

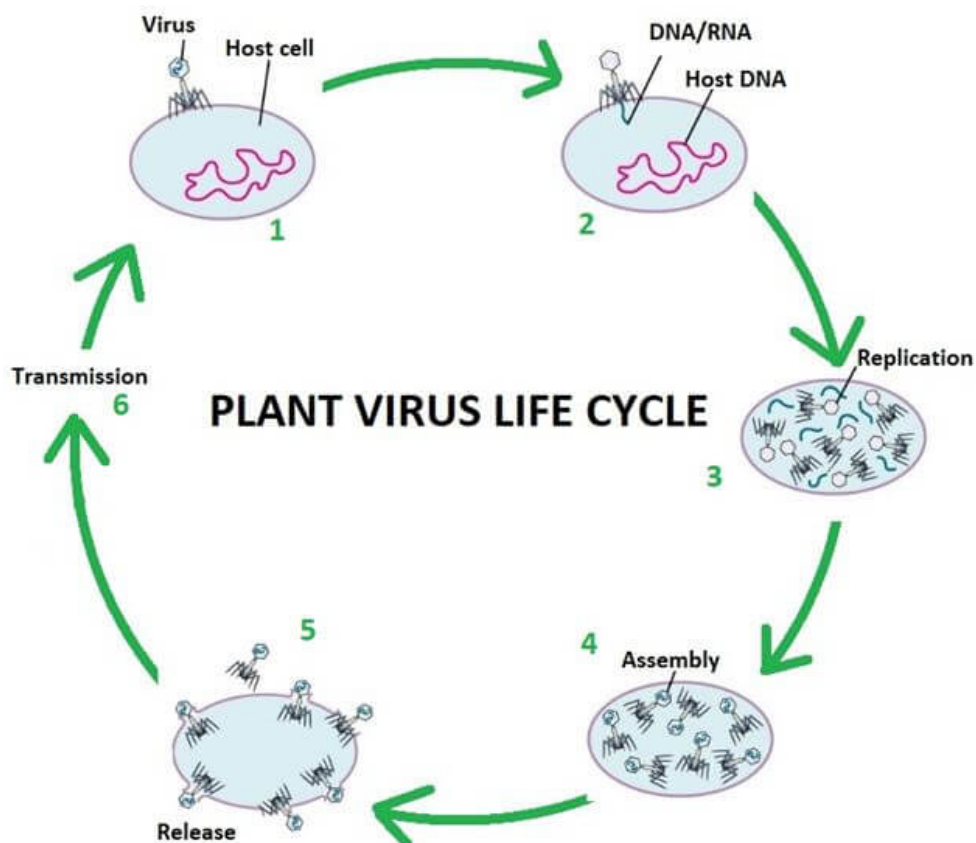
## What are viruses?

Viruses are very small (submicroscopic) infectious particles (virions) composed of a protein coat and a nucleic acid core. They carry genetic information encoded in their nucleic acid, which typically specifies two or more proteins. Translation of the genome (to produce proteins) or transcription and replication (to produce more nucleic acid) takes place within the host cell and uses some of the host's biochemical "machinery". Viruses do not capture or store free energy and are not functionally active outside their host. They are therefore parasites (and usually pathogens) but are not usually regarded as genuine microorganisms.

## Why are viruses important?

Viruses cause many important plant diseases and are responsible for huge losses in crop production and quality in all parts of the world. Infected plants may show a range of symptoms depending on the disease but often there is leaf yellowing (either of the whole leaf or in a pattern of stripes or blotches), leaf distortion (e.g. curling) and/or other growth distortions (e.g. stunting of the whole plant, abnormalities in flower or fruit formation).

## Life Cycle of Plant Viruses



- Attachment – the virus attaches itself to the outside of a plant cell.
- Penetration – the protein pushes the nucleic acid strand into the plant cell
- Replication – the viruses' nucleic acid uses the plant cell DNA to make many new nucleic acid strands and protein sheathes
- Assembly – the nucleic acid and protein assembly into millions of new virus copies
- Release – the viruses leave the cell – at this stage the cell is normally dead and bursts releasing the viruses

### **Symptoms of Viral Diseases In Plants:**

The symptoms of viral diseases in plants is important for virus identification and are often used to name the virus. The symptoms will change according to the plant virus strain / mixed virus infections, the host plant species, the nutritional status of the plant, the age of the plant, the stage of the infection and physiological growing conditions. Plant virus symptoms can be confused with bacterial and fungal diseases, nematode infections, plant nutrient deficiencies, abiotic stresses and herbicide injuries.

It is generally very difficult to identify a virus from symptoms alone. Viruses are sub-microscopic and plant samples should be sent to the laboratory for confirmation.

Viruses can be present but not expressed in healthy plants, weeds, and cuttings and seedlings. Symptoms can appear when the plants are stressed and in hotter weather. Multiple viruses can be present in one plant, and/or be present with bacterial or fungal infections that can form disease complexes that can be catastrophic with 100% plant loss.

### **Plant virus symptoms include, but are not limited to the following:**

- |                                   |   |
|-----------------------------------|---|
| • Mosaic or mottled leaf patterns | • bunchy tops                                   |
| • leaf yellowing                  | • leaf tip necrosis                             |
| • chlorosis                       | • veinal necrosis                               |
| • vein clearing                   | • ring spots                                    |
| • green vein banding              | • plant stunting                                |
| • yellow vein banding             | • wilting, tumours/galls                        |
| • leaf rolling                    | • colour streaking in flowers, leaves or fruits |
| • leaf curling                    | • plant death                                   |
| • leaf shoe-stringing             |   |
| • leaf blistering                 |   |
| • witches' brooms                 |   |



Yellow mosaic symptoms on lettuce caused by *Lettuce mosaic virus*.



Yellow vein-banding symptoms on grapevine caused by *Grapevine fanleaf virus*.



Fruit distortion on eggplant fruit caused by *Tomato bushy stunt virus*. A healthy fruit is shown on the left..



Bark scaling caused by *Citrus psorosis virus*.

How are viruses transmitted?

Some important animal and human viruses can be spread through aerosols. The viruses have the "machinery" to enter the animal cells directly by fusing with the cell membrane (e.g. in the nasal lining or gut).

By contrast, plant cells have a robust cell wall and viruses cannot penetrate them unaided. Most plant viruses are therefore transmitted by a vector organism that feeds on the plant or (in some diseases) are introduced through wounds made, for example, during cultural operations (e.g. pruning). A small number of viruses can be transmitted

### **The major vectors of plant viruses are:**

**Insects.** This forms the largest and most significant vector group and particularly includes.

Aphids: transmit viruses from many different genera, including *Potyvirus*, *Cucumovirus* and *Luteovirus*. The picture shows the green peach aphid *Myzus persicae*, the vector of many plant viruses, including *Potato virus Y*.

Whiteflies: transmit viruses from several genera but particularly those in the genus *Begomovirus*. The picture shows *Bemisia tabaci*, the vector of many viruses including *Tomato yellow leaf curl virus* and *Lettuce infectious yellows virus*.

Hoppers: transmit viruses from several genera, including those in the families *Rhabdoviridae* and *Reoviridae*. The picture shows *Micrutalis malleifera*, the treehopper vector of *Tomato pseudo-curly top virus*.

Thrips: transmit viruses in the genus *Tospovirus*. The picture shows *Franklinella occidentalis*, the western flower thrips that is a major vector of *Tomato spotted wilt virus*.

Beetles: transmit viruses from several genera, including *Comovirus* and *Sobemovirus*.

**Nematodes:** these are root-feeding parasites, some of which transmit viruses in the genera *Nepovirus* and *Tobravirus*.

**Plasmodiophorids:** these are root-infecting obligate parasites traditionally regarded as fungi but now known to be more closely related to protists. They transmit viruses in the genera *Benyvirus*, *Bymovirus*, *Furovirus*, *Pecluvirus* and *Pomovirus*.

**Mites:** these transmit viruses in the genera *Rymovirus* and *Tritimovirus*. The picture shows *Aceria tosichella*, the vector of *Wheat streak mosaic virus*. including *Barley yellow mosaic virus*, growing within a barley root cell.

**Plant viruses cannot be directly controlled by chemical application, The major means of control (depending on the disease) include:**

- Chemical or biological control of the vector (the organism transmitting the disease, often an insect): this can be very effective where the vectors need to feed for some time on a crop before the virus is transmitted but are of much less value where transmission occurs very rapidly and may already have taken place before the vector succumbs to the pesticide.
- Growing resistant crop varieties: in some crops and for some viruses there are highly effective sources of resistance that plant breeders have been using for many years. However, no such "natural" resistance has been identified for many others. Transgenic resistance has shown considerable promise for many plant-virus combinations following the discovery that the incorporation of part of the virus genome into the host plant may confer a substantial degree of resistance. For example, the use of this approach in Hawaii to control *Papaya ringspot virus* has been credited with saving the local papaya industry. However, this technology is controversial, particularly in Europe, and the extent to which it will be used commercially is currently uncertain.
- Use of virus-free planting material: in vegetatively propagated crops (e.g. potatoes, many fruit crops) and where viruses are transmitted through seed major efforts are made through breeding, certification schemes etc., to ensure that the planting material is virus-free.
- Exclusion: the prevention of disease establishment in areas where it does not yet occur. This is a major objective of plant quarantine procedures throughout the world as well as more local schemes.

(Article reference <http://www.dpvweb.net/intro/> and [www.croputs.com](http://www.croputs.com) some content.)