



Nursery & Garden Industry  
Australia



# TOMATO POTATO PSYLLID

**Nursery & Garden  
Industry Australia**

Enterprise management plan

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# INTRODUCTION

**Tomato potato psyllid (TPP) is potentially a serious pest for production nurseries due to it being recognised as the vector for transmission of the bacterium *Candidatus Liberibacter solanacearum*\* (CLso). CLso is associated with a range of symptoms which could affect the production and economic performance of your nursery.**

TPP was first detected on mainland Australia in Western Australia (WA) in February 2017. This prompted a comprehensive biosecurity response to minimise the impact of TPP on Australian businesses.

After national agreement TPP could not be eradicated, efforts focussed on developing the science, biosecurity and business systems to improve the capacity of growers and industry to manage TPP.



**ABOVE:** Mature adult TPP in comparison to a 5 cent coin.

An essential component of transition to management is the development and implementation of enterprise management plans for affected industries. The plans outline measures to effectively control TPP and demonstrate industry commitment to minimising its spread and impact. They are critical in supporting ongoing efforts to renew and maintain market access, as well as underpin certification and assurance schemes.

Our aim is to build on current best practice to include the management of TPP, without creating unnecessary additional work.

## **THIS PLAN INCLUDES FIVE KEY COMPONENTS:**

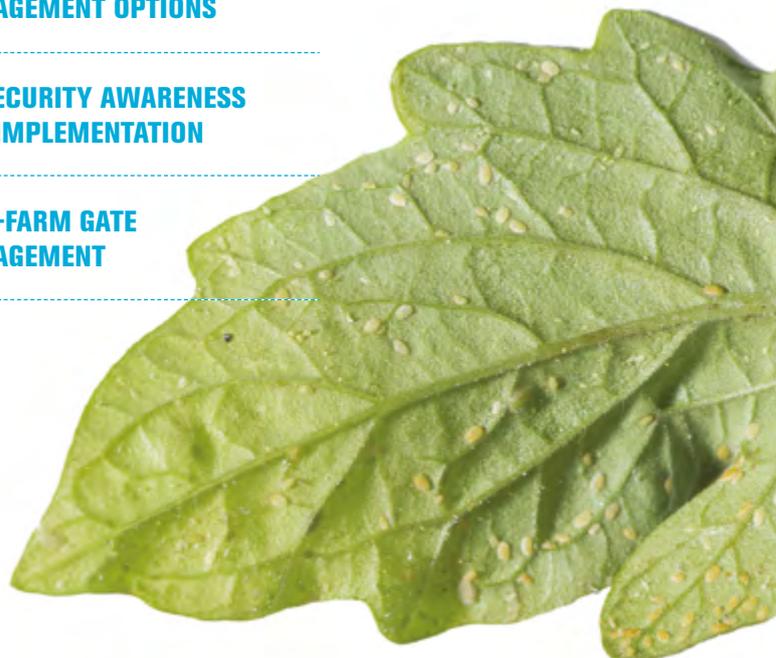
- 1 UNDERSTANDING PEST AND PATHOGEN BIOLOGY AND THEIR IDENTIFICATION**
- 2 IDENTIFYING RISK PATHWAYS**
- 3 APPLYING CONTROL AND MANAGEMENT OPTIONS**
- 4 BIOSECURITY AWARENESS AND IMPLEMENTATION**
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**TPP WAS FIRST DETECTED ON MAINLAND AUSTRALIA IN WESTERN AUSTRALIA IN FEBRUARY 2017.**

*\* As at October 2018, surveillance confirms that CLso is not present in WA*

**BELOW:** TPP nymphs on underside of leaf.



## 1

# UNDERSTANDING PEST AND PATHOGEN BIOLOGY AND THEIR IDENTIFICATION



Egg – less than 1mm long



Nymph – up to 2mm long



Adult – about 3mm long

ABOVE: TPP life stages.

## What is TPP?

TPP (*Bactericera cockerelli*) is a tiny sap-sucking insect which feeds on tomato, potato, capsicum, chilli, tamarillo and sweet potato, and solanaceous weeds like nightshade, leading to loss of plant vigour and yield. The complete host list important to nursery and garden industries includes all solanaceous and convolvulaceae plants. Please see Appendix 1 for a list of hosts.

## TPP life stages

TPP has three stages of development – egg, nymph and adult. Adults and nymphs cause injury to plants by feeding with sucking mouth parts.

- **Adults** resemble a winged aphid and are about 3mm long. The body is brownish and has white or yellowish markings on the thorax and a broad white band on the abdomen. Wings are transparent and rest roof-like over the body.
- **Nymphs** are up to 2mm long, oval shaped, flattened and scale-like in appearance. Young nymphs are yellow with a pair of red eyes and three pairs of short legs. Older nymphs are greenish and fringed with hairs and have visible wing buds.
- **Eggs** are less than 1mm long and are attached to the plant by a short vertical stalk. They are usually laid on the lower surface of leaves or as a halo around the leaf edge. Eggs are white when first laid then turn yellow to orange after a few hours.



## Symptoms of TPP infestation

Symptoms may be difficult to detect in production nurseries due to the quick turn-over of host plants.

Advanced stock of host plants have a higher risk of developing symptoms.

- Look for damage on the underside of leaves.
- Insects jumping from the foliage when disturbed.
- Severe wilting of plants caused by high numbers of psyllids feeding.
- Yellowing of leaf margins and upward curling of the leaves.
- White sugar-like granules (excreted by adults and nymphs), which coat plant leaves and stems, and can lead to the development of sooty mould.
- Ants on plants may be symptomatic of the presence of sugars.
- Stem death symptoms similar to other potato and tomato disorders.

## *Candidatus* Liberibacter Solanacearum\* (CLso)

TPP can carry a bacterium called *Candidatus* Liberibacter solanacearum (CLso) which is associated with a range of symptoms, including the potato disease 'zebra chip'.

TPP not only cause damage to plants through feeding but they can also infect plants with the CLso bacterium which causes disease. It only takes 1–2 hours of feeding on the sap for the psyllid to infect a plant.

### SYMPTOMS OF CLso

Symptoms of the CLso bacterium in the nursery may look similar to other plant conditions. Growers are urged to be vigilant.

- Parts of the plant may die back
- Foliage symptoms include leaves becoming misshapen, pale green or yellow with spiky tips and leaf stalks appear stunted
- Flowers may drop prematurely
- Symptoms vary in severity between cultivars

\* As at October 2018, surveillance confirms that CLso is not present in WA



# IDENTIFYING RISK PATHWAYS



## Where did the pest come from?

TPP was detected in Western Australia for the first time in February 2017, prompting a comprehensive biosecurity response. It had not previously been found on the Australian mainland and the origin of this detection is unknown. TPP is present on Norfolk Island and in other countries including USA, Canada, Central America and New Zealand.

It can spread through the movement of host plant material. It can also disperse through natural pathways such as flight, wind and human – assisted movement (movement of plant material).



**FIGURE 1: Distribution of TPP worldwide**



## What is being done to protect our industry?

A Quarantine Area Notice is currently in effect in and around the Perth metropolitan area to limit the spread of TPP within the state.

In addition, New South Wales, Northern Territory, Queensland, South Australia, Tasmania and Victoria have all applied movement conditions to reduce the risk of TPP spreading interstate.

## 3

## APPLYING CONTROL AND MANAGEMENT OPTIONS

Apply sound crop hygiene/biosecurity practices to prevent the entry, establishment and spread of pests and diseases.

- Check the plants you purchase are free of pests and don't bring infested plants into your property.
- Control host plants in a buffer around your cropping area.
- Regularly monitor your plants for any unfamiliar pests or diseases.



**EARLY DETECTION IS IMPORTANT IN ANY PEST MANAGEMENT SCENARIO.**

### Monitoring for TPP

In addition to looking for symptoms as described earlier, growers should install sticky traps to monitor for TPP. Remember early detection is important in any pest management scenario.

More information about monitoring is available at [nurseryproductionfms.com.au](http://nurseryproductionfms.com.au)

### How many traps do I need on my property?

The number of traps will depend on a range of factors including:

- Are you growing on open fields or shadehouse/greenhouse?
- The host crops you grow and their growth stage.

**TABLE 1: Trap numbers**

Open field/growing beds	
Total area (ha)	No. of traps
<0.5	6
0.5–1	10
1–5	12
5–10	15
>10	20
Greenhouse/polyhouse/glasshouse	
Total area (m <sup>2</sup> )	No. of traps
0–200	1
200–500	2
500–1000	4
1000–5000	6
5000–10000	10

Source: Nursery & Garden Industry Australia



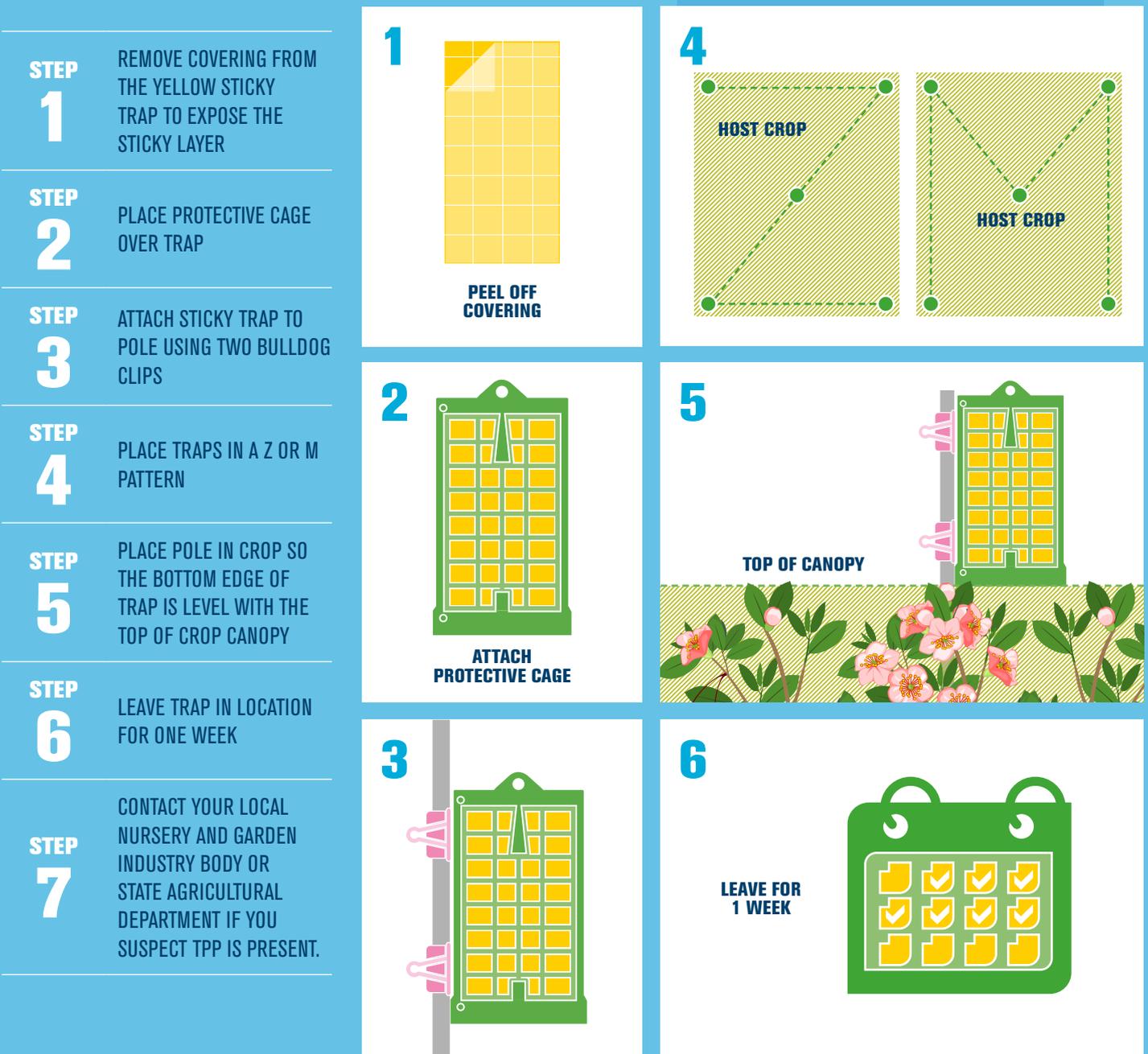


FIGURE 2: How to install sticky traps



**SCIENTIFIC R&D IS CRITICAL TO IMPROVING OUR UNDERSTANDING OF TPP IN AUSTRALIA, AND INCREASING MANAGEMENT OPTIONS AVAILABLE TO GROWERS.**

## Pest thresholds and control

Much of the local research is just beginning, therefore biological control and pest thresholds for TPP in Australia are yet to be defined. Until local trial data is available, current best practice is to monitor and if no TPP is found, continue with your current pest control program.

The Department of Primary Industries and Regional Development (DPIRD) has led a program of R&D as part of the nationally-agreed TPP Transition to management plan. The plan aimed to develop the science, biosecurity and business systems to support growers and industry to manage TPP.

Key research activities and preliminary trial results are provided in a series of factsheets available in the Appendix of this plan.

Note: some insecticides have been made available through emergency permits for use in nursery stock (Table 2).



**ABOVE:** Ladybird feeding on adult TPP.

**TABLE 2:** Available permits for nursery stock. Growers should download the full permit and read in conjunction with the product label before using

Active Action Group	Permit No. Holder Expiry	Crops	Rates	WHP (days)	Location	Comments
<b>Abamectin Contact/ingestion Group 6A</b>	<b>PER84229</b> NSWDPI 28/02/2020	Nursery stock (non-food) (Field and protected cropping systems)	<b>18g/L product:</b> 90mL/100L or 450mL/ha Plus 500mL summer spray oil <b>36g/L product:</b> 45mL/100L or 225mL/ha Plus 500mL summer spray oil	NA	All states	<ul style="list-style-type: none"> <li>DO NOT apply more than two (2) applications per crop</li> <li>Apply with a minimum re-treatment interval of 7–10 days</li> </ul>
<b>Bifenthrin Contact/ingestion Group 3</b>	<b>PER84229</b> NSWDPI 28/02/2020	Nursery stock (non-food) (Field ONLY)	<b>100g/L product:</b> 80mL/100L or 800mL/ha <b>250g/L product:</b> 32mL/100L or 320mL/ha	NA	All states	<ul style="list-style-type: none"> <li>DO NOT apply more than two (2) applications per crop</li> <li>Apply with a minimum re-treatment interval of 14–20 days</li> </ul>
<b>Methomyl Contact/ingestion Group 1</b>	<b>PER84229</b> NSWDPI 28/02/2020	Nursery stock (non-food) (Field ONLY)	<b>225g/L product:</b> 200mL/100L or 2L/ha	NA	All states	<ul style="list-style-type: none"> <li>Apply with a minimum re-treatment interval of 7–10 days</li> </ul>

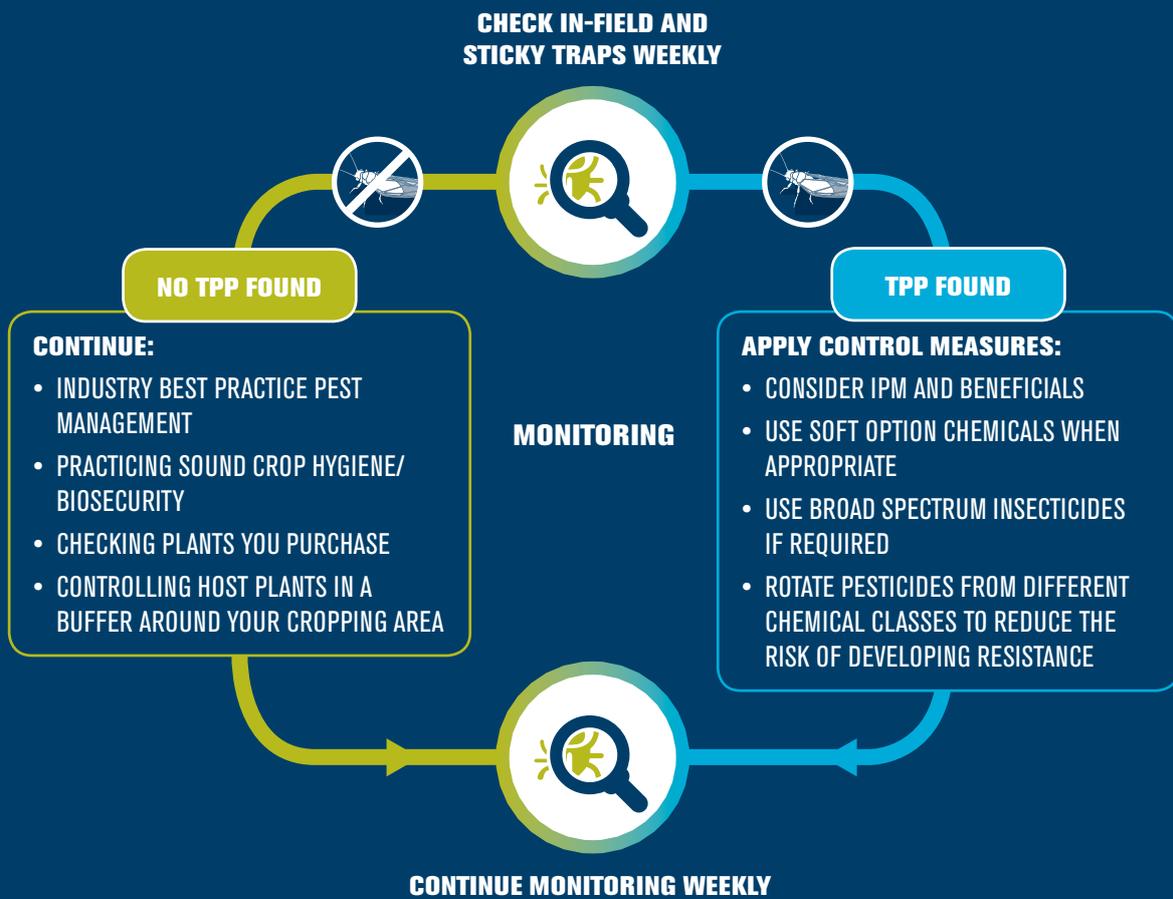


FIGURE 2: TPP action plan

## 4

## BIOSECURITY AWARENESS AND IMPLEMENTATION

The nursery industry has developed robust guidelines that enable businesses to identify and mitigate biosecurity risks.

Training staff is very important as the first defence to ensure your business is protected. The Nursery Production FMS website has valuable information and videos you can access to help you with raising awareness of the biosecurity issues and threats your business could face.

The NIASA, EcoHort and BioSecure HACCP accreditation programs are an important resource you can use to implement strategies that address biosecurity risks. You can access the guidelines to these important accreditation schemes via the website <http://nurseryproductionfms.com.au/>

Below is a generic biosecurity health checklist you can use as the first step to safeguard your business.

**TABLE 2: Generic farm biosecurity health check**

Biosecurity practice	In place	In progress	No	N/A
Customers have a dedicated parking area away from production areas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A visitors register is maintained	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
An inspection process is in place for any vehicle entering your production area	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Growing media is sourced from an accredited supplier	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Growing media is stored correctly to ensure no contamination	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
New containers and trays are stored correctly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Containers and trays that are recycled have been cleaned and stored correctly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Plant material used in your production facility is from an accredited supplier or source	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A suitable quarantine site has been allocated for plant imports	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Staff are trained in pest and disease identification	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Staff are trained in effective monitoring techniques	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Staff are trained in effective biosecurity protocols	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Regular crop monitoring for pest and diseases is recorded	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Regular sticky trap placement, inspection and recording	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Regular onsite monitoring for pest and diseases is recorded	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Regular perimeter monitoring for pest and disease is recorded	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Regular disinfestation of working surfaces. i.e. benches, tools and machinery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fertiliser and chemicals are stored correctly to ensure no contamination	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Water tested regularly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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# POST FARM GATE MANAGEMENT

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Growers must be aware of their status with regard to TPP. While TPP had been detected in parts of Western Australia, CLSo had not been detected.

## Interstate movement

Australia's states and territories can apply movement conditions to material that could pose a quarantine risk to their state/territory. These conditions may apply to the movement of fruit, vegetables, nursery stock, flowers, plants, and seeds, or other risk pathways such as soil, timber, vehicles and machinery.

Movement conditions are applied to manage the quarantine risk of any pests and diseases that may be present on the produce. They can include specified treatments (e.g. washing procedures or chemical treatments), inspection of produce, state or area freedom certification, or other requirements. If a suitable treatment is not available, produce may be prohibited entry into that state or territory.

When exporting quarantine risk material to another state or territory, it is the responsibility of the exporter to ensure they have met the movement conditions of the jurisdiction they are exporting to. If you intend to move produce into more than one state or territory, you must check the movement conditions for each.

Interstate movement conditions change regularly. Please check the latest relevant jurisdictions plant material and produce requirements.

Contact details and links to websites are provided on the Australian Interstate Quarantine plant quarantine regulator contacts page: [www.interstatequarantine.org.au/producers/committees/quarantine-regulators/](http://www.interstatequarantine.org.au/producers/committees/quarantine-regulators/)

## TPP Quarantine Area in Western Australia

A Quarantine Area is in place to direct the movement and treatment of host plants within WA.

Prescribed treatment is required for host plants, such as seedlings or nursery stock, where they are moving from the Quarantine Area to specified local government areas in WA.

Growers should be familiar with the prescribed treatments outlined in the Quarantine Area Notice.

For full details including the published Quarantine Area Notice, additional treatment options and a list of areas in the Quarantine Area and specified local government areas, please visit [www.agric.wa.gov.au/tpp/tpp-quarantine-area](http://www.agric.wa.gov.au/tpp/tpp-quarantine-area)



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**INTERSTATE MOVEMENT  
CONDITIONS CHANGE REGULARLY.  
PLEASE CHECK THE LATEST  
RELEVANT JURISDICTIONS  
PLANT MATERIAL AND PRODUCE  
REQUIREMENTS.**

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# APPENDIX 1 – Host list

Appendix 1: Host plants of TPP with a Reliability Index showing the quality of evidence for the host association

Common name(s)	Scientific name	Reliability Index	Status in Australia
<b>Family Convolvulaceae</b>			
Sweet potato, kumara	<i>Ipomoea batatas</i> (L.) Lam.	10	Cultivated (commercial, domestic)
Field bindweed, wild morning glory	<i>Convolvulus arvensis</i>	10	Trailing plant, up to 2m long, weed
<b>Family Solanaceae</b>			
African boxthorn, Boxthorn	<i>Lycium ferocissimum</i> Miers	10	Spiny shrub 0.5–2.5m, weed in some areas of Australia
Apple of Peru, Peru apple, Chinese lantern	<i>Nicandra physalodes</i> (L.) Gaertn.	10	Shrub to 1m, environmental weed
Black nightshade, nightshade, tomato bush, potato bush, garden nightshade*	<i>Solanum nigrum</i> L.	3	Shrub to 1m, weed in Australasia
Christmas cherry, Jerusalem cherry, Madeira winter cherry, capsicum weed, false capsicum*	<i>Solanum pseudocapsicum</i> L.	3	Shrub to 2m, widely naturalised in southern and eastern Australia, grown as a decorative shrub in some areas, weed
Cape gooseberry, Inca berry	<i>Physalis peruviana</i> L.	10	Shrub to 1.6m, cultivated (domestic)
Capsicum (green, red, sweet bell etc)	<i>Capsicum annum</i> L.	10	Cultivated (commercial, domestic)
Chilli	<i>Capsicum frutescens</i> L.	10	Cultivated (commercial, domestic)
Chinese boxthorn, wolfberry	<i>Lycium barbarum</i> L.	10	Spiny shrub 0.8–2m, occurs in Australia
Common thornapple, Jimsons weed, Thornapple	<i>Datura stramonium</i> L.	10	Shrub up to 1.5m, weed
Egg plant	<i>Solanum melongena</i> L.	5	Cultivated crop (commercial, domestic)
Kangaroo apple, Pōpopo, Poroporo, NZ nightshade	<i>Solanum aviculare</i> G.Forster	10	Shrub to 4m, native to Australia, NZ and Papua New Guinea
Kangaroo apple, Poroporo	<i>Solanum laciniatum</i> Aiton	10	Shrub to 3m native to south-eastern Australia, NZ
Maori potato	<i>Solanum tuberosum</i> ssp. <i>andigena</i> and ssp. <i>tuberosum</i> L.	10	Cultivated in NZ
Potato	<i>Solanum tuberosum</i> L.	10	Cultivated (commercial, domestic)
Tamarillo, Tree tomato	<i>Solanum betaceum</i> Cav.	10	Small tree, cultivated (domestic)
Tobacco	<i>Nicotiana tabacum</i> L.	10	Cultivated
Tomato, cherry tomato	<i>Solanum lycopersicum</i> L.	10	Cultivated (commercial, domestic)
Wild tobacco tree	<i>Solanum mauritianum</i> L.	10	Shrub-small tree, 1.5–4m tall; environmental weed some areas

(10 = high, 3 = partial host).

\* Noted that TPP failed to develop in greenhouse in NZ.

# APPENDIX 2 – Preliminary results



## Tomato potato psyllid

### Research and development preliminary results

#### Factsheet



#### About Tomato potato psyllid (TPP)

Tomato potato psyllid (*Bactericera cockerelli*) was detected in Perth, Western Australia in February 2017.

TPP is a tiny sap-sucking insect which attacks a range of cultivated crops in the Solanaceae family including potato, tomato, eggplant, capsicum, chilli and tamarillo and weeds such as nightshade.

TPP damages plants by directly feeding on fruits with attached green material and leaves, and causes the disease psyllid yellows which can result in yellowing and stunting in tomato and potato plants.

TPP has also been identified as the vector of *Candidatus Liberibacter solanacearum* (CLso), the putative causal agent of Zebra Chip disease in potato. CLso has not been detected in Australia.



© Whitney Cranshaw, Colorado State University

#### TPP research and development

The Western Australian Department of Primary Industries and Regional Development (DPIRD) has completed a series of laboratory and glasshouse trials on the performance of insecticides and Biological Control Agents (BCA) on TPP.

An overview of preliminary trial results are outlined in this factsheet. Further research results are available in the TPP biological control and chemical control factsheets.



© DPIRD

L-R: Tomato potato psyllid adults and nymphs on the back of a leaf. Mature adult TPP in comparison to a 5 cent coin.

## APPENDIX 2 – Preliminary results (cont.)

### 2

Tomato potato psyllid  
Research and development preliminary results



**An Integrated Pest Management strategy (IPM) is recommended for the effective control of TPP.**

#### What is IPM?

IPM is an approach to crop production and protection that combines the use of insecticides with other management techniques including chemical control, biological control, cultural control and physical control.

IPM provides benefits such as reduced risk of pesticide contamination, decreased production costs, reduced risk of insecticide resistance and helps preserve naturally occurring beneficials.

### Monitoring and treatment decisions

- Yellow sticky traps placed at field edges near the tops of plants can be used as an indicator of psyllid movement in areas where TPP occurs.
- If adults are caught on traps, the leaves of host plants on the field edges should be examined for eggs and nymphs.
- If all life stages are present, an insecticide treatment may be warranted.
- It is recommended growers select insecticides that are compatible for use in IPM programs.
- To prevent insecticide resistance from developing in TPP populations, insecticides from different chemical classes need to be used in rotation.
- Growers should contact their chemical advisors to talk through an appropriate Insecticide Resistance Management strategy for their business.
- Insecticides are only effective against TPP and do not prevent the spread of the CLso bacterium.



## Preliminary research and development results

### Biological control

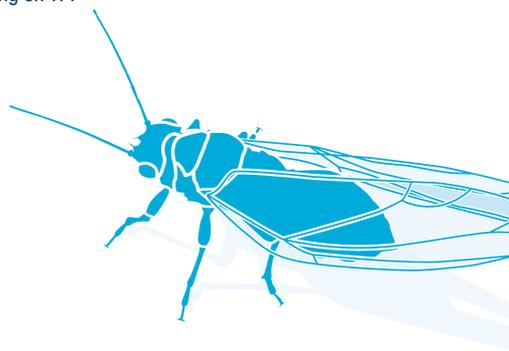
- In laboratory and glasshouse trials, several commercially-available BCA's were assessed for their performance against TPP in tomato, capsicum and potato.
- All BCAs tested are generalist predators and occur naturally in some commercial crops and regions.
- The efficiency of predators against TPP varied with host crop type.
- In laboratory trials, adult ladybird beetles *Harmonia conformis*, *Cryptolaemus montrouzieri*, and the larval stage of the green lacewing (*Mallada signata*), were most efficient predators of TPP in tomato, capsicum and potato.
- On capsicum, ladybird beetle species *H. variegata*, *H. octomaculata* and *Chilocorus circumdatus* were also effective predators of TPP.
- Three releases (at 21 day intervals) of the mirid bug *Nesidiocoris tenuis* effectively suppressed TPP populations in a glasshouse trial in tomato.



**Figure 1.** Most efficient predators of TPP in tomato, capsicum and potato, in laboratory trials: (A) *H. conformis* feeding on TPP eggs and foraging on capsicum leaf. (B) *C. montrouzieri* feeding on TPP nymph. (C) *M. signata* larva.

### Chemical control

- Thirty insecticides from 11 chemical classes have been identified for use in Australia.
- These chemicals are registered in Australia for use against other sucking insect pests, but not currently registered for control of TPP. *Please note: some insecticides have been made available through emergency permits for use in host crops and nursery stock.*
- Resistance to imidacloprid, a neonicotinoid, and abamectin has been observed in populations of TPP in Texas and Mexico. However, resistance to these insecticides was not observed in laboratory and glasshouse trials in WA.
- Insecticides are only effective against TPP and do not prevent the spread of the CLso bacterium, associated with TPP in other parts of the world.



## APPENDIX 2 – Preliminary results (cont.)

## 4

Tomato potato psyllid  
Research and development preliminary results*Insecticide toxicity —  
laboratory trials*

- The toxicity of 15 pre-harvest insecticides with various modes of action were screened in capsicum, tomato and potato.
- Abamectin, spinetoram, methidathion, methomyl, chlorpyrifos, cyantraniliprole, DC-164 (experimental chemical) and sulfoxaflor caused 100% mortality to all life stages of TPP.
- Imidacloprid applied as a soil drench was toxic to TPP life stages causing significant mortality for up to 10 days post-drenching.

*Insecticide efficacy —  
glasshouse trials*

- In the glasshouse trial, three applications (at 21 day intervals) of abamectin, cyantraniliprole, and spirotetramat in capsicum, tomato and potato, and flonicamid in tomato, effectively suppressed TPP populations.
- Pymetrozine failed to suppress TPP populations in glasshouse trials in capsicum, tomato and potato.

*Organically acceptable  
alternatives*

- Azadirachtin, eco-oil, agri-50 and paraffinic oil were evaluated against TPP eggs, nymphs and adults.
- In lab trials, all plant-based derivatives (azadirachtin, eco-oil, agri-50 and paraffinic oil) were least toxic to TPP mature nymphs (3rd – 5th instar).
- Azadirachtin was very toxic to TPP adults. Paraffinic oil, agri-50 and eco-oil in potato and capsicum were less toxic to TPP adults.
- Egg laying was observed with azadirachtin, agri-50, eco-oil, and paraffinic oil, though none hatched after 7 days.
- Of 13 chemicals tested against eggs, hatching was observed with spirotetramat, abamectin, methomyl, chlorpyrifos, eco-oil, paraffinic oil and azadirachtin, but none developed to adult.



**SCIENTIFIC R&D IS CRITICAL TO IMPROVING OUR UNDERSTANDING OF TPP IN AUSTRALIA AND INCREASING MANAGEMENT OPTIONS AVAILABLE TO GROWERS.**

**Transition to  
management**

TPP was detected in Western Australia in February 2017, prompting a comprehensive biosecurity response.

Following national agreement TPP could not be eradicated, a Transition to management plan was developed which aimed to improve the capacity of industry and growers to manage this pest and build confidence around the status of the CLso bacterium.

The TPP R&D program was a major component of the Transition to management plan.



Visit [agric.wa.gov.au/tpp](http://agric.wa.gov.au/tpp) for more information on the signs and symptoms of TPP.

This factsheet is an initiative of the national TPP Transition to Management Plan.

**Important disclaimer:** The Chief Executive Officer of the Department of Primary Industries and Regional Development (DPIRD) and the State of Western Australia accept no liability whatsoever by reason of negligence or otherwise arising from the use or release of this information or any part of it.

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**STOP.  
CHECK.  
PROTECT.**

Help limit the spread of the Tomato potato psyllid

[agric.wa.gov.au/tpp](http://agric.wa.gov.au/tpp)

# APPENDIX 3 – Biological control results



## Tomato potato psyllid



## Biological control results

### Factsheet

### About Tomato potato psyllid (TPP)

Tomato potato psyllid (*Bactericera cockerelli*) is a tiny sap-sucking insect which attacks a range of cultivated crops in the Solanaceae family including potato, tomato, eggplant, capsicum, chilli and tamarillo and weeds such as nightshade.

TPP damages plants by directly feeding on fruits with attached green material and leaves, and causes the disease psyllid yellows which can result in yellowing and stunting in tomato and potato plants.

TPP has also been identified as the vector of *Candidatus Liberibacter solanacearum* (CLso), the putative causal agent of Zebra Chip disease in potato. CLso has not been detected in Australia.

An Integrated Pest Management strategy (IPM) is recommended for the effective control of TPP.



### TPP research and development

The Western Australian Department of Primary Industries and Regional Development (DPIRD) has completed a series of laboratory and glasshouse trials on the performance of insecticides and Biological Control Agents (BCA) on TPP.

Preliminary results of biological control trials are outlined in this factsheet.



L-R: Tomato potato psyllid adults and nymphs on the back of a leaf.  
Mature adult TPP in comparison to a 5 cent coin.

## APPENDIX 3 – Biological control results (cont.)

Tomato potato psyllid  
Biological control results

### Biological control

Several commercially available beneficial insects have been identified for potential use in biological control of TPP. There were significant differences in TPP consumption between BCAs tested.

To preserve beneficials, it is recommended that growers select insecticides that are compatible for use in IPM programs.

#### Predators

Several species of generalist predators including lacewings, ladybirds, mirid bugs, hoverflies and predatory mites feed on nymphs and adult TPP (Table 1).

All predators feed on a range of crop pests and are naturally occurring in some areas in Australia.

#### Lacewings

Larvae of the brown lacewing, *Micromus tasmaniae*, feed on all stages of the psyllid and occur naturally in field crops in Australia. In New Zealand, *M. tasmaniae* has been reported to feed on TPP in unsprayed potato crops.

The larvae of the green lacewing, *Mallada signata* are predators of aphids, moth eggs and small larvae, scales and whiteflies. In laboratory experiments, late instar larvae and adults consumed all life-stages of TPP.

Nymphs appeared to be more efficient consumers of TPP than adults.



**Figure 1.** Green lacewing, *M. signata* (A) larva and (B) adult. (C) *N. tenuis* nymph and (D) *N. tenuis* adult. (E) *O. tantillus* nymph and (F) *O. tantillus* adult.

#### True Bugs

*Nesidiocoris tenuis* is a natural enemy of whiteflies, moth eggs and small grubs. The minute pirate bug *Orius tantillus* and *N. tenuis* are both used for control of thrips and whitefly species in greenhouse crops.

Lab experiments showed that they predated on TPP, though were not as voracious as some lady beetle species and green lacewing.

#### Parasitoids

*Tamarixia triozae* parasitises late instars of TPP and has been imported into New Zealand for further evaluation.

In Australia, no parasitoids are commercially available for the control of TPP. However, Australia is regarded to be a 'hotspot' of psyllid diversity and it is possible that naturally occurring parasitoids are present.

**Table 1:** A list of potential candidate BCAs present in Australia.

Scientific name	Common name	Classification	Present in Australia
<i>Typhlodromalus limonicus</i> (Garman & McGregor)	Mite	Acari: Mesostigmata: Phytoseiidae	Unknown
<i>Chilocorus circumdatus</i> * Gyllenhal	Red Chilocorus	Coleoptera: Coccinellidae	Commercially available
<i>Coccinella transversalis</i> * Fabricius	Transverse ladybird	Coleoptera: Coccinellidae	Commercially available, naturally occurring
<i>Cryptolaemus montrouzieri</i> * Mulsant	Mealybug ladybird	Coleoptera: Coccinellidae	Native, commercially available
<i>Harmonia conformis</i> * (Boisduval)	Large spotted ladybird	Coleoptera: Coccinellidae	Native; commercially available
<i>Harmonia octomaculata</i> * (Fabricius)	Spotted ladybird	Coleoptera: Coccinellidae	Commercially available
<i>Hippodamia variegata</i> * (Goeze)	Adonis ladybird	Coleoptera: Coccinellidae	Commercially available
<i>Adalia bipunctata</i> (L.)	Two-spotted ladybird	Coleoptera: Coccinellidae	Native to North America; naturalized in Australia
<i>Cleobora mellyi</i> (Mulsant)	Southern ladybird	Coleoptera: Coccinellidae	Native, wide spread in Australia
<i>Coccinella undecimpunctata</i> L.	Eleven-spotted ladybird	Coleoptera: Coccinellidae	Native to northern hemisphere; naturalized in Australia & New Zealand
<i>Halmus chalybeus</i> (Boisduval)	Steel-blue ladybird	Coleoptera: Coccinellidae	Native
<i>Scymnus loewii</i> Mulsant	Loew's ladybeetle	Coleoptera: Coccinellidae	Unknown
<i>Melanostoma fasciatum</i> (Macquart)	Small hoverfly (Fly)	Diptera: Syrphidae	Native
<i>Orius armatus</i> * Gross	Minute pirate bug	Hemiptera: Anthocoridae	Native, Commercially available
<i>Orius tantillus</i> * (Motschulsky)	Flower bug	Hemiptera: Anthocoridae	Native, Commercially available
<i>Nesidocoris tenuis</i> * Reuter	Mirid bug	Hemiptera: Miridae	Commercially available
<i>Nabis kinbergii</i> Reuter	Pacific damsel bug	Hemiptera: Nabidae	Native
<i>Mallada signata</i> * (Schneider)	Green lacewing	Neuroptera: Chrysopidae	Native, commercially available
<i>Micromus tasmaniae</i> * (Walker)	Brown lacewing	Neuroptera: Hemerobiidae	Native
<i>Drepanacra binocula</i> (Newman)	Hook-tipped brown lacewing	Neuroptera: Hemerobiidae	Native

\* Indicates potential biological control agents present in Australia (preliminary laboratory and glasshouse study under TPP Transition to management program).

## APPENDIX 3 – Biological control results (cont.)

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Tomato potato psyllid  
Biological control results

**Figure 2.** Adult ladybird beetles: (A) *H. octomaculata*, (B) *H. variegata* feeding on TPP nymph (C) *H. conformis* feeding on TPP eggs and foraging on capsicum leaf, (D) *C. circumdatus* feeding on TPP nymph, (E) *C. montrouzieri* feeding of TPP nymphs and (F). *C. transversalis* feeding on TPP nymph.

#### Ladybird beetles (Coleoptera: Coccinellidae)

Several species of commercially available ladybird fed on TPP adults and nymphs in lab experiments.

The large spotted ladybird *Harmonia conformis* and the mealybug ladybird *Cryptolaemus montrouzieri* were effective predators of TPP in capsicum, tomato and potato.

In addition *Hippodamia variegata*, *Harmonia octomaculata* and *Chilocorus circumdatus* also fed on TPP.



Visit [agric.wa.gov.au/tpp](http://agric.wa.gov.au/tpp) for more information on the signs and symptoms of TPP.

This factsheet is an initiative of the national TPP Transition to Management Plan.

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**SCIENTIFIC R&D IS CRITICAL TO IMPROVING OUR UNDERSTANDING OF TPP IN AUSTRALIA AND INCREASING MANAGEMENT OPTIONS AVAILABLE TO GROWERS.**

#### Transition to management

TPP was detected in Western Australia in February 2017, prompting a comprehensive biosecurity response.

Following national agreement TPP could not be eradicated, a Transition to management plan was developed which aimed to improve the capacity of industry and growers to manage this pest and build confidence around the status of the bacterium *Candidatus Liberibacter solanacearum* (CLso).

The TPP R&D program was a major component of the Transition to management plan.



Help limit the spread of the Tomato potato psyllid

[agric.wa.gov.au/tpp](http://agric.wa.gov.au/tpp)

# APPENDIX 4 – Chemical control results



## Tomato potato psyllid



## Chemical control results

### Factsheet

### About Tomato potato psyllid (TPP)

Tomato potato psyllid (*Bactericera cockerelli*) is a tiny sap-sucking insect which attacks a range of cultivated crops in the Solanaceae family including potato, tomato, eggplant, capsicum, chilli and tamarillo and weeds such as nightshade.

TPP damages plants by directly feeding on fruits with attached green material and leaves, and causes the disease psyllid yellows which can result in yellowing and stunting in tomato and potato plants.

TPP has also been identified as the vector of *Candidatus Liberibacter solanacearum* (CLso), the putative causal agent of Zebra Chip disease in potato. CLso has not been detected in Australia.



### Chemical control

- In the USA, Mexico and NZ, chemical control is the most widely used technique to manage TPP/CLso.
- While conventional pesticides (all active ingredients other than biological pesticides and antimicrobial pesticides) may not kill TPP quickly enough to prevent CLso transmission, they may be useful for reducing the overall TPP population.
- A list of insecticides from different chemical classes have been identified for use in Australia, though are not currently registered specifically for control of TPP (Table 1). Note: some insecticides have been made available through emergency permits for use in host crops and nursery stock.

Continued on page 4

### TPP research and development

The Western Australian Department of Primary Industries and Regional Development has completed a series of laboratory and glasshouse trials on the performance of insecticides and Biological Control Agents (BCA) on TPP.

Further research is needed to validate preliminary findings and support registration of insecticides for control of TPP by the Agricultural Pesticides and Veterinary Medicines Authority.

## APPENDIX 4 – Chemical control results (cont.)

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Tomato potato psyllid  
Chemical control results**Table 1:** Insecticides with potential use against TPP. Refer to the legend below this table for further information on toxicity ratings.

Active ingredient (trade name)	Product mode of action
Methomyl 225g/L (e.g. Lannate)	1A; Acetylcholinesterase (AChE) inhibitors
Oxamyl (Vydate L)	1A, AChE inhibitors
Methidathion 400g/L (e.g. Suprathion)	1B; AChE inhibitors
Chlorpyrifos 500g/L (Chlorpyrifos 500EC)	1B; Anti-cholinesterase compound
Alpha-cypermethrin 100g/L–250g/L (e.g. Alpha 100 Duo, Nufarm Astound Duo, BASF Fastac)	3A; Synthetic pyrethroids
Bifenthrin 250g/L (e.g. Bifenthrin 250EC; Astral™ 250EC)	3A; Synthetic pyrethroids
Deltamethrin 27.5g/L (e.g. Cropro D-sect, Decis, Deltamethrin Duo)	3A; Synthetic pyrethroids
Lambda-cyhalothrin 250g/L (e.g. Karate Zeon®)	3A; Synthetic pyrethroids
Taufluvalinate 240g/L (e.g. Mavrik®, Klartan®)	3A; Synthetic pyrethroids
Deltamethrin 20g/L and thiacloprid 150g/L (Proteus®)	3A/4A; synthetic pyrethroid, noenicitinoid
Imidacloprid 200g/L (e.g. Confidor® 200SC, Imidacloprid 200SC)	4A; NACHR competitive modulator
Sulfoxaflor 240g/L (Transform™)	4C; NACHR competitive modulators
Spinetoram 120g/L (Success Neo™)	5; NACHR allosteric modulators
Abamectin 18g/L (e.g. Vertimec®)	6; Avermectins; Chloride channel activation
Pymetrozine	9B; Chordotonal organ TRPV channel modulators
Flonicamid 500g/kg (Mainman®)	9C; Chordotonal organ modulators — undefined target site
Buprofezin (Applaud®)	16; Inhibitors of chitin biosynthesis, type 1
Spirotetramat 240g/L (Movento 240SC)	23; Acetyl choline esterase carboxylase inhibition
Cyantraniliprole 100g/L (Benevia®)	28; Ryanodine receptor modulator
Agri-50NF	UN; MoA unknown; derived from plant extracts
Azadirachtin 10g/L (AzaMax™)	UN; uncertain MoA unknown
Emulsifiable botanical oils 850g/L (Eco-Oil®)	UN; MoA unknown
Paraffinic oil 815 g/L (Socoa BioPest)	UN; blocks spiracles; inhibits feeding

**Toxicity rating to TPP**

■ Low <25%; ■ Slightly toxic 26–50%; ■ Moderately toxic 51–74%; ■ Highly toxic >75%

↓ decreases egg laying; <sup>1</sup> up to 7 DAT; <sup>2</sup> up to 14 DAT

\* toxic to beneficials, but has a short residual life

Tomato potato psyllid  
Chemical control results

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Registered use	Eggs	Nymphs	Adults	Translaminar activity	IPM compatible
Tomato, capsicum				N	N
Capsicum, sweet potato, tomato	Unknown			N	N
Fruits, vegetables				N	N
Fruits, vegetables				N	N
Tomato			Unknown	N	N
Tomato, capsicum			Unknown	N	N
Outdoor tomato, sweet potato			Unknown	N	N
Tomato, potato			Unknown	N	N
Tomato			Unknown	N	N
Potato	↓ <sup>1</sup>	Unknown		N	N
Vegetables				Y	N
Fruits, vegetables	↓ <sup>1</sup>			Y	Y (may be toxic to parasitic wasps)
Vegetables, ornamentals	↓ <sup>1</sup>			Y	?
Fruits, vegetables	↓			Y	N
Capsicum, eggplant, potato, tomato	↓		Unknown	Y	Y (although may not be compatible with predatory bugs and mites)
Potatoes				Y	Y
Tomato, capsicum	Unknown		Unknown	N	Y (slightly toxic to parasitic wasp; highly toxic to some lady beetles species)
Vegetables	↓ <sup>2</sup>			Y	Y
Potato, field tomatoes	↓ <sup>2</sup>			Y	Y
Fruits, vegetables				N	Y
Fruits, vegetables				N	Y
Vegetables, ornamentals		?		N	*
Fruits				N	*

## APPENDIX 4 – Chemical control results (cont.)

## 4

Tomato potato psyllid  
Chemical control results

- Efficacy against TPP life stages has been indicated where information is available from published literature, or laboratory and glasshouse trials. Note that insecticides may not be effective against all life stages.
- Good insecticide coverage, or translaminar activity, is important as TPP are usually found on the underside of the leaves.
- Insecticides with translaminar activity are absorbed by one side of the leaf surface so that the active ingredient is available to the untreated side.
- Apply at least two or three applications of each insecticide, 7–14 days apart to kill all the nymphs as most insecticides will not kill eggs.
- Follow the directions on the label.
- It is important to control psyllids on young plants as this stage is most affected by the psyllid yellows disease.
- Older plants are still vulnerable to infection by the bacterium, but the fruit that has set will still be harvestable.
- During the growing season, use insecticides from more than one insecticide group, always complete a cycle of applications with one insecticide before switching to another insecticide from a different chemical class.
- Laboratory experiments indicate ladybird beetles and lacewings will also feed on TPP adults and nymphs.
- The compatibility of insecticides with potential use for TPP are indicated in Table 1. Note that the effect of insecticides can also vary with species and life stage.

**Organically acceptable alternatives**

- Azadirachtin, eco-oil, agri-50 and paraffinic oil are available commercially and have activity against TPP.
- Azadirachtin was very toxic to TPP adults, paraffinic oil, agri-50 and eco-oil in potato and capsicum were less toxic to TPP adults.
- Azadirachtin, eco-oil, agri-50 and paraffinic oil were least toxic to mature nymphs (3rd-5th instar).
- Egg laying was observed with azadirachtin, agri-50, eco-oil, and paraffinic oil, though none hatched after 7 days.

**Insecticide resistance**

- Imidacloprid and abamectin are widely used to control TPP in potato and tomato crops in the USA and Mexico, with resistance in TPP populations observed in Texas and Mexico.
- Resistance to these insecticides was not observed in laboratory and glasshouse experiments in Western Australia.

**Integrated Pest Management compatibility**

- Many species of beneficial insects such as ladybird beetles, brown and green lacewings and hoverflies (syrphids) occur naturally.
- All are generalist predators and feed on a range of pests including aphids, whiteflies, thrips and caterpillars.



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