



LETTUCE

Strategic Agrichemical Review Process 2007

Horticulture New Zealand

AgAware Consulting

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Purpose of the report:

This report was funded by Horticulture New Zealand to investigate the pest problem, agrichemical usage and pest management alternatives for the lettuce industry across New Zealand. The information in this report will assist the lettuce industry with its agrichemical selection and usage into the future.

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- Horticulture New Zealand

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Disclaimer:

Any recommendations contained in this publication do not necessarily represent current Horticulture New Zealand policy. No person should act on the basis of the contents of this publication without first obtaining independent professional advice on their specific situation.

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Recommendations

In Auckland November 2006, a Strategic Agrichemical Review Process was conducted in lettuce with the assistance of leading growers, consultants, retailers, government agencies and selected Horticulture New Zealand staff.

The purpose of the meeting was to record a ‘snap-shot’ of the plant pest issues and the pest management options used in lettuce. Information was collected on the importance of plant pest, the frequency, selection and efficacy of the agrichemical use and any other issues related to pest management control in lettuce.

Diseases and fungicides

The high priority diseases are:

Downy Mildew	<i>Bremia lactucae</i>
Rhizoctonia Root Rot	<i>Rhizoctonia solani</i>
Ring Spot or Mycosphaerella Leafspot	<i>Mycosphaerella brassici-cola</i>
Sclerotinia Rot	<i>Sclerotinia minor</i> & <i>S. sclerotiorum</i>

The new fungicides that can be pursued for these uses are:

Product (active)	Target disease	Action
Amistar (azoxystrobin)	Downy Mildew; Rhizoctonia Root Rot; Ring spot; Sclerotinia Rot	New uses
Bravo (chlorothalonil)	Downy Mildew	Adding to existing registrations
Ridomil (metalaxyl-M + mancozeb)	Downy Mildew	New use
Foscheck (phosphorous acid)	Downy Mildew	New use
Manzate (mancozeb)	Rhizoctonia Root Rot	Adding to existing registrations
Score (difenoconazole)	Ring spot	New use
Shirlan (fluazinam)	Sclerotinia rot	New use
Sumisclex (procymidone)	Sclerotinia rot	New use
Filan (boscalid)	Sclerotinia rot	New use
Switch (cyprodinil + fludioxonil)	Sclerotinia rot	New use
Folicur (tebuconazole)	Sclerotinia rot	New use

Steps forward

1. For each of the major diseases identified, efficacy and crop safety trials (especially in greenhouse lettuce crops) are required in the major lettuce growing areas to determine the most efficacious fungicides for the control of Downy mildew using azoxystrobin, chlorothalonil, metalaxyl-M + mancozeb and phosphorous acid; for the control of Rhizoctonia Root Rot using azoxystrobin and mancozeb; for the control of Ring spot using azoxystrobin and difenoconazole; and for the control of Sclerotinia rot using azoxystrobin, fluazinam, procymidone, boscalid, cyprodinil + fludioxonil and tebuconazole all in combination with currently registered products.
2. Once efficacy and the use pattern (and the withholding period) are determined, residue trials may be required in the major lettuce growing areas for these fungicides so that they comply with the default MRL (0.1 mg/kg). Residue data for some fungicides may

be available from Australia or elsewhere. Some confirmatory trials in NZ may be necessary.

3. Provide the lettuce industry with sound technical information for the control of Downy Mildew, Rhizoctonia Root Rot, Ring spot and Sclerotinia Rot listing fungicides, use patterns and withholding periods.
4. Registration can be discussed with the manufacturer, otherwise a use pattern developed to comply with the NZ agrichemical regulations.

One of the major diseases in NZ lettuce crops – Downy mildew, is a fungus that has the potential to develop resistance to fungicides if overused. To maintain a high level of disease control, growers must alternate the fungicides used between the different resistance groups, not between products from the same resistance group. Product selection should also take into account ‘soft’ fungicides that are IPM compatible. Disease management strategies use fungicides and biological products should be developed for the NZ lettuce industry.

Insects and insecticides

The high priority insects are:

Aphids (especially Green Peach Aphid, Lettuce aphid)	<i>Myzus persicae, Nasonovia ribis-nigri</i>
Caterpillars (especially Soybean Looper, Corn Earworm)	<i>Thysanoplusia orichalcea, Helicoverpa spp</i>
Slugs & snails	<i>Gastropoda spp.</i>

The new insecticides that can be pursued for these uses are:

Product (active)	Target insect	Action
Talstar (bifenthrin)	Aphids Lepidoptera	New use
Confidor (imidacloprid)	Aphids (foliar)	New use
Proclaim (emamectin)	Lepidoptera	New use
Ascend (fipronil)	Lepidoptera	New uses
Entrust (spinosad)	Lepidoptera	New uses
Steward (indoxacarb)	Lepidoptera	Adding to existing registrations

Steps forward

1. For each of the major insect pests identified, efficacy and crop safety trials (especially in greenhouse lettuce) are required in the major lettuce growing areas to determine the most efficacious insecticides for the control of aphids using bifenthrin and imidacloprid; and for Lepidoptera (caterpillars) using bifenthrin, emamectin, fipronil, spinosad and indoxacarb all in combination with currently registered products. No new control options were found for snails and slugs.
2. Once efficacy and the use pattern (and the withholding period) are determined, residues trials may be required in the major lettuce growing for these insecticides so that they comply with the default MRL (0.1 mg/kg). Residue data for some insecticides may be available from Australia or elsewhere. Some confirmatory trials in NZ may be necessary.
3. Provide the lettuce industry with sound technical information for the control of aphids and Lepidoptera caterpillars listing insecticides, use patterns and withholding periods.
4. Registration can be discussed with the manufacturer, otherwise a use pattern developed to comply with the NZ agrichemical regulations.

Both of the major insect pests in NZ lettuce crops – aphids and Lepidoptera are also insects that have a history of developing resistance to insecticides if overused. To maintain a high level of insect control, growers must alternate the insecticides used between the different resistance groups, not between products from the same resistance group. Product selection should also take into account ‘soft’ insecticides that are IPM compatible. Insect management strategies using insecticides and biological products should be developed for the NZ lettuce industry.

Weeds and herbicides

The main weed gaps identified by lettuce growers are:

Groundsel	<i>Senecio vulgaris</i>
Potatoes (volunteer)	<i>Solanum tuberosum</i>
Mayweed (Chamomile)	<i>Anthemis cotula</i>
Wild turnip	<i>Rapistrum rugosum</i>
Shepherd’s purse	<i>Capsella bursa-pastoris</i>
Cleavers	<i>Galium aparine</i>
Fumitory	<i>Fumaria spp.</i>

In each of these cases, the weeds can be controlled to some degree with existing registered herbicides. In most cases, the only control available is pre-plant weed control with glyphosate, oxyfluorfen or paraquat/diquat. These are existing registered uses.

New herbicides that can be pursued for these uses are:

Product (active)	Target insect	Action
Dacthal (chlorthal-dimethyl)	Weeds – pre-emergent	New use
Ramrod (propachlor)	Weeds – pre-emergent	New use

Steps forward

1. Trials are required in the major lettuce growing areas to demonstrate the techniques required for effective pre-plant weed control of problem weeds with currently registered herbicides – pre-plant weed control and selective herbicides.
2. Efficacy and crop safety trials are required in the major lettuce growing areas before pursuing the use of chlorthal-dimethyl and propachlor.
3. Once the use pattern (including the withholding period and crop safety) are determined, residues trials may be required in the major lettuce growing areas for these herbicides so that they comply with the default MRL (0.1 mg/kg). Residue data for some herbicides may be available from Australia or elsewhere. Some confirmatory trials in NZ may be necessary.
4. Provide the brassica industry with sound technical information for the control of weeds listing the herbicides, use patterns and withholding periods.
5. Registration can be discussed with the manufacturer, otherwise a use pattern developed to comply with the NZ agrichemical regulations.

The New Zealand lettuce industry

Introduction

The New Zealand vegetable industry comprises a large proportion of small owner-operated businesses. Most of the vegetables produced are consumed domestically. Brassicas, carrots, kumara, onions, potatoes, pumpkins, squash and sweet corn are the major vegetables produced. Asparagus, capsicums, carrots, onions, potatoes, squash and tomatoes are the major fresh vegetables exported. The main processed vegetables exported are dried and frozen peas, frozen potatoes, sweet corn, mixed vegetables, dried vegetables and vegetable preparations.

The main lettuce growing areas are in (HortResearch¹):

- Auckland
- Canterbury

There are (HortResearch¹):

- 315 lettuce growers
- 1,207 hectares planted
- \$39.1 million from domestic sales
- \$1.2 million from fresh export sales (2006)

Growers of all horticultural crops frequently suffer from a lack of legal access to crop protection products (agrichemicals). The problem is that whilst their crops are valuable, they are too small individually for agchem manufacturers to bear the high cost of registering agrichemicals for their use. This is particularly true for small crops, such as lettuce, where a problem may only be localised or spasmodic.

The Agricultural Compounds and Veterinary Medicines (ACVM) Group is responsible for the regulatory control of agricultural compounds (plant compounds / veterinary medicines), and their importation, manufacture, sale and use, on behalf of the New Zealand Food Safety Authority under the Agricultural Compounds and Veterinary Medicines Act 1997.

But growers are increasingly trapped in a situation where they face severe losses from diseases, pests and weeds (plant pests) if they do nothing to protect their crops, or face penalties if they use a product that is not registered and residue violations occur.

Fortunately, the ACVM Group has legislation available to growers where a default maximum residue limit (dMRL) of 0.1 mg/kg (or ppm) is permitted to allow the off-label use of registered agrichemicals (on another crop) without jeopardising the crop or the produce. But even with this allowance, issues still arise.

The lettuce industry is very aware of the possible consequences that can occur from the use of unregistered agrichemicals even with the dMRL in place. These can include;

- Produce with unauthorised agrichemical residues, as the application rate or withholding period was incorrectly determined.
- Crop damage from unregistered agrichemical use.
- Rejection of produce from local markets due to residue non-compliance.
- Temporary exclusion from market access.
- Rejection of produce from export markets due to residue non-compliance.
- Jeopardising of export trading arrangements due to unacceptable agrichemical use or residue non-compliance.
- Fines and penalties

¹ HortResearch FreshFacts 2006
AgAware Consulting P/L

Agrichemicals have always been an important tool in the production of lettuce. Fungicides and insecticides are used as a necessary tool to control plant pests, which can proliferate in ideal growing conditions. Herbicides are also used as pre-emergents and post-emergents to minimize weed competition.

The lettuce industry has access to a range of agrichemicals to control the plant pests that affect the crop, during the establishment phase, during crop development, during head maturity and pre harvest.

Strategic Agrichemical Review Process

As a consequence of the issues facing the lettuce industry regarding limited agrichemical access, AgAware Consulting Pty Ltd in association with Horticulture New Zealand Ltd undertook a review of the agrichemical requirements in lettuce via a Strategic Agrichemical Review Process (SARP). See Diagram 1 – the Strategic Agrichemical Review Process.

The aims of the process are:

- to determine the current and future agrichemical requirements for lettuce
- to protect the crops from plant pests by providing access to agrichemicals that they currently do not have legally available; and
- to provide information to use the agrichemicals under the dMRL legislation.

The project will undertake the assessment of agrichemical suitability, resistance, IPM, residues and exports in its evaluations and recommendations.

SARP was conducted with the New Zealand vegetable industry in Auckland in November 2006. This assessment provided a list of key plant pests that are of major concern to the lettuce industry. Against these threats the agrichemicals, agrichemical group, withholding period, registered uses and overall suitability (IPM, residues, efficacy, trade and environment) for these pests were identified. Any potential new risks to the industry were also identified.

This report will provide the lettuce industry with a clear picture of any gaps in the existing pest control options, and note the potential to address gaps with effective IPM compatible agrichemicals.

Solutions to the identified gaps (where acceptable agrichemicals are not legally available), were determined with new agrichemical control options using:

- Critical selection criteria for potential alternatives and/or new agrichemical
- Domestic and overseas information and resources that provide options and assist decision making

The list of agrichemical solutions for each identified gap will have the benefit of:

- IPM compatibility, wherever possible
- Improved scope for resistance management
- Sound biological profile
- Residue and trade acceptance domestically and for export

The results of the process will provide the lettuce industry with sound agrichemical options that the industry can pursue for registration with the manufacturer.

This report is not a comprehensive assessment of ALL pests and control methods of lettuce but attempts to prioritise the major problems.

Methods

SARP was conducted in Auckland November 2006, as part of a specially convened vegetable specialists meeting. The meeting included members of key vegetable industry bodies, consultants, government agencies and Horticulture New Zealand.

- Participants were given a comprehensive list of the major pests of lettuce and asked to prioritise them into high, moderate and low categories.
- Each of the pests was listed by common and scientific name.
- Participants were asked to list the main agrichemicals and or other control agents used for each pest.
- Each agrichemical active ingredient as well as bio-control agent (biological, bio-fungicide or bio-insecticide) were listed along with a common trade name.
- The lists provided were certainly not comprehensive but a starting point for further assessment.
- The registration status in New Zealand was determined for each agrichemical and bio-control agent. As well as harvest withholding periods and comments collected for each pest and product.
- A further assessment and evaluation was then conducted for each control method as to whether the agrichemical was registered for each particular crop. This was done using information from the ACVM Group (ACVM 2007). The New Zealand Agrichemicals Manual (Agrimedia 2007) and Novachem Manual (Novachem Services Ltd, 2006/2007) were also used.
- Agrichemicals that are under review by the ACVM Group and by the Australian Agrichemicals and Veterinary Medicines Authority (APVMA) were listed. Information was collated onto Excel spreadsheets for plant pests.
- Agrichemical resistance groupings were assigned to each agrichemical (Australian information) to make it easier to identify each product and its mode of action. For example:
 - The fungicide, mancozeb belongs to the dithiocarbamate resistance group and has multi-site activity; it belongs to the Group Y fungicides.
 - The insecticide, diazinon belongs to the organophosphate resistance group and has contact/stomach activity; it belongs to the Group 1B insecticides.
 - The herbicide, linuron belongs to the photosynthesis inhibitor resistance group; it belongs to the Group C herbicides.
- The information was circulated to participants for further comments to ensure the accuracy of the information.
- An assessment and evaluation was conducted for each of the plant pests of lettuce that required new or additional control options.
- Each alternative agrichemical 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 agrichemicals for the lettuce industry to pursue are listed.

Results

For the lettuce crops discussed in this SARP report, the two main types reviewed were:

Head lettuce	<i>Lactuca sativa</i> included Crisphead varieties
Leafy lettuce	<i>Lactuca sativa</i> included leafy or fancy varieties

For ease of management and because the plant pests for each crop are the same, both crops will be discussed as a whole and not individually.

Specific differences will be discussed.

Special mention is made to greenhouse grown lettuce, as this offers some specific plant pest issues, that many not be relevant to field-grown crops.

The complete list of SARP worksheets is presented.

- Table 1 – results of the lettuce Strategic Agrichemical Review Process – Fungicides registered and used for the control of the MAJOR recorded diseases in lettuce.
- Table 2 – results of the lettuce Strategic Agrichemical Review Process – Fungicides registered and used for the control of the MINOR recorded diseases in lettuce.
- Table 3 – results of the lettuce Strategic Agrichemical Review Process – Insecticides registered and used for the control of the MAJOR recorded insect pests in lettuce.
- Table 4 – results of the lettuce Strategic Agrichemical Review Process – Insecticides registered and used for the control of the MINOR recorded insect pests in lettuce.
- Table 5: Herbicides registered and used for the control of the weeds in lettuce.

Discussions

Diseases of lettuce

The major diseases of lettuce recorded are:

Common name	Scientific name
<u>HIGH PRIORITY</u>	
Downy Mildew	<i>Bremia lactucae</i>
Rhizoctonia Root Rot	<i>Rhizoctonia solani</i>
Ring Spot or Mycosphaerella Leafspot	<i>Mycosphaerella brassici-cola</i>
Sclerotinia Rot	<i>Sclerotinia minor</i> & <i>S. sclerotiorum</i>

MODERATE PRIORITY

Botrytis	<i>Botrytis cinerea</i>
Damping off	<i>Various diseases</i>
Early blight	<i>Alternaria solani</i>
Fusarium Dry Rot	<i>Fusarium spp.</i>
Pythium Root Rot	<i>Pythium spp.</i>

LOW/POTENTIAL PRIORITY

Nil

See **Table 1:** Fungicides registered and used for the control of the MAJOR recorded diseases in lettuce.

High priority disease

Downy mildew (*Bremia lactucae*)

Downy mildew (*Bremia lactucae*) is reported as the most important disease of lettuce in New Zealand. No distinction was made between field grown and greenhouse lettuce in relation to disease severity.

Fungicides registered for Downy mildew control in lettuce or vegetables are:

Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
COPPER HYDROXIDE	Kocide	Registered for 'lettuce'.	Y	0	Occasionally used and effective. AU label - registered for DM in lettuce.
COPPER OXYCHLORIDE	Agpro	Registered for 'lettuce'. Some variety sensitivity	Y	0	Commonly used & effective.
DIMETHOMORPH	Acrobat	Registered for 'lettuce'.	X	14	Commonly used & effective.
MANCOZEB	Manzate	Registered for 'lettuce'.	Y	14	Commonly used & effective.

* Resistance groups combine agrichemicals with the same mode of action.

	Registered
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All of these products are commonly/occasionally used as foliar treatments in lettuce. There is little risk of resistance developing in the future with the continued use of the copper based fungicides and mancozeb as they are multi-site, protectant fungicides. But the overuse of Acrobat (dimethomorph) can lead to an increased risk of resistance developing. It was identified that alternatives are required, particularly systemic/curative fungicides.

From the reports received, the current fungicides used for Downy mildew (*Bremia lactucae*) control in lettuce are working adequately.

Fungicides that are used off-label in lettuce for the control of Downy mildew are:

Active ingredient	Common Trade Name	Registrations	Resistance group	Comments
AZOXYSTROBIN	Amistar	Registered for downy mildew control in onions and peas.	K	Occasionally used and effective.
BORDEAUX MIXTURE	Cuprofix	Listed for Downy Mildew control in grapes.	Y	Commonly used & effective.
CARBENDAZIM	Carbendazim	No listing for DM in any crop.	Y	Occasionally used and effective.
CHLOROTHALONIL	Bravo	Controls Downy Mildew in cucurbits, grapes, and vegetable brassicas.	Y	Occasionally used and effective.
METALAXYL-M + MANCOZEB	Ridomil Gold MZ	Downy Mildew control for brassica seedbeds, cucurbits, grapes, onions.	D	Occasionally used and effective.
PHOSPHOROUS ACID	Foschek	No registrations in any crop for Downy Mildew control	Y	Occasionally used and effective.

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust
	Used off-label

Feedback indicates, the current off-label fungicides used for Downy mildew control in lettuce are working adequately. The products used are a mixture of protectants/curative (Amistar and Ridomil) and protectants (Cuprofix, carbendazim, Bravo and Foschek). Ridomil products are prohibited in Aust. for use in greenhouse crops due to the increased risk of resistance developing.

Fungicides that are not registered in brassicas but control Downy mildew in other situations, and could possibly be alternatives include:

Active ingredient	Common Trade Name	Resistance group	Comments
CAPTAN	Captan	Y	Downy Mildew control is listed for grapes.
COPPER OXIDE	Nordox	Y	Registered for DM in peas, grapes and cucumber. AU label - registered for DM in lettuce.
METALAXYL-M	Apron	D	Registered for Downy Mildew control as a seed treatment in peas
METIRAM	Polyram	Y	Registered controls DM in grapes. AU label - registered for DM in lettuce.
PROPINEB	Antracol	Y	Registered for DM control in onions. AU label - registered for DM in lettuce.

* Resistance groups combine agrichemicals with the same mode of action.

Of these products the only selected ones that are registered or have maximum residue limits (MRL) set in overseas countries that could support a registration in New Zealand are:

- Amistar (azoxystrobin)
 - MRL in: Aust, EU, Japan, Switzerland, Taiwan, USA (lettuce, vegetables)
- Bravo (chlorothalonil)
 - MRL in: Australia, China, EU, Indonesia, Japan, Korea, Malaysia, NZ, Singapore, Switzerland, Taiwan (lettuce, leafy vegetables, vegetables)
- Ridomil (metalaxyl-M + mancozeb)
 - MRL (metalaxyl) in: Australia, Canada, Codex, EU, Indonesia, Israel, Japan, Korea, Singapore, Switzerland, Taiwan, USA (lettuce, leafy vegetables, vegetables)
 - MRL (metalaxyl-M) in: EU, Italy, Japan, (lettuce, leafy vegetables, vegetables)
- Foscheck (phosphorous acid)
 - MRL in: Aust, Italy, NZ (exempt), Switzerland, USA (lettuce, leafy vegetables, vegetables)
- Captan (captan)
 - MRL in: Austria, Belgium, Denmark, EU, France, Indonesia, Italy, Japan, Korea, NZ, Singapore, Switzerland, Thailand. UK, USA (lettuce, vegetables)
- Polyram (metiram)
 - MRL in: Aust, Canada, Codex, EU, Indonesia, Japan, NZ, Switzerland, Taiwan (lettuce, vegetables)
- Antracol (propineb)
 - MRL in: Aust, Codex, EU, Indonesia, Japan, Malaysia, Switzerland, Taiwan (lettuce, leafy vegetables, vegetables)

Please check with the New Zealand Food Safety Authority for the most current MRL in export markets.

FUNGICIDE ALTERNATIVES IN LETTUCE FOR BREMIA

In reviewing the possible alternatives:

- Amistar (azoxystrobin) – is a protectant/curative fungicide with a wide spectrum of activity. Resistance management is an issue. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field and greenhouse). Residue data may also be necessary. Although there are few overseas MRL, **the product should be pursued**, provided efficacy is confirmed. This will provide a necessary new systemic fungicide.
- Bravo (chlorothalonil) - a protectant fungicide with a wide disease control spectrum. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field and greenhouse). Residue data may also be necessary. As there are MRL in NZ and many overseas countries, **the product should be pursued** after efficacy is confirmed.
- Ridomil (metalaxyl-M + mancozeb) – is a protectant/curative fungicide with a wide spectrum of activity. Resistance management is an issue. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field only). Residue data may also be necessary. Although there are few overseas MRL (metalaxyl-M), **the product should be pursued**, provided efficacy is confirmed. This product should not be used in greenhouse lettuce due to the resistance risk. This will provide a necessary new systemic fungicide.
- Foscheck (phosphorous acid) – a systemic fungicide with good active on Oomycetes. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field and greenhouse). Residue data may also be necessary. As overseas MRL are limited a use pattern needs to be developed to

comply with overseas MRL. **The product should be pursued** if efficacy can be confirmed.

- Captan, Polyram (metiram) and Antracol (propineb) – are protectant fungicides. These do not offer any significant advantages over chlorothalonil and mancozeb. They should not be pursued.

A resistance management strategy needs to be developed for the control of Downy mildew in lettuce using all available fungicides and other management systems.

Rhizoctonia Root Rot (*Rhizoctonia solani*)

Rhizoctonia Root Rot (*Rhizoctonia solani*) control in lettuce is considered a major problem in field grown lettuce only.

Fungicides registered for Rhizoctonia Root Rot control in lettuce or vegetables are:

Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
QUINTOZENE	Terrachlor	Listed for use on 'Vegetable Seedlings'	Y	Na	Used in nurseries - need to have healthier seedlings produced. Applied as a pre-sowing soil treatment. Listed to control Rhizoctonia and Fusarium.

* Resistance groups combine agrichemicals with the same mode of action.

	Registered
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- Reports are that Terrachlor is providing adequate control of Rhizoctonia Root Rot in lettuce when used in seedling production.

Fungicides that are used off-label in lettuce for the control of Rhizoctonia Root Rot are:

Active ingredient	Common Trade Name	Registrations	Resistance group	Comments
AZOXYSTROBIN	Amistar	No registration for lettuce and no mention of Rhizoctonia on any other crop	K	Commonly used & effective. AU permit - registered for Rhizoctonia in peanuts. AU label – potatoes (in-furrow), turf.

* Resistance groups combine agrichemicals with the same mode of action.

	Used off-label
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- Reports are that Amistar is providing adequate control of Rhizoctonia Root Rot in lettuce. Use in Aust in peanuts, potatoes and turf are all as soil applied treatments. But the continual use of Amistar as the only fungicide for Rhizoctonia control can lead to resistance developing.

Fungicides that are not registered in lettuce but control Rhizoctonia Root Rot in other situations, and could possibly be alternatives include:

Active ingredient	Common Trade Name	Registrations	Resistance group	Comments
IPRODIONE	Rovral	Label lists Rhizoctonia control as seed treatment in brassicas.	B	AU label - registered for Rhizoctonia in various crops as a seed treatment.
MANCOZEB	Manzate	Registered in lettuce for Ringspot	Y	AU label - registered for Rhizoctonia in lettuce.
Trichoderma harzianum	Trichopel	Registered for addition to nursery propagation media for many diseases.	Biological	

* Resistance groups combine agrichemicals with the same mode of action.

Of these products the only ones that are registered or have maximum residue limits (MRL) set in overseas countries that could support a registration in New Zealand are:

- Amistar (azoxystrobin)
 - MRL in: Aust, EU, Japan, Switzerland, Taiwan, USA (lettuce, vegetables)
- Rovral (iprodione)
 - MRL in: Aust, Canada, Codex, EU, Indonesia, Israel, Japan, Korea, NZ, Singapore, Switzerland, Taiwan, USA (lettuce, leafy vegetables, vegetables)
- Manzate (mancozeb)
 - MRL in: Aust, Canada, Codex, EU, Indonesia, Japan, Malaysia, NZ, Singapore, Switzerland, Taiwan (lettuce, leafy vegetables, vegetables)

Please check with the New Zealand Food Safety Authority for the most current MRL in export markets.

FUNGICIDE ALTERNATIVES IN LETTUCE FOR RHIZOCTONIA

In reviewing these possible alternatives:

- Amistar (azoxystrobin) – is a protectant/curative fungicide with a wide spectrum of activity. Resistance management is an issue. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field only). Residue data may also be necessary. Although there are few overseas MRL, **the product should be pursued**, provided efficacy is confirmed. This will provide a necessary new systemic fungicide.
- Rovral (iprodione) – is a protectant/curative fungicide. As Terrachlor is already registered as a seed treatment in NZ, the product should not be pursued.
- Manzate (mancozeb) - is a protectant fungicide with good IPM fit and a wide disease control spectrum. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field only). Residue data should not be necessary as it is already registered in lettuce. As there are MRL in NZ and many overseas countries, **the product should be pursued** after efficacy is confirmed.

Ring spot or Mycosphaerella Leafspot (*Mycosphaerella brassici-cola*)

Ringspot or Mycosphaerella Leafspot (*Mycosphaerella brassici-cola*) control in lettuce is considered a major problem in field grown lettuce only.

Fungicides registered for Ring spot or Mycosphaerella Leafspot control in lettuce or vegetables are:

Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
CHLOROTHALONIL	Bravo	Registered for 'lettuce'. Some chlorothalonil products list Ringspot	Y	10	Commonly used & effective.
COPPER OXYCHLORIDE	Agpro	Registered for 'lettuce'.	Y	0	Commonly used & effective.
MANCOZEB	Manzate	Registered for 'lettuce'.	Y	14	Commonly used & effective.

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Registered

All of these products are used in lettuce. There is little risk of resistance developing in the future with the continued use of the chlorothalonil, copper and mancozeb as they are multi-site, protectant fungicides.

From the reports received, the current fungicides used for Ring spot or *Mycosphaerella* Leafspot (*Mycosphaerella brassici-cola*) control in lettuce are working adequately. But it was identified that alternatives are required, particularly systemic/curative fungicides.

Fungicides that are used off-label in lettuce for the control of Ring spot or *Mycosphaerella* Leafspot are:

Active ingredient	Common Trade Name	Registrations	Resistance group	Comments
AZOXYSTROBIN	Amistar	No mention of Ringspot disease on NZ label	K	Commonly used & effective.
DIFENOCONAZOLE	Score	Label lists Ringspot control in brassicas	C	Commonly used & effective.

* Resistance groups combine agrichemicals with the same mode of action.

	Used off-label
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Feedback indicates, the current off-label fungicides used for Ring spot or *Mycosphaerella* Leafspot (*Mycosphaerella brassici-cola*) control in lettuce are working adequately.

Although other fungicides were identified as having activity on Ring spot or *Mycosphaerella* Leafspot (*Mycosphaerella brassici-cola*), it was considered that they offered no advantages over current registered or used fungicides.

Of these products the only ones that are registered or have maximum residue limits (MRL) set in overseas countries that could support a registration in New Zealand are:

- Amistar (azoxystrobin)
 - MRL in: Aust, EU, Japan, Switzerland, Taiwan, USA (lettuce, vegetables)
- Score (difenoconazole)
 - MRL in: Austria, EU, Germany (lettuce, vegetables)

Please check with the New Zealand Food Safety Authority for the most current MRL in export markets.

FUNGICIDE ALTERNATIVES IN LETTUCE FOR MYCOSPHAERELLA

In reviewing the possible alternatives:

- Amistar (azoxystrobin) – is a protectant/curative fungicide with a wide spectrum of activity. Resistance management is an issue. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field only). Residue data may also be necessary. Although there are few overseas MRL, **the product should be pursued**, provided efficacy is confirmed. This will provide a necessary new systemic fungicide.
- Score (difenoconazole) – a protective/systemic fungicide. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field only). Residue data may also be necessary. Although there are limited overseas MRL, no triazole fungicides are registered. A use pattern needs to be determined to comply with overseas MRL. Therefore **the product should be pursued.**

A resistance management strategy needs to be developed for the control of Ring spot or Mycosphaerella Leafspot (*Mycosphaerella brassici-cola*) in lettuce using all available fungicides and other management systems.

Sclerotinia rot (*Sclerotinia minor* & *S. sclerotiorum*)

Sclerotinia rot (*Sclerotinia minor* and *S. sclerotiorum*) is considered the major problem in all field grown lettuce crops. The severity of the disease is dependent on the rotations practiced and the weather.

Fungicides registered for Sclerotinia rot control in lettuce or vegetables are:

Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
CARBENDAZIM	Carbendazim	Registered for 'lettuce'.	A	21	Commonly used & effective.

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust
	Registered

Carbendazim is occasionally used as foliar treatment in lettuce. There is some risk of resistance developing in the future with the continued use of this fungicide alone.

Feedback indicates, carbendazim used for Sclerotinia rot (*Sclerotinia sclerotiorum*) control in lettuce is working adequately. It was identified that alternatives are required.

Fungicides that are used off-label in lettuce for the control of Sclerotinia rot are:

Active ingredient	Common Trade Name	Registrations	Resistance group	Comments
FLUAZINAM	Shirlan	Registrations for Sclerotinia control in tomato and potato	Y	Occasionally used & effective.
PROCYMIDONE	Sumislex	Controls Sclerotinia in many vegetables.	B	Commonly used & effective.
THIOPHANATE-METHYL	Topsin	Registered for Sclerotinia in beans, field tomatoes.	A	Occasionally used

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust
	Used off-label

From the reports received, the Shirlan and Sumislex used for Sclerotinia rot (*S. minor* & *S. sclerotiorum*) control in lettuce are working adequately. Topsin is used, but there were no comments regarding efficacy. Topsin is also under review.

Fungicides that are not registered in lettuce but control Sclerotinia Rot in other situations, and could possibly be alternatives include:

Active ingredient	Common Trade Name	Resistance group	Comments
AZOXYSTROBIN	Amistar	K	AU label - registered for Sclerotinia in tomatoes.
BOSCALID	Filan	G	Product to be registered in NZ. AU permit - registered for Sclerotinia in various vegetables, including lettuce.
CYPRODINIL + FLUDIOXONIL	Switch	I+L	No vegetable registrations in NZ. AU permit - registered for Sclerotinia in various peas, working on lettuce.

Active ingredient	Common Trade Name	Resistance group	Comments
IPRODIONE	Rovral WP	B	Label lists Sclerotinia control in ornamentals & kiwi fruit. AU label - registered for Sclerotinia in lettuce.
TEBUCONAZOLE	Folicur	C	AU permit - registered for Sclerotinia in lettuce.
Trichoderma harzianum	Trichopel	Biological	Registered for addition to nursery propagation media for many diseases.

* Resistance groups combine agrichemicals with the same mode of action.

Of these products the only selected ones that are registered or have maximum residue limits (MRL) set in overseas countries that could support a registration in New Zealand are:

- Shirlan (fluazinam)
 - MRL in: EU, Germany, Japan, Netherlands (lettuce, vegetables)
- Sumisclex (pprocymidone)
 - MRL in: Codex, EU, Japan, Korea, NZ, Switzerland, Taiwan, (lettuce, leafy vegetables, vegetables)
- Amistar (azoxystrobin)
 - MRL in: Aust, EU, Japan, Switzerland, Taiwan, USA (lettuce, vegetables)
- Filan (boscalid)
 - MRL in: Aust, EU, Germany, Japan, Netherlands, UK, USA (lettuce)
- Switch (cyprodonil)
 - MRL in: Austria, Codex, EU, Germany, Japan, Netherlands, Switzerland, USA, (lettuce, vegetables)
(fludioxnil)
 - MRL in: Austria, EU, Germany, Japan, Switzerland, USA, (lettuce, vegetables)
- Folicur (tebuconazole)
 - MRL in: Aust, Austria, EU, Germany, Japan, (lettuce, vegetables)

Please check with the New Zealand Food Safety Authority for the most current MRL in export markets.

FUNGICIDE ALTERNATIVES IN LETTUCE FOR SCLEROTINIA

In reviewing these possible alternatives:

- Shirlan (fluazinam) – is a protectant fungicide. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field only). Residue data may also be necessary. As there are limited overseas MRL, a use pattern needs to be developed to fit the residue requirements. This will provide a necessary new protectant fungicide. **The product should be pursued.**
- Sumisclex (procymidone) – is a protectant/curative systemic fungicide with good activity on Sclerotinia. This product was registered for Sclerotinia control in lettuce in Aust, but is currently under review. It is expected that registration will be re-introduced. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field only). Residue data may also be necessary. As there are limited overseas MRL, a use pattern needs to be developed to fit the residue requirements. **The product should be pursued.**
- Amistar (azoxystrobin) – is a protectant/curative fungicide with a wide spectrum of activity. Resistance management is an issue. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field only). Residue data may also be necessary. Although there are few overseas MRL, **the product should be pursued**, provided efficacy is confirmed. This will provide a necessary new systemic fungicide.

- Filan (boscalid) – is a curative systemic fungicide with excellent activity on Sclerotinia. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field only). Residue data may also be necessary. As there are limited overseas MRL, a use pattern needs to be developed to fit the residue requirements. **The product should be pursued.**
- Switch (cyprodinil + fludioxonil) – is a protectant/curative systemic fungicide with good activity on Sclerotinia. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field only). Residue data may also be necessary. As there are many overseas MRL, **the product should be pursued**, provided efficacy is confirmed. This will provide a necessary new protectant/curative fungicide.
- Folicur (tebuconazole) - is an effective protectant/curative systemic fungicide with a wide disease spectrum. Some resistance risk. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field only). Residue data may also be necessary. As there are limited overseas MRL, a use pattern needs to be developed to fit the residue requirements. **The product should be pursued.**

Other diseases

See **Table 2:** Fungicides registered and used for the control of the MINOR recorded diseases in lettuce.

Botrytis (*Botrytis cinerea*)

Damping off (various diseases)

Early Blight (*Alternaria solani*)

Fusarium Dry Rot (*Fusarium spp.*)

Pythium Root Rot (*Pythium spp.*)

New fungicide that can be pursued

Product (active)	Target disease	Action
Amistar (azoxystrobin)	Downy Mildew Rhizoctonia Root Rot Ring spot / Mycosphaerella Leafspot Sclerotinia Rot	New uses
Bravo (chlorothalonil)	Downy Mildew	Adding to existing registrations
Ridomil (metalaxyl-M + mancozeb)	Downy Mildew	New use
Foscheck (phosphorous acid)	Downy Mildew	New use
Manzate (mancozeb)	Rhizoctonia Root Rot	Adding to existing registrations
Score (difenoconazole)	Ring spot / Mycosphaerella Leafspot	New use
Shirlan (fluazinam)	Sclerotinia rot	New use
Sumislex (procymidone)	Sclerotinia rot	New use
Filan (boscalid)	Sclerotinia rot	New use
Switch (cyprodinil + fludioxonil)	Sclerotinia rot	New use
Folicur (tebuconazole)	Sclerotinia rot	New use

Insects of lettuce

The insects of lettuce recorded are:

Common name

Scientific name

HIGH PRIORITY

Aphids (especially Green Peach Aphid, Lettuce aphid)

Myzus persicae, Nasonovia ribis-nigri

Caterpillars (especially Soybean Looper, Corn Earworm)

Thysanoplusia orichalcea, Helicoverpa spp

Slugs & snails

Gastropoda spp.

MEDIUM PRIORITY

Thrips

various

Weevils

various

Springtails

Collebola spp.

Wireworm

Heteroderus spp.

Mites

various

LOW PRIORITY

Nil

See **Table 3:** Insecticides registered and used for the control of the MAJOR recorded insect pests in lettuce.

High priority insects

Aphids - Green Peach Aphid (*Myzus persicae*); Lettuce aphid (*Nasonovia ribis-nigri*)

Although there are several aphid species that affect lettuce crops in New Zealand, rather than discussing each aphid individually, they will be discussed as a group. This approach will consider:

- Individual differences between aphid species and lettuce varieties affected
- Resistance issues between species, especially Lettuce aphid
- Insecticides that control all aphid species
- No distinction was made between field grown and greenhouse lettuce in relation to aphid severity.

Insecticides registered for aphid control in lettuce or vegetables are:

Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
ACEPHATE	Orthene		1B	3	
APHID PARASITE	<i>Aphidius colemani</i>		Biological	0	
APHIDOLETED	<i>Aphidoletes aphidimyza</i>		Biological	0	

Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
CANOLA OIL	Eco-oil	GPA	Vegetable Oil	16	
DIAZINON	Diazinon	Aphids	1B	14	
DICHLORVOS	Divap	Aphids Vegetables	1B	3	Occasionally used & effective.
FATTY ACIDS (K SALTS)	Nature's Way Insect Spray		Unlisted	1	
IMIDACLOPRID	Confidor	Confidor 5G registered for aphid control in vegetable seedlings. Not registered for foliar use for aphids.	4A	49	Commonly used & effective as a seedling drench - Confidor 5G. Commonly used and effective as foliar treatment or seedling drench - Confidor for Lettuce aphid.
MALATHION	Malathion	Aphids	1B	3	
METHOMYL	Lannate	GPA	1A	7	Occasionally used and effective - not IPM compatible.
PERMETHRINS + PIPERONYL BUTOXIDE	Greenseals Pyrethrum	Aphids	3A	Na	
PIRIMICARB	Pirimor	Aphids	1A	3	Commonly used and effective.
PYMETROZINE	Chess	Lettuce Aphid	9A	7	Commonly used and effective. Chess is the only product compatible with Aphidius.
PYRETHRINS	Garlic & Pyrethrum Concentrate	Aphids	3A	1	
ROTENONE	Derris Dust		21A	1	

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust
	Registered
	Used off-label

All the products indicated are commonly/occasionally used as foliar insecticides in lettuce. Some of the insecticides used are quite old, suggesting that resistance may be an issue. There is some risk of resistance developing in the future with some aphid species (Green peach aphid and Lettuce aphid) with the continued use of some insecticides. Resistance has been recorded in GPA to pirimicarb in Australia and LA is resistant to many commonly used insecticides.

In nearly all cases, Lettuce aphid is treated at the nursery stage as a seedling drench with imidacloprid.

The use of specialist aphicides such as Pirimor and Chess allows the use of beneficial insects in IPM systems.

From the reports received, the current insecticides used for aphid control in lettuce are working adequately. To maintain a high level of aphid control, growers must alternate the insecticides used between the different resistance groups, not between products from the same resistance group.

Insecticides that are used off-label in lettuce for the control of aphids are:

Active ingredient	Common Trade Name	Registrations	Resistance group	Comments
ALPHA-CYPERMETHRIN	Dominex Fastac	'Aphids' listed for tomatoes	3A	Occasionally used & effective. Resistance management issues very important.
BIFENTHRIN	Talstar	Reg. on field tomatoes, pumpkins, squash for 'aphids'	3A	Occasionally used & effective. Resistance management issues very important.
DELTAMETHRIN	Decis	Reg. for 'aphids' in squash	3A	Occasionally used & effective. Resistance management issues very important.
IMIDACLOPRID	Confidor		4A	Commonly used and effective as foliar treatment for aphids. Green peach aphid listed on AU label.
METHAMIDOPHOS	Monitor Tamaron	Registered for 'aphids' in potato	1B	Occasionally used and effective - not IPM compatible.

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Registered
	Actives under review in Aust
	Used off-label

Synthetic pyrethroids are commonly used for Green Peach aphid control. Resistance is an important issue with these products. Confidor is commonly used as a foliar aphicide. This application can be in addition to imidacloprid already being used as a seedling drench for Lettuce aphid control. This multiple application can increase the resistance risk.

From the reports received, the current off-label insecticides used for aphid control in lettuce are working adequately.

Insecticides that are not registered in lettuce but control aphids in other situations, and could possibly be alternatives include:

Active ingredient	Common Trade Name	Resistance group	Comments
AZADIRACHTIN	NeemAzal	Botanical insecticide	Not registered on any vegetable. Aphids only on non-fruit bearing trees and vines.
Beauveria bassiana	Botanigard	Biological	
CHLORPYRIFOS	Lorsban	1B	Reg for 'aphids' in winter squash and vegetable brassicas
DIMETHOATE	Perfekthion	1B	Reg. for CA in potato, carrots and brassicas. AU label - registered for aphids in lettuce.
ENDOSULFAN	Thiodan	2A	Reg. on tomato, vegetable brassica and potato
IMIDACLOPRID	Gaucho	4A	Reg. on potato and squash for 'aphids'
Lecanicillium lecanii blastospores		Biological	
PERMETHRIN + PIRIMIPHOS-METHYL	Attack	3A+1B	Reg. for 'aphids' in GH tomato, cucurbits group and vegetable brassica
PHORATE	Phorate	1B	Reg for 'aphids' in cucurbits group, squash, vegetable brassicas, potato and carrot
TAU-FLUVALINATE	Mavrik	3A	Reg. on field tomato for GPA
TERBUFOS	Counter	1B	Aphids listed for forage brassicas as a seed/fertiliser treatment.
THIACLOPRID	Calypso	4A	Requested by growers, but same resistance group as Confidor and no vegetable or aphid registrations.
THIOPHANATE-METHYL + CHLOROTHALONIL + TAUFLUVALINATE	Guardall	3A	Reg. for 'aphids' on tomato

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust

Of these products the only selected ones that are registered or have maximum residue limits (MRL) set in overseas countries that could support a registration in New Zealand are:

- Talstar (bifenthrin)
 - MRL in: Aust, EU, Germany, Japan, Korea, Switzerland, Taiwan, USA (lettuce, vegetables)
- Confidor (imidacloprid)
 - MRL in: Aust, Austria, Canada, Codex, EU, Germany, Japan, Korea, Sweden, Taiwan, USA (lettuce, vegetables)
- Calypso (thiacloprid)
 - MRL in: Austria, EU, UK (lettuce, vegetables)

Please check with the New Zealand Food Safety Authority for the most current MRL in export markets.

INSECTICIDES ALTERNATIVES IN LETTUCE FOR APHIDS

In reviewing the possible alternatives:

- Talstar (bifenthrin) – is a synthetic pyrethroid with a wide spectrum of activity. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field and greenhouse). Residue data may also be necessary. Although the SP can be highly prone to developing resistance, one of the SP used should be selected. Bifenthrin is one of the better SP. **This product should be pursued**
- Confidor (imidacloprid) – is a systemic foliar insecticide with activity on various pests. Some impact on beneficial insects. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field and greenhouse). Residue data may also be necessary. As Gaucho and Confidor 5G are already registered, Confidor as a foliar insecticide **should not be pursued**.
- Calypso (thiacloprid) – is a systemic insecticide with excellent activity on a range of pests, but not labelled for aphids. As it is in the same resistance group as Confidor and Gaucho, it should not be pursued.

Caterpillars - Soybean Looper (*Thysanoplusia orichalcea*); Corn earworm (*Helicoverpa spp.*)

Soybean Looper (*Thysanoplusia orichalcea*) and Corn Earworm (*Helicoverpa spp.*) are major pests of lettuce. No distinction was made between field grown and greenhouse lettuce in relation to caterpillar severity.

Although there are several Lepidoptera species that affect lettuce crops in New Zealand, rather than discussing each pest individually, they will be discussed as a group. This approach will consider:

- Individual differences between caterpillar species and lettuce varieties affected
- Resistance issues between species
- Insecticides that control all Lepidoptera species

Insecticides registered for Lepidoptera control in lettuce or vegetables are:

Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
ACEPHATE	Orthene	Caterpillars	1B	3	Occasionally used & effective - Looper & Heliothis.
<i>Bacillus thuringiensis t sub. Kurstaki</i>	Dipel	Caterpillars	11C	0	Commonly used & effective - Looper & Heliothis.
CARBARYL	Sevin	Various caterpillars on 'Vegetable Crops'	1A	1	Corn Earworm listed in sweet corn
DIAZINON	Diazinon	Caterpillars	1B	14	Occasionally used & effective - Looper & Heliothis.
DICHLORVOS	Divap	Caterpillars Vegetables	1B	3	Occasionally used & effective - Looper & Heliothis.
IDOXACARB	Steward	Reg. in 'head' lettuce (outdoors) only.	22A	3	Commonly used & effective - Heliothis.
MALATHION	Malathion	Diamondback moth, Tomato Fruitworm, White Butterfly	1B	3	Occasionally used & effective - Looper & Heliothis.
METHOMYL	Lannate L	Looper	1A	7	Commonly used & effective - Looper & Heliothis.
PARATHION METHYL	Folidol	Registered in vegetables for Lepidoptera.	1B	14	
PYRETHRUM	Garlic & Pyret Conc	Cabbage Moth and caterpillars	3A	1	
ROTENONE	Derris Dust	Diamondback moth, White Butterfly	21A	1	

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust
	Registered
	Used off-label

All products indicated are commonly/occasionally used as foliar insecticides for a range of Lepidoptera pests in lettuce. Noticeably, most of these insecticides are very old carbamates (1A), organophosphates (1B) and synthetic pyrethroids (3A). Unfortunately most of these are quite disruptive of IPM programs. Bt and Steward (indoxacarb) are the only registered product that are IPM compatible.

Feedback indicates the current insecticides used for Lepidoptera control in lettuce are working adequately. To maintain a high level of control, growers must alternate the insecticides used between the different resistance groups, not between products from the same resistance group.

Steward (indoxacarb) is the only insecticide registered specifically for Soybean Looper in head lettuce only i.e. not leafy lettuce. Sevin (carbaryl) and Lannate L (methomyl) are registered for Looper caterpillars in lettuce.

Insecticides used off-label in lettuce for the control of Lepidoptera (caterpillars) are:

Active ingredient	Common Trade Name	Registrations	Resistance group	Comments
ALPHA-CYPERMETHRIN	Dominex Fastac	Reg. in tomato and vegetable brassica. Corn Earworm listed in sweet corn.	3A	Occasionally used & effective – Looper. AU label - registered for Heliothis in lettuce.
<i>Bacillus thuringiensis sub. Xen tari</i>	XenTari	Reg. in vegetable brassicas and GH tomato	11C	Commonly used & effective - Looper & Heliothis.
BIFENTHRIN	Talstar	Reg. in vegetable brassicas and field tomato	3A	Occasionally used & effective - Looper & Heliothis.
CHLORPYRIFOS	Lorsban	Not registered in lettuce. Corn Earworm listed in sweet corn.	1B	Occasionally used & effective - Looper & Heliothis.
CYPERMETHRIN	Ripcord	Reg. in cauliflower, cabbage and tomato. Corn Earworm listed in sweet corn	3A	Occasionally used & effective - Looper & Heliothis

Active ingredient	Common Trade Name	Registrations	Resistance group	Comments
DELTAMETHRIN	Decis	Reg, in field tomato, potato and vegetable brassicas. Corn Earworm listed in corn.	3A	Occasionally used & effective - Looper & Heliothis.
LAMBDA-CYHALOTHRIN	Karate	Reg, in field tomato, vegetable brassica and potato	3A	Occasionally used & effective - Looper & Heliothis.
METHAMIDOPHOS	Monitor Tamaron	Reg. for various caterpillars in tomato, vegetable brassica and potato	1B	Occasionally used & effective - Looper & Heliothis.

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust
	Used off-label

From the reports received, the current off-label insecticides used for Lepidoptera control in lettuce are working adequately. All of these products are currently registered in other crops for lepidoptera control. Growers are using these insecticides mostly in field grown lettuce crops. No comments were received regarding this pest from greenhouse lettuce growers.

Again, many of the insecticides used off-label in lettuce for Lepidoptera are very old organophosphates (1B) and synthetic pyrethroids (3A). These are quite disruptive of IPM programs even though they are effective. There is also a significant resistance risk with the continued use of SP. Many Lepidoptera species in Aust are resistant to SP from overuse.

Insecticides that are not registered in lettuce but control Lepidoptera (caterpillars) in other situations, and could possibly be alternatives include:

Active ingredient	Common Trade Name	Resistance group	Comments
Beauvaria bassiana	Botanigard	Biological	
CHLORANTRANOPRILE	Dupont - new product		E2Y45 - Efficacy trials underway: IPM compatible.
EMAMECTIN	Proclaim	6A	Registered in fruit. AU label - registered for Heliothis in lettuce.
ENDOSULFAN	Thiodan	2A	Reg. for various caterpillars in tomato, vegetable brassica and potato
ESFENVALERATE	Sumi-Alpha	3A	Reg, in tomato, cucurbits group, vegetable brassicas, potato and onion. Corn Earworm listed in sweet corn
FIPRONIL	Ascend	2C	DBM and WB in Veg. Brassicas. Efficacy trials underway: IPM compatible questionable.
PERMETHRIN + PIRIMIPHOS-METHYL	Attack	3A+1B	Reg, in GH tomato, cucurbits group and vegetable brassicas
SPINOSAD	Entrust Naturalyte	5A	Reg, in field tomato and vegetable brassica. AU label - registered for Heliothis & Looper in lettuce.
TAU-FLUVALINATE	Mavrik	3A	Reg. in cabbage and field tomato
THIOPHANATE-METHYL + CHLOROTHALONIL + TAUFLUVALINATE	Guardall	3A	Reg, in tomato and cabbage
TRICHLORFON	Trifon	1B	Reg, in tomato and vegetable brassica. Corn Earworm listed in sweet corn
TRICHLORFON + CYPERMETHRIN	Partna	1B+3A	Reg. in cauliflower, cabbage and tomato. Corn Earworm listed in sweet corn

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust

- DuPont is developing a new agrichemical E2Y45 (chlorantranopriole) for caterpillar control in a variety of crops. IPM compatible. This should be pursued for lettuce when it is registered in New Zealand.
- Fipronil (Ascend) efficacy trials are underway. Fipronil does impact on IPM systems.

Of these products the only selected ones that are registered or have maximum residue limits (MRL) set in overseas countries that could support a registration in New Zealand are:

- Talstar (bifenthrin)
 - MRL in: Aust, EU, Germany, Japan, Korea, Switzerland, Taiwan, USA (lettuce, vegetables)
- Proclaim (emamectin)
 - MRL in: Aust, Israel, Japan, Taiwan, USA (lettuce)
- Ascend (fipronil)
 - MRL in: EU, Japan, Netherlands, Taiwan (lettuce, vegetables)
- Entrust (spinosad)
 - MRL in: Aust, Codex, EU, Israel, Japan, Taiwan, USA (lettuce, leafy vegetables)

Please check with the New Zealand Food Safety Authority for the most current MRL in export markets.

INSECTICIDES ALTERNATIVES IN LETTUCE FOR LEPIDOPTERA (CATERPILLAR)

In reviewing the possible alternatives:

- Talstar (bifenthrin) – is a synthetic pyrethroid with a wide spectrum of activity. Crop safety data needs to be generated in the major lettuce growing areas (field and greenhouse). Residue data may also be necessary. Although the SP can be highly prone to developing resistance, one of the SP needs to be developed. Bifenthrin is one of the better SP. **The product should be pursued.** A use pattern should be developed to comply with the residue conditions for overseas countries.
- Proclaim (emamectin) - a contact/systemic insecticide with good efficacy and minimal impact on IPM beneficial insects. Efficacy and crop safety data needs to be generated in the major lettuce growing areas (field and greenhouse). Residue data may also be necessary. Although there are limited overseas MRL, a use pattern should be developed to comply with the residue conditions for overseas countries. **The product should be pursued.**
- Ascend (fipronil) - a contact/systemic insecticide with good efficacy, but can be disruptive to IPM beneficial insects. Crop safety data needs to be generated in the major lettuce growing areas (field and greenhouse). Residue data may also be necessary. Although there are limited overseas MRL, a use pattern should be developed to comply with the residue conditions for overseas countries. **The product should be pursued.**
- Entrust (spinosad) - a contact/systemic insecticide with good efficacy and minimal impact on IPM beneficial insects. It is very effective and has some overseas MRL. There is some resistance risk in some insects due to overuse. Crop safety needs to be determined in greenhouse lettuce. As it is very effective in controlling a range of pests both in NZ and Aust **it should be pursued.**

- Steward (indoxacarb) - a contact/systemic insecticide with good efficacy and minimal impact on IPM beneficial insects. This product is already registered in head lettuce. **The product should be pursued in leafy lettuce.**

The selection of Proclaim (emamectin), Ascend (fipronil), Entrust (spinosad) and Steward (indoxacarb) will add greatly to the suite of insecticides available to lettuce growers (field and greenhouse) for the control of Lepidoptera (caterpillar) pests. This will also relieve some of the resistance pressure on current commonly used products.

Slugs & snails (Gastropoda spp.)

Slugs & snails (*Gastropoda spp.*) control in lettuce is considered a major problem in field grown lettuce only.

Molluscicide registered for slugs and snails control in lettuce or vegetables are:

Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
IRON PHOSPHATE	Neudorff Slug and Snail Bait	Registered in crops. Don't apply to edible plant parts.	No listing	Na	
IRON SODIUM EDTA	Multiguard	Registered in crops. Don't apply to edible plant parts.	No listing	Na	
Metaldehyde	Slugout	Registered in crops. Don't apply to edible plant parts.	Molluscicide	Na	Commonly used and effective
METHIOCARB	Mesuroil	Registered in crops. NO WHP. If product comes into contact with edible plant portions then a WHP of 21 days apply.	1A	Na or 21	Commonly used and effective
THIODICARB	Larbait	Registered in vegetables.	1A	21	

* Resistance groups combine agrichemicals with the same mode of action.

	Registered
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These products have been recorded as being used and:

- Very effective in controlling snails and slugs within the crop during development
- With the baits, care is taken not to contact the plants themselves.

INSECTICIDE ALTERNATIVES IN LETTUCE FOR GASTROPODA

- **No new molluscicide could be found for the control of snails and slugs in lettuce or other crops.**

Other insects

See **Table 4:** Insecticides registered and used for the control of the MINOR recorded insect pests in lettuce.

- Thrips (various spp.)
- Weevils (various spp.)
- Springtails (*Collebola spp.*)
- Wireworm (*Heteroderus spp.*)
- Mites (various spp.)

New insecticides that can be pursued

Product (active)	Target insect	Action
Talstar (bifenthrin)	Aphids Lepidoptera	New use
Confidor (imidacloprid)	Aphids (foliar)	New use
Proclaim (emamectin)	Lepidoptera	New use
Ascend (fipronil)	Lepidoptera	New uses
Entrust (spinosad)	Lepidoptera	New uses
Steward (indoxacarb)	Lepidoptera	Adding to existing registrations

Herbicide use in lettuce

See **Table 5:** Herbicides registered and used for the control of weeds in lettuce.

Weed control in lettuce is a major activity that leads to a successful crop. Weed control is required prior to sowing (general knockdown), pre-plant (selective weed control) and post-emergent (selective weed control). Weed control is only relevant to field grown lettuce crops.

Herbicides registered for use in lettuce are:

Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
CHLORPROPHAM	Alliacine		E	Na	Pre-emergent or pre-plant annual broadleaf and grass control.
CLETHODIM	Centurion		A	35	Occasionally used and effective. Reg. early post-emergent grass control.
FLUAZIFOP-P-BUTYL	Fusilade WG		A	35	Occasionally used and effective. AU label - registered in lettuce
PENDIMETHALIN	Stomp	Transplanted	D	Na	Occasionally used and effective. Pre-transplant broadleaf and grass control.
PROPYZAMIDE	Kerb		K	Na	Occasionally used and effective. Pre-emergent or post-emergent annual broadleaf and grass control.
QUIZALOFOP-P-ETHYL	Leopard		A	Na	Occasionally used and effective. Reg. - early post-emergent grass control.
SETHOXYDIM	Poast		A	35	Vegetables - early post-emergent grass control.
DIQUAT	Reglone		L	Na	Used pre-plant
GLYPHOSATE	Roundup		M	Na	Used pre-plant
GLYPHOSATE-TRIMESIUM	Touchdown		M	Na	
OXYFLUORFEN	Burnout		G	Na	Used pre-plant with Roundup.
PARAQUAT	Paraquat		L	Na	Used pre-plant
PINE OIL	Organic Interceptor			Na	

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in Aust
	Registered

All the products indicated are listed as being commonly or occasionally used as either pre-plant weed control (general knockdown herbicides), pre-emergent herbicides or early post-emergent herbicides.

From the reports received, the current herbicides used for weed control in lettuce are working adequately.

To maintain a high level of weed control, growers must alternate the herbicides used between the different resistance groups, not between products from the same resistance group.

Herbicides used off-label in lettuce for the control of various weeds are:

Active ingredient	Common Trade Name	Resistance group	Comments
CHLORTHAL DIMETHYL	Dacthal	D	Occasionally used and effective. AU permit - registered in lettuce (annual broadleaf and grass control).
HALOXYFOP	Gallant	A	Occasionally used and effective (post-em grass control).
PROPACHLOR	Ramrod	K	Occasionally used and effective. AU permit - registered in lettuce (annual broadleaf and grass control).

* Resistance groups combine agrichemicals with the same mode of action.

	Used off-label
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Feedback indicates the current off-label herbicides used for weed control in lettuce are working adequately with no reports of any crop damage (phytotoxicity). Dacthal and Ramrod are currently permitted for use in lettuce in Aust.

Gallant (haloxyfop) is used occasionally and is effective as a post-emergence grass herbicide. However it is not registered in lettuce. Other registered products such as Fusilade, Centurion, Leopard and Poast control a similar range of grass weeds.

Weeds that were identified as being difficult to control by growers were:

- Groundsel *Senecio vulgaris*
- Potatoes (volunteer) *Solanum tuberosum*
- Mayweed (Chamomile) . *Anthemis cotula*
- Wild turnip *Rapistrum rugosum*
- Shepherd’s purse *Capsella bursa-pastoris*
- Cleavers *Galium aparine*
- Fumitory *Fumaria spp.*

In each of these cases, the weeds can be managed with existing registered herbicides. Otherwise the only control available is pre-plant weed control with glyphosate, oxyfluorfen or paraquat. These are existing registered uses.

Herbicides that have activity on these weeds and can be used in lettuce are:

Groundsel	Glyphosate + oxyfluorfen or paraquat/diquat – apply as a pre-plant total weed control.
Potatoes (volunteer)	Glyphosate + Oxyfluorfen or paraquat/diquat – apply as a pre-plant total weed control.
Mayweed (Chamomile)	Glyphosate + oxyfluorfen or paraquat/diquat – apply as a pre-plant total weed control.
Wild turnip	Glyphosate + oxyfluorfen or paraquat/diquat or Pine oil – apply as a pre-plant total weed control. Pendimethalin – apply as pre-emergent at 2-3 L/ha (AU label - brassicas).
Shepherd’s purse	Glyphosate trimesium + oxyfluorfen or paraquat/diquat or Pine oil – apply as a pre-plant total weed control. Pendimethalin – apply as pre-emergent at 2-3 L/ha (AU label - brassicas).
Cleavers	Glyphosate + oxyfluorfen or paraquat/diquat – apply as a pre-plant total weed control.
Fumitory	Glyphosate + oxyfluorfen or paraquat/diquat or Pine oil – apply as a pre-plant total weed control. Pendimethalin – apply as pre-emergent at 2-3 L/ha (AU label - brassicas).

Unfortunately, most of the identified problem weeds can only be controlled with general broad-spectrum herbicides prior to planting. Pendamethalin is the only selective herbicide available for some of the problem weeds.

Although there are many herbicides available for the control of these problem weeds, most are unsuitable to be used as pre- or post-emergent herbicides in lettuce due to the potential crop damage.

New opportunities for new or alternative agrichemicals in lettuce

International collaboration with USA IR-4 program

The following table lists the USA IR-4 projects for new or existing agrichemicals in lettuce. These projects are in various stages of development with some already registered, including agrichemicals that the NZ lettuce industry has identified as required alternatives to current products or targeting specific plant pests.

Agrichemical	Pest / Status	Relevance to NZ
FUNGICIDES		
BOSCALID (Filan)	Lettuce (head & leafy) - SCLEROTINIA, RHIZOCTONIA, BOTRYTIS – use registered	Disease control identified as a high priority
BOSCALID + PYRACLOSTROBIN (new product)	Lettuce (head & leafy) – various diseases – use registered	Disease control identified as a high priority
CYAZOFAMID (New product)	Lettuce (head & leafy) - DOWNY MILDEW – in progress	Disease control identified as a high priority
CYPRODINIL + FLUDIOXONIL (Switch)	Lettuce (head & leafy) – ALTERNARIA, SEPTORIA, BOTRYTIS, SCLEROTINIA – use registered	Disease control identified as a high priority
FAMOXADONE + CYMOXANIL (New product)	Lettuce (head & leafy) - DOWNY MILDEW – in progress	Disease control identified as a high priority
FLUAZINAM (Shirlan)	Lettuce (head & leafy) –SCLEROTINIA – use registered	Disease control identified as a high priority
NOA 446510 (New product)	Lettuce (head & leafy) – Downy mildew – manufacturer to register	Disease control identified as a high priority
PHOSPHOROUS ACID (Foschek)	Lettuce (leafy) - DOWNY MILDEW – use registered	Disease control identified as a high priority
POLYOXIN D (New product)	Lettuce (head & leafy) - LETTUCE DROP (SCLEROTINIA MINOR & S. SCLEROTIUM), POWDERY MILDEW - in progress	Disease control identified as a high priority
PYRACLOSTROBIN (new product)	Lettuce (head & leafy) – ALTERNARIA, CERCOSPORA, ANTHRACNOSE, SEPTORIA, DOWNY MILDEW – use registered	Disease control identified as a high priority
HERBICIDES		
PRONAMIDE (New product)	Lettuce (leafy) – WEEDS – under review	Pre & post emergent
S-METOLACHLOR (Dual Gold)	Lettuce (leafy) – NUTSEDGE, ANNUAL GRASSES, BROADLEAF WEEDS – in progress	Pre & post transplant

Many other projects have been identified and are being conducted by IR-4 in lettuce crops. These are not listed, as they do not contain high priority plant pest.

There may be an opportunity to collaborate with IR-4 to assess their data for use in New Zealand. This will require a collaborative and financial commitment from HortNZ.

References

ACVM 2007 Website

<http://www.nzfsa.govt.nz/acvm/about/overview.htm>

AgraQuest

<http://www.agraquest.com/products/serenade/index.html>

Agrimedia 2007 'New Zealand Agrichemical Manual.

Agrimm 2007

<http://www.tricho.com/sentinel.html>

Australian Horticultural Statistics Handbook, 2003.

Australian Pesticide and Veterinary Medicines Authority website. Website:

www.apvma.gov.au

Biobest 2007

<http://207.5.17.151/biobest/en/nieuws/scanivital.htm>

Bioworks 2007

<http://www.bioworksinc.com/index.html>

Crop Life 2007

[CropLife New Zealand](http://www.crop-life.co.nz)

Diseases of Vegetable Crops. Department of Primary Industries Queensland

Infopest, Department of Primary Industries and Fisheries, Queensland Government, November 2007.

The IR-4 Project. Website: <http://ir4.rutgers.edu/index.html>

Acronyms

ACVM	Agricultural Compounds and Veterinary Medicines
AgAware	AgAware Consulting Pty Ltd
APVMA	Australian Agrichemicals and Veterinary Medicines Authority
dMRL	default Maximum residue limit (mg/kg or ppm)
HortNZ	Horticulture New Zealand
IPM	Integrated pest management
IR-4	Interregional Program 4 (USA)
MRL	Maximum residue limit (mg/kg or ppm)
Plant pests	Diseases, insects, nematodes, viruses, weeds, etc
Agrichemicals ...	Plant protection products (fungicide, insecticide, herbicide, nematicides, etc).
SARP	Strategic Agrichemical Review Process
WHP	Withholding period

Acknowledgement

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Appendices

DIAGRAM 1: The Strategic Agrichemical Review Process

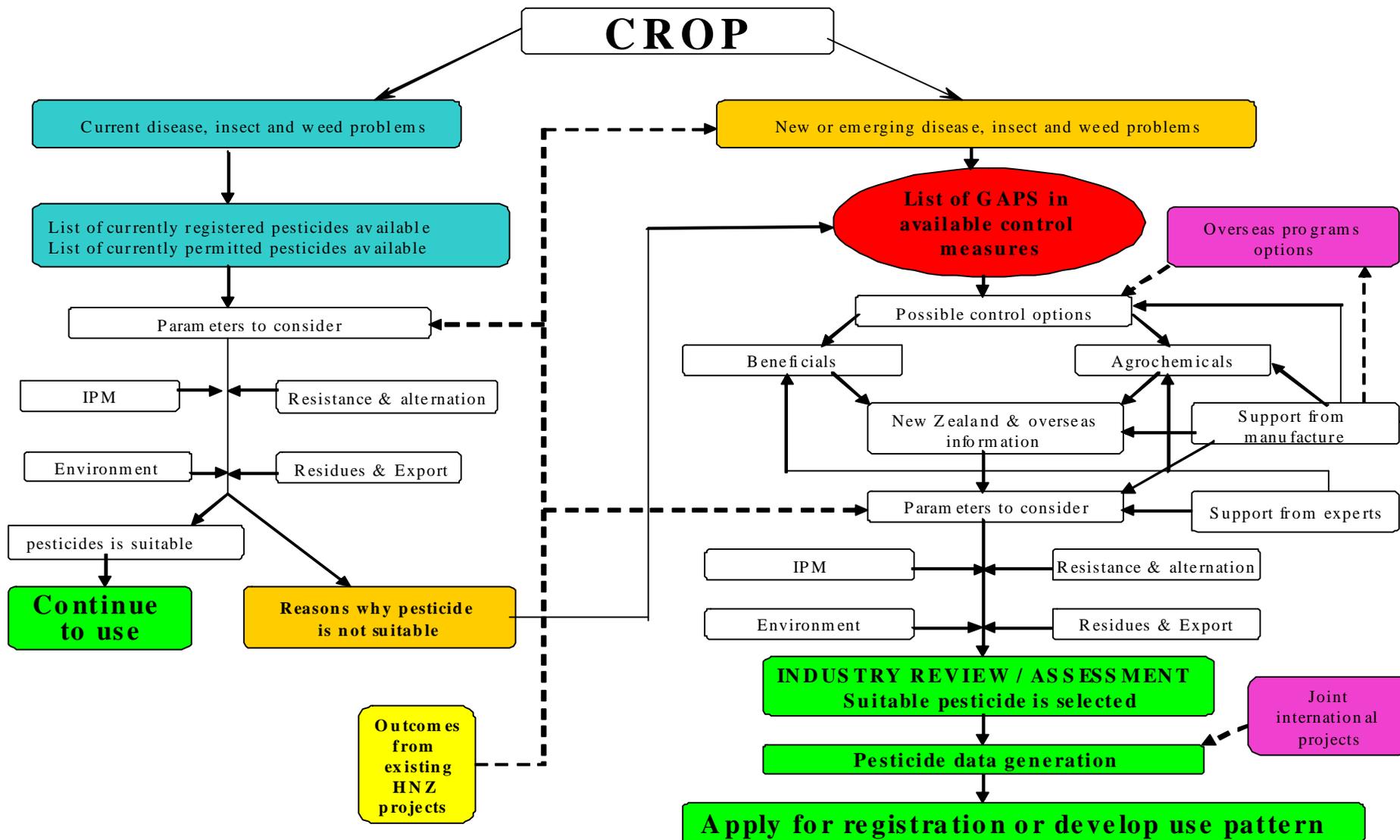


Table 1: Fungicides registered and used for the control of the MAJOR recorded diseases in lettuce.

Crop	Disease name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
Lettuce (head & leafy)	Downy mildew <u>Bremia lactucae</u>	High - No. 1 major disease	AZOXYSTROBIN	Amistar WP	No registrations for lettuce. Registered for downy mildew control in onions and peas.	K		Occasionally used and effective.
			BORDEAUX MIXTURE	Cuprofix	No registration for Downy Mildew control in lettuce. Listed for Downy Mildew control in grapes.	Y		Commonly used & effective.
			CAPTAN	Captan	No registration for Downy Mildew on lettuce. Downy Mildew control is listed for grapes.	Y		
			CARBENDAZIM	Carbendazin	Registered in lettuce for Sclerotinia. No listing for DM in any crop.	Y		Occasionally used and effective.
			CHLOROTHALONIL	Bravo 720 SC	Registered in lettuce for Ringspot only. Controls Downy Mildew in cucurbits, grapes, and vegetable brassicas.	Y		Occasionally used and effective.
			COPPER HYDROXIDE	Kocide 2000 DF	Registered for 'lettuce'.	Y	0	Occasionally used and effective. AU label - registered for DM in lettuce.
			COPPER OXIDE	Nordox 75WG	Not reg. in lettuce however reg. for DM in peas, grapes and cucumber	Y		AU label - registered for DM in lettuce.
			COPPER OXYCHLORIDE	Agpro 800 WP	Registered for 'lettuce'. Some variety sensitivity	Y	0	Commonly used & effective.
			DIMETHOMORPH	Acrobat MZ 690	Registered for 'lettuce'.	X	14	Commonly used & effective.
			MANCOZEB	Manzate 200 DF	Registered for 'lettuce'.	Y	14	Commonly used & effective.
			METALAXYL-M	Apron	Apron is a seed dressing. No registration in lettuce. Registered for Downy Mildew control as a seed treatment in peas	D		
			METALAXYL-M + MANCOZEB	Ridomil Gold MZ WG	No registration for Lettuce. Downy Mildew control for brassica seedbeds, cucurbits, grapes, onions.	D		Occasionally used and effective. AU label - registered for DM in lettuce.
			METIRAM	Polyram DF	No reg. in lettuce however controls DM in grapes.	Y		AU label - registered for DM in lettuce.
			PHOSPHOROUS ACID	Foschek	No registration for lettuce. No registrations in any other crop for Downy Mildew control	Y		Occasionally used and effective. AU permit - registered for DM in lettuce.
PROPINEB	Antracol	Reg. for DM control in onions.	Y		AU label - registered for DM in lettuce.			

Table 1(cont): Fungicides registered and used for the control of the MAJOR recorded diseases in lettuce.

Crop	Disease name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
Lettuce (head & leafy)	Rhizoctonia Root Rot <i>Rhizoctonia solani</i>	High - for field crops	AZOXYSTROBIN	Amistar WP	No registration for lettuce and no mention of Rhizoctonia on any other crop	K		Commonly used & effective. AU permit - registered for Rhizoctonia in peanuts.
			IPRODIONE	Rovral WP	Not registered in lettuce. Label lists Rhizoctonia control as seed treatment in brassicas.	B		AU label - registered for Rhizoctonia in various crops as a seed treatment.
			QUINTOZENE	Terrachlor	Listed for use on 'Vegetable Seedlings'	Y	Na	Used in nurseries - need to have healthier seedlings produced. Applied as a pre-sowing soil treatment. Listed to control Rhizoctonia and Fusarium.
			MANCOZEB	Manzate	Registered in lettuce for Ringspot.	Y		AU label - registered for Rhizoctonia in lettuce.
			Trichoderma harzianum	Trichopel	Registered for addition to nursery propagation media for many diseases.	Bio-fungicide		
	Ringspot <i>Mycosphaerella brassicicola</i>	High - major depending on season - field grown only	AZOXYSTROBIN	Amistar WP	No registered for lettuce and no mention of Ringspot disease on NZ label	K		Commonly used & effective.
			CHLOROTHALONIL	Bravo 720 SC	Registered for 'lettuce'. Some chlorothalonil products list Ringspot	Y	10	Commonly used & effective. AU label - registered for Ringspot in brassicas.
			COPPER OXYCHLORIDE	Agpro 800 WP	Registered for 'lettuce'.	Y	0	Commonly used & effective.
			DIFENOCONAZOLE	Score	Not registered for lettuce. Lists Ringspot control in brassicas	C		Commonly used & effective.
			MANCOZEB	Manzate 200 DF	Registered for 'lettuce'.	Y	14	Commonly used & effective.
Sclerotinia Rot <i>Sclerotinia minor</i> & <i>S. sclerotiorum</i>	High - major issue in field grown - weather dependent	AZOXYSTROBIN	Amistar WG	Not registered for lettuce.	K		AU label - registered for Sclerotinia in tomatoes.	
		BOSCALID	Filan	Product to be registered in NZ.	G		AU permit - registered for Sclerotinia in various vegetables.	
		CARBENDAZIM	Carbendazim	Registered for 'lettuce'.	A	21	Commonly used & effective.	
		CYPRODINIL + FLUDIOXONIL	Switch	No vegetable registrations in NZ.	I+L		AU permit - registered for Sclerotinia in various peas.	
		FLUAZINAM	Shirlan	No registration for lettuce. Registrations for Sclerotinia control in tomato and potato	Y		Occasionally used & effective.	

Table 1(cont): Fungicides registered and used for the control of the MAJOR recorded diseases in lettuce.

Crop	Disease name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
Lettuce (head & leafy)	Sclerotinia Rot (cont)		IPRODIONE	Rovral WP	Not registered in lettuce. Label lists Sclerotinia control in ornamentals & kiwi fruit.	B		AU label - registered for Sclerotinia in lettuce.
			PROCYMIDONE	Sumisclex	Not registration in lettuce. Controls Sclerotinia in many vegetables.	B		Commonly used & effective. AU permit - registered for Sclerotinia in various vegetables.
			TEBUCONAZOLE	Folicur	Not registered for lettuce.	C		AU permit - registered for Sclerotinia in lettuce.
			THIOPHANATE-METHYL	Topsin M-4 A	Not registered for lettuce. Reg. for Sclerotinia in beans, field tomatoes.	A		Occasionally used
			Trichoderma harzianum	Trichopel	Registered for addition to nursery propagation media for many diseases.	Bio-fungicide		

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust
	Registered
	Used off-label

Table 2: Fungicides registered and used for the control of the MINOR recorded diseases in lettuce.

Crop	Disease name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
Lettuce (head & leafy)	Botrytis <i>Botrytis cinerea</i>	Moderate - field problem depending on transplants	AZACONAZOLE + IMAZALIL	Scomid Limb Aerosol	No registrations for lettuce however registered for botrytis on tomato as a wound dressing (WHP 3 days)	C+C		
			Bacillus subtilis	Serenade	Starting to be used. Controls botrytis in vegetables	Bio-fungicide		
			CARBENDAZIM	Bayer Carbendazim	Registered in lettuce for Sclerotinia. Registered for botrytis on tomato.	A		
			CHLOROTHALONIL	Bravo	Registered in lettuce for Ringspot only. Registered for Botrytis in various crops.	Y		Commonly used & effective.
			CYPRODINIL + FLUDIOXONIL	Switch	No registration in lettuce however controls botrytis in grapes	I		
			FENHEXAMIDE	Teldor	No registration in lettuce or other vegetables. Controls botrytis in grapes, boysenberries and strawberries	J		
			FLUAZINAM	Shirlan	No registrations lettuce however registered for botrytis on field tomato	Y		
			IPRODIONE	Rovral WP	No registrations in lettuce however registered for botrytis on glasshouse tomato WHP 3 days	B		Occasionally used and effective.
			PROCYMIDONE	Sumisclex	No registration in lettuce. Registered for botrytis control in field cucurbits, field tomatoes, grapes and strawberries.	B		
			PYRIMETHANIL	Scala	No registration in lettuce or any vegetables however controls botrytis in grapes.	I		
			Scaniavital silica	Scaniavital silica		Bio-fungicide		
			THIOPHANATE-METHYL	Topsin M-4A	Not registered in lettuce. Controls botrytis in glasshouse tomatoes.	A		Commonly used & effective.
			THIRAM	Thiram	Not registered in lettuce. Controls botrytis in tomatoes.	Y		Commonly used & effective.
			TOLYFLUANID	Euparen Multi	No registration in lettuce or any vegetables. Controls botrytis in grapes. AU label lists 'grey mould' control in strawberries.	X		
Trichoderma atroviride	Sentinel	No registration for lettuce however registered for 'stem end rot' control in tomato and botrytis control in grapes in NZ	Bio-fungicide					

Table 2 (cont): Fungicides registered and used for the control of the MINOR recorded diseases in lettuce.

Crop	Disease name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
Lettuce (head & leafy)	Damping off	Moderate - generally a nursery problem	ETRIDIAZOLE	Terrazole	Registered in vegetable seedlings.	X	Na	
			IPRODIONE	Rovral WP	No registrations in lettuce.	B		Occasionally used and effective on seedlings.
	Early Blight <i>Alternaria solani</i>	Moderate - in baby leaf lettuce only	AZOXYSTROBIN	Amistar WG	No registration in lettuce. Rego for early blight in potatoes & tomatoes.	K		
			BENALAXYL + MANCOZEB	Galben M8-65	No registration in lettuce. Registered in potato for early blight control.	D		
			CHLOROTHALONIL	Bravo	Not registered in lettuce. Reg. for Alternaria control in strawberries & tomatoes.	Y		
			COPPER HYDROXIDE	Various	Not registered in lettuce for early blight however reg. for Downy Mildew and Ringspot control. Registered in potatoes for Early blight.	Y		
			COPPER HYDROXIDE + MANCOZEB	Mancocide DF	Not reg. in lettuce however reg. for early blight in potatoes.	Y		
			COPPER OXIDE	Nordox 75WG	Not reg. in lettuce however reg. for early blight in potatoes.	Y		
			COPPER OXYCHLORIDE	Various	Not registered in lettuce for early blight however reg. for Downy Mildew and Ringspot control. Registered in potatoes & tomatoes for Early blight.	Y		Commonly used & effective
			DIFENOCONAZOLE	Score	Not registered in lettuce however control early blight in potatoes and Alternaria in carrots.	C		
			DIMETHOMORPH	Acrobat MZ 690	Not listed for early blight control in lettuce however reg. for early blight control in potatoes.	X		
			FENAMIDONE +MANCOZEB	Sereno	No registration for lettuce however registered for early blight control in potatoes.	X?+Y		
			FLUAZINAM	Shirlan	Not registered in lettuce. Reg. for early blight control in potatoes.	Y		
			MANCOZEB	Manzate 200 DF	Not registered for early blight in lettuce however reg. for Downy Mildew, Leafspot and Ringspot in lettuce. Reg. for early blight in potatoes and tomatoes.	Y		Commonly used & effective
			METALAXYL-M	Ridomil Gold MZ WG	Not registered for early blight control in lettuce however reg. for early blight control in potatoes and tomatoes.	D		

Table 2 (cont): Fungicides registered and used for the control of the MINOR recorded diseases in lettuce.

Crop	Disease name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
Lettuce (head & leafy)	Early Blight (cont)		PROCYMIDONE	Sumisclex 500SC	Not registered for early blight in lettuce however reg. for early blight in potatoes.	B		
			PROPINEB	Antracol	Not registered for early blight in lettuce however reg. for early blight in potatoes.	Y		
	Fusarium Dry Rot <i>Fusarium spp.</i>	Moderate - generally a nursery problem	DICHLOROPROPENE	Telone C-35	Label lists 'Vegetables'	X		Occasionally used. Good initial control however re-colonisation occurs rapidly.
			METAM SODIUM	Fumasol	Label lists 'Vegetables'			Occasionally used. Good initial control however re-colonisation occurs rapidly.
			QUINTOZENE	Terrachlor 75 WP	Pre-sowing soil treatment for all 'vegetables'.	Y		Occasionally used. Good initial control however re-colonisation occurs rapidly.
			Trichoderma harzianum	Trichopel	Registered for addition to nursery propagation media for many diseases.	Bio-fungicide		
	Pythium Root Rot <i>Pythium spp.</i>	Moderate - generally a nursery problem or poor water quality	ETRIDIAZOLE	Terrazole	Can be applied as a 'dry soil mix in seed box and potting mixes' for Pythium control. No mention of greenhouse use.	X		Seedlings often treated with Rovral
			METALAXYL-M	Apron	Not registered in lettuce. Apron label lists Pythium control as a seed treatment for brassica, lucerne and peas.	D		
			METAM SODIUM	Fumasol	Pre-sowing soil treatment for all 'vegetables'.			
			PHOSPHOROUS ACID	Foscheck	Registered for 'nursery crops' for Pythium control.	Y		
			PROPAMORCARB	Previcur	No registrations in any vegetable in NZ. Listed for 'ornamentals' only.	Y		
			THIRAM	Thiram	No registration in lettuce. Registered in ornamentals for 'damping off', seed and root rots'.	Y		
	Trichoderma harzianum	Trichopel	Registered for addition to nursery propagation media for many diseases.	Bio-fungicide				

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust
	Registered
	Used off-label

Table 3: Insecticides registered and used for the control of the MAJOR recorded insect pests in lettuce.

Crop	Insect name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
LETTUCE (head & leafy)	APHIDS	High - Green Peach aphid & Lettuce aphid are major pests. Resistance management is a major issue.	ACEPHATE	Orthene		1B	3	
			ALPHA-CYPERMETHRIN	Dominex Fastac	No registration in lettuce. 'Aphids' listed for tomatoes	3A		Occasionally used & effective. Resistance management issues very important.
	Green Peach Aphid (GPA) <i>Myzus persicae</i>		APHID PARASITE'	<i>Aphidius colemani</i>		Bio-insecticides	0	
	Lettuce Aphid <i>Nasonovia ribis-nigri</i>		APHIDOLETED	<i>Aphidoletes aphidimyza</i>		Bio-insecticides	0	
	Black Peach Aphid <i>Brachycaudus persicae</i>		AZADIRACHTIN	NeemAzal-T/S	Not registered on any vegetable and only on non-fruit bearing trees and vines however mentions aphid control	Botanical insecticide		
	Cabbage Aphid <i>Brevicoryne brassicae</i>		Beauvaria bassiana	Botanigard ES, Naturalis-O		Bio-insecticides		
	Carrot black aphid <i>Cavariella aegopodii</i>		BIFENTHRIN	Talstar 100EC	No registration in lettuce. Reg. on field tomatoes, pumpkins, squash for 'aphids'	3A		Occasionally used & effective. Resistance management issues very important.
	Carrot willow aphid <i>Cavariella aegopodii</i>		CANOLA OIL	Eco-oil	GPA	Vegetable Oil	16	
	Fox Glove <i>Aulacorthum solani</i>		CARBARYL	Sevin	No listing of aphids on any crop	1A		
	Melon aphid <i>Aphis gossypii</i>		CHLORPYRIFOS	Lorsban 50EC	No registration in lettuce. Reg for 'aphids' in winter squash and vegetable brassicas	1B		
	Potato aphid <i>Macrosiphum euphorbiae</i>		DELTAMETHRIN	Decis Forte	No registration in lettuce. Reg. for 'aphids' in squash	3A		Occasionally used & effective. Resistance management issues very important.
			DIAZINON	Diazinon	Aphids	1B	14	
			DICHLORVOS	Divap	Aphids Vegetables	1B	3	Occasionally used & effective.
			DIMETHOATE	Perfekthion S	No registration in lettuce. Reg. for CA in potato, carrots and brassicas.	1B		AU label - registered for aphids in lettuce.
	ENDOSULFAN	Thiodan	No registration in lettuce. Reg. on tomato, vegetable brassica and potato	2A				

Table 3 (cont): Insecticides registered and used for the control of the MAJOR recorded insect pests in lettuce.

Crop	Insect name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY	
LETTUCE (head & leafy)	APHIDS (cont)		FATTY ACIDS (K SALTS)	Nature's Way		Unlisted	1		
			IMIDACLOPRID	Gaucho	No registration in lettuce. Reg. on potato and squash for 'aphids'	4A			
			IMIDACLOPRID	Confidor	Confidor 5G registered for aphid control in vegetable seedlings. Not registered for foliar use for aphids.	4A	49	Commonly used & effective as a seedling drench - Confidor 5G. Commonly used and effective as foliar treatment or seedling drench - Confidor for Lettuce aphid. Green peach aphid listed on AU label.	
			Lecanicillium lecanii blastospores						
			MALATHION	Malathion 50EC	Aphids	1B	3	AU label - registered for aphids in lettuce.	
			METHAMIDOPHOS	Monitor Tamaron	No registration in lettuce. Reg. for 'aphids' in potato	1B		Occasionally used and effective - not IPM compatible.	
			METHOMYL	Lannate L	GPA	1A	7	Occasionally used and effective - not IPM compatible.	
			PERMETHRIN + PIRIMIPHOS-METHYL	Attack	No registration in lettuce. Reg. for 'aphids' in GH tomato, cucurbits group and vegetable brassica	3A+1B			
			PERMETHRINS + PIPERONYL BUTOXIDE	Greenseals Pyrethrum	Aphids	3A	Na		
			PHORATE	Phorate	No registration in lettuce. Reg for 'aphids' in cucurbits group, squash, vegetable brassicas, potato and carrot	1B			
			PIRIMICARB	Pirimor 50	Aphids	1A	3	Commonly used and effective.	
			PIRIMIPHOS-METHYL	Only available alone for stored insects	No registration in lettuce. Only available alone for stored insects	1B			
			PYMETROZINE	Chess WG	Lettuce Aphid	9A	7	Commonly used and effective. Chess is the only product compatible with Aphidius.	
			PYRETHRINS	Garlic & Pyrethrum Concentrate	Aphids	3A	1		

Table 3 (cont): Insecticides registered and used for the control of the MAJOR recorded insect pests in lettuce.

Crop	Insect name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
LETTUCE (head & leafy)	APHIDS (cont)		ROTENONE	Derris Dust		21A	1	
			TAU-FLUVALINATE	Mavrik	No registration in lettuce. Reg. on field tomato for GPA	3A		
			TERBUFOS	Counter 20G	No registration in lettuce. Aphids listed for forage brassicas as a seed/fertiliser treatment.	1B		
			THIACLOPRID	Calypso	No registration in lettuce.	4A		Requested by growers, but same resistance group as Confidor and no vegetable or aphid registrations.
			THIOPHANATE-METHYL + CHLOROTHALONIL + TAUFUVALINATE	Guardall	No registration in lettuce. Reg. for 'aphids' on tomato	3A		
CATERPILLARS	Major - Soybean	Looper (not green looper) & Corn Earworm are	ACEPHATE	Orthene	Caterpillars	1B	3	Occasionally used & effective - Looper & Heliothis.
			ALPHA-CYPERMETHRIN	Dominex/Fastac	Reg. in tomato and vegetable brassica	3A		Occasionally used & effective - Looper. Corn Earworm listed in sweet corn. AU label - registered for Heliothis in lettuce.
	Soybean looper (SL) <i>Thysanoplusia orichalcea</i>	major problems. Occasionally Spodoptera a problem.	<i>Bacillus thuringiensis sub.Xen tari</i>	XenTari	Reg. in vegetable brassicas and GH tomato	11C		Commonly used & effective - Looper & Heliothis.
	Heliothis or Corn earworm <i>Helicoverpa spp.</i>		<i>Bacillus thuringiensis t sub. Kurstaki</i>	Dipel	Caterpillars	11C	0	Commonly used & effective - Looper & Heliothis.
	Army Caterpillar <i>Pseudaletia separata</i>		Beauveria bassiana	Botanigard ES, Naturalis-O		Bio-insecticides		
	Copper caterpillar (Kumara) <i>Lycaena salustius</i>		BIFENTHRIN	Talstar 100EC and Talstar 80 SC	Reg. in vegetable brassicas and field tomato	3A		Occasionally used & effective - Looper & Heliothis.
	Corn Earworm/Tomato Fruitworm (TFW) <i>Helicoverpa armigera</i>		CARBARYL	Sevin	Various caterpillars on 'Vegetable Crops'	1A	1	Corn Earworm listed in sweet corn
	Cutworm <i>Agrostis spp.</i>		CHLORPYRIFOS	Lorsban	Not registered in lettuce. Registered for cutworm in maize.	1B		Occasionally used & effective - Looper & Heliothis. Corn Earworm listed in sweet corn

Table 3 (cont): Insecticides registered and used for the control of the MAJOR recorded insect pests in lettuce.

Crop	Insect name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
LETTUCE (head & leafy)	Diamond Back Moth (DBM) <i>Plutella xylostella</i>		CHLORANTRANOPRILE	Dupont - new product	E2Y45 - Efficacy trials underway: IPM compatible.			
	Greasy cutworm(GC) <i>Agrotis ipsilon</i>		CYPERMETHRIN	Ripcord	Reg, in cauliflower, cabbage and tomato	3A		Occasionally used & effective - Looper & Heliothis. Corn Earworm listed in sweet corn
	Green lopper (GL) <i>Thysanoplusia orichalcea</i>		DELTAMETHRIN	Decis Forte	Reg, in field tomato, potato and vegetable brassicas	3A		Occasionally used & effective - Looper & Heliothis. Corn Earworm listed in sweet corn
	Loopers(L) <i>Lepidoptera spp.</i>		DIAZINON	Diazinon 50 WP	Caterpillars	1B	14	Occasionally used & effective - Looper & Heliothis.
	Potato Tuber Moth (PTM) <i>Phthorimaea operculella</i>		DICHLORVOS	Divap	Caterpillars Vegetables	1B	3	Occasionally used & effective - Looper & Heliothis.
	Tomato stem borer <i>Symmetrischema plaesiosoma</i>		EMAMECTIN	Proclaim	Registered in fruit	6A		AU label - registered for Heliothis in lettuce.
	Tropical Caterpillar <i>Spodoptera litura (F.)</i>		ENDOSULFAN	Thiodan	Reg. for various caterpillars in tomato, vegetable brassica and potato	2A		
	White Butterfly (WB) <i>Pieris rapae</i>		ESFENVALERATE	Sumi-Alpha	Reg, in tomato, cucurbits group, vegetable brassicas, potato and onion	3A		Corn Earworm listed in sweet corn
			FIPRONIL	Ascend	DBM and WB in Veg. Brassicas. Efficacy trials underway: IPM compatible questionable.	2C		
			IDOXACARB	Steward 150SC	Reg. in 'head' lettuce (outdoors), cauliflower, cabbage and Brussel sprouts.	22A	3	Commonly used & effective - Heliothis.
			LAMBDA-CYHALOTHRIN	Karate	Reg, in field tomato, vegetable brassica and potato	3A		Occasionally used & effective - Looper & Heliothis.
			MALATHION	Malathion 50EC	DBM,TFW, WB	1B	3	Occasionally used & effective - Looper & Heliothis. Corn Earworm listed in sweet corn
		METHAMIDOPHOS	Monitor Tamaron	Reg. for various caterpillars in tomato, vegetable brassica and potato	1B		Occasionally used & effective - Looper & Heliothis. AU label - registered on Lepidoptera in various vegetables.	

Table 3 (cont): Insecticides registered and used for the control of the MAJOR recorded insect pests in lettuce.

Crop	Insect name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
LETTUCE (head & leafy)	CATERPILLARS (cont)		METHOMYL	Lannate L	Looper	1A	7	Commonly used & effective - Looper & Heliothis. Corn Earworm listed in sweet corn
			PARATHION METHYL	Folidol	Registered in vegetables for Lepidoptera.	1B	14	
			PERMETHRIN + PIRIMIPHOS-METHYL	Attack	Reg. in GH tomato, cucurbits group and vegetable brassicas	3A+1B		
			PYRETHRUM	Garlic & Pyre. Conc.	Cabbage Moth and caterpillars	3A	1	
			ROTENONE	Derris Dust	DBM,WB	21A	1	
			SPINOSAD	Entrust Naturalyte	Reg. in field tomato and vegetable brassica	5A		AU label - registered for Heliothis & Looper in lettuce.
			TAU-FLUVALINATE	Mavrik	Reg. in cabbage and field tomato	3A		
			THIOPHANATE-METHYL + CHLOROTHALONIL + TAUFLUVALINATE	Guardall	Reg. in tomato and cabbage	3A		
			TRICHLORFON	Trifon	Reg. in tomato and vegetable brassica	1B		Corn Earworm listed in sweet corn
			TRICHLORFON + CYPERMETHRIN	Partna	Reg. in cauliflower, cabbage and tomato	1B+3A		Corn Earworm listed in sweet corn
Slugs & snails <i>Gastropoda spp.</i>	High - major problem - field crops only		IRON PHOSPHATE	Neudorff Slug and Snail Bait	Registered in crops. Don't apply to edible plant parts.	No listing	Na	
			IRON SODIUM EDTA	Multiguard	Registered in crops. Don't apply to edible plant parts.	No listing	Na	
			Metaldehyde	Slugout	Registered in crops. Don't apply to edible plant parts.	Molluscicide	Na	Commonly used and effective
			METHIOCARB	Mesurol	Registered in crops. NO WHP. If product comes into contact with edible plant portions then a WHP of 21 days apply.	1A	Na or 21	Commonly used and effective
			THIODICARB	Lar bait	Registered in vegetables.	1A	21	

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust
	Registered
	Used off-label

Table 4: Insecticides registered and used for the control of the MINOR recorded insect pests in lettuce.

Crop	Insect name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
LETTUCE (head & leafy)	THRIPS 	Moderate - Onion thrips, WFT in isolated cases. Intonsa Flower thrip a problem	ALPHA-CYPERMETHRIN	Dominex/Fastac	Reg. in tomato and onions	3A		
	<i>Amblyseius cucumeris</i>		Mite-A, Thripex	Reg. on GH tomato, GH capsicum and GH cucumber	Bio-insecticides			
	Intonsa Flower Thrip <i>Frankliniella intonsa</i>		AZADIRACTIN	NeemAzal-T/S	Not registered on any vegetable and only on non-fruit bearing trees and vines however mentions thrips control	Botanical insecticide		
	Onion Thrips <i>Thrips tabaci</i>		CARBARYL	Sevin	No thrips control in any veg. crop however controls thrips in fruit crops	1A		
	Western Flower Thrip <i>Frankliniella occidentalis</i>		CHLORPYRIFOS	Lorsban 750 WG	Reg. in kumara for 'thrips'	1B		
			DELTAMETHRIN	Decis Forte	Reg. in kumara for 'thrips'	3A		
			DIAZINON	Diazinon 800	Reg. for 'thrips' on tomato, vegetable brassicas and onions	1B		
			DIAZINON	Diazinon 50 WP	Thrips	1B	14	
			DICHLORVOS	Divan	Reg. for 'thrips' on GH tomato and GH capsicum	1B		
			ENDOSULFAN	Thiodan	Reg. in kumara for 'thrips'	2A		
			ENDOSULFAN	Thionex EC	Reg. in kumara and tomato for 'thrips'	2A		
			FIPRONIL	Ascend	No mention of thrips on NZ label	2C		Fipronil trials underway
			<i>Hypoaspis aculeifer</i>	Hypomite	Thrips pupae	Bio-insecticides	0	
			IMIDACLOPRID	Confidor	Reg. for thrips on onion	4A		
			IMIDACLOPRID + CYFLUTHRIN	Confidor Supra	Reg. for 'thrips' on onion	4A+3A		
			LAMBDA-CYHALOTHRIN	Karate	Reg. for 'onion thrips' on onions	3A		Commonly used and effective.
			Lecanicillium lecanii blastospores					
			MALATHION	Malathion 50EC	Thrips listed on various fruit crops however no vegetables	1B		
	METHAMIDOPHOS	Monitor Tamaron	Reg. for thrips on onion	1B		Commonly used and effective.		

Table 4 (cont): Insecticides registered and used for the control of the MINOR recorded insect pests in lettuce.

Crop	Insect name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
LETTUCE (head & leafy)	THRIPS (cont)		PYRETHRUM	Garlic & Pyrethrum Concentrate	Thrips	3A	1	
			TAU-FLUVALINATE	Mavrik	Reg. for thrips on onion	3A		
			THIACLOPRID	Calypso	Thrips listed on avocados, peaches and nectarines but not any vegetable	4A		
	WEEVILS 	Moderate - Vegetable weevil an occasional problem	CHLORPYRIFOS	Suscon Green	Only ornamentals and flowering plants	1B		Occasionally used & effective - Vegetable weevil
			DIAZINON	DIAZINON 20g	No weevil listed on label	1B		Occasionally used & effective - Vegetable weevil
			FIPRONIL	Ascend	Weevils not listed on label for any crop	2C		
			FURATHIOCARB	Promax 400 CS	Various weevils are controlled on a range of crops as a seed treatment	No AU Listing		
			<i>Heterorhabditis bacteriophora</i>	Otinem	Ornamentals only'	bio-insecticide		
			IMIDACLOPRID	GaUCHO	Black vine weevil not listed on label however various weevils listed	4A		
			LAMBDA-CYHALOTHRIN	Karate	Fuller rose weevil listed for citrus only	3A		Occasionally used & effective - Vegetable weevil
			METHAMIDOPHOS	Monitor Tamaron	No weevils listed on label	1B		Occasionally used & effective - Vegetable weevil
			PHORATE	Phorate	Weevils list for forage brassica	1B		
			TERBUFOS	Counter 20G	Listed for weevil control in forage brassicas as a seed/fertiliser treatment	1B		
	Springtails <i>Collebola spp.</i>	Low - forage brassicas	CHLORPYRIFOS	Lorsban 750 WG	Springtails listed on forage brassica labels	1B		
			FURATHIOCARB	Promax 400 CS	Springtails listed on forage brassica labels as a seed treatment	No AU Listing		
IMIDACLOPRID			GaUCHO	Listed for squash and forage brassicas	4A			
Black Vine Weevil Larvae <i>Otiorhynchus sulcatus</i>								
Plant Weevils <i>Curculionidae spp.</i>								
Stem weevil <i>Listronotus bonariensis</i>								
Vegetable weevil <i>Listroderes difficilis</i>								
White fringed weevil <i>Naupactus leucoloma</i>								

Table 4 (cont): Insecticides registered and used for the control of the MINOR recorded insect pests in lettuce.

Crop	Insect name (occurrence)	Priority	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
LETTUCE (head & leafy)	WEEVILS (cont)		DIAZINON	Diazinon 800	Reg. for 'springtails' in vegetable brassica	3A		
			TERBUFOS	Counter 20G	Sprintails listed for brassica vegetables as a seed/fertiliser treatment.	1B		
			PHORATE	Phorate	Reg. for 'springtails' in forage brassicas	1B		
	Wireworm <i>Heteroderus spp.</i>	Low - occasional problem	PHORATE	Phorate	Reg. for 'cucurbits' squash and potato	1B		
			ACEPHATE	Orthene	No listing for 'wireworm' for any crop			
	MITES  European Red Mite (ERM) <i>Bradysia spp.</i> Tomato Russet Mite (TRM) <i>Aceria lycopersici</i> Two-Spotted Mite (TSM) <i>Tetranychus urticae</i>	Moderate - Tomato russet mite major mite problem, not all miticide work on it	DICOFOL	Kelthane 35	Mites 7	2B	7	Tomato Russet mite checked on all labels. Only on Abamectin label for glasshouse tomatoes
			FATTY ACIDS (K SALTS)	Yeates Mite Killer	ERM, TSM	Not listed	1	
			FENBUTATIN OXIDE	Torque	Only registered in fruit.	12A		AU label - registered for ERM and TSM in various fruit crops but not vegetables.
			CANOLA OIL	Eco-oil	TSM		0	
			CLOFENTEZINE	Apollo 50SC	Label lists TSM and ERM for various crops but not vegetable crops	10A		AU label - lists ERM and TSM control in various fruit crops but not vegetables
			DICHLORVOS	Divap	Mites	1B	3	
			AZOCYCLOTIN	Peropal	No Reg. in Vegetable Crops. Controls TSM and ERM in various fruit crops			
			<i>Phytoseiulus persimilis</i>	Two spotted mite predator		Bio-insecticide	0	
			ABAMECTIN	Avid	TRM, TSM listed for GH Tomato ERM listed for pipfruit	6A		
			TAU-FLUVALINATE	Mavrik Flo	Reg. for Mites in Ornamentals			
	MILBEMECTIN	Mit e mec	Reg for TSM, ERM in apples					
FENPYROXIMATE	Fenamite	Reg. for TSM, ERM in pipfruit						
PROPARGITE	Omite 30W	No Reg. in Vegetable Crops. TSM and ERM control in various crops	14A					

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in NZ
	Actives under review in Aust
	Registered
	Used off-label

Table 5: Herbicides registered and used for the control of the weeds in lettuce.

Crop	Active ingredient	Common Trade Name	Registrations	Resistance group	WHP (days)	CURRENT PRODUCT SUITABILITY
LETTUCE (head & leafy)	CHLORPROPHAM	Alliacine 40EC		E	Na	Pre-emergent or pre-plant annual broadleaf and grass control.
	CHLORTHAL DIMETHYL	Dacthal 75W		D		Occasionally used and effective. AU permit - registered in lettuce
	CLETHODIM	Centurion		A	35	Occasionally used and effective. Vegetables - early post-emergent grass control.
	FLUAZIFOP-P-BUTYL	Fusilade WG		A	35	Occasionally used and effective. AU label - registered in lettuce
	HALOXYFOP	Gallant		A		Occasionally used and effective.
	PENDIMETHALIN	Stomp Xtra	Transplanted	D	Na	Occasionally used and effective. Pre-transplant annual broadleaf and grass control.
	PROPACHLOR	Ramrod Flowable		K		Occasionally used and effective. AU permit - registered in lettuce
	PROPYZAMIDE	Kerb 500F		K	Na	Occasionally used and effective. Pre-emergent or post-emergent annual broadleaf and grass control.
	QUIZALOFOP-P-ETHYL	Leopard		A	Na	Lettuce - early post-emergent grass control.
	SETHOXYDIM	Poast		A	35	Vegetables - early post-emergent grass control.
Vegetables	DIQUAT	Reglone		L	Na	Used pre-plant
	GLYPHOSATE	Roundup		M	Na	Used pre-plant
	GLYPHOSATE-TRIMESIUM	Touchdown		M	Na	
	OXYFLUORFEN	Burnout		G	Na	Used pre-plant with Roundup.
	PARAQUAT	Paraquat		L	Na	Used pre-plant
	PINE OIL	Organic Interceptor			Na	

* Resistance groups combine agrichemicals with the same mode of action.

	Actives under review in Aust
	Registered
	Used off-label