



# KUMARA

## Strategic Agrichemical Review Process 2007

Vegetables New Zealand

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**Purpose of the report:**

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

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**Disclaimer:**

Any recommendations contained in this publication do not necessarily represent current Vegetables 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 .....  | 4  |
| The New Zealand kumara industry .....                                  | 7  |
| Introduction .....   | 7  |
| Strategic Agrichemical Review Process .....                            | 8  |
| Methods .....  | 9  |
| Results .....  | 10 |
| Discussions .....  | 11 |
| Diseases of kumara .....   | 11 |
| High priority diseases .....   | 11 |
| Fungicide in kumara for Rhizopus Soft Rot .....                        | 11 |
| Fungicide in kumara for Scurf (Black Rot) .....                        | 13 |
| Fungicide in kumara for Botrytis Rot .....                             | 14 |
| Fungicide in kumara for Pythium Root Rot .....                         | 17 |
| Fungicide in kumara for Rhizoctonia Root Rot .....                     | 18 |
| Fungicide in kumara for Sclerotinia (Pink Rot) .....                   | 20 |
| Other diseases .....   | 21 |
| New fungicide that can be pursued .....                                | 22 |
| Nematodes of kumara .....  | 23 |
| Insects of kumara .....  | 24 |
| High priority insects .....  | 24 |
| Insecticide in kumara for Lepidoptera .....                            | 24 |
| Insecticide in kumara for Black beetle .....                           | 28 |
| Insecticide in kumara for Weevils .....                                | 30 |
| Insecticide in kumara for Symphilids .....                             | 32 |
| Other insects .....  | 33 |
| New insecticides that can be pursued .....                             | 34 |
| Herbicide use in kumara .....  | 35 |
| New herbicides that can be pursued .....                               | 37 |
| New opportunities for new or alternative agrichemicals in kumara ..... | 38 |
| International collaboration with USA IR-4 program .....                | 38 |
| References .....   | 39 |
| Acronyms .....   | 39 |
| Acknowledgements .....   | 39 |
| Disclaimers .....  | 40 |
| Appendices .....   | 41 |

## Recommendations

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

The purpose of the meeting was to record a 'snap-shot' of the plant pest issues and the pest management option used in kumara. 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 issues in kumara.

### Diseases and fungicides

The high priority diseases are:

|                                  |                                 |
|----------------------------------|---------------------------------|
| Rhizopus Soft Rot (post harvest) | <i>Rhizopus oryzae</i>          |
| Scurf (Black Rot)                | <i>Monilochaetes infuscans</i>  |
| Botrytis                         | <i>Botrytis cinerea</i>         |
| Pythium Root Rot                 | <i>Pythium spp</i>              |
| Rhizoctonia Root Rot             | <i>Rhizoctonia solani</i>       |
| Sclerotinia (Pink Rot)           | <i>Sclerotinia sclerotiorum</i> |

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

| Product (active)                  | Target disease  | Action   |
|-----------------------------------|---|----------|
| Amistar (azoxystrobin)            | Rhizoctonia Root Rot<br>Sclerotinia (Pink Rot)  | New uses |
| Bravo (chlorothalonil)            | Botrytis<br>Rhizoctonia Root Rot<br>Sclerotinia (Pink Rot)  | New uses |
| Switch (cyprodinil + fludioxonil) | Botrytis  | New use  |
| Shirlan (fluazinam)               | Scurf (Black Rot)<br>Botrytis<br>Sclerotinia (Pink Rot)   | New uses |
| Fungaflor (imazalil)              | Rhizopus Soft Rot (post harvest)  | New use  |
| Rovral (iprodione)                | Rhizopus Soft Rot (post harvest)<br>Scurf (Black Rot)<br>Botrytis<br>Rhizoctonia Root Rot<br>Sclerotinia (Pink Rot) | New uses |
| Apron or Ridomil (metalaxyl)      | Pythium Root Rot  | New use  |
| Sumiscllex (procymidone)          | Scurf (Black Rot)<br>Sclerotinia (Pink Rot)   | New uses |
| Tecto (thiabendazole)             | Scurf (Black Rot)   | New use  |
| Thiram (thiram)                   | Botrytis<br>Rhizoctonia Root Rot  | New uses |

### Steps forward

1. Efficacy trials are required in the major kumara growing areas to determine the most efficacious fungicides for the control of Rhizopus Soft Rot using iprodione and imazalil; Scurf (Black Rot) using fluazinam, iprodione, procymidone and thiabendazole; Botrytis using chlorothalonil, cyprodinil + fludioxonil, fluazinam,

- iprodione and thiram; Pythium using metalaxyl; Rhizoctonia using azoxystrobin, chlorothalonil, iprodione and thiram; and Sclerotinia using azoxystrobin, chlorothalonil, iprodione and thiram; in combination with currently registered products.
- Once efficacy and the use pattern (and the withholding period) are determined, residues trials are required in the major kumara 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.
  - Provide the kumara industry with sound technical information for the control of Rhizopus Soft Rot, Scurf (Black Rot), Botrytis, Pythium, Rhizoctonia and Sclerotinia listing fungicides, use patterns and withholding periods.
  - 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:

|                               |                                 |
|-------------------------------|---------------------------------|
| Army and Tropical Caterpillar | <i>Pseudaletia spp.</i>         |
| Cutworm                       | <i>Agrostis spp.</i>            |
| Soybean looper                | <i>Thysanoplusia orichalcea</i> |
| Wireworm                      | <i>Heteroderus spp.</i>         |
| Black beetle                  | <i>Heteroderus spp.</i>         |
| White-fringed weevil          | <i>Naupactus leucoloma</i>      |
| Argentine Stem weevil         | <i>Listronotus bonariensis</i>  |
| Symphilids                    | <i>Scutigereilla immaculata</i> |

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

| <b>Product (active)</b>     | <b>Target insect</b>  | <b>Action</b> |
|-----------------------------|---|---------------|
| Karate (lambda-cyhalothrin) | Lepidoptera - Army and Tropical Caterpillar, Cutworm, Soybean looper<br>Black beetle<br>Symphilids                            | New uses      |
| Talstar (bifenthrin)        | Lepidoptera - Army and Tropical Caterpillar, Cutworm, Soybean looper<br>Black beetle<br>White-fringed & Argentine Stem weevil | New uses      |
| Lannate (methomyl)          | Lepidoptera - Army and Tropical Caterpillar, Cutworm, Soybean looper  | New uses      |
| Entrust (spinosad)          | Lepidoptera - Army and Tropical Caterpillar, Cutworm, Soybean looper  | New uses      |
| Ascend (fipronil)           | Lepidoptera - Army and Tropical Caterpillar, Cutworm, Soybean looper<br>White-fringed & Argentine Stem weevil<br>Symphilids   | New uses      |
| Steward (indoxacarb)        | Lepidoptera - Army and Tropical Caterpillar, Cutworm, Soybean looper<br>White-fringed & Argentine Stem weevil                 | New use       |
| Lorsban (chlorpyrifos)      | Black beetle<br>White-fringed & Argentine Stem weevil   | New use       |
| Confidor (imidacloprid)     | Black beetle  | New use       |

### Steps forward

1. Efficacy trials are required in the major kumara growing areas to determine the most efficacious insecticides for the control of the various lepidoptera pest using lambda-cyhalothrin, bifenthrin, methomyl, spinosad, fipronil and indoxacarb: Black beetle using lambda-cyhalothrin, bifenthrin, chlorpyrifos and imidacloprid; weevils using bifenthrin, fipronil and chlorpyrifos; and Symphilids using lambda-cyhalothrin and fipronil; in combination with currently registered products.
2. Once efficacy and the use pattern (and the withholding period) are determined, residues trials may be required in the major kumara growing areas 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 kumara industry with sound technical information for the control of lepidoptera, Black beetle, weevils and Symphilids 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:

- Fat hen (*Chenopodium spp.*)
- Willow weed (*Polygonum persicaria*)
- Blackberry nightshade (*Solanum nigrum*)
- Alligator weed (?)

In each of these cases, the weeds can be controlled with existing registered herbicides in a pre-plant situation with general knockdown herbicides (glyphosate, oxyfluorfen or paraquat), but little is available for in-crop weed control.

| <b>Product (active)</b>      | <b>Target insect</b>   | <b>Action</b> |
|------------------------------|--|---------------|
| Dacthal (chlorthal-dimethyl) | Pre-plant residual weed control of grasses and broadleaf weeds | New use       |
| Dual (S-metolachlor)         | Pre-plant residual weed control of grasses and broadleaf weeds | New use       |

### Steps forward

1. Trials are required in the major kumara growing areas to demonstrate the techniques required for effective pre-plant weed control of problem weeds with currently registered herbicides.
2. Efficacy and crop safety trials are required in the major kumara growing areas to determine if Dacthal and Dual are effective and safe. If so, residue trials will be required to comply with the default MRL (0.1 mg/kg). Some Aust residue data may be available.
3. Provide the kumara industry with sound technical information for effective pre-plant weed control of problem weeds using currently registered herbicides and the use pattern (and the withholding period) for the new herbicides.
4. Registration can be discussed with the manufacturer, otherwise a use pattern developed to comply with the NZ agrichemical regulations.

# The New Zealand kumara 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 kumara growing area is in (HortResearch<sup>1</sup>):

- Northland

There are (HortResearch<sup>1</sup>):

- 99 kumara growers
- 1,462 hectares planted
- 17,500 T produced
- \$ 33.8 million from domestic sales (2006)

There was no recorded kumara export.

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 kumara, where a problem may also 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 kumara 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.
- Jeopardising of export trading arrangements due to unacceptable agrichemical use or residue non-compliance.

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<sup>1</sup> HortResearch FreshFacts 2006

- Rejection of produce from export markets due to residue non-compliance.
- Fines and penalties

Agrichemicals have always been an important tool in the production of kumara. 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 kumara 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 kumara industry regarding limited agrichemical access, AgAware Consulting Pty Ltd in association with Horticulture New Zealand Ltd undertook a review of the agrichemical requirements in kumara 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 kumara
- 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 November 2006. This assessment provided a list of key plant pests that are of major concern to the kumara 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 kumara 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 kumara industry with sound agrichemical options for the future that can be pursued for registration with the manufacturer.

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



## Methods

SARP was conducted in Auckland in 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 kumara 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 (biological agent, 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 (of the agrichemical registered for each particular crop) was then conducted for each control method. 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 any further comments and to ensure the accuracy of the information.
- An assessment or evaluation was conducted for each of the plant pests of kumara 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 kumara industry to pursue are listed.

## **Results**

The complete list of SARP worksheets is presented.

- Table 1 – results of the kumara Strategic Agrichemical Review Process – Fungicides registered and used for the control of diseases in kumara.
- Table 2 – results of the kumara Strategic Agrichemical Review Process – Nematicides registered and used for the control of nematodes in kumara.
- Table 3.1 – results of the kumara Strategic Agrichemical Review Process – Fungicides registered and used for the control of the MAJOR recorded diseases in kumara.
- Table 3.2 – results of the kumara Strategic Agrichemical Review Process – Insecticides registered and used for the control of the MINOR recorded insect pests in kumara.
- Table 4: Herbicides registered and used for the control of the weeds in kumara.

## Discussions

### Diseases of kumara

The major diseases of kumara recorded are:

| <b>Common name</b>                     | <b>Scientific name</b>                 |
|--|--|
| <b><u>HIGH PRIORITY</u></b>            |  |
| Rhizopus Soft Rot (post harvest) ..... | <u><i>Rhizopus oryzae</i></u>          |
| Scurf (Black Rot) .....                | <u><i>Monilochaetes infuscans</i></u>  |
| Botrytis .....                         | <u><i>Botrytis cinerea</i></u>         |
| Pythium Root Rot .....                 | <u><i>Pythium spp</i></u>              |
| Rhizoctonia Root Rot .....             | <u><i>Rhizoctonia solani</i></u>       |
| Sclerotinia (Pink Rot) .....           | <u><i>Sclerotinia sclerotiorum</i></u> |

### **MODERATE PRIORITY**

None

### **LOW PRIORITY**

None

See Table 1 - Fungicides with activity on specific kumara diseases.

### **High priority disease**

#### **Rhizopus Soft Rot (*Rhizopus oryzae*)**

Fungicides registered for Rhizopus Soft Rot (*Rhizopus oryzae*) control in kumara or vegetables are:

| Active ingredient | Common Trade Name | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY   |
|-------------------|-------------------|-------------------|------------|---|
| DICLORAN          | Brotran           | ?                 | Nil        | Commonly used product and effective. Used pre plant and post harvest. |

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

|  |            |
|--|------------|
|  | Registered |
|--|------------|

- Brotran (dicloran) is a systemic post-harvest fungicide. It is the only fungicide registered for Rhizopus Soft Rot control in kumara. Commonly used and effective.
- There is a risk of deregistration of dicloran because it is being removed from some export markets. An alternative fungicide is urgent for the post harvest control of Rhizopus.

No fungicides were recorded as being used off-label in kumara for the control of Rhizopus Soft Rot (post harvest).

Fungicides that are not registered in kumara but control Rhizopus in other crops, and could possibly be alternatives are:

| Active ingredient | Common Trade Name | Resistance group* | Registration  | Comments   |
|-------------------|-------------------|-------------------|---|--|
| CARBENDAZIM       | Carbendazim       | A                 | No NZ registration for Rhizopus spp in any crop               | AU label - registered for Rhizopus soft rot in rockmelons.                         |
| IMAZALIL          | Fungaflor         | C                 | No NZ registration for Rhizopus control and no reg. in kumara | AU label - registered for 'Rhizopus Soft Rot control in rockmelon for post harvest |
| IPIRODIONE        | Rovral            | B                 | No NZ Registration for Rhizopus spp in any crop.              | AU label - Rovral registered for Rhizopus spp. or 'Transit Rot' in Stone Fruit     |
| GUAZATINE         | Panoctine         | X                 | No product registered in NZ                                   | AU label - registered for Rhizopus soft in tomatoes and rockmelons                 |

\* 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:

- Carbendazim
  - MRL in: Aust, Singapore, EU, Japan, Singapore, Switzerland (sweet potato, vegetables)
- Fungaflor (imazalil)
  - MRL in: EU, Japan, Switzerland, Taiwan (sweet potato, vegetables)
- Rovral (iprodione)
  - MRL in: EU, Israel, Japan, Switzerland (sweet potato, vegetables)
- Panoctine (guazatine)
  - MRL in: Austria, EU, Germany, Netherlands (vegetables)

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

## FUNGICIDE ALTERNATIVES IN KUMARA FOR RHIZOPUS

In reviewing these possible alternatives:

- Carbendazim – as this product is under review in NZ and Australia, it should not be pursued until the results of the review are completed.
- Fungaflor (imazalil) – a systemic fungicide that is registered in NZ in citrus for the post harvest control of various diseases. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. As it is registered in Australia in melons post harvest, data sharing could be possible. As there are MRL in several overseas countries; **the product should be pursued** after efficacy is confirmed.
- Rovral (iprodione) – a contact/systemic fungicide registered in NZ in various crops as a foliar fungicide and seed treatment. There are no post harvest registrations, but pre-harvest treatments provide post harvest diseases control. Efficacy and crop safety data needs to be generated in the major kumara growing areas – pre and post harvest. Residue data may also be necessary. As it is already registered in Australia in stonefruit post harvest, data sharing could be possible. As there are MRL in several overseas countries; **the product should be pursued** after efficacy is confirmed.
- Panoctine (guazatine) – given this product is not registered in NZ and limited overseas MRL, other options should be investigated first.

## Scurf (Black Rot) (*Monilochaetes infusans*)

Fungicides registered for Scurf (Black Rot) control in kumara or vegetables are:

| Active ingredient  | Common Trade Name | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY  |
|--------------------|-------------------|-------------------|------------|--|
| CARBENDAZIM        | Carbendazim       | A                 | NA         | Immerse plants prior to planting. Commonly used product and effective. |
| THIOPHANATE-METHYL | Topsin            | A                 | NA         |  |

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

|  |                              |
|--|------------------------------|
|  | Actives under review in NZ   |
|  | Actives under review in Aust |
|  | Registered                   |

Both contact/systemic products are commonly used as seed piece treatments prior to planting. There is little risk of resistance developing in the future with the continued use of these fungicides.

Feedback indicated, the current fungicides used for Scurf (Black Rot) control in kumara are working adequately.

Alternatives are required because:

- UK importers will not allow the use of Topsin in kumara.
- Carbendazim and thiophanate-methyl are under review in NZ and Aust.

Fungicides that are used off-label in kumara for the control of Scurf (Black Rot) are:

| Active ingredient | Common Trade Name | Resistance group* | Comments  |
|-------------------|-------------------|-------------------|---|
| IPRODIONE         | Rovral            | B                 | No registration listed for NZ in kumara or Scurf. AU label – registered for <i>Rhizoctonia solani</i> in potatoes as seed treatment. Need seed bed treatment use pattern. Used occasionally for agrichemical rotation. Variable efficacy. |
| FLUAZINAM         | Shirlan           | Y                 | No registration listed for NZ in kumara or for scurf. Used occasionally. Alternative needed   |

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

|  |                |
|--|----------------|
|  | Used off-label |
|--|----------------|

These products are occasionally used but with variable efficacy:

- Rovral (iprodione) – a contact/systemic fungicide which is registered in NZ in various crops as a foliar fungicide and seed treatment (onions).
- Shirlan (fluazinam) - a protectant fungicide which is registered in NZ in various crops as a foliar fungicide and soil treatment (brassicas).

If these products are to continue to be used by growers for Scurf (Black Rot) control, they will require efficacy trials to determine if they are effective.

Fungicides that are not registered in kumara but control Scurf (Black Rot) in other situations, and could possibly be alternatives include:

| Active ingredient | Common Trade Name | Resistance group* | Comments  |
|-------------------|-------------------|-------------------|---|
| THIABENDAZOLE     | Tecto             | A                 | Protectant/eradicator, systemic fungicide. Reg. in potatoes for <i>Fusarium</i> and <i>Phoma</i> as seed piece treatment. AU permit - Scurf control in sweet potato as pre-plant dip & pre-storage treatment. |

\* 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:

- Rovral (iprodione)
  - MRL in: EU, Israel, Japan, Switzerland (sweet potato, vegetables)
- Shirlan (fluazinam)
  - MRL in: EU, Japan, Germany, Netherlands (sweet potato, vegetables)
- Tecto (thiabendazole)
  - MRL in: EU, Japan, Switzerland, USA (sweet potato, vegetables)

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

### FUNGICIDE ALTERNATIVES IN KUMARA FOR MONILOCHAETES

In reviewing these possible alternatives:

- Rovral (iprodione) – a contact/systemic fungicide registered in NZ registered in potatoes as a seed treatment. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. Data sharing with Bayer could be possible. As there are MRL in several overseas countries; **the product should be pursued** after efficacy is confirmed.
- Shirlan (fluazinam) – is a protectant fungicide. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are several overseas MRL, but a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.
- Tecto (thiabendazole) – is a protectant already registered in NZ and available via permit in Aust. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. Although there are limited overseas MRL; **the product should be pursued** after efficacy is confirmed.

### Botrytis (*Botrytis cinerea*)

There are no fungicides registered for Botrytis control in kumara or vegetables in NZ.

Bio-fungicides registered for Botrytis control in vegetables are:

| Active ingredient | Common Trade Name | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY                                 |
|-------------------|-------------------|-------------------|------------|---|
| Bacillus subtilus | Serenade          | Bio-fungicide     | NA         | Starting to be used. Reg. to control botrytis in vegetables |

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

|  |            |
|--|------------|
|  | Registered |
|--|------------|

Serenade is occasionally used and effective.

Fungicides that are used off-label in kumara for the control of Botrytis are:

| Active ingredient  | Common Trade Name | Resistance group* | Comments   |
|--------------------|-------------------|-------------------|--|
| THIOPHANATE-METHYL | Topsin            | A                 | Registered for black scurf control in kumara but not botrytis. Reg. for botrytis in beans, grapes and tomatoes. Commonly used product 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               |

- Topsin is a contact/systemic product and commonly used. From the reports received, Topsin is working adequately.

Alternatives are required because:

- UK importers will not allow the use of Topsin in kumara.
- Thiophanate-methyl is under review in NZ and Aust.

Fungicides that are not registered in kumara but control Botrytis in other situations, and could possibly be alternatives include:

| Active ingredient             | Common Trade Name    | Resistance group* | Comments  |
|-------------------------------|----------------------|-------------------|---|
| AZACONAZOLE + IMAZALIL        | Scomlid Limb Aerosol | C+C               | No registration of azaconazole in kumara. Listed for tomato – wound treatment.  |
| AZOXYSTROBIN                  | Amistar              | K                 | Reg. in potatoes, but no Botrytis reg in NZ. AU label – reg in grapes, permit in peas.  |
| BOSCALID                      | Filan                | G                 | In development in NZ. AU label – reg in grapes, permit in peas & onions.  |
| CAPTAN                        | Captan               | Y                 | Reg in potato as seed treatment; in raspberries for Botrytis. AU label – reg in grapes & strawberries.                                |
| CARBENDAZIM                   | Carbendazim          | A                 | Carbendazim only registered for Scurf control in Kumara   |
| CYPRODINIL + FLUDIOXONIL      | Switch               | IL                | Reg. to control botrytis in grapes. AU permit – reg. in peas for Botrytis.  |
| CHLOROTHALONIL                | Bravo                | Y                 | Registered for Botrytis in berries, grapes, ornamentals and tomatoes. AU label – potato for other diseases.                           |
| FLUAZINAM                     | Shirlan              | Y                 | Registrations in field tomatoes for botrytis.   |
| IMAZALIL                      | Fungaflor            | C                 | Registered for post-harvest diseases of citrus. No registration for kumara  |
| IPRODIONE                     | Rovral               | B                 | Registered for botrytis control in glasshouse tomato. AU label – potato for other diseases.   |
| FENHEXAMID                    | Teldor               | J                 | Reg. to control botrytis in grapes, boysenberries and strawberries  |
| PYRIMETHANIL                  | Scala                | I                 | No registration in any vegetables. Reg. to control botrytis in grapes. AU permit – reg to control Botrytis in GH tomato and capsicum. |
| PROCYMIDONE                   | Sumisclex            | B                 | Registered for botrytis control in field cucurbits, field tomatoes, grapes and strawberries. AU label – potato for other diseases.    |
| THIRAM                        | Thiram               | Y                 | Not registered in kumara for any crop. Lists botrytis control in strawberries and tomatoes.   |
| Scaniavital silica            | Scaniavital silica   | Bio-fungicide     |   |
| <i>Trichoderma atroviride</i> | Sentinel             | Biological        | Sentinel product registered in tomato for 'botrytis stem rot'   |

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

|  |                              |
|--|------------------------------|
|  | Actives under review in NZ   |
|  | Actives under review in Aust |
|  | Registered                   |

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:

- Azoxystrobin
  - MRL in: EU, Japan, USA (sweet potato, vegetables)
- Boscalid
  - MRL in: Japan, USA (sweet potato)

- Carbendazim
  - MRL in: Australia, , EU, Japan, Singapore Switzerland (sweet potato, vegetables)
- Switch (cyprodinil + fludioxonil)
  - MRL (cyprodinil) in: EU, Austria, Germany, Netherlands (root vegetables, vegetables)
  - MRL (fludioxonil) in: EU, Austria, Germany, Japan & USA (sweet potato, root vegetables, vegetables)
- Bravo (chlorothalonil)
  - MRL in: Australia, EU, Japan, Singapore Switzerland (sweet potato, vegetables)
- Shirlan (fluazinam)
  - MRL in: EU, Japan, Germany, Netherlands (sweet potato, vegetables)
- Fungaflor (imazalil)
  - MRL (imazalil) in: EU, Japan, Switzerland, Taiwan (vegetables)
- Rovral (iprodione)
  - MRL in: EU, Israel, Japan, Switzerland, Taiwan (sweet potato, vegetables)
- Teldor (fenhexamid)
  - MRL in: EU (vegetables)
- Scala (pyrimethanil)
  - MRL in: EU (vegetables)
- Sumisclex (procymidone)
  - MRL in: Australia, EU, Switzerland, Japan (sweet potato, vegetables)
- Thiram (thiram)
  - MRL in: EU, Finland, Japan, Netherlands, NZ, Sweden, Switzerland, Taiwan (sweet potato, vegetables)
- *Bacillus subtilis*, Scaniavital silica & *Trichoderma atroviride* - are bio-fungicides and MRL do not apply

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

## FUNGICIDE ALTERNATIVES IN KUMARA FOR BOTRYTIS

In reviewing these possible alternatives:

- Amistar (azoxystrobin) – a systemic protectant/curative fungicide with a wide range of activity. Given the limited registrations for Botrytis, it should not be pursued at this stage.
- Filan (boscalid) – a new systemic protectant/curative fungicide. Given it is still in the development phase in NZ, it should not be pursued at this stage.
- Carbendazim – as this product is under review in NZ and Australia, it should not be pursued until the results of the review are completed.
- Switch (cyprodinil + fludioxonil) - is a protectant/curative fungicide with good IPM and resistance management. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are several overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.
- Bravo (chlorothalonil) - is a protectant fungicide with good IPM fit. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.



- Shirlan (fluazinam) – is a protectant fungicide. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.
- Fungaflor (imazalil) – a systemic fungicide which is registered in NZ in citrus for the post harvest control of various diseases. Given there are no in-crop uses and limited overseas MRL, other options should be investigated first.
- Rovral (iprodione) – is a protectant/curative fungicide. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. As it is already registered in Australia in potatoes, data sharing with Bayer could be possible. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.
- Teldor (fenhexamid) – a systemic fungicide which is registered in NZ in berries and grapes. Very effective botrytis fungicides. But given the limited overseas MRL, other options should be sort. This product may be required in the future.
- Scala (pyrimethanil) - a systemic fungicide which is registered in NZ in grapes. Very effective botrytis fungicides. But given the limited overseas MRL, other options should be sort. This product may be required in the future.
- Sumisclex (procymidone) – is a protectant/curative fungicide in the same resistance group as iprodione. Therefore it should not be pursued.
- Thiram (thiram) - is a protectant fungicide with good IPM fit. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are several overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.

### Pythium Root Rot (*Pythium spp*)

Pythium Root Rot control in kumara is considered a major problem in nursery stock only.

Fungicides registered for Pythium Root Rot control in kumara or vegetables are:

| Active ingredient | Common Trade Name | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY   |
|-------------------|-------------------|-------------------|------------|---|
| ETRIDIAZOLE       | Terrazole         | X                 | NA         | Registered as a 'dry soil mix in seed box and potting mixes' for Pythium control  |
| METAM SODIUM      | Fumasol           | Fumigant          | NA         | Registered for all crops  |
| PHOSPHOROUS ACID  | Foschek           | Y                 | NA         | Registered for 'nursery stock' for Pythium as a foliar treatment. Listed as a fertiliser soil drench - no disease control mentioned |

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

|  |            |
|--|------------|
|  | Registered |
|--|------------|

- Reports are that Terrazole is not providing adequate control of Pythium Root Rot in kumara. This needs to be investigated.

No fungicides are reported as being used off-label in kumara for the control of Pythium Root Rot.

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

| Active ingredient            | Common Trade Name | Resistance group* | Comments   |
|------------------------------|-------------------|-------------------|--|
| PROPAMOCARB                  | Previcur          | Y                 | No registrations in any vegetable in NZ. Listed for 'ornamentals' only.  |
| <i>Trichoderma harzianum</i> | Trichopel         | Biological        | Sold as 'biological fertilisers' not fungicides.   |
| METALAXYL-M                  | Apron             | D                 | Reg. to control Pythium as a seed treatment in peas & brassicas. AU label - various vegetables as seed treatment for Damping off.  |
| METALAXYL-M                  | Ridomil Gold 2.5G | D                 | No mention on Ridomil labels for Pythium control as a soil applied treatment. AU label - various vegetables as soil treatment for Damping off (Pythium) either as potting mix or pre-transplant. |

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

- Reports are that metalaxyl is not providing adequate control of Pythium Root Rot in other crops. This needs to be investigated.

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:

- Previcur (propamocarb)
  - MRL in: EU, Netherlands, NZ, Switzerland (vegetables)
- Apron or Ridomil (metalaxyl)
  - MRL in: Aust, EU, Japan, Switzerland, USA (sweet potato, vegetable)

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

## FUNGICIDE ALTERNATIVES IN KUMARA FOR PYTHIUM

In reviewing these possible alternatives:

- Previcur (propamocarb) – is a systemic fungicide. As it has no vegetable registrations in NZ and limited overseas MRL, other options should be sort.
- Apron or Ridomil (metalaxyl) – is a systemic fungicide with excellent activity on Pythium on seedlings or early plant growth. Resistance management is an issue. Efficacy and crop safety data needs to be generated in the major kumara growing areas as a seed treatment and in-crop treatment. Residue data may also be necessary. There are several overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.

## Rhizoctonia Root Rot (*Rhizoctonia solani*)

Rhizoctonia Root Rot control in kumara is considered a major problem in nursery stock only.

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

| Active ingredient | Common Trade Name | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY  |
|-------------------|-------------------|-------------------|------------|--|
| QUINTOZENE        | Terrachlor        | X                 | NA         | Registered on 'Vegetable Seedlings'. Applied as a pre sowing soil treatment. Listed to control Rhizoctonia. Occasionally used. |
| METAM SODIUM      | Fumasol           | Fumigant          | NA         | Registered for all crops   |

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

|  |            |
|--|------------|
|  | Registered |
|--|------------|

- Reports are that Terrachlor is not providing adequate control of Rhizoctonia Root Rot in kumara. This needs to be investigated.

No fungicides are reported as being used off-label in kumara for the control of Rhizoctonia Root Rot.

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

| Active ingredient | Common Trade Name | Resistance group* | Comments   |
|-------------------|-------------------|-------------------|--|
| AZOXYSTROBIN      | Amistar           | Y                 | AU label – Black scurf (Rhizoctonia) control in potatoes as in-furrow treatment.                             |
| CAPTAN            | Captan            | Y                 | Reg in potato as seed treatment; in raspberries for Botrytis. AU label – reg in grapes & strawberries.       |
| CHLOROTHALONIL    | Bravo             | Y                 | AU label – Rhizoctonia control in cucurbits.   |
| IPRODIONE         | Rovral            | B                 | Only Rovral WP registered for Rhizoctonia in brassicas. AU label – Rhizoctonia control in potatoes and turf. |
| THIRAM            | Thiram            | Y                 | Lists root rots control in seedbeds and turf. AU label – turf.   |
| TOLCLOFOS-METHYL  | Rizolex           | X                 | Registered in seed potatoes. AU label – seed borne Rhizoctonia control in potatoes as seed treatment.        |

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

|  |                            |
|--|----------------------------|
|  | Actives under review in NZ |
|--|----------------------------|

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: EU, Japan, USA (sweet potato, vegetables)
- Captan (captan)
  - MRL in EU, Japan, NZ, Thailand (sweet potato, vegetables)
- Bravo (chlorothalonil)
  - MRL in: Australia, EU, Japan, Singapore Switzerland (sweet potato, vegetables)
- Rovral (iprodione)
  - MRL in: EU, Israel, Japan, Switzerland, Taiwan (sweet potato, vegetables)
- Thiram (thiram)
  - MRL in Australia, EU, Japan, Netherlands, Sweden, Switzerland, NZ, Taiwan
- Rizolex (tolclofos-methyl)
  - MRL in: EU, Japan (sweet potato, vegetables)

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

## FUNGICIDE ALTERNATIVES IN KUMARA FOR RHIZOCTONIA

In reviewing these possible alternatives:

- Amistar (azoxystrobin) – is a protectant/curative fungicide. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are several overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be**

**pursued** after efficacy is confirmed. Australian data should assist with registration.

- Captan (captan) - is a protectant fungicide. As there are limited overseas MRL, this product should not be pursued at this time. Bravo and Thiram may be better alternatives.
- Bravo (chlorothalonil) - is a protectant fungicide with good IPM fit. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are several overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.
- Rovral (iprodione) – is a protectant/curative fungicide. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are several overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed. As it is already registered in Australia in potatoes, data sharing with Bayer could be possible.
- Thiram (thiram) - is a protectant fungicide. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are several overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.

### Sclerotinia (Pink Rot (*Sclerotinia sclerotiorum*))

Sclerotinia (Pink Rot) is considered the major problem in kumara.

No fungicides are registered for Sclerotinia (Pink Rot) control in kumara or vegetables.

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

| Active ingredient  | Common Trade Name | Resistance group* | Comments   |
|--------------------|-------------------|-------------------|--|
| FLUAZINAM          | Shirlan           | Y                 | Registered for Sclerotinia in potato. Commonly used in kumara beds.  |
| PROCYMIDONE        | Sumislex          | B                 | Registered for Sclerotinia in tomatoes, cucurbits & beans. Used in kumara seed beds and in field situations where Sclerotinia is a problem especially in gold variety. |
| THIOPHANATE-METHYL | Topsin M          | A                 | Only registration in kumara is for black scurf control. Sclerotinia in field tomatoes is registered.   |

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

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

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

| Active ingredient | Common Trade Name | Resistance group* | Comments   |
|-------------------|-------------------|-------------------|--|
| AZOXYSTROBIN      | Amistar           | K                 | Not registered in kumara. No reference to Sclerotinia on labels in NZ. AU label – Sclerotinia control in tomatoes; permit in carrots.                                      |
| BOSCALID          | Filan             | G                 | No product available in NZ, but will be registered. AU permit - for Sclerotinia control in peas (snow and green), leafy brassica vegetables, lettuce, brassicas and beans. |

| Active ingredient        | Common Trade Name | Resistance group* | Comments  |
|--------------------------|-------------------|-------------------|---|
| CARBENDAZIM              | Carbendazim       | A                 | Kumara listed on label only for scurf control. Sclerotinia listed for tomato (GH and field), lettuce & beans.                                     |
| CHLOROTHALONIL           | Bravo             | Y                 | No registration in kumara. Occasionally used products and effective.  |
| CYPRODINIL + FLUDIOXONIL | Switch            | IL                | AU permit – reg. in peas for Sclerotinia.   |
| IPRODIONE                | Rovral            | B                 | Rovral WP and Rovral Gold list Sclerotinia control in kiwifruit. No registration for kumara.  |
| TEBUCONAZOLE             | Folicur           | C                 | No registration for kumara however lists white rot control in onions. AU Folicur label lists Sclerotinia control in pyrethrum. Permit in lettuce. |

\* 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:

- Shirlan (fluazinam)
  - MRL in: EU, Japan, Germany, Netherlands (sweet potato, vegetables)
- Sumisclex (procymidone)
  - MRL in: Australia, EU, Switzerland, Japan (sweet potato, vegetables)
- Azoxystrobin
  - MRL in: EU, Japan, USA (sweet potato, vegetables)
- Boscalid
  - MRL in: Japan, USA (sweet potato)
- Bravo (chlorothalonil)
  - MRL in: Australia, EU, Japan, Singapore Switzerland (sweet potato, vegetables)
- Switch (cyprodinil + fludioxonil)
  - MRL (cyprodinil) in: EU, Austria, Germany, Netherlands (root vegetables, vegetables)
  - MRL (fludioxonil) in: EU, Austria, Germany, Japan & USA (sweet potato, root vegetables, vegetables)
- Rovral (iprodione)
  - MRL in: EU, Israel, Japan, Switzerland, Taiwan (sweet potato, vegetables)
- Folicur (tebuconazole)
  - MRL in: EU (sweet potato, vegetables)

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

## FUNGICIDE ALTERNATIVES IN KUMARA 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 kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.
- Sumisclex (procymidone) – is a protectant/curative fungicide in the same resistance group as iprodione. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be

developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed. As it is already registered in Australia in potatoes, data sharing may be possible.

- Amistar (azoxystrobin) – is a protectant/curative fungicide. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are several overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed. Australian data should assist with registration.
- Filan (boscalid) – await registration in NZ before pursuing.
- Bravo (chlorothalonil) - is a protectant fungicide with good IPM fit. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.
- Switch (cyprodinil + fludioxonil) - is a protectant/curative fungicide with good IPM and resistance management. Given the limited registrations for Switch in controlling Botrytis, this product should not be pursued at this time.
- Rovral (iprodione) – is a protectant/curative fungicide. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are several overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed. As it is already registered in Australia in potatoes, data sharing with Bayer could be possible.
- Folicur (tebuconazole) - is a protectant/curative fungicide. Given the limited overseas MRL and limited NZ and Aust registration, other options should be pursued.

### **New fungicide that can be pursued**

| <b>Product (active)</b>           | <b>Target disease</b>   | <b>Action</b>                   |
|-----------------------------------|---|---------------------------------|
| Amistar (azoxystrobin)            | Rhizoctonia Root Rot<br>Sclerotinia (Pink Rot)  | New use                         |
| Bravo (chlorothalonil)            | Botrytis<br>Rhizoctonia Root Rot<br>Sclerotinia (Pink Rot)  | New use                         |
| Switch (cyprodinil + fludioxonil) | Botrytis  | New use                         |
| Shirlan (fluazinam)               | Scurf (Black Rot)<br>Botrytis<br>Sclerotinia (Pink Rot)   | New uses                        |
| Fungaflor (imazalil)              | Rhizopus Soft Rot (post harvest)  | New use (efficacy to be tested) |
| Rovral (iprodione)                | Rhizopus Soft Rot (post harvest)<br>Scurf (Black Rot)<br>Botrytis<br>Rhizoctonia Root Rot<br>Sclerotinia (Pink Rot) | New use (efficacy to be tested) |
| Apron or Ridomil (metalaxyl)      | Pythium Root Rot  | New use                         |
| Sumislex (procymidone)            | Scurf (Black Rot)<br>Sclerotinia (Pink Rot)   | New use                         |
| Tecto (thiabendazole)             | Scurf (Black Rot)   | New use                         |
| Thiram (thiram)                   | Botrytis<br>Rhizoctonia Root Rot  | New use                         |

**Nematodes of kumara**

The nematodes of kumara recorded are:

| <b>Common name</b> | <b>Scientific name</b> |
|--------------------|------------------------|
|--------------------|------------------------|

**MEDIUM PRIORITY**

|                                 |                        |
|---------------------------------|------------------------|
| <b>Root Knot Nematode</b> ..... | <i>Meloidogyne spp</i> |
|---------------------------------|------------------------|

**Medium priority**

**Root Knot Nematode (Meloidogyne spp)**

See Table 2 - Nematicides with activity on specific kumara nematodes.

## Insects of kumara

The insects of kumara recorded are:

| <b>Common name</b>                  | <b>Scientific name</b>          |
|-------------------------------------|---------------------------------|
| <b><u>HIGH PRIORITY</u></b>         |                                 |
| Army and Tropical Caterpillar ..... | <i>Pseudaletia spp.</i>         |
| Cutworm .....                       | <i>Agrostis spp.</i>            |
| Soybean looper .....                | <i>Thysanoplusia orichalcea</i> |
| Wireworm .....                      | <i>Heteroderus spp.</i>         |
| Black beetle .....                  | <i>Heteroderus spp.</i>         |
| White-fringed weevil .....          | <i>Naupactus leucoloma</i>      |
| Argentine Stem weevil .....         | <i>Listronotus bonariensis</i>  |
| Symphilids .....                    | <i>Scutigera immaculata</i>     |

### **MEDIUM PRIORITY**

|                          |                          |
|--------------------------|--------------------------|
| Rats .....               | <i>Ratus spp.</i>        |
| Copper Caterpillar ..... | <i>Lycaena salustius</i> |

See Table 3 - Insecticides with activity on specific kumara insect pests.

### **High priority insects**

**Lepidoptera pests:** **Army and Tropical Caterpillar (*Pseudaletia spp.*)**  
**Cutworm (*Agrostis spp.*)**  
**Soybean looper (*Thysanoplusia orichalcea*)**  
**Wireworm (*Heteroderus spp.*)**

Lepidoptera pests including Army and Tropical Caterpillar, Cutworm, Soybean looper and Wireworm are major pests of kumara. The insecticides used are very similar so the control information will be grouped together. Any differences will be discussed.

Tropical Armyworm (*Spodoptera litura*) lays egg masses on leafy material and gets into drying storage sheds, or the egg-laying moths getting into sheds

Insecticides registered for Army and Tropical Caterpillar, Cutworm and Wireworm control in kumara or vegetables are:

| <b>Active ingredient</b>      | <b>Common Trade Name</b> | <b>Resistance group *</b> | <b>WHP (days)</b> | <b>CURRENT PRODUCT SUITABILITY</b>  |
|-------------------------------|--------------------------|---------------------------|-------------------|---|
| DICHLORVOS                    | Divap                    | 1B                        | 3                 | Registered in vegetables for caterpillars. No record of use.  |
| PARATHION-METHYL              | Folidol                  | 1B                        | 14                | Registered in vegetables for caterpillars, armyworms and other sucking insect pests. No record of use |
| <i>Bacillus thuringiensis</i> | Dipel                    | 11C                       | 11C               | Caterpillars on vegetables. Occasionally used   |
| MALDISON                      | Malathion                | 1B                        | 1B                | Diamondback moth, Tomato Fruitworm & White butterfly in vegetables. Not used                          |
| ROTENONE                      | Derris Dust              | 21A                       | 21A               | Diamondback moth & White butterfly in vegetables. Not used  |



| Active ingredient | Common Trade Name              | Resistance group * | WHP (days) | CURRENT PRODUCT SUITABILITY  |
|-------------------|--------------------------------|--------------------|------------|--|
| CARBARYL          | Sevin                          | 1B                 | 1A         | Looper, Potato tuber moth, Tomato Fruitworm + other caterpillars on vegetables. Not used |
| PYRETHRUM         | Garlic & Pyrethrum Concentrate | 3A                 | 3A         | Cabbage Moth and caterpillars on vegetables. Not used                                    |

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

|  |                              |
|--|------------------------------|
|  | Actives under review in NZ   |
|  | Actives under review in Aust |
|  | Registered                   |

- Of the registered product, only Bt is occasionally used.

Insecticides that are used off-label in kumara for the control of and Tropical Caterpillar, Cutworm, Soybean looper and Wireworm are:

| Active ingredient  | Common Trade Name | Resistance group * | Comments  |
|--------------------|-------------------|--------------------|---|
| LAMBDA-CYHALOTHRIN | Karate            | 3A                 | Reg. in various vegetables including potatoes. Record that it has been used. Efficacy good on cutworm. Possible resistance issues with over-use on some Lepidoptera.  |
| METHAMIDOPHOS      | Monitor Taron     | 1B                 | Reg. for various caterpillars in various vegetable & potato. Record that it has been used. Efficacy good.   |
| DELTAMETHRIN       | Decis             | 3A                 | Reg. in tomato, potato and brassicas. Record that it has been used. Efficacy good. Commonly used for caterpillar control prior to storage. Possible resistance issues with over-use on some Lepidoptera.  |
| CHLORPYRIFOS       | Lorsban           | 1B                 | Reg. for various caterpillars in various vegetable and potato. Is effective on caterpillar but needs alternatives in control programme to control potential resistance. AU label – reg. in sweet potato for cutworm. Commonly used as soil treatment. |
| PERMETHRIN         | Permigas          | 3A                 | Registered as an in-storage gas treatment. Record that it has been used. Efficacy good.   |
| ALPHA-CYPERMETHRIN | Dominex Fastac    | 3A                 | Reg. in tomato and brassica. Commonly used for cutworm.   |
| BIFENTHRIN         | Talstar           | 3A                 | Reg. in tomato and brassica. Commonly used for cutworm.   |
| CYPERMETHRIN       | Ripcord           | 3A                 | Reg. in tomato and brassica. Commonly used for cutworm.   |

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

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

Each of these products has been recorded as being used and very effective. For Karate, Decis and Lorsban, growers have raised concerns that resistance may be developing as an issue. This would be accelerated by the regular use of the same products. There is an over-reliance on synthetic pyrethroids used for Lepidoptera control in kumara (lambda-cyhalothrin, deltamethrin, permethrin, alpha-cypermethrin, bifenthrin and cypermethrin). This needs to be modified to avoid resistance. Monitor (in-field use) and Permigas (in-storage use) are both reported as being very effective.

Insecticides that are not registered in kumara but control Lepidoptera pests in other situations, and could possibly be alternatives include:

| Active ingredient                                     | Common Trade Name  | Resistance group * | Comments   |
|---|--------------------|--------------------|--|
| ACEPHATE  | Orthene            | 1B                 | Reg. in various vegetables including potatoes.   |
| DIAZINON  | Diazinon           | 1B                 | Reg. in vegetable and potato   |
| ENDOSULFAN  | Thionex            | 2A                 | Reg. in tomato, vegetable brassicas and onion for 'caterpillars'. AU label – reg. in sweet potato for various pests. |
| <u>Beauveria bassiana</u>                             | Botanigard         | Biological         |  |
| FIPRONIL  | Ascend             | 2C                 | Reg. for Diamondback moth & White butterfly in brassicas. AU permit – reg. in sweet potato for weevil.               |
| EMAMECTIN   | Proclaim           | 6A                 | Reg. in fruit for Lepidoptera. AU label – reg. in various vegetables for Lepidoptera.                                |
| THIOPHANATE-METHYL + CHLOROTHALONIL + TAU-FLUVALINATE | Guardall           | 3A                 | Reg. for various caterpillars in vegetable brassicas and potato  |
| TAU-FLUVALINATE                                       | Mavrik             | 3A                 | Reg. in cabbage and field tomato   |
| PERMETHRIN + PIRIMIPHOS-METHYL                        | Attack             | 3A+1B              | Reg. in various vegetables   |
| ESFENVALERATE   | Sumi-Alpha         | 3A                 | Reg. in vegetable and potato   |
| METHOMYL  | Lannate L          | 1A                 | Reg. cauliflower, cabbage, lettuce and tomato  |
| SPINOSAD  | Entrust Naturalyte | 5A                 | Reg. in tomato and brassica. AU label – reg. in sweet potato for various lepidoptera.                                |
| TRICHLORFON   | Trifon             | 1B                 | Reg. in tomato and brassica  |
| TRICHLORFON + CYPERMETHRIN                            | Partna             | 1B+3A              | Reg. in brassicas and tomato   |
| IDOXACARB   | Steward            | 22A                | Reg. in 'head' lettuce, cauliflower, cabbage and Brussel sprouts   |

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

|  |                              |
|--|------------------------------|
|  | Actives under review in NZ   |
|  | Actives under review in Aust |

Although there are many Lepidoptera insecticides available, many are either old, have resistance issues, and are under review or trade issues. Therefore only selected insecticides will be discussed for possible alternatives.

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:

- Karate (lambda-cyhalothrin)
  - MRL in: EU, Switzerland, Japan, Korea (sweet potato, vegetables)
- Talstar (bifenthrin)
  - MRL in: Australia, EU, Japan, Korea, Switzerland, USA (sweet potato, vegetables)
- Ascend (fipronil)
  - MRL in: Australia, Japan, Netherlands, EU (sweet potato, vegetables)
- Proclaim (emamectin)
  - MRL in: Japan (sweet potato)
- Lannate (methomyl)
  - MRL in: EU, Japan, Switzerland, Taiwan, Korea, USA (sweet potato, root vegetables, vegetables)
- Entrust (spinosad)
  - MRL in: Australia, EU, Japan, USA (sweet potato, root vegetables)
- Steward (indoxacarb)
  - MRL in: EU, Japan ((sweet potato, vegetables)

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

## INSECTICIDE ALTERNATIVES IN KUMARA FOR LEPIDOPTERA

- Karate (lambda-cyhalothrin) - a contact/systemic insecticide. Registered in many vegetables for various insects (fruitworm, cutworm, weevil, thrips and other lepidoptera). Poor IPM compatibility. Resistance issues if overused. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed for soil and in-storage Lepidoptera control.
- Talstar (bifenthrin) – a contact/systemic insecticide. Registered in many vegetables for various insects (fruitworm, cutworm, weevil, thrips and other lepidoptera). Poor IPM compatibility. Resistance issues if overused. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed for soil Lepidoptera control. Aust are working on high rates of bifenthrin for residual wireworm control.
- Ascend (fipronil) - a contact/systemic insecticide. Registered in brassicas for Lepidoptera. Poor IPM compatibility. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed for soil Lepidoptera control.
- Proclaim (emamectin) - a contact/systemic insecticide. Due to the limited overseas MRL the product should not be pursued at this time.
- Lannate (methomyl) – an old contact/systemic insecticide. Registered in many vegetables for various insects (aphids, lepidoptera, cutworm, whitefly and mealy bug). Fair IPM compatibility. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed for foliar Lepidoptera control.
- Entrust (spinosad) - a contact/systemic insecticide. Registered in select vegetables for lepidoptera. Excellent IPM compatibility. Australian registration for lepidoptera and thrips in multiple crops. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed for foliar Lepidoptera control.
- Steward (indoxacarb) - a contact/systemic insecticide. Registered in brassicas for Lepidoptera. Australian registration and permits for Lepidoptera (vegetables) and weevil (grapes). Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed for foliar Lepidoptera control.

\* With all these products, a use pattern needs to be developed to minimise the potential for resistance developing and a WHP to accommodate overseas MRL.

## **Black beetle (*Heteronychus spp.*)**

Insecticides registered for Black beetle control in kumara or vegetables are:

| Active ingredient | Common Trade Name | Resistance group * | WHP (days) | CURRENT PRODUCT SUITABILITY  |
|-------------------|-------------------|--------------------|------------|--|
| PARATHION-METHYL  | Folidol           | 1B                 | 14         | Registered in vegetables for caterpillars, armyworms and other sucking insect pests. 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                   |

- There is no record of parathion-methyl use in kumara. It was identified that alternative systemic insecticides are required.

Insecticides that are used off-label in kumara for the control of Black beetle are:

| Active ingredient | Common Trade Name | Resistance group * | Comments   |
|-------------------|-------------------|--------------------|--|
| BIFENTHRIN        | Talstar 10EC      | 3A                 | Registered in turf for armyworm, webworm, stem weevil, Black beetle and ants. Commonly used  |
| CHLORPYRIFOS      | Lorsban           | 1B                 | Reg. in brassicas, potatoes, tomatoes and other crops. Commonly used   |
| IMIDACLOPRID      | Confidor          | 4A                 | Registered in turf and ornamentals for Black beetle, scarab, aphids, thrips, bugs, scale, mealy bugs, flatids and beetles. 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               |

Although these products are all recorded as being commonly/occasionally used, there are no reports of how effective they are.

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

| Active ingredient  | Common Trade Name | Resistance group* | Comments   |
|--------------------|-------------------|-------------------|--|
| PHORATE            | Phorate           | 1B                | Registered in maize for black beetle. Also controls aphids, weevils, wireworm and mites. Systemic soil applied insecticides. |
| LAMBDA-CYHALOTHRIN | Karate            | 3A                | Various vegetables including potatoes. Only beetles listed are bronze and grass grub beetles in grapes.                      |
| METHAMIDOPHOS      | Monitor Taron     | 1B                | Reg. for various caterpillars in vegetable and potato. No 'beetles' listed on label.   |
| THIAMETHOXAM       | Actara            | 4A                | Registered in turf for Black beetle and bilbugs. Not used  |

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

|  |                              |
|--|------------------------------|
|  | Actives under review in NZ   |
|  | Actives under review in Aust |

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: Australia, EU, Japan, Korea, Switzerland, USA (sweet potato, vegetables)

- Lorsban (chlorpyrifos)
  - MRL in: Australia, EU, Japan, Korea, Taiwan, Switzerland, USA (sweet potato, vegetables)
- Confidor (imidacloprid)
  - MRL in: Australia, EU, Japan, USA (sweet potato, root vegetables, vegetables)
- Phorate (phorate)
  - MRL in: Australia, EU, Japan, Switzerland (vegetables)
- Karate (lambda-cyhalothrin)
  - MRL in: EU, Switzerland, Japan, Korea (sweet potato, vegetables)
- Monitor (methamidophos)
  - MRL in: China, EU, Japan, Switzerland, Taiwan (sweet potato, root vegetables, vegetables)
- Actara (thiamethoxam)
  - MRL in: Canada, EU, Japan, Netherlands, USA (sweet potato, vegetables)

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

### INSECTICIDE ALTERNATIVES IN KUMARA FOR HETERONYCHUS

- Talstar (bifenthrin) – a contact/systemic insecticide. Registered in many vegetables for various insects (fruitworm, cutworm, weevil, thrips and other lepidoptera). Poor IPM compatibility. Resistance issues if overused. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.
- Lorsban (chlorpyrifos) - a contact/systemic insecticide. Registered in many vegetables for various insects (aphids, lepidoptera, cutworm, whitefly and mealy bug). Poor IPM compatibility. Although it is still very effective and the most commonly used product for Black beetle in Aust, as it is such an old product, is under review in both NZ and Aust its long term future is unknown. Other options should be pursued.
- Confidor (imidacloprid) - a contact/systemic insecticide. Registered in other vegetables for other insects. Australian registration for beetles on non-food crops. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. As there are several overseas MRL, **the product should be pursued** after efficacy is confirmed.
- Phorate – is a organophosphate and a very effective, systemic soil insecticide for the control of a range of sucking and chewing pests. As it is such an old product, its long term future is unknown. Other options should be pursued.
- Karate (lambda-cyhalothrin) - a contact/systemic insecticide. Registered in many vegetables for various insects (fruitworm, cutworm, weevil, thrips and other lepidoptera). Poor IPM compatibility. Resistance issues if overused. Australian registration for Lepidoptera and beetles. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued.**
- Monitor (methamidophos) - is an old foliar insecticide and that is still very effective for the control of a range of sucking and chewing pests. As it is such an old product, is under review in both NZ and Aust its long term future is unknown. Other options should be pursued.

- Actara (thiamethoxam) - a contact/systemic insecticide. Registered is still limited. As it is the same resistance group as Confidor, it should not be pursued.

With all these products, a use pattern needs to be developed to minimise the potential for resistance developing and a WHP to accommodate overseas MRL.

### White-fringed weevil (*Naupactus leucoloma*)

### Argentine Stem weevil (*Listronotus bonariensis*)

Weevil pests including White-fringed weevil and Argentine Stem weevil are major pests of kumara. As the insecticides used for both pests are very similar, the insecticide information will be grouped together.

No insecticides are registered for the control of White-fringed weevil and Argentine Stem weevil in kumara or vegetables.

Insecticides that are used off-label in kumara for the control of weevils are:

| Active ingredient | Common Trade Name | Resistance group * | Comments   |
|-------------------|-------------------|--------------------|--|
| BIFENTHRIN        | Talstar 10EC      | 3A                 | Registered in turf for armyworm, webworm, stem weevil, Black beetle and ants. Occasionally used  |
| FIPRONIL          | Ascend            | 2C                 | Registered in potatoes for White-fringed weevil. Also controls thrips, mirids, scarids, wireworm and borer in various crops. Commonly used |

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

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

- Both Talstar and Ascend are used in kumara for weevil control, but no comments were received about their efficacy.

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

| Active ingredient | Common Trade Name | Resistance group* | Comments   |
|-------------------|-------------------|-------------------|--|
| PHORATE           | Phorate           | 1B                | Systemic soil applied insecticides. Registered in maize for weevils. Also controls aphids, black beetle, wireworm and mites. |
| TEBUFOS           | Counter 20G       | 1B                | Systemic soil applied insecticides. Registered in maize, sweet corn and forage brassicas for aphids and weevils.             |
| OXAMYL            | Vydate            | 1B                | Systemic soil applied or foliar insecticides. Registered pastures for Argentine Stem weevil. Rego in carrots for nematodes.  |
| CHLORPYRIFOS      | Lorsban           | 1B                | Systemic soil applied insecticides. Reg. in pastures for Argentine Stem weevil.  |
| METHAMIDOPHOS     | Monitor Taron     | 1B                | Reg. for various lepidoptera, aphids, thrips and jassids in vegetable. AU label - reg in peanuts for White-fringed weevil.   |
| IDOXACARB         | Steward           | 22A               | AU label – reg. for weevil control in grapes.  |

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

|  |                              |
|--|------------------------------|
|  | Actives under review in NZ   |
|  | Actives under review in Aust |

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: Australia, EU, Japan, Korea, Switzerland, USA (sweet potato, vegetables)
- Ascend (fipronil)
  - MRL in: Australia, Japan, Netherlands, EU (sweet potato, vegetables)
- Phorate (phorate)
  - MRL in: Australia, EU, Japan, Switzerland (vegetables)
- Counter (tebufos)
  - No MRL could be found.
- Vydate (oxamyl)
  - MRL in: Austria, Germany, EU, Indonesia, Japan, Korea, Singapore, Netherlands (sweet potato, root vegetables, vegetables)
- Lorsban (chlorpyrifos)
  - MRL in: Australia, EU, Japan, Korea, Taiwan, Switzerland, USA (sweet potato, vegetables)
- Monitor (methamidophos)
  - MRL in: China, EU, Japan, Switzerland, Taiwan (sweet potato, root vegetables, vegetables)

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

## INSECTICIDE ALTERNATIVES IN KUMARA FOR NAUPACTUS AND LISTRONOTUS

- Talstar (bifenthrin) – a contact/systemic insecticide. Registered in many vegetables for various insects. Poor IPM compatibility. Resistance issues if overused. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.
- Ascend (fipronil) - a contact/systemic insecticide. Registered in brassicas for Lepidoptera. Poor IPM compatibility. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.
- Phorate – is a organophosphate and a very effective, systemic soil insecticide for the control of a range of sucking and chewing pests. As it is such an old product, its long term future is unknown. Other options should be pursued.
- Counter (tebufos) - organophosphate contact/systemic insecticide. As no overseas MRL could be found it should not be pursued.
- Vydate (oxamyl) - organophosphate contact/systemic insecticide. Registered in pastures only. Australian registration for nematodes and borer only. Given the limited vegetable data, other options should be pursued.
- Lorsban (chlorpyrifos) - a contact/systemic insecticide. Registered in many vegetables for various insects. Poor IPM compatibility. As it is still very effective product, is under review in both NZ and Aust, its has many overseas MRL and is also being pursued for Black beetle. Therefore a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.

- Monitor (methamidophos) - is an old foliar insecticide and that is still very effective for the control of a range of sucking and chewing pests. As it is such an old product, is under review in both NZ and Aust its long term future is unknown. Other options should be pursued.
  - Steward (indoxacarb) - a contact/systemic insecticide. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed for foliar Lepidoptera control.
- \* With all these products, a use pattern needs to be developed to minimise the potential for resistance developing and a WHP to accommodate overseas MRL.

### Symphilids (*Scutigereella immaculate*)

There are no insecticides registered for the control of Symphilids in kumara.

Insecticides that are used off-label in kumara for the control of and Symphilids are:

| Active ingredient  | Common Trade Name  | Resistance group* | Comments  |
|--------------------|--------------------|-------------------|---|
| LAMBDA-CYHALOTHRIN | Karate             | 3A                | Reg. for various caterpillars in vegetable and potato. Record that it has been used. Efficacy good. Use pattern unknown.  |
| METHAMIDOPHOS      | Monitor<br>Tamaron | 1B                | Reg. for various caterpillars in vegetable and potato. Record that it has been used. Efficacy good. Use pattern unknown.  |
| DIAZINON           | Diazinon           | 1B                | Reg. for aphids, thrips and caterpillars in vegetables. Record that it has been used. Efficacy good. Use pattern unknown. |

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

|  |                              |
|--|------------------------------|
|  | Actives under review in NZ   |
|  | Actives under review in Aust |

- Each of these products has been recorded as being used with good efficacy.

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

| Active ingredient | Common Trade Name | Resistance group * | Comments  |
|-------------------|-------------------|--------------------|---|
| FIPRONIL          | Ascend            | 2C                 | Registered in potato for White-fringed weevil. AU permits - for Symphilids control in ginger as a dip and pre-plant soil treatment. |
| CHLORPYRIFOS      | Lorsban           | 1B                 | AU label – registered for Symphilids control in sugarcane as a pre-plant soil treatment.  |

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

|  |                              |
|--|------------------------------|
|  | Actives under review in NZ   |
|  | Actives under review in Aust |

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:

- Karate (lambda-cyhalothrin)
  - MRL in: EU, Switzerland, Japan, Korea (sweet potato, vegetables)
- Monitor (methamidophos)



- MRL in: China, EU, Japan, Switzerland, Taiwan (sweet potato, root vegetables, vegetables)
- Diazinon (diazinon)
  - MRL in: Australia, EU, Switzerland, Indonesia, NZ, Singapore, Israel, Japan, Korea, USA (sweet potato, vegetables)
- Ascend (fipronil)
  - MRL in: Australia, Japan, Netherlands, EU (sweet potato, vegetables)
- Lorsban (chlorpyrifos)
  - MRL in: Australia, EU, Japan, Korea, Taiwan, Switzerland, USA (sweet potato, vegetables)

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

## INSECTICIDE ALTERNATIVES IN KUMARA FOR SCUTIGERELLA

- Karate (lambda-cyhalothrin) - a contact/systemic insecticide. Registered in many vegetables for various insects (fruitworm, cutworm, weevil, thrips and other lepidoptera). Poor IPM compatibility. Resistance issues if overused. Australian registration for Lepidoptera and beetles. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued.**
- Monitor (methamidophos) - is an old foliar insecticide and that is still very effective for the control of a range of sucking and chewing pests. As it is such an old product, is under review in both NZ and Aust its long term future is unknown. Other options should be pursued.
- Diazinon (diazinon) - is a Group 1B insecticide and is a very effective, foliar insecticide for the control of a range of sucking and chewing pests. As it is such an old product, is under review in both NZ and Aust its long term future is unknown. Other options should be pursued.
- Ascend (fipronil) - a contact/systemic insecticide. Registered in brassicas for Lepidoptera. Poor IPM compatibility. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. There are few overseas MRL, so a use pattern needs to be developed to fit the residue requirements. **The product should be pursued** after efficacy is confirmed.
- Lorsban (chlorpyrifos) - a contact/systemic insecticide. Registered in many vegetables for various insects (aphids, lepidoptera, cutworm, whitefly and mealy bug). Poor IPM compatibility. Although it is still very effective and the most commonly used product for Black beetle in Aust, as it is such an old product, is under review in both NZ and Aust its long term future is unknown. Other options should be pursued.

\* With all these products, a use pattern needs to be developed to minimise the potential for resistance developing and a WHP to accommodate overseas MRL.

## Other insects & pests

- **Copper caterpillar** (*Lycaena salustius*)

See Table 3 - Insecticides with activity on specific kumara insect pests.

- **Rats** (*Rattus spp*)

See Table 4 - Insecticides with activity on specific kumara insect pests.

### **New insecticides that can be pursued**

| <b>Product (active)</b>     | <b>Target insect</b>   | <b>Action</b> |
|-----------------------------|--|---------------|
| Karate (lambda-cyhalothrin) | Lepidoptera - Army and Tropical Caterpillar,<br>Cutworm, Soybean looper<br>Black beetle<br>Symphilids                            | New uses      |
| Talstar (bifenthrin)        | Lepidoptera - Army and Tropical Caterpillar,<br>Cutworm, Soybean looper<br>Black beetle<br>White-fringed & Argentine Stem weevil | New uses      |
| Lannate (methomyl)          | Lepidoptera - Army and Tropical Caterpillar,<br>Cutworm, Soybean looper  | New uses      |
| Entrust (spinosad)          | Lepidoptera - Army and Tropical Caterpillar,<br>Cutworm, Soybean looper  | New uses      |
| Ascend (fipronil)           | Lepidoptera - Army and Tropical Caterpillar,<br>Cutworm, Soybean looper<br>White-fringed & Argentine Stem weevil<br>Symphilids   | New uses      |
| Steward (indoxacarb)        | Lepidoptera - Army and Tropical Caterpillar,<br>Cutworm, Soybean looper<br>White-fringed & Argentine Stem weevil                 | New use       |
| Lorsban (chlorpyrifos)      | Black beetle<br>White-fringed & Argentine Stem weevil  | New use       |
| Confidor (imidacloprid)     | Black beetle   | New use       |

## Herbicide use in kumara

Herbicides registered for use in kumara are:

| Active ingredient    | Common Trade Name   | Resistance group* | WHP (days)   | CURRENT PRODUCT SUITABILITY  |
|----------------------|---------------------|-------------------|--------------|--|
| ALACHLOR             | Alanex Lasso        | A                 | 35           | Pre-emergent broad spectrum herbicide. Commonly used and effective product - post-plant. But some reports of weed escapes.                         |
| FLUAZIFOP-P-BUTYL    | Fusilade WG         | A                 | 35           | Early post-emergence for grass weeds. Commonly used and effective product - early post-em, especially for Rice grass.                              |
| SETHOXYDIM           | Poast               | A                 | 35           | Post-emergent grass selective herbicide. Registered in vegetables. No record of use.   |
| CLETHODIM            | Arrow               | A                 | 35           | Post-emergence for grass weeds. Registered in vegetables. No record of use.  |
| GLYPHOSATE           | Roundup             | M                 | Not required | Broad spectrum knockdown herbicide. Registered in vegetables. Used pre-plant for perennial weed control – very effective.                          |
| GLYPHOSATE-TRIMESIUM | Touchdown           | M                 | Not required | Similar weed control to Roundup however may provide better control of some broadleaf weeds. Registered in vegetables. Occasionally used pre-plant. |
| PARAQUAT             | Gramoxone           | L                 | Not required | Pre-plant or inter-row for broad spectrum knockdown weed control. Registered in vegetables. Very commonly used and effective product.              |
| DIQUAT               | Reglone             | L                 | Not required | Pre-plant or inter-row for broad spectrum knockdown weed control. Registered in vegetables. Very commonly used and effective product.              |
| PINE OIL             | Organic Interceptor |                   | Not required | Registered in vegetables. Inconsistent results, weed escapes and pricing prohibitive.  |
| OXYFLUORFEN          | Goal 40 WP          | G                 | Not required | Registered as an in-crop weed control in brassicas and onions. Used in kumara as a spike to Roundup.   |

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

|  |                              |
|--|------------------------------|
|  | Actives under review in Aust |
|  | Registered                   |

Herbicides that are not registered in kumara but have been used and could possibly be alternatives include:

| Active ingredient  | Common Trade Name  | Resistance group* | Comments  |
|--------------------|--------------------|-------------------|---|
| ACETOCHLOR         | Sylon              |                   | Registered in NZ as a pre-emergent weed control in sweet corn and maize. Some reports of weed escapes.  |
| AMITROLE + DALAPON | Amitrole + Dalapon | F + J             | Registered in NZ for non-selective weed control. Used for Rice grass control – no contact with the crop.  |
| DALAPON            | Dalapon            | J                 | Registered in NZ in pastures, lucerne & potatoes. Used for Rice grass control in mixtures with Sylon – no contact with the crop.                        |
| CLOMAZONE          | Magister           | F                 | Registered in NZ for pre-emergent grass and broadleaf weed control in squash, pumpkin, beans and potatoes. Some use reported.                           |
| DIMETHENAMID       | Frontier           | K                 | Registered in NZ for pre-emergent grass and broadleaf weed control in maize, onions, sweet corn, squash, beans and forage brassicas. Some use reported. |

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

|  |                |
|--|----------------|
|  | Used off-label |
|--|----------------|

The main weed gaps identified by growers are:

- Fat hen (*Chenopodium spp.*) – general knockdown herbicides will control the weed pre-plant. Can be controlled by Frontier pre-emergent in some situations. Moderate control with Sylon. Well controlled by Magister as a pre-emergent. Needs to be controlled as a seedling.
- Willow weed (*Polygonum persicaria*) – general knockdown herbicides will control the weed pre-plant. No selective post-emergent herbicides could be identified for kumara. Moderate control with Sylon. Well controlled by Magister as a pre-emergent. Needs to be controlled as a seedling.
- Blackberry nightshade (*Solanum nigrum*) - general knockdown herbicides will control the weed pre-plant. Well controlled by Frontier as a pre-emergent. Moderate control by Magister as a pre-emergent. Needs to be controlled as a seedling.
- Alligator weed (?) – considered a big problem in some areas as it smoothers the kumara. There is no effective weed control other than general knockdown herbicides used pre-plant.

Selective herbicides that are not registered in kumara in NZ but are registered in Aust and could possibly be alternatives include:

| Active ingredient  | Common Trade Name | Resistance group* | Comments  |
|--------------------|-------------------|-------------------|---|
| CHLORTHAL DIMETHYL | Dacthal           | D                 | Registered in NZ as a pre & post-emergent in onions, sweet potato and other crops. Controls Blackberry nightshade & Fat hen. AU label – many vegetables for many weeds including Blackberry nightshade, Polygonum & Fat hen |
| S-METOLACHLOR      | Dual              | K                 | Registered in NZ as a pre-emergent in various vegetables. Controls Blackberry nightshade & Fat hen. AU label – many vegetables for many weeds including Blackberry nightshade & Fat hen. Polygonum (suppression).           |

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

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

In all of these cases, the weeds can be controlled with existing registered herbicides, but growers are looking for residual control of all weeds and better control of specific weeds.

Good control is available pre-plant with glyphosate, oxyfluorfen or paraquat which are existing registered uses.

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:

- Sylon (acetochlor)
  - MRL in: EU (root vegetables)
- Amitrole (amitrole)
  - MRL in: EU (vegetables)
- Dalapon (dalapon / 2,2-DPA)
  - No MRL found
- Magister (clomazone)
  - MRL in: EU, Germany, Japan, Korea, USA, Netherlands, (sweet potato, vegetables)
- Frontier (dimethenamid)
  - MRL in: EU, Japan, USA (sweet potato, vegetables)

- Dacthal (chlorthal-dimethyl)
  - MRL in: Aust, Canada, USA, Japan, EU, Netherlands (sweet potato, vegetables)
- Dual (S-metolachlor)
  - MRL in: Aust, Austria, Germany, Japan, Netherlands, Taiwan (sweet potato, vegetables)

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

Before any of these herbicides are pursued, correct management of the crop, the herbicides and the weeds needs to be determined to maximise the weeds control with minimal impact on the crop and minimising any risk of resistance developing.

## HERBICIDE POSSIBILITIES IN KUMARA FOR WEED CONTROL

- Sylon (acetochlor), Amitrole (amitrole) and Dalapon (dalapon) – as there are limited or no overseas MRL, each of these products need to be used as a pre-plant weed control or as an interrows weed control with no risk of contamination of the crop. Trials are required to demonstrate if these herbicides offer any advantages over registered products or if they offer any control of the main weed gaps.
- Magister (clomazone) and Frontier (dimethenamid) – crop safety needs to be determined before pursuing these herbicides. Trials are required to demonstrate if these herbicides offer any advantages over registered products or if they offer any control of the main weed gaps.
- Dacthal (chlorthal-dimethyl) – a residual herbicide with a wide weed spectrum. Registered in Aust in sweet potato. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. Given the wide spectrum of weed control and MRL in several overseas countries, **the product should be pursued.**
- Dual (S-metolachlor) – a residual herbicide with a wide weed spectrum. Registered in Aust in sweet potato. Efficacy and crop safety data needs to be generated in the major kumara growing areas. Residue data may also be necessary. Given the wide spectrum of weed control and MRL in some overseas countries, **the product should be pursued.**

## New opportunities for new or alternative agrichemicals in kumara

### International collaboration with USA IR-4 program

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

| <b>Agrichemical</b>                           | <b>Pest / Status</b>  | <b>Relevance to NZ</b>                 |
|---|---|--|
| <b>FUNGICIDES</b>                             |   |  |
| BOSCALID +<br>PYRACLOSTROBIN<br>(Aero – Aust) | RHIZOPUS SOFT ROT - in progress   | Diseases identified as a high priority |
| DIFENOCONAZOLE<br>(Score)                     | ROOT ROT - in progress  | Not a priority                         |
| ETHEPHON<br>(Ethrel)                          | REDUCE SKINNING OF SWEETPOTATO ROOTS -<br>in progress   | Not a priority                         |
| FLUDIOXONIL<br>(New product)                  | RHIZOPUS SOFT ROT – in progress   | Diseases identified as a high priority |
| THIOPHANATE<br>METHYL (Topsin)                | FUSARIUM SPP - proposed   | Not a priority                         |
| <b>INSECTICIDES</b>                           |   |  |
| CHLORPYRIFOS<br>(Lorsban)                     | WIREWORM, FLEA BEETLES – in progress  | Insects identified as a high priority  |
| FENPROPATHRIN<br>(New product)                | WEEVILS, VINEGAR FLY – trials to start  | Insects identified as a high priority  |
| FIPRONIL<br>(Ascend)                          | WIREWORMS, WHITE GRUBS, WHITE FRINGED<br>BEETLE, ROOTWORMS, SWEETPOTATO<br>WEEVIL, BANDED & SPOTTED CUCUMBER<br>BEETLES, SUGARCANE BEETLE – in progress | Insects identified as a high priority  |
| IMIDACLOPRID<br>(Confidor)                    | APHIDS, FLEA BEETLES, LEAFHOPPER,<br>WHITEFLIES - in progress   | Not a priority                         |
| METHOXYFENOZIDE<br>(Prodigy)                  | BEET AND FALL ARMYWORM – in progress  | Insects identified as a high priority  |
| <b>HERBICIDES</b>                             |   |  |
| FLUMIOXAZIN<br>(New product)                  | BROADLEAF WEEDS - REGISTERED  | Weed spectrum unknown                  |

Many other projects have been identified and are being conducted by IR-4 in kumara 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.

## **References**

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

Bioworks 2007

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

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[CropLife New Zealand](#)

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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**

|                           |   |
|---------------------------|---|
| Contributors:             | SARP meeting participants                 |
| Horticulture New Zealand: | Peter Ensor and Ron Gall                  |
| Work colleagues:          | Eileen Dal Santo and Rob Velthuis (Xeron) |

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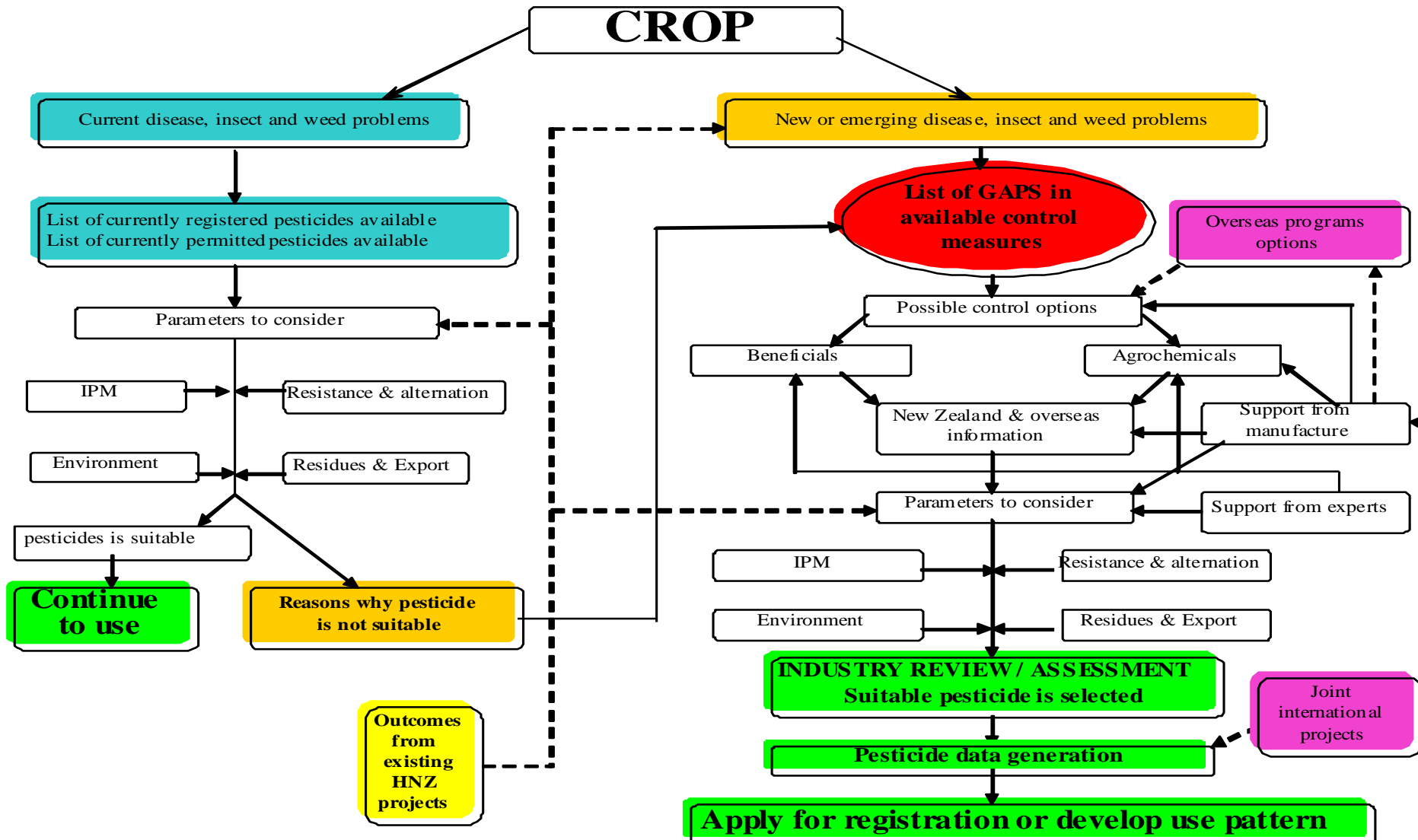
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**Appendices**

**DIAGRAM 1: The Strategic Agrichemical Review Process**



**Table 1:** Fungicides registered and available for the control of diseases in kumara or vegetables.

| Disease name (occurrence)  | Priority             | Active ingredient  | Common Trade Name                | Registrations  | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP)   |
|--|----------------------|--------------------|----------------------------------|--|-------------------|------------|---|
| Rhizopus Soft Rot (Post Harvest Disease)<br><i>Rhizopus oryzae</i> | High - major disease | DICLORAN           | Bortran 75 WP (Post Harvest dip) |  |                   |            | Commonly used product and effective - dicloran (risk to deregistration). Used pre plant and post harvest.   |
|  |                      | IMAZALIL           | Fungaflor 75 WSP                 | No NZ Registration of imazalil for Rhizopus control and no reg. in kumara      | C                 |            | Urgent alternative needed AU Label. Imazgard registered for 'Rhizopus Soft Rot (Rhizopus spp) control in rockmelon for post harvest                   |
|  |                      | IPRODIONE          | Rovral Flo or Rovral Gold        | No NZ Registration of iprodione for Rhizopus spp in Kumara or any other crop.  | B                 |            | UK Importers will not allow Topsin use. AU Label. Rovral Aquaflo registered for Rhizopus or 'Transit Rot' in Stone Fruit                              |
|  |                      | GUAZATINE          |                                  | No product registered in NZ  | X                 |            | Dicloran is now removed from use in some export markets Panocrine AU Label registered for Rhizopus soft rot (Rhizopus spp) in tomatoes and rockmelons |
|  |                      | CARBENDAZIM        | Carbendazim                      | No NZ Registration of carbendazim for Rhizopus spp in Kumara or any other crop | A                 |            | AU label - carbendazim (eg Baviston FL) registered for Rhizopus soft rot (Rhizopus spp) in rockmelons.  |
| Scurf (Black Rot)<br><i>Monilochaetes infuscans</i>                | High - major disease | CARBENDAZIM        | Carbendazim                      | Immerse plants for 3 minutes prior to setting ou in the field'                 | A                 | Not Listed | Commonly used product and effective: Shirlan (fluazinam), Rovral (iprodione), Topsin (thiophanate - plant dip/seed beds).                             |
|  |                      | THIOPHANATE-METHYL | Topsin M-4A                      | Submerge plants before planting  | A                 | N/A        |   |
|  |                      | IPRODIONE          | Rovral                           | No registration listed for NZ in Kumara or for any Rhizopus spp                | B                 |            | Need seed bed treatment use pattern. Used occasionally for agrichemical rotation. Ineffective   |
|  |                      | FLUAZINAM          | Shirlan                          | No registration listed for NZ in Kumara or for any Rhizopus spp                | Y                 |            | Alternative needed  |

| Disease name (occurrence)           | Priority                           | Active ingredient   | Common Trade Name   | Registrations   | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP)     |
|-------------------------------------|------------------------------------|---|---------------------|---|-------------------|------------|---|
| Botrytis<br><i>Botrytis cinerea</i> | High - major disease, nursery only | AZACONAZOLE + IMAZALIL  | Scomid Limb Aerosol | No registration of azaconazole in kumara. Listed for tomato   | C+C               |            |   |
|                                     |                                    | CARBENDAZIM   | Bravo Weather Stik  | Carbendazim only registered for Scurf control in Kumara   | A                 |            |   |
|                                     |                                    | CYPRODINIL + FLUDIOXONIL                                      | Switch              | No registration in kumara however controls botrytis in grapes   | I                 |            |   |
|                                     |                                    | CHLOROTHALONIL  | Bravo               | No registration in kumara   | Y                 |            |   |
|                                     |                                    | FLUAZINAM   | Shirlan             | No registration. Registration in tomatoes for botrytis control  | Y                 |            |   |
|                                     |                                    | IMAZALIL  | Fungaflor 75 WSP    | Fungaflor registered for post-harvest diseases of citrus. No registration for kumara  | C                 |            |   |
|                                     |                                    | IPRODIONE   | Rovral              | Registered for botrytis control in tomato. No registration for kumara   | B                 |            |   |
|                                     |                                    | FENHEXAMIDE   | Teldor              | No registration. Controls botrytis in grapes and berries  | J                 |            |   |
|                                     |                                    | PYRIMETHANIL  | Scala               | No registration in kumara or any other vegetables however controls botrytis in grapes   | I                 |            |   |
|                                     |                                    | PROCYMIDONE   | Sumisclex           | No registration in kumara however registered for botrytis control in field cucurbits, field tomatoes, grapes and strawberries               | B                 |            |   |
|                                     |                                    | THIOPHANATE-METHYL  | Topsin M-4A         | Registered for black scurf control in kumara but not botrytis control. Listed for botrytis in beans, grapes, field and glasshouse tomatoes. | A                 |            | Commonly used product and effective: Topsin (thiophanate). Cannot use Topsin for our UK exports |
|                                     |                                    | THIRAM  | Thiram              | Not registered in kumara for any crop. Lists botrytis control in strawberries and tomatoes.   | Y                 |            |   |
|                                     |                                    | <i>Bacillus subtilis</i>                                      | Bacillus subtilis   | Starting to be used. Control botrytis in vegetables   | Bio-fungicide     |            |   |
| Scaniavital silica                  | Scaniavital silica                 |   | Bio-fungicide       |   |                   |            |   |
| <i>Trichoderma atroviride</i>       | Sentinel                           | Sentinel product registered in tomato for 'botrytis stem rot' | Bio-fungicide       |   |                   |            |   |

| Disease name (occurrence)                      | Priority                           | Active ingredient            | Common Trade Name | Registrations  | Resistance group* | WHP (days)          | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP) |
|--|------------------------------------|------------------------------|-------------------|--|-------------------|---------------------|---|
| Pythium Root Rot <i>Pythium spp</i>            | High - major disease, nursery only | ETRIDIAZOLE                  | Terrazole         | Applied as a 'dry soil mix in seed box and potting mixes' for Pythium control  | X                 |                     | Pythium : At present get no good control  |
|  |                                    | METAM SODIUM                 | Fumasol           |  |                   |                     |   |
|  |                                    | PROPAMORCAR B                | Previcur N        | No registrations in any vegetable in NZ . Listed for 'ornamentals' only. No WHP listed.  | Y                 |                     |   |
|  |                                    | PHOSPHROUS ACID              | Foschek           | Registered for 'nursery stock' for Pythium control as a plant applied treatment. Listed as a fertiliser soil drench - no disease control mentioned                                       | Y                 |                     |   |
|  |                                    | <i>Trichoderma harzianum</i> | Trichopel         | Sold as 'biological fertilisers' not fungicides. Other products 'T-22, T-22HB,Bio-Trek, RootShield' are sold by BioWorks in USA.   | Bio-fungicide     |                     |   |
|  |                                    | METALAXYL-M                  | Apron XL          | No mention on Ridomil labels for pythium control as a soil applied treatment. Apron controls Pythium as a seed applied treatment in peas and brassicas                                   | D                 |                     |   |
| Rhizoctonia Root Rot <i>Rhizoctonia solani</i> | High - major disease, nursery only | QUINTOZENE                   | Terrachlor        | nursery problem - need to have healthier seedlings produced. Listed for use on 'Vegetable Seedlings' Applied as a pre-sowing soil treatment. Listed to control Rhizoctonia and Fusarium. | <u>Y</u>          | -                   | Rhizoctonia: At present we get no good control  |
|  |                                    | IPRODIONE                    | Rovral WP         | nursery issue (resistance management issue, rather than residues - depending on WHP?). Only WP Rovral registered for Rhizoctonia and Alternaria only. Apron only registered for Pythium. | B                 | NA (seed treatment) |   |
|  |                                    | THIRAM                       | Thiram            | Not registered for Seedbeds in vegetables however registered in ornamentals for 'damping off, seed and root rots'.   | Y                 |                     |   |

| Disease name (occurrence)                             | Priority                  | Active ingredient  | Common Trade Name  | Registrations   | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP)   |
|---|---------------------------|--------------------|--------------------|---|-------------------|------------|---|
| Sclerotinia (Pink Rot) <i>Sclerotinia sclerotinia</i> | High - No 1 major disease | CHLOROTHALO NIL    | Bravo Weather Stik | No registration in kumara.  | Y                 |            | Commonly used products and effective: Sumisclex (procymidone), Topsin (thiophanate) & Shirlan (fluazinam)                                     |
|   |                           | FLUAZINAM          | Shirlan            | No registration in kumara but registered for Sclerotinia in potato  | Y                 |            | Fluazinam commonly used in kumara beds  |
|   |                           | AZOXYSTROBIN       | Amistar            | No reference to Sclerotinia or kumara on labels in NZ. Reference to S. minor on Amistar 250 Australian label for field tomatoes | K                 |            |   |
|   |                           | CARBENDAZIM        | Carbendazim        | Kumara listed on label only for scurf control. Sclerotinia listed for Tomato (Greenhouse and Field), lettuce, beans             | A                 |            |   |
|   |                           | PROCYMIDONE        | Sumisclex 500SC    | No reference to Sclerotinia on kumara however Sclerotinia listed for field tomatoes, field cucurbits and beans                  | B                 |            | Applied to seed bed and late in the crop. Used in seed beds and in field situations where Sclerotinia is a problem especially in gold variety |
|   |                           | TEBUCONAZOLE       | Folicur            | No registration for kumara however lists white rot control in onions.   | C                 |            | AU Folicur label lists Sclerotinia rot control in pyrethrum   |
|   |                           | BOSCALID           | Filan              | No product available in NZ  | G                 |            | AU Filan label has permits for Sclerotinia control in peas (snow and green), leafy brassica vegetables, lettuce, brassicas and beans          |
|   |                           | IPRODIONE          | Rovral             | Rovral WP and Rovral Gold lists Sclerotinia control in kiwifruit. No registration for kumara                                    | B                 |            |   |
|   |                           | THIOPHANATE-METHYL | Topsin M-4A        | Only registration in kumara is for black scurf control. Sclerotinia in field tomatoes is registered                             | A                 |            |   |

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



Registered  
 Actives under review in NZ  
 Actives under review in Aust


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

| Active ingredient | Common Trade Name | Registration   | Resistance group* | WHP (days)     | Comments                        |
|-------------------|-------------------|--|-------------------|----------------|---------------------------------|
| DICHLOROPROPENE   | Telone C-35       | Label lists 'Vegetable crops' – controls nematodes, diseases and suppresses some weeds | Soil Fumigant     | Not applicable | No record of use                |
| OXAMYL            | Vydate            |  | 22A Insecticide   | Not listed     | No record of use                |
| FENAMIPHOS        | Nemacur           |  | 1B Insecticide    | Not listed     | Occasionally 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                |

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


|  |                              |
|--|------------------------------|
|  | Registered                   |
|  | Actives under review in NZ   |
|  | Actives under review in Aust |

**Table 3-1:** Insecticides and bio-insecticides registered and available for the control of key insect pests in kumara or vegetables.

| Insect name (occurrence)   | Priority  | Active ingredient | Common Trade Name                         | Registrations  | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP)  |
|--|---|-------------------|---|--|-------------------|------------|--|
| CATERPILLAR<br> | Army caterpillar including tropical caterpillar are 'High - No. 1 major pest. Cutworms are a major problem. Tropical Caterpillar is key pest. | ACEPHATE          | Orthene                                   | Reg. in tomato, vegetable brassicas, lettuce and potato                | 1B                |            |  |
|  |   | CHLORPYRIFOS      | Lorsban 750 WG                            | Cutworm not listed on label  | 1B                |            |  |
| Heliothis <i>Helicoverpa spp.</i>  |   | CHLORPYRIFOS      | Lorsban 50 EC                             | Cutworm listed for maize   | 1B                |            |  |
| Tomato stem borer <i>Symmetrischema plaesiosoma</i>  |   | CARBARYL          | Sevin                                     | L, PTM,TFW + other caterpillars 'Vegetable Crops'                      | 1A                | 1          | Commonly used product and effective: Karate (lambda-cyhalothrin - only a leaf problem), Lorsban (chlorpyrifos), Decis (deltamethrin) |
| Loopers(L) <i>Lepidoptera spp.</i>   |   | DIAZINON          | Diazinon 800                              | Reg. in tomato, vegetable brassicas and onion for 'caterpillars'       | 1B                |            | What about caterpillar getting onto roots prior to roots going into storage.   |
| Tomato Fruitworm(TFW) <i>Helicoverpa armigera</i>  |   | DIAZINON          | Diazinon 50 WP                            | Caterpillars   | 1B                | 14         |  |
| Greasy cutworm(GC) <i>Agrotis ipsilon</i>  |   | ENDOSULFAN        | Thiodan                                   | Reg. for various caterpillars in tomato, vegetable brassica and potato | 2A                |            |  |
| Green lopper (GL) <i>Thysanoplusia orichalcea</i>  |   | ENDOSULFAN        | Thiodan                                   | Reg. for various caterpillars in vegetable brassicas and potato        | 2A                |            |  |
| Soybean looper (SL)  |   | METHAMIDOPHOS     | Monitor Tamaron                           | Reg. for various caterpillars in tomato, vegetable brassica and potato | 1B                |            |  |
| White Butterfly (WB) <i>Pieris rapae</i>   |   | PYRETHRUM         | Garlic & Pyrethrum Concentrate            | Cabbage Moth and caterpillars  | 3A                | 1          |  |
| Diamond Back Moth (DBM) <i>Plutella xylostella</i>   |   | TAU-FLUVALINATE   | Mavrik                                    | Reg. in cabbage and field tomato                                       | 3A                |            |  |
| Army Caterpillar <i>Pseudaletia separata</i>   |   | DICHLORVOS        | Divap                                     | Caterpillars Vegetables  | 1B                | 3          |  |
| Tropical Caterpillar <i>Spodoptera litura (F.)</i>   | <i>Bacillus thuringiensis t sub. Kurstaki</i>   | Dipel             | Caterpillars                              | 11C  | 0                 |            |  |
| Copper caterpillar <i>Lycaena salustius</i>  | <i>Bacillus thuringiensis</i>   | XenTari           | Reg. in vegetable brassicas and GH tomato | 11C  |                   |            |  |

| Insect name (occurrence)                                  | Priority | Active ingredient                                     | Common Trade Name                         | Registrations  | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP)  |
|---|----------|---|---|--|-------------------|------------|--|
| Cutworm<br><i>Agrostis spp.</i>                           |          | DELTA METHRIN   | Decis Forte                               | Reg. in field tomato, potato and vegetable brassicas                   | 3A                |            | SP's including lambda-cyhalothrin and deltamethrin are effective and give good control of cutworm  |
| Potato Tuber Moth (PTM)<br><i>Phthorimaea operculella</i> |          | ALPHA-CYPERMETHRIN                                    | Dominex/Fastac                            | Reg. in tomato and vegetable brassica                                  | 3A                |            |  |
|   |          | BIFENTHRIN  | Talstar 100EC and Talstar 80 SC           | Reg. in vegetable brassicas and field tomato                           | 3A                |            |  |
|   |          | CYPERMETHRIN  | Ripcord                                   | Reg. in cauliflower, cabbage and tomato                                | 3A                |            |  |
|   |          | PERMETHRIN + PIRIMIPHOS-METHYL                        | Attack                                    | Reg. in GH tomato, cucurbits group and vegetable brassicas             | 3A+1B             |            |  |
|   |          | ESFENVALERATE   | Sumi-Alpha                                | Reg. in tomato, cucurbits group, vegetable brassicas, potato and onion | 3A                |            |  |
|   |          | LAMBDA-CYHALOTHRIN                                    | Karate                                    | Reg. in field tomato, vegetable brassica and potato                    | 3A                |            | SP's including lambda-cyhalothrin and deltamethrin are effective and give good control of cutworm. Lambda-cyhalothrin is effective on caterpillar but needs alternatives in control programme to control potential resistance. Nothing we can use is effective on soil living direct kumara damaging bugs. |
|   |          | METHOMYL  | Lannate L                                 | Reg. cauliflower, cabbage, lettuce and tomato                          | 1A                |            |  |
|   |          | SPINOSAD  | Entrust Naturalite (WP)                   | Reg. in field tomato and vegetable brassica                            | 5A                |            |  |
|   |          | SPINOSAD  | Spinosad Naturalite                       | Reg. in field tomato, cauliflower and cabbage                          | 5A                |            |  |
|   |          | THIOPHANATE-METHYL + CHLOROTHALONIL + TAU FLUVALINATE | Guardall (Backyard use ie small packsize) | Reg. in tomato and cabbage   | 3A                |            |  |
|   |          | TRICHLORFON   | Trifon                                    | Reg. in tomato and vegetable brassica                                  | 1B                |            |  |



| Insect name (occurrence)   | Priority   | Active ingredient          | Common Trade Name          | Registrations                           | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP) |
|--|--|----------------------------|----------------------------|---|-------------------|------------|---|
|  |  | TRICHLORFON + CYPERMETHRIN | Partna                     | Reg. in cauliflower, cabbage and tomato | 1B+3A             |            |   |
|  |  | MALDISON                   | Malathion 50EC             | DBM,TFW, WB                             | 1B                | 3          |   |
|  |  | ROTENONE                   | Derris Dust                | DBM,WB                                  | 21A               | 1          |   |
|  |  | Beauvaria bassiana         | Botanigard ES, Naturalis-O |   | Bio-insecticides  |            |   |
|  |  | FIPRONIL                   | Ascend                     |   | 2C                |            |   |
|  |  | PARATHION METHYL           | Folidol                    |   |                   |            |   |
|  |  | IDOXACARB                  | Steward 150SC              | Reg. in 'head' lettuce and brassicas    | 22A               |            |   |
| Rats<br><i>Ratus spp.</i>  | Low. High problem in storage.                      | HYDROCYANIC ACID           | Cyanosil                   | Registered product in NZ                | 8B                |            | Minor problem - Storm (flocoumaten) and Talon (brodifacoum) used in bait stations.          |
|  |  | METHYL BROMIDE             | Ag Fume M.B.               | Registered product in NZ                | 8A                |            |   |
|  |  | ALUMINIUM PHOSPHIDE        | Genfume AP                 | Registered product in NZ                | 8B                |            |   |
|  |  | COUMATETRALYL L            | Racumin                    | Registered product in NZ                |                   |            |   |
|  |  | BROMADIOLONE               | Rid Rat Super              | Registered product in NZ                |                   |            |   |
|  |  | BRODIFACOUM                | Talon                      | Registered product in NZ                |                   |            |   |
|  |  | DIPHACINONE                | Pest Gone Rodent Bait      | Registered product in NZ                |                   |            |   |
|  |  | FLOCOUMAFEN                | Storm Secure               | Registered product in NZ                |                   |            |   |
|  |  | Corn Cob - powdered'       | No rats                    | Registered product in NZ                |                   |            |   |
| WEEVILS<br><br>Black Vine Weevil Larvae<br><i>Otiorhynchus sulcatus</i> | White Fringed weevil is high. Stem weevil is high. | IMIDACLOPRID               | Gaicho                     | Argentine Stem weevil in vegetables     | 4A                |            |   |
|  |  | FURATHIOCARB               | Promax 400 CS              | ASW on sweet corn                       | No AU Listing     |            |   |
|  |  | TERBUFOS                   | Counter 20G                | ASW on sweet corn                       | 1B                |            |   |
|  |  | CHLORPYRIFOS               | Suscon Green               | Only ornamentals and flowering plants   | 1B                |            |   |


| Insect name (occurrence)                                      | Priority | Active ingredient                    | Common Trade Name             | Registrations  | Resistance group*                | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP)                     |
|---|----------|--------------------------------------|-------------------------------|--|----------------------------------|------------|---|
| White fringed weevil (WFW)<br><i>Naupactus leucoloma</i>      |          | CHLORPYRIFOS                         | Lorsban 750 WG and Lorsban EC | Lists ASW in pasture.  | 1B                               |            |   |
| Plant Weevils<br><i>Curculionidae spp.</i>                    |          | <i>Heterorhabditis bacteriophora</i> | Otinem                        | Ornamentals only   | bio-insecticide                  |            |   |
| Argentine Stem weevil (ASW)<br><i>Listronotus bonariensis</i> |          | FIPRONIL                             | Ascend                        | Weevils not listed on label for any veg. in NZ. Veg brassicas on label   | 2C                               |            | WFW listed for sweet potato in Australia  |
|   |          | LAMBDA-CYHALOTHRIN                   | Karate                        | Fuller rose weevil listed for citrus only. Various veges listed on label | Fuller rose weevil - citrus only |            | PER8572 in Australia lists Vegetable Weevil for Beetroot  |
|   |          | METHAMIDOPHOS                        | Monitor Tamaron               | No weevils listed on label   | No weevils listed on label       |            | Australia PER5754 lists Vegetable Weevil control in Celery and Parsley. Label lists control of WFW in peanuts.  |
|   |          | PHORATE                              | Phorate                       | Weevils list for forage brassica   | 1B                               |            | Weevils' listed for forage brassica and 'stem weevil' listed for maize. 'ASW' listed for newly sown pasture     |
|   |          | DIAZINON                             | DIAZINON                      | No weevil listed on label  | 1B                               |            | Australian label lists ASW control in turf.   |
| Wireworm<br><i>Heteroderus spp.</i>                           | High     | PHORATE                              | Phorate                       | Wireworm registered for control in squash and potatoes                   | 1B                               |            | Australian label lists wireworm control in potatoes.  |
|   |          | CHLORPYRIFOS                         | Lorsban 750 WG and Lorsban EC | Wireworm not listed on either label                                      | 1B                               |            | Australian label lists wireworm control in potatoes.  |
|   |          | ACEPHATE                             | Orthene                       | No listing for 'wireworm' for any crop                                   |                                  |            | Wireworm not listed on Orthene label  |
| Black beetle<br><i>Heteronychus spp.</i>                      | High     | LAMBDA-CYHALOTHRIN                   | Karate                        | Only beetles listed are bronze and grass grub beetles in grapes          | 3A                               |            | Australian label does not list any beetles.   |
|   |          | CHLORPYRIFOS                         | Lorsban 750 WG and Lorsban EC | Only 'Brown Beetle' control for pipfruit and stonefruit                  | 1A                               |            | Australian label lists African Black Beetle ( <i>Heteronychus arator</i> ) on label in various vegetable crops. |
|   |          | CARBARYL                             | Sevin                         | No 'beetles' listed on NZ labels   | 1A                               |            | Australian label lists 'beetle' control in capsicum   |
|   |          | METHAMIDOPHOS                        | Monitor Tamaron               | No 'beetles' listed on labels  | 1A                               |            | Australian label does not list any beetles.   |

| Insect name (occurrence)                     | Priority | Active ingredient                 | Common Trade Name             | Registrations                      | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP) |  |
|--|----------|-----------------------------------|-------------------------------|------------------------------------|-------------------|------------|---|--|
| Symphilids<br><i>Scutigerella immaculata</i> | High     | LAMBDA-CYHALOTHRIN                | Karate                        | Symphilids not listed on the label | 3A                |            | Symphilids not listed on the Australian label   |  |
|  |          | METHAMIDOPHOS                     | Monitor Tamaron               | Symphilids not listed on the label | 1B                |            | Symphilids not listed on the Australian label   |  |
|  |          | 1,3 DICHLOOPROPENE + CHLOROPICRIN | Telone C-35                   |                                    |                   |            |   | Australian label lists Symphilids for vegetables pre-plant               |
|  |          | CHLORPYRIFOS                      | Lorsban 750 WG and Lorsban EC |                                    |                   |            |   | Australian label lists Symphilids control in sugarcane                   |
|  |          | MONOMEHTYL DITHIOCARBAMATE        | Envirofume                    |                                    |                   |            |   | AU label lists Symphilids control as a pre-plant soil applied treatment. |
|  |          | METHAM SODIUM                     | Fumasol                       |                                    |                   |            |   | AU label lists Symphilids control as a pre-plant soil applied treatment. |
|  |          | CAV VACCINE                       |                               |                                    |                   |            |   | AU label lists Symphilids control as a pre-plant treatment in seedbeds.  |
|  |          | DIAZINON                          | Diazinon 800                  | Symphilids not listed on the label | 1B                |            | Symphilids not listed on the Australian label   |  |

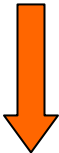
\* Resistance groups combine agrichemicals with the same mode of action.

|  |                              |
|--|------------------------------|
|  | Registered                   |
|  | Actives under review in NZ   |
|  | Actives under review in Aust |

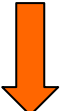
**Table 3-2:** Insecticides and bio-insecticides registered and available for the control of minor insect pests in kumara or vegetables.

| Insect name (occurrence)   | Priority | Active ingredient                  | Common Trade Name              | Registrations  | Resistance group*     | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP)                                   |
|--|----------|------------------------------------|--------------------------------|--|-----------------------|------------|---|
| <b>APHIDS</b><br> |          | ALPHA-CYPERMETHRIN                 | Dominex/Fastac                 | Aphids' listed for tomatoes  | 3A                    |            |   |
|  |          | PYRETHRINS                         | Garlic & Pyrethrum Concentrate | Aphids   | 3A                    | 1          | May be resistance management issues depending on species of aphids involved' DOES THIS MEAN APHIDS ARE A PROBLEM IN KUMARA??? |
|  |          | Beauveria bassiana                 | Botanigard ES, Naturalis-O     |  | Bio-insecticides      |            |   |
|  |          | CANOLA OIL                         | Eco-oil                        | GPA  | Vegetable Oil         | 20         |   |
| Melon aphid<br><i>Aphis gossypii</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 |            |   |
| Potato aphid<br><i>Macrosiphum euphorbiae</i>  |          | BIFENTHRIN                         | Talstar 100EC                  | Reg. on field tomatoes, pumpkins, squash for 'aphids'  | 3A                    |            |   |
| Carrot willow aphid<br><i>Cavariella aegopodii</i>   |          | CARBARYL                           | Sevin                          | No listing of aphids on any crop   | 1A                    |            |   |
| Carrot black aphid<br><i>Cavariella aegopodii</i>  |          | DIAZINON                           | Diazinon 800                   | Reg. on tomato, cauliflower, cabbage and onion for 'aphids'  | 1B                    |            |   |
| Cabbage Aphid (CA) <i>Brevicoryne brassicae</i>  |          | DIAZINON                           | Diazinon 50 WP                 | Aphids   | 1B                    | 14         |   |
| Fox Glove<br><i>Aulacorthum solani</i>   |          | ENDOSULFAN                         | Thiodan                        | Reg. on tomato, vegetable brassica and potato  | 2A                    |            |   |
| Lettuce Aphid<br><i>Nasonovia ribis-nigri</i>  |          | IMIDACLOPRID                       | Gaicho                         | Reg. on potato and squash for 'aphids'   | 4A                    |            |   |
| Sow thistle?? Weed?  |          | IMIDACLOPRID                       | Confidor                       | Registered for CA on brassicas and lettuce   | 4A                    |            | Products commonly used and effective: IPM friendly. Green peach aphid listed on AU label.                                     |
| Green Peach Aphid (GPA) <i>Myzus persicae</i>  |          | Lecanicillium lecanii blastospores |                                |  |                       |            |   |

| Insect name (occurrence)                         | Priority | Active ingredient                                    | Common Trade Name                       | Registrations  | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP)                     |
|--|----------|--|---|--|-------------------|------------|---|
| APHIDS (cont)                                    |          | PERMETHRINS + PIPERONYL BUTOXIDE                     | Greenseals Pyrethrum                    | Aphids   | 3A                |            |   |
| Black (Peach) Aphid <i>Brachycaudus persicae</i> |          | PIRIMICARB   | Pirimor 50                              | Reg. on tomato, cucurbits group, vegetable brassicas and lettuce       | 1A                |            | Products commonly used and effective: IPM friendly  |
|  |          | PIRIMIPHOS-METHYL                                    | Only available alone for stored insects | Only available alone for stored insects                                | 1B                |            |   |
|  |          | PYMETROZINE  | Chess WG                                | Reg. in tomato, vegetable brassica, lettuce and potato                 | 9A                |            | Products commonly used and effective: IPM friendly. Chess is the only product compatible with <u>Aphidius</u> . |
|  |          | TAU-FLUVALINATE                                      | Mavrik                                  | Reg. on field tomato for GPA   | 3A                |            |   |
|  |          | THIOPHANATE-METHYL + CHLOROTHALONIL + TAUFLUVALINATE | Guardall                                | Reg. for 'aphids' on tomato  | 3A                |            |   |
|  |          | PERMETHRIN + PIRIMIPHOS-METHYL                       | Attack                                  | Reg. for 'aphids' in GH tomato, cucurbits group and vegetable brassica | 3A+1B             |            |   |
|  |          | PERMETHRIN+PIPERONYL BUTOXIDE                        | Permigas                                | Reg. in GH capsicum  | 3A                |            |   |
|  |          | DICHLORVOS   | Divap                                   | Aphids Vegetables  | 1B                | 3          |   |
|  |          | FATTY ACIDS (POTASSIUM SALTS)                        | Nature's Way Insect Spray               |  | Unlisted          | 1          |   |
|  |          | APHID PARASITE'                                      | <i>Aphidius colemani</i>                |  | Bio-insecticides  |            |   |
|  |          | APHIDOLETED  | <i>Aphidoletes aphidimyza</i>           |  | Bio-insecticides  |            |   |
|  |          | MALDISON   | Malathion 50EC                          | Aphids   | 1B                | 3          |   |
|  |          | DELTAMETHRIN   | Decis Forte                             | Reg. for 'aphids' in squash  | 3A                |            |   |

| Insect name (occurrence)  | Priority  | Active ingredient         | Common Trade Name | Registrations   | Resistance group*                      | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP) |  |
|---|---|---------------------------|-------------------|---|--|------------|---|--|
| APHIDS (cont)   |   | ROTENONE                  | Derris Dust       |   | 21A                                    | 1          |   |  |
|   |   | METHOMYL                  | Lannate L         | Reg. for GPA in tomato, cauliflower, cabbage and lettuce                              | 1A                                     |            | Lannate (methomyl) not IPM friendly but occasionally used.                                  |  |
|   |   | PHORATE                   | Phorate           | Reg for 'aphids' in cucurbits group, squash, vegetable brassicas, potato and carrot   | 1B                                     |            |   |  |
|   |   | TERBUFOS                  | Counter 20G       | Aphids listed for forage brassicas as a seed/fertiliser treatment                     | 1B                                     |            |   |  |
|   |   | CHLORPYRIFOS              | Lorsban 50EC      | Reg for 'aphids' in winter squash and vegetable brassicas                             | 1B                                     |            |   |  |
|   |   | DIMETHOATE                | Perfekthion S     | Reg. for CA in potato, carrots and cauliflower, cabbage, Brussel sprouts and broccoli | 1B                                     |            |   |  |
|   |   | ACEPHATE                  | Orthene           | Reg. for 'aphids' in lettuce and potato   | 1B                                     |            |   |  |
|   |   | METHAMIDOPHOS             | Monitor Tamaron   | Reg. for 'aphids' in potato   | 1B                                     |            |   |  |
| <b>THRIPS</b><br> |   | ALPHA-CYPERMETHRIN        | Dominex/Fastac    | Reg. in tomato and onions   | 3A                                     |            |   |  |
|   |   | CHLORPYRIFOS              | Lorsban 750 WG    | Reg. in kumara for 'thrips'   | 1B                                     |            |   |  |
|   |   | DELTA-METHRIN             | Decis Forte       | Reg. in kumara for 'thrips'   | 3A                                     |            |   |  |
|   |   | ENDOSULFAN                | Thiodan           | Reg. in kumara for 'thrips'   | 2A                                     |            |   |  |
|   | Onion Thrips<br><i>Thrips tabaci</i>                      |                           | ENDOSULFAN        | Thionex EC  | Reg. in kumara and tomato for 'thrips' | 2A         |   |  |
|   | Western Flower Thrip<br><i>Frankliniella occidentalis</i> |                           | FIPRONIL          | Ascend  | No mention of thrips on NZ label       | 2C         |   |  |
|   | Intonsa Flower Thrip<br><i>Frankliniella intonsa</i>      |                           | IMIDACLOPRID      | Confidor  | Reg. for thrips on onion               | 4A         |   |  |
| Cucumerous (Cucumber) thrips (WFT)  |   | IMIDACLOPRID + CYFLUTHRIN | Confidor Supra    | Reg. for 'thrips' on onion  | 4A+3A                                  |            |   |  |

| Insect name (occurrence) | Priority | Active ingredient                  | Common Trade Name                            | Registrations  | Resistance group*     | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP) |
|--------------------------|----------|------------------------------------|--|--|-----------------------|------------|---|
| THRIPS (cont)            |          | LAMBDA-CYHALOTHRIN                 | Karate                                       | Reg. for 'onion thrips' on onions  | 3A                    |            |   |
|                          |          | AZADIRACHTIN                       | NeemAzal-T/S                                 | Only registered on non-fruit bearing trees and vines however mentions thrips | Botanical insecticide |            | Not registered on any vegetable and only on non-fruit bearing trees and vines.              |
|                          |          | METHAMIDOPHOS                      | Monitor Tamaron                              | Reg. for thrips on onion   | 1B                    |            |   |
|                          |          | TAU-FLUVALINATE                    | Mavrik                                       | Reg. for thrips on onion   | 3A                    |            |   |
|                          |          | CARBARYL                           | Sevin  | No thrips control in any veg. crop however controls thrips in fruit crops    | 1A                    |            |   |
|                          |          | <i>Amblyseius cucumeris</i>        | Mite-A, Thripex (Biological)                 | Reg. on GH tomato, GH capsicum and GH cucumber                               | Bio-insecticides      |            |   |
|                          |          | <i>Hypoaspis aculeifer</i>         | Hypomite                                     | Thrips pupae   | Bio-insecticides      | 0          |   |
|                          |          | DIAZINON                           | Diazinon 800                                 | Reg. for 'thrips' on tomato, vegetable brassicas and onions                  | 1B                    |            |   |
|                          |          | DIAZINON                           | Diazinon 50 WP                               | Thrips   | 1B                    | 14         |   |
|                          |          | Lecanicillium lecanii blastospores | Can't find a reference to a product anywhere | Can't find a reference to a product anywhere                                 |                       |            |   |
|                          |          | DICHLORVOS                         | Divan  | Reg. for 'thrips' on GH tomato and GH capsicum                               | 1B                    |            |   |
|                          |          | THIACLOPRID                        | Calypso                                      | Thrips listed on avocados, peaches and nectarines but not any vegetable      | 4A                    |            | Thrips listed on avocados, peaches and nectarines   |
|                          |          | MALDISON                           | Malathion 50EC                               | Thrips listed on various fruit crops however no vegetables                   | 1B                    |            |   |
|                          |          | PYRETHRUM                          | Garlic & Pyrethrum Concentrate               | Thrips   | 3A                    | 1          |   |

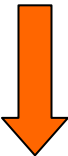
| Insect name (occurrence)  | Priority | Active ingredient                  | Common Trade Name         | Registrations  | Resistance group*     | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP)   |
|---|----------|------------------------------------|---------------------------|--|-----------------------|------------|---|
| WHITEFLIES<br> |          | THIACLOPRID                        | Calypso                   | Whitefly not listed on Calypso label   | 4A                    |            | No Whitefly listed on AU label or NZ label  |
|   |          | BUPROFEZIN                         | Applaud Ovation           | Reg. on tomato, capsicum and cucurbits   | 17A                   |            | Buprofezin does not list whitefly. Permits available for Silverleaf whitefly control in Aust. |
|   |          | ENDOSULFAN                         | Thiodan                   | Reg. for whitefly on tomato  | 2A                    |            |   |
| Greenhouse whitefly(GW)<br><i>Trialeurodes vaporariorum</i>                                     |          | CANOLA OIL                         | Eco-oil                   | Greenhouse Whitefly  | Vegetable Oil         | 0          |   |
| Tobacco Whitefly (TW)(Silverleaf)<br><i>Bemisia tabaci</i> (biotype B)                          |          | AZADIRACHTIN                       | NeemAzal-T/S              | Not registered on vegetables Only on non-fruit bearing trees and vines however mentions whitefly control | Botanical insecticide |            | Not registered on any vegetable and only on non-fruit bearing trees and vines.                |
|   |          | IMIDACLOPRID                       | GaUCHO                    | No Whitefly control for any crop   | 4A                    |            | Permits available for Silverleaf whitefly control in Aust.                                    |
|   |          | Lecanicillium lecanii blastospores |                           |  |                       |            |   |
|   |          | <i>Encarsia formosa</i>            | 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                    |            | Permits available for Silverleaf whitefly control in Aust.                                    |
|   |          | METHOMYL                           | Lannate L                 | Reg. for 'whitefly' on GH tomato, GH capsicum and GH cucumber  | 1A                    |            | Permits available for Silverleaf whitefly control in Aust.                                    |
|   |          | PERMETHRUM                         | Garlic Concentrate        | GW   | 3A                    | 1          |   |
|   |          | PIRIMIPHOS-METHYL                  | Actellic                  | Reg. for 'under glass' tomato and 'under glass' cucurbits group  | 1B                    |            |   |
|   |          | PERMETHRIN + PIRIMIPHOS-METHYL     | Attack                    | Reg. for GH tomato   | 3A+1B                 |            |   |
|   |          | FATTY ACIDS (POTASSIUM SALTS)      | Nature's Way Insect Spray | 1  | Unlisted              | 1          | AU label lists whitefly. No listing of Whitefly on NZ label                                   |



| Insect name (occurrence)                         | Priority | Active ingredient                  | Common Trade Name   | Registrations  | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP) |
|--|----------|------------------------------------|---------------------|--|-------------------|------------|---|
| Potato psyllid<br><i>Psyllidae spp.</i>          |          | ABAMECTIN                          | Avid                | Psyllids not listed for any crop   | 6A                |            | New pest, found in one potato and caps crop only.   |
|  |          | SPINOSAD                           | Spinosad Naturalyte | Psyllids not listed for any crop   | 5A                |            | No products found for 'potato psyllid' control in any vegetable crops                       |
|  |          | METHOMYL                           | Lannate L           | Psyllids not listed for any crop   | 1A                |            |   |
|  |          | ENDOSULFAN                         | Thiodan             | Psyllids not listed for any crop   | 2A                |            |   |
|  |          | IMIDACLOPRID                       | Confidor            | AU label - lists psyllid (lerps) control in non-bearing citrus           | 4A                |            | Confidor RTU label in AU lists psyllid (lerps) control in non-bearing citrus                |
|  |          | PYMETROZINE                        | Chess WG            | Psyllids not listed for any crop   | 9A                |            |   |
|  |          | BUPROFEZIN                         | Applaud/Ovation     | Psyllids not listed for any crop   | 17A               |            |   |
|  |          | SYNTHETIC PYRETHROIDS              |                     | No psyllid mentioned   | 3A                |            | Checked the most common SP labels.  |
|  |          | DIMETHOATE                         | Dimethoate          | AU labels list 'Psyllids (lerps) control in non fruit and non veg. trees | 1B                |            | AU label lists psyllid control in eucalypts   |
|  |          | ORGANOPHOSPHATES                   |                     | No psyllid mentioned   | 1B                |            | Checked the most common OP labels.  |
|  |          | ESFENVALERATE                      | Sumi-Alpha          | No mention of Psyllids on label for any crop                             | 3A                |            |   |
| Cabbage Leaf Miner<br><i>Liriomyza brassicae</i> |          | SYNTHETIC PYRETHROIDS              |                     | No 'leafminer' mentioned   | 3A                |            | Leafminer fly?? ( <i>Scaptomyza flava</i> ). Checked the most common SP labels.             |
|  |          | DIMETHOATE                         | Dimethoate          | AU label lists 'leafminers' for vegetables                               | 1B                |            |   |
|  |          | ENDOSULFAN                         | Thiodan             | AU label lists 'leafminers' for tobacco and beet leafminer in beetroot   | 2A                |            |   |
| Sciarid Flies<br><i>Bradysia spp.</i>            |          | IMIDACLOPRID                       | Gaicho              | Sciarid fly control not mentioned for any crop                           | 4A                |            | No mention of sciarid flies on label  |
|  |          | <i>Hypoaspis aculeifer</i>         | Entomite            |  | Bio-insecticides  | 0          |   |
|  |          | <i>Hypoaspis aculeifer</i>         | Hypomite            |  | Bio-insecticides  | 0          |   |
|  |          | Bacillus thuringiensis israelensis | VictoBac 12AS       | Label lists mosquitoes and blackflies                                    | Bio-insecticide   |            | Label lists mosquitoes and blackflies   |

| Insect name (occurrence)                      | Priority | Active ingredient         | Common Trade Name                | Registrations  | Resistance group*     | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP) |
|---|----------|---------------------------|----------------------------------|--|-----------------------|------------|---|
| Sciarid Flies<br><i>Bradysia spp.</i>         |          | DICHLORVOS                | Divap                            | Reg. for 'sciarid fly' in GH tomato, GH capsicum   | 1B                    |            |   |
|   |          | <i>Steinermema feltae</i> | Gnatnem                          |  | Bio-insecticides      | 0          |   |
| Mealy Bugs<br><i>Pseudococcus spp.</i>        |          | IMIDACLOPRID              | Gaicho                           | Mealy bug not listed on label in NZ  | 4A                    |            |   |
|   |          | CARBARYL                  | Sevin                            | Mealy bug control in pipfruit  | 1A                    |            |   |
|   |          | AZADIRACHTIN              | NeemAzal-TS                      | Not registered on any vegetable and only on non-fruit bearing trees and vines however mentions mealy bug control | Botanical insecticide |            |   |
|   |          | BUPROFEZIN                | Applaud Ovation                  | Mealy bug listed for peaches, grapes, persimmons, pipfruit   | 17A                   |            |   |
|   |          | THIACLOPRID               | Calypso                          | Mealy bug control reg. for apples however no vegetable crop  | 4A                    |            |   |
|   |          | PROTHIOFOS                | Tokuthion                        | Controls mealy bug in grapes and pipfruit  | 1B                    |            |   |
|   |          | CRYPTOBUG (Biological)    | <i>Cryptolaemus montrouzieri</i> |  | Bio-insecticide       |            |   |
| Green Vegetable Bug<br><i>Nezara viridula</i> |          | CARBARYL                  | Sevin                            | Green Veg. Bug not listed for any crop in NZ   | 1A                    |            |   |
|   |          | ENDOSULFAN                | Thiodan Thionex                  | Reg. for GVB control in tomato   | 2A                    |            |   |
|   |          | IMIDACLOPRID + CYFLUTHRIN | Confidor Supra                   | Lists Green Vegetable Bug for sweet corn   | 4A+3A                 |            |   |
|   |          | METHAMIDOPHOS             | Monitor Tamaron                  | Listed on maize/sweet corn for Green veg bug   | 1B                    |            | Listed on maize/sweet corn for Green veg bug  |
|   |          | IMIDACLOPRID              | Confidor                         | Green Vegetable Bug not listed on Confidor label in NZ or AU   | 4A                    |            | Green Vegetable Bug not listed on Confidor label in NZ or AU                                |
|   |          | TRICHLORFON               | Trifon                           | Reg. for tomato  | 1B                    |            |   |

| Insect name (occurrence)                    | Priority | Active ingredient                   | Common Trade Name | Registrations  | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP) |
|---|----------|-------------------------------------|-------------------|--|-------------------|------------|---|
| Grassgrub Beetle<br><i>Oncopera spp.</i>    |          | PHORATE                             | Phorate           | Grass Grub not listed on Phorate label for any crop                      | 1B                |            |   |
|   |          | IMIDACLOPRID                        | Gaicho            | Reg. for 'grass grub beetle in squash                                    | 4A                |            | Check Sp's . Listed on cucurbit spreadsheet   |
|   |          | DIAZINON                            | DIAZINON          | Reg. for established pastures  | 1B                |            |   |
|   |          | TERBUFOS                            | Counter 20G       | Controls 'grass grub' in new pastures/cereals                            | 1B                |            |   |
| Leafroller<br><i>Trotricidae spp.</i>       |          | CHLORPYRIFOS                        | Lorsban 750 WG    | Leafroller listed for forage brassicas                                   | 1B                |            |   |
|   |          | Bacillus thuringiensis sub. Aizawai | Dipel/Xentari     | Bt for leafroller control listed for a number of crops                   | 11C               |            |   |
| Nyssius Wheat Bug<br><i>Nyssius huttoni</i> |          | ENDOSULFAN                          | Thiodan           | Nyssium listed for forage brassicas                                      | 2A                |            |   |
|   |          | TERBUFOS                            | Counter 20G       | Nyssius listed for forage brassicas with seed or fertiliser              | 1B                |            |   |
|   |          | FENITROTHION                        | Caterkil 1000     | Listed for forage brassicas  | 1B                |            |   |
|   |          | PHORATE                             | Phorate           | Reg. for 'nyssius' in forage brassica                                    | 1B                |            |   |
|   |          | CHLORPYRIFOS                        | Lorsban 750 WG    | Springtails listed on forage brassica labels                             | 1B                |            |   |
| Springtails<br><i>Collebola spp.</i>        |          | FURATHIOCARB                        | Promax 400 CS     | Springtails listed on forage brassica labels as a seed treatment         | No AU Listing     |            |   |
|   |          | IMIDACLOPRID                        | Gaicho            | Listed for squash and forage brassicas                                   | 4A                |            |   |
|   |          | 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                |            |   |

| Insect name (occurrence)   | Priority | Active ingredient     | Common Trade Name            | Registrations   | Resistance group* | WHP (days) | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP) |
|--|----------|-----------------------|------------------------------|---|-------------------|------------|---|
| Slugs & snails<br><i>Gastropoda spp.</i>   |          | <u>IRON PHOSPHATE</u> | Neudorff Slug and Snail Bait | Don't apply to edible plant parts                                       | No listing        |            |   |
|  |          | IRON SODIUM EDTA      | <u>Multiguard</u>            | Don't apply to edible plant parts                                       | No listing        |            |   |
|  |          | METHIOCARB            | <u>Mesuro</u>                | Registered everywhere   | 1A                | 0 / 21     | 0 day WHP if no contact with crop, otherwise 21D  |
|  |          | Metaldehyde           | <u>Slugout</u>               | Do not apply to edible plant parts.                                     | Molluscicide      |            |   |
|  |          | THIODICARB            | Larbait                      | Registered in vegetables  | 1A                |            |   |
|  |          | PHORATE               | Phorate                      | Reg. for 'cucurbits' squash and potato                                  | 1B                |            |   |
| MITES<br><br> |          | FATTY ACIDS (K SALTS) | Yeates Mite Killer           | ERM, TSM  | Not listed        | 1          | No Tomato Russet Mite on this label   |
|  |          | FENBUTATIN OXIDE      | Torque                       | Registered in many crops  | 12A               |            | AU label 'Torque' registered for ERM and TSM in various fruit crops but not vegetables.     |
|  |          | CANOLA OIL            | Eco-oil                      | TSM   |                   | 0          |   |
|  |          | CLOFENTEZINE          | Apollo 50SC                  | Label for various crops but not vegetable crops                         | 10A               |            | AU label - lists ERM and TSM control in various fruit crops but not vegetables              |
| European Red Mite<br><i>Bradysia spp.</i>  |          | <b>DICHLORVOS</b>     | <b>Divap</b>                 | Mites   | 1B                | 3          |   |
| Tomato Russet Mite (TRM)<br><i>Aceria lycopersici</i><br>( <i>Wolffenstein</i> )               |          | AZOCYCLOTIN           | Peropal                      | No Reg. in Vegetable Crops. Controls TSM and ERM in various fruit crops | No AU Listing     |            |   |
| Two-Spotted Mite<br><i>Tetranychus urticae</i>   |          | ABAMECTIN             | Avid                         | Label for pipfruit  | 6A                |            | TRM, TSM listed for GH Tomato ERM   |
|  |          | TAU-FLUVALINATE       | Mavrik Flo                   | Reg. for Mites in Ornamentals   | 3A                |            |   |
|  |          | MILBEMECTIN           | Mit e mec                    | Reg for TSM, ERM in apples  | 6B                |            |   |
|  |          | FENPYROXIMATE         | Fenamite                     | Reg. for TSM, ERM in pipfruit   | 10A               |            |   |
|  |          | PROPARGITE            | Omite 30W                    | No Reg. in Vegetable Crops.   | 14A               |            | TSM and ERM control in various crops  |

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



Registered  
Actives under review in NZ  
Actives under review in Aust

**Table 4:** Herbicides registered or available for weed control in kumara or vegetables.

| Crop        | Active ingredient    | Common Trade Name | Resistance group*                                  | CURRENT PRODUCT SUITABILITY (availability, efficacy, IPM, residues, resistance, trade, WHP) |
|-------------|----------------------|-------------------|--|---|
| Kumara      | ALACHLOR             | Alanex Lasso      |  | Occasionally used   |
|             | FLUAZIFOP-P-BUTYL    | Fusilade WG       | A  | Commonly used early post emergent for grass weeds   |
| Vegetables  | CHLORPROPHAM         | Alliacine 40EC    | E  | Do not use in near seed potatoes or in areas where they may be stored.                      |
|             | CHLORTHAL DIMETHYL   | Dacthal 75W       | D  | No record of use  |
|             | CLOMAZONE            | Magister          | F  | No record of use  |
|             | DALAPON              | Dalapon           | J  | Occasionally used pre-plant   |
|             | DIMETHENAMID         | Frontier          | K  | Occasionally used pre-plant   |
|             | CLETHODIM            | Arrow             | A  | Occasionally used early post emergent for grass weeds                                       |
|             | PENDIMETHALIN        | Stomp Xtra        | D  | No record of use  |
|             | QUIZALOFOP-P-ETHYL   | Targa             | A  | No record of use  |
|             | SETHOXYDIM           | Poast             | A  | No record of use  |
|             | S-METOLACHLOR        | Dual Gold         | K  | No record of use  |
|             | TRIFLURALIN          | Trifluralin       | D  | No record of use  |
|             | GLYPHOSATE           | Roundup           | M  | Pre-plant and inter-row weed control  |
|             | GLYPHOSATE-TRIMESIUM | Touchdown         | M  | Pre-plant and inter-row weed control  |
|             | DIQUAT               | Reglone           | L  | Pre-plant and inter-row weed control  |
|             | PARAQUAT             | Paraquat          | L  | Pre-plant and inter-row weed control  |
| PINE OIL    | Organic Interceptor  |                   | Before crop emergence and inter-row                |   |
| OXYFLUORFEN | Burnout              | G                 | Pre-plant and inter-row weed control with Roundup. |   |

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

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Registered  
 Actives under review in NZ  
 Actives under review in Aust