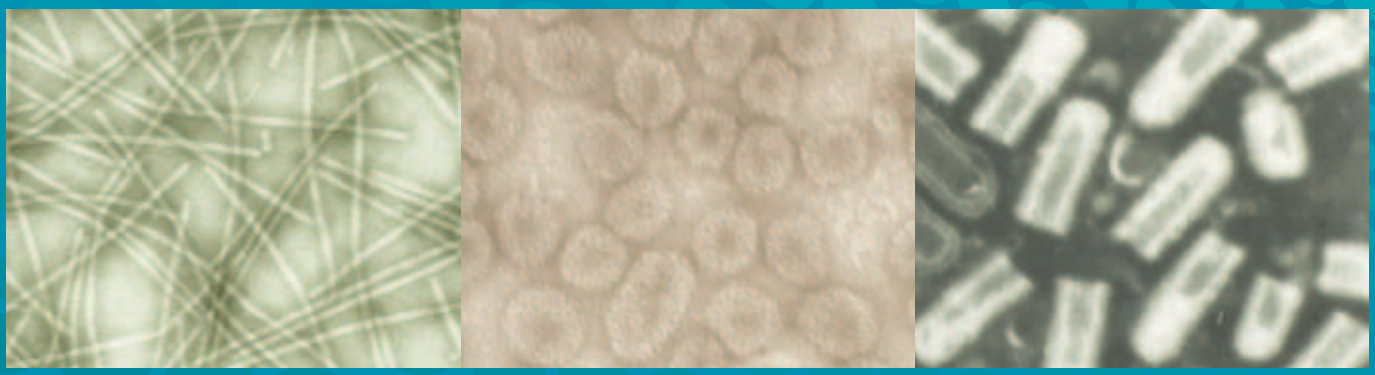
Department of **Employment, Economic Development and Innovation**
Agri-Science Queensland

Viruses in vegetable crops in Australia

Integrated virus disease management



Viruses are a major cause of loss in many Australian vegetable crops. Often the intricate relationships between the virus, host plants and the vector, or carrier, create problems in developing effective management systems. This reference note provides information on plant viruses and how they are transmitted, and lists viruses of importance to the Australian vegetable industry.

Summary

- most viruses infecting vegetables are transmitted by sap-sucking insects
- non-persistent transmission of viruses by insects is a rapid process
- persistent transmission takes several hours
- weed and other hosts are crucial in the life cycle of many viruses and their vectors
- infected plants cannot be cured—control aims to prevent or delay infection
- using a combination of management options can be successful in preventing infection.

What are viruses?

Viruses are minute, non-cellular pathogens that multiply within the cells of their hosts. This is usually to the detriment of the host and results in the development of disease symptoms.

Viruses are obligate parasites—that is, parasites that must live with their host or they die. Obligate parasites depend on the presence of a host to complete their life cycle.

A virus particle consists of a nucleic acid core, which contains the genetic information necessary for multiplication, surrounded by a protective protein coat.

How do plant viruses spread?

Viruses are immobile and rely on other organisms for dispersal.

Most plant viruses are transmitted from plant to plant by a living organism called a vector or carrier. The most important vectors are sap-sucking insects—aphids, whiteflies, thrips and leafhoppers.

Plant viruses can also be spread by:

- other insects (e.g. mealybugs, leaf chewing-beetles)
- mites (e.g. the eriophyid mite *Aceria tosichella* transmits Wheat streak mosaic virus)
- nematodes (e.g. the dagger nematode transmits Tobacco ringspot virus)
- fungi (e.g. *Olpidium virulentus* transmits Mirafiori lettuce virus)
- infected or contaminated seeds (e.g. Lettuce mosaic virus, Tomato mosaic virus)

(from left to right) Common carriers of plant viruses—whiteflies, aphids and thrips.

- infected pollen (e.g. Tobacco streak virus)
- infected vegetative propagating material, (e.g. Potato leaf roll virus is transmitted in tubers)
- contact between plants (e.g. Tomato mosaic virus).

Host plants

A virus has specific host plants and cannot infect all plant species with which it comes into contact.

Several viruses have a wide range of hosts—for example Tomato spotted wilt virus and Cucumber mosaic virus infect hundreds of different plant species. Papaya ringspot virus-type W, however, infects only cucurbits.

Plant viruses are generally named after the first host in which they were found, though this may not give a true indication of the importance of the virus to that host.

Celery mosaic virus.

Insect transmission

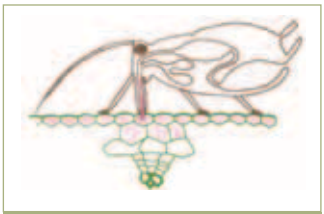
Insect transmission of a virus is a specific biological process. A particular virus is transmitted by one vector type only—for example an aphid or a whitefly, not both.

The most significant insect vectors of plant viruses are aphids, leafhoppers, whiteflies and thrips. All have piercing-sucking mouthparts that include a needle-like stylet that allows the insects to access and feed on the contents of plant cells.

During this feeding there is an exchange of insect saliva and plant cell contents.

As the insect stylet is inserted, saliva and virus particles can enter the plant cell. As the insect withdraws the cell sap, virus particles present within those cells are also acquired by the insect. Thus, if an insect has acquired virus particles from one plant, it can then deposit them in the next plant it feeds on, which leads to subsequent infection.

Persistent transmission
Insect needs to feed for several hours, often in food conducting tissues of plants, to obtain the virus.



Non-persistent transmission
Insect needs only very short feeding times, usually from tissues near the surface of leaves, to obtain the virus.

There are two broad categories of insect transmission:

- persistent
- non-persistent.

The terms relate to the length of time an insect takes to acquire and to transmit a virus and the length of time the insect remains capable of transmitting the virus.

How do viruses survive?

With very few exceptions, viruses cannot survive outside living host plants or insects.

Viruses survive adverse conditions and intervals between crop cycles in alternative annual and perennial weed hosts, volunteer crop plants, abandoned crops, infected seeds and vegetative plant parts. Persistently-transmitted viruses may also survive in the insect vector.

How can you manage virus diseases?

Plants cannot be cured once infected by a virus. Instead, disease control aims to prevent or delay the infection of plants.

No single method is likely to provide perfect control. Nevertheless, by using a combination of the following management options disease control can be successfully implemented.

Tomato mosaic is easily spread by contact and on contaminated seed.

Exclusion/avoidance

- plant virus-free seed and seedling transplants
- grow crops in regions where the disease seldom occurs or during periods when the virus or its vector are at a low level
- quarantine (international, state and regional).

Reduction in virus inoculum levels

- control weeds and other virus hosts and insect vectors
- destroy old crops promptly
- separate new crops from maturing crops and avoid overlapping crops, especially continuous year-round cropping.

Protection of the host

- plant virus-resistant or virus-tolerant varieties
- use highly reflective mulches and oil sprays to deter insects
- use barrier crops and bare land to reduce vector activity
- use insecticides strategically to protect plants from insects.

Virus management can be achieved by planting resistant varieties. The zucchini variety on the left is virus susceptible; the variety on the right is resistant.

Insecticides are more effective against persistently transmitted viruses because insects are killed before they have time to acquire and transmit the virus.

Vectors of non-persistent viruses will eventually be killed after feeding on plants sprayed with systemic insecticide. However, because these viruses can be transmitted within seconds, many plants become infected before the insect dies or moves out of the crop.

In fact, some insecticides agitate the insects and encourage movement and feeding of greater numbers of plants, resulting in increased transmission rates.

A key aspect of virus disease management is to accurately identify the virus causing the disease and then implement appropriate management strategies.

Important vegetable crops and the viruses infecting them

Crop/family	Virus	Means of transmission
Bean—Fabaceae	Bean common mosaic virus (BCMV)	Seed, aphids (non-persistent)
	Bean yellow mosaic virus (BYMV)	Aphids (non-persistent)
	Subterranean clover stunt virus (SCSV)	Aphids (persistent)
	Tobacco yellow dwarf virus (TYDV) (Bean summer death disease)	Leafhopper (*Orosius argentatus*), (persistent)
Brassicas—Brassicaceae	Beet western yellows virus (BWYV)	Aphids (persistent)
	Turnip mosaic virus (TuMV)	Aphids (non-persistent)
Capsicum—Solanaceae	Capsicum chlorosis virus (CaCV)	Thrips (persistent)
	Cucumber mosaic virus (CMV)	Aphids (non-persistent)
	Pepper mild mottle virus (PMMV)	Seed, contact
	Potato virus Y (PVY)	Aphids (non-persistent)
	Tomato spotted wilt virus (TSWV)	Thrips (persistent)
Carrot—Apiaceae	Carrot virus Y (CaVY)	Aphids (non-persistent)
Celery—Apiaceae	Celery mosaic virus (CeMV)	Aphids (non-persistent)
Cucurbits—Cucurbitaceae	Beet pseudoyellows virus (BSYV)	Whiteflies (*Trialeurodes vaporariorum*) (semi-persistent)
	Cucumber mosaic virus (CMV)	Aphids (non-persistent)
	Papaya ringspot virus—type W (PRSV-W)	Aphids (non-persistent)
	Squash mosaic virus (SqMV)	Seed, beetle
	Watermelon mosaic virus (WMV)	Aphids (non-persistent)
	Zucchini yellow mosaic virus (ZYMV)	Aphids (non-persistent), contact
Eggplant—Solanaceae	Tomato spotted wilt virus (TSWV)	Thrips (persistent)
Lettuce—Asteraceae	Cucumber mosaic virus (CMV)	Aphids (non-persistent)
	Lettuce mosaic virus (LMV)	Lettuce seed, aphids (non-persistent)
	Mirafiori lettuce virus (MiLV); Lettuce big-vein virus (LBVV) – (Lettuce big-vein disease)	Soil-borne fungus *Olpidium*; infested transplants, contaminated soil and hydroponic systems
	Lettuce necrotic yellows virus (LNYV)	Aphids (persistent)
	Tomato spotted wilt virus (TSWV)	Thrips (persistent)
	Turnip mosaic virus (TuMV)	Aphids (non-persistent)
Onion and related species—Alliaaceae	Iris yellow spot virus (IYSV)	Thrips (*Thrips tabaci*), (persistent)
	Onion yellow dwarf; Leek yellow stripe virus (OYDV; LYSV)	Aphids (non-persistent), infected garlic cloves and onion bulbs
Pea—Fabaceae	Bean yellow mosaic virus (BYMV)	Aphids (non-persistent)
	Pea seed-borne mosaic virus (PSbMV)	Seed, aphids (non-persistent)
	Subterranean clover stunt virus (SCSV)	Aphids (persistent)
Potato—Solanaceae	Potato leafroll virus (PLRV)	Aphids (persistent), infected seed tubers
	Potato virus X (PVX)	Contact
	Potato virus Y (PVY)	Aphids (non-persistent)
	Potato virus S (PVS)	Infected 'seed' tubers, contact
	Tomato spotted wilt virus (TSWV)	Thrips (persistent)
Sweet corn—Poaceae	Johnson grass mosaic virus (JGMV)	Aphids (non-persistent)
Sweet potato—Convolvolaceae	Sweet potato feathery mottle virus (SPFMV)	Aphids (non-persistent)

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(left, middle) Capsicum leaf and fruit affected by Tomato spotted wilt virus. (*right*) Zucchini plants severely affected by Papaya ringspot virus (typeW).

Persistent transmission:

- it takes several **hours** of **feeding** for an insect to **acquire** the virus
- the virus must circulate through the insect's body to the salivary glands before transmission can occur
- there is a latent period during which transmission cannot occur (while the virus particles travel through the insect's body)
- when the latent period is completed, the insect can then transmit the virus for many weeks or the rest of its life without needing to obtain more viruses from an infected plant.

There are two types of persistent transmission.

1. Non-propagative—virus circulates through the vector's body, but does not multiply. Examples are Potato leaf roll and Tomato yellow leaf curl viruses.

2. Propagative—virus needs to multiply in the cells of the insect vector before transmission can occur. The transmission latent period is normally longer with these viruses. Examples are Tomato spotted wilt and Lettuce necrotic yellows viruses.

Non-persistent transmission:

it takes **less than one minute** of **feeding** for an insect to **acquire** the virus

- virus particles remain on insect mouthparts for a few hours
- insect needs to re-feed on another infected plant if further transmission is to occur.

Among important vegetable viruses transmitted in this way are:

- Cucumber mosaic virus
- Celery mosaic virus
- Potato virus Y
- Papaya ringspot virus.

The silverleaf whitefly transmits Tomato yellow leaf curl virus (*left*). The greenhouse whitefly transmits Beet pseudoyellows virus (cucumber yellows).

Crop/family	Virus	Means of transmission
Tomato—Solanaceae	Capsicum chlorosis virus (CaCV)	Thrips (persistent)
	Cucumber mosaic virus (CMV)	Aphids (non-persistent)
	Potato virus Y (PVY)	Aphids (non-persistent)
	Potato leafroll virus (Tomato yellow top virus) (PLRV)	Aphids (persistent)
	Tomato spotted wilt virus (TSWV)	Thrips (persistent)
	Tomato mosaic virus (TMV)	Contact, contaminated seed and equipment, tomato crop debris
	Tomato leaf curl virus (Australia) (TLCV); Tomato yellow leaf curl virus (TYLCV)	Whiteflies (*Bemisia tabaci*)

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