Lettuce

Strategic Agrichemical Review Process 2011-2014

HAL Projects - MT10029 & VG12081

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Horticulture Australia project no:
MT10029 – Managing pesticide access in horticulture.
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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 lettuce 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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Contents

1. Media Summary 2
2. The Australian lettuce industry 3
3. Introduction 4
3.1. Background 4
3.2. Minor use permits and registration 5
3.3. Methods 5
3.4. Results and discussions 5
4. Pests and diseases of lettuce 6
4.1. Diseases of Lettuce 6
4.1.1 High priority diseases 6
4.1.2 Summary 11
4.2 Insects of Lettuce 14
4.2.1 High priority insects 14
4.2.2 Summary 22
4.3 Herbicide use in lettuce 25
5. References 27
Information: 27
Acronyms 27
Acknowledgement 27
6. Appendices 28

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 lettuce were conducted in New South Wales, Queensland, Victoria and Western Australia as part of combined vegetable meetings in 2008, 2010 and 2011. The results of the process provide the lettuce 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

Diseases identified as high priorities:

Disease (common name)	Disease (scientific name)
Botrytis rot	Botrytis cinerea
Downy mildew	Bremia lactucae
Sclerotinia rot (Drop)	Sclerotinia minor, Sclerotinia sclerotiorum
Septoria spot or Late blight	Septoria apiicola

Growers need further options to manage the range of diseases in lettuce, and as a major crop it is difficult to justify the issue of permits. There are also problems within the overall sector in that not all registered and approved chemistry is available across field and protected, and leafy and head lettuce. It is not a simple matter of extending the approvals: as the efficacy and residue situations vary with the lettuce type and growing situation, data must usually be generated to allow an extension.

INSECTS

Insects identified as high priorities:

Insect (common name)	Insect (scientific name)
Green peach aphid	Myzus persicae
Helioverpa	Helicoverpa spp.
Lettuce aphid	Nasonovia ribis-nigri
Rutherglen bug	Nysius vinitor
Silverleaf whitefly	Bemisia tabaci Biotype B & Q
Western flower thrips	Frankliniella occidentalis

The chemistry available to lettuce growers has increased significantly in recent years with new entrants to the market. So for some pests, growers have reasonable options for developing a treatment schedule with good alternation of products from different chemical groups. It is expected that the use of the new chemistry will be carefully managed - the industry has observed the benefits of IPM techniques, both in reducing pest problems and as a means of reducing resistance risks that come from overuse of chemicals.

There are no or limited chemicals permitted for a number of the lesser pests of lettuce. Growers must rely on control by other chemicals already being used in the crop. This can be difficult when the management strategy is not targeted to the problem.

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 registered are either pre-emergent herbicides or early post-emergent herbicides. Most weeds can be controlled with currently available herbicides.

Weeds identified as high priorities:

Weed (common name)	**Weed (scientific name)**
Clevers	Galium aparine
Fleabane	Conyza spp.
Fumitory	Fumaria spp.
Groundsel*	Senecio spp.
Marshmallow	Malva parviflora
Potato weed	Galinsoga spp.
Wild turnip	Brassica spp.
Winter grass	Poa annua
Shepherd's Purse	Capsella bursa-pastoris

2. The Australian lettuce industry

The Australian lettuce industry is a growing, innovative, resourceful and dynamic horticultural industry. Consumption of lettuces has risen in recent years, with the consumption pattern changing from heading types to more loose leafed types. It is Australia's 6th largest vegetable crop in 2008/09, accounting for 6.2% of total vegetable production. (Ausveg 2011)

Lettuce is grown throughout Australia with the main growing regions being:

- Melbourne Metro area (Vic)
- East Gippsland (Lindenow Valley, Maffra & Sale) Vic
- Sunraysia (Vic)
- Lockyer Valley (QLD)
- Eastern Darling Downs & Stanthorpe (Qld)
- Perth Metro outer areas (WA)
- North Adelaide Plains (SA)
- Sydney Basin (NSW)
- Central West and Hay (NSW)
- Cambridge/Richmond (Tas)

In 2009, Victoria accounted for 37% of lettuce production and Queensland 34%.

The area planted to lettuce in 2008/09 was 7,411 ha by 566 growers. The average yield per hectare in 2008/09 for heading plus loose leaf types was 22.2 t/ha. In 2008/09, the total lettuce production in Australia was 165 kt with a gross value of $187 mill. (HAL, 2012). The ABS data recently released for 2011-12 showed a decline in area grown to 6,000 ha. (ABS, 2013)

Due to the variety of weather and growing conditions across Australia, utilisation of protected cropping and the introduction of different varieties of lettuce, the Australian industry is now able to supply domestic and international markets with fresh lettuce throughout the year. In addition to a move from head to loose leafed lettuce varieties there has been diversification in the presentation in the market, now including washed, processed, bagged and other convenience forms.

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 lettuce 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 lettuce. 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 lettuce as a group as a major crop, although elements within the group such as leafy lettuce are minor. The crop fits within the APVMA crop group 013: Leafy vegetables (including brassica leafy vegetables).

As a consequence of the issues facing the lettuce industry regarding pesticide access, Horticulture Australia Ltd and the vegetable industry undertook a review of the pesticide requirements in lettuces 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 lettuce 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 lettuce production in Australia but attempts to prioritise the major problems.

3.2. Minor use permits and registration

Lettuce is classified as a major crop by the APVMA. Therefore access to minor use permits can be difficult, and will only be granted for limited uses within the crop. 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 lettuce industry is for manufacturers to register new pesticides uses in the crop.

3.3. Methods

The SARP was conducted in New South Wales, Queensland, Victoria and Western Australia as part of combined vegetable meetings in 2008, 2010 and 2011. The meeting included leading growers, consultants, government agencies, agchem companies and agricultural reseller staff.

- Participants were given a comprehensive list of most major pests of lettuces 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 lettuce 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 lettuce

4.1. Diseases of Lettuce

Common name	Scientific name
HIGH PRIORITY	
Botrytis rot	*Botrytis cinerea*
Downy mildew	*Bremia lactucae*
Sclerotinia rot (Drop)	*Sclerotinia minor, Sclerotinia sclerotiorum*
Septoria spot or Late blight	*Septoria apiicola*
MODERATE PRIORITY	
Anthracnose	*Microdochium panattonianum*
Bacterial spot	*Xanthomonas campestris pv. Vesicatoria*
Dry leaf spot	*Xanthomonas campestris pv. Vitians* spp.
Pythium	*Pythium* spp.
LOW PRIORITY	
Damping off	*Pythium* spp., *Phytophthora* spp., *Fusarium* spp., *Rhizoctonia* spp.
Powdery mildew	*Erysiphe cichoracearum*
Rhizoctonia Base rot	*Rhizoctonia* spp.
Biosecurity risk	
None listed	

Opinion on the priority of diseases can vary across the industry. As an example, **Anthracnose** was considered a high priority for some growers: it has been reported as a seasonal high priority in the southern states There are registrations for control of Anthracnose: copper, dimethomorph, mancozeb, mancozeb + metalaxyl and prochloraz. Thiram is also registered, but not for NSW. Penthiopyrad (FONTELIS) is a potential tool that could be investigated.

4.1.1 High priority diseases

Grey mould / Botrytis rot- *Botrytis cinerea*

Botrytis cinerea is the main cause of Botrytis or Grey mould. The organism is most active in spring and relatively cool/warm summers when there are periods of high humidity or rain. Its spores are spread by the wind and mainly infect outer leaves first, especially if they are damaged by the weather or insects first. Symptoms of Botrytis begin with yellow/brown patches on leaves, followed by a grey feathery dust. In severe cases the area can turn black and die.

- Botrytis rot is considered a major-moderate problem in Vic, NSW and Qld.
  - Growers alternate the use of different fungicides to reduce the resistance risk.
  - Growers would like other protective/curative fungicides for alternation.
  - Botrytis can be a significant problem in humid warm conditions. It can lead to significant crop losses.

- Fungicides **registered** for the control of Botrytis rot in lettuce are:

    - Cyprodinil + fludioxonil (SWITCH^) - Group 9 +12 protective and systemic fungicide
        - Allowed in head lettuce only - Botrytis and Sclerotinia.
        - Allowed for use in field and protected grown crops.
        - Also controls Sclerotinia rot.
        - Minimal impact on most beneficial insects.

    - Iprodione (various products) – Group B protectant and curative fungicide
        - Occasionally used.
        - Used as a protectant / curative fungicide.
        - Growers suspect there is possible resistance in NSW & Qld.
        - Minimal impact on all beneficial insects

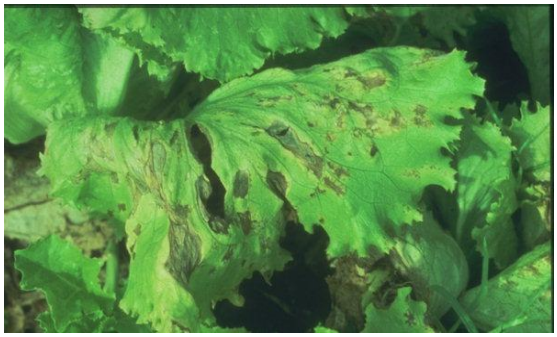
    - Thiram (various) - Group M3 protectant fungicide.
        - Occasionally used.
        - Reported as not effective in high pressure situations.
        - Moderately harmful to some beneficial insects.

- Fungicides listed for the control of Botrytis rot in lettuce via **permit** are:
    - Captan (various) – Group M4 fungicide (PER 14326, exp 11/16)
        - – leafy lettuce in protected situations only
    - Fenhexamid (TELDOR^, PER12447, expires May 2016) - Group 17 protective fungicide
        - Allowed in head and leafy lettuce.
        - Allowed for use in field and protected grown crops.
        - Occasionally used.
        - It is very effective but considered very expensive.
        - Minimal impact on all beneficial insects.

    - Pyrimethanil (various, PER12565, expires Sep 2017) - Group 9 protective fungicide
        - Allowed in head and leafy lettuce.
        - Allowed for use in protected situations only.
        - Occasionally used.
        - It is very effective but considered very expensive.
        - Moderately harmful to some beneficial insects.

Not all growers use every product. They generally alternate between the different fungicides. There are reports of some resistance concerns in NSW and Qld. Growers require new fungicide options for their spring and autumn crops which is when disease pressure is at a peak.

Downy mildew (*Bremia lactucae*)



Downy mildew is a fungal disease which can affect both seedlings and mature plants. The first signs of the disease usually appear on the older leaves. First symptoms are yellow or light green blotchy areas appearing on the upper sides of the leaves. A white downy webbing then appears on the underside of the leaf if the infection is not treated rapidly at this stage the infected area of the leaf will soon turn brown and die.

Bremia lactucae produces spores which are carried by the wind or by rain splash contaminating new areas of the crop. Mild infection sites caused by *B. lactucae* are also more susceptible to other fungal infections such as Botrytis.

- Downy mildew is considered a major-moderate problem in Vic, NSW and WA and a moderate problem in Qld.
    - Growers alternate the use of fungicides from different chemical groups.
    - Growers would like other protective/curative fungicides for alternation.
    - Most growers are using downy mildew tolerant/resistant lettuce varieties for some of the season. However resistance to downy mildew regularly breaks down as the pathogen mutates

- Fungicides **registered** for the control of Downy mildew in lettuce are:
  - Copper (various) - Group M1 – protectant fungicide
    - Commonly used as a protectant.
    - It is not effective in high pressure situations.
    - Moderately harmful to some beneficial insects.
  - Dimethomorph (various) - Group 40 - systemic, protective and curative fungicide
    - Used as a protectant / curative fungicide.
    - It is very effective, especially in Queensland, however there is a restricted number of applications.
  - Mancozeb (various) - Group M3 protectant fungicide
    - Commonly used.
    - It is not effective in high pressure situations.
    - Moderately harmful to some beneficial insects.
  - Metalaxyl/metalaxyl-m + mancozeb (various) – Group 4/M3 systemic, protective/curative fungicide
    - Commonly used.
    - Used as a protectant / curative fungicide.
    - Reports of efficacy are mixed.
    - There is a restricted number of applications.
    - Considered expensive.
    - Moderately harmful to some beneficial insects
  - Metiram (POLYRAM^) - Group M3 protectant fungicide
    - Commonly used.
    - Reported as not effective in high pressure situations.
    - Moderately harmful to some beneficial insects.
  - Propineb (ANTRACOL^) - Group M3 protectant fungicide
    - Occasionally used.
    - Reported as not effective in high pressure situations.
    - Moderately harmful to some beneficial insects
  - Propineb + oxadixyl (various) – Group 4/M3 systemic, protective/curative fungicide:
    - Occasionally used.
    - Used as a protectant / curative fungicide.
    - Preferred as has a 3 day WHP compared to Ridomil of 14 days.
    - There is a restricted number of applications.
    - Moderately harmful to some beneficial insects

- Fungicides listed for the control of Downy mildew in lettuce via **permit** are:
  - Phosphorous acid (various, PER13698, expires Sep 2017) - Group 33 protective and systemic fungicide - enhances plants natural defence mechanisms
    - Protective and systemic fungicide - enhances plants natural defence mechanisms.
    - Commonly used.
    - It is effective when it is used in rotation with other fungicides.
    - Minimal impact on all beneficial insects.

- **Potential** fungicides for control of downy mildew in lettuce:

  - Fluopicolide is a new Bayer active in the FRAC group 43. This would be a novel group in Australia. It is a systemic fungicide affecting oomycetes. Bayer CropScience has applied for approval of the active in Australia but registration of a registered product will take some time. There is overseas registration on leafy vegetables / *Peronospora farinose*. It would be sensible to approach Bayer to discuss development opportunities.

  - Cyazofamid (likely to be called RANMAN^?, new ISK/FMC Fungicide) – FRAC code 21 – contact and residual fungicide
    - Application for registration with the APVMA, for potatoes, brassicas and possibly brassica leafy
    - Inhibits oomycetes fungal development

- Resistance management tool
- The registrant should be approached for interest in developing the product on minor crops

- Ametoctradin + dimethomorph (ZAMPRO^) – FRAC code 21+ Group 40 – contact and residual fungicide
  - Controls late blight and downy mildew on potatoes and other crops, including vines. Overseas work on bulb vegetables, brassica vegetables, fruiting vegetables, leafy vegetables, celery and hops has been reported.
  - BASF couldould be approached for interest in developing the product on minor crops

Sclerotinia rot (*Sclerotinia minor, Sclerotinia sclerotiorum*)

S. sclerotiorum and *S. minor*, are the causes of Sclerotinia rot in lettuce. These organisms overwinter on lettuce debris on the ground and in soil.
There are two phases of this disease: the damping-off phase, which affects seedlings and the phase called "drop" which causes a watery soft rot in mature lettuce.
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 fungal mass that produces abundant sclerotia.

- Sclerotinia rot is considered a major problem in Qld, Vic, NSW and WA.
  - Crop rotation is critical to minimise disease. But as more lettuce is grown crop rotation is difficult.
  - Iprodione is registered for control of Sclerotinia, but gives poor control.
  - The industry needs alternatives.

- Fungicides **registered** for the control of Sclerotinia rot in lettuce are:

  - Boscalid (FILAN^) – Group 7 protectant and curative fungicide
    - Commonly used.
    - It is very effective but considered very expensive.
    - Care must be taken to avoid development of resistance
    - Minimal impact on all beneficial insects.

  - Cyprodinil + fludioxonil (SWITCH^) - Group 9 +12 protective and systemic fungicide
    - Minimal impact on beneficials.
    - Increasing use.

  - Iprodione (various) – Group B protectant and curative fungicide
    - Occasionally used.
    - Growers have concerns that there is possible resistance in NSW & Qld.
    - Minimal impact on all beneficial insects.

  - Penthiopyrad (FONTELIS^) - Group 7 – residual, preventative and post-infection activity.
    - Broad spectrum
    - Growing use.
    - Resistance management tool

  - Tebuconazole (various) – Group 3 protectant/curative fungicide:
    - Commonly used.
    - Considered effective.
    - Moderately harmful to some beneficial insects.

- Fungicides listed for Sclerotinia rot control in lettuce via **permit** are:
  - None

- **Potential** fungicides for Sclerotinia rot control in lettuce:

- Not all growers use all products. They alternate between the different fungicides. Sclerotinia rot can be a significant problem in cool wet conditions which can lead to significant crop losses. Growers feel they need more systemic/curative options. The control of this disease needs a management strategy put in place to reduce the risk of resistance to the currently available products.

- Biofumigants (especially Caliente mustard) have been trialled with moderate success in suppression of Sclerotina suppression.

Septoria spot / late blight (*Septoria apiicola*)

Lettuce is commonly planted in the field as transplants, which are produced by commercial seedling growers. Transplants compensate for the uneven germination of lettuce seed and the slow growth of lettuce seedlings, yielding a more uniform lettuce crop in the field. However, conditions in greenhouses can favour the outbreak of disease on lettuce transplants.

Septoria spot, caused by the seed-borne fungus *Septoria apiicola*, can reach high levels on lettuce.

Symptoms are generally first seen on the older leaves and consist of small, irregular yellowish spots. The spots increase in size, turn brown, dry out and may fall out giving the leaves a tattered appearance. Although this disease doesn't look as damaging as some others it is still capable of causing a considerable amount of crop damage.

- Septoria spot is considered a major to moderate problem in Vic, NSW and WA.
  - The fungus is generally introduced into an area in diseased seed and can be spread throughout a crop on implements and animals, and by rain and irrigation water.
  - Crop rotation is important.

- Fungicides **registered** for the control of Septoria spot in lettuce are:
  - Dimethomorph (various) - Group 40 - systemic, protective and curative fungicide
    - Also registered for control of downy mildew and anthracnose.
    - There is a restricted number of applications.
    - Considered expensive
  - Mancozeb (various) - Group M3 protectant fungicide
    - Mancozeb is commonly used for a variety of diseases.
    - Effective as a preventative, but some products can leave residues on crop.
    - Moderately harmful to some beneficial insects.
    - Also controls Downy mildew.
  - Metalaxyl/metalaxyl-m + mancozeb (various) – Group 4/M3 systemic, protective/curative fungicide
    - Used as a protectant / curative fungicide.
    - The control of Septoria is provided by the mancozeb
    - There is a restricted number of applications.
    - Moderately harmful to some beneficial insects
  - Metiram (POLYRAM^) - Group M3 protectant fungicide
    - Commonly used.
    - Moderately harmful to some beneficial insects.
    - Also controls Downy mildew.
  - Thiram (various) - Group M3 protectant fungicide
    - Rarely used.
    - Moderately harmful to some beneficial insects.
    - Also controls Botrytis.

- No fungicides are available in lettuce for the control of Septoria spot via **permit**.
- Potential fungicides for the control of Septoria spot.
  - None identified

4.1.2 Summary

High Priority Diseases and control options

Growers need further options to manage the range of diseases in lettuce, and as a major crop it is difficult to justify the issue of permits. There are also problems within the overall sector in that not all registered and approved chemistry is available across field and protected, and leafy and head lettuce. It is not a simple matter of extending the approvals: as the efficacy and residue situations vary with the lettuce type and growing situation, data must usually be generated to allow an extension.

Disease	Control option
Grey mould / Botrytis rot *(Botrytis **cinerea**)*	**Currently registered fungicides** Captan (various) – Group M4 fungicide Cyprodinil + fludioxonil (SWITCH^) - Group 9 +12 protective and systemic fungicide Iprodione (various products) – Group B protectant and curative fungicide Thiram (various) - Group M3 protectant fungicide. **Currently permitted fungicides** Fenhexamid (TELDOR^) (PER14211, expires Sep 2016) - Group 17 protectant fungicide Pyrimethanil (various) (PER13633, expires Jun 2014 (renewal requested)) - Group 9 fungicide **Fungicide gaps** Additional protective and curative fungicides for alternation. **Potential fungicide solutions** None nominated by growers. **Non-chemical options** Cultivation techniques, for example to allow good airflow.
Downy mildew (*Bremia lactucae*)	**Currently registered fungicides** Copper (various) - Group M1 – protectant fungicide Dimethomorph (various) - Group 40 - systemic, protective and curative fungicide Mancozeb (various) - Group M3 protectant fungicide Metalaxyl/metalaxyl-m + mancozeb (various) – Group 4/M3 systemic, protective/curative fungicide Metiram (POLYRAM^) - Group M3 protectant fungicide Propineb (ANTRACOL^) - Group M3 protectant fungicide Propineb + oxadixyl (various) – Group 4/M3 systemic, protective/curative fungicide: **Currently permitted fungicides** Phosphorous acid (various, PER13698, expires Sep 2017) - Group 33 protective and systemic fungicide **Fungicide Gaps** Although there are a number of registered or permitted chemicals growers believe there is some resistance. They would like further options for alternation. **Potential fungicide solutions** Ametoctradin + dimethomorph (ZAMPRO^) – new BASF chemistry registered for downy mildew in other crops. Cyazofamid (likely to be called RANMAN^?, new ISK/FMC Fungicide) – first new product registration under assessment at the APVMA. Fluopicolide, a new Bayer fungicide being assessed for first registration by the APVMA. **Non-chemical options** Crop rotation Plant spacing to improve air flow and spray penetration Resistant varieties

Disease	Control option
Sclerotinia rot	**Currently registered fungicides** Boscalid (various) – Group 7 protectant and curative fungicide. Cyprodinil + fludioxonil (SWITCH^) - Group 9 +12 protective and systemic fungicide. Iprodione (various) – Group B protectant and curative fungicide Penthiopyrad (FONTELIS^) - Group 7. Tebuconazole (various) – Group 3 protectant/curative fungicide. **Currently permitted fungicides** None. **Fungicide Gaps** Although there are several options available growers would like further options for alternation **Potential fungicide solutions** Biofumigants **Non-chemical options** Crop rotation. Good hygiene
Septoria spot / late blight (*Septoria apiicola*)	**Currently registered fungicides** Dimethomorph (various) - Group 40 - systemic, protective and curative fungicide Mancozeb (various) - Group M3 protectant fungicide Metalaxyl/metalaxyl-m + mancozeb (various) – Group 4/M3 systemic, protective/curative fungicide Metiram (POLYRAM^) - Group M3 protectant fungicide Thiram (various) - Group M3 protectant fungicide **Currently permitted fungicides** None **Fungicide gaps** None identified **Potential fungicide solutions** None nominated by growers **Non-chemical options** Best practice crop management

Currently available fungicides

Disease Name	Active ingredient	WHP	Chemical group
Anthracnose	copper	1	M1
	dimethomorph	14	40
	mancozeb + metalaxyl	14	4/M3
	mancozeb	14	M3
	prochloraz	7	3
	thiram (not NSW)	7	M3
Bacterial spot	copper	1	M1
Bactericide	iodine	NR	_
Damping off	Metalaxyl-M(PER14318, protected)	NR	4
Downy mildew	copper	1	M1
	dimethomorph	14	40
	mancozeb + metalaxyl	14	4/M3
	mancozeb	14	M3
	Metiram (POLYRAM^)	7	M3

Disease Name	Active ingredient	WHP	Chemical group
	phosphorous acid (PER13698, protected)	1	33
	propineb + oxadixyl	3	4/M3
	Propineb (ANTRACOL^)	3	M3
Dry leaf spot	copper (various)	1	M1
Fungi	iodine	NR	_
Grey mould	captan	7	M3
	cyprodinil+ fludioxonil (SWITCH^)	7	9+12
	fenhexamid (PER12447)	3	17
	iprodione	7	2
	penthiopyrad (FONTELIS^)	3(H), *(G)	7
	pyrimethanil (PER12565, protected)		
	Thiram (Not NSW)	7	M3
Powdery mildew	potassium bicarbonate (PER13695)	NR	M2
	penthiopyrad (FONTELIS^)	3(H), *(G)	7
	Sulphur	NR	_
Sclerotinia rot	boscalid (FILAN)	14	7
	cyprodinil+ fludioxonil (SWITCH^)	7	9+12
	iprodione	7	2
	penthiopyrad (FONTELIS^)	3(H), *(G)	7
	tebuconazole	35	3
Septoria spot	dimethomorph	14	40
	mancozeb + metalaxyl	14	4/M3
	mancozeb	14	M3
	metiram	7	M3
	thiram	7	M3
Soil borne diseases incl Fusarium, Verticillium wilts, Rhizoctonia, Pythium	1,3-dichloropropene + chloropicrin	NR	8B

4.2 Insects of Lettuce

Common name	Scientific name
HIGH PRIORITY	
Green peach aphid	*Myzus persicae*
Helioverpa	*Helicoverpa spp.*
Lettuce aphid	*Nasonovia ribis-nigri*
Rutherglen bug	*Nysius vinitor*
Silverleaf whitefly	*Bemisia tabaci Biotype B & Q*
Western flower thrips	*Frankliniella occidentalis*
MODERATE PRIORITY	
African Black Beetle	*Heteronychus arator*
Cutworm	*Agrotis* spp.
Plague thrips	*Thrips imaginis*
Soldier beetle	*Chauliognathus pulchellus*
LOW PRIORITY	
Green Vegetable bug	*Nezara viridula*
Leafminer flies	*Scaptomyza flava*
Looper caterpillars	*Chrysodeixis spp.*
Redlegged earth mite	*Halotydeus destructor*
Two-spotted mite	*Tetranychus urticae*
Webworm	*Lepidoptera*
Wireworm and False wireworms	*Elateridae, Gonocephalum* spp.
Biosecurity risk	
None listed	

Opinion on the priority of pests can vary across the industry. As an example, soldier beetles were rated as a moderate priority overall but they have increased in significance as contaminant for processors, marketers and retailers during last few years

4.2.1 High priority insects

Green peach aphid (*Myzus persicae*)

Lettuce aphid (*Nasonovia ribis-nigri*)

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

Lettuce aphid is a recent arrival to Australia and was first found in Tasmania in 2004. Adult aphids can be winged or wingless, and are approximately 2-2.5mm in length, greenish to yellow-green to brown with and generally have irregular narrow dark patches on their backs. 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 reliance on parasitic wasps. Beneficial species for controlling aphids - Brown lacewings, Hoverflies, Parasitic wasps and Ladybird beetles. Any insecticide used in lettuce needs to be compatible with beneficials, particularly lacewings.

- Aphids are considered a major-moderate problem. Lettuce aphids are considered a major problem in all areas and are especially important for all growers who supply fresh cut processors , restaurants and retailers.
  - Growers want IPM compatible alternatives.
  - Although beneficial insects play a very important role in managing aphids there is still reliance on insecticides.
  - New aphicides have come on the market since the time of the SARP meetings and the priority has dropped somewhat.

- Insecticides **registered** for the control of aphids in lettuce are:
  - Chlorantraniliprole + thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide
    - Commonly used as a seedling drench or soil drench for aphid control - also controls lepidoptera, whitefly and thrips.
    - Adds significantly to the cost of seedlings from nurseries.
    - Growers expressed concern that with regular use that resistance may develop.
    - Very effective on sucking and chewing insects
    - Efficacy lasts 35-40 days.
    - Moderately harmful to some beneficial insects.
  - Fenamiphos (various) – Group 1B contact and systemic insecticide
    - Fenamiphos is not used.
    - Harmful to many beneficial insects.
    - Fenamiphos is under review by APVMA.
  - Imidacloprid (various) - Group 4A contact and systemic insecticide
    - Almost always used as a seedling drench or soil drench for Lettuce aphid control - also controls all other aphids.
    - Very effective treatment method.
    - Moderately harmful to some beneficial insects.
  - Maldison (various) – Group 1B contact and systemic insecticide
    - Maldison is not used.
    - Harmful to many beneficial insects.
    - Maldison is under review by APVMA.
    -
  - Pirimicarb (various) - Group 1A contact and systemic insecticide
    - Occasionally used - only when needed - imidacloprid does not provide complete control.
    - Can be very effective but there have been resistance issues for the last couple of years..
    - Moderately harmful to some beneficial insects.
  - Potassium salts of fatty acids (various) – contact biological insecticide
    - Not used for this pest.
    - Minimal impact on all beneficial insects
  - Pyrethrins+piperonyl butoxide (various) – Group 3A contact insecticide
    - Good knockdown
    - Harmful to beneficials
  - Spirotetramat (MOVENTO^) – Group 23 contact and systemic insecticide
    - Occasionally used - only when needed - imidacloprid does not provide complete control.
    - Very effective. Also controls whitefly.
    - Moderately harmful to some beneficial insects.
  - Sulfoxaflor (TRANSFORM^) – Group 4C insecticide
    - Field situations only.
    - May have adverse effects on parasitic wasps in IPM situations.
    - Registered for green peach aphid and melon (cotton) aphid in cucurbits

- Insecticides listed for the control of aphids in lettuce via **permit** are:
  - Petroleum oil (various, PER 12221) – contact insecticide
    - For use in cucurbits against all aphids.
    - Occasionally used - only when needed.
    - Effective.
    - Also controls thrips and whiteflies.
    - Moderately harmful to some beneficial insects.
  - Pymetrozine (various, PER13111) – Group 9B contact and systemic insecticide
    - Occasionally used - only when needed - imidacloprid does not provide complete control.
    - Very effective. Also controls whitefly.
    - Minimal impact on most beneficial insects.
    - Expires 31-May-14. Syngenta may register use.
    -

- **Potential** insecticides for control of aphids in lettuce.
  - Cyantraniliprole (BENEVIA^) – Group 28 contact and systemic insecticide
    - Registered in cotton for control of sucking insects – silverleaf whitefly, cotton aphid (suppression only) and for chewing insects – Helicoverpa
    - Product being assessed at the APVMA. Residues studies, primarily from overseas, have been submitted for cucurbits, lettuce, peppers, tomatoes, melons, blueberries, pome and stone fruit, potatoes, beans, citrus, almonds, pecans, onion, leafy vegetables, brassica vegetables.
    - This is from the same group as Chlorantraniliprole so may have limited use for alternation.
    - The initial target Australian use pattern is not known
    - Dupont could be approached for consideration of minor crops in its development program
  - Flonicamid (new ISK/FMC product)– Group 9C
    - First registration application in assessment at APVMA. Likely first registration on cucurbits
    - Aphicide
    - IR4 projects on thrips, aphids
    - Overseas registrations on aphids / brassica vegetables, root vegetables, tuberous and corm vegetables, cucurbit vegetables, hops, leafy vegetables, fruiting vegetables, pome fruit and stone fruit
  - Metaflumizone (New BASF active) - Group 22B
    - Activity against Lepidoptera, Coleoptera, Hemiptera, Hymenoptera, Isoptera, and Diptera.
    - At this stage an active ingredient approval is in review at the APVMA
    - BASF could be approached for consideration of minor use crops in its development program. The Australian target use pattern is not known.

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

This caterpillar varies greatly in appearance. They can reach lengths of 50 mm. It is generally initially pale green, sometimes with black dots, and a pattern of thin dark lines running along the body, the lines being darker around the second and third segments. Later the dark lines become less conspicuous, and the black spots develop red areas around them.

All species of Helicoverpa have hairs protruding from each black (or white) dot.
Most obvious damage is caused by larvae that burrow directly into developing fruit causing holes in fruit to be 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 major – moderate problem in all areas.
- Insecticides **registered** for Helicoverpa control in lettuce are:
  - Alpha-cypermethrin (various) - Group 3A contact and systemic insecticide
    - Occasionally used in some regions.
    - Considered effective against H. punctigera but only with limited efficacy against H. armigera.
    - Moderately harmful to harmful to many beneficial insects.

- Bacillus Thuringiensis var Kurstaki (Btk) (various) - Group I16 contact insecticide
  - Btk is sometimes used.
  - Very effective on small grubs, but needs regular reapplication.
  - Minimal impact on all beneficial insects.
- Chlorantraniliprole (various, including CORAGEN^) - Group 28 contact and systemic insecticide
  - Commonly used.
  - Very effective under moderate temperatures – some variable results in very warm/hot conditions.
  - Minimal impact on all beneficial insects.
- Chlorantraniliprole + Thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide
  - Controls a broad range of insect pests
  - Adds significantly to the cost of seedlings from nurseries.
  - Overuse should be avoided to reduce risk of resistance developing.
  - Moderately harmful to some beneficial insects
- Emamectin (various) – Group 6 contact and systemic insecticide
  - Commonly used in some regions.
  - Considered effective.
  - Moderately harmful to some beneficial insects.
- Flubendiamide (BELT^) – Group 28 contact and systemic insecticide
  - Commonly used in some regions.
  - Very effective.
  - Minimal impact on all beneficial insects.
- Helicoverpa NPV (various) – biological insecticide
  - Frequently used by some growers.
  - Very effective on small grubs.
  - Minimal impact on all beneficial insects.
- Indoxacarb (various) - Group 22A contact and systemic insecticide
  - Commonly used in some regions.
  - Considered effective in lettuce which has not hearted
  - No residual control..
  - Moderately harmful to some beneficial insects.
- Methomyl (various) - Group 1A contact and systemic insecticide
  - Occasionally used in some regions, regularly used in Qld for egg control
  - Very effective on a range of pests, including thrips.
  - Recently re-registered in lettuce by Dupont with a new WHP - 7 days.
  - Harmful to many beneficial insects.
  - Methomyl is under review by APVMA.
- Spinetoram (SUCCESS NEO^) - Group 5A contact and systemic insecticide
  - Commonly used in some regions.
  - Very effective on a range of pests, including thrips.
  - Resistance issues when used for WFT control.
  - Moderately harmful to some beneficial insects.
- Chlorantraniliprole + thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide
  - Commonly used as a seedling drench or soil drench for aphid control - also controls lepidoptera, whitefly and thrips.
  - Adds significantly to the cost of seedlings from nurseries.
  - Growers expressed concern that with a heavy reliance resistance may develop.
  - Very effective treatment method.
  - Moderately harmful to some beneficial insects.

- Insecticides are available for the control of Helioverpa in lettuce via **permit**.
  - Methoxyfenozide (PRODIGY^) - Group 18 insect growth regulator
    - Field – label, protected – PER12391)
    - Considered very effective but expensive.
    - Minimal impact on all beneficial insects

- **Potential** insecticides for control of Helicoverpa:
  - Cyantraniliprole (BENEVIA^) – Group 28 contact and systemic insecticide
    - Registered in cotton for control of sucking insects – silverleaf whitefly, cotton aphid (suppression only) and for chewing insects – Helicoverpa
    - Product being assessed at the APVMA. Residues studies, primarily from overseas, have been submitted for cucurbits, lettuce, peppers, tomatoes, melons, blueberries, pome and stone fruit, potatoes, beans, citrus, almonds, pecans, onion, leafy vegetables, brassica vegetables.
    - This is from the same group as Chlorantraniliprole so may have limited use for alternation.
    - The initial target Australian use pattern is not known
    - Dupont should be approached for consideration of minor crops in its development program

  - Metaflumizone (New BASF active) - Group 22B
    - activity against important Lepidoptera, Coleoptera, Hemiptera, Hymenoptera, Isoptera, and Diptera.
    - New chemical class of insecticides, the semicarbazones, which block the voltage-dependent Na+ channel of susceptible insects.
    - At this stage an active ingredient approval is in review at the APVMA
    - BASF could be approached for consideration of minor use crops in its development program. The Australian target use pattern is not known

  - Novaluron - Group 15. Farmoz and United Phosphorous have approvals of this active
    - The status of development of an end use product is unknown.
    - The active is the subject of IR4 project work: cabbage / diamondback moth, cabbage looper, Lepidoptera; cauliflower / lepidoptera

Rutherglen bug (*Nysius vinitor*)

Rutherglen bugs are a common native insect 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 and can reach plague proportions in some seasons in some crops.

Rutherglen bugs feed like aphids, by sucking sap from plant foliage including leaves. They also damage lettuce crops by contamination.

- The Rutherglen bug is considered a high-moderate priority in all south eastern Aust states and a moderate priority in WA and Qld.
  - They also feed on weeds so weed control is important in managing this pest.
  - In southern states during January a fungus usually attacks this pest turning it white and drastically reducing population numbers.

- Insecticides **registered** for the control of Rutherglen bug in lettuce are:
  - Maldison (various) – Group 1B contact and systemic insecticide
    - Maldison is occasionally used for the control of aphids, Green vegetable bugs, jassids, leaf hoppers, Rutherglen bugs and thrips.
    - Maldison is a relatively old product but is still used effectively if applications are regular.
    - Moderately harmful to harmful to many beneficial insects.

  - Trichlorfon (various) – Group 1B contact and systemic insecticide
    - Growers didn't mention using this chemical.

- Insecticides listed for control of Rutherglen bugs in lettuce via **permit**.
  - Petroleum oil (various, PER12221 and PER14351) – contact insecticide
    - Occasionally used.
    - Offers short term suppression.
    - Also controls other pests.
    - Moderately harmful to some beneficial insects.

Silverleaf (Poinsettia) whitefly *(Bemisia tabaci* - all biotypes*)*

Silverleaf whitefly was 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.

Whiteflies damage lettuce by sucking enormous 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 lettuce, needs to be compatible with these beneficial insects.

- Silverleaf whitefly are considered a major-moderate problem in NSW and Qld.
  - Whitefly numbers can vary, but can be heavy.
  - Growers want IPM compatible alternatives.
  - Silverleaf whitefly are more difficult to kill than Greenhouse whitefly (*Trialeurodes vaporariorum*).
  - There are insecticides available, but growers are concerned at the ability of Silverleaf whitefly developing resistance to many insecticides.

- Insecticides **registered** for the control of Silverleaf whitefly in lettuce are:
  - Chlorantraniliprole + thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide
    - Commonly used as a seedling drench or soil drench for whitefly control - also controls aphids, lepidoptera and thrips.
    - Adds significantly to the cost of seedlings from nurseries.
    - Growers expressed concern that with regular use resistance may develop.
    - Very effective treatment method.
    - Moderately harmful to some beneficial insects.

  - Emulsifiable botanical oil - contact insecticide
    - Occasionally used.
    - Very effective. Also controls some other pests.
    - Caution needed in hot weather.
    - Moderately harmful to some beneficial insects.

  - Potassium salts of fatty acids (various) – contact biological insecticide
    - Greenhouse and silverleaf whitefly.
    - 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
    -

  - Sulfoxaflor (TRANSFORM^) – Group 4C insecticide
    - Field situations only.
    - Registered for control of greenhouse whitefly.
    - May have adverse effects on parasitic wasps in IPM situations.

- Insecticides listed for the control of Silverleaf whitefly in lettuce via **permit** are:
  - Bifenthrin (various) - Group 3A contact and systemic insecticide
    - Occasionally used.
    - Very effective. Also controls some other pests.
    - Growers expressed concern that with a heavy reliance that resistance may develop.
    - Moderately harmful to harmful to many beneficial insects.

- Petroleum oil (various, PER12221, Expires Nov 2017) – contact insecticide
  - Occasionally used.
  - Reported as not very effective, but offers short term suppression.
  - Also controls other pests.
  - Moderately harmful to some beneficial insects.
- Pymetrozine (various, PER13111) – Group 9B contact and systemic insecticide
  - Occasionally used 1-2 times per crop.
  - Very effective. Also controls aphids.
  - Minimal impact on all beneficial insects.
  - Expires 31-May-14. Syngenta may register use.

- Potential insecticides for control of whitefly:

  There are now a number of registrations and permits. The greatest need is to manage their use to avoid resistance.
  - Cyantraniliprole (BENEVIA^) – Group 28 contact and systemic insecticide
    - Registered in cotton for control of sucking insects – silverleaf whitefly, cotton aphid (suppression only) and for chewing insects – Helicoverpa
    - Product being assessed at the APVMA. Residues studies, primarily from overseas, have been submitted for cucurbits, lettuce, peppers, tomatoes, melons, blueberries, pome and stone fruit, potatoes, beans, citrus, almonds, pecans, onion, leafy vegetables, brassica vegetables.
    - This is from the same group as Chlorantraniliprole so may have limited use for alternation.
    - The initial target Australian use pattern is not known
    - Dupont could be approached for consideration of minor crops in its development program

  - Metaflumizone (New BASF active) - Group 22B
    - Activity against Lepidoptera, Coleoptera, Hemiptera, Hymenoptera, Isoptera, and Diptera.
    - At this stage an active ingredient approval is in review at the APVMA
    - BASF could be approached for consideration of minor use crops in its development program. The Australian target use pattern is not known

  - Novaluron - Group 15. Farmoz and United Phosphorous have approvals of this active. The status of development of an end use product is unknown. The active is the subject of IR4 project work on whitefly. Efficacy and residue work would be required.

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.

While thrips can cause direct damage to foliage and fruit, their role as vectors of tomato spotted wilt is of primary concern, especially in tomato and pepper. They are weak fliers but are capable of infesting large areas of crop as they are easily blown by wind.

They 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. Virus transmission is also a major issue, mainly Tomato Spotted Wilt Virus.

- Western flower thrips are considered a major-moderate problem Vic, NSW and WA and a moderate problem in Queensland. The importance has, however, dropped in recent years as new control options have become available.
  - 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 Western flower thrips in lettuce are:
  - Abamectin (various) - Group 6 contact and systemic insecticide
    - Occasionally used in some regions.
    - Very effective on a range of pests, including mites.
    - Growers expressed concern that with regular use that resistance has developed.
    - Moderately harmful to some beneficial insects.
  - Chlorantraniliprole + thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide
    - Commonly used as a seedling drench or soil drench for aphid control - also controls lepidoptera, whitefly and thrips.
    - Adds significantly to the cost of seedlings from nurseries.
    - Growers expressed concern that with regular use that resistance may develop.
    - Very effective treatment method.
    - Moderately harmful to some beneficial insects.
    -
  - Methomyl (various) - Group 1A contact and systemic insecticide
    - Occasionally used in some regions, regularly used in Qld for egg control
    - Very effective on a range of pests, including thrips.
    - Recently re-registered in lettuce by Dupont with a new WHP - 7 days.
    - Harmful to many beneficial insects.
    - Methomyl is under review by APVMA.
  - Spinetoram (SUCCESS NEO^) - Group 5A contact and systemic insecticide
    - Commonly used in some regions.
    - Very effective on a range of pests, including heliothis.
    - Moderately harmful to some beneficial insects.
    - Used for Lepidoptera and WFT although resistance is a concern in WFT

- The insecticides that are registered for the control of thrips in lettuce:
  - Fenamiphos (various) – Group 1B contact and systemic insecticide
  - Maldison (various) – Group 1B contact and systemic insecticide

  are likely to be ineffective against Western flower thrips due to resistance.

- Insecticides listed for control of Western flower thrips in lettuce via **permit**:
  - Petroleum oil (various, PER12221, Expires Nov 2017) – contact insecticide
    - Occasionally used.
    - Reported as not very effective, but offers short term suppression.
    - Also controls other pests.
    - Moderately harmful to some beneficial insects.
- **Potential** insecticides for control of Western flower thrips in lettuce:
  - Cyantraniliprole (BENEVIA^) – Group 28 contact and systemic insecticide
    - Registered in cotton for control of sucking insects – silverleaf whitefly, cotton aphid (suppression only) and for chewing insects – Helicoverpa
    - Product being assessed at the APVMA. Residues studies, primarily from overseas, have been submitted for cucurbits, lettuce, peppers, tomatoes, melons, blueberries, pome and stone fruit, potatoes, beans, citrus, almonds, pecans, onion, leafy vegetables, brassica vegetables.
    - This is from the same group as Chlorantraniliprole so may have limited use for alternation.
    - The initial target Australian use pattern is not known
    - Dupont should be approached for consideration of minor crops in its development program
    - IR4 projects for various crops/thrips, beetles, leafminer, psyllids, whitefly
  - Flonicamid (new ISK/FMC product)– Group 9C
    - First registration application in assessment at APVMA. Likely first registration on cucurbits.
    - IR4 projects on thrips
    - Overseas registrations on aphids / brassica vegetables, root vegetables, tuberous and corm vegetables, cucurbit vegetables, hops, leafy vegetables, fruiting vegetables, pome fruit and stone fruit

4.2.2 Summary

High Priority Insects and control options
The chemistry available to lettuce growers has increased significantly in recent years with new entrants to the market. So for some pests, growers have reasonable options for developing a treatment schedule with good alternation of products from different chemical groups. It is expected that the use of the new chemistry will be carefully managed - the industry has observed the benefits of IPM techniques, both in reducing pest problems and as a means of reducing resistance risks that come from overuse of chemicals.

There are no or limited chemicals permitted for a number of the lesser pests of lettuce. Growers must rely on control by other chemicals already being used in the crop. This can be difficult when the management strategy is not targeted to the problem.

Insect	Control option
Green peach aphid (*Myzus persicae*) Lettuce aphid (*Nasonovia ribis-nigri*)	**Currently registered insecticides** Chlorantraniliprole + thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide Fenamiphos (various) – Group 1B contact and systemic insecticide Imidacloprid (various) - Group 4A contact and systemic insecticide Maldison (various) – Group 1B contact and systemic insecticide Pirimicarb (various) - Group 1A contact and systemic insecticide Potassium salts of fatty acids (various) – contact biological insecticide Pyrethrins+piperonyl butoxide (various) – Group 3A contact insecticide Spirotetramat (MOVENTO^) – Group 23 contact and systemic insecticide Sulfoxaflor (TRANSFORM^) – Group 4C insecticide **Currently permitted insecticides** Petroleum oil (various, PER 12221) – contact insecticide Pymetrozine (various, PER13111) – Group 9B contact and systemic insecticide **Insecticide Gaps** Unlikely to be a gap with new introductions to the market in recent years **Potential insecticide solutions** If further options are need the following are possibilities: Cyantraniliprole (BENEVIA^) – Group 28 contact and systemic insecticide Flonicamid (new ISK/FMC product)– Group 9C Metaflumizone (New BASF active) - Group 22B **Non-chemical options** Best management practice includes the use of IPM compatible insecticides in combination with reliance on parasitic wasps.
Helicoverpa *Helicoverpa* spp.	**Currently registered insecticides** Alpha-cypermethrin (various) - Group 3A contact and systemic insecticide Bacillus Thuringiensis var Kurstaki (Btk) (various) - Group I16 contact insecticide Chlorantraniliprole (various, including CORAGEN^) - Group 28 contact and systemic insecticide Chlorantraniliprole + Thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide Emamectin (various) – Group 6 contact and systemic insecticide Flubendiamide (BELT^) – Group 28 contact and systemic insecticide Helicoverpa NPV (various) – biological insecticide Indoxacarb (various) - Group 22A contact and systemic insecticide Methomyl (various) - Group 1A contact and systemic insecticide Spinetoram (SUCCESS NEO^) - Group 5A contact and systemic insecticide Chlorantraniliprole + thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide

Insect	Control option
	Currently permitted insecticides Methoxyfenozide (PRODIGY^) - Group 18 insect growth regulator **Insecticide Gaps** None identified by growers during SARP **Potential insecticide solutions** Cyantraniliprole (BENEVIA^) – Group 28 contact and systemic insecticide Metaflumizone (New BASF active) - Group 22B Novaluron - Group 15. Farmoz and United Phosphorous have approvals of this active **Non-chemical options** IPM strategies to manage resistance..
Rutherglen bug (Nysius vinitor)	**Currently registered insecticides:** Maldison (various) – Group 1B contact and systemic insecticide Trichlorfon (various) – Group 1B contact and systemic insecticide **Currently permitted insecticides:** Petroleum oil (various, PER12221 and PER14351) – contact insecticide **Insecticides Gaps** Registrations and permits required, although chemistry registered to control other insects will incidentally control Rutherglen bug. **Potential insecticides solutions** None specifically requested by growers. **Non-chemical options** Weed control around crops – this pest feeds on weeds then moves to the crop as weeds die. Management of the Retail / supermarket zero tolerance of live insects.
Silverleaf whitefly (*Bemisia tabaci*)	**Currently registered insecticides** Chlorantraniliprole + thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide Emulsifiable botanical oil - contact insecticide Potassium salts of fatty acids (various) – contact biological insecticide Pyrethrins+piperonyl butoxide (various) – Group 3A contact insecticide Sulfoxaflor (TRANSFORM^) – Group 4C insecticide **Currently permitted insecticides** Bifenthrin (various) - Group 3A contact and systemic insecticide Petroleum oil (various, PER12221, Expires Nov 2017) – contact insecticide Pymetrozine (various, PER13111) – Group 9B contact and systemic insecticide **Insecticide Gaps** There are now a number of registrations and permits. The greatest need is to manage their use to avoid resistance. **Potential insecticide solutions** - Cyantraniliprole (BENEVIA^) – Group 28 contact and systemic insecticide This is from the same group as Chlorantraniliprole so may have limited use for alternation. - Metaflumizone (New BASF active) - Group 22B Activity against Lepidoptera, Coleoptera, Hemiptera, Hymenoptera, Isoptera, and Diptera. **Non-chemical options** IPM strategies – required to manage resistance.

Insect	Control option
Western flower thrips (*Frankliniella occidentalis*)	**Currently registered insecticides** Abamectin (various) - Group 6 contact and systemic insecticide. Chlorantraniliprole + thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide. Methomyl (various) - Group 1A contact and systemic insecticide Spinetoram (SUCCESS NEO^) - Group 5A contact and systemic insecticide. Insecticides registered for general thrips control in lettuce that are unlikely to be effective due to resistance: Fenamiphos (various) – Group 1B contact and systemic insecticide Maldison (various) – Group 1B contact and systemic insecticide **Currently permitted insecticides** Petroleum oil (various, PER12221, Expires Nov 2017) – contact insecticide Insecticides listed for control of Western flower thrips in lettuce via **permit**: Petroleum oil (various, PER12221, Expires Nov 2017) – contact insecticide **Insecticide Gaps** New registrations in recent years have filled gaps **Potential insecticide solutions** Cyantraniliprole (BENEVIA^) – Group 28 contact and systemic insecticide This is from the same group as Chlorantraniliprole so may have limited use for alternation. Flonicamid (new ISK/FMC product)– Group 9C First registration application in assessment at APVMA. Likely first registration on cucurbits. **Non-chemical options:** IPM strategies

Currently available insecticides
As a major crop lettuce has a considerable number of insecticide registrations. Refer to Appendix 3. Permits are listed below:

Permit	Active	Insect	Comment
PER14210	Bifenazate	Two spotted mite	head and leafy, Protected
PER12947	Bifenthrin	Silverleaf whitefly	
PER11472	BT subs. Israelensis Serotype H14 (VECTOBAC^ WG)	Fungus gnats	
PER14077	Emulsifiable botanical oils	Silverleaf whitefly	Protected
PER14336	Methoxyfenozide	Cluster caterpillar, Looper, LBAM	Protected
PER12391	Methoxyfenozide	Native budworm, tomato grub, cluster caterpillar	leafy
PER12221	Petroleum	Aphids, Green mired, Green vegetable bug, Grey cluster bug, Leafhoppers, Mites, Rutherglen bug, Thrips	
		Greenhouse whitefly, *Bemisia tabaci* species (Sweet potato whitefly, Silverleaf whitefly B biotype and Whitefly Q biotype)	
PER14351	Petroleum	Leafhopper, Green veg bug- Grey cluster bug- Rutherglen bug- Green mirid	Protected
PER13920	Potassium	Greenhouse whitefly, Silverleaf whitefly	Protected
PER13111	Pymetrozine	Silverleaf whitefly	
PER13111	Pymetrozine	Lettuce aphid	

4.3 Herbicide use in lettuce

- Herbicides registered and used in in lettuce:
  - Clethodim (various) – Group A grass selective post-emergent herbicide
    - Commonly used.
    - Considered very effective.
    - It is used to spot spray grass weeds such as couch grass post-emergent.
    - Controls most grass weeds. Does not control Winter grass (Poa annum).
  - Fluazifop-P as butyl (various) – Group A grass selective post-emergent herbicide
    - Commonly used.
    - Considered very effective.
    - It is used to spot spray grass weeds such as couch grass post-emergent.
    - Controls most grass weeds. Does not control Winter grass (Poa annum).
  - Pendimethalin (various) - Group D pre-plant residual herbicide
    - It is occasionally used as an effective pre-transplant herbicide for broadleaf and grass control.
    - Growers comment that does not control all weeds that occur.
    - Causes stunting in seedlings during cooler months
  - Propyzamide (various) - Group K selective pre-emergent and early post-emergent herbicide
    - It is commonly used as an effective pre or post- emergent annual broadleaf and grass control.
    - Considered very effective. Most commonly used herbicide.
    - Controls most weeds.
    - Variable results if unscheduled irrigation or large rain events wash herbicide deep in the profile.
    - Application should be delayed during cold weather
  - Sethoxydim (various) - Group A grass selective post-emergent herbicide
    - Occasionally.
    - Used to spot spray grass weeds post-emergent.
  - 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

- The herbicides listed for control of weeds in lettuce via **permits** are:
  - Chlorthal-dimethyl (various, PER12386) – Group D general knockdown and residual herbicide
    - Occasionally used at planting to control annual broadleaf weeds.
    - Considered very effective.
    - Controls many weeds.
    - Only for use in SA and WA.
    - Permit expires 30-Sep-15. No manufacturer interested in registering use.
  - Phenmedipham (BETANAL^/BETANAL^ FLOW, PER11855) - Group C selective post-emergent herbicide.
    - Occasionally used as effective in the control post- emergent of annual broadleaf and grass.
    - Considered very effective.
    - Controls many weeds.
    - Caution need with rates used on some soils.
    - Permit expires 30-Jun-14. No manufacturer interested in registering use.
  - Propachlor (RAMROD^, PER12008) – Group H selective post-emergent herbicide
    - It is commonly used as an effective post- emergent annual broadleaf and grass control herbicide.
    - Considered very effective.
    - Controls many weeds.
    - Permit expires 30-Sep-15. No manufacturer interested in registering use.

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 registered are either pre-emergent herbicides or early post-emergent herbicides.

Most weeds can be controlled with currently available herbicides.

- Weeds identified as a high priority for control are:

Weed (common name)	**Weed (scientific name)**	**Herbicide registered for control**
Clevers	*Galium aparine*	Propyzamide, Paraquat + diquat
Fleabane	*Conyza* spp.	Propachlor (RAMROD^), Knockdown herbicides
Fumitory	*Fumaria* spp.	Pendimethalin, Knockdown herbicides
Groundsel*	*Senecio* spp.	Knockdown herbicides
Marshmallow	*Malva parviflora*	Knockdown herbicides
Potato weed	*Galinsoga* spp.	Pendimethalin, Phenmedipham (BETANAL^/BETANAL^ FLOW), propachlor (RAMROD^), Knockdown herbicides
Wild turnip	*Brassica* spp.	Propyzamide, Knockdown herbicides
Winter grass	*Poa annua*	Chlorthal-dimethyl, Clethodim, Pendimethalin, Phenmedipham (BETANAL^/BETANAL^ FLOW), Propachlor (RAMROD^), Propyzamide, Knockdown herbicides
Shepherd's Purse	*Capsella bursa-pastoris*	

*Same family as lettuce therefore control can be difficult

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Images:

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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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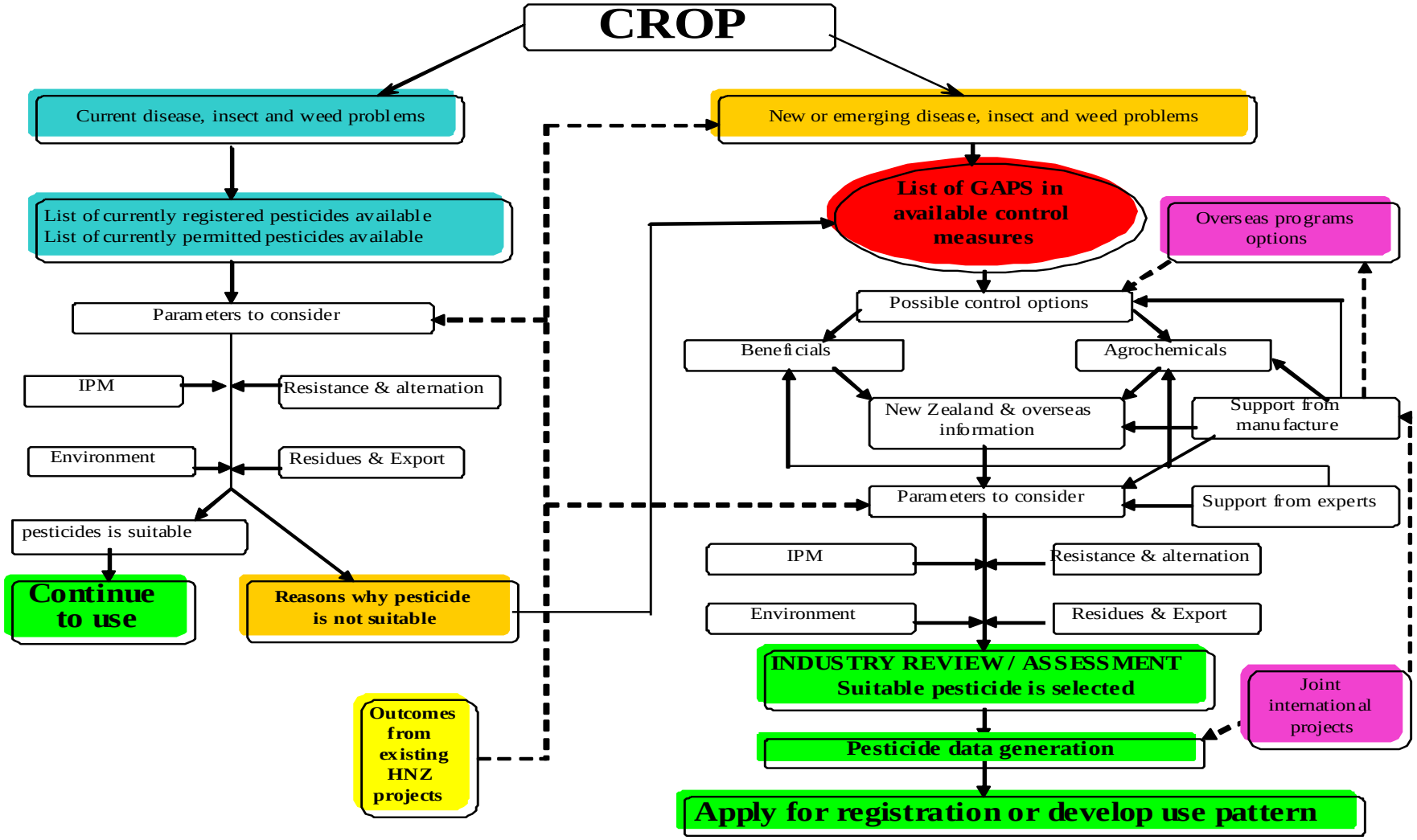
^Trademark

6. Appendices

DIAGRAM 1: The Strategic Agrichemical Review Process



Appendix 2 – currently available fungicides in lettuce.

Disease Name	Active ingredient	WHP	Chemical group
Anthracnose	copper	1	M1
	dimethomorph	14	40
	mancozeb + metalaxyl	14	4/M3
	mancozeb	14	M3
	prochloraz	7	3
	thiram (not NSW)	7	M3
Bacterial spot	copper	1	M1
Bactericide	iodine	NR	_
Damping off	Metalaxyl-M (PER14318)	NR	4
Downy mildew	copper	1	M1
	dimethomorph	14	40
	mancozeb + metalaxyl	14	4/M3
	mancozeb	14	M3
	Metiram (POLYRAM^)	7	M3
	phosphorous acid (incl. PER13698, protected)	1	33
	propineb + oxadixyl	3	4/M3
	Propineb (ANTRACOL^)	3	M3
Dry leaf spot	copper (various)	1	M1
Fungi	iodine	NR	_
Grey mould	captan	7	M3
	cyprodinil+ fludioxonil (SWITCH^)	7	9+12
	fenhexamid (PER12447)	3	17
	iprodione	7	2
	penthiopyrad (FONTELIS^)	3(H), *(G)	7
	pyrimethanil (PER12565, protected)		
	Thiram (Not NSW)	7	M3
Powdery mildew	potassium bicarbonate (PER13695)	NR	M2
	penthiopyrad (FONTELIS^)	3(H), *(G)	7
	Sulphur	NR	_
Sclerotinia rot	boscalid (FILAN)	14	7
	cyprodinil+ fludioxonil (SWITCH^)	7	9+12
	iprodione	7	2
	penthiopyrad (FONTELIS^)	3(H), *(G)	7
	tebuconazole	35	3
Septoria spot	dimethomorph	14	40
	mancozeb + metalaxyl	14	4/M3
	mancozeb	14	M3
	metiram	7	M3
	thiram	7	M3
Soil borne diseases incl Fusarium, Verticillium wilts, Rhizoctonia, Pythium	1,3-dichloropropene + chloropicrin	NR	8B

(H)=Harvest
(G)= Grazing
NR= not required
*= do not graze or cut for stockfood

Appendix 3 – currently available insecticides in lettuce.

Insect name	Active ingredient	WHP	Chemical group
28-spotted potato ladybird	maldison	3	1B
Aphids	fenamiphos	56	1B
	maldison	3	1B
	pirimicarb	2	1A
	petroleum (PER12221)	NR	_
	potassium salts of fatty acids	NR	_
	pyrethrins+piperonyl butoxide	1	3A
Aphid - brown sowthistle	chlorantraniliprole + thiamethoxam (DURIVO^)	28	4A+28
	spirotetramat (MOVENTO^)	1	23
	sulfoxaflor (TRANSFORM^)	3	4C
Aphid - green peach	chlorantraniliprole + thiamethoxam (DURIVO^)	28	4A+28
	spirotetramat (MOVENTO^)	1	23
	sulfoxaflor (TRANSFORM^)	3	4C
Aphid - lettuce aphid	ethyl formate	NR	8A
	imidacloprid	28	4A
	pymetrozine (PER13111)	3	9B
	spirotetramat (MOVENTO)	1	23
	chlorantraniliprole + thiamethoxam (DURIVO^)	28	4A+28
Aphid - pea	pyrethrins	NR	3A
Armyworms	Bacillus thuringiensis kurstaki	NR	11C
Cabbage moth	Bacillus thuringiensis kurstaki		
	trichlorfon	NR	1B
Cabbage white butterfly	Bacillus thuringiensis kurstaki	NR	11C
	trichlorfon	NR	1B
Caterpillars	diazinon	14	1B
	pyrethrins+piperonyl butoxide	1	3A
Cluster caterpillar	chlorantraniliprole + thiamethoxam (DURIVO^)	28	4A+28
	methomyl	7	1A
	methoxyfenozide (PER12391 + PER14336)	NR	18
	permethrin	2	3A
Crickets – field, mole	chlorpyrifos	5	1B
Cutworms	chlorpyrifos	5	1B
	diazinon	14	1B
	trichlorfon (QLD, NT only)	2	1B
Green mirid	petroleum (PER12221 and PER14351)	NR	_
Green vegetable bug	petroleum (PER12221 and PER14351)	NR	_
	maldison	3	1B
	trichlorfon	NR	1B
Grey cluster bug	petroleum (PER12221 and PER14351)	NR	_
Fungus gnats	Bacillus thuringiensis berliner	NR	11C
	BT subs. Israelensis Serotype H14 (VECTOBAC^ WG) (PER11472)	NR	11
Helicoverpa	flubendiamide (BELT^)	1	28
	methomyl	7	1A
Helicoverpa armigera (Corn earworm /	Bacillus thuringiensis kurstaki	NR	11C
	chlorantraniliprole (CORAGEN^)	3	28

Insect name	Active ingredient	WHP	Chemical group
cotton collworm)	chlorantraniliprole + thiamethoxam (DURIVO^)	28	4A+28
	Helicoverpa NPV	NR	_
	indoxacarb	3	22A
Helioverpa punctigera (native budworms)	alpha-cypermethrin	3	3A
	Bacillus thuringiensis kurstaki	NR	11C
	chlorantraniliprole (CORAGEN^)	3	28
	chlorantraniliprole + thiamethoxam (DURIVO^)	28	4A+28
	emamectin	3	6
	Helicoverpa NPV	NR	_
	indoxacarb	3	22A
	methoxyfenozide (PER12391, leafy)	NR	18
	Spinetoram (SUCCESS NEO^)	3(H), *(G)	5a
Insects - Sucking	fenamiphos	56	1B
Jassids	maldison	3	1B
Leafhoppers	maldison	3	1B
	petroleum (PER12221 and PER14351)	NR	_
	pyrethrins+piperonyl butoxide	1	3A
Leafhopper - vegetable	chlorantraniliprole + thiamethoxam (DURIVO ^)	28	4A+28
Lightbrown apple moth	Bacillus thuringiensis kurstaki	NR	11C
	methoxyfenozide (PER14336) (protected)	NR	18
Locust - Australian plague, spur-throated, migratory	fenitrothion	14	1B
Locust - Australian plague	carbaryl + chlorpyrifos + diazinon + maldison	SL	1A/1B
Loopers	Bacillus thuringiensis kurstaki	_	11
	chlorantraniliprole + thiamethoxam (DURIVO ^)	28	4A+28
	methoxyfenozide (PER14336) (protected)	NR	18
	Spinetoram (SUCCESS NEO^)	3(H), *(G)	5A
Lucerne leafroller	chlorantraniliprole + thiamethoxam (DURIVO ^)	28	4A+28
Mealybug	potassium salts of fatty acids	NR	_
Mites	petroleum (PER12221)	NR	_
Mite – blue oat	chlorpyrifos	7	1B
Mite - redlegged earth mite	chlorpyrifos	7	1B
	maldison	3	1B
Mite - two-spotted (Red spider)	abamectin	3	6
	Bifenazate (PER14210)	10	UN
	diclofol	14	UN
	potassium salts of fatty acids	NR	_
	propargite (21 day re-entry)	7	12C
	sulphur	NR	_
Nematodes	1,3-dichloropropene + chloropicrin	_	8B
	fenamiphos	56	1B
Rutherglen bug	maldison	3	1B
	petroleum (PER12221 and PER14351)	NR	_
	trichlorfon	NR	1B
Stable fly larvae	Chlorpyrifos (PER14565, WA only)	NR(H), *(G)	1B

Insect name	Active ingredient	WHP	Chemical group
Symphylans (garden centipedes)	fenamiphos	56	1B
Thrips	fenamiphos	56	1B
	maldison	3	1B
	petroleum (PER12221)	NR	_
	potassium salts of fatty acids	NR	_
	pyrethrins+piperonyl butoxide	1	3A
Thrips – Western Flower	abamectin	3	6
	fenitrothion	14	1B
	chlorantraniliprole + thiamethoxam (DURIVO ^)	28	4A+28
	methomyl	7	1A
	spinetoram (SUCCESS NEO^)	3(H), *(G)	5a
Tomato grub	emamectin	3	6
	methoxyfenozide (PER12391, leafy lettuce)	NR	18
Vegetable weevil	chlorpyrifos	5	1B
Whiteflies	petroleum (PER12221)	NR	_
	potassium salts of fatty acids	NR	_
	pyrethrins+piperonyl butoxide	1	3A
Whitefly – greenhouse, silverleaf	botanical oil - emulsifiable	NR	_
Whitefly - silverleaf	bifenthrin (PER12947)	7	3A
	chlorantraniliprole + thiamethoxam (DURIVO ^)	28	4A+28
	pymetrozine (PER13111)	3	9B
	sulfoxaflor (TRANSFORM^)	3	4C
Wireworms	fenamiphos	56	1B
Rotting crop residues of leafy vegetable crops, brassicas, celery, silverbeet, leek, lettuce / Stable fly larvae (Stomoxys calcitrans)	Chlorpyrifos, permethrin, deltamethrin, alpha-cypermethrin, beta-cyfluthrin, fipronil, emamectin, esfenvalerate, diazinon (PER14565, expires Mar 2019, WA only)	NR(H), *(G)	Various

(H)=Harvest
(G)= Grazing
NR= not required
*= do not graze or cut for stockfood

Appendix 4 – currently available herbicides in lettuce.

Active ingredient	Chemical group
chlorthal-dimethyl (permit)	D
clethodim	A
fluazifop	A
pendimethalin	D
propyzamide	K
Phenmedipham (permit)	C
Propachlor (permit)	H
sethoxydim	A
Glyphosate	M
Paraquat+diquat	L