CARROTS

Strategic Agrichemical Review Process 2007

Horticulture New Zealand

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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 carrot industry across New Zealand. The information in this report will assist the carrot industry with its agrichemical selection and usage into the future.

Funding sources:

- 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.

Table of Contents

Recommendations

In Auckland, November 2006 a Strategic Agrichemical Review Process was conducted in carrots 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 carrots. 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 carrots.

Diseases and fungicides

The high priority diseases are:

Cercospora Leaf spot or Cercospora blight	*Cercospora carotae*
Early blight	*Alternaria dauci*

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

Product (active)	**Target disease**	**Action**
Amistar (azoxystrobin)	Leaf spot (Cercospora) Early blight (Alternaria)	New uses
Bravo (chlorothalonil)	Leaf spot (Cercospora) Early blight (Alternaria)	New uses
Copper hydroxide / oxychloride	Leaf spot (Cercospora)	Adding to existing registrations
Score (difenoconazole)	Early blight (Alternaria)	Adding to existing registrations
Rovral (iprodione)	Early blight (Alternaria)	New use

Steps forward

1. Efficacy and crop safety trials are required in the major carrot growing areas to determine the most efficacious fungicides for the control of Cercospora Leaf spot using azoxystrobin, chlorothalonil and Copper hydroxide / oxychloride; and Early blight using azoxystrobin, chlorothalonil, difenoconazole and iprodione, in combination with currently registered products.
2. Once efficacy and the use pattern (and the withholding period) are determined, residues trials are required in the major carrot growing area for these fungicides so that they comply with the default MRL (0.1 mg/kg) for azoxystrobin, chlorothalonil and iprodione, and comply with the current MRL for copper and difenoconazole. Residue data for some fungicides may be available from Australia or elsewhere.
3. Provide the carrot industry with sound technical information for the control of Cercospora Leaf spot and Early blight 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.

Insects and insecticides

The high priority insects are:

Carrot rust fly	*Psila Rosae*
Manuka beetle	*Pyronota festiva*

No insecticides were found that have known activity on Carrot rust fly or Manuka beetle

In reviewing the possible alternative insecticides for these uses:

- No product should be pursued until efficacies against these pests are determined.
- Products requiring testing are:
  Carrot rust fly - imidacloprid seed treatment

Manuka beetle -	beta-cyfluthrin	bifenthrin	chlorpyrifos
	cypermethrin	fipronil	imidacloprid (foliar)
	indoxacarb	methomyl	

Steps forward

1. Small scale efficacy trials are required in the major carrot growing areas to determine the most efficacious insecticides for the control of Carrot rust fly using imidacloprid seed treatment and Manuka beetle using a range of insecticides.
2. Once efficacy and the use pattern (and the withholding period) are determined, residue trials are required in the major carrot growing areas for the selected insecticides so that they comply with the default MRL or current MRL.
3. Provide the carrot industry with sound technical information for the control of Carrot rust fly and Manuka beetle 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.

Weeds and herbicides

The main weed gaps identified by growers are:

- Wireweed (Polygonum aviculare)
- Groundsel (Senecio vulgaris)
- Cleaver (Galium aparine)
- Volunteer potatoes (Solanum tuberosum)

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

Steps forward

1. Trials are required in the major carrot growing areas to demonstrate the techniques required for effective pre-plant weed control of problem weeds with currently registered herbicides (pre and post plant).
2. No residue trials are required as the herbicides are already registered in carrots.
3. Provide the carrot industry with sound technical information for effective pre-plant weed control of problem weeds using currently registered herbicides.

The New Zealand carrot 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 carrot growing areas are in (HortResearch[1]):

- Auckland
- Canterbury
- Manawata / Wanganui

There are (HortResearch[1]):

- 99 carrot growers
- 1,450 hectares planted
- 65,000 T produced
- $ 41.3 million from domestic sales (2006)
- $ 6.8 million from fresh export sales (2006)
- $ 0.5 million from processed export sales (2006)

The main carrot export destinations are (HortResearch[1]):

- Bahrain
- Hong Kong
- Japan
- Korea
- Malaysia
- Pacific islands (various)
- Papua New Guinea
- Singapore
- South Africa
- Taiwan

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. It is also a problem in larger crops, such as carrots, 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.

[1] HortResearch FreshFacts 2006

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 carrot 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, due to an incorrectly determined application rate or withholding period.
- 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

Agrichemicals have always been an important tool in the production of carrots. 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 carrot 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 root maturity and pre harvest.

Strategic Agrichemical Review Process

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

The aims of the process were:

- to determine the current and future agrichemical requirements for carrots
- 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.

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 carrot industry. Against these threats the agrichemicals, agrichemical resistance 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 carrot 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 carrot industry with sound agrichemical options that can be pursued for registration with the manufacturer.

This report is not a comprehensive assessment of ALL pests and control methods of carrots 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 carrots and asked to prioritise them into high, moderate and low categories.
- Each of the pests were listed by common and scientific name.
- Participants were then 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 (biologicals, 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 were listed, as were agrichemicals under review by the Australian Agrichemicals and Veterinary Medicines Authority (APVMA).
- 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 grouping and has multi-site activity; it belongs to the Group Y fungicides.
    - The insecticide, diazinon belongs to the organophosphate resistance grouping and has contact/stomach activity; it belongs to the Group 1B insecticides.
    - The herbicide, linuron belongs to the photosynthesis inhibitor resistance grouping; it belongs to the Group C herbicides.
- The information was circulated to participants for further comments and to ensure the accuracy of the information.
- An assessment or evaluation was conducted for each of the plant pests of carrots 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 carrot industry to pursue are listed.

Results

The complete list of SARP worksheets is presented.

- Table 1 – results of the carrot Strategic Agrichemical Review Process – currently registered fungicides and uses.
- Table 2 – results of the carrot Strategic Agrichemical Review Process – currently registered nematicides and uses.
- Table 3 – results of the carrot Strategic Agrichemical Review Process – currently registered insecticides and uses.
- Table 4 – results of the carrot Strategic Agrichemical Review Process – currently registered herbicides and uses.
- Table 5 – results of the carrot Strategic Agrichemical Review Process – fungicides used off-label in carrots for registered pests.
- Table 6 – results of the carrot Strategic Agrichemical Review Process – insecticides used off-label in carrots for registered pests.
- Table 7 – results of the carrot Strategic Agrichemical Review Process – herbicides used off-label in carrots for registered pests.
- Table 8 – Fungicides with activity on specific carrot pests.
- Table 9 – Nematicides with activity on specific carrot pests.
- Table 10 – Insecticides with activity on specific carrot pests.
- Table 11 – Herbicides with activity on specific carrot pests.

Discussions

Diseases of carrots

The major diseases of carrots recorded are:

Common name	Scientific name
HIGH PRIORITY	
Leaf spot, Cercospora Leaf spot or Cercospora blight ……	*Cercospora carotae*
Early blight …….	*Alternaria dauci*
MODERATE PRIORITY	
Sclerotinia rot ……..….	*Sclerotinia sclerotiorum*
LOW PRIORITY	
Pythium root rot or Cavity spot ……..	*Pythium violae*
Violet root rot …….	*Rhizoctonia crocorum*
Rhizoctonia root rot ……	*Rhizoctonia solani*
NO PRIORITY	
Powdery Mildew ……..……	*Erysiphe polygoni*

High priority disease

Leaf spot, Cercospora Leaf spot or Cercospora blight (*Cercospora carotae*)

Fungicides registered for Leaf spot (Cercospora) control in carrots or vegetables are:

Active ingredient	Common Trade Name	Registration	Resistance group*	WHP (days)	CURRENT PRODUCT SUITABILITY
CAPTAN	Captan		Y	14	Commonly used and effective
MANCOZEB	Manzate		Y	14	Commonly used and effective
DIFENOCONAZOLE	Score		C	14	Commonly used and effective

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

	Registered

All the protectant fungicides are commonly used with multiple applications per crop. There is little risk from the continued use of these products. Difenoconazole is commonly used, but should only be applied a maximum of 3 applications per crop. Over use of difenoconazole can lead to resistance developing in Cercospora.

From the reports received, the current fungicides used for Leaf spot (Cercospora) control in carrots are working adequately. But it was identified that alternatives are required that are protectant/curative fungicide, for application during crop development phase.

Fungicides that are used off-label in carrots for the control of Leaf spot (Cercospora) are:

Active ingredient	Common Trade Name	Registration	Resistance group*	Comments
AZOXYSTROBIN	Amistar	No reg. in carrots. Reg. in various vegetable crops but Cercospora not mentioned on any crop	K	Currently being used with good effect.
CHLOROTHALONIL	Bravo	No reg. in carrots. Registered in various vegetable crops. Registered in Aust in peanuts, celery & cucurbits for Cercospora.	Y	Currently being used with good effect
CYPROCONAZOLE	Alto	No reg. in carrots. Registered in various vegetable crops. Registered in Aust in peanuts for Cercospora.	C	Currently being used with good effect

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

	Actives under review in NZ

These products are all occasionally used and considered effective.

- Amistar is seen as a new mode-of-action fungicide, but care is required as there is some risk of resistance developing in the future with its continued use.
- Bravo is an effective protectant with little resistance risk and a better IPM fit than mancozeb. It may be seen as a replacement for mancozeb.
- Alto is from the same agrichemical group as Score and its use will only accelerate any resistance developing to this group of fungicides.

Fungicides that are not registered in carrots but control Leaf spot (Cercospora) in other crops, and could possibly be alternatives include:

Active ingredient	Common Trade Name	Registration	Resistance group*	Comments
CARBENDAZIM	Carbendazim	Not registered in carrots in NZ. Registered in Aust for Cercospora control in clover	A	Protectant, systemic fungicide.
COPPER	various	Registered in 'vegetables' for Early blight of carrots. Registered in Aust in bananas & celery for Cercospora.	Y	Protectant, contact fungicide. Currently being used for other diseases.
METIRAM	Polyram	Not registered in carrots NZ. Registered in Aust for Cercospora control in carrots.	Y	Protectant, contact fungicide. Similar to mancozeb, but IPM compatible.
PYRACLOSTROBIN	Comet	Comet (Cabrio in Aust) not registered in carrots in NZ but Cornell Uni list as reasonably effective on Cercospora Leaf Spot in carrots. Not registered in any vegetable crop	K	Protectant/eradicant, systemic fungicide.
ZINEB	Zineb	No registration in NZ but effective. Registered in carrots in Aust for Cercospora in carrots	Y	Protectant, contact fungicide. Similar to mancozeb

* 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 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) – Australian registration, MRL in Australia & EU (0.2 mg/kg), Israel (1.0 mg/kg), Japan & Switzerland (0.1 mg/kg), USA (0.5 mg/kg).
- Topsin (carbendazim) - MRL in Australia & Japan (3.0 mg/kg - vegetables), Canada & Singapore (5.0 mg/kg), EU & Switzerland (0.1 mg/kg - vegetables), Israel (0.5 mg/kg), Korea (1.0 mg/kg), Taiwan (0.2 mg/kg).
- Bravo (chlorothalonil) – Australian registration, MRL in Australia (7.0 mg/kg), Canada, Codex, EU, Indonesia, Israel, Korea, Singapore, Taiwan & USA (1.0 mg/kg, Japan (0.1 mg/kg).
- Copper (copper oxychloride) – Australian registration, MRL in Australia (8.0 mg/kg - vegetables), EU (20 mg/kg- vegetables), Canada (50.0 mg/kg- vegetables), Finland (10.0 mg/kg- vegetables), Japan, Malaysia & Taiwan (exempt), Singapore (30.0 mg/kg- vegetables), Switzerland (15.0 mg/kg- vegetables).
- Alto (cyproconazole) - MRL in Austria, EU & Netherlands (0.05 mg/kg – vegetables.
- Polyram (metiram) – Australian registration, MRL in Australia, Codex & Japan (1.0 mg/kg), EU & Switzerland (0.2 mg/kg), Indonesia (0.5 mg/kg), Taiwan (0.5 mg/kg).
- Comet (pyraclostrobin) – MRL in EU (0.1 mg/kg), Israel (0.03 mg/kg), Japan & USA (0.4 mg/kg), Netherlands (0.5 mg/kg), UK (T0.1 mg/kg).
- Zineb (zineb) – Australian registration, MRL in Australia & Codex (1.0 mg/kg).

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

FUNGICIDE ALTERNATIVES IN CARROTS FOR CERCOSPORA

In reviewing these possible alternatives:

- Amistar (azoxystrobin) – is a protectant/curative fungicide. Efficacy and crop safety data needs to be generated in the major carrot growing areas. Residue data may also be necessary. Australian data may be available. Although there are few overseas MRL, **the product should be pursued**, provided a use pattern is developed to fit the residue requirements. This will provide a necessary new systemic fungicide.
- Topsin (carbendazim) – as this product is under review in NZ and Australia, it should not be pursued until the results of the review are completed.
- Bravo (chlorothalonil) – is a protectant fungicide in the same agrichemical group with similar activity to mancozeb. It is unknown if chlorothalonil will add any benefit in controlling Leaf spot to existing protectant fungicides. Efficacy and crop safety data needs to be generated in the major carrot growing areas. Residue data may also be necessary. As there are many overseas MRL, **the product should be pursued.** Chlorothalonil is said to have a better IPM profile than mancozeb, which is known to disrupt some predatory mites.
- Copper (copper oxychloride) – is a protectant fungicide with a wide spectrum of activity. Efficacy and crop safety data needs to be generated in the major carrot growing areas. Residue data may also be necessary. Australian data may be available. As there are many overseas MRL, **the product should be pursued.**
- Alto (cyproconazole) - is in the same agrichemical group as Score (difenoconazole), therefore should not be pursued.
- Polyram (metiram) – is a protectant fungicide in the same agrichemical group with similar activity to mancozeb therefore should not be pursued.

- Comet (pyraclostrobin) – is in the same agrichemical group as Amistar (azoxystrobin), therefore should not be pursued.
- Zineb (zineb) – is a protectant fungicide with similar activity to mancozeb. As it is not registered in NZ, it should not be pursued.

Early blight (*Alternaria dauci*)

Fungicides registered for Early blight (Alternaria) control in carrots or vegetables are:

Active ingredient	Common Trade Name	Registrations	Resistance group*	WHP (days)	CURRENT PRODUCT SUITABILITY
SULPHUR	Various		Y	Nil	Commonly used and effective
COPPER OXYCHLORIDE	Copper Oxychloride		Y	Nil	Commonly used and effective
MANCOZEB	Manzate		Y	14	Commonly used and effective

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

	Registered

All the registered fungicides are protectant products that are commonly used with multiple applications per crop. There is little risk of resistance developing in the future with the continued use of the protectant fungicides.

From the reports received, the current fungicides used for Early blight (Alternaria) control in carrots are working adequately. But it was identified that alternatives are required that are protectant/curative fungicides.

Fungicides used off-label in carrots for the control of Early blight are:

Active ingredient	Common Trade Name	Registration	Resistance group*	Comments
AZOXYSTROBIN	Amistar	No registration in carrots. Permits in Australia for Alternaria in brassicas, carrots and cucumber.	K	Protectant/eradicant, systemic fungicide. Currently being used with good effect.
CHLOROTHALONIL	Bravo	No registration in carrots. Registered in Australia for Alternaria in tomatoes & ornamentals.	Y	Protectant, contact fungicide. Currently being used with good effect
CYPROCONAZOLE	Alto	No registration in carrots. Registered in various vegetable crops.	C	Protectant/curative, systemic fungicide. Currently being used with good effect
DIFENOCONAZOLE	Score	Registration in carrots for Cercospora. Registered in Australia for Alternaria in carrots.	C	Protectant/curative, systemic fungicide. Currently being used with good effect

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

	Actives under review in NZ

These products are all occasionally used and considered effective.

- Amistar is seen as a new mode-of-action fungicide, but care is required as there is some risk of resistance developing in the future with its continued use.
- Bravo is an effective protectant with little resistance risk and a better IPM fit than mancozeb. It may be seen as a replacement for mancozeb.

- Alto and Score are from the same agrichemical resistance group so only one of these products should be selected; otherwise overuse will only accelerate any resistance developing to this group of fungicides.

Fungicides that are not registered in carrots but control Early blight (Alternaria) in other crops, and could possibly be alternatives include:

Active ingredient	Common Trade Name	Registration	Resistance group*	Comments
CARBENDAZIM	Carbendazim	Not registered in carrots in NZ.	A	Protectant, systemic fungicide.
IPRODIONE	Rovral	No registered for Alternaria in carrots. Rovral registered for Alternaria control in tangelos. Registered in Australia for Alternaria in potato & tomato.	B	Protectant/eradicant, contact fungicide. Similar to Sumisclex.
METIRAM	Polyram	No registration in carrots in NZ but effective. Registered in Australia for Alternaria in carrots.	Y	Protectant, contact fungicide. Similar to mancozeb, but IPM compatible.
PROCYMIDONE	Sumisclex	No registered for Alternaria in carrots. Registered in Australia for Alternaria in potato.	B	Protectant/eradicant, contact fungicide. Similar to Rovral.
PYRACLOSTROBIN	Comet	Not registered in carrots NZ but Cornell Uni list as effective on Alternaria in carrots	K	Protectant/eradicant, systemic fungicide. Similar to Amistar.
ZINEB	Zineb	No registration in carrots in NZ but effective. Is registered in carrots Australia for Alternaria control	Y	Protectant, contact fungicide. Similar to mancozeb.

* 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 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)
  - Australian registration; MRL in: Australian & EU (0.2 mg/kg): Israel (1.0 mg/kg); Japan & Switzerland (0.1 mg/kg); USA (0.5 mg/kg)
- Topsin (carbendazim)
  MRL in: Australia & Japan (3.0 mg/kg - vegetables); Canada & Singapore (5.0 mg/kg); EU & Switzerland (0.1 mg/kg - vegetables); Israel (0.5 mg/kg); Korea (1.0 mg/kg); Taiwan (0.2 mg/kg)
- Bravo (chlorothalonil)
  - Australian registration; MRL in: Australia (7.0 mg/kg); Canada, Codex, EU, Indonesia, Israel, Korea, Singapore, Taiwan & USA (1.0 mg/kg); Japan (0.1 mg/kg)
- Alto (cyproconazole)
  MRL in: Austria, EU & Netherlands (0.05 mg/kg – vegetables)
- Score (difenoconazole)
  - Australian registration; MRL in: Australia, Belgium, France, Germany, Italy, Netherlands & Switzerland (0.2 mg/kg); Austria & Israel (0.1 mg/kg)
- Rovral (iprodione)
  MRL in: Canada & Japan (5.0 mg/kg); Codex & Israel (10.0 mg/kg); EU (0.3 mg/kg)

- Polyram (metiram)
  - Australian registration; MRL in: Australia, Codex & Japan (1.0 mg/kg); EU & Switzerland (0.2 mg/kg); Indonesia (0.5 mg/kg); Taiwan (0.5 mg/kg); Japan & Taiwan (0.5 mg/kg)
- Sumisclex (procymidone)
  MRL in: Australia (T1.0 mg/kg); EU (0.02 mg/kg - vegetables)
- Comet (pyraclostrobin)
  MRL in: EU (0.1 mg/kg); Israel (0.03 mg/kg); Japan & USA (0.4 mg/kg); Netherlands (0.5 mg/kg); UK (T0.1 mg/kg)
- Zineb (zineb)
  - Australian registration; MRL in: Australia & Codex (1.0 mg/kg)

FUNGICIDE ALTERNATIVES IN CARROTS FOR ALTERNARIA

In reviewing these possible alternatives:

- Amistar (azoxystrobin) – is a protectant/curative fungicide. Efficacy and crop safety data needs to be generated in the major carrot growing areas. Residue data may also be necessary. Australian data may be available. Although there are few overseas MRL, **the product should be pursued**, provided a use pattern is developed to fit the residue requirements. This will provide a necessary new systemic fungicide.
- Topsin (carbendazim) – as this product is under review in NZ and Australia, it should not be pursued until the results of the review are completed.
- Bravo (chlorothalonil) – is a protectant fungicide in the same agrichemical group with similar activity to mancozeb. It is unknown if chlorothalonil will add any benefit in controlling Leaf spot to existing protectant fungicides. Efficacy and crop safety data needs to be generated in the major carrot growing areas. Residue data may also be necessary. As there are many overseas MRL, **the product should be pursued.** Chlorothalonil is said to have a better IPM profile than mancozeb, which is known to disrupt some predatory mites.
- Score (difenoconazole) - is a protectant/curative fungicide and already registered in carrots in NZ for Cercospora. T**he product should be pursued**
- Alto (cyproconazole) - is in the same agrichemical group as Score (difenoconazole), therefore should not be pursued.
- Rovral (iprodione) – is a protectant/curative fungicide. Efficacy and crop safety data needs to be generated in the major carrot growing areas. Residue data may also be necessary. Australian data may be available from Bayer Australia – potatoes. Although there are few overseas MRL, **the product should be pursued**, provided a use pattern is developed to fit the residue requirements.
- Polyram (metiram) – is a protectant fungicide in the same agrichemical group with similar activity to mancozeb. Therefore the product should not be pursued.
- Sumisclex (procymidone) – is a protectant/curative fungicide in the same agrichemical group as Rovral. As this product is under review in Australia, it should not be pursued until the results of the review are completed.
- Comet (pyraclostrobin) – is in the same agrichemical group as Amistar (azoxystrobin), therefore should not be pursued.
- Zineb (zineb) – is a protectant fungicide with similar activity to mancozeb. As it is not registered in NZ, it should not be pursued.

Other diseases

Sclerotinia rot (*Sclerotinia sclerotiorum*)

See Table 1 and 8 - Fungicides with activity on specific carrot diseases.

Pythium root rot or Cavity spot (*Pythium violae*)

See Table 1 and 8 - Fungicides with activity on specific carrot diseases.

Violet root rot (*Rhizoctonia crocorum*)

See Table 1 and 8 - Fungicides with activity on specific carrot diseases.

Rhizoctonia root rot (*Rhizoctonia solani*)

See Table 1 and 8 - Fungicides with activity on specific carrot diseases.

Powdery Mildew (*Erysiphe polygoni*)

See Table 1 and 8 - Fungicides with activity on specific carrot diseases.

New fungicide that can be pursued

Product (active)	**Target disease**	**Action**
Amistar (azoxystrobin)	Leaf spot (Cercospora) Early blight (Alternaria)	New uses
Bravo (chlorothalonil)	Leaf spot (Cercospora) Early blight (Alternaria)	New uses
Copper hydroxide/oxychloride	Leaf spot (Cercospora)	Adding to existing registrations
Score (difenoconazole)	Early blight (Alternaria)	Adding to existing registrations
Rovral (iprodione)	Early blight (Alternaria)	New use

Nematodes of carrots

The nematodes of carrots recorded are:

Common name	**Scientific name**
MEDIUM PRIORITY	
Root Knot Nematode …..……..	*Meloidogyne spp*

Medium priority

Root Knot Nematode (Meloidogyne spp)

See Table 2 and 9 - Nematicides with activity on specific carrot nematodes.

Insects of carrots

The insects of carrots recorded are:

Common name	Scientific name
HIGH PRIORITY	
Carrot rust fly ……..	*Psila Rosae*
Manuka beetle …….	*Pyronota festiva*
MEDIUM PRIORITY	
Carrot willow aphid & Green peach aphid .	*Cavariella aegopodii and Myzus persicae*
White-fringed weevil ……..	*Naupactus leucoloma*
LOW PRIORITY	
Cabbage aphid ……...…	*Brevicoryne brassicae*
Carrot weevil & Vegetable weevil …….....	*Listronotus oregonensis / L. texanus and L. obliquus*
Wireworm ……..…	*Heteroderus spp.*

High priority insects

Carrot rust fly (*Psila Rosae*)

Carrot rust fly is considered a major pest of carrots in NZ. Feedback indicated that Carrot rust fly is a growing problem in carrots.

Insecticides registered for Carrot rust fly control in carrots or vegetables are:

Active ingredient	Common Trade Name	Registration	Resistance group*	WHP (days)	CURRENT PRODUCT SUITABILITY
PHORATE	Thimet		1B	56	Occasionally used and effective – down sowing tubes
DIAZINON	Diazinon		1B	14	No record of use

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

	Actives under review in NZ
	Actives under review in Aust
	Registered

Phorate is occasionally used and is effective. There is no record of diazinon use.

There are not reports of any risk resistance from the use of Group 1B insecticide in Carrot rust fly. It was identified that alternatives are required due to the severity of the pest.

Insecticides that are used off-label in carrots for the control of Carrot rust fly are:

Active ingredient	Common Trade Name	Registrations	Resistance group*	Comments
IMIDACLOPRID	Gaucho	No reg. in carrots. No reg. for any 'fly' pests.	4A	Systemic seed treatment – range of soil, sucking and chewing insects. Record that it has been used. Efficacy unknown.

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

This product has been recorded as being used and:

- Gaucho is a very effective, systemic seed treatment for the control of a range of sucking and chewing pests.
- There are no reports on the efficacy against Carrot rust fly.
- There is no reference on 'fly' control as a seed treatment in any crop in NZ or Aust.

INSECTICIDE ALTERNATIVES IN CARROTS FOR PSILA

- **No insecticides could be found for the control of carrot rust fly in carrots or other crops.**

Manuka Beetle (*Pyronota festiva*)

Manuka Beetle is considered a major pest of carrots in NZ.

There are no products registered for Manuka Beetle control. Adults cause a problem by feeding on foliage.

Two products were identified as possible candidates for control, these are:

Active ingredient	Common Trade Name	Registration	Resistance group*	Comments
PHORATE	Phorate	No mention of Manuka beetle on label. Registered in carrots for aphids, carrot root weevil and carrot rust fly.	1B	Systemic soil applied insecticides.
TEBUFOS	Counter	No mention of Manuka beetle on label	1B	Systemic soil applied insecticides.

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

Both these products have been recorded as being used and:

- Phorate (Group 1B insecticide) is a very effective, systemic soil insecticide for the control of a range of sucking and chewing pests. Some level of control is expected on Manuka Beetle.
- Tebufos (Group 1B insecticide) is an effective, systemic soil insecticide for the control of a range of sucking and chewing pests. Some level of control is expected on Manuka Beetle.

There are no reports to confirm the effectiveness of phorate and tebufos to control Manuka Beetle in carrots. It was identified that systemic insecticides are required.

Insecticides that are not registered in carrots but control beetles in other crops, and could possibly be alternatives include:

- Talstar (bifenthrin) – Group 3A contact/systemic insecticide. Registered in other vegetables for other insects. Australian registration for beetles.
- Ripcord (cypermethrin) – Group 3A contact/systemic insecticide. Registered in other vegetables for other insects. Australian registration for beetles.
- Ascend (fipronil) - Group 2C contact/systemic insecticide. Registered in other vegetables for other insects. Australian registration for beetles.
- Confidor (imidacloprid) - Group 4A contact/systemic insecticide. Registered in other vegetables for other insects. Australian registration for beetles.
- Steward (indoxacarb) - Group 22A contact/systemic insecticide. Registered in other vegetables for other insects. Australian registration for beetles.
- Lannate (methomyl) - Group 1B contact/systemic insecticide. Registered in other vegetables for other insects. Australian registration for beetles.

Of these products the 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: EU (0.05 mg/kg – vegetables); Japan (0.1 mg/kg); Switzerland (0.1 mg/kg – vegetables); Korea (0.05 mg/kg – vegetables)
- Ripcord (cypermethrin)
  - MRL in: Australian (0.1 mg/kg – vegetables); Codex, EU, Indonesia, Singapore, Switzerland, Thailand (0.05 mg/kg – vegetables); Israel, Japan, Korea (0.05 mg/kg)
- Ascend (fipronil)
  - MRL in: EU (0.02 mg/kg – vegetables); Japan (0.002 mg/kg); Netherlands (0.01 mg/kg – vegetables)
- Confidor (imidacloprid)
  - MRL in: EU (0.05 mg/kg – vegetables); Japan (0.1 mg/kg); Mexico (0.4 mg/kg); USA (0.4 mg/kg).
- Steward (indoxacarb)
  - MRL in: EU (0.02 mg/kg); Japan (0.1 mg/kg)
- Lannate (methomyl)
  - MRL in: EU (0.05 mg/kg – vegetables); Israel (0.1 mg/kg); Japan (0.5 mg/kg); Korea, Switzerland & USA (0.2 mg/kg); Taiwan (2 mg/kg)

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

INSECTICIDE ALTERNATIVES IN CARROTS FOR PYRONOTA

In reviewing these possible alternatives:

- No product should be pursued until efficacy against Manuka Beetle in carrots is confirmed and a use pattern is suitable to be used in carrots. Several products should be selected.
- Once efficacy and the use pattern (and the withholding period) are determined, then the decision can be made to undertake residue trials to comply with the default MRL.
- Other products worth investigating for efficacy against Manuka Beetle in carrots as there are registrations against Scarabs (same family) in Australia are:
  - Beta-cyfluthrin
  - Chlorpyrifos

Other insects

- **Carrot willow aphid** (Cavariella aegopodii), **Green peach aphid** (Myzus persicae), **Cabbage aphid** (Brevicoryne brassicae)

  See Table 3 and 10 - Insecticides with activity on specific carrot insect pests.

- **Carrot rust fly** (*Psila rosae*)

  See Table 3 and 10 - Insecticides with activity on specific carrot insect pests.

- **Carrot weevil** (*Listronotus oregonensis or L. texanus*)

  See Table 3 and 10 - Insecticides with activity on specific carrot insect pests.

Herbicide use in carrots

Herbicides registered for use in carrots are:

Active ingredient	Common Trade Name	Resistance group (Aust)*	WHP (days)	CURRENT PRODUCT SUITABILITY
FLUAZIFOP-P-BUTYL	Fusilade	A	35	Early post-emergence for grass weeds. Commonly used early post emergent for grass weeds
SETHOXYDIM	Poast	A	35	Post-emergent grass selective herbicide. No record of use
CLETHODIM	Arrow	A	35	Early post-emergence for grass weeds. Commonly used early post emergent for grass weeds
LINURON	Linuron	C	Not required	Pre-emergent and post-emergent broad spectrum herbicide. Mostly used post-emergence. The major product used and very effective. Also used pre-emergence.
METRIBUZIN	Lexone	C	Not required	Pre-emergent and post-emergent broad spectrum herbicide. Commonly used and effective. Used both pre and post-emergence.
PROMETRYN	Gesagard	C	Not required	Pre-emergent and post-emergent broad spectrum herbicide. Commonly used and effective - used pre and post emergent
PROPAZINE	Gesamil	C	Not required	Pre-emergent broad spectrum herbicide. No record of use
PENDIMETHALIN	Stomp	D	Not required	Pre-emergent broad spectrum herbicide. Commonly used and effective. Used pre and post-emergence.
TRIFLURALIN	Trifluralin	D	Not required	Pre-emergent broad spectrum herbicide. No record of use
CHLORPROPHAM	Alliacine	E	Not required	Pre-emergent broad spectrum herbicide. No record of use
GLYPHOSATE	Roundup	M	Not required	Broad spectrum knockdown herbicide. Used pre-plant.
GLYPHOSATE-TRIMESIUM	Touchdown	M	Not required	Similar weed control to Roundup however may provide better control of some broadleaf weeds. Used pre-plant.
PARAQUAT	Gramoxone	L	Not required	Pre-plant or inter-row for broad spectrum knockdown weed control.
PINE OIL	Organic Interceptor		Not required	No record of use
OXYFLUORFEN	Goal	G	Not required	An 'additive' to Roundup for control of additional weeds. Used pre-plant.

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

	Actives under review in Aust

The main weed gaps identified by growers are:

- Wireweed (*Polygonum aviculare*) - Pendimethalin (Stomp) is particularly strong on this weed as a pre-emergent treatment. Larger plants hard to control after crop emergence. Linuron and prometryn have some activity as post-emergents, but only on small plants. Should be controlled pre-plant if possible with glyphosate, oxyfluorfen or paraquat to reduce weed burden.
- Groundsel (Senecio vulgaris) – only pre-plant weed control is possible with glyphosate, oxyfluorfen or paraquat.

- Cleaver (Galium aparine) - only pre-plant weed control is possible with glyphosate, oxyfluorfen or paraquat.
- Volunteer potatoes (Solanum tuberosum) - Linuron has some activity as post-emergent, but only on small plants. Pre-plant weed control is possibly oxyfluorfen.

Alternative herbicides available for the control of specific weeds in carrots are listed in Table 11.

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

Another product identified as required by the industry is:

- Haloxyfop (Gallant). Group A post-emergent grass selective herbicide.
    - The only advantage of haloxyfop over other grass herbicides such as fluazifop, clethodim and sethoydim is that it controls storksbill/corkscrew (Erodium spp.)
    - Erodium was not listed as a weed of concern.

A product that is not currently registered in carrots but is in Australia is:

- Chlorthal-dimethyl (Dacthal) - Group D at-planting broad spectrum herbicide. Registered in onions in NZ. Registered in carrots in Australia.

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

- Gallant (haloxyfop)
    - MRL in: Austria & Netherlands (0.05 mg/kg – vegetables); EU (0.1 mg/kg)
- Dacthal (chlorthal-dimethyl)
    - MRL in: Aust & Japan (5.0 mg/kg); EU, Israel, Taiwan (0.1 mg/kg – vegetables); Netherlands (0.01 mg/kg – vegetables)

Although both these herbicides do offer some benefits to carrot growers regarding weed spectrum control, this is limited as they are from the same agrichemical resistance group of herbicides that are currently available.

Also, neither Gallant (haloxyfop) or Dacthal (chlorthal-dimethyl) will control the problem weeds identified of carrots. Therefore there is little benefit in pursuing either of these herbicides.

New opportunities for new or alternative agrichemicals in carrots

International collaboration with USA IR-4 program

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

Agrichemical	Pest / Status	Relevance to NZ
FUNGICIDES		
BOSCALID + PYRACLOSTROBIN (Aero – Aust)	ALTERNARIA, CERCOSPORA, POWDERY MILDEW, SCLEROTIUM ROLFSII - registered	Diseases controlled identified as a high priority
CYPRODINIL + FLUDIOXONIL (Switch)	ALTERNARIA, CERCOSPORA – submitted for registration	Diseases controlled identified as a high priority
FAMOXADONE + CYMOXANIL (New product)	ALTERNARIA LEAF BLIGHT - in progress	Disease controlled identified as a high priority
FENAMIDONE (Sereno)	PYTHIUM DAMPING OFF & FORKING - proposed	Not a priority
FLUTOLANIL (New product)	CRATER ROT (RHIZOCTONIA), SOUTHERN BLIGHT (SCLEROTIUM ROLFSII) – in progress	Not a priority
INSECTICIDES		
BIFENTHRIN (Talstar)	FIRE ANTS, FOLIAR PESTS, CARROT WEEVIL – submitted for registration	Not a priority
FIPRONIL (Ascend)	ROOT MAGGOTS, FLEABEETLES, CARROT WEEVIL – in progress	Not a priority
FLONICAMID (New product)	APHIDS - proposed	Not a priority
LAMBDA-CYHALOTHRIN (Karate)	CARROT RUST FLY, CARROT WEEVIL – in progress	Insect controlled identified as a high priority
METHOXYFENOZIDE (Prodigy)	LEPIDOPTERA LARVAE, ARMYWORM – in progress	Not a priority
THIAMETHOXAM (Actara)	SOIL DWELLING INSECTS, CARROT WEEVIL - registered	Not a priority
HERBICIDES		
DCPA (New product)	WEEDS - proposed	Weed spectrum unknown
PENDIMETHALIN (Stomp)	DODDER - registered	Not a priority
PENDIMETHALIN (Stomp)	BROADLEAF WEEDS & ANNUAL GRASSES (post-em) - registered	Weed spectrum will not control priority weeds
OXYFLUORFEN (Goal)	BROADLEAF WEEDS (post-em) – in progress	Weed spectrum unknown
S-METOLACHLOR (Dual Gold)	NUTSEDGE, GALINSOGA, PURSLANE, WILD BUCKWHEAT – in progress	Not a priority

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

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.

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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

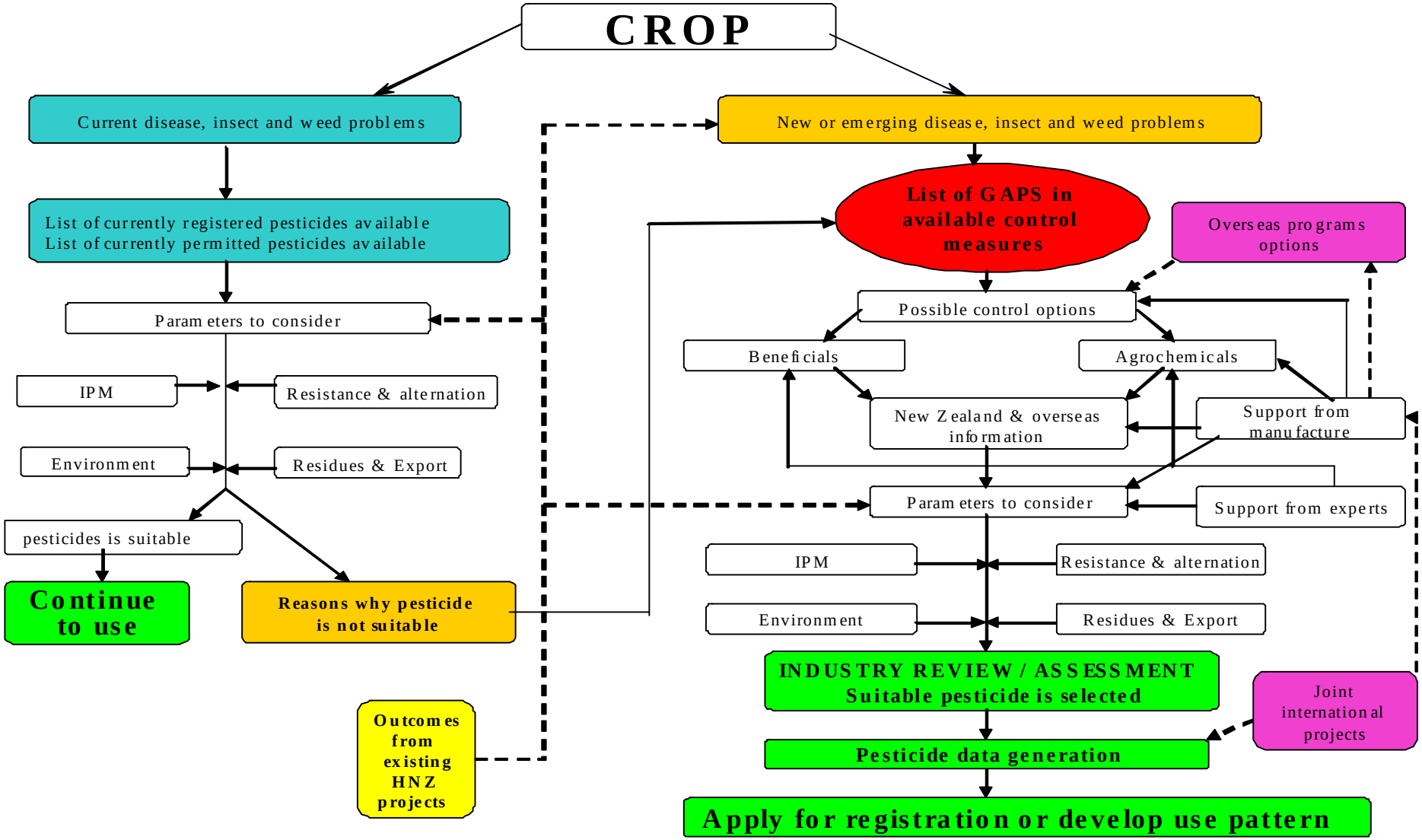

Table 1: Fungicides registered for the control of Leaf spot, Cercospora leaf spot, Cercospora blight, Early blight, Sclerotinia rot, Pythium root rot and Violet Root Rot (recorded problems) in carrots or vegetables.

Active ingredient	Common Trade Name	Registration in Carrots	Resistance group (Aust)	WHP (days)	Comments
Leaf spot, Cercospora leaf spot or Cercospora blight (*Cercospora carotae*)					**High priority** – major problem
CAPTAN	Captan		Y	14	Commonly used and effective
MANCOZEB	Manzate 200 DF		Y	14	Commonly used and effective
DIFENOCONAZOLE	Score		C	14	Commonly used and effective
Early blight (*Alternaria dauci*)					**High priority** – major problem
SULPHUR	Kumulus DF	Label lists 'Vegetables'	Y	Nil	Commonly used and effective
COPPER OXYCHLORIDE	Copper Oxychloride	Label lists 'Vegetables'	Y	Nil	Commonly used and effective
MANCOZEB	Manzate 200 DF		Y	14	Commonly used and effective
Sclerotinia rot (*Sclerotinia sclerotiorum*)					Medium priority – moderate problem
CHLOROTHALONIL	Bravo Weatherstik	Label lists 'Vegetables'	Y	Nil	No record of use
THIOPHANATE-METHYL	Banrot	Label lists 'Vegetables'	Y	Nil	No record of use
Pythium root rot (Cavity spot) (*Pythium violae*)					Low priority – extent unknown
ETRIDIAZOLE	Terrazole 35WP	Registered for 'vegetable seedlings. Seed bed & seedlings'	X	Not applicable	Occasionally used
METALAXYL-M	???	Registered for 'vegetable'	D	???	Occasionally used
Violet root rot (*Rhizoctonia crocorum*) and **Rhizoctonia root rot** (*Rhizoctonia solani*)					Low priority
QUINTOZENE	Terrachlor 75WP	Registered for vegetables seedlings for Rhizoctonia & Fusarium control as a pre-sowing soil treatment.	Y	Not applicable	Not used

Registered
Actives under review in NZ
Actives under review in Aust

Table 2: Nematicides registered for the control of Root knot Nematode (recorded problems) in carrots or vegetables.

Active ingredient	Common Trade Name	Registration in Carrots	Resistance group (Aust)	WHP (days)	Comments
Root Knot Nematode (Meloidogyne spp)					Medium priority – moderate problem
DICHLOROPROPENE	Telone C-35	Label lists 'Vegetable crops' – controls nematodes, diseases and suppresses some weeds	Soil Fumigant	Not applicable	Occasionally used
OXAMYL	Vydate		22A Insecticide	Not listed	Occasionally used in furrow – efficacy uncertain
FENAMIPHOS	Nemacur		1B Insecticide	Not listed	Commonly used and effective
DAZOMET	Basamid	Label lists 'outdoor crops' – controls nematodes, diseases, insects and weeds	Soil Fumigant	Not listed	No record of use
METHAM SODIUM	Fumasol	Label lists 'crops' – controls nematodes, diseases, insects and weeds	1A Insecticide	Not listed	No record of use

Registered
Actives under review in NZ
Actives under review in Aust

Table 3: Insecticides and bio-insecticides registered for the control of Aphid, Carrot rust fly and Carrot weevil (recorded problems) in carrots or vegetables.

Active ingredient	Common Trade Name	Registration in Carrots	Resistance group (Aust)	WHP (days)	Comments
Carrot willow aphid (Cavariella aegopodii) **and Green peach aphid** (Myzus persicae), as well as **Cabbage aphid** (Brevicoryne brassicae) (to a lesser extent)					Medium priority - occasional problem
DIAZINON	Diazinon	'Aphids' in vegetables	1B	14	Not used due to resistance
DICHLORVOS	Divap	'Aphids' in vegetables	1B	3	No record of use
MALDISON	Malathion	'Aphids' in vegetables	1B	3	No record of use
PHORATE	Thimet 20G	Aphids	1B	56	No record of use
DIMETHOATE	Perfekthion	Carrot aphid	1B	14	Commonly used and effective
PYRETHRINS	Garlic & Pyrethrum Concentrate	'Aphids' in vegetables	3A	1	Rarely used, but effective
PERMETHRIN + PBO	Greenseals Pyrethrum	'Aphids' in vegetables	3A	nil	Rarely used, but effective
ROTENONE	Derris Dust	'Aphids' in vegetables	21A	??	No record of use
FATTY ACIDS (K SALTS)	Nature's Way Insect Spray	'Aphids' in vegetables	Unlisted	??	No record of use
APHID PARASITE	*Aphidius colemani*		Bio-insecticides	nil	No record of use
APHIDOLETED	*Aphidoletes aphidimyza*		Bio-insecticides	nil	No record of use
Carrot rust fly (*Psila rosae*)					**High priority** – major problem
PHORATE	Thimet 20G		1B	56	Occasionally used and effective – down sowing tubes
DIAZINON	DIAZINON 20G		1B	14	No record of use
Carrot weevil (*Listronotus oregonensis or L. texanus*)					Low priority
PHORATE	Thimet 20G		1B	56	No record of use

Registered
Actives under review in NZ
Actives under review in Aust

Table 4: Herbicides registered for weed control in carrots or vegetables.

Active ingredient	Common Trade Name	Registration in Carrots	Resistance group (Aust)	WHP (days)	Comments
FLUAZIFOP-P-BUTYL	Fusilade WG		A	35	Commonly used early post emergent for grass weeds
SETHOXYDIM	Poast		A	35	No record of use
CLETHODIM	Arrow		A	35	Commonly used early post emergent for grass weeds
LINURON	Linuron		C	Not available	Use pre-emergent. Major product used post emergent & very effective.
METRIBUZIN	Lexone DF		C	Not available	Commonly used and effective - used pre and post emergent
PROMETRYN	Gesagard 500		C	Not available	Commonly used and effective - used pre and post emergent
PROPAZINE	Gesamil		C	Not available	No record of use
PENDIMETHALIN	Stomp Xtra		D	Not required	Commonly used and effective - used pre emergent only. Not effective on wireweed
TRIFLURALIN	Trifluralin		D	Not required	No record of use
CHLORPROPHAM	Alliacine		E	Not required	No record of use
GLYPHOSATE	Roundup	Vegetables - Pre-plant weed control	M	Not required	No record of use
GLYPHOSATE-TRIMESIUM	Touchdown	Vegetables - Pre-plant weed control	M	Not required	No record of use
PARAQUAT	Gramoxone	Vegetables - Inter-row weed control	L	Not required	No record of use
PINE OIL	Organic Interceptor	Vegetables - Pre-plant weed control and Inter-row weed control		Not required	No record of use
OXYFLUORFEN	Goal	Vegetables - Pre-plant weed control	G	Not required	No record of use

Registered

Table 5: Fungicides recorded as being used off-label in carrots for registered pests.

Active ingredient	Common Trade Name	Crops registered for this use	Resistance group (Aust)	WHP (days) alternative crops	Comments
Leaf spot, Cercospora leaf spot or Cercospora blight (*Cercospora carotae*)					**High priority** – major problem
AZOXYSTROBIN	Amistar	Potatoes & tomatoes	K	14	Protectant and eradicant, systemic fungicide - occasionally used and effective
CYPROCONOZOLE	Alto	Nil	C	Not available	Protectant and eradicant, contact & systemic fungicide - occasionally used and effective
CHLOROTHALONIL	Bravo Weatherstik	Black currants, potatoes and tomatoes	Y	Not listed	Protectant, contact fungicide - occasionally used and effective
Early Blight (*Alternaria dauci*)					**High priority** – major problem
AZOXYSTROBIN	Amistar	Potatoes & tomatoes	K	14	Protectant and eradicant, systemic fungicide - occasionally used and effective
CYPROCONOZOLE	Alto	Nil	C	Not available	Protectant and eradicant, contact & systemic fungicide - occasionally used and effective
CHLOROTHALONIL	Bravo Weatherstik	Black currants, potatoes and tomatoes	Y	Not listed	Protectant, contact fungicide - occasionally used and effective
DIFENOCONAZOLE	Score	Carrots	C	14	Not registered for this use. Protectant and eradicant, contact & systemic fungicide - occasionally used and effective
Sclerotinia rot (*Sclerotinia sclerotiorum*)					Medium priority – moderate problem
PROCYMIDONE	Sumisclex	Beans, cucurbits & tomatoes	B	3	Protectant and localised systemic, contact fungicide - occasionally used and effective
CARBENDAZIM	Prolific	Beans, Kiwifruit, lettuce, and tomatoes	A	beans – 14 lettuce – 21 tomato - 3	Protectant and localised systemic, contact fungicide - occasionally used and effective

Actives under review in NZ
Actives under review in Aust

Table 6A: Insecticides recorded as being used off-label in carrots for registered pests.

Active ingredient	Common Trade Name	Crops registered for this use	Resistance group (Aust)	WHP (days) alternative crops	Comments
Carrot rust fly (*Psila rosae*)					**High priority** – major problem
IMIDACLOPRID	Gaucho	nil	4A	Not applicable	Systemic seed treatment – range of soil, sucking and chewing insects. Record that it has been used. Efficacy unknown.

Table 6B: Insecticides recorded as being used off-label in carrots for unregistered pests.

Active ingredient	Common Trade Name	Crops registered for this use	Resistance group (Aust)	WHP (days) alternative crops	Comments
Manuka beetle (*Pyronota festiva*)					**High priority** – especially Ohakune
PHORATE	Thimet 20G	Carrot	1B	56	Registered for Carrot weevil – use unknown, but recorded.
TEBUFOS	Counter	Maize and sweet corn	1B	42	Use unknown, but recorded.
White-fringed weevil (*Naupactus leucoloma*)					Medium priority - occasional problem
FIPRONIL	Ascend	Citrus & vegetable brassicas	2C	2 (brassicas)	Use unknown, but recorded.
Wireworm (*Heteroderus spp.*)					Medium priority – occasional problem
CHLORPYRIFOS	Lorsban	none	1B	10 (various vegetables)	Use unknown, but recorded.
DIAZINON	Diazinon	none	1B	14 (various vegetables)	Use unknown, but recorded.
PYRETHROIDS	various	none	3A	3 (brassicas) 14 (onions)	Use unknown, but recorded.
Vegetable weevil (*Listroderes obliquus*)					Low priority
ORGANOPHOSPHATES	various	none	1B	10 (various vegetables)	Use unknown, but recorded.
PYRETHROIDS	various	none	3A	3 (brassicas) 14 (onions)	Use unknown, but recorded.

Actives under review in NZ
Actives under review in Aust

Table 7: Herbicides recorded as being used off-label in carrots for registered pests.

Active ingredient	Common Trade Name	Crops registered for this use	Resistance group (Aust)	WHP (days) alternative crops	Comments
Grass weeds					Moderate priority
HALOXYFOP	Gallant	Asparagus, peas, lentils & onions	A	35 (onions)	Selective, post-emergent grass herbicide in the same agrichemical group as Fusilade. Record that it has been used.

Table 8: Fungicides with activity on specific carrot diseases.

Disease name	Active ingredient	Common Trade Name	Registration	Resistance group	Comments
Leaf spot, Cercospora leaf spot or Cercospora blight *Cercospora carotae*	AZOXYSTROBIN	Amistar	No registration in carrots but effective. Registered in various vegetable crops but Cercospora not mentioned on any crop	K	Protectant/eradicant, systemic fungicide. Currently being used with good effect.
	CARBENDAZIM	Carbendazim	Not registered in carrots in NZ. Registered in Aust for Cercospora control in clover	A	Protectant, systemic fungicide.
	CHLOROTHALONIL	Bravo	No registration in carrots but effective. Registered in various vegetable crops. Registered in Aust in peanuts, celery & cucurbits for Cercospora.	Y	Protectant, contact fungicide. Currently being used with good effect
	COPPER	various	Registered in 'vegetables' for Early blight of carrots. Registered in Aust in bananas & celery for Cercospora.	Y	Protectant, contact fungicide. Currently being used for other diseases.
	CYPROCONAZOLE	Alto	No registration in carrots but effective. Registered in various vegetable crops. Registered in Aust in peanuts for Cercospora.	C	Protectant/curative, systemic fungicide. Currently being used with good effect
	METIRAM	Polyram	Not registered in carrots NZ. Registered in Aust for Cercospora control in carrots.	Y	Protectant, contact fungicide. Similar to mancozeb, but IPM compatible.
	PYRACLOSTROBIN	Comet	Comet (Cabrio in Aust) not registered in carrots in NZ but Cornell Uni list as reasonably effective on Cercospora Leaf Spot in carrots. Not registered in any vegetable crop	K	Protectant/eradicant, systemic fungicide.
	ZINEB	Zineb	No registration in NZ but effective. Registered in carrots in Aust for Cercospora in carrots	Y	Protectant, contact fungicide. Similar to mancozeb

Table 8 (continue)

Disease name	Active ingredient	Common Trade Name	Registration	Resistance group	Comments
Early blight *Alternaria dauci*	AZOXYSTROBIN	Amistar	No registration in carrots but effective. Permits in Australia for Alternaria in brassicas, carrots and cucumber.	K	Protectant/eradicant, systemic fungicide. Currently being used with good effect.
	CARBENDAZIM	Carbendazim	Not registered in carrots in NZ.	A	Protectant, systemic fungicide.
	CHLOROTHALONIL	Bravo	No registration in carrots but effective. Registered in Australia for Alternaria in tomatoes & ornamentals.	Y	Protectant, contact fungicide. Currently being used with good effect
	CYPROCONAZOLE	Alto	No registration in carrots but effective. Registered in various vegetable crops.	C	Protectant/curative, systemic fungicide. Currently being used with good effect
	DIFENOCONAZOLE	Score	Registration in carrots for Cercospora. Registered in Australia for Alternaria in carrots.	C	Protectant/curative, systemic fungicide. Currently being used with good effect
	IPRODIONE	Rovral	No registered for Alternaria in carrots. Rovral registered for Alternaria control in tangelos. Registered in Australia for Alternaria in potato & tomato.	B	Protectant/eradicant, contact fungicide. Similar to Sumisclex.
	METIRAM	Polyram	No registration in carrots in NZ but effective. Registered in Australia for Alternaria in carrots.	Y	Protectant, contact fungicide. Similar to mancozeb, but IPM compatible.
	PROCYMIDONE	Sumisclex	No registered for Alternaria in carrots. Registered in Australia for Alternaria in potato.	B	Protectant/eradicant, contact fungicide. Similar to Rovral.
	PYRACLOSTROBIN	Comet	Not registered in carrots NZ but Cornell Uni list as effective on Alternaria in carrots	K	Protectant/eradicant, systemic fungicide. Similar to Amistar.
	ZINEB	Zineb	No registration in carrots in NZ but effective. Is registered in carrots Australia for Alternaria control	Y	Protectant, contact fungicide. Similar to mancozeb.

Table 8 (continue)

Disease name	Active ingredient	Common Trade Name	Registration	Resistance group
Sclerotinia rot *Sclerotinia sclerotiorum*	AZOXYSTROBIN	Amistar	No reference to Sclerotinia on labels in NZ. Sclerotinia on Amistar Australian label for field tomatoes	K
	BOSCALID	Filan	Registered and permits in many vegetables in Australia for Sclerotinia.	G
	CARBENDAZIM	Carbendazim	Carrot not on any label. Sclerotinia listed for Tomato, lettuce, beans.	A
	CHLOROTHALONIL	Bravo	No registration in carrots.	Y
	FLUAZINAM	Shirlan	No registration in carrots but registered for Sclerotinia in potato.	Y
	PROCYMIDONE	Sumisclex	No reference to Sclerotinia on carrot however Sclerotinia listed for tomatoes, cucurbits and beans.	B
	THIABENDAZOLE	Tecto	No registration in carrots.	A
	THIOPHANATE-METHYL	Topsin	No registration in carrots however Sclerotinia in tomatoes is registered.	A
Pythium root rot or Cavity spot *Pythium violae*	ETRIDIAZOLE	Terrazole	Registered for 'damping off and root rot' in ornamentals not vegetables.	X
	METALAXYL-M	Apron	No registration in carrots. Apron registered for 'Pythium control by seed treatment on brassicas, lucerne and peas.'	D
Violet root rot *Rhizoctonia crocorum*	AZOXYSTROBIN	Amistar	No reference to Rhizoctonia on labels in NZ. Rhizoctonia on Australian label for peanuts & potatoes.	K
	CHLOROTHALONIL	Bravo	No reference to Rhizoctonia on labels in NZ. Rhizoctonia on Australian label for cucurbits and turf.	Y
Rhizoctonia root rot *Rhizoctonia solani*	IPRODIONE	Rovral	No reference to Rhizoctonia on labels in NZ. Registered in Australia for Rhizoctonia in potato.	B
Powdery Mildew *Erysiphe polygoni*	AZOXYSTROBIN	Amistar	No registration for carrots. Registered for Powdery Mildew in peas.	K
	BUPIRIMATE	Nimrod	Not registered for carrots. Powdery Mildew listed for pumpkins, squash and apples.	H
	CARBENDAZIM	Carbendazim	Not registered in carrots.	A
	CHLOROTHALONIL	Bravo	Not registered in carrots. Controls powdery mildew in cucurbits & grapes.	Y
	CYPROCONAZOLE	Alto	No reg. in carrots. Reg. for PM control in grapes and peas	C
	DIFENOCONAZOLE	Score	No reg. in cucurbits. Reg. for PM control in apples	C

Table 8 (continue)

Disease name	Active ingredient	Common Trade Name	Registration	Resistance group
Powdery Mildew *Erysiphe polygoni*	EPOXYCONAZOLE	Opus	No reg. in cucurbits. Reg. for PM in barley and wheat	C
	FENAMIROL	Rubigan	Not registered in carrots however reg. for PM control in peas, pip fruit and grapes	C
	FLUSILAZOLE	Nustar	Not registered on carrots however Powdery Mildew listed for apples	C
	KRESONIM-METHYL	Stoby	Not registered on carrots however Powdery Mildew listed for apples	K
	MYCOBUTANIL	Systhane	Not registered in carrots however Powdery Mildew listed for pip fruit and grapes	C
	PENCONAZOLE	Topas	Not registered in carrots. Powdery Mildew listed for peas, grapes, cucurbits and apples	C
	POTASSIUM BICARBONATE	Ecocarb	Not registered in carrots however controls powdery mildew in tomatoes, cucurbits, strawberries, apples and grapes.	X
	TRIADIMEFON	Miltek	No reg. in carrots. Reg. for PM control in grapes and peas and cucumbers	C
	SPIROXAMINE	Impulse	No reg. for carrots however reg. for powdery mildew in grapes, wheat and barley	K
	TEBUCONAZOLE	Orius	No reg. in carrots. Reg. for PM control in peas and wheat	C
	THIOPHANATE-METHYL	Topsin	Not registered for carrots. Lists ornamental for powdery mildew control	A
	TOLYFLUANID	Euparean Multi	Could not find any reference	X
	TRIADEMENOL	Cereous	Cereous - could not find a copy of label for NZ. Bayfidan. Reference to 'powdery mildew control in peas' on Tribute label	C
	TRIFLOXYSTROBIN	Flint	Not registered for carrots however controls Powdery Mildew in apples, winter squash and pumpkins	K
	TRIFORINE	Saprol	Not registered in carrots however Powdery Mildew listed for apples, tamarillo and cucurbits.	X

Actives under review in NZ
Actives under review in Aust

Table 9: Nematicides with activity on specific carrot nematodes.

Disease name	Active ingredient	Common Trade Name	Registration	Resistance group
Root Knot Nematode (Meloidogyne spp)	CADUSAFOS	Rugby	No registration in NZ. Registered in Australia in bananas, ginger, sugarcane, tobacco and tomatoes.	1A

Table 10A: Insecticides with activity on key carrot insect pests.

Insect name	Active ingredient	Common Trade Name	Registration	Resistance group	Comments
Carrot Rust Fly *Psila rosae*	IMIDACLOPRID	Gaucho	Carrot Rust fly not mentioned for any crops in NZ	4A	Systemic seed treatment with wide spectrum of activity
Manuka beetle *Pyronota festiva*	PHORATE	Phorate	No mention of Manuka beetle on label. Registered in carrots for aphids, carrot root weevil and carrot rust fly.	1B	Systemic soil applied insecticides.
	TEBUFOS	Counter 20G	No mention of Manuka beetle on label	1B	Systemic soil applied insecticides.

Table 10B: Insecticides with activity on specific carrot insect pests.

Insect name	Active ingredient	Common Trade Name	Registration	Resistance group
Aphids	ALPHA-CYPERMETHRIN	Dominex / Fastac	No registration in NZ. Aphids' listed for tomatoes.	3A
	Beauvaria bassiana	Botanigard ES	Product availability in NZ ??	Bio-insecticide
Melon aphid *Aphis gossypii*	AZADIRACHTIN	NeemAzal-T/S	Not registered on any vegetable and only on non-fruit bearing trees and vines however mentions aphid control	Botanical
Potato aphid *Macrosiphum euphorbiae*	BIFENTHRIN	Talstar 100EC	Reg. on field tomatoes, pumpkins, squash for 'aphids'	3A
Carrot willow aphid *Cavariella aegopodii*	CARBARYL	Sevin	No listing of aphids on any crop	1A
Carrot black aphid *Cavariella aegopodii*	DIAZINON	Diazinon 800	Reg. on tomato, cauliflower, cabbage and onion for 'aphids'	1B
Fox Glove aphid *Aulacorthum solani*	ENDOSULFAN	Thiodan	Reg. on tomato, vegetable brassica and potato	2A
Lettuce Aphid *Nasonovia ribis-nigri*	IMIDACLOPRID	Gaucho	Reg. on potato and squash for 'aphids'	4A
Sow thistle aphid	IMIDACLOPRID	Confidor	Registered for CA on vegetable brassicas and lettuce	4A
Green Peach Aphid *Myzus persicae*	Lecanicillium lecanii blastospores	??	Product availability in NZ ??	
Black Peach Aphid *Brachycaudus persicae*	CHLORPYRIFOS	Lorsban 50EC	Reg for 'aphids' in winter squash and vegetable brassicas	1B
	DELTAMETHRIN	Decis Forte	Reg. for 'aphids' in squash	3A
	PYMETROZINE	Chess WG	Reg, in tomato, vegetable brassica, lettuce and potato	9A
	METHOMYL	Lannate L	Reg. for GPA in tomato, cauliflower, cabbage and lettuce	1A
	PERMETHRIN	Permigas	Reg. in GH capsicum	3A
	PERMETHRIN + PIRIMIPHOS-METHYL	Attack	Reg. for 'aphids' in GH tomato, cucurbits group and vegetable brassica	3A+1B
	PIRIMICARB	Pirimor 50	Reg. on tomato, cucurbits group, vegetable brassicas and lettuce	1A
	PIRIMIPHOS-METHYL		Only available alone for stored insects	1B
	THIOPHANATE- + CHLOROTHALONIL + T-FLUVALINATE	Guardall	Reg. for 'aphids' on tomato	3A
	TERBUFOS	Counter 20G	Aphids listed for forage brassicas as a seed/fertiliser treatment	1B
	ACEPHATE	Orthene	Reg. for 'aphids' in lettuce and potato	1B
	METHAMIDOPHOS	Tamaron	Reg. for 'aphids' in potato	1B

Table 10 (continue)

Insect name	Active ingredient	Common Trade Name	Registration	Resistance group
BEETLES				
Black beetle *Heteronychus spp.*	LAMBDA-CYHALOTHRIN	Karate	Only beetles listed are bronze and grass grub beetles in grapes	3A
	METHAMIDOPHOS	Tamaron	No 'beetles' listed on labels	1B
Grassgrub Beetle *Oncopera spp.*	DIAZINON	DIAZINON	Reg. for established pastures	1B
	IMIDACLOPRID	Gaucho	Reg. for 'grass grub beetle in squash	4A
	PHORATE	Phorate	Grass Grub not listed on Phorate label for any crop	1B
	TERBUFOS	Counter	Controls 'grass grub' in new pastures/cereals	1B
Cabbage Leaf Miner *Liriomyza brassicae*	DIMETHOATE	Dimethoate	Aust label lists 'leaf miners' for vegetables	1B
	ENDOSULFAN	Thiodan	Aust label lists 'leaf miners' for tobacco and beet leafminer in beetroot	2A
	SYNTHETIC PYRETHROIDS		Checked the most common SP labels. No 'leafminer' mentioned	3A
BUGS				
Mealy Bugs *Pseudococcus spp.*	AZADIRACHTIN	NeemAzal-TS	Not registered on any vegetable and only on non-fruit bearing trees and vines however mentions mealy bug control	Biological
	CARBARYL	Sevin	Mealy bug control in pip fruit	1A
	BUPROFEZIN	Applaud / Ovation	Mealy bug listed for peaches, grapes, persimmons, pip fruit	17A
	IMIDACLOPRID	Gaucho	Mealy bug not listed on label in NZ	4A
	THIACLOPRID	Calypso	Mealy bug control reg. for apples however no vegetable crop	4A
	PROTHIOFOS	Tokuthion	Controls mealy bug in grapes and pip fruit	1B
Green Vegetable Bug *Nezara viridula*	CARBARYL	Sevin	Green Veg. Bug not listed for any crop in NZ	1A
	ENDOSULFAN	Thiodan	Reg. for GVB control in tomato	2A
	IMIDACLOPRID + CYFLUTHRIN	Confidor Supra	Lists Green Vegetable Bug for sweet corn	4A+3A
	IMIDACLOPRID	Confidor	Green Vegetable Bug not listed on Confidor label in NZ or AU	4A
	METHAMIDOPHOS	Tamaron	Listed on maize/sweet corn for Green veg bug	1B
	TRICHLORFON	Trifon	Reg. for tomato	1B

Table 10 (continue)

Insect name	Active ingredient	Common Trade Name	Registration	Resistance group
Nyssius Wheat Bug Nysius huttoni	CHLORPYRIFOS	Lorsban	Nyssius listed for forage brassicas	1B
	ENDOSULFAN	Thiodan	Nyssium listed for forage brassicas	2A
	FENITROTHION	Caterkil 1000	Listed for forage brassicas	1B
	PHORATE	Phorate	Reg. for 'Nyssius' in forage brassica	1B
	TERBUFOS	Counter 20G	Nyssius listed for forage brassicas with seed or fertiliser	1B
CATERPILLARS	ACEPHATE	Orthene	Reg. in tomato, vegetable brassicas, lettuce and potato	1B
	CHLORPYRIFOS	Lorsban	Caterpillar listed for maize	1B
Copper caterpillar *Lycaena salustius*	DELTAMETHRIN	Decis Forte	Reg, in field tomato, potato and vegetable brassicas	3A
Corn Earworm or Tomato Fruitworm *Helicoverpa armigera*	CARBARYL	Sevin	Corn Ear Worm listed for Maize/Sweet corn in NZ	1A
	ALPHA-CYPERMETHRIN	Alpha scud	Corn Ear Worm listed for Maize/Sweet corn in NZ	3A
	CHLORPYRIFOS	Lorsban	Corn Ear Worm listed for Maize/Sweet corn in NZ	1B
	DELTAMETHRIN	Delfin WG	Corn Ear Worm listed for Maize/Sweet corn in NZ	3A
	METHOMYL	Lannate L	Corn Ear Worm listed for Maize/Sweet corn in NZ	1A
	TRICHLORFON + CYPERMETHRIN	Partna	Corn Ear Worm listed for Maize/Sweet corn in NZ	1B+3A
	CYPERMETHRIN	Ripcord	Corn Ear Worm listed for Maize/Sweet corn in NZ	3A
	ESFENVALERATE	Sumi-Alpha	Corn Ear Worm listed for Maize/Sweet corn in NZ	3A
	TRICHLORFON	Trifon	Corn Ear Worm listed for Maize/Sweet corn in NZ	1B
	Acephate	Orthene	Corn earworm not listed on NZ label	1B
	Bacillus thuringiensis	Agree	Registered in other vegetables, but not for corn earworm	Bio-insecticide
	IDOXACARB	Steward 150SC	Corn earworm not listed on NZ label	22A
	SPINOSAD	Spinosad Naturalyte	Reg, in field tomato, cauliflower and cabbage	5A
	THIOPHANATE- + CHLOROTHALONIL + T-FLUVALINATE	Guardall (Home garden)	Reg, in tomato and cabbage	3A

Table 10 (continue)

Insect name	Active ingredient	Common Trade Name	Registration	Resistance group
Corn Earworm or Tomato Fruitworm *Helicoverpa armigera*	TRICHLORFON	Trifon	Reg, in tomato and vegetable brassica	1B
	TRICHLORFON + CYPERMETHRIN	Partna	Reg. in cauliflower, cabbage and tomato	1B+3A
	Beauvaria bassiana	Botanigard ES, Naturalis-O	Product in NZ ?	Bio-insecticides
	FIPRONIL	Ascend		2C
	IDOXACARB	Steward 150SC	Reg. in 'head' lettuce, cauliflower, cabbage and Brussel sprouts	22A
	ENDOSULFAN	Thiodan	Reg. for various caterpillars in tomato, vegetable brassica and potato	2A
Cutworm *Agrostis spp.*	ALPHA-CYPERMETHRIN	Dominex / Fastac	Reg. in tomato and vegetable brassica	3A
Greasy cutworm *Agrotis ipsilon*	ENDOSULFAN	Thionex	Reg. for various caterpillars in vegetable brassicas and potato	2A
Green lopper *Thysanoplusia orichalcea*	METHAMIDOPHOS	Tamaron	Reg. for various caterpillars in tomato, vegetable brassica and potato	1B
Potato Tuber Moth *Phthorimaea operculella*	Beauvaria bassiana	Botanigard ES, Naturalis-O	Can't find a product in NZ	Bio-insecticides
	BIFENTHRIN	Talstar	Reg, in vegetable brassicas and field tomato	3A
	CYPERMETHRIN	Ripcord	Reg, in cauliflower, cabbage and tomato	3A
	ESFENVALERATE	Sumi-Alpha	Reg, in tomato, cucurbits group, vegetable brassicas, potato and onion	3A
	FIPRONIL	Ascend	Can't find a reference to a product	2C
	IDOXACARB	Steward 150SC	Reg. in 'head' lettuce, cauliflower, cabbage and Brussel sprouts	22A
	LAMBDA-CYHALOTHRIN	Karate	Reg, in field tomato, vegetable brassica and potato	3A
	METHOMYL	Lannate L	Reg. cauliflower, cabbage, lettuce and tomato	1A
	PERMETHRIN + PIRIMIPHOS	Attack	Reg, in GH tomato, cucurbits group and vegetable brassicas	3A+1B
	SPINOSAD	Spinosad Naturalyte	Reg, in field tomato, cauliflower and cabbage	5A
	TRICHLORFON	Trifon	Reg, in tomato and vegetable brassica	1B
	TRICHLORFON + CYPERMETHRIN	Partna	Reg. in cauliflower, cabbage and tomato	1B+3A

Table 10 (continue)

Insect name	Active ingredient	Common Trade Name	Registration	Resistance group
Leafroller *Trotricidae spp.*	Bacillus thuringiensis sub. Aizawai	Dipel/Xentari	Bt for leafroller control listed for a number of crops	11C
Tomato stem borer *Symmetrischema plaesiosoma*	DIAZINON	Diazinon 800	Reg. in tomato, vegetable brassicas and onion for 'caterpillars'	1B
Tropical Caterpillar *Spodoptera litura*	*Bacillus thuringiensis sub.Xen tari*	Xentari	Reg. in vegetable brassicas and GH tomato	11C
White Butterfly *Pieris rapae*	TAU-FLUVALINATE	Mavrik	Reg. in cabbage and field tomato	3A
MITES				
European Red Mite *Bradysia spp.*	CLOFENTEZINE	Apollo 50SC	Label lists TSM and ERM for various crops but not vegetable crops	10A
Tomato Russet Mite *Aceria lycopersici*	DICHLORVOS	Divap	Mites 3	1B
Two-Spotted Mite *Tetranychus urticae*	ABAMECTIN	Avid	TRM, TSM listed for GH Tomato ERM listed for pipfruit	6A
	AZOCYCLOTIN	Peropal	No Reg. in Vegetable Crops. Controls TSM and ERM in various fruit crops	
	FENPYROXIMATE	Fenamite	Reg. for TSM, ERM in pipfruit	21A
	MILBEMECTIN	Mit e mec	Reg for TSM, ERM in apples	6B
	Phytoseiulus persimilis		Two spotted mite predator	Bio-insecticide
	PROPARGITE	Omite 30W	No Reg. in Vegetable Crops. TSM and ERM control in various crops	14A
	TAU-FLUVALINATE	Mavrik Flo	Reg. for Mites in Ornamentals	3A
Potato psyllid *Psyllidae spp.*	ABAMECTIN	Avid	Psyllids not listed for any crop	6A
	BUPROFEZIN	Applaud	Psyllids not listed for any crop	17A
	DIMETHOATE	Dimethoate	Aust labels list 'Psyllids(lerps) control in non fruit and non veg.	1B
	ENDOSULFAN	Thiodan	Psyllids not listed for any crop	2A
	ESFENVALERATE	Sumi-Alpha	No mention of Psyllids on label for any crop	3A
	IMIDACLOPRID	Confidor	Confidor (Aust) lists psyllid control in non-bearing citrus	4A

Table 10 (continue)

Insect name	Active ingredient	Common Trade Name	Registration	Resistance group
Potato psyllid *Psyllidae spp*	METHOMYL	Lannate L	Psyllids not listed for any crop	1A
	ORGANOPHOSPHATES		Checked the most common OP labels. No psyllid mentioned	1B
	PYMETROZINE	Chess WG	Psyllids not listed for any crop	9A
	SPINOSAD	Naturalyte	Psyllids not listed for any crop	5A
	PYRETHROIDS		Checked the most common SP labels. No psyllid mentioned	3A
Rats *Ratus spp.*	ALUMINIUM PHOSPHIDE	Genfume AP	Registered product in NZ	8B
	BRODIFACOUM	Talon	Registered product in NZ	
	BROMADIOLONE	Rid Rat Super	Registered product in NZ	
	Corn Cob -powdered'	No rats	Registered product in NZ	
	COUMATETRALYL	Racumin	Registered product in NZ	
	DIPHACINONE	Pest Gone Rodent Bait	Registered product in NZ	
	FLOCOUMAFEN	Storm Secure	Registered product in NZ	
	HYDROCYANIC ACID	Cyanosil	Registered product in NZ	8B
	METHYL BROMIDE	Ag Fume M.B.	Registered product in NZ	8A
Sciarid Flies *Bradysia spp.*	Bacillus thuringiensis israelensis	VictoBac 12AS	Label lists mosquitoes and black flies	Bio-insecticide
	DICHLORVOS	Divap	Reg. for 'scariad fly' in GH tomato, GH capsicum	1B
	IMIDACLOPRID	Gaucho	Sciarid fly control not mentioned for any crop	4A
Springtails Collebola spp.	CHLORPYRIFOS	Lorsban	Springtails listed on forage brassica labels	1B
	DIAZINON	Diazinon 800	Reg. for 'springtails' in vegetable brassica	3A
	FURATHIOCARB	Promax 400 CS	Springtails listed on forage brassica labels as a seed treatment	
	IMIDACLOPRID	Gaucho	Listed for squash and forage brassicas	4A
	PHORATE	Phorate	Reg. for 'springtails' in forage brassicas	1B
	TERBUFOS	Counter 20G	Springtails listed for brassica vegetables as a seed/fertiliser treatment	1B

Table 10 (continue)

Insect name	Active ingredient	Common Trade Name	Registration	Resistance group
Symphillids	DIAZINON	Diazinon 800		1B
	LAMBDA-CYHALOTHRIN	Karate		3A
	METHAMIDOPHOS	Tamaron		1B
Thrips	ALPHA-CYPERMETHRIN	Dominex/Fastac	Reg. in tomato and onions	3A
	CHLORPYRIFOS	Lorsban 750 WG	Reg. in kumara for 'thrips'	1B
	DELTAMETHRIN	Decis Forte	Reg. in kumara for 'thrips'	3A
	ENDOSULFAN	Thionex EC	Reg. in kumara and tomato for 'thrips'	2A
Cucumerous (Cucumber) thrips	*Amblyseius cucumeris*	Mite-A, Thripex	Reg. on GH tomato, GH capsicum and GH cucumber	Bio-insecticides
	AZADIRACHTIN	NeemAzal-T/S	Not registered on any vegetable and only on non-fruit bearing trees and vines however mentions thrips control	Botanical insecticide
	CARBARYL	Sevin	No thrips control in any veg. crop however controls thrips in fruit crops	1A
	DIAZINON	Diazinon 800	Reg. for 'thrips' on tomato, vegetable brassicas and onions	1B
	DICHLORVOS	Divan	Reg. for 'thrips' on GH tomato and GH capsicum	1B
	Hypoaspis aculeifer	Hypomite	Thrips pupae	Bio-insecticides
	LAMBDA-CYHALOTHRIN	Karate	Reg. for 'onion thrips' on onions	3A
	Lecanicillium lecanii blastospores		NZ registration ??	Bio-insecticide
	MALATHION	Malathion	Thrips listed on various fruit crops however no vegetables	1B
	METHAMIDOPHOS	Tamaron	Reg. for thrips on onion	1B
	PYRETHRUM	Garlic & Pyrethrum	Thrips	3A
	TAU-FLUVALINATE	Mavrik	Reg. for thrips on onion	3A
	THIACLOPRID	Calypso	Thrips listed on avocados, peaches and nectarines but not any vegetable	4A

Table 10 (continue)

Insect name	Active ingredient	Common Trade Name	Registration	Resistance group
Onion Thrips *Thrips tabaci*	FIPRONIL	Ascend	No mention of thrips on NZ label	2C
Intonsa Flower Thrips *Frankliniella intonsa*	IMIDACLOPRID + CYFLUTHRIN	Confidor Supra	Reg. for 'thrips' on onion	4A + 3A
Western Flower Thrips *Frankliniella occidentalis*	IMIDACLOPRID	Confidor	Reg. for 'thrips' on onion	4A
Weevils	FURATHIOCARB	Promax 400 CS	Various weevils on a range of crops as a seed treatment	
	IMIDACLOPRID	Gaucho	Various weevils listed	4A
Black Vine Weevil Larvae *Otiorhynchus sulcatus*	TERBUFOS	Counter 20G	Listed for weevil control in forage brassicas as a seed/fertiliser treatment	1B
White fringed weevil *Naupactus leucoloma*	CHLORPYRIFOS	Suscon Green (granule)	Only ornamentals and flowering plants	1B
Plant Weevils *Curculionidae spp.*	*Heterorhabditis bacteriophora*	Otinem	Ornamentals only'	bio-insecticide
Stem weevil *Listronotus bonariensis*	FIPRONIL	Ascend	Weevils not listed on label for any crop	2C
Carrot Weevil *Listronotus oregonensis* and *L. texanus*	LAMBDA-CYHALOTHRIN	Karate	Fulllers rose weevil listed for citrus only	3A
Vegetable weevil *Listroderes obliquus*	DIAZINON	DIAZINON	No weevil listed on label	1B
	METHAMIDOPHOS	Tamaron	No weevils listed on label	1B
	PHORATE	Phorate	Weevils list for forage brassica	1B
Whiteflies	THIACLOPRID	Calypso	Whitefly not listed on Calypso label	4A
	BUPROFEZIN	Applaud / Ovation	Reg. on GH tomato, GH capsicum, GH cucumber, melon and zucchini	17A
	ENDOSULFAN	Thiodan	Reg, for whitefly on tomato	2A
Tobacco Whitefly (Silverleaf) *Bemisia tabaci (biotype B)*	AZADIRACHTIN	NeemAzal-T/S	Not registered on any vegetable and only on non-fruit bearing trees and vines however mentions whitefly control	Botanical insecticide

Table 10 (continue)

Insect name	Active ingredient	Common Trade Name	Registration	Resistance group
Tobacco Whitefly (Silverleaf) *Bemisia tabaci (biotype B)*	IMIDACLOPRID	Gaucho	No Whitefly control for any crop	4A
	Lecanicillium lecanii blastospores		NZ registration ??	
	Encarsia formosa	En-force, En-Strip	Reg. on GH tomato, GH capsicum and GH cucumber	Bio-insecticides
	DICHLORVOS	Divap	Reg. for 'whitefly on GH tomato and GH capsicum	1B
	PYMETROZINE	Chess WG	Reg. for 'whitefly' on GH and field tomato	9A
	METHOMYL	Lannate L	Reg. for 'whitefly' on GH tomato, GH capsicum and GH cucumber	1A
	PIRIMIPHOS-METHYL	Actellic	Reg. for 'under glass' tomato and cucurbits group	1B
	PERMETHRIN + PIRIMIPHOS-METHYL	Attack	Reg. for GH tomato	3A+1B
Wireworm *Heteroderus spp.*	ACEPHATE	Orthene	No listing for 'wireworm' for any crop	1B
	CHLORPYRIFOS	Suscon or Chlorpyrifos	Wireworm not found on label for any crop	1B
	DIAZINON	diazinon	Wireworm not found on label for any crop	1B
	PHORATE	Phorate	Reg. for 'cucurbits' squash and potato	1B
	SYNTHETIC PYRETHOIDS	Various	Wireworm not found on label for any crop	3A

Actives under review in NZ
Actives under review in Aust

Table 11: Herbicides with activity on specific carrot weeds.

Active ingredient	Common Trade Name	Registration	Resistance group
BENTAZONE	Basagran		C
ALACHLOR	Alanex /Lasso		
CHLORIDAZON	Chloronion		C
CHLORPROPHAM	Alliacine 40EC	Carrots	E
CHLORTHAL DIMETHYL	Dacthal 75W		D
CLOMAZONE	Magister		F
CYANAZINE	Bladex 90WG		C
DALAPON	Dalapon		J
DIMETHENAMID	Frontier		
ENDOTHAL	Des-i-cate 11		K
FLUAZIFOP-P-BUTYL	Fusilade WG	Carrots	A
CLETHODIM	Arrow	Carrots	A
HALOXYFOP	Gallant NF		A
IOXYNIL	Elliotril		C
IOXYNIL + FLUROXYPYR	Twin Star		C+I
LINURON	Linuron	Carrots	C
METHABENZTHIAZURON	Tribunil		C
METRIBUZIN	Lexone DF	Carrots	C
OXADIAZON	Foresite		G
OXYFLUORFEN	Goal 40 WP		G
PENDIMETHALIN	Stomp Xtra	Carrots	D
PROMETRYN	Gesagard 500	Carrots	C
PROPACHLOR	Ramrod Flowable		K
PROPAZINE	Gesamil	Carrots	C
PROPYZAMIDE	Kerb 500F		K
QUIZALOFOP-P-ETHYL	Targa		A
SETHOXYDIM	Poast	Carrots	A
S-METOLACHLOR	Dual Gold		K
SULFENTRAZONE	Authority		
TERBUTHYLAZINE	Assett		C
TERBUTRYN + TERBUTHYLAZINE	Battalion		**C**
THIFENSULFURON-METHYL	Harmony		**B**
TRIBENURON-METHYL	Granstar		**B**

Registered
Actives under review in NZ
Actives under review in Aust