Parsley

Strategic Agrichemical Review Process 2011-2014

HAL Projects - MT10029 & VG12081

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Horticulture Australia project no:
MT10029 – Managing pesticide access in horticulture.
VG12081 - Review of vegetable SARP reports.

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Purpose of the report:
This report was funded by Horticulture Australia and the Australian vegetable industry to investigate the pest problem, agrichemical usage and pest management alternatives for the parsley industry across Australia. The information in this report will assist the industry with its agrichemical selection and usage into the future.

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Horticulture Australia

Contents

1. Media Summary

A Strategic Agrichemical Review Process (SARP) through the process of a desktop audit and industry liaison assesses the importance of the diseases, insects and weeds (plant pests) that can affect a horticultural industry; evaluates the availability and effectiveness of fungicides, insecticides and herbicides (pesticides) to control the plant pests; determines any 'gaps' in the pest control strategy and 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.

SARP workshops for parsley were conducted in Queensland, Victoria and Tasmania as part of combined vegetable meetings in 2008, 2010 and 2011. The results of the process provide the parsley industry with pesticide options for the future that the industry can pursue for registration with the manufacturer, or minor-use permits with the Australian Pesticides and Veterinary Medicines Association (APVMA).

DISEASE

The diseases identified as a high priority are:

Disease (common name)	**Disease (scientific name)**
Alternaria leaf blight	*Alternaria petroselini*
Cercospora leaf spot	*Cercospora* spp.
Damping-off	*Pythium* spp., *Phytophthora* spp., *Fusarium* spp., *Rhizoctonia* spp
Sclerotinia rot	*Sclerotinia sclerotiorum*

There are few control options for the diseases of parsley. A problem is that the residue situation in parsley and other herbs does not necessarily mirror that in vegetables. Therefore residue data is required for registration and in many cases for permit renewal. This has meant that a number of previous permits have not been renewed. The industry will need to conduct residue trials to have access to more chemistry.

Without appropriate chemistry the main options for growers are crop management techniques, including varietal choice, crop rotations and good farm and crop hygiene

INSECTICIDES

The insects identified as a high priority are:

Insect (common name)	**Insect (scientific name)**
Green peach aphid	Myzus persicae
Helicoverpa	*Helicoverpa* spp.
Rutherglen bug	*Nysius vinitor*
Slugs and snails	*Gastropoda*
Western flower thrips	*Frankliniella occidentalis*
Greenhouse whitefly and Silverleaf whitefly	*Trialeurodes vaporariorum* & *Bemisia tabaci*

Pest priorities have changed over the years. In some cases this is due to resistance developing to traditional chemistry. Some pests, such as Rutherglen bug, have increased in importance with the reduced use of broad spectrum insecticides.

There are a few products registered for control of each of the priority pests. However there need to be more options for alternation, to ensure each chemical is not applied too many times in a crop and to minimise the development of resistance.

Some alternate chemistry, permitted previously, has not had permits renewed. In most cases this is because residue studies are required to show that the temporary MRLs and withholding periods put in place are realistic. Similarly any permits for new actives are likely to be only issued on the proviso that residue data is generated to enable later renewal.

As an example of the impact of lack of renewal of permits, jassids and vegetable leaf hoppers have become a higher priority without buprofezin. This highlights the need for resources to be placed with parsley data generation.

Since overall, growers are looking for "soft" chemistry to use in IPM programs, the options are reduced. This is particularly the case as there is less overseas data on newer chemistry to support minor use permit applications, and pressure is put on the local industry to commit resources.

Non-chemical control options are often favoured. These include a range of crop management and integrated pest management practices and should be explored in greater depth in subsequent SARPs. For the future the expectation of the retail /supermarket sector for zero or low damage produce also needs to be addressed across the horticultural industries.

WEEDS

Growers generally use a pre-plant weed control (general knockdown herbicides) to prepare the paddock. Growers then either alternate the herbicides used or use them in combination for effective weed control. All the herbicides available are either pre-emergent herbicides or early post-emergent herbicides.

Most weeds can be controlled with currently available herbicides.

No weeds were identified as a high priority for control during the SARP discussions but the reports of increasing annual rye grass resistance make this weed a priority.

Growers would like their industry to be considered as registrants develop new chemistry for Australia

2. The Australian parsley industry

The Australian parsley industry is a small horticultural industry. Consumption of parsley has risen in recent years with the growth in healthier lifestyles and moves to fresh food, especially salads.

Accurate statistics on parsley production is not available, but it is known to be grown in reasonable quantities in the:

- Melbourne Metro area (Vic)
- Lockyer Valley (Qld)
- Perth Metro outer areas (WA)
- North Adelaide Plains (SA)
- Sydney Basin (NSW)
- North east (Tas)

The parsley species referred to in this report is *Petroselinum crispum*. The most common grown commercial parsley variety is 'common' parsley with its dark green flat leaves and 'Italian or continental' parsley with its dark green lobed leaves.

In 2008/09, there were 343 growers growing 200 ha parsley, producing 2003 tonnes worth $8.2 million (farm gate) (Ausveg 2012).

Due to Australia's varying weather conditions and the introduction of different varieties of parsley, the Australian industry is now able to supply domestic markets with fresh parsley throughout the year.

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 is not of sufficient size for agchem manufacturers 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 agchem companies unwilling to bear the initial high cost of registering suitable pesticides. As an added complication some horticultural crops may be grown in protected cropping or hydroponic situations. These can have a significant impact on pesticide performance and residue outcomes, further increasing product development requirements and registration costs.

Growers may at times be in a situation where they face severe losses from diseases, pests and weeds if they do nothing to protect their crops, or face penalties if they use a product that is not registered or available via a permit. The parsley industry is very aware of the possible consequences of the use of unregistered or non-permitted pesticides. These can include: produce with unauthorised pesticide residues; rejection at both local and export market levels; placing Australian export trading arrangements in jeopardy, and; fines and penalties.

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.

Pesticides have always been an important tool in the production of parsley. 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 utilized in seedling production, pre-plant, during plant establishment, through crop development and into crop maturity to maximise crop yield, quality and customer appeal.

From a pesticide access perspective, the APVMA classifies parsley as a minor crop. The crop fits within the APVMA crop group 027 Herbs.

As a consequence of the issues facing the parsley industry regarding pesticide access, Horticulture Australia Ltd and the vegetable industry undertook a review of the pesticide requirements in parsley via a Strategic Agrichemical Review Process (SARP). See Appendix 1 – the Strategic Agrichemical Review Process. The aim was to determine solutions (primarily pesticide) to current and future pest threats.

This SARP process identified diseases, insect pests and weeds of major concern to the industry. Against these threats available registered or permitted pesticides, along with non-pesticide solutions, were evaluated for overall suitability in terms of IPM, resistance, residues, withholding period, efficacy, trade, human safety and environmental issues. Where tools were unavailable or unsuitable the process aimed to identify potential future solutions.

This report is not a comprehensive assessment of all pests and control methods impacting on parsley production in Australia but attempts to prioritise the major problems.

3.2 Minor-use permits and registration

Parsley is classified as minor by the APVMA. Therefore access to minor use permits can be relatively straight forward as long as a reasonable justification is provided. Possible justification for future permit applications could be based on:

- New disease, insect or weed identified as a cropping issue
- No pesticide available
- Current pesticides no longer work – resistance
- Current pesticides limiting trade
- IPM, environmental or operator issues
- Loss of pesticides due to removal from market
- New, effective pesticide registered in another crop
- Alternate pesticide has overseas registration or minor use permit

With each of these options, sound, scientific argument is required to justify any new registrations or permit applications.

Another option for the industry is for manufacturers to register new pesticides uses in the crop.

3.3 Methods

The SARP was conducted in Queensland, Tasmania and Victoria as part of combined vegetable meetings in 2008, 2010 and 2011. The meeting included leading growers, consultants, government agencies, Agchem companies and retail outlet staff.

- Participants were given a comprehensive list of most major pests of parsley and asked to prioritise them into high, moderate and low categories.
- Participants were then asked to list the main pesticides and or other control agents used for each pest.
- Mostly pesticide trade names were used and the list provided was certainly not comprehensive but a starting point for further assessment.
- Pesticides that are under review by the Australian Pesticides and Veterinary Medicines Authority (AVPMA) were listed.
- Information was collated onto Excel spreadsheets for diseases, insects and weeds.
- The information was circulated to participants for any further comments to ensure the accuracy of the information.
- Each alternative pesticide was assessed for:
    - IPM compatibility
    - Improved scope for resistance management
    - Sound biological profile
    - Residue and trade acceptance domestically and for export

Final selections of proposed new pesticides for the industry to pursue were listed.

3.4. Results and discussions

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

4. Pests and diseases of parsley

4.1 Diseases of parsley

Common name	Scientific name
HIGH PRIORITY	
Alternaria leaf blight	*Alternaria petroselini*
Cercospora leaf spot	*Cercospora* spp.
Damping off	*Pythium* spp., *Phytophthora* spp, *Fusarium* spp., *Rhizoctonia* spp.
Sclerotinia rot	*Sclerotinia sclerotiorum*
MODERATE PRIORITY	
Anthracnose	*Colletotrichum* spp.
Downy mildew	*Plasmopara petroselini*
Rust	*Puccinia menthae*
Septoria	*Septoria petroselini*
LOW PRIORITY	
Grey mould	*Botrytis cinerea*
Powdery mildew	*Erysipheheraclei*

4.1.1 High priority diseases

Alternaria leaf blight (*Alternaria petroselini)*

Alternaria leaf blight was first found in Australia on parsley crops in Queensland and Victoria in 2005. The disease is caused by the fungus *Alternaria petroselini* and commonly infects parsley overseas. In Queensland, it caused significant damage to a single crop following extensive wet, humid weather. In Victoria, the disease has been found only on one property, where it caused minor damage. The disease is also known as leaf spot or scorch and can cause dark spots on leaves that may lead to leaf and petiole death.

Alternaria leaf blight is considered a major-moderate problem in Qld and minor problem in Vic and Tas.

- Growers want more protective/curative fungicides for alternation.
- The slightest disease on leaves can lead to whole crop being unmarketable.

- No fungicides are **registered** for the control of Alternaria leaf blight in parsley.

- Fungicides listed for control of Alternaria leaf blight control in parsley via **permits**:
  - Chlorothalonil (various) (PER11526, expires Sep 2014)– Group M5 protectant fungicide
    - Commonly used.
    - Used as a protectant only. It is not effective in high pressure situations.
    - Controls Downy mildew, Botrytis, Alternaria and Cercospora.
    - Moderately disruptive to some beneficial insects.
    - Residue data most likely required for renewal

- **Potential** fungicides for the control of Alternaria leaf blight in parsley:
  There are a range of actives registered or permitted for control of alternaria in vegetables, including azoxystrobin, boscalid, copper, difenconazole (SCORE^), iprodione, mancozeb, mancozeb+melatlaxyl, metiram, penthiopyrad (FONTELLIS^), trifloxystrobin, zineb. Of these, permament MRLs are only in place for copper, mancozeb, metalaxyl, metiram and zineb.

Cercospora leaf spot (*Cercospora* spp.)

Cercospora leaf spots are circular, about 2 to 4 mm in diameter, with light to dark tan centres and dark-brown to reddish-purple borders. Elliptical lesions may occur on leaf blades, veins, and petioles. Leaf spots coalesce and kill large areas of leaf tissue. Severely diseased leaves wither and die, but remain attached to the crown

Cercospora leaf spot is considered a major-moderate problem in SA and a minor problem in Qld, Vic and Tas.

- Growers want more protective/curative fungicides for alternation.
- The slightest disease on leaves can lead to whole crop being unmarketable.

- No fungicides are **registered** for the control of Cercospora leaf spot in parsley.

- Fungicides listed for control of Cercospora leaf spot control in parsley via **permits**:
  - Chlorothalonil (various) (PER11526, expires Sep 2014)– Group M5 protectant fungicide
    - Commonly used.
    - Used as a protectant only. It is not effective in high pressure situations.
    - Controls Downy mildew, Botrytis, Alternaria and Cercospora.
    - Moderately disruptive to some beneficial insects.
    - Residue data most likely required for renewal.

- **Potential** fungicides for the control of Cercospora in parsley:

  There are a range of actives registered or permitted for control of cercospora in vegetables, including copper, difenconazole (SCORE^), hydrogen peroxide + peroxy acetic acid (PERATEC PLUS^) mancozeb, metiram, propiconazole, trifloxystrobin, zineb. Cyprodinil + fludioxonil (SWITCH) is also being trialled in IR-4 cercospora / vegetable trials. Of these, permament MRLs are only in place for copper, mancozeb,metiram and zineb. (MRLs would not be required for Peratec Plus.)

Damping off (*Pythium* spp., *Phytophthora* spp., *Fusarium* spp., *Rhizoctonia* spp.)

Symptoms of damping-off and root rot consist of poor seed germination, pre-emergence death of seedlings, post-emergence death of newly emerged seedlings, stunted plants, yellowed lower leaves, general poor growth, wilting, and eventual collapse and death of older plants. Roots of infected plants can appear water-soaked or brown to black in colour. In severe cases, nearly all roots may be girdled or rotted off.

Severe damping-off is associated with clay or poorly draining soils with a history of frequent production. While all stages of parsley can be infected by root rot organisms, newly emerging plants and young seedlings are very susceptible.

Note that a recent HAL publication should be consulted for greater depth of discussion on root disease in parsley: *VG12102, Grigg 2013. SummerrRoot rot inpParsley: a scoping study.*

Damping-off is considered a major-moderate problem in all states.

- Growers use crop rotations to minimise disease.
- Limited control options available.

- There are no fungicides **registered** for the control of damping-off in parsley.

- Fungicides listed for control of damping-off control in parsley via **permit**:
  - Metalaxyl, Metalaxyl-M (various) (PER13121, expires Nov 2016)– Group 4 protective and curative fungicide
    - Occasionally used at planting.
    - Used as a protectant / curative fungicide.
    - Considered effective but expensive.
    - Minimal impact on most beneficial insects.

  - Phosphorous acid (various) (PER13791, expires Jun 2016) - Group 33 systemic fungicide - IPM fit

- **Potential** fungicides for the control of damping-off in parsley:
  There are a range of actives registered or permitted for control of damping off in vegetables, including tolclofos-methyl and fumigants such as 1,3-dichloropropene+ chloropicrin.

  There are also some fungicides in development (not registered yet in Australia):

  - Cyazofamid (likely to be called RANMAN^?, new ISK/FMC Fungicide) – FRAC code 21 – contact and residual fungicide
    - Application for registration is with the APVMA, for potatoes, brassicas and possibly brassica leafy vegetables.
    - Inhibits oomycetes fungal development.
    - Overseas registration on brassica leafy for white rust (*Albugo occidentalis*), downy mildew, pythium damping-off, club root (*Plasmodiophora brassicae*)
    - Resistance management tool.

  - Fluopicolide is a new Bayer active in the FRAC group 43, a group with no actives registered in Australia. Bayer CropScience has applied for approval of the active in Australia but registration of a registered product will take some time. An IR-4 use request indicates efficacy on *Aphanomycete* spp. and *Pythium* spp. It would be sensible to approach Bayer to discuss development opportunities.

- **Non-chemical** options for the control of damping-off in parsley:
  A range of management techniques are utuilised and include farm and crop hygiene, irrigation programs and nutrition programs. Refer to Grigg, 2013 for further detail.

Sclerotinia rot (*Sclerotinia sclerotiorum*)

Sclerotinia overwinter on plant debris on the ground and in soil. There are two phases of this disease: the damping-off phase, which affects seedlings and the phase which causes a watery soft rot in mature parsley. Sclerotinia organisms are active in temperatures above 10°C when humidity is high.
The symptoms begin as small watery areas; the watery spots enlarge and develop a cottony white mass that converts the plant to a slimy, wet mass that produces abundant sclerotia.

Sclerotinia rot is considered a major-moderate problem in all states.
- Growers use crop rotations to minimise disease.
- Limited control options available.

- There are no fungicides **registered** for the control of Sclerotinia rot in parsley.

- No fungicides are listed for Sclerotinia rot control in parsley via **permits**.

- **Potential** fungicides for the control of Sclerotinia in parsley:

  There are a range of actives registered or permitted for control of sclerotinia in vegetables, including Cyprodinil + fludioxonil (SWITCH), boscalid, iprodione, penthiopyrad (FONTELLIS). Permanent MRLs are not in place for any of these

4.1.2 Summary

High priority diseases and control options

There are very few control options for the diseases of parsley. A problem is that the residue situation in parsley and other herbs does not necessarily mirror that in vegetables. Therefore residue data is required for registration and in many cases for permit renewal. This has meant that a number of previous permits have not been renewed. The industry will need to conduct residue trials to have access to more chemistry.

Growers have suggested difenconazole and propiconazole as potential fungicides with their relatively short withholding periods. Temporary MRLs are in place for these and residue data will likely be required.

Without appropriate chemistry the main options for growers are crop management techniques, including varietal choice, crop rotations and good farm and crop hygiene

Currently available fungicides

Active		**Disease**	**WHP, days**	**Chemical Group**
Chlorothalonil	(PER11526, expires Sep 2014)	Alternaria leaf blight (leaf scorch)	14	M5
		Botrytis leaf spots	14	M5
		Cercospora	14	M5
		Downy Mildew	14	M5
Copper	(PER13702, expires Jun 2015)	Ceratocystis Paradoxa (Including Black Scorch Of Date Palm), Diplodia (Diplodia Phoenicum) And Pink Disease (Erythricium Salmonicolor)	1	1
Mancozeb	(PER12016, expires Mar 2015)	Anthracnose (Colletotrichum Spp.)	14	M3
		Septoria	14	M3
Metalaxyl	(PER13121, expires Nov 2016)	Pythium Root Rot, Phytophthora Root Rot	NR	4
Phosphorous acid	(PER13791, expires Jun 2016)	Damping Off: *Rhizoctonia solani*, *Phytophthora* spp., *Pythium* spp. and other pathogens that may be involved.	1	33
		Downy Mildew	1	33
Potassium	(PER13695, expires Aug 2017)	Powdery Mildew	NR	_

Current parsley and Herb Fungicide MRLs

Commodity	Active	Status
Herbs	Copper	Permanent
Parsley	Dithiocarbamates (mancozeb, metham, metiram, propineb, thiram, zineb and ziram)	
Parsley	Metalaxyl	
Herbs	Methyl bromide	
Parsley	Azoxystrobin	Temporary
Herbs	Chlorothalonil	
Herbs	Fenhexamid	
Herbs	Myclobutanil	
Herbs	Procymidone	
Herbs	Propiconazole	
Herbs	Quinoxyfen	
Herbs	Tebuconazole	

4.2 Insects and molluscs of parsley

Common name	Scientific name
HIGH PRIORITY	
Green peach aphid	*Myzus persicae*
Helicoverpa	*Helicoverpa* spp.
Rutherglen bug	*Nysius vinitor*
Slugs and snails	*Gastropoda*
Western flower thrips	*Frankliniella occidentalis*
Whitefly - Greenhouse, Silverleaf	*Trialeurodes vaporariorum, Bemisia tabaci*
MODERATE PRIORITY	
Cluster caterpillar	*Spodoptera litura*
Onion maggot	*Delia platura*
Redlegged earth mite	*Halotydeus destructor*
Thrips - Plague, Melon	*Thrips imaginis, Thrips palmi*
Vegetable Leaf Hoppers	*Austroasca viridigrisea*
LOW PRIORITY	
African Black Beetle	*Heteronychus arator*
Grasshoppers	*Orthoptera*
Jassids	*Cicadellidae*
Lightbrown apple moth	*Epiphyas postvittana*
Mealybugs	*Pseudococcidae*
Mites - including Two-spotted, Tomato russet, European red, Rust	*Tetranychus urticae, Aculops lycopersici, Panonychus ulmi, Eriophyidae*
Vegetable weevil	*Listroderes difficilis*
Wireworms	*Elateridae*

4.2.1 High priority insects

Green peach aphid (*Myzus persicae*)

Aphids are sap-sucking insects that deposit a sugary waste that encourages the growth of a sooty mould.

Aphids can develop large colonies. They stunt young plants by sucking the sap and nutrients from leaves.

However the greatest problem is contamination of produce, making it unsaleable. They also cause problems when they act as vectors for viruses.

Best management practice includes the use of IPM compatible insecticides in combination with beneficial species for controlling aphids - Brown lacewings, Hoverflies, Parasitic wasps and Ladybird beetles.

Aphids are considered a major-moderate problem in all areas.

- Aphid numbers can vary, but can be heavy.
- Growers want IPM compatible alternatives.

- Insecticides **registered** for the control of aphids in parsley:
  - Potassium salts of fatty acids (various) – contact biological insecticide
    - Occasionally used.
    - Reported as effective, but only offers short term control.
    - Minimal impact on most beneficial insects.

  - Pyrethrins+piperonyl butoxide (various) – Group 3A contact insecticide
    - Good knockdown
    - Harmful to beneficials

- Insecticides listed for control of aphids in parsley via **permit**:
  - Petroleum oil (various) (PER12221, expires Nov 2017) – contact insecticide
    - Commonly used.
    - Effective.
    - Controls a range of insect pests - aphids, thrips, mites, scale, mealybugs, leaf miner.
    - Moderately disruptive to some beneficial insects.

- **Potential** insecticides for the control of aphids in parsley:

  There are a range of actives registered or permitted for control of aphids in vegetables, including emulsifiable botanical oil, imidacloprid, maldison, paraffinic oil / petroleum oil, pirimicarb, spirotetramat (MOVENTO^), sulfoxaflor (TRANSFORM^), pymetrozine.

  There are no relevant MRLs associated with any of these actives so it is most likely that residue data would be required for any registrations or permits.

Helicoverpa (*Helicoverpa armigera* and *Helicoverpa punctigera*)

This caterpillar varies in colour from green through yellow and brown to nearly black, with pale stripe down each side. They can grow to 40-50 mm and have hairs protruding from dark spots along the body.

The most obvious damage is caused by larvae that burrow directly into developing fruit causing holes and making them unsaleable. Smaller larvae may cause pinprick holes which can act as entry points for disease.

First stage larvae can damage flowers which decreases potential yield.

Helicoverpa are considered a moderate-major problem in all areas.

- Insecticides **registered** for Helicoverpa control in parsley:

  - Bacillus Thuringiensis var Kurstaki (Btk) (various) - Group 11C contact insecticide
    - Commonly used.
    - Very effective on small grubs, but needs regular reapplication.
    - Minimal impact on all beneficial insects.

  - Flubendiamide (BELT^) – Group 28 contact and systemic insecticide
    - Occasionally used in some regions. .
    - Considered very effective but expensive.
    - Minimal impact on all beneficial insects.
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  - Spinetoram (SUCCESS NEO^) - Group 5A contact and systemic insecticide
    - Occasionally used.
    - Very effective on various Lepidoptera. Also controls thrips, but not on label.
    - Moderately disruptive to some beneficial insects.

- Insecticides available for the control of Helicoverpa in parsley via **permit**:

- Chlorantraniliprole (various, including CORAGEN^) (PER13303, expires Mar 2015)- Group 28 contact and systemic insecticide
  - Occasionally used in some regions.
  - Very effective, but expensive.
  - Minimal impact on all beneficial insects.

- **Potential** insecticides for the control of helicoverpa in parsley:

  There are a range of actives registered or permitted for control of helicoverpa in vegetables, including indoxacarb, methoxyfenozide (PRODIGY^), emamectin, methomyl, methoxyfenozide (PRODIGY^)

  There are no relevant MRLs associated with any of these actives so it is most likely that residue data would be required for any registrations or permits.

Rutherglen bug (*Nysius vinitor*)

Rutherglen bugs are common native insects that attack a wide range of crops. Adults are 3-4 mm long and grey-brown in colour with clear wings folded flat on their back. Nymphs are wingless and have a dark red, pear-shaped body. Rutherglen bugs are usually a problem in spring, but can also be a pest of crops in autumn. They are regarded as opportunistic, nomadic and can reach plague proportions in drought periods.

Rutherglen bugs feed like aphids, by sucking sap from plant foliage including leaves. They also impact crops by contaminating the packed saleable commodity.

The Rutherglen bug has been identified as a major pest in some areas, including in South Australia.
- Rarely causes significant crop damage.
- Contamination is a major issue for supermarket rejections when there is zero tolerance to live insects.
- Local management will have little impact in seasons when there are major influxes of bugs from outside the cropping region in spring. As RGB also feed on weeds, managing weeds in and around paddocks prior to sowing can reduce the likelihood of bugs moving from dying weeds onto emerging seedlings.
- Have increased as a pest problem with the reduced use of broad spectrum insecticides.
- RGB generally succumb to fungal attack as humidity rises after Christmas and become much less of an issue.
- Growers currently rely on incidental control from insecticides being used to control other pests
- Chemistry with an IPM fit is required

- No insecticides are **registered** for the control of Rutherglen bug in parsley.

- Insecticides **permitted** for the control of Rutherglen bug in parsley:

  - Lambda-cyhalothrin (various) - Group 3A contact and systemic insecticide
    - Considered effective, but some level of resistance in some regions.
    - Controls a range of Lepidoptera.
    - IPM disruptive - high impact on beneficial insects and mites - use with caution.

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Slugs and snails (*Gastropoda*)

Slugs and snails prefer moist environments and live off decaying animal matter, algae, and plant material such as leaves and stems. These pests are most active on cool, wet and humid nights.
Slugs and snails leave silvery trails which can dry to appear like gold dust. These trails are the mucus they secrete in order to move.
Slugs and snails eat holes in leaves of plants and seedlings chewed off at the base.

Slugs and snails are considered a high-moderate priority in all areas.

- They also feed on weeds so weed control is important in managing this pest.

- Products **registered** for the control of slugs and snails in parsley are:

    - Iron Edta Complex (various) – molluscicide
        - Occasionally used.
        - Very effective.
        - Needs constant re-application.
        - Metaldehyde (various) – molluscicide

    - Metaldehyde (various) – molluscicide.
        - Commonly used.
        - Very effective.
        - Needs constant re-application.

    - Methiocarb (various) – Group 1A insecticide
        - Commonly used.
        - Very effective.
        - Needs constant re-application.
        - Under review by APVMA.

There are no molluscicide listed for control of slugs and snails in parsley via **permit**.

Western flower thrips (*Frankliniella occidentalis*)

The adults are tiny insects, generally measuring only 1 to 2 mm in length. They have thin bodies and vary in colour from near black to straw coloured.

Western Flower Thrips (WFT) are weak fliers but are capable of infesting large areas of crop as they are easily blown by wind.

WFT cause most damage by discolouring, scaring and deforming leaves as they feed. They are fast breeders when the weather is warm but not too hot and are capable. of producing 12-15 generations per year with optimal conditions. Females live for up to 90 days and are capable of reproducing after approximately 15-20 days.

Western flower thrips are considered a major-moderate problem in Vic, NSW and WA and a moderate problem in Queensland.

- All insecticides used in alternation due to rapid resistance development to many commonly used insecticides.
- Growers find it difficult to distinguish difference between thrips species with the naked eye due to their very small size.
- WFT develop resistance more easily than other thrips species.
- Growers need multiple options.

- Insecticides **registered** for the control of thrips in parsley are:

    - Potassium salts of fatty acids (various) – contact biological insecticide
        - General thrips claim.
        - Occasionally used in some regions.
        - Very effective on a range of pests.
        - Minimal impact on all beneficial insects.

    - Pyrethrins+piperonyl butoxide (various) – Group 3A contact insecticide
        - General thrips claim.
        - Good knockdown.
        - Harmful to beneficials.

- Insecticides listed for control of Western flower thrips in parsley via **permit**:

    - Methomyl (various) (PER13396, expires Jun 2015) - Group 1A contact and systemic insecticide
        - Occasionally used.
        - Very effective.
        - Also controls other insect pests.
        - Moderately disruptive to disruptiveto many beneficial insects

    - Petroleum oil (various) (PER12221, expires Nov 2017) – contact insecticide
        - General thrips claim.
        - Commonly used.
        - Effective.
        - Controls other insect pests - aphids, thrips, mites, scale, mealybugs, leaf miner.
        - Moderately disruptive to some beneficial insects.

Greenhouse whitefly and Silverleaf whitefly (*Trialeurodes vaporariorum* & *Bemisia tabaci*)

Greenhouse whitefly thrives on numerous crops as well as weed species. Greenhouse whitefly adults have a yellow body and white powdery wings which are held almost parallel to the body. The wings overlap and form a heart shape, and obscure the body when viewed from above. They are about 1-2 mm in length.

Greenhouse whitefly adults are larger than the similar Silverleaf whitefly.

Adults and nymphs suck on sap and excrete honeydew, a sugary liquid that becomes infected with sooty mould fungus. Heavy infestations cause plant wilt, reduced yield and failure to set seed.

Silverleaf whitefly (SKWF) were first detected in Australia in 1994. Adults are approximately 1 mm long and are a narrow white wedge-shaped insect. When an infested plant is disturbed the whiteflies can be seen to flutter out and rapidly resettle.

Adults feed and lay their eggs on the undersides of young leaves and a female can lay up to 160 eggs during a 60 day lifespan. The eggs turn from white to brown as they get close to hatching. There is an indigenous whitefly called the Sweet potato whitefly which is identical in appearance to the Silverleaf whitefly.

Whiteflies damage parsley by sucking large quantities of sap and covering plants with sticky honeydew. Black sooty mould grows over the honeydew.

Beneficial insects, play a very important role in the control of whitefly. Therefore any insecticide used in parsley, needs to be compatible with these beneficial insects.

Whiteflies are considered a major-moderate problem in all states, although SLWF are only a pest of northern states.

- Whitefly numbers can vary, but can be heavy.
- Growers want IPM compatible alternatives.
- Growers commented that Silverleaf whitefly are more difficult to kill than Greenhouse whitefly.
- There are insecticides available, but growers are concerned at the ability of Silverleaf whitefly to develop resistance to many insecticides.

- Insecticides **registered** for the control of whiteflies in parsley:

  - Potassium salts of fatty acids (various) – contact biological insecticide
    - Occasionally used in some regions.
    - Very effective on a range of pests.
    - Minimal impact on all beneficial insects.

  - Pyrethrins+piperonyl butoxide (various) – Group 3A contact insecticide
    - General whitefly claim.
    - Good knockdown.
    - Harmful to beneficials.

No insecticides are listed for the control of whiteflies in parsley via **permit.**

- **Potential** insecticides for the control of whiteflies in parsley:

  There are a range of actives registered or permitted for control of whiteflies in vegetables, including Bifenthrin, chlorantraniliprole + thiamethoxam (DURIVO^), imidacloprid, emulsifiable botanical oil, paraffinic oil / petroleum oil and spirotetramat (MOVENTO^).

  In addition to addressing residue needs there are concerns on resistance in some existing chemistry. New chemistry with first registration applications in assessment at the APVMA includes flonicamid and metaflumizone which could be helpful for resistance management. However it is likely registrants will want to restrict horticultural registrations as a means of resistance risk management.

4.2.2 Summary

High Priority insects and molluscs and control options

Pest priorities have changed over the years. In some cases this is due to resistance developing to traditional chemistry. Some pests, such as Rutherglen bug, have increased in importance with the reduced use of broad spectrum insecticides.

There are a few products registered for control of each of the priority pests. However there need to be more options for alternation, to ensure each chemical is not applied too many times in a crop and to minimise the development of resistance.

Some alternate chemistry, permitted previously, has not had permits renewed. In most cases this is because residue studies are required to show that the temporary MRLs and withholding periods put in place are realistic. Similarly any permits for new actives are likely to be only issued on the proviso that residue data is generated to enable later renewal.

As an example of the impact of lack of renewal of permits, jassids and vegetable leaf hoppers have become a higher priority without buprofezin. This highlights the need for resources to be placed with parsley data generation.

Since overall, growers are looking for "soft" chemistry to use in IPM programs, the options are reduced. This is particularly the case as there is less overseas data on newer chemistry to support minor use permit applications, and pressure is put on the local industry to commit resources.

Non-chemical control options are often favoured. These include a range of crop management and integrated pest management practices and should be explored in greater depth in subsequent SARPs. For the future the expectation of the retail /supermarket sector for zero or low damage produce also needs to be addressed across the horticultural industries.

Currently available insecticides

Chemical	Insect	WHP, days	Chemical group
1,3-dichloropropene + chloropicrin	Plant parasitic nematodes, Symphylans (garden centipedes), Wireworms	NR	8B
Abamectin (PER114387, expires Aug 2017)	Mite-Broad, Mite-European Red, Mite-Two spotted, Thrips (excluding WFT)	14	6
Bacillus thuringiensis kurstaki	Armyworm, Cabbage Moth /Diamond back moth, Cabbage White Butterfly, *Helicoverpa armigera* (Corn Earworm / Cotton Bollworm), *Helicoverpa punctigera* (Native Budworm), Lightbrown Apple Moth, Loopers, Vine Moth	NR	11
BT subs. Israelensis Serotype H14 (VECTOBAC WG) (PER11472, expires May 2014)	Fungas Gnats	NR	11
Chlorantraniliprole (CORAGEN) (PER13303, expires Mar 2015)	Cluster Caterpillar, Helicoverpa	3	28
Chlorpyrifos (PER14583, expires Mar 2019)	Vegetable Weevil	70(H), *(G)	1B
Diazinon PER13499, expires Mar 2017)	Onion Maggot	NR	1B
Flubendiamide (BELT)	Cabbage white butterfly, Cluster caterpillar, Diamondback moth, Helicoverpa	1	
Lambda-cyhalothrin (PER11850, expires Aug 2015)	Grey Cluster Bug (GCB), Looper, Mite-Redlegged Earth Mite, Rutherglen Bug (RGB), Thrips-Plague,	14	3A
Methomyl (PER13396, expires Jun 2015	Thrips, Thrips – western flower	3	1A
Petroleum (PER12221, expires Nov 2017)	Aphids, Green Mired, Green Vegetable Bug, Grey Cluster Bug, Leafhoppers, Mites, Rutherglen Bug, Thrips	1	_
Potassium Salts Of Fatty Acids (Outdoor)	Aphids, Mealybug, Mites - Two Spotted Mite / Spider Mite, Thrips, Whitefly	NR	-
Propargite	Mites – two spotted	7	12C
Pyrethrins+Piperonyl Butoxide	Aphids, Caterpillars, Leafhoppers, Thrips, Whiteflies	1	3A
Spinetoram (SUCCESS NEO^)	Cabbage (Diamondback) moth, Helicoverpa, Lightbrown apple moth, Loopers	3	5

Parsley and herb Insecticide MRLs

Crop	Active	Status
Parsley	Chlorpyrifos	Permanent
Parsley	Diazinon	
Herbs	Flubendiamide	
Herbs	Inorganic bromide	
Herbs	Permethrin	
Herbs	Spinetoram	
Herbs	Spinosad	
Herbs	Methyl bromide	
Herbs	Bifenthrin	Temporary
Herbs	Buprofezin	
Herbs	Chlorantraniliprole	
Herbs	Chlorfenapyr	
Parsley	Cyhalothrin	
Herbs	Cypermethrin	
Herbs	Emamectin	
Herbs	Etoxazole	
Herbs	Fipronil	
Herbs	Imidacloprid	
Herbs	Indoxacarb	
Herbs	Methomyl	
Herbs	Methoxyfenozide	
Herbs	Phosphorous acid	
Herbs	Pirimicarb	
Herbs	Pymetrozine	
Herbs	Pyriproxyfen	

Parsley and herb molluscicide MRLs

Crop	Active	Status
Herbs	Metaldehyde	Permament

4.3 Weeds of parsley

Herbicides **registered** and used in parsley are:

- Glyphosate (various) – Group M pre-plant general knockdown herbicide
  - Commonly used.
  - Works well as a pre-crop spray.

- Paraquat + diquat (various) - Group L pre-plant general knockdown herbicide
  - Occasionally used.
  - Works well as a pre-crop spray

Herbicides listed for control of weeds in parsley via **permit**:

- Chlorthal-dimethyl (various) (PER14032, expires Sep 2023) – Group D general knockdown and residual herbicide
  - Applied at sowing or transplant only.
  - Commonly used as a pre or post sowing before crop emergences for broadleaf and grass weed control.
  - Growers comment that it provides excellent control of broadleaf weeds.

- Fluazifop-P as butyl (various) (PER12017, expires Jun 2016)– Group A grass selective post-emergent herbicide
  - Commonly used.
  - Considered very effective.
  - Controls most grass weeds. Does not control Winter grass (Poa annum).
  - Resistance to annual rye grass is an escalating problem
  - Permit expires 30-Jun-16. No manufacturer interested in registering use.

- Metolachlor (various) (PER14158, expires Jun 2023) - Group K pre-plant residual herbicide
  - It is commonly used as an effective pre- emergent annual broadleaf and grass control herbicide.
  - Considered very effective.
  - Aust Herb & Spice Industry Assoc permit.
  - Controls many weeds.
  -
- Pendimethalin (various) (PER8628, expires Sep 2014) - Group D residual herbicide
  - It is commonly used as an effective pre- emergent annual broadleaf and grass control herbicide.
  - Considered very effective.
  - Controls many weeds.
  -

4.2.2 Summary

High priority weeds and control options

Growers generally use a pre-plant weed control (general knockdown herbicides) to prepare the paddock. Growers then either alternate the herbicides used or use them in combination for effective weed control. All the herbicides available are either pre-emergent herbicides or early post-emergent herbicides.

Most weeds can be controlled with currently available herbicides.

No weeds were identified as a high priority for control during the SARP discussions but the reports of increasing annual rye grass resistance make this weed a priority.

Growers would like their industry to be considered as registrants develop new chemistry for Australia

Parsley herbicide permits

Active		Weed	WHP, days	Chemical Group
Chlorthal dimethyl	(PER14032, expires Sep 2023)	Grass And Broadleaf - Various	NR(H), 85(G)	D
Fluazifop-P-butyl	(PER12017, expires Jun 2016)	Grass Weeds-Label	28(H), 28(G)	A
Pendimethalin	(PER8628, expires Sep 2014)	Grass And Broadleaf	NR	D
S-metolachlor	(PER14158, expires Jun 2023)	Grass And Broadleaf - Various	56	K

Parsley and herb herbicide MRLs

Crop	Active	Status
Herbs	Pendimethalin	Permanent
Parsley	Chlorthal-dimethyl	Temporary
Herbs	Fluazifop-p-butyl	
Herbs	Linuron	
Herbs	Metolachlor	
Herbs	Trifluralin	

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Acronyms

APVMA ……..	Australian Pesticides and Veterinary Medicines Authority
DPI ……..	Department of Primary Industries
HAL ……..	Horticulture Australia Ltd
IPM ……..	Integrated pest management
IR-4 ……..	Interregional Research Program 4 (USA)
MRL ……..	Maximum residue limit (mg/kg or ppm)
Plant pests …..	Diseases, insects, nematodes, viruses, weeds, etc
Pesticides ……	Plant protection products (fungicide, insecticide, herbicide, nematicides, etc).
SARP …….	Strategic Agrichemical Review Process
WHP ……..	Withholding period

Australian states and territories: NSW (New South Wales), NT (Northern Territory), Qld (Queensland), SA (South Australia), Tas (Tasmania), Vic (Victoria), WA (Western Australia)

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^Trademark

6. Appendix

DIAGRAM 1: The Strategic Agrichemical Review Process