



Zucchini

Strategic Agrichemical Review Process
2011-2014

HAL Projects - MT10029 & VG12081

AgAware Consulting Pty Ltd
Checkbox 3D Pty Ltd

March 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 zucchini 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:

14 March 2014

Disclaimer:

Any recommendations contained in this publication do not necessarily represent current Horticulture Australia Ltd policy. No person should act on the basis of the contents of this publication without first obtaining independent professional advice in respect of the matters set out in this publication.



Horticulture Australia

Contents

MEDIA SUMMARY	2
2. THE AUSTRALIAN ZUCCHINI INDUSTRY	3
3. INTRODUCTION	3
3.1 BACKGROUND	3
3.2 MINOR-USE PERMITS AND REGISTRATION	4
3.3 METHODS	4
4. PESTS AND DISEASES OF ZUCCHINI	5
4.1 DISEASES OF ZUCCHINI	5
4.1.1 <i>High priority diseases</i>	5
4.1.2 <i>Summary</i>	7
4.2 INSECTS OF ZUCCHINI	10
4.2.1 <i>High priority insects</i>	10
4.2.2 <i>Summary</i>	13
4.3 WEEDS OF ZUCCHINI	18
5. REFERENCES	19
<i>Information</i>	19
<i>Acronyms</i>	19
<i>Acknowledgement</i>	19
6. APPENDICES	20

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 zucchini were conducted in Queensland and Victoria as part of combined vegetable meetings in 2008, 2010 and 2011. The results of the process provide the zucchini 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)
Powdery mildew	<i>Sphaerotheca fuliginea</i>

Powdery mildew was the only disease nominated during the SARP process as a high priority. As there are now a considerable number of registered products there should be no need for additional permits. By contrast there are few options for other diseases of concern nominated by growers. This highlights the problem for minor crops and situations where there are often limited opportunities for research into potential tools, let alone resources for registrations and permits.

As with many horticultural crops, growers are looking more to non-chemical solutions, partly due to lack of approved pesticides, but partly also by choice. Integrated crop and pest management strategies are considered best practice in many cases.

INSECTS

Insects identified as high priorities:

Insect (common name)	Insect (scientific name)
Silverleaf whitefly	<i>Bemisia tabaci</i> (Biotype B)
Two-spotted mite	<i>Tetranychus urticae</i>

There are a considerable number of insecticides registered for use in zucchini, including the new entrants to the market: chlorantraniliprole (CORAGEN[^]), flubendiamide (BELT[^]) and sulfoxaflor (TRANSFORM[^]). So for some pests, growers have reasonable options for developing a treatment schedule with good alternation of products from different chemical groups. It is expected that the use of this chemistry will be carefully managed - the industry has observed the benefits of IPM techniques, both in reducing pest problems and as a means of reducing resistance risks that come from overuse of chemicals.

There are no or limited chemicals permitted for a number of the lesser pests of zucchini. Growers must rely on control by other chemicals already being used in the crop. This can be difficult when the management strategy is not targeted to the problem.

WEEDS

For field zucchinis, growers generally use a pre-plant weed control (general knockdown herbicide) to prepare the paddock. Growers then usually only spot spray grass weeds with a grass selective herbicide.

No weeds were reported as a high priority for new registrations or permits. Overall there is a desire for newer chemistry and increased options for control of weeds, although most weeds can currently be controlled with available herbicides. Non-chemical options should be considered in future SARPs.

2. The Australian zucchini industry

The Australian zucchini industry, is a small but growing horticultural industry, with an opportunity for growth alongside the general increase in vegetable consumption in Australia. Consumption of zucchini rose in 2011 and it was the 11th most purchased vegetable. Zucchini has moved from a predominantly summer vegetable to one consumed all year round (Ausveg 2011).

Zucchini are grown across Australia with the main growing regions being:

- Bowen / Burdekin (Qld)
- Atherton Tableland (Qld)
- Bundaberg (Qld)
- Lockyer Valley (QLD)
- Bathurst (NSW)
- Riverina (NSW)
- Sydney Basin (NSW)
- Melbourne Metro (Vic)
- Sunraysia (Vic)
- North Adelaide Plains (SA)
- Riverland (SA)
- Gosford (NSW)
- Perth Metro outer areas (WA)

In 2009/10, total zucchini production was 34,788 T with Qld produced 64% of the national zucchini crop (22,154 T), Vic 17% (6,086 T), NSW 11% (3,798T), WA 5% (1,939 T), SA 2% (591 T) and Tas 1% (220 T).

In 2008/09, there were 621 growers. The area planted was 2,20 ha. The zucchini production was 23,989 tonnes with a gross value of \$65.2 mill (Ausveg 2012).

Due to Australia's varying weather conditions and the introduction of different varieties of zucchini, the Australian industry is now able to supply domestic with fresh zucchini 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 zucchini 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 zucchini. 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 zucchini as a minor crop. The crop fits within the APVMA crop group 011 Fruiting vegetables-cucurbits.

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

3.2 Minor-use permits and registration

Zucchini 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 industry is for manufacturers to register new pesticides uses in the crop.

3.3 Methods

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

- Participants were given a comprehensive list of most major pests of zucchini 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 (APVMA) 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 industry to pursue were listed.

3.4 Results

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

4. Pests and diseases of zucchini

4.1 Diseases of zucchini

Common name	Scientific name
HIGH PRIORITY	
Powdery mildew	<i>Sphaerotheca fuliginea</i>
MODERATE PRIORITY	
Alternaria leaf blight	<i>Alternaria cucumerina</i>
Damping-off	<i>Pythium</i> spp., <i>Phytophthora</i> spp.
Downy Mildew	<i>Pseudoperonospora cubensis</i>
Grey mould	<i>Botrytis cinerea</i>
Gummy stem blight	<i>Didymella bryoniae</i>
LOW PRIORITY	
Angular leaf spot	<i>Pseudomonas syringa</i>
Anthraxnose	<i>Colletotrichum orbiculare</i>
Bacterial spot	<i>Xanthomonas campestris</i>
Phytophthora soil fungus	<i>Phytophthora</i> spp.
Rhizoctonia ground rot	<i>Rhizoctonia solani</i>
Septoria spot	<i>Septoria cucurbitacearum</i>
Scab	<i>Cladosporium</i> spp.
Biosecurity risk	
None listed	

4.1.1. High priority diseases

Powdery mildew (*Sphaerotheca fuliginea*)



Powdery mildew first appears as pale yellow spots on stems, petioles, and leaves. These spots enlarge as the white, fluffy mycelium grows over plant surfaces and produces spores, which give the lesions a powdery appearance. Affected leaves become dull, chlorotic, and may show some degree of wilting in the afternoon heat; eventually they become brown and papery. Infection is favoured by high humidity (50 to 90%), and disease development is favoured by vigorous plant growth and moderate temperatures.

Powdery mildews can have substantial effects on yield, as they rob the host plant of nutrients, reduce the photosynthetic process, increase respiration and transpiration, impair growth, and reduce yields.

Powdery mildew is considered a major problem in all states. It is a high priority in Qld and Vic.

- Fungicides **registered** for the control of Powdery mildew in zucchini are:
 - Azoxystrobin (various) Group 11 protectant and curative fungicide
 - Registered in cucurbits.
 - Restrictions in the number of applications.
 - Occasionally used.
 - Used as a protectant fungicide.
 - Vic growers report it as very effective, Qld growers report variable efficacy.
 - Growers expressed concern that with a heavy reliance that resistance may develop.
 - Minimal disruption to most beneficial insects.
 - Boscalid + kresoxim-methyl (COLLIS[^]) Group 7 + 11 systemic, protective and curative fungicide
 - Registered in cucurbits.
 - Occasionally used.
 - Used as a protectant fungicide.
 - Minimal disruption to most beneficial insects.
 - Chlorothalonil (various products) Group M5 protectant fungicide
 - Registered in cucurbits.
 - Commonly used.
 - Used as a protectant fungicide.
 - Considered effective, especially in low disease pressure.
 - Moderately disruptive to some beneficial insects in an IPM situation.
 - Copper (various) Group M1 protectant fungicide
 - Commonly used.
 - Growers report that only provided good efficacy in low pressure situation.
 - Minimal disruption to all beneficial insects.
 - Cyflufenamid (FLUTE[^]) – Group U6 fungicide.
 - First registration in 2013.
 - Care should be exercised with regard to broad registration and potential overuse across vegetable crops and associated resistance threats.
 - Fenarimol (RUBIGAN[^]) – Group C preventative and curative fungicide
 - Registered in cucurbits.
 - Occasionally used.
 - Used as a protectant fungicide.
 - Minimal disruption to most beneficial insects.
 - Hydrogen peroxide + peroxyacetic acid (PERATEC PLUS[^]) - Group M fungicide
 - Not commonly used
 - Variable efficacy
 - Metrafenone (VIVANDO[^]) Group U8 protective fungicide
 - Recently registered.
 - Registered in cucurbits.
 - Oxythioquinox (MORESTAN[^]) Group 14 systemic, protective and curative fungicide
 - No longer commercially available.
 - Penthiopyrad (FONTELIS[^]) Group 7 -
 - Registered for grey mould, gummy stem blight and powdery mildew.
 - Potassium bicarbonate (various) – Group M2 fungicide
 - limited efficacy against heavy infections
 - often tank mixed with other PM fungicides
 - Proquinazid (TALENDO[^]) - Group 13 - protective fungicide
 - Field grown cucurbits only.
 - 1 day withholding period.

- Sulphur (various) – Fungicide
 - High selectivity.
 - Only short term impact on beneficials.
- Triadimefon (various) Group 3 systemic, protective and curative fungicide
 - Rarely used.
 - Many Qld growers report poor efficacy.
 - Minimal disruption to all beneficial insects.
- Triadimenol (various) Group 3 systemic, protective and curative fungicide Occasionally used.
 - Many Qld growers report poor efficacy.
 - Minimal disruption to all beneficial insects.
- Fungicides listed for control of Powdery mildew control in zucchini via permit:
 - Bupirimate (NIMROD[^]) (PER10979, expires Sep 2014) Group 8 systemic, protective and curative fungicide
 - Permit in cucurbits.
 - Occasionally used.
 - Used as a protectant. (It has limited curative action).
 - Qld growers report as very effective.
 - Minimal disruption to all beneficial insects.
 - Growers expressed concern that with regular use that resistance may develop.

Not all growers use every product. They generally alternate between the different fungicides. There have been some suspected cases of resistance to some fungicides in Qld but these have never been validated.

4.1.2 Summary

High Priority Diseases and control options

Powdery mildew was the only disease nominated during the SARP process as a high priority. As there are now a considerable number of registered products there should be no need for additional permits.

By contrast there are few options for other diseases of concern nominated by growers. This highlights the problem for minor crops and situations where there are often limited opportunities for research into potential tools, let alone resources for registrations and permits.

As with many horticultural crops growers are looking more to non-chemical solutions, partly due to lack of approved pesticides, but partly also by choice. Integrated crop and pest management strategies are considered best practice in many cases.

Disease	Control option
Powdery mildew (<i>Sphaerotheca fuliginea</i>)	Registered fungicides <ul style="list-style-type: none"> - Azoxystrobin (various products) Group 11 protectant and curative fungicide - Boscalid + kresoxim-methyl (COLLIS[^]) Group 7 + 11 systemic, protective and curative fungicide - Chlorothalonil (various) Group M5 protectant fungicide - Copper (various) Group M1 protectant fungicide - Cyflufenamid (FLUTE[^]) – Group U6 fungicide. - Fenarimol (RUBIGAN[^]) – Group C preventative and curative fungicide - Hydrogen peroxide + peroxyacetic acid (PERATEC PLUS[^]) - Group M fungicide - Metrafenone (VIVANDO[^]) Group U8 protective fungicide - Oxythioquinox (MORESTAN[^]) Group 14 systemic, protective and curative fungicide - Penthiopyrad (FONTELIS[^]) Group 7 - - Potassium bicarbonate (various) – Group M2 fungicide - Proquinazid (TALENDO[^]) - Group 13 - protective fungicide - Sulphur (various) – fungicide - Triadimefon (various) Group 3 systemic, protective and curative fungicide - Triadimenol (various) Group 3 systemic, protective and curative fungicide O

Disease	Control option
	<p>Permitted fungicides</p> <ul style="list-style-type: none"> Bupirimate (NIMROD[^]) (PER10979, expires Sep 2014) Group 8 systemic, protective and curative fungicide <p>Fungicide Gaps</p> <p>No</p> <p>Potential fungicide solutions</p> <p>-</p> <p>Non-chemical options</p> <p>Various crop cultivation and management techniques.</p>

Currently available fungicides

Disease Name	Active Ingredient	WHP, days	Chemical group
Alternaria Leaf Blight	Chlorothalonil	1	M5
	Dimethomorph	7	40
	Mancozeb + Metalaxyl	7	4/M3
Angular Leaf Spot	Copper	1	M1
Anthracnose	Chlorothalonil	1	M5
	Copper	1	M1
	Dimethomorph	7	40
	Mancozeb	7	M3
	Mancozeb + Metalaxyl-M	7	4/M3
	Propineb + Oxadixyl	3	4/M3
Bacterial Spot	Copper	1	M1
Downy Mildew	Azoxystrobin	1	11
	Copper	1	M1
	Cu As Hydroxide + Mancozeb	7	M1/M3
	Cu As Hydroxide + Metalaxyl-M	7	4/M1
	Mancozeb	7	M3
	Mancozeb + Metalaxyl	7	4/M3
	Metiram	2	M3
	Phosphorous Acid	NA	33
	Propineb	3	M3
	Propineb + Oxadixyl	3	4/M3
	Zineb	7	M3
Grey Mould / Botrytis	Chlorothalonil	1	M5
	Mancozeb	7	M3
	Penthiopyrad (FONTELIS [^])	1	7
Gummy Stem Blight	Azoxystrobin	1	11
	Chlorothalonil	1	M5
	Copper	1	M1
	Cu As Hydroxide + Mancozeb	7	M1/M3
	Dimethomorph	7	40
	Mancozeb	7	M3
	Mancozeb + Metalaxyl	7	4/M3
	Metiram	2	M3
	Penthiopyrad (FONTELIS [^])	1	7
Propineb + Oxadixyl	3	4/M3	

Disease Name	Active Ingredient		WHP, days	Chemical group
Powdery Mildew	Azoxystrobin		1	11
	Boscalid + Kresoxim-Methyl (COLLIS^)		7	7/11
	Bupirimate (NIMROD^)	(PER10979, expires Sep 2014, Zucchini)	1	8
	Chlorothalonil		1	M5
	Copper		1	M1
	Cyflufenamid (FLUTE^)		1	U6
	Fenarimol (RUBIGAN^)		3	3
	Hydrogen peroxide + peroxyacetic acid (PERATEC PLUS^)		1	M
	Metrafenone (VIVANDO^)		7	U8
	Oxythioquinox (MORESTAN^)		7	14
	Penthiopyrad (FONTELIS^)		1	7
	Potassium Bicarbonate		NA	M2
	Proquinazid (TALENDO^)	Field cucurbits only	1	13
	Sulphur		NR	M2
	Tea Tree Oil		NA	
	Triadimefon		1	3
Triadimenol		1	3	
Trifloxystrobin		3	11	
Septoria Spot	Mancozeb		7	M3
Target Leafspot	Chlorothalonil		1	M5
Soil borne diseases incl Fusarium, Verticillium wilts, Rhizoctonia, Pythium	1,3-Dichloropropene + Chloropicrin		NR	–
Damping Off	Metalaxyl		7	4
Phytophthora Soil Fungus	Metalaxyl		7	4
Rhizoctonia Ground Rot	Chlorothalonil		1	M5

4.2 Insects of zucchini

Common name	Scientific name
HIGH PRIORITY	
Silverleaf whitefly	<i>Bemisia tabaci (Biotype B)</i>
Two-spotted mite	<i>Tetranychus urticae</i>
MODERATE PRIORITY	
Aphids	<i>Aphidae</i>
Helicoverpa	<i>Helicoverpa</i> spp.
Fungus gnats	<i>Diptera</i>
Green vegetable bug	<i>Nezara viridula</i>
Thrips - other than WFT	<i>Thysanoptera</i>
Western flower thrips	<i>Frankliniella occidentalis</i>
LOW PRIORITY	
28-spotted potato ladybird	<i>Henosepilachna vigintiseipunctata</i>
Ants	<i>Formicidae</i>
Cucumber fly	<i>Bactrocera cucumis</i>
Cucumber moth	<i>Diaphania indica</i>
Jassids	<i>Cicadellidae</i>
Leafhoppers	<i>Cicadellidae</i>
Mealybugs	<i>Pseudococcidae</i>
Melon thrips	<i>Thrips palmi</i>
Pumpkin beetle	<i>Aulacophora hilaris</i>
Wingless grasshopper	<i>Phaulacridium vittatum</i>
Biosecurity risk	
None listed	

4.2.1 High priority insects

Silverleaf (Poinsettia) whitefly (*Bemisia tabaci* - all biotypes)



Silverleaf whitefly was first detected in Australia in 1994. Whiteflies colonize the underside of leaves; adults and eggs are commonly found on the lower surface of younger leaves and the scalelike nymphal stages on somewhat older leaves.

Desiccation of plants occurs with moderate-to-heavy populations and the production of honeydew gives rise to sooty mould. The plant becomes unthrifty and non-productive, and the fruit is rendered unmarketable.

In light-to-moderate infestations of Silverleaf whitefly, leaves show no distinctive symptoms as a result of their feeding; however, copious quantities of honeydew are deposited on leaves, resulting in a sticky, shiny appearance. Silverleaf whitefly has become a serious pest because of its high reproductive capability, wide host range, high rate of feeding, and exudation of sticky honeydew. Beneficial insects, play a very important role in the control of whitefly. Therefore any insecticide used in zucchini, needs to be compatible with these beneficial insects.

Silverleaf whitefly is considered a major problem in NSW and Qld.

- Numbers can vary from light to heavy, but all populations can cause damage.
- Growers report that current products are not working and suspect there are resistance issues.
- There are insecticides available, but growers are concerned at the ability of Silverleaf whitefly developing resistance to many insecticides.
-
- Insecticides **registered** for the control of Silverleaf whitefly in zucchini are:
 - Bifenthrin (various) Group 3A contact and systemic insecticide
 - Highly toxic to bees and other beneficials.
 - Chlorpyrifos (various) – Group 1B contact and systemic insecticide
 - General whitefly claim.
 - Insecticide under review by APVMA.
 - Emulsifiable botanical oil (various) - contact insecticide.
 - Greenhouse whitefly only.
 - Occasionally used - only when needed.
 - Imidacloprid (various) Group 4A contact and systemic insecticide
 - Most commonly used insecticide for whitefly. Heavy reliance.
 - Growers expressed concern that due to a heavy reliance and limited options that resistance may develop.
 - Very effective.
 - Moderately disruptive to highly disruptive to many beneficial insects in an IPM situation.
 - Paraffinic oil (various) – contact insecticide
 - Occasionally used.
 - Reported as not very effective, but offers short term suppression.
 - Silverleaf whitefly but not greenhouse whitefly registration.
 - Moderately harmful to some beneficial insects.
 - Potassium salts of fatty acids (various) – contact biological insecticide
 - General whitefly claim for vegetables
 - Occasionally used.
 - Reported as effective, but only offers short term control.
 - Minimal impact on most beneficial insects.
 - Pyrethrins+piperonyl butoxide (various) – Group 3A contact insecticide
 - General whitefly claim.
 - Good knockdown.
 - Harmful to beneficials
 - Spirotetramat (MOVENTO[^]) Group 23 contact and systemic insecticide
 - Often used.
 - Very effective.
 - Expensive.
 - Also controls other pests.
 - Moderately disruptive to some beneficial insects in an IPM situation.
- Insecticides listed for the control of Silverleaf whitefly in zucchini via **permit**:
 - Petroleum oil (various) (PER12221, expires Nov 2017) contact insecticide
 - Occasionally used.
 - Growers need to apply in cool weather as high UV intensity can cause burn.
 - Reported as effective.
 - Also controls other pests such as aphids and thrips.
 - Moderately disruptive to some beneficial insects in an IPM situation

- Pymetrozine (various) (PER13111, expires May 2014) Group 9B contact and systemic insecticide
 - Permit for cucurbits.
 - Occasionally used.
 - Moderately effective.
 - Minimal impact on most beneficial insects.

Two-spotted mite (*Tetranychus urticae*)



Mites generally overwinter as adult females in protected places in the litter, trash, and weeds on the crop floor. The mites become active in early spring. Mites generally favoured hot, dry conditions, and as the weather becomes warmer, they increase in numbers and move through the plant until the entire plant is infested. Their feeding stimulates the production of the distorted growth where they shelter and feed. Mites are frequent pest of foliage, flowers and fruit.

Mite feeding results in the destruction of chlorophyll; leaves become pale, stippled, and in later stages of infestation dry up and die. Loss of colour is pronounced on the under surface of leaves before it becomes apparent on the upper side. Light infestations can be tolerated, but heavy infestations can result in reduced yield and fruit quality

Two-spotted mites (TSM) are considered a major pest of Vic and Qld.

- Infestations are often patchy with hot-spots of high populations.
 - Populations are generally high along tracks and road where dust is common.
 - Biological control with predatory mites play an important role in TSM control.
- Insecticides **registered** for the control of two-spotted mites in zucchini:
 - Abamectin (various) Group 6 contact and systemic insecticide
 - Commonly used in all states.
 - Considered very effective, also controls Western flower thrips (Vic).
 - Moderately to highly disruptive to many beneficial insects in an IPM situation.
 - Emulsifiable botanical oil (various) - contact insecticide.
 - Greenhouse whitefly only.
 - Occasionally used - only when needed.
 - Oxythioquinox (MORESTAN[^]) Group 14 systemic, protective and curative fungicide
 - No longer commercially available
 - Paraffinic oil (various) – contact insecticide
 - Occasionally used.
 - Reported as not very effective, but offers short term suppression.
 - Silverleaf whitefly but not greenhouse whitefly registration.
 - Moderately harmful to some beneficial insects.
 - Petroleum oil (various) contact insecticide
 - Occasionally used.
 - Growers need to apply in cool weather as can cause burn.
 - Reported as effective.
 - Also controls other pests.
 - Moderately disruptive to many beneficial insects in an IPM situation
 - Potassium salts of fatty acids (various) contact biological insecticide
 - Occasionally used.
 - Moderately effective.
 - Minimal impact on most beneficial insects.

- Propargite (various) – Group 12 C
 - No comment from growers.
 - 21 day re-entry period is restrictive.
- Sulphur (various) – insecticide
 - High selectivity.
 - Only short term impact on beneficials.
- Insecticides available for the control of mites in zucchini via **permit**:
 - Bifenazate (various) (PER12906, expires Mar 2018) Group 2D contact and systemic insecticide
 - Insect growth regulator which needs to target low populations
 - Limit of 1 foliar application per crop
 - Minimal disruption to all beneficial insects except predatory mites
 - Etoxazole (various) (PER13304, expires Jun 2018) Group 10B contact and systemic insecticide
 - Very effective.
 - Limit of 1 foliar application per crop.
 - Minimal disruption to all beneficial insects except predatory mites.

NOTE: In some regions miticides are applied 1-2 times per crop. Growers alternate between insecticides to minimise the resistance risk and the use of beneficial insects.

4.2.2 Summary

There are a considerable number of insecticides registered for use in zucchini, including the new entrants to the market: chlorantraniliprole (CORAGEN[^]), flubendiamide (BELT[^]) and sulfoxaflor (TRANSFORM[^]). So for some pests, growers have reasonable options for developing a treatment schedule with good alternation of products from different chemical groups. It is expected that the use of this chemistry will be carefully managed - the industry has observed the benefits of IPM techniques, both in reducing pest problems and as a means of reducing resistance risks that come from overuse of chemicals.

There are no or limited chemicals permitted for a number of the lesser pests of zucchini. Growers must rely on control by other chemicals already being used in the crop. This can be difficult when the management strategy is not targeted to the problem.

High priority insects and control options

Insect	Control option
<p>Silverleaf whitefly (<i>Bemisia tabaci</i> – all biotypes)</p>	<p>Currently registered insecticides</p> <ul style="list-style-type: none"> - Bifenthrin (various) Group 3A contact and systemic insecticide - Chlorpyrifos (various) – Group 1B contact and systemic insecticide - Emulsifiable botanical oil (various) - contact insecticide. - Imidacloprid (various) Group 4A contact and systemic insecticide - Paraffinic oil (various) – contact insecticide - Potassium salts of fatty acids (various) – contact biological insecticide - Pyrethrins+piperonyl butoxide (various) – Group 3A contact insecticide - Spirotetramat (MOVENTO[^]) Group 23 contact and systemic insecticide <p>Currently permitted insecticides</p> <ul style="list-style-type: none"> - Petroleum oil (various) (PER12221, expires Nov 2017) contact insecticide - Pymetrozine (various) (PER13111, expires May 2014) Group 9B contact and systemic insecticide <p>Insecticide Gaps</p> <p>There are a considerable number of registered and permitted chemicals now so there is unlikely to be urgency to gain alternate options</p> <p>Potential insecticide solutions</p> <p>If additional tools are sought the following could be considered.</p> <ul style="list-style-type: none"> - Chlorantraniliprole + thiamethoxam (DURIVO[^]) - Group 4A/28 – good efficacy, care needed to prevent resistance - Cyantraniliprole (BENEVIA[^], not yet registered) – Group 28 – new product in assessment at APVMA. Same chemical group as Chlorantraniliprole. IR4 projects for various crops/thrips, beetles, leafminer, psyllids, whitefly. - Flonicamid (new ISK/FMC product)– Group 9C. First registration application in assessment at APVMA. IR4 project on peppers and eggplant / aphids, whiteflies, plant bugs, thrips. - Metaflumizone (New BASF active, not yet registered) - Group 22B - activity against Lepidoptera, Coleoptera, Hemiptera, Hymenoptera, Isoptera, and Diptera. <p>Non-chemical options</p> <p>IPM strategies – required to manage resistance.</p>
<p>Two-spotted mite (<i>Tetranychus urticae</i>)</p>	<p>Currently registered insecticides</p> <ul style="list-style-type: none"> - Abamectin (various) Group 6 contact and systemic insecticide - Emulsifiable botanical oil (various) - contact insecticide. - Oxythioquinox (MORESTAN[^]) Group 14 systemic, protective and curative fungicide - Paraffinic oil (various) – contact insecticide - Petroleum oil (various) contact insecticide - Potassium salts of fatty acids (various) contact biological insecticide - Propargite (various) – Group 12 C - Sulphur (various) – insecticide <p>Currently permitted insecticides</p> <ul style="list-style-type: none"> - Bifenazate (various) (PER12906, expires Mar 2018) Group 2D contact and systemic insecticide - Etoxazole (various) (PER13304, expires Jun 2018) Group 10B contact and systemic insecticide <p>Insecticide Gaps</p> <p>Good alternation needed as mites quickly develop resistance to chemicals.</p> <p>Potential insecticide solutions</p> <p>None identified.</p> <p>Non-chemical options</p> <p>IPM strategies – required to manage resistance.</p>

Currently available insecticides

Insect Name	Active Ingredient		WHP	Chemical group
28-Spotted Potato Ladybird	Carbaryl		NR	1A
	Maldison		3	1B
Ants	Chlorpyrifos		5	1B
	Pyrethrins+Piperonyl Butoxide	Vegetables	1	3A
Aphid - Brown Sowthistle	Sulfoxaflor (TRANSFORM^)	Cucurbits	3	4C
Aphid - Cotton	Spirotetramat		1	23
Aphid - Green Peach	Imidacloprid		1	4A
	Spirotetramat		1	23
	Sulfoxaflor (TRANSFORM^)	Cucurbits	3	4C
Aphids	Botanical Oil	Vegetables	NR	-
	Maldison		3	1B
	Paraffinic Oil		1	oil
	Petroleum Oil		1	oil
	Pirimicarb		2	1A
	Potassium Salts Of Fatty Acids	Vegetables	NR	-
	Pyrethrins+Piperonyl Butoxide	Vegetables	1	3A
Armyworm	Bacillus thuringiensis kurstaki	Vegetables	NR	11
	Carbaryl		NR	1A
Black Fungus Gnats	Bti		NR	11
Cabbage Moth	Bacillus thuringiensis kurstaki	Vegetables	NR	11
	Trichlorfon	Vegetables	2	1B
Cabbage White Butterfly	Bacillus thuringiensis kurstaki	Vegetables	NR	11
	Trichlorfon	Vegetables	2	1B
Caterpillars	Diazinon		14	1B
	Pyrethrins+Piperonyl Butoxide	Vegetables	1	3A
Crickets – Mole, Field	Chlorpyrifos		5	1B
Cucumber Moth	Chlorantraniliprole (CORAGEN^)	Cucurbits	3	28
	Flubendiamide (BELT^)	Cucurbits	1	28
Cucurbit Stemborer	Carbaryl		NR	1A
Cutworms	Carbaryl		NR	1A
	Chlorpyrifos		5	1B
	Diazinon		14	1B
	Trichlorfon, Qld, NT only	Vegetables	2	1B
European Earwig	Carbaryl		NR	1A
Fruit Fly	Methyl bromide	(PER10145, PER11092, expires Oct 2014, Fruiting Vegetables (Not Persons Generally))	3	8A
Fruit Fly - Mediterranean	Maldison		3	1B
Fruit Fly - Queensland	Maldison		3	1B
Green Vegetable Bug	Carbaryl		NR	1A
	Maldison		3	1B
	Trichlorfon	Vegetables	2	1B

Insect Name	Active Ingredient		WHP	Chemical group
Helicoverpa	Chlorantraniliprole (CORAGEN [^])	Cucurbits	3	28
	Flubendiamide (BELT [^])	Cucurbits	1	28
<i>Helicoverpa armigera</i> (Corn Earworm / Cotton Bollworm)	Bacillus thuringiensis kurstaki	Vegetables	NR	11
	Bifenthrin		1	3A
	Helicoverpa NPV Armigera		NR	
<i>Helicoverpa punctigera</i> (Native Budworm)	Bacillus thuringiensis kurstaki	Vegetables	NR	11
	Carbaryl		NR	1A
	Spinetoram		3	5
	Bifenthrin		1	3A
	Helicoverpa NPV Armigera		NR	
Jassids	Maldison		3	1B
Leafeating Ladybirds	Carbaryl		NR	1A
	Maldison		3	1B
	Paraffinic Oil		1	oil
	Petroleum Oil		1	oil
Leafhoppers	Pyrethrins+Piperonyl Butoxide	Vegetables	1	3A
Lightbrown Apple Moth	Bacillus thuringiensis kurstaki	Vegetables	NR	11
Locust - Australian Plague	Carbaryl			
	Chlorpyrifos			
	Diazinon			
	Maldison			
Loopers	Bacillus thuringiensis kurstaki	Vegetables	NR	11
Mealybug	Potassium Salts Of Fatty Acids	Vegetables	NR	-
Mite – Bean Spider	Sulphur	Vegetables	NR	_
Mite - European Red	Tebufenpyrad		14	21A
Mite - Redlegged Earth Mite	Maldison		3	1B
Mite - Two-Spotted (Red Spider)	Abamectin		3	6
	Bifenazate	(PER12906, expires Mar 2018)	7	2D
	Botanical Oil	Vegetables	NR	-
	Etoxazole	(PER13304, expires Jun 2018, Zucchini)	7	10B
	Potassium Salts Of Fatty Acids	Vegetables	NR	-
	Propargite	Vegetables	7	12C
	Sulphur	Vegetables	NR	_
Mites	Paraffinic Oil		1	oil
	Petroleum Oil		1	oil
Plant parasitic nematodes	1,3-dichloropropene + chloropicrin	Vegetables	NR	8B
Potato Moth (Leafminer)	Carbaryl		NR	1A
Pumpkin Beetle	Carbaryl		NR	1A
	Maldison		3	1B
Rutherglen Bug	Carbaryl		NR	1A
	Maldison		3	1B
	Trichlorfon	Vegetables	2	1B

Insect Name	Active Ingredient		WHP	Chemical group
Symphylans (garden centipedes)	1,3-dichloropropene + chloropicrin	Vegetables	NR	8B
Thrips	Diazinon		14	1B
	Paraffinic Oil		1	oil
	Petroleum Oil		1	oil
	Methyl bromide	(PER10145, expires Oct 2014, Food Producing Plants (Not Persons Generally))	3	8A
	Potassium Salts Of Fatty Acids	Vegetables	NR	-
	Pyrethrins+Piperonyl Butoxide	Vegetables	1	3A
Thrips - Western Flower	Abamectin		3	6
	Spinetoram		3	5
Vegetable Weevil	Chlorpyrifos		5	1B
Whiteflies	Chlorpyrifos		5	1B
	Pyrethrins+Piperonyl Butoxide	Vegetables	1	3A
	Potassium Salts Of Fatty Acids	Vegetables	NR	-
Whitefly - Greenhouse	Petroleum	(PER12221, expires Nov 2017, Peppers Including Capsicum, Chilli And Paprika)	1	-
	Sulfoxaflor (TRANSFORM^)	Cucurbits	3	4C
Whitefly – Greenhouse, Silverleaf	Botanical Oil	Vegetables	NR	-
Whitefly- <i>Bemisia Tabaci</i> Species (Sweet Potato Whitefly, Silverleaf Whitefly B Biotype And Whitefly Q Biotype)	Petroleum	(PER12221, expires Nov 2017, Peppers Including Capsicum, Chilli And Paprika)	1	-
Whitefly - Silverleaf	Bifenthrin		1	3A
	Imidacloprid		NR	4A
	Paraffinic Oil		1	oil
	Pymetrozine	(PER13111, expires May 2014, Cucurbits)	3	9B
	Spirotetramat		1	23
Wingless Grasshopper	Carbaryl		NR	1A
Wireworms	1,3-dichloropropene + chloropicrin	Vegetables	NR	8B
Zucchini Fly	Maldison		3	1B
Zucchini Moth	Bifenthrin		1	3A
	Permethrin		2	3A
	Spinetoram		3	5

4.3 Weeds of zucchini

- **Registered** herbicides used in zucchini:
 - Clomazone (various) Group F pre-emergent residual herbicide
 - Occasionally used.
 - Reported as causing crop phyto on sandy soils.
 - Controls most weeds.
 - Can only be used in situations where crop is direct sown – cannot be used in situations where seedlings are transplanted.
 - Cannot be used on soilw with both organic carbon of <2% and clay content of <15%
 - Controls several broadleaf weeds.
 - Fluazifop-P as butyl (various) Group A grass selective post-emergent herbicide
 - Commonly used.
 - Considered very effective.
 - Controls most grass weeds.
 - 21 day withholdin period
 - Glyphosate (various) Group M preplant general knockdown herbicide
 - Only used in field grown crops.
 - Commonly used for weed control prior to sowing / transplanting..
 - Works well as a pre-crop spray.
 - Paraquat + diquat (various) Group L pre-plant general knockdown herbicide
 - Only used in field grown crops.
 - Occasionally used for weed control prior to sowing/transplanting.
 - Commonly used for weed control in interrows.
 - Sethoxydim (various) Group A grass selective post-emergent herbicide
 - Occasionally used.
 - Controls most grass weeds.
 - 28 day withholding period
- No herbicides are listed for control of weeds in zucchini via **permit**.

Field zucchini growers planting into bare beds generally use a pre-plant weed control (general knockdown herbicide) to prepare the paddock. Growers then usually only spot-spray grass weeds with a grass selective herbicide.

No weeds were reported as a high priority for new registrations or permits. Overall there is a desire for newer chemistry and increased options for control of weeds, although most weeds can currently be controlled with available herbicides. Non-chemical options should be considered in future SARPs.

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 'Domestic Vegetable Industry Snapshot' (2009) website: <http://www.ausveg.com.au>
- Ausveg 'Fresh Vegetable Exports' (2011) website: <http://www.ausveg.com.au>
- Biobest 2008 <http://207.5.17.151/biobest/en/nieuws/scanivital.htm>
- Codex MRL database
- Diseases of Vegetable Crops. Department of Primary Industries Queensland, 1994.
- Infopest, Department of Primary Industries and Fisheries, Queensland Government, November 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: http://www.iobc-wprs.org/expert_groups/01_wg_beneficial_organisms.html
- 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 Industries websites.
- New Zealand Horticulture and AgAware: Zucchiniir SARP report 2008.
- Pest management strategy documents for Queensland's fruit and vegetable industries, Queensland Fruit and Vegetable growers, 2003 & 2008.
- USA Foreign Ag Service- www.mrl-database.com

Images:

- Google images
- Infopest, Department of Primary Industries and Fisheries, Queensland Government, July 2012.

Acronyms

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

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

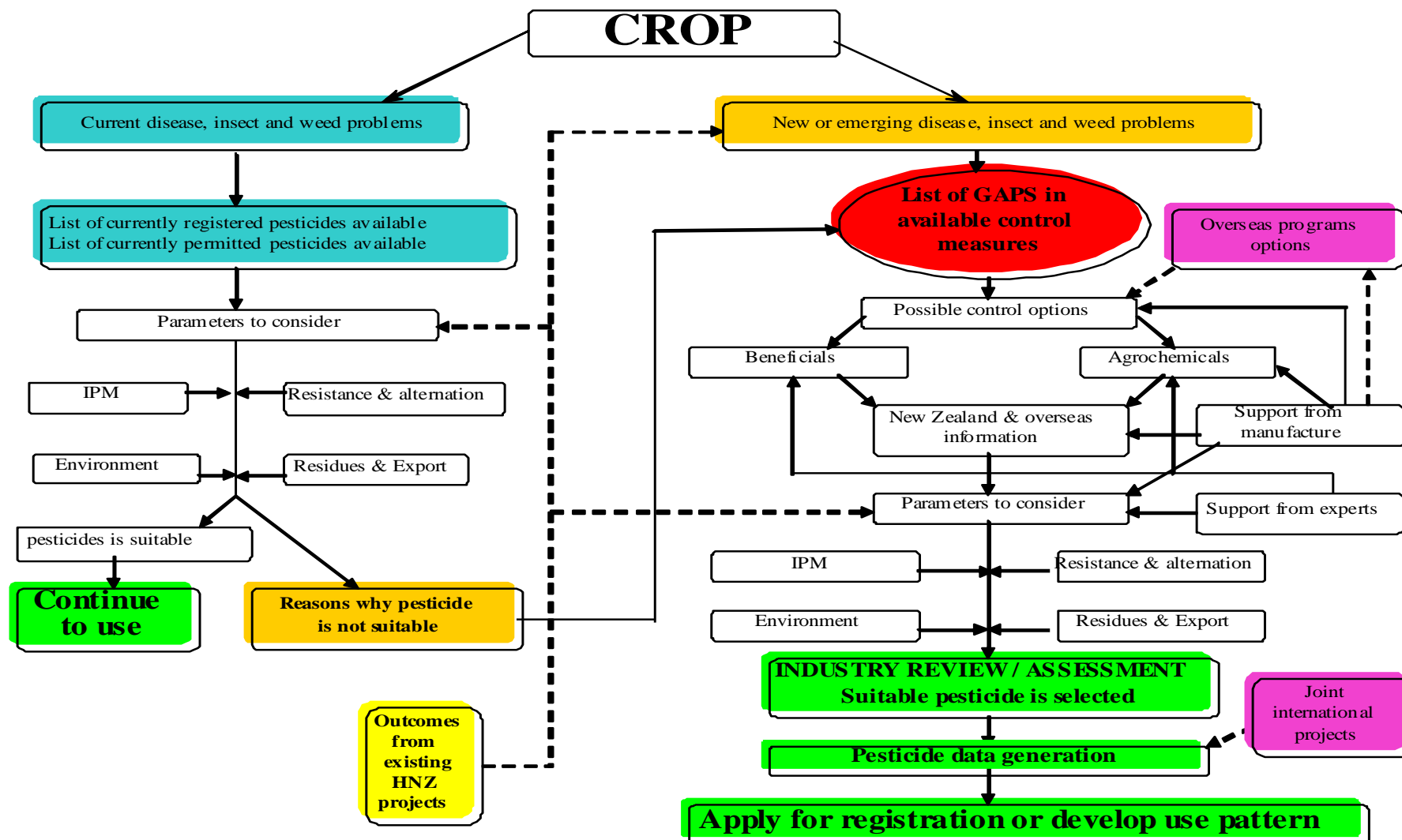
Acknowledgement

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 zucchini.

Active Ingredient		Disease Name	WHP, days	Chemical group
1,3-Dichloropropene + Chloropicrin		Soil borne diseases incl Fusarium, Verticillium wilts, Rhizoctonia, Pythium	NR	–
Azoxystrobin		Downy Mildew	1	11
Azoxystrobin		Gummy Stem Blight	1	11
Azoxystrobin		Powdery Mildew	1	11
Boscalid + Kresoxim-Methyl		Powdery Mildew	7	7/11
Bupirimate (NIMROD^)	(PER10979, expires Sep 2014, Zucchini)	Powdery Mildew	1	8
Chlorothalonil		Alternaria Leaf Blight	1	M5
Chlorothalonil		Anthrachnose	1	M5
Chlorothalonil		Botrytis Rot	1	M5
Chlorothalonil		Gummy Stem Blight	1	M5
Chlorothalonil		Powdery Mildew	1	M5
Chlorothalonil		Rhizoctonia Ground Rot	1	M5
Chlorothalonil		Target Leafspot	1	M5
Copper		Angular Leaf Spot	1	M1
Copper		Anthrachnose	1	M1
Copper		Bacterial Spot	1	M1
Copper		Downy Mildew	1	M1
Copper		Gummy Stem Blight	1	M1
Copper		Powdery Mildew	1	M1
Cu As Hydroxide + Mancozeb		Downy Mildew	7	M1/M3
Cu As Hydroxide + Mancozeb		Gummy Stem Blight	7	M1/M3
Cu As Hydroxide + Metalaxyl-M		Downy Mildew	7	4/M1
Cyflufenamid (FLUTE^)		Powdery Mildew	1	U6
Dimethomorph		Alternaria Leaf Blight	7	40
Dimethomorph		Anthrachnose	7	40
Dimethomorph		Gummy Stem Blight	7	40
Fenarimol		Powdery Mildew	3	3
Fenarimol (RUBIGAN^)		Powdery Mildew	3	3
Mancozeb		Anthrachnose	7	M3
Mancozeb		Downy Mildew	7	M3
Mancozeb		Grey Mould	7	M3
Mancozeb		Gummy Stem Blight	7	M3
Mancozeb		Septoria Spot	7	M3
Mancozeb + Metalaxyl		Alternaria Leaf Blight	7	4/M3
Mancozeb + Metalaxyl		Downy Mildew	7	4/M3
Mancozeb + Metalaxyl		Gummy Stem Blight	7	4/M3
Mancozeb + Metalaxyl-M		Anthrachnose	7	4/M3
Metalaxyl		Damping Off	7	4
Metalaxyl		Phytophthora Soil Fungus	7	4

Active Ingredient		Disease Name	WHP, days	Chemical group
Metiram		Downy Mildew	2	M3
Metiram		Gummy Stem Blight	2	M3
Metrafenone		Powdery Mildew	7	U8
Oxythioquinox		Powdery Mildew	7	14
Penthiopyrad (FONTELIS^)		Grey Mould	1	7
Penthiopyrad (FONTELIS^)		Gummy Stem Blight	1	7
Penthiopyrad (FONTELIS^)		Powdery Mildew	1	7
Phosphorous Acid		Downy Mildew	NA	33
Potassium Bicarbonate		Powdery Mildew	NA	M2
Propineb		Downy Mildew	3	M3
Propineb + Oxadixyl		Anthraco nose	3	4/M3
Propineb + Oxadixyl		Downy Mildew	3	4/M3
Propineb + Oxadixyl		Gummy Stem Blight	3	4/M3
Proquinazid (TALENDO^)	Field cucurbits only	Powdery Mildew	1	13
Sulphur		Powdery Mildew	NR	M2
Tea Tree Oil		Powdery Mildew	NA	
Triadimefon		Powdery Mildew	1	3
Triadimenol	Cucurbits	Powdery Mildew	1	3
Trifloxystrobin		Powdery Mildew	3	11
Zineb		Downy Mildew	7	M3

Appendix 3 – currently available insecticides in zucchini

Active Ingredient		Insect Name	WHP	Chemical group
1,3-dichloropropene + chloropicrin	Vegetables	Plant parasitic nematodes	NR	8B
1,3-dichloropropene + chloropicrin	Vegetables	Symphylans (garden centipedes)	NR	8B
1,3-dichloropropene + chloropicrin	Vegetables	Wireworms	NR	8B
Abamectin		Thrips - Western Flower	3	6
Abamectin		Mite - Two-Spotted (Red Spider)	3	6
Bacillus thuringiensis kurstaki	Vegetables	Armyworm	NR	11
Bacillus thuringiensis kurstaki	Vegetables	Cabbage Moth	NR	11
Bacillus thuringiensis kurstaki	Vegetables	Cabbage White Butterfly	NR	11
Bacillus thuringiensis kurstaki	Vegetables	<i>Helicoverpa armigera</i> (Corn Earworm / Cotton Bollworm)	NR	11
Bacillus thuringiensis kurstaki	Vegetables	<i>Helicoverpa punctigera</i> (Native Budworm)	NR	11
Bacillus thuringiensis kurstaki	Vegetables	Lightbrown Apple Moth	NR	11
Bacillus thuringiensis kurstaki	Vegetables	Loopers	NR	11
Bifenazate	(PER12906, expires Mar 2018)	Mite - Two-Spotted (Red Spider)	7	2D
Bifenthrin		<i>Helicoverpa armigera</i> (Corn Earworm)	1	3A
Bifenthrin		<i>Helicoverpa punctigera</i> (Native Budworm)	1	3A
Bifenthrin		Whitefly - Silverleaf	1	3A
Bifenthrin		Zucchini Moth	1	3A
Botanical Oil	Vegetables	Aphids	NR	-
Botanical Oil	Vegetables	Mite - Two-Spotted (Red Spider)	NR	-
Botanical Oil	Vegetables	Whitefly - Greenhouse	NR	-
Botanical Oil	Vegetables	Whitefly – greenhouse	NR	-
Botanical Oil	Vegetables	Whitefly - Silverleaf	NR	oil
Bti		Black Fungus Gnats	NR	11
Carbaryl		28-Spotted Potato Ladybird	NR	1A
Carbaryl		Armyworms	NR	1A
Carbaryl		Cucurbit Stemborer	NR	1A
Carbaryl		Cutworms	NR	1A
Carbaryl		European Earwig	NR	1A
Carbaryl		Green Vegetable Bug	NR	1A
Carbaryl		<i>Helicoverpa punctigera</i> (Budworms)	NR	1A
Carbaryl		Leafeating Ladybirds	NR	1A
Carbaryl		Locust - Australian Plague		
Carbaryl		Potato Moth (Leafminer)	NR	1A
Carbaryl		Pumpkin Beetle	NR	1A
Carbaryl		Rutherglen Bug	NR	1A

Active Ingredient		Insect Name	WHP	Chemical group
Carbaryl		Wingless Grasshopper	NR	1A
Chlorantraniliprole (CORAGEN [^])	Cucurbits	Cucumber moth	3	28
Chlorantraniliprole (CORAGEN [^])	Cucurbits	Helicoverpa	3	28
Chlorpyrifos		Ants	5	1B
Chlorpyrifos		Crickets – Mole, Field	5	1B
Chlorpyrifos		Cutworms	5	1B
Chlorpyrifos		Locust - Australian Plague		
Chlorpyrifos		Vegetable Weevil	5	1B
Chlorpyrifos		Whiteflies	5	1B
Diazinon		Caterpillars	14	1B
Diazinon		Cutworms	14	1B
Diazinon		Locust - Australian Plague		
Diazinon		Thrips	14	1B
Etoxazole	(PER13304, expires Jun 2018, Zucchini)	Mites-Red Spider	7	10B
Etoxazole	(PER13304, expires Jun 2018, Zucchini)	Mites-Two Spotted	7	10B
Flubendiamide (BELT [^])	Cucurbits	Cucumber moth	1	28
Flubendiamide (BELT [^])	Cucurbits	Helicoverpa	1	28
Helicoverpa NPV Armigera		<i>Helicoverpa armigera</i> (Corn Earworm)	NR	
Helicoverpa NPV Armigera		<i>Helicoverpa punctigera</i> (Native Budworm)	NR	
Imidacloprid		Aphid - Green Peach	1	4A
Imidacloprid		Whitefly - Silverleaf	NR	4A
Maldison		28-Spotted Potato Ladybird	3	1B
Maldison		Aphids	3	1B
Maldison		Fruit Fly - Mediterranean	3	1B
Maldison		Fruit Fly - Queensland	3	1B
Maldison		Green Vegetable Bug	3	1B
Maldison		Jassids	3	1B
Maldison		Leafhoppers	3	1B
Maldison		Locust - Australian Plague		
Maldison		Mite - Redlegged Earth Mite	3	1B
Maldison		Pumpkin Beetle	3	1B
Maldison		Rutherglen Bug	3	1B
Maldison		Zucchini Fly	3	1B
Methyl bromide	(PER10145, PER11092, expires Oct 2014, Fruiting Vegetables (Not Persons Generally))	Fruit Fly	3	8A
Methyl bromide	(PER10145, expires Oct 2014, Food Producing Plants (Not Persons Generally))	Thrips	3	8A
Paraffinic Oil		Aphids	1	oil
Paraffinic Oil		Leafhoppers	1	oil

Active Ingredient		Insect Name	WHP	Chemical group
Paraffinic Oil		Mites	1	oil
Paraffinic Oil		Thrips	1	oil
Paraffinic Oil		Whitefly - Silverleaf	1	oil
Permethrin		Zucchini Moth	2	3A
Petroleum	(PER12221, expires Nov 2017, Peppers Including Capsicum, Chilli And Paprika)	Whitefly- <i>Bemisia Tabaci</i> Species (Sweet Potato Whitefly, Silverleaf Whitefly B Biotype And Whitefly Q Biotype)	1	-
Petroleum	(PER12221, expires Nov 2017, Peppers Including Capsicum, Chilli And Paprika)	Whitefly-Greenhouse	1	-
Petroleum Oil		Aphids	1	oil
Petroleum Oil		Leafhoppers	1	oil
Petroleum Oil		Mites	1	oil
Petroleum Oil		Thrips	1	oil
Pirimicarb		Aphids	2	1A
Potassium Salts Of Fatty Acids	Vegetables	Aphids	NR	-
Potassium Salts Of Fatty Acids	Vegetables	Mealybug	NR	-
Potassium Salts Of Fatty Acids	Vegetables	Thrips	NR	-
Potassium Salts Of Fatty Acids	Vegetables	Mites - Two Spotted Mite / Spider Mite	NR	-
Potassium Salts Of Fatty Acids	Vegetables	Whitefly	NR	-
Propargite	Vegetables	Mites – Two Spotted	7	12C
Pymetrozine		Whitefly - Silverleaf	3	9B
Pymetrozine	(PER13111, expires May 2014, Cucurbits)	Whitefly- Silverleaf	3	9B
Pyrethrins+Piperonyl Butoxide	Vegetables	Ants	1	3A
Pyrethrins+Piperonyl Butoxide	Vegetables	Aphids	1	3A
Pyrethrins+Piperonyl Butoxide	Vegetables	Caterpillars	1	3A
Pyrethrins+Piperonyl Butoxide	Vegetables	Leafhoppers	1	3A
Pyrethrins+Piperonyl Butoxide	Vegetables	Thrips	1	3A
Pyrethrins+Piperonyl Butoxide	Vegetables	Whiteflies	1	3A
Spinetoram		<i>Helicoverpa punctigera</i> (Budworms)	3	5
Spinetoram		Thrips - Western Flower	3	5
Spinetoram		Zucchini Moth	3	5
Spirotetramat		Aphid - Cotton	1	23
Spirotetramat		Aphid - Green Peach	1	23
Spirotetramat		Whitefly - Silverleaf	1	23
Sulfoxaflor (TRANSFORM [^])	Cucurbits	Aphid - Brown Sowthistle	3	4C

Active Ingredient		Insect Name	WHP	Chemical group
Sulfoxaflor (TRANSFORM^)	Cucurbits	Aphid – Green Peach	3	4C
Sulfoxaflor (TRANSFORM^)	Cucurbits	Whitefly - greenhouse	3	4C
Sulphur	Vegetables	Mite – bean spider	NR	_
Sulphur	Vegetables	Mite – Two Spotted	NR	_
Trichlorfon	Vegetables	Cabbage Moth	2	1B
Trichlorfon	Vegetables	Cabbage White Butterfly	2	1B
Trichlorfon	Vegetables	Cutworms, Qld, NT only	2	1B
Trichlorfon	Vegetables	Green Vegetable Bug	2	1B
Trichlorfon	Vegetables	Rutherglen Bug	2	1B

Appendix 4 – currently available herbicides in zucchini.

Active ingredient	Chemical group
Clomazone	Q
Fluazifop-P	A
Paraquat+Diquat	L
Sethoxydim	A