Hosts and symptoms of *Plum pox virus*: Herbaceous hosts

G. Llácer

*Instituto Valenciano de Investigaciones Agrarias (IVIA), Apartado Oficial, 46113 Moncada, Valencia (Spain); e-mail: gllacer@ivia.es

*Plum pox virus* (PPV) is polyphagous and epidemic. Apart from cultivated and wild *Prunus* species, a large number of herbaceous plants can be hosts of the virus. New herbaceous host species are continuously being reported following artificial inoculation studies. Some of these herbaceous hosts, *Chenopodium foetidum*, *Nicotiana clevelandii*, *N. benthamiana* and *Pisum sativum* are very useful for concentrating and purifying the virus. The list of plants that have been found to be infected with PPV in their natural environment is shorter than the list of plants which can be experimentally infected. The role of weed species in PPV survival and spread in orchards is poorly understood. It is widely accepted that annual plants or weeds are not important in the epidemiology of PPV.

**Introduction**

*Plum pox virus* (PPV) is polyphagous and very epidemic. Apart from cultivated and wild *Prunus* species, a large number of herbaceous plants can be hosts of the virus. We shall distinguish between experimental and natural hosts.

**Experimental hosts**

The first herbaceous host, *Nicotiana quadrivalvis*, of PPV was reported in 1960 by Šutić (OEPP/EPPO, 1974). It was infected by sap inoculation from young leaves of plum. In following years, numerous herbaceous plants were shown to be susceptible to PPV in laboratory studies using young leaves of infected *Prunus* as source of inoculum. In the sharka revision published by the European and Mediterranean Plant Protection Organization (OEPP/EPPO, 1974), 78 species from 9 families were referred as hosts of PPV. Of these 78 species, 46 were *Solanaceae* (30 *Nicotiana* spp.) and 16 were *Papilionaceae*. The virus induced local and/or systemic lesions, depending on plant species, virus isolates and experimental conditions, Morvan & Chastellière (1980) tested by sap inoculation the sensitivity of more than two hundred herbaceous species under greenhouse conditions, searching for the best host for isolating PPV from woody sources. They found that *Senecio sylvaticus* L. (*Compositae*) was the most suitable host, being consistently infected by diverse isolates of PPV. Even in late summer, *S. sylvaticus* showed pale green vein banding and circular spots 3 weeks after inoculation.

The host range of PPV is still not fully known as new herbaceous host species are continuously being reported after artificial inoculation studies (Virscek Marn et al., 2004). However, since methods for virus detection based on serology and molecular techniques have been set up, the use of herbaceous indicators for PPV greenhouse indexing has been restricted to *N. benthamiana*. The reason is the lack of specificity and reliability of most herbaceous hosts (ISHS, 2004). Some of these herbaceous hosts, such as *Chenopodium foetidum*, *N. clevelandii* and *Pisum sativum* are very useful for concentrating and purifying the virus (Desvignes, 1999). Even *Arabidopsis thaliana*, the model plant for genetic and molecular studies, can be a host of PPV (García et al., 2006).

**Natural hosts**

The list of plants infected with PPV in their natural environment is shorter than the list of plants that can be artificially infected. The role of weed species in PPV survival and spread in the field is poorly understood. Two authors (Kroell, 1973 and Sutic, 1973, cited by OEPP/EPPO, 1974), showed some weeds to be infected by PPV in infected plum orchards, including *Vicia* spp. The authors suggested these plants could play an important role in the epidemiology of the disease. More recently some authors (Minou & Pattantyus, 1997 and Isac et al., 1998, cited by Virscek Marn et al., 2004) considered herbaceous plants to be a continuous source of infection for fruit species. Other authors, however, have indicated that natural transmission between such herbaceous plants and *Prunus* has never been demonstrated (OEPP/EPPO, 1992; Desvignes, 1999).

PPV infection of weed species grown in plum and apricot orchards was studied by Milusheva & Rankova (2002). PPV infection was confirmed in *Capsella bursa pastoris*, *Lactuca serriola*, *Lythospermum arvensis*, *Rumex crispus* and *Veronica hederifolia*. In order to clarify the role of weed species as a possible reservoir of PPV, 548 samples of weed species belonging to 59 genera were collected in PPV-M infected peach orchards at different locations in Slovenia (Virscek Marn et al., 2004). DAS-ELISA analysis of collected samples using the Bioreba antiserum showed positive results for several common weed species. The data is displayed in Table 1. The following weed species were reported as PPV hosts for the first time: *Taraxacum officinale*, *Cirsium arvense*, *Convolvulus arvensis*, *Clematis sp.*, *Cichorium sp.*, *Rorippa sylvestris* and *Ajuga genevensis*. These
Table 1 Detection of PPV in weed species belonging to 59 genera

<table>
<thead>
<tr>
<th>Plant name</th>
<th>Total number of samples</th>
<th>Number of samples in which PPV was found</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Taraxacum officinale</strong></td>
<td>119</td>
<td>18</td>
</tr>
<tr>
<td><strong>Sonchus sp.</strong></td>
<td>52</td>
<td>3</td>
</tr>
<tr>
<td><strong>Cirsium arvense</strong></td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td><strong>Convolvulus arvensis</strong></td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td><strong>Solanum nigrum</strong></td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td><strong>Clematis sp.</strong></td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td><strong>Trifolium sp.</strong></td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td><strong>Cichorium sp.</strong></td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>Rorippa sylvestris</strong></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Ajuga genevensis</strong></td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

results were obtained by DAS-ELISA with polyclonal antibodies and need to be confirmed by molecular methods (Viršcek Marn et al., 2004).

In a very different situation, surveys were made in 76 peach orchards infected with the PPV-D strain within the Niagara quarantine area (Ontario, Canada). A total of 99 328 weed specimens were collected during 2 years of surveying, representing 188 species from 53 plant families (Stobbs et al., 2005). Samples were tested for PPV using the specific monoclonal antibodies 5B-IVIA (Durviz kit). Healthy and PPV infected leaves from peach were used as controls. Any samples considered suspect or positive for PPV were resampled from the field within 2 weeks and retested with ELISA and PCR. These tests failed to demonstrate the presence of the PPV in any of the samples examined. This is consistent with other studies in Pennsylvania (USA) where PPV-D strain was not found to occur naturally in native weed populations. Stobbs et al. (2005) conclude that weeds do not appear to represent a significant reservoir of PPV, and consequently are not prominent in the epidemiology of the disease in North America.

The contradiction between the results obtained in some European and North American countries could be explained by the different PPV strains (M in Central European surveys, D in North American surveys) and the infection levels (high and low, respectively). The PPV strains M and D differ by their host range and transmission ability (Viršcek Marn et al., 2004). Even if some herbaceous plants grown in orchards are hosts of the virus, their volume of foliage is very limited relative to the foliage of an adult fruit tree (Labonne and Dallot 2006). Consequently, the most widely accepted hypothesis, even in Europe, is that annual plants or weeds are not important in PPV epidemics.

Hôtes et symptômes du Plum pox virus : hôtes herbacés

Le Plum pox virus (PPV) est polyphage et épidémique. A part les espèces de Prunus cultivées et sauvages, un grand nombre de plantes herbacées peuvent être hôtes pour ce virus. De nouvelles espèces herbacées hôtes sont continuellement signalées suite à des études d’inoculation artificielle. Certains de ces hôtes herbacés, comme Chenopodium foetidum, Nicotiana clevelandii, N. benthamiana et Pisum sativum sont très utiles pour concentrer et purifier le virus. La liste de plantes qui ont été trouvées infectées par le PPV dans leur environnement naturel est plus courte que la liste de celles qui peuvent être infectées expérimentalement. Le rôle des espèces adventices dans la survie et la dissémination du PPV dans les vergers est mal compris. Il est largement accepté que les plantes ou adventices annuelles ne sont pas importantes dans l’épidémiologie du PPV.

Растения-хозяева и симптомы Plum pox virus : травяные хозяева

Plum pox virus (PPV) является эпидемическим полифагом. Кроме выращиваемых и диких разновидностей Prunus, многие травяные растения могут являться хозяевами вируса. Новые травяные виды постоянно отмечаются в исследованиях по искусственной инокуляции. Некоторые из этих травяных хозяев, такие как Chenopodium foetidum, Nicotiana clevelandii, N. benthamiana и Pisum sativum весьма полезны для концентрирования и очистки вируса. Список растений, которые могут быть инфицированными PPV в естественной среде, не длиннее списка растений, которые могут быть инициированы экспериментально. Роль сорняков в выживании PPV и его распространении в плодовых садах в настоящее время изучена еще недостаточно. Широко признано, что однолетние растения или сорняки не имеют существенного значения в эпидемиологии PPV.

References