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Disease Of Papaya: Papaya Ring Spot Virus and Its Management

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Papaya (Carica papaya L) is one of the most important fruit crops of the country. It belongs to the family Caricaceae. Its origin is Southern Mexico. It is also cultivated in the USA, India, Brazil, Mexico, China, Taiwan, Peru, Indonesia, Thailand, and the Philippines. Papaya fruit is well known for its high medicinal and nutritive value [Mak*et al.*, 2012]. It is a rich source of vitamin A, B, C and proteolytic enzymes *viz.* papain, chymopapain etc. Beta carotene helps in the prevention of cancer, diabetes, and heart diseases. Ripened fruits are usually eaten fresh and can be processed into jam, jelly, marmalade and candy. It is also used in the cosmetic and pharmaceutical industries [Retuta*et al.*, 2012]. Now a day's not only in India but also worldwide industries that depend on papaya is threatened by the most serious disease i.e., papaya ringspot disease. It is caused by Papaya Ring Spot Virus (PRSV), which is a member of the genus Potyvirus (Gonsalves, 19980). Symptoms of PRSV are prominent mosaic patterns on the leaf lamina, wet-oily streaks on the petioles and the tree trunk and complete distortion of young leaves. The fruit exhibits bumps and the classic "ringspot". This led to a 50% or even more reduction in fruit production.

Papaya Ring Spot Virus (PRSV) is one of the major hindrances for boosting papaya production in thecountry. There is no absolute curative control measure available through conventional methods to date. Precautionary measures for PRSV incidence *viz.* rouging, cross-protection, vector control etc. are notmuch helpful. The transgenic (GM) papaya varieties *viz.* Rainbow and Sunup were developed in Hawaii in 1998. However, in the present

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state, in countries like India where there are legal restrictions on research on genetically modified (GM) food crops, introgression of the PRSV-P resistance gene into *C. papaya* from its wild relatives (species of *Vasconcellea*) is one of the optimistic option available with researchers.

Nature of Transmission

The virus is transmitted by aphids in a non-persistent manner. Many species of aphids can transmit PRSV, particularly the *Myzuspersicae*and *Aphis gossypii*. The acquisition and transmission of infectious PRSV virion particlesoccur during the brief period when the aphid superficially probes into the plant. In addition to this, it is also notified that this virus can also betransmitted mechanically, and stated that it is not typically seed-transmitted (Yeh and Gonslaves, 1984).

Hosts

This virus has a narrow number of hosts belonging to the families Caricaceae, Chenopodiaceae and Cucurbitaceae. The propagation hosts of PRSV are *Carica papaya*, *Cucurbita pepo* and *Cucumis metuliferus*. The lesion assay hosts of PRSV are *Chenopodium quinoa* and *Chenopodium amaranticolor*(Yeh and Gonslaves, 1984).

PRSV Disease Management:

There are four main methods of control for PRSV, quarantine, rouging, netting, cross-protection and genetic modification of the host plant.

Quarantine:

PRSV is a non-persistent virus and is subsequently transmitted to healthy plants by aphids within a very short period, insecticidal control is difficult and impractical. Once symptoms have been observed, it is already too late to spray for aphids the disease has been already transmitted to nearby healthy plants. To implement successful vector control, frequent preventive sprays are required. Prevention through quarantine and geographic displacement of cropland is common when fields become infected; attempts to relocate growing areas to virus-free fields are made. This is usually just a temporary avoidance of the disease, which eventually spreads to the new fields.

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Rouging

Rouging is the removal and destruction of infected plants, is a way to control the spread of PRSV. Though it is difficult to control the spread of PRSV, it spreads very rapidly and effectively by aphids. This method can also lead to heavy economic losses.

Use of Insecticides

PRSV is transmitted through aphids. Hence, control of aphids spread in the orchards is one of the measures to control the spread of the virus. The aphid management at regular intervals should be started at the nursery stage. It can be done by using systemic insecticides. The systemic insecticides *viz.Imidacloprid,Carbosulfan*and *Acetamiprid etc.* should be used in low concentrations at the nursery stage and regular concentrations at the field stage. However, it is very challenging to control the aphids at the field level. Hence, this method is not much effective.

Netting

This method can also be used to prevent insect vectors from spreading the virus. Production under netting is expensive for maintenance and small-scale producers (Fuller,2005).

Planting time

Planting time also plays a major role in PRSV disease management. It was observed that during the lean period of the vector population, there was less incidence of the disease. Papaya (Red Lady) planted from February to April showed significantly less incidence of PRSV compared to those planted from September to January. Border crop of banana reduced aphid population in papaya plantation. Papaya production increased marginally in the vicinity of uprooted infected plants.

Cross protection

Cross protection was used to control PRSV which involved the use of a mild virus strain against economic damage caused by severe strains of the same virus (Yeh and Gonsalves,1984). The development of cross-protection in papaya has resulted in a delay in

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the onset of symptoms, as well as a reduction in the severity of symptoms. Though, inoculation of the mild strain also caused pathogenesis on the papaya plants. Cross protection depends on the availability of mild strains that can be used for effective protection against the target virus. However, strain specificity and the technical difficulties associated with propagating pure strains of mild forms of the virus and the unavailability of such mild strains limit the benefits of Cross protection.

Convectional breeding

Resistance levels of PRSV differ with environmental factors and plant development stages. Broad-spectrum resistance against different PRSV isolates depends on the homology of transgenes with viral target genes and the genetic divergence of different PRSV strains which are correlated with their geographical distribution. The papaya varieties resistant to PRSV against different viral strains must be developed individually for various papaya growing regions. The development of PRSV resistant lines is generally considered the best strategy for efficient PRSV disease control in papaya for long-term protection (Fermin *et al.*, 2010), Introgression of the PRSV-P resistance gene into *Carica papaya* from its wild relatives (species of *Vasconcellea*) is the most optimistic option available with researchers.

Transgenics

Resistance to viral disease may be developed through genes derived from viral sequences providing pathogen-derived resistance (PDR), genes from various other sources that can interfere with the target virus, and natural resistance genes. Pathogen derived genes interfere with the replication process of viruses in their host plants in different ways. So far, PRSV-resistant transgenic papaya has been developed through coat protein (CP), RNA silencing and replicase gene technology.

There are two transgenic varieties of papaya, both of which were created by Dennis Gonsalves, they were Rainbow and SunUp. Rainbow is an F_1 hybrid, which is a cross between the yellow-fleshed Kapoho and the red-fleshed SunUp. SunUp is thought to be more resistant to exotic strains of PRSV, while Rainbow has shown susceptibility to such exotic strains of the virus (Fermin *et al* 2010).

Biosafety issues concerning GE papaya:

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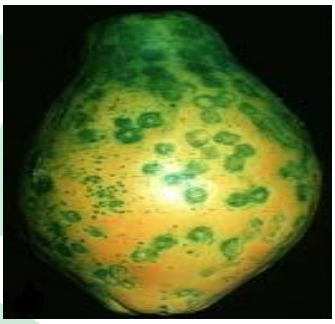
Even after 17 years of the release of transgenic papaya, there is no report on its adverse effect on environmental bio-safety issues. The emergence of the undesirable virus isolate due to transgenic papaya has not been observed so far.

Conclusion:

PRSV is a major threat tothe papaya industry worldwide. Transgenic papaya through gene technology has been used for PRSV disease management. The breakdown of PRSV resistance is the major challenge facing transgenic papaya cultivation. The adoption of PRSV-resistant transgenic papaya is still slow and it depends upon the demand for papaya, bio-safety regulations and social acceptance of the technology. Earlier studies indicate that PRSV-resistant transgenic papaya is environmentally safe and has no adverse effects on human health. It concluded that in addition to conventional breeding methods it is necessary to develop PRSV resistant transgenic papaya using their PRSV strains.

PRSV infected at early stages



PRSV infected at later stages

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