Leeks

Strategic Agrichemical Review Process
2011-2014

HAL Projects - MT10029 & VG12081

AgAware Consulting Pty Ltd
Checkbox 3D Pty Ltd

February 2014

Horticulture Australia project no:
MT10029 – Managing pesticide access in horticulture.
VG12081 - Review of vegetable SARP reports.

Contact:
Noelene Davis
Checkbox 3D Pty Ltd
PO Box 187 Beecroft NSW 2119
Ph: 0424 625 267 Email: ndavis@checkbox3d.com.au

Purpose of the report:
This report was funded by Horticulture Australia and the Australian vegetable industry to investigate the pest problem, agrichemical usage and pest management alternatives for the leek industry across Australia. The information in this report will assist the industry with its agrichemical selection and usage into the future.

Funding sources:
MT10029 - This project has been funded by HAL using the vegetable industry levy and across industry funds with matched funds from the Australian Government.
VG12081 - This project has been funded by HAL using the vegetable industry levy and matched funds from the Australian Government.

Date of report:
10 February 2014

Horticulture Australia

Contents

1. Media Summary

A Strategic Agrichemical Review Process (SARP) through the process of a desktop audit and industry liaison assesses the importance of the diseases, insects and weeds (plant pests) that can affect a horticultural industry; evaluates the availability and effectiveness of fungicides, insecticides and herbicides (pesticides) to control the plant pests; determines any 'gaps' in the pest control strategy and identifies suitable new or alternatives pesticides to address the 'gaps'.

Alternative pesticides should ideally be selected for benefits of:

- Integrated pest management (IPM) compatibility
- Improved scope for resistance management
- Sound biological profile
- Residue and trade acceptance domestically and for export

SARP workshops for leeks were conducted in South Australia, Victoria and Western Australia as part of combined vegetable meetings in 2008, 2010 and 2011. The results of the process provide the leek industry with pesticide options for the future that the industry can pursue for registration with the manufacturer, or minor-use permits with the Australian Pesticides and Veterinary Medicines Association (APVMA).

DISEASE

Diseases identified as high priorities:

Disease (common name)	**Disease (scientific name)**
Downy mildew	*Peronospora destructor*
Purple blotch	*Alternaria porri*
White rot	*Sclerotium cepivorum*

Very few fungicides are registered for control of disease in leeks. Extension of registrations for onions and other alliums would be helpful. There are also some new chemistry, particularly for downy mildew, that should be considered.

INSECTS

Insects identified as high priorities:

Insect (common name)	**Insect (scientific name)**
Onion thrips	*Thrips tabaci*

There are few products registered or permitted for use in leeks. The impact of resource recovery as a driver of research and development choices for product registrants is evident in this minor crop – the cost of the efficacy and residue data packages required relative to the value of the potential chemical sales are usually too high to justify the work.

WEEDS

Growers generally use a pre-plant weed control (general knockdown herbicides) to prepare the paddock. Growers then either alternate the herbicides used or use them in combination for effective weed control. All the herbicides registered/permitted are either pre-emergent herbicides or early post-emergent herbicides.

Most weeds can be controlled with currently available herbicides.

2. The Australian leek industry

The Australian leek industry is a small horticultural industry. Consumption of leeks has risen in recent years with the growth in healthier lifestyles and moves to fresh food.

Accurate statistics on leek production are not available, but it is known to be grown in reasonable quantities at:

- Melbourne Metro area (Vic)
- Stanthorpe (Qld)
- Perth Metro outer areas (WA)
- Adelaide Hills (SA)

The leek species referred to in this report is *Allium ampeloprasum var. porrum*.

In 2008/09, there were 149 growers growing 316 ha leeks, producing 7,019 t worth $19.7M (farm gate). In recent years, the area grown has decreased, but yield (t/ha) has significantly increased (Ausveg 2012).

Due to Australia's varying weather conditions and the introduction of different varieties of leeks, the Australian industry is now able to supply domestic markets with fresh leeks throughout the year.

3. Introduction

3.1. Background

Growers of some horticultural crops suffer from a lack of legal access to crop protection products (pesticides). The problem may be that whilst a relatively small crop area is valuable in an agricultural sense, it is not of sufficient size for agchem manufacturers to justify the expense of registering a product use on that crop. Alternately, the disease, pest, or weed problem may be regional or spasmodic, making agchem companies unwilling to bear the initial high cost of registering suitable pesticides. As an added complication some horticultural crops may be grown in protected cropping or hydroponic situations. These can have a significant impact on pesticide performance and residue outcomes, further increasing product development requirements and registration costs.

Growers may at times be in a situation where they face severe losses from diseases, pests and weeds if they do nothing to protect their crops, or face penalties if they use a product that is not registered or available via a permit. The leek industry is very aware of the possible consequences of the use of unregistered or non-permitted pesticides. These can include: produce with unauthorised pesticide residues; rejection at both local and export market levels; placing Australian export trading arrangements in jeopardy, and; fines and penalties.

Environmental concerns, consumer demands, and public opinion are also significant influences in the marketplace related to pest management practices. Industry/IPM Practitioners must strive to implement best management practices and tools to incorporate a pest management regime where strategies work in harmony with each other to achieve the desired effects while posing the least risks.

Pesticides have always been an important tool in the production of leek. They control the various diseases, insects and weeds that affect the crop and can cause severe economic loss in modern high intensity growing operations. Pesticides are utilized in seedling production, pre-plant, during plant establishment, through crop development and into crop maturity to maximise crop yield, quality and customer appeal.

From a pesticide access perspective, the APVMA classifies leek as a group as a minor crop. The crop fits within the APVMA crop group 009 Bulb vegetable.

As a consequence of the issues facing the leek industry regarding pesticide access, Horticulture Australia Ltd and the vegetable industry undertook a review of the pesticide requirements in leeks via a Strategic Agrichemical Review Process (SARP). See Appendix 1 – the Strategic Agrichemical Review Process. The aim was to determine solutions (primarily pesticide) to current and future pest threats.

This SARP process identified diseases, insect pests and weeds of major concern to the leek industry. Against these threats available registered or permitted pesticides, along with non-pesticide solutions, were evaluated for overall suitability in terms of IPM, resistance, residues, withholding period, efficacy, trade, human safety and environmental issues. Where tools were unavailable or unsuitable the process aimed to identify potential future solutions.

This report is not a comprehensive assessment of all pests and control methods impacting on leek production in Australia but attempts to prioritise the major problems.

3.2. Minor use permits and registration

Leeks are classified as minor by the APVMA. Therefore access to minor use permits can be relatively straight forward as long as a reasonable justification is provided. Possible justification for future permit applications could be based on:

- New disease, insect or weed identified as a cropping issue
- No pesticide available
- Current pesticides no longer work – resistance
- Current pesticides limiting trade
- IPM, environmental or operator issues
- Loss of pesticides due to removal from market
- New, effective pesticide registered in another crop
- Alternate pesticide has overseas registration or minor use permit

With each of these options, sound, scientific argument is required to justify any new registrations or permit applications.

Another option for the leek industry is for manufacturers to register new pesticides uses in the crop.

3.3. Methods

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

- Participants were given a comprehensive list of most major pests of leeks and asked to prioritise them into high, moderate and low categories.
- Participants were then asked to list the main pesticides and or other control agents used for each pest.
- Mostly pesticide trade names were used and the list provided was certainly not comprehensive but a starting point for further assessment.
- Pesticides that are under review by the Australian Pesticides and Veterinary Medicines Authority (AVPMA) were listed.
- Information was collated onto Excel spreadsheets for diseases, insects and weeds.
- The information was circulated to participants for any further comments to ensure the accuracy of the information.
- Each alternative pesticide was assessed for:
    - IPM compatibility
    - Improved scope for resistance management
    - Sound biological profile
    - Residue and trade acceptance domestically and for export

Final selections of proposed new pesticides for the leek industry to pursue were listed.

3.4. Results and discussions

Results and discussions are presented in the body of this document.

4. Pests and diseases of leek

4.1 Diseases of leeks

Common name	Scientific name
HIGH PRIORITY	
Downy mildew	*Peronospora destructor*
Purple blotch	*Alternaria porri*
White rot	*Sclerotium cepivorum*
MODERATE PRIORITY	
Bacterial blight	*Pseudomonas syringae*
Fusarium	*Fusarium* spp.
LOW PRIORITY	
Blue mould	*Penicillium* spp.
Grey mould	*Botrytis* spp.
Biosecurity risk	
None listed	

4.1.1 High priority diseases

Downy mildew (*Peronospora destructor*)

The first evidence of Downy mildew is a fine, furry, greyish white to purple growth on the surface of older leaves. Leaf tissue under the growth becomes pale green, then yellow, and finally collapses. Large, yellowish, circular clumps of infected plants may be the first symptom noticed in the crop. The yellowing patterns often enlarge in the direction of prevailing winds. Downy mildew can develop from an initial infection by airborne spores into an epidemic very quickly if humidity and temperature conditions are favourable. Spores can travel long distances in moist air, but are quickly killed by dry conditions. Initial sources of disease can be infected bulbs, sets, seeds, and plant debris.

- Downy mildew is considered a major - moderate problem in all states. It is a fairly new disease in Australian leeks.
  - In some seasons, when conditions favour the disease, it may not be controlled to control.
  - Growers alternate the use of different fungicides to reduce the resistance risk.
  - Growers would like other protective/curative fungicides for alternation.

- Fungicides **registered** for the control of Downy mildew in leeks are:
  - Metalaxyl + copper as hydroxide (RIDOMIL^ GOLD PLUS) – Group 4 + M1 systemic, protective and curative fungicide
    - For the control of downy mildew and purple blotch.
    - Commonly used.
    - Used as a protectant / curative fungicide.
    - There is a restricted number of applications - maximum of 2.
    - Considered very effective, but expensive.
    - Minimal impact on most beneficial insects.
  - Hydrogen peroxide + peroxyacetic acid (PERATEC PLUS^) - Group M fungicide
    - Maximum 5 sprays per crop
    - 1 day withholding period is advantageous.

- Fungicides listed for control of Downy mildew control in leeks via **permit** are:
  - Azoxystrobin (PER10914, Expires May 2014)– Group 11 protectant and curative fungicide
    - Commonly used.
    - Used as a protectant / curative fungicide.

- Considered very effective, but expensive.
- There is a restricted number of applications - maximum of 3.
- Growers expressed concern that a heavy reliance that resistance may develop.
- Minimal impact on all beneficial insects.
- Permit may not be renewed.

- Dimethomorph + Mancozeb (ACROBAT^ MZ/WDG, PER14473, expires Jun 2018)- Group 40 + M3 protectant and systemic fungicide
  - Commonly used.
  - There is a restricted number of applications - maximum of 2.
  - Considered very effective, but expensive.
  - Minimal impact on all beneficial insects.

- Phosphorous acid (PER13698, Expires Sep 2017) - Group 33 protective and systemic fungicide - enhances plants natural defence mechanisms
  - Listed for the suppression of Downy mildew.
  - Commonly used.
  - It is effective when it is used in rotation with other fungicides.
  - Considered very cheap.
  - Minimal impact on all beneficial insects.
  - Permit expires 30-Sep-17. No manufacturers interested in registering use.

Not all growers use every product. They generally alternate between the different fungicides.

- Potential fungicides for control of downy mildew in leeks:
  - Fluopicolide is a new Bayer active in the FRAC group 43. This would be a novel group in Australia. It is a systemic fungicide affecting oomycetes. Bayer CropScience has applied for approval of the active in Australia but registration of a registered product will take some time. It would be sensible to approach Bayer to discuss development opportunities.

  - Cyazofamid (likely to be called RANMAN^?, new ISK/FMC Fungicide) – FRAC code 21 – contact and residual fungicide
    - Application for registration with the APVMA, for potatoes, brassicas and possibly brassica leafy.
    - Inhibits oomycetes fungal development.
    - Resistance management tool .
    - The registrant should be approached for interest in developing the product on minor crops.

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

Purple blotch (*Alternaria porri*)

Purple blotch, caused by *Alternaria porri*, attacks onions, leeks and shallots. Purple blotch occur primarily as oval-shaped tan and deep purple lesions on leaf blades. Yellow streaks, which turn brown, extend along the blade in both directions from the lesion. In advanced stages lesions may girdle and kill leaves and seed stems. Concentric zones may develop within the lesions. The disease is favoured by heavy dew in desert areas and by foggy and rainy weather.

- Purple blotch is considered a major - moderate problem in all states.
  - Growers alternate the use of different fungicides to reduce the resistance risk.
  - Growers would like other protective/curative fungicides for alternation.

- Fungicides **registered** for the control of Purple blotch in leeks are:
  - Chlorothalonil (various brand name products) – Group M5 protectant fungicide
    - Registered for Purple blotch control in leeks only.
    - Also used for Downy mildew control in leeks.
    - Used as a protectant fungicide.
    - Commonly used.
    - Effective when used with other fungicides.
    - Moderately harmful to some beneficial insects.
  - Metalaxyl + copper as hydroxide (RIDOMIL^ GOLD PLUS) – Group 4 + M1 systemic, protective and curative fungicide
    - For the control of Downy mildew and Purple blotch.
    - Commonly used.
    - Used as a protectant / curative fungicide.
    - There is a restricted number of applications - maximum of 2.
    - Considered very effective, but expensive.
    - Moderately harmful to some beneficial insects.

- Fungicides listed for control of Purple blotch control in leeks via **permit** are:
  - Dimethomorph + Mancozeb (ACROBAT^ MZ/WDG, PER14473, expires Jun 2018)- Group 40 + M3 protectant and systemic fungicide
    - Commonly used.
    - There is a restricted number of applications - maximum of 2.
    - Considered very effective, but expensive.
    - Minimal impact on all beneficial insects.

White rot (Sclerotium cepivorum)

Leaves of plants infected with the white rot show yellowing, leaf dieback, and wilting. Leaf decay begins at the base, with older leaves being the first to collapse. A semi-watery decay of the bulb scales results. Roots also rot, and the plant can be easily pulled from the ground. Associated with the rot is a fluffy white mycelium growth, which develops around the base of the bulb. As the disease progresses, the mycelium becomes more compacted, less conspicuous, with numerous small spherical black bodies, sclerotia. The sclerotia are the resting bodies of the disease.

Sclerotia can survive for over 20 years, even in the absence of a host plant. Disease severity depends on sclerotia levels in the soil at planting. Plants can become infected at any stage of growth.

- White rot is considered a major - moderate problem in Vic, Qld and parts of SA. It is not a problem in NSW and WA.
  - There is a need for more management options which are currently being investigated by HAL with the onion industry.

- Soil fumigants **registered** for the control of diseases, nematodes, insects and weeds in vegetables are:
  - Chloropicrin (various) – Group 8A insecticide/biocide
  - Dazomet (various) – insecticide/ biocide
  - Metham sodium (METHAM^) - Group 1A broad spectrum insecticide/biocide fumigant

- No fungicides are **registered** for the control of White rot in leeks.

- Fungicides listed for white rot control in leek via **permit** are:
  - Azoxystrobin (various, PER12999, expires Mar 2014) – Group 11 protectant and curative fungicide
    - For use in alliums.
    - Protective and systemic fungicide.
    - Commonly used.
    - It is very effective but growers concerned at over reliance.
    - Minimal impact on all beneficial insects.
    - Syngenta is reported to be interested in registering the use but it doesn't seem that this will occur before the permit expires.

4.1.2 Summary

High Priority Diseases and control options

Very few fungicides are registered for control of disease in leeks. Extension of registrations for onions and other alliums would be helpful. There is also some new chemistry, particularly for downy mildew, that should be considered.

Disease	**Control option**
Downy mildew *(Peronospora farinosa)*	**Currently registered fungicides** - Metalaxyl-M + mancozeb (RIDOMIL^ GOLD MZ)– good efficacy, minimum impact on beneficials - Hydrogen peroxide + peroxyacetic acid (PERATEC PLUS^) - 1 day withholding period is advantageous. **Currently permitted fungicides** - Azoxystrobin (PER10914, Expires May 2014)- commonly used, registration expected but uncertain. - Dimethomorph + Mancozeb (ACROBAT^ MZ/WDG, PER14473, expires Jun 2018)- efficacious, minimal impact on beneficials. - Phosphorous acid (PER13698, Expires Sep 2017) – cheap, effective in rotations, minimal beneficials impact. **Fungicide Gaps** New chemistry with IPM fit. **Potential fungicide solutions** - Cyazofamid (likely to be called RANMAN^?, new ISK/FMC Fungicide) – first new product registration under assessment at the APVMA. - Fluopicolide, a new Bayer fungicide being assessed for first registration by the APVMA. - Ametoctradin + dimethomorph (ZAMPRO^) – new BASF chemistry registered for downy mildew in other crops. **Non-chemical options** Not discussed in meetings. Should be explored in next SARP.

Disease	Control option
Purple blotch (*Alternaria porri*)	**Currently registered fungicides** - Chlorothalonil – useful in rotations, registration for Purple patch but also efficacious on downy mildew. - Metalaxyl + copper as hydroxide (RIDOMIL^ GOLD PLUS) – efficacious but moderately harmful to some beneficial insects. **Currently permitted fungicides** Dimethomorph + Mancozeb (ACROBAT^ MZ/WDG, PER14473, expires Jun 2018)- efficacious, minimal impact on beneficial insects. **Fungicide Gaps** New chemistry with IPM fit. **Potential fungicide solutions** Penthiopyrad (FONTELIS^) – registered for purple blotch on onions and shallots **Non-chemical options** Not discussed in meetings. Should be explored in next SARP.
White rot (*Sclerotium cepivorum*)	**Currently registered fungicides** Soil fumigants for the control of diseases, nematodes insects and weeds. There are no specific fungicides for control of white rot in leeks. **Currently permitted fungicides** Azoxystrobin (various, PER12999, expires Mar 2014) – efficacious, minimal impact on beneficials, uncertainty on registration or renewal of permit **Fungicide Gaps** New chemistry with IPM fit. **Potential fungicide solutions** None identified or requested by growers **Non-chemical options** Not discussed in meetings. Should be explored in next SARP.

Currently available fungicides

Disease name**	Active ingredient	WHP, days	Chemical group
Botrytis rots / neck and bulb rot	Dimethomorph + Mancozeb (ACROBAT^ MZ/WDG, PER14473, expires Jun 2018)	7, *	40, M3
	Hydrogen peroxide+ peroxyacetic acid (PERATEC PLUS)	1	M
Downy mildew	Azoxystrobin (PER10914, Expires May 2014)	7	11
	Copper + metalaxyl-M (RIDOMIL^ GOLD PLUS)	7	4+M1
	Dimethomorph + Mancozeb (ACROBAT^ MZ/WDG, PER14473, expires Jun 2018)	7(H), *(G)	40, M3
	Hydrogen peroxide+ peroxyacetic acid (PERATEC^ PLUS)	1	M
	Phosphorous acid (PER13698, Expires Sep 2017)	1	33
Purple blotch	Chlorothalonil		M5
	Copper + metalaxyl-M (RIDOMIL^ GOLD PLUS)	7	4+M1
	Dimethomorph + Mancozeb (ACROBAT^ MZ/WDG, PER14473, expires Jun 2018)	7(H), *(G)	40, M3
Sclerotinia	Boscalid (PER12050, expires Jun 2015)	14	7
Soil borne diseases incl Fusarium, Verticillium wilts, Rhizoctonia, Pythium	1,3-dichloropropene + chloropicrin	NR	8B
White rot	Azoxystrobin (PER12999, Expires Mar 2014)		11

(H)=Harvest (G)= Grazing NR= not required
*= do not graze or cut for stockfood
**Note that for some broad registrations the pests may not occur in leek

4.2 Insects of leeks

Common name	Scientific name
HIGH PRIORITY	
Onion thrips	*Thrips tabaci*
MODERATE PRIORITY	
Aphids	Aphidae
Onion maggot	Delia antiqua
Western flower thrips	Frankliniella occidentalis
LOW PRIORITY	
Crickets	*Gryllidae*
Cutworms	*Agrotis* spp.
Jassids	*Cicadellidae*
Mites	*Acarina*
Redlegged earth mite	*Halotydeus destructor*
Snails	Gastropoda
Spotted vegetable weevil	*Desiantha diversipes*
Thrips	*Thysanoptera*
Vegetable weevil	*Listroderes difficilis*
Wingless grasshopper	*Phaulacridium vittatum*
Wireworm	*Heteroderes sp.*
Biosecurity risk	
None listed	

4.2.1 High priority insects

Onion thrips (*Thrips tabaci*)

Onion thrips are very small and slender. Mature thrips are 1.3 mm long. Adults are pale yellow to light brown in colour. The immature stages have the same body shape as adults but are lighter in colour and are wingless. A hot, dry spring that follows a mild, dry winter favours this pest. Onion thrips have a very extensive range of hosts, including cereals and broadleaved crops. Symptoms are 'white flecking' on the leaves of plants.

High populations of thrips can reduce both yield and keeping quality of Alliums. Onions thrips can affect onions throughout the growing phase in all regions. Marking of leek stems makes them unmarketable.

- Onion thrips are considered a major problem in all states.
  - There is reported resistance to commonly used insecticides. These insecticides are hard on beneficial insects.
  - Onion thrips are easier to control than Western Flower Thrips, in that they do not develop resistance to insecticides as quickly.

- No insecticides are **registered** for the control of Onion thrips in leek although potassium salts have a general thrips registration.

- Insecticides listed for Onion thrips control in leeks via **permit** are:

- Alpha-cypermethrin (various, PER12397, expires Nov 2014, application made for renewal) - Group 3A contact and systemic insecticide.
  - For use in all leeks, spring onions and shallots.
  - Occasionally used.
  - Controls Onion thrips only (not WFT).
  - Growers expressed concern that heavy reliance could lead to resistance.
  - Moderately harmful to harmful to many beneficial insects.
- Maldison (PER13653, expires Oct 2018)– Group 1B contact and systemic insecticide
  - For use in all leeks, spring onions and shallots.
  - Commonly used.
  - Controls Onion thrips only (not WFT).
  - Works well.
  - Growers expressed concern that heavy reliance could lead to resistance.
  - Moderately harmful to harmful to many beneficial insects.
- Petroleum (various, PER12221, expires Nov 2017)and shallots.
  - Controls aphids, Green mirid, Green vege bug, Grey cluster bug, Leafhopper, mites, Rutherglen bug, thrips.
  - Occasionally used.
  - Works well if applied at correct time.
  - Moderately harmful to some beneficial insects.

- **Potential** insecticides listed for control of thrips.
  - chlorantraniliprole + thiamethoxam + (DURIVO^) - Group 4A + 28 contact and systemic insecticide
    - Registered in other vegetables as a seedling drench or soil drench for aphids, lepidoptera, whitefly and thrips.
    - Effective but moderately harmful to some beneficial insects.
  - Sulfoxaflor (TRANSFORM^) – Group 4C insecticide
    - Thrips registrations in a range of vegetables
    - May have adverse effects on parasitic wasps in IPM situations

4.2.2. Summary

High priority insects and control options

There are few products registered or permitted for use in leeks. The impact of resource recovery as a driver of research and development choices for product registrants is evident in this minor crop – the cost of the efficacy and residue data packages required relative to the value of the potential chemical sales are usually too high to justify the work.

Insect	Control option
Onion thrips (*Thrips tabaci*)	**Currently registered insecticides** Potassium salts (various) **Currently permitted insecticides** Alpha-cypermethrin (various, PER12397, expires Nov 2014, application made for renewal) Maldison (PER13653, expires Oct 2018 Petroleum (various, PER12221, expires Nov 2017) **Insecticide Gaps** Soft alternatives, more alternatives **Potential insecticide solutions** Sulfoxaflor (TRANSFORM^) – Group 4C – thrips registrations in many crops Thiamethoxam + chlorantraniliprole (DURIVO, Group 4A+28, efficacious but moderately harmful to some beneficial insects **Non-chemical options** None identified – this should be investigated in future SARPS

Currently available insecticides

Insect name**	Active ingredient	WHP	Chemical group
Aphids	petroleum (PER12221, expires Nov 2017)	1	_
	pirimicarb	2	1A
	potassium salts of fatty acids	1	3A
Cutworms	chlorpyrifos	5	1B
Field crickets	chlorpyrifos	5	1B
Green mired	petroleum (PER12221, expires Nov 2017)	1	_
Green vegetable bug	petroleum (PER12221, expires Nov 2017)	1	_
Grey cluster bug	petroleum (PER12221, expires Nov 2017)	1	_
Leafhoppers	petroleum (PER12221, expires Nov 2017)	1	_
Mealybug	potassium salts of fatty acids	1	3A
Mites	petroleum (PER12221, expires Nov 2017)	1	_
Mite - two spotted	dicofol	24	UN
	propargite (21 day re-entry)	7	12C
Onion seedling maggot	Diazinon (PER10272, Expires Sep 2016)	21	1B
Plant parasitic nematodes	1,3-dichloropropene + chloropicrin	NR	8B
Rotting crop residues of leafy vegetable crops, brassicas, celery, silverbeet, leek, lettuce / Stable fly larvae (*Stomoxys calcitrans*)	Chlorpyrifos, permethrin, deltamethrin, alpha-cypermethrin, beta-cyfluthrin, fipronil, emamectin, esfenvalerate, diazinon (PER14565, expires Mar 2019, WA only)	NR(H), *(G)	Various
Rutherglen bug	petroleum (PER12221, expires Nov 2017)	1	_
Symphylans (garden centipedes)	1,3-dichloropropene + chloropicrin	NR	8B
Thrips	petroleum (PER12221, expires Nov 2017)	1	_
	potassium salts of fatty acids	1	3A
Thrips - onion	Alpha cypermethrin (PER12397, Expires Nov 2014, Application made for renewal)	14	3A
	Maldison (PER13653, expires Oct 2018)	7	1B
Thrips – Western Flower	Spinetoram (PER13088, Expires Mar 2017)	3(H), *(G)	5
Vegetable weevil	chlorpyrifos	5	1B
Wireworms	1,3-dichloropropene + chloropicrin	NR	8B

(H)=Harvest
(G)= Grazing
NR= not required
*= do not graze or cut for stockfood
**Note that for some broad registrations the pests may not occur in leek

4.3 Herbicide use in leeks

- Herbicides **registered** and used in leeks:
  - Glyphosate (various) – group M pre-plant general knockdown herbicide
    - Commonly used.
    - Works well as a pre-crop spray.
  - Paraquat + diquat (various) - Group L pre-plant general knockdown herbicide
    - Occasionally used.
    - Works well as a pre-crop spray
- Herbicides listed for control of weeds in leek via **permit** are:
  - Clethodim (PER13257, expires Mar 2017)– Group A grass selective post-emergent herbicide
    - For use in all leeks, spring onions and shallots.
    - Commonly used.
    - Considered very effective on most annual grass weeds, especially winter grass
    - Also used to spot spray couch grass post-emergent.
    - Permit expires 31-Mar-17. No manufacturer interested in registering use.
  - Fluazifop-P as butyl (PER13394, Sep 2015) – Group A grass selective post-emergent herbicide
    - For use in all leeks, spring onions and shallots.
    - Commonly used.
    - Considered very effective on most annual grass weeds.
    - Also used to spot spray couch grass post-emergent.
  - Linuron (PER13367, expires Apr 2016) – Group C herbicide
    - Grass and broadleaf
  - Methabenzthiazuron (various, PER13584) - Group C post-emergent herbicide
    - For use in all leeks, spring onions and shallots.
    - Commonly used for grass and broadleaf weeds control early post- emergent.
    - Considered very effective.
    - Controls many weeds.
    - Can cause crop damage in hot weather.
    - Permit expires 30-Jum-14. No manufacturer interested in registering use.
  - Various (simazine, cyanazine, propachlor, ioxynil, pendimethalin, ethofumesate, oxyfluorfen - PER13466) - Group C, K, D, J & G pre-emergent and post-emergent herbicides.
    - These products are used in mixtures to control a range of weeds applied after seeding / transplanting or in-crop.
    - Commonly used for broadleaf weeds control.
    - Considered very effective as tank mixes.
    - Controls many weeds.
    - Permit expires 30-Sep-15. No manufacturer interested in registering use.

Growers generally use a pre-plant weed control (general knockdown herbicides) to prepare the paddock. Growers then either alternate the herbicides used or use them in combination for effective weed control. All the herbicides registered/permitted are either pre-emergent herbicides or early post-emergent herbicides.

Most weeds can be controlled with currently available herbicides.

5. References

Information:

- Australasian Biological Control 2008 (http://www.goodbugs.org.au/)
- Australian Bureau of Statistics, Agricultural Commodities, 2002-03. 7121.0.
- Australian Horticultural Statistics Handbook (2003)
- Australian Pesticide and Veterinary Medicines Authority website. Website: www.apvma.gov.au
- Ausveg 'Fresh Vegetable Exports' (2011) website: http://www.ausveg.com.au
- Bejo Zaden, The Netherlands, website: www.bejo.com
- Biobest 2008 http://207.5.17.151/biobest/en/nieuws/scanivital.htm
- Codex MRL database
- Cornell university- http://plantclinic.cornell.edu/FactSheets.htm
- Diseases of Vegetable Crops. Department of Primary Industry Queensland, 1994.
- Infopest, Department of Primary Industry and Fisheries, Queensland Government, July 2012.
- Integrated Pest Management for crops and pastures (2008) Paul Horne and Jessica Page
- IOBC Working Group - Classification of side effects to beneficial insects website.
- IPM Technologies final report. Project: Pesticide effects on beneficial insects and mites in vegetables.
- IR-4 Project. Website- http://ir4.rutgers.edu/index.html
- Managing Insects and Mites in horticultural crops, QLD DPI, 1994.
- McMaugh, 'What garden pest or disease is that?' published 1989.
- New South Wales Department of Primary Industry websites.
- New Zealand Horticulture and AgAware: Leek SARP report 2008.
- Pest management strategy documents for Queensland's fruit and vegetable industry, Queensland Fruit and Vegetable growers, 2003 & 2008.
- USA Foreign Ag Service- www.mrldatabase.com

Images:
- Google images
- Infopest, Department of Primary Industry and Fisheries, Queensland Government, July 2012.

Acronyms

APVMA ……..	Australian Pesticides and Veterinary Medicines Authority
DPI ……..	Department of Primary Industry
HAL ……..	Horticulture Australia Ltd
IPM ……..	Integrated pest management
IR-4 ……..	Interregional Research Program 4 (USA)
MRL ……..	Maximum residue limit (mg/kg or ppm)
Plant pests …..	Diseases, insects, nematodes, viruses, weeds, etc
Pesticides …….	Plant protection products (fungicide, insecticide, herbicide, nematicides, etc).
SARP …….	Strategic Agrichemical Review Process
WHP ……..	Withholding period

Australian states and territories: NSW (New South Wales), NT (Northern Territory), Qld (Queensland), SA (South Australia), Tas (Tasmania), Vic (Victoria), WA (Western Australia)

Acknowledgement

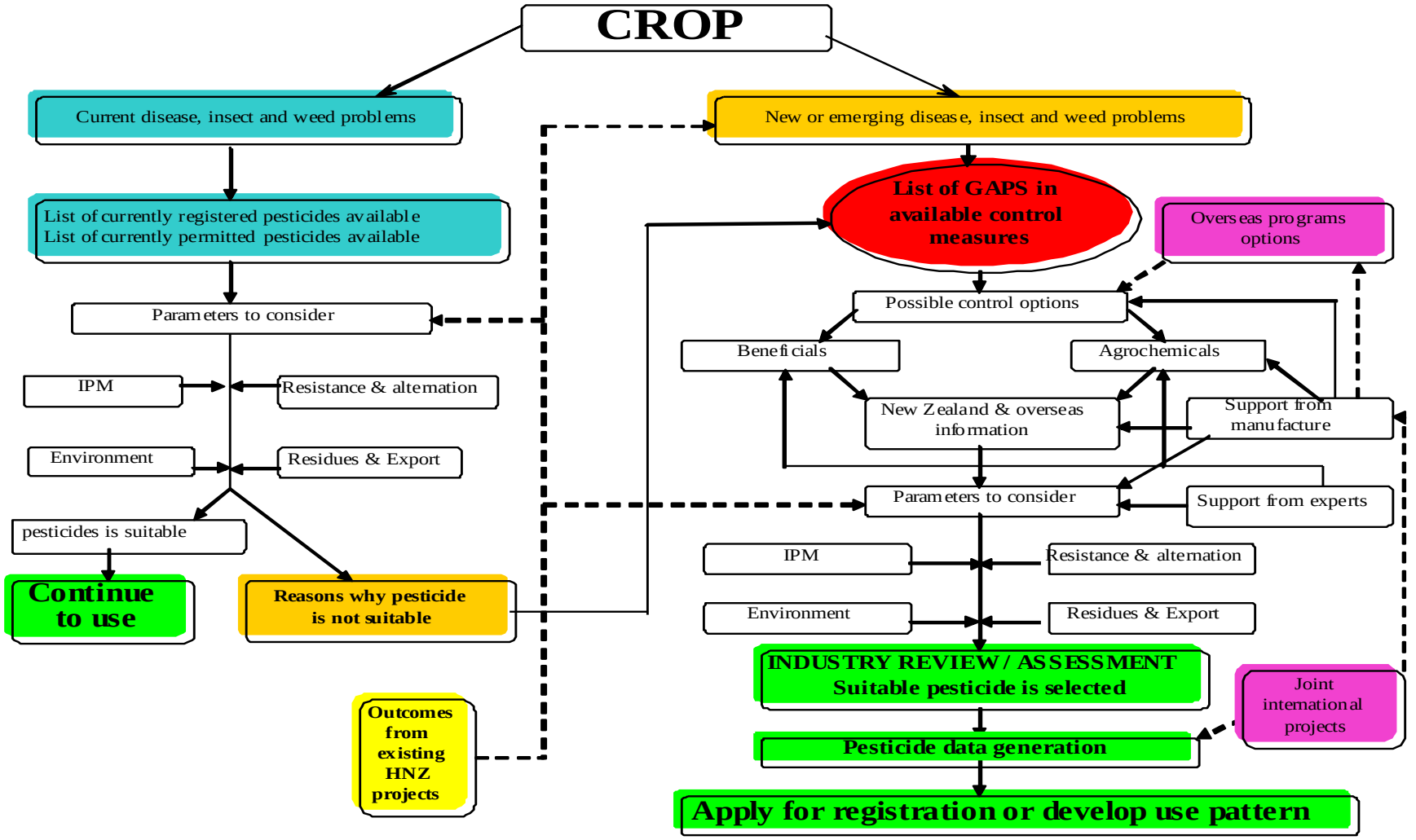
APVMA: All staff especially Alan Norden
Government agencies: Each state DPI as excellent sources of information
Industry development officers and associates

Thanks go to the many industry people who contributed information and collaborated on the review of this report.

^Trademark

6. Appendices

DIAGRAM 1: The Strategic Agrichemical Review Process



Appendix 2 – currently available fungicides in leek.

Active ingredient	Disease name	WHP	Chemical group
1,3-dichloropropene + chloropicrin	Soil borne diseases incl Fusarium, Verticillium wilts, Rhizoctonia, Pythium	NR	8B
Azoxystrobin (PER10914, Expires May 2014)	Downy mildew	7	11
Azoxystrobin (PER12999, Expires Mar 2014)	White rot	1	11
Boscalid (PER12050, expires Jun 2015)	Sclerotinia	14	7
Chlorothalonil	Purple blotch		
Copper + metalaxyl-M (RIDOMIL GOLD PLUS)	Downy mildew	7	4+M1
	Purple blotch	7	4+M1
Dimethomorph + mancozeb (ACROBAT^ MZ/WDG, PER14473, expires Jun 2018)	Botrytis rots	7(H), *(G)	40, M3
	Downy mildew	7(H), *(G)	40, M3
	Purple blotch	7(H), *(G)	40, M3
Hydrogen peroxide+ peroxyacetic acid (PERATEC PLUS)	Neck and bulb rot (Botrytis spp)	1	M
	Downy mildew	1	M
Phosphorous acid (PER13698, Expires Sep 2017)	Downy mildew	1	33

(H)=Harvest
(G)= Grazing
NR= not required
*= do not graze or cut for stockfood
**Note that for some broad registrations the pests may not occur in leek

Appendix 3 – currently available insecticides in leek.

Active ingredient	Insect name**	WHP	Chemical group
1,3-dichloropropene + chloropicrin	Plant parasitic nematodes	NR	8B
	Symphylans (garden centipedes)	NR	8B
	Wireworms	NR	8B
Alpha cypermethrin (PER12397, Expires Nov 2014, Application made for renewal)	Onion thrips	14	3A
Chlorpyrifos	Cutworms	5	1B
	Field crickets	5	1B
	Vegetable weevil	5	1B
Chlorpyrifos, permethrin, deltamethrin, alpha-cypermethrin, beta-cyfluthrin, fipronil, emamectin, esfenvalerate, diazinon (PER14565, expires Mar 2019, WA only)	Rotting crop residues of leafy vegetable crops, brassicas, celery, silverbeet, leek, lettuce / Stable fly larvae (Stomoxys calcitrans)	NR(H), *(G)	Various
Diazinon (PER10272, Expires Sep 2016)	Onion seedling maggot	21	1B
Dicofol	Two spotted mite	24	UN
Maldison (PER13653, expires Oct 2018)	onion thrips	7	1B
Petroleum (PER12221, expires Nov 2017)	Aphids	1	_
	Green mired	1	_
	Green vegetable bug	1	_
	Grey cluster bug	1	_
	Leafhoppers	1	_
	Mites	1	_
	Rutherglen bug	1	_
	Thrips	1	_
Potassium salts of fatty acids	Aphids	1	3A
	Mealybug	1	3A
	Thrips	1	3A
Propargite (21 day re-entry)	Two spotted mite	7	12C
Pirimicarb	Aphids	2	1A
Spinetoram (PER13088, Expires Mar 2017)	Western flower thrip	3(H), *(G)	5

(H)=Harvest
(G)= Grazing
NR= not required
*= do not graze or cut for stockfood
**Note that for some broad registrations the pests may not occur in leek

Appendix 4 – currently available herbicides in leek.

Active ingredient	Weed name	WHP	Chemical group
Clethodim (PER13257, expires Mar 2017)	Grass weeds	14	A
Cyanazine (PER13466, Expires Sep 2015, NSW, Tas, SA only)	Grass and broadleaf-label for onions	NR	C
Ethofumesate (PER13466, Expires Sep 2015, NSW, Tas , SA only)	Grass and broadleaf-label for onions	NR	J
Fluazifop (PER13394, Sep 2015)	Grass weeds-various	35	A
Glyphosate	Grass and broadleaf	NR	M
Ioxynil (PER13466, Expires Sep 2015, NSW, Tas, SA only)	Grass and broadleaf-label for onions	NR	C
Linuron (PER13367, expires Apr 2016)	Grass and broadleaf weeds	70	C
Methabenzthiazuron (PER13584, expires Jun 2014)	Broadleaf	7	C
Oxyfluorfen (PER13466, expires Sep 2015, NSW, Tas, SA only)	Grass and broadleaf-label for onions	NR	G
Paraquat+diquat	Grass and broadleaf	NR	L
Pendimethalin (PER13466, Expires Sep 2015, NSW, TAS, SA only)	Hogweed	NR	D
Propachlor (PER13466, Expires Sep 2015, NSW, TAS, SA only)	Grass and broadleaf-label for onions	NR	H
Simazine (PER13466, Expires Sep 2015, NSW, TAS, SA only)	Grass and broadleaf	NR	C