STUDIES ON INSECT TRANSMISSION OF THE TRISTEA VIRUS IN THE PHILIPPINES

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ABSTRACT

Nine different insects were used as vectors in the transmission of the tristeza virus. Only Toxoptera citricidae, T. aurantii and Aphis gossypii transmitted the virus. T. citricidae was a more efficient vector than either T. aurantii or A. gossypii.

INTRODUCTION

Transmission of the tristeza virus by insects was first demonstrated in Brazil in 1946 by Meneghini(10) who used Toxoptera citricidae Kirk as a vector. In 1948, Bennett and Costa (1) confirmed the results on insect transmission obtained by Meneghini. In California, Dickson et al.(5) reported the transmission of tristeza virus by Aphis gossypii Glover. This aphid was not as efficient as T. citricidae.(5,11) In 1957, the capability of Toxoptera aurantii B. de Fonsc. in transmitting tristeza was also reported in Florida.(12)

In the Philippines, the first study on the transmission of the tristeza virus by budding was conducted by Bigornia and Calica.(2) No insect transmission, however, was attempted by these authors.

According to J. M. Wallace, University of California (personal communication), the budwood of Batangas mandarin from the Philippines, that was received in the United States as early as 1914, was found to be infected with tristeza. This may suggest that tristeza has been present for a long time in the Philippines but no incidence of the disease was noticed, not until 1958, when many of the Calamondin (Citrus mitis) trees in the Bicol Region were reported to be declining. (2) Such trees when indexxed to lime seedling yielded tristeza. In the early part of 1960, many citrus growers, research workers and various agents of the Philippine Government, were alarmed by the dying of citrus in Batangas and other provinces. Investi-
gations were initiated immediately, giving special attention to virus diseases of citrus. In preliminary transmission experiments, seedlings of Mexican (Key, West Indian) lime inoculated by tissue grafts from the dying trees, gave the tristeza reaction, that is, vein clearing and stem pitting are diagnostic symptoms of the tristeza virus.\(^{(3, 7, 9, 13)}\)

The origin of the tristeza disease in the Philippines is unknown. Also, no record is available as to whether or not citrus is a native plant in the Philippines. However, there were various introductions of citrus varieties from other countries, either through seeds or budwood. These introductions were continuously propagated vegetatively. In some places in the Philippines, where citrus was planted, good financial returns were realized. Thus, the growing of citrus was greatly accelerated, and it has become one of the profitable industries in Batangas, Camarines Sur, Albay, Iloilo, Isabela, Pangasinan, Bukidnon, Cebu, and Davao, for the past 10 or 15 years. Lady and Szinkom mandarins were commercially grown for local markets.

From available literature, insects, particularly aphids, are agents responsible for transmitting tristeza in other countries, and because of the different insects that were found feeding on citrus in the Philippines, studies on the capabilities of these insects to transmit the tristeza virus were conducted.

**MATERIALS AND METHODS**

Key (Mexican, West Indian) lime seedlings that were previously infected with tristeza by budding were maintained as sources of virus for insect transmission studies. The different insects used as vectors were *Toxoptera citricidus* Kirk., *T. aurantii* B. de Fonsc., *Aphis gossypii* Glover; *Ferrisia virgata* Ckll., *Pseudococcus* sp. v. *flamentosus*, *Pseudococcus* citricidus Green., *Diaphorina citri* Kyuwa, *Coccus viridus* Green and *Hysteroneura setariae* Thomas. These insects were collected from time to time in the field. To insure that these insects were free of the tristeza virus that might have been acquired in the field, they were first made to feed on healthy citrus seedlings for about 5 days inside the greenhouse before allowing them to feed on the virus source.\(^{(4)}\) Then, a maximum period of 20 hours was given for each insect species to feed on the virus source before transferring to healthy test seedlings of key lime. Twenty-five individuals each of the insect species were used on each test plant. The insects were allowed to feed on the test plant for 24 hours before they were killed by collecting them with a wet cotton swab and then crushing them by hand. Control plants were similarly treated, using insects which were not fed on diseased plants.

**RESULTS AND DISCUSSIONS**

The results of transmission of the tristeza virus by the different insect tested are summarized in Table 1. Three out of the nine insect species were found capable of transmitting the virus, and these were *Toxoptera citricidus*, *T. aurantii* and *Aphis gossypii*, which are all in the aphid group. The other six insects used did not transmit the virus. Of the 75 plants exposed to infection by *T. citricidus*, 32 were infected. Four out of 25 plants exposed to infection by *T. aurantii*, and 3 out of 50 plants by *A. gossypii*, were infected.

**Table 1: Results of insect transmission tests of the tristeza virus.**

<table>
<thead>
<tr>
<th>Kind of Insect</th>
<th>Number of insects used/plant</th>
<th>Number of plants exposed to feeding <em>a</em></th>
<th>Number of plants infected</th>
<th>Percentage of infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>Toxoptera citricidus</em> Kirk.</td>
<td>25</td>
<td>25</td>
<td>32</td>
<td>45.5</td>
</tr>
<tr>
<td>2. <em>Toxoptera aurantii</em> B. de Fonsc.</td>
<td>25</td>
<td>25</td>
<td>4</td>
<td>16.0</td>
</tr>
<tr>
<td>3. <em>Aphis gossypii</em> Glover</td>
<td>25</td>
<td>25</td>
<td>3</td>
<td>12.0</td>
</tr>
<tr>
<td>4. <em>Ferrisia virgata</em> Ckll.</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>5. <em>Pseudococcus</em> sp. v. <em>flamentosus</em></td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>6. <em>Pseudococcus</em> citricidus Green</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>7. <em>Diaphorina citri</em> Kyuwa</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>8. <em>Coccus viridus</em> Green</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>9. <em>Hysteroneura setariae</em> Thomas</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* Wing aphids were used.
* *a* Equal number of plants maintained as control with no infection observed.

*T. citricidus* appears to be the most efficient aphid vector in these studies. *T. aurantii* is not as efficient as *T. citricidus* but it seems more efficient than *A. gossypii*. The percentage of infection obtained with *T. citricidus* was less than that obtained by other workers.\(^{(1, 4, 10)}\) This might be explained by the fact that only 25 aphids were used in each test plant while other workers used 100 to 300 aphids. In the case of *A. gossypii*, the percentage of infection obtained by Dickson and associates \(^{(5, 6)}\) was about 6.3 per cent. Although 25 aphids were used in the present studies, the percentage of infection with *A. gossypii* is 6.0 per cent. This agrees with the findings of Dickson and associates that *A. gossypii* is inefficient in transmitting the...
tristeza virus. *T. aurantii* was also found inefficient, confirming the report from Florida.\(^{(12)}\)

The symptoms on Key lime seedlings infected by the three aphid vectors in these studies were the same as those previously described for tristeza.\(^{(3, 7, 8, 12)}\) Infected plants showed vein clearing, chlorosis, cupping of the leaves and stunting. Stem pitting was also produced in the infected plants, six to eight months after inoculation.

The inability of the other species of insects (Table 1) to transmit the tristeza virus could not be explained in the present studies. These insects are all citrus feeders in the Philippines, like the 3 aphid species, except for *Hysterothorax setariae*.

Hughes and Lister\(^{(8)}\) reported that 15 lime seedlings out of 18 exposed to mealy bugs, *Ferrisia virgata* Cockerell, which had first fed on source plants showing symptoms of dieback (tristeza) developed the same symptoms as plants infected of this virus by aphid vectors. In the present studies, no symptoms developed on any of the 50 lime seedlings exposed to mealy bugs. The high percentage of infection reported by Hughes and Lister and the lack of transmission by the mealy bugs in the writer's tests suggest that further studies should be made on these insects.

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**LITERATURE CITED**


