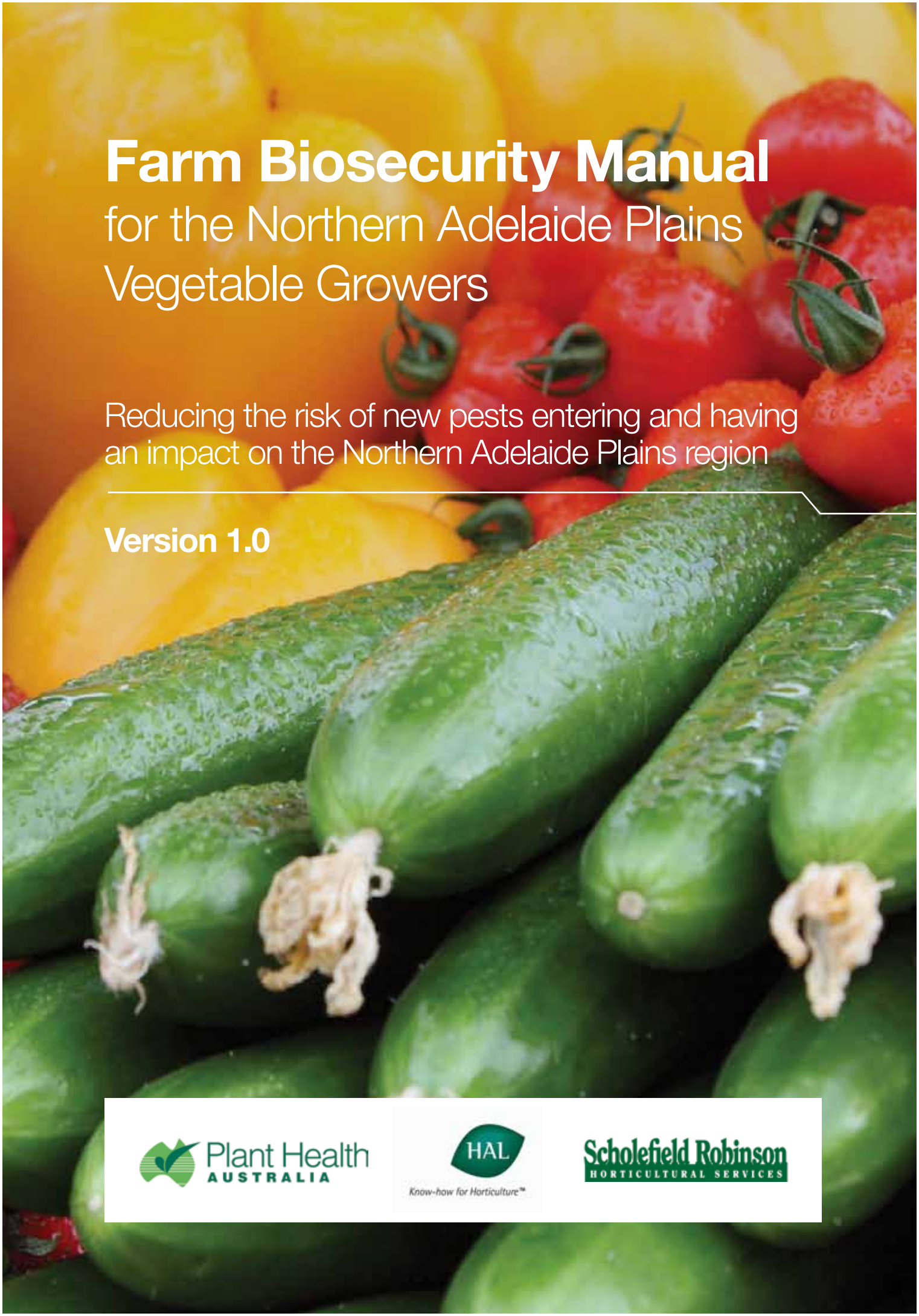

# Farm Biosecurity Manual

## for the Northern Adelaide Plains Vegetable Growers

Reducing the risk of new pests entering and having an impact on the Northern Adelaide Plains region

**Version 1.0**

Plant Health AUSTRALIA

HAL Know-how for Horticulture™

Scholefield Robinson HORTICULTURAL SERVICES

Plant Health Australia (PHA) is the lead national coordinating body for plant health in Australia. PHA works in partnership with industry, governments, researchers and others, providing national coordination to improve biosecurity policy and practice across Australia's plant industries and to build capacity to respond to plant pest emergencies.
**www.planthealthaustralia.com.au**



**Phone:** 02 6215 7700
**Fax:** 02 6260 4321
**E-mail:** biosecurity@phau.com.au
**Website:** www.planthealthaustralia.com.au

An electronic copy of this manual is available from the website listed above.



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# Six easy ways to protect your farm

**2** **You have an important role to play in protecting your farm and the entire vegetable industry from biosecurity threats.**

Here are six simple things you can do to reduce the threat of new pests entering and establishing on your farm. Don't put your livelihood at risk by neglecting farm biosecurity.

### 1. Be aware of biosecurity threats

Make sure you, your farm workers and contractors are familiar with the most important vegetable pest threats. Conduct a biosecurity induction session on your farm to explain hygiene practices for workers, equipment and vehicles.

### 2. Use quality, pest-free propagation material from known sources

Ensure all propagation material (seed, transplants, tubers, corms, bulbs, rhizomes, etc.) and farm inputs are fully tested and pest free. Keep records (batch numbers, source) and retain a sample of your farm inputs.

### 3. Keep it clean

Practicing good sanitation and hygiene will help prevent the entry and movement of pests onto your property. Workers, visitors, vehicles and equipment can spread pests, so make sure they are decontaminated before they enter and leave your farm.

### 4. Check your crop

Monitor your crops frequently. Knowing the usual crop appearance will help you recognise new or unusual pests or plant symptoms. Keep written and photographic records of all unusual observations. Constant vigilance is vital for early detection of any exotic plant pest.

### 5. Abide by the law

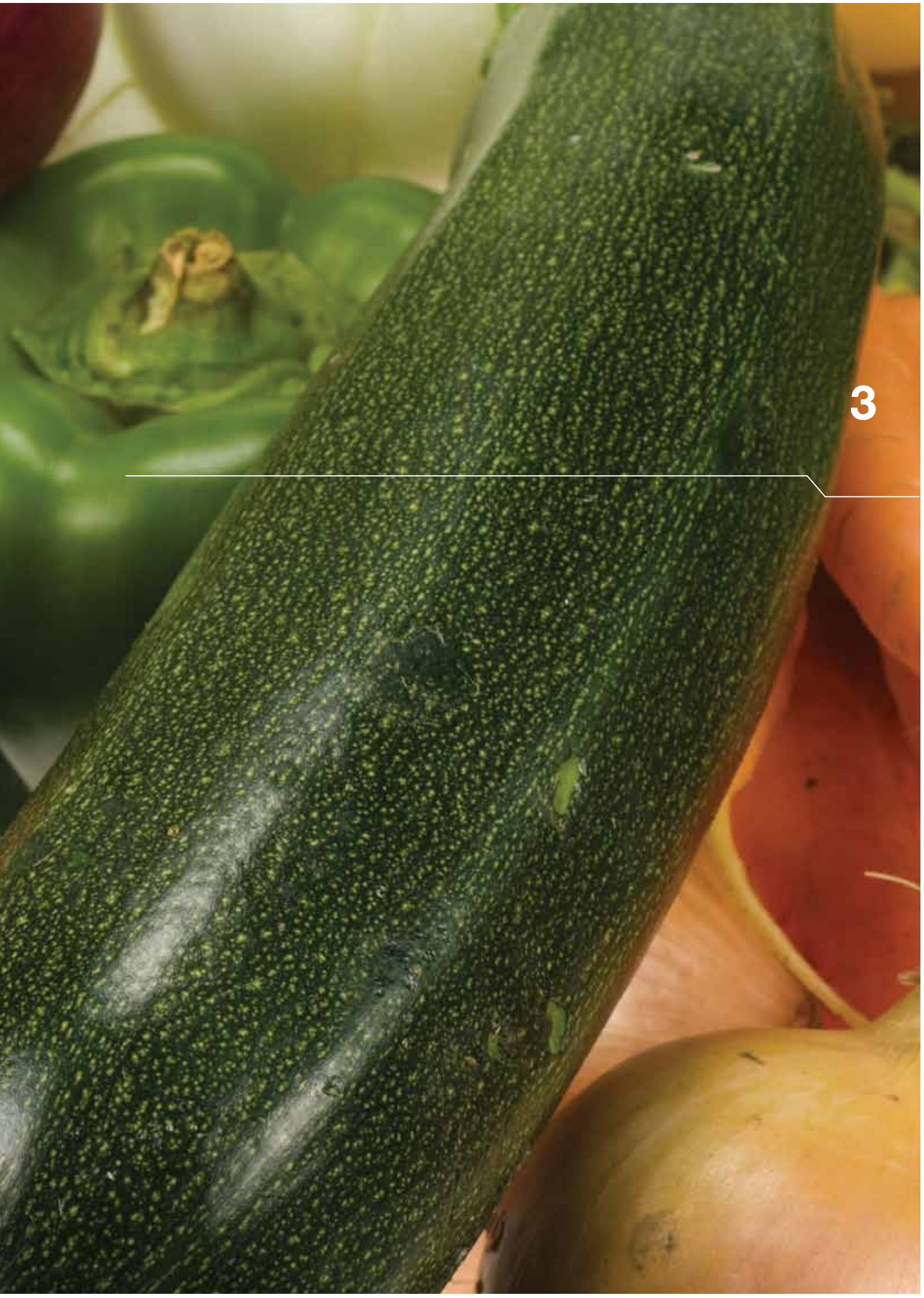
Support and be aware of laws and regulations established to protect the vegetable industry and other horticultural industries in your region.

### 6. Report anything unusual

If you suspect a new pest – **report it immediately.**

**If you see anything unusual, call the Exotic Plant Pest Hotline**

EXOTIC PLANT PEST HOTLINE
**1800 084 881**



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# Biosecurity overview



This manual is designed to assist you in protecting your vegetable farm and the vegetable industry from new and invasive pests. By implementing the recommended measures in your day-to-day operations, you will enhance your biosecurity and that of your region, while minimising productivity losses and unnecessary costs.

## What is biosecurity?

Biosecurity is a set of measures that can be put in place at the national, regional or farm level to protect against the introduction and spread of new pests, and to effectively deal with them should they arrive.

Australia is currently free from many of the pests that are affecting plant production overseas. Maintaining freedom from these pests through effective biosecurity measures is essential for the future profitability of Australian horticulture. In addition, 'area freedom' from a number of localised, endemic pests, is vital to the prosperity of the vegetable industries.

**Early detection and immediate reporting increases the chance of an effective eradication of a new pest.**

The definition of a **pest** used in this manual covers all insects, mites, snails, nematodes, pathogens (diseases) and weeds that are injurious to plants or plant products. **Exotic** pests are those not currently present in Australia. **Endemic** (or established) pests are those present within Australia.

**Farm biosecurity** is a set of management practices and activities that are carried out on-farm to protect a property from the entry and spread of pests. Farm biosecurity is essential for protecting livelihoods and it is the responsibility of every person working or visiting the farm.

The farm biosecurity measures in this manual will protect properties from pests exotic to the region and minimise the impact of those already established. Farm biosecurity should be supported throughout the region and the activities outlined here are applicable to all properties that you visit.

**Hive biosecurity** is also important to some vegetable production regions. Be on the lookout for any unusual bee behaviour or the presence of new bees, as these can negatively affect on vegetable production in the long term. More information is provided on page 16.



## Regional biosecurity

Biosecurity implementation at the regional level supports the measures implemented on your property. Consider starting or contributing to meetings in your region, that coordinate and promote regional biosecurity, and reduce threats to all properties.

At a regional level, potential biosecurity threats may originate from neighbouring farms (operating or abandoned), nurseries, other commercial plantings, native vegetation or amenity plantings. Movement of vegetable products within the region, such as when travelling to markets or swap meets, also increases biosecurity risks.

Reducing risks at the regional level can be achieved through activities such as raising awareness of key threats to the area, identifying and documenting the locations of vegetable production, providing guidance on the appropriate protocols to follow when moving produce within the region and engaging the local council. Councils are not only integral to facilitating biosecurity planning, but they also have roles in the management of some risk areas (such as roadside weeds and plantings, water courses and regional events).

Within a region, every agricultural business will be financially affected in the event of an incursion and the response to it. The impact might be in lost production, restrictions on market access, compliance costs, quarantined produce or forced crop destruction.

Implementation of farm biosecurity underpins regional biosecurity, which in turn underpins national biosecurity. Promotion of biosecurity at the regional level is enhanced through broad engagement of the community, understanding the region, the source and nature of threats, and having knowledge of the expertise and resources available to the region. This is supported by a commitment from everyone to implement biosecurity measures, carry out surveillance and report suspect pests.

If farm measures are supported by community-based measures, a regional framework for biosecurity can be coordinated, and is achievable.

# Pests

## 6 High priority exotic pests

Exotic pests are not currently present in Australia. The pests listed here have the potential to enter and become established in vegetable production regions. In addition, each of these pests would have a high economic impact on vegetable production if they were to become established. Implementation of biosecurity measures is required to minimise the risk of this occurring.

For a complete list of exotic pests that could impact on the vegetable industry refer to Vegetable Industry Biosecurity Plan, available from **www.phau.com.au/biosecurity/vegetables**.

### Carrot rust fly

- Fly – *Psila rosae*
- Found in Europe, Canada, USA, New Zealand
- Attacks carrots, parsnips, celery and parsley
- Adult fly (6-8 mm in length) has a black body, reddish head, yellow legs and transparent wings
- Damage caused by larvae, which are up to 1 cm in length and have a white-yellow cylindrical body without a distinctive head
- Plant symptoms include irregular brown channels under the root surface, root deformation, leaf discolouration, reduction in plant growth and occasionally plant death
- Larvae spread in soil and infested produce

EPPO R. Collier, Warick HRI

### Exotic leafminers

- Flies – *Liriomyza* spp., including the American serpentine, Tomato, Pea and Vegetable leafminers
- Found in most vegetable producing countries worldwide
- Attack a wide range of vegetable crops
- Leafminers are small flies whose larvae feed internally on plants
- Feeding punctures can be seen as white speckles on leaves
- Mining scars, which can be easily seen on leaves or stems, range from straight to serpentine, depending on the species
- Larvae can be spread in infested plant material

Merle Shepard, Gerald R.Carner, and P.A.C Ooi, Bugwood.org



## Bacterial ring rot

- Bacteria – *Clavibacter michiganensis* subsp. *sepedonicus*
- Found throughout Europe, Asia and North America
- Infects tomato, eggplant and potato
- Lower leaves show the first symptoms of wilting and discolouration of interveinal regions, and these progress up the stem
- Primary potato tuber symptom is a discolouration of vascular tissue, visible as a yellow to brown ring when cut, which will ooze a creamy material
- Freshly cut stems of infected plants also exude a white ooze
- Spread with infected plant material

Central Science Laboratory, Harpenden Archive, British Crown, Bugwood.org

## Colorado potato beetle

- Beetle – *Leptinotarsa decemlineata*
- Found throughout Europe, Asia and Central and North America
- Attacks eggplant, capsicums, tomatoes and potato
- Adult beetles are about 1 cm in length and larvae are bright red with a black head when young, changing to an orange colour before pupation
- Both adults and larvae feed on leaves and stems, leaving sticky black excrement
- Leaf defoliation is the most obvious symptom
- Adults can fly up to 160 km but can also be spread with plant material or on farm machinery

David Cappaert, Michigan State University, Bugwood.org

**Remain observant for anything unusual on your farm.** If a pest is found that is not normally present on your farm, it may be new not only to your farm, but to the region, state or even Australia.

## Priority alert pests for the Northern Adelaide Plains

Alert pests are those present in Australia, but have not yet become established on the Northern Adelaide Plains (NAP). If any of these pests are detected in the region, they should be reported immediately to ensure vegetable production in the area is not negatively affected by their establishment.



### Queensland fruit fly and Mediterranean fruit fly

- Fly – *Bactrocera tyroni* (Queensland fruit fly; Qfly) and *Ceratitis capitata* (Mediterranean fruit fly; Medfly)
- Qfly is found in Eastern Australia and Medfly is found in Western Australia
- Maggots found in fresh fruit and vegetables may be that of Qfly or Medfly
- Qfly is wasp like, red-brown with yellow marks and is about 8 mm long
- Medfly is 3-5 mm long, light brown with mottled wings that have distinct brown bands extending to the wing tips
- After laying eggs in the fruit, some necrosis may be visible around the puncture mark. This may be followed by decomposition of the fruit


G. T. O'Loughlin, Department of Agriculture, Bugwood.org


Florida Department of Agriculture and Consumer Services, Bugwood.org

### Melon thrips

- Thrips – *Thrips palmi*
- Attacks a wide range of vegetable species
- Adults (about 1 mm in length) are pale yellow but with numerous dark hairs on the body
- Infested leaves become white or brown, then crinkle and die
- Leaves and terminal shoots become stunted
- Fruit may also show scars and deformities
- Heavily infested fields can display a bronze colour
- Can act as a vector for viruses

J. Guyot, INRA, Pointe-à-Pitre, Bugwood.org

### Potato spindle tuber viroid (PSTVd)

- Viroid – *Potato spindle tuber viroid* (*Pospiviroid*)
- Primary hosts are tomato, potato and avocado
- PSTVd symptoms can be confused with other virus and viroid infections
- Mild strains show no or minor symptoms
- Severe strains induce leaves to curl downwards and become spindly with a rough surface and darker colour
- Tubers become small, spindly and elongated, and may have growth cracks
- Spread can occur through seed, tubers or mechanical transmission

Plant Protection Service Archive, Bugwood.org



## Priority endemic pests

Pests in this category are present in Australia and on the NAP. They are pests causing on-going problems on the NAP and are expensive or difficult to manage. The presence of these pests has forced specific monitoring and scouting, as they affect both the quality and yield of vegetables. Monitoring for the presence and life stages of these pests will allow for the most effective management procedures to be put in place.

### Western flower thrips

- Thrips – *Frankliniella occidentalis*
- Attacks a very wide range of vegetables, weeds and ornamentals
- Insects are tiny and yellow to brown in colour
- Can transmit a range of tospoviruses, including Tomato spotted wilt virus, which reduces tomato, capsicum, and eggplant quality and yield
- Symptoms of infestation vary depending on the host
- Fruit may become distorted or split
- Thrips feeding symptoms include silvering, malformation and feeding scars
- Spread by people movement, wind and infested plant material

J. Guyot, INRA, Pointe-à-Pitre, Bugwood.org

### Currant-lettuce aphid

- Aphid – *Nasonovia ribisnigri*
- Mainly attacks currants (*Ribes* spp.) and lettuce
- Adults (2-3 mm in length) have long legs and a spindle-shaped body that is green on *Ribes* spp. hosts, but can vary on other hosts
- Aphid infestation results in leaf curl symptoms, dead hearts in head lettuce, and some stunting of plants
- Fancy lettuce and leaf lettuce develop few symptoms
- Honeydew production can result in sooty mould growth
- Spread by wind or with infested plant material

J. Guyot, INRA, Pointe-à-Pitre, Bugwood.org

### Greenhouse whitefly

- Bug – *Trialeurodes vaporariorum*
- Main crops attacked are ornamentals, cotton and vegetables, especially transplants and seedlings of greenhouse vegetables
- Nymphs or 'crawlers' range from pale green to brown and resemble scale insects
- Adults (1.5 mm long) resemble tiny moths, with pale yellow wings that are held flat
- Key impact of infestation is the production of honeydew, which encourages the development of sooty mould
- Heavy infestations can result in leaf wilting and failure to set seed
- Spread with infested plant material, on people and by wind

J. Guyot, INRA, Pointe-à-Pitre, Bugwood.org

# 10 Pest surveillance

Pest surveillance, or crop monitoring, involves looking for, recording and managing plant pests. It can be incorporated into existing Integrated Pest Management (IPM) practices, quality assurance programs, or as a component of best management practices.

Pest surveillance is important because:

- Early detection of new pests improves the chance of eradication or effective management, minimising the impact of the pest.
- Surveillance information helps maintain access to markets, domestic and international.
- More effective endemic pest management can be achieved by understanding pest populations through surveillance, and optimal treatment times.

All pest (exotic and established) surveillance activities carried out on your property should be recorded. These records can be used in the response to a pest outbreak and provide support to industry surveillance activities. An example of a pest surveillance datasheet is included in this manual on page 29.

## Case study: Citrus canker

Citrus canker is an exotic bacterial pest of citrus trees that causes canker development and lesions on leaves, stems and fruit. Yield is severely reduced on plants infected with the bacterium. Citrus canker was detected in Queensland in 2004, resulting in restrictions in trade and an eradication operation removing all citrus trees in the area. Australia was declared free of Citrus canker in 2009.

Even though the outbreak was localised to the Emerald region, the eradication of Citrus canker from Australia cost over $26 million. When combined with the loss of trade due to restrictions during the eradication timeframe, the Citrus canker introduction had a severe negative impact on the Australian citrus industry.


## Report suspect pests

Early detection and reporting of new pests may prevent or minimise long-term damage, the quarantine period applied, and the effects on your farm, the region and the vegetable industry as a whole.

Calls to the Exotic Plant Pest Hotline will be forwarded to an experienced person in your state or territory who will:

- Collect information about what you have seen.
- Arrange for a sample to be collected or to be sent to a specified diagnostic facility.
- Provide further information about the most appropriate precautions to be followed.

In some states, the Exotic Plant Pest Hotline operates only during business hours. Outside these hours, leave your full contact information and a brief description of the issue and your call will be followed up as soon as possible. Every report will be checked out and treated confidentially.

### Case Study: Western flower thrips

The arrival and establishment of Western flower thrips (WFT) in Australia in the 1990s provides an example of the impact new pests can have on Australian horticulture. Following its detection in Western Australia, WFT spread throughout Australia within four years, with only small areas of the country remaining free of the pest.

WFT is a vector for Tomato spotted wilt virus. Although other vectors were present before the arrival of WFT, this thrip is a more efficient vector with a wider host range. WFT presence has increased the impact of this virus. WFT are difficult to control with chemicals due to their ability to develop insecticide resistance. A regional approach to integrated resistance management appears warranted in some areas.

Increased attention to management, greenhouse and glasshouse design, and movement of farm workers has been required to limit WFT impact on production. Monitoring programs, more chemical applications and rotations of them, modifications to IPM programs and the planting of cultivars that develop less severe symptoms have occurred in response to WFT's arrival.

The implementation of good biosecurity measures in the vegetable industry will reduce the threat of more exotic pests establishing and minimise any increases in pest control costs to growers and the industry.



If you have found a suspected exotic plant pest, the following general precautions should be taken:

- Mark the location of the pest detection.
- Do not touch, move or transport affected plant material.
- Wash hands, clothes and footwear that have been in contact with affected plant material or soil.
- Do not allow movement of people and equipment near the affected area.
- Follow the directions provided by the Exotic Plant Pest Hotline or by the state or territory government.

**If you see anything unusual, call the Exotic Plant Pest Hotline**

EXOTIC PLANT PEST HOTLINE
**1800 084 881**

## The Emergency Plant Pest Response Deed and the vegetable industry

The Emergency Plant Pest Response Deed (EPPRD) is a formal, legally binding document between Plant Health Australia, Australian and state/territory governments and plant industry signatories. As a signatory to the EPPRD, AUSVEG, the national peak body for the vegetable industry, has a seat at the decision making table and also contributes to funding if an approved Response Plan is implemented to eradicate an Emergency Plant Pest.

Under the EPPRD, AUSVEG members have a responsibility to report suspect pests. The earlier a new pest is detected, the greater the chance an eradication response will be mounted and the more likely it will be successful.

Within an approved Response Plan, grower reimbursement payments (Owner Reimbursement Costs) are included for direct costs incurred as a result of eradication of a pest incursion.

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# Product management

## 14 Planting material and farm inputs

Planting material (including seeds and seedlings) and other farm inputs (such as growing substrates, pesticides, fertilisers, mulches and nutrient mixes) have the potential to carry pests or contaminants onto your farm. Plant material infected with pests such as fungi, bacteria and viruses may look healthy to the naked eye.

When purchasing planting material and farm inputs:

- Purchase only from reputable suppliers, preferably ones that are certified, who take biosecurity, hygiene, health testing and record keeping seriously.
- Check planting material thoroughly for evidence of pests or unusual symptoms. Isolate new plant material from production areas.
- Maintain a record of all planting material and farm inputs brought onto the property.
- Request and retain documentation in relation to planting material and farm inputs – source, testing regimes and import details.

Reduce the risk of pest infestations or contamination of planting material and other farm inputs by storing them appropriately. For example, mulches and fresh manure, composts and fertilisers should be stored on impermeable surfaces away from production areas.

Record the use, movement, testing and storage of all planting material and farm inputs that are used on your property.

## Waste products

Maintaining good farm hygiene can minimise cross-contamination and pest population build-up. Waste generated through cropping and harvesting practices must be disposed of appropriately to reduce the biosecurity risk.

Green waste (e.g. fresh mulch, green crop debris, slashed weeds) can be beneficial if treated correctly. However, careful and timely management is required to reduce the risk of outbreaks of unwanted pests.

Appropriate disposal mechanisms for plant waste include total removal, deep burial (away from production areas), burning (where restrictions permit) or hot composting. Waste should be disposed of immediately and undertaken in combination with an effective monitoring/pest management program. If immediate removal is not possible, the waste should be contained separately to production areas and covered.

Ensure that no soil, plant material or insects are left adhering to vehicles, bins or other equipment (including hand tools) that are used on farm.



## Biosecurity and Quality Assurance

If your farm, seed or transplant provider maintains a Quality Assured scheme such as ISO 9000, SQF 2000, NIASA, Freshcare or Woolworths Quality Assurance Scheme, it is likely that some fundamental techniques of biosecurity best practice are already being applied.

Ensure that the schemes, requirements and records are in accordance with your farm scheme and expectations for traceability. Your records, together with service provider records should allow full traceability (e.g. the ability to trace-back plant material on your farm to its source, including all seed and planting material, health testing specifics and authenticity records) and provide evidence of the surveillance and pest management practices undertaken on your property.

Auditable Quality Assurance schemes and achievement of membership to them, is beneficial in terms of biosecurity, market access, meeting specifications and customer expectations of food quality and food safety.

### Case study: Biosecurity opening a new market

As a direct result of growers and the industry implementing and recording good biosecurity and farm hygiene measures, Tasmanian cherries have appeared in fruit bowls in South Korea for the first time. South Korean government officials visited Tasmanian cherry orchards and packing houses, assessed the pest risk of fruit, and concluded the cherries were biosecure. As a result cherries from Tasmania are now exported to South Korea without prior fumigation.

The new market in South Korea is expected to boost Tasmania's cherry production by about 75% over a three year period, demonstrating that biosecurity has been a good investment for Tasmanian cherry growers.



## Farmers' markets

Farmers' markets provide a great opportunity to sell products directly to the consumer. Commercial growers from around the region and non-commercial backyard producers gather at these markets with their produce, and this provides a mechanism for the spread of pests.

To maintain these markets as positives for the industry, the following basic practices should be followed:

- Don't share equipment or mix other growers' produce with yours – keep them separate
- Ensure all produce sold is fresh, healthy and of high quality
- Remove all soil and adhering plant material from produce before sale
- Keep an eye out for any signs of pests – and report them immediately if spotted
- Disinfect all equipment on arrival back at your property
- Do not bring back unsold produce to your farm – you risk introducing new pests to your property

## Hive biosecurity

Vegetable crops including cucumber, peas, pumpkin and zucchini benefit from pollination by honey bees. To ensure the vegetable industry (and others e.g. almonds) continue to benefit from honey bees, the risk of new pest introductions should be minimised through the implementation of good hive biosecurity measures.

There are a number of bee and hive pests that are currently not in Australia, with the highest threat posed by Varroa mite. These pests could have serious impacts on the honey bee and pollination-dependent industries if they were to become established. Many of these pests are prevalent in neighbouring countries.

Work with your hive providers to implement good hive biosecurity measures, including monitoring for unusual bee behaviour, minimising contact with the hives and cleaning equipment and hives before moving between properties.

**If you see any unusual signs or pests in your bees call the Emergency Animal Disease Watch Hotline or the Exotic Plant pest Hotline.**

EXOTIC PLANT PEST HOTLINE
**1800 084 881**

EMERGENCY ANIMAL DISEASE WATCH HOTLINE
**1800 675 888**

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# People and biosecurity



## Biosecurity signs

Well designed signage informs visitors that biosecurity on your farm is a focus and that they share responsibility for maintaining it. The signs serve to alert people to the potential impact of their visit. Signs also demonstrate your commitment to farm hygiene, safety and auditable systems.

Biosecurity signage should be placed at the main gate, other entrances, visitor parking areas and wash-down facilities, and where appropriate, include translations into the relevant languages.

Biosecurity signs should direct visitors to contact the owner/farm manager to formally register their presence before entering any production areas. The sign should include important contact details, such as the home telephone number, mobile number and/or two-way channel.

Contact Plant Health Australia for further information on obtaining biosecurity signs for your property.


## Managing people movement

People moving between home and farms, nurseries and other horticultural sites (including market places, food stalls, etc.) can spread pests on vehicles, equipment, boots and clothing. Even hair and watchbands can carry fungal spores and bacteria. The most obvious risks are pests carried in soil and plant material.

Implementing the following measures will reduce the threat associated with people movement.

- Maintain a visitor register (example on page 28), that records visitor arrivals, departures and purpose. This is a safety and biosecurity measure.
- Brief all workers (including casual workers), contractors and visitors on your farm biosecurity measures.
- Employee and visitor footwear and clothing must be free of soil and plant material before entering or leaving the farm.
- Provide scrubbing brushes, footbaths, boot covers, rubber boots and protective clothing such as disposable overalls, for people entering or leaving your farm, or moving from contaminated to clean areas of the property.
- Display biosecurity awareness material in staff rooms, trimming and packing sheds, and rest rooms. Keep the messages simple and effective.



## Casual workers and tourists

Casual workers and travellers (e.g. backpackers, retirees, etc.) are often employed to assist with farm activities that bring them in contact with the crop. This includes planting, trimming, weeding, harvesting, picking and packing.

While their contribution is highly valued, they are a particular biosecurity threat because they move from farm-to-farm and region-to-region. They can potentially carry and spread pests between and around farms on their clothing, footwear, gloves, car tyres and personal equipment (e.g. knives).

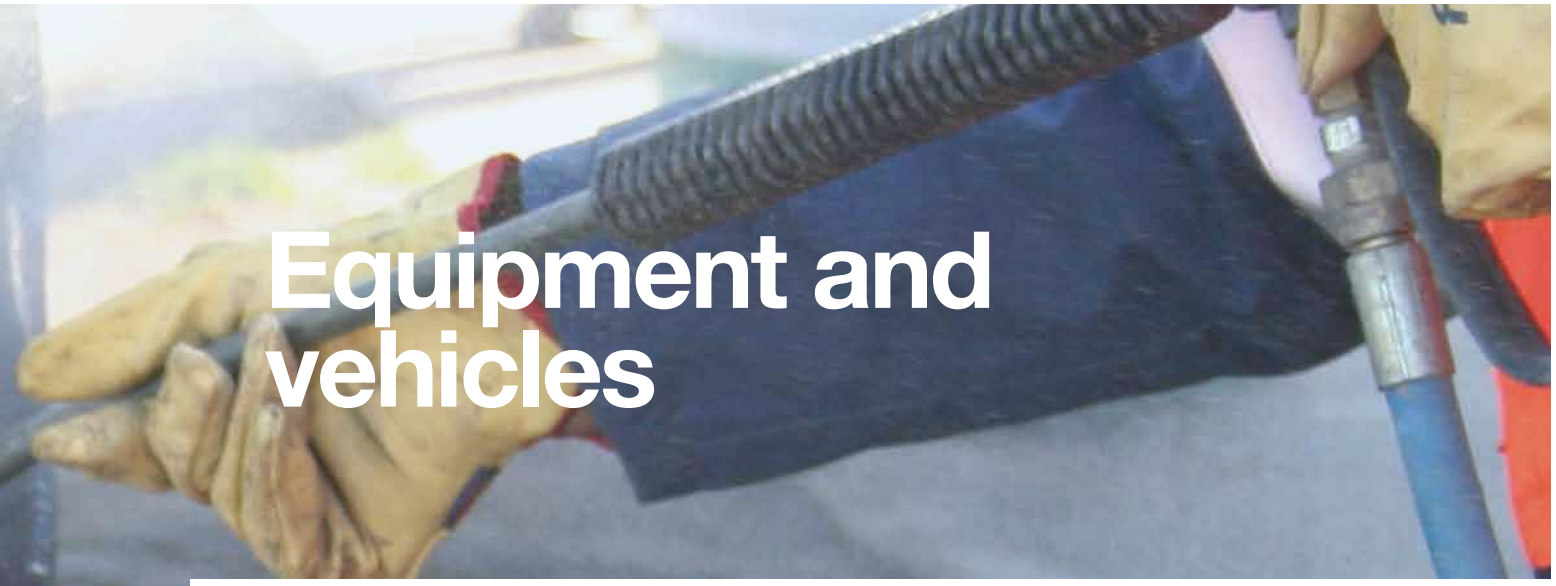
Before entering production areas or packing sheds, make sure casual workers are well briefed on biosecurity measures at your property, have changed or washed their clothes and boots, and all tools and equipment are cleaned and disinfected.

## Overseas travellers

People returning from overseas are a threat to regional and farm biosecurity, especially if they have visited farms, nurseries, or markets where plant material or produce was sold.

Several vegetable specimens carrying pests have been intercepted at the Australian border and overseas travellers have unknowingly brought in pests in the past. Air travel means exotic plant pests are only a few hours away.

To protect your farm from exotic (overseas) pests, ensure that all people who have recently returned from overseas have cleaned their boots and clothes before entering your property.



# Equipment and vehicles



## Movement of vehicles and machinery

Vehicles and farm equipment such as sprayers, tractors and hand tools can carry pests and weed seeds around and between farms, in adhering soil, sap and plant material. Ensure vehicles and equipment are cleaned before moving between areas of the farm or moving between properties.

Inspecting and cleaning machinery is more time and cost effective than managing a new pest.

Farms open to the public (e.g. U-Pick businesses) and those open to growers (e.g. for field days, equipment demonstrations, etc.) have a heightened risk and designated parking areas away from production sites are important.

To reduce the risk of pest entry on equipment and vehicles include:

- Use a dedicated farm vehicle to carry visitors around your farm.
- Keep vehicle movement to a minimum in production areas and stick to regular pathways.
- Keep farm vehicles clean by clearing the vehicle floor of soil, weed seeds and insects, especially after visiting other properties.
- Vehicles and equipment should be cleaned in a designated wash-down area before entering your property. This process should be repeated before leaving the property.
- Ensure all vehicles and equipment, including contractors, delivery trucks and earth moving equipment, are clean and follow your farm wash-down procedures.
- Regularly clean all tools and equipment used on your farm, preferably with an antiseptic or bleach solution.
- Keep a vehicle log to trace movement between properties.
- Carry a biosecurity kit in each vehicle.

A basic biosecurity kit includes:

- Stiff brushes
- Broom for cleaning inside of vehicle
- Scraper for removing dirt from boots and tyres
- Plastic footbath for disinfecting boots and hand equipment
- Disinfectant solutions and spray bottles
- Personal safety gear – gloves, overalls and boot covers
- Sealable plastic bags for sample collection
- Soap and at least five litres of water

## 22 Wash-down facilities

A wash-down facility allows farm employees, contractors and visitors to clean their vehicle and equipment (including hand tools) in an easily managed area where waste water is contained. This will ensure that plant material, insects and soil is not moved onto or out of your farm.

Aim to have a wash-down area that:

- Is readily accessible and located between the driveway and farm roads.
- Is isolated from production areas.
- Has access to power and high-pressure water.
- Has a sealed (concrete or bitumen) or packed gravel surface.
- Does not drain into a waterway or production areas.
- Have a sump or collection area for easy inspection and waste management.

For additional protection, an added detergent-based degreaser or disinfectant (for example, Septone Truckwash®, Castrol Farmcleanse® or Virkon®) may be appropriate. For best results, seek advice from re-sellers on the best product, and remove as much soil and plant material as possible from the equipment before using the disinfectant.

The wash-down area may be the same as that used for chemical wash-down of vehicles and equipment. If so, all occupational health and safety issues associated with chemical wash-down areas must be taken into account.

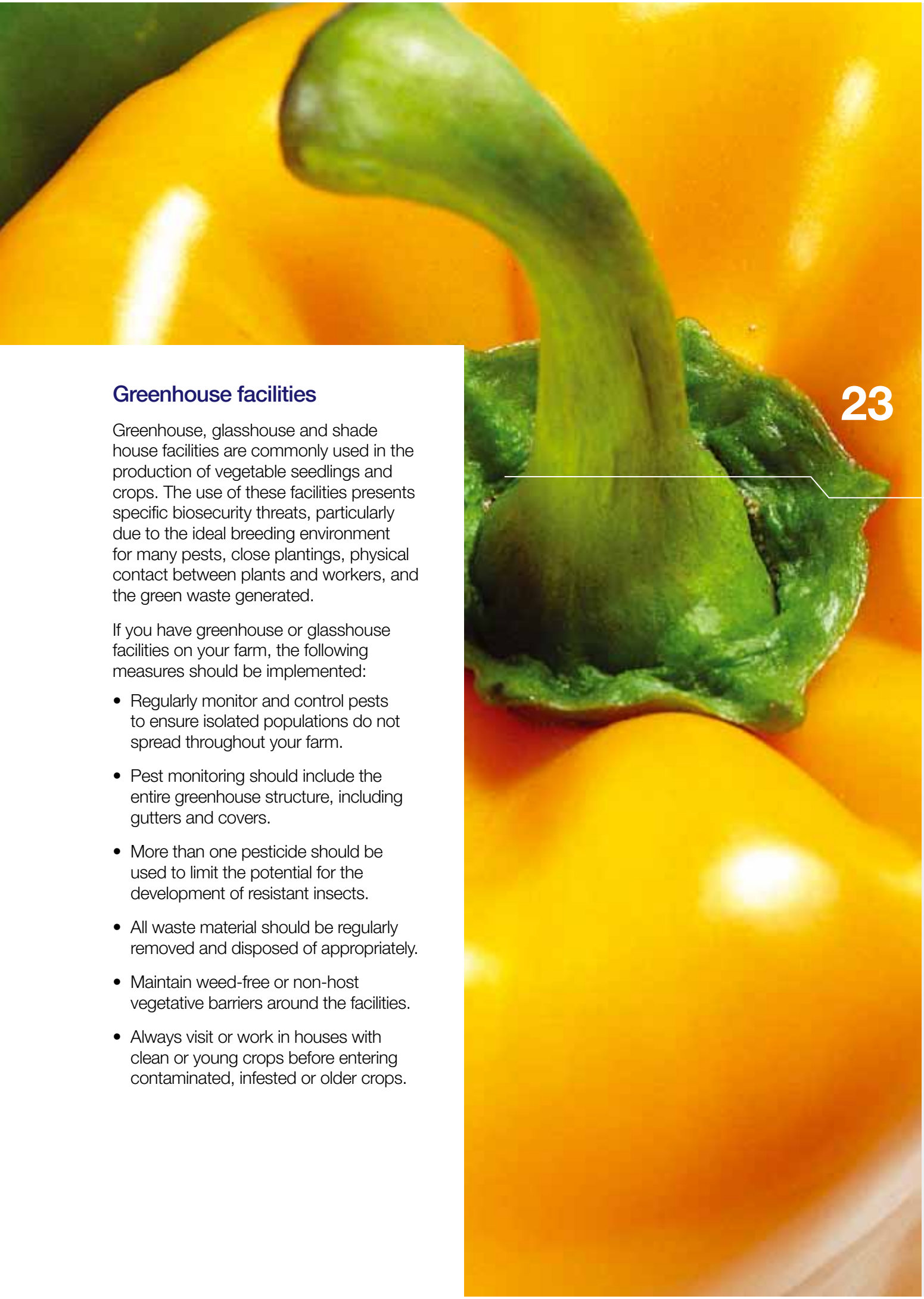
## Designated parking areas

A well sign-posted designated parking area should be provided for all visitors to your property. Dedicated farm vehicles should then be used for transport of visitors around your property.

The designated parking area should be located away from production areas. A biosecurity sign in the parking area will remind visitors of the importance of biosecurity and farm hygiene on the property.

Designated parking areas serve to contain the entry of new pests to an area away from production sites. They also allow for the inspection of tyres, equipment, floor mats and boots for soil and plant material which may carry new pests.

Do not allow the movement of on-farm machinery or vehicles through the parking area.



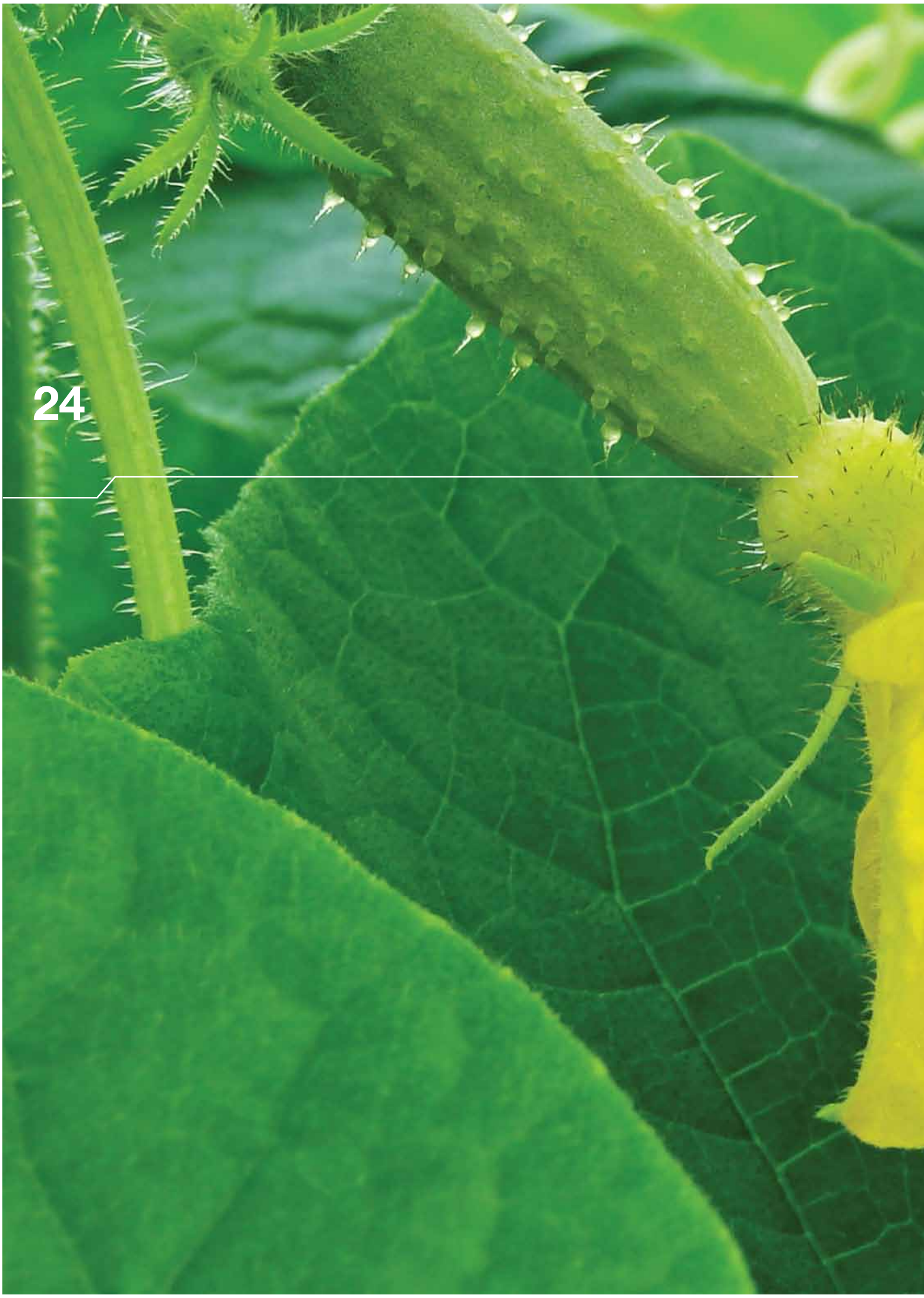


## Greenhouse facilities

Greenhouse, glasshouse and shade house facilities are commonly used in the production of vegetable seedlings and crops. The use of these facilities presents specific biosecurity threats, particularly due to the ideal breeding environment for many pests, close plantings, physical contact between plants and workers, and the green waste generated.

If you have greenhouse or glasshouse facilities on your farm, the following measures should be implemented:

- Regularly monitor and control pests to ensure isolated populations do not spread throughout your farm.
- Pest monitoring should include the entire greenhouse structure, including gutters and covers.
- More than one pesticide should be used to limit the potential for the development of resistant insects.
- All waste material should be regularly removed and disposed of appropriately.
- Maintain weed-free or non-host vegetative barriers around the facilities.
- Always visit or work in houses with clean or young crops before entering contaminated, infested or older crops.



# Summary

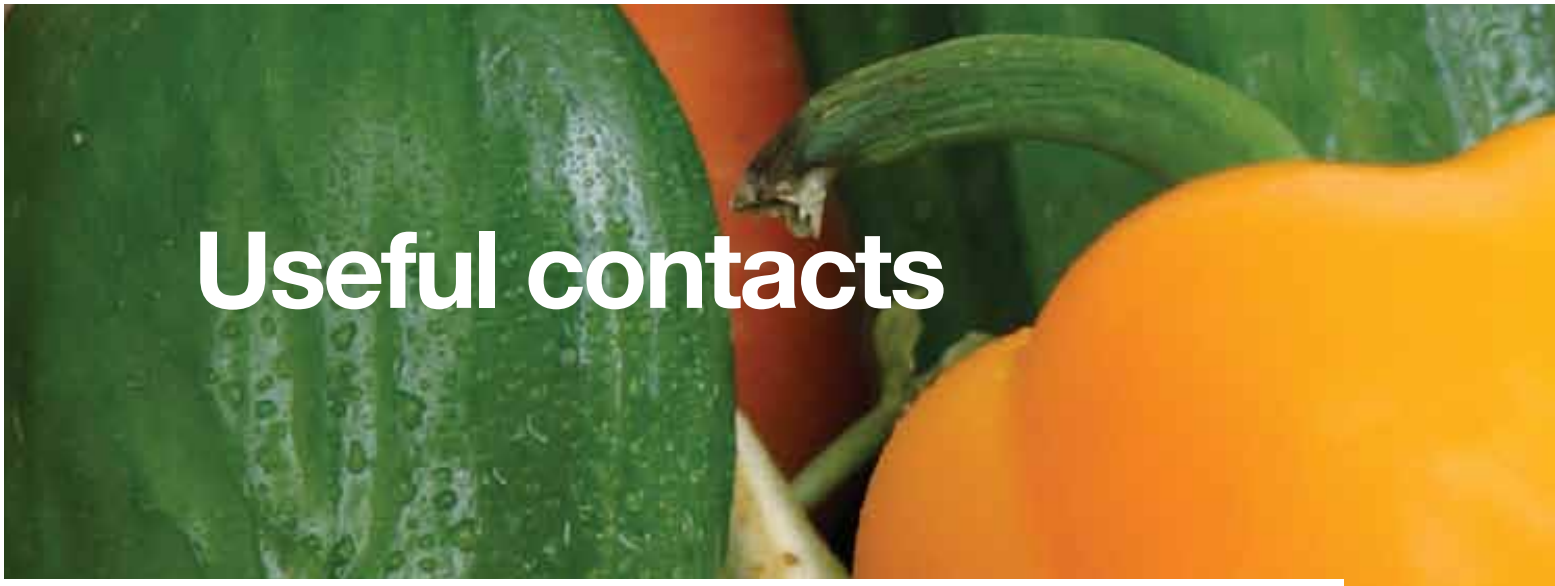
## This is a summary of key risks and priority actions to consider in improving vegetable industry biosecurity.



| Key risks to biosecurity | Priority actions to help minimise these risks |
|---|---|
| **Pests** (page 6) | • Crop monitoring should be carried out and recorded to reduce the risk of new pests establishing, maintain access to markets and provide information for better pest control.<br>• If you suspect a new pest or see unusual symptoms on the crops:<br>– Report it immediately to the Exotic Plant Pest Hotline on 1800 084 881.<br>– Restrict movement of people and equipment in the area.<br>– Wash clothes and skin in contact with affected crops, produce or equipment.<br>• Be aware of key vegetable industry pest threats. |
| **Product management** (page 14) | • Planting material and farm inputs can carry pests onto your farm.<br>• Ensure planting material is from a reputable supplier and retain all documentation.<br>• Dispose of waste and by-products appropriately, away from production areas.<br>• Be aware that hive biosecurity measures impact on your farm and crops.<br>• Implement a Quality Assurance scheme on-farm. |
| **People and biosecurity** (page 18) | • Biosecurity signs should be placed at the main gate and other entrances to the property and strategically around the facilities.<br>• Use a visitor register to track people movement.<br>• Ensure all visitors have cleaned their vehicles, clothing and equipment before entering the property.<br>• Provide cleaning equipment for visitors and employees. |
| **Equipment and vehicles** (page 21) | • Provide a wash-down facility on-farm, or identify an available wash-down facility in your region.<br>• Do not allow entry to contractors, visitors and employees who do not clean their vehicles and equipment.<br>• Provide a designated parking area away from production areas. |

**If you see anything unusual, call the Exotic Plant Pest Hotline**

EXOTIC PLANT PEST HOTLINE
**1800 084 881**



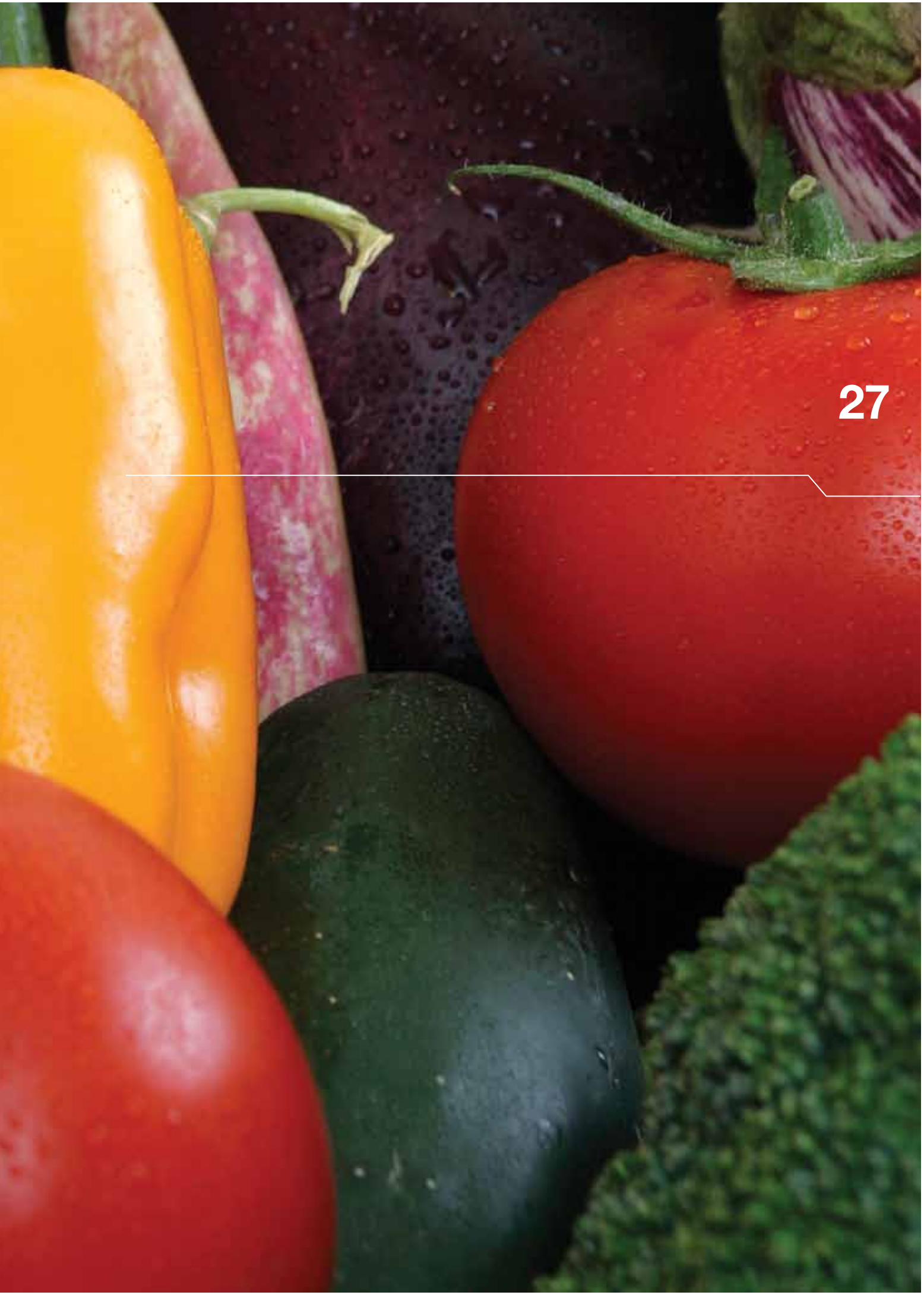
# Useful contacts

**26** More information on biosecurity, farm hygiene, pests and the horticultural industry can be found through the following sources.

| Organisation | Contact details |
|---|---|
| **Plant Health Australia** | **Phone:** 02 6215 7700<br>**Email:** biosecurity@phau.com.au<br>**Website:** www.phau.com.au |
| **Scholefield Robinson Horticultural Services** | **Phone:** 08 8373 2488<br>**Email:** srhs@srhs.com.au<br>**Website:** www.srhs.com.au |
| **AUSVEG** | **Phone:** 03 9544 8098<br>**Email:** info@ausveg.com.au<br>**Website:** www.ausveg.com.au |
| **Farm Biosecurity** | **Phone:** 02 6215 7700<br>**Email:** info@farmbiosecurity.com.au<br>**Website:** www.farmbiosecurity.com.au |
| **Department of Agriculture, Fisheries and Forestry (DAFF)** | **Phone:** 02 6272 3933<br>**Website:** www.daff.gov.au |
| **South Australia – Department of Primary Industries and Resources** | **Phone:** 1300 666 010 or 08 8168 5200<br>**Website:** www.pir.sa.gov.au |

**If you see anything unusual, call the Exotic Plant Pest Hotline**

EXOTIC PLANT PEST HOTLINE
**1800 084 881**



# Visitor register

Please enter your details to assist us with our farm biosecurity records

| Date | Time on property | | Name | Reason for visit | Vehicle registration or mobile | Blocks/ greenhouses visited | Location/date of last contact with commercial vegetables or seed production sites |
|---|---|---|---|---|---|---|---|
| | Arrival | Departure | | | | | |
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**If you see anything unusual, call the Exotic Plant Pest Hotline**

EXOTIC PLANT PEST HOTLINE
**1800 084 881**

# Pest surveillance data sheet

Farm: _____

Scout: _____

Date: _____

| | | Established pests | | | | Exotic pests | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Paddock** | **No. sites** | Pest 1 | Pest 2 | Pest 3 | Pest 4 | Pest 1 | Pest 2 | **Other pests found** | **Comments** |
| | | | | | | | | | |
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**If you see anything unusual, call the Exotic Plant Pest Hotline**

NB Estimated infestation level of endemic and exotic pest presence/absence to be scored (e.g. zero/low/med/high or % plants/blocks affected)
Pests targeted by surveillance must be named before surveillance initiated (for both endemic and exotic pests)

EXOTIC PLANT PEST HOTLINE
**1800 084 881**

Fact sheet

Plant Health AUSTRALIA

# Carrot rust fly

## What is Carrot rust fly?

Carrot rust fly (*Psila rosae*) is a primarily a pest of carrots, but it also affects parsnip, celery and parsley. The larvae channel into the roots of host plants, where feeding activities impact on plant vigour and tap root quality. Under ideal conditions, the Carrot rust fly can have up to three generations per year.

## What does it look like?

The mature fly has a black body, reddish head, yellow legs and transparent wings. These flies are about 8 mm in length and can be spotted on the leaf surfaces of host plants.

The larvae are 8-10 mm long and white or yellowish in colour. They have a pair of prominent black feeding hooks at the front end. Pupae are shiny brown and about 5 mm in length.

## What can it be confused with?

The small fly may be hard to distinguish from other fly pests in the field, while the Carrot rust fly damage can be confused with nutritional deficiencies or water stress. However, host symptoms in combination with the presence of flies or larvae should be reported.

## What should I look for?

Host plant symptoms are the easiest way to detect the presence of the Carrot rust fly.

Seedlings can be killed or injured by larvae feeding on tap roots. Look for gaps in the crop, but also yellowing and reddening of the leaves. In more mature carrots, the larvae attack the tap roots creating channels, distorting them and making the crop unfit for market.

EPPO Rosemary Collier, Warwick HRI

The small fly has a black body with transparent wings

EPPO Rosemary Collier, Warwick HRI

Distorted carrots with deep channelling as a result of larval feeding

EPPO Rosemary Collier, Warwick HRI

The cylindrical larvae of the Carrot rust fly

## How does it spread?

The pest can be spread as larvae in bulbs, tubers, corms or rhizomes, and also by the transportation of pupae in infested soil. The adult fly is a weak flier and is not a significant spread risk.

## Where is it now?

Carrot rust fly is widespread in Europe, Canada, USA and New Zealand.

## How can I protect my farm from Carrot Rust Fly?

Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common pests of the vegetable industry so you can tell if you see something different.

**If you see anything unusual, call the Exotic Plant Pest Hotline 1800 084 881.**

EXOTIC PLANT PEST HOTLINE
**1800 084 881**

Whitney Cranshaw, Colorado State University, Bugwood.org

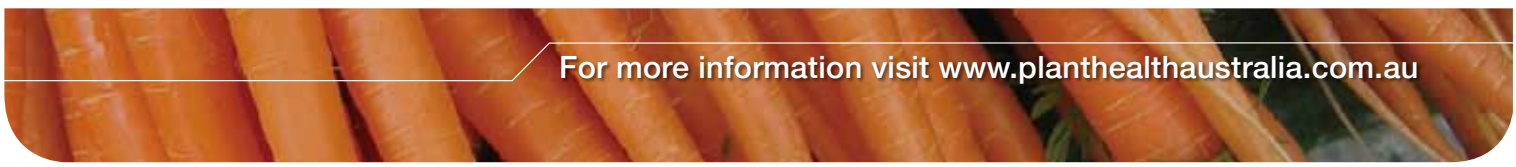
Larvae feed on tap roots, resulting in unsaleable products

EPPO Rosemary Collier, Warwick HRI

The adult fly is about 8 mm in length

Rasbak

The white to yellow larvae can grow up to 10 mm in length



Fact sheet

Plant Health AUSTRALIA

# Exotic leaf miners

## What are leafminers?

There are over 300 species of leafminers worldwide. However, only four are considered serious horticultural pests:

- American serpentine leafminer (*Liriomyza trifolii*)
- Vegetable leafminer (*L. sativae*)
- Tomato leafminer (*L. bryoniae*)
- Pea leafminer (*L. huidobrensis*)

Leafminers quickly establish in most crops and are particularly a problem in protected cropping systems. Plants can be affected during all growth stages.

All *Liriomyza* species are leaf-mining flies. Leaf damage occurs through puncture wounds from adult feeding and egg deposition, and the larvae tunnel, or mine, within the leaf tissue. The damage can reduce the photosynthetic capacity of the plants.

The host range for each species is large:

- *L. bryoniae* - many vegetables, mainly tomatoes
- *L. huidobrensis* - 15 plant families, key pest of potato
- *L. sativae* - 40 hosts in 10 plant families, including Cucurbitaceae, Fabaceae and Solanaceae
- *L. trifolii* - 28 plant families, key pest of Asteraceae

## What do they look like?

Adult flies are small, yellow and black, with variations in colour allowing the species to be distinguished. Although female adults are larger and more robust than males, their small size still limits field identification.

The larval stages are not usually seen as they remain inside the leaf tissue. However, the mines are easily spotted and are evidence of larvae presence.

Merle Shepard, Gerald R. Carner and P. A. C. Ooi, Bugwood.org

Pea leafminer (*L. huidobrensis*) mining damage

Central Science Laboratory, Harpenden Archive, British Crown, Bugwood.org

Black and yellow markings of the American serpentine leafminer (*L. trifolii*) adult fly

Plant Protection Service Archive, Bugwood.org

Tomato leafminer (*L. bryoniae*) mining damage

## What can they be confused with?

There are a number of other leafminer species already present in Australia, but these do not impact on horticultural production.

## What should I look for?

Stippled foliage (as upper leaf cells are destroyed), white or greenish-white mines (lines) and blotches on leaves indicate the presence of leafminers.

Fungal infection may also occur, as the feeding damage increases susceptibility to secondary infections.

## How does it spread?

The insects spread by flying within the crop. Long distance transport is likely to occur through the movement of infested plants, plant tops, soil or packaging.

## Where is it now?

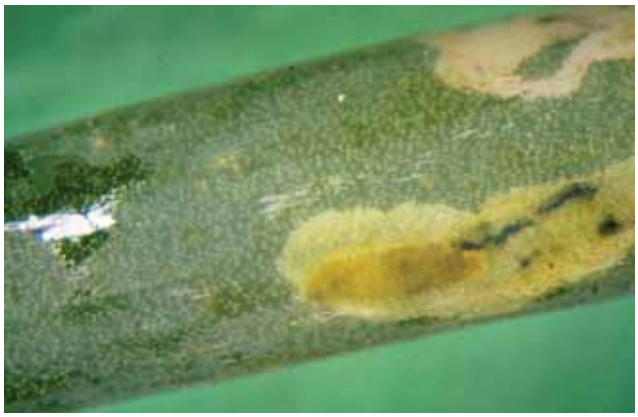
Each of these exotic leafminers have different distributions, however they are all widespread throughout vegetable producing countries worldwide, with the exception of Australia.

## How can I protect my farm from exotic leafminers?

Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common pests of the vegetable industry so you can tell if you see something different.

**If you see anything unusual, call the Exotic Plant Pest Hotline**

**EXOTIC PLANT PEST HOTLINE**
**1800 084 881**



Whitney Cranshaw, Colorado State University, Bugwood.org

Vegetable leafminer (*L. sativae*) larvae visible at the end of a mine in onion leaf

Whitney Cranshaw, Colorado State University, Bugwood.org

Leaf mining damage in pea pods caused by vegetable leafminer (*L. sativae*) larvae

Central Science Laboratory, Harpenden Archive, British Crown, Bugwood.org

Mining damage to a chrysanthemum leaf caused by the American serpentine leafminer (*L. trifolii*)

Fact sheet

Plant Health AUSTRALIA

# Bacterial ring rot

## What is Bacterial ring rot?

Bacterial ring rot (*Clavibacter michiganensis* pv. *sepedonicus*) is one of the most feared diseases of the potato industry, particularly for seed producers. The pathogen can spread quickly through a crop or property, which usually results in serious losses.

## What does it look like?

Symptoms include wilting and yellowing of the leaf, and markings which later turn brown and appear 'burned'. In the later stages of the disease, lower leaves and stems may die and leaf margins become brittle.

Tubers rot from the inside, initially in the vascular ring of the tuber. Infected tubers exude a creamy, odourless bacterial exudate in cheese-like ribbons when squeezed and tuber skins can crack under heavy infection levels.

## What can it be confused with?

Bacterial ring rot can be confused with potato brown rot caused by *Ralstonia solanacearum* which is already present in Australia. If you are unsure, have it checked out by an expert.

## What should I look for?

Symptoms rarely develop quickly and infections usually remain latent for long periods. Watch out for wilting and yellowing of above ground plant parts and frequently dig developing tubers to check for symptoms.

William M. Brown Jr., Bugwood.org

Tubers initially rot from the inside

Central Science Laboratory, Harpenden Archive, British Crown, Bugwood.org

Rotten tubers exude a creamy white bacterial ooze

J.D. Janse, Plant Protection Service, Bugwood.org

Above-ground symptoms include wilting and yellowing of leaves

## How does it spread?

Bacterial ring rot is usually transmitted in infected tubers and micro-propagated plantlets. The bacteria can survive in soil (usually in association with unharvested tubers) and on volunteers and plant debris.

The bacteria can also survive for several years on contaminated equipment. It can survive in water for more than a month and can be transmitted through wash water.

## Where is it now?

Bacterial ring rot is currently found in Europe, North America, Asia, North Africa, Mexico and Venezuela.

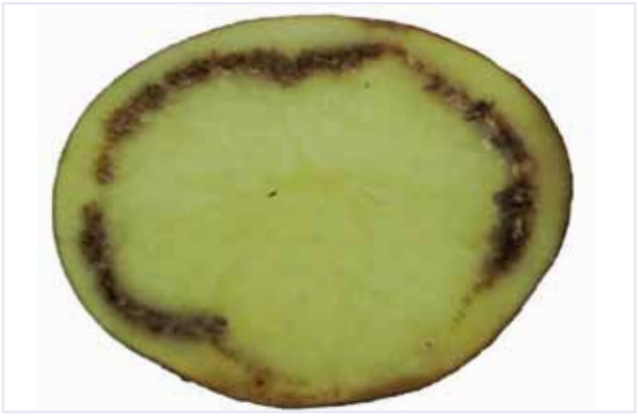
## How can I protect my farm from Bacterial ring rot?

Source seed tubers and plant material only from clean, accredited suppliers. Keep equipment clean and remove plant debris from growing sites.

Check your farm frequently, especially in the heat of the day, for the presence of new pests and unusual symptoms. Make sure you are familiar with common pests of the vegetable industry so you can tell if you see something different.

**If you see anything unusual, call the Exotic Plant Pest Hotline**

**EXOTIC PLANT PEST HOTLINE**
**1800 084 881**



Dr Solke H. De Boer, Canadian Food Inspection Agency

Rotting and discolouration of the vascular ring caused by Bacterial ring rot

Larry L. Strand, University of California Statewide IPM Program

Tuber skins may crack under high disease intensity

William M. Brown Jr., Bugwood.org

At later stages leaves turn brown and appear burned

Fact sheet

Plant Health AUSTRALIA

# Colorado potato beetle

## What is Colorado potato beetle?

The Colorado potato beetle (*Leptinotarsa decemlineata*) is a serious and persistent pest in temperate regions. In countries where it is established, it is both difficult and expensive to control, and insecticide resistance is a major issue.

The preferred host plants are potatoes, eggplant, capsicums and tomatoes. Adult beetles and larvae feed on stems, leaves and growing tips, and they produce a sticky black excrement.

## What does it look like?

Adult beetles are about 1 cm in length and visible to the naked eye. They have five dark line markings on each wing cover, with a yellow to red underlying colour. They are found on stems and leaves, externally on fruit or tubers and sometimes in produce packed from infested fields.

The larvae are also brightly coloured and grow to 15 mm in length. Initially they are bright red with a black head and legs, but this changes to a pale orange before pupation.

## What can it be confused with?

There are no beetles with similar morphology native to Australia.

Defoliation and leaf tatter caused by the Colorado potato beetle is similar to the damage caused by other insects, but the black sticky deposits help confirm the Colorado potato beetle is present.

## What should I look for?

Leaf defoliation caused by Colorado beetle feeding is the most obvious sign of the pests' presence during in field inspections. Shake potato plants and observe the ground around them for beetles. Larvae and adults can been seen easily on young plants. Also check nearby Solanaceous weeds.

David Cappaert, Michigan State University, Bugwood.org

Adult beetles have distinctive dark lines on wing covers

USDA APHIS PPQ Archive, Bugwood.org

Defoliation damage caused by Colorado potato beetle feeding

David Cappaert, Michigan State University, Bugwood.org

The larva is brightly coloured and has two rows of dark spots along each side

## How does it spread?

The adults can fly short distances within a host crop and have been known to travel up to 160 km when assisted by strong winds.

The larvae and adults can be transported as 'hitch-hikers' on plant material, produce, machinery and packaging.

## Where is it now?

Colorado potato beetle is widespread throughout Europe, Asia, Mexico and in the western USA. It has been eradicated from the UK and is contained within regions of Canada.

## How can I protect my farm from Colorado potato beetle?

Do not plant tubers from unknown sources. Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common pests of the vegetable industry so you can tell if you see something different.

**If you see anything unusual, call the Exotic Plant Pest Hotline**

**EXOTIC PLANT PEST HOTLINE**
**1800 084 881**

David Cappaert, Michigan State University, Bugwood.org

The brightly coloured Colorado potato beetle eggs are laid in clumps on leaf surfaces

David Cappaert, Michigan State University, Bugwood.org

Beetles are yellow to red with dark markings and segmented antennae

Whitney Cranshaw, Colorado State University, Bugwood.org

Cream coloured pupa of the Colorado potato beetle

Fact sheet

Plant Health AUSTRALIA

# Queensland and Mediterranean fruit flies

## What are they?

Mediterranean fruit fly (*Ceratitis capitata*; MedFly) is one of the world's most destructive agricultural pests, and the Queensland fruit fly (*Bactrocera tryoni*; Qfly) is also considered a very serious pest of a wide variety of fruit and vegetables. The presence of these flies in production regions has severe consequences on trade, both locally and internationally.

Both QFly and MedFly have short life cycles in warmer weather. Each has egg, larval (maggots), pupa (in soil) and adult stages. The larval stage is the most damaging as larvae feed within fruit or vegetable tissue. Secondary infections with fungi cause rot and decay around wounds. 'Stinging' sites (where eggs are laid) may also provide entry points for secondary organisms.

It is the falling of infested fruit/vegetables to soil that allows the life cycle of the flies to be continued as the pupation occurs in soil.

## What do they look like?

MedFly is 3-5 mm long, has a light brown body with mottled wings. The wings have distinctive brown bands extending to the tips. Larvae are creamy-white and about 7-8 mm long. The life cycle in warmer conditions is completed in about a month.

QFly is wasp-like and about 7-8 mm long, reddish brown, with yellow markings. Larvae are cream-white, legless, and they develop in three stages. They reach 9 mm in length. QFly prefers warm-hot and humid conditions for development.

## What can they be confused with?

The damage symptoms of Medfly and Qfly will aid in distinguishing them from other endemic fruit fly species.

Scott Bauer, USDA Agricultural Research Service, Bugwood.org

The adult Medfly is light brown and about 3-5 mm in length

G.T. OLoughlin, Department of Agriculture, Bugwood.org

Qfly adult laying eggs through fruit surface, which results in 'stinging sites' and allows the entry of pathogens

Division of Plant Industry Archive, Florida Department of Agriculture and Consumer Services, Bugwood.org

Medfly larvae feed in fruit and vegetables causing severe damage

## What should I look for?

Infested fruit and vegetables may show “sting” marks, indicative of egg-laying. Maggots found within any produce may indicate the presence of these fruit flies.

## How do they spread?

These flies are spread through the movement of maggot-infested produce. There should be no produce or green waste movement from known infested zones to fruit fly-free zones. The adult flies can also fly short distances.

## Where are they now?

Medfly is a pest in most parts of the world, including Western Australia. QFly is native to Australia, but it is not present in South Australia, Western Australia or Tasmania.

## How can I protect my farm from MedFly and QFly?

Dispose of rotten produce appropriately. Do not move any produce out of fruit fly infested areas. Early detections of fruit fly can be monitored using lure traps.

South Australia is a declared Fruit Fly Exclusion Zone. If an Medfly or Qfly is suspected, contact PIRSA through the Exotic Plant Pest Hotline.

**If you see anything unusual, call the Exotic Plant Pest Hotline**

EXOTIC PLANT PEST HOTLINE
**1800 084 881**

Division of Plant Industry Archive, Florida Department of Agriculture and Consumer Services, Bugwood.org

Medfly pupae, which develop in the soil following infested fruit falling from the tree

Pest and Diseases Image Library, Bugwood.org

Medfly wings have distinctive brown bands


K. Walker, Pest and Diseases Image Library

Qfly adults are 7-8 mm long and wasp-like in appearance

# Fact sheet

Plant Health AUSTRALIA

## Melon thrips

### What are Melon thrips?

Melon thrips (*Thrips palmi*) attack a wide variety of crops including beans, capsicum, cucumbers, eggplant, melons, pumpkin, squash and zucchini. Weed hosts include plants from the Cucurbitaceae and Solanaceae families. This pest is also known to be a potential virus vector.

### What do they look like?

Adult melon thrips are about 1.5 mm in length and are a yellow-orange colour. The adults have feather-like wings with black hairs along the fringe, which resembles a black line down the body of the thrip. Juveniles (nymphs) are smaller, paler in colour and wingless.

Melon thrips are found most often on the underside of leaves, in flowers and on fruit.

### What can they be confused with?

Melon thrips can be confused with other thrip species and are likely to be distinguished by a lack of response to current insecticides. If normal insect controls do not work, have the pest checked out by an expert.

### What should I look for

Infested plants will show an overall stunting. Leaf feeding of the thrips results in a silvery effect becoming present on the surface. Under high infestation levels there is a bronzing of the leaves and they later crinkle and die.

Fruit on infested plants are reduced in quality, normally through the development of scar tissue on the surface.

Edith Smith, Shady Oak Butterfly Farm

Melon thrips usually reside on the underside of leaves

J. Guyot, INRA, Pointe-à-Pitre, Bugwood.org

Heavy infestations cause leaf bronzing

Division of Plant Industry Archive, Florida Department of Agriculture and Consumer Services, Bugwood.org

Adult Melon thrips are a yellow-orange colour and 1.5 mm in length

## How do they spread?

Thrips can be spread as hitch-hikers on machinery, clothes and plant material.

The movement of certain produce from infested zones to 'clean' zones requires fumigation. Produce from the Northern Territory must be inspected by quarantine staff prior to entry into South Australia.

## Where is it now?

Melon thrips originated in Malaysia and Indonesia and have now spread to south-east Asia, Japan, Papua New Guinea, North America, the Caribbean islands, South America and Europe. In Australia, they are present in Darwin and South-East Queensland.

## How can I protect my farm from Melon thrips?

Regular monitoring for Melon thrips following after transplanting material increases the chances of detecting an infestation early. Report any thrips infestations that do not respond to commonly used controls, both chemical and biological.

**If you see anything unusual, call the Exotic Plant Pest Hotline**

EXOTIC PLANT PEST HOTLINE
**1800 084 881**

J. Guyot, INRA, Pointe-à-Pitre, Bugwood.org

Fruit infested with Melon thrips can show scarring

Plant Protection Service Archive, Bugwood.org

Adult Melon thrips have feather-like wings with black hair along the fringe

R. Mau, University of Hawaii

Affected leaves appear silvery as Melon thrips kill the leaf surface cells

Fact sheet

Plant Health AUSTRALIA

# Potato spindle tuber viroid

## What is Potato spindle tuber viroid?

Potato spindle tuber viroid (*Pospiviroid*; PSTVd) is a pathogen that poses a threat to potato, tomato and eggplant crops in Australia.

Symptom development is dependent on the strain of the viroid in conjunction with the host species and stage of development. In potatoes, severe PSTVd strains have caused losses of up to 65% in tuber number and size. In tomatoes, losses of 40-50% in yield have been reported.

## What does it look like?

Infected tubers have pointed ends, giving them a spindle shape with a round cross-section. Infected tubers are also often smaller than healthy ones.

Above ground symptoms of PSTVd infection of potato include a reduction in leaf size, thin stems which develop in a more upright manner, and an increase in the length of the internodes (stem regions between the leaves). These symptoms are usually only present under high infection levels.

Infection of tomato causes the foliage to become mottled, and yellow or purple, and the plants are stunted. Fruit produced from these plants is smaller, misshapen and will fail to ripen.

Symptoms can be mild at first but will become more severe with each successive generation.

## What can it be confused with?

PSTVd symptoms can be confused with nutrient deficiency or toxicity, spray damage, insect damage or plant viruses.

Central Science Laboratory, Harpenden Archive, British Crown, Bugwood.org

In tomatoes the virus causes severe yellowing of leaves

R.P. Singh, Bugwood.org

In potatoes the smaller leaves and thinner stems of infected plants (middle plant) are difficult to distinguish from healthy plants (left and right)

Plant Protection Service Archive, Bugwood.org

Infected tubers (right) are typically smaller than healthy tubers (left) and pointed at the ends

## What should I look for?

Above ground symptoms of leaf distortion and discolouration, together with modified growth patterns are normally only detected under heavy infection levels. Observation of the deformed potato tubers when harvested is the most likely method of detecting this pathogen.

## How does it spread?

Mechanical transmission of the viroid, for example by machinery, people, tools and clothing that has been in contact with infected plants, is the most likely method of spread.

## Where is it now?

The disease is present in Asia, Africa, North America, South America, Europe, and New Zealand.

PSTVd has been reported in tomatoes in the Northern Territory, Western Australia and New South Wales, as well as in potatoes in Victoria, New South Wales and South Australia. In each instance, eradication has been undertaken and has generally been successful. However, the viroid appears more persistent in Western Australia.

## How can I protect my farm from Potato spindle tuber viroid?

Farm hygiene is crucial in minimising the risk of PSTVd introduction through mechanical transmission. Only use planting material from reliable sources and ensure there is traceability on all seed supplies purchased.

**If you see anything unusual, call the Exotic Plant Pest Hotline**

**EXOTIC PLANT PEST HOTLINE**
**1800 084 881**

European and Mediterranean Plant Protection Organization Archive, Bugwood.org

PSTVd infection reduces the size and yield of potato tubers

William M. Brown Jr., Bugwood.org

Potato tubers showing symptoms of infection with PSTVd

Dr. Weidemann, Biologische Bundesanstalt für Land-und Forstwirtschaft, Bugwood.org

Reduced size and elongated shape of infected potato tubers

# Fact sheet

Plant Health AUSTRALIA

# Western flower thrips

## What are Western flower thrips?

Western flower thrips (*Franklinella occidentalis;* WFT) were introduced to Australia in the 1990s and have since impacted on vegetable production. They can attack a variety of field crops, but generally cause greater damage to greenhouse crops.

WFT is an efficient vector of Tomato spotted wilt virus (TSWV) and is harder to control than other thrips species in Australia.

## What do they look like?

WFT are small flying insects (1-2 mm in length), which are yellow to brown in colour. Adults have tiny, narrow wings carried over their back. Nymphs are similar in shape, pale yellow-orange, wingless and smaller than adults.

Eggs are laid in slits in leaves and growing points. Nymphs and adults feed in flowers and growing tips.

## What can they be confused with?

Due to their small size, thrips species cannot be distinguished with the naked eye. In particular, WFT cannot be easily distinguished from plague, tomato or onion thrips.

## What should I look for?

Detection of WFT usually occurs through trapping the insects or detecting plant symptoms, rather than direct observation of the insects.

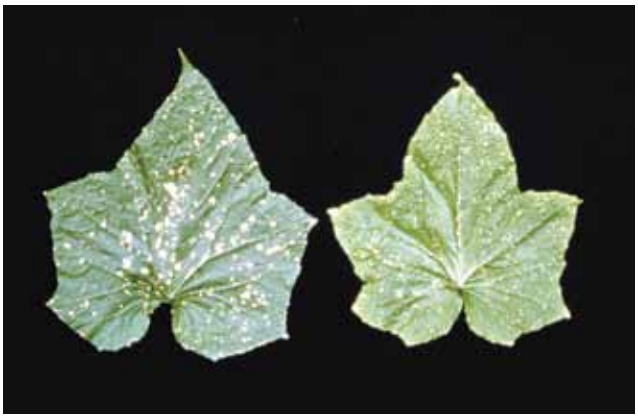
Infested crops can be damaged directly through feeding, which leads to leaf discolouration, deformed new growth and buds, and spotted foliage. However, the transmission of TSWV causes the greatest impact on vegetable crops. TSWV produces distinct symptoms in some hosts, such as ringspots, patterns, distortion of fruit and some leaf spots.

P.M.J. Ramakers, Applied Plant Research , Bugwood.org

WTF are yellow or brown in colour with bodies 1-2 mm long

William M. Brown Jr., Bugwood.org

Tomato fruit showing severe symptoms of Tomato spotted wilt virus, which is transmitted by WFT



P.M.J. Ramakers, Applied Plant Research , Bugwood.org

Spotted foliage caused by WFT has a coarser pattern (left) than damage caused by *Thrips tabaci* (right)

Look for TSWV symptom and thrips hotspots. Check population levels on yellow sticky traps and make routine examinations of leaves, flowers and fruit.

## How does it spread?

Spread occurs primarily with infested plant material or contaminated equipment. Short distance movement can occur through WFT flight, especially when assisted by wind.

## Where is it now?

WFT is native to North America but has now spread to most European countries, Japan, Kenya, South Africa, Hawaii, Costa Rica, Colombia, New Zealand and Australia.

## How can I protect my farm from Western flower thrips?

Ensuring plant material is clean and appropriately disposing of crop debris will reduce the risk of WFT and TSWV impacting on your farm. Where possible, source planting material raised in a WFT and TSWV free area.

Maintaining high levels of farm hygiene, controlling weeds and using mesh and double door entries to greenhouses minimises the threats posed by these pests.

Monitor all crops routinely for the presence of pests and use yellow sticky traps where possible.

P.M.J. Ramakers, Applied Plant Research , Bugwood.org

Eggs are laid in slits in the leaves

Whitney Cranshaw, Colorado State University, Bugwood.org

Feeding on leaves can lead to leaf discolouration

George Kelley, University of Kentucky, Bugwood.org

Close-up of the leaflets with areas of purple/brown tissue due to infection with TSWV

Fact sheet

Plant Health AUSTRALIA

# Currant-lettuce aphid

## What is Currant-lettuce aphid?

Currant-lettuce aphid (*Nasonovia ribisnigri;* CLA), also known as lettuce aphid, is a serious pest of lettuce, endive and chicory.

This pest attacks host plants at all stages of development and is primarily a problem because the colonisation of the inner leaves (and hearts of lettuce) render the product unmarketable. Due to this behavoir, CLA does not impact on fancy lettuce to the same extent as traditional head lettuce varieties.

CLA is also known to transmit Cucumber mosaic virus and Lettuce mosaic virus.

## What does it look like?

Adults (2-3 mm in length) have long legs and a spindle-shaped body, and may be present in either a winged or wingless form. Colouration of CLA is dependent on the host plant species, ranging from yellow to green, through to pink to red.

## What can it be confused with?

In the field, CLA is difficult to distinguish from other *Nasonovia* species. Be observant of the pest response to control programs.

## What should I look for?

Colonies of CLA may be visible on infested plants. However, CLA prefers to feed while hidden in the centre of host plants (particularly lettuces), and are generally found on the underside of leaves.

Affected lettuce leaf symptoms include leaf curling, stunting, blistering and abnormal colouring. Under heavy insect loads, lettuce hearts fail to form or die. Sticky honeydew can also be seen in leaves leading to sooty mould growth.

Whitney Cranshaw, Colorado State University, Bugwood.org

A wingless adult Currant-lettuce aphid

Whitney Cranshaw, Colorado State University, Bugwood.org

The winged adult has narrow dark bands on the abdomen

Whitney Cranshaw, Colorado State University, Bugwood.org

A colony of aphids at varying growth stages infest the underside of a leaf

## How does it spread?

Movement of winged adults in wind currents over relatively wide areas is the predominant means of dispersal for CLA. Movement can also occur with infested plant material.

## Where is it now?

CLA is found in Europe, North America, South America, New Zealand and all states of Australia.

## How can I protect my farm from Currant-lettuce aphid?

Maintain good farm hygiene practices to reduce the risk of introducing the aphid onto your property or into greenhouses. Once CLA is introduced it is difficult to eradicate.

Control volunteer lettuce/chicory plants and wild hosts (e.g. speedwall, prickly lettuce) on your property and plough in heavily infested lettuce crops as soon as possible.

If CLA becomes established on your farm, the pest can be managed through integrated pest management schemes and the use of resistant varieties. Chemical control is difficult due to the location of the aphid on plant material.

Stephen Ausmus

CLA colouration is dependent on the host plant

Whitney Cranshaw, Colorado State University, Bugwood.org

Light banding is present on the legs, antennae and body of the aphid

Whitney Cranshaw, Colorado State University, Bugwood.org

Leaf distortion of lettuce caused by CLA infestation

Fact sheet

Plant Health AUSTRALIA

# Greenhouse whitefly

## What is Greenhouse whitefly?

Greenhouse whiteflies (*Trialeurodes vaporariorum*) are a serious pest of most greenhouse vegetables and many ornamentals. These pests are able to complete their life cycle and feed on the underside of host plant leaves.

Both the adult and immature life cycle stages feed on the host plants sap. The immature nymphs are the most damaging and their feeding can cause yellowing and mottling of leaves. Honeydew excreted by the feeding insects promotes sooty mould growth.

## What does it look like?

The mobile juvenile instars are white to pale yellow and resemble scale insects. The juveniles become immobile and develop distinctive red eyes. At maturity, adults are small (about 1.5 mm long), white and moth-like in appearance.

## What can it be confused with?

Greenhouse whitefly is very similar in appearance to the Ash whitefly and Silverleaf whitefly, but the latter prefers a hotter climate.

## What should I look for?

Look for whitefly populations, which may include adults, larvae, nymphs and eggs, on the undersides of leaves. Infested plants usually become yellow (chlorotic) and they lose vigour with leaves dropping prematurely.

The presence of honeydew and the development of sooty mould on leaves is an indication of feeding activity.

David Cappaert, Michigan State University, Bugwood.org

Adult insects are white and around 1.5 mm in length

W. Billen, Pflanzenbeschaustelle, Weil am Rhein, Bugwood.org

Nymphs (depicted alongside an adult) are yellow/white with red eyes

Peter Bryant, University of California

Adults and nymphs are typically found on the underside of leaves

## How does it spread?

Whiteflies are spread with infested plant material and attached to people and equipment. Greenhouse whiteflies are not strong fliers and will not spread large distances without assistance.

## Where is it now?

Greenhouse whitefly is widespread in the southern states of Australia and it continues to cause problems in protected horticulture and nursery operations.

## How can I protect my farm from Greenhouse whitefly?

Monitor for the presence of Greenhouse whiteflies through the use of yellow sticky traps. Regular inspections of plant material, particularly the undersides of leaves, will also increase the chances of detecting populations early.

Maintain good farm and greenhouse hygiene measures, including checking clothing for the presence of whiteflies, and where appropriate changing them, before entering clean greenhouse and farm areas. Dispose of crop residues and waste appropriately, and remove volunteers and weeds prior to planting, to limit the breeding environments for this pest.

Peter Bryant, University of California

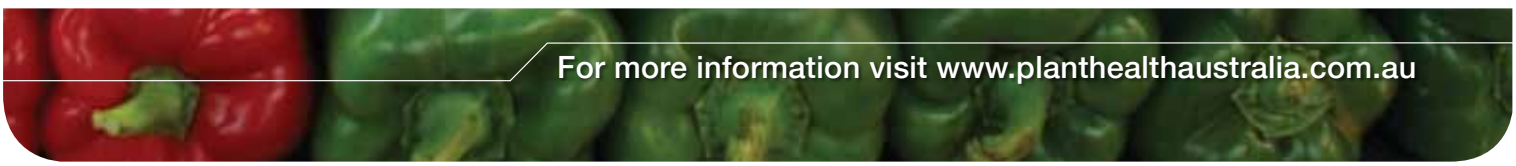
Pupa on the underside of a leaf

Peter Bryant, University of California

Pupae cuticles often remain on the underside of leaves after the departure of the young nymphs

Whitney Cranshaw, Colorado State University, Bugwood.org

Multiple life cycle stages can be found on an infested leaf



# Notes

**Plant Health Australia**
ABN 97 092 607 997
Suite 5, FECCA House
4 Phipps Close
DEAKIN ACT 2600

Phone 02 6215 7700
Fax 02 6260 4321
Email biosecurity@phau.com.au
www.planthealthaustralia.com.au

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