PROBLEMS OF INSECT-BORNE VIRUS DISEASES OF FRUIT TREES IN ASIA

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ABSTRACT

The production of new commercial fruit crops in the Asian and Pacific region has meant the appearance of new virus diseases. This paper reviews virus or virus-like-diseases vectored by insects found in passionfruit, longan and other fruit crops in Asia. It warns that some diseases which now appear minor have the potential of causing severe damage in the future.

INTRODUCTION

Insect-borne virus or virus-like diseases are a major constraint to fruit production in Asia. Many of them have a harmful effect on production, with lower yields, poor fruit quality, and a decline in the vigor of the tree. Some have been introduced from foreign countries, while others have broken out spontaneously in a particular place. In the early stages they are found only within a small area, but they become prevalent when favorable conditions appear. The dissemination of infected plants and insect vectors is an important factor. The appearance of a new host or interhost, and the occurrence of mutations, are also possible factors in disease spread.

This paper reviews insect-borne virus or virus-like diseases which have occurred over the past ten years in various fruit (not including major fruit crops such as citrus, banana or papaya). Some of these diseases are widespread in Asia, while others are still local or not yet found in Asia, (i.e. they are exotic). Even if they are fairly unimportant, they have the potential of becoming prevalent and causing severe damage in the future. We should pay attention to these minor diseases, as well as to the major ones.

Keywords: Chinese jujube, cucumber mosaic virus, insect vectors, kaki, longan, passionfruit mottle virus, passionfruit, passionfruit woodiness virus, soursop, virus disease

PASSIONFRUIT

Passionfruit (Passiflora edulis Sims.) originated in South America, and has now become popular in tropical and subtropical Asia. The fruit is either eaten fresh, or is used commercially for juice production. The golden passionfruit (P. edulis f. flavicarpa Deg.) is the most important cultivar. Many viruses or virus-like diseases occur in the plants.

Potyvirus Group

Passionfruit Woodiness Virus (PWV)

This virus disease was first reported in 1953 in Australia, although the disease "woody fruit" had been recognized since 1901 (Taylor and Greber 1973). An outbreak of PWV in Taiwan occurred in 1980. PWV has been found in Brazil (Kitajima et al. 1986) and South Africa (Brand et al. 1993) and is probably present in tropical Asia.

Symptoms of mosaic, rugosity and distortion of leaves, with yellow spots on older leaves, develop on infected P. edulis plants. Ringspots, which vary in color from pale green to chlorotic, are found together with leaf mosaic on the spring growth of golden passionfruit and hybrid passionfruit (P. edulis/P. e. f. flavicarpa). The fruit is frequently distorted, and the pericarp is hard and thick, giving the disease the common name of "woody fruit". The
productive life of the plant is greatly shortened (Taylor and Greber 1973).

The virus particles are flexible filaments about 12 nm wide and 750 nm in length (Taylor and Greber ibid). They are transmitted in a non-persistent manner by the aphids Myzus persicae and Aphis gossypii. They are sap-transmissible to a wide range of hosts, particularly leguminous plants. However, there is no evidence of transmission through seed.

Several strains have been recognized, distinguished by the severity of the symptoms they produce in Passiflora edulis. The virus also occurs naturally in some tropical legumes, including Arachis hypogea, Centrosema pubescens, Crotalaria usaramoensis, Glycine max and Phaseolus atropurpureus, but does little damage to these species.

In Australia, the use of a hybrid P. edulis/P. e. f. flavicarpa (Taylor and Greber 1973) or pre-inoculation with a mild strain of PWV (Pares et al. 1985) reduced the damage from severe strains of PWV.

**Passionfruit Mottle Virus (PaMV)**

This virus was found in Taiwan in 1987 (Chang 1992). The particles are similar to those of PWV in morphology. The capsid protein of PaMV is 38 kDa, while that of PWV is 37 kDa. The cylindrical inclusion bodies are large and bundle-shaped, while those of PWV are short and plate-like. Both viruses share a common host range, with the exception of a few leguminous species. The most important difference between the two is the symptoms produced in a hybrid cultivar, Tainung No. 1 (P. edulis/P. e. f. flavicarpa). When this cultivar is infected with PaMV, it shows only mild mottling of the leaves, while PWV induces severe foliage mosaic and woody, misshapen fruits. PaMV is transmitted by the aphid Myzus persicae, and there is no evidence of seed transmission. PaMV is antigenically related to, but distinct from, PWV, Bean Common Mosaic Virus and Blackeye Cowpea Mosaic Virus. It reacts weakly with Soybean Mosaic Virus, but is unrelated to other potyviruses.

**Sri Lankan Passionfruit Mottle Virus (SLPFMV)**

This virus is found in golden passionfruit in Sri Lanka (Dassanayake and Hicks 1992). Typical symptoms are mottled leaves with numerous chlorotic spots, reduction of vigor, and fruit with a shrunk, blotchy appearance. The virus infects systemically 23 species in five plant families, including a wide range of Leguminosae.

The particles are filaments approximately 841 nm in length. Two polypeptides of molecular weight 33.2 and 28.7 kDa can be detected. The aphids Myzus persicae, Aphis spiraeola, A. gossypii and A. craccivora transmit the virus. SLPFMV reacts with antisera to PWV, Passionfruit Ringspot Virus, and Potato Virus Y, but reacts only weakly to Watermelon Mosaic 2, and not at all to Bean Common Mosaic Virus.

**Passionfruit Ringspot Virus (PFRSV)**

This virus, found in Ivory Coast, West Africa, causes leaf mottling and ring-spotting in golden passionfruit (De Wijs 1974). The virus particles are 15 x 810-830 nm, and react with antisera to PWV from Australia, but not in an identical way. The virus seems to belong to the potato virus Y group.

**The Puerto Rican Passionfruit Virus (PRPFV)**

This virus, from Puerto Rico and the Dominican Republic, is considered to be an isolate of Watermelon Mosaic Virus 2. This identification is based on host reactions, serological relations, and the capsid protein molecular weight (Niblett et al. 1991).

**Cucumovirus**

Infection of passionfruit with Cucumber Mosaic Virus (CMV) is found in many countries. Golden passionfruit infected with CMV show both mosaic and striking coalescent yellow rings on the leaves, with occasional slight deformation of the foliage (Colariccio et al. 1987). Dual infection with CMV and PWV causes severe symptoms.

Woodiness disease of passionfruit in South Africa was shown to be associated, not only with a single potyvirus infection, but also with multiple infections by at least three different viruses, including CMV (Brand and Wechmar 1993). Recently, it was reported from Australia that a double infection with CMV and a mild strain of PWV caused vine-tip necrosis, so that the vines died back (Pares et al. 1985).

The use of vegetatively propagated hybrids in Australia, coupled with pre-inoculation with a mild strain of PWV, has been claimed to control a severe strain of PWV, so that CMV became more important (Pares et al. ibid).
Tymovirus Group

Passionfruit Yellow Mosaic Virus (PYMV)

This virus has been found in Brazil (Crestani et al. 1986). Infected golden passionfruit showed characteristic bright yellow mosaic, with yellow netting, and crinkling on the leaves. The particles are isometric, around 30 nm in diameter. The host range is definitely limited to the genus *Passiflora*. A chrysomelid beetle (*Diabrotica speciosa* Germ) transmits the virus, and there is no evidence of seed transmission. The disease is still of little importance in Brazil.

Purple Granadilla Mosaic Virus

This virus was also found in Brazil, where it was identified on *P. edulis* (Chagas et al. 1984). It is characterized by leaf mosaic, vein clearing and irregular chlorotic bands on the vines, deformation and hardening of the fruit, and poor fruit-set. The host range, morphology, and vectors of the virus are similar to those of PYMV. However, the virus did not react serologically to 33 different isometric viruses, including PYMV (Oliveira 1994).

Rhabdovirus

Passionfruit Vein Clearing Virus

This virus has been prevalent in golden passionfruit plantations in Brazil since 1981 (Kitajima and Crestani 1985, 1986). Vines infected with the disease have short internodes and brittle leaves with characteristic clear veins. Infected trees have poor yields of deformed (and sometimes woody) fruit. Mixed infection with PWV or witches’ broom mycoplasma is common. The effective vector has not yet been confirmed, but since plant rhabdoviruses are transmitted by plant-sucking arthropods, mostly Hemiptera (Peter 1981), the presence of a vector can be assumed. The relationship between Passionfruit Vein Clearing Virus and other rhabdoviruses is still unknown.

Nepovirus

Tomato Ringspot Virus (TRV) is found in *P. edulis* in Peru (Koenig and Fribourg 1986). It is well known that the nematode *Xiphinema americanum* transmits TRV. TRV and *X. americanum* have been endemic in North America, but the virus became worldwide with the movement of infected ornamental and berry crops (Stace-Smith 1984).

Geminivirus

Passionfruit Leaf Mottle

This disease, caused by a geminivirus, is found in *P. edulis* in Puerto Rico (Brown and Fletcher 1993). The virus is transmitted by the whitefly *Bemisia tabaci* (Gennadius), as well as by grafting, but not by sap inoculation, or aphids, nor can it be transmitted through seed.

Mycoplasma-like Organisms (MLO)

Witches’ broom disease, caused by MLO, is prevalent in some parts of Brazil (Kitajima et al. 1986). Its vector and host range are unknown.

LONGAN

Witches’ broom of longan (*Euphoria longan* Lam.) is found in China (Chen et al. 1992) and neighboring countries. A flexible virus has been isolated from infected longan trees. The virus is transmitted by a stinkbug, *Tessaratoma papillosa* Drury, and a psylliid, *Corneogenapsylla sinica* Yang et Li. It is transmitted from one longan tree to another, and also from longan to litchi (*Litchi chinensis* Sonnerat). The symptoms in longan are very similar to those produced by litchi witches’ broom disease. A close relationship between the two diseases is indicated.

CHINESE JUJUBE

Witches’ broom of Chinese jujube (*Ziziphus jujuba* Mill.) is found in China and Korea. The causal agent has been confirmed to be a mycoplasma-like organism (Zhang et al. 1991, Zhu et al. 1988). The MLO is transmitted by a leaf hopper, *Hishimonoides chinensis* Anufrive.

SOURSOP

Soursop (*Annona muricata* L.), also known as guanabana, is a fruit tree belonging to the Annonaceae, and is native to the American tropics. Soursop Yellow Blotch Virus (SYBV), a rhabdovirus, has been found in Brazil. The symptoms are yellow blotches on the leaves (Kitajima and Martins 1993). The presence of a vector is assumed.
KAKI

Kaki, or Japanese persimmon (*Diospyros kaki* L.), is free of any virus or virus-like disease in Japan. However, a disease characterized by leaf yellowing, the dieback of young shoots and tree decline has been found in Brazil since around 1979 (Matsuoka and Carvalho 1987). The disease has become locally widespread and is destructive. A mycoplasma-like organism (MLO) is associated with the disease. The cultivars Fuyu, Gimbo, Rama Forte and IAC hybrids are susceptible.

**DISCUSSION**

Over the last ten years, new findings of insect-born virus or virus-like diseases of fruits, particularly in tropical and subtropical areas, have increased. In many cases, the vector, interhost and mode of infection are still unknown. Why are new diseases occurring one after another? The most probable cause is the movement of infected materials from the endemic area to disease-free countries.

However, another possibility should be considered. For example, kaki, the Japanese persimmon which originated in Japan or China, has been free of any insect-born virus or virus-like disease for several thousand years. However, a disease of kaki caused by MLO occurred in Brazil (Matsuoka and Carvalho 1987), where the plant had been introduced only 50 years earlier. This suggests that the pathogen and its vector had been endemic in Brazil, affecting some other plant species, and was then given the opportunity to infect kaki. At some stage, either the pathogen or its vector may have undergone a change in pathogenicity or transmissibility, so that it became able to infect the kaki plant. To prove whether this assumption is true or not, we need much more information about the host range of both the pathogen and the vector, and about the taxonomic situation of the pathogen.

Chang and Lin (1992) demonstrated the effectiveness of annual eradication of all passionfruit trees and replanting of virus-free seedlings, even in a situation where insect-borne viruses have become established. These results are an encouraging example of the control of insect-borne diseases. However, difficulties in eradication may arise if the pathogen has become widely established, not only in cultivated plants but also in wild ones. In this situation, considerable effort and funding will be needed for many years if eradication is to be achieved.

Whatever method is used to control vector-borne diseases, rapid and reliable indexing is needed. An effective propagation system which can supply sufficient healthy plants to growers is also necessary. The development and application of protective mild strains is also useful, but some fear still remains of a synergistic reaction with other viruses.

In conclusion, the breeding or selection of resistant varieties is the most important and convenient way of controlling virus and virus-like diseases of fruit which are vectored by insects. For this purpose, the collection of genetic resources and a search for useful genes should be carried out.

**REFERENCES**


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