

Whitefly-transmitted viruses in vegetable crops

Integrated virus disease management



Adult silverleaf whitefly

Eggs and adult silverleaf whitefly

The whitefly is a small sucking insect related to aphids, leafhoppers and mealybugs.

Two species of whitefly are important pests in vegetable crops in Australia:

- the greenhouse whitefly (*Trialeurodes vaporariorum*)
- the silverleaf whitefly (*Bemisia tabaci*).

Whitefly prefer the undersides of young leaves and have the capacity for rapid reproduction when conditions are favourable. When leaves are disturbed in infested crops, clouds of white flying insects indicate their presence.

Both species of whitefly have a wide range of host plants among crops, weed species and ornamental plants. They damage plants by sucking the plant's sap causing reduced growth, stunting and yield reduction. Honeydew secretions from whitefly can result in the development of sooty mould on produce. The silverleaf whitefly injects toxic saliva while feeding, causing silvering of leaves in cucurbits and irregular ripening and blotching in tomato fruit.

The whitefly is also an important vector or carrier of viruses which result in enormous economic losses in vegetable, grain and fibre crops worldwide.

Although Australia is fortunate to be free of many of these whitefly-borne viruses, several viruses do occur and result in important crop losses. The nature and management of these virus diseases and their whitefly vectors is outlined below.

Bemisia tabaci exists as a number of strains or biotypes which are distinguished by host crops, responses to insecticides and DNA 'fingerprints'.

The silverleaf whitefly or B biotype arrived in Australia in the early 1990s and is now abundant in vegetable and field cropping areas in northern Australia. It has also been found in Perth and Carnarvon in Western Australia, and the north coast, Sydney basin, Narrabri and Riverina areas of New South Wales.

Biotype B is a serious pest in many vegetables including cucurbits, capsicums, tomato, eggplant, brassicas, lettuce, sweetpotato and beans. The insect has a high reproduction rate and a short generation time. It also has the ability to quickly develop resistance to insecticides.

Trialeurodes vaporariorum, the greenhouse whitefly has been present in Australia for many years. It favours temperate environments and is a common pest in greenhouses and other protected cropping situations.



Symptoms of Tomato yellow leaf curl virus on tomato



Cucumber yellows (Beet pseudoyellows virus)

Whitefly life cycle

The life cycles of the silverleaf whitefly and greenhouse whitefly are similar, although the two species prefer different temperature ranges for optimal development. The silverleaf whitefly prefers temperatures of 25°C to 30°C for development and rapid generation time while the greenhouse whitefly prefers temperatures of 20°C to 25°C.

Whitefly eggs are attached to the underside of the leaf surface, usually younger leaves. Eggs hatch in eight to 10 days. There are four immature or nymphal stages.

Crawlers or first instar nymphs crawl a short distance before settling to feed on plant tissue. Second and third instar nymphs are stationary and remain attached to the leaf surface where they feed until developing into the fourth and final nymphal stage. These fourth instar nymphs stop feeding, pupate and emerge from the pupal case as fully developed adults. The active adult whitefly is largely responsible for virus spread from plant to plant.

The silverleaf whitefly takes 18 to 28 days from egg to adult in warm weather and 30 to 48 days in winter.

At 22°C the greenhouse whitefly completes a life cycle in about 28 days.

Viruses spread by whitefly

Insect transmission of a virus is a specific biological process. A particular virus is transmitted by one vector type only and the viruses discussed below are transmitted only by whitefly and cannot be spread by aphids, thrips, leafhoppers or beetles. These viruses are not spread by contact, pruning or harvesting and do not survive in soil.

Begomoviruses

This large group of viruses are members of the Geminivirus family. The begomoviruses, named after *Bean golden mosaic virus*, are transmitted only by the silverleaf whitefly and cause major crop losses in vegetable, grain legume and cotton crops throughout tropical, subtropical and Mediterranean regions.

New begomovirus virus species continue to be found worldwide and these often result from genetic recombination between viruses present in plants as multiple infections.

Fortunately, few begomovirus occur in Australia. *Tomato yellow leaf curl virus* (TYLCV) is a recent incursion and was found in south east Queensland in 2006 and now causes serious crop losses throughout the region, particularly at Bundaberg. In 2011 the virus was found at Mareeba on the Atherton tableland.

Symptoms: Affected plants grow slowly and become stunted. Leaflets are rolled upwards and inwards and develop interveinal chlorosis. Leaves are often bent downwards and are stiff. Yield and fruit quality is reduced.

'The whitefly acquires TYLCV while feeding on sap from the phloem tissues of virus infected plants'

Virus spread: Although the immature nymphal stages of the silverleaf whitefly can acquire virus from infected plants, it is the active adult insects that are responsible for almost all virus spread into and within crops. The whitefly acquires TYLCV while feeding and sucking sap from the phloem tissue of virus-infected plants.

The insect needs to feed on an infected plant for at least 15 minutes to acquire the virus and then feed for 15 to 30 minutes to transmit the virus to another host plant. The efficiency of transmission increases the longer whitefly feed on plants.

After whitefly acquire TYLCV there is a period of up to 24 hours before the insect can transmit the virus. This is called a latent period and allows time for the virus to move through the insect into the salivary glands where it is available to mix with the saliva during feeding and be passed to another plant during subsequent feedings. After the latent period adults are generally able to transmit TYLCV for life.

Host plants: TYLCV can infect French beans, capsicum and several weed species. Tomato including infected transplants and old crops appear to be the major source of virus to start new infections.

A related virus, *Tomato leaf curl virus*, is endemic in northern Australia and causes sporadic losses in tomato crops in the Northern Territory. This virus has occasionally been detected in Cape York Peninsula and on the far northern tropical coast of Queensland. It has not been found in the major tomato production areas. Although the silverleaf whitefly can transmit this virus, natural spread is currently by a native whitefly species with a narrow host range and a limited capacity to disperse.

Cucumber yellows

Cucumber yellows disease is caused by the crinivirus *Beet pseudoyellows virus* and has probably affected greenhouse-grown cucumber crops in southern Australia for some years. However the extent of the problem has only become apparent in recent years as symptoms can be difficult to distinguish from those due to nutritional and environment disorders.

Symptoms: Older leaves of cucumber develop chlorosis or yellowing between the veins which remain green. Leaf margins of older leaves curl downward and necrotic or dead areas may develop between the veins. Symptoms progress to the younger leaves. Fruit set is reduced and severely affected plants are stunted. Many of these symptoms are not easily distinguished from nutritional and environmental disorders thus laboratory testing is often needed to confirm diagnosis.

Spread: *Beet pseudoyellows virus* (BPYV) is transmitted in a semi-persistent manner by the greenhouse whitefly. Insects can acquire the virus when feeding on infected plants for less than one hour and can transmit to another plant in several minutes while feeding. The virus is retained by the insects for several days. The virus is not seed-borne and is not spread by contact.

BPYV has a relatively wide host range including lettuce, beet, endive and common weeds including prickly lettuce (*Lactuca serriola*), nettleleaf goosefoot (*Chenopodium murale*), dandelion (*Taraxacum officinale*) and shepherd's purse (*Capsella bursa-pastoris*).

Tomato torrado disease

This disease is caused by *Tomato torrado virus* (ToTV), the type or reference species for a new group of plant viruses called Torradovirus. The virus has been found in glasshouse grown tomato crops on the North Adelaide Plain and at Lara in Victoria.

Symptoms: The early symptoms of *Tomato torrado virus* are necrotic or dead spots, surrounded by a light green or yellow area at the base of the leaflets. The affected areas may fall out, leaving holes (shot holes) in the leaflets. Necrosis and mottling extend to the remainder of the leaves. In very susceptible varieties, leaves become necrotic, wither and die.

The disease was first seen in Spain where growers called the disease 'torrado', meaning burned or roasted which describes the effects on severely affected plants.

'The virus can be spread from plant to plant by both the greenhouse whitefly and the silverleaf whitefly...'

The virus also causes necrotic streaks on stems while fruit may develop necrotic line patterns which often develop into cracks, making them unmarketable.

Host plants and spread: The virus can be spread from plant to plant by both the greenhouse whitefly and the silverleaf whitefly, although the former is currently responsible for spread in Australia. Transmission is most likely semi-persistent as discussed for *Beet pseudoyellows virus*.

ToTV is not spread by other insects such as thrips or aphids and is not spread by contact or pruning.

Capsicum and eggplant are host plants in Europe as are a range of broadleaf weeds. These include weed genera commonly found in southern Australia, for example *Amaranthus*, *Atriplex*, *Chenopodium*, *Malva*, *Polygonum*, *Nicotiana* and *Solanum*.

Biosecurity risk

Two of the three viruses discussed above have entered Australia in the last ten years indicating that new pathogen incursions can and do occur.

Begomoviruses are a particular threat as this group of viruses are common and very damaging on a wide range of crop plants throughout Asia. These viruses are all transmitted by the silverleaf whitefly which is present throughout northern Australia.

Although not carried in seeds, begomoviruses can enter Australia through infected plant material, whitefly infested produce or plants or in whitefly introduced via severe weather disturbances, e.g. cyclones.

Vegetable crops at risk from exotic begomoviruses include bean, cucurbits, capsicum, eggplant, sweetpotato and tomato.

Containment of whitefly transmitted viruses following an incursion is difficult due to the wide distribution, abundance and mobility of the whitefly vectors.

Criniviruses, **Ipomoviruses** and **torrado viruses** are also biosecurity risks to the Australian vegetable industry.

If unusual disease symptoms are seen, seek advice from a crop protection specialist or contact the Plant Health Australia hotline (1800 084 881).

Management of whitefly transmitted viruses

Integrated management methods that reduce or eliminate insecticide use are encouraged for whitefly management as these insects, particularly silverleaf whitefly, rapidly develop resistance to insecticides, resulting in management crisis. The aim is to maximise cultural and biological controls and minimise insecticide use.

Management methods are outlined below:

- Prevent seedling infestation by whitefly and virus infection—use netting or screening and isolation to maximise protection.
- Do not transport seedling transplants to other farms, districts or regions where whitefly and the viruses are not present. Each virus discussed in this note has a restricted distribution and movement of infested or infected transplants carries a high risk of moving the diseases to new areas.

Tomato torrado virus symptoms on leaflets



Tomato torrado virus on a susceptible tomato variety



Destroy old and abandoned crops promptly. Ensure that post harvest destruction of a crop will not result in mass migration of insects to young plantings. Apply an insecticide or oil spray to kill adult whitefly before crop destruction.

- Control weeds in and around crops and greenhouse areas as these host both whitefly and the viruses they spread. This should occur throughout the year and is critical in the month before planting.
- Where possible plant new crops upwind from old crops.
- Plant virus resistant varieties. The level of whitefly management needed to reduce virus infection below economic damage levels is higher than that usually required to manage damage from direct feeding and achieving this will often be a challenge. Resistant varieties are available for TYLCV and *Tomato torrado virus* and should be considered where these viruses are likely to be a problem. Measures to reduce disease and insect levels should still be used to reduce the chances of resistance-breaking strains developing and

overcoming virus resistance.

- Maximise biological control opportunities. Several parasitic wasps attack whitefly and are valuable management tools. *Eretmocerus hayati*, originally from Pakistan was released in Queensland in 2006 and is having significant effects on silverleaf whitefly populations in Queensland and parts of NSW. *Encarsia* species attack both silverleaf whitefly and the greenhouse whitefly with *Encarsia formosa* being used in integrated pest management programs for Greenhouse whitefly in protected cropping situations.
- Chemical control. Systemic insecticides applied as seedling drenches or pre-plant soil applications can be effective for silverleaf whitefly control.
- Apply insecticides to crops based on insect monitoring. Use registered insecticides targeted to the undersides of leaves and applied with calibrated equipment, small droplet size and high water rates. Select the most appropriate product for the growth stage of the whitefly and crop.



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Key points

- Silverleaf whitefly *Bemisia tabaci* B biotype is a major global pest and is widespread in northern Australia.
- In addition to direct damage from feeding, this species is the only carrier of begomoviruses which are common and extremely damaging worldwide.
- Tomato yellow leaf curl virus is a member of the begomoviruses group and causes serious crop losses in Bundaberg and other areas of south east Queensland.
- Australia is at risk from many damaging begomoviruses affecting vegetable crops overseas.
- The greenhouse whitefly *Trialeurodes vaporariorum* is favoured by temperate climates and is a common pest in greenhouse and protected cropping situations. It is also the carrier of *Beet pseudoyellows* virus which causes cucumber yellows and *Tomato torrado virus*, both of which occur in protected cropping in southern Australia.

More information

For more information, contact the Department of Employment, Economic Development and Innovation (DEEDI) on **13 25 23** or visit www.deedi.qld.gov.au

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