# Protect your nursery from virus diseases

Chlorotic ringspots on Spathiphyllum infected with *Impatiens necrotic spot virus*.

*Almost every plant species can be infected with one or more viruses and can be associated with major economic loss. Symptoms can be extremely varied and are often mistaken for disorders caused by nutritional or environmental conditions or fungal or bacterial pathogens. Infected plants cannot be cured and should not be sold. Management of viruses in production nurseries focuses on preventing infection through best management hygiene and propagation practices and weed management.*

*All viruses are spread by cuttings taken from of infected plants. Some viruses are spread in other ways including by certain insect groups, seed, secateurs, touching infected plants or even rubbing infected leaves against healthy plants. Therefore it is important to have viruses present in a nursery identified to manage outbreaks most appropriately.*

*This factsheet covers the biology of plant viruses including how they are spread, symptoms that are produced by viruses, cultural practices that help prevent infections and how to manage an infestation once it has occurred.*

Hort Innovation NURSERY FUND

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## WHAT ARE PLANT VIRUSES?

Viruses are minute, non-cellular pathogens which multiply within the cells of their hosts; they can only be seen using an electron microscope. Virus infections usually harm their host and result in plants becoming unsaleable. Viruses are obligate parasites and cannot multiply outside of a host cell nor be cultured on any growth media. Plants infected with viruses cannot be cured.

*Tomato spotted wilt virus* on clematis

## 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. Plant viruses can be spread in the following ways:

- Infected vegetative propagating material. Plant viruses usually cause systemic infection and any plant part used for propagation will carry the virus e.g. budwood, cuttings, bulbs, corms.
- Contact between plants (e.g. *Tomato mosaic virus*, *Cymbidium mosaic virus*).
- Some viruses are mechanically transmitted with secateurs, on hands or clothing, others are not.
- Infected or contaminated seeds (e.g. *Lettuce mosaic virus*; *Tomato mosaic virus*).
- Insects, particularly aphids, whiteflies, thrips and mealybugs. Sometimes leafhoppers and beetles can spread specific viruses.
- Certain mites can transmit viruses including eriophyid mites and flat mites, e.g. *Brevipalpus californicus* transmits *Orchid fleck virus*.
- Nematodes (e.g. dagger nematodes transmits *Grapevine fan leaf virus*).
- Fungi (e.g. *Olpidium virulentus* transmits *Mirafiori lettuce virus* which causes lettuce big vein disease).
- Infected pollen (e.g. *Prunus necrotic ringspot virus* in *Prunus* species)

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. The exception to this rule is *Tobacco mosaic virus* (TMV) which is a serious pathogen in production nurseries, that can survive in dead plant material and on equipment potentially for several months.

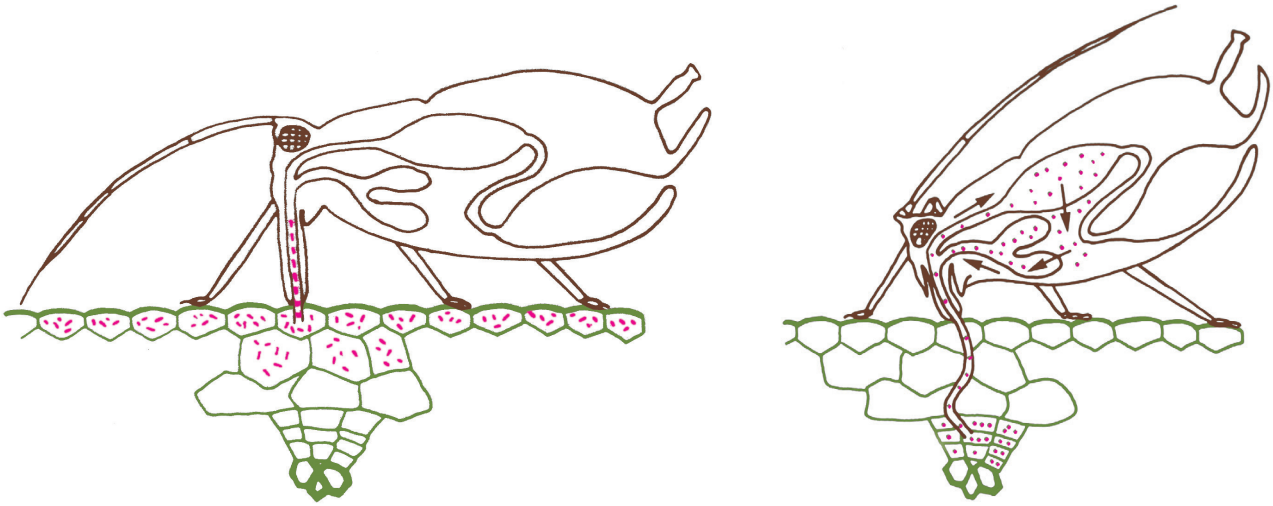
### INSECT TRANSMISSION

Transmission of viruses by an insect is a specific biological process. A particular virus is transmitted by one vector type only, e.g. an aphid, a whitefly or a thrips. If a virus has an insect vector, it is transmitted by only one insect group. In other words, if aphids transmit the virus, it will not be transmitted by whiteflies, thrips or any other insect.

As mentioned above, the most important insect vectors of plant viruses are aphids, whiteflies, thrips and leafhoppers. All have piercing-sucking mouthparts that include a needle-like stylet which allow the insects to access and feed on the contents of plant cells.

Two broad categories of insect transmission are recognised: non-persistent and 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. Non-persistent transmission is very rapid while persistent transmission takes at least several hours.

In **non-persistent transmission**, an insect feeding time of less than one minute is enough for the virus to be acquired from an infected plant or transmitted to another plant. The virus particles are usually only retained on the insect's mouthparts for a few hours, after which the insect needs to feed again on an infected plant to obtain more virus if further transmission is to occur. Many important viruses are transmitted in this way, including *Cucumber mosaic virus* and *Turnip mosaic virus*.



Non-persistent transmission (left) of viruses occurs quickly. Feeding from tissues near the surface of leaves is sufficient to obtain the virus. Persistent transmission (right) occurs over a longer period of time; the insect needs to feed for several hours, often in food-conducting tissues of the plant to obtain the virus.

In **persistent transmission**, the insect needs to feed on an infected plant for several hours to acquire the virus, which then must circulate through the insect's body to the salivary glands before transmission can occur. As a result, there is a latent period, or lag time 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 virus particles from an infected plant. This form of transmission is also known as circulative transmission because of the circular pathway the viruses take through the insect's body. Viruses transmitted in this way include *Potato leaf roll* and *Tomato yellow leaf curl viruses*.

## HOST PLANTS AND SYMPTOMS

A virus has specific host plants that it can infect. Several virus species have very wide host ranges, for example, *Tomato spotted wilt virus* and *Cucumber mosaic virus* (Table 1). Conversely, *Papaya ringspot virus*-type W infects only members of the cucurbit family. Plant viruses are generally named after the first host in which they were found and this may not give a true indication of the importance of the virus to that host.

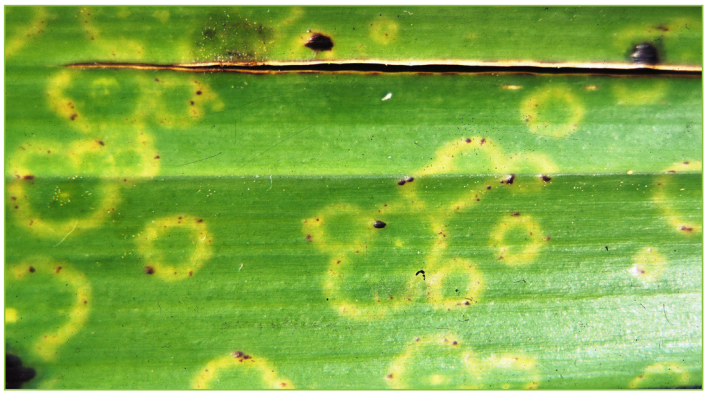
Plants develop a wide of range of symptoms following virus infection (see all pictures). These include mosaic and mottle patterns on leaves, roughly circular chlorotic or necrotic ringspots on leaves and fruit, patterns of discolouration on flowers called colour break and chlorosis or yellowing of leaves. Other symptoms include tissue death or necrosis, leaf rolling, deformed leaves and stunting.

Not all of these symptoms are always the result of virus infection and may be caused by nutritional issues, growing conditions or other pathogens, particularly phytoplasmas.

Virus symptoms can be very confusing. The same virus can produce very different symptoms on different host plants or on different plant parts of the same plant species. In addition, certain viruses can produce very different symptoms on different plant species and sometimes different viruses can produce the same symptoms and may have different management actions.

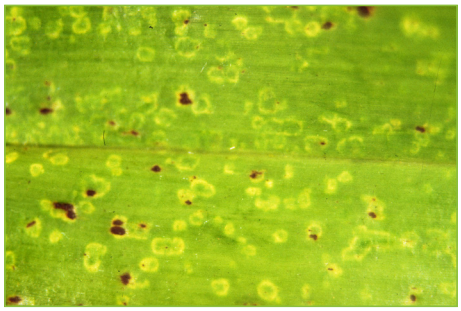
This similarity in symptoms across viruses and host plants emphasises the importance of accurate identification of the virus causing the problem before implementing control measures.

*Orchid fleck virus* on *Oncidium*



*Orchid fleck virus* on *Cymbidium*

*Odontoglossum ringspot virus* on *Cattleya*



*Odontoglossum ringspot virus* on *Cymbidium*

Colour break caused by *Odontoglossum ringspot virus* on *Cattleya*

## IDENTIFYING VIRUSES

Virus identification requires specialised testing to be completed by diagnostic laboratories. Most virus tests detect a single virus species, or perhaps a group of closely related viruses, e.g. potyviruses. There are no tests available that can detect any and all viruses that could potentially be present in a plant. Therefore, plant virologists use knowledge of the host plant, symptoms, the geographic location and other information to test for virus species that are most likely to be infecting the plant. Accurate identification is important as it can direct management actions to reduce spread and losses.

If you suspect that a plant is infected by a plant virus contact a diagnostic laboratory with virus expertise. All Australian production nurseries receive 6 free samples per calendar year until the end of 2025 at Grow Help Australia. If in doubt, send photos of virus symptoms to receive a better idea of whether it is worth submitting samples for testing.

Perhaps the two most common viruses in production nurseries are *Tobacco mosaic virus* (TMV) and *Tomato spotted wilt virus*.

Tomato infected with *Tomato yellow leaf curl virus*

### TOBACCO MOSAIC VIRUS (TOBAMOVIRUS GROUP)

TMV has an extremely wide host range (Table 1), is present throughout the world and is spread between plants very easily. Common symptoms include distorted new growth, stunting, leaf curling, chlorotic foliage (mosaic and mottle) and necrotic leaf spots. Dark green areas of mottled foliage may appear thicker and somewhat raised giving a blister-like appearance. Infected plants often have reduced fruit set and may sometimes have blemishes or distorted fruit. Plants may be 'dwarfed' and flowers may also be discoloured. Different host plant species display different symptoms which can mask the overall problem and allow the problem to spread. It can even be present in weeds without symptoms and be spread to nursery stock. Furthermore, symptoms can be influenced by abiotic conditions, including temperature, light, nutritional factors and water stress.

TMV is not spread by insects. Contact is the major means of spread. The virus can be spread simply by touching infected leaves followed by handling healthy plants. Infected leaves rubbing against healthy plants can also spread the disease. TMV can be spread on clothes, contaminated implements, e.g. cutting knives, secateurs etc. TMV survives in dead plant material, including decomposing plant matter and in cigarettes. As such, strict hygiene measures should be put in place to eliminate spread of the virus from employees after cigarette breaks (refer to decontamination section). TMV has been shown to survive for up to 4 months on equipment that is not exposed to UV radiation and can infect healthy plants if they contact the contaminated equipment.

Management of TMV must be treated very seriously. If TMV is detected in nursery stock it is recommended to test all mother stock plants of all potentially infected hosts for presence of the virus. Any plant testing positive for the disease should be discarded immediately. Be sure to collect material for testing in a hygienic manner so as not to spread the disease to healthy plants (refer to decontamination section below). *Tomato mosaic virus* (ToMV) is a very closely related virus, also with a wide host range and identical

Petunia infected with *Tobacco mosaic virus*

Kalanchoe infected with *Impatiens necrotic spot virus*

management strategies. However, ToMV is not spread through cigarettes.

The entire growing area should be decontaminated following an infestation of TMV including benches, shadehouses and polytunnels and any area which has come in contact with infected plants. Any employee that has touched cigarettes, cigarette packets or lighters should wash their hands in milk-powder or another appropriate product before commencing work.

### *TOMATO SPOTTED WILT VIRUS* AND *IMPATIENS NECROTIC SPOT VIRUS* (TOSPOVIRUSES)

There are two economically important tospoviruses that are serious nursery pathogens, *Tomato spotted wilt virus* (TSWV) and *Impatiens necrotic spot virus* (INSV). Both can infect a very large number of host plant species (Table 1), produce similar symptoms and have similar biology. They are vectored by thrips, particularly western flower thrips (*Franklinella occidentalis*), tomato thrips (*F. schultzei* species complex), melon thrips (*Thrips palmi*) and onion thrips (*T. tabaci*). Tospoviruses are not spread by seed, secateurs or equipment, manual handling or plant rub and do not survive in soil or decaying crop residues.

TSWV occurs throughout Australia. *INSV* is a relatively new virus introduction and has been found in Victoria and New South Wales. This is likely to change over time, particularly if virus infected plants are sold. Do not sell plants that are suspected to be infected with a virus. Management of weeds is of critical importance because both of these viruses can infect many weeds and may not produce symptoms in weed hosts.

Impatiens infected with *Tomato spotted wilt virus*

## VIRUS DISEASE MANAGEMENT

Plants cannot be cured once infected by a virus; disease control must be focussed on preventing infection of nursery plants. No single method alone is likely to provide good control and therefore using as many actions as possible will increase success.

### EXCLUSION/AVOIDANCE

- Quarantine plants for a period of time when you first receive them. Inspect for signs of pests or diseases before inclusion in the rest of the nursery. The exact length of time will vary depending on the host plant and size, risk and purpose.
- Grow virus-free seed from accredited sources where possible
- Grow crops in regions where the disease seldom occurs or during periods when the virus or its vector are at a low level.

- Grow crops in insect-proof protected structure, particularly using UV absorbing materials that reduce the rate of insects entering the structures.

### REDUCTION IN VIRUS INOCULUM LEVELS

- Manage weeds proactively
- Discard unsaleable stock and 'pet' plants hygienically, offsite by deep burial.
- Do not discard infected plants in a compost heap on-site; this practice could lead to reinfestation of the virus to stock plants
- Physical separation of new crops from maturing crops and avoiding overlapping crops where possible, particularly when managing an outbreak
- Grow virus resistant or tolerant varieties
- Using highly reflective mulches and oil sprays to deter insect vector feeding
- Barrier crops and bare land to reduce vector activity
- Strategic use of insecticides can protect plants from the virus insect vectors, particularly during high risk periods
- Insecticides are more effective against persistently transmitted viruses because insects are killed before they have time to acquire and transmit

Vectors of non-persistent viruses will eventually be killed after feeding on plants sprayed with systemic insecticide. However, because these viruses may be transmitted within seconds, many plants may become infected before the insect dies or moves out of the crop. In fact, some insecticides agitate the insects and encourage movement and feeding on greater numbers of plants, with a resulting increase in transmission rates.

*Hoya* infected with *Capsicum chlorosis virus*

## DECONTAMINATION OF HANDS AND EQUIPMENT

There are a range of methods to decontaminate tools, work areas, hands and other equipment, which is particularly important for viruses that are transmitted mechanically. Trisodium orthophosphate or 0.6% sodium hypochlorite can be very effective at eliminating viruses on secateurs and other small equipment. Sodium hypochlorite should be rinsed off using clean water after 5–10 minutes to reduce corrosion. Milk powder (20% (wt./vol) of non-fat milk powder), is effective against TMV and other Tobamaviruses. Milk powder has the advantage of being non-toxic on skin for cleaning hands and is not corrosive, unlike bleach and some other products, and binds Tobamovirus particles almost instantly. However care must be taken owing to intolerances and allergies. Appropriate safety procedures should be put in place for all of these products.

It is recommended to have more than one pair of secateurs and to leave at least one pair in the decontaminant while using another. The exact length of time will depend on the product and the concentration. As with TMV, decontaminate the working area thoroughly with an appropriate product.

Cucurbit infected with *Papaya ringspot virus*

## VIRUS BIOSECURITY THREATS

There are many virus species which are not recorded in Australia which would cause substantial economic loss if introduced. If the virus is detected at an early stage it is possible to eradicate it from Australia.

It is therefore very important to identify unusual symptoms observed by sending samples to a diagnostic laboratory, particularly when importing plants. If you see anything unusual, contact your local agricultural department or call the Exotic Plant Health Hotline on 1800 084 881.

### FURTHER READING

- Tospovirus
- Potyvirus
- Webinars on virus management in production nurseries and thrips
- Weed management

**TABLE 1. SOME IMPORTANT VIRUSES THAT CAN AFFECT NURSERY CROPS IN AUSTRALIA, THEIR MEANS OF SPREAD AND OVERVIEW OF PLANT SPECIES THEY CAN INFECT. THIS IS NOT A COMPREHENSIVE LIST.**

| VIRUS (VIRUS GROUP) | MEANS OF SPREAD | IMPORTANT CROP HOSTS |
|---|---|---|
| *Alfalfa mosaic virus* (Alfamovirus) | Seed, propagation, mechanical, aphids (non-persistent) | Very wide host range including *Solanum* sp., *Nicotiana* sp., Capsicum, cucurbits, hibiscus, tomato, *Petunia* sp., beans, peas, *Vinca* sp., *Zinnia* sp. |
| Bean *yellow mosaic virus* (Potyvirus) | Aphids (non-persistent) | Beans, peas, gladiolus, lisianthus, *Nicotiana* sp. *Freesia* sp., clover, vetch |
| *Beet yellows virus* (Polerovirus) | Aphids (persistent) | Brassicas, lettuce, legumes, brassica weed species |
| *Cucumber mosaic virus* (Cucumovirus) | Seed, vegetative propagation, aphids (non-persistent) | Infects over 150 plant species including chrysanthemum, salvia, geranium, gladiolus, heliotrope, hyacinth, larkspur, lily, marigold, morning glory, nasturtium, periwinkle, petunia, phlox, snapdragon, tulip, and zinnia. Vegetables infected include cucurbits, tomato, spinach, celery, peppers, water cress, beet, sweet potato, turnip, beans, onion, eggplant, potato, carrot, parsley, milkweed and various weed species. |
| *Cymbidium mosaic virus* (Potexvirus) | Propagation, mechanical including contact between plants. | Main hosts are orchids including *Cymbidium* sp. *Cattleya* sp.,*Phalaenopsis* sp., *Vanda* sp., *Epidendrum* sp, *Laelia* sp., *Laeliocaltleya* sp. *Oncedium* sp., *Zygopetalum* sp. |
| *Dahlia mosaic virus* (Caulimovirus) | Propagation, mechanical, aphids (non-persistent) | *Dahlia* sp., *Ageratum* sp., *Zinnia* sp., *Amaranthus* sp., *Nicotiana* sp., *Gladiolus* sp. |
| *Hippeastrum mosaic* virus (Potyvirus) | Propagation, aphids (non-persistent) | *Hippeastrum* spp., *Eucharis* sp., *Nicotiana* sp., *Petunia* sp. |
| *Impatiens necrotic spot virus* (Tospovirus) | Propagation, thrips (persistent) | Very wide host range including ornamental, vegetable and weed species. |
| *Poinsettia mosaic virus* (Tymovirus) | Mechanical and propagation. | *Euphorbia* (poinsettia) sp., *Nicotiana* sp., *Datura* sp. |
| *Prunus necrotic ringspot virus* (Ilarvirus) | Seed, propagation, mechanical, pollen | *Prunus* sp., rose, *Vinca* sp., *Zinnia* sp., *Petunia* sp., *Helianthus* sp. |
| *Tobacco mosaic virus* (Tobamovirus) | Seed, propagation, mechanical including contact between plants | Very wide host range including chrysanthemum, *Datura* sp., delphinium, wisteria, tomato, capsicum, *Nicotiaana* sp., *Petunia* sp. plants, orchids, *Calibrachoa*, cyclamen, gerbera, helianthus, impatiens, lisianthus and penstemon, and many other solanaceous plants. |
| *Tomato spotted wilt virus* (Tospovirus) | Thrips (persistent) propagative) | Very wide host range including ornamental, vegetable and weed species, e.g. *Aster* sp, *Amaranthus* sp., *Petunia* sp., *Primula* spp. chrysanthemum, cyclamen, gerbera, hydrangea, geranium, tomato, capsicum, cucumber, celery, beans, lettuce, *Solanum* sp., *Verbena* sp. and many others. |
| *Turnip mosaic virus* (Potyvirus) | Propagation, aphids (non-persistent) | Wide host range including, *Datura* sp., *Nicotiana* sp., *Physalis* sp., anemone, nasturtium, petunia, statice, wallflower, zinnia, brassicas and cruciferous weeds |

*Prepared by Denis Persley and Andrew Manners(Agri-science Queensland, Department of Agriculture and Fisheries (DAF) in 2024. This fact sheet was produced as part of a Hort Innovation, Nursery levy and DAF funded project, NY20000 Resourcing, supporting, and assessing biosecurity in nursery production. This is an update of an earlier version of the factsheet produced in 2014. All photographs by DAF.*