Silverbeet and Spinach

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 siverbeet and spinach 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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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 silverbeet and spinach were conducted in Tasmania, South Australia and Victoria as part of combined vegetable meetings in 2008, 2010 and 2011. The results of the process provide the silverbeet and spinach 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)**
Cercospora leaf spot	*Cercospora* spp.
Damping off	*Pythium* spp., *Phytophthora* spp., *Fusarium* spp., *Rhizoctonia* spp.
Sclerotinia rot (silverbeet only)	*Sclerotinia spp.*

*Downy mildew can also be a high priority in spinach crops.

As with most minor crops there is a gap in the available fungicides for treatment of major diseases. Growers need further chemistry for alternation to keep disease under control and to reduce the risk of resistance developing.

At the same time it must be recognised that some of the Agchem companies are making efforts to add minor crops to product registrations.

INSECTS and MOLLUSCS

Insects and molluscs identified as high priorities:

Pest (common name)	**Pest (scientific name)**
Green peach aphid	*Myzus persicae*
Helioverpa	*Helicoverpa* spp.
Slugs and snails	*Gastropoda*
Vegetable weevil	*Listroderes difficilis*
Western flower thrips	*Frankliniella occidentalis*

As a generalisation there is a need for different chemistry to be used for alternation, in particular to reduce resistance risks. However for some pests, such as aphids, control can be easier if IPM is used. This reduces the priority of the pest for action on new insecticides.

There are no chemicals permitted for a number of low priority uses. 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

No weeds were reported as a high priority for new registrations or permits. Most weeds can be controlled with currently available herbicides but growers would welcome inclusion of silverbeet and spinach in new chemical registrations.

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.

2. The Australian silverbeet and spinach industries

The Australian silverbeet and spinach industries are small horticultural industries. Consumption of silverbeet and spinach has risen in recent years with the growth in healthier lifestyles and moves to fresh food.

Accurate statistics on silverbeet and spinach production are not available, but they are known to be grown in reasonable quantities at:

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

In 2008/09, silverbeet and spinach was grown by 386 growers on 1,373 ha, producing 8,638 tonnes at 6.3 tonnes/ha worth $24.7 million (farm gate).

The silverbeet species referred to in this report is *Beta vulgaris* and the spinach species referred to in this report is *Spinacia oleracea*.

The most common grown commercial silverbeet variety is the crumpled textured, large, glossy dark green leafed, thick white fleshy stemmed varieties. The most common grown commercial spinach variety is the slightly crinkled, vivid green leafed, fine stemmed varieties.

For both silverbeet and spinach, there is also a range of 'baby-leaf' varieties that fit within the 'salad mix' niche market. These are not included in this review.

Due to the variety of weather and growing conditions across Australia and the introduction of different varieties of silverbeet and spinach, the Australian industry is now able to supply domestic markets with fresh silverbeet and spinach 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 silverbeet and spinach 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 silverbeet and spinach. 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 silverbeet and spinach as a group as minor crops. The crop fits within the APVMA crop group 013: Leafy vegetables (including brassica leafy vegetables).

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

3.2. Minor use permits and registration

Silverbeet and spinach are 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 silverbeet and spinach industry is for manufacturers to register new pesticides uses in the crop.

3.3. Methods

The SARP was conducted in Tasmania, South Australia and Victoria 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 silverbeet and spinach 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 silverbeet and spinach 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 silverbeet and spinach

4.1 Diseases of silverbeet and spinach

Common name	Scientific name
HIGH PRIORITY	
Cercospora leaf spot	*Cercospora* spp.
Damping off	*Pythium* spp., *Phytophthora* spp., *Fusarium* spp., *Rhizoctonia* spp.
Sclerotinia rot (silverbeet only)	*Sclerotinia* spp.
MODERATE PRIORITY	
Alternaria leaf spot	*Alternaria* spp.
Downy mildew*	*Peronospora* spp.
Powdery mildew**	*Erysiphe betae*
Rust	*Uromyces betae*
LOW PRIORITY	
Anthracnose	*Colletotrichum* spp.
Grey mould	*Botrytis cinerea*
Biosecurity risk	
None listed	

* Can be a high priority in spinach crops
** Rarely seen in spinach crops

Opinion on the priority of diseases can vary across the industry, and equally the priorities can vary with the seasons. Mildews, for example, can be devastating in certain seasons.

4.1.1 High priority diseases

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 issue in all states in silverbeet but is not seen in spinach crops.
  - Growers alternate the use of different fungicides to reduce the resistance risk.
  - Growers would like other protective/curative fungicides for alternation.
  - The slightest disease on leaves can lead to whole crop being unmarketable.

- Fungicides **registered** for the control of Cercospora leaf spot in silverbeet and spinach are:
  - Mancozeb (various products) - Group M3 protectant fungicide
    - Commonly used.
    - 14 day withholding period.
    - Used as a protectant only. It is not effective in high pressure situations.
    - Also registered for downy mildew control.
    - Growers have concerns that mancozeb requires regular applications and will not control the disease once established.
    - Moderately disruptive to some beneficial insects in an IPM situation.

- Fungicides listed for control of Cercospora leaf spot control in silverbeet and spinach via permit are:
  - Propiconazole (various) (PER14479, expires Oct 2017) - Group 3 protectant/curative fungicide
    - For use in silverbeet only.
    - Commonly used.
    - Reported as very effective.
    - Growers expressed concern that with a heavy reliance that resistance may develop.
    - Minimal impact on most beneficial insects.
    - Application has been made to renew the permit.

- Potential fungicides for control of Cercospora leaf spot control in silverbeet and spinach:
  - Several actives are registered for control of Cercospora in other vegetables, including chlorothalonil, copper, hydrogen peroxide+peroxyacetic acid (PERATEC PLUS^), sulphur.

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.

While all stages of silverbeet and spinach can be infected by root rot organisms, newly emerging plants and young seedlings are very susceptible.

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

- Fungicides **registered** for the control of Damping-off in silverbeet and spinach.
  The only registrations are for soil fumigants, including:
  - 1,3-dichloropropene + chloropicrin (various) fumigant
    - Restricted chemical
    - Broad vegetable claim for control of soil borne diseases as pre-plant treatment
    - Schedule 7 dangerous poison
- There are no fungicides listed for control of Damping-off control in silverbeet and spinach via **permit**.
- **Potential** fungicides for the control of soil borne diseases :
  - 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 registrations for pythium damping-off
    - 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.

Sclerotinia rot (*Sclerotinia* spp.)

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 on mature plants.

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 in silverbeet. Symptoms have not been found in spinach although there may be miss-diagnosis of related symptoms, and there are registrations and permits for control of the disease in spinach.
  - Growers use crop rotations to minimise disease.
  - Limited control options available.

- Fungicides **registered** for the control of Sclerotinia rot in silverbeet and spinach.
  - Boscalid (various) – Group 7 protectant and curative fungicide
    - Efficacious, especially when applied 3-4 weeks after planting.
    - Grower concern with the development of resistance in Sclerotinia resulting from overuse of Filian and limited options.
  - Penthiopyrad (FONTELIS) Group 7 – protectant Fungicide.
    - Applied before disease development.
    - Also registered for powdery mildew
  - Cyprodinil + fludioxonil (SWITCH) - Group 9 +12 protective and systemic fungicide
    - Use increasing
    - Minimal impact on beneficials

- Fungicides listed for Sclerotinia rot control in silverbeet and spinach via **permit** are:
  - Tebuconazole (various, PER14456, exp Jun 2019) – Group 3 protectant and curative fungicide:
    - Occasionally used.
    - Considered effective.
    - Should be applied during early stages of disease.
    - Growers concerned at limited options available.
    - Minimal impact on all beneficial insects.

4.1.2 Summary

High Priority Diseases and control options
As with most minor crops there is a gap in the available fungicides for treatment of major diseases. Growers need further chemistry for alternation to keep disease under control and to reduce the risk of resistance developing.

At the same time it must be recognised that some of the Agchem companies are making efforts to add minor crops to product registrations.

Disease	Control option
Cercospora leaf spot (*Cercospora* spp.) Silverbeet only	**Currently registered fungicides** Mancozeb (various products) - Group M3 protectant fungicide **Currently permitted fungicides** Propiconazole (various) (PER14479, expires Oct 2017)- Group 3 protectant/curative fungicide **Fungicide gaps** New, "safer" chemistry **Potential fungicide solutions** Several actives registered in other vegetables, including chlorothalonil, copper, hydrogen peroxide+peroxyacetic acid (PERATEC PLUS^), sulphur **Non-chemical options** Crop rotation
Damping off (*Pythium* spp., *Phytophthora* spp., *Fusarium* spp., *Rhizoctonia* spp.) Silverbeet and spinach	**Currently registered fungicides** Only soil fumigants such as 1,3-dichloropropene + chloropicrin are registered. **Permitted fungicides:** None **Fungicide Gaps:** New, "safer" chemistry **Potential fungicide solutions** - 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. Efficacy on Aphanomycete spp. and Pythium spp. - Pencycuron (MONCERON^) – reported as efficacious in trials but the product may not be widely available **Non-chemical options** Crop management techniques, including: - Varietal choice - Grafting onto resistant rootstocks - Crop rotations - Good farm and crop hygiene - Optimal irrigation scheduling, - Disinfection and testing of the water supply - Control of fungus gnats which spread the fungus
Sclerotinia rot Silverbeet only	**Currently registered fungicides** Boscalid (various) – Group 7 protectant and curative fungicide. Cyprodinil + fludioxonil (SWITCH^) - Group 9 +12 protective and systemic fungicide. Penthiopyrad (FONTELIS^) - Group 7. **Currently permitted fungicides** Tebuconazole (various, PER14456) – Group 3 protectant and curative fungicide. **Fungicide Gaps:** None identified **Non-chemical options** Crop rotation. Good hygiene

Currently available fungicides

Disease	Active		WHP, days	Chemical group
Alternaria Leaf Spots	Chlorothalonil+Pyrimethanil	(PER11352, expires Sep 2014) (PER14841 Oct 2014-Sept 2019)	7(H), *(G)	M5+9
Anthracnose	Zineb	(PER14839, expires Sep 2019)	7(H), 14(G)	M3
Botrytis blight / Botrytis rot / grey mould	Chlorothalonil+Pyrimethanil	(PER11352, expires Sep 2014) (PER14841 Oct 2014-Sept 2019)	7(H), *(G)	M5+9
	Penthiopyrad (FONTELIS^)		3	7
Downy Mildew	Copper		1	M1
	Fosetyl-Aluminium	(PER13068, expires Jun 2016)	7	33
	Mancozeb		14	M3
	Mancozeb + Metalaxyl-M (RIDOMIL GOLD MZ^)	(PER13673, expires Sep 2016)	14	4+M3
	Phosphorous Acid	(PER11951, expires Mar 2015)	NR	33
Fungi, bacteria	Iodine		NA	-
Leaf Spot (Cercospora Beticola)	Mancozeb		14	M3
	Propiconazole (silverbeet)	(PER14479, expires Oct 2017)	7	3
Powdery Mildew	Penthiopyrad (FONTELIS^)		3	7
	Potassium Bicarbonate	(PER13695, expires Aug 2017)	NR	M2
	Propiconazole (silverbeet)	(PER14479, expires Oct 2017)	7	3
	Quinoxyfen	(PER11991, expires Mar 2016)	7	13
	Sulphur		NR	M2
	Trifloxystrobin (FLINT^)	(PER13658, expires Sep 2014)	3	11
Rust	Propiconazole (silverbeet)	(PER14479, expires Oct 2017)	7	3
	Sulphur		NR	M2
Sclerotinia Rot	Boscalid		7	7
	Cyprodinil+ Fludioxonil (SWITCH^)		7	9+12
	Penthiopyrad (FONTELIS^)		3	7
	Tebuconazole	(PER14456, exp Jun 2019)	35	3
Soil borne diseases incl Fusarium, Verticillium wilts, Rhizoctonia, Pythium	1,3-dichloropropene + chloropicrin		NR	

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

4.2 Insects and molluscs of silverbeet and spinach

Common name	Scientific name
HIGH PRIORITY	
Green peach aphid	*Myzus persicae*
Helioverpa	*Helicoverpa spp.*
Slugs and snails	*Gastropoda*
Vegetable weevil	*Listroderes difficilis*
Western flower thrips	*Frankliniella occidentalis*
MODERATE PRIORITY	
African Black Beetle	*Heteronychus arator*
Bud / crown rot	*Rhizoglyphus* spp.
Mites - including Two-spotted, Tomato russet, European red, Rust	*Tetranychus urticae, Aculops lycopersici, Panonychus ulmi, Eriophyidae*
Redlegged earth mite	*Halotydeus destructor*
LOW PRIORITY	
Beet webworm	Spoladea recurvalis
Green Vegetable bug	Nezara viridula
Jassids	Cicadellidae
Looper caterpillars	*Chrysodeixis* spp.
Plague thrips	*Thrips imaginis*
Rutherglen bug	*Nysius vinitor*
Webworm	*Lepidoptera*
Wireworm and False wireworms	*Elateridae, Gonocephalum* spp.
Biosecurity risk	
None listed	

Decisions on priority pests can be difficult, as some moderate or low priorities can cause major crop losses at different times. As an example, Rutherglen Bug can cause huge problems along with thrips. These pests affect many crops and control is difficult, when they are continually blown in by winds.

4.2.1 High priority insects and molluscs

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 largest 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.

- Aphids are considered a major-moderate problem in all areas.
  - Aphid numbers can vary, but can be heavy.
  - Growers want IPM compatible alternatives.
  - A number of aphicides have been introduced to the market in recent years.

- Insecticides **registered** for the control of aphids in silverbeet and spinach are:
    - Chlorantraniliprole + thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide
        - For use as a seedling drench or soil drench for aphid control - also controls lepidoptera, whitefly and thrips.
        - Registered for green peach and brown sowthistle aphid only
        - Adds significantly to the cost of seedlings from nurseries.
        - Rarely used.
        - Moderately disruptive to some beneficial insects (including predator mites) in an IPM situation.
    - Pirimicarb (various) - Group 1A contact and systemic insecticide
        - Spinach registration only
        - Occasionally used.
        - Can be very effective although green peach aphid is now resistant to this product through many regions.
        - Minimal impact on most beneficial insects.
    - Potassium salts of fatty acids (various) – contact biological insecticide
        - Minimal impact on most 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.
        - Green peach aphid registration only
        - Very effective.
        - Moderately disruptive to some beneficial insects in an IPM situation.
    - Sulfoxaflor (TRANSFORM^) – Group 4C insecticide
        - Field situations only.
        - May have adverse effects on parasitic wasps in IPM situations.
        - Registered for green peach and brown sowthistle aphid only
- Insecticides are listed for control of aphids in silverbeet and spinach via **permit:**
    - Petroleum oil (various) – contact insecticide
        - General aphid claim.
        - Occasionally used - only when needed.
        - Effective.
        - Also controls thrips and whiteflies.
        - Moderately harmful to some beneficial insects.

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.
Helicoverpa species feed prolifically on leaves and are capable of causing large amounts of damage.

- Helicoverpa are considered a moderate-major problem in all areas.
    - Several years ago Helicoverpa was difficult to control with available insecticides due to insecticide resistance.
    - A number of new products have been introduced to the market in recent years.
- Insecticides **registered** for Helicoverpa control in silverbeet and spinach are:
    - Bacillus Thuringiensis var Kurstaki (Btk) (various) - Group 11C contact insecticide
        - Bt is commonly 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
  - Occasionally used in some regions.
  - Very effective, but expensive.
  - Minimal impact on all beneficial insects.
- Chlorantraniliprole + Thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide
  - For use 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.
  - Rarely used.
  - Moderately disruptive to some beneficial insects in an IPM situation.
- Flubendiamide (BELT^) – Group 28 contact and systemic insecticide
  - Occasionally used in some regions.
  - Very effective, but expensive.
  - Minimal impact on all beneficial insects.
  - *Helicoverpa punctigera* registration only.
- Helicoverpa NPV (various) – biological insecticide
  - Occasionally used in some regions.
  - Very effective on small grubs.
  - Minimal impact on all beneficial insects.
- Indoxacarb (various) - Group 22A contact and systemic insecticide
  - Occasionally used in some regions.
  - Considered effective.
  - Moderately harmful to some beneficial insects.
- Spinetoram (SUCCESS NEO^) - Group 5A contact and systemic insecticide
  - *Helicoverpa punctigera* registration only.
  - Commonly used in some regions.
  - Very effective on a range of pests, including thrips.
  - Moderately disruptive to some beneficial insects in an IPM situation.
  - Growers expressed concern that resistance may develop.
  - Used for Lepidoptera and WFT.

Resistance to some insecticides is an important issue. Growers are trying to manage resistance with the selective use of selective insecticides and beneficial insects.

- No insecticides are available for the control of Helioverpa in silverbeet and spinach via **permit**.

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.

- Insecticides **registered** for the control of slugs and snails in silverbeet and spinach are:
  - Iron Edta Complex (various) – molluscicide
    - Occasionally used.
    - Very effective.
    - Needs constant re-application.
  - Metaldehyde (various) – molluscicide
    - Commonly used.
    - Very effective.
    - Needs constant re-application.

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

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

Vegetable weevil (*Listroderes difficilis*)

Vegetable weevil adults are greyish-brown and the snout is short and stout. Adults are about 8 mm long. Larvae are legless, slightly curved grubs. Larvae are initially creamy-white with a black head. As foliage is consumed, they develop a yellow-green colour and reach a length of about 14 mm.

Both adults and larvae feed upon foliage and roots and can inflict serious damage. The principal damage is reported to occur when larvae feed on the developing tissue of plants, stunting plant development.

Large larvae will feed on mature foliage, consuming everything except the large veins. Initially, larval feeding produces small round holes, but larger larvae produce large irregular holes.

- Vegetable weevil is considered a major-moderate problem in all states.
  - They are very difficult to control and can occur in large numbers.
  - Growers want IPM compatible alternatives.

- No insecticides are **registered** for the control of Vegetable weevil in silverbeet and spinach.

- Insecticides listed for the control of Vegetable weevil in silverbeet and spinach via **permit:**
  - Alpha Cypermethrin (PER14433, Expires Jun 2017) - Group 3A insecticide
  - Chlorpyrifos (PER14583, expires Mar 2019) - Group 1B insecticide

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 30-45 days and are capable of reproducing after approx 15-20 days.

- Western flower thrips are considered a major-moderate problem 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 Western flower thrips in silverbeet and spinach are:
  - Abamectin (various) - Group 6 contact and systemic insecticide
    - Commonly used in some regions.
    - Very effective on a range of pests, including mites.
    - Growers expressed concern that with a heavy reliance and limited options that resistance may develop.
    - Moderately disruptive to some beneficial insects in an IPM situation.
  - Chlorantraniliprole + Thiamethoxam (DURIVO^) - Group 4A + 28 contact and systemic insecticide
    - For use 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.
    - Rarely used.
    - Moderately disruptive to some beneficial insects in an IPM situation.
  - Spinetoram (SUCCESS NEO^) - Group 5A contact and systemic insecticide
    - Commonly used in some regions.
    - Very effective on a range of pests, including heliothis.
    - Moderately disruptive to some beneficial insects in an IPM situation.
    - Growers expressed concern that a heavy reliance and limited options that resistance may develop.
    - Used for Lepidoptera and WFT.
- No insecticides are listed for control of Western flower thrips in silverbeet and spinach via **permit.**

4.2.2 Summary

High Priority Insects and control options

As a generalisation there is a need for different chemistry to be used for alternation, in particular to reduce resistance risks. However for some pests, such as aphids, control can be simple if IPM is used. This reduces the priority of the pest for action on new insecticides.

There are no chemicals permitted for a number of low priority uses. 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,)*	**Currently registered insecticides** Chlorantraniliprole + thiamethoxam (DURIVO^) - Group 4A + 28 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) – contact insecticide **Insecticide Gaps** Sufficient permits and registrations now **Potential insecticide solutions** None identified by growers at SARP meetings. **Non-chemical options** Best management practice includes the use of IPM compatible insecticides in combination with reliance on parasitic wasps.

Insect	Control option
Helicoverpa *Helicoverpa* spp.	**Currently registered insecticides** Bacillus Thuringiensis var Kurstaki (Btk) (various) - Group 11C contact insecticide Chlorantraniliprole (various, including CORAGEN^) - Group 28 contact and systemic insecticide Chlorantraniliprole + Thiamethoxam (DURIVO^) - Group 4A + 28 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 Spinetoram (SUCCESS NEO^) - Group 5A contact and systemic insecticide **Currently permitted insecticides** None **Insecticide Gaps** Helicoverpa resistance to many chemicals however recent introductions to the market have reduced the gaps. **Potential insecticide solutions** Metaflumizone (New BASF active). Novaluron - Group 15. Farmoz and United Phosphorous have approvals of this active. **Non-chemical options** IPM strategies to manage resistance.
Slugs and snails	**Currently registered molluscicides** Iron Edta Complex (various) – molluscicide. Metaldehyde (various) – molluscicide. Methiocarb (various) – Group 1A insecticide. **Currently permitted molluscicides** None **Molluscicide Gaps** None identified by participants in SARP **Non-chemical options** IPM strategies – required to manage resistance.
Vegetable weevil (*Listroderes difficilis*)	**Currently registered insecticides** None **Currently permitted insecticides** Alpha Cypermethrin (PER14433, Expires Jun 2017) - Group 3A insecticide Chlorpyrifos (PER14583, expires Mar 2019) - Group 1B insecticide **Insecticide Gaps** Products, in particular IPM compatible, to control these pests **Potential insecticide solutions** A range of actives have in-crop weevil approvals for other crops and also have MRLs established for silverbeet / spinach. These include: Bifenthrin, imidacloprid, indoxacarb, maldison, tau-fluvalinate **Non-chemical options** IPM strategies to manage resistance.

Insect	Control option
Western flower thrips (*Frankliniella occidentalis*)	**Currently registered insecticides** Abamectin (various) - Group 6 Chlorantraniliprole + thiamethoxam + (DURIVO) - Group 4A + 28 Spinetoram (SUCCESS NEO^) - Group 5A contact and systemic insecticide **Currently permitted insecticides** Phorate (various, PER8930, expires Jul 2016) - Group 1B – 10 wk WHP. **Insecticide Gaps** Soft alternatives, more alternatives. **Potential insecticide solutions** Efficacy and residue data required - Cyantraniliprole (BENEVIA^, not yet registered) – Group 28 – new product in assessment at APVMA. Same chemical group as Chlorantraniliprole. IR4 projects for various crops/thrips, beetles, leafminer, psyllids, whitefly - Flonicamid (new ISK/FMC product)– Group 9C. First registration application in assessment at APVMA. IR4 projects on whiteflies. **Non-chemical options** IPM strategies

Currently available insecticides

Insect	Active		WHP, days	Chemical group
African Black Beetle	Chlorpyrifos	(PER14583, expires Mar 2019)	NR	1B
Ants	Pyrethrins+Piperonyl Butoxide		1	3A
Armyworm	*Bacillus thuringiensis kurstaki*		NR	11
Aphid - Brown Sowthistle	Chlorantraniliprole +Thiamethoxam (DURIVO^)		28	4A28
	Sulfoxaflor (TRANSFORM^)		3	4C
Aphid – Green Peach	Chlorantraniliprole +Thiamethoxam (DURIVO^)		28	4A28
	Spirotetramat (MOVENTO^)		3	23
	Sulfoxaflor (TRANSFORM^)		3	4C
Aphids	Petroleum	(PER12221, expires Nov 2017)	1	_
	Potassium salts of fatty acids		NR	_
	Pirimicarb		2	1A
	Pyrethrins+Piperonyl Butoxide		1	3A
Cabbage moth	*Bacillus thuringiensis kurstaki*		NR	11
	Trichlorfon		2	1B
Cabbage white butterfly	*Bacillus thuringiensis kurstaki*		NR	11
	Trichlorfon		2	1B
Caterpillars	Bifenthrin		NR(H), 28(G)	3A
	Pyrethrins+Piperonyl Butoxide		1	3A
Cluster Caterpillar	Chlorantraniliprole +Thiamethoxam (DURIVO^)		28	4A+28
Cricket	Chlorpyrifos		NR	1B
Cucumber moth	Spinetoram (SUCCESS NEO^)		3	5
False Wireworms	Chlorpyrifos	(PER14583, expires Mar 2019)	NR	1B

Insect	Active		WHP, days	Chemical group
Green Mired	Petroleum	(PER12221, expires Nov 2017)	1	_
Green Vegetable Bug	Petroleum	(PER12221, expires Nov 2017)	1	_
	Trichlorfon		2	1B
Grey Cluster Bug	Petroleum	(PER12221, expires Nov 2017)	1	_
Helicoverpa	*Bacillus thuringiensis kurstaki*		NR	11
	Chlorantraniliprole (CORAGEN^)		3	28
	Chlorantraniliprole +Thiamethoxam (DURIVO^)		28	4A+28
	Helicoverpa NPV		NA	
	Indoxacarb		3	22A
Helioverpa Punctigera - Native Budworm	Flubendiamide (BELT^)		1	28
	Spinetoram (SUCCESS NEO^)		3	5
Leafhoppers	Petroleum	(PER12221, expires Nov 2017)	1	_
	Pyrethrins+Piperonyl Butoxide		1	3A
Lightbrown apple moth	*Bacillus thuringiensis kurstaki*		NR	11
Locust - Australian Plague	Carbaryl + Chlorpyrifos + Diazinon + Maldison		SL	1A/1B
Loopers	*Bacillus thuringiensis kurstaki*		NR	11
	Chlorantraniliprole +Thiamethoxam (DURIVO^)		28	4A+28
Lucerne Leafroller	Chlorantraniliprole +Thiamethoxam (DURIVO^)		28	4A+28
Mite – Blue Oat	Chlorpyrifos		NS	1B
Mite - Redlegged Earth Mite	Alpha Cypermethrin	(PER14433, Expires Jun 2017)	1	3A
	Chlorpyrifos		NA	1B
Mealybug	Potassium salts of fatty acids		NR	_
Mites	Petroleum	(PER12221, expires Nov 2017)	1	_
	Bifenthrin		NR(H), 28(G)	3A
Mites – two spotted	Potassium salts of fatty acids		NR	_
	Propargite		7	12C
	Sulphur		NR	_
Rutherglen Bug	Dimethoate	(PER13308, expires Oct 2014, Vic only)	NR (seed only)	1B
Rutherglen Bug	Petroleum	(PER12221, expires Nov 2017)	1	_
	Trichlorfon		2	1B
Stable Fly Larvae (*Stomoxys Calcitrans)*	Chlorpyrifos, Permethrin, Deltamethrin, Alpha-Cypermethrin, Beta-Cyfluthrin, Fipronil, Emamectin, Esfenvalerate, Diazinon (Per14565, Expires Mar 2019)	(PER14565, expires Mar 2019, WA only)	NR(H), *(G)	_
Thrips	Petroleum	(PER12221, expires Nov 2017)	1	_
	Potassium salts of fatty acids		NR	_
	Pyrethrins+Piperonyl Butoxide		1	3A
Thrips - Western Flower Thrips	Abamectin		3	6
	Chlorantraniliprole +Thiamethoxam (DURIVO^)		28	4A+28

Insect	Active		WHP, days	Chemical group
	Spinetoram (SUCCESS NEO^)		3	5
Thrips-Plague	Alpha Cypermethrin	(PER14433, Expires Jun 2017)	1	3A
Vegetable Leafhopper	Chlorantraniliprole +Thiamethoxam (DURIVO^)		28	4A+28
Vegetable Weevil	Alpha Cypermethrin	(PER14433, Expires Jun 2017)	1	3A
	Chlorpyrifos	(PER14583, expires Mar 2019)	NR	1B
Webworms	Diazinon		14	1B
Whitefly	Bifenthrin		NR(H), 28(G)	3A
	Potassium salts of fatty acids		NR	_
	Pyrethrins+Piperonyl Butoxide		1	3A
Whitefly-greenhouse	Botanical Oil		NR	-
	Sulfoxaflor (TRANSFORM^)		3	4C
Whitefly - Silverleaf	Chlorantraniliprole +Thiamethoxam (DURIVO^)		28	4A+28
Wireworms	Chlorpyrifos	(PER14583, expires Mar 2019)	NR	1B

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

4.3 Herbicides use in silverbeet and spinach

Herbicides **registered** and used in silverbeet and spinach:

- Chloridazon (PYRAMIN^) – Group C general pre-emergent residual herbicide
  - For use in silverbeet 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.
- Phenmedipham (BETANAL^ FLOW) - Group C post-emergent herbicide.
  - Registered for use in silverbeet only.
  - Commonly used as a early post emergent for broadleaf weed control.
  - Growers comment that it provides excellent control of broadleaf weeds - used via previous issued permit.
- 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 silverbeet and spinach via **permit** are:

- Clethodim (PER13397, expires Dec 2016) – Group A grass selective post-emergent herbicide
  - Annual Ryegrass (Lolium Rigidum) and Winter Grass (Poa Annua) That Are Resistant To Quizalafop Herbicides.
  - Considered very effective.
- Ethofumesate (various, PER14703 expires Jul 2019) – Group K general residual herbicide
  - Used pre-plant in silverbeet and spinach.
  - Commonly used.
  - Considered very effective.
  - Issues with use on some varieties and soil types - crop phytotoxicity.
  - Permit expires 31-Jul-13. No manufacturer in registering use
- Fluazifop-P as butyl (various, PER12017, expires Jun 2016) – Group A grass selective post-emergent herbicide .
  - For use in silverbeet and spinach.
  - 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).
  - Permit expires 30-Jun-16. No manufacturer in registering use.
- Metolachlor (various, PER13626, expires Jun 2017)) - Group K pre-plant residual herbicide
  - For use in silverbeet and spinach.
  - It is commonly used as an effective pre- emergent annual broadleaf and grass control herbicide.
  - Considered very effective.
  - Controls many weeds.
  - Permit expires 30-Sep-17. No manufacturer in registering use.
- Phenmedipham (BETANAL/BETANAL FLOW, (PER14795, expires Dec 2015)) - Group K selective post-emergent herbicide.
  - Recently registered for use in silverbeet.
  - Commonly used as a early post emergent for broadleaf weed control.
  - Growers comment that it provides excellent control of broadleaf weeds - used via previous issued permit.
  - Permit expires 30-Jun-14.

- Propachlor (RAMROD^, PER12008, expires Sep 2015) - Group K selective post-emergent herbicide.
    - For use in silverbeet and spinach.
    - 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 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.

- Nettles are a major issue to a number of growers and chickweed is a winter issue even where these herbicides are used

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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

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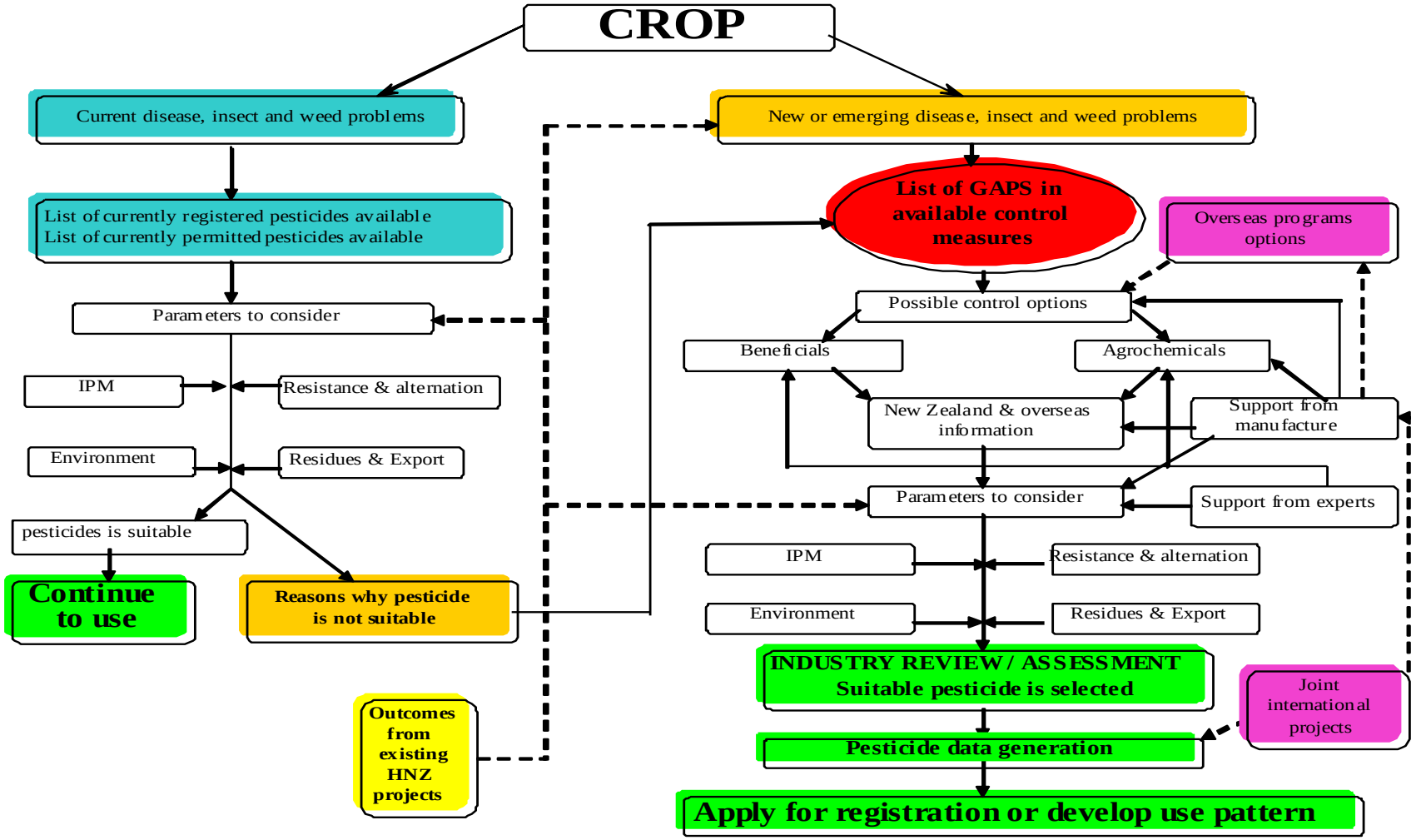
^Trademark

6. Appendices

DIAGRAM 1: The Strategic Agrichemical Review Process



Appendix 2 – currently available fungicides in silverbeet and spinach.

Active		Disease	WHP, days	Chemical group
Chlorothalonil+Pyrimethanil	(PER11352, expires Sep 2014) (PER14841 Oct 2014-Sept 2019)	Alternaria leaf spots	7(H), *(G)	M5+9
		Botrytis blight / grey mould		
Penthiopyrad (FONTELIS^)		Botrytis blight / grey mould	3	7
		Powdery mildew		
		Sclerotinia		
Copper		Downy Mildew	1	M1
Fosetyl-Aluminium	(PER13068, expires Jun 2016)	Downy Mildew	7	33
Iodine		Bacteria, fungi	-	-
Mancozeb		Cercospora Leaf Spot	14	M3
		Downy Mildew		
		Leaf Spot		
Mancozeb + Metalaxyl-M (RIDOMIL GOLD MZ^)	(PER13673, expires Sep 2016)	Downy Mildew	14	4+M3
Phosphorous Acid	(PER11951, expires Mar 2015)	Downy Mildew	NR	33
Potassium	(PER13695, expires Aug 2017)	Powdery Mildew	NR	M2
Propiconazole (silverbeet)	(PER14479, expires Oct 2017)	Leaf Spot (*Cercospora Beticola*)	7	3
		Powdery Mildew		
		Rust		
Quinoxyfen	(PER11991, expires Mar 2016)	Powdery Mildew	7	13
Boscalid		Sclerotinia Rot	7	7
cyprodinil+ fludioxonil (SWITCH^)		Sclerotinia Rot	7	9+12
Tebuconazole	(PER14456, expires Jun 2019)	Sclerotinia Rot	35	3
Trifloxystrobin (FLINT^)	(PER13658, expires Sep 2014)	Powdery Mildew	3	11
Zineb	(PER14839, expires Sep 2019)	Anthracnose	7(H), 14(G)	M3
Sulphur		Bean rust	NR	M2
		Powdery mildew		
1,3-dichloropropene + chloropicrin		Soil borne diseases incl Fusarium, Verticillium wilts, Rhizoctonia, Pythium	NR	-

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

Appendix 3 – currently available insecticides in silverbeet and spinach.

Active		Insect	WHP, days	Chemical group
1,3-dichloropropene + chloropicrin		Plant parasitic nematodes	NR	8B
		Symphylans (garden centipedes)		
		Wireworms		
Abamectin		Thrips - Western Flower Thrips	3	6
Alpha Cypermethrin	(PER14433, Expires Jun 2017)	Mite-Redlegged Earth Mite	1	3A
		Thrips-Plague		
		Vegetable Weevil		
Bifenthrin		Caterpillars	NR(H), 28(G)	3A
		Mites		
		Whiteflies		
Botanical Oil		Whitefly – greenhouse	NR	-
Carbaryl + Chlorpyrifos + Diazinon + Maldison		Locust - Australian Plague	SL	1A/1B
Chlorantraniliprole (CORAGEN^)		Helicoverpa	3	28
Chlorpyrifos	(PER14583, expires Mar 2019)	African Black Beetle	NR	1B
		Cricket – field, mole		
	(PER14583, expires Mar 2019)	False Wireworms		
	Spinach	Mite – Blue Oat		
	Spinach	Mite - Redlegged Earth Mite		
	(PER14583, expires Mar 2019)	Vegetable Weevil		
	(PER14583, expires Mar 2019)	Wireworms		
Chlorpyrifos, Permethrin, Deltamethrin, Alpha-Cypermethrin, Beta-Cyfluthrin, Fipronil, Emamectin, Esfenvalerate, Diazinon (Per14565, Expires Mar 2019)	(PER14565, expires Mar 2019, WA only)	Stable Fly Larvae (*Stomoxys Calcitrans)*	NR(H), *(G)	_
Diazinon		Webworms	14	1B
Dimethoate	(PER13308, expires Oct 2014, Vic only)	Rutherglen Bug	NR (seed only)	1B
Flubendiamide (BELT^)		Helioverpa Punctigera - Native Budworm	1	28
Helicoverpa NPV		Helicoverpa	NA	
Indoxacarb		Helicoverpa	3	22A
Petroleum	(PER12221, expires Nov 2017)	Aphids	1	_
		Green Mired		
		Green Vegetable Bug		
		Grey Cluster Bug		
		Leafhoppers		
		Mites		
		Rutherglen Bug		
		Thrips		
Pirimicarb		Aphids	2	1A

Active	Insect	WHP, days	Chemical group
Potassium Salts Of Fatty Acids	Aphids	NR	_
	Mealybug		
	Thrips		
	Two Spotted Mite / Spider Mite		
	Whitefly		
Propargite	Mites – two spotted	7	12C
Pyrethrins+Piperonyl Butoxide	Ants	1	3A
	Aphids		
	Caterpillars		
	Leafhoppers		
	Thrips		
	Whiteflies		
Spinetoram (SUCCESS NEO^)	Helioverpa Punctigera - Native Budworm	3	5
	Cucumber moth		
	Thrips - Western Flower Thrips		
Spirotetramat (MOVENTO^)	Aphid – Green Peach	3	23
Sulfoxaflor (TRANSFORM^)	Aphid - Brown Sowthistle	3	4C
	Aphid – Green Peach		
	Whitefly - greenhouse		
Sulphur	Mites – two spotted	NR	_
Chlorantraniliprole +Thiamethoxam (DURIVO^)	Aphid - Brown Sowthistle	28	4A+28
	Aphid – Green Peach		
	Cluster Caterpillar		
	Helicoverpa		
	Loopers		
	Lucerne Leafroller		
	Thrips - Western Flower Thrips		
	Vegetable Leafhopper		
	Whitefly - Silverleaf		
Bacillus thuringiensis kurstaki	Armyworm	NR	11
	Cabbage Moth		
	Cabbage White Butterfly		
	Helicoverpa armigera (Corn Earworm / Cotton Bollworm)		
	Helicoverpa punctigera (Native Budworm)		
	Lightbrown Apple Moth		
	Loopers		
	Vine Moth		
Trichlorfon	Cabbage Moth	2	1B
	Cabbage White Butterfly		
	Cutworms, Qld, NT only		
	Green Vegetable Bug		
	Rutherglen Bug		

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

Appendix 4 – currently available herbicides in silverbeet and spinach.

Active		Weed	Chemical group
Clethodim	(PER13397, expires Dec 2016)	Annual Ryegrass (Lolium Rigidum) And Winter Grass (Poa Annua) That Are Resistant To Quizalafop Herbicides.	A
Ethofumesate	various, PER14703 expires Jul 2019	Grass and Broadleaf	J
S-metolachlor	(PER13626, expires Jun 2017)	Grass and Broadleaf	K
Propachlor (RAMROD^)	(PER12008, expires Sep 2015)	Grass and Broadleaf-Label	
Fluazifop-P-butyl	(PER12017, expires Jun 2016)	Grass Weeds-Label	A
Phenmedipham (BETANAL^ FLOW)	(PER14795, expires Dec 2015)	Label Weeds	C
Chloridazon		Grass and Broadleaf	C
Glyphosate		Grass and Broadleaf	M
Paraquat + diquat		Grass and Broadleaf	L