

Aphid-transmitted viruses in vegetable crops

Integrated virus disease management

The majority of viruses infecting plants are spread by insects, and aphids are the most common group of virus vectors or carriers. All potyviruses (the largest group of plant viruses) are transmitted by aphids.

Aphids are sap-sucking insects and have piercing, sucking mouthparts. Their mouthparts include a needle-like stylet that allows the aphid to access and feed on the contents of plant cells. During feeding, aphids simultaneously ingest sap contents and inject saliva, which can contain viruses if the aphid has previously fed on an infected plant.

The structure of aphid mouthparts, their searching behaviour for host plants, the range of available host plants and high reproductive rates contribute to the efficiency of aphids to act as virus carriers.

Aphid transmission

Transmission of a virus by insects is a specific biological process. A particular virus is transmitted by one carrier group only—for example aphids or whiteflies, not both.

The two broad categories of aphid transmission are:

- non-persistent
- persistent or circulative.

These terms relate to the length of time an aphid takes to acquire and then transmit a virus, and the length of time the aphid remains capable of transmitting the virus.

Non-persistent transmission

- It takes less than one minute of feeding for an aphid to acquire the virus and the same short time to infect another plant when feeding.
- Viruses remain viable on aphids mouthparts for a few hours only.
- When an aphid loses the virus from its mouthparts when feeding it has to feed again on another infected plant to obtain a new 'charge' of virus before it can infect other plants.

Persistent transmission

- It takes several hours of feeding for an aphid to acquire a virus.
- The virus must circulate through the aphid's body to the salivary glands before transmission can occur. This period is at least 12 hours.
- Once an aphid can transmit the virus it is able to do so for many weeks or the rest of its life without needing to obtain more virus from an infected plant.
- The virus is retained in the aphid's moult (shedding of outer cover or cuticle during growth stages).

A virus can only be transmitted by an aphid in one way—non-persistent or persistent



Left to right: Johnson grass mosaic virus symptoms on a corn leaf; papaya ringspot virus on a pumpkin; celery mosaic disease



Non-persistent transmission

The insect needs only very short feeding times, usually from tissues near the surface of leaves, to obtain the virus.



Persistent transmission

The insect needs to feed for several hours, often in food-conducting tissues of plants, to obtain the virus.

Table 1: Some important vegetable crop viruses spread by aphids in a non-persistent way

Crop	Virus
Bean	Bean common mosaic virus
Brassicas	Turnip mosaic virus
Capsicum	Cucumber mosaic virus, Potato virus Y
Carrot	Carrot virus Y
Celery	Celery mosaic virus
Cucurbits (cucumber, squash, pumpkin, watermelon, rockmelon and zucchini)	Papaya ringspot virus (W strain), watermelon mosaic virus, zucchini yellow mosaic virus
Lettuce	Lettuce mosaic virus
Sweet corn	Johnson grass mosaic virus
Sweetpotato	Sweetpotato feathery mottle virus

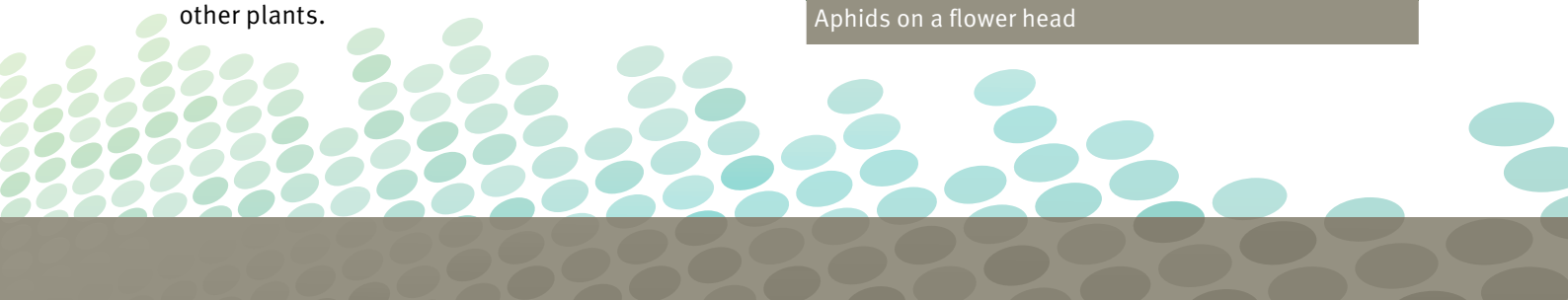
The majority of aphid-transmitted viruses affecting vegetables are transmitted in a non-persistent way.

It is difficult to manage viruses transmitted in this way:

- A large number of aphid species can generally transmit non-persistent viruses, including those that may only feed on hosts unrelated to the particular crop species.
- A significant amount of virus is spread when aphids move through a crop and briefly feed as they search for attractive hosts. These aphids do not settle or colonise the affected crop, and their presence generally remains undetected, despite their efficiency as virus carriers.
- Insecticides are not usually effective in controlling non-persistent, aphid-transmitted viruses because the viruses can be spread from plant to plant in a less than a minute. Although the aphid may eventually be killed by insecticide, considerable virus spread will have already occurred. Also, aphid movement from plant to plant is accelerated by the presence of insecticide on the leaves, which increases transmission to other plants.



Aphids on a flower head



Management of non-persistent viruses

Plants cannot be cured once infected by a virus. Instead, disease management aims to prevent or delay the infection of plants and minimise economic losses.

Although no single method is likely to provide adequate control, integrating several management options will often provide effective control.

Exclude or avoid the virus

- Plant virus-free seed and healthy seedling transplants, cuttings and tubers. This is a key management tool as infected seeds, transplants or tubers introduce viruses at a very early stage of crop growth and provide a source of virus that can be further spread by aphids.
- Grow crops in regions where the virus seldom occurs or during periods when the virus or aphids are at a low level (e.g. this measure is often used in the production of potato seed tubers).
- Australia remains free of many serious diseases because of our strong quarantine regulations. It is in everyone's interests that any introductions of seeds or plant material from overseas should be in accordance with Australian Quarantine and Inspection Service regulations.
- Avoid movement of transplants with possible virus infection or aphid infestation between regions, as this practice can very easily introduce a virus into another production area.

Reduce virus levels

- Control weeds and other hosts of viruses and aphids around crops, headlands and farm buildings etc.
- Destroy old crops promptly, as these often have a high level of viral infection and are an important source of infection for new crops.
- Do not plant new crops next to old, diseased plantings as these provide a nearby source of the virus, which will rapidly spread to the new crop. Separate new crops from maturing crops and avoid overlapping crops and side-by-side plantings, especially continuous year-round cropping.
- Plant upwind of potential virus sources to reduce the numbers of aphids moving from sources of infection to young crops.

Protect the crop

- Plant virus-resistant or virus-tolerant varieties. These are available for some virus/host combinations (e.g. the three potyviruses infecting zucchini and pumpkin, and potato virus Y in capsicum).



Mosaic symptoms on zucchini

- Use highly reflective mulches and oil sprays to deter aphids from landing and feeding, and interfere with probing/feeding patterns. Straw mulch on the soil surface also deters landings. These methods delay virus infection rather than totally prevent it. Reflective and straw mulches become ineffective once plant growth covers most of the mulch. Oil sprays need to be applied at least weekly with good coverage of leaf surfaces, including young, recently unfolded leaves.
- Use tall barrier crops, windbreaks and bare land to reduce the numbers of aphids entering the crop. Aphids landing on plants in windbreaks and barrier crops can lose the virus from their mouthparts before they move on, or they may remain trapped in the barrier plants and not move into the virus-susceptible crop. Bare land without weeds and volunteer crops between plantings can reduce the numbers of aphids entering a crop. A distance of about 25 m is useful, but larger distances are more effective.
- Row covers have been successfully used for some crops to protect plants from aphids until flowering (when covers are removed to allow pollination). Preventing infection at the vulnerable early growth stage often allows plants to escape severe virus symptoms and can reduce final infection levels and minimise economic losses.
- Although appropriate insecticides are usually very effective in killing aphids breeding on plants and can provide good control of viruses transmitted in a persistent manner, they are usually ineffective in preventing the spread of non-persistent viruses. This is because of the extremely short feeding times needed to transmit non-persistent viruses from plant to plant. As aphids move through a crop and briefly probe, by the time an aphid receives a lethal dose of insecticide it will often be long gone and the damage already done. Some insecticides agitate aphids and encourage greater movement and feeding, resulting in increased rates of virus spread.

More information

For more information, contact the Department of Employment, Economic Development and Innovation (DEEDI) on 13 25 23.

For a copy of *Viruses in vegetable crops in Australia* (2009), contact DEEDI on 13 25 23.

You can also purchase *Diseases of vegetable crops in Australia* (eds Persley, Cooke & House 2010) from CSIRO Publishing at www.publish.csiro.au

This technical reference note has been produced by Denis Persley and Cherie Gambley (DEEDI) as part of the Horticulture Australia Limited project VGo 7128-Integrated management of viral diseases in vegetables.

