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Cornell University

Integrated Pest Management

Plum pox disease of stone fruits

Plum pox virus

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Introduction

Plum pox is a viral disease of stone fruits first reported in Bulgarian plums in the 1910's. More widely known around the world by its Slavic name, sharka, the disease first spread slowly through eastern Europe, gaining momentum in the 1950's through the 1970's as it reached western Europe. Movement of the disease continued in North Africa, the middle East, India and the People's Republic of China, with symptoms first detected in the western hemisphere in Chile in 1992. In the US, plum pox disease was recorded in Pennsylvania in 1999, followed by New York and Michigan in 2006. In Canada, it was detected in Nova Scotia and Ontario in 2000.

Causal agent

Plum pox virus (PPV) is the causal agent of plum pox disease. To date, seven strains of PPV (D, M, El-Amar, C, W, T. and Rec) have been identified based on their biological, serological and molecular properties; all occurrences in North America thus far have been attributed to strain D.

PPV is regarded as an invasive species by the US Department of Agriculture (USDA) because it was not known to occur in the country prior to its discovery in 1999. The Animal and Plant Health Inspection Service (APHIS), an agency of the USDA, is responsible for implementing eradication programs of PPV in close collaboration with State institutions, and for preventing its further introduction and spread through budwood and planting stock.

Host range, impact and symptoms

PPV can infect all cultivated stone fruit species including peach, nectarine, apricot, plum, almond, and sweet and sour cherry, as well as wild and ornamental Prunus. PPV-D, the strain that occurs in New York, naturally infects peach, nectarine, apricot and plum; almond and cherry are not natural hosts although they can be artificially infected. Epidemics of PPV-D progress slowly in peach and this virus strain is not seed-transmitted.

PPV reduces fruit yield and quality, and shortens productive lifespan in orchards. The economic impact of PPV to the peach, plum and apricot industry worldwide is estimated at $600 million per year.

Symptoms of PPV vary in type and severity depending on the strain of the virus, timing of infection, cultivar, and environmental factors. Diagnostic symptoms occur mainly on leaves and fruits in New York. Symptoms may develop during the cooler temperatures of spring and fall but fade during the hot summer months. Leaf

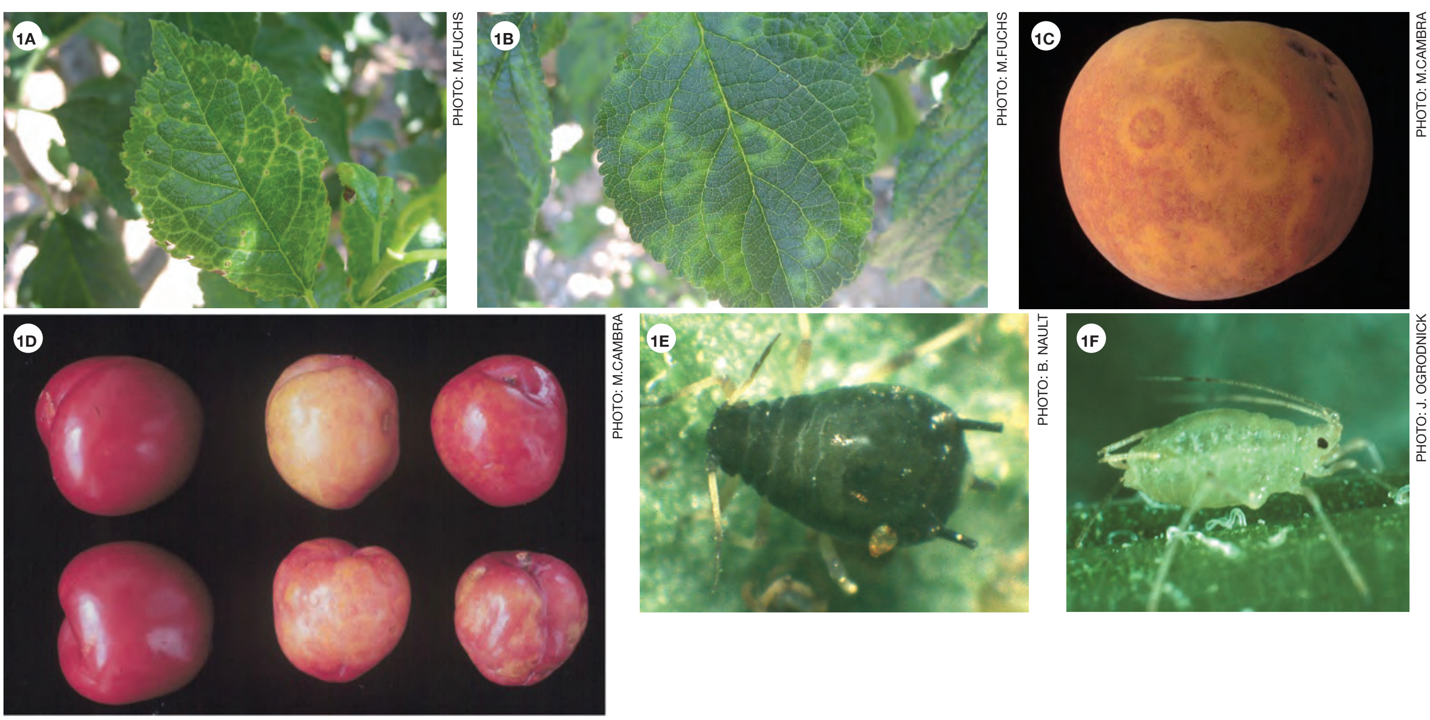

Figure 1. Plum pox virus causes (A) vein yellowing and (B) light green patterns on plum leaves; (C) ringspots on a peach fruit; (D) deformation and discoloration on plum fruits (right) relative to healthy fruits (left). (E) The black bean aphid, *Aphis fabae,* and (F) the green peach aphid, *Myzus persicae,* are major vectors of PPV.

symptoms include vein yellowing or light green to yellow rings. Plums can exhibit acute symptoms, including chlorotic and necrotic ring patterns or blotches (Figures 1A, 1B). Peach leaves may show leaf crinkling, puckering, or curling. Apricot leaves show lighter symptoms than plum or peach. Peach fruits may develop lightly pigmented rings or line patterns that result from the convergence of several rings (Figure 1C). Apricot fruits may be misshapen, turn brown or become necrotic and may have rings on the surface of the seed. Plum fruits are often deformed and have dark rings or spots and a reddish discoloration of the flesh (Figure 1D). Also, some plum cultivars will drop fruit prematurely. Newly infected trees take a few years to show symptoms; symptoms of PPV occur sporadically and often are not apparent until three or more years after infection.

Transmission and Spread

Long-distance spread of PPV over several miles occurs primarily by movement of infected plants or plant propagation materials through infected nursery stock or buds collected from infected trees.

Short distance spread of PPV from several yards to a few miles is via aphid vectors, which are plant-feeding homopterous insects. Several aphid species can transmit PPV but only a few of them are considered important vectors in the US: *Aphis fabae* or black bean aphid, *Aphis spiraecola* or spirea aphid, *Brachycaudus persicae* or black peach aphid, and *Myzus persicae* or green peach aphid (Figures 1E, 1F). The spirea and green peach aphids can colonize Prunus.

Aphid vectors transmit PPV nonpersistently. They test leaf and fruit surfaces by probing them. During test probes, which last as little as 30 seconds, the aphid's sap sucking mouthpart (stylet) penetrates plant tissue and draws up cell contents, including virus particles. Once acquired, PPV remains in the stylet up to three hours. During this time the virus can be spread to other trees when viruliferous aphids expel their stylet contents, including virus particles, during new probes. Spring aphid flights are important for spread within and between orchards. All infected trees, even when not showing symptoms, are sources of possible PPV transmission to other stone fruit trees.

Spatial analysis of PPV-infected trees in orchards suggests a preferential virus spread several tree spaces away from infected trees, rather than to neighboring trees.

Management

The foremost control method for PPV is exclusion. A careful regulation and inspection of imported plant material is handled by USDA-APHIS; only pathogen-free material is released for commercial use. Growers and nursery propagators should only purchase planting stock that is virus-tested and certified after it has been checked for PPV and other viruses. The production of PPV-free trees through the selection of PPV-free budwood and rootstocks is vital to preventing virus spread to new orchards. Almost universally, intercontinental spread of PPV has been associated with illegal transfer of infected materials or poorly controlled introduction of infected budwood materials.

As a result of the discovery of PPV in New York, USDA-APHIS declared an emergency situation and NY State Department of Agriculture and Markets issued a regulatory framework that governs intrastate movement of plant, nursery stock and bud materials of PPV-susceptible Prunus species. Quarantine and regulated areas were defined around the locations of PPV-infected stone fruit trees found in 2006 and 2007. No material can be propagated from the quarantine and regulated areas, nor moved from, within or outside the quarantine and regulated areas. In addition, replanting to PPV-susceptible stone fruits after a PPV outbreak is only possible if there is no further detection for at least three consecutive years.

There is no cure for PPV in the orchard. Therefore, early detection based on extensive surveys of commercial orchards, parks and homeowner properties, and subsequent removal and destruction of infected trees is highly critical for PPV eradication. Detection of PPV relies on serological and molecular tests because symptom expression can be latent and virus expression can be sporadic within an infected tree. Highly reliable and sensitive serological and molecular assays are available for the detection of the virus prior to the appearance of symptoms. Once a tree has been confirmed infected by PPV it is removed immediately along with any other PPV-susceptible trees within a 50 m radius to prevent spread of the virus to a new area (Figures 2A, 2B). If tree stumps are left behind they should be treated with herbicide to avoid the development of sucker shoots, which can carry PPV (Figure 2C).

Chemical control of aphids is ineffective for managing PPV. Application of insecticides may reduce the overall population of aphids but a single aphid can transmit PPV to a new host tree in a matter of seconds. Furthermore, total control of aphid vectors is impossible to achieve.

Plant resistance is the ideal control strategy for PPV. Limited resistance genes are available for use in developing highly resistant fruit varieties. Most cultivars with host resistance genes are tolerant to the disease in that they express few, if any, symptoms but carry the virus. Such cultivars are of limited value to prevent the spread of PPV. Currently, the most promising prospect for PPV resistance is genetic engineering. The insertion of PPV gene segments into plum trees confers high levels of resistance to PPV through the anti-viral pathways of RNA silencing, a potent natural defense mechanism against viruses in plants. This resistance is heritable and can be transferred to other cultivars through conventional breeding. This technology offers great promise for the development of commercial stone fruits that are resistant to PPV.

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Figure 2. Full removal of peach trees that are either infected with plum pox virus or healthy but located within 50 m from an infected tree; (A) stumps were removed and (B) trees prepared for burning; (C) sucker shoots developing on a peach tree stump infected with plum pox virus provide a source of virus for aphid spread.