RAMA UNIVERSITY

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FACULTY OF AGRICULTURAL SCIENCES & ALLIED INDUSTRIES

Lecture 2

Virus-vector relationship

Plant virus Transmission

Plant viruses are transmitted from plant to plant in a number of ways. Modes of transmission include vegetative propagation, mechanically through sap, through seed, pollen, dodder, and by specific insects, mites, nematodes, and fungi. There are two types of plant virus transmission:

Horizontal transmission- Horizontal transmission is by vectors, human, pruning shears and tools, and other direct, external contamination.

Vertical transmission- Vertical transmission occurs when a plant gets it from its parent plant. Either through asexual propagation (cuttings) or in sexual reproduction via infected seeds.

Mechanical Transmission

- Occurs when plant comes in contact with other plant and leaves rub together.
- By the action of humans
- Mechanical transmission involves the introduction of infective virus or biologically active virus into a suitable site in the living cells through wounds or abrasions in the plant surface.

This method is generally used for experimental purposes under laboratory conditions- also known as **Sap inoculation**

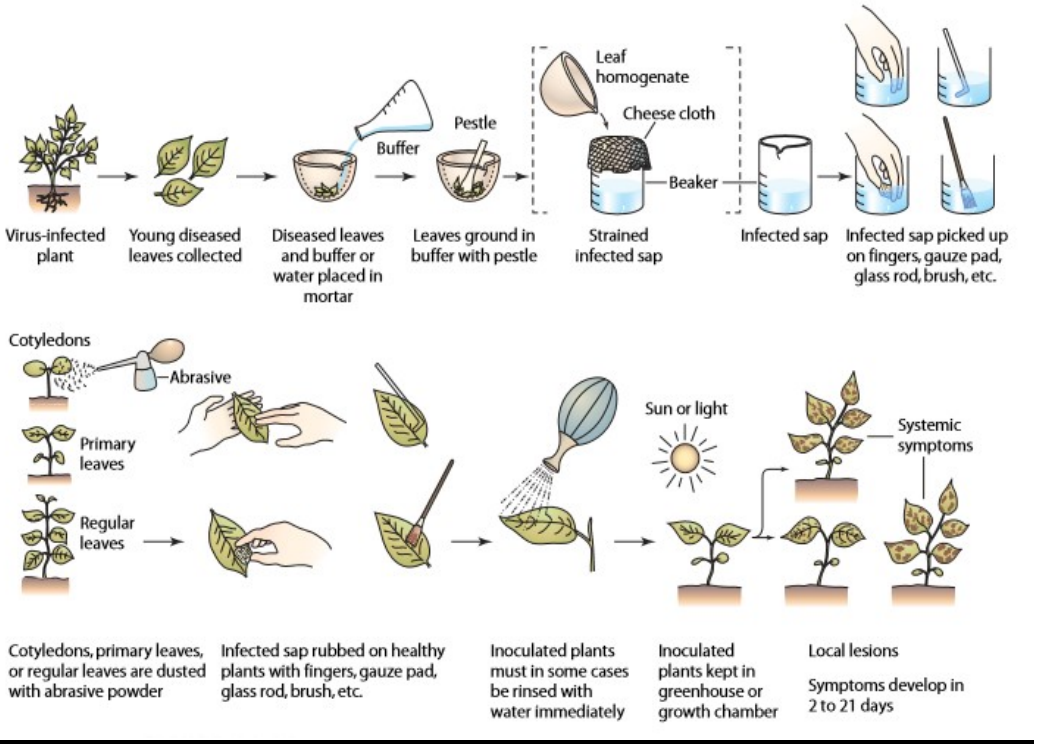


Figure- Steps in mechanical or sap transmission of plant viruses

Non-Insect transmission:

- Sap inoculation/ Mechanical: TMV, PVY
- Seed: BCMV
- Fungi: *Olpidium brassicae*- TNV
- Vegetative & graft transmission: PVY, PLRV,
- Fruit viruses
- Nematodes: *Xiphinema index*: Grapevine fan leaf virus
- Dodder: CMV, TRV

Insect Transmission: PVY, CMV, BGMV

Insect Transmission

Undoubtedly the most common and economically most important means of transmission of viruses in the field is by insect vectors. Members of relatively few insect groups, however, can transmit plant viruses.

The order Homoptera, which includes aphids (Aphididae), leafhoppers (Cicadellidae), and planthoppers (Delphacidae), contains by far the largest number and the most important insect vectors of plant viruses. Other Homoptera that transmit plant viruses are whiteflies

(Aleurodidae), which transmit the usually severe geminiviruses and several other viruses, mealybugs (Coccoidae), and certain treehoppers (Membracidae).

A few insect vectors of plant viruses belong to other orders, such as true bugs (Hemiptera), chewing/sucking thrips (Thysanoptera), and beetles (Coleoptera). Grasshoppers (Orthoptera) occasionally seem to carry and transmit a few viruses also. The most important virus vectors are aphids, leafhoppers, whiteflies, and thrips. These and the other groups of Homoptera, as well as true bugs, have piercing and sucking mouthparts. Beetles and grasshoppers have chewing mouthparts. Of these, the beetles are quite effective vectors of certain viruses.

Terminology use in virus transmission

Acquisition access period time for which a initially virus free vector is allowed to access a virus source and could if it desire feed on that source.

Acquisition feeding period: time period necessary for successful acquisition of the virus by its vector which then becomes viruliferous.

Inoculation access period: time for which a virus carrying vector is allowed to access a virus free plant and could feed on it.

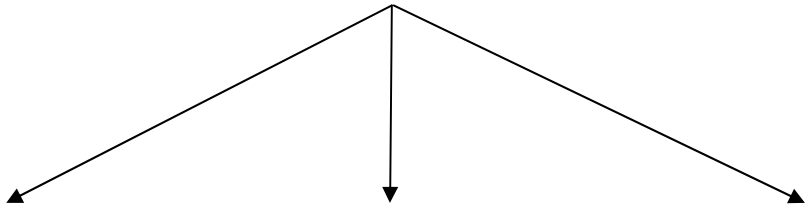
Inoculation feeding period: time period for which a virus carrying vector appears to be feeding on a virus free plant to transmit it.

Transmission threshold or inoculation threshold or Inoculation access threshold: the minimum initial time period that a vector needs to acquire a virus and inoculate it to the virus free plant.

Infective capacity or retention period of vector: time period for which a vector carries/ retain/ transmit the virus to host plant and remain viruliferous.

Incubation period or latent period: The time period from the start of acquisition feeding period until the vector can infect the healthy plant with the virus.

Insect Transmission



Non-persistent	Semi-persistent	Persistent
Transmission window to disseminate the virus to a new host plant after feeding on an infected plant by the vector lasts from seconds to minutes.	Transmission window to disseminate the virus to a new host plant after feeding on an infected plant by the vector lasts from hours to days.	Transmission window to disseminate the virus to a new host plant after feeding on an infected plant by the vector lasts from days to weeks.
Non-persistent plant viruses are retained in the insect stylet.	Semi-persistent viruses are internalized in the insect by binding to chitin lining the gut, but do not appear to enter tissues.	Persistent viruses are taken up into and retained by insect tissues and are characterized by invading the salivary glands.
		Persistent viruses can be further divided into:
		Circulative, Non-propagative, circulative, propagative

Relationships between plant viruses and their vectors

Virus transmission group			Transmission characteristics						
Site in vector	Type of transmission	Virus product inter-acting with vector	Aquisition time (max dose)	Retention time (half-life)	Transtadial passage	Virus in vector hemo-lymph	Latent period	Virus multiples in vector	Transovarial transmission
Externally borne	Non-persistently transmitted, stylet-borne	Capsid Helper factor	Seconds to minutes	Minutes	No	No	No	No	No
	Non-persistently transmitted, foregut-borne (semi-persistent)	Capsid Helper factor	Minutes to hours	Hours	No	No	No	No	No
Internally borne	Persistent, circulative		Hours to days	Days to weeks	Yes	Yes	Hours to days	No	No
	Persistent, propagative		Hours to days	Weeks to months	Yes	Yes	Weeks	Yes	Often

Non-persistent transmission

Of the approximately 290 or so known aphid- borne viruses, most are non-persistent. The following virus genera have definite members transmitted in a non-persistent manner: Alfamovirus, Caulimovirus (by M. persicae), Cucumovirus, Fabavirus, Macluravirus and Potyvirus.

Acquisition time: Non-persistently transmitted viruses are acqui- red rapidly from plants, usually in a matter of seconds. During this time, aphids stylets do not usually penetrate beyond the epidermal cells.

Retention time: With a non-persistent virus, aphids begin to lose the ability to infect immediately after the acquisition feed.

Release: The mechanical transmis- sion theory suggests that the virus is simply inoculated by the stylet. (2) In the ingestion-egestion theory, release is affected by regurgitation and salivation. (3) As the food and salivary canals of the stylets fuse near the tip of the maxillary stylet, non-persistently stylet-borne viruses could be released by saliva alone.

- Such viruses are acquired by the vector during probing and feeding on host parenchyma including epidermal cells

- Probing takes as little as 5 seconds.
- Vector becomes infective immediately after feeding
- Virus lost by the vector during moultin
- No latent period
- Such viruses are mechanically transmissible
- Acquisition fasting increases acquisition of virus and transmission.
- E.g. CMV, BCMV, PVY, PSBMV, PRSV, PMV

Semi-persistant viruses

- Virus persist in its vector for 10-100 hrs.
- Acquired from phloem region with long feeding.
- No latent period
- Do not circulate and multiply in its vector
- Infectivity lost in moulting
- Particles accumulate at special sites
- High vector specificity
- E.g. CTV, CaMV, BYV

Persistent viruses

Circulative nonpropogative

Circulative, non-propagative viruses do not replicate in vector tissues, but traverse the insect gut, hemolymph and salivary tissue membranes to reach the salivary glands for transmission. Luteovirids, geminiviruses and nanoviruses are vectored by phloem-feeding insects in this manner, but these vectors need to feed for extensive periods of time to facilitate efficient transmission.