

Pesticides and insect pest control in vegetables



**Integrated
Crop Protection**
PROTECTING CROPS

**Hort
Innovation**



RMCG



Pesticides & Chemical Groups



IRAC MoA group	Insecticide category	Active Ingredient(s)	Example trade names
GROUP 1A INSECTICIDE	Carbamates	pirimicarb	Pirimicarb, Pirimor
GROUP 1B INSECTICIDE	Organophosphates	chlorpyrifos, diazinon, dimethoate, maldison, omethoate, phorate	Strike Out, Danadim, Fyanon, Thimet, Fokus, Pyrinex Super ¹
GROUP 3A INSECTICIDE	Synthetic Pyrethroids	permethrin, piperonyl butoxide, pyrethrins, tau-fluvalinate	Ambush, Klartan, Pyrinex Super ¹
GROUP 4A INSECTICIDE	Neonicotinoids	acetamiprid, imidacloprid, thiamethoxam	Intruder, Confidor, Nuprid, Actara, Durivo ²
GROUP 4C INSECTICIDE	Sulfoximines	sulfoxaflor (Isoclast™ active)	Transform
GROUP 9B INSECTICIDE	Pymetrozine	pymetrozine	Chess, Endgame
GROUP 23 INSECTICIDE	Tetronic and Tetramic acid derivatives	spirotetramat (iso)	Movento
GROUP 28 INSECTICIDE	Diamides	cyantraniliprole, chlorantraniliprole	Benevia, Durivo ²
GROUP 29 INSECTICIDE	Flonicamid	flonicamid	Mainman

Pesticides & Chemical Groups



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Crop Protection**

PROTECTING CROPS

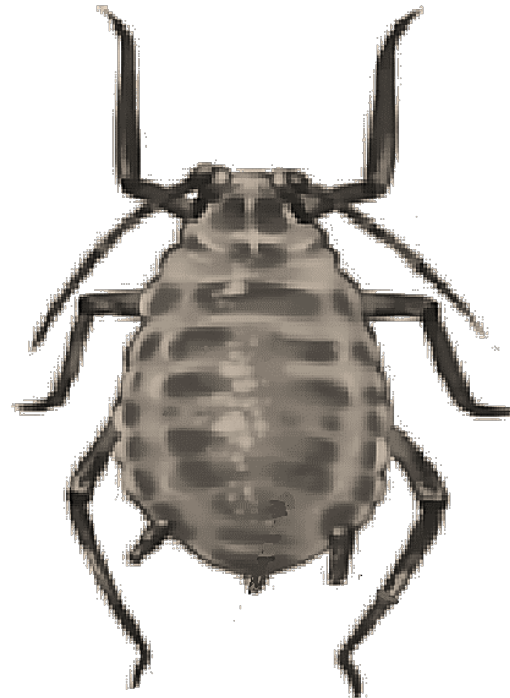
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Pesticides & Chemical Groups



Bifenthrin

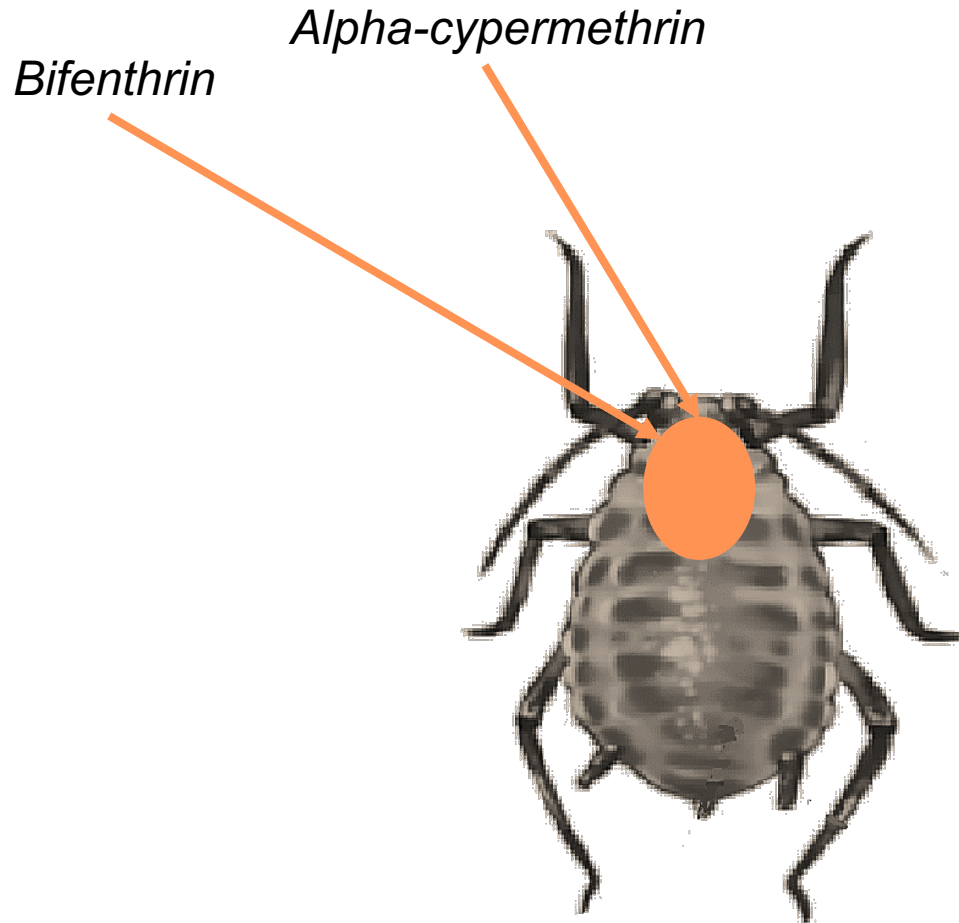
Alpha-cypermethrin



Spinetoram

Spinosad

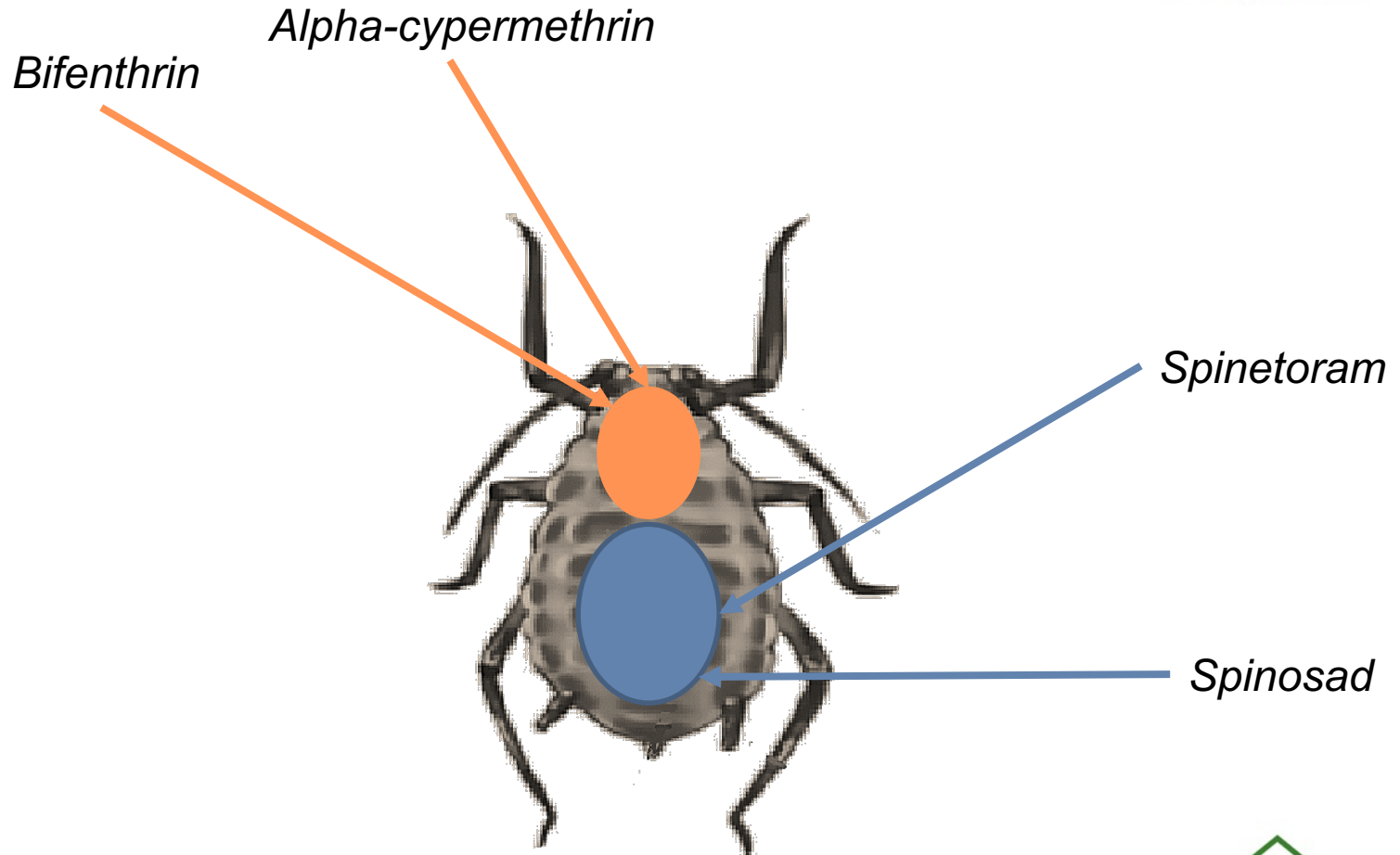
Pesticides & Chemical Groups



Spinetoram

Spinosad

Pesticides & Chemical Groups



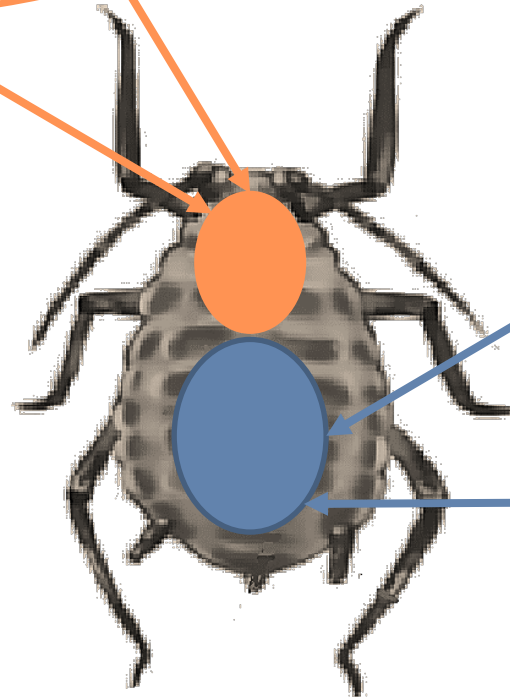
Pesticides & Chemical Groups



Group 3a

Bifenthrin

Alpha-cypermethrin



Spinetoram

Group 5

Spinosad



Insecticide Resistance Action Committee

Pesticides & Chemical Groups



Insecticide Resistance Action Committee



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Crop Protection

PROTECTING CROPS



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DU PONT

DuPont™ Coragen®

INSECTICIDE

Technical Information

Active Constituent:
200 g/L CHLORANTRANILIPROLE

Pack Sizes:
1 L
5 L

GROUP **28** INSECTICIDE



For the control of Lepidopteran species of insect pests in certain vegetables, as per the Directions for Use

FIRST AID

If poisoning occurs, contact a doctor or Poisons Information Centre. Phone Australia 13 11 26.

SAFETY DATA SHEET

Additional information is listed in the Material Safety Data Sheet available from www.cropprotection.dupont.com.au

DU PONT

DuPont™ Benevia®

insecticide

Technical Information

Active Constituent:
100 g/L CYANTRANILIPROLE

Pack Sizes:
5 L

GROUP **28** INSECTICIDE



CAUTION

KEEP OUT OF REACH OF CHILDREN

READ SAFETY DIRECTIONS BEFORE OPENING OR USING

For the control of insect pests in certain vegetables, as per the Directions for Use

SAFETY DIRECTIONS

May irritate the eyes and skin. Repeated exposure may cause allergic disorders. Avoid contact with eyes and skin. When opening the container and preparing spray and using the prepared spray, wear chemical resistant gloves. Wash hands after use. After each day's use wash gloves and contaminated clothing.

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POISON
KEEP OUT OF REACH OF CHILDREN
READ SAFETY DIRECTIONS BEFORE OPENING OR USING

Nuprid® 350SC

Insecticide

ACTIVE CONSTITUENT: 350 g/L IMIDACLOPRID

GROUP **4A** INSECTICIDE

For the control of various insect pests of cotton, fruit, vegetables and ornamentals as a foliar spray, for stem injection and as a soil drench in bananas, and as a soil applied treatment for the control of various cane, silverleaf whitefly in vegetable crops and certain pests in apples, citrus and specified in the Directions for Use table.

READ THE ATTACHED LEAFLET BEFORE USING THIS PRODUCT

Trademark of Nufarm Australia Limited

CAUTION

KEEP OUT OF REACH OF CHILDREN
READ SAFETY DIRECTIONS BEFORE OPENING OR USING

Confidor® 200 SC

Insecticide



RLP
Approved



ACTIVE CONSTITUENT: 200 g/L IMIDACLOPRID

GROUP **4A** INSECTICIDE

For the control of various insect pests of fruit, vegetables and ornamentals as specified in the DIRECTIONS FOR USE table

1 L

IMPORTANT: READ THE ATTACHED BOOKLET BEFORE USE

POISON
KEEP OUT OF REACH OF CHILDREN
READ SAFETY DIRECTIONS BEFORE OPENING OR USING

Movento® 240 SC

INSECTICIDE

ACTIVE CONSTITUENT: 240 g/L SPIROTETRAMAT

GROUP **23** INSECTICIDE

For the control of various insect pests in cotton and certain fruit and vegetable crops as specified in the DIRECTIONS FOR USE table



DUPONT

DuPont™ Coragen® INSECTICIDE

Technical Information

Active Constituent: 200 g/L CHLORANTRANILIPROLE
Pack Sizes: 1 L, 5 L

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DUPONT

DuPont™ Benevia® insecticide

Technical Information

Active Constituent: 100 g/L CYANTRANILIPROLE
Pack Sizes: 5 L

GROUP **28** INSECTICIDE



CAUTION
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Nufarm

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Trademark of Nufarm Australia Limited

CAUTION
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READ SAFETY DIRECTIONS BEFORE OPENING OR USING

Confidor® 200 SC
Insecticide

BAYER

APRIMA
RLP
Approved

DISPLAYED
BIOLOGICAL
FOREST

ACTIVE CONSTITUENT: 200 g/L IMIDACLOPRID

GROUP **4A** INSECTICIDE

1 L

IMPORTANT: READ THE ATTACHED BOOKLET BEFORE USE

For the control of various insect pests of fruit, vegetables and ornamentals as specified in the DIRECTIONS FOR USE table

POISON
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Movento® 240 SC
INSECTICIDE

ACTIVE CONSTITUENT: 240 g/L SPIROTETRAMAT

GROUP **23** INSECTICIDE

For the control of various insect pests in cotton and certain fruit and vegetable crops as specified in the DIRECTIONS FOR USE table

2XSYS



DUPONT

DuPont™ Coragen® INSECTICIDE

Technical Information

Active Constituent:
200 g/L CHLORANTRANILIPROLE

Pack Sizes:
1 L
5 L

GROUP 28 INSECTICIDE



For the control of Lepidopteran species of insect pests in certain vegetables, as per the Directions for Use

FIRST AID

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DuPont™ Benevia® insecticide

Technical Information

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GROUP 28 INSECTICIDE



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Confidor® 200 SC
Insecticide

BAYER

APRIMA
RLP
Approved

DISPLAYED
B
FOREST

ACTIVE CONSTITUENT: 200 g/L IMIDACLOPRID

GROUP 4A INSECTICIDE

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2XSYS



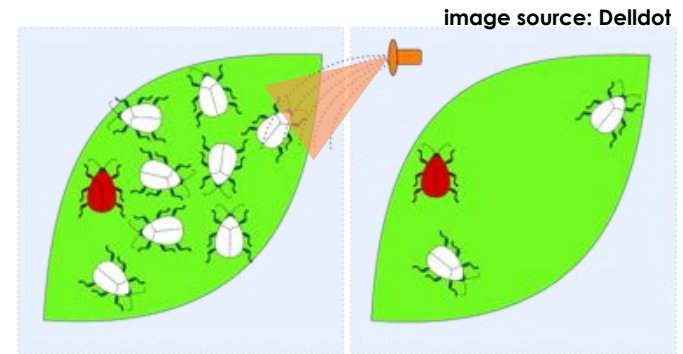
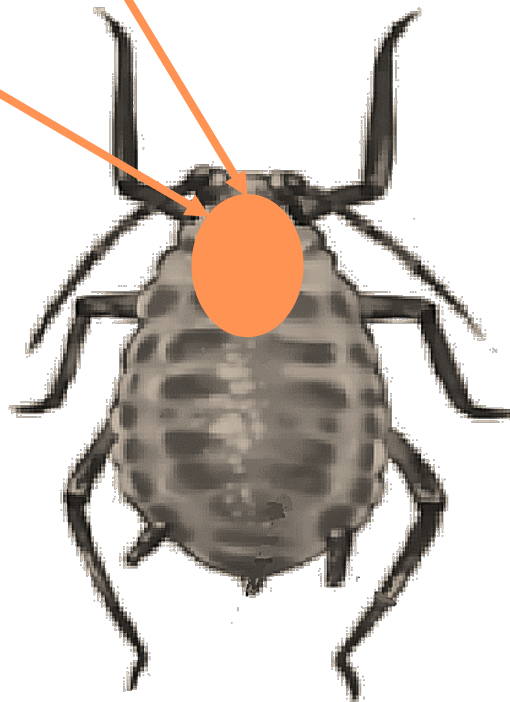
Evolution of pesticide resistance



Group 3a

Alpha-cypermethrin

Bifenthrin



Evolution of pesticide resistance



Group 3a

Alpha-cypermethrin

Bifenthrin

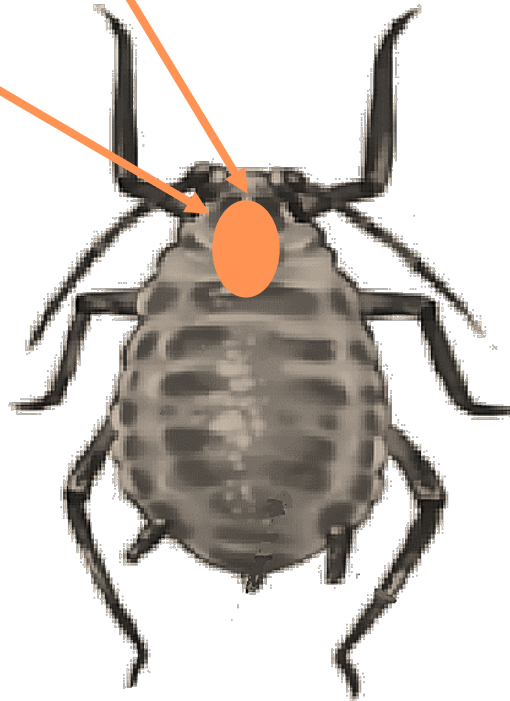
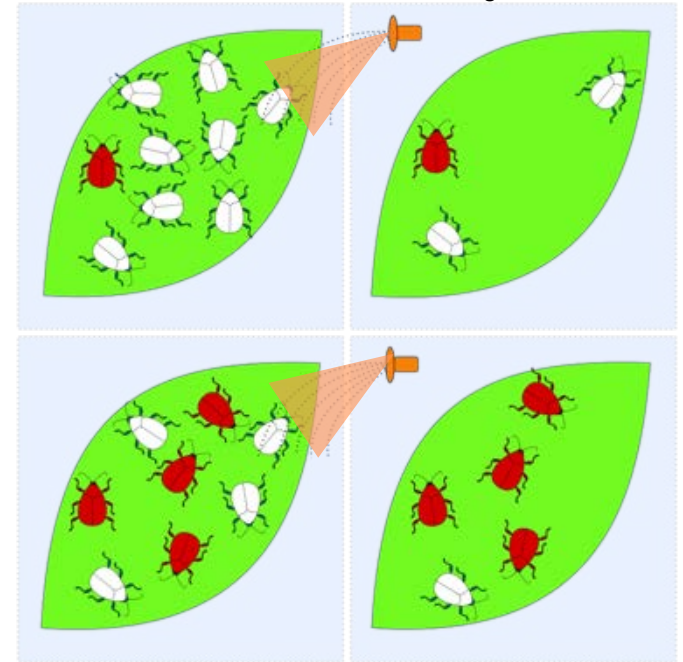


image source: Delldot



Evolution of pesticide resistance



Group 3a

Bifenthrin

Alpha-cypermethrin

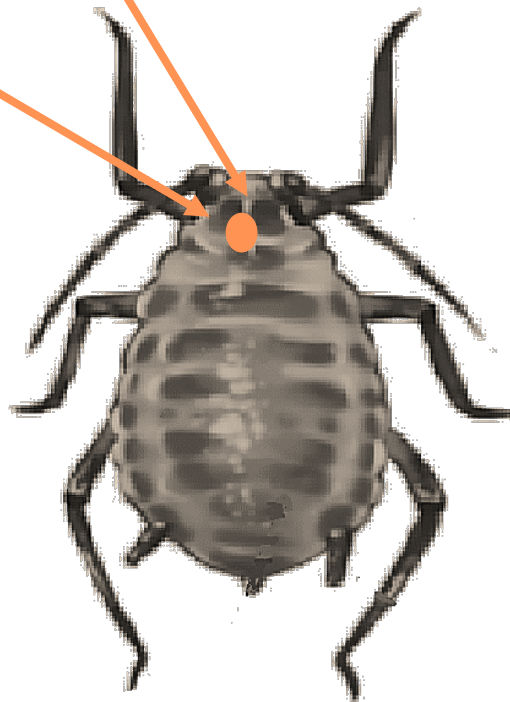
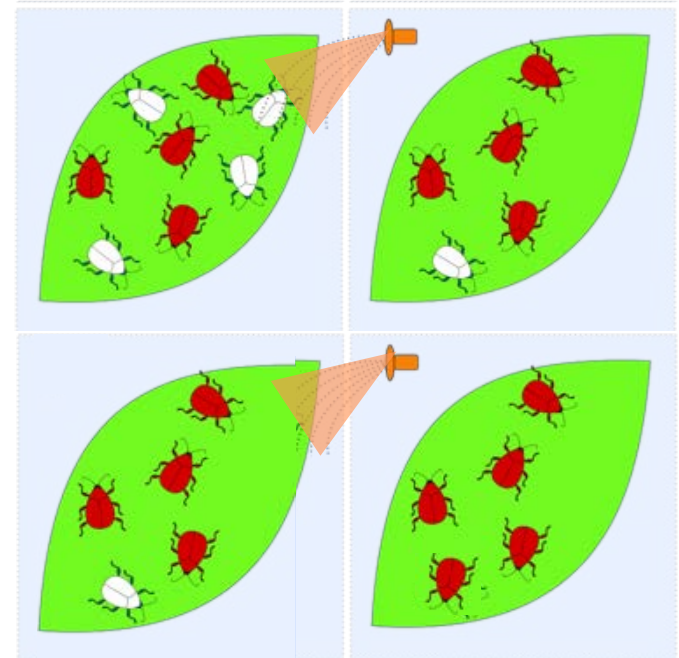


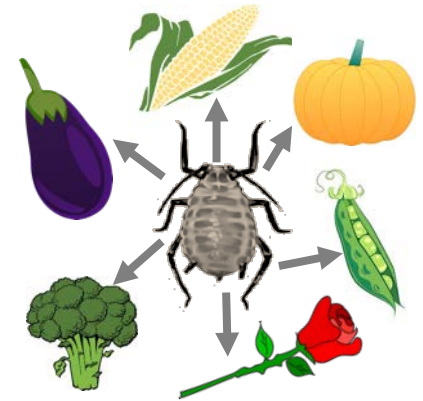
image source: Delldot



Evolution of pesticide resistance



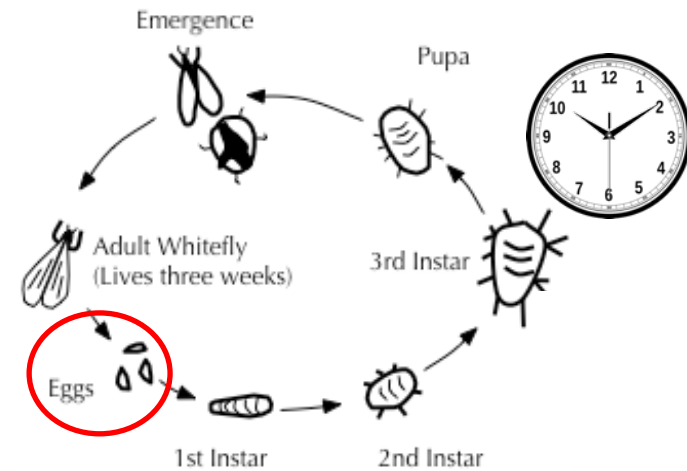
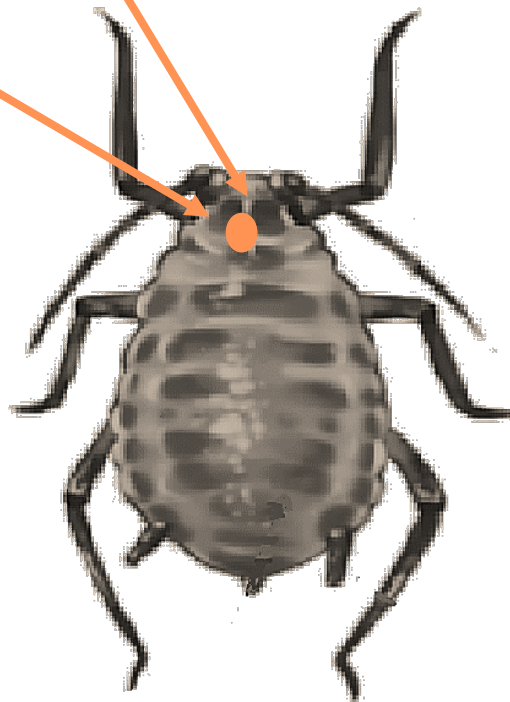
**Integrated
Crop Protection**
PROTECTING CROPS



Group 3a

Bifenthrin

Alpha-cypermethrin



Resistant pests in vegetable crops



Source: CSIRO



Silverleaf whitefly
Bemisia tabaci

Source: J. Holopainen



Two-spotted mite
Tetranychus urticae

Diamondback moth
Plutella xylostella

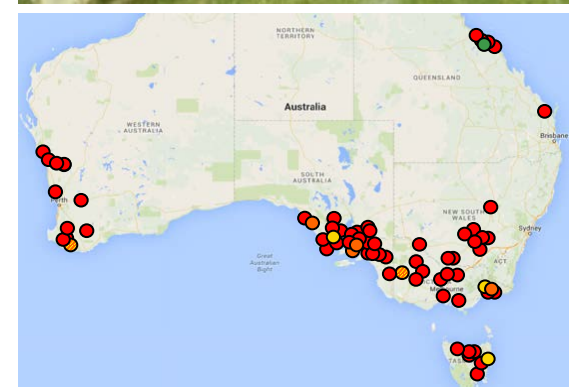


Source: CSIRO



Green peach aphid
Myzus persicae

Green peach aphid control in veg



MoA	Active ingredients	Resistance
Group 1A	Pirimicarb	yes
Group 1B	Chlorpyrifos, Diazinon, Dimethoate, Maldison, Omethoate, Phorate	yes
Group 3A	Permethrin, Tau-fluvalinate, Pyrethrins, Piperonyl butoxide	yes
Group 4A	Thiamethoxam, Imidacloprid, Acetimidiprid	yes
Group 4C	Sulfoxaflor	
Group 9B	Pymetrozine	-
Group 23	Spirotetramat	-
Group 28	Cyantraniliprole	-
Group 29	Flonicamid	-

Worldwide – reported resistance to more than 80 insecticides

Diamondback moth control in veg



MoA	Active ingredients	Resistance
Group 1A	Methomyl, Thiodicarb	-
Group 2B	Fipronil	-
Group 3A	Synthetic Pyrethroids (various)	yes
Group 5	Spinetoram	-
Group 6	Emamectin benzoate	yes
Group 11A	<i>Bacillus thuringiensis</i>	-
Group 13	Chlorfenapyr	-
Group 22A	Indoxacarb	-
Group 28	Chlorantraniliprole, Flubendiamide	-



Worldwide – reported resistance to more than 82 insecticides including Group 28 (Diamides) and *Bacillus thuringiensis*

Silverleaf whitefly control in veg



MoA	Active ingredients	Resistance
Group 1B	Chlorpyrifos	-
Group 3A	Bifenthrin	yes
Group 4A	Thiamethoxam, Imidacloprid	-
Group 7C	Pyriproxyfen	yes
Group 9B	Pymetrozine	-
Group 16	Buprofezin	-
Group 23	Spirotetramat	-
Group 28	Cyantraniliprole, Chlorantraniliprole	-
Group 29	Flonicamid	-



Source: CSIRO



Source: CSIRO

Worldwide – reported resistance to more than 50 insecticides

Two-spotted mite control in veg



MoA	Active ingredients	Resistance
Group 1B	Dimethoate, Omethoate, Phorate	yes
Group 3A	Bifenthrin, Pyrethrins, Tau-fluvalinate	yes
Group 6	Abamectin, Milbemectin	yes
Group 10B	Etoxazole	yes
Group 12C	Propargite	yes
Group 20D	Bifenazate	-



Worldwide – reported resistance to more than 90 insecticides

Insecticides are no longer recommended as a viable option for this pest as it develops resistance to almost all chemicals used to control it.

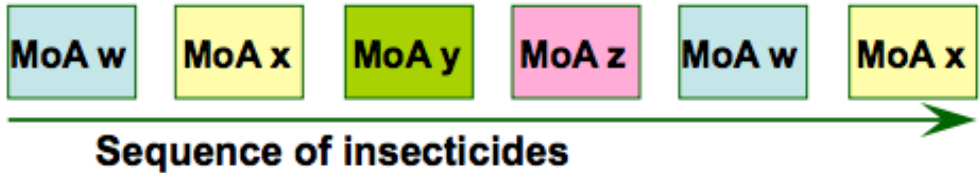
Resistance Management



Resistance Management strategies are available for most pests.

Key message (if chemical control is needed):

Rotate between different IRAC MoA groups



June 2016
Resistance Management Strategy for the green peach aphid in Bundaberg field vegetable crops

Green peach aphid and insecticide resistance

Key points

- Green peach aphid (GPA) are an important pest of vegetables, causing damage by feeding and transmitting viruses.
- Many chemical groups are registered to control GPA in vegetables. Insecticides are also registered for GPA control, and pyrethroids are registered for suppression.
- High levels of resistance to carbamates, pyrethroids and organophosphates are found across Queensland crops, often through the use of insecticides in combination. Low levels of resistance to neonicotinoids have also been observed in some GDC populations.
- A strategy to manage insecticide resistance in GDC populations is available for use by vegetable growers in Bundaberg, involving rotating different chemical groups, and using alternative IPM methods to reduce pest and virus loads.

Describe the layout, size, and what images are shown: ranging from shades of light and dark green, purple, blue and red. It shows the selection pressure for resistance in the field of insecticide resistance between different colour morphs of GPA. A single parent (P1) or 'father' of GPA can be made up of both green and red morphs, and these different colour morphs from a single parent population are resistant in exactly the same way to insecticides.

The use of insecticides to control GPA in vegetable and field vegetable crops continues to grow in Australia, leading to insecticide resistance.

June 2017
RESISTANCE MANAGEMENT STRATEGY FOR DIAMONDBACK MOTH IN AUSTRALIAN CANOLA

Key points

- DBM is a major pest of canola and vegetable crops, particularly in flowering and podding, and it is a major resistance issue in vegetable crops.
- Five chemical sub-groups are registered to control DBM in Australian vegetable crops: pyrethroids, pyrethroids, Group 10 (organophosphates) (Group 10), Carbamate (Group 1A), and Insect Growth Regulators (Group 15).
- Resistance to pyrethroids and organophosphates is widespread in Australia. Use to moderate levels of resistance to insecticides are also common across Australian canola and vegetable production regions.
- Growers are encouraged to reduce selection pressure on remaining products by using integrated pest management tactics and rotating efficacious products.

Describe the layout, size, and what images are shown: The diamondback moth (Plutella maculipennis), DBM is a pest of canola, brassica, vegetable and range crops. DBM larvae feed on plant tissue, stems, roots, leaves and pods. The larvae can be found at any stage of canola development, with their numbers often increasing in the lead up to flowering. Canola can tolerate considerable leaf damage before causing yield loss, however severe infestations can cause complete defoliation and yield losses of up to 80 per cent in canola.

The use of insecticides in canola and vegetable crops continues to grow in Australia, placing strong selection pressure on the development of resistance. DBM has a high capacity to develop resistance and there are more than 80 insecticide compounds registered globally to which DBM has developed resistance. Because of the high observed levels of DBM control, resistant individuals can now dominate a population if there is widespread use of the same insecticide group. With resistance to

three key insecticide groups (pyrethroids, organophosphates and insecticides) already established, canola growers need to understand how to minimise the further development of resistance.

Resistance management and minimisation strategy

The aim of this strategy is to increase the selection pressure for resistance to the same chemical groups across consecutive generations of DBM. The strategy includes three insecticide groups (pyrethroids, insecticides and organophosphates) and the insecticide Group 10 products. It includes the pyrethroid Group 3A and organophosphates Group 10 products. Insecticide resistance to these products is already high in Australian DBM populations at levels that render them ineffective. Suitable pyrethroids and organophosphates are not recommended for DBM control.



Insecticide Resistance Management Strategies
Developed by the CropLife Australia Insecticide Resistance Management Review Group
Valid as at 10 June 2017

Crop(s) : Various
Insect(s) : Silverleaf Whitefly

Guidelines:

1. Monitor pest numbers and apply control measures before adult populations reach high levels.
2. Select registered insecticide control measures according to the primary growth stage of the pest, the infestation level and the age and type of crop.
3. In cotton, spray decisions should be based on the Silverleaf Whitefly threshold matrix. Refer to the current [Cotton Pest Management Guide](#) for further details
4. Where possible, utilise selective insecticides during the early stages of crop development to minimise the impact on beneficial insects.

When DBM larvae are detected, they will spread, and they do so. For this reason, a wider focus is needed.

DBM larvae move through the plants to the underside of a damaged canola leaf. Pests start to grow in canola. First, larvae damage the underside of the leaf.

KEY POINTS

Diamondback moth and insecticide resistance

Describe the layout, size, and what images are shown: This image shows a close-up of a diamondback moth larva on the underside of a canola leaf, illustrating the damage caused by the pest.

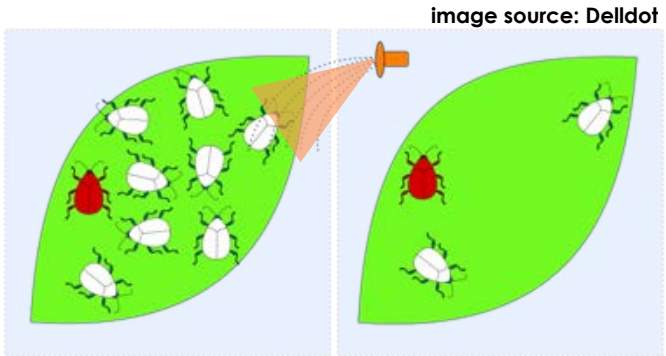
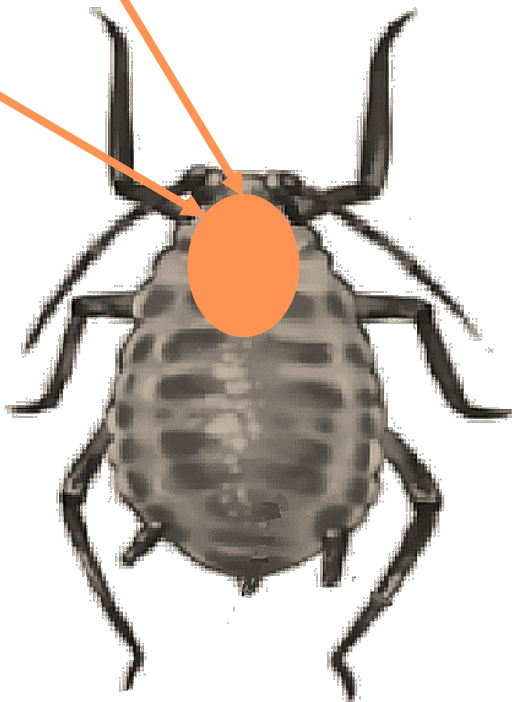
Rotation of MoA groups



Group 3a

Bifenthrin

Alpha-cypermethrin



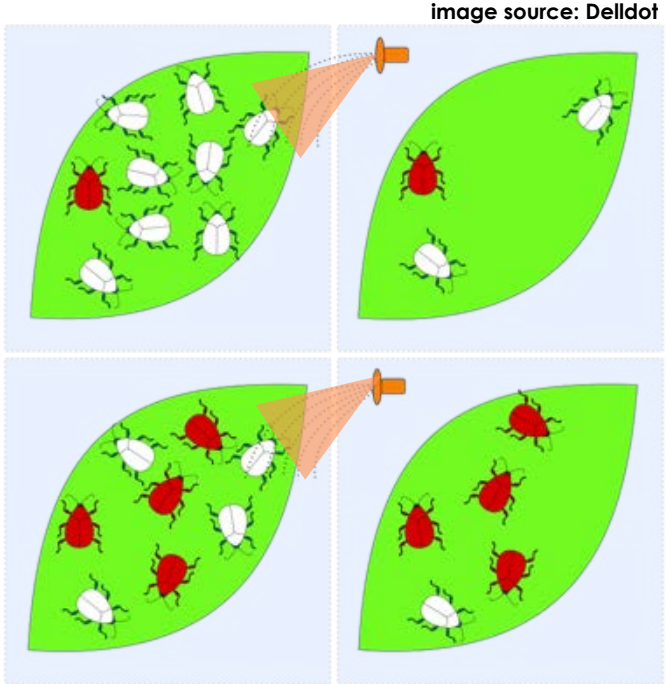
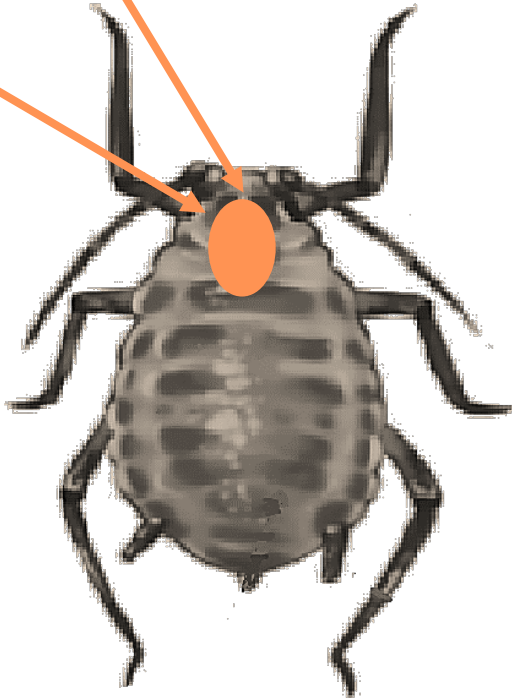
Rotation of MoA groups



Group 3a

Bifenthrin

Alpha-cypermethrin



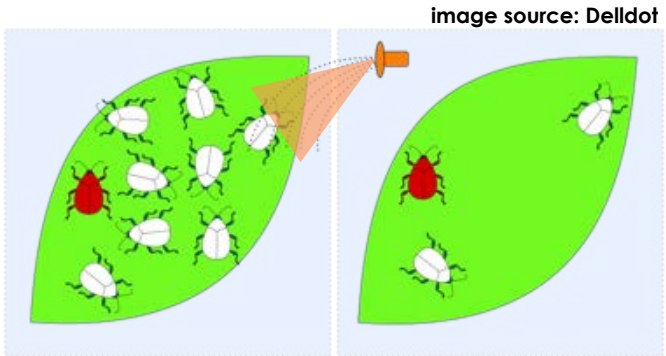
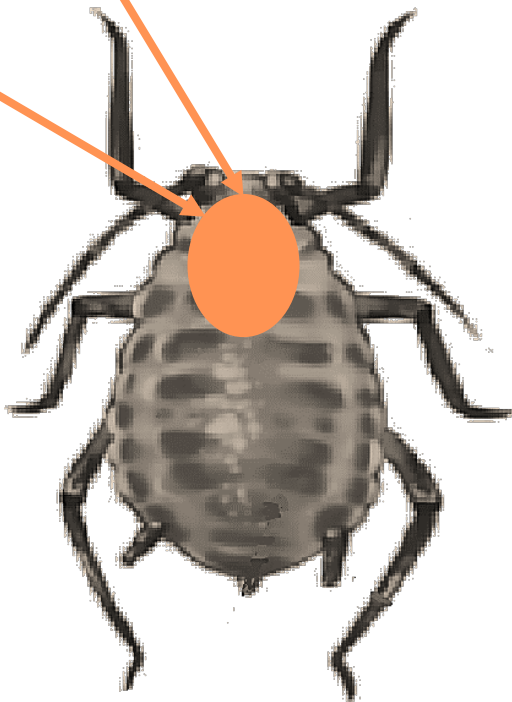
Rotation of MoA groups



Group 3a

Bifenthrin

Alpha-cypermethrin



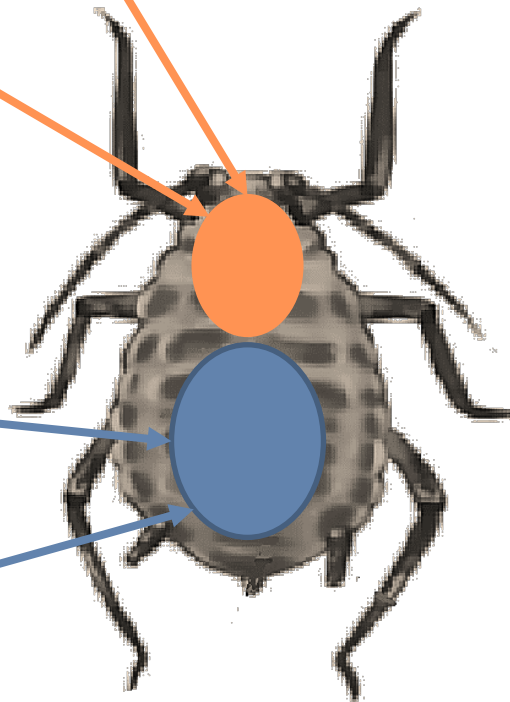
Rotation of MoA groups



Group 3a

Alpha-cypermethrin

Bifenthrin

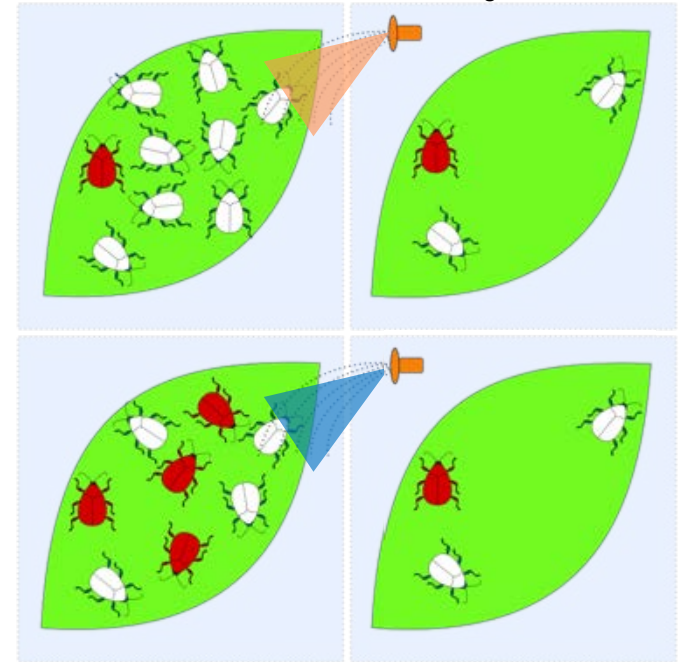


Spinetoram

Group 5

Spinosad

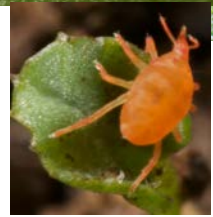
image source: Delldot



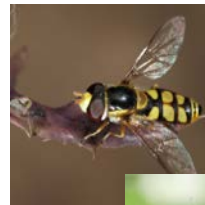
Beneficial insects in your crop



Beneficial insects in your crop



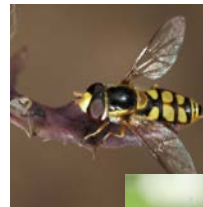
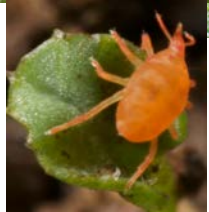
Beneficial insects in your crop



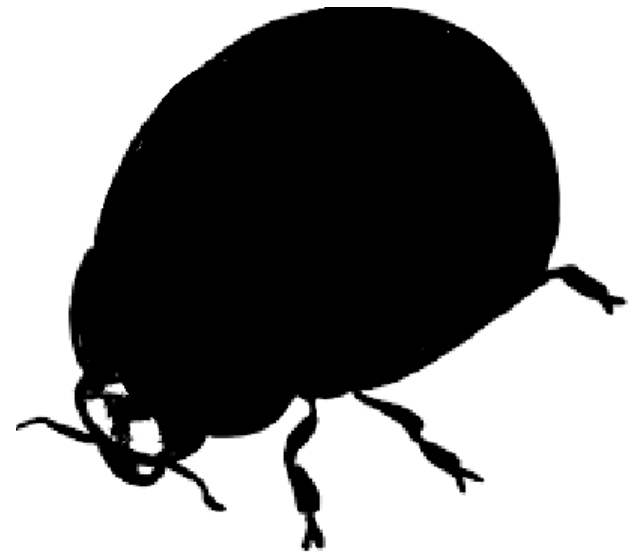
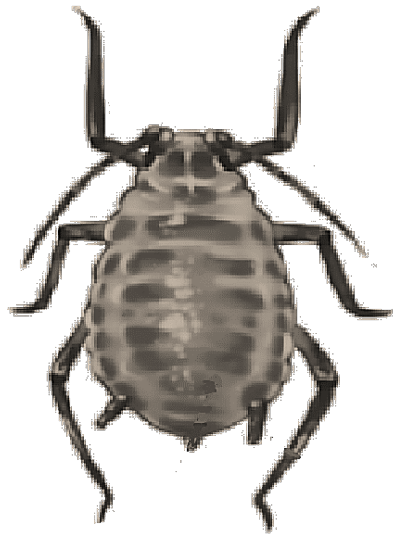
Beneficial insects in your crop



Integrated
Crop Protection
PROTECTING CROPS



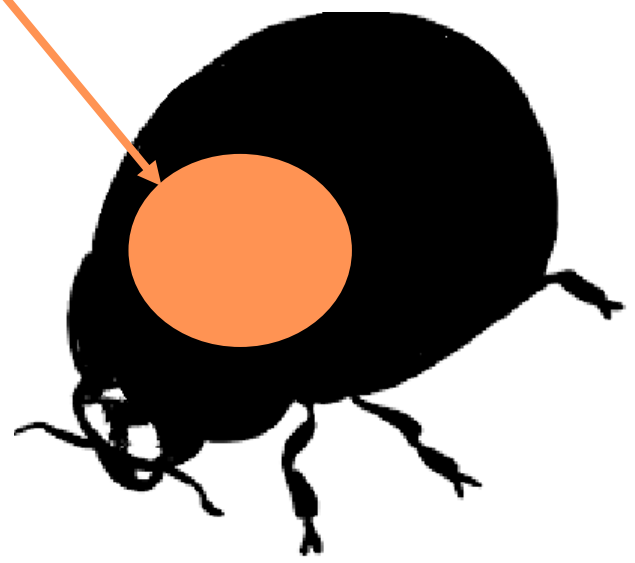
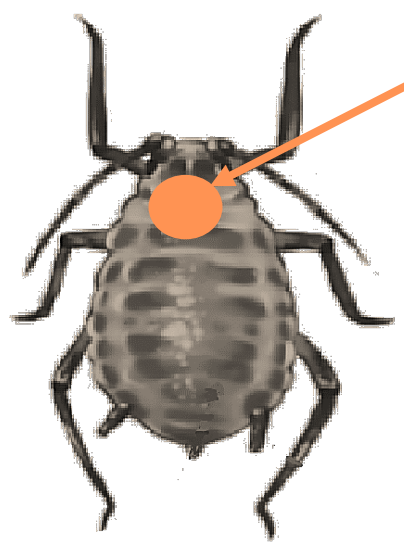
Pest vs beneficial sensitivity



Pest vs beneficial sensitivity



Group
3A

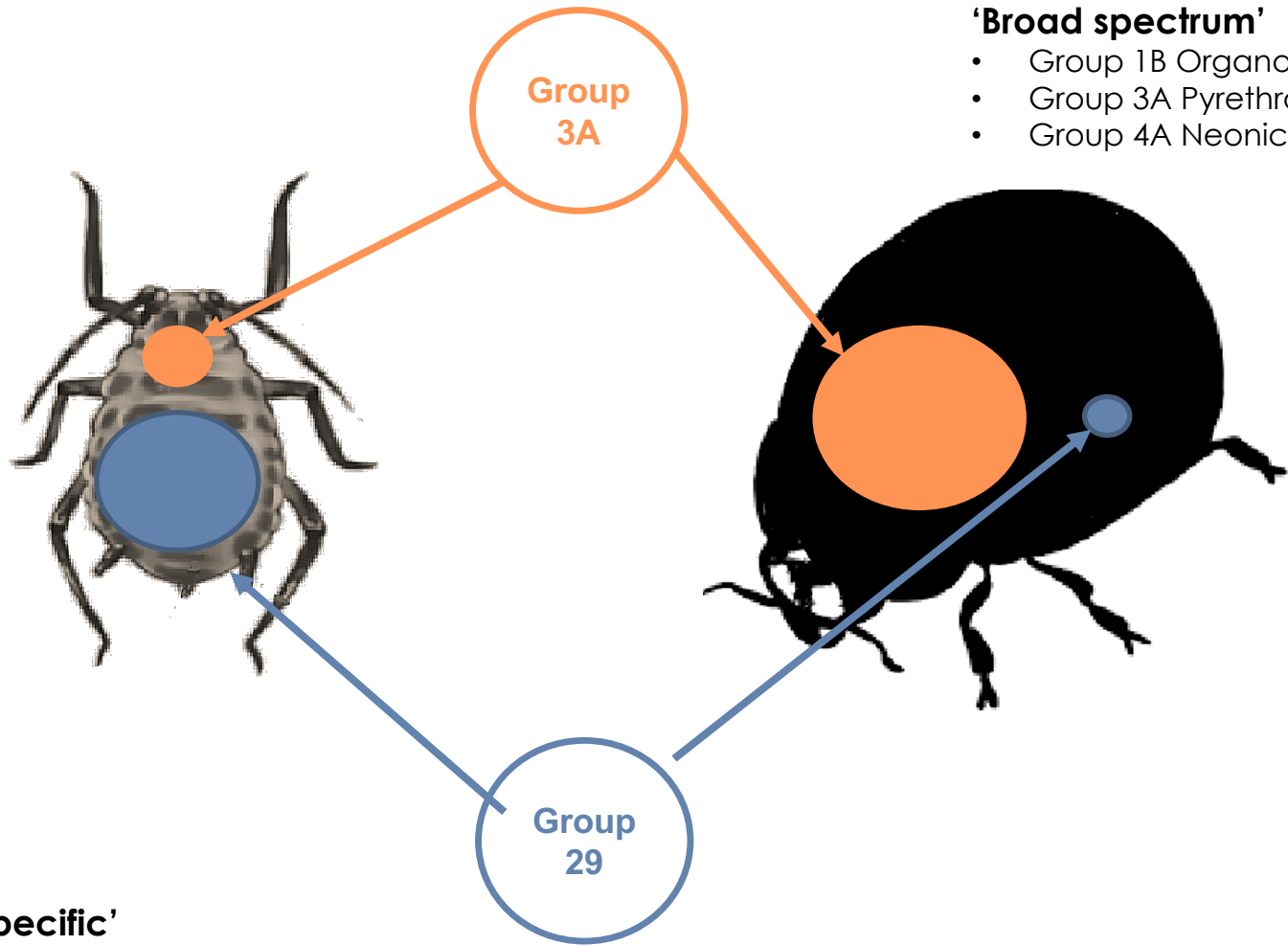


'Broad spectrum'

- Group 1B Organophosphates
- Group 3A Pyrethroids
- Group 4A Neonicotinoids



Pest vs beneficial sensitivity



- 'Broad spectrum'**
- Group 1B Organophosphates
 - Group 3A Pyrethroids
 - Group 4A Neonicotinoids

'Selective/Specific'
e.g. pirimicarb for aphids

Beneficial Insects and chemicals



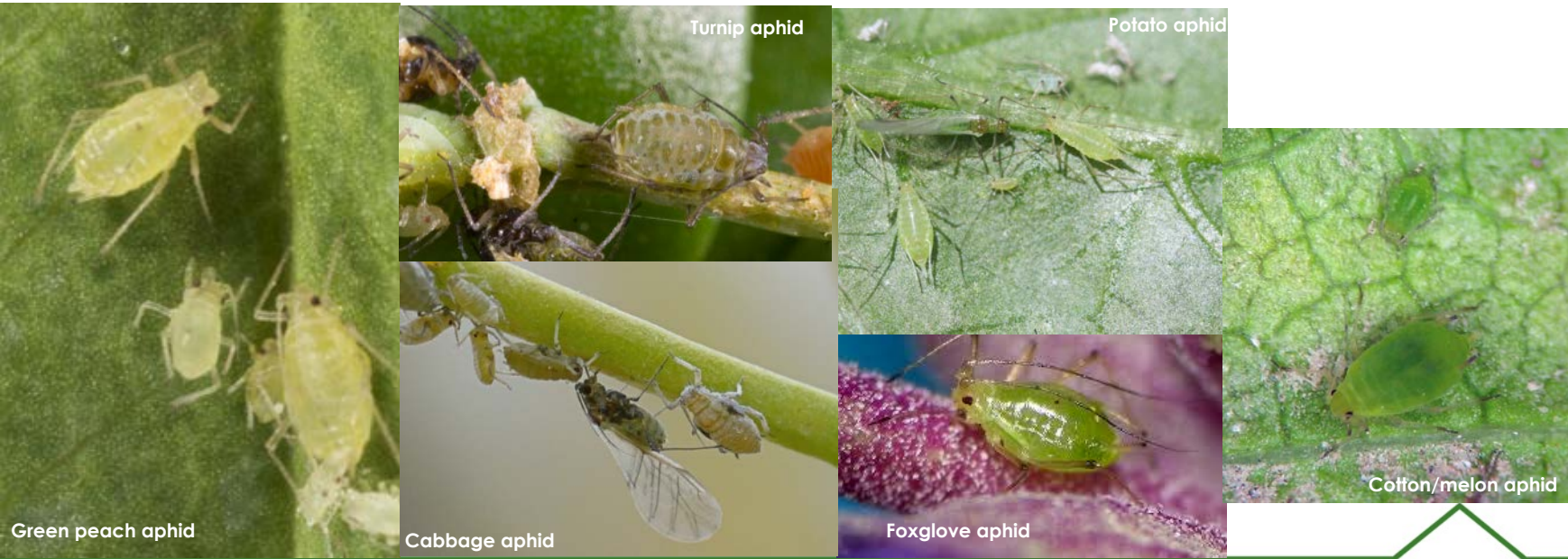
Insecticide	Predatory beetles ¹				Predatory bugs					Predatory mites	Spiders	Hymenoptera (small wasps) ⁶					Lacewing adults	Thrips ⁸	Toxicity to bees ⁹	
	Total ²	Red & Blue beetle	Minute 2-spotted lady beetle	Other lady beetles	Total ³	Damsel bugs	Big-eyed bugs	Other Predatory bugs	Apple Dimpling			Total (wasps)	<i>Eretmocerus</i> ⁷	<i>Encarsia formosa</i>	<i>Trichogramma</i>	<i>Aphytis</i>				<i>Aphidius</i>
Paraffinic Oil	VL	L	L	VL	VL	VL	VL	VL	VL	-	L	VL	-	-	VL	-	-	VL	VL	VL
Petroleum Oil	-	-	-	L	-	-	-	-	-	M	-	-	-	H	-	M	-	-	-	-
Cyantraniliprole	M	M	VL	L	M	M	M	H	L	-	M	VL	L	-	VL	-	-	VH	H	-
Spirotetramat	M	L	H	H	VL	VL	VL	VL	M	-	M	M	L	-	M	-	-	VH	M	-
Pirimicarb	H	VL	VL	L	M	L	M	VL	VL	L	VL	VL	M	H	H	L	L	L	L	VL
Fonicamid	L	VL	VL	VL	H	H	VH	H	H	-	M	M	L	-	H	-	M	L	H	-
Diafenthiuron	M	H	VL	M	L	M	VL	L	H	-	L	L	H	-	L	-	VH	L	L	M
Pymetrozine	M	M	M	M	M	L	L	VL	H	L	L	L	L	M	L	L	M	M	VL	VL
Sulfoxaflor	H	L	M	H	L	VL	L	M	VH	-	L	M	-	-	H	-	-	H	H	-
Chlorantraniliprole / Thiamethoxam	-	-	-	-	-	-	-	-	-	-	-	-	M	-	-	-	-	-	-	-
Imidacloprid (Irrigating)	H ⁴	-	-	-	VH	-	-	-	-	-	-	-	L	-	L	-	L	L	-	-
Acetamiprid	H	M	VH	H	H	M	H	M	VH	-	VL	L	H	-	H	-	H	L	VH	M ¹⁰
Imidacloprid (Spraying)	H	L	VH	H	H	M	H	L	VH	M	L	L	VH	VH	H	H	VH	M	H	M
Thiamethoxam	H	H	H	H	H	M	M	H	H	-	VL	M	M	-	H	-	VH	M	H	H
Organophosphates ⁵	H	M	H	H	H	M	H	H	VH	H	M	H	VH	VH	VH	H	VH	M	H	H
Tau-Fluvalinate	VH	-	-	-	VH	-	-	-	-	-	-	-	VH	-	VH	-	VH	M	-	-
Piperonyl Butoxide / Pyrethrins	VH	-	-	-	VH	-	-	-	VH	-	VH	VH	VH	-	VH	-	VH	H	VH	H
Bifenthrin / Chlorpyrifos	VH	-	-	-	VH	-	-	-	VH	-	VH	VH	VH	-	VH	-	VH	VH	VH	H
Permethrin	VH	-	-	H	VH	-	-	-	VH	H	VH	VH	VH	VH	VH	H	VH	VH	VH	H

Don't spray unless you need to!



Monitoring & Correct ID

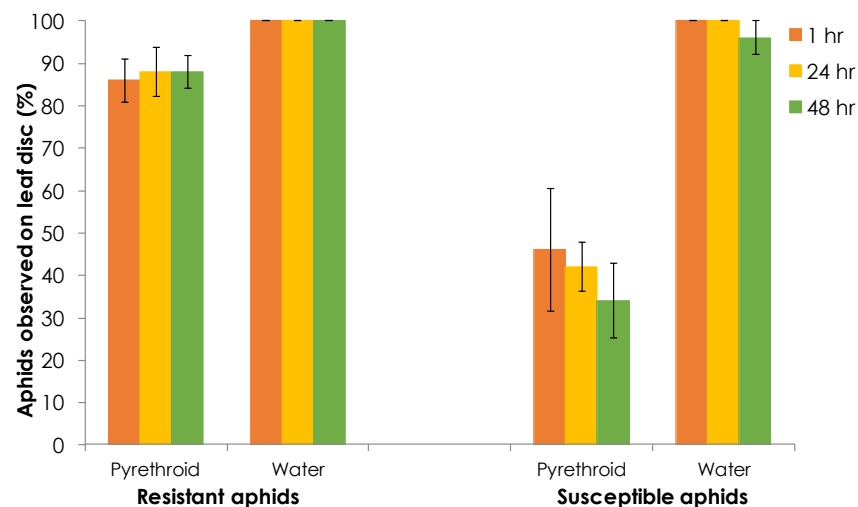
- What?** Do you have a resistant pest or another aphid species
- Where?** Know where to look for the pest in your crop
- When?** Seasonal abundance of the pest
- How?** Yellow sticky traps, hand lens
- Should I Spray?** Check economic thresholds



Non-chemical control methods



- Do not use 'insurance' sprays.
- Plant wind-barriers between crops to avoid wind-assisted pest movement
- Eliminate weed virus hosts
- Change the microclimate – watering & nutrition management



Resources

APVMA PubCRIS database search (<https://portal.apvma.gov.au/pubcris>)

IRAC website (www.irac-online.org)

CropLife (www.croplife.org.au)

www.soilwealth.com.au

www.cesaraustralia.com

<http://horticulture.com.au/resistance-management-strategy-for-the-green-peach-aphid-in-bundaberg-field-vegetable-crops/>

@PestFactscesar 

Veg Pest ID app 



June 2016

Resistance Management Strategy for the green peach aphid in Bundaberg field vegetable crops

sustainability through science and innovation

Key points

- Green peach aphid (GPA) are an important pest of vegetables, causing damage by feeding and transmitting viruses.
- Many chemical groups are registered to control GPA in vegetables. However, only one class (neonicotinoids) is registered for GPA control, and pyrethroids are registered for suppression.
- High levels of resistance to carbamates, pyrethroids and organophosphates are found across Australia. Low levels of resistance to neonicotinoids have also been observed in some GPA populations.
- A strategy to manage insecticide resistance in GPA populations is available for use by vegetable growers in Bundaberg, involving rotating different chemical groups, and using alternative (GPA) methods to reduce pest and virus loads.

Green peach aphids and insecticide resistance

In Australia, the green peach aphid (GPA), *Myndus persicae*, primarily attacks Cruciferae, Solanaceae and Fabaceae crops, as well as being a common pest in bulbocrotch crops (such as carrots and beets). The aphids feed by sucking sap from leaves and flower buds. When populations are large, the crops' entire foliage may be covered, resulting in retarded growth of young plants. GPA can transmit more than 100 plant-invasive viruses at commercial vegetable crops (GPA) and produce crop-specific virus strains.

Outside the range, GPA are not always green in colour, ranging from shades of light and dark green, yellow, grey and red. Scientific studies have shown that there is no difference in the level of insecticide resistance between different colour morphs of GPA. A single genetic lineage or 'clone' of GPA can be made up of both green and red morphs, and the different colour morphs from a single clonal population respond in exactly the same way to insecticides.

The use of chemicals to control GPA in horticulture and vegetable crops continues to grow in Australia, placing strong selection pressure on the development of resistance. As a general principle, the spraying that are chosen of the most resistant individuals can soon dominate a landscape if there is widespread use of the same insecticide across paddocks and farms.

With resistance to these key insecticide groups already established in Australia, and resistance developing to a fourth group, vegetable growers are encouraged to understand how to minimise the further development of resistance.

Colour morphs of green peach aphid
Photo: A. Wess, Cesar



How can I control pests?
Options for controlling high priority pests in peppers

March 2016

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Horticulture Innovation Australia (HIA) and the vegetable industry recommend pesticide registration in organic production and certified as a Strategic Agricultural Resource Process (SAR) in 2014. The SAR process identified chemicals that pose an overall benefit to the organic industry. Against these criteria, available registered pesticide products, along with non-pesticide solutions, were evaluated for overall suitability in terms of integrated Pest Management (IPM), resistance, selection, withholding periods, efficacy, toxic human safety and environmental risks.

The following tables list the high priority pests, and control methods, impacting production of peppers in Australia. Some control options apply only to other exposures or climates, or only to either leaf or protected growing situations. Where this is the case, it is specified.

High Priority Diseases

Disease	IPM in control	Options
Bacterial wilt Bacterial blight Fusarium wilt	Currently registered	• Copper based (Group M1) - effective
	Currently permitted	• Copper based, PEST 400, espouse Sep 2010 - Group M1 - effective
	Non-chemical options	• Manage farm and crop hygiene • Investigate biocontrol agents
Proteus wilt Wound rot	Currently registered	• Other plant defence inducer chemicals (for research only)
	Currently permitted	• Hydroxy benzoic amino acids (PEMTEC-FLUR) - Group M • Penicillium (CONTUL) - Group 7 • Sulphur (Sulphur) - Ineffective • The use of nematode - root wash • Traditional (organic) - Group 3 - effective
Other diseases	Currently permitted	• Substituted (PERSIDOL) - PEST 1400, espouse Sep 2010 - Group 8 - effective
	Currently permitted	• Potassium bicarbonate (Spectra, PEST 300), espouse Aug 2011 - Group M2 - potential situations only
	Non-chemical options	• Dispersant (SULTR, PEST 400), espouse Jan 2010 - Group 17 - potential situations only • None identified

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Thank You



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