Integrated Management of Thrips-borne Tospoviruses in Vegetable Cropping Systems in South and Southeast Asia

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1. Tospoviruses

In recent years, tospoviruses (Type member: *Tomato spotted wilt virus*; Genus: *Tospovirus*; Family: *Tenuivirus*) have received international attention because they cause serious damage to agronomic crops, ornamentals, and vegetables worldwide. Tospoviruses replicate in two disparate hosts - plants and thrips. At least fifteen different tospoviruses have been characterized globally. There are about twelve species of thrips ( *Thysanoptera: Thripidae*) that have been confirmed as vectors of one or more tospoviruses worldwide.

Tospoviruses have complex genome and intricate replication strategy. The virus particles (Fig 1 & 2) contain three single-stranded genomic segments. Each segment is encapsidated separately with the nucleocapsid (N) protein to form helical structures and is associated with polymerase. The virus genome is contained within a host-derived lipid envelope containing virus-encoded glycoproteins (GPs). G1, G2, and G3. The two GPs appear as spike-like projections on the surface of the virions (Fig. 2). The three genomic segments codes for three structural and three non-structural proteins (Fig. 3 & 4).

2. Tospoviruses: vector transmission

Thrips-mediated transmission of tospoviruses is closely linked to the developmental stages of the thrips on plants (Fig. 5). Successful transmission by adult thrips occurs only when the virus is acquired at the first-instar larval stage of the thrips life cycle. Since virus replicate in the vector, adult thrips, that acquire a tospovirus during the larval stage, remain viruliferous throughout their life. Thus, adult thrips contribute to short- and long-distance spread of the virus. Males exhibit a higher transmission rate than females.

3. Tospoviruses: a global view

All tospoviruses characterized so far fall into two major groups indicating geographic clustering.

However, there are certain exceptions:

- TSWV is present outside Americas – in Europe, Africa, Australia and Japan. IYSV, reported initially from Europe and Israel, is present in the Americas, Australia and India.
- Tospoviruses are ‘generalists’ because they have wide host range. They are mostly ‘opportunists’ because they survive by infecting many species that include crops and weeds, invade new geographic areas and quickly exploit suitable ecological ‘niche’.

4. Expansion of geographic range of vector thrips

- A native to the southwestern USA
- Spread through global trade in ornamental greenhouse plants around the world since 1980s

The minute size of thrips and their cryptic behavior make them difficult to detect either in the field or in fresh vegetables, fruits and ornamental flowers transported through international trade and commerce. As a result, many species of thrips and tospoviruses have now spread from their original natural habitats and hosts to favorable new environments of valuable crops.

5. Challenges in controlling tospovirus diseases

- Broad host range
- Multiple vector species
- Evolution of new strains
- Ability to overcome host plant resistance

6. South & Southeast Asia region: a biological ‘Cuisinart’ for tospoviruses?

Tospoviruses are emerging as a significant limiting factor in the sustainable production of vegetables and other economically important crops in smallholder farming systems in the region.

- 60% of ‘global’ tospoviruses occur in the region
- Four distinct tospovirus species documented in India:
  - PBNV, WBNV, IYSV and PYSV
- Three distinct tospoviruses documented in Thailand:
  - CaCV, WSMV and MSYV
- Tospoviruses are more diverse in India
- Status of tospoviruses in other countries not known

7. Tospoviruses are a threat to sustainable production of vegetables in India

Second largest producer of vegetables in the world - estimated production of about 50.09 million tons from an area of 4.5 million hectares at an average yield of 11.3 tons/hectare

- With 2% of the world’s geographical area, India is home for 16% of global human population and over a quarter of the world’s people
- Vegetables constitute the most important food next only to cereals and milk
- The demand for vegetables has been rapidly increasing due to urban population growth at more than 3% per annum
- Consequently, peri-urban farming of vegetables, which account for nearly 95% of peri-urban vegetable production, has intensified
- Smallholder farmers cultivate their land throughout the year to produce vegetables
- Intensive and widespread use of pesticides is the predominant tactic farmers deploy to manage virus diseases
- The number and extent of vegetable crops affected by tospoviruses increasing

8. Management of tospoviruses requires a multidisciplinary team effort

- Tospoviruses have complex genome, replicate in plants and vectors and produce a range of symptoms
- The life cycle of a tospovirus involves transmission from plant to plant by several species of polyphagous thrips
- Efforts to control vector thrips with insecticides have been mostly unsuccessful
- Durable resistance difficult due to rapid evolution of virulent and resistance-breaking strains of tospoviruses
- A comprehensive understanding of tospovirus pathosystem is critical
- Multidisciplinary team effort can bring long-lasting solutions for the management of diseases caused by tospoviruses

The way forward

Objectives of the project funded by IPM-CRSP of USAID

- Conduct strategic research on tospoviruses and thrips vectors
- Carrying out applied and adaptive research to deploy ‘eco-friendly’ IPM strategies to control tospovirus diseases
- Develop strategies for strengthening institutional capacities within host countries to conduct problem-oriented research on virus diseases

Crop-specific problems

- Estimated losses due to PBNV in peanut in 1990s - US $89 million/year
- Current status - losses increasing due to expansion to other field crops and vegetables

**PBNV infects a broad range of crops**

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<thead>
<tr>
<th>Crop</th>
<th>Peanut</th>
<th>Tomato</th>
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<tr>
<td>Virus</td>
<td>WBNV</td>
<td>IYSV</td>
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**Yield losses due to PBNV**

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<tr>
<th>Yield Loss %</th>
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