Transmission of Tobacco Mosaic Virus by *Myzus persicae*

*(Accepted 21 June 1972)*

It is well known that many plant viruses can be transmitted by aphids, but the highly infectious tobacco mosaic virus (TMV) seems to have no aphid vector. Only Hoggan (1934) reported a very low level of transmission which, however, has not been substantiated (Orlob, 1963; Pirone, 1969). Some progress on this problem was made when Teakle & Sylvester (1962) showed that TMV could be inoculated by aphids placed on virus-covered leaves. More recently we demonstrated that aphids can transmit TMV from a virus-covered leaf to a healthy leaf (Lojek & Orlob, 1969). Now we wish to describe experiments in which the green peach aphid, *Myzus persicae* Sulz., transmitted TMV from tomato and doubly infected tobacco.

The following plants were used as virus sources: *Nicotiana tabacum* L. var. Havana or *Lycopersicon esculentum* L. var. Potentate for TMV or TMV/cucumber mosaic virus (CMV); *N. tabacum* var. Xanthi n.c. for CMV and potato virus Y (PVY). The following test plants were used: *N. glutinosa* L. or Havana tobacco for TMV, *Chenopodium hybridum* L. for CMV, and Xanthi tobacco for PVY.

Aphids were reared and handled as described previously (Lojek & Orlob, 1969, 1972). Before each experiment, aphids were brushed off leaves, counted, and placed in vials for a 20 to 30 min starvation period. They were then deposited on the source leaves for a 2 to 60 min acquisition period, after which they were transferred to test leaves or plants for 4 h or 24 h periods respectively. To avoid contamination, aphids were brushed off the source leaf and then carefully dropped on the test leaves from a distance of about 1 cm. In consecutive acquisition tests, starved aphids were placed for 5 min on a leaf infected with one virus and then for 5 min on a leaf infected with the other virus. In determining the length of virus retention, aphids were placed on infected leaves for 5 min, then placed in a vial for 1 to 3 h after which they were transferred to test leaves. Each set of experiments consisted of 6 x 30 half-leaves infested with 30 aphids each, and a corresponding set of control half-leaves infested with aphids from virus-free plants.

To determine the virus concentration in different plants, Havana tobacco was inoculated with TMV or TMV and CMV, and tomato with TMV. Eleven days later leaves usually used for virus acquisition were detached and leaf discs cut out with a No. 4 cork borer. Ten discs were then ground in 2 ml of distilled water and inoculated to *N. glutinosa* half-leaves.

As can be seen from Table 1 *M. persicae* transmitted TMV from doubly infected tobacco (TMV/CMV) or singly infected tomato. The transmission rate from singly infected Havana tobacco seems too low to be significant. CMV was included in these tests to determine its rate of transmission from a systemically infected host to a local lesion test plant. To make sure that lesions produced in these experiments were of virus origin, randomly selected lesions were ground and inoculated to Xanthi tobacco. Typical TMV lesions developed in all instances.

We have also determined the rate of TMV transmission from tomato to a systemic host (Havana tobacco): 27 out of 30 plants became infected when 30 aphids (2 min access to tomato) were placed on each test plant; 8 out of 30 plants were infected by 10 aphids/plants, and 6 out of 30 plants by 5 aphids/plants. All controls remained healthy.
Short communications

Table 1. Transmission of tobacco mosaic virus (TMV) and cucumber mosaic virus (CMV) by Myzus persicae from tomato and doubly infected tobacco

<table>
<thead>
<tr>
<th>Acquisition period (min)</th>
<th>Number of lesions*</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>TMV† Havana</td>
</tr>
<tr>
<td>2</td>
<td>--</td>
</tr>
<tr>
<td>5</td>
<td>2/360</td>
</tr>
<tr>
<td>30</td>
<td>--</td>
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<tr>
<td>60</td>
<td>--</td>
</tr>
</tbody>
</table>

* Number of lesions produced by 30 aphids per half-leaf/number of half-leaves used.
† Virus and source plant used. Test plants were Nicotiana glutinosa for TMV, Chenopodium hybridum for CMV, Xanthi tobacco for PVY.
‡ Aphids fed first on CMV-infected Xanthi tobacco then on TMV-infected Havana tobacco or vice versa.

Table 2. Transmission of tobacco mosaic virus (TMV) by starved Myzus persicae

<table>
<thead>
<tr>
<th>Time of starvation* (min)</th>
<th>No. of lesions†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TMV</td>
</tr>
<tr>
<td>0</td>
<td>87</td>
</tr>
<tr>
<td>30</td>
<td>--</td>
</tr>
<tr>
<td>60</td>
<td>32</td>
</tr>
<tr>
<td>120</td>
<td>10</td>
</tr>
<tr>
<td>180</td>
<td>0</td>
</tr>
</tbody>
</table>

* Aphids were given a 5 min acquisition period, placed in a small vial and left for various periods of time.
† Number of lesions produced on Nicotiana glutinosa half-leaves. The source plants were tomato infected with TMV, and Havana tobacco infected with TMV and cucumber mosaic virus (CMV).

In studying retention of TMV, aphids (30/half-leaf) remained viruliferous 30 to 60 min after leaving the virus source, but no transmission occurred after 3 h (Table 2).

The results reported above raise a number of interesting points. First, contrary to currently prevailing views, M. persicae can transmit TMV from tomato and tobacco infected with CMV and TMV. Why aphids are more efficient in transmitting TMV from doubly infected plants than from singly infected tobacco is more difficult to explain. Although the overall virus concentration was found to be the same in different plants, it is still possible that virus concentration differs in the epidermal tissues on which aphids probe, TMV is more accessible in tomato or doubly infected plants, or aphid behaviour is changed on these hosts in some way that makes transmission more likely. Another possibility may be that in the case of double infection, transmission of TMV is aided by a helper virus (CMV) as has been shown recently in mixed infections of potato virus C and potato aucuba mosaic virus (Kassanis & Govier, 1971). However, in contrast to this work, we obtained no transmission when aphids first fed on one source and then on the other (Table 1). This implied that both viruses have to be present in the same host for transmission to occur. It is also of interest to note that PVY did not aid transmission of TMV (Table 1). The same results have been reported by Watson & Plumb (1972).

Transmission of TMV from tomato has been obtained by Hoggan (1934) but the rate of transmission with M. persicae was very low. This low rate and the failure of one of us (Orlob, 1963) to substantiate her work might have been due to the long acquisition periods used in these experiments. We have now described conditions under which transmission of
TMV from tomato is relatively efficient, and we believe that the most important single factor is a short acquisition period. In this and previous work we found it difficult to keep M. persicae on tomato for long periods because they did not adopt to this plant.

Another aspect of the TMV-aphid relationship is noteworthy. When aphids acquire virus from infected leaves they quickly cease to transmit it, but the opposite trend was noticed in the transmission of TMV from virus-covered leaves (Lojek & Orlob, 1969).

Recently, K. F. Harris and R. H. Bradley (personal communication) obtained evidence for the involvement of the aphids' tarsi in the inoculation and transmission of TMV. Our results could be explained on this basis, but more work is needed to determine whether tarsi or mouth-parts or both are involved in transmission.

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REFERENCES


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