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

sustainability through science and innovation

Green peach aphids
Photo: A. Weeks, **cesar**

Key points

- Green peach aphids (GPA) are an important pest of vegetables, causing damage by feeding and transmitting viruses.
- Nine chemical groups are registered to control GPA in vegetables. Botanic oils are also registered for GPA control, and paraffinic oils 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 (IPM) methods to reduce pest and virus loads.

Colour morphs of green peach aphids
Photo: A. Weeks, **cesar**

Green peach aphids and insecticide resistance

In Australia, the green peach aphid (GPA), *Myzus persicae*, primarily attacks Cucurbit, Solenacea and Brassica crops, as well as being a common pest in broadacre crops (such as canola and pulses). The aphids feed by sucking sap from leaves and flower buds. When populations are large, the crop's entire foliage may be covered, resulting in retarded growth of young plants. GPA can transmit more than 100 plant viruses such as cucumber mosaic virus (CMV) and papaya ring spot virus (PRSV).

Despite the name, GPA are not always green in colour, ranging from shades of light and dark green, yellow, pink 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 biotype or 'clone' of GPA can be made up of both green and red morphs; and these different colour morphs from a single clonal population respond in exactly the same way to insecticides.

The use of chemicals to control GPA in horticultural and broadacre crops continues to grow in Australia, placing strong selection pressure on the development of resistance. As aphids produce offspring that are clones of the mother, resistant individuals can soon dominate a landscape if there is widespread use of the same insecticide across paddocks and farms.

With resistance to three 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.

Resistance management and minimization strategy

Chemicals within a specific chemical group usually share a common target site within the pest, and thus share a common mode of action (MoA). There are nine chemical groups registered to control GPA in vegetable crops (see Table 1). Botanic oils are also registered for GPA control, and paraffinic oils are registered for suppression. The basis of this strategy is to minimise the selection pressure for resistance to the same chemical group across consecutive generations of GPA.

In developing this strategy, the latest resistance surveillance results from 2014-2015 have been used. These results show that carbamate (e.g. pirimicarb), pyrethroid (e.g. permethrin) and organophosphate (e.g. dimethoate) resistance are now commonplace across Australia, in both horticultural and grains crops. Resistance to neonicotinoids (e.g. imidacloprid) has recently been confirmed in some vegetable crops.

This strategy has been specifically developed for the Bundaberg vegetable growing region, particularly Cucurbit and Solenacae crops.

Key recommendations to minimize resistance

Rotate chemical compounds from different MoA groups.

Avoid the repeated use of insecticides from the same chemical group, as this will increase selection pressure for resistance development, not only in GPA, but also in other species such as whiteflies and diamondback moths. Table 2 will help guide growers' selection of seasonal control options for GPA in Bundaberg field vegetable crops.

Implement non-chemical control tactics and consider beneficial insects when managing GPA populations.

Table 3 will help guide grower's choice of chemicals given their likely impact on beneficial insects of relevance to vegetable crops.

Other IPM recommendations include:

- assess aphid and beneficial populations over successive checks (note if aphid numbers are trending up or down) to determine if chemical control is warranted, particularly following seedling drenches (which should provide control for 4-6 weeks).
- use economic spray thresholds where available and do not spray if pest pressure is low.
- avoid the use of pyrethroids and organophosphates. There is nation-wide resistance to these chemical groups and their use is likely to be disruptive to beneficial insects and/or flare whitefly populations.
- comply with all directions for use on product labels, and ensure spray rigs are properly calibrated and sprays achieve good coverage, particularly in crops with a bulky canopy.
- do not re-spray a paddock in the same season where a known spray failure has occurred using the same product or another product from the same chemical group.

GPA can carry many different plant viruses. The movement of viruses is difficult to control because transmission by aphids can occur within a very short time period (within a few seconds to minutes once aphids have begun to feed). To minimise the spread of viruses into paddocks, recommendations include:

- do not spray crops 'prophylactically' as insecticidal sprays are generally ineffective in managing non-persistent viruses and may enhance virus spread through increased vector activity.
- be aware of edge effects; aphids can move in from weeds around paddock edges. Where GPA are colonising crop margins and fence-lines, consider a border spray with an insecticide to prevent/delay the build-up of aphids and retain beneficial insects.
- consider planting wind barriers (e.g. sugar cane) around paddocks and plant new crops upwind of old crops, to avoid wind-assisted movement of aphids.
- use reflective mulches to reduce landing rates of winged aphids on crop plants.
- use herbicides or other tactics to eliminate weed hosts for common viruses, such as wild melon, prickly paddy melon, bitter paddy melon (wild gourd) and ivy gourd.
- plant non-virus host cover (or barrier) crops; aphids land on these plants (that don't host the virus) and clean virus particles from their mouthparts whilst probing the plant. It is important to select the cover (or barrier) crop in relation to the expected rotation of crops in neighboring paddocks to prevent other pest and disease build-up.

More Information

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Useful Resources

Science behind the resistance management strategy for the green peach aphid (Myzus persicae) in Bundaberg field vegetable crops – 2016 www.cesaraustralia.com/latest-news/all/RMS-GPA-bundaberg-vegetables

Green peach aphid – Red and green colour morphs www.cesaraustralia.com/latest-news/sustainable-agriculture/insecticide-resistance-in-green-peach-aphids-red-or-green-you-re-asking-the-wrong-question

Green peach aphid – Pestnote www.cesaraustralia.com/sustainable-agriculture/pestnotes/insect/green-peach-aphid

Green peach aphid – Resistance testing service www.cesaraustralia.com/latest-news/all/new-service-to-screen-for-insecticide-resistance-in-aphids

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Horticulture Innovation Australia

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Table 1. Insecticide Resistance Action Committee (IRAC) Mode of Action classification of insecticides, including active ingredients with label claims for GPA in Australian vegetable crops, and example trade names of chemical products.

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

1. Co-formulation containing Group 1B and 3A insecticides
2. Co-formulation containing Group 28 and 4A insecticides

Source: APVMA-PUBCRIS; accessed Feb 2016

Table 2. Chemical control recommendations for GPA in Bundaberg field vegetable crops.

<table>
<tr><th></th><th colspan="4">Spray Windows[1]</th><th>Rationale</th></tr>
<tr><td>Seedling treatment</td><td colspan="4">Neonicotinoids (Group 4A)
used only in seedling drenches and drip irrigation.</td><td>Resistance recently confirmed to neonicotinoid (Group 4A) insecticides in Queensland. Minimising the number of applications will minimise further resistance development and increase the longevity of this chemical group.</td></tr>
<tr><td rowspan="3">Rotate through products for duration of window</td><td>Autumn (Mar—May)</td><td>Winter (Jun—Aug)</td><td>Spring (Sept—Nov)</td><td>Summer (Dec—Feb)</td><td rowspan="3">Winter and Summer spray windows:
Cyantraniliprole is likely to be commonly used in summer to control silverleaf whitefly and western flower thrips.
Use Spirotetramat as the first spray following a seedling treatment, as this chemical is relatively soft on beneficial insects (see Table 3). Cyantraniliprole should not be used as the first spray following a seedling treatment involving Durivo® as this product also contains a Group 28 active ingredient (chlorantraniliprole). Cyantraniliprole should only be used as the first spray following a seedling treatment involving imidacloprid or thiamethoxam.
In non-cucurbit crops, rotate between applications of Spirotetramat and Cyantraniliprole. In cucurbit crops, rotate between applications of Spirotetramat and Flonicamid.

Autumn and Spring spray windows:
Sulfoxalfor is relatively fast acting, and thus has a fit in the spray window with the slower acting product Pymetrozine.
Sulfoxaflor should not be used as the first spray following a seedling treatment due to possible cross-resistance with neonicotinoids (Group 4A).
Rotate between applications of Sulfoxaflor and Pymetrozine during these windows.</td></tr>
<tr><td>Pymetrozine (Group 9C)</td><td>Spirotetramat (Group 23)</td><td>Pymetrozine (Group 9C)</td><td>Spirotetramat (Group 23)</td></tr>
<tr><td>Sulfoxaflor (Group 4C)</td><td>Cyantraniliprole (Group 28) Or Flonicamid (Group 29)</td><td>Sulfoxaflor (Group 4C)</td><td>Cyantraniliprole (Group 28) Or Flonicamid (Group 29)</td></tr>
<tr><td>Clean-up only</td><td colspan="4">Carbamates (Group 1A) - IPM compatible</td><td>Resistance to carbamates (Group 1A) is relatively widespread within Australia and thus the expected field efficacy against GPA is inconsistent. The use of this chemical group is only recommended as a last resort, despite the fact it is soft on beneficial insects.</td></tr>
</table>

1. Botanic oils and paraffinic oils can be used to control GPA at any time.

Table 3: Likely impact of insecticides on beneficial insects of relevance to field vegetable crops.

This information has been collated from the Cotton Pest Management Guide (2015), the BioBest side-effects manual (2015), The Good Bug Book (2002), and through discussion with experts.

The scores indicate a reduction in beneficial species following chemical application: VL (very low) <10%; L (low) 10–20%; M (moderate) 20–40%; H (high) 40–60%; VH (very high) > 60%. '–' indicates no data available for species. Note: the impact of chemicals may differ between crop types.

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)	*Eretmocerus*[7]	*Encarsia formosa*	*Trichogramma*	*Aphytis*	*Aphidius*			
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
Flonicamid	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

1. Toxicity ratings for predatory beetles are for adults only.
2. Total predatory beetles – ladybeetles, red and blue beetles, other predatory beetles.
3. Total predatory bugs – big-eyed bugs, minute pirate bugs, brown smudge bugs, glossy shield bug, predatory shield bug, damsel bug, assassin bug, apple dimpling bug.
4. This rating is for the larval stage of predatory beetles because irrigating affects soil organisms.
5. Organophosphates: diazinon, chlorpyrifos, dimethoate, maldison, methamidophos, omethoate, phorate.
6. Toxicity ratings for hymenoptera are for adults only.
7. Rankings for *Eretmocerus* based on data from Jamie Hopkinson in semi-laboratory replicated experiments (QDAF) and on ranking for *E. mundus* (P. De Barro, CSIRO, unpublished) and for *E. eremicus* (Koppert Biological Systems, The Netherlands http://side-effects.koppert.nl/#).
8. Effects on thrips are for populations found on leaves. This is relevant to seedling crops, where thrips damage leaves, and to mid-late season when thrips adults and larvae help control mites by feeding on them as well as on leaf tissue.
9. Data Source: British Crop Protection Council. 2003. The Pesticide Manual: A World Compendium (Thirteenth Edition). Where LD50 data is not available impacts are based on comments and descriptions. Where LD50 data is available impacts are based on the following scale: very low = LD50 (48h) > 100 ug/bee, low = LD50 (48h) <100 ug/bee, moderate = LD50 (48h) < 10 ug/bee, high = LD50 (48h) < 1 ug/bee, very high = LD50 (48h) < 0.1 ug/bee.
10. Wet residue of these products is toxic to bees, however, applying the products in the early evening when bees are not foraging will allow spray to dry, reducing risk to bees the following day.