Department of Primary Industries
Department of Regional NSW

Berry plant protection guide 2023–24

NSW DPI MANAGEMENT GUIDE

Melinda Simpson and Gaius Leong

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FORTUNA GLOBE 750 WG

750g/kg Mancozeb

- High loaded Dry-Flowable granule for ease of mixing and minimal dust
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- Control of Botrytis, Rust and Downy mildew in Blackberries, Blueberries and Raspberries

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HYDROCOP WG

500g/kg Copper Hydroxide

- Dry-Flowable granule for ease of mixing and minimal dust
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COPPOX WG

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Image acknowledgements

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Contents

About this guide

This is the fifth edition of the *Berry plant protection guide*. It is the latest in a series of similar publications that have served industry for over 60 years, providing up-to-date information on all aspects of protecting your orchard from pests and diseases. This edition will have an integrated pest management (IPM) focus, providing information on a range of different methods that can be used to manage pests and diseases in berry crops.

Distribution

The guide aims to provide commercial berry growers with up-to-date technical information on all aspects of crop protection. It is available free to Australian blueberry, raspberry and blackberry growers. The guide is also available to download from the NSW DPI website (www.dpi.nsw.gov.au/agriculture/horticulture/berries).

Pesticides

We do not list every pesticide that is registered for a specific use but rather guide growers in their choice of chemicals. It is our policy to use common chemical names or active ingredients rather than trade names when referring to pesticides, crop regulation compounds and nutrient sprays. This is because there can be many product names for the same active ingredient and it would be impossible to list them all at each mention in the guide.

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

Using common chemical names in recommendations is intended to simplify the advice. It also means that at least one product containing that active ingredient is registered for the purpose given. Pesticide users must follow all label and permit instructions.

Pesticide use is under constant scrutiny through residue surveys. These valuable tools for fruit production must not be misused.

Always read the label

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

Permits

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

Acknowledgements

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

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

Gaius Leong

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Expanding crop protection options for controlling blueberry rust – second trial results

Melinda Simpson (NSW DPI) and Jay Anderson (Centre for Organics Research, Southern Cross University)

NSW Department of Primary Industries, with Southern Cross University (SCU), have recently conducted a second round of field trials to evaluate a range of organic crop protectants to manage blueberry rust disease (caused by *Thekopsora minima*).

This trial is part of a larger project led by Kara Barry from the Tasmanian Institute of Agriculture and funded via the Tasmanian Government through the Agricultural Innovation Fund.

The field trial

The trial was carried out on a commercial blueberry orchard in Brooklet, NSW, using the southern highbush variety 11-11. High disease levels were experienced during the trial due to the high rainfall that fell on the Northern Rivers throughout the trial.

The trial evaluated 8 products for control of blueberry rust (Table 1). Products were applied as foliar sprays every 2 weeks from December 2021 through to March 2022. Mancozeb and copper were included as reference treatments in addition to the products being evaluated.

Trials were set up in a complete randomised block design with 4 replicate blocks per treatment with 3 plants assessed in each treatment block. Each block had a 2-plant internal buffer, and each row was separated by a buffer row.

Measuring rust severity

Disease severity was assessed on 20 leaves per plant by visually rating the leaf area affected by blueberry rust every 2 weeks (Figure 1). This amounted to a massive 25,000+ leaves assessed over the season. The cumulative disease severity for the whole season can be visualised by looking at the area under the disease progress curve (Figure 2).

Visual assessment of whole plants revealed a very similar result with copper, mancozeb and polyoxin D zinc salt treatments having very low levels of leaf drop or leaf yellowing compared with other treatments.

Table 1. Fungicides and application rates evaluated for their efficacy against blueberry rust.

Active ingredient	FRAC* code	Formulation	Application rate per 100 L
Bacillus amyloliquefaciens strain QST 713	BM02	Wettable powder	250 g
Copper present as hydroxide	M2	Water dispersible granule	105 g
Crustacean and wild fish waste fortified with trace minerals and vitamins Emulsifiable botanical oil	NA	Liquid Liquid	1 L 250 mL
Electrolysed oxidised water	NA	Liquid	20 L
Emulsifiable botanical oils	NA	Liquid	250 or 500 mL
Mancozeb	M3	Water dispersible granule	200 g
Polyoxin D zinc salt	19	Water dispersible granule	40 g
Potassium bicarbonate + potassium silicate Emulsifiable botanical oil	M2	Powder Liquid	400 g 250 mL

*FRAC = Fungicide Resistance Action Committee.

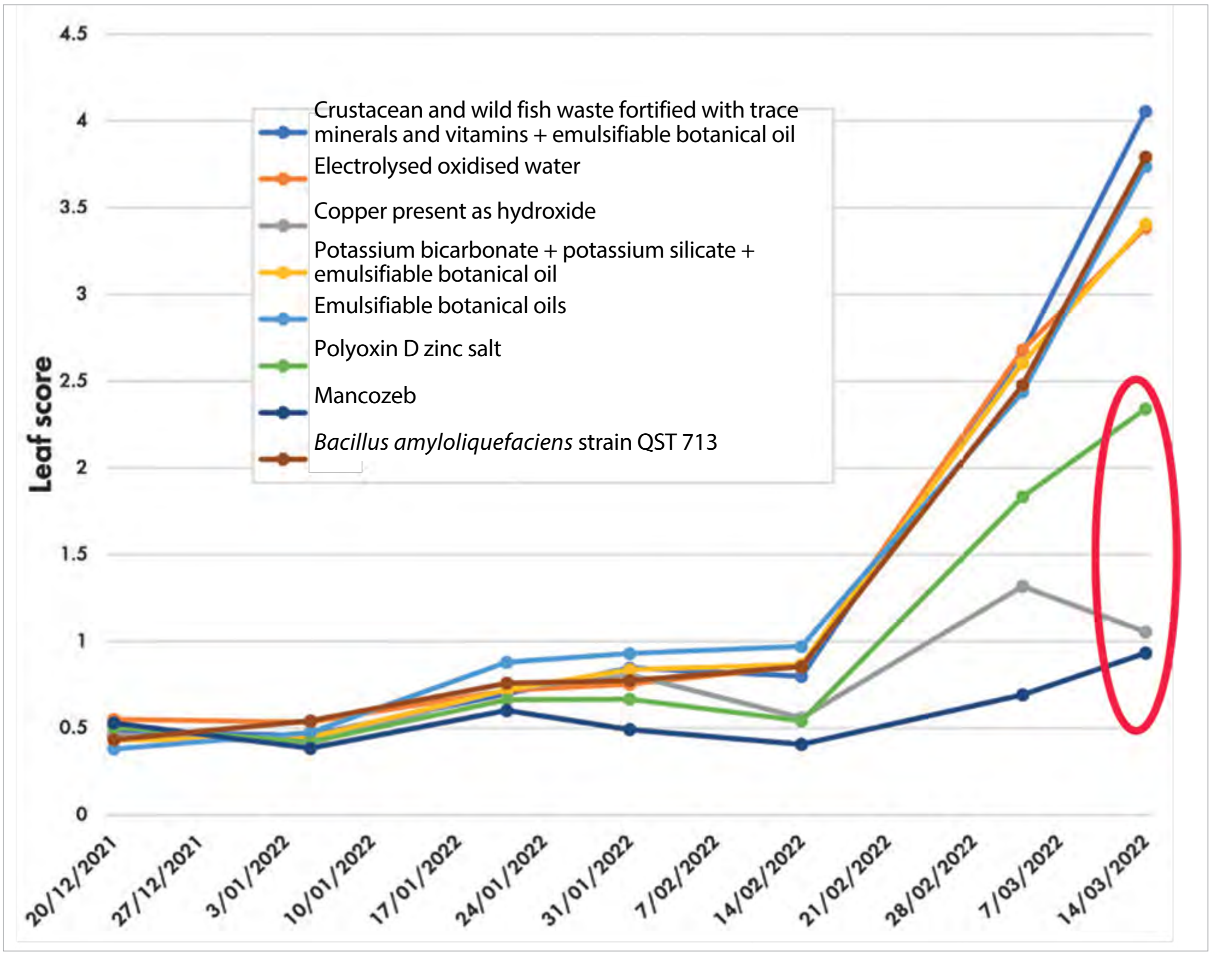

Figure 1. Disease severity after applying treatments for blueberry rust. Data presented are the average disease scores over time, where a score of 0 indicates leaves with no blueberry rust and 4 indicates leaves with 15–25% leaf area affected by blueberry rust.

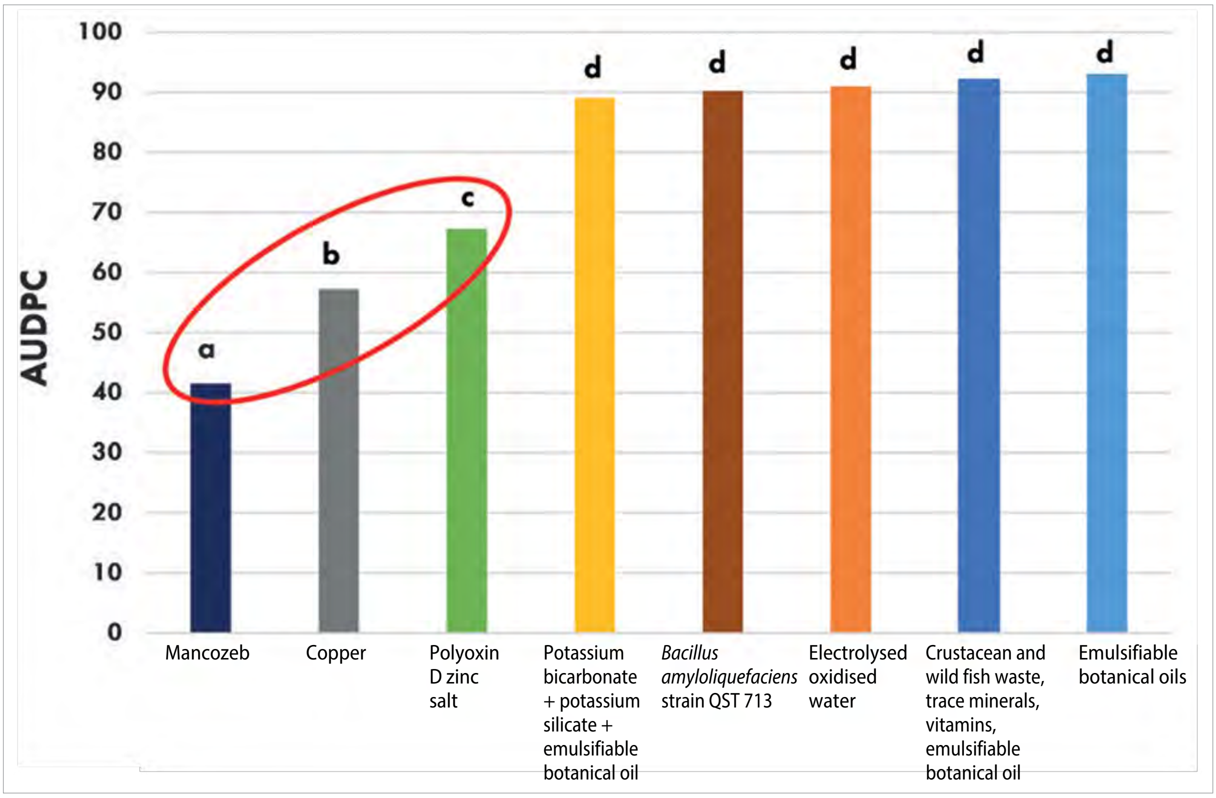

Figure 2. Disease severity of blueberry rust expressed as the area under the disease progress curve (AUDPC) following fortnightly application of selected chemicals from December 2021 to March 2022. Different letters at each column indicate significant differences between treatments ($P<0.05$).

What's next?

The team has successfully obtained a minor use permit (PER92997) for polyoxin D zinc salt (Nufarm Intervene®) for managing rust in blueberries. Nufarm Intervene® is currently certified for organic use, which will give organic growers a new management option for suppressing blueberry rust.

New study to develop on-farm management strategies for blueberry rust

A new 3-year study beginning in 2023 will test on-farm strategies to help prevent and manage blueberry rust, funded by the Tasmanian Government Agricultural Innovation Fund.

The project team will tackle two key management issues:

1. Managing rust on semi-evergreen and evergreen cultivars where infection persists on leaves over winter.
2. Understanding what environmental conditions are optimal for blueberry rust survival and infection and relating these to both climatic conditions in Tasmania and the cultivars grown.

The research study includes:

Defoliation studies: the aim is to break the rust life cycle in semi-evergreen varieties. We will measure the effect of short term (8–10 week) defoliation on plant health, bud development, fruit yield and quality.

Survival and infection studies: the team will assess what environmental conditions are needed for blueberry rust survival and infection to help identify higher risk sites and weather conditions. These data will feed into blueberry rust models to pinpoint when and where there is a risk of infection or if blueberry rust is likely to persist over winter.

Growers will be able to use the information to decide if defoliation would be an effective strategy to prevent blueberry rust from overwintering in their orchard.

How to use this guide

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

Step 1: go to Table 2 or Table 3 and find the pest or disease you are interested in. These are listed alphabetically under the column titled 'Common name'.

Step 2: check to see if the pest or disease is considered a major problem in your crop. If there is a red cross (X) 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 by it and control strategies are recommended.

Step 3: scan across the table to find the relevant page number for the pest or disease. The icons shown in Figure 3 to Figure 5 are used to identify the crops covered in this guide.

Alternatively, visit the contents table (Page 3) 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, avoiding spray drift and responsible pesticide use.

This guide provides berry growers with suggestions for managing the main pests and diseases with the responsible use of pesticides (Page 82). For pesticides to be most effective, implementing practices such as integrated pest, disease and weed management (IPDWM) is essential. Good management and anti-resistance strategies must also be strictly followed.

Weather influences the pests and diseases that affect berries. By observing the weather, berry 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 conditions for pests and diseases is essential.

These steps are crucial in managing chemical resistance, prolonging the life of pesticides and for achieving effective pest and disease control.

Figure 3. The blueberry icon. Source: PNG Tree.

Figure 4. The raspberry icon. Source: PNG Tree.

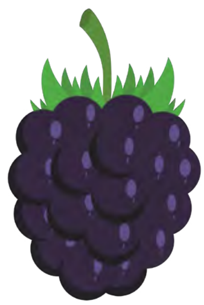

Figure 5. The blackberry icon. Source: PNG Tree.

Diseases affecting berries

Table 2. Diseases affecting berries in Australia.

Common name	Scientific name	Which crops are primarily affected?			
		Blueberries	Raspberries	Blackberries	Where to look
Alternaria fruit rot	*Alternaria* spp.	✓	✓	✓	Page 16
Anthracnose	*Colletotrichum simmondsii*	✓	✓	✓	Page 17
Bacterial blight/canker	*Pseudomonas syringae*	✓	X	X	Page 18
Blueberry rust	*Thekopsora minima*	✓	X	X	Page 19
Cane spot	*Elsinöe veneta*	X	✓	✓	Page 21
Cladosporium fruit rot	*Cladosporium* spp.	X	✓	X	Page 22
Crown gall	*Agrobacterium tumefaciens*	✓	X	✓	Page 23
Downy mildew	*Peronospora* spp.	X	X	✓	Page 24
Grey mould/flower blight	*Botrytis cinerea*	✓	✓	✓	Page 26
Phomopsis blight	*Phomopsis* spp.	✓	X	X	Page 28
Phytophthora root rot	*Phytophthora* spp.	✓	✓	✓	Page 30
Powdery mildew	*Podosphaera macularis* and *Erysiphe* spp.	X	✓	✓	Page 32
Stem blight	*Neofusicoccum* spp., *Lasiodiplodia* spp. and *Botryosphaeria dothidea*	✓	X	X	Page 34
Yellow rust	*Phragmidium rubi-idaei*	X	✓	X	Page 35

Pests affecting berries

Table 3. Pests affecting berries in Australia.

Common name	Scientific name	Which crops are primarily affected?			
		Blueberries	Raspberries	Blackberries	Where to look
Aphids (green peach aphid)	*Myzus persicae*	✓	✓	✓	Page 36
Broad mite	*Polyphagotarsonemus latus*	X	✓	✓	Page 38
Budworms	*Helicoverpa* spp.	✓	✓	✓	Page 39
Cottonseed bug	*Oxycarenus luctuosus*	X	✓	✓	Page 42
Dried fruit beetle (Carpophilus beetle)	*Carpophilus* spp.	✓	✓	✓	Page 44
Elephant weevil	*Orthorhinus cylindrirostris*	✓	X	X	Page 45
European earwig	*Forficula auricularia*	✓	✓	✓	Page 46
Fruit spotting bug and banana spotting bug	*Amblypelta nitida* and *Amblypelta lutescens lutescens*	✓	✓	X	Page 48
Green stink bug	*Plautia affinis*	✓	✓	✓	Page 49
Green vegetable bug	*Nezara viridula*	✓	✓	✓	Page 50
Leafhoppers/Jassids	*Cicadellidae* spp.	✓	✓	✓	Page 51
Leaf rollers	Tortricidae	✓	X	X	Page 52
Light brown apple moth	*Epiphyas postvittana*	✓	✓	✓	Page 53
Loopers	*Lepidoptera* spp.	✓	✓	✓	Page 55
Mirids (green, brown and crop)	*Creontiades dilutus, Creontiades pacificus and Sidnia kinbergi*	X	✓	✓	Page 56
Plague thrips	*Thrips imaginis*	✓	✓	✓	Page 57
Queensland fruit fly	*Bactrocera tryoni*	✓	✓	✓	Page 59
Redberry mite	*Acalitus essigi*	X	X	✓	Page 63
Red-shouldered leaf beetle	*Monolepta australis*	✓	✓	✓	Page 65
Rutherglen bug	*Nysius vinitor*	X	✓	✓	Page 67
Scale insects	*Coccidae* spp., *Diaspididae* spp. *and Eriococcidae* spp.	✓	✓	✓	Page 68
Scarab beetle	*Heteronychus arator*	✓	X	X	Page 70
Two-spotted mite	*Tetranychus urticae*	✓	✓	✓	Page 71
Western flower thrips	*Frankliniella occidentalis*	✓	✓	✓	Page 73

Blueberry development stages


Figure 6. Tight bud.


Figure 7. Budswell.


Figure 8. Bud break.


Figure 9. Tight cluster.


Figure 10. Early pink bud.

Figure 11. Late pink bud.

Figure 12. Full bloom.

Figure 13. Petal fall.

Figure 14. Green fruit.

Figure 15. Fruit colouring.

Blackberry development stages

Figure 16. Closed bud. Photo: Damien Clothier, Mountain Blue Farms.

Figure 17. Opening bud to bloom. Photo: Damien Clothier, Mountain Blue Farms.

Figure 18. Blackberry Bloom. Photo: Damien Clothier, Mountain Blue Farms.

Figure 19. Fruit development. Photo: Damien Clothier, Mountain Blue Farms.

Figure 20. Fruit ripening. Photo: Damien Clothier, Mountain Blue Farms.

Figure 21. Ripe fruit. Photo: Botanicoir.

Raspberry development stages

Figure 22. Raspberry bud.

Figure 23. Raspberry bloom.

Figure 24. Bloom to green fruit.

Figure 25. Green fruit.

Figure 26. Green to ripe fruit.

Managing diseases in berries

Alternaria fruit rot

Alternaria spp.

Alternaria fruit rot can affect blueberries, raspberries and blackberries. The fungus overwinters in old twigs and plant debris on the ground. The optimal temperature for the fungus to grow and the spores to germinate is 28 °C, but 20 °C is optimal for disease development.

Risk period

Table 4. The peak risk period for alternaria fruit rot.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

Alternaria fruit rot is characterised by sunken areas with dark green-greyish spores (Figure 27). Infected fruit becomes soft and shrivelled. Increased infection on leaves can cause considerable damage to fruit after harvest. In packing facilities, spores from in-field infected berries can contaminate inspection belts and other surfaces. Healthy berries coming into contact with these surfaces pick up the spores and become infected through wet stem scars.

Management

Cultural and physical

Remove or break down all leaf and pruning residue, especially when there was leaf disease in the previous season. In larger commercial-sized orchards, mechanised mulching can be used to hasten prunings and leaf matter breakdown (Figure 28). Picking buckets, packing lines and inspection belts should be cleaned frequently to reduce the chances of contamination by fungal spores.

Figure 27. Alternaria fruit rot in blueberries. Photo: Pscheidt and Ocamb (2021).

Figure 28. Mulching prunings to hasten the breakdown of diseased leaf matter.

Biological

There are no known biological controls for alternaria fruit rot in berries.

Chemical

The chemical option for controlling alternaria fruit rot is listed in Table 5.

Table 5. Registered or permitted product for alternaria fruit rot in Australia.

Active constituent (example trade name)	Fungicide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Boscalid + pyraclostrobin (Pristine®) PER82986 (expires 31.8.24)	7 + 11	1	Low	Blackberries Raspberries (field and protected grown)

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

Anthracnose

Colletotrichum simmondsii

Anthracnose affects blueberries and is caused by *Colletotrichum* species fungi, mainly *Colletotrichum simmondsii*. The pathogen overwinters on infected twigs, old fruiting spurs, live buds, infected prunings and fruit left in the orchard. In spring, spores are produced and released from blighted twigs and can continue to be released throughout the growing season. Optimum development for anthracnose is moist conditions between 20 and 27 °C. Flowering is the most critical time for infection.

Risk period

Table 6. The peak risk period for anthracnose.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

Infection on fruit begins during flowering. Infected fruit remain symptom-free until berries ripen. The first symptom will usually be berry shrivelling, then the characteristic sunken lesions will develop, particularly during warm, moist conditions. On ripe fruit, orange–pink spore masses form during humid conditions (Figure 29). Symptom development is often delayed until after harvest.

Figure 29. Orange spore masses characteristic of anthracnose. Photo: Pscheidt and Ocamb (2021).

Management

Cultural and physical

Regular pruning allows air circulation in the canopy and reduces drying time after the bushes have become wet. Remove all dead twigs, fruit and prunings from blocks. Cool berries rapidly after harvest.

Biological

Botector® is a biological fungicide containing a naturally occurring fungus, *Aureobasidium pullulans*. It is registered in blueberries for the suppression of anthracnose. Botector® works through competitive exclusion, creating a physical barrier at potential infection sites.

Chemical

The chemical treatment options for anthracnose are listed in Table 7.

Table 7. Registered or permitted products for anthracnose in Australia.

Active constituent (example trade name)	Fungicide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Aureobasidium pullulans strain DSM 14940 and DSM 14941 (Botector®)	–	Not required when used as directed	Low	Blackberries, blueberries, raspberries (suppression only)
Boscalid + pyraclostrobin (Pristine®) PER82986 (expires 31.8.24)	7 + 11	3	Low	Blackberries, blueberries, raspberries
Captan PER13958 (expires 31.8.25)	M4	1	Low	Blueberries
Copper (present as copper hydroxide or cupric hydroxide) PER84176 (expires 31.12.25)	M1	1	Medium	Blueberries
Cyprodinil + fludioxonil (Switch®) PER84891 (expires 31.1.28)	9 + 12	7	Low	Blueberries

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

Bacterial blight/canker

Pseudomonas syringae* pv. *syringae

Bacterial canker mainly affects blueberries. It is caused by the bacterium *Pseudomonas syringae*, which is naturally in the environment and can survive on the surface of the stem. It only infects the plant if it enters the stem through wounds, such as from frost damage, or through natural openings, such as leaf scars. The bacteria can be spread by wind, rain, or insects, or introduced with infested propagation wood or nursery stock.

Risk period

Table 8. The peak risk period for bacterial blight.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

Symptoms appear first as water soaking on 1-year old stems (Figure 30). These lesions rapidly develop into reddish-brown to black cankers (Figure 31) with margins and can extend the length of the stem. Buds above or in the canker area are killed. Dead tissue reduces plant vigour and yield. Shoot-tip dieback is the most common symptom in young plants in nurseries.

Figure 30. Infected buds fail to open and die, also some stem necrosis. Photo: Anco and Ellis (2011).

Figure 31. Buds within the canker area are killed. Photo: British Columbia Ministry of Agriculture.

Management

Cultural and physical

Cultural controls are required to manage the disease, including pruning out diseased wood, avoiding excessive nitrogen applications and maintaining strict hygiene to avoid spreading the pathogen through the orchard. Prune out diseased wood as soon as it is noticed and especially before rain to prevent the spread of the bacteria.

Biological

There are no biological control options for bacterial canker in blueberries.

Chemical

There are no chemical control options for bacterial canker in blueberries.

Blueberry rust

Thekopsora minima

The fungus *Thekospora minima* causes blueberry rust. Spores spread from old infections to infect new tissues. Infected leaves remaining on the plant after pruning can become an inoculum source for new infections. Young leaves are most susceptible to infection. Periods of leaf wetness (e.g. 7 hours at 21 °C) are required for infection.

Risk period

Table 9. The peak risk period for blueberry rust.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

The fungus grows into the leaf and, depending on environmental conditions, pustules can develop from 10 days after infection. Spores are then moved by air or moisture to infect new tissues. Spore numbers can build up rapidly and there can be many infection cycles in a season. Spores survive at least 4–8 weeks on leaves on the orchard floor, although viability declines over time.

Early blueberry rust signs will appear as small chlorotic (yellow) spots on upper leaf surfaces (Figure 32). As the disease develops, the spots become larger and turn dark red–brown (Figure 33), then merge and become necrotic. Yellow–orange pustules develop on the corresponding lower leaf surface (Figure 34). The pustules contain spores that can infect new leaves; there can be thousands of spores in a single pustule (Figure 35). If the disease is severe, infected leaves can drop prematurely, and entire plants can be defoliated. Lesions and pustules can also form on fruit (Figure 36), reducing berry quality and marketability.

Figure 32. Early blueberry rust symptoms.

Figure 33. Progressive blueberry rust symptoms.

Figure 34. Orange pustules on the underside of leaves.

Figure 35. Blueberry rust pustules.

Figure 36. Blueberry rust spores on fruit.

Figure 37. Pruning allows air circulation and reduces drying time after bushes get wet. Photo: G Mittasch, OzGroup.

Monitoring

In favourable conditions, spores can be produced and dispersed at any time of the year. Spring through to autumn is the best time to check plants for signs of blueberry rust, especially when conditions are favourable.

Management

Cultural and physical

Diligent hygiene practices will minimise the spread of blueberry rust. Where possible, remove all diseased wood and leaves during pruning and dispose of all fallen and pruned leaves from branches. Pruning allows air circulation in the canopy and reduces drying time after bushes become wet (Figure 37).

Biological

There are no known biological controls for blueberry rust.

Chemical

The chemical treatment options for blueberry rust are listed in Table 10.

Table 10. Registered or permitted products for blueberry rust in Australia.

Active constituent (example trade name)	Fungicide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Boscalid + pyraclostrobin (Pristine®) PER82986 (expires 31.8.24)	7 + 11	3	Low	Blueberries (suppression only)
Chlorothalonil PER91300 (expires 30.9.26)	M5	28	Low	Blueberries
Copper (present as copper hydroxide or cupric hydroxide) PER84176 (expires 31.12.25)	M1	1	Medium	Blueberries
Dithianon PER82601 (expires 31.12.26)	M9	21	Low	Blueberries
Mancozeb PER13958 (expires 31.8.25)	M3	7	Medium	Blueberries
Polyoxin D zinc salt PER92997 (expires 31.3.25)	19	Not required when used as directed	Low	Blueberries (suppression only)
Propiconazole (Tilt®) PER14740 (expires 30.6.24)	3	3	Low	Blueberries

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

Cane spot

Elsinöe veneta

Cane spot is caused by the fungus *Elsinöe veneta*. It is often referred to as anthracnose and affects raspberries and blackberries. Cane spot usually damages the stems but can also affect the leaves and fruit. The pathogen overwinters on infected twigs and leaves. Cane spot can be introduced by infected plants or by spores that are dispersed by rain or water, blown in on the wind, or transported on contaminated clothing, vehicles or machinery.

Risk period

Table 11. The peak risk period for cane spot.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

On leaves, cane spot symptoms appear as irregularly shaped, yellow spots. These spots enlarge and develop grey centres with a reddish–purple border (Figure 38). Over time these grey centres can fall out, giving the spots a shot-hole effect. Symptoms begin as small, distinct purplish spots on younger stems. The spots get larger and their centres turn grey, while the outer edge stays purple (Figure 39). In severe cases, the spots join, causing the stem to become weak and, in some cases, die.

Figure 38. A leaf infected with cane spot.

Figure 39. A cane infected with cane spot. Photo: Charles Drake, Virginia Polytechnic Institute and State University.

Management

Cultural and physical

Cane spot control begins with clean, disease-free planting material, promoting good air movement by keeping fruit rows narrow, spacing canes adequately and controlling weeds.

Biological

There are no known biological controls for cane spot in raspberries and blackberries.

Chemical

The chemical treatment options for cane spot are listed in Table 12.

Table 12. Registered or permitted products for cane spot in Australia.

Active constituent (example trade name)	Fungicide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Azoxystrobin (Amistar®)	11	1	Low	Blackberries, raspberries
Boscalid + pyraclostrobin (Pristine®) PER82986 (expires 31.8.24)	7 + 11	1	Low	Blackberries, raspberries
Captan PER13958 (expires 31.8.25)	M4	1	Low	Blackberries, raspberries
Copper (present as copper oxychloride) (Coppox)	M1	1	Medium	Raspberries

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

Cladosporium fruit rot

***Cladosporium* spp.**

Cladosporium spp. are naturally present environmental fungi that can be isolated from air, soil and dead woody materials. Cladosporium fruit rot is primarily a postharvest storage disease of raspberries. The optimal temperature for *Cladosporium* spp. growth is between 20 and 25 °C, but can occur at lower temperatures during normal fruit storage.

Risk period

Table 13. The peak risk period for cladosporium fruit rot.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

Cladosporium spp. infection on the fruit will appear as a velvety olive-green growth, generally restricted to the fruit surface with little or no damage to the tissues (Figure 40). However, the appearance of fungal growth renders the berries unfit for sale. The disease is favoured by rainfall followed by temperatures between 20 and 25 °C. Monitor weather conditions and take a preventative approach to controlling infections.

Figure 40. Velvety olive-green growth is characteristic of cladosporium. Photo: S Evangelista, Mountain Blue Farms.

Management

Cultural and physical

Practice good sanitation and manage moisture in the planting to reduce inoculum levels and infection risk. Harvest regularly and carefully, removing damaged and infected fruit. Cool berries as rapidly as possible.

Adjust pot moisture and root pressure according to transpiration. Avoid excessive pot moisture going into long periods of reduced transpiration.

Biological

There are no known biological controls for cladosporium in raspberries.

Chemical

The chemical treatment option for cladosporium fruit rot is listed in Table 14.

Table 14. Registered or permitted product for cladosporium in Australia.

Active constituent (example trade name)	**Fungicide group(s)**	**WHP[1] (days)**	**Effect on beneficials**	**Registered for use in...[2]**
Azoxystrobin (Amistar®)	11	1	Low	Blackberries, raspberries

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

Crown gall

Agrobacterium tumefaciens

Crown gall is caused by the bacterium *Agrobacterium tumefaciens*. It is spread by moving soil, infected plant material or pruning tools. Strict orchard hygiene should be employed to manage the spread.

Risk period

Table 15. The peak risk period for crown gall.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

The bacterium enters through natural or mechanical wounds on stems and roots, then induces gall formation at the base of canes (Figure 41) or on the main roots (Figure 42). Galls can also occasionally form on branches higher in the bush. Young galls are cream to light brown and spongy in texture. They turn dark, rough and harden with age. The disease is less of a problem in acidic soils.

Figure 41. Blueberry crown gall on the base of canes. Photo: Gaius Leong, OzGroup.

Figure 42. Crown gall often occurs on roots as a solid mass. Photo: OSU Plant Pathology Slide Collection.

Management

Cultural and physical

Managing crown gall involves starting with planting disease-free nursery stock in non-infected soils, minimising wounds, sterilising pruners and removing and destroying plants if they become infected.

Biological

Agrobacterium radiobacter K1026 is a non-pathogenic biological control agent used to prevent crown gall in the field. It works by colonising wounded plant tissue and blocking infections by the agrobacteria.

Chemical

The chemical treatment options for crown gall are listed in Table 16.

Table 16. Registered or permitted products for crown gall in Australia.

Active constituent (example trade name)	Fungicide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Rhizobium rhizogenes (NoGall™) PER13150 (expires 30.9.27)	–	Not required when used as directed	Low	Blackberries
Agrobacterium radiobacter var. radiobacter (NoGall™) PER89523 (expires 31.7.28)	–	Not required when used as directed	Low	Blueberries

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

Downy mildew

Peronospora spp.

Downy mildew, caused by the oomycete *Peronospora* species, is mainly a problem in blackberries. It overwinters inside roots, crowns and canes. Downy mildew favours warm, humid areas and is most prevalent during wet weather with temperatures between 18 and 22 °C. Spores can be carried by insects, wind, rain, people and equipment.

Risk period

Table 17. The peak risk period for downy mildew.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

Symptoms appear as light green to yellow discolouration on the upper leaf surface that progresses to red and purple (Figure 43). Lesions are usually angular and restricted by veins. On the underside of the leaf, light pink to tan areas appear directly below the blotches on the upper surface (Figure 44). Spore masses are produced only on the lower leaf surface and are initially white but become light grey with age. Infected green fruit causes premature reddening and the berries to shrivel and harden.

Figure 43. The top of a blackberry leaf infected with downy mildew. Photo: P Bachi, University of Kentucky Research and Education Centre.

Figure 44. The underside of a blackberry leaf infected with downy mildew. Photo: S Koike, University of California Cooperative Extension.

Management

Cultural and physical

Use pathogen-free planting stock. Ensure good airflow through the canopy to promote quick leaf drying. Prune, train and thin out canes early to reduce humidity in the canopy. Remove and destroy old and infected prunings to reduce inoculum build-up.

Biological

There are no available biological controls for downy mildew in blackberries.

Chemical

The chemical treatment options for downy mildew are listed in Table 18.

Table 18. Registered or permitted products for downy mildew in Australia.

Active constituent (example trade name)	Fungicide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Chlorothalonil PER14449 (expires 31.3.25)	M5	28	Low	Blackberries, raspberries
Mancozeb PER13958 (expires 31.8.25)	M3	7	Medium	Blackberries, raspberries
Metalaxyl-M + mancozeb (Ridomil Gold® MZ) PER84973 (expires 31.12.27)	4 + M3	14	Low	Blackberries, raspberries
Propamocarb hydrochloride + fluopicolide (Infinito® SC) PER93024 (expires 31.8.26)	28 + 43	1	Low	Blackberries, raspberries

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


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Grey mould/flower blight

Botrytis cinerea

Botrytis cinerea is a fungus that causes blossom blight during flowering and fruit rot during postharvest handling and storage. Infections occur in the field during flowering, so this is the most effective time to implement controls. *Botrytis cinerea* is always present but causes serious losses when the weather is wet and cool for several consecutive days. Infection is favoured by high relative humidity, fog and long wet periods. Studies have found that at 20 °C, only 6 hours of leaf wetness is required for infection. The spores germinate and penetrate plant tissue using natural openings or micro-wounds.

Risk period

Table 19. The peak risk period for grey mould.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

Blossoms are the most susceptible tissue, turning brown when infected (Figure 45) after only a few days of high relative humidity. In continued humid conditions, masses of grey mycelia and spores are produced on blighted blossoms (Figure 46). Developing berries also become infected (Figure 47 and Figure 48), but few rot in the field before harvest.

Spores are produced in moisture and carried by air currents and water splash. Flowers are most susceptible shortly after they open, although earlier infection is possible. Slow pollination and ageing flowers can favour infection. Non-pollinated ovaries from which petals have shed are also highly susceptible to infection. They can remain attached for about 10 days and become a source of secondary inoculum. The fungus can grow from these ovaries into the stalk to infect other flowers and fruit in the cluster. It can also grow into the stem causing twig blight.

Figure 45. Blossoms infected by *Botrytis cinerea*.

Figure 46. *Botrytis cinerea* spores and mycelia.

Figure 47. *Botrytis cinerea* on blueberries.

Figure 48. *Botrytis cinerea* on a raspberry.

Management

Cultural and physical

Remove infected fruit and plant material from the orchard. Each infected fruit with spores can infect more flowers and fruit. Raspberries should be trained to encourage airflow and row bases should be kept clean and narrow. Blueberries should be pruned annually to keep the canopy open and improve air circulation. This will help with drying when the plant has become wet from dew or rain.

Avoid excessive use of nitrogen fertiliser in spring because the *Botrytis* fungus will readily infect succulent green growth. Cool berries rapidly after harvest and use sulfur pads in stacked trays.

Biological

Botector® is a biological fungicide that contains a naturally occurring fungus, *Aureobasidium pullulans*. Botector® works through competitive exclusion, creating a physical barrier at potential infection sites. Serenade® Opti is another biological fungicide that contains the bacteria *Bacillus amyloliquefaciens* strain QST713.

Chemical

The chemical treatment options for grey mould are listed in Table 20.

Table 20. Registered or permitted products for grey mould in Australia.

Active constituent (example trade name)	Fungicide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Aureobasidium pullulans strain DSM 14940 and DSM 14941 (Botector®)	–	Not required when used as directed	Low	Blackberries, blueberries, raspberries
Azoxystrobin (Amistar®)	11	1	Low	Blackberries, raspberries
Bacillus amyloquefaciens strain MBI600 (Serifel®)	BM02	Not required when used as directed	Low	Blackberries, blueberries, raspberries
Boscalid + pyraclostrobin (Pristine®) PER82986 (expires 31.8.24)	7 + 11	1 Raspberries and blackberries 3 Blueberries	Low	Blackberries, blueberries, raspberries
Captan PER13958 (expires 31.8.25)	M4	1	Low	Blackberries, blueberries, raspberries
Chlorothalonil PER91300 (expires 30.9.26)	M5	28	Low	Blackberries, raspberries
Cyprodinil + fludioxonil (Switch®) PER14422 (expires 30.6.24)	9 + 12	7	Low	Blackberries, raspberries
Cyprodinil + fludioxonil (Switch®) PER84891 (expires 31.1.28)	9 + 12	7	Low	Blueberries
Fenhexamid (Teldor® 500 SC)	17	1	Low	Blackberries, raspberries
Fenhexamid PER86489 (expires 31.1.24)	17	1	Low	Blueberries
Iprodione (Ippon® 500 Aquaflo) NSW, Qld, Tas, WA	2	1	Low	Blueberries
Iprodione (Ippon® 500 Aquaflo)	2	1	Low	Raspberries
Isofetamid (Kenja®)	7	Not required when used as directed	Low	Blackberries, blueberries, raspberries
Mancozeb PER13958 (expires 31.8.25)	M3	7	Medium	Blackberries, blueberries, raspberries
Polyoxin D zinc salt (Intervene®)	19	Not required when used as directed	Low	Blackberries, blueberries, raspberries
Pydiflumetofen + fludioxonil (Miravis® Prime)	7 + 12	1	Low	Blackberries, blueberries, raspberries
Pyrimethanil (Scala®) PER13958 (expires 31.8.25)	9	1	Low	Blackberries, blueberries, raspberries

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

Phomopsis twig blight

Phomopsis spp.

Phomopsis twig blight in blueberries is caused by *Phomopsis* species fungi. It survives the winter in dead or infected twigs.

Risk period

Table 21. The peak risk period for phomopsis twig blight.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

Infection occurs in flower buds and advances 50–150 mm down the stem, causing a brown lesion and dieback of the flower-bearing stems (Figure 49). This sunken necrotic area spreads as the disease progresses. From bud break to bloom, fungal spores ooze from small black structures (pycnidia) on previously infected twigs and are spread by rain. These spores infect flower buds and the fungus spreads into and through the twig to other flower and leaf buds (Figure 50). The fungus does not grow into and infect older wood.

Figure 49. Necrotic tissue spreading from a bud infected with *Phomopsis* spp. Photo: P Wharton, University of Idaho.

Figure 50. A blighted twig caused by *Phomopsis* spp. Photo: W Cline, North Carolina State University.

Management

Cultural and physical

Prune and destroy infected twigs during pruning. This removes sources of inoculum and limits the availability of wounds as points of infection during the growing season.

Biological

Botector® is a biological fungicide that contains a naturally occurring fungus, *Aureobasidium pullulans*. Botector® works through competitive exclusion, creating a physical barrier at potential infection sites.

Chemical

The chemical treatment option for phomopsis twig blight is listed in Table 22.

Table 22. Registered or permitted products for phomopsis twig blight in Australia.

Active constituent (example trade name)	Fungicide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Aureobasidium pullulans strain DSM 14940 and DSM 14941 (Botector®)	–	Not required when used as directed	Low	Blueberries (suppression only)

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


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Phytophthora root rot

Phytophthora spp.

Phytophthora species cause phytophthora root rot in blueberries, raspberries and blackberries. Moisture is required for disease reproduction and spread. Fine feeder roots are infected, compromising water and nutrient uptake. Phytophthora root rot develops when soil temperatures are greater than 12 °C, where there is poor drainage, water ponding, heavy soil types or low levels of organic matter in the soil.

Risk period

Table 23. The peak risk period for phytophthora root rot.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

Symptoms mostly occur during warm weather, often in plant clusters spread along drainage lines. In blackberries and raspberries, primocanes wilt and shoot tips dieback. Floricanes (fruiting canes) will have weak lateral shoots. Leaves wilt, then become yellow or brown from the margins until the leaf dies (Figure 51). Roots will be discoloured (black to brown; Figure 52) and fine feeder roots will be missing. Affected plants are easily pulled from the soil. If cut open, the centre of the main root will be brown.

Figure 51. Foliar symptoms of phytophthora root rot.

Figure 52. Root symptoms of phytophthora root rot.

In blueberries, early symptoms are often above ground and include leaf yellowing and wilting, resembling drought or water loss (Figure 53). As the disease advances, stunting of terminal growth, leaf necrosis and plant dieback can occur. Below-ground symptoms include young rootlet and crown necrosis, with the main roots turning reddish–brown. Disease symptoms might follow drainage lines as the pathogen can be spread by water. Bushes can eventually die (Figure 54).

Figure 53. Foliar symptoms of phytophthora root rot. Photo: M Rocchetti, Costa Berries.

Figure 54. Plant death due to phytophthora root rot. Photo: M Rocchetti, Costa Berries.

Management

Cultural and physical

- Source new planting material from phytophthora-free nurseries.
- Prepare new sites by mounding and improving soil organic matter using cover crops and manure. Ammonia and volatile organic acids released by decomposing organic material reduce phytophthora spores and stimulate beneficial microorganisms. Incorporating gypsum into planting sites also helps to act as a weak fungicide and reduces the number of spores in the soil.
- In heavy soil types or high rainfall areas, grow blueberries on mounds with good drainage in the inter-row. In high rainfall areas, blueberry mounds should run up and down the slope for quick drainage rather than across the contours.
- Avoid planting in poorly drained sites or improve the drainage before planting.
- Grow rooted cuttings or nursery plants on raised beds and avoid over-irrigating and ponding.
- Monitor irrigation to avoid over watering and water logging.

Biological

Beneficial soil bacteria and antagonistic fungi can play a role in reducing the risk of soil-borne diseases. Building healthy soil by adding organic matter will help encourage beneficial soil organisms. *Bacillus amyloliquefaciens* strain QST 713 (Serenade® Prime Soil Ameliorant and Biofungicide) can be applied to the soil to improve the bioavailability of soil resources.

Chemical

The chemical treatment options for phytophthora root rot are listed in Table 24.

Table 24. Registered or permitted products for phytophthora root rot in Australia.

Active constituent (example trade name)	Fungicide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Metalaxyl (Ridomil) PER13958 (expires 31.8.25)	4	48	Low	Blackberries, blueberries, raspberries
Metham present as sodium salt (Nemasol)	–	Not required when used as directed	High	Blackberries, blueberries, raspberries
Phosphorous acid PER13958 (expires 31.8.25)	33	Not required when used as directed	Low	Blackberries, blueberries, raspberries

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

Powdery mildew

Podosphaera macularis **and** ***Erysiphe*** **spp.**

Powdery mildew in Rubus is caused by *Podosphaera macularis* and *Erysiphe* spp. These fungi overwinter in the dormant buds on stunted cane tips. Infections start on dry leaves in high humidity with temperatures over 15 °C. Optimum conditions include over 97% humidity and temperatures between 18 and 25 °C. Visible signs appear 28 days after infection. Spores are spread by wind.

Risk period

Table 25. The peak risk period for powdery mildew.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

Infected raspberry and blackberry leaves initially develop light green (chlorotic) patches on the upper surface. Leaves and shoots are later covered with white to grey fungal growth (Figure 55).

Affected leaves can be curved, twisted, or otherwise distorted. Severely infected shoots become long and spindly, with dwarfed leaves that curl upward. Severely diseased plants can be stunted. The fungus can prevent late buds from developing into fruit. It can also render fruit unsaleable by completely covering it with white fungal growth.

Figure 55. Raspberry leaves infected with powdery mildew. Photo: M Grabowski, University of Minnesota Extension.

Management

Cultural and physical

Remove late-forming infected primocanes and ensure good airflow through the canopy. Prune, train and thin out primocanes early to reduce humidity in the canopy. Use tip pruning to remove infection sources before next season. Raspberries and blackberries should be monitored when conditions favour the disease. Manage nutrition and irrigation to avoid highly vigorous canopies.

Biological

There are no available biological controls for powdery mildew in blackberries and raspberries.

Chemical

The chemical treatment options for powdery mildew are listed in Table 26.

Table 26. Registered or permitted products for powdery mildew in Australia.

Active constituent (example trade name)	Fungicide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Boscalid + pyraclostrobin (Pristine®) PER82986 (expires 31.8.24)	7 + 11	1	Low	Blackberries, raspberries
Mancozeb PER13958 (expires 31.8.25)	M3	7	Medium	Blackberries, raspberries
Polyoxin D zinc salt (Intervene®)	19	Not required when used as directed	Low	Blackberries, raspberries
Triadimenol PER13958 (expires 31.8.25)	3	7	Low	Blackberries, raspberries

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

AUSTRALIA HAS A NEW MODE OF ACTION FOR BOTRYTIS AND POWDERY MILDEW CONTROL.

Available now is an exciting novel solution by Nufarm. Nufarm Intervene fungicide will arm growers with a flexible option to tackle botrytis and powdery mildew in all berry crops. It is a brand new mode of action (Group 19) to the Australian market which growers can rely on.

Recently on the Northern NSW Coast, our business development manager, Matt Moyle, has been working with the blueberry industry to put Nufarm Intervene to the test and gain a better understanding of how Intervene WG would fit into a standard blueberry spray program.

Key features of Nufarm Intervene fungicide are:

- Registered in ALL berry crops (field and protected) for the control of Botrytis and Powdery Mildew
- NO withholding period
- BRAND NEW mode of action
- Maximum of 6 sprays per crop
- An ACO Certified Allowed Input (ACO CERT. NO. 11540)

Jimmy Kandola is a berry grower in the Woolgoolga Region of NSW and had the below comments about his recent experiences with Intervene.

"I grow my blueberries in tunnels and if the botrytis gets in there, all the crops get it. That can make a difference of thousands of dollars a day on what I can get for the fruit.

I trialled Intervene in a challenging block - for the last three years it's yielded a maximum of 1 kg of fruit. Fungus has been a big problem, especially in the centre of the tunnels. I wanted to try the Intervene on some of the worst spots, to see if it could help where the other products struggled to have an impact.

The Intervene was almost 100% effective - it was a very noticeable difference. Where I'd normally have 100-200 flowers damaged by botrytis, there were maybe 5 or 10 affected. It was soft on beneficials as well, which is important in winter when the bees only have a few hours of activity to pollinate.

With previous chemicals, we'd find something really effective but it would have a 7-day withholding period, or we could only use it twice a year. Intervene is one of the most effective fungicides I've seen, with none of those drawbacks. The zero withholding period is the biggest bonus for me because it gives me total flexibility with harvesting, and we can also use it 6 times over the year.

For me, it's very simple - the results are all I need to see, and Intervene gave fantastic results. I would recommend it to any grower, no problem."

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For more information, contact your local Nufarm Business Development Manager

Nufarm INTERVENE®

Stem blight

Neofusicoccum* spp., *Lasiodiplodia* spp. and *Botryosphaeria dothidea

Fungi associated with stem blight in Australia include *Neofusicoccum parvum*, *N. australe*, *N. oculatum*, *N. macroclavatum*, *Lasiodiplodia theobromae*, *L. pseudotheobromae* and *Botryosphaeria dothidea*. The fungi survive in infected wood and leaves of blueberry and other woody hosts. Spores produced on infected plant material are dispersed by air or water-splash to infect shoots, stems, branches and buds. Stem blight is favoured by high relative humidity, rainfall and a wide range of temperatures (5–35 °C) as well as plant stress and injury.

Risk period

Table 27. The peak risk period for stem blight.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

Infection usually begins in the branches. Symptoms include reddening leaves (Figure 56), necrosis on one or more branches, and a characteristic 'flagging' of a dead branch with leaves still attached. A pale brown–grey discolouration can be seen inside infected stems (Figure 57). In severe cases the infection progresses into the base of the plant, resulting in systemic branch dieback over weeks or months, eventually killing the plant. Raised black fruiting bodies can occur on infected stems. The fungi enter the host plant through wounds, including herbicide injury, pruning wounds, insect damage and crown injury due to salt burn. They can also enter through natural openings such as growth cracks, leaf scars, lenticels (stem pores) and root to root contact. The fungi often remain latent in the plant, not causing symptoms until the plant becomes stressed.

Figure 56. Reddening leaves caused by stem blight.

Figure 57. Stem blight discolouration.

Management

Cultural and physical

Source clean, disease-free planting material when establishing a new block or orchard. Avoid any activities that might stress or injure the plants; ensuring good irrigation and nutrition practices will help with managing this disease. Practice strict orchard hygiene measures.

The best control is achieved by pruning out infected plant parts and removing them from the orchard. Prune at least 150–200 mm beyond diseased (discoloured) wood to prevent the infection from spreading. Prune during dry periods to reduce spread and disinfect tools between plants, especially if cutting through a diseased branch. Cutting at an angle when pruning can promote water run-off.

Biological

There are no available biological controls for stem blight in blueberries.

Chemical

There are no available chemical controls for stem blight in blueberries.

Yellow rust

Phragmidium rubi-idaei

Yellow rust is caused by *Phragmidium rubi-idaei*, a fungus that overwinters on the bark of remaining floricanes. These are then the source of inoculum that affects emerging leaves and primocanes the following season. *Phragmidium rubi-idaei* can defoliate canes when prolonged wet weather in spring encourages rapid development. Leaf wetness, high humidity and mild temperatures (11–25 °C) favour infection.

Risk period

Table 28. The peak risk period for yellow rust.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

The initial symptoms appear as raised yellow–orange pustules on the upper side of raspberry leaves (Figure 58). Later in the season, orange–yellow spots appear on the underside of leaves (Figure 59). These turn black as the fungus life cycle progresses.

Figure 58. Yellow rust on the upper leaf surface.

Management

Check plants weekly from early spring for pinhead-size yellow raised spots on leaf tops. Look on the underside for yellow rust spots, particularly where there is old leaf debris.

Cultural and physical

Manage primocane density to maintain an open canopy to increase airflow and reduce humidity. Keep ground cover low to reduce humidity around canes.

Figure 59. Orange-yellow spots on the underside of leaves are characteristic of yellow rust.

Biological

There are no available biological controls for yellow rust in raspberries.

Chemical

The chemical treatment options for yellow rust are listed in Table 29.

Table 29. Registered or permitted products for yellow rust in Australia.

Active constituent (example trade name)	Fungicide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Boscalid + pyraclostrobin (Pristine®) PER82986 (expires 31.8.24)	7 + 11	1	Low	Blackberries, raspberries
Chlorothalonil PER14449 (expires 31.3.25)	M5	28	Low	Blackberries, raspberries
Copper (present as copper hydroxide) PER14443 (expires 31.1.24)	M1	Not required when used as directed	Medium	Blackberries, raspberries
Copper (present as copper oxychloride)	M1	1	Medium	Blackberries, raspberries
Mancozeb PER13958 (expires 31.8.25)	M3	7	Medium	Blackberries, raspberries
Myclobutanil PER92308 (expires 31.10.25)	3	1	Low	Blackberries, raspberries

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

Managing pests in berries

Aphids (green peach aphid)

Myzus persicae

Most aphids are soft-bodied, pear-shaped (Figure 60) and approximately 1–2 mm long.

Risk period

Table 30. The peak risk period for aphids.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Aphids prefer feeding on tender growing shoots, causing new growth to deform, wilt and defoliate. High infestations can reduce fruiting bud formation for the following year's crop.

Aphids produce copious amounts of honeydew, making the leaves and fruit sticky, sensitising plant tissue to sunburn and promoting sooty mould growth.

Look for aphids on areas of the bush with tender tissue such as new branch growth, buds, shoots, both sides of the leaves and into leaf curls.

Figure 60. Wingless adult female and nymph stage green peach aphids.

Management

Cultural and physical

Aphid populations increase rapidly on most plants receiving excess nitrogen. Regulate nitrogen fertilisers for optimum, but not excessive, growth and vigour. If needed, prune to remove excess growth.

Biological

Release predatory arthropods and create inviting habitats for beneficial insects. The main aphid predators include common hoverflies, green lacewings (Figure 61), assassin bugs and lady beetles (Figure 62). Parasitic wasps such as *Aphidius colemani*, *A. ervi* and *Aphelinus abdominalis* are commercially available for release.

Figure 61. Green lacewings are natural aphid predators. Photo: Whitney Cranshaw, Colorado State University, Bugwood.org.

Figure 62. Common spotted lady beetles are natural aphid predators. Photo: Lesley Ingram, Bugwood.org.

Chemical

The chemical options for controlling aphids are listed in Table 31.

Table 31. Registered or permitted products for aphids in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Afidopyropen PER90178 (expires 30.4.24)	9D	1	Low	Blackberries, raspberries
Dimethoate	1B	7	High	Blackberries, raspberries
Dimethoate	1B	1	High	Blueberries
Flonicamid PER89214 (expires 28.2.27)	29	3	Low–medium	Blackberries, raspberries
Primicarb (Pirimor®)	1A	2	Low	Blueberries
Primicarb (Pirimor®)	1A	7	Low	Blackberries
Sulfoxaflor PER90208 (expires 31.5.24)	4C	1	High	Blackberries, raspberries

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

Broad mite

Polyphagotarsonemus latus

Broad mites are microscopic and generally go unnoticed until damage on new growth and reproductive structures is observed. The ideal climatic conditions for broad mites are tropical, subtropical and greenhouse habitats where temperatures are warm and humid. They differ from other mites in that they feed on the upper leaf surface of the plant tissue rather than the underside.

Risk period

Table 32. The peak risk period for broad mite.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

The adult female mite is white or pale yellow, oval, and 0.2 mm long. The male is smaller, with longer hindlegs and is more active. A distinguishing feature of broad mite is the male's habit of carrying pre-adult females on their backs in a 'T' shape until they are sexually mature. Another identifying characteristic is the eggs, which are dome-shaped, translucent and covered with white 'studs' or tubercles.

Signs of broad mite activity on blackberries include terminal leaf rigidity, discolouration, inter-veinal chlorosis, leaf cupping up or down and lateral bud blackening/dropping (Figure 63). Subsequent years of broad mite damage can result in weakened floricanes with reduced or no yield, and left unchecked, will result in plant death.

Management

Cultural and physical

Dusty environments favour pest mite activity. If weather conditions are hot and dry, traffic should be limited and operators should drive slowly to limit the dust on plants. Maintaining green ground cover can reduce dust while also providing an attractive alternate habitat for beneficial predatory insects.

Figure 63. Leaf distortion and cupping from broad mite infestation. Photo: Donn Johnson, University of Arkansas.

Biological

Broad mite can be controlled by the predatory mites *Neoseiulus cucumeris* and *Neoseiulus californicus*, which are available for purchase commercially. Careful selection of IPM-friendly insecticides will help to encourage predatory mites and other beneficials. Throughout this guide, look at the 'Effect on beneficials' column in the chemical tables to identify the effect each chemical will have on beneficials and bees.

Chemical

The chemical options for controlling broad mite are listed in Table 33.

Table 33. Registered or permitted products for broad mite in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Fenbutatin oxide PER89407 (expires 28.2.26)	12A	1	Low	Blackberries Raspberries (field and protected cropping)
Sulfur PER87245 (expires 31.3.24)	M2	Not required when used as directed	Low	Blackberries

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

Budworms

Helicoverpa spp.

Helicoverpa species (previously known as heliothis and commonly known as budworms) can cause substantial crop damage and are becoming more common in all Australian growing regions. The moth larvae can cause extensive feeding damage.

Risk period

Table 34. The peak risk period for budworms.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Budworm larvae are cream with dark-brown heads. As they mature, the larvae will become darker and develop stripes along their bodies (Figure 64). They develop into adult moths, which are approximately 15–18 mm long and are light brown to red–brown, with numerous dark spots and blotches. The hind wings of the adult moth are pale with a dark band along the lower edge (Figure 65) and span 30–35 mm.

Figure 64. *Helicoverpa* spp. caterpillars.

Figure 65. Female *Helicoverpa* spp.

After hatching, the caterpillar crawls around the plant feeding, particularly on tender tissues such as plant tips, flowers and fruit (Figure 66).

A notable feature of this pest is its capacity to migrate at high altitudes over large distances (100–1,000 km) at night. The moths fly from areas where conditions do not favour another generation to areas with abundant food plants for further breeding.

Management

During spring and early summer monitor carefully for young caterpillars.

Cultural and physical

Helicoverpa spp. will lay eggs on a wide range of plants including weeds, therefore managing these can help to reduce any resident populations.

Figure 66. Caterpillar damage to blueberries.

Biological

Predators and parasitoids such as predatory shield bugs (*Podisus* spp.), tachinid fly (*Trichopoda* spp.), green lacewings (*Mallada signata*), brown lacewings (*Micromus tasmaniae*), damsel bugs (*Nabi kinsbergii*) and *Trichogramma pretiosum* are all biological control options for *Helicoverpa* spp. Once hatched, lacewing larvae are wide-ranging predators that will eat small caterpillars, aphids and mites. *Bacillus thuringiensis* (Bt) is a bacterium that affects the caterpillar stage of *Lepidoptera* insects and is commercially available as an insecticide. Using a 'softer' more selective insecticide program will assist with the biological control of budworms.

Figure 67. A reusable weatherproof delta trap for use with pheromone lures to monitor moth populations. Photo: www.bugsforbugs.com.au.

A pheromone lure is available for purchase for *Helicoverpa punctigera*. This pheromone attracts male moths by mimicking the scent of the female moth. Monitoring with this pheromone in combination with a trap (e.g. delta trap; Figure 67) will give an early warning of the arrival or emergence of the pest and can indicate pest pressure throughout the season.

Chemical

The chemical options for controlling budworms are listed in Table 35.

Table 35. Registered or permitted products for budworms in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Bacillus thuringiensis Berliner subsp. *aizawai* strain GC-91 (DiPel®)	11	Not required when used as directed	Very low	Blueberries
Carbaryl (Bugmaster®)	1A	7	High	Raspberries
Chlorantraniliprole (Coragen®) PER84178 (expires 31.1.26)	28	3	Low	Blueberries
Emamectin (Proclaim®) PER85422 (expires 29.2.28)	6	5	Medium	Blueberries
Methomyl (Nufarm Methomyl 225 Insecticide) (NSW and WA)	1A	5	High	Blueberries (field use only)
Methomyl PER87495 (ACT, NT, Qld, SA, Tas, Vic; expires 28.2.24)	1A	5	High	Blueberries (field use only)
Nuclear polyhedrosis virus (Vivus®)	–	Not required when used as directed	Very low	Blackberries, blueberries, raspberries
Spinetoram (Success® Neo)	5	1	High	Blackberries, blueberries, raspberries
Spinosad (Entrust®)	5	1	Medium	Blackberries, blueberries, raspberries
Tebufenozide PER91907 (expires 30.6.24)	18	3	Low	Blueberries

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

Cottonseed bug

Oxycarenus luctuosus

Cottonseed bugs can swarm in large numbers and will cause significant damage to ripening fruit.

Risk period

Table 36. The peak risk period for cottonseed bug.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Cottonseed bug adults are about 3 mm long and have triangular patterns on their backs (Figure 68). Nymphs are black with a blood-red abdomen. They are soft-bodied and can be easily squashed, releasing a bad smell.

They are attracted to lights at night and can be seen in huge numbers in and around houses as well as on rural properties and in orchards. The swarms can congregate for several weeks, depending on site suitability. They are attracted to shade, humidity and moisture (e.g. from irrigation) and this is often found near houses, buildings and orchards.

Figure 68. Adult cottonseed bug, note the triangular pattern. Photo: Biosecurity New Zealand.

Cottonseed bug causes damage by:

1. bleaching and deforming the fruit
2. causing the fruit to be unsaleable because the bug sticks to the fruit, causing contamination.

Management

Cultural and physical

Cottonseed bug control can be difficult. Since the bugs are native, they breed in bushland and although it might be necessary to apply sprays to reduce numbers, this does not prevent any further swarms from moving onto properties.

Biological

There are no known biological controls for cottonseed bug in berries.

Chemical

The chemical option for controlling cottonseed bug is listed in Table 37. Remember, applying sprays will reduce numbers temporarily, but it will not prevent any further swarms from moving onto properties.

Table 37. Registered or permitted product for cottonseed bug in Australia.

Active constituent (example trade name)	**Insecticide group(s)**	**WHP[1] (days)**	**Effect on beneficials**	**Registered for use in...[2]**
Sulfoxaflor PER90208 (expires 31.5.24)	4C	1	High	Blackberries, raspberries

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

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Dried fruit beetle (carpophilus beetle)

Carpophilus spp.

Carpophilus species beetle can cause serious losses when they enter ripening fruit. The adult can fly several kilometres in search of hosts. Summer rain and rotting fruit are ideal breeding conditions.

Risk period

Table 38. The peak risk period for carpophilus beetle.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Carpophilus species beetles are small (2–3 mm long) and black or brown (Figure 69). Their wing covers are short and they have clubbed antennae. The larvae are yellowish, about 5 mm long when fully grown and have a brown head and forked tail.

Carpophilus species beetles feed on ripe and decomposing fruit. Adults are mechanical carriers of brown rot and botrytis, transmitting spores as they move across the fruit, which develops at the sites of beetle damage on fruit.

Figure 69. Adult *Carpophilus* species beetle.

Management

Cultural and physical

The most important management strategy for *Carpophilus* species beetles 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 *Carpophilus* species infestation.

Biological

When deployed at least 4 weeks before harvest, an attract and kill system using synthetic aggregation pheromones plus a food-attractant protects ripening crops. Continuing to mass-trap through harvest and for an additional 2 weeks will help reduce the resident pest population. Placing traps (Figure 70) upwind on the outside edges of blocks will ensure maximum pheromone spread.

Figure 70. *Carpophilus* species traps can be used for monitoring and mass trapping. Photo: bugsforbugs.com.au.

Chemical

The chemical option for controlling *Carpophilus* species beetle is listed in Table 39.

Table 39. Registered or permitted product for carpophilus beetle in Australia.

Active constituent (example trade name)	**Insecticide group(s)**	**WHP[1] (days)**	**Effect on beneficials**	**Registered for use in...[2]**
3-methyl-1-butanol, 2-methyl-1-butanol, ethyl acetate, acetaldehyde, sec butanol, ethanol, carpophilus aggregation pheromones (Carpophilus Catcha Trapping System)	–	Not required when used as directed	Low	Blackberries, blueberries, raspberries

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

Elephant weevil

Orthorhinus cylindrirostris

The elephant weevil larval stage causes the most economic damage. Adults emerge from September to February when they climb onto upper branches and mate, usually a few weeks after pruning. This is the optimum time for control. Oviposition (egg-laying) lasts from September to February but peaks in October. Plants can remain suitable as egg-laying sites for multiple years as long as they do not die from elephant weevil attack.

Risk period

Table 40. The peak risk period for elephant weevil.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

The elephant weevil's body is densely covered with scales (Figure 71) that vary from grey to black. The weevils can be up to 20 mm long. The larvae are soft, fleshy, creamy–yellow and legless. They hatch and feed by boring tunnels through the stem, crown and roots of the plant. As larvae exit the base of the plant to mature, they leave large emergence holes (Figure 72).

Some blueberry varieties (e.g. MBO 11-11, Star, Costa cv. 42) are more attractive to elephant weevil than others, so monitor these carefully. Practices that reduce stress (such as fertilisation and irrigation) are essential in drought to reduce the susceptibility of bushes.

Figure 71. Adult elephant weevil.

Figure 72. Elephant weevil exit damage.
Photo: M Rocchetti, Costa Berries.

Management

Cultural and physical

Monitor for bore holes in the wood. Rapidly remove and thoroughly destroy all infested bushes and material to prevent premature metamorphosis and emergence of any weevils in the bushes. Removing adults might help break population cycles.

Biological

A braconid wasp has been found at elephant weevil-infested vineyards, but confirmation of a parasitoid-host relationship was not made from rearing, and further work in this area is required.

Chemical

The chemical options for controlling elephant weevil are listed in Table 41. Chemical treatment is most effective when the adults emerge and climb on to the upper branches of recently pruned plants.

Table 41. Registered or permitted products for elephant weevil in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Bifenthrin PER84972 (expires 30.11.27)	3A	1	High	Blueberries
Indoxacarb PER13289 (expires 31.5.28)	22A	3	High	Blueberries

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

Managing pests in berries

European earwig

Forficula auricularia

European earwigs have a very broad host range, feeding on many horticultural and broadacre crops.

Risk period

Table 42. The peak risk period for European earwig.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Adult European earwigs 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).

European earwigs will feed on foliage, leaving irregularly shaped holes. Most economic loss occurs from the earwigs feeding on the fruit, causing shallow depressions. They can also cause a contamination threat as they often hide in fruit clusters.

Figure 73. Adult European earwigs, male on the left and female on the right.

Management

Cultural and physical

Practising good farm hygiene will prevent the introduction and spread of European earwig. Generally, European earwigs will seek shelter during the day in the plant and among fruit clusters, so keeping canopies open (where possible) will help reduce the potential for fruit damage. 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 certain horticulture crops where the fruit is generally hard, European earwig is considered a beneficial insect because it predates on other insect pests.

Chemical

Currently there are no chemical options for controlling European earwig in berries.

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Fruit spotting bug and banana spotting bug

Amblypelta nitida **and** ***Amblypelta lutescens lutescens***

The fruit spotting bug (*Amblypelta nitida*) and the banana spotting bug (*A. lutescens lutescens*) are fairly new pests of blueberries and currently only affect those in the Queensland growing region.

Risk period

Table 43. The peak risk period for fruit spotting bug.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Fruit spotting bug (FSB) nymphs are 2–10 mm long. Their main feature is 2 black spots on the abdomen (Figure 74). Nymphs are distinguished from adults by the absence of external wings. Adult FSB are approximately 11–15 mm long and slender. Their body is often tinted yellow-orange.

FSB have piercing-sucking mouthparts. They feed by inserting 2 pairs of stylets (slender, piercing tube structures) into the plant tissue. These inject salivary fluid containing enzymes, including sucrase. In berry crops, FSB target flowers and fruit, leaving a sunken brown lesion on immature fruit (Figure 75).

Figure 74. Fruit spotting bug nymph.

Figure 75. Fruit spotting bug feeding damage on blueberries. Photo: M Rocchetti, Costa Berries.

Management

Cultural and physical

A pheromone-based trap for FSB is commercially available. The pheromone lure is an aggregation chemical that attracts *Amblypelta lutescens lutescens*. This trap is sold as single units or as a pack of 10, which is enough to monitor the insect over 1 ha of crop for 6 weeks.

Biological

Use cover crops in the inter-row to provide habitat for natural FSB predators, such as:

- egg parasitoids
  - Anastatus spp. nr pentatomidivorus (Eupelmidae)
  - Ooencyrtus caurus (Encyrtidae)
  - Gryon spp. (Scelionidae)
  - Centrodora darwini (Aphelinidae)
- nymph and adult parasitoids include the tachinid fly, *Trichopoda giacomellii*
- predators: spiders, ants e.g. green tree ant (*Oecophylla smaragdina*) and big head ants *Pheidole* spp., predatory bugs e.g. assassin bug (*Pristhesancus papuensis)* and lacewings (e.g. brown lacewing *Micromus tasmaniae)*.

Chemical

Currently there are no available chemical options for controlling FSB in berries in Australia.

Green stink bug

Plautia affinis

Adult green stink bugs overwinter on other hosts (e.g. corn crops), under tree bark or in farm sheds. In warmer coastal areas, the green stink bug will feed and breed all year round. It can be a contaminant pest that can cause significant damage to crops.

Risk period

Table 44. The peak risk period for green stink bug.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Adult green stink bugs are approximately 8 mm long and have a green shield-shaped body with brown wing covers (Figure 76). Each female lays about 200–300 eggs in small loose rafts (average of 30 eggs each raft) on raspberry leaves. Nymphs are cream and yellow with prominent dark markings (Figure 77). Nymphs hatch and pass through 5 instars before becoming adults.

Both nymphs and adults pierce plants with needle-like mouthparts, sucking sap from buds and blossoms. Adults and nymphs also feed directly on the green, ripening and ripe berries causing discolouration and reduced firmness. Adults can lay eggs on the fruit (Figure 77), which can cause contamination when picking.

Figure 76. Adult green stink bug. Photo: M Rocchetti, Costa Berries.

Figure 77. Green stink bug eggs (top left) and nymphs (middle).

Management

Biological

Spiders, ants and predatory bugs (e.g. lacewing larva) are green stink bug predators, particularly of eggs and young nymphs. Eggs can be parasitised by wasps (*Trissolcus basalis*, *T. oenone* and *Telenomus cyrus*).

Chemical

The chemical option for controlling green stink bug is listed in Table 45.

Table 45. Registered or permitted products for green stink bugs in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Pyrethrin (PyGanic®) PER80070 (expires 31.10.25)	3A	Not required when used as directed.	High	Blackberries, blueberries, raspberries

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

Green vegetable bug

Nezara viridula

Adult green vegetable bugs overwinter on other hosts (e.g. legumes), under tree bark or in farm sheds. In warmer coastal areas, green vegetable bug (GVB) will feed and breed all year round.

Risk period

Table 46. The peak risk period for green vegetable bug.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

The adult GVB is 15 mm long, green and shield-shaped (Figure 78). When disturbed, it releases a strong aroma to deter predators. The nymphal stages look similar to the adult, but with a range of green, yellow and black markings.

Green vegetable bug invade crops at flowering, laying eggs underneath leaves in rafts. Nymphs and adults feed by piercing flower buds and fruitlets.

Figure 78. Adult green vegetable bug.

Management

Cultural and physical

Remove weeds from around the crop, as many (i.e. turnip weed, wild radish and variegated thistle) are breeding hosts for the GVB.

Biological

Green vegetable bug eggs are parasitised by the wasp *Trissolcus basalis* (Figure 79). Parasitised eggs are easily recognised as they turn black. Nymphs are attacked by ants, spiders and predatory bugs. The final instar and adult are parasitised by the tachinid fly (*Trichopoda giacomelli*).

Figure 79. Stink bug egg parasite (*Trissolcus basalis*). Photo: Guido Bohne, Bugwood.org.

Chemical

The chemical option for controlling green vegetable bug is listed in Table 47.

Table 47. Registered or permitted product for green vegetable bug in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Flonicamid PER89214 (expires 28.2.27)	29	3	Low–medium	Blackberries, raspberries (suppression)
Pyrethrin (PyGanic®) PER80070 (expires 31.10.25)	3A	Not required when used as directed	High	Blackberries, blueberries, raspberries

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

Leafhoppers/jassids

Cicadellidae

Leafhoppers are small, leaf-feeding insects.

Risk period

Table 48. The peak risk period for leafhoppers.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Leafhoppers are about 3 mm long, and wedge-shaped (Figure 80) with a broad, rounded head and short antennae. They range from green to yellow. They are quick to jump, hop sideways or fly away if disturbed. Nymphs usually resemble adults but are smaller and wingless. Adults and nymphs pierce the leaf and feed on the plant sap. Severe infestations can cause damage to foliage (Figure 81), flowers and fruit.

Figure 80. Adult flatid planthopper. Photo: Brisbane Insects.

Figure 81. Leaves yellowing and curling from leafhopper damage. Photo: Hanson et al. (2014).

Management

Cultural and physical

Well-watered, vigorously growing crops can generally tolerate damage. Maintain good farm hygiene and remove other host plants (e.g. weeds).

Biological

Generalist predators will attack leafhoppers but are unlikely to provide sufficient control of leafhopper outbreaks.

Chemical

The chemical options for controlling leafhoppers are listed in Table 49.

Table 49. Registered or permitted products for leafhoppers in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Dimethoate	1B	1	High	Blueberries
Dimethoate	1B	7	High	Blackberries, raspberries
Flonicamid PER89214 (expires 28.2.27)	29	3	Low–medium	Blackberries, raspberries

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

Leaf rollers

Tortricidae

Several leaf roller species can damage berries, including *Dudua aprobola* (mango flower webworm; Figure 82), *Isotenes miserana* (orange fruit borer; Figure 83) and *Lobesia physophora*.

Figure 82. *Dudua aprobola* larva. Photo: Pestnet.org.

Figure 83. *Isotenes miserana* larva.

Risk period

Table 50. The peak risk period for leaf rollers.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Moths in the Tortricidae family are often referred to as leaf rollers because the caterpillars of many species roll the leaves, joining them together with silk, and live and pupate in this leafy shelter. The caterpillars are generally small, with soft, smooth skin and fine, sparse hairs. They often wriggle backwards when disturbed, trying to withdraw into any available crevice. They will also drop on a silken thread.

In blueberries, the leaf roller caterpillar causes the most damage, mainly from feeding activity that destroys vegetative growth, flowers and fruit. Damage can also reduce fruit quality through skin marks.

Management

Cultural and physical

Prune plants to maximise spray coverage.

Biological

There are limited biological options for controlling these leaf roller species.

Chemical

The chemical options for controlling leaf rollers are listed in Table 51.

Table 51. Registered or permitted products for leaf rollers in Australia.

Active constituent (example trade name)	**Insecticide group(s)**	**WHP[1] (days)**	**Effect on beneficials**	**Registered for use in...[2]**
Chlorantraniliprole (Coragen®) PER84178 (expires 31.1.26)	28	3	Low	Blueberries
Emamectin (Proclaim®) PER85422 (expires 29.2.28)	6	5	Medium	Blueberries
Tebufenozide PER91907 (expires 30.6.24)	18	3	Low	Blueberries

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

Light brown apple moth

Epiphyas postvittana

The light brown apple moth (LBAM) is a native Australian leaf roller (Figure 84) with a wide host range including fruit crops, broadleaf pastures and weeds. Light brown apple moths do not survive well at high temperatures; they are a more serious problem in cooler areas with mild summers.

Risk period

Table 52. The peak risk period for light brown apple moth.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

The moths are pale brown (Figure 85) with a wingspan of about 10 mm. Caterpillars are yellow when young and become green with a brown head. Pupae are 10–12 mm long and turn from green to brown. Egg masses can be green, yellow or brown.

Larvae feed on the leaves, buds, flowers and berries. Their feeding on berry surfaces under webbed leaves causes scarring as well as providing a site for rot or infection (Figure 86).

Figure 84. Rolled leaf with light brown apple moth caterpillar inside.

Figure 85. Adult light brown apple moth.

Figure 86. Fruit damage from light brown apple moth.

Management

Cultural and physical

Reduce weeds such as dock and capeweed (Figure 87) because LBAM survive on these weeds during winter.

Figure 87. Capeweed can host light brown apple moth during winter. Photo: Joseph M DiTomaso, University of California Davis, Bugwood.org.

Biological

Monitoring using commercially available pheromone traps (Figure 88) provides early warning of LBAM arrival or emergence, helping with early control and management. Monitoring should start early in the season e.g. August.

Trichogramma carverae are commercially available parasitic wasps for controlling LBAM. Natural predators such as other parasitic wasps, lacewings, spiders and predatory shield bugs also contribute to overall biological control.

Bacillus thuringiensis (Bt) is a naturally occurring, commercially available soilborne bacteria that is toxic to LBAM larvae when consumed.

Pheromone isomate wire ties (Figure 89) placed in the orchard at a rate of 500/ha are effective non-chemical mating disrupters. They work by flooding the orchard with a pheromone that confuses the male. It does not kill the adult or any stage of the LBAM life cycle, but disrupts the mating behaviour.

Figure 88. Commercially available pheromone trap being used for light brown apple moth monitoring.

Figure 89. A pheromone isomate wire tie in place.

Chemical

The chemical options for controlling light brown apple moth are listed in Table 53.

Table 53. Registered or permitted products for light brown apple moth in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Bacillus thuringiensis Berliner subsp. *aizawai* strain GC-91	11	Not required when used as directed	Very low	Blueberries
Carbaryl (Bugmaster®)	1A	7	High	Raspberries
Chlorantraniliprole (Coragen®) PER84178 (expires 31.1.26)	28	3	Low	Blueberries
Emamectin (Proclaim®) PER85422 (expires 29.2.28)	6	5	Medium	Blueberries
Indoxacarb (Avatar® eVo)	22A	7 Blueberries 3 Raspberries and blackberries	Medium–high	Blackberries, blueberries, raspberries (all field grown only)
Indoxacarb (Avatar®) PER13289 (expires 31.5.28)	22A	3	Medium–high	Blackberries, blueberries, raspberries
Methoxyfenozide (Prodigy®)	18	7	Very low	Blueberries
Spinetoram (Success® Neo)	5	1	High	Blackberries, blueberries, raspberries
Spinosad	5	1	Medium	Blackberries, blueberries, raspberries
Tebufenozide PER91907 (expires 30.6.24)	18	3	Low	Blueberries

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

Loopers

Chrysodeixis spp.

Loopers can damage berries and are easily distinguished by the looping characteristic of their body as they move.

Risk period

Table 54. The peak risk period for loopers.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Looper larvae are greyish-white, green or pale brown and can be mottled or striped. Some loopers, such as the green looper, will have green larvae with faint white lines running down the side of their body (Figure 90). Most looper larvae will grow to about 40 mm long.

It is the caterpillar stage of loopers that cause the most damage by feeding predominately on leaves, although they can attack growing tips, flowers and fruit.

Figure 90. A green looper caterpillar.

Management

Cultural and physical

Control of broadleaf weeds in the orchard might help reduce the potential for looper infestation.

Biological

Bacillus thuringiensis (Bt) is a bacterium that works as an effective biological control agent against loopers, affecting the caterpillar stage.

Chemical

The chemical options for controlling loopers are listed in Table 55.

Table 55. Registered or permitted products for loopers in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Bacillus thuringiensis Berliner subsp. *aizawai* strain GC-91	11	Not required when used as directed	Very low	Blueberries
Chlorantraniliprole (Coragen®) PER84178 (expires 31.1.26)	28	3	Low	Blueberries
Emamectin (Proclaim®) PER85422 (expires 29.2.28)	6	5	Medium	Blueberries
Spinetoram (Success® Neo)	5	1	High	Blackberries, blueberries, raspberries
Spinosad	5	1	Medium	Blackberries, blueberries, raspberries

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

Mirids (green, brown and crop)

Creontiades dilutus*, *Creontiades pacificus* and *Sidnia kinbergi

Several different species of mirids can damage berries, including *Creontiades dilutus* (green mirid), *Creontiades pacificus* (brown mirid) and *Sidnia kinbergi* (crop mirid). Mirids are widely distributed throughout Australia, feeding and developing on a wide range of other host plants, including many common weed species such as wild turnips, verbena and thistles. Mirids overwinter in low numbers, then as temperatures begin to rise in August, populations increase.

Risk period

Table 56. The peak risk period for mirids.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Mirids are highly mobile insects about 7–8 mm long with long antennae. Adults have clear wings folded flat on the back (Figure 91). Green mirid adults are pale green and often have red markings, young green mirids have pear-shaped bodies and the antennae tips are reddish-brown. Brown mirids look similar to green mirids but the front part of the body is brown. Crop mirid adults are grey–green on top and bright green underneath. Younger green mirids are green with brown and white striped antennae and have a black spot on their back.

Both adults and nymphs pierce plant tissue and release a chemical that destroys cells in the feeding zone. They damage buds, flowers and growing points through feeding. This results in reduced berry weight and increased fruit distortion (Figure 92).

Figure 91. Adult green mirid.

Figure 92. Mirid damage to berries. Photo: Nightingale (2016).

Management

Cultural and physical

Controlling host weeds, including wild turnips, wild beans, wild sunflower, marshmallow, Noogoora burr, verbena and thistles can help reduce mirid infestation and damage.

Biological

A green mirid pheromone to use as a monitoring tool is available for purchase through EcoKimiko IPM Pty Ltd. The green mirid pheromone lure contains the sex attractant chemicals used by female green mirids to attract males for mating. Damsel bugs, big-eyed bugs, predatory shield bugs, as well as lynx, night stalker and jumping spiders feed on mirid adults, nymphs and eggs.

Chemical

The chemical option for controlling mirids is listed in Table 57.

Table 57. Registered or permitted products for mirids in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Sulfoxaflor PER90208 (expires 31.5.24)	4C	1	High	Blackberries, raspberries

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

Plague thrips

Thrips imaginis

Plague thrips is a native insect that can cause damage to all berries. They can migrate in large numbers on the wind and can invade blocks in a very short time. Regularly inspecting crops will help to identify any sudden increases in thrips numbers.

Risk period

Table 58. The peak risk period for plague thrips.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Adult plague thrips can be seen during flowering, crawling on flowers and around the reproductive parts of the flowers (Figure 93). They are usually brown, narrow-bodied and about 1.0–1.3 mm long.

Plague thrips can damage 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, affecting pollination and fruit set. Secondly, feeding on the developing fruitlet surface causes fruit russetting that becomes unsightly as the fruit grows, making it unmarketable (Figure 94).

Figure 93. Adult plague thrips on a flower stamen.

Figure 94. Fruit russett caused by thrips feeding on the fruitlet.

Management

Cultural and physical

If possible, avoid mowing inter-rows and adjacent pastures at or just before bloom as this might drive thrips into the crop.

Biological

Monitor for plague thrips using yellow sticky traps placed throughout blocks from budburst to petal drop. The traps will give an indication of thrips activity and can also be used to obtain a formal identification of the pest species. 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. numbers/flower) and damage, which will appear as brown spots on the stamens and stigmas.

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

Chemical

The chemical options for controlling plague thrips are listed in Table 59. An effective control program will be based on strategic spraying based on 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 59. Registered or permitted products for plague thrips in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Bifenthrin PER84972 (expires 30.11.27)	3A	1	Very high–high	Blackberries, raspberries
Dimethoate	1B	7	High	Blackberries, raspberries
Dimethoate	1B	1	High	Blueberries
Methomyl (Nufarm Methomyl 225 Insecticide)	1A	5	High	Blueberries (field use only)
Methomyl PER87495 (ACT, NT, Qld, SA, Tas, Vic; expires 28.2.24)	1A	5	High	Blueberries (field use only)

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

Queensland fruit fly

Bactrocera tryoni

Queensland fruit fly (QFF) is a significant pest of fruit crops throughout northern and eastern Australia. It is an important quarantine pest of concern to most importing countries.

Risk period

Table 60. The peak risk period for Queensland fruit fly.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Adult Queensland fruit flies are about 6–8 mm long, reddish–brown with yellow markings (Figure 95). They are most active in warm, humid conditions and after rain. QFF lay eggs in maturing and ripe fruit on bushes and sometimes in fallen fruit.

QFF damage the fruit by inserting their ovipositor and laying their eggs into the skin of developing fruit (most commonly as the fruit approaches maturity). When the eggs hatch, the developing larvae burrow in the fruit, causing the flesh to decay and fruit to fall (Figure 96).

Figure 95. Adult Queensland fruit fly.

Management

A single control method is not sufficient to eradicate QFF from an area. A combination of methods, including population monitoring by trapping, area saturation with male annihilation technology (using pheromones to attract and kill males), protein bait sprays and strict orchard hygiene practices are required.

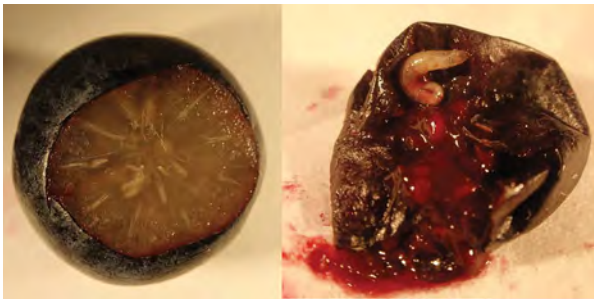

Figure 96. Queensland fruit fly larvae in a blueberry.

Cultural and physical

Monitor using fruit fly traps to determine population trends (Figure 97). To improve the flow in traps, replace the wicks every 3–6 months (depending on product). Start monitoring in spring and continue until winter. Monitoring over time provides information on fly behaviour, where to focus control efforts and an assessment of the management strategies.

Orchard hygiene is essential as bushes with fallen and rotting fruit are a source of fruit fly infestations. Fruit flies can travel several hundred metres, so infected fruit should not be left within 1 km of the orchard. Practice good packing shed hygiene with thorough inspections to remove any infested fruit and disposing of it appropriately.

Figure 97. A fruit fly trap used to monitor Queensland fruit fly populations.

Male annihilation technology (MAT) is an 'attract and kill' strategy for male flies. The aim is to reduce male populations to low levels, thus reducing mating opportunities for females. The technique involves distributing devices containing Cue-Lure (male attractant) and an insecticide. Place the lures throughout the crop and in alternative hosts (i.e. fruiting windbreaks) at a density of about 16–20 per hectare.

Additional lures should be placed every 20 m around the perimeter of the property early in the season (late winter) to reduce the number of male flies entering the orchard. New lures should be placed into the orchard 3 times a year and each MAT device should be left in the field for 12 months. Distribute MAT cups the next season using orange in spring, yellow in summer and pink in autumn (Figure 98).

Figure 98. 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.

Both male and female QFF need protein to reach sexual maturity, therefore **protein bait spraying** is an effective control method. It involves using a protein source (e.g. yeast autolysate, PER13785) to attract QFFs and an insecticide (e.g. malathion or trichlorfon) to kill them. Begin spraying as soon as traps indicate QFF are present or fruit is at a susceptible stage. Apply bait sprays to the trunks of bushes or on trellis posts (Figure 99) where QFF are likely to be active. To avoid concerns about residue and fruit damage, do not spray the fruit. Repeat applications every 7 days, or sooner if rain has washed off the mixture.

Figure 99. Protein bait spray on a trellis post. Photo: area-wide-management.com.au.

Biological

QFF has several natural predators including the parasitoid *Diachasmimorpha tryoni*. Although not commercially available for release, studies have investigated the use of *D. tyroni* as part of an integrated management program.

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

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 61).

Table 61. Registered or permitted products for Queensland fruit fly in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in…[2]
Abamectin (used in bait application)	6	7	Medium–high	Blackberries, blueberries, raspberries
Alpha-cypermethrin PER90027 (expires 31.7.25)	3A	7	High	Blueberries
Dimethoate (NSW and WA)	1B	1	High	Blueberries
Dimethoate PER88174 (Qld, expires 31.7.24)	1B	1	High	Blueberries
Malathion (Fyfanon®)	1B	3	High	Blackberries, blueberries, raspberries
Spinetoram (Success® Neo) PER87408 (expires 30.4.24)	5	1	High	Blackberries, blueberries, raspberries (suppression)
Spinosad (Naturalure®) (use in bait application)	5	Not required when used as directed	Medium	Blackberries, blueberries, raspberries
Trichlorfon (Lepidex®) (NSW)	1B	2	High	Blueberries
Trichlorfon PER12486 (ACT, NSW, Qld, SA and WA; expires 31.3.26)	1B	2	High	Blueberries
Trichlorfon PER12486 (ACT, NSW, Qld, SA and WA; expires 31.3.26)	1B	14	High	Blackberries, raspberries

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

Redberry mite

Acalitus essigi

Redberry mite (RBM) is a tiny mite that infests blackberries in Australia and many other blackberry producing countries.

Risk period

Table 62. The peak risk period for redberry mite.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Redberry mites are tiny, whitish, 0.5 mm long and look similar to a worm but have legs at one end of their body.

Redberry mite is believed to be the primary cause of redberry disease, a disorder that causes incomplete, delayed or uneven ripening of blackberry drupelets so that some stay hard and red while others are fully black and ripe (Figure 100).

Figure 100. Redberry mite damage to blackberry fruit.

Monitoring

Fruit monitoring

Collect 40 red fruit from a block, ensuring the calyx is included as this is where the mite will generally be located. Use the 'wash and shake' method to extract and count mites.

Wash and shake – extracting and counting mites

Mites and predators can be extracted from fruit buds by placing them in a small quantity of 70% ethanol and shaking gently for 1 minute. If ethanol cannot be sourced, methylated spirits or a solution containing tap water, 2% household bleach and 2–3 drops of detergent is also effective. Pour the solution into a Petri dish or small clear plastic container and place it over black cardboard to make counting easier. Count the mites using a minimum of 20× magnification.

Winter bud monitoring

Monitoring for RBM in winter can indicate the pest potential in the following season. Collect 10 buds from a block. Tease apart the bud to open it up gently before using the wash and shake method to extract and count the mites.

Management

Cultural and physical

Weed removal: wild blackberries are a hotspot for RBM. A higher incidence of RBM was found in fruit when wild blackberries were within 100 m of the commercial crop (Law et al. 2020). Removing wild blackberries close to the crop could help prevent reinfestation and reduce pest pressure.

Canopy management: primocane fruiting varieties managed with a complete mow down each season appear to have very low incidence of redberry mite due to habitat removal preventing large populations from building up.

Biological

Some blackberry varieties are more susceptible than others to RBM and some varieties do not show damage even when mites are present. Primocane varieties are less susceptible due to the annual removal of floricanes reducing RBM populations below problematic levels. Chester and Driscoll Victoria varieties are more susceptible than Elvira, Loch Ness and Karaka.

Redberry mite belongs to the family of *Eriophyid* mites, of which there are commercially available predatory mites. Introducing *Typhlodromus doreenae* and *Typhlodromalus lailae* in late spring and summer has been associated with reduced levels of redberry mite in commercial blackberry crops.

Chemical

Outdoor crops managed with low pesticide and softer fungicide programs had very low levels of redberry mite over multiple seasons. Chemical control (Table 63) should be considered when sampling indicates high levels in a susceptible crop. This should be integrated with both cultural and biological management for maximum effectiveness.

Table 63. Registered or permitted products for redberry mite in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Fenbutatin oxide PER89407 (expires 28.2.26)	12A	1	Low	Blackberries, raspberries
Sulfur PER87245 (expires 31.3.24)	M2	Not required when used as directed.	–	Blackberries

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

This information was developed by the Tasmanian Institute of Agriculture through the project 'Integrated pest management of Redberry mite on blackberries'.

Red-shouldered leaf beetle

Monolepta australis

Red-shouldered leaf beetles have a wide host range. Early detection is essential as swarms can strip leaves, fruit and buds, and numbers increase quickly.

Risk period

Table 64. The peak risk period for red-shouldered leaf beetles.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Red-shouldered leaf beetles are 6 mm long and yellow, with a dark red band across the shoulders and 2 purple spots on the ends of their wing covers (Figure 101). Their yellowish eggs are small and oval. The larvae are white, slightly flattened with hard brown plates at both ends and up to 10 mm long.

Adult beetles attack leaves, fruit (Figure 102) and flowers. High populations will shred leaves (Figure 103) and strip plants of flowers. Hatching occurs from grassed rows in spring through to autumn after rain. Infestations are likely after heavy rainfall (20–40 mm) in spring and summer. The beetles enter orchards from prevailing winds and collect on a few plants before dispersing.

Figure 101. Adult red-shouldered leaf beetle.

Figure 102. Red-shouldered leaf beetle damage to blueberries.

Figure 103. Red-shouldered leaf beetle damage to blueberry leaves.

Management

Cultural and physical

Eucalyptus torelliana is highly attractive to red-shouldered leaf beetle and is useful for early detection and control. Yellow sticky traps in boundary trees provide an early indication of beetle presence.

Biological

Currently there are no known biological control measures.

Chemical

Effective control can be achieved if incursions are discovered early and are spot-sprayed before they disperse to the rest of the orchard. Check crops after heavy rainfall as populations of greater than 20 beetles per square metre will cause significant damage.

The chemical treatment options for red-shouldered leaf beetles are in Table 65.

Table 65. Registered or permitted products for red-shouldered leaf beetle in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Bifenthrin PER84972 (expires 30.11.27)	3A	1	High–very high	Blackberries, raspberries
Methomyl (Nufarm Methomyl 225 Insecticide)	1A	5	High	Blueberries (field use only)
Methomyl PER87495 (ACT, NT, Qld, SA, Tas, Vic; expires 28.2.24)	1A	*5*	High	Blueberries (field use only)
Pyrethrin (Pyganic®) PER80070 (expires 31.10.25)	3A	Not required when used as directed.	High	Blackberries, blueberries, raspberries

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

Rutherglen bug

Nysius vinitor

Rutherglen bugs are native insects with a wide host range. They are strong fliers that migrate in swarms. They are most prevalent in spring and summer during warm dry periods and when surrounding weeds are drying off.

Risk period

Table 66. The peak risk period for Rutherglen bug.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Adult Rutherglen bugs are grey-brown with clear wings (Figure 104). They are 4 mm long with a narrow body and prominent eyes. They are a highly mobile insect and often swarm in the hundreds over the fruit surface.

Rutherglen bugs cause damage by sucking sap from fruit and leaves.

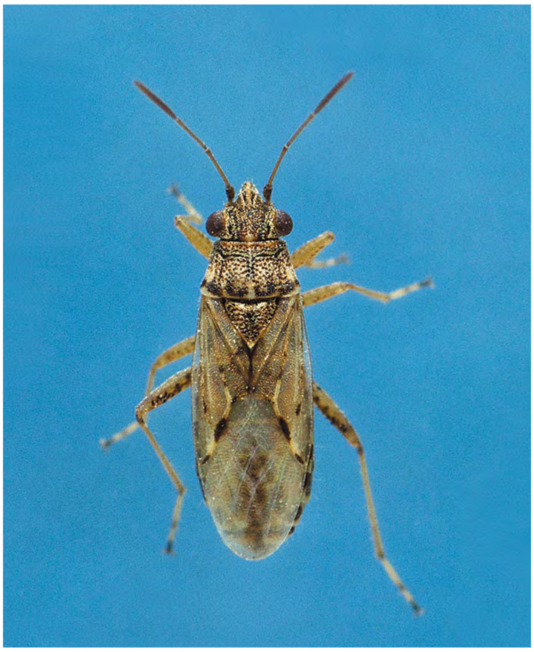

Figure 104. Adult Rutherglen bug.

Management

Cultural and physical

Managing weeds around the crop can reduce the likelihood of Rutherglen bugs moving from weeds into the crop.

Biological

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

Chemical

The chemical treatment options for Rutherglen bug are listed in Table 67.

Table 67. Registered or permitted products for Rutherglen bug in Australia.

Active constituent (example trade name)	**Insecticide group(s)**	**WHP[1] (days)**	**Effect on beneficials**	**Registered for use in...[2]**
Carbaryl (Bugmaster®)	1A	7	High	Raspberries
Dimethoate (Qld, Vic, Tas, SA and WA)	1B	7	High	Blackberries, raspberries
Flonicamid PER89214 (expires 28.2.27)	29	3	Low–medium	Blackberries, raspberries (suppression)
Sulfoxaflor PER90208 (expires 31.5.24)	4C	1	High	Blackberries, raspberries (suppression)

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

Managing pests in berries

Scale insects

Coccidae spp., *Diaspididae* spp. and *Eriococcidae* spp.

Scale are insects that feed on plant tissue and secrete honeydew. Managing scale insects should focus on preventing infestations and controlling populations before they cause economic loss. Monitoring should include visual observations, including turning over leaves, looking for black sooty mould and ants on the plants.

Risk period

Table 68. The peak risk period for scale insects.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

The term 'scale' refers to the substance secreted over the back of the insect. The white wax (Figure 105) is seen around autumn when the adults settle, so treatment should be applied when the insects are crawlers. Scale insects often do not have functional legs and adult females are generally sedentary. Most species lay eggs underneath their body.

Scale insects feed on young growing tips, causing distorted foliage. Feeding on leaves causes leaf yellowing and the plant to appear stressed and stunted. If left uncontrolled, scale can weaken the bush, predisposing it to disease or abiotic problems.

Coccus hesperidum (Figure 106) affects mainly blueberry leaves but their feeding activity will cause sooty mould on the plants (Figure 107), including the fruit, which makes it unsaleable.

Figure 105. Scale on a blueberry bush. Photo: J Saeck, Blueberry Fields.

Figure 106. Scale on a blueberry leaf.

Management

Cultural and physical

Pruning and destroying old, weak canes and scale-infested wood prevents scale populations from increasing and removes a large pool of eggs.

Biological

There are several natural predators for managing scale insects. Some are commercially available predatory insects (e.g. lady beetles) such as *Cryptolaemus* spp. and blue chilocorus (*Chilicoris circumdatus*), naturally occurring parasitoid wasps (e.g. *Aphytis lingnanensis* and *A. melinis)* and predators such as green lacewings (*Mallada signata*).

Chemical

The chemical treatment options for scale insects are listed in Table 69.

Figure 107. Sooty mould caused by scale on blueberry leaves.

Table 69. Registered or permitted products for scale insects in Australia.

Active constituent (example trade name)	**Insecticide group(s)**	**WHP[1] (days)**	**Effect on beneficials**	**Registered for use in...[2]**
Diazinon (NSW)	1B	14	High	Blueberries
Paraffinic oil	–	1	Low	Blueberries
Petroleum oil PER13957 (expires 31.12.27)	–	1	Low	Blackberries, raspberries
Spirotetramat (Movento®)	23	1	Low	Blueberries

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

Scarab beetle

Heteronychus arator

The African black beetle (*Heteronychus arator*) and various cockchafers belong to the scarab family.

Risk period

Table 70. The peak risk period for scarab beetles.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Scarab larvae are usually cream, white or light brown. When they hatch they are small (1–3 mm long), but generally develop until they are longer than the adult. Many species of scarab larvae appear similar and often curl into a characteristic C-shape when at rest or disturbed (Figure 108). They have 3 pairs of well developed legs and usually a hard, brown, dark red or black head. Adults can vary in appearance, often being brown or black (Figure 109) but can be green, yellow or red and are sometimes iridescent. Most scarab beetles are approximately 8–20 mm long.

Risk periods for scarab beetles include summer and early autumn, especially those with dry springs and summers; this is when populations build up. Most damage is caused by the larvae feeding on the underground roots of young plants (Figure 110). Adults often kill growing points, causing the central shoots to wither and the plants to become dead-hearted. As they emerge (usually around December), African black beetles crawl up plants to feed and mate rather than go into the soil. This is when damage can occur to the young stems of newly established plants. The damage that scarabs cause is often difficult to diagnose, other than seeing signs of stress to the below-ground plant parts.

Figure 108. Scarab larvae. Photo: Clemson University, USDA Cooperative Extension Slide Series, Bugwood.org.

Figure 109. African black beetle. Photo: Hanna Royals, Screening Aids, USDA APHIS PPQ, Bugwood.org.

Figure 110. Scarab damage to the below-ground parts of the plant.

Management

Biological

The entomopathogenic nematode *Heterorhabditis zealandica* is commercially available through retail outlets. It is recommended to apply this to populations of small larvae.

Chemical

Since chemical treatment should focus on preventing larvae from feeding on young plants, chemicals should be applied at planting and before root flushes each year. The chemical treatment options for scarab beetles are listed in Table 71.

Table 71. Registered or permitted product for scarab beetles in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Chlorpyrifos PER90666 (expires 31.5.24)	1B	Not required when used as directed	High	Blueberries
Imidacloprid PER12534 (expires 31.10.25)	4A		Medium	Blueberries

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

Two-spotted mite

Tetranychus urticae

Two-spotted mite (TSM) is more likely to become a problem in warm to hot, dry summers and when predatory insects are disrupted by sprays for other key pests and diseases.

Risk period

Table 72. The peak risk period for two-spotted mite.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Disease identification and damage

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 with 2 distinctive dark patches (spots) on either side of the upper and forward part of the body (Figure 111). Adult males are smaller and less distinctive than females. Eggs are also opaque, cream-coloured and very small, i.e. 0.1 mm. TSM activity is often associated with the presence of webbing over the affected foliage. TSM damage crops by feeding mostly on the underside of leaves, causing cells to turn yellow–whitey. Heavy feeding results in severe speckling of the foliage, which gives a bronzed look (Figure 112). Severe damage can reduce photosynthetic capacity and therefore yield and fruit quality.

Figure 111. Two-spotted mite adults.

Figure 112. Two-spotted mite damage. Photo: J Robertson, Costa Berries.

Management

Cultural and physical

Similar to most mite pests, TSM seem to prefer dusty conditions and often thrive in plants adjacent to unsealed tracks. Any method that reduces dust arising from such sources will help decrease TSM activity.

Maintaining good soil moisture and minimising plant stress, particularly through the hottest part of the season, will help plants recover from mite attack and resist damage.

Biological

The predatory mites *Galendromus occidentalis* (formerly *Typhlodromus occidentalis*), *Neoseiulus californicus* and *Phytoseiulus persimilis* (Figure 113) are all reared commercially for purchase and release. They can be very effective biological control agents for TSM if seasonal conditions and crop protection chemical selection are favourable.

Figure 113. The predatory mite *Phytoseiulus persimilis* attacking two-spotted mites.

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

Decisions to spray for TSM are best made based on the results of regular mite monitoring. During the growing season, and particularly as spring and summer temperatures increase, monitor the undersides of leaves for TSM and their eggs. Scouting for plant damage such as bronzed or yellowed leaves can be a quick way to identify pest mite hotspots. Note: applying pesticides that are not soft on beneficials often leads to outbreaks of mites because biocontrol agents are eliminated. The chemical treatment options for TSM are listed in Table 73.

Table 73. Registered or permitted products for two-spotted mite in Australia.

Active constituent (example trade name)	**Insecticide group(s)**	**WHP[1] (days)**	**Effect on beneficials**	**Registered for use in...[2]**
Abamectin	6	7	Medium–high	Blackberries, raspberries
Bifenazate PER14425 (expires 31.7.28)	20D	1	Low	Blackberries, raspberries
Botanical oil PER14234 (expires 31.5.28)	–	Not required when used as directed	Low	Blackberries, blueberries, raspberries
Dimethoate	1B	1	High	Blueberries
Dimethoate	1B	7	High	Blackberries, raspberries
Etoxazole PER89406 (expires 31.1.26)	10B	1	Low	Blackberries, raspberries
Fenbutatin oxide PER89407 (expires 28.2.26)	12A	1	Low	Blackberries, raspberries
Paraffinic oil	–	1	Low	Blueberries
Petroleum oil PER13957 (expires 31.12.27)	–	1	Low	Blackberries, raspberries
Sulfur PER87245 (expires 31.3.24)	M2	Not required when used as directed	–	Blackberries

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

Western flower thrips

Frankliniella occidentalis

Western flower thrips (WFT) attack a wide variety of horticulture crops, both in the field and in greenhouses. Due to their small size, WFT are usually detected by trapping the insects or seeing plant symptoms rather than direct observation of the insects.

Risk period

Table 74. The peak risk period for Western flower thrips.

Budswell	Bloom	Fruit development	Harvest	Postharvest	Vegetative growth

Pest identification and damage

Adult WFT are pale brown to yellow with narrow bodies (Figure 114) about 1–2 mm long. Western flower thrips are hard to identify in the field and a light microscope will usually be required to differentiate them from other pest species such as plague thrips and onion thrips.

Western flower thrips are usually found in flowers where they feed on nectar and pollen. In blueberries, feeding causes bronzing of the corolla (Figure 115).

Figure 114. Western flower thrips. Photo: David Cappaert, Bugwood.org.

Figure 115. Western flower thrips damage to blueberry flowers. Photo: M Rocchetti, Costa Berries.

Management

Cultural and physical

Monitor for thrips species using yellow sticky traps (Figure 116) hung throughout blocks from budburst to harvest. The traps will give an indication of thrips activity.

Several management practices will reduce pest numbers and minimise damage. As broadleaved weeds (particularly clover) are an alternative host for WFT, keep ground covers mown short throughout the year to prevent flowering, but do not mow when plants are in bloom. Choose pesticides that are less harmful to beneficial insects to encourage their presence and survival.

Biological

Neoseiulus cucumeris and *Typhlodromips montdorensis* are predatory mites available for thrips control. Basil can be planted throughout orchards to act as a banker plant for *Orius* thrips predators, and as a trap plant for WFT.

Figure 116. Sticky traps are a useful monitoring tool.

Use approximately 200 bankers/ha (more or less depending on thrips pressure).

There are several natural thrips predators including predatory mites, lacewings, predatory thrips, lady beetles and parasitic wasps. However, these are unlikely to provide full control of WFT.

Chemical

The chemical treatment options for WFT are listed in Table 75.

Table 75. Registered or permitted products for Western flower thrips in Australia.

Active constituent (example trade name)	Insecticide group(s)	WHP[1] (days)	Effect on beneficials	Registered for use in...[2]
Dimethoate	1B	1	High	Blueberries
Dimethoate	1B	7	High	Blackberries, raspberries
Spinetoram (Success® Neo)	5	1	High	Blackberries, blueberries, raspberries
Spinosad	5	1	Medium	Blackberries, blueberries, raspberries

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

Further reading

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British Columbia Ministry of Agriculture (nd) *Blueberry field guide: identification of pests, diseases and other disorders in blueberry fields* (https://fieldguide.bcblueberry.com/).

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Pscheidt JW and Ocamb CM (senior eds) (2021) *Pacific Northwest plant disease management handbook*, Oregon State University (https://pnwhandbooks.org/plantdisease/host-disease/blueberry-vaccinium-corymbosum-alternaria-fruit-rot).

Frost injury – blueberries

Identification and damage

Significant frost damage to fruit can usually be detected 3 to 5 days after exposure. Less severe damage during pollination can take up to 14 days to be noticeable. To determine the extent of frost damage, dissect developing fruit (post petal fall through to small pea-sized green fruit) with a sharp knife.

Common signs of frost damage include:

- corolla damage, brown shrivel and drop (Figure 117)
- internal fruit browning (from small developing fruit through to ripe berries; Figure 118)
- irregular colouring and ripening of berries
- water-soaked or irregular colour to fruit calyx (Figure 119)
- irregular and misshapen berries (carried over from flower or developing fruit damage; Figure 120).

Figure 117. Corolla damage. Photo: MS Fruit Extension.

Figure 118. Internal browning of fruit. Photo: Bill Cline, North Carolina State University.

Figure 119. Water-soaked and irregular colour to fruit calyx. Photo: Australian Blueberry Growers Association.

Figure 120. Irregular and misshapen berries. Photo: Australian Blueberry Growers Association.

Temperatures

The temperature at which frost injury occurs will depend on the berry development stage. As flower budswell progresses, cold tolerance decreases. By the time individual flowers start to protrude from the bud, temperatures below −7 °C can damage the most exposed flowers. When corollas have reached half of their full length, temperatures below −5 °C will kill the flowers. Blossoms on Rabbiteye blueberries can receive corolla damage when temperatures are −1 °C. This will cause the corolla to wither, although it usually remains attached.

Immediately after corolla drop and before the berry begins to swell is one of the most sensitive stages. On open blossoms, more than a few minutes at −1.5 °C can cause damage. A few minutes at below −2 °C is high risk for damage. As the berry begins to enlarge, susceptibility is similar to the critical temperature of −2 °C for open blossoms.

Cold damage is not always immediately obvious. Following temperatures well below the critical levels, flowers or small fruit will develop a water-soaked appearance, shrivel and drop. However, a very brief time at the critical temperature might damage only the pistil. All or a portion of the damaged pistil will turn brown, preventing pollination and fruit set.

Ovules, which develop into the seeds in the berry, can also be damaged without any exterior symptoms. Healthy ovules are plump and white, but become black with cold injury. If many ovules or young seeds are black, the flower or fruit will probably drop. Seeds produce hormones that help fruit to develop, so if only a few are damaged, fruit development usually continues, but the fruit will be later ripening and smaller than those with plenty of healthy seeds.

Management strategies

Orchard layout

Design the orchard to avoid frost problems. Leave a shelter belt above the orchard to restrict cold air coming into the orchard. Plant a windbreak to protect the orchard from cold winds. Arrange rows to allow for cold air to move through and drain out of the orchard. Use late flowering species and cultivars in frost-prone locations.

Frost machines

On clear, calm nights, a strong temperature inversion develops, where temperatures within 1.8 m of the ground can become much colder than temperatures 15–30 m above ground. By mixing these air layers, wind can raise the temperature near the ground by about 15 °C. The exact amount will vary with the strength of the temperature inversion and the effectiveness of the air mixing. A single wind machine (Figure 121) normally provides a maximum increase in temperature of about 15 °C over an area of about 4 ha.

Maintain soil moisture

Increasing the amount of water in the soil will enable it to absorb more heat during the day and to conduct more heat to the surface for plant protection. When soils are dry, they hold very little heat and a dry surface acts as an excellent insulator to prevent beneficial heat release. Excess water for extended periods must be avoided to prevent flooding and root rot damage.

Ground cover and weeds

A thick mat of grass, weeds or mulch on the soil surface will reduce solar soil heating as well as heat release from the soil at night. However, this can make frosts cause more damage. Therefore, delay applying mulches until the risk of frosts has passed. Ensure weeds are well controlled with their foliage totally decayed or removed before winter.

Figure 121. A wind machine in a blueberry orchard. Photo: D Clothier, Mountain Blue Farms.

Managing weeds

Why manage weeds?

Rapid canopy establishment and early cropping are key to profitability in an orchard, particularly in modern, intensive systems. Weeds compete with bushes for moisture and nutrients and can create a micro-climate that favours pests and diseases.

Research shows that weed competition in young, developing orchards can slow canopy establishment and delay productivity. A poor weed management strategy will also have a negative effect on yields in established orchards, whereas an effective strategy will help growers to achieve their goals for orchard establishment, early yields and hygiene.

Hygiene comes first

Good orchard hygiene is the first step in any weed management strategy. Weed movement on and throughout a property and the appearance of new weed species are largely determined by the degree of weed hygiene employed. Be aware of new weeds appearing on the property. Have them identified if necessary, and work towards eradicating them or reducing their spread. Moving machinery from non-crop areas to the orchard and between blocks can spread new weeds. Often introduced weeds can carry resistance to herbicides. Regularly cleaning orchard equipment can reduce the spread of new weeds.

Management strategies and control options

The most appropriate weed management strategy will vary from site to site and will depend on factors including orchard size, bush age, weed spectrum and density, soil type, available moisture and choice of under bush management (e.g. bare earth, mulched or sod culture). Strategies will 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.

Physical weed control methods

Cultivation

Cultivation was once a common commercial practice in orchards that reduces competition from weeds, but at some cost. Disturbing the topsoil negatively affects soil structure and organic matter levels. Cultivation also increases erosion risk and can damage roots, especially in blocks on dwarf stocks. Spot cultivation using a hoe is labour intensive, but might be an option for smaller orchards as an alternative to broad-scale cultivation or spot spraying.

Thermal weeding

Research shows that flame or thermal weeding using propane burners, hot air or hot water can be effective on small seedlings, but is less effective against larger annuals or perennial weeds. There are also occupational health and safety issues and fire hazards associated with these methods. Do not use thermal weeding near bushes less than 3 years old as they can be severely damaged.

Grazing

Grazing sheep, geese and fowl can suppress weed growth and reduce seed load in the orchard. Geese are heavy feeders of weeds such as grasses, and they also help to clean up windfall fruit. Sheep can damage bushes if other feed is scarce. If the animals grazing the orchard are intended for sale, be aware of chemical residue issues. Consult chemical labels for information on stock withholding periods.

Mulching

If done correctly, mulching is the most effective alternative to chemical weed control. Mulching mounds with large quantities of organic materials such as straw, old hay or woodchips, has multiple benefits including moisture retention, soil temperature regulation, and building up organic matter and soil microbes.

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

In blueberry orchards with bushes planted on mounds in rows, the mounds must be broad enough to prevent organic mulches from sliding off them. As the mulch decomposes, it will need to be renewed, possibly every few years. Growers should also be aware of the possibility of nitrogen being tied up in the soil and not available to the crop when it is breaking down some compost types.

Side cast mowers deposit slashed material along the bush row, which can help to suppress weeds and build up organic matter. However, this is not effective as a stand-alone mulch treatment if the aim is to achieve a weed-free strip.

Synthetic weed mat is used for weed control in high rainfall areas. It is effective at reducing weeds on mounds, but it can lead to disease and soil health problems inside mounds. Many growers use weed mat to control weeds on the side of the mound, but have a large planting hole cut into the weed mat that is covered with organic mulch to allow planting, access to irrigation lines, fertiliser application and to allow rainfall to penetrate.

Chemical weed control

Types of herbicide and when to spray

Weeds can be sprayed either just before (pre-emergent) or just after germination (post-emergent). Most weeds germinate in either spring or autumn. Small weeds are easier to control than older, more mature weeds. Orchard herbicides can be grouped into 3 broad categories:

1. **Pre-emergent residual herbicides** (Table 76) work best when applied to bare soil that is free from 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 grass weeds.
2. **Post-emergent selective grass herbicides** (Table 77) 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 (previously A) herbicide mode of action (MOA) group. This group are highly prone to developing resistance and should be used in accordance with resistance management principles.
3. **Post-emergent non-selective knockdown herbicides** (Table 78) perform best when applied to young, actively growing weeds. As these herbicides are non-selective, some can be harmful to fruit bushes. Young bushes are particularly prone to injury if not protected from knockdown herbicides. Consult product labels for specific recommendations.

Should I be concerned about herbicide resistance?

Yes.

Herbicides work by interfering with specific processes in plants, known as the mode of action (MoA). All herbicides have been classified into groups according to their MoA.

Herbicide MoA classifications have been updated internationally to capture new active constituents and ensure the MoA classification system is globally relevant. The global MoA classification system is based on numerical codes that provide infinite capacity to accommodate new herbicide MoA becoming available, unlike the alphabetical codes currently used in Australia. We have updated our MoA tables to include both the new number and the old letter (shown in brackets).

Some groups are more likely to develop resistance and are considered high risk. Refer to product labels or Table 76 to Table 78 to determine the MoA group.

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

- Know the herbicide groups.
- Do not rely on chemicals from the same group for every spray.
- Use a lower risk herbicide in preference to a high risk one: for example, never use a Group 1 (A) herbicide when a Group 9 (L) or 22 (M) herbicide will do the job.
- Look for surviving weeds after spraying and prevent these from setting seed.
- Use as many weed control techniques as practical and do not rely solely on herbicides.

Herbicide sprayer setup

A properly configured and well calibrated sprayer is essential to ensure herbicides are applied in accordance with label recommendations to achieve the intended weed control. Some important points to consider are:

- Ensure all equipment is properly calibrated before use.
- 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 being used.
- Always use a low-drift type nozzle wherever possible, e.g. 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 the section on Avoiding spray drift in berries on page 88.
- 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 at ground level. Too low will result in herbicide being applied unevenly, while too high will increase the risk of off-target damage.
- If an individual nozzle's output (litres per minute) varies by more than 5% from the manufacturers' specifications, replace that nozzle.
- Herbicide labels can include mandatory advice on droplet spectrum, e.g. medium–coarse. If so, be sure to choose the right nozzle and operating pressure.

Important: always read the product label or permit before applying any herbicide in an orchard. Failure to do so could result in poor product performance or damage to bushes.

Simple and easy calibration

The most common procedure for calibrating herbicide spray equipment is:

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

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

Assume

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

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

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

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

Application rate of product [**R**] = 3.75 kg/ha

Then

Area covered by a full tank is **L** × **W** × **T** ÷ **V**

In our example, the area covered is 100 m × 1.5 m × 500 L ÷ 10 L = 7,500 m^2 or 0.75 ha

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

So the 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 kg/ha × 0.75 ha = 2.8 kg.

Herbicides and their uses

Table 76. Pre-emergent residual herbicides for blueberry, raspberry and blackberry orchards. Always read the label.

Active ingredient	Example trade name	Herbicide group*	Crop	Withholding period (harvest)	Weeds controlled	Remarks
Dichlobenil (Tas)	Casoron® 4G	29 (O)	Raspberries	Not required when used as directed.	Annual grasses and broadleaf weeds.	Apply late winter to early spring before growth has started.
Dichlobenil (Permit PER12219 expires 21.3.24)	Casoron® 4G	29 (O)	Blueberries	Not required when used as directed.	Annual grasses and broadleaf weeds.	Do not apply more than 2 applications per year.
Flumioxazin	Chateau®	14 (G)	Blueberries	Do not harvest for 14 weeks after application.	Active against a wide range of grass and broadleaf weeds.	Needs at least 15 mm of irrigation or rain to activate. When large weeds are present, use a knockdown herbicide at the full rate, allow weeds to die back and ensure debris is minimal before application.
Metham present as sodium salt	Nemasol	–	Blackberries, blueberries, raspberries	Not required when used as directed.	Germinating weed seeds.	Refer to APVMA approved label 34049 for trickle irrigation: field application to bed or rows.
Oryzalin (non-bearing plants)	Stonewall®	3 (D)	Blackberries, blueberries, raspberries	Not required when used as directed.	Certain annual grasses and broadleaf weeds.	Activated by moisture. For use on non-bearing bushes only.
Simazine	Simazine 500	5 (C)	Raspberries	Not required when used as directed.	A range of broadleaf weeds.	Do not apply to foliage or when fruit is present. Use on established plants only.

*The number in the herbicide column represents the new MoA and the previous letter is in brackets.

Table 77. Post-emergent selective grass herbicides for blueberry orchards. Always read the label.

Active ingredient	Example trade name	Herbicide group*	Crop	Withholding period (harvest)	Weeds controlled	Remarks
Fluazifop-P (Permit PER86586 expires 31.5.28)	Fusilade® Forte	1 (A)	Blueberries	Do not harvest for 4 weeks after application.	Barnyard grass, crowsfoot grass, stink grass, Urochloa grass, carpet grass, couch grass, Johnson grass, kikuyu and paspalum.	Use higher water volumes if weeds are dense.
Haloxyfop	Imtrade Haloxyfop 900 EC	1 (A)	Blueberries	Not required when used as directed.	Annual and perennial grasses.	Spray should be directed to the base of the bush to avoid contact with fruit and foliage.

*The number in the herbicide column represents the new MoA and the previous letter is in brackets.

Table 78. Post-emergent non-selective knockdown herbicides for blueberry, raspberry and blackberry orchards. Always read the label.

Active ingredient	Example trade name	Herbicide group*	Crop	Withholding period (harvest)	Weeds controlled	Remarks
Glufosinate-ammonium	Basta®	10 (N)	Blueberries	Not required when used as directed.	A broad-spectrum herbicide that controls a wide range of grasses and broadleaf weeds.	Do not: • apply in unfavourable weather conditions • apply to young, green or uncalloused and damaged blueberry plants • allow spray or spray drift to contact the crop.
Glufosinate-ammonium (NSW, Vic, Tas)	Basta®	10 (N)	Blackberries, raspberries	Not required when used as directed.	Primocane and sucker control.	Contact with flowers, developing fruit or foliage will cause damage.
Glyphosate	Roundup® Complete Herbicide	9 (M)	Blueberries, raspberries	Not required when used as directed.	Controls a wide range of annual and perennial weeds.	Do not: • allow spray or spray drift to contact green bark, fresh wounds, foliage or fruit. • use near bushes less than 3 years old unless they are properly protected from spray drift.
Paraquat	Inferno® Herbicide	22 (L)	Blueberries	Not required when used as directed.	Most annual grasses and some broadleaf weeds.	Avoid spray drift onto plant parts. Spray only actively growing weeds (50–100 mm high). Do not use in home gardens.

*The number in the herbicide column represents the new MoA and the previous letter is in brackets.

Your responsibilities when applying pesticides

Farm Chemicals Section, Biosecurity and Food Safety, NSW DPI

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 importing, registering 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* does not allow off-label use unless a permit is approved by the APVMA. A list of current permits and registered products is available at the APVMA (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 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. See 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 a non-target area. However, some chemicals can also travel long distances as a vapour after spraying. There could be a risk of injury or damage to humans, plants, animals, the environment or property.

Buffer zones reduce the risk of chemical drift reaching sensitive and non-target areas. Applicators must adhere to buffer zones and other drift reduction instructions on labels.

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 (including drones). They also provide a recommendation for the minimum water volume for aerial application.

More information on the legal requirements for aerial application is available on the EPA website (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 controls pesticide use in NSW. The aim is to minimise risk to human health, the environment, property, industry and trade.

The primary principle of the *Pesticides Act* 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 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 (Table 79). 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. blueberries
- 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 application
- records must be 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) 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/law-and-regulation/codes-practice) for different industries and situations to provide guidance for industries.

Work Health and Safety Act 2011 (NSW)

SafeWork NSW administers the *Work Health and Safety Act 2011* (https://www.legislation.nsw.gov.au/#/view/act/2011/10) and the Work Health and Safety Regulation 2011 (https://www.legislation.gov.au/Details/F2011L02664).

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 addresses the management of hazardous substances (i.e. most pesticides). It covers identifying hazardous substances in the workplace, 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 accumulation of flammable and combustible materials
- provision of fire protection, firefighting 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 Agroscience Testing (https://www.eurofins.com.au/locations/eurofins-agroscience-testing-lane-cove/), phone 02 9900 8442

National Measurement Institute (info@measurement.gov.au), phone 1800 020 076

National Association of Testing Authorities (https://www.nata.com.au), phone 02 9736 8222

Information sources

Australian Pesticides and Veterinary Medicines Authority (https://apvma.gov.au/)

Australian Code for the Transport of Dangerous Goods by Road and Rail (https://www.ntc.gov.au/codes-and-guidelines/australian-dangerous-goods-code)

Bureau of Meteorology (http://www.bom.gov.au/)

Environment Protection Authority (https://www.epa.nsw.gov.au/)

Hazardous Substances Information System (https://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)

National Association of Testing Authorities (https://nata.com.au/)

NSW DPI resources on Queensland fruit fly (https://www.dpi.nsw.gov.au/biosecurity/insect-pests/qff)

Safe use and storage of chemicals in agriculture (https://www.safework.nsw.gov.au/hazards-a-z/hazardous-chemical)

Work Health and Safety Act 2011 (https://legislation.nsw.gov.au/view/html/inforce/current/act-2011-010)

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

Table 79. An example spray record form.

Chemical application record							
Property address:						Date:	
Owner:			Address:			Phone:	
Person applying chemical:			Address:			Phone:	
Spray application area				**Situation of use**			
Spray map including sensitive areas, wind direction, order of treatment				Area sprayed and order of spraying			
				Block name/ number	Area (ha)	Crop	Growth stage
				Pest(s)		Pest growth stage	Pest density
GPS reference: S E				**Application equipment**			
Comments (including risk control measures for sensitive areas):				Equipment type	Nozzle	Pressure	Speed
No-spray zone (metres):				Water quality (e.g. pH, hardness)	Droplet size	Boom height (above target)	Other
Chemical details							
Full product name (including additives)	Chemical rate	Water rate	Total amount of concentrate	Total amount of chemical mix used	Mixing order	Re-entry period	WHP (days)
Weather details							
Rainfall (amount and time from spraying)	Before: mm		During: mm		After: mm		
Time of spraying:	Temperature °C	Relative humidity %	Delta T	Wind direction	Wind speed	Variability eg. gusting speed and direction	
Start:							
Finish:							
Start:							
Finish:							
Clean up							
Disposal of rinsate:				Decontamination of sprayer:			

Source: Adapted from SMARTtrain Chemical Accreditation Program Calibration and Records Supplement.

Avoiding spray drift in berries

Melinda Simpson and Bruce Browne

Introduction

An effective spray application will deliver the right amount of product to the desired area. However, if any part of the spray equipment is not set up or calibrated appropriately, the target could be missed, or spray might drift to non-target areas.

Type of sprayer used

The 3 main types of sprayers used in berries are ducted air (Figure 122), multi-head (Figure 123) and axial fan air-blast (Figure 124) sprayers. The axial fan air-blast sprayer is more prone to missing the target than the multi-head and ducted sprayers, but by carefully following the instructions included herein, many of the off-target risks can be reduced.

Figure 122. A ducted air sprayer.

Figure 123. A multi-head sprayer. Photo: Dave Farmer, Croplands.

Figure 124. An axial air-blast sprayer.

Adjust spray water volume to match the canopy size

Chemical application rate depends on the spray water volume (when using the per 100 L water rate), which depends on the crop canopy volume. An industry standard for spray water volumes in blueberries is shown in Figure 125. If spray water volumes are not matched to crop canopy volumes (i.e. less water than industry standard), chemical application rates should be adjusted (i.e. using a concentration factor) to achieve the same dose per plant. Using these water volumes and the per 100 L label rate will achieve the most desirable amount of chemical per leaf area.

Dilute spray volume is required to calculate the correct amount of chemical to be applied to cover the canopy. Water-sensitive paper should be used to verify these volumes provide adequate coverage.

Nozzle selection

Coarser droplets are preferable when spraying near sensitive areas (always follow the label recommendations). Combining coarse spray quality and an appropriate surfactant will significantly reduce the risk of off-target drift. Some product labels state the size of the spray droplets required and/or nominated no-spray zones; both must be followed.

As much as 60% of the applied spray can end up either on the ground or drifting away if spray equipment is not set up properly.

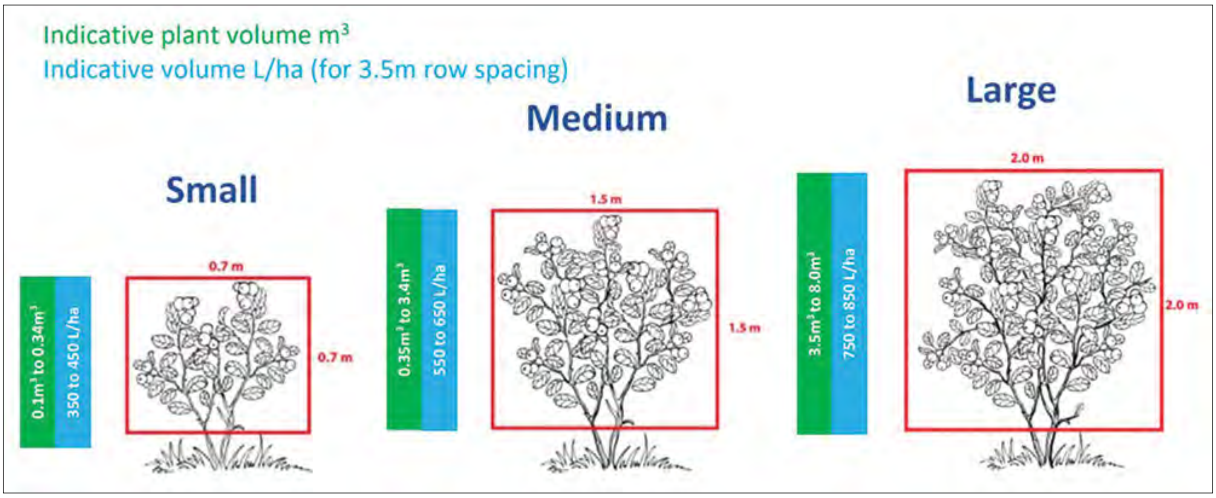

Figure 125. Industry standards for water volumes for dilute spraying in blueberries.

Over time, all nozzles suffer from wear and tear, causing their orifices to increase the desired or calibrated output. When nozzles are producing up to a 5% increase in the flow rate at a given pressure compared with a new nozzle or manufacturer's guide, they should be replaced. Reduced flow could indicate blockages or restrictions to a particular nozzle. Uneven wear can cause poor spray patterns and poor control; both potentially causing crop damage. Regularly cleaning nozzles will improve delivery rates by removing debris build-up (Figure 126).

Figure 126. Regularly cleaning nozzles will improve delivery rates by removing debris build-up.

Rules of thumb with nozzles

- Hollow cone nozzles produce finer sprays than solid cone nozzles.
- Wide-angle nozzles produce finer sprays than narrow-angle nozzles.
- Smaller orifice nozzles produce finer sprays than higher output nozzles at equivalent pressures.

Direct the sprayer output towards the target canopy

The main risk with spraying is failing to hit the target. To assess spray output, park the sprayer in a block to be treated. Look at which nozzles should be turned on and what proportion of the output is directed to the different bush zones (Figure 127). Adjust nozzles as required for better coverage and use water-sensitive paper (Page 92) or fluorescent tracer dyes and ultraviolet lights to help assess the coverage.

Figure 127. Assessing the sprayer output is towards the canopy.

An observer should monitor leaf movement to ensure sprayer-generated air is displacing the air within the canopy.

Make sure the sprayer is turned off at the ends of rows when turning. When spraying outside rows of a block, use single-sided spraying i.e. turn off nozzles not directed at the crop row.

Manage travel speed

Travel speed is a compromise between getting the job completed in good time and achieving thorough coverage. Research has shown that increasing travel speeds from 2.1 km/h to 7.7 km/h while keeping all other settings the same, will halve the chemical deposition rate from axial air-blast sprayers (Celen et al. 2008). Sprayer speeds can have a significant effect on spray deposits distribution, i.e. increasing sprayer speed can increase spray drift.

Sprayer speed and the effect on spray drift is a very complex subject, therefore many factors need to be considered, including weather conditions, droplet size, type of sprayer, air speed and tree canopy density and height.

Use deflectors

When using axial air-blast sprayers, deflectors can be used to channel the air into the target rather than over or under the target (Figure 128). Deflectors help to compress the air from sprayers into a tighter stream that easily reaches and penetrates the canopy.

To check where the air is going from the sprayer, attach 250 mm lengths of strong ribbon to each active nozzle position. Turn the sprayer on and the direction that the ribbons move will show where the air (and spray) is being directed (Figure 129). Adjust the nozzles and deflectors so that the air stream is directed into the canopy.

Note: most manufacturers can supply aftermarket deflectors.

Figure 128. Deflectors on an air-blast sprayer. Photo: Deveau (2015).

Figure 129. Using ribbons to work out where the air is being directed from the sprayer. Photo: Deveau (2015).

Consider fan speed

Throughout the season, fan settings should be adjusted to produce the most effective air speed. This is important because the air carries the chemical and if the air speed is too fast or too slow, the chemical will end up in the next row, on the ground or drifting away.

To estimate the required air speed, tie 250 mm lengths of ribbon to the top, middle and lower parts of the plant on the opposite side of the canopy. Drive past the canopy and note where the ribbons are being directed. This will show if the air speed is correct for spraying (Figure 130).

How to reduce air speed

Many sprayers have gearboxes that allow the fan speed to be changed. Consider using 'gear up throttle down' (GUTD) to do this. Going to a higher gear and reducing the throttle speed to around 1,500 rpm will slow the fan speed. It will also reduce fuel use by approximately 40%. Note: GUTD will only work with piston, diaphragm or roller pumps; it will not work with centrifugal pumps.

Increasing ground speed will reduce air penetration.

Note: if the air speed is increased, the sprayer volume will need to be recalibrated.

How to increase air speed

- change fan gear
- reduce speed but remember the sprayer volume will need to be recalibrated if the canopy is too dense, it might need thinning.

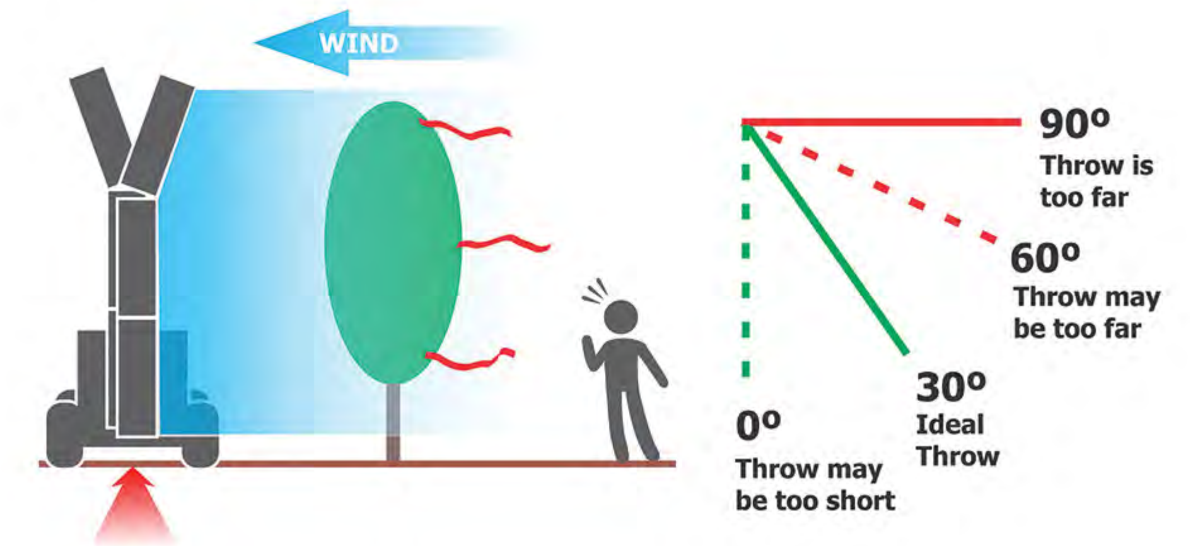

Figure 130. Using ribbons to determine adequate air speed for spraying. Source: Deveau (2015).

Natural and artificial barriers for spray drift mitigation

An artificial or natural barrier can be effective at intercepting some airborne droplets and deflecting the airflow to reduce spray drift potential by 60–90%. Wind slows and distorts as it travels through porous barriers such as a windbreak. Windbreaks protect for approximately 10 times their height. For example, if the windbreak is 20 m high, the area 200 m beyond it will receive reduced pesticide. The windbreak should have 50% porosity (i.e. can see through it) as solid windbreaks that allow little or no wind to pass through can cause turbulence on the side it is meant to protect.

Figure 131. An artificial barrier made of shade cloth with 50% porosity. Photo: Andrew Hewitt.

Artificial barriers

Artificial barriers can be made of a variety of materials such as shade cloth with 50% porosity (Figure 131). The advantage of artificial barriers is little or no waiting time for them to establish. However, they are generally not as high as natural windbreaks, so the distance protected is less.

Vegetative buffers

Vegetation barriers can be planted and maintained on downwind edges of fields and properties adjacent to susceptible areas. Trees and shrubs planted to form buffer zones should be a narrow leaf type, i.e. *Casuarina* (Figure 132) as these are much more effective at capturing droplets than larger leaved species. Also ensure the plant species is not a favoured host for common insect pests.

Figure 132. Casuarina as a vegetative buffer. These are evergreen and have fine greyish needle-like foliage down to ground level. Casuarina requires hedging to be effective.

Weather conditions affecting spraying

Wind

Avoid spraying when the wind is blowing towards a non-target area and during calm or still conditions as this is when droplets are more likely to remain suspended in the air. Avoid spraying when wind speed is too low (<4–5 km/h) or too high (>15 km/h). The ideal safe wind speed is 7–10 km/h. Leaves and twigs are in constant motion (a light breeze). Wind speeds of 11–14 km/h (moderate breeze) are suitable for spraying if low drift nozzles or higher volume applications (80–120 L/ha per nozzle) are used.

Also avoid spraying when wind speed is <10 km/h when the wind direction is towards the coast and the sun is less than 20 degrees above the horizon. Be aware that drainage winds and morning land breezes do not mix the air the same way as synoptic winds (BoM predicted direction). Drainage winds and land breezes can transport droplets far from the application site.

High temperatures

Avoid spraying when temperatures exceed 28 °C.

Humidity

Avoid spraying when relative humidity is low i.e. when delta T (the difference between wet and dry thermometers; Figure 133) exceeds 10 °C. Avoid spraying when delta T is above 8 °C with a medium spray quality or finer. High humidity extends droplet life and can greatly increase the drift hazard from fine droplets under local surface temperature. This results from an increased life of droplets smaller than 100 microns.

Methods to assess coverage

Water-sensitive paper

Water-sensitive paper (Figure 134) is an effective and economical way to monitor spray distribution. To test coverage, place 6 pieces of water-sensitive paper per plant, locating them on the top, middle and bottom and on the underside and top of the leaf surface, for multiple plants along a row. Generally, 85 fine-medium-sized droplets per square centimetre, with about 15% total surface coverage, should be adequate for most foliar applications. Be prepared to make changes to the sprayer set-up and calibration to compensate for plant height, canopy density and weather conditions throughout the season. Using water-sensitive paper takes some time and effort but is far more accurate than looking over your shoulder and/or on leaf residue.

Folding the water-sensitive paper in half before placing it in the canopy can provide an opportunity to look at upper and lower leaf coverage.

Take photos of the set-up for future reference to see if changes have improved deposition and coverage. With a smartphone, the SnapCard App (https://www.agric.wa.gov.au/grains/snapcard-spray-app) can be used to quantify spray coverage from a water-sensitive spray card.

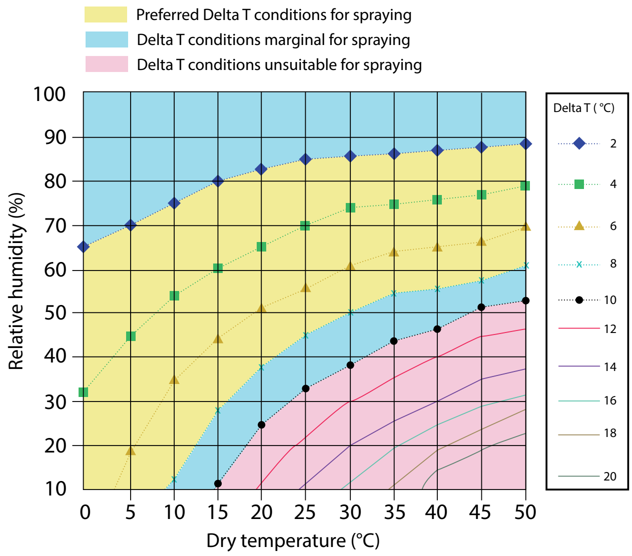

Figure 133. Delta T chart indicating appropriate conditions for spraying.

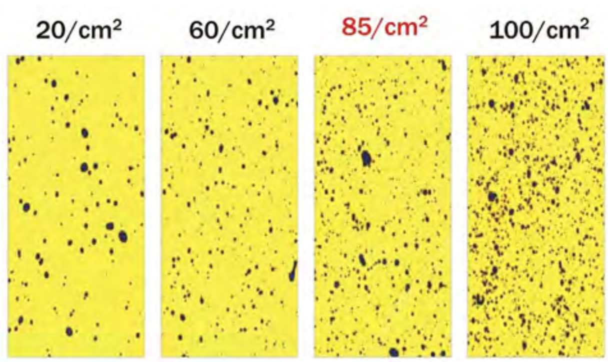

Figure 134. 85 droplets per square centimetre provides the appropriate coverage. Photo: Deveau (2015).

Clay markers

Spraying with clay markers such as kaolin clay shows coverage over the entire canopy as well as in detail. Clay markers are also effective at picking up uneven banding or shading in the canopy as well as excessive run-off (Figure 135).

The clay droplets need to dry to become visible. It is advisable to wait 20 minutes after applying them before carrying out the assessment. If using clay markers, make sure the tank and nozzles are cleaned afterwards as it can clog up nozzles and might deactivate some products in future tanks.

Figure 135. Using clay markers to demonstrate coverage.

UV dyes

There are commercially available, water-soluble, non-toxic fluorescent dyes that can be used to assess where sprays have deposited. The dyes highlight where individual droplets have landed in the crop, or onto the inter-row. To be able to see the individual droplets requires the use of a black light ultraviolet (UV-A) torch or hand-held UV-A lamp that causes the individual droplets to glow in the dark (Figure 136).

Figure 136. Using fluorescent dyes to demonstrate coverage.

Summary

Ensuring the spraying equipment is set up correctly will help reduce the risk of spray drift. Always adjust the spray water volume to match the canopy size and select the right nozzle for the job. Use ribbons to assess sprayer output and adjust the nozzles until the output is directed towards the target area.

If necessary, use a deflector (if using an axial air-blast sprayer) to channel the air into the target rather than over or under the target.

Make sure the travel speed is the most appropriate to get the desired coverage. Fan speed must also be adjusted to produce the most effective air speed so that the chemical is carried to the target. Using the 'ribbon method' is an easy way to assess this. Remember, any changes made to the travel or fan speed might require recalibration of the sprayer volume. Physical barriers can be used to help prevent spray drift and these can be either natural (e.g. a tree line) or artificial (e.g. shade cloth).

Only apply sprays in suitable weather conditions such as when the wind is between 7–10 km/h and away from sensitive areas, the temperature is below 28 °C and Delta T is within the preferred range. Finally, assess the coverage using either water-sensitive paper, clay markers or UV dyes.

References

Celen IH, Arin S and Durgut MR (2008) The effect of the air-blast sprayer speed on the chemical distribution in a vineyard. *Pakistan Journal of Biological Sciences,* 11: 1472–1476, (https://scialert.net/fulltext/?doi=pjbs.2008.1472.1476).

Deveau J (2015) *Air-blast 101 – a handbook of best practices in air-blast spraying*, (http://sprayers101.com/wp-content/uploads/2016/04/43656_OMAFRA_2015_Airblast_101_eBook_a8-FINAL.pdf).

Acknowledgements

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Avoiding chemical resistance

Resistance of a pest or disease to a specific chemical happens when the chemical no longer provides the control it did previously. Repeatedly spraying populations of pests and diseases with a particular chemical can cause resistance. All populations contain very small numbers of individuals that are resistant to a given pesticide. Continuing to use the pesticide will kill susceptible individuals, but it will also select a strain that is increasingly composed of resistant forms. Once the resistant population reaches a critical proportion, the chemical will not be effective.

Managing resistance

Managing resistance to all pesticides is now an important consideration when choosing a control strategy. One strategy is rotating chemical groups so that the weed, fungus, pest or disease is not being repeatedly treated with the same type of chemical.

All registered pesticides have a symbol on the label that identifies the action group to which they belong. This helps growers to choose a product from a different chemical action group when seeking to rotate chemicals in a program. An identification scheme also exists for both herbicides and fungicides.

Product labels incorporate a resistance warning and many include crop-specific instructions relating to the number of applications permitted for use in that crop. Agricultural chemical users must always read the label and any permit before using the product and strictly follow the conditions as directed. Complying with resistance management instructions will help to minimise resistance.

Predatory mites

If two-spotted mite is a problem and predatory mites have not previously been detected in the orchard, or if predatory mites no longer respond to an increase in the pest mites, consider releasing predatory mites.

Insecticides

Unfortunately the berry industry in NSW and Qld relies heavily on the same group of chemicals (1A and 1B), limiting rotation options. However, the option is there and must be used to prevent resistance to the few chemicals that are still available. In the early stages of plant production for pre-flowering and flowering pests, options are limited to a range of 1A products. At later stages of berry development, preference should be given to products that are not in the 1A group and have short WHPs.

A typical scenario could be to spray thrips early with a 1A product at flowering, but avoid foraging bees. Continue monitoring regularly for pests at this critical stage. Another product might be required later during flowering. Then, just before harvest, there is an opportunity to use a different chemical group, e.g. 3A.

Suggestions in the remarks column of the tables in this guide are designed to help growers decide how to rotate their chemical use to avoid resistance.

Research to continually screen the effectiveness of new chemical formulations as they become available should be ongoing. Additionally, this research should also involve identifying ways that these new formulations can be incorporated into the spray program to achieve better integrated pest management (IPM) strategies.

Fungicides

Fungicide resistance arises because most of the newer fungicides are very specific in their effects on fungal cells. In any collection of spores, a very low number will be resistant to a specific fungicide. If the same fungicide is used repeatedly, the resistant spores will not be killed and are likely to multiply, until almost all of the remaining spores are resistant to, and unaffected by, the fungicide. By using a fungicide with a different mode of action, the new strain can be controlled, but damage to the crop is already done.

Avoiding fungicide resistance

Generally, horticultural crops have a variety of fungicides to prevent resistance build-up. Rosalie Daniel, Plant Pathologist with NSW DPI, developed an anthracnose and botrytis control management strategy. In this, she has suggested which products are available to the industry that can be used without causing resistance (Table 80).

Available products to prevent blueberry rust, the industry's main disease concern for interstate market access, are limited. A similar management strategy for blueberry rust that would also comply with Interstate Certification Assurance (ICA31) is in Table 81. Alternative products should be used when market advantages such as ICA are not required.

When a fungus develops resistance to a particular fungicide, it will often also be resistant to related chemicals. Therefore, when selecting a disease control program, always ensure that the chemicals come from different MOA groups (Table 82 and Table 83).

If demethylation inhibitor (DMI) fungicides are used alone, do not use more than 4 applications, then follow with a protective fungicide within 7 days. If more than 4 DMI applications are required, subsequent sprays should be mixed with a protective fungicide that has a different mode of action to the DMIs. Refer to product labels for anti-resistance strategies.

Specific recommendations for avoiding fungicide resistance are now shown on many labels and the chemicals are classified into groups. The main groups shown in Table 82 correspond with those adopted by the agrochemical industry through CropLife Australia (https://www.croplife.org.au/). Only fungicides in this guide are shown.

Table 80. An example anthracnose and botrytis management strategy.

Spray strategy	1st spray (before buds open)	2nd spray (14–28 days after 1st spray)	3rd spray (14–28 days after 2nd spray)	4th spray (14–28 days after 3rd spray)
1	Copper (before fruit set)	Chlorothalonil*	Switch®	Captan
2	Scala®	Chlorothalonil*	Copper	Switch®
3	Chlorothalonil*	Scala®	Captan	Captan
4	Scala®	Copper	Chlorothalonil*	Switch®

* 28-day WHP.

Table 81. An example blueberry rust control strategy. Always read the label.

Spray strategy	1st spray (early, before rust is visible)	2nd spray (14 days after 1st spray)	3rd spray (14 days after 2nd spray)	4th spray (14 days after 3rd spray)
1	Mancozeb	Tilt®	Mancozeb	Pristine®
2	Chlorothalonil*	Mancozeb	Tilt®	Pristine®
3	Mancozeb	Chlorothalonil*	Pristine®	Tilt®
4	Mancozeb	Mancozeb	Pristine®	Tilt®

* Not for ICA31.

Table 82. Fungicide groups[1,2.] Always read the label.

Group	Chemical class	Common name	Example trade name*
1	Benzimidazole	Carbendazim	Spin Flo®
2	Dicarboximide	Iprodione	Rovral®
		Procymidone	Sumisclex®
3	Triazole	Propiconazole	Tilt®
		Difenoconazole	Score®
4	Phenylamide	Metalaxyl	Ridomil®
4 + M1	Phenylamide + inorganic	Metalaxyl + copper hydroxide	Ridomil Gold Plus®
7 + 11	Carboxamides + methoxycarbamates	Boscalid + pyraclastrobin	Pristine®
8	Hydroxypyrimidine	Bupirimate	Nimrod®
9	Anilinopyrimidines	Pyrimethanil	Scala®
9 + 12	Anilinopyrimidines + PhenylPyrroles	Cyprodinil + fludioxonil	Switch®
11	Quinone	Pyroclostrobin	Cabrio
12	Phenylpyrrole	Fludioxonil	Scholar®
33		Phosphoric acid	Agrifos®
33/Y	Ethylphosphonate	Phosphoric acid	Phospot®

Avoiding chemical resistance

Group	Chemical class	Common name	Example trade name*
M1	Inorganic	Copper fungicides	Kocide®
M2	Inorganic	Sulfur as polysulfide	Lime Sulfur
		Sulfur (elemental)	Thiovit®
M3	Dithiocarbamate	Mancozeb	Dithane®
M4	Phthalimide	Captan	Orthocide®
M5	Chloronitrile	Chlorothalonil	Bravo®

Table 83. Insecticide and miticide groups[1,2.] Always read the label.

Group	Chemical class	Common name	Example trade name*
1A	Carbamate	Carbaryl	Bugmaster Flowable®
		Methomyl	Nufarm Methomyl 225 Insecticide
		Pirimicarb	Aphidex®
1B	Organophosphate	Azinphos-methyl	Gusathion®
		Chlorpyrifos	Lorsban®
		Diazinon	Diazol®
		Fenthion	Lebaycid®
		Malathion	Fyfanon®
		Methidathion	Suprathion®
		Omethoate	Folimat®
		Prothiofos	Tokuthion®
		Trichlorfon	Dipterex®
3	Pyrethroid	Alpha-cypermethrin	Fastac Duo®
		Bifenthrin	Talstar®
		Tau-fluvalinate	Mavrik Aquaflow®
4	Neonicotinoid	Imidacloprid	Confidor®
		Thiacloprid	Calypso®
5	Spinosyn	Spinosad	Success 2®
		Spinetoram	Delegate®
6	Avermectin	Abamectin	Vertimec®
7B	Juvenile hormone mimic	Fenoxycarb	Insegar®
9B	Feeding blocker	Pymetrozine	Chess®
10A	Tetrazine	Clofentezine	Apollo®
	Thiazolodine	Hexythiazox	Calibre®
10B		Etoxazole	Paramite®
11	Microbial	*Bacillus thuringiensis*	Dipel®
12B	Organotin	Fenbutatin oxide	Torque®
12C		Propargite	Betamite®
13	Pyrrole compound	Chlorfenapyr	Secure®
16	Thiadiazine	Buprofezin	Applaud®
18	Diacylhydrazine	Methoxyfenozide	Prodigy®
21A	Mite growth inhibitor	Tebufenpyrad	Pyranica®
22A	Oxadiazine	Indoxacarb	Avatar®
28	Diamide	Chlorantraniliprole	Altacor®
UN		Bifenazate	Acramite®

[1] Trade names that include the common name are not listed.
[2] This information shows fungicide and insecticide groups based on the mode of action only. For a chemical's compatibility with IPM, please see the chemical listings for individual crops.
* Example only. Other products registered.
Source: APVMA (https://portal.apvma.gov.au/pubcris) and CropLife Australia (https://www.croplife.org.au/).

Never rely solely on chemicals from one group for whole of season disease and pest control, no matter how effective it seems; use at least 2 chemicals with different modes of action.

Disposing of farm chemicals and their containers

After chemicals have been applied according to the label directions, empty chemical containers and any unused chemicals must be disposed of in an environmentally responsible manner. Containers can be recycled through drumMUSTER (http://www.drummuster.org.au) while chemicals can be disposed of through ChemClear® (http://www.chemclear.org.au).

drumMUSTER

drumMUSTER provides Australian agricultural and veterinary (agvet) chemical users with a recycling pathway for eligible empty agvet chemical containers. Developed with the environment in mind, the drumMUSTER program collects and recycles eligible, clean agvet containers.

Working with local councils and other collection agencies, drumMUSTER has established collection facilities all over Australia. Since its inception in 1998, 35 million containers have been recycled. Once containers are collected, they are recycled into products such as wheelie bins, road signs, fence posts and bollards.

The drumMUSTER service benefits users, the environment, industry and the wider community by providing a reliable, cost-effective and sustainable option for recycling empty, eligible agvet chemical containers.

Disposing of these containers in the right way is crucial to the reputation and sustainability of the agricultural industry in Australia. By using the drumMUSTER recycling program, unwanted containers can be turned into useful, sustainable products rather than having them placed into landfill or building up on farms.

Only containers with 'drumMUSTER eligible container' printed on the label, as a sticker or embossed on the container (Figure 137) are accepted. To contact drumMUSTER, visit the drumMUSTER website (https://www.drummuster.org.au/) or phone 1800 008 707 or 02 6230 6712.

Cleaning containers for collection

When rinsing chemical containers, the personal protective equipment (PPE) specified on the label for applying, mixing or loading the pesticide should be worn. This is because the chemical remaining in a container is the concentrate, which is the most toxic form of the chemical, even though it is diluted during rinsing.

Rinsing is the most effective method while the containers are still moist inside. The longer the residues have to dry and cake on the inside of containers, the more difficult they are to remove. This is the reason for rinsing during mixing and loading because the rinsate can be emptied into the spray or mixing tank of the application equipment. Using the rinsate this way avoids the necessity for having to dispose of the container residues separately.

To **triple rinse** a container up to 20 L to meet drumMUSTER standards:

1. Remove the cap, invert the container and allow it to drip drain into the mixing tank for 30 seconds.
2. Add rinse water to 20% of the container volume (e.g. 1 L per 5 L).
3. Replace the cap and shake vigorously for 1 minute.
4. Remove the cap, invert and drip drain into the mixing tank for 30 seconds.
5. Repeat twice.
6. Rash the cap separately and replace on the container.

Note: triple rinsing is only suitable for small containers, up to 20 L.

Figure 137. A chemical container with a 'drumMUSTER eligible container' printed on the label. Photo: drumMUSTER.

Alternatively, use a pressure nozzle to triple rinse small containers. There are 2 main types of nozzle. One has a rotating spray head, which can be used either to rinse an inverted container in the induction hopper or directly over the tank. The other type has a hardened, pointed shaft to pierce drums and the hollow shaft itself has 4 holes at 90° to spray the water around the container.

To **pressure rinse** a container up to 20 L:

1. Remove the cap, invert the container and allow it to drip drain into the mixing tank for 30 seconds.
2. Ensure clean rinse water is at 35–60 psi pressure.
3. Insert the pressure rinsing probe either into the container opening or through the pierced base of the container (depending on the type of nozzle).
4. Invert the container over the mixing tank and rinse for 30 seconds or longer if the water coming from the container is not clear, moving the probe about to ensure all inner surfaces are rinsed.
5. Wash the cap in clear rinse water.
6. Turn off the water, remove the probe and drip drain the container into the mixing tank for 30 seconds.
7. Replace the lid on the container.

Large containers, e.g. 200 L, are best rinsed with a chemical transfer probe that has a flushing cycle as well as the primary suction cycle. Such probes are standard on many boom sprays, and options on most others. The drums might have to be slightly inclined to ensure all rinsate is removed. Typical rinse time for a 200 L drum would be 3–5 minutes.

Non-rigid containers, i.e. bags and cartons, have to be buried. Plastic bags should be rinsed first, and paper bags punctured or shredded. Cartons also have to be punctured or shredded before burial.

Burning is specifically prohibited.

For more information, visit drumMUSTER (http://www.drummuster.org.au) or call 1800 008 707.

ChemClear®

ChemClear® provides Australian agvet chemical users with a collection and disposal pathway for their unwanted chemicals. ChemClear® complements drumMUSTER by providing agvet chemical users with a recycling and disposal option. Both programs are funded by AgStewardship Australia Limited through a 6 cents per litre levy placed on participating manufacturers' products and passed on to consumers at the point of sale.

ChemClear® collects 2 categories of agvet chemicals:

Group 1 chemicals are those currently registered products manufactured by participating companies signed into the Industry Waste Reduction Agreement. These products are collected free of charge.

Group 2 chemicals are those products manufactured by non-participating companies, or, deregistered, unknown, mixed or out-of-date products (by 2 years). A per litre/kilogram fee for disposal applies.

For more information or to register for the program, visit ChemClear® (http://www.chemclear.org.au) or call 1800 008 182.

Disposing of rinsate or dilute chemical

Labels contain a prohibition on disposing of concentrate on-site or on-farm, as per state environmental legislation. The unused chemical has first to be diluted and, if not applied in terms of the label use pattern, has to be disposed of in an environmentally responsible manner, such as an evaporation pit. This pit should be 1 m deep, lined with plastic sheeting over which has been spread hydrated lime, and any waste covered with at least 0.5 m of soil. Disposal pits are only suited to small volumes and for diluted chemicals. In the case of a concentrate spill, the chemical would have to be diluted to at least standard label rates before transfer to the disposal pit.

Berry grower's resources

Publications

Many publications mentioned in this guide are available from NSW DPI through Shop Regional (https://shop.regional.nsw.gov.au/) or are available free from the NSW DPI website (https://www.dpi.nsw.gov.au/agriculture/horticulture/berries).

Spray Sense provides information on sprayer calibration, testing for residues, storing pesticides, disposal of empty containers, how to read a label and several other topics. Download the Spray Sense leaflet series free from the NSW DPI website (https://www.dpi.nsw.gov.au/agriculture/chemicals/spray-sense-leaflet-series).

The good bug book (https://bugsforbugs.com.au/product/good-bug-book-cd/) is a valuable reference source of the beneficial organisms commercially available for biological control in Australia. It includes illustrations of many beneficials as well as tables of information on their susceptibility to pesticides.

Childers NF (2006) *Blueberries for growers, gardeners, and promoters,* Norman F Childers Horticultural Publications. This edition is good background reading for growers and plant propagators, covering topics on production trends in North America, varietal breeding and propagation techniques.

Funt RC and Hall HK (2013) *Raspberries: crop production science in horticulture*, CABI, Cambridge, UK. A very useful book for raspberry growers. The book covers topics such as propagation, soil and water management, pest and disease management and production.

Funt RC and Hall HK (2017) *Blackberries and their hybrids: crop production science in horticulture*, CABI Cambridge, UK. A very useful book for growers of blackberries and their hybrids, covering topics such as growth and development, plant nutrition and pest and disease management.

Retamales JB and Hancock JF (2012) *Blueberries: crop production science in horticulture*, CABI Cambridge, UK. This is a very useful book for growers of highbush and Rabbiteye varieties. It includes topics from production, nutrition, growth, pests and harvesting.

Schilder A and Isaacs R (2004) *A pocket guide to IPM scouting in highbush blueberries*, Michigan State University, Bulletin E2928. This guide is excellent for identifying some diseases and nutritional problems in blueberries. However, as it is an overseas publication, it does not include many of the pests and diseases we have here in Australia.

Internet sites

Agricultural industry organisations

Berries Australia (https://berries.net.au/)

Horticulture Industry Network (https://www.hin.com.au/)

Horticulture Innovation Australia Limited (https://www.horticulture.com.au/)

International Blueberry Organisation (https://www.internationalblueberry.org/)

National Farmers Federation (https://nff.org.au/)

NSW Farmers Association (https://www.nswfarmers.org.au/)

State government

Agriculture Victoria (https://agriculture.vic.gov.au/)

Climate Research Strategy for Primary Industries (https://crspi.com.au/)

Department of Natural Resources and Environment Tasmania (https://nre.tas.gov.au/)

Department of Primary Industries and Regional Development, Western Australia (https://www.wa.gov.au/organisation/department-of-primary-industries-and-regional-development)

Department of Primary Industries and Regions, South Australia (https://pir.sa.gov.au/)

NSW Department of Primary Industries (https://www.dpi.nsw.gov.au/)

NSW Local Land Services (https://www.lls.nsw.gov.au/)

Queensland Department of Agriculture and Fisheries (https://www.daf.qld.gov.au/)

SafeWork NSW (https://www.safework.nsw.gov.au/)

Water NSW (https://www.waternsw.com.au/)

Rural assistance

Centrelink (https://www.servicesaustralia.gov.au/centrelink?context=1)

NSW Health (https://www.health.nsw.gov.au/)

NSW Rural Assistance Authority (https://www.raa.nsw.gov.au/)

Federal government

Australian Pesticides and Veterinary Medicines Authority (https://apvma.gov.au/)

Australian Trade Commission (https://www.austrade.gov.au/)

Department of Agriculture, Fisheries and Forestry (https://www.agriculture.gov.au/)

Environment, land and water (https://www.nsw.gov.au/environment-land-and-water)

Plant Health Australia (https://www.planthealthaustralia.com.au/)

Climate

Bureau of Meteorology (http://www.bom.gov.au/)

The Long Paddock (https://www.longpaddock.qld.gov.au/)

Environment

Department of Climate Change, Energy, the Environment and Water (https://www.dcceew.gov.au/)

Department of Energy, Environment and Climate Action (https://www.deeca.vic.gov.au/)

Environment Protection Authority NSW (https://www.epa.nsw.gov.au/)

Environment Protection Authority Victoria (https://www.epa.vic.gov.au/)

NSW Environment and Heritage (https://www.environment.nsw.gov.au/)

Alternative systems (organics)

Australian Organic Limited (AOL) (https://austorganic.com/)

Organic Federation of Australia (https://organicindustries.org.au/OFA)

Economic information

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) (https://www.agriculture.gov.au/abares)

Australian Bureau of Statistics (https://www.abs.gov.au/)

Market price information

Sydney Produce Surveyors (https://sydprod.com.au/)

Technical production information

Commonwealth Scientific and Industrial Research Organisation (CSIRO) (https://www.csiro.au/)

Fall Creek Nursery (https://www.fallcreeknursery.com/)

Fruit and Nut Research and Information, University of California (https://fruitsandnuts.ucdavis.edu/)

Michigan State University Extension Services (https://www.canr.msu.edu/outreach/)

New Zealand Ministry for Primary Industries (https://www.mpi.govt.nz/)

North Carolina State University Extension Services (https://blueberries.ces.ncsu.edu/)

South Australia Research and Development Institute (https://pir.sa.gov.au/research)

United Kingdom Department for Environment, Food and Rural Affairs (https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs)

United States Department of Agriculture (USDA) (https://www.usda.gov/)

University of Florida IFAS Extension (https://edis.ifas.ufl.edu/)

Integrated pest management

Australasian Biological Control Association Inc (http://www.goodbugs.org.au/index.html)

Biological Services (https://www.biologicalservices.com.au/)

BioResources (https://bioresources.com.au/)

Bug Central (https://www.bugcentral.com.au/)

Bugs for Bugs (https://bugsforbugs.com.au/)

IPM Technologies (https://ipmtechnologies.com.au/)

Quality assurance

Freshcare Australia (https://www.freshcare.com.au/)

Harmonised Australian Retailer Produce Scheme (https://harpsonline.com.au/)

Berry marketing agents

Driscoll's Australia Pty Ltd (https://www.driscolls.com.au/) phone 07 5478 8871

Fresh Produce Group (https://fpg.com.au/) phone 02 9704 8300

Mountain Blue (https://www.mountainblue.com.au/marketing)

Perfection Fresh Australia Pty Ltd (https://www.perfection.com.au/home) phone 02 9763 1877

YV Fresh Australia Pty Ltd (https://www.yvfresh.com.au/) phone 03 9737 9534

Blueberry nurseries

CleanGROW (https://cleangrow-au.myshopify.com/)
60 Rookery Road Winkleigh TAS 7275, phone Karen Brock 03 6394 4807, 0439 972 793

Moondarra Blueberries (https://www.moonblue.com.au/)
20 Brown Road Moondarra VIC 3825, phone 03 5165 3238

Mountain Blue (https://www.mountainblue.com.au/)
Bruxner Highway Wollongbar NSW 2477, phone 02 6624 8258

Tarra Valley Nursery (https://www.taravalleynursery.com/)
348 California Creek Road Cornubia QLD 4130, phone 07 3287 6139

Raspberry and blackberry nurseries

Berry Plant Micropropagation
325 Eacotts Road Hoddles Creek VIC 3139, contact Ryan Brightwell 0429 384 577,
email (ryan@berryplants.com.au)

CleanGROW (https://cleangrow-au.myshopify.com/)
460 Rookery Road Winkleigh TAS 7275, contact Karen Brock 03 6394 4807, 0439 972 793

Humphris Nurseries (http://humphris.com.au/)
218–220 Cardigan Road Mooroolbark VIC 3138, contact James Edge 03 9761 9688, 0438 310 938 or email (james@humphris.com.au)

Mansfield's Propagation Nursery (https://mansfields.net.au/)
150 Taylors Road Skye VIC 3977, contact Daniel Mansfield 03 9782 2404 or email (daniel@mansfields.net.au)

Ramm Botanicals (https://www.ramm.com.au/)
255 Pacific Highway Kangy Angy NSW 2258, contact Ryan Webber 02 4351 2099 or email (ryan.webber@ramm.com.au)

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NSW Local Land Services (Horticulture)

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

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

NSW DPI Biosecurity and Food Safety

NSW DPI Biosecurity and Food Safety is the contact point in this state for anyone who requires advice on intrastate or interstate movement of fruit or plants and other biosecurity-related issues. All enquiries should be directed via Plant Health Australia's Domestic Quarantine Line 1800 084 881. This phone number will connect you with an automated system to allow you to choose the state or territory relevant to your report or enquiry.

EXOTIC PLANT PEST HOTLINE
1800 084 881

Seasonal Conditions Monitoring Program

State Seasonal Update: Conditions and Outlook

The **State Seasonal Update** is produced monthly and is the official point of reference of seasonal conditions across NSW for producers, government, stakeholders and the public.

Combined Drought Indicator: Latest NSW Drought Maps

Is an interactive tool that provides a snapshot of current seasonal conditions for NSW, factoring in rainfall, soil moisture and pasture/crop growth indices.

Seasonal Conditions Information Portal

Uses technology that allows fast, stable transfer of data and information direct from the EDIS system to your computer. The portal contains several downloadable features from the **NSW Combined Drought Indicator.**

Farm Tracker Mobile Application

Farm Tracker is a tool you can use to record seasonal conditions. You can:

1. Complete a simple crop, pasture or animal survey
2. Keep and manage a photo diary of your farm
3. Monitor the same paddock over many years

Have your say

Complete this survey and tell us what is important to you as DPI continues to improve our Seasonal Conditions monitoring program. Eg. improved local accuracy of data and climate networks, better ways of communicating, or strengthening linkages to drought management and relief measures.

Department of Primary Industries
www.dpi.nsw.gov.au

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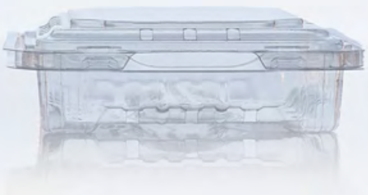

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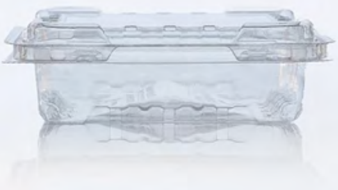

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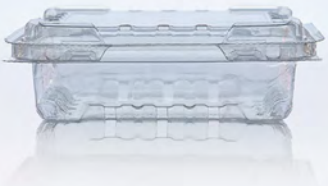

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Fully committed to sustainable practices, Multisteps creates 100% recyclable packaging solutions and is at the forefront of the development and implementation of innovative bio plastics that are increasingly environmentally friendly.

Working with our customers and production managers closely to develop customised packaging solutions, Multisteps delivers exceptional experience over every step of the journey.

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Flush insect pests from your crop... Naturally

For low residue, high impact control of a range of insect pests in over 90 crops

- Naturally grown pyrethrum active ingredient
- Application up to and including the day of harvest*
- Broad label with wide range of uses
- Low user toxicity
- Low environmental persistence and totally biodegradable
- Insect flushing effect for cleaner produce
- 15 min re-entry

** PyGanic has zero withholding period for many crops and 1 day for others.*

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