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Data Sheets on Quarantine Pests

Plum pox potyvirus

IDENTITY

Name: Plum pox potyvirus
Synonyms: Sharka virus
Taxonomic position: Viruses: Potyviridae: *Potyvirus*
Common names: PPV (acronym)
Sharka, plum pox (English)
Variole du prunier, sharka (French)
Scharka-Krankheit (German)
Vaiolatura delle drupacee (Italian)
Notes on taxonomy and nomenclature: PPV was long unique as a potyvirus of fruit trees, but a related virus was recently discovered and named Asian prunus latent potyvirus (Hadidi & Levy, 1994). This was detected in North America in peach and *Prunus mume* imported from eastern Asia. This can be distinguished from PPV using certain specific DNA primers, but cross-reacts in other tests.
EPPO computer code: PLPXXX
EPPO A2 list: No. 96
EU Annex designation: II/A2

HOSTS

The main woody hosts are the fruit-producing species of *Prunus*, including apricots (*P. armeniaca*), peaches (*P. persica*) and plums (*P. domestica* and *P. salicina*). Almonds (*P. dulcis*) can be infected by PPV but show few symptoms (Festic, 1978). The virus has been artificially transmitted to species in the cherry group, but infection remains localized and the virus has never been shown to be translocated (Dosba *et al*., 1987). Natural infection of *P. cerasus* was recently reported by Kalashyan *et al.* (1994), but PPV infection of cherries is still considered extremely unusual, being practically unknown throughout most of Europe.

PPV infects most wild or ornamental species of *Prunus*,, such as *P. besseyi*, *P. cerasifera*, *P. insititia*, *P. tomentosa*. *P. spinosa* was long considered as a good natural host of PPV. However, results recently obtained in Yugoslavia have not confirmed this, other viruses such as prune dwarf ilarvirus or prunus necrotic ringspot ilarvirus frequently being detected (Rankovic & Dulic-Markovic, 1992). Numerous cultivated or weedy annual plants can carry potential inoculum, but natural transmission between such herbaceous plants and *Prunus* has never been demonstrated.

Susceptible *Prunus* spp. are widely grown for fruit production (varieties and rootstocks) throughout all European parts of the EPPO region. Wild woody and herbaceous hosts are also widespread and are potential reservoirs of the disease.

GEOGRAPHICAL DISTRIBUTION

PPV has its origin in eastern Europe (Bulgaria) and has spread from there to most of the continent (OEPP/EPPO, 1974). Until recently, no case had been reported from outside the Euro-Mediterranean area, but PPV has now been found in India (Thakur *et al*., 1994) and Chile (Acuña in Roy & Smith, 1994).

EPPO region: PPV is present, or has occurred, in practically all European countries, but to very different extents. Roy & Smith (1994) distinguished three zones: (i) the central and eastern countries in which PPV spread relatively early and levels are generally high (Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Moldova, Poland, Romania, Serbia, Slovakia, Slovenia, Ukraine); (ii) the Mediterranean countries in which spread is recent and there is a high risk of further spread (Albania, Cyprus, Egypt, Greece, Italy, Portugal, Spain, Syria, Turkey); (iii) the northern and western countries in which levels of PPV are very uneven (fairly widespread in Austria, Germany and the UK (England), very localized in Belgium, France and Luxemburg, eradicated in Denmark, Netherlands and Switzerland. PPV has only recently spread to southern Russia. It has been recorded from but did not establish in Estonia.

Asia: Azerbaijan (unconfirmed), Cyprus, Georgia (unconfirmed), India (Himachal Pradesh), Syria, Turkey.

Africa: Egypt.

South America: Found in 1992 in Chile, now eradicated.

Oceania: The unconfirmed record for New Zealand which appeared in the first edition of the EPPO data sheet (OEPP/EPPO, 1983) is an error.

EU: Present.

Distribution map: See CMI (1970, No. 392).

BIOLOGY

Infected *Prunus* trees are the major source of inoculum. The virus is transmitted from them either by grafting or non-persistently by the aphid vectors *Aphis spiraecola* and *Myzus persicae*. Other aphids have been shown to transmit at lower frequency than the two main vectors: *Aphis craccivora*, *A. fabae*, *Brachycaudus cardui*, *B. helychrysi*, *B. persicae*, *Hyalopterus pruni*, *Myzus varians*, *Phorodon humuli* (Kunze & Krczal, 1971; Leclant, 1973). Avinent *et al.* (1994) have recently added *Aphis gossypii* to the list of minor PPV vectors in Spain, while Labonne *et al.* (1994) in France have added this species and also *A. hederae* and *Rhopalosiphum padi*, using transmission to a herbaceous host.

The number of trees becoming infected in an orchard is directly related, in a given season, to numbers of winged aphids. These aphids probe or feed on infected leaves, then fly to other trees where they again probe or feed. Gottwald *et al*. (1995), analysing the spatial distribution of aphid-borne spread in eastern Spain, concluded that aphids spread the disease not so much to immediately adjacent trees, as to trees several spaces away. In summer, the aphids may also migrate to various herbaceous species present in orchards and come back to the fruit trees to lay their winter eggs (Kunze & Krczal, 1971). *Phorodon humuli*, after fasting, has been shown to be capable of spreading PPV over long distances, 2-3 h after acquisition (Krczal & Kunze, 1972). The capacity for vector transmission varies considerably between strains (Massonié & Maison, 1976). After inoculation, the incubation period may last several months and systemic spread may take several years (OEPP/EPPO, 1983). Accordingly, the virus may be distributed very irregularly in the tree. Németh & Kolber (1983) have demonstrated seed transmission in *Prunus* but this has not been confirmed by other workers, and is unknown in practice.

Various strains of PPV were originally distinguished (necrotic, intermediate, yellow) on the basis of symptoms obtained by inoculation of herbaceous indicator plants. Kerlan &

Dunez (1979) then serologically differentiated D (Dideron) and M (Markus) types, the former on apricot in France and the latter originally on peach in Greece. In the 1980s, it appeared that a strain of the M type occurred in France and was aggressive on peach, presenting new problems of containment (Candresse *et al.*, 1993). This "necrogenic" strain involved has been referred to as PPV-SP and further characterized by Adamolle *et al.* (1994). A further serological type, the El Amar strain from Egypt, is distinct from the other two also on the basis of divergences in RNA sequence (Wetzel *et al.*, 1991a). More recently, Bousalem *et al.* (1994) have examined 28 PPV isolates from 11 countries and found that they could be consistently grouped into the two major types (D and M) using three techniques: electrophoretic mobility of coat protein, antigenic properties of the N and C regions of coat protein, presence of a specific restriction site in the C-terminal region of the coat protein.

DETECTION AND IDENTIFICATION

Symptoms

Symptoms may appear on leaves or fruits. They are particularly clear on leaves in spring: chlorotic spots, bands or rings, vein clearing, or even leaf deformation in peaches. Infected fruits show chlorotic spots or rings. Diseased plums and apricots are deformed and show internal browning of the flesh; their stones show pale rings or spots (Dunez, 1987). Symptoms of sharka depend very much on locality, season, *Prunus* species and cultivar and plant organ (leaf or fruit) (Dosba *et al.*, 1986).

Morphology

PPV is a filamentous virus with particles 750 nm long and 15 nm in diameter. It has single-stranded RNA with a molecular weight of 3.5×10^6 Da. Protein inclusions of the pinwheel type are present in the cytoplasm of infected leaves and fruits. Different RNAs from PPV have been cloned (Ravelonandro *et al.*, 1988) and the nucleotide sequence of the virus has been determined (Maiss *et al.*, 1989). Genome function in PPV is now increasingly understood, and this virus is now a model for studies on the molecular biology of potyviruses (García *et al.*, 1994).

Detection and inspection methods

In spite of the irregular distribution of the virus in the tree, visual inspection does allow detection by symptoms, especially during the period of active growth. Testing on susceptible indicators (peaches or *Prunus tomentosa*) by chip-budding can give symptoms in 6-8 weeks (ISHS, 1983; OEPP/EPPO, 1983). Mechanical inoculation to *Chenopodium foetidum* or peas gives symptoms in 6-8 days.

Dunez *et al.* (1994) have reviewed the great progress that has been made in detection techniques for PPV. The ELISA test, which was first applied in plant virology for the detection of PPV, is now widely used to confirm the presence of the virus even at low concentrations in roots, bark, flowers, leaves, fruits or seeds (Adams, 1978). The method has been applied quantitatively (Himmler *et al.*, 1987).

Methods based on electron microscopy, viz. immuno-electron microscopy (Kerlan et al., 1981) and with colloidal gold staining (Himmler *et al.*, 1988) can also be used. Monoclonal antibodies can now be used very effectively, and will distinguish between different strains (M and D types) (Cambra *et al.*, 1994). Molecular hybridization tests based on nucleic acid sequences specifically complementary to virus RNA are now being developed. A dot-blot molecular hybridization test using radioactive DNA or RNA probes has been developed by Varveri *et al.* (1987; 1988). Enzymatic amplification of the DNA sequence (by PCR) has recently increased the sensitivity level of the test to 10 fg of purified viral RNA (Wetzel *et al.*, 1991b).

Immunocapture-PCR has been developed as a highly sensitive assay for PPV (Candresse *et al.*, 1994). An EPPO quarantine procedure for PPV has been prepared (OEPP/EPPO, 1992).

MEANS OF MOVEMENT AND DISPERSAL

The disease appears randomly in orchards. After 2-3 years, infection begins to spread from the first infected trees (Llácer *et al.*, 1986). Graft transmission can contribute significantly to spread in infected areas if certified virus-free material is not used. Movement of the virus between areas or countries is most often with uncertified plants for planting. PPV is occasionally intercepted in fruit-tree material imported into the USA from eastern Europe (Waterworth, 1994).

PEST SIGNIFICANCE

Economic impact

The importance of plum pox in European stone-fruit production has been reviewed by Németh (1994). Sharka disease is particularly serious in the fruit-producing areas of central and eastern Europe. In the last 10 years or so, it has progressively spread to some Mediterranean countries such as Egypt (Wetzel *et al*., 1991a), Spain (Llácer *et al.*, 1985) and Portugal (Louro & Monte Corvo, 1986). Virus infection can lead to considerable yield losses, reaching 100%. European plums may show premature fruit drop, while Japanese plums and peaches show ring-spotting on fruit, and apricots show serious fruit deformation.

Control

There is no anti-virus treatment available to control sharka disease in orchards. There are, however, considerable differences in susceptibility between the cultivars available for use in countries where infection is widespread (Hamdorf, 1986; Kegler *et al*., 1989; Mainou & Syrgianidis, 1992). Biological control by inoculation of trees with hypo-aggressive strains has not proved as successful in the field as under controlled conditions (Kerlan *et al*.,, 1980). Other effective control methods are to produce healthy plants for planting within a certification system, to control aphid vectors by regular treatment with aphicides, and to destroy diseased trees in orchards. Such methods are being used to contain PPV in several countries (e.g. France, Italy). EPPO recommends a certification scheme for fruit trees, which takes account of PPV (OEPP/EPPO, 1991/1992). Resistance to PPV has been reviewed by Dosba *et al*. (1994) and this approach shows some promise, whether by traditional breeding or by transgenic methods (Laimer da Camara Machado *et al*., 1992; Escalettes *et al.*, 1994). New cultivars with high resistance should become available.

Phytosanitary risk

PPV is an EPPO A2 quarantine pest (OEPP/EPPO, 1983). It is also considered to be a quarantine pest by IAPSC and NAPPO.

In the EPPO region, it presents a major risk to apricots, plums and peaches in many countries where it is still absent or very localized. In addition, its presence in a country creates difficulties for export of certified planting material.

PHYTOSANITARY MEASURES

EPPO recommends that all imported host material (except seeds) should come from a field subject to growing-season inspection. If the virus is present in the exporting country, this inspection should also concern the immediate vicinity of the field, and the material should derive from tested mother plants (OEPP/EPPO, 1990). Material produced following the

EPPO certification scheme for virus-free fruit trees would satisfy these requirements (OEPP/EPPO, 1991/1992).

Measures can effectively be taken to prevent spread of PPV from foci of infection and even to eradicate it. These include planting no host plants in infected areas, using tolerant or resistant cultivars, controlling the vectors and destroying all diseased trees.

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