Carrots

Strategic Agrichemical Review Process (SARP)

December 2019

Hort Innovation
Project – VG18004

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VG18004 – Vegetable Strategic Agrichemical Review Process (SARP) Report Updates

SARP Service Provider:
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Purpose of the report:
This report was funded by Hort Innovation to investigate the pest problem, agrichemical usage and pest management alternatives for the carrot industry across Australia. The information in this report will assist the industry with its agrichemical selection and usage into the future.

Date of report:
December 2019

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Hort Innovation Strategic levy investment | VEGETABLE FUND

This project has been funded by Hort Innovation using the vegetable research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

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1. Summary

The strategic levy investment project Vegetable Industry SARP Report Updates (VG18004) is part of the Hort Innovation Vegetable Fund. A Strategic Agrichemical Review Process (SARP), through the process of a desktop audit and industry liaison;

(i) Assesses the importance of the diseases, insects and weeds (plant pests) that can affect a horticultural industry;

(ii) Evaluates the availability and effectiveness of fungicides, insecticides and herbicides (pesticides) to control the plant pests;

(iii) Determines any gaps in the pest control strategy and

(iv) Identifies suitable new or alternatives pesticides to address the gaps.

Alternative pesticides should ideally be selected for benefits of:

- Integrated Pest Management (IPM) compatibility
- Improved scope for resistance management
- Sound biological profile
- Residue and trade acceptance domestically and for export

The results of this process will provide the carrot industry with sound pesticide usage for the future that the industry can pursue for registration with the manufacturer, or minor-use permits with the Australian Pesticide and Veterinary Medicines Authority (APVMA).

1.1 Diseases

The high priority disease is:

Common name	Scientific name
Cavity spot	*Pythium* spp*. Pythium sulcatium, Pythium violae*

1.2 Insects and nematodes

The moderate priority insect and nematodes of carrots are:

Common name	Scientific name
Carrot aphid, Carrot willow aphid	*Cavariella aegopodii*
Green Peach Aphid	*Myzus persicae*
Cutworms	*Agrotis spp.*
Redlegged earth mite	*Halotydeus destructor*
Rutherglen bug	*Nysius vinitor*
Root-Knot Nematodes	*Meloidogyne spp.*

1.3 Weeds

The high priority weed is:

Common Name	Scientific Name
Annual ryegrass (Resistance - predominantly Group A)	*Lolium rigidum*

2. The Australian Carrot Industry

The Australian carrot industry is a major horticultural industry. Australia is a net exporter of carrots, with the majority of carrots produced in Western Australia.

Carrots are grown in most states of Australia. The major carrot production areas are Gingin and Preston in Western Australia; the Riverland region of South Australia; East Gippsland in Victoria; and Forth in Tasmania.

The Global Trade Atlas groups trade data for carrots and turnips together. For the year ending in June 2018, Australia produced 330,655 tonnes of carrots and turnips collectively. Of this:

- 61% was sent to fresh market
- 33% was sent for fresh export
- 6% was sent for processing

For the year ending in June 2018:

- Australia exported 108,175 tonnes of carrots and turnips
- The value of production was $215.7m

The major growing period of carrots is from March to August. Due to Australia's diverse weather conditions and the introduction of different varieties of varieties, the Australian industry is now able to supply the domestic market with fresh carrots throughout the year.

Fresh Carrot Seasonality by State

State	17/18 Tonnes	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
New South Wales	6,334												
Victoria	57,890												
Queensland	33,937												
Western Australia	127,680												
South Australia	50,621												
Tasmania	54,192												
Availability legend			High			Medium			Low			None	

Hort Innovation (2019). Australian Horticulture Statistics Handbook 2017/18. [online] Available at: https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/australian-horticulture-statistics-handbook/

3. Introduction

3.1 Background

Growers of some horticultural crops suffer from a lack of legal access to crop protection products (pesticides). The problem may be that whilst a relatively small crop area is valuable in an agricultural sense, it may not be of sufficient size for Agrichemical companies to justify the expense of registering a product use on that crop. Alternately, the disease, pest, or weed problem may be regional or spasmodic, making Agrichemical companies unwilling to bear the initial high cost of registering suitable pesticides.

Growers may face severe losses from diseases, pests and weeds due to a lack of registered or approved (via a permit) chemical control tools.

Environmental concerns, consumer demands, and public opinion are also significant influences in the marketplace related to pest management practices. Industry IPM practitioners must strive to implement best management practices and tools to incorporate a pest management regime where strategies work in harmony with each other to achieve the desired effects while posing the least risks.

In combination with cultural practices, pesticides are important tools in Carrot production and respective IPM programs. They control the various diseases, insects and weeds that affect the crop and can cause severe economic loss in modern high intensity growing operations. Pesticides are utilised during establishment and development, and to maximise quality and customer appeal.

As a consequence of the issues facing the Carrot industry regarding pesticide access, Hort Innovation undertook a review of the pesticide requirements via a Strategic Agrichemical Review Process (SARP) in 2014. The current project is to update the SARP with the latest information and progress.

The SARP process identifies diseases, insect pests and weeds of major concern to the Carrot industry. Against these threats, available registered or permitted pesticides are evaluated for overall suitability in terms of IPM, resistance, efficacy, trade, human safety and environmental issues. Where tools are unavailable or unsuitable the process aims to identify potential future solutions. Potential new risks to the industry are also identified.

The results will provide the Carrot industry with a clear outlook of gaps in existing pest control options. This report is not a comprehensive assessment of ALL pests and control methods used in Carrots but attempts to prioritise the major problems.

Exotic plant pests, not present in Australia, are not addressed in this document. A biosecurity plan has been developed for the Vegetable Industry in consultation with industry, government and scientists. The Biosecurity Plan for the Vegetable Industry which covers Carrots outlines key threats to the industry, risk mitigation plans, identification and categorisation of exotic pests and contingency plans. High priority exotic pests have been assessed based on their potential to enter, establish, and spread in Australia (e.g. environmental factors, host range, vectors) and the cost to industry of control measures.

https://ausveg.com.au/app/uploads/2018/06/Industry-Biosecurity-Plan-for-the-Vegetable-Industry.pdf

3.2 Minor use permits and registration

From a pesticide access perspective, the APVMA classifies carrots as a major crop. The crop fits within the APVMA crop group VR0075: Root and tuber vegetables, within the subgroup VR0577: Carrot. Therefore, access to minor use permits can be relatively difficult. Possible justification for future permit applications could be based on:

- New disease, insect or weed identified as a cropping issue
- No pesticide approved for the problem
- Insufficient options for resistance management
- Current pesticides ineffective due to resistance
- Trade risk - current pesticides unsuitable where crop commodities will be exported
- IPM, environment or OH&S issues
- Loss of pesticides due to removal from market or chemical review restrictions
- Opportunity to extrapolate a use pattern when a new, effective pesticide is registered in another crop
- Alternate pesticide has overseas registration or minor use permit
- Market failure – insufficient return on investment for registrant.

With each of these options, sound, scientific argument is required to justify any new permit applications. Another option for the carrot industry is for manufacturers to register new pesticides uses in the crop.

3.3 Methods

The current update of the Carrot Strategic Agrichemical Review Process (SARP), which was last updated in 2014, was conducted by desktop audit using industry information gathered during 2011-2014 under MT10029 – Managing pesticide access in horticulture and finalised under VG12081 - Review of vegetable SARP reports. The process included gathering, collating and confirming information:

Hort Innovation Project Reference	Process of Review - Activity
VG16060 - Vegetable Agrichemical Pest Management Needs and Priorities (AUSVEG) - Commenced: 2 May 2017	Engagement and consultation with growers and other relevant stakeholders. Including; Online crop specific surveys, workshops and one on one consultation Nationally. Collation of information collected by commodity on applicable pests, diseases and weeds in order of priority.
MT17019 – Regulatory Support & Co-ordination (AKC)	**Carrot Agrichemical Regulatory Risk Assessment Document** To assist strategic planning, with respect to future pest management options, this document was developed as part of the Hort Innovation funded project MT17019 to highlight the regulatory threats to agrichemicals currently approved for the management of the pests and diseases in Carrot as well as current initiatives aimed at addressing identified pest management deficiencies.
VG18004 – Vegetable Strategic Agrichemical Review Process (SARP) Report Updates	**SARP updated via a desktop audit:** • Review list of priorities ranked as high, moderate and low for each plant pest groups (disease, insects and weeds) – provided by VG16060 • Identify industries pest priority gaps in order of importance • Update current pesticides available via label registrations or minor use permits • Update available pesticide use patterns, IPM ranking/compatibility, mode of action and chemical group. • Identify pesticides at risk (under review and/or limited uses) via MT17019 Regulatory Support & Co-ordination – AKC consulting. • Identify any appropriate solutions through the outcomes of the AgChem Forum's or similar market intelligence and their overall suitability (IPM compatibility, Chemical group to manage resistance, risk profile, existing domestic MRL's or global MRL's including any potential trade barriers, efficacy, OH&S, environmental safety and sustainability). • Include known pesticide solutions that are currently under development with registrants for new uses in the nominated crops or in current Hort Innovation projects. • Update MRL tables to include Australian MRL's, Codex and any applicable export market MRL's

3.4 Results and discussions

3.4.1 Detail

Results and discussions are presented in the body of this document.

3.4.2 Appendices

Refer to additional information in the appendices:

Appendix 1. Products available for disease control in Carrot vegetables
Appendix 2. Products available for control of insects and mites in Carrot vegetables
Appendix 3. Products available for weed control in Carrot vegetables
Appendix 4. Current permits for use in Carrot vegetables
Appendix 5. Carrot Maximum Residue Limits (MRLs)
Appendix 6. Carrot regulatory risk assessment

4. Diseases, pests and weeds of carrots

Resistance management: To manage the risk of resistance development, integrated disease/pest/weed management (IDM/IPM/IWM) strategies should be adopted. The general principle is to integrate diverse chemical and non-chemical strategies; maximise efficacy; not rely on singular tools and rotate between different modes of action. It is always essential to follow all the label instructions. Specific resistance management strategies may apply. These can be found, along with other useful information, on the CropLife Australia website. https://www.croplife.org.au/resources/programs/resistance-management/

Information on regulatory risk derived from project MT17019 (Chapter 4) - Regulatory support and coordination (Appendix 6) has been incorporated.

Some of the suggested options have no overseas MRLs (see Appendix 5). If treated fruit is to be exported nil residues at harvest would be needed for these options.

While care has been taken to ensure the accuracy of the information provided in this document the APVMA registered label and where relevant the APVMA approved permit must always be followed.

4.1 Diseases of carrot

4.1.1 Disease priorities

Common name	Scientific name
High	
Cavity spot	*Pythium sulcatium, Pythium violae*
Moderate	
Bacterial leaf blight	*Xanthomonas hortorum pv. carotae*
Bacterial soft rot	*Erwinia spp., Pectobacterium spp.*
Powdery mildew	*Erysiphe heraclei*
Sclerotinia rot / White mould	*Sclerotinia sclerotiorum, S. minor, S. rolfsii*
Low	
Alternaria leaf spot	*Alternaria dauci*
Black root rot	*Thielaviopsis basicola, Chalaropsis thielavioides*
Carrot Black rot	*Alternaria radicina*
Cercospora Leaf spot	*Cercospora carotae*
Crater rot	*Rhizoctonia carotae*
Crown rot	*Fusarium spp., Rhizoctonia spp*
Damping off	*Rhizoctonia spp. Pythium spp.*
Liquorice rot	*Mycocentrospora acerina*
Root rot complex	*Phytophthora spp., Pythium spp.*

The most important disease issue based on the feedback received was Cavity spot (forking) which can affect product quality. This issue received a low priority in the previous SARP (2014). The main factors affecting cavity spot development are soil temperature, soil pH and soil moisture. Cavity spot can be minimised by using an integrated control program based on tolerant varieties, rotation, liming, scheduled harvesting and metalaxyl application. https://www.horticulture.com.au/globalassets/hort-innovation/resource-assets/vg15010-pythium-in-carrots-fact-sheet.pdf & https://www.agric.wa.gov.au/carrots/cavity-spot-disease-carrots?page=0%2C1

Bacterial soft rots are caused by several bacteria, most commonly *Pectobacterium* spp. *Erwinia* spp. and certain species of *Pseudomonas, Bacillus* and *Clostridium*. These bacteria can enter plants through wounds caused by tools, insects, severe weather such as hail, or through natural openings. The bacteria can be spread from plant to plant by insects, on contaminated tools, or by movement of infested plant debris, soil, or contaminated water. Bacterial soft rots tend to be more of a problem during wet weather and has shown to be more severe when plants lack sufficient calcium.

Once soft rot bacteria have infected plant tissue, there are no treatments. Immediately remove and discard infected plants or plant parts. Use soft rot-resistant vegetables in rotation with susceptible vegetables. Corn, snap beans and beets are vegetables that are not considered susceptible to soft rot.

Some organisms such as Corky crown rot and smooth crown rot (*Streptomyces* species, *Fusarium* species, *Rhizoctonia*, or *Sclerotinia*) and Tiger stripe or ring rot (*Phytophthora* species) have been mentioned in Tasmania but they are not ranked nationally. The causal organisms may be carried on cutting knives or on residue in produce bins. Therefore, good farm hygiene is also important in preventing such occurrences.

Some of the fungal and bacterial diseases that have received moderate to low priority have few options to suppress or control but should be supplemented by management practices that would increase airflow and minimise moisture in the plant canopy. Soil fumigation also helps in preventing some diseases such as Cavity spot and Damping off in carrots.

Management methods that promote clean seeds and transplant material, early detection and disposal of infected seedlings would keep most of these diseases in check whilst eliminating alternative hosts, crop rotation, cover crops and farm hygiene are also important to prevent spread of these between sites. Taking precautions to prevent spread of disease from nursery to field would also help in this effort.

In controlling fungal and bacterial diseases, the industry should be mindful of resistance management. CropLife Australia has a resistance management strategy and users must refer to it before using any product; http://www.croplife.org.au/industry-stewardship/resistance-management
CropLife Australia recommends that in the absence of a specific resistance management strategy the use of fungicides from a specific mode of action be limited to a maximum of one-third of the total. The number of consecutive applications of the same group should also be limited by rotating/alternating between products from different activity groups. An exception is the use of Group M fungicides as they have a low risk of resistance development. https://www.croplife.org.au/resources/programs/resistance-management/fungicide-resistance-management-strategies1/fungicide-resistance-management-strategies1-draft/

4.1.2 Available and potential products for priority diseases

TABLE KEY: Note that blank fields in the table indicate no information has been provided.

Availability		Regulatory risk (refer to Appendix 6)	
A	Available via either registration or permit approval	R1	Short-term: Critical concern over retaining access
P	Potential - a possible candidate to pursue for registration or permit	R2	Medium-term: Maintaining access of significant concern
P-A	Potential, already approved in the crop for another use	R3	Long-term: Potential issues associated with use - Monitoring required

Withholding Period (WHP) – Number of days from last treatment to harvest (H) or Grazing (G)			
Harvest	H	Not Required when used as directed	NR
Grazing	G	No Grazing Permitted	NG

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Cavity spot / forking (*Pythium sulcatium, Pythium violae*) **Priority: High**							
Cavity spot has been ranked High in all States except SA where it received a Moderate ranking. In 2014 it received a low ranking. It is a problem mainly in Summer and Autumn harvested crops. Widespread across most varieties and developing resistance is always a concern. Loss due to the disease is said to be around 20%. Whilst fungicide control options available are limited, varietal tolerances also vary.							
Chloropicrin (Tripicrin)	8A	General pre-plant soil fumigation	NR	A	ALL	It is registered as a general fumigant to control Nematodes, insects, ***Pythium,*** *Phytophthora, Fusarium, and Verticillium.* Do not plant for 10 d after soil treatment.	-
Metalaxyl (Barmac)	4	Protective and curative	NR	A	ALL	Registered in carrots for control of ***Pythium*** **spp** and *Phytophthora* spp. Apply dry granules in a 30 cm wide band at planting or early seedling stages. Rainfall or irrigation is required after application for incorporating to soil. [Max no. of applications not specified]	-

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Metham sodium (Imtrade)	-	Soil fumigant	-	A	NSW, Qld, SA, Vic and WA	Registered for pre-planting soil treatment to control soil borne fungal diseases in Food crops.	-
Streptomyces lydicus WYEC108 (Actinovate)	-	Protective Biofungicide	NR	A	ALL	Actinovate is a biological fungicide that helps supress the effects of root rot and damping-off fungi and certain foliar fungal pathogens when used as part of a total health management program. Registered in vegetables as a seed treatment for *Fusarium, Rhizoctonia and* ***Pythium*** Management. Registered in all crops as a soil drench as a biological soil amendment to supplement the activity of natural soil organisms by making nutrients more available for improved plant growth. Registered in carrots for control of Powdery mildew. Apply prior to onset of disease season. [Max. no. of applications and retreatment interval not specified].	-
Cyazofamid (Ranman) ISK	21	Systemic and protective		P		Registered for use on turf for control of ***Pythium*** **spp.** Registered in USA (ISK) for control of cavity spot caused by *Pythium* spp.	
Fluopicolide (Presidio) Valent	43	Systemic and protective		P		Not registered in Australia although the active is approved. Registered in USA (Valent) for control of cavity spot caused by ***Pythium*** spp. in carrots. Bayer has product (Infinito with Fluopicolide + Propamocarb) registered for control of Downy mildew in Brassica, bulb vegetables, cucurbits, leafy vegetables and lettuce and Phytophthora in potatoes.	
Fludioxonil + Sedaxane (Vibrance Premium) Syngenta	7+12	Systemic and protective		P		Registered as a seed treatment as a pre-plant application and pre-storage application for control of Black scurf (Rhizoctonia), Silver scurf, Black rot, Gangrene, Fusarium dry rot and suppression of common scab in potatoes. Hort Innovation is undertaking data generation project (ST17000) for a label registration for Rhizoctonia in beetroot.	
Metalaxyl + Azoxystrobin (Uniform) Syngenta	11+4	Preventative and systemic		P		Registered in Barley for control of ***Pythium*** **spp.** and *Rhizoctonia solani*. Hort Innovation is undertaking studies in beetroot for control of damping-off as a direct spray at planting.	

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Thiophanate-methyl + Etridiazole (Banrot)	1+14	Systemic		P		Registered in container grown ornamentals and in ground bedding plants as a post plant soil drench for control of ***Pythium***, *Phytophthora, Rhizoctonia* and *Thielaviopsis.*	
Bacterial leaf blight (*Xanthomonas hortorum pv. Carotae*) **Priority: Moderate**							
Bacterial leaf blight has not been identified as a priority disease in the industry survey, however other industry sources indicate that it is a significant disease in carrots. The bacterium is seed borne, but spreads through irrigation water and runoff as well as carried on machinery and by insects. The bacterium can survive in the soil on crop residues but has a limited host range, so crop rotation is an important control strategy.							
Copper-Cupric hydroxide (Champ)	M1	Protective and curative	1	A	ALL	Registered in carrots for the control of **bacterial leaf spots** and other fungal and bacterial diseases in many crops. Apply at first signs of infection. [Max no. of applications not specified; re-treatment interval 10-14 d]	-
Bacillus amyloliquefaciens (Serenade Opti & Serifel) Bayer & BASF	44	Protective Biofungicide		P	ALL	Registered for control Botrytis in strawberries and grapes, suppression of bacterial spot in tomato, chili and capsicum and control of anthracnose and suppression of stem end rot in tropical fruits. Registered in US for control of Botrytis, Sclerotinia, **Xanthomonas** and Erwinia in grapes, strawberries, pome fruits, tree nuts, leafy vegetables and potatoes.	
Bacterial Soft rot (*Erwinia* spp., *Pectobacterium* spp.) **Priority: Moderate**							
Bacterial root rot has not been identified as a priority disease in the survey, however other industry sources indicate that it is a significant disease in carrots. In order to prevent spread, farm hygiene is important and crop residues after harvest need to be destroyed. Copper products may control these causal organisms.							
Copper-Cupric hydroxide (Champ)	M1	Protective and curative	1	A	ALL	Registered in carrots for the control of **bacterial spots,** canker and other fungal and bacterial diseases in many crops. Apply at first signs of infection. [Max no. of applications not specified; re-treatment interval 10-14 d]	-
Bacillus amyloliquefaciens (Serenade Opti & Serifel) Bayer & BASF	44	Protective Biofungicide		P	ALL	Registered for control Botrytis in strawberries and grapes, suppression of bacterial spot in tomato, chili and capsicum and control of anthracnose and suppression of stem end rot in tropical fruits. Registered in US for control of Botrytis, Sclerotinia, Xanthomonas and Erwina in grapes, strawberries, pome fruits, tree nuts, leafy vegetables and potatoes.	

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Powdery mildew (*Erysiphe heraclei*) **Priority: Moderate**							
Powdery mildew is a moderate priority for respondents in the current update. Frequently attacks seedlings; Management techniques may include cultural practices that increase airflow and minimise moisture in the plant canopy. Developing resistance due to overuse and heavy reliance of fungicides is always a concern.							
Azoxystrobin (EuroChem)	11	Protective and curative	21	A	ALL	Registered in carrots for the control of **Powdery mildew**. [Max 3 applications per crop, 2 consecutive; re-treatment interval 10-14 d]	-
Azoxystrobin+ difenoconazole (Amistar Top)	3+11	Protective and curative	7	A	ALL	Registered in carrots for control of **Powdery mildew**. [Max. 3 applications per year; retreatment interval 10-14 d; subject to Crop Life resistance management strategy].	R3
Penthiopyrad (Fontelis)	7	Protectant	7	A	ALL	Registered in carrots for control of **Powdery mildew** and *Alternaria* spp. [Max. 2 sequential applications per crop; retreatment interval 7-14 d; subject to Crop Life resistance management strategy].	-
Streptomyces lydicus WYEC108 (Actinovate)	-	Protective Biofungicide	NR	A	ALL	Registered in carrots for control of **Powdery mildew**. Apply prior to onset of disease season. [Max. no. of applications and retreatment interval not specified].	-
Sulphur (Solo)	M2	Contact	NR	A	Variable -refer to label	Registered in vegetables for control of **Powdery mildew**. Apply when disease is first seen [Max. no. of applications not specified; retreatment interval 7-21 d].	-
Tebuconazole (Folicur 430SC) PER82461	3	Protective and curative	21	A	NSW, SA and Tas only	PER82461 for suppression of **Powdery mildew** in carrots. [Max 2 applications per Crop; re-treatment interval 7-10 d].	R3
Cyflufenamid (flute)	U6	Protective and curative		P		Registered for control of **powdery mildew** in grapevines and cucurbits. PER80670 for control of powdery mildew in strawberry runners.	

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Fluopyram + Tebuconazole (Luna Experience) Bayer	3+7	Protective		P		Registered overseas as Luna Experience. The US label is for use in almond, Brassica leafy vegetables, legume vegetables, melons and various fruit crops for control of a variety of diseases including **powdery mildew**, Alternaria leaf spot, gummy stem blight, Septoria, Botrytis, Cladosporium, Cercospora, Sclerotinia and anthracnose and suppression of Rhizoctonia. Australian registration in various crops are progressing.	R3
Fluopyram + Trifloxystrobin (Luna Sensation) Bayer	7+11	Protective		P		Registered for control of **powdery mildew**, black spot and Alternaria in apples.	
Pyriofenone (Kusabi)	50	Systemic		P		Registered for control of **powdery mildew** in cucurbits.	
Sclerotinia rot / White mould (*Sclerotinia sclerotiorum, Sclerotinia minor, S. rolfsii*) **Priority: Moderate**							
Sclerotinia rot was ranked as high priority in VIC and QLD and as a moderate priority in the WA, SA and TAS. It is a problem in most vegetable crops in Tasmania. Developing resistance due to overuse and heavy reliance of fungicides is always a concern.							
Azoxystrobin (EuroChem)	11	Protective and curative	21	A	ALL	Registered in carrots for the control of **Sclerotinia rot**. [Max 3 applications per crop, 2 consecutive; re-treatment interval 10-14 d]	-
Boscalid (Filan)	7	Systemic	7	A	ALL	Registered in Root and tuber vegetables for the control of **Sclerotinia rot**. [Max 4 applications per crop; re-treatment interval 7-14 d; subject to CropLife resistant management strategy]	-
Azoxystrobin + difenconazole (Amistar Top)	3+11	Protective and curative		P-A		Registered in carrots for control of **powdery mildew**. Hort Innovation project (ST 17000) for data generation for a label extension with Syngenta is underway and trials are due for completion at the end of 2020.	R3
Azoxystrobin + Oxathiapiprolin (Orondis Flexi) Syngenta	11+4 +9	Protective		P		Registered in bulb vegetables, Brassica vegetables, cucurbits, lettuce and leafy vegetables for control of **Sclerotinia**.	-

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Bacillus amyloliquefaciens (Serenade Opti & Serifel) Bayer & BASF	44	Protective Biofungicide		P		Registered for control Botrytis in strawberries and grapes, suppression of bacterial spot in tomato, chili and capsicum and control of anthracnose and suppression of stem end rot in tropical fruits. Registered in US for control of **Sclerotinia** in carrots.	-
Cyprodinil + fludioxonil (Switch)	9+12	Protective and systemic		P		Registered in several vegetable crops including peas, beans, leafy vegetables and lettuce for control of **Sclerotinia,** Botrytis and other diseases. Registered in the UK for use in carrots against Sclerotinia and Alternaria. GAP of 3 x 0.8 kg/ha with a 7 day WHP	-
Fluazinam	29	Protective		P		Registered in brassica vegetables in Australia for club root. Registered in the US for **Sclerotinia** and Alternaria control in carrots with a GAP of 4 x 0.58 kg ai/ha with a 7-day WHP.	-
Fluopyram + Tebuconazole (Luna Experience) Bayer	3+7	Protective		P		Registered overseas as Luna Experience. The US label is for use in almond, Brassica leafy vegetables, legume vegetables, melons and various fruit crops for control of a variety of diseases including powdery mildew, Alternaria leaf spot, gummy stem blight, Septoria, Botrytis, Cladosporium, Cercospora, **Sclerotinia** and anthracnose and suppression of Rhizoctonia. Australian registration in various crops are progressing.	R3
Iprodione (Kenso)	2	Protective and systemic		P		Registered in almonds, celery, lettuce, potatoes and tomatoes for control of **Sclerotinia.**	R2
Alternaria leaf spot (*Alternaria dauci*) **Priority: Low**							
This fungal pathogen favoured by wet, cool conditions and is considered a low priority. Tends to be seed-borne and are dispersed between plants by rain splash. Seed and soil treatment can be options.							
Azoxystrobin+ difenoconazole (Amistar Top)	3+11	Protective and curative	7	A	ALL	Registered in carrots for control of **Alternaria leaf spot** and Cercospora leaf spot. [Max. 3 applications per year; retreatment interval 10-14 d; subject to Crop Life resistance management strategy].	R3
Chlorothalonil (AC Clatter)	M5	Protectant	7	A	ALL	Registered in carrots for the control of **Alternaria leaf spot.** Apply at first signs of infection. [Max no. of applications not specified; re-treatment interval 7-14 d]	R2

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Copper-Cupric hydroxide (Champ)	M1	Protective and curative	1	A	ALL	Registered in carrots for the control of **Alternaria leaf spot.** Apply at first signs of infection. [Max no. of applications not specified; re-treatment interval 10-14 d]	-
Copper oxychloride + Copper Hydroxide (Relyon Airone)	M1	Protective and curative	1	A	ALL	Registered in carrots for control of *Cercospora, **Alternaria*** and *Septoria* leaf spots. [Max no. of applications not specified; re-treatment interval 10-14 d]	-
Copper ammonium complex (Liquicop)	Y	Protective	1	A	ALL	Registered in carrots for control of *Cercospora, **Alternaria*** and *Septoria* leaf spots. [Max no. of applications not specified; re-treatment interval 10-14 d]	-
Copper-Cupric hydroxide + Mancozeb (Mankocide)	M1+ M3	Protective and curative	7	A	ALL	Registered in carrots for control of *Cercospora, **Alternaria*** and *Septoria* leaf spots. [Max no. of applications not specified; re-treatment interval 10-14 d]	R2
Difenoconazole (Genfarm)	3	Non-systemic, protective	7	A	ALL	Registered in carrots for the control of *Cercospora* and **Alternaria leaf spot.** Apply at first signs of infection. [Max. 2 sequential applications per crop; retreatment interval 10-14 d; subject to AVCARE resistance management strategy].	R3
Mancozeb (Sabakem)	M3	Protective	7	A	ALL	Registered in carrots for the control of *Cercospora* and **Alternaria leaf spot.** Apply at first signs of infection. [Max no. of applications not specified; re-treatment interval 7-10 d]	R2
Metiram (Polyram)	M3	Non-systemic, protective	7	A	ALL	Registered in carrots for control of **Alternaria leaf spot** and *Cercospora* leaf spot. Apply when disease first appears. [Max no. of applications not specified; re-treatment interval 7-10 d]	R2
Penthiopyrad (Fontelis)	7	Protective	7	A	ALL	Registered in carrots for control of **Alternaria leaf spot**. [Max. 2 sequential applications per crop; retreatment interval 7-14 d; subject to Crop Life resistance management strategy].	-

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Zineb (Barmac)	M3	Protective	7	A	NSW, Vic, SA, WA, TAS (Qld check label)	Registered in carrots for control of **Alternaria leaf spot.** Apply when disease threatens. [Max no. of applications not specified; re-treatment interval 7 d]	R2
Fluazinam	29	Protective		P		Registered in brassica vegetables in Australia for Club root. Registered in the US for Sclerotinia and **Alternaria** control in carrots with a GAP of 4 x 0.58 kg ai/ha with a 7-day WHP.	
Fluopyram + Trifloxystrobin (Luna Sensation) Bayer	7+11	Protective		P		Registered for control of powdery mildew, black spot and suppression of **Alternaria leaf blotch** in apples.	-
Black root rot (*Thielaviopsis basicola, Chalaropsis thielavioides*) **Priority: Low**							
Bacterial root rot has not been identified a priority disease in the survey, however other industry sources indicate that it is a significant disease in carrots. This is predominantly a postharvest problem that occurs when washed carrots are not properly dried and cooled below 5° C before packing. Spores are often present in the soil and can grow rapidly in the injuries produced by harvest and packing processes.							
Thiophanate-methyl + Etridiazole (Banrot)	1+14	Systemic		P		Registered in container grown ornamentals and in ground bedding plants as a post plant soil drench for control of *Pythium*, *Phytophthora, Rhizoctonia* and *Thielaviopsis.*	
Carrot Black rot (*Alternaria radicina*) **Priority: Low**							
Caused by an organism that thrives under wet and cool conditions and is considered a low priority. Precautions are needed to prevent spread of disease from nursery to field.							
Azoxystrobin (EuroChem)	11	Protective and curative	21	A	ALL	Registered in Carrot vegetables for the suppression of **Black rot**. [Max 3 applications per crop, 2 consecutive; re-treatment interval 10-14 d]	-

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Iprodione (Rovral) PER84955	2	Protective and curative	NR	A	ALL (excl. Vic)	PER84955 for suppression of **black rot** in carrots. [Max 2 applications per crop; re-treatment interval 7-10 d]	R2
Bacillus amyloliquefaciens (Serenade Opti)	44	Biological		P		Registered for control of *Xanthomonas* in tomato, capsicum, chilli in field and protected cropping systems. Registered in US for control of ***Alternaria*** spp. Black rot and Brown rot in carrots.	
Fluopyram + Tebuconazole (Luna Experience) Bayer	3+7	Protective		P		Registered overseas as Luna Experience. The US label is for use in almond, Brassica leafy vegetables, legume vegetables, melons and various fruit crops for control of a variety of diseases including powdery mildew, **Alternaria leaf spot**, gummy stem blight, Septoria, Botrytis, Cladosporium, Cercospora, Sclerotinia and anthracnose and suppression of Rhizoctonia. Australian registration in various crops are progressing.	R3
Fluopyram + Trifloxystrobin (Luna Sensation) Bayer	7+11	Protective		P		Registered for control of powdery mildew, black spot and **Alternaria** in apples.	
Cercospora Leaf spot (*Cercospora carotae*) **Priority: Low**							
Disease can be associated with seed and infected crop debris. Can be spread by rain/irrigation, workers and machinery. A preventative fungicide spray program, crop rotation, removal of crop debris, hygiene for workers and equipment would help.							
Azoxystrobin + difenconazole (Amistar Top)	3+11	Protective and curative	7	A	ALL	Registered in carrots for control of **Cercospora leaf spot** and Alternaria leaf spot. [Max. 3 applications per year; retreatment interval 10-14 d; subject to Crop Life resistance management strategy].	R3
Copper-Cupric hydroxide (Champ)	M1	Protective and curative	1	A	ALL	Registered in carrots for the control of **Cercospora leaf spot.** Apply at first signs of infection. [Max no. of applications not specified; re-treatment interval 10-14 d]	-

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Copper oxychloride + Copper Hydroxide (Relyon Airone)	M1	Protective and curative	1	A	ALL	Registered in carrots for control of ***Cercospora***, *Alternaria* and *Septoria* leaf spots. [Max no. of applications not specified; re-treatment interval 10-14 d]	-
Copper ammonium complex (Liquicop)	Y	Protective	1	A	ALL	Registered in carrots for control of ***Cercospora***, *Alternaria* and *Septoria* leaf spots. [Max no. of applications not specified; re-treatment interval 10-14 d]	-
Difenoconazole (Genfarm)	3	Non-systemic, protective	7	A	ALL	Registered in carrots for the control of Alternaria and **Cercospora leaf spot.** Apply at first signs of infection. [Max. 2 sequential applications per crop; retreatment interval 10-14 d; subject to AVCARE resistance management strategy].	R3
Mancozeb (Sabakem)	M3	Protective	7	A	ALL	Registered in carrots for the control of Alternaria and **Cercospora leaf spot.** Apply at first signs of infection. [Max no. of applications not specified; re-treatment interval 7-10 d]	R2
Metiram (Polyram)	M3	Non-systemic, protective	7	A	ALL	Registered in carrots for control of **Cercospora leaf spot** and *Alternaria* leaf spot. Apply when disease first appears. [Max no. of applications not specified; re-treatment interval 7-10 d]	R2
Zineb (Barmac)	M3	Protective	7	A	NSW, Vic, SA, WA, TAS (Qld check label)	Registered in carrots for the control of **Cercospora leaf spot.** Apply when disease threatens. [Max no. of applications not specified; re-treatment interval 7 d]	R2
Fluopyram + Tebuconazole (Luna Experience) Bayer	3+7	Protective		P		Registered overseas as Luna Experience. The US label is for use in almond, Brassica leafy vegetables, legume vegetables, melons and various fruit crops for control of a variety of diseases including powdery mildew, Alternaria leaf spot, gummy stem blight, Septoria, Botrytis, Cladosporium, **Cercospora**, Sclerotinia and anthracnose and suppression of Rhizoctonia. Australian registration in various crops are progressing.	R3

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Hydrogen peroxide + peroxy acetic acid (Peratec)	M	Contact		P		Registered in celery for control of **Cercospora leaf spot.**	
Petroleum oil (BioAAid)	M	Contact		P		Registered in bananas for control of **Cercospora leaf spot.**	
Crater rot (*Rhizoctonia carotae*) **Priority: Low**							
Crater rot has not been identified as a priority disease in the survey, however other industry sources indicate that it is a significant disease in carrots. Its spread is favoured by cool weather (below 23^0 C) combined with high humidity. Crop hygiene, selection of planting date and crop density, tillage approaches that ensure good soil structure and drainage, crop residue management to foster their breakdown, and timely harvest are some cultural practices that reduce the impact of root diseases.							
Streptomyces lydicus WYEC108 (Actinovate)	-	Protective Biofungicide	NR	A	ALL	Actinovate is a biological fungicide that helps supress the effects of root rot and damping-off fungi and certain foliar fungal pathogens when used as part of a total health management program. Registered in vegetables as a seed treatment for *Fusarium, **Rhizoctonia** and Pythium* Management.	-
Fludioxonil + Sedaxane (Vibrance Premium)	7+12	Systemic and protective		P		Registered as a seed treatment for control of Black scurf (***Rhizoctonia***), Silver surf, Black dot, Gangrene, Fusarium dry rot and suppression of common scab in potatoes.	
Thiophanate-methyl + Etridiazole (Banrot)	1+14	Systemic		P		Registered in container grown ornamentals and in ground bedding plants as a post plant soil drench for control of *Pythium*, *Phytophthora, **Rhizoctonia*** and *Thielaviopsis.*	

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Crown rot (*Fusarium spp., Rhizoctonia spp*) **Priority: Low**							
Crown rot has not been identified as a priority disease in the survey, however other industry sources indicate that it is a significant disease in carrots. It is favored by mild conditions (over 18° C) and wet soils. Symptoms have been associated with low soil pH, nutritional imbalances and high organic matter in soil. Crown rot is common in Tasmania, and during winter in more northern production areas.							
Chloropicrin (Tripicrin)	8A	General pre-plant soil fumigation	NR	A	ALL	Registered as a general fumigant to control Nematodes, insects, *Pythium, Phytophthora, **Fusarium**, and Verticillium.* Do not plant for 10 d after soil treatment.	-
Dazomet (Cerlong)	-	General pre-plant soil fumigation	NR	A	ALL	Registered as a general fumigant to control Nematodes, insects, weeds and soil fungi *Pythium, Phytophthora, **Fusarium**, and Verticillium.* Do not plant for 14- 42 d after soil treatment.	-
Streptomyces lydicus WYEC108 (Actinovate)	-	Protective Biofungicide	NR	A	ALL	Actinovate is a biological fungicide that helps supress the effects of root rot and damping-off fungi and certain foliar fungal pathogens when used as part of a total health management program. Registered in vegetables as a seed treatment for ***Fusarium, Rhizoctonia*** *and Pythium* Management.	-
Fludioxonil + Sedaxane (Vibrance Premium) Syngenta	7+12	Systemic and protective		P		Registered as a seed treatment for control of Black scurf (*Rhizoctonia*), Silver surf, Black dot, Gangrene, **Fusarium** dry rot and suppression of common scab in potatoes.	
Thiophanate-methyl + Etridiazole (Banrot)	1+14	Systemic		P		Registered in container grown ornamentals and in ground bedding plants as a post plant soil drench for control of *Pythium*, *Phytophthora, **Rhizoctonia*** and *Thielaviopsis.*	
Damping off (*Pythium* spp.*, Phytophthora* spp.*, Fusarium* spp.*, Rhizoctonia* spp.) **Priority: Low**							
This disease has been identified as a low priority. Good farm hygiene is crucial as the fungus will over-winter on plant residues and can be spread on tools and water splashes. Soil fumigation could help control this. This impacts seedling plants.							

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Chloropicrin (Tripicrin)	8A	General pre-plant soil fumigation	NR	A	ALL	Registered as a general fumigant to control Nematodes, insects, ***Pythium, Phytophthora****, Fusarium, and Verticillium.* Do not plant for 10 d after soil treatment.	-
Dazomet (Cerlong)	-	General pre-plant soil fumigation	NR	A	ALL	Registered as a general fumigant to control Nematodes, insects, weeds and soil fungi ***Pythium****, Phytophthora, Fusarium, and Verticillium.* Do not plant for 14- 42 d after soil treatment.	-
Mancozeb + Metalaxyl -M (Ridomil Gold) PER14045 Version 3	M3+4	Systemic, protective and curative	7	A	ALL (excl. Vic)	PER14045 for control of **Pythium** and Phytophthora in carrots. [Max 2 applications per crop; re-treatment interval not specified]	R2
Metalaxyl (Barmac)	4	Protective and curative	NR	A	ALL	Registered in carrots for control of ***Pythium*** **spp***.* Apply dry granules in a 30 cm wide band at planting or early seedling stages. Rainfall or irrigation is required after application for incorporating to soil. [Max no. of applications not specified]	**-**
Phosphorous acid (Eazycrop) PER14184	33	Protective and systemic	1	A	ALL (exc. Vic)	PER14184 for control of damping off in carrots. [Max. 4 applications per year; retreatment interval 7 d].	**-**
Streptomyces lydicus WYEC108 (Actinovate)	-	Protective Biofungicide	NR	A	ALL	Actinovate is a biological fungicide that helps supress the effects of root rot and damping-off fungi and certain foliar fungal pathogens when used as part of a total health management program. Registered in vegetables as a seed treatment for ***Fusarium, Rhizoctonia and Pythium*** Management.	-
Fludioxonil + Sedaxane (Vibrance Premium) Syngenta	7+12	Systemic and protective		P		Registered as a seed treatment for control of Black scurf (***Rhizoctonia***), Silver surf, Black dot, Gangrene, **Fusarium** dry rot and suppression of common scab in potatoes.	

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Mancozeb + Metalaxyl -M (Ridomil Gold) PER14045	M3+4	Systemic, protective and curative	7	P	ALL (excl. Vic)	Registered in cucurbits, lettuce, onions and potatoes for control of various fungal diseases. PER14045 allows for control of **Pythium** and Phytophthora in carrots.	R2
Thiophanate-methyl + Etridiazole (Banrot)	1+14	Systemic		P		Registered in container grown ornamentals and in ground bedding plants as a post plant soil drench for control of ***Pythium***, ***Phytophthora, Rhizoctonia*** and *Thielaviopsis.*	
Liquorice rot (*Mycocentrospora acerina*) **Priority: Low**							
Liquorice rot has not been identified as a priority disease in the survey, however other industry sources indicate that it is a significant disease in carrots. It is favoured by moist and humid conditions. Although infection can occur any time, symptoms mainly develop during postharvest storage. Crop hygiene, selection of planting date and crop density, tillage approaches that ensure good soil structure and drainage, crop residue management to foster their breakdown, and timely harvest are some cultural practices that reduce the impact of root diseases.							
Root rot complex (*Phytophthora spp., Pythium spp.*) **Priority: Low**							
Root rot complex has not been picked up as a priority disease in the survey, but other industry sources indicate that it is a significant disease in carrots.							
Chloropicrin (Tripicrin)	8A	General pre-plant soil fumigation	NR	A	ALL	Registered as a general fumigant to control Nematodes, insects, ***Pythium, Phytophthora****, Fusarium, and Verticillium.* Do not plant for 10 d after soil treatment.	-
Dazomet (Cerlong)	-	General pre-plant soil fumigation	NR	A	ALL	Registered as a general fumigant to control Nematodes, insects, weeds and soil fungi ***Pythium, Phytophthora****, Fusarium, and Verticillium.* Do not plant for 14- 42 d after soil treatment.	-
Mancozeb + Metalaxyl -M (Ridomil Gold) PER14045	M3+4	Systemic, protective and curative	7	A	ALL (excl. Vic)	PER14045 for control of ***Pythium*** and ***Phytophthora*** in carrots. [Max 2 applications per crop; re-treatment interval not specified]	R2

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Metalaxyl (Barmac)	4	Protective and curative	NR	A	ALL	Registered in carrots for control of ***Pythium* spp***.* Apply dry granules in a 30 cm wide band at planting or early seedling stages. Rainfall or irrigation is required after application for incorporating to soil. [Max no. of applications not specified]	**-**
Streptomyces lydicus WYEC108 (Actinovate)	-	Protective Biofungicide	NR	A	ALL	Actinovate is a biological fungicide that helps supress the effects of root rot and damping-off fungi and certain foliar fungal pathogens when used as part of a total health management program. Registered in vegetables as a seed treatment for *Fusarium, Rhizoctonia and* ***Pythium*** Management.	-
Fosetyl-Aluminium (Aliette)	33	Systemic		P		Registered in apples, peaches, avocados and pineapples for control of ***Phytophthora* spp.**	
Mancozeb + Metalaxyl -M (Ridomil Gold)	M3+4	Systemic, protective and curative		P		Registered in cucurbits, lettuce, onions and potatoes for control of various fungal diseases. PER14045 allows for control of **Pythium** and **Phytophthora** in carrots.	R2
Phosphorous acid (Eazycrop) PER14184	33	Protective and systemic		P		Registered in avocado, citrus and pineapples for control of **Phytophthora**. PER14184 for control of damping off in carrots. [Max. 4 applications per year; retreatment interval 7 d].	**-**
Thiophanate-methyl + Etridiazole (Banrot)	1+14	Systemic		P		Registered in container grown ornamentals and in ground bedding plants as a post plant soil drench for control of ***Pythium*, *Phytophthora***, *Rhizochtonia* and *Thielaviopsis.*	

4.2 Insect, mite, nematode and other invertebrate pests of carrots

4.2.1 Insect, mite, nematode and other invertebrate pest priorities

Common name	Scientific name
Moderate	
Carrot aphid, Carrot willow aphid	*Cavariella aegopodii*
Green Peach Aphid	*Myzus persicae*
Cutworms	*Agrotis* spp.
Redlegged earth mite	*Halotydeus destructor*
Rutherglen bug	*Nysius vinitor*
Root-Knot Nematodes	*Meloidogyne* spp.
Low	
Lesser armyworm	*Spodoptera exigua*
Green vegetable bug	*Nezara viridula*
Helicoverpa Cotton bollworm Native budworm	*Helicoverpa* spp. *H. armigera* *H. punctigera*
Jassids	*Austroasca viridigrisea*
Loopers	Chrysodeixis spp
Lucerne leafroller	*Merophyas divulsana*
Root lesion nematodes	*Pratylenchus spp*
Thrips Onion thrips Plague thrips Tomato thrips Western Flower thrips	 *Thrips tabaci,* *T. imagines,* *Frankliniella schultzei,* *F. occidentalis*
Vegetable weevil	*Listroderes difficilis*
White-fringed weevil	*Naupactus leucoloma*
Wire worms - False wireworms and true wireworm	*Gonocephalum* spp. *Arachnodima* spp., *Agrypnus* spp.

No pest was identified as a high priority, but five species were ranked as moderate.

4.2.2 Available and potential products for priority insects and mites

TABLE KEY: Note that blank fields in the table indicate no information has been provided.

Availability		Regulatory risk (refer to Appendix 6)	
A	Available via either registration or permit approval	R1	Short-term: Critical concern over retaining access
P	Potential - a possible candidate to pursue for registration or permit	R2	Medium-term: Maintaining access of significant concern
P-A	Potential, already approved in the crop for another use	R3	Long-term: Potential issues associated with use - Monitoring required
Withholding Period (WHP) – Number of days from last treatment to harvest (H) or Grazing (G)			
Harvest	H	Not Required when used as directed	NR
Grazing	G	No Grazing Permitted	NG
IPM – indicative overall impact on beneficials (based on the Cotton Pest Management Guide 2018-19 and cotton use patterns)			
VL – Very low; L – Low; M – Moderate; H – High; VH – Very High; - not specified			

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Carrot aphid/Carrot willow aphid (*Cavariella aegopodii*) **Green Peach Aphids:** (*Myzus persicae*) **Priority: Moderate**								
Aphids were consistently ranked as a moderate priority in every consulted region. They are not direct pests of carrot but act as vectors in transmitting many viral diseases. Weed control will assist management as aphids can have a range of hosts. Having a good IPM program will also help as beneficial insects such as wasps and ladybird beetles can reduce aphid numbers.								
Imidacloprid (Confidor) PER10918	4A	Systemic	7	A	ALL	PER0918 for control of **aphids** including **green peach aphid**, **carrot aphid** and fennel aphid in Carrots. [Max. 1 application per crop]	M M-Bees	R2

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Maldison (Hy-mal)	1B	Contact and systemic	3	A	NSW, Vic, NT, SA, WA, Tas only	Registered in carrots for control of **aphid,** Green vegetable bug, Jassids, leaf hopper & Rutherglen bug. [Apply at first sight of infestation: max no. of applications not specified]	H H-Bees	-
Phorate (various)	1B	Contact and systemic	70	A	ALL	Registered in carrots for the control of or control of carrot fly, **aphids,** thrips and jassids. Incorporate into soil or apply as band 5 cm from each side of crop. Apply when rai is expected, or overhead irrigation can be made.	H H-Bees	R3
Potassium salts of fatty acids (Multicrop)	-	Contact	NR	A	ALL	Registered in vegetables for control of **aphids**, thrips, mealybug, two spotted mite, spider-mite and whitefly. Apply mornings or evenings when temperatures are cooler. [Max no. of applications not specified; re-treatment interval 5-7 d]	-	-
Pyrethrins+piperonyl butoxide (Kendon)	3A	Contact	1	A	ALL	Registered in vegetables for control of ants, **aphids**, thrips, caterpillars, leaf hoppers, and whitefly. [Max no. of applications not specified; re-treatment interval: 7 d]	VH H-Bees	-
Rotenone (Amgrow Derris Dust)	-	-	1	A	ALL	Registered in vegetables for control of **aphids**. [Max no. of applications not specified; Re-treatment interval: 10-14 d]	-	-
Sulfoxaflor (Transform)	4C	Systemic	7	A	ALL	Registered in carrots for control of **Green peach aphid,** tomato-potato psyllid and Rutherglen bug. [Max. no. of applications not specified; re-treatment interval 7-10 d]	M VH-Bees	-
Afidopyropen (Versys)	9D	Behaviour disruption		P		Registered in potato, sweet potato and ginger for **aphid** control. Hort Innovation data generation project (ST16000) underway for a label registration with BASF in carrots.	L	-
Clothianidin + Imidacloprid (Poncho Plus)	4A	Protective		P		Registered in sweet corn, sunflower, canola and forage brassica for control of wireworms, cutworms and **aphids**. Will provide early protection for 3-4 weeks after sowing.	M VH-Bees	R2

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Flonicamid (Mainman)	9C	Systemic		P		Registered in cucurbits for control of **aphids** and silverleaf white fly; **aphids** in potatoes; **aphids** and mealybugs in apples and pears; aphids and mirids in cotton. Hort Innovation is undertaking trials in bulb vegetables in support of a permit for thrip control.	M	
Cutworms (*Agrotis* spp.) **Priority: Moderate**								
Cutworm was ranked as a moderate priority in QLD, WA and TAS. Considered to be an issue in the early part of the season. Monitoring is important and spray only if numbers are high.								
Diazinon (Accensi)	1B	Contact and systemic	14 NG	A	Qld, NSW, Vic, SA & WA	Registered in carrots for control of **cutworms** and caterpillars. [max no. of applications and re-treatment interval not specified]	H H-Bees	R3
Alpha-cypermethrin (Itrade)	3A	Contact and systemic		P-A		PER13700 in carrots (seed production only for employees of South Pacific Seeds) for control of **cutworms** in parsley. Registered in winter cereals, grain legumes, grape vine and linseed for control of **cutworms**.	VH H-Bees	-
Clothianidin + Imidacloprid (Poncho Plus)	4A	Protective		P		Registered in sweet corn, sunflower, canola and forage brassica for control of wireworms, **cutworms** and aphids. Will provide early protection for 3-4 weeks after sowing.	M VH-Bees	R2
Cyantraniliprole + Thiamethoxam (Spinner)	4A+28	Systemic, contact and stomach		P		Registered in Turf for control of caterpillars including **cutworms** and army worms, African black beetle larvae, Argentinian scarab larvae and stem weevil larvae. US label (Minecto Duo) approves use on Brassica, cucurbits, fruiting vegetables, leafy vegetables and tuberous and corm vegetables on a range of insect pests including army worm, leaf hoppers, leaf miners, diamond back moth and potato beetle.	M VH-Bees	
Redlegged earth mite (*Halotydeus destructor*) **Priority: Moderate**								
Ranked as a moderate issue for growers in WA and SA only. Can be an issue in early stages of the crop, on seedlings and it can be hard to manage when present. Usually attack the edges of the crop as they come from weeds and pasture. Soil fumigation and weed control would help.								
1,3-dichloropropene (Tri-Form)	-	Soil fumigant	NR	A	ALL	Registered in tuber crops for control of soil borne pests. Leave soil undisturbed for 14 d after treatment.	-	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Alpha-cypermethrin (Imtrade)	3A	Contact and stomach		P-A		Registered in canola and field peas for control of **redlegged earth mites.** PER13700 has been issued for use in carrots (seed production) for control of **redlegged earth mite**, Rutherglen bug and budworm.	VH H-Bees	
Bifenthrin (4Farmers)	3A	Contact and stomach		P		Registered in faba beans for control of **Redlegged earth mite**. [Max. no. of applications and re-treatment interval not specified]	VH H-Bees	
Diafenthiuron + Cyantraniliprole (Minecto Forte) Syngenta	12A + 28	Contact and stomach		P		Registration is progressing (Syngenta) for control of **mites** and other insects in fruiting vegetables and cucurbits.	M VH-Bees	
Spiromesifen (Oberon) Bayer	23	Non-systemic		P		Registered in US for control of two-spotted spider mite, whiteflies and tomato potato psyllid in tuberous and corm vegetables.	M	-
Rutherglen bug (*Nysius vinitor*) **Priority: Moderate**								
Rutherglen bug was ranked as moderate to low priority in VIC, QLD, TAS (an issue in mid-Summer), SA and WA (an issue in Spring).								
Trichlorfon (Tyranex)	1B	Contact and systemic	2	A	ALL	Registered in vegetables for control of **Rutherglen bug.** [Max no. of applications not specified; re-treatment: 7-10 d]	H H-Bees	R1
Sulfloxaflor (Transform / Expedite Full)	4C	Systemic	7	A	ALL	Registered in carrots for control of **Rutherglen bug**. [Max. no. of applications not specified; re-treatment interval 7-10 d]	M VH-Bees	-
Alpha-cypermethrin (Itrade)	3A	Contact and systemic	NR	P-A	NSW, SA & Tas only	PER13700 in carrots (seed production only for employees of South Pacific Seeds) for control of red legged earth mite, **Rutherglen bug** and budworm. [Max. 2 applications per crop; re-treatment interval not specified].	VH H-Bees	-
Lambda-cyhalothrin (Karate)	3A	Contact and systemic	NR	P-A	NSW, SA & Tas only	PER13700 in carrots (seed production only for employees of South Pacific Seeds) for control of red legged earth mite, **Rutherglen bug** and budworm. [Max. 2 applications per crop; re-treatment interval not specified].	VH H-Bees	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
SYNFOI21 (Syngenta)	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for thrips, **bugs** and caterpillars.	-	
Root-Knot Nematodes (*Meloidogyne* spp.) **Priority: Moderate** **Root lesion nematodes** (*Pratylenchus spp*) **Priority: Low**								
Root-Knot Nematode was consistently ranked as a moderate priority in every consulted region. Can be an issue in sandy soils and is related to poor crop rotation and soil health issue. Biofumigants would help manage situation. **Root lesion nematodes** have not been identified as a priority pest in the survey, however other industry sources indicate that it is a significant pest in carrots. Unlike the root knot nematode, root lesion nematodes move around inside the plant root causing damage. Feeding injuries to the roots often lead to secondary fungal infections. Maintaining good farm hygiene and crop rotation can keep infections under control.								
1,3-dichloropropene (Tri-Form)	-	Soil fumigant	NR	A	ALL	Registered in tuber crops for control of plant parasitic **nematodes**. Leave soil undisturbed for 14 d after treatment.	-	-
Dazomet (Cerlong)	-	Soil fumigant	NR	A	ALL	Registered in various situations for control of soil fungi, **nematodes**, soil insects and weeds. Soil moisture is essential for release of gas and plastic cover brings optimum results. See label for details.	-	-
Metham sodium (Imtrade)	-	Soil fumigant	NR	A	NSW, Qld, SA, Vic & WA	Registered in various situations for control of soil fungi, **nematodes**, soil insects and weeds. Moisture is essential and see label for details.	-	-
Fluensulfone 480EC (Nimitz)	-	Novel mode of action	-	A	ALL	Registered in carrots for the control of **Root-knot nematode.** [Max 1 application 7 d prior to sowing]	L-M	-
Abamectin (Tervigo)	6	Contact	NR	P	ALL	Registered in tomato, capsicum, chilli, eggplant and cucurbits for control of **root-knot nematodes** [max 4 applications per crop; re-treatment interval 14 d]	M H-Bees	-
Fluopyram (Velum) Bayer	7			P		Pending registration as a **nematicide** by Bayer. Registered in US for control of nematodes in a range of vegetables.	L	
Sulfonamide (Reklemel) Corteva	New MOA			P		Pending registration as a **nematicide** by Corteva. Previously known product (Velloxine) is to be launched as Rekelemel in North America and Asia Pacific in 2021. Reklemel is a novel sulfonamide nematicide with a unique mode of action against plant-parasitic nematodes.	L	

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Beet / Lesser armyworm (*Spodoptera exigua*) **Priority: Low**								
Lesser Armyworm has not been identified as a priority pest in the survey however, other industry sources indicate that it is a significant pest in carrots.								
Bacillus thuringiensis subsp. Kurstaki (Biocrystal)	11	Biological	NR	A	ALL	Registered in vegetables for control of **caterpillars.** [Apply a minimum of 2 sprays, 3 d apart; re-treatment interval 3-5 d]	VL	-
Diazinon (Accensi)	1B	Contact and systemic	14 G 14	A	Qld, NSW, Vic, SA & WA	Registered in carrots for control of **caterpillars**. [Max no. of applications and re-treatment interval not specified]	H VH-Bees	R3
Emamectin (Proclaim Pro)	6	Contact and systemic	3	A	ALL	Registered in carrots and other tuber vegetables for control of Helicoverpa, Diamondback moth, **loopers** and cluster caterpillars. [Max of 4 sprays per crop; re-treatment interval 7 d]	M H-Bees	-
Pyrethrins+piperonyl butoxide (Kendon)	3A	Contact	1	A	ALL	Registered in vegetables for control of ants, aphids, thrips, **caterpillars**, leaf hoppers, and whitefly. [Max no. of applications not specified; re-treatment interval: 7 d]	VH H-Bees	-
Rotenone (Amgrow Derris Dust)	-	-	1	A	ALL	Registered in vegetables for control of **caterpillars**. [Max no. of applications not specified; Re-treatment interval: 10-14 d]	-	-
Broflanilide (Vedira) BASF	30	Contact and ingestion		P		Registration submitted concurrently in Australia, Canada, USA, and Mexico as a soil application and seed treatment against chewing insects such as ants, cockroaches and ***Spodoptera*** spp. BASF are seeking registrations in amenity turf initially, then potential horticultural crops thereafter.	H VH-Bees	-
Indoxacarb + Novaluron (Plemax)	22A + 15	Contact and stomach		P		Registration pending for control of **Lepidoptera** including Helicoverpa spp. Registered in South Africa on a range of crops for Lepidoptera control.	M M-Bees	
Spinosad (Entrust)	5	Contact and ingestion	3	P		Dow is going through the process of registering product for control of Diamondback moth, Cabbage white butterfly, Cabbage cluster caterpillar, Cabbage centre grub, **Loopers**, Heliothis and Western flower thrip in Brassica vegetables.	L H-Bees	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
SYNFOI21 (Syngenta)	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for thrips, bugs and **caterpillars**.	-	
Tetraniliprole (Vayego) Bayer	28	Disrupts feeding		P		Not registered in Australia, but Bayer is proceeding with registering it in New Zealand and Australia in multiple crops for several insect pests such as weevils, borers, leafrollers, white grubs, **Lepidoptera** and beetles including African black beetle. Hort innovation has several projects underway towards crop extension to cover several crops; stalk and stem veg for LBAM, Helicoverpa; Potato for Whitefringed weevil, African black beetle; Sweet potato for weevil and whitefringed weevil.	M VH-Bees	
Green vegetable bug (*Nezara viridula*) **Priority: Low**								
Green vegetable bug was consistently ranked as a low priority in every consulted region.								
Maldison (Hy-mal)	1B	Contact and systemic	1	A	All Exc Vic & ACT	Registered in carrots for control of aphid, **green vegetable bug**, jassid, leaf hopper. [Apply at first sight of infestation: max no. of applications not specified]	H H-Bees	-
SYNFOI21 (Syngenta)	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for thrips, **bugs** and caterpillars.	-	-
Helicoverpa (Heliothis): (*Helicoverpa* spp.) **Cotton bollworm** (*H. armigera*) and **Native budworm** (*H. punctigera*) **Priority: Low**								
Budworm was consistently ranked as a low priority in every consulted region.								
Bacillus thuringiensis subsp. Kurstaki (Biocrystal)	11	Biological	NR	A	ALL	Registered in vegetables for control of **caterpillars.** [Apply a minimum of 2 sprays, 3 d apart; re-treatment interval 3-5 d]	VL	-
Emamectin (Proclaim Pro)	6	Contact and systemic	3	A	ALL	Registered in carrots and other tuber vegetables for control of **Helicoverpa**, Diamondback moth, loopers and cluster caterpillars. [Max of 4 sprays per crop; re-treatment interval 7 d]	M H-Bees	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Flubendiamide (Belt)	28	Contact and systemic	1	A	ALL	Registered in carrots for the control of diamondback moth, cabbage white butterfly, cluster caterpillar, potato moth (leafminer) and ***Helicoverpa* spp.** [Max no. of applications not specified; re-treatment interval: 7-14 d]	L-M	-
Spinetoram (Success Neo)	5	Contact and ingestion	3	A	ALL	Registered in Tuber & root vegetables for the control of **Helicoverpa**, Lightbrown apple moth and Potato moth (leafminer). [Max no. of applications not specified; re-treatment interval: 7-14 d]	-	-
Indoxacarb + Novaluron (Plemax)	22A + 15	Contact and stomach		P		Registration pending for control of Lepidoptera including ***Helicoverpa*** spp. Registered in South Africa on a range of crops for Lepidoptera control.	M M-Bees	
Spinosad (Entrust)	5	Contact and ingestion		P		Dow is going through the process of registering product for control of **Diamondback moth**, Cabbage white butterfly, Cabbage cluster caterpillar, Cabbage centre grub, Loopers, Heliothis and Western flower thrip in Brassica vegetables.	L H-Bees	-
SYNFOI21 (Syngenta)	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for thrips, bugs and **caterpillars**.	-	-
Tetraniliprole (Vayego) Bayer	28	Disrupts feeding		P		Not registered in Australia, but Bayer is proceeding with registering it in New Zealand and Australia in multiple crops for several insect pests such as weevils, borers, leafrollers, white grubs, **Lepidoptera** and beetles including African black beetle. Hort innovation has several projects underway towards crop extension to cover several crops; stalk and stem veg for LBAM, Helicoverpa; Potato for Whitefringed weevil, African black beetle; Sweet potato for weevil and whitefringed weevil.	M VH-Bees	
Jassids (*Austroasca viridigrisea*) **Priority: Low**								
Jassids have not been identified as a priority pest in the survey however, other industry sources indicate that it is a significant pest in carrots.								
Maldison (Hy-mal)	1B	Contact and systemic	1	A	All Exc Vic & ACT	Registered in carrots for control of aphid, green vegetable bug, **jassid**, leaf hopper. [Apply at first sight of infestation: max no. of applications not specified]	H H-Bees	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Phorate (Zeemet)	1B	Contact and systemic	70	A	ALL	Registered in carrots for the control of or control of carrot fly, aphids, thrips and **jassids**. Incorporate into soil or apply as band 5 cm from each side of crop. Apply when rai is expected, or overhead irrigation can be made.	H H-Bees	R3
SYNFOI21 (Syngenta)	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for thrips, **bugs** and caterpillars.	-	-
Loopers (Geometridae - unidentified species) **Priority: Low**								
Loopers was consistently ranked as a low priority in every consulted region.								
Bacillus thuringiensis subsp. kurstaki (Biocrystal)	11	Biological	NR	A	ALL	Registered in vegetables for control of **caterpillars.** [Apply a minimum of 2 sprays, 3 d apart; re-treatment interval 3-5 d]	VL	-
Diazinon (Accensi)	1B	Contact and systemic	14 G 14	A	Qld, NSW, Vic, SA & WA	Registered in carrots for control of **caterpillars**. [Max no. of applications and re-treatment interval not specified]	H VH-Bees	R3
Emamectin (Proclaim Pro)	6	Contact and systemic	3	A	ALL	Registered in carrots and other tuber vegetables for control of Helicoverpa, Diamondback moth, **loopers** and cluster caterpillars. [Max of 4 sprays per crop; re-treatment interval 7 d]	M H-Bees	-
Pyrethrins+piperonyl butoxide (Kendon)	3A	Contact	1	A	ALL	Registered in vegetables for control of ants, aphids, thrips, **caterpillars**, leaf hoppers, and whitefly. [Max no. of applications not specified; re-treatment interval: 7 d]	VH H-Bees	-
Rotenone (Amgrow Derris Dust)	-	-	1	A	ALL	Registered in vegetables for control of **caterpillars**. [Max no. of applications not specified; Re-treatment interval: 10-14 d]	-	-
Indoxacarb + Novaluron (Plemax)	22A + 15	Contact and stomach		P		Registration pending for control of **Lepidoptera** including Helicoverpa spp. Registered in South Africa on a range of crops for Lepidoptera control.	L H-Bees	

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Spinosad (Entrust)	5	Contact and ingestion		P		Corteva is going through the process of registering product for control of Diamondback moth, Cabbage white butterfly, Cabbage cluster caterpillar, Cabbage centre grub, **Loopers**, Heliothis and Western flower thrip in Brassica vegetables.	L H-Bees	-
SYNFOI21 (Syngenta)	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for thrips, bugs and **caterpillars**.	-	-
Tetraniliprole (Vayego) Bayer	28	Disrupts feeding		P		Not registered in Australia, but Bayer is proceeding with registering it in New Zealand and Australia in multiple crops for several insect pests such as weevils, borers, leafrollers, white grubs, **Lepidoptera** and beetles including African black beetle. Hort innovation has several projects underway towards crop extension to cover several crops; stalk and stem veg for LBAM, Helicoverpa; Potato for Whitefringed weevil, African black beetle; Sweet potato for weevil and whitefringed weevil.	M VH-Bees	
Lucerne leafroller (*Merophyas divulsana*) **Priority: Low**								
Lucerne leafroller has not been identified as a priority pest in the survey however, other industry sources indicate that it is a significant pest in carrots.								
Bacillus thuringiensis subsp. kurstaki (Biocrystal)	11	Biological	NR	A	ALL	Registered in vegetables for control of **caterpillars.** [Apply a minimum of 2 sprays, 3 d apart; re-treatment interval 3-5 d]	VL	-
Diazinon (Accensi)	1B	Contact and systemic	14 G 14	A	Qld, NSW, Vic, SA & WA	Registered in carrots for control of **caterpillars**. [Max no. of applications and re-treatment interval not specified]	H VH-Bees	R3
Emamectin (Proclaim Pro)	6	Contact and systemic	3	A	ALL	Registered in carrots and other tuber vegetables for control of Helicoverpa, Diamondback moth, **loopers** and cluster caterpillars. [Max of 4 sprays per crop; re-treatment interval 7 d]	M H-Bees	-
Pyrethrins+piperonyl butoxide (Kendon)	3A	Contact	1	A	ALL	Registered in vegetables for control of ants, aphids, thrips, **caterpillars**, leaf hoppers, and whitefly. [Max no. of applications not specified; re-treatment interval: 7 d]	VH H-Bees	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Rotenone (Amgrow Derris Dust)	-	-	1	A	ALL	Registered in vegetables for control of **caterpillars**. [Max no. of applications not specified; Re-treatment interval: 10-14 d]	-	-
Indoxacarb + Novaluron (Plemax)	22A + 15	Contact and stomach		P		Registration pending for control of **Lepidoptera** including Helicoverpa spp. Registered in South Africa on a range of crops for Lepidoptera control.	L H-Bees	
Spinosad (Entrust)	5	Contact and ingestion		P		Dow is going through the process of registering product for control of Diamondback moth, Cabbage white butterfly, Cabbage cluster caterpillar, Cabbage centre grub, **Loopers**, Heliothis and Western flower thrip in Brassica vegetables.	L H-Bees	-
SYNFOI21 (Syngenta)	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for thrips, bugs and **caterpillars**.		
Thrips (Thysanoptera) **Onion thrips, Plague thrips, Tomato thrips, Western Flower thrips** (*Thrips tabaci, T. imagines, Frankliniella schultzei, F. occidentalis*) **Priority: Low**								
Thrips were consistently ranked as a low priority in every consulted region. Thrips normally move in from other crops and weeds. They are not direct pests of carrot but act as vectors in transmitting many viral diseases such as Tomato Spotted Wild Virus (TSWV). Weed control will assist management as thrips can have a range of hosts.								
Maldison (Hy-mal)	1B	Contact and systemic	1	A	All Exc ACT & QLD	Registered in carrots for control of aphid, green vegetable bug, Jassids, Rutherglen bug and **thrips**. [Apply at first sight of infestation: max no. of applications not specified]	H H-Bees	-
Potassium salts of fatty acids (various)	-	Contact biological	NR	A	ALL	Registered for control of aphids, thrips, mealybug, two spotted mite, spider-mite and whitefly.	-	-
Phorate (Umet)	1B	Contact and systemic	70	A	ALL	Registered in carrots for the control of or control of carrot fly, aphids, **thrips** and jassids. Incorporate into soil or apply as band 5 cm from each side of crop. Apply when rai is expected, or overhead irrigation can be made.	H H-Bees	R3
Pyrethrins+piperonyl butoxide (Kendon)	3A	Contact	1	A	ALL	Registered in vegetables for control of ants, aphids, **thrips**, caterpillars, leaf hoppers, and whitefly. [Max no. of applications not specified; re-treatment interval: 7 d]	VH	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Rotenone (Amgrow Derris Dust)	-	-	1	A	ALL	Registered in vegetables for control of **thrips**. [Max no. of applications not specified; Re-treatment interval: 10-14 d]	-	-
Flonicamid (Mainman)	9C	Systemic		P		Registered in cucurbits for control of **aphids** and silverleaf white fly; **aphids** in potatoes; **aphids** and mealybugs in apples and pears; aphids and mirids in cotton. Hort Innovation is undertaking trials in bulb vegetables in support of a permit for thrip control.	M	
Spirotetramat (Movento 240 SC)	23	Contact and systemic		P		Currently registered in other vegetables for control of **thrips**. IPM compatible.	M	
SYNFOI21 (Syngenta)	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for **thrips**, bugs and caterpillars.	-	-
Beauveria bassiana (Broadband OD) BASF	-	Biological		P		Registered for control of **thrips**, mites and aphids in protected vegetables and ornamentals. Another product, (Velifer) with the same active is registered by BASF and is expected in the market soon.	VL	-
Vegetable weevil (*Listroderes difficilis*) **Priority: Low**								
Vegetable weevil has not been identified as a priority pest in the industry survey, however other industry sources indicate that it is a significant pest in carrots.								
Chlorpyrifos (Guangxin)	1B	Systemic and contact	NR	A	NSW & WA	Registered in carrots for control of Lightbrown apple moth, wingless grasshopper, cutworm, field crickets, mole crickets and **vegetable weevil**.	H H-Bees	R1
Indoxacarb (Avatar)	22A	Contact and stomach		P		Registered for control of **weevils** in pome and stone fruits.	M M-Bees	

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Tetraniliprole (Vayego) Bayer	28	Disrupts feeding		P		Not registered in Australia, but Bayer is proceeding with registering it in New Zealand and Australia in multiple crops for several insect pests such as **weevils**, borers, leafrollers, white grubs, Lepidoptera and beetles including African black beetle. Hort innovation has several projects underway towards crop extension to cover several crops; stalk and stem veg for LBAM, Helicoverpa; Potato for Whitefringed weevil, African black beetle; Sweet potato for weevil and whitefringed weevil.	M VH-Bees	
White-fringed weevil (*Naupactus leucoloma*) **Priority: Low**								
White-fringed weevil was consistently ranked as a low priority in every consulted region apart from TAS, where it was ranked as a moderate priority. It can be an issue in late spring and monitoring is crucial for to decide on spray. Big issue for fresh market carrot growers. Crop rotation with other crops can help in managing this issue.								
Fipronil (various) PER86665	2B	Contact and systemic	NR	A	ALL (excl. Vic)	PER86665 for control of **white fringed weevil** and symphylids in carrots. [Max of 1 application per crop]	M VH-Bees	R3
Indoxacarb (Avatar)	22A	Contact and stomach		P		Registered for control of **weevils** in pome and stone fruits.	M M-Bees	
Tetraniliprole (Vayego) Bayer	28	Disrupts feeding		P		Not registered in Australia, but Bayer is proceeding with registering it in New Zealand and Australia in multiple crops for several insect pests such as **weevils**, borers, leafrollers, white grubs, Lepidoptera and beetles including African black beetle. Hort innovation has several projects underway towards crop extension to cover several crops; stalk and stem veg for LBAM, Helicoverpa; Potato for Whitefringed weevil, African black beetle; Sweet potato for weevil and whitefringed weevil.	M VH-Bees	
Wireworms and False wireworms (*Arachnodima* spp., *Agrypnus* spp., *Gonocephalum* spp.) **Priority: Low**								
False wireworms were consistently ranked as a low priority in every consulted region. Soil fumigation can help as they live in soil feeding on young plant roots.								
1,3-dichloropropene (Tri-Form)	-	Soil fumigant	NR	A	ALL	Registered in vegetables for control of soil borne pests. Leave soil undisturbed for 14 d after treatment.	-	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Bifenthrin (Genfarm)	3A	Contact and ingestion		P		Registered in cotton and sugar cane for control of **wireworm**.	VH H-Bees	-
Broflanilide (Vedira) BASF	30	Contact and ingestion		P		Registration submitted concurrently in Australia, Canada, USA, and Mexico as a soil application and seed treatment against chewing insects such as ants, cockroaches and *Spodoptera* spp. BASF are seeking registrations in amenity turf initially, then potential horticultural crops thereafter.	H VH-Bees	-
Clothianidin + Imidacloprid (Poncho Plus)	4A	Protective		P		Registered in sweet corn, sunflower, canola and forage brassica for control of **wireworms**, cutworms and aphids. Will provide early protection for 3-4 weeks after sowing.	M VH-Bees	R2
Fipronil (Agritrading)	2B	Contact and systemic		P		Registered in potatoes for control of **wireworms**. Apply as a broadcast spray to surface of soil and incorporate to a depth of 15 cm prior to planting.	M VH-Bees	R3
Imidacloprid (RedQueen)	4A	Systemic		P		Registered in cotton, maize, sorghum, sunflower and sweet corn for control of **wireworm**.	M M-Bees	R2
Phorate (Zeemet)	1B	Contact and systemic		P-A		Registered in carrots for the control of or control of carrot fly, aphids, thrips and jassids. Registered in potatoes for control of **wireworms**.	H H-Bees	R3

4.3 Weeds in carrots

4.3.1 Weed priorities

Common Name	Scientific Name
High	
Annual ryegrass (Resistance - predominantly Group A)	*Lolium rigidum*
Moderate	
Nutgrass	*Cyperus rotundus*

Other weeds nominated	State
Potato weed (*Galinsoga* spp.)	WA
Carrot weed *(Cotula australis)*	Qld & Tas
Fumitory *(Fumaria* spp.*)*	Qld
Marshmallow *(Malva parviflora)*	Vic & Qld
Stinging nettle *(Urtica* spp.*)*	Qld
Cleavers *(Galium aparine L.)*	Tas
Sow thistle *(Sonchus oleraceus)*	WA & Tas
Wild radish *(Raphanus raphanistrum)*	WA

The high priority weed issues based on the feedback received was Ryegrass whilst Nut grass received a Moderate priority which was not present in the previous SARP report.

Weed control in many cases is aided by soil fumigation, which also helps in controlling some soil borne pests and pathogens.

Given the small number of respondents it is difficult to assess how broadly these weed issues are impacting across the industry.

Specific resistance management strategies for high resistance risk (A and B) and moderate resistance risk (C, D, F, G, I, J, K, L, M, N, Q and Z) herbicide modes of action are available on the CropLife Australia webpage.
https://www.croplife.org.au/resources/programs/resistance-management/herbicide-resistance-management-strategies-2/

4.3.2 Available and potential products for weed control

TABLE KEY: Note that blank fields in the table indicate no information has been provided.

Availability			
A	Available via either registration or permit approval		
P	Potential – a possible candidate to pursue for registration or permit		
P-A	Potential, already approved in the crop for another use		
Resistance risk		**Regulatory risk (refer to Appendix 6)**	
		R1	Short-term: Critical concern over retaining access
**	Moderate resistance risk	R2	Medium-term: Maintaining access of significant concern
***	High resistance risk	R3	Long-term: Potential issues associated with use - Monitoring required
Withholding Period (WHP) – Number of days from last treatment to harvest (H) or Grazing (G)			
Harvest	H	Not Required when used as directed	NR
Grazing	G	No Grazing Permitted	NG

Active ingredient (Trade Name)	Chemical Group	Crop/ Situation	Comment / Use / Weed	WHP (days)	Availability	States	Regulatory risk
Annual ryegrass (predominantly Group A) (*Lolium rigidum*) **Priority: High**							
Resistant ryegrass was consistently ranked as a high priority in every consulted region apart from QLD where it was ranked as a moderate priority. Where ryegrass is not resistant, control options were good especially in WA. In situations where ryegrass is resistant to herbicides, hand weeding and use of mechanical control seem to be an option.							
Clethodim (Arysta) PER82459	A***	Carrots / post-emergent	PER82459 for control of grass weeds (including **annual rye grass**) in carrots. [Max. 1 application per crop]	28	A	ALL	R3
Fluazifop-P as butyl (Surefire)	A***	Carrots / post-emergent	Registered for control of various grasses including **annual rye grass**.	49	A	ALL	-
Glyphosate (various)	M**	General knockdown. Pre-crop spray	Registered for control of general weeds as a pre-crop spray	NR	A	ALL	-

Active ingredient (Trade Name)	Chemical Group	Crop/ Situation	Comment / Use / Weed	WHP (days)	Availability	States	Regulatory risk
Metribuzin (Sencor) PER80169 Version 3	C**	Carrots/ pre-emergent	PER80169 for control of broadleaf and grass weeds including **annual rye grass** in carrots. [Max. 2 applications per crop]	NR	A	Qld only	-
Paraquat +/- diquat (various)	L**	General seed bed preparation / Post-emergence inter-row weed control	General weeds as a pre-crop spray. Only used in field grown crops. Post-emergence inter-row weed control (shielded spray – do not touch the crop). Add diquat where broadleaf weeds dominate. [Max no of applications not specified]	NR	A	ALL	R2
Prometryn (Nufarm)	C**	Carrots / pre- and post-emergent	Registered in carrots for control of broad leaf and grass weeds including suppression of **annual rye grass**.	NR	A	NSW, Vic & Tas only	-
Quizalofop-P-ethyl (Sabakem)	A***	Carrots/Post emergent grass selective	Registered in carrots for control of various grass weeds (including **annual ryegrass**). Apply when weeds are actively growing. [Max no of applications not specified]	70	A	ALL	R3
Sethoxydim (Sertin)	A***	Carrots / Post-emergent	Registered in carrots for control of various grass weeds (including a**nnual ryegrass**). [Max no of applications not specified]	NR	A	ALL	-
Trifluralin (Titan)	D**	Carrots / pre-emergent	Registered in carrots for control of various grass weeds (including a**nnual ryegrass**).	NR	A	ALL	-
Metolachlor+ Prosulfocarb (Boxer Gold)	J+K**	Potatoes / Pre-emergent weed control	Registered in potatoes for control of **ryegrass**. Apply after planting, but no later than 25% potato shoot emergence. Hort Innovation is progressing to undertake the required studies in carrots for a label registration	NR	P	ALL	
Norflurazon (Zoliar)	F**	asparagus, citrus, grapes, nuts, stone and pome fruits / pre-emergent / grass and broadleaf	Registered in asparagus, citrus, grapes, nuts, stone and pome fruits for control of **grass** and **broadleaf weeds** including **nut grass**. [Max. 2 applications per year; re-treatment interval not specified].	14	P	ALL	

Active ingredient (Trade Name)	Chemical Group	Crop/ Situation	Comment / Use / Weed	WHP (days)	Availability	States	Regulatory risk
Pendimethalin (Stark)	D**	Carrots/ pre-emergent / grass and broadleaf	Registered in wheat, barley, chickpeas, faba beans, safflower, lupins and field peas for control of **annual ryegrass**. Registered in carrots for control of various grasses and broadleaf weeds.	NR	P-A	ALL	
Pendimethalin + Dimethenamid (Podium)	D+K**	Ornamental plants & recreational turf / pre-emergent /grass and broadleaf	Registered in ornamentals & recreational turf for control of **grass** and **broadleaf weeds** [Max. no. of applications not specified; re-treatment interval 60 – 90 d]	NG	P	ALL	
Nut grass (*Cyperus rotundus*) **Priority: Moderate**							
This weed is dormant in Winter. Management can be done by spot spraying and mechanical removal.							
2,4-D Acid (Farmalinx)	I**	Post emergent spot spray/selective	Registered for spot spraying on all situations for control of a range of weeds including **nutgrass**. Thorough wetting of weed essential. [Spray within 4 weeks of foliage emergence; repeat if necessary].	NR	A	ALL	-
Glyphosate (various)	M**	General knockdown. Pre-crop spray	Registered for control of general weeds as a pre-crop spray	NR	A	ALL	-
Norflurazon (Zoliar)	F**	asparagus, citrus, grapes, nuts, stone and pome fruits / pre-emergent / grass and broadleaf	Registered in asparagus, citrus, grapes, nuts, stone and pome fruits for control of **grass** and **broadleaf weeds** including **nut grass**. [Max. 2 applications per year; re-treatment interval not specified].	14	P	ALL	
Potato weed (*Galinsoga* spp.), **Carrot weed** *(Cotula australis)* (Qld & Tas), **Fumitory** (*Fumaria* spp.) (Qld), **Marshmallow** (*Malva parviflora*) (Vic & Qld), **Stinging nettle** (*Urtica* spp.) (Qld), **Cleavers** (*Galium aparine L.*) (Tas), **Sow thistle** (*Sonchus oleraceus*) (WA) and **Wild radish** (*Raphanus raphanistrum*) (WA).							
The above weeds were issues in one or two States. Managing these would be possible using herbicides mentioned in Appendix 3 or by various management practices such as soil fumigation, pre-crop spraying, spot spraying, or using mechanical devices.							

Active ingredient (Trade Name)	Chemical Group	Crop/ Situation	Comment / Use / Weed	WHP (days)	Availability	States	Regulatory risk
Chlorthal-Dimethyl (AgProject)	D**	Carrots / pre-emergent	Registered in carrots for control of various grass and broadleaf weeds including **sow thistle**. Spray at transplanting.	NR	A	ALL	-
Glyphosate (various)	M**	General knockdown. Pre-crop spray	Registered for control of general weeds as a pre-crop spray	NR	A	ALL	-
Linuron (4Farmers)	C**	Carrots / pre-emergent	Registered in carrots for control of a range of broadleaf weeds including **wild radish**, wild turnip and slender **thistle**. Do not apply before carrots are in 2-3 leaf stage.	70	A	ALL	
Pendimethalin (Stark)	D**	Carrots/ pre-emergent / grass and broadleaf	Registered in carrots for control of various grasses and broadleaf weeds including **wild radish** and **sow thistle.** For optimum performance, 12-25 mm of spray irrigation or rainfall is needed within 1 d of application.	NR	A	Qld, NSW, Vic, SA, Tas, WA only	-
Prometryn (Nufarm)	C**	Carrots / pre- and post-emergent	Registered in carrots for control of grass and broad leaf weeds including **fumitory, wild radish, sow thistle** (Qld) and potato weed (SA & WA).	NR	A	NSW, Vic & Tas only	-
Prometryn (Nufarm) PER12048 Version 3	C**	Carrots / post-emergent	PER12048 for control of broadleaf weeds in carrots including **wild radish**. [Max. 1 application per crop]	NR NG	A	Qld only	-
Norflurazon (Zoliar)	F**	asparagus, citrus, grapes, nuts, stone and pome fruits / pre-emergent / grass and broadleaf	Registered in asparagus, citrus, grapes, nuts, stone and pome fruits for control of **grass** and **broadleaf weeds.** [Max. 2 applications per year; re-treatment interval not specified].	14	P	ALL	

5. References

5.1 Information:

AgChem Access Priority Access Forum	https://www.agrifutures.com.au/national-rural-issues/agvet-chemicals/
Australian Pesticide and Veterinary Medicines Authority	www.apvma.gov.au
APVMA Chemical review	https://apvma.gov.au/chemicals-and-products/chemical-review/listing
APVMA MRLs	www.comlaw.gov.au/Series/F2012L02501
APVMA Permit search	https://productsearch.apvma.gov.au/permits
APVMA Product search	https://productsearch.apvma.gov.au/products
Codex MRL database	http://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/en/
Cotton Pest Management Guide 2018-19	https://www.cottoninfo.com.au/publications/cotton-pest-management-guide
CropLife Australia	https://www.croplife.org.au/
Growcom – Infopest Database	www.infopest.com.au
Hort Innovation	www.horticulture.com.au
Ausveg	https://ausveg.com.au/
Agriculture and Food - WA	https://www.agric.wa.gov.au

5.2 Abbreviations and Definitions:

APVMA	Australian Pesticides and Veterinary Medicines Authority
IPM	Integrated pest management
LOQ	Limit of quantification
MRL	Maximum residue limit (mg/kg or ppm)
Pesticides	Plant protection products (fungicide, insecticide, herbicide, nematicides, rodenticides, etc.).
Plant pests	Diseases, insects, nematodes, rodents, viruses, weeds, etc.
SARP	Strategic Agrichemical Review Process
TBC	To be continued
WHP	Withholding Period

5.3 Acknowledgements:

Thanks go to the many industry people who contributed information and collaborated on the review of this report.

6. Appendices:

Appendix 1. Products available for disease control in carrot
Appendix 2. Products available for control of insects and mites in carrot
Appendix 3. Products available for weed control in carrot
Appendix 4. Current permits for use in carrot
Appendix 5. Carrot Maximum Residue Limits (MRLs)
Appendix 6. Carrot regulatory risk assessment

Appendix 1. Products available for disease control

Active Ingredient (Trade Name)	Chem. group	Situation	Diseases / Comments	States	WHP Days	Regulatory risk
Azoxystrobin + difenoconazole (Amistar)	3+11	Carrots	Leaf blight (Alternaria and Cercospora), powdery mildew	ALL	7	R3
Boscalid (various)	7	Root & Tuber vegetables	Sclerotinia in root and tuber vegetables.	ALL	7	-
Chlorothalonil (various)	M5	Carrots	Leaf blight	ALL	7	R2
Copper (various)	M1	Carrots	Leaf spot	ALL	1	-
Dazomet (Cerlong)	-	Soil fumigant	Soil fungi, nematodes, soil insects and weeds	ALL	NR	-
Difenoconazole	3	Carrots	Leaf spot	ALL	7	R3
Iprodione PER84955	2	Carrots	PER84955- suppression of black rot	ALL (Excl. Vic)	NR	R2
Mancozeb	M3	Carrots	Cercospora leaf spot, Alternaria leaf spot	ALL	7	R2
Mancozeb+ Metalaxyl/metalaxyl-M (Ridomil Gold MZ) PER14045	4 +M3	Carrots	PER14045- *Pythium* spp. and *Phytophthora* spp.	ALL (Excl. Vic)	7	R2
Metalaxyl (various)	4	Carrots	Damping off, *Phytophthora* spp.	NSW, Qld, WA only	NR	-
Metalaxyl-M (various)	4	Carrots	Damping off (seed treatment)	ALL	NR	-
Metham sodium (Metham)	-	Soil fumigant	Nematodes, fungi, and weed seeds.	ALL	NR	-
Metiram (Polyram)	M3	Carrots	Cercospora leaf spot, Alternaria leaf spot	ALL	7	R2

Active Ingredient (Trade Name)	Chem. group	Situation	Diseases / Comments	States	WHP Days	Regulatory risk
Penthiopyrad (Fontelis)	7	Carrots	Early blight (Target spot, leaf spot), powdery mildew	ALL	7	-
Phosphorous acid PER14184	33	Carrots	PER14184- Damping off	ALL (Excl. Vic)	1	-
Streptomyces lydicus strain WYEC108 (Actinovate)	-	Carrots	Powdery mildew - Foliar All crops – Biological soil amendment to supplement the activity of natural soil organisms (soil-drench) Vegetable Seed Treatment: *Fusarium, Rhizoctonia and Pythium*	ALL	NR	-
Sulphur + Mancozeb (various)	M3	Vegetables	Damping off	ALL	7	R2
Sulphur (Solo)	M2	Vegetables	Powdery mildew, rust, tomato russet mite, bean spider mite, and two-spotted mite	Variable refer to label	NR	-
Tebuconazole (Folicur 430SC) PER82461	3	Carrots	PER82461- suppression of powdery mildew	NSW, SA and Tas only	21	-
Zineb (Barmac Zineb)	Y	Carrots	Cercospora leaf spot, Alternaria leaf spot	Variable. Refer to label.	7	R2

Appendix 2. Products available for control of insects, mites and other invertebrates

Active Ingredient (Trade Name)	Chem. group	Situation	Pests / Comments	States	WHP Days	Regulatory risk
1,3-dichloropropene (Tri-Form)	-	Field crops	Plant parasitic nematodes in field crops.	ALL	NR	-
Bacillus Thuringiensis var Kurstaki (Btk) (Biocrystal)	11	Vegetables	*Helicoverpa armigera and Helicoverpa punctigera* and various Lepidoptera. Very effective on small grubs but needs regular reapplication. UV sensitive	ALL	NR	-
Chlorpyrifos (various)	1B	Carrots	Lightbrown apple moth, wingless grasshopper, cutworm, field crickets, mole crickets, vegetable weevil	ALL	NR	R2
Dazomet (Cerlong)	-	Soil fumigant	Soil fungi, nematodes, soil insects and weeds	ALL	NR	-
Diazinon (Various)	1B	Carrots	Caterpillars, cutworms	Qld, NSW, Vic, SA & WA only	14	-
Flubendiamide (Belt)	28	Carrots	diamondback moth, cabbage white butterfly, cluster caterpillar, potato moth (leaf miner) and *Helicoverpa* spp.	ALL	1	-
Imidacloprid (Confidor) PER10918	4A	Carrots	Aphids (including Green Peach Aphid Carrot Aphid and Fennel Aphid)	ALL	7	R2
Maldison (Fyfanon, Hy-Mal)	1B	Carrots	Aphid, green vegetable bug, jassid, leaf hopper, red legged earth mite, Rutherglen bug, twenty-eight spotted ladybirds	NSW, Vic, Qld, SA, WA, Tas only	3	-
Metham sodium (METHAM)	-	Soil fumigant	Nematodes, various weeds and fungi in field crops.	ALL	NR	-
Phorate (various)	1B	Carrots	Aphids, carrot fly, thrips and jassids	ALL	70	R3

Active Ingredient (Trade Name)	Chem. group	Situation	Pests / Comments	States	WHP Days	Regulatory risk
Potassium salts of fatty acids (Natrasoap)	-	Vegetables	Aphids, thrips, mealybug, two-spotted mite, spider mite, whitefly. Not used by growers.	ALL	Nil	-
Pyrethrins+piperonyl butoxide (various)	3A	Vegetables	Ants, aphids, thrips, caterpillars, leaf hoppers, and whitefly.	ALL	1	-
Rotenone (Derris Dust)	-	Vegetables	Aphids, cabbage white butterfly, cabbage moth, cabbage-centre grub, caterpillars, potato moth (leafminer), thrips	ALL	1	-
Spinetoram (Success Neo)	5	Tuber & root vegetables	Helicoverpa, Lightbrown apple moth, Potato moth (Leafminer)	ALL	3	-
Sulfoxaflor (Transform)	4C	Carrots	Green peach aphid	ALL	7	-
Trichlorfon (Tyranex)	1B	Vegetables	Cabbage white butterfly, cabbage moth, green vegetable bug, and Rutherglen bug	ALL	2	R1

Appendix 3. Products available for weed control in carrots

Active ingredient (Trade Name)	Chem. Group	Situation	Comment / Use / Weed	WHP (days)	States	Regulatory risk
2,4-D Acid (Farmalinx)	I**	Post emergent spot spray/selective	Post emergent spot spray spraying on all situations for control of a range of weeds including nutgrass.	NR	ALL	-
Chlorthal-dimethyl (various)	D**	Carrots/ Pre-emergent residual	Large number of weeds in carrots. Rarely used and only for problem paddocks - specific weeds.	NR	Qld, Vic, SA, WA, Tas, NT only	-
Clethodim (Select) PER82459	A***	Carrots / Grass selective post-emergent	Grass weeds. Used for fop resistant ryegrass and Winter grass control. Considered effective. Some issues with resistant ryegrass. Used as a spot spray for couch control.	28	ALL	-
Fluazifop-P as butyl (various)	A***	Carrots / Grass selective post-emergent	Grass weeds including annual rye grass.	49	ALL	-
Glyphosate	M**	Pre-plant general knockdown	Pre-crop spray, general weeds	NR	ALL	-
Glyphosate PER13305	M**	Shielded sprays between rows	PER13305- shielded sprays between rows. Do not let product contact crops.	NR	ACT, NSW, Qld, SA, Tas, NT & WA	-
Linuron (Lorox)	C**	Carrots / General knockdown & residual	Pre- and post-emergent, broad leaf weeds including Blackberry nightshade, Fat hen and Stinging nettles. Do not apply after 5-leaf stage.	70	ALL	-
Metribuzin PER80169	C**	Carrots / Selective broadleaf spray, pre and post emergent	Various broadleaf and grass weeds including annual rye grass.	NR	Qld only	-
Paraquat +/- diquat (various)	L**	General seed bed preparation / Post-emergence inter-row weed control	General weeds as a pre-crop spray. Only used in field grown crops. Post-emergence inter-row weed control (shielded spray – do not touch the crop). Add diquat where broadleaf weeds dominate.	NR	ALL	-

Active ingredient (Trade Name)	Chem. Group	Situation	Comment / Use / Weed	WHP (days)	States	Regulatory risk
Pendimethalin (Stomp)	D**	Carrots / pre-emergent / Residual	Most annual grasses and certain Broadleaf weeds including fat hen, chick weed and dead nettle. Suppresses certain weeds including blackberry nightshade, fumitory, Brassica weeds and winter grass.	NR	Qld, NSW, Vic, SA, Tas, WA only	-
Prometryn (various) PER12048	C**	Carrots / Pre and post emergent	Broadleaf weeds. Use in different stages of carrot growth is subject to different state regulations. Refer to permit and labels.	NR NG	Qld only	-
Quizalofop-P-ethyl (Sabakem)	A***	Carrots / grass selective post-emergent	Selected grass weeds including annual ryegrass.	14	ALL	R3
Sethoxydim (various)	A***	Grass selective post-emergent	Selected grass weeds including annual ryegrass.	NR	ALL	-
Trifluralin (Titan)	D**	Residual	Pre-tank mix with linuron. Various grass weeds including annual rye grass and broad leaf weeds including pig weed, red root, redshank and wire weed.	NR	ALL	-

Appendix 4. Current permits for use in carrots

Permit No.	Description	Issued Date	Expiry Date	States	Permit Holder
PER82459	Clethodim / Carrots / Various grass weeds	19-Apr-17	30-Sep-21	ALL	Hort Innovation
PER86665	Fipronil / Carrots / White fringed weevil and Symphylids	4-Jan-19	31-Jan-22	ALL (Excl. Vic)	Hort Innovation
PER13305 Version 4	Glyphosate (various) / Carrots / Grass and broadleaf weeds (Shielded sprays between rows)	28-May-12	30-Jun-20	ALL (Excl. Vic)	Hort Innovation
PER10918 Version 3	Imidacloprid / Carrots / Aphids (Green peach, Carrot and Fennel Aphids)	30-Jun-15	31-Dec-23	ALL	Hort Innovation
PER84955	Iprodione / Carrots / Black rot suppression	12-Feb-18	28-Feb-23	ALL (Excl. Vic)	Hort Innovation
PER14045 Version 3	Mancozeb + Metalaxyl-M / Carrots / Pythium and Phytophthora	01-Apr-13	31-Mar-22	ALL (Excl. Vic)	Hort Innovation
PER80169 Version 3	Metribuzin / Carrots / Various broadleaf and grass weeds as per product label	03-Mar-15	30-Apr-24	QLD only	Hort Innovation
PER14184 Version 2	Phosphorous acid / Carrots / Damping off	01-Jul-13	30-Jun-22	ALL (Excl. Vic)	Hort Innovation
PER12048 Version 3	Prometryn / Parsnip & Carrot / Broadleaf weeds as listed on the approved label	9-May-12	30-Sep-20	Qld only	Hort Innovation
PER82461	Tebuconazole / Carrots / Powdery mildew (suppression only)	16-Aug-17	31-Aug-20	ALL (Excl. Vic)	Hort Innovation

Appendix 5. Carrot Maximum Residue Limits (MRLs)

CODEX commodity grouping of Root and tuber vegetables:

VR0075 Root and tuber vegetables
VR0577 Carrot

Note: Major export markets for carrots include United Arab Emirates, Saudi Arabia, Malaysia, Singapore and Qatar. Available information indicates that in the absence specific limits in legislation the most countries defers to Codex, followed by EU MRL standards or applies a 0.01ppm default value. Food exported to New Zealand from Australia may be legally sold if it complies with Australian requirements. MRLs and legislation are subject to change; the values presented should not be relied on.

Chemical	Codex	Description	APVMA MRL mg/kg	Codex MRL mg/kg
Abamectin	VR0075	Root and tuber vegetables	T*0.01	-
Aldrin and Dieldrin	VR0075	Root and tuber vegetables	E0.1	0.1
Azoxystrobin	VR0075	Root and tuber vegetables	-	1
	VR0577	Carrot	0.2	
Bifenthrin	VR0075	Root and tuber vegetables	-	0.05
Boscalid	VR0075	Root and tuber vegetables	1	2
Carbaryl	VR0577	Carrot	-	0.5
Carbendazim	VR0577	Carrot	-	0.2
Chlorantraniliprole	VR0577	Carrot	-	0.08
	VR0075	Root and tuber vegetables	T0.05	
Chlorothalonil	VR0075	Root and tuber vegetables	-	0.3
	VR0577	Carrot	7	
Clothianidin	VR0075	Root and tuber vegetables	-	0.2
Chlorpyrifos	VR0577	Carrot	-	0.1
Cyantraniliprole	VR0075	Root and tuber vegetables	-	0.05
Cycloxydim	VR0577	Carrot	-	5
Cyhalothrin (includes lambda-cyhalothrin)	VR0075	Root and tuber vegetables	-	0.01
Cypermethrins (including alpha- and zeta- cypermethrin)	VR0075	Root and tuber vegetables	-	0.01
Cyprodinil	VR0577	Carrot	-	1.5
DDT	VR0577	Carrot	-	0.2
Deltamethrin	VR0577	Carrot	-	0.02
Diazinon	VR0577	Carrot	-	0.5
Dichloran	VR0577	Carrot	-	15
Difenoconazole	VR0577	Carrot	0.2	0.2
Dimethoate	VR0577	Carrot	T0.3	-
Dithiocarbamates	VR0577	Carrot	1	1
Fenamidone	VR0577	Carrot	-	0.2
Fenamiphos	VR0075	Root and tuber vegetables	0.2	-
Fentin	VR0577	Carrot	0.2	-
Fluazifop-p-butyl	VR0075	Root and tuber vegetables	T1	-
Flubendiamide	VR0075	Root and tuber vegetables	0.2	-
Fludioxonil	VR0577	Carrot	-	0.7
Fluopyram	VR0577	Carrot	-	0.4
Fluxapyroxad	VR0577	Carrot	-	1
Glufosinate-Ammonium	VR0577	Carrot	-	0.05
Glyphosate	VR0075	Root and tuber vegetables	*0.1	-

Chemical	Codex	Description	APVMA MRL mg/kg	Codex MRL mg/kg
Heptachlor	VR0577	Carrot	E0.2	-
Imidacloprid	VR0075	Root and tuber vegetables	-	0.5
	VR0577	Carrot	T0.5	-
Iprodione	VR0577	Carrot	T0.5	10
Maldison	VR0577	Carrot	0.5	-
Maleic hydrazide	VR0577	Carrot	T40	-
Metalaxyl	VR0577	Carrot	-	0.05
Methomyl	VR0075	Root and tuber vegetables	1	-
Methoxyfenozide	VR0577	Carrot	-	0.5
Metribuzin	VR0577	Carrot	T0.3	-
Myclobutanil	VR0075	Root and tuber vegetables	-	0.06
Oxamyl	VR0577	Carrot	-	0.1
Paraquat	VR0075	Root and tuber vegetables	-	0.05
Pendimethalin	VR0075	Root and tuber vegetables	*0.05	-
Penthiopyrad	VR0577	Carrot	-	0.6
	VR0075	Root and tuber vegetables	2	-
Permethrin	VR0577	Carrot	-	0.1
Phorate	VR0577	Carrot	0.5	-
Phosphine	VR0075	Root and tuber vegetables	T*0.01	-
Phosphorous acid	VR0075	Root and tuber vegetables	T100	-
Pirimicarb	VR0075	Root and tuber vegetables	-	0.05
Procymidone	VR0075	Root and tuber vegetables	T1	-
Pyraclostrobin	VR0577	Carrot	-	0.5
Pyrethrins	VR0075	Root and tuber vegetables	-	0.05
Pyrimethanil	VR0577	Carrot	-	1
Quizalofop-ethyl	VR0577	Carrot	*0.02	-
Quizalofop-P-tefuryl	VR0577	Carrot	*0.02	-
Sethoxydim	VR0075	Root and tuber vegetables	1	-
Spinetoram	VR0075	Root and tuber vegetables	0.02	-
Spinosad	VR0075	Root and tuber vegetables	0.02	-
Sulfoxaflor	VR0577	Carrot	-	0.05
	VR0075	Root and tuber vegetables	0.05	-
Tebuconazole	VR0577	Carrot	T0.5	0.4
Thiamethoxam	VR0075	Root and tuber vegetables	T0.7	0.3
Trifloxystrobin	VR0577	Carrot	-	0.1
Trifluralin	VR0577	Carrot	0.5	-

NOTE: MRLs are constantly under review and subject to change. Check for current MRLs and do not rely on the values stated above.

* Indicates that an MRL is at the Limit of Quantitation (LOQ)
NR - Uses of substances where MRLs are not necessary / required.
T =Temporary MRL
E = The MRL is based on extraneous residues

Sources: APVMA MRLs: Agricultural and Veterinary Chemicals Code Instrument No. 4 (MRL Standard) 2012. Compilation 75. Prepared 28 May 2019. CODEX MRLs: In addition to the online CODEX database, meeting reports were used to update recent changes (to February 2019).

Appendix 6. Carrot regulatory risk assessment

Carrot
Agrichemical Regulatory
Risk Assessment

October 2019

Regulatory pressures on agrichemicals are increasing globally, with many being either restricted or withdrawn from use. For older agrichemicals these pressures are often the result of reconsiderations involving new or refined risk assessment methodologies that requiring the generation of new data. A consequence of which can be that many of these agrichemicals are not meeting contemporary risk assessment standards as the necessary data is unavailable, or where data is available, the risk posed is considered unacceptable.

The use of agrichemicals can also be impacted through differences in standards between trading partners. The lack of an appropriate pesticide maximum residue limit (MRL) in an importing country can, for practical purposes, effectively prohibit use in the exporting country so as to ensure compliance, as a MRL breach would adversely affect market access.

The effects of the above are greater regulatory pressure placed on the use of individual agrichemicals or chemical groups. As a consequence, it is possible that the number of approved agrichemical options could be adversely impacted.

To assist strategic planning, with respect to future pest management options, the following tables have been developed to highlight the regulatory threats to agrichemicals currently approved for the management of the pests and diseases in carrots as well as current initiatives aimed at addressing identified pest management deficiencies.

Carrot regulatory risk assessment

R1	Short-term: Critical concern over retaining access
R2	Medium-term: Maintaining access of significant concern
R3	Long-term: Potential issues associated with use - Monitoring required

Problem	Active Constituents	Chemical Group	Comment	Activities
INSECT AND MITE PESTS				
Aphids				
Aphids	Imidacloprid (PER10918)	**4A**	Canada – Proposed cancelling majority of foliar and soil uses EU – Removal of all field uses	Commonwealth Grant project data generation for Versys®
	Maldison	**1B**	APVMA – Under review – chemistry	
	Phorate	**1B**	APVMA – Nominated for review EU: No authorisation in place	
Carrot aphid	Imidacloprid (PER10918)	**4A**	Canada – Proposed cancelling majority of foliar and soil uses EU – Removal of all field uses	
	Phorate	**1B**	APVMA – Nominated for review EU: No authorisation in place	
Fennel aphid	Imidacloprid (PER10918)	**4A**	Canada – Proposed cancelling majority of foliar and soil uses EU – Removal of all field uses	
Green peach aphid	Imidacloprid (PER10918)	**4A**	Canada – Proposed cancelling majority of foliar and soil uses EU – Removal of all field uses	
	Sulfoxaflor	**4C**	USA – Pollinator concerns	

Carrot regulatory risk assessment

Problem	Active Constituents	Chemical Group	Comment	Activities
Beetles				
28-spotted potato ladybird	Maldison	**1B**	APVMA – Under review – chemistry	
Spotted vegetable weevil Vegetable weevil	Chlorpyrifos	**1B**	Currently under review by the APVMA & outcome uncertain. Potential issues w.r.t. environmental loading and dietary exposure. EU: Under review Canada – proposed cancellation of most uses. USA – EPA decision to allow continued use	
White fringed weevil	Fipronil (PER86665)	**2B**	APVMA – Under review EU: No authorisation in place	
Lepidoptera				
Budworms (Heliothis)	Emamectin as benzoate	**6**		
	Flubendiamide	**28**		
	Methomyl	**1A**	APVMA – nominated for review Canada – Re-evaluation completed (2018). Majority of uses removed EU: No authorisations	
	Spinetoram	**5**		
Cabbage white butterfly	Emamectin as benzoate	**6**		
	Flubendiamide	**28**		
	Maldison	**1B**	APVMA – Under review – chemistry	
Caterpillars	Diazinon	**1B**	EU – Deregistered Codex - To be reviewed by 2020/21.	
	Spinetoram	**5**		
Cluster caterpillar	Emamectin as benzoate	**6**		
	Flubendiamide	**28**		
	Methomyl	**1A**	APVMA – nominated for review Canada – Re-evaluation completed (2018). Majority of uses removed EU: No authorisations	
Cucumber moth				

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Problem	Active Constituents	Chemical Group	Comment	Activities
Cutworms	Chlorpyrifos	1B	Currently under review by the APVMA & outcome uncertain. Potential issues w.r.t. environmental loading and dietary exposure. EU: Under review Canada – proposed cancellation of most uses. USA – EPA decision to allow continued use	
	Diazinon	1B	EU – Deregistered Codex - To be reviewed by 2020/21.	
Diamondback (Cabbage) moth	Emamectin as benzoate	6		
	Flubendiamide	28		
	Maldison	1B	APVMA – Under review – chemistry	
Lightbrown apple moth	Chlorpyrifos	1B	Currently under review by the APVMA & outcome uncertain. Potential issues w.r.t. environmental loading and dietary exposure. EU: Under review Canada – proposed cancellation of most uses. USA – EPA decision to allow continued use	
	Spinetoram	5		
Loopers	Emamectin as benzoate	6		
	Methomyl	1A	APVMA – nominated for review Canada – Re-evaluation completed (2018). Majority of uses removed EU: No authorisations	
	Spinetoram	5		
Potato moth (Leafminer)	Flubendiamide	28		
	Spinetoram	5		
Webworms	Methomyl	1A	APVMA – nominated for review Canada – Re-evaluation completed (2018). Majority of uses removed EU: No authorisations	

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Problem	Active Constituents	Chemical Group	Comment	Activities
Grasshoppers/Locusts				
Australian plague locust Migratory locust Spur-throated locust	Chlorpyrifos	**1B**	Currently under review by the APVMA & outcome uncertain. Potential issues w.r.t. environmental loading and dietary exposure. EU: Under review Canada – proposed cancellation of most uses. USA – EPA decision to allow continued use	
	Maldison	**1B**	APVMA – Under review – chemistry	
Black field cricket Field crickets Mole crickets Wingless grasshopper	Chlorpyrifos	**1B**	Currently under review by the APVMA & outcome uncertain. Potential issues w.r.t. environmental loading and dietary exposure. EU: Under review Canada – proposed cancellation of most uses. USA – EPA decision to allow continued use	

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Problem	Active Constituents	Chemical Group	Comment	Activities
Jassids/Plant bugs				
Green vegetable bug	Maldison	**1B**	APVMA – Under review – chemistry	
Jassids	Maldison	**1B**	APVMA – Under review – chemistry	
	Phorate	**1B**	APVMA – Nominated for review EU: No authorisation in place	
Leafhoppers	Maldison	**1B**	APVMA – Under review – chemistry	
Rutherglen bug	Maldison	**1B**	APVMA – Under review – chemistry	
	Methomyl	**1A**	APVMA – nominated for review Canada – Re-evaluation completed (2018). Majority of uses removed EU: No authorisations	
Mites				
Redlegged earth mite	Maldison	**1B**	APVMA – Under review – chemistry	
Thrips				
Thrips	Maldison	**1B**	APVMA – Under review – chemistry	
	Methomyl	**1A**	APVMA – nominated for review Canada – Re-evaluation completed (2018). Majority of uses removed EU: No authorisations	
	Phorate	**1B**	APVMA – Nominated for review EU: No authorisation in place	
Western flower thrips	Methomyl		APVMA – nominated for review Canada – Re-evaluation completed (2018). Majority of uses removed EU: No authorisations	
Other				
Symphylids	Fipronil	**2B**	APVMA – Under review EU: No authorisation in place	
Vegetable leafminer	Abamectin	**6**		

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Problem	Active Constituents	Chemical Group	Comment	Activities
DISEASES				
Alternaria leaf spot	Azoxystrobin	**11**		
	Chlorothalonil	**M5**	APVMA - Nominated for review Canada – Review recently completed; continued use considered acceptable Europe - Deregistration proposed.	
	Copper	**M1**		
	Difenoconazole	**3**	APVMA - Nominated for review Canada – Currently being reviewed	
	Mancozeb	**M3**	APVMA - Nominated for review Canada – Under review Codex - To be reviewed 2020/21	
	Metiram	**M3**	APVMA - Nominated for review Canada – Proposed cancelling of foliar uses Codex - To be reviewed 2020/21	
	Penthiopyrad	**7**		
	Zineb	**M3**	APVMA - Nominated for review Codex - To be reviewed 2020/21 EU: No authorisation in place	
Bactericide	Iodine			
Black rot	Azoxystrobin	**11**		
	Iprodione (PER84995)	**2**	Europe – Deregistered Canada – Majority of food crop uses deleted Codex – Review scheduled for 2022	
Cercospora leaf spot	Copper	**M1**		
	Mancozeb	**M3**	APVMA - Nominated for review Canada – Under review Codex - To be reviewed 2020/21	

Carrot regulatory risk assessment

Problem	Active Constituents	Chemical Group	Comment	Activities
Damping off	Metalaxyl	**4**		
	Phosphorous acid	**33**		
	Thiram	**M3**	APVMA - Nominated for review Canada – Proposed cancelling of all foliar uses Codex - To be reviewed 2020/21 Europe – No authorisation in place	
Fungi	Iodine			
Leaf diseases/spots	Copper	**M1**		
	Mancozeb	**M3**	APVMA - Nominated for review Canada – Under review Codex - To be reviewed 2020/21	
Leaf spot	Azoxystrobin	**11**		
	Copper	**M1**		
	Difenoconazole	**3**	APVMA - Nominated for review Canada – Currently being reviewed	
	Mancozeb	**M3**	APVMA - Nominated for review Canada – Under review Codex - To be reviewed 2020/21	
	Metiram	**M3**	APVMA - Nominated for review Canada – Proposed cancelling of foliar uses Codex - To be reviewed 2020/21	
	Zineb	**M3**	APVMA - Nominated for review Codex - To be reviewed 2020/21 EU: No authorisation in place	
Phytophthora soil fungus (Dieback)	Metalaxyl +metalaxyl-M	**4**		
	Metalaxyl	**4**		

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Problem	Active Constituents	Chemical Group	Comment	Activities
Powdery mildew	Azoxystrobin	**11**		
	Difenoconazole	**3**	APVMA - Nominated for review Canada – Currently being reviewed	
	Mancozeb	**M3**	APVMA - Nominated for review Canada – Under review Codex - To be reviewed 2020/21	
	Penthiopyrad	**7**		
	Streptomyces lydicus WYEC 108	**-**		
	Tebuconazole (PER82461)	**3**	APVMA - Nominated for review	
Pythium diseases - soil borne	Metalaxyl +metalaxyl-M	**4**		
Sclerotinia rot	Azoxystrobin	**11**		
	Boscalid	**7**		
Septoria leaf spot	Copper	**M1**		
	Mancozeb	**M3**	APVMA - Nominated for review Canada – Under review Codex - To be reviewed 2020/21	

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Problem	Active Constituents	Chemical Group	Comment	Activities
WEEDS				
Broadleaf weeds and grasses	Chlorthal-dimethyl	**D**	EU: No authorisation in place	
	Clethodim (PER82459)	**A**	Codex: MRLs proposed for deletion	
	Fluazifop-P as butyl	**A**		
	Glyphosate (PER13305)	**M**	Ongoing issues internationally	
	Linuron	**C**	EU: No authorisation in place	
	Metribuzin (PER80169)	**C**		
	Pendimethalin	**D**		
	Prometryn (PER12048)	**C**		
	Propazine (PER13795)	**C**	EU: No authorisation in place	
	Quizalofop-P	**A**	Canada – Under re-evaluation - proposed completion June 2019. EU – Candidate for substitution	
	Sethoxydim	**A**	EU: No authorisation in place	
	Trifluralin	**D**	EU: No authorisation in place	
Plant growth regulator				
Post-harvest	1-Methylcyclopropene			

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