Biological: there are no biological control measures for fly speck.

Chemical: the chemical options for controlling fly speck are listed in Table 90.

Table 90. Registered or permitted products for fly speck in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Mancozeb (Dithane® Rainshield® NeoTec®)	M3	14	Medium	Apples, pears
Metiram (Polyram®)	M3	14	Medium	Apples, pears

¹ WHP = withholding period. ² Always refer to the label.



Figure 163. Fly speck on an apple. Photo: Bruce Watt, University of Maine, Bugwood.org.

Freckle

Venturia carpophilum

Freckle (or scab) is a fungal disease caused by *Venturia carpophilum*. This disease affects stone fruit and is found in all growing regions. It is particularly prevalent when conditions are warm and wet during the growing season.



Risk period

Table 91. The peak risk period for freckle.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Freckle infection on the fruit will appear as greenish–brown to black spots arising at the stem end (Figure 164), which can combine to form a greenish, velvety blotched area if the infection is severe. Symptoms on the leaves first appear as pale, green areas, which go dark brown as the disease progresses.



Figure 164. Freckle on stone fruit.

Damage

Damage from freckle can affect fruit growth and increase the incidence of cracks in the fruit, making it unmarketable. With severe infection, leaves can fall prematurely, resulting in reduced photosynthetic capacity and general tree decline.

Monitoring

Monitor weather conditions and take a preventative approach to controlling infection. Freckle is favoured by temperatures between 18 °C and 24 °C after rain.

Management

Cultural and physical: ensure there is adequate airflow throughout the canopy to increase the rate of drying after rain. Avoid planting in low-lying areas. Remove and destroy infected fruit.

Biological: there are no biological controls for freckle.

Chemical: spray programs for other stone fruit diseases are likely to control freckle. However, there are fungicides registered (Table 92) to control freckle if a specific treatment is required.

Table 92. Registered or permitted products for freckle in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Chlorothalonil (Bravo Weather Stik®)	M5	7	Low	Apricots
Copper-based fungicides (various)	M1	1	Low	Check product labels for crops
Dithianon (Dragon®)	M9	21	Low	Apricots, nectarines, peaches
Mancozeb (Dithane® Rainshield® NeoTec®)	M3	14	Medium	Stone fruit
Penthiopyrad (Fontelis®)	7	Not required when used as directed	Low	Stone fruit
Sulfur as polysulfide sulfur (7 Worlds Ag Lime Sulphur)	M2	Not required when used as directed	Medium	Pears, apricots, nectarines, peaches, plums, prunes; stone fruit dormant to bud swell spray only
Thiram (Thiram WG)	M3	7	Low	Stone fruit
Ziram (Ziram WG)	M3	7	Medium	Stone fruit except apricots

¹ WHP = withholding period. ² Always refer to the label.

Peach leaf curl



Taphrina deformans

Peach leaf curl is a fungal disease that affects peaches and nectarines. If untreated, it is one of the most serious and common diseases of these crops.

Risk period

Table 93. The peak risk period for peach leaf curl.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Leaf curl is often seen in the top of the canopy, where spray coverage might not have reached. Infection will appear on younger leaves first; they will be pink-red with the characteristic curling leaf (Figure 165).

Damage

Peach leaf curl is favoured by a cool, wet spring around bud swell followed by warm, humid conditions, which bring about rapid growth. The optimum temperature range for fungal growth is between 20 °C and 26 °C.

After the initial infection, leaves will curl and become severely distorted. Leaves then tend to turn yellow and fall, causing new tissue to replace fallen leaves. The energy required for this new growth reduces fruit set and weakens trees. Leaf curl can also affect young shoots, which become stunted and distorted, often resulting in shoot death. Infected fruit will have raised, irregularly shaped and rough areas on the skin surface (Figure 166).



Figure 165. Peach leaf curl. Photo: Whitney Cranshaw, Colorado State University.



Figure 166. Peach leaf curl symptoms on a peach. Photo: Gerald Holmes, Strawberry Centre, Cal Poly San Luis Obispo.

Monitoring

Correct timing of protectant sprays in early spring (particularly copper-based fungicides) is vital for controlling the disease. Monitor bud development in late winter to early spring to ensure correct spray timing according to label instructions.

Monitor and record the incidence of leaf infection in the current season to inform management decisions for the next season.

Management

Cultural and physical: 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.

Biological: there are no known biological control agents for peach leaf curl. However, copper sprays provide effective control and some copper-based fungicides have been approved for use in organic production systems.

Chemical: the chemical options for controlling peach leaf curl are listed in [Table 94](#).

Table 94. Registered or permitted products for peach leaf curl in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Chlorothalonil (Bravo Weather Stik®)	M5	7	Low	Peaches
Copper-based fungicides (various)	M1	1	Low	Nectarines, peaches
Dithianon (Dinon 700 WG)	M9	21	Low	Nectarines, peaches
Dodine (Syllit®)	U12	Do not apply after petal fall	Low	Nectarines, peaches
Sulfur as polysulfide sulfur (7 Worlds Ag Lime Sulphur)	M2	Not required when used as directed	Medium	Stone fruit except cherries (dormant to bud swell spray only)
Ziram (Ziram WG)	M3	7	Low	Cherries, nectarines, peaches

¹ WHP = withholding period. ² Always refer to the label.

Phytophthora root and collar rot



Phytophthora species

Soil pathogens from *Phytophthora* species can cause root and collar rots. These pathogens affect pome and stone fruit trees and can cause significant tree decline and losses. Periods of high rainfall and wet soil create the highest risk for phytophthora root and collar rots.

Risk period

Table 95. The peak risk period for phytophthora root and collar rots.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Although several species of *Phytophthora* can cause root and collar rot in temperate fruit orchards, the symptoms are generally the same in all temperate fruit trees. The first obvious sign of an infection is likely to be leaf yellowing, followed by premature leaf drop and a gradual decline in tree health, leading to tree death (Figure 167). This can occur in individual trees or groups, usually along a tree row. Closer inspection around the base of sick trees should reveal the tell-tale wood rot (collar rot) where the tree trunk meets the soil (Figure 168).



Figure 167. *Phytophthora* collar rot on an apple tree, showing various stages of decline from a light yellowing to premature leaf drop.



Figure 168. Apple tree on M26 rootstock with typical collar rot symptoms.

Damage

Phytophthora spp. are water-borne soil pathogens that infect tree roots and crowns, causing a loss of root mass, trunk collar rot and significant tree decline. They are usually associated with poorly drained and waterlogged soil. Spores move through the soil in water, so disease spread might be increased with excessive irrigation.

Monitoring

Treatment options are limited, so strategies for prevention and early detection are essential. Monitor orchards regularly for the early signs of leaf yellowing and tree decline.

Management

Cultural and physical: cultural control of phytophthora root and collar rot focuses on preventative measures including:

- selecting well-drained sites for establishing new orchards
- using resistant rootstocks (options exist for apple and cherry)
- maintaining and improving soil structure
- managing irrigation water to avoid periods of soil saturation
- good orchard biosecurity practices, such as washing boots in footbaths before entering orchards, can prevent the disease from spreading.

Biological: beneficial soil bacteria and antagonistic fungi can help reduce the risk of soil-borne diseases. Building healthy soil by adding organic matter will help encourage beneficial soil organisms.

Chemical: the chemical options for controlling phytophthora are listed in [Table 96](#).

Table 96. Registered or permitted products for phytophthora root and collar rot in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Copper-based fungicides (various)	M1	1	Low	Nectarines, peaches, plums; trunk treatment
Fosetyl-aluminium (Aliette®)	33	Apples 14; peaches not required when used as directed	Low	Apples, peaches
Fosetyl-aluminium (PER85273 , expires 31.1.28)	33	Not required when used as directed	Low	Apricots, nectarines, peaches, plums

¹ WHP = withholding period. ² Always refer to the label.

Powdery mildew



Podosphaera leucotricha

Powdery mildew is one of the most common diseases in apples. It can severely affect tree growth, particularly in young trees.

Risk period

Table 97. The peak risk period for powdery mildew.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Leaves and shoots are most susceptible to powdery mildew in the first few days after opening. The first indication of powdery mildew is pale patches on the upper leaf surface (Figure 169). As the disease advances, the patches become powdery white and will cover both sides of the leaf. Leaves infected with mildew will have crinkled and cupped edges (Figure 170), giving them a narrow appearance.

Damage

Infected leaves can often fall during summer, reducing the photosynthetic rate. Powdery mildew can severely affect tree growth, particularly on young trees. Infected floral buds might abort or produce small, stunted fruit, resulting in reduced yield and pack-out. Infections during flowering and early fruit development can damage the skin of apples, resulting in a russet that makes the fruit unmarketable.

Monitoring

Powdery mildew outbreaks are most likely in spring and early summer, and with new growth in autumn. Relatively humid, mild conditions (10–25 °C) without rain favour this disease, although it can withstand hot, dry conditions and produce spores. These spores are then spread by wind but are killed in high temperatures. Monitor powdery mildew during winter and throughout the growing season. Growers can choose designated monitoring trees and assess 10 extension shoots on these trees. Inspect the top 5 unfolded leaves per shoot for the signs of powdery mildew, recording any incidences. Frequent monitoring of these shoots will increase the opportunity to intervene at the correct time, as powdery mildew can develop rapidly.



Figure 169. Early signs of powdery mildew infection on an apple leaf.



Figure 170. Powdery mildew on a new season apple shoot.

Management

Cultural and physical: powdery mildew can be controlled by removing infected buds as this reduces the source of spores for infecting new leaves and buds. Winter pruning is a good time to remove infected shoot tips. Look for the white stems of infected one-year-old shoots and cut them back to uninfected wood. Removing infected prunings from the orchard will help reduce the potential for the disease to spread.

Pruning to open the canopy can also help reduce infection, as it encourages airflow through the canopy. Modifying the environment around the trees can also reduce the incidence of powdery mildew. Windbreaks, netting and tree planting should be managed to optimise airflow, particularly in regions where powdery mildew is problematic.

Biological: there is currently no biological control available for powdery mildew in apples.

Chemical: the chemical options for controlling powdery mildew are listed in [Table 98](#).

Table 98. Registered or permitted products for powdery mildew in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Boscalid + pyraclostrobin (Pristine®)	7 + 11	14	Low	Apples
Bupirimate (Nimrod®)	8	7	Low	Apples
Difenoconazole (Bogard®)	3	28	Low	Apples, pears; suppression only
Fluopyram + trifloxystrobin (Luna® Sensation)	7 + 11	14	Low	Apples
Fluxapyroxad (Sercadis®)	7	0	Low	Apples
Hexaconazole (Hostile 50SC)	3	7	Low	Apples
Ipflufenquin (Migiwa® Kinoprol®)	52	42	Unknown	Apples
Isopyrazam (Seguris Flexi®)	7	21	Low	Apples
Kresoxim-methyl (Stroby®)	11	42	Low	Apples
Mefentrifluconazole (Belanty®)	3	7	Low	Apples
Myclobutanil (Systhane® 400 WP)	3	21	Low	Apples
Penconazole (Topas®)	3	14	Low	Apples
Penthiopyrad (Fontelis®)	7	28	Low	Pome fruit
Polyoxin D zinc salt (Intervene® WG)	19	Not required when used as directed	Low	Apples
Potassium bicarbonate + potassium silicate (Ecocarb® Plus)	M2	Not required when used as directed	Low	Apples
Proquinazid (Talendo®)	13	28	Low	Apples, pears
Sulfur as polysulfide sulfur (7 Worlds Ag Lime Sulphur)	M2	Not required when used as directed	Medium	Apples
Sulfur (Thiovit Jet®)	M2	Not required when used as directed	High	Pome fruit
Trifloxystrobin (Flint®)	11	35	Low	Apples, pears
Triforine (Saprol®)	3	1	Low	Apples; do not apply to Golden Delicious or Cox's Orange Pippin

¹ WHP = withholding period. ² Always refer to the label.

Rust



Tranzschelia discolor

Rust is caused by a fungus (*Tranzschelia discolor*) and is identified by brown rust spores on the undersides of leaves. It can be a serious disease in stone fruit. Note, another genus of rust-causing fungi is *Uromyces* spp., and some chemical product labels list this on the label.

Risk period

Table 99. The peak risk period for rust.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Rust symptoms can appear on the leaves, shoots and fruit. The upper surface of the leaf will become speckled with small yellow patches, while the underside develops rusty brown spots (Figure 171). Infected shoots will have small dead patches where the bark splits. Rust infection on the fruit can be identified by small, depressed spots with a dark reddish centre, often with a pale green border.

Damage

Severe rust infection can cause premature leaf fall. Trees with rust will have considerably reduced yield, with fruit on defoliated trees having reduced sugar levels. Infected fruit is unsaleable as the infection can penetrate several millimetres into the flesh.

Monitoring

Rust is favoured by warm weather with rain or heavy dew. Wet periods of 4 hours or more with an optimum temperature range of 13–26 °C are 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. Carefully monitoring weather conditions (Figure 172) and treating orchards in periods that favour disease development is crucial for reducing rust in trees.



Figure 171. Rust on a plum leaf.



Figure 172. Monitoring weather in a prune orchard.

Management

Cultural and physical: good orchard hygiene will moderate the severity of rust infections. Where possible, remove all diseased wood and leaves during pruning and remove all fallen leaves from branches and crotches. Trees can carry small numbers of green leaves throughout winter. These should be removed and destroyed.

Biological: there are no known biological control agents for the rust pathogen.

Chemical: the chemical options for controlling rust are listed in [Table 100](#).

Table 100. Registered or permitted products for rust in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Chlorothalonil (Bravo Weather Stik®)	M5	Apricots, cherries, peaches 7; plums 1	Low	Apricots, cherries, peaches, plums
Copper oxychloride (Coppox®)	M1	1	Low	Stone fruit
Dithianon (Dinon 700 WG)	M9	21	Low	Nectarines, peaches, plums, prunes
Mancozeb (Dithane® Rainshield® NeoTec®)	M3	14	Medium	Stone fruit
Metiram (Polyram®)	M3	14	Medium	Stone fruit
Propiconazole (Tilt® 500 EC)	3	1	Low	Plums for prune production
Sulfur as polysulfide sulfur (7 Worlds Ag Lime Sulphur)	M2	Not required when used as directed	Medium	Apricots, peaches, plums, prunes, nectarines
Sulfur (Thiovit Jet®)	M2	Not required when used as directed	Medium	Nectarines, peaches, plums
Zineb (Barmac Zineb)	M3	14	Low	Nectarines, peaches, plums (not early varieties), prunes

¹ WHP = withholding period. ² Always refer to the label.

Shot hole

Stigmina carpophila

Shot hole is caused by a fungus (*Stigmina carpophila*) and affects the leaves, fruit and buds. It is very common in cherry orchards in NSW.



Risk period

Table 101. The peak risk period for shot hole.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Shot hole is initially identified by small brown spots with reddish rims on the leaves (Figure 173). These spots grow and the centre falls out, leaving a round shot hole in the leaf. On the fruit, the spots (Figure 174) can develop into deep indentations.



Figure 173. Shot hole infection in cherry leaves.



Figure 174. Shot hole infection on a peach. Photo: William Brown Jr, Bugwood.org.

Damage

Shot hole reduces the tree's photosynthetic capacity, which can affect fruit yield and quality. If the infection is severe, the tree might suffer from premature leaf fall. Fruit can also be marked and disfigured, making it unmarketable.

Monitoring

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. Infection requires at least 24 hours of continuous wetness and spores can germinate in temperatures as low as 1 °C. Rain during bud swell helps to spread the disease.

Management

Cultural and physical: where practical, prune out infected wood and burn the prunings. Hastening leaf fall will reduce the amount of inoculum that builds up during autumn.

Biological: there are no known biological control agents for shot hole.

Chemical: the chemical options for controlling shot hole are listed in Table 102.

Table 102. Registered or permitted products for shot hole in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Chlorothalonil (Bravo Weather Stik®)	M5	Apricots, cherries, nectarines, peaches 7; plums 1	Low	Apricots, cherries, nectarines, peaches, plums
Copper-based fungicides (various)	M1	1	Low	Stone fruit
Dithianon (Dinon 700 WG)	M9	Stone fruit 21	Low	Stone fruit
Fluopyram + trifloxystrobin (Luna® Sensation)	7 + 11	1	Low	Stone fruit
Mancozeb (Dithane® Rainshield® NeoTec®)	M3	14	Medium	Stone fruit
Metiram (Polyram®)	M3	14	Medium	Stone fruit
Sulfur as polysulfide sulfur (7 Worlds Ag Lime Sulphur)	M2	Not required when used as directed	Medium	Stone fruit (dormant to bud swell spray only)
Thiram (Thiram WG)	M3	7	Low	Stone fruit
Ziram (Ziram WG)	M3	7	Low	Cherries, nectarines, peaches

¹ WHP = withholding period. ² Always refer to the label.

Silver leaf

Chondrostereum purpureum

Silver leaf occurs mainly in apples and stone fruit in all growing regions but is particularly common in areas with high humidity during the growing season.



Risk period

Table 103. The peak risk period for silver leaf.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

The foliage of infected trees will develop a silvery sheen (Figure 175) that is caused by light shining through leaf cells that are damaged by toxins produced by the fungus.

Damage

Overall tree health declines, with reduced leaf area, poor root growth and low yields of poor-quality fruit that does not store well. In storage, infected fruit is susceptible to decay caused by other secondary infections.

Apple trees tolerate the disease better than stone fruit trees, which often die. The disease can lead to an increased incidence of water core in apples.



Figure 175. The silver sheen on an apple leaf affected by silver leaf.

Monitoring

Damp, overcast conditions can increase the incidence of silver leaf in orchards. Particular attention to pruning wounds when these conditions are present is recommended. Other forms of wound sites, such as from hail, could create infection sites for silver leaf and should be monitored regularly.

Management

Cultural and physical: silver leaf can be controlled by careful pruning and using wound dressings. Winter pruning should be avoided, particularly on damp, overcast days. Apply wound dressings as soon as possible after pruning and grafting to avoid infection.

Biological: there are currently no biological control options for this disease.

Chemical: the chemical options for controlling silver leaf are listed in Table 104.

Table 104. Registered or permitted products for silver leaf in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Cyproconazole + iodocarb (Garrison Rapid)	3 + 28	Do not use on trees during the growing season	Low	Apples, apricots, peaches, plums
Tebuconazole (Green Seal®)	3	Not required when used as directed	Low	Apples, cherries

¹ WHP = withholding period. ² Always refer to the label.

Sooty blotch

Gloeodes pomigena



Sooty blotch is a fungal disease that causes surface blemishes on apples and pears, usually late in summer.

Risk period

Table 105. The peak risk period for sooty blotch.

Bud swell/ green tip	Bloom	Mid season	Harvest	Postharvest	Dormancy

Disease identification

Sooty blotch is identified by patches of interconnecting irregular-shaped brown–black spots on the fruit surface (Figure 176). Although sooty blotch can appear separately, it is commonly found with fly speck (page 111).

Damage

The disease results in unappealing markings on the fruit skin, making it unmarketable. In unsprayed orchards, infection levels can be very high. It is rarely seen where conventional fungicide spray programs for other diseases are used.



Figure 176. Sooty blotch on unsprayed Cripps Pink apples.

Monitoring

Sooty blotch is favoured by cool, wet conditions and dense, slow-drying canopies. Monitor by inspecting fruit for blotches through mid to late summer.

Management

Cultural and physical: pruning to encourage airflow and light penetration through the canopy is recommended.

Biological: there are currently no biological control measures for sooty blotch.

Chemical: the chemical options for controlling sooty blotch are listed in Table 106.

Table 106. Registered or permitted products for sooty blotch in NSW.

Active constituent (example trade name)	Fungicide group(s)	WHP ¹ (days)	Effect on beneficials	Registered for use in... ²
Mancozeb (Dithane® Rainshield® NeoTec®)	M3	14	Medium	Apples, pears
Mancozeb + zinc EDTA (Manic® WG)	M3	14	Medium	Apples, pears
Metiram (Polyram®)	M3	14	Medium	Apples, pears
Zineb (Barmac Zineb)	M3	14	Low	Pome fruit

¹ WHP = withholding period. ² Always refer to the label.



Non-bearing trees

Young trees (Figure 177) that are not bearing fruit do not need the same intensive spray schedule as bearing trees.



Figure 177. Young, non-bearing orchards require monitoring for pests and diseases affecting tree health.

Problems most likely to be encountered with young temperate fruit trees are listed in Table 107 to Table 109. However, preparation and prevention provide the best route to healthy trees. Always source new trees from reputable nurseries and choose varieties with known pest and disease resistance. Avoid stress in young trees by supplying appropriate levels of nutrition and irrigation, and preventing competition from weeds. Taking special care of young trees by increasing inputs such as compost, a good fertiliser regime and regular crop monitoring will ensure they reach their maximum potential.

Table 107. Problems most likely to be encountered with young apple and pear trees.

Pest or disease	Damage	Control
Apple scab	Can severely impede young tree development. Scab infections on leaves will result in reduced growth and premature leaf drop.	A protective schedule is required to minimise leaf infections. Removing and mulching infected leaves in winter will promote breakdown and prevent the infection from overwintering in the orchard.
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 result in problems with growth and canopy establishment. 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: some fungicides will control both scab and mildew.
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 fencing is the most reliable means of preventing an 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	Tree growth can be reduced, and in some cases, lead to tree death.	Make sure 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 108. Problems most likely to be encountered with young stone fruit trees.

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 bud swell. Prevent infection by establishing good orchard hygiene with practices such as cleaning pruning equipment between each tree.
Cherry aphid and black peach aphid	Aphids can infest the lateral growth of stone fruit in autumn and become a problem in spring.	Closely observe trees for the insects and take action if warranted.
Crown gall	This bacterial disease can cause significant losses in stone fruit trees by infecting the crown root.	Treating seeds, rootstock seedlings and bare-rooted trees before planting with a biocontrol agent is advised. Refer to Protecting beneficial insects on page 94 .
Leaf curl	This disease causes distorted foliage, premature leaf fall and marked or misshapen fruit. Heavy leaf fall can lead to fruit drop and small fruit. It affects mainly nectarines, peaches and, to a lesser extent, apricots.	A protective spray schedule based on copper fungicides is advised between leaf fall and early bud swell. 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.	Closely observe trees for thrips 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 fencing is the most reliable means of preventing an attack.
Rust	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 scale 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 bud swell.
Summer trunk canker	This is a potentially serious disease affecting stone fruit on peach rootstock in wet soil. Severely infected trees might die.	Staking the trees to prevent movement during rain and windy weather will reduce disease incidence. Orchard mounding and using fungicide treatments can help.

Table 109. Problems most likely to be encountered with young persimmon trees.

Pest or disease	Damage	Control
Ants, mealybugs, scale insects	Before they become productive, young trees can be infested by scale insects and/or mealybugs. Ants can protect and encourage these pests, leading to problems when trees start bearing fruit.	Monitor young trees closely for ants, mealybugs and scale insects and treat with insecticide or oil as required to keep pest levels down.
Leaf spotting diseases	If left unprotected, young trees can suffer significant leaf infection, resulting in premature leaf drop or defoliation.	Consider maintaining some fungicide inputs to protect young trees from infection.



Managing postharvest diseases and disorders

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Crop protection does not end at picking. The fruit continues to be at risk of infection and breakdown throughout harvest, storage, packing and during marketing (i.e. the postharvest supply chain). Many postharvest rots start during flowering and fruit growth in the orchard, but the decay is only seen after harvest. Therefore, maintaining good crop protection measures in the orchard is critical. Fungal infections are the main pathological diseases in temperate fruit and these can cause large postharvest losses during storage.

Numerous pre and postharvest factors interact to influence the incidence of postharvest decay, including the fungal spore load in the orchard or packing shed, fruit nutritional status, maturity and type of calyx of the apple. For example, apple varieties with open calyxes (i.e. open between the external calyx and the core) are more prone to rots such as mouldy core or core rot, which can enter via the calyx during postharvest handling.

Common postharvest fungal diseases and their pathogens of temperate fruit in NSW include brown rot (*Monilinia fructicola* and *M. laxa*), alternaria rot (*Alternaria alternata*), blue mould (*Penicillium* spp.), grey mould (*Botrytis cinerea*), anthracnose, target rot/spot (*Phlyctaema vagabunda* and others), mucor rot (*Mucor piriformis*), ripe fruit spot (*Gloeosporium* spp.) and transit rot (*Rhizopus* spp.).

Blue mould is the most common and important postharvest disease. It is caused by the fungus *Penicillium expansum* (Figure 178) and, less often, other *Penicillium* species.

Grey mould, caused by *Botrytis cinerea*, is the most common disease in untreated fruit stored in bins. As *B. cinerea* frequently spreads from fruit to fruit, losses from an initial infection can be significant.

Anthracnose rots have been called ripe fruit rot, lenticel rot, target rot or spot, and bitter rot and are primarily caused by the related fungi *Phlyctaema vagabunda*, *Cryptosporiopsis malicorticis* and *Colletotrichum gloeosporioides*. Infection starts during fruit growth and remains dormant, but can develop when the fruit becomes less resistant to disease during ripening.



Figure 178. Blue mould (*Penicillium expansum*) is the most common and important postharvest disease of apples.

Preharvest disease management

Controlling postharvest diseases begins with good crop protection and orchard hygiene throughout the growing season. This ensures the fruit is as clean as possible when harvested, thus minimising postharvest decay during storage. Information on controlling diseases associated with postharvest decay in the field is provided in the diseases section of this guide (page 96), with specific information given for bitter rot (page 105), brown rot (page 106) and *Alternaria* species (page 96).

Some fungicide-based orchard sprays include label recommendations for application leading up to and just before harvest for certain diseases. Additionally, late-season sprays can help to ensure fruit enters the storage and processing chain with reduced spore loads and lower potential for infection and breakdown. Check individual product labels for registered crops, diseases and harvest withholding periods.

Resistance can be common due to the overuse of postharvest fungicides in the packhouse. To prevent fungicide resistance in postharvest systems, rotate fungicides with different modes of action, adhere strictly to label rates and timing, and integrate non-chemical practices such as sanitation and temperature control.

The susceptibility of the fruit tissue to fungal attack is influenced by fruit maturity, nutritional status and the spore load in the packing shed. Therefore, fruit should be harvested at optimum maturity

and always handled carefully to prevent creating injury points for infection, such as puncture marks or bruising. Fruit injury sites are ideal entry points to fungal spores such as *Penicillium* and *Mucor* species.

Postharvest dipping and drenching

Other postharvest diseases that are primarily a problem during storage include blue mould, grey mould, ripe fruit spot and transit rot.

Dipping or drenching the fruit as it comes into the storage and packing facility (Figure 179) is essential for minimising potential fruit losses.

Table 110 lists chemicals with registration for use as postharvest dips or drenches in NSW for pome and stone fruit and the target diseases for these crops.



Figure 179. Dipping or drenching fruit in a fungicide solution as it comes into the packing shed.

Equipment and water transport systems

Many postharvest temperate fruit handling and grading systems (such as in apples and cherries) use water flumes to transport fruit from harvest bins to sorting, washing lines and packing lines (Figure 180).

The water used must be properly treated to prevent bacterial and fungal pathogens from spreading, potentially causing fruit infections and food safety issues for human health. Good packing shed hygiene and sanitation (including dump tanks and flotation conveyors) are crucial for reducing the build-up of fungal spore populations and should be a part of good postharvest and food safety practices.

Some of the key chemical products available for sanitising packing shed fruit dipping water transport systems and/or fruit washing systems are listed in Table 111. Always consult your chemical supplier and the product label for details of registered or approved uses and applications in fruit processing.

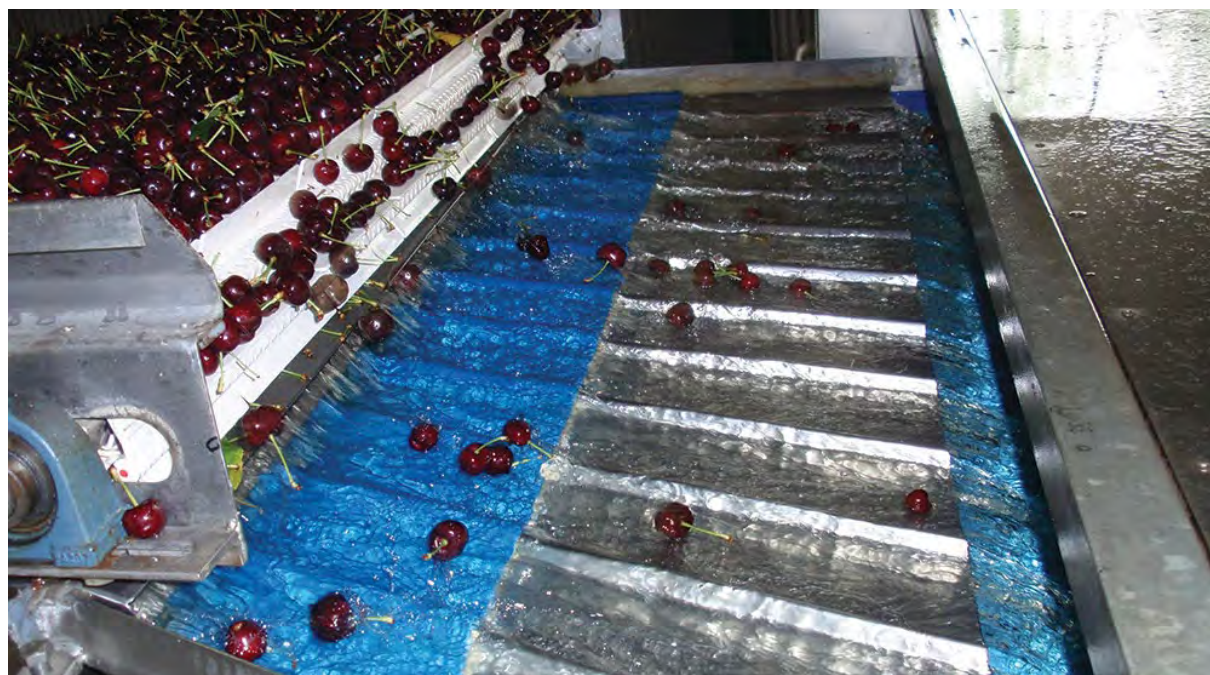


Figure 180. Sanitising water transport systems is essential to prevent the build-up and spread of fungal and bacterial infections.

Table 110. Chemicals registered for use in NSW for protecting postharvest fruit from fungal diseases.

Active constituent (example trade name)	Fungicide group	For managing or controlling...
Fludioxonil (Starling)	12	Pome fruit: blue mould, grey mould Stone fruit: brown rot, grey mould, rhizopus rot
Imazalil (Imazacure 500 EC)	3	Apples and pears: blue mould
Iprodione (Rovral Aquaflo®)	2	Apples and pears: storage rots caused by <i>Botrytis</i> spp., <i>Gloeosporium</i> spp. and <i>Penicillium</i> spp. Stone fruit: brown rot, transit rot (suppression)
Pyrimethanil (EcoFOG-160 PYR)	9	Apples and pears moulds caused by <i>Penicillium</i> spp., <i>Botrytis</i> spp. and <i>Neofabrea</i> spp.
Thiabendazole (Storite®)	1	Apples and pears: blue mould, grey mould, fruit rot (<i>Gloeosporium album</i>)
Triforine (Saprol®)	3	Apricots, nectarines, peaches, plums, prunes: brown rot

Table 111. Common chemicals used for sanitising harvested fruit, equipment and processing water in fruit processing facilities. Note, these are approved for use in postharvest fruit.

Active constituent (example trade name)	For managing or controlling...
Bromo-chloro-dimethyl-hydantoin (Nylate®)	External rot-causing organisms (surface sterilisation in postharvest wash systems)
Chlorine as calcium hypochlorite (Activ8®)	Bacterial and fungal control
Iodine (AIS®)	Bacterial and fungal control
Peroxyacetic acid + hydrogen peroxide (Absolve®)	Bacterial growth in process water
Sodium chlorite (Zydox®)	Bacterial growth in flumes, lines and rinses

Superficial scald

Superficial scald (scald) is a long-term storage disorder of apples (particularly Red Delicious and Granny Smith) and pears. Scald is a physiological disorder, which means it occurs randomly during storage and is not caused by a disease.

Scald is characterised by brown, irregular patches on the skin (Figure 181) during long-term cold storage. These areas become sunken and turn darker brown as the disorder develops. Although the damage is only superficial (Figure 182), it is sufficient to greatly downgrade fruit quality and grower returns.

Scald symptoms develop slowly in cold storage, usually within 3 months of harvest, and increase with time in storage. They will rapidly increase in severity within a few days at ambient air temperatures.



Figure 181. Superficial scald symptoms on a Granny Smith apple.



Figure 182. The peel removed from a scalded and non-scalded region of a Granny Smith.

Scald incidence

Several inter-related variety, orchard and management factors influence the incidence of scald, including tree vigour and nutrition, preharvest temperatures, sunlight, rainfall, fruit size and mineral content. However, the main factors influencing scald susceptibility are:

- fruit maturity: immature fruit are more susceptible than mature fruit
- seasonal conditions: fruit grown in warm, dry areas is more susceptible to scald than fruit grown in cool, moist climates
- variety: fruit variety (Table 112) is probably the overriding factor in scald development.

Scald severity

Factors affecting scald severity include:

- storage atmosphere composition and ventilation
- storage temperature and duration.

Scald control

Scald can be controlled by postharvest chemical treatments such as:

1. diphenylamine (DPA)
2. 1-methylcyclopropane (1-MCP)
3. dynamically controlled atmospheres (DCA).

Diphenylamine treatment

Scald can be controlled with diphenylamine (DPA) as a postharvest dip, drench or by fogging. However, DPA should not be used on export fruit unless permitted by the importing country.

DPA application rates depend on variety, district and the composition of the storage atmosphere. Therefore, application rates need to be adjusted according to the variety being treated, not only to control scald but to avoid damage to the skin.

DPA must be used according to label instructions; residue issues have occurred from not following label rates, inadequate mixing of the dip tanks and incorrect top-up procedures. The postharvest dipping manual [Guidelines for postharvest drenching of apples and pears](https://apal.org.au/wp-content/uploads/2019/09/dpa-use-guidelines-revised-0407.pdf) (https://apal.org.au/wp-content/uploads/2019/09/dpa-use-guidelines-revised-0407.pdf) provides further information.

DPA application

DPA can be applied via dip/drench or fogging. As a dip/drench, DPA should be applied as soon as possible after harvest; delaying treatment by 2 weeks or more greatly reduces its effectiveness.

Using a fogging system to apply DPA is a relatively new and efficient method. It involves using a special liquid form of DPA that is suitable for use with a thermal electro-fogger to form a fine fog, which is used on dry fruit. Similar to the dip application of DPA, this treatment should be applied as soon as possible after harvest and within 15 days of harvest and storage.

Electro-foggers should only be used by qualified, certified operators due to the high level of safety requirements (such as a full-face respirator with organic vapour filter) for this application method.

All product label and safety precautions must be followed.

Potential issues with DPA treatment

DPA has been used for the last 60 years to successfully manage scald, but some markets, particularly the EU, have no tolerance for DPA residues in fruit. A major problem with the long and continued use of DPA in packing sheds is that chemical residues can sometimes impregnate fruit bins, packing lines and storage cool rooms over time. These DPA residues can then potentially re-contaminate non-DPA-treated fruit, causing potential market access issues. Therefore, alternative scald control measures should be considered.

1-methylcyclopropane treatment

1-methylcyclopropane (1-MCP) inhibits scald while maintaining apple quality during storage. It is registered in apples to:

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

1-MCP works with the natural ripening process to temporarily stop the fruit from producing the naturally occurring ripening hormone ethylene, and from responding to outside sources of ethylene, such as other apples. 1-MCP works in a non-toxic way and has no detectable residues. For effective scald control, 1-MCP must be applied at the appropriate harvest maturity and as soon as possible after harvest (generally within 5 days), and before storage and packing. 1-MCP is applied as a gas so using an airtight room is essential.

When applied correctly, the benefits of 1-MCP treatment continue to work after removal from cold storage. Once treated fruit are removed from storage, ripening continues at a much slower rate. It is this delay in ripening that reduces softening and inhibits superficial scald.

Note: 1-MCP is not a substitute for correct postharvest handling, storage and transport practices. Correct temperature management is still paramount for maintaining quality fruit.

Dynamically controlled atmospheres

Dynamically controlled atmospheres (DCA) are a non-chemical method for managing scald and maintaining the postharvest quality of apples in long-term cold storage. This system has been researched for many years and is used commercially in many apple storage rooms around the world, including Australia. DCA maintains very low oxygen in the controlled atmosphere (CA) for long-term storage. The dynamic maintenance of low oxygen in the storage atmosphere is done using methods such as chlorophyll fluorescence or ethanol levels.

DCA can be an effective tool to manage scald during storage, but it is not practical in all long-term storage situations as it relies on good airtight CA storage rooms. Many commercial CA rooms in Australia are older and not sufficiently airtight to maintain the very low oxygen levels required for DCA to be effective.

Table 112. Scald susceptibility of apple and pear varieties.

Highly susceptible	Moderately susceptible	Least susceptible
Apples: Granny Smith, Lady Williams, Red Delicious	Apples: Bonza, Cripps Red, Firmgold, Fuji	Apples: Cripps Pink, Gala, Golden Delicious
Pears: Packham’s Triumph, Anjou	Pears: Beurre Bosc, Josephine	–



Chemical thinners for pome and stone fruit

Chemical thinning

Responses from chemical thinning can be unpredictable, making optimal crop load management a difficult task. There are many interacting factors influencing the thinning response of chemical thinning agents, including cultivar, climate, pollination and tree history.

A structured program combining both blossom and post-bloom chemical thinners will give the most reliable results. To be effective, chemical thinning programs need to start early in the flowering period.

Blossom thinners

Ammonium thiosulfate (ATS) works by desiccating or burning the style and stigma of the flower, preventing pollination and fertilisation. While leaf damage can happen with desiccants, the degree of damage that occurs when using the recommended rates does not affect fruit development, size or quality. Higher temperatures can also cause greater desiccation. Light rain can also re-activate the chemical, causing further desiccation and potential leaf damage.

Application timing is critical to achieving satisfactory thinning. The chemical must be applied when sufficient flowers have already been fertilised for a good crop load: in apples this can be as early as 20% bloom. Multiple applications are recommended, as the aim is to remove the later-opening flowers. In cultivars with extended flowering, such as Gala, 3 applications might be necessary.

Ethephon can be a vigorous thinner, completely removing weak spurs or depleting fruit positioned low on the tree.

Ethephon can also be used for complete fruit removal when used at 40–50 days after full bloom (dAFB) to remove damaged crops, e.g. by hail. This not only saves removing the crop by hand but also has a positive effect on return bloom.

Naphthalene acetic acid (NAA): while NAA can thin most cultivars between full bloom (FB) and 21 dAFB, the earlier it is applied, the better the response in fruit size. NAA promotes vegetative growth, which is advantageous in green apples such as Golden Delicious or Granny Smith, but a disadvantage in red apples where extra vegetative growth shades fruit, inhibiting red colour production.

NAA interacts with plant bioregulators containing the gibberellins GA 4 + 7. Hence, it is not compatible with formulations such as Cytolin® (6-benzyladenine; gibberellin A4 and gibberellin A7) when applied at the normal recommended rate. However, if the rate of NAA is reduced to 3–4 ppm, then a Cytolin®/NAA program works well.

Lime sulfur (LS) is a crop protectant often used in organic orchards that has a desiccating effect when applied during flowering. LS is not registered for thinning either pome or stone fruit.

Post-bloom thinners

6-benzyladenine (BA) works most effectively following treatment at flowering with one of the blossom thinners, e.g. ATS, ethephon or NAA. It is temperature-dependent, being more effective in warmer temperatures.

BA is suitable for IPM programs as it is not persistent or toxic. It can also increase fruit size independently of the thinning effect and has been observed to increase fruit firmness.

Carbaryl is regarded as a mild thinner and usually only removes the slower-growing fruit within bunches. Carbaryl is temperature-dependent, requiring warm, dry conditions for effective thinning. The warmer the temperature, the greater the thinning effect. It can also be used on trees where using a primary thinner is not warranted, either because the trees are young or because of sparse blossom buds.

Metamitron acts by temporarily inhibiting photosynthesis for 7–10 days after application, targeting the weakest fruit within a cluster. It is rainfast within 2 hours, non-persistent and has no

effect on beneficials. The thinning effect is dependent on radiation, or rather, a lack of it; thinning will be stronger in reduced light such as cloudy conditions or under netting.

Thiram is a protectant fungicide that has a slight thinning effect when applied after petal fall, but its effect is mild and can be unreliable. Thiram improves the efficacy of carbaryl when tank-mixed.

All chemical thinners have some disadvantages (Table 113). Despite these limitations, a chemical thinning program produces markedly superior results to hand-thinning, both economically and for tree physiology.

The most effective chemical thinning programs combine blossom and post-bloom thinners. A sequential spray program allows lower chemical quantities to be used each time, thus reducing the risk of over-thinning. If chemical thinners have been effective, then all that should be required is a subsequent light hand-thin to remove damaged fruit or break up any remaining bunches.

Benefits of chemical thinning

To achieve suitable thinning and fruit quality, all chemical thinners need to be applied at the appropriate physiological stage and under the climatic conditions best suited to each chemical. Choice of thinning agent is important, as some cultivars do not respond well to some chemicals.

Table 113. Chemicals available for thinning in Australia.

Generic name (example trade name)	Type of thinner	Crop	Application timing	Disadvantages
Ammonium thiosulfate (ATS; Culminate®)	Blossom	Apples, plums, some peaches	Apple 20% and 80% bloom. Peach and plum 80–100% bloom.	• Can cause russet. • Timing critical.
Benzyladenine (BA; Maxcel™)	Post-bloom	Fuji, Gala, Golden Delicious, Cripps Pink, Red Delicious, Sundowner	Fuji and Gala 15–22 dAFB*. Red Delicious 10–20 dAFB. Golden Delicious 10–20 dAFB.	Temperature dependent: needs >15 °C and rising temperature for 2–3 days after application.
Carbaryl (Bugmaster®)	Post-bloom	Pome fruit	14–60 dAFB, repeat at 7–10 day intervals as required.	• Requires warm, dry conditions. • Toxic to bees, beneficial invertebrates and mammals. • Can cause russet and reduce seed number. • Banned from some export markets.
Ethephon** (Gro-Phon 720)	Blossom	Apples	Balloon blossom to 7 dAFB.	• Tendency to flatten fruit. • Higher rates can depress fruit size. • Not effective at cooler temperatures.
Gibberellic acid (GA; ProGibb® LV PLUS)	Inhibits next season's blossom	Apricots, nectarines, peaches	Flower bud initiation stage.	• Applied previous season. • Might delay harvest.
Metamitron (Brevis®)	Post-bloom	Apples, pears	8–16 mm fruitlet diameter.	• Can cause minor leaf phytotoxicity. • Thinning effect dependent on radiation.
Naphthalene acetic acid (NAA; NAA20)	Blossom	Apples, pears	Full bloom to 5 dAFB. 2 sequential sprays might be required, the first applied at full bloom and the second 3–5 dAFB.	• Can depress fruit size, cause russet and reduce seed number. • Pygmy fruit if applied later than 10 dAFB. • Interacts with cytolin. • Rewetting causes over-thinning.

*dAFB = days after full bloom.

**Ethephon is not registered in NSW for fruit thinning but can be used for complete fruit removal.



Chemical tools for managing bud dormancy, flowering, vegetative growth, harvest and storage quality

Plant growth regulation (PGR) products are important tools in modern temperate fruit production systems. PGRs provide cost-effective management solutions for some of the tree and crop management issues faced by producers. In this section, we have grouped some of the most important PGRs for pome and stone fruit production according to their uses in:

- managing vegetative growth
- managing harvest and fruit quality
- bud dormancy and manipulation of flowering.

Vegetative growth management products (Table 114) can be used in conjunction with other management tools such as pruning, root pruning, thinning and fertiliser and water management to encourage the desired shoot growth within the tree canopies.

Harvest and fruit quality management products (Table 115) can be used to delay or advance maturity and improve postharvest fruit quality attributes such as colour, firmness and storage potential.

Marginal or insufficient winter chilling can result in a delayed, protracted and uneven bloom. Bud dormancy products (Table 116) can help break dormancy and/or compress flowering to encourage more even bloom, pollination and fruit set.

Table 114. Vegetative growth management products registered for use in NSW.

Active constituent (example trade name)	Purpose	Registered for use in...
Ethephon (Promote®)	Retard vegetative growth and stimulate flowering in the following season	Apples
Gibberellins A4 and A7 + 6-benzyladenine (7 Worlds Ag BaGA®)	Stimulate lateral growth	Apples, cherries
Paclobutrazol (Payback®)	Reduce vegetative growth	Apples (Red Delicious, Granny Smith), apricots, cherries, nectarines, peaches, plums
Prohexadione-calcium (Regalis-Plus®)	Reduce shoot growth	Apples, cherries

Table 115. Harvest management and fruit quality products registered in NSW.

Active constituent (example trade name)	Purpose	Registered for use in...
1-methylcyclopropene (1-MCP)	(Harvista®) Decrease fruit maturation rate	Apples preharvest
	(SmartFresh™) Improve postharvest quality	Apples, apricots, nectarines, pears, plums, persimmons
6-benzyladenine + gibberellins A4 and A7 (7 Worlds Ag BaGA)	Improve fruit typiness (elongation)	Apples (Braeburn, Gala, Cripps Pink and Red Delicious)
Aminoethoxyvinylglycine (AVG; Retain®)	Delay fruit maturity, increase fruit firmness, size and storage potential	Apples, stone fruit except cherries

Table 115. Harvest management and fruit quality products registered in NSW, page 2 of 2

Active constituent (example trade name)	Purpose	Registered for use in...
Ethephon (Promote®)	Apples (certain varieties): advances maturity, enhances fruit colour	Apples (varieties, refer to label)
	Cherries (certain varieties): promotes evenness of maturity and early colour development	Cherries (varieties, refer to label)
Gibberellic acid (GA; ProGibb®)	Delays harvest maturity	Cherries, prunes
Forchlorfenuron (Ambitious 10SL)	Increases fruit size in apples and cherries	Apples (Royal Gala and Fuji) and cherries
Naphthalene acetic acid (NAA) (7 Worlds Ag NAA20)	Helps prevent preharvest fruit drop	Apples, pears

Table 116. Bud dormancy and flowering manipulation products registered in NSW.

Active constituent (example trade name)	Purpose	Registered for use in...
Aminoethoxyvinylglycine (AVG; Retain®)	Extend flower life	Cherries
Cyanamide (Dormex®)	Regulate dormancy	Apples, plums, prunes
Decanol alkoxylate (Erger®)	Break dormancy	Fertiliser adjuvant with label recommendations for apples and cherries
Fatty acid esters-canola (Waiken®)	Advance or set back bud break	Apples, cherries



Managing weeds

Why manage weeds?

A weed is simply a plant growing where it is not wanted. Usually, the significance of a weed species is determined by its effect on agricultural production, the environment, aesthetics, or the risk it poses to human health.

An effective weed control strategy is vital when establishing an orchard to enable rapid canopy establishment and early cropping. This is essential for profitability in any orchard block, particularly modern, capital-intensive systems. Controlling or removing pest habitat can reduce pest and disease pressure in a system and, therefore, its associated inputs. Lastly, it is good agricultural practice and stewardship to prevent or reduce the spread of agricultural weeds to neighbours and the environment. One of the high-priority agricultural weed species often found in temperate horticulture orchards is marshmallow weed. Note, synonyms for marshmallow include small-flowered mallow, cheeseweed, and mallow.

Marshmallow weed

Marshmallow, or *Malva parviflora*, is a high-priority weed in cherry and pome fruit orchards, and is also a significant concern in persimmon orchards. In these horticultural systems, its dense growth (Figure 183 left) can compete for moisture and nutrients, interfere with irrigation infrastructure, and affect harvesting operations. In grain and vegetable cropping industries, marshmallow is an aggressive competitor for light, nutrients, and water, often leading to reduced crop yields. The plant can grow up to 1.5 metres tall and spread several metres wide, and depending on environmental conditions, it can behave as an annual, biennial, or short-lived perennial. Its deep, woody taproot (Figure 183 middle) makes it particularly resilient to mechanical control methods, and under ideal conditions, it can reproduce within 2 months of germination, producing thousands of seeds per plant (Figure 183 right).



Figure 183. Marshmallow, or *Malva parviflora*, has dense growth, a woody taproot and can reproduce quickly.

Beyond its competitive nature, *Malva parviflora* also acts as a reservoir for insect pests such as harlequin bugs and aphids, and a potential green bridge for plant viruses and fungi. This makes marshmallow populations a potential source of reinfestation and spread within and between growing seasons. Seed dispersal occurs via water, soil movement, and ingestion by birds or mammals, contributing to its persistence. Marshmallow is highly adaptable, capable of thriving in a wide range of soil types, including saline and compacted soil. Its seeds are long-lived, with the potential to remain viable in the soil for decades, making early and sustained control efforts essential.

An integrated weed management (IWM) approach is critical when dealing with *Malva parviflora* infestations. Single-method strategies, such as herbicide-only programs, are often insufficient due to the species' natural tolerance to glyphosate and its seed longevity. Effective management should combine cultural, mechanical, and chemical control methods, with a strong emphasis on preventing seed set and maintaining strict farm hygiene to limit the spread. Early intervention is vital.

AVOID THE HORRORS



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Management strategies and control options

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

Hygiene comes first

Good orchard hygiene is the first step in any weed management strategy. It will help prevent any new weed species from establishing or moving between blocks. Be aware of new weeds appearing, have them identified if necessary, and work towards eradicating them and reducing their spread. Moving machinery from non-crop areas to the orchard and between blocks is a common method for spreading new weeds. Reduce the spread of new weeds by periodically cleaning orchard equipment.

Table 117. Strategies to manage weeds, and particularly marshmallow (*Malva parviflora*).

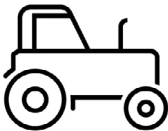
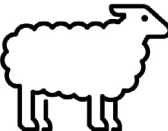
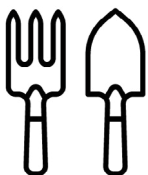
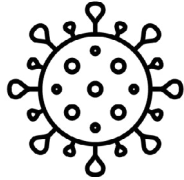
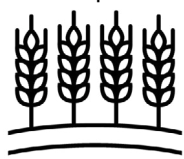
Strategy	Summary
Tillage 	Tillage or cultivation is an effective control strategy where feasible, particularly between rows and on headlands. It is most successful when repeated and timed early in the weed's life cycle to prevent seed set and maturation. However, tillage in areas with a history of marshmallow infestation can stimulate germination by scarifying dormant seeds. Notably, marshmallow tends to establish more successfully in zero-till systems than in minimal tillage systems. Take care that cultivation does not cause root damage to trees, particularly in blocks on dwarf rootstocks where root architecture is usually shallower and less extensive.
Herbicides 	Marshmallow exhibits a natural tolerance to glyphosate. However, its tolerance can be significantly reduced by tank-mixing glyphosate with certain herbicides, including Group 14 herbicides, such as carfentrazone (e.g. Hammer®) or oxyfluorfen (e.g. Goal®). Note also that control with knockdown herbicides can be unreliable. Always follow label directions when using herbicides. For best results, apply herbicides when plants are small, young, and actively growing (early post-emergence). Avoid spraying when plants are stressed due to drought, physical damage or frost. To date, herbicide resistance has not been reported in Australian populations of marshmallow. Rotating between the several herbicide modes of action available to growers remains best practice. Refer to 'Weed control using chemical control methods on page 139 for best practice guidance on herbicide selection, application and resistance management when relying on chemical control of weeds.
Slashing or mowing 	Slashing or mowing is a valuable strategy to reduce seed set. Aim for early autumn and spring. In spring, removing flowering weeds from the inter-row can promote pollinator activity in the canopy. Note that slashing or mowing is not effective on mature plants unless they are cut below the crown, as marshmallow readily regrows and re-establishes from above-ground cuts.
Grazing 	Marshmallow has low palatability to livestock. Sheep are known to tolerate marshmallow, but consuming large quantities might cause 'staggers', a condition involving tremors and falling. Note also that sheep can cause damage to trees if other feed is scarce. Research has shown that marshmallow seeds can survive mastication and rumen digestion by sheep, indicating that grazing might contribute to the plant's spread.
Mulching 	Marshmallow seeds do not require sunlight to germinate. However, if applied in a thick layer, mulching the under-tree row with large quantities of organic materials such as straw, old hay or bark chips can suppress weed growth and provide other benefits to tree and soil health. Growers should be aware of the possibility of nitrogen tie-up effects when using some raw, non-composted mulches.

Table 117. Strategies to manage weeds, and particularly marshmallow (*Malva parviflora*), page 2 of 2.

Strategy	Summary
Hand weeding 	Hand weeding is made difficult by marshmallows' long taproot, but it can be effective for light infestations of young plants, or for isolated larger plants. It is also a useful follow-up method after herbicide or tillage treatments.
Thermal weeding 	No reports were available on the viability of thermal weeding using propane burners, hot air or hot water on marshmallow weed. As a general rule, do not use thermal weeding near trees younger than 3 years old, as crops can be severely damaged.
Biological control 	In South Australia, viticulturists have reported that the rust fungus <i>Puccinia malvacearum</i> can reduce the vigour and abundance of marshmallow in vineyard settings. However, this is not yet a widely adopted or formally evaluated control method. Conversely, marshmallow plants can be frequently seen covered in rust pustules, and despite this, they readily reproduce.
Cover crops 	As a minimum, mulch and inter-row grass cover should be used to reduce reliance on herbicide control for weeds. Research in the vegetable production industry has shown that cover crops can suppress marshmallow re-establishment through competition, particularly when the cover crop produces a large biomass. However, in dry seasons, maintaining this biomass might come at the expense of nutrient and water availability, increasing stress, particularly for young trees, potentially affecting crop productivity.

References and further reading

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Weed control using chemical control methods

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

The best time to spray for weeds is either just before (pre-emergent) or just after (post-emergent) germination. Most weeds germinate in either spring or autumn, and small weeds are easier to control than older, more mature weeds. Orchard herbicides can be grouped into 3 broad categories:

1. **Pre-emergent residual herbicides** (Table 118) perform best if applied to bare soil that is totally free of weeds, mulch and debris. Any material that prevents the herbicide from contacting and penetrating the soil surface will reduce its effectiveness on germinating weeds. Most pre-emergent herbicides will provide effective control for a wide range of annual broadleaf weeds

and grasses. Established perennials, such as paspalum, will not be controlled using a pre-emergent herbicide.

2. **Post-emergent selective grass herbicides** (Table 119) are useful where the predominant weed species are grasses. The 3 active ingredients with registrations for use in NSW as selective grass herbicides are all members of the Group 1 herbicide mode of action (MoA). This group is considered highly prone to developing resistance and should be used in accordance with resistance management principles.
3. **Post-emergent non-selective knockdown herbicides** (Table 120) perform best when applied to young, actively growing weeds. As these herbicides are non-selective, some can be harmful to fruit trees. Young trees are particularly prone to injury if not protected from knockdown herbicides. Consult product labels for specific recommendations.

A summary of the range of active ingredients available for use in deciduous fruit orchards is in [Herbicides and their uses on page 142](#).

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

A note on herbicide resistance

Herbicides function by disrupting specific biological processes in plants, a concept known as their mode of action (MoA). To help growers manage herbicide use effectively, herbicides are classified into MoA groups, which identify how each product works. Some MoA groups are more prone to resistance development and are considered high risk, with groups 1 and 2 being particularly notable. Resistance occurs when a herbicide that once controlled a weed population at the label rate no longer works, often defined by a survival rate of 20% or more in testing. This resistance is exacerbated when the same MoA group is used repeatedly, creating selection pressure that favours the survival and reproduction of resistant individuals. Viable seeds in the soil can sustain weed populations and perpetuate resistance for many years. It is important to consider that while herbicide use reduces overall weed density, it does alter the ratio of resistant to susceptible individuals in the population.

To minimise the risk of resistance, it is essential to rotate herbicides rather than relying on the same group for every spray. Choosing lower-risk herbicides when possible, monitoring for surviving weeds after application, and preventing them from setting seed are all vital steps.

Effective resistance management also depends on the quality of spray application. It starts with 3 core principles:

1. always read and follow product labels carefully
2. apply the full recommended rate of registered pesticides
3. ensure the application method achieves thorough coverage of the target area to maximise herbicide contact. Poor application practices can lead to sublethal dosing and uneven coverage, both of which contribute to the development of resistance.

Some MoA groups are more likely to develop resistance and are considered high risk. Refer to product labels or [Table 118](#) to [Table 120](#) to determine the MoA group.

Herbicide sprayer setup

A properly configured and well-calibrated sprayer is essential to ensure herbicides are applied in accordance with label recommendations and to achieve the intended weed control. 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 pressure gauges are working accurately.
- Use the correct (specified) pressure range for the nozzles.
- If a nozzle's output (litres per minute) varies by more than 5% of the manufacturer's specifications, replace that nozzle.

- Always use a low-drift type nozzle wherever possible, such as an air induction (AI) nozzle. Flat fan nozzles used to be the popular choice for herbicide spraying, but these are no longer appropriate when it comes to reducing spray drift. For more information, refer to [Simple and easy calibration on page 141](#).
- 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.
- Ensure all equipment is properly calibrated before use.
- Herbicide labels can include mandatory advice on droplet spectrum, e.g. medium coarse; always choose the right nozzle and operating pressure.

Managing herbicide spray drift

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 those applying herbicides have a moral and legal obligation to adopt current best practices.

Although there remains confusion among some growers about nozzle selection, the industry in general, backed largely by several years of trials on application rates, nozzle designs and travel speeds, generally agrees (and recommends) 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 the 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 selective (Group 1) products.

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

More information on managing spray drift can be found on the [APVMA website](https://apvma.gov.au/node/10796) (<https://apvma.gov.au/node/10796>).

Simple and easy calibration

The most common procedure for calibrating herbicide spray equipment is:

1. Select the tractor engine revolutions per minute (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 in step 2.

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

Application rate of product [R] = 3.75 kg/ha

Then

Area covered by the full tank is $(L \times W \times T) \div V$

In our example, the area covered is

$(100 \text{ m} \times 1.5 \text{ m} \times 500 \text{ L}) \div 10 \text{ L} = 7,500 \text{ m}^2$ or 0.75 ha (there are 10,000 m² per hectare)

Herbicide required in a full tank

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

In our example the amount of herbicide required = $3.75 \text{ kg/ha} \times 0.75 \text{ ha} = 2.8 \text{ kg}$

Herbicides and their uses

Table 118. Pre-emergent residual herbicides.

Active ingredient (example trade name)	Herbicide group	Crop	Weeds controlled	Remarks
Flumioxazin (Chateau®)	14	Pome and stone fruit	A wide range of grass and broadleaf weeds.	Requires at least 15 mm of rain or irrigation to activate. Applied postharvest to bud break, add a knockdown for weeds taller than 100 mm.
Isoxaben (Gallery® 750)	29	Orchards	Certain broadleaf weeds.	Requires incorporation by at least 12.5 mm rainfall or irrigation within 21 days of application.
Napropamide (Devrinol-C 500 WG)	0	Stone fruit	Annual grasses and some broadleaf weeds.	Incorporate to a depth of 20–50 mm.
Norflurazon (Zoliar® 800 DF)	12	Apples, pears, stone fruit	A wide range of annual broadleaf weeds and grasses.	Do not use more than 4.2 kg of product/ha in one season. Do not apply to trees younger than 18 months.
Oryzalin (Cameo™ 500)	3	Apples, pears and stone fruit	A wide range of annual broadleaf weeds and grasses.	Use a lower rate for short-term (up to 4 months) and a higher rate for longer-term (6–8 months) control. Activated by moisture.
Oxyfluorfen (Goal®)	14	Apples, pears, apricots, plums and peaches	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 after bud swell. For a post-emergent spike, use at 75 mL/ha with a glyphosate product or 250 mL/ha with a paraquat ¹ or diquat ¹ / paraquat ¹ product. Do not use on apples or pears younger than 3 years old.
Pendimethalin (Stomp 440®)	3	Deciduous fruit	A wide range of annual broadleaf weeds and grasses.	Requires moisture for incorporation.
Simazine (various)	5	Apples, pears	A range of broadleaf weeds.	Do not use on trees younger than 2 years old. Use a higher rate for medium to heavy textured soil types.
Terbacil (Sinbar®)	5	Apples, peaches	Annual weeds and perennial grasses.	Do not apply to trees younger than 3 years old. Do not apply to sandy or gravelly soil types. Sorrel can become predominant after repeated applications of terbacil.

¹ Use pattern might be affected by APVMA review outcomes, refer to the [2025 update on Australian Pesticides and Veterinary Medicines Authority chemical reviews on page 13](#).

Table 119. Post-emergent selective grass herbicides.

Active ingredient (example trade name)	Herbicide group	Crop	Weeds controlled	Remarks
Clethodim (Status®)	1	Non-bearing fruit trees	Annual grasses	Apply to 2-leaf to fully tillered grasses.
Fluazifop-p-butyl (Fusilade® Forte)	1	Apples, pears, stone fruit	Annual and perennial grasses	Withholding period is not required on these crops when used as directed.
Haloxypop (Verdict®)	1	Apples, pears, stone fruit, persimmons	Annual and perennial grasses	Apply to small, actively growing grasses.

Table 120. Post-emergent non-selective knockdown herbicides.

Active ingredient (example trade name)	Herbicide group	Crop	Weeds controlled	Remarks
Amitrole + ammonium thiocyanate (Amitrole T)	34	Orchards	Broad-spectrum: broadleaf weeds (including marshmallow) and sedges.	Trees should be at least 3 years old. Do not apply within 56 days from harvest. Wet weeds thoroughly. Use a higher rate for marshmallow.
Amitrole + paraquat ¹ (Guerrilla®)	22 + 34	Orchards	Various.	Spray young weeds in late winter for spring–summer. Use a higher rate in spring.
Asulam (Rattler® 400)	18	Apples	Dock.	Apply to actively growing dock in spring when leaves are fully expanded but before flower shoots emerge.
Carfentrazone-ethyl (Spotlight Plus®)	14	Young or established orchards	Small-flowered mallow and certain other annual broadleaf weeds.	Tank mix with a knockdown herbicide to assist with weed control. Registered for sucker control in pome and stone fruit including prunes (plums).
Diquat ¹ (Reglone®)	22	Orchards	Capeweed.	Avoid spray drift onto green plant parts. Spray only actively growing weeds (50–100 mm high). Wet thoroughly (add wetter).
Glufosinate ammonium (Basta®)	10	Pome and stone fruit orchards	Broad-spectrum: a wide range of grass and broadleaf weeds including willow herb.	Do not use around trees younger than 2 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.
Glufosinate-ammonium + carfentrazone-ethyl (Hellcat®)	10 + 14	Pome and stone fruit	Perennial and annual weeds.	Do not allow spray or spray drift to contact desirable foliage or green (uncalloused) bark.
Glyphosate (Roundup®)	9	Apples, pears and stone fruit	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 younger than 3 years old unless they are properly protected from spray and drift.
Glyphosate + carfentrazone-ethyl (Broadway®)	9 + 14	Pome and stone fruit orchards	Broadleaf weeds including marshmallow.	Do not allow spray or drift to contact green bark, stems, foliage or fruit.
Nonanoic acid (Slayer® Organic Herbicide)	Unknown	Orchards	Seedling and young annual and perennial weeds.	Use on fallow soil. Spray to completely cover the weed surface. Reapplication at around 7 days might be necessary if regrowth occurs.
Paraquat ¹ (Gramoxone®)	22	Orchards	Most annual grasses and some broadleaf weeds. Add diquat ¹ to control capeweed.	Avoid spray drift onto green plant parts. Spray only actively growing weeds (50–100 mm high). Wet thoroughly.
Paraquat ¹ + diquat ¹ (Spray. Seed®)	22	Orchards	Broad-spectrum.	Avoid spray drift onto plant parts with green pigment. Spray only actively growing weeds (50–100 mm high). Wet thoroughly.
Saflufenacil (Sharpen®)	14	Pome fruit orchards	A range of broadleaf weeds and grasses.	Do not apply as a spray near trees younger than 3 years old unless they are effectively shielded from spray and spray drift.

¹ Use pattern might be affected by APVMA review outcomes, refer to the [2025 update on Australian Pesticides and Veterinary Medicines Authority chemical reviews on page 13](#).



Avoiding pesticide resistance

Farm Chemicals Unit, Agriculture and Biosecurity, NSW DPIRD

A pest or disease is resistant to a specific chemical when that chemical no longer provides the control it did previously. Genetically, all populations contain a small number of individuals with resistance to a pesticide. While repeatedly spraying pests and diseases with a particular chemical will continue to kill susceptible individuals, it will also increase the number of resistant individuals. This is referred to as resistance pressure. Once the resistant population reaches a critical proportion, the chemical will no longer be effective. Managing resistance to all pesticides is essential when choosing a control strategy.

Managing resistance

Resistance management starts with the 3 principles of best practice spray application:

1. Product labels are carefully read and followed.
2. Full recommended rates of registered pesticides are used.
3. The application method achieves thorough coverage of the target area to maximise contact.

Product labels incorporate a resistance warning. Many include crop-specific instructions relating to the number of applications permitted for that crop. Agricultural chemical users must always read the label and any permit before using the product and strictly follow the conditions as directed. Following all label and permit instructions is vital to managing resistance.

In addition to good spray application, a key resistance management strategy is rotating chemical groups to prevent the target from being repeatedly treated with the same active ingredient. All registered pesticides have a symbol on the label that identifies the action group to which they belong. This helps growers choose a product from a different chemical action group to rotate the active ingredients used in a program. There are identification schemes for herbicides ([Table 118](#) to [Table 120](#)), fungicides ([Table 121](#)), and insecticides and miticides ([Table 122](#)).

CropLife Australia manages the Insecticide Resistance Management Review Group (IRMRG). On the [CropLife Australia website](#) is information on this work and specific chemical rotation plans for high-profile horticulture pests such as two-spotted mite, European mite, and green peach aphid. CropLife Australia also facilitates the [Fungicide Resistance Action Committee](#) (FRAC) activities, which annually reviews and updates fungicide resistance management recommendations for modes of action and specific crops.

Table 121. Fungicide groups^{1,2}.

Group	Chemical class	Common name	Example trade name*
1	Benzimidazole	Thiabendazole	Tecto Flowable®
2	Dicarboximide	Iprodione	Rovral®
		Procymidone	Sumisclex® 500
	Imidazole	Imazalil	Fungaflor®
	Piperazine	Triforine	Saprol®
3	Triazole	Difenoconazole	Bogard®
		Hexaconazole	AW Hostile 50SC
		Mefentrifluconazole	Belanty®
		Myclobutanil	Systhane®
		Penconazole	Topas®
		Propiconazole	Tilt® 500 EC
7	Pyrazole carboxamide	Fluxapyroxad	Sercadis®
		Penthiopyrad	Fontelis®
		Isopyrazam	Seguris® Flexi

Table 121. Fungicide groups^{1,2}, page 2 of 2.

Group	Chemical class	Common name	Example trade name*
7	Pyridine carboxamides	Boscalid	Pristine®
	Pyridinyl-ethyl-benzamides	Fluopyram	Luna® Sensation
8	Hydroxypyrimidine	Bupirimate	Nimrod®
9	Anilinopyrimidine	Cyprodinil	Chorus®
11	Strobilurin	Kresoxim-methyl	Stroby®
		Trifloxystrobin	Flint®
		Mandestrobin	Intuity™
12	Phenylpyrrole	Fludioxonil	Scholar®
19	Polyoxins	Polyoxin-D zinc salt	Intervene®
33	Ethyl phosphonate	Fosetyl	Aliette®
M1	Inorganic	Copper fungicides	Coppox®
M2	Inorganic	Potassium bicarbonate + potassium silicate	Ecocarb® Plus
		Sulfur as polysulfide sulfur	7 Worlds Ag Lime Sulphur
		Sulfur (elemental)	Thiovit Jet®
M3	Dithiocarbonate	Mancozeb	Dithane® Rainshield® NeoTec®
		Metiram	Polyram®
		Thiram	Thiram WG
		Zineb	Barmac Zineb
		Ziram	Ziram WG
M4	Phthalimide	Captan	Orthocide®
M5	Chloronitrile	Chlorothalonil	Bravo®
M9	Quinone	Dithianon	Dinon 700 WG
U12	Guanidine	Dodine	Syllit®

Table 122. Insecticide and miticide groups^{1,2}.

Group	Chemical class	Common name	Example trade name*
1A	Carbamate	Carbaryl	Bugmaster®
		Methomyl	Nufarm Methomyl
		Pirimicarb	Aphidex®
1B	Organophosphate	Malathion	Fyfanon®
		Omethoate	Folimat®
		Prothiofos	Tokuthion®
		Trichlorfon	Lepidex®
2B	Phenylpyrazoles (fiproles)	Fipronil ³	Amulet Cue-Lure®
3	Pyrethroid	Alpha-cypermethrin	Alpha-Scud®
		Bifenthrin	Talstar®
		Tau-fluvalinate	Mavrik® Aquaflow
3A	Pyrethroid-ester	Etofenprox	Trebon®
4A	Neonicotinoid	Acetamiprid	Cormoran® (a component of)
		Clothianidin	Samurai®
		Imidacloprid	Confidant 200SC
		Thiacloprid	Calypso®

Table 122. Insecticide and miticide groups^{1,2}, page 2 of 2.

Group	Chemical class	Common name	Example trade name*
4C	Sulfoximine	Sulfoxaflor	Transform®
5	Spinosyn	Spinetoram	Delegate®
		Spinosad	Entrust® Organic
6	Avermectin	Abamectin	Vertimec®
	Milbemycin	Milbemectin	Milbeknock®
7B	Juvenile hormone mimic	Fenoxycarb	Insegar®
9B	Feeding blocker	Pymetrozine	Chess®
10A	Tetrazine	Clofentezine	Apollo®
	Thiazolodine	Hexythiazox	Calibre®
10B	Diphenyloxazoline	Etoazole	Paramite®
11	Microbial	<i>Bacillus thuringiensis</i> subsp. <i>Kurstaki</i>	DiPel®
12A	Organotin	Fenbutatin oxide	Talk Miticide
12C	Organosulfur miticide	Propargite	Betamite®
13A	Chlorfenapyr	Chlorfenapyr	Secure®
15	Benzoylureas	Novaluron	Cormoran® (a component of)
16	Thiadiazine	Buprofezin	Applaud®
18	Diacylhydrazine	Methoxyfenozide	Prodigy®
		Tebufenozide	Ecdypro 700 WP
20B	Quinoline	Acequinocyl	Kanemite®
20D	Carbazate	Bifenazate	Acramite®
21A	Mite growth inhibitor	Tebufenpyrad	Pyranica®
22A	Oxadiazine	Indoxacarb	Avatar® eVo
23	Tetramic acid derivative	Spirotetramat	Movento®
25	Beta-ketonitrile derivatives	Cyflumetofen	Danisaraba®
28	Diamide	Chlorantraniliprole	Altacor® Hort
		Cyclaniliprole	Teppan® 50 SL
		Tetraniliprole	Vayego® 200 SC
29	Pyridincarboxamide	Flonicamid	Mainman®

¹ Trade names that include the common chemical name are not listed.

² The table shows fungicide groups based on mode of action only. For a chemical's compatibility with integrated pest management (IPM), please refer to the individual crop tables and the label.

³ Use pattern might be affected by APVMA review outcomes, refer to the [2025 update on Australian Pesticides and Veterinary Medicines Authority chemical reviews on page 13](#).

*Example only.

Source: [CropLife Australia](https://www.croplife.org.au/) (https://www.croplife.org.au/).

Resources

[Fungicide Resistance Action Committee \(FRAC\)](https://www.croplife.org.au/resources/programs/resistance-management/fungicide-resistance-management-strategies/) https://www.croplife.org.au/resources/programs/resistance-management/fungicide-resistance-management-strategies/

[Insecticide Resistance Management Review Group \(IRMRG\)](https://www.croplife.org.au/resources/programs/resistance-management/insecticide-resistance-management-strategies/) https://www.croplife.org.au/resources/programs/resistance-management/insecticide-resistance-management-strategies/



Your responsibilities when applying pesticides

Farm Chemicals Unit, Plant Biosecurity and Product Integrity, NSW DPIRD

The Australian Pesticides and Veterinary Medicines Authority (APVMA), NSW Environment Protection Authority (EPA), SafeWork Australia and SafeWork NSW are the government agencies that regulate pesticides in NSW.

Agricultural and Veterinary Chemicals Code Act 1994 (Commonwealth)

The APVMA administers the *Agricultural and Veterinary Chemicals Code Act 1994*. Under the Act, the APVMA is responsible for the import, registration and labelling of pesticides. States and territories regulate the use of pesticides.

Permits for off-label use

Where there is a need to use pesticides outside the registered use pattern, the APVMA can approve off-label use by issuing a **minor use, emergency or research permit**. In NSW, the *Pesticides Act 1999* does not allow off-label use unless a permit is approved by the APVMA. A list of current permits and registered products is available on the [APVMA website](https://portal.apvma.gov.au/pubcris) (<https://portal.apvma.gov.au/pubcris>).

Any individual or organisation can apply for a permit. The APVMA can be contacted on 02 6770 2300 or by [email](mailto:enquiries@apvma.gov.au) (enquiries@apvma.gov.au).

The label

Chemical labels are legal documents. The *NSW Pesticides Act 1999* requires all chemical users to read and comply with label instructions.

Signal heading

Pesticides fall into 3 of the 10 schedules in the Poisons Standard. All pesticides carry a signal heading. Signal headings for pesticides include:

- Caution (Schedule 5)
- Poison (Schedule 6)
- Dangerous Poison (Schedule 7).

Re-entry intervals

The re-entry interval is the time that must elapse between applying a pesticide and entering the sprayed crop, unless the person is wearing full personal protective equipment (PPE).

Pesticides and the environment

Many pesticides are toxic to aquatic organisms, bees and birds. Following label instructions will minimise the risk to off-target organisms.

Many labels carry the warning: '**Dangerous to bees. Do not spray any plants in flower while bees are foraging**'. It is often safe to spray early in the morning or late in the afternoon but only when bees are not foraging.

Organophosphate and carbamate insecticides are toxic to some birds, especially in granular formulations. Refer to the label for details on how to minimise the danger to birds.

Withholding periods

The withholding period (WHP) is the minimum time that must elapse between the last application of a pesticide and harvest, grazing or cutting the crop or pasture for fodder. The purpose of the WHP is to minimise the risk of residues in agricultural commodities and foods for human and animal consumption.

Some export markets have a lower residue tolerance than Australian maximum residue limits (MRL). Contact your processor or packing shed to determine their market requirements.

Managing spray drift

Spray drift is the physical movement of chemical droplets onto non-target areas where humans, sensitive plants, animals, and the environment might be unduly exposed. Drift can be onto adjacent areas or travel long distances.

Buffer zones reduce the risk of drift onto non-target areas. Applicators must adhere to buffer zones and other drift reduction instructions on labels and avoid application during temperature inversion conditions.

Safety instructions

Safety instructions on labels provide information about personal protective equipment and other safety precautions that are essential when using the product.

Note: before opening and using any farm chemical, consult the label and the Safety Data Sheet (SDS) for safety directions.

Applying pesticides by aircraft

Product labels indicate which products are suitable for application by aircraft. They also provide a recommendation for the minimum water volume for aerial application. Drones are also aircraft.

More information on the legal requirements for aerial application is available on the [EPA website](http://www.epa.nsw.gov.au/pesticides/aerialapplicators.htm) (www.epa.nsw.gov.au/pesticides/aerialapplicators.htm).

Pesticides Act 1999 (NSW)

The Environment Protection Authority administers the *Pesticides Act 1999* and Pesticides Regulation 2017, which control pesticide use in NSW. The aim is to minimise risks to human health, the environment, property, industry and trade.

The primary principle of the *Pesticides Act 1999* is that pesticides must only be used for the purpose described on the product label and label instructions must be followed.

The Act and Regulation require pesticide users to:

- Only use pesticides registered or permitted by the APVMA.
- Obtain an APVMA permit if they wish to use a pesticide contrary to label instructions.
- 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.
- Keep all registered pesticides in containers bearing an approved label.
- Prevent damage to people, property, non-target plants and animals, the environment and trade when applying pesticides.

Training

The minimum prescribed training qualification is the AQF2 competency unit, 'Apply chemicals under supervision'. However, chemical users are encouraged to also complete the AQF3 competency units: 'Prepare and apply chemicals' and 'Transport, handle and store chemicals'.

Record keeping

All people who use pesticides for commercial or occupational purposes must make a record of their pesticide use. Records must be made within 24 hours of applying a pesticide and include:

- date, start and finish time
- operator details – name, address and contact information
- crop treated, e.g. apples
- 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, boom spray
- full name of the product or products (e.g. Bayfidan 250 EC Fungicide® – not just 'Bayfidan')
- total amount of concentrate product used
- total amount of water, oil or other products mixed in the tank with the concentrate
- size of the block sprayed and the order of blocks treated
- an estimate of the wind speed and direction at the start of spraying
- weather conditions at the time of spraying and weather conditions specified on the label

- changes to wind and weather conditions during the application
- records must be made in English and kept for 3 years.

Globally Harmonised System of classifying and labelling of chemicals

The Globally Harmonised System (GHS) is an international system for classifying hazards and communication about dangerous goods and hazardous substances. The GHS replaces the old hazardous substances and dangerous goods classification.

The [SafeWork Australia website](https://www.safework.nsw.gov.au/resource-library/list-of-all-codes-of-practice) (<https://www.safework.nsw.gov.au/resource-library/list-of-all-codes-of-practice>) lists all the codes of practice you will need, including 'Labelling of workplace hazardous chemicals' and another for 'Preparation of safety data sheets for hazardous chemicals' to provide industry with guidance on how to comply with the GHS.

Work Health and Safety Act 2011 (Commonwealth)

SafeWork Australia administers the *Commonwealth Work Health and Safety Act 2011* and the Work Health and Safety Regulation 2011.

The Act defines the responsibilities of employers or the person conducting a business or undertaking (PCBU) and the responsibilities of workers.

The Regulation covers hazardous substances and dangerous goods, including applying the GHS in Australia.

SafeWork Australia has published several [Codes of Practice](https://www.safeworkaustralia.gov.au/resources_publications/model-codes-of-practice) for different industries and situations to provide guidance for industries (https://www.safeworkaustralia.gov.au/resources_publications/model-codes-of-practice).

Work Health and Safety Act 2011 (NSW)

SafeWork NSW administers the *Work Health and Safety Act 2011* (WHS Act; <https://www.legislation.nsw.gov.au/#/view/act/2011/10>) and the *Work Health and Safety Regulation 2017* (<https://www.legislation.nsw.gov.au/#/view/regulation/2017/404>).

The Act implements the Commonwealth WHS Act in NSW. It outlines the primary responsibility of the employer or the PCBU to maintain a safe workplace. There is an emphasis on consultation with workers, risk assessment and management, and attention to worker training and supervision.

The WHS Regulation 2017 includes managing hazardous substances (i.e. most pesticides). It covers identifying hazardous substances in the workplace, and assessing and managing risks associated with their use.

The WHS Regulation 2017 includes responsibilities for managing risks to health and safety at a workplace including:

- correctly labelling containers
- maintaining a register of hazardous chemicals
- identifying risk and ensuring the stability of hazardous chemicals
- ensuring that exposure standards are not exceeded
- information, training and supervision for workers
- spill containment kits to be kept on-site
- SDS for chemicals kept on-site
- controlling ignition sources and the accumulation of flammable and combustible materials
- providing fire protection, fire-fighting equipment, emergency and safety equipment
- developing and displaying an emergency plan for the workplace
- stability, support and appropriate plumbing for bulk containers.

Dangerous Goods (Road and Rail Transport) Act 2008

The Environment Protection Authority (EPA) and SafeWork NSW administer the *Dangerous Goods (Road and Rail Transport) Act 2008* and Regulation. The EPA deals with transport while SafeWork NSW is responsible for classification, packaging and labelling. This act regulates the transport of all dangerous goods except explosives and radioactive substances.

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Analytical laboratories

Below is a list of commercial laboratories that undertake analysis of food commodities and other materials for chemical residues:

Eurofins Agrosience Testing

Phone 02 9900 8442

Website <https://www.eurofins.com.au/locations/eurofins-agrosience-testing-lane-cove/>

National Measurement Institute

Phone 1800 020 076

Email info@measurement.gov.au

National Association of Testing Authorities

Phone 02 9736 8222

Website <https://www.nata.com.au>

Information sources

[APVMA](http://www.apvma.gov.au) (www.apvma.gov.au)

[Australian Code for the Transport of Dangerous Goods by Road and Rail](http://www.ntc.gov.au/heavy-vehicles/safety/australian-dangerous-goods-code/) (www.ntc.gov.au/heavy-vehicles/safety/australian-dangerous-goods-code/)

[Bureau of Meteorology](http://www.bom.gov.au) (www.bom.gov.au)

[Environment Protection Authority](http://www.epa.nsw.gov.au/) (www.epa.nsw.gov.au/)

[Hazardous Substances Information System](http://hcis.safeworkaustralia.gov.au/) (<http://hcis.safeworkaustralia.gov.au/>)

[Managing risks of hazardous chemicals in the workplace](https://www.safeworkaustralia.gov.au/doc/model-code-practice-managing-risks-hazardous-chemicals-workplace) (<https://www.safeworkaustralia.gov.au/doc/model-code-practice-managing-risks-hazardous-chemicals-workplace>)

[National Association of Testing Authorities](http://www.nata.com.au/) (www.nata.com.au/)

[NSW DPIRD resources on QFF](http://www.dpi.nsw.gov.au/biosecurity/insect-pests/qff) (www.dpi.nsw.gov.au/biosecurity/insect-pests/qff)

[Safe use and storage of chemicals in agriculture](https://www.safework.nsw.gov.au/advice-and-resources) (<https://www.safework.nsw.gov.au/advice-and-resources>)

[Work Health and Safety Act 2011](http://www.legislation.gov.au/Details/C2017C00305) (www.legislation.gov.au/Details/C2017C00305)

[Work Health and Safety Regulation 2017](https://www.legislation.nsw.gov.au/#/view/regulation/2017/404) (<https://www.legislation.nsw.gov.au/#/view/regulation/2017/404>)



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 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 the standard formula (above) by the tank size and $\div 100$.

Examples

Spraying thinners

How much carbaryl (product strength 500 g/L) is required per 100 L of water if the concentration rate for Granny Smith apples is 1,000 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 (2 g/L) using a 310 g/L DPA product in a 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)

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

$$= 7 \text{ L of DPA product per tankful.}$$

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)

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

$$= 1,125 \text{ mL (1.125 L) product in the vat.}$$

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 QFF, then the calculation is:

Required amount of product A (in L)

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

$$= 4,500 \text{ mL (4.5 L) product in the vat.}$$

For this example, the sprayer puts out 2,000 L/ha dilute spray 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 $2,000 \div 500$ or 4x.

When configured for concentrate spraying, the spray unit now covers 4 times the area compared to its previous dilute setup. Always consult the product label for specific instructions on concentrate application. Be sure to follow all safety directions and precautions to manage exposure appropriately.



Figure 184. Hand spraying at Schramm Orchard.

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**A Smarter Way to
Tackle Your Farm's Pain Points**

Agtech Toolbox: www.agtech.dpi.nsw.gov.au



Useful resources

Publications

Several publications are mentioned in this guide. Many are available from NSW DPIRD through the Tocal Agricultural College bookshop. Contact details are:

Phone: 1800 025 520

Email tocal.college@dpiird.nsw.gov.au

Web www.tocal.nsw.edu.au/publications

Primefacts usually contain illustrations of the pest or disease being described. These are available free from the [NSW DPIRD website](http://www.dpiird.nsw.gov.au/agriculture/horticulture) (www.dpiird.nsw.gov.au/agriculture/horticulture).

Integrated pest, disease and weed management manual for Australian apple and pears is a practical guide for pome fruit orchardists wanting to implement IPM. This is available free from the [Hort Innovation website](http://www.horticulture.com.au/globalassets/hort-innovation/resource-assets/2020-21-australian-apple-and-pear-ipdm-manual.pdf) (www.horticulture.com.au/globalassets/hort-innovation/resource-assets/2020-21-australian-apple-and-pear-ipdm-manual.pdf).

Integrated pest and disease management for Australian summer fruit is a practical guide for summer fruit orchardists wanting to implement IPDM. This is available free from the [NSW DPIRD website](http://www.dpiird.nsw.gov.au/agriculture/horticulture/stone-fruit/pests,-diseases-and-disorders/summerfruit-ipdm) (www.dpiird.nsw.gov.au/agriculture/horticulture/stone-fruit/pests,-diseases-and-disorders/summerfruit-ipdm).

George A, Nissen B, Bignell G, Hutton D, Broadley R and Dunn D (2017) ***Integrated pest and disease management manual for persimmon***, second edition. Department of Agriculture and Fisheries, Queensland, <https://www.horticulture.com.au/globalassets/hort-innovation/resource-assets/pr13007-integrated-pest-and-disease-mgmt-edition-2-pdf.pdf>

Internet sites

Pesticides – use and disposal

[Australian Pesticides and Veterinary Medicines Authority](http://www.apvma.gov.au) (www.apvma.gov.au)

[bagMUSTER](https://www.bagmuster.org.au/) (<https://www.bagmuster.org.au/>)

[ChemClear](http://www.chemclear.com.au) (www.chemclear.com.au)

[drumMuster](http://www.drummuster.org.au) (www.drummuster.org.au)

Agricultural industry organisations

[Apple and Pear Australia Ltd](http://www.apal.org.au) (www.apal.org.au)

[Cherry Growers Australia](http://www.cherrygrowers.org.au) (www.cherrygrowers.org.au)

[Hort Innovation](http://www.horticulture.com.au) (www.horticulture.com.au)

[National Farmers' Federation](http://www.nff.org.au) (www.nff.org.au)

[NSW Farmers' Association](http://www.nswfarmers.org.au) (www.nswfarmers.org.au)

[Persimmons Australia](http://www.persimmonsaustralia.com.au) (www.persimmonsaustralia.com.au)

[Summerfruit Australia Ltd](http://www.summerfruit.com.au) (www.summerfruit.com.au)

State government

[Department of Jobs, Precincts and Regions, Victoria](https://djpr.vic.gov.au/) (<https://djpr.vic.gov.au/>)

[Department of Natural Resources and Environment, Tasmania](http://www.dpipwe.tas.gov.au) (www.dpipwe.tas.gov.au)

[Department of Primary Industries and Regions, SA](https://www.pir.sa.gov.au/) (<https://www.pir.sa.gov.au/>)

[Department of Primary Industries, Queensland](https://www.dpi.qld.gov.au/) (<https://www.dpi.qld.gov.au/>)

[Local Land Services](http://www.ils.nsw.gov.au) (www.ils.nsw.gov.au)

[NSW Department of Primary Industries and Regional Development](http://www.dpiird.nsw.gov.au) (www.dpiird.nsw.gov.au)

[NSW Environment, Energy and Science](http://www.environment.nsw.gov.au) (www.environment.nsw.gov.au)

[NSW Rural Assistance Authority](http://www.raa.nsw.gov.au) (www.raa.nsw.gov.au)

[SafeWork NSW](http://www.safework.nsw.gov.au) (www.safework.nsw.gov.au)

[WA Department of Primary Industries and Regional Development](https://www.dpiird.wa.gov.au/) (<https://www.dpiird.wa.gov.au/>)

Rural assistance

[Health NSW](http://www.health.nsw.gov.au) (www.health.nsw.gov.au)

[NSW Rural Assistance Authority](http://www.raa.nsw.gov.au) (www.raa.nsw.gov.au)

[Services Australia](https://www.servicesaustralia.gov.au/) (<https://www.servicesaustralia.gov.au/>)

Federal government

[ABC Rural Department](http://www.abc.net.au/rural) (www.abc.net.au/rural)

[Australian Trade Commission](http://www.austrade.gov.au) (www.austrade.gov.au)

[Department of Agriculture, Fisheries and Forestry](http://www.agriculture.gov.au) (www.agriculture.gov.au)

[Plant Health Australia](http://www.planthealthaustralia.com.au) (www.planthealthaustralia.com.au)

Climate

[Bureau of Meteorology](http://www.bom.gov.au) (www.bom.gov.au)

Environment

[Department of Agriculture, Water and the Environment](http://www.environment.gov.au) (www.environment.gov.au)

[NSW Environment, Energy and Science](http://www.environment.nsw.gov.au) (www.environment.nsw.gov.au)

[NSW Environment Protection Authority](http://www.epa.nsw.gov.au) (www.epa.nsw.gov.au)

Alternative systems (organics)

[Australian Organic](http://www.austorganic.com) (www.austorganic.com)

[National Association for Sustainable Agriculture Australia](https://nasaaorganic.org.au/) (<https://nasaaorganic.org.au/>)

[Organic Industries Australia](https://organicindustries.org.au/) (<https://organicindustries.org.au/>)

Economic information

[Australian Bureau of Agricultural and Resource Economics and Sciences](http://www.agriculture.gov.au/abares) (www.agriculture.gov.au/abares)

Export and import support

[Biosecurity Import Conditions Database](http://www.agriculture.gov.au/import/online-services/bicon) (BICON; www.agriculture.gov.au/import/online-services/bicon)

[Codex – International Food Standards](http://www.agriculture.gov.au/ag-farm-food/food/codex) (www.agriculture.gov.au/ag-farm-food/food/codex)

[Manual of Importing Country Requirements](http://www.agriculture.gov.au/export/micor) (MICoR; www.agriculture.gov.au/export/micor)

Technical production information**Agencies and universities**

[Commonwealth Scientific and Industrial Research Organisation](http://www.csiro.au) (CSIRO; www.csiro.au)

[Fruit and Nut Research and Information Centre, University of California](http://fruitandnuts.ucdavis.edu) (<http://fruitandnuts.ucdavis.edu>)

[New Zealand Ministry for Primary Industries](http://www.mpi.govt.nz) (www.mpi.govt.nz)

[South Australia Research and Development Institute](http://www.pir.sa.gov.au/research) (www.pir.sa.gov.au/research)

[Tasmanian Institute of Agriculture](http://www.utas.edu.au/tia) (www.utas.edu.au/tia)

[United Kingdom Department for Environment, Food and Rural Affairs](http://www.gov.uk/defra) (www.gov.uk/defra)

[United States Department of Agriculture](http://www.usda.gov) (USDA; www.usda.gov)

Integrated pest management

[Australasian Biological Control Association Inc](http://www.goodbugs.org.au) (www.goodbugs.org.au)

[Australian apple and pear IPDM](https://extensionaus.com.au/ozapplepearipdm/home) (<https://extensionaus.com.au/ozapplepearipdm/home>)

[Australian apple and pear IPDM Facebook page](https://www.facebook.com/groups/579194849206452/) (<https://www.facebook.com/groups/579194849206452/>)

[Integrated pest disease and weed management manual for Australian apples and pears](https://extensionaus.com.au/ozapplepearipdm/ipdm-manual-for-apples-and-pears/) (<https://extensionaus.com.au/ozapplepearipdm/ipdm-manual-for-apples-and-pears/>)

[The AgVic Pocket Guide](https://extensionaus.com.au/ozapplepearipdm/draft_useful-tool-pests-pocket-guide/) (https://extensionaus.com.au/ozapplepearipdm/draft_useful-tool-pests-pocket-guide/)

Quality assurance

[Freshcare Australia](http://www.freshcare.com.au) (www.freshcare.com.au)

Nurseries

[Australian Nurserymen's Fruit Improvement Company](http://www.anfic.com.au) (ANFIC; www.anfic.com.au)

[Fleming's Nurseries](https://www.flemings.com.au/nurseries/) (<https://www.flemings.com.au/nurseries/>)



Need more help or information?

Talk with our Temperate Fruit Development Team



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Facebook group

 Want to interact with us and other temperate fruit growers on Facebook? Why not join our closed group [NSW DPIRD Temperate Fruit](https://www.facebook.com/groups/2952421994827990/) (<https://www.facebook.com/groups/2952421994827990/>)

Feedback please

The authors want to make sure the information we are providing is what you need to help your business grow. We welcome suggestions, comments and ideas from growers and technical people alike that might improve the usefulness and relevance of the guide. Please contact us with your suggestions.

Other sources of information

NSW Local Land Services (Horticulture)

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

Producers can contact their nearest [LLS office](https://www.lls.nsw.gov.au/) (<https://www.lls.nsw.gov.au/>) by phoning 1300 795 299.

NSW DPIRD Biosecurity and Food Safety

Biosecurity NSW is the contact point in this state for anyone who requires advice on moving fruit or plants and other issues of a biosecurity nature in Australia. All enquiries should be directed to [Plant Health Australia](https://www.planthealthaustralia.com.au/) (<https://www.planthealthaustralia.com.au/>) on **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.



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