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Transovarial transmission of leaf hopper transmitted viruses

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Among sucking insects, cicadellids are the second most important vectors of plant viruses. The word "Vector" is commonly used to indicate the invertebrate transmitter necessary for the successful passage of certain diseases from the infected to the non-infected host. The term "Vector" derives from the Latin "Vehere" means to carry. These vectors are not merely carriers but they can also serve as alternate hosts or constitute important reservoirs of disease causing organisms. In the transmission of plant viruses two major types of virus-host interactions are recognized.

– Vectors of one type may acquire a virus in short feeding periods and transmit it almost immediately. Such vectors soon lose the virus.

– Vectors of the second type may also acquire virus by feeding for short periods on infected plants, although generally longer acquisition feeding is required.

In contrast to first type, however, these vectors are unable to transmit virus to healthy plants immediately. An incubation period of considerable length occurs between the time of acquisition of virus and the time of its transmission to a susceptible host. Only after an incubation period of many hours, days, or even weeks, do vectors of this type become infective. Plant viruses retained by such vectors for considerable lengths of time, often for the remainder of their lives, without need of replenishment from infected plants. The virus – vector relationship in this case represents a highly specialized adaptation of the virus to the cicadellid. The obligatory relationship between vector and transmitter is indicated by a high degree of specificity. This relationship is often called as biological and the transmission is then known as biological transmission.

About 73-77 (38 viruses, 31 MLOS, 4 *Spiroplasmas* and 4RLO's) plant diseases are known to be transmitted by 131 leaf hopper species and total number of viruses known now to be transmitted by leaf hoppers is 44. Some plant viruses transmitted by leaf hoppers like maize streak, potato yellows, rice tungro and Wound Tumour Viruses are transmitted by two or more than two leaf hopper vectors while majority of viruses are transmitted by only one leaf hopper vector each. Similarly, a few leaf hopper vectors can transmit more than one virus while the rest can transmit only one virus each.

All leaf hoppers which feed on plants possess piercing and sucking type of mouthparts which mainly consists of 2 pairs of stylets, a labium, a large slender rigid organ with a deeply concave anterior surface forming the channel of beak, a labrum, mandibles and maxillae. The two pairs of stylets form a compact bundle or fasicle which studies in the groove of labium and constitutes the piercing organ. Piercing organ has two channels 1. Salivary Channel through which saliva is injected into the plant 2. Food Channel through which food is sucked up from the plant.

Leaf hopper secrete two types of saliva 1. Viscous type of saliva - Form a sheath around mouth parts because of formation of disulphide and 'H' bonds on exposure to oxidized condition. 2. Watery type of saliva - Soluble in water helps in Diluting viscous sap and Lubrication of mouth parts. Most of the leaf hoppers form this sheath around their stylets during feeding process. Stylet sheath is laid by vector in tissue of the host and it stays even on withdraw of stylets. Mostly leaf hoppers feed intracellularly and suck sap from phloem.

Virus vector relationships / Methods of virus transmission: Two sets of different terminologies are used to describe virus vector relationship

I. Stylet borne
- Circulative
- Propagative

II. - Non-persistant
- Semi persistant
- Persistant

All leaf hopper transmitted viruses (except beet curly top, rice tungro and few other viruses) are propagative viruses. They propagate within their insect vectors which transmit them for a long time but very often for as long as they live. These viruses posses an incubation period which is presumably the time needed for them to multiply and to reach a definite concentration to become transmissible. They thus have a biological relationship with their vectors.

Transovarial transmission of leaf hopper transmitted

Locations of some propagative viruses in different parts of their vectors

Virus	Vector	Parts of vector
Rice dwarf virus	*Nephotettix cinticeps*	Fat body, blood, intestine, salivary glands, Oesophagus, Neurons, Mycetome and Epidermis
Wound Tumor virus	*Agallia constricta*	Filter chamber, ventriculus, haemolyph, fat body, brain, MTS, Muscles, Salivary glands, Oesophagus, Nervous system, Mycotome and Epidermis
Potato yellow dwarf	*Agallia constricta*	Fat body, blood, intestine, salivary glands, Oesophagus, Nervous system, Mycotome, and Epidermis

viruses : Transovarial transmission means transmission of viral particles from mother to off-spring via egg by which off-spring will be also infective.

Eg: Rice Stunt Virus,
Clover Club Leaf Virus,
Wound Tumour Virus,
Rugose Leaf Curl of Alfa Alfa Virus,
Rice Stripe Virus,
European Weed Striate Mosaic virus,
Maize rough dwarf virus,
Potato Yellow dwarf virus.

No hypothesis has yet been advanced as to the manner in which virus enters an insect egg. It could possibly do so in the early stages of egg development or be carried along with the symbionts when these are transferred from the Mycetomes to the eggs or it could enter through the micropyle. In any case, presuming that the blood is the virus reservoir, only a small proportion of the virus in the blood would be available at the entry points, whatever the mode of entry, it is specific and limited in time.

Effect of viruses on the insect which transmit transovarially : There are reports that infective female adult *Delphacodes pellucida*, produced 40% fewer progeny when it was fed on plant infected with european wheat striate virus. He observed that this was due to death of embryos at a later stage of development. He concluded that the egg mortality was due to the pathogenicity of virus to eggs.

Yoshii (1959) while working with *Nephotettix apicalis* var. *Cinticeps* and rice stunt disease found abnormal phosphorus metabolism in infected vector due to the presence of more number of vacuoles that were observed in the fat bodies of infected adults. The shape of nucleus is modified to star shape. The virus is reported to cause hardening of mycetome. NASU (1963) found that 52% of eggs laid by the infecting leaf hopper carrying stripe virus died prematurely. High mortality was observed in congenitally viruliferous plant hoppers. The mortality was high in nymphs of 1st and 2nd instar. Showers and Everett (1967) working with Hoja Blanca virus observed progeny produced from infective female had a shorter life span.

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