

Data Sheets on Quarantine Pests

Potato spindle tuber viroid**IDENTITY**

Name: Potato spindle tuber viroid

Synonyms: Tomato bunchy top virus

Taxonomic position: Viroids

Common names: PSTVd (acronym)

Potato spindle tuber (English)

Spindelknollenkrankheit (German)

Notes on taxonomy and nomenclature: PSTVd is related to citrus exocortis viroid and chrysanthemum stunt viroid (EPPO/CABI, 1996), with which it shares considerable sequence homology. Relatively short sequences seem to determine pathogenicity to different hosts, possibly through effects on molecular conformation (Flores, 1984).

EPPO computer code: POSTXX

EPPO A2 list: No. 97

EU Annex designation: I/A1

HOSTS

The main host is potatoes, but the disease also affects tomatoes and other *Solanum* spp. A wide range of other members of the Solanaceae have been experimentally infected, as well as a few species in other families (Singh, 1973). Sweet potatoes have recently been reported as a host (Salazar, 1989). In the EPPO region, potatoes and tomatoes are the main hosts of concern.

GEOGRAPHICAL DISTRIBUTION

EPPO region: Egypt, Poland, Russia (European), Turkey (unconfirmed), Ukraine. Found but eradicated in the Commonwealth Potato Collection held in Scotland (UK), in the 1970s.

Asia: Afghanistan, China (Hebei, Heilongjiang, Jiangsu), India (Maharashtra), Turkey (unconfirmed), probably other countries (He *et al.*, 1987). The report from Japan (Takahashi, 1987) is erroneous.

Africa: Egypt, Nigeria, South Africa (unconfirmed; found absent in nuclear-stock potatoes; Pietersen, 1985).

North America: Canada (Alberta, British Columbia, Ontario, Quebec), but reported absent from seed potato crops in New Brunswick (Singh & Crowley, 1985a) and Prince Edward Island (Singh *et al.*, 1988a), USA (Kansas, Maryland, Maine, Michigan, New York, Wisconsin).

South America: The first edition of the EPPO data sheet on PSTVd (OEPP/EPPO, 1978) cited the viroid as widespread in South America. There are unconfirmed records for Argentina and Brazil and the pest is declared absent in Uruguay. Uncertain record from Peru (on avocado intercropped with potato). The situation in other countries remains obscure.

Oceania: Australia, found in 1982 in germplasm collections in quarantine in New South Wales, Victoria and South Australia (Navaratnam, 1984); eradicated (Catley, 1987).

EU: Absent.

BIOLOGY

Aphids, in particular *Macrosiphum euphorbiae* and *Myzus persicae*, and other insects occurring in Europe (*Eupteryx atropunctata*, *Empoasca flavescens*, *Lygus pratensis* and *Leptinotarsa decemlineata*) have been implicated as probable vectors (Werner-Solska, 1983) but, because of the ease of mechanical transmission, doubt now surrounds these reports.

The disease is mechanically transmitted by contact between healthy and diseased plants, tractor wheels, cutting knives, etc. The viroid appears to reach greatest concentration in the leaf hairs. Within tomato plants, it moves rapidly and systemically from an inoculated leaf to actively growing tissue via the phloem (Palukaitis, 1987). Within potato plants, it is found most readily in the upper leaves and tubers (Weidemann, 1987).

Transmission in true seed of potato depends upon the cultivar, and values from 0 to 100% have been recorded. The viroid can pass through both the pollen and ovule. In tomato seed, 7.9-11.1% transmission rates have been found.

For more information, see Diener & Raymer (1971).

DETECTION AND IDENTIFICATION

Symptoms

Mild strains generally cause no obvious symptoms in either potato or tomato, but can be detected experimentally in potato by cross-protection methods (Singh *et al.*, 1990).

Severe strains in sensitive cultivars cause the following symptoms:

On potatoes

In the field, a clockwise phyllotaxy of the foliage may be apparent when the plants are viewed from directly above. Foliage is spindly and very upright, often being a darker green than normal and slightly rugose. There may be an accumulation of pigment at the top of the stems, usually accompanied by an upward rolling of the terminal leaflets. Axillary buds may proliferate to give symptoms similar to those of witches' broom. Plants are stunted. Tubers are small, elongated, cylindrical, spindle or dumb-bell-shaped, with prominent eyes evenly distributed over the tuber. Sprouting is slower than in healthy tubers.

On tomatoes

Epinasty and rugosity of the apical leaves is followed by a necrosis of the leaflet midribs and a yellowing of leaflets in the central region of the plant. In the severe chronic stage, the entire plant is stunted, the apical leaves are small and compacted and the central leaves die.

For more details see Hooker (1981), Jones *et al.* (1991).

Morphology

PSTVd is a small viroid, with 359 nucleotides, whose sequence has been completely determined (Gross *et al.*, 1978).

Detection and inspection methods

Field and in-transit inspection will sometimes detect severe strains in sensitive cultivars. Laboratory tests are essential under most circumstances, by testing on indicator plants, electrophoresis or nucleic acid probes. PSTVd was covered by an EPPO quarantine procedure for potato quarantine viruses generally (OEPP/EPPO, 1984). An updated version specifically concerning PSTVd is in preparation.

The tomato cultivars most commonly used for biological testing are Sheyenne, Rutgers and Allerfrüheste-Freiland (Fernow *et al.*, 1969). They have the disadvantage of being slow (up to 4-6 weeks) and laborious to perform, but can be very sensitive. *Scopolia sinensis* has been used as a local lesion host (Mozhaeva *et al.*, 1989), but problems involving variability in sensitivity have been encountered. *Solanum x berthaultii* has recently been recommended (Singh, 1984).

Polyacrylamide gel electrophoresis is a rapid and convenient method (OEPP/EPPO, 1984), and has been refined by the use of the "return-electrophoresis" technique, in which normal electrophoresis is followed by a second run in the opposite direction under denaturing conditions (Schumacher *et al.*, 1986). The technique can be used to detect PSTVd in a single true potato seed (Singh *et al.*, 1988b), and also to separate severe from mild strains (Singh & Boucher, 1987). A simplified version of the technique for routine use has been proposed by Schroeder & Weidemann (1989).

Nucleic acid probes have been developed. These include both radioactive DNA (Salazar *et al.*, 1983; Bernardy *et al.*, 1987), radioactive RNA (Lakshman *et al.*, 1986; Salazar *et al.*, 1988; Candresse *et al.*, 1990), biotinylated DNA (McInnes *et al.*, 1989) and biotinylated RNA probes (Roy *et al.*, 1989; Candresse *et al.*, 1990).

Many authors have made comparisons between techniques (Singh & Crowley, 1985b; Harris & James, 1987; Huttinga *et al.*, 1987; Singh & Boucher, 1988; Mozhaeva *et al.*, 1989; Schubert *et al.*, 1989). An initial preference for electrophoresis seems to be shifting to probes, as these improve in quality.

MEANS OF MOVEMENT AND DISPERSAL

The viroid moves over short distances within crops by mechanical transmission. Over longer distances, it is most likely to be carried by potato tubers, and also by germplasm material, including true seed of potato and other *Solanum* spp. It may also be carried in tomato seed.

PEST SIGNIFICANCE

Economic impact

Both mild and severe strains of PSTVd exist. Severe strains in sensitive cultivars can reduce yield by up to 40% in individual plants, due to a reduction in both the size and number of tubers. Tuber quality can also be affected. In North America, it has been estimated that spindle tuber causes an overall loss of 1% to the potato industry. Losses vary with cultivar, disease strain and season, but are particularly severe under dry conditions. The general pattern is of a progressive decrease in yield with an increase in infection.

Control

Control is essentially by production of healthy planting material (Morris & Smith, 1977) and good crop sanitation. Cold treatment, followed by meristem-tip culture, can be used to eliminate PSTVd from potato stocks (Paduch-Cichal & Kryczynski, 1987). Resistance is looked for in potato cultivars in infested countries, e.g. Poland (Chrzanowska *et al.*, 1984).

Phytosanitary risk

PSTVd is an EPPO A2 quarantine pest (OEPP/EPPO, 1978) and is also of quarantine significance for NAPPO. Though present in some parts of eastern Europe, it is not cited as a major problem there, although PSTVd resistance is considered in potato breeding programmes. PSTVd is likely to cause most direct damage in warm dry areas of southern, central and eastern Europe. The disease could also establish itself as a latent infection in

seed-potato stocks in the cooler north-western countries, with severe consequences for export potential.

PHYTOSANITARY MEASURES

EPPO suggests that importation of seed potatoes may be prohibited from countries where PSTVd occurs (OEPP/EPPO, 1990). Alternatively, the whole potato production system should have been found free from PSTVd (if the viroid occurs in the exporting country), or the crop must have been found free from PSTVd during the growing season (if the viroid does not occur). The risk from ware potatoes can be reduced by treatments designed to prevent sprouting of the tubers.

Eradication of PSTVd has proved possible, at least within potato collections in Scotland (UK) and Australia (Catley, 1987). Even in countries where PSTVd is present (such as Canada), elimination from seed potato stocks is reported to be possible (Singh & Crowley, 1985a). Testing nuclear stocks for PSTVd is a precaution which could be taken in any seed-potato production system.

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