EPPO Datasheet: *Tepovirus tafsolani*

Last updated: 2022-07-05

IDENTITY

Preferred name: *Tepovirus tafsolani*
Taxonomic position: Viruses and viroids: Riboviria: Orthornavirae: Kitrinoviricota: Alsuviricetes: Tymovirales: Betaflexiviridae
Other scientific names: *PVT*, *Potato T capillovirus*, *Potato T trichovirus*, *Potato virus T*
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EPPO Categorization: A1 list
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EU Categorization: Quarantine pest ((EU) 2019/2072 Annex II A)
EPPO Code: PVT000



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Notes on taxonomy and nomenclature

Potato virus T (PVT) was first reported infecting asymptomatic potatoes of the cultivar Antarqui (*Solanum tuberosum* subsp. *tuberosum* x *S. tuberosum* subsp. *andigenum*) (Salazar, 1972) and it was subsequently described as a new Andean potato virus (Salazar & Harrison, 1977; 1978). It has had a complex taxonomic history (Rubino *et al.*, 2012) and had been placed in the genus *Capillovirus* because of its serological relationship to apple stem grooving capillovirus, then in the related genus *Trichovirus* and then in the family Betaflexiviridae as an unassigned species. However, following sequencing of the complete genome in 2009, it was found to differ sufficiently from the type species of all the genera in the family Betaflexiviridae, to warrant its classification in a new genus, *Tepovirus* (Rubino *et al.*, 2012*;* ICTV 2019). PVT differs from all other virus type members of genera in the family Betaflexiviridae, which have a 30K-type movement protein and it is phylogenetically distant from all of these viruses.

A PVT isolate differing in virulence was obtained from Bolivia in 1976 (Abad, 1979), but although sequence differences show that PVT-Bol is distinct from 12 other PVT isolates with complete genomic sequences in GenBank, it is considered as belonging to the same species (Adams *et al*., 2018).

HOSTS

PVT has been reported infecting potato (*S. tuberosum*) (Salazar, 1972; Abad, 1979; Vásquez *et al*., 2006) but as far as is known there are no reports of it infecting wild Solanum tuber-forming species in the field, although it has been found in wild species in gene bank accessions at CIP (CIP, 1991). It has also been found infecting *in vitro* accessions of mashua (*Tropaeolum tuberosum*), oca (*Oxalis tuberosa*) and ulluco (*Ullucus tuberosus*) (Lizárraga *et al*., 2000) (see Geographical distribution). Infection of these Andean tuber crops is perhaps not to be unexpected, since in the Peruvian highlands they are often grown in small plots in association with potato (Salazar & Harrison, 1978). However, there are no reports of it infecting *Chenopodium quinoa*, a susceptible experimental host which may also be grown in association with potato in this region.

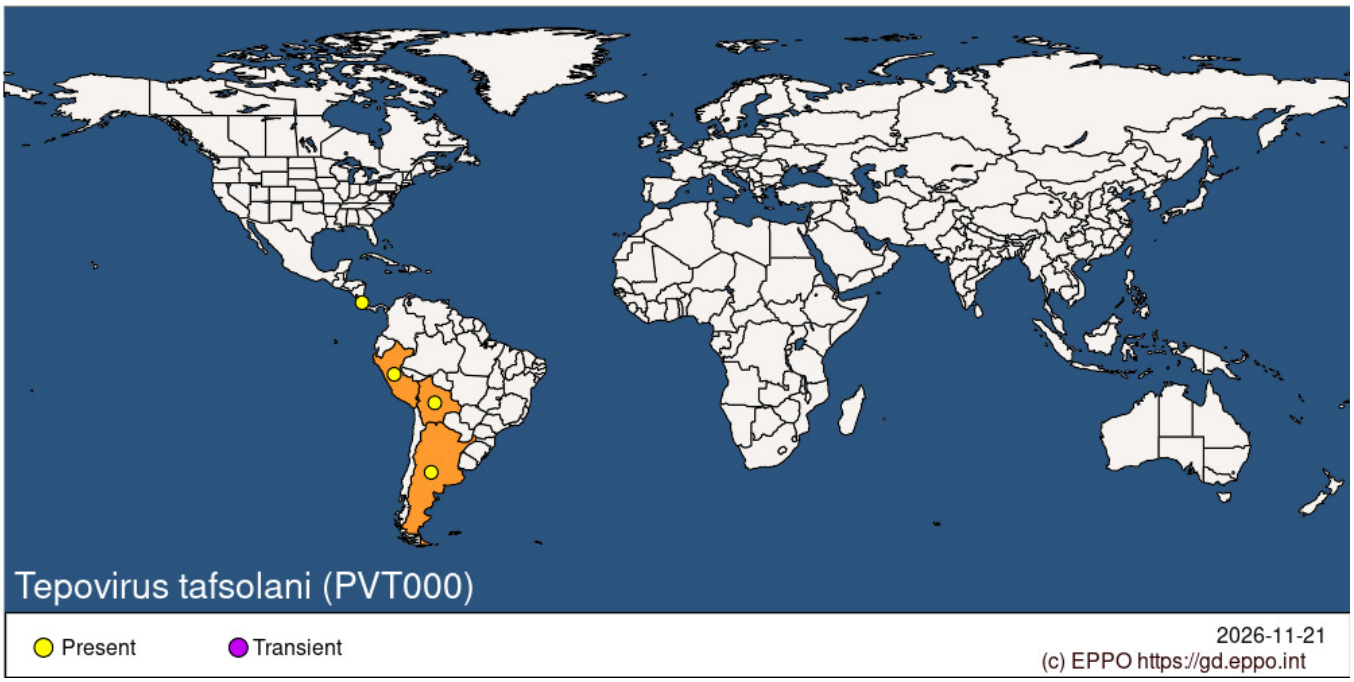
Experimentally, PVT has been transmitted mechanically to infect species in eight plant families including Chenopodiaceae, Fabaceae and Solanaceae, including wild *Solanum* tuber-forming species (Salazar & Harrison, 1978).

Host list: *Oxalis tuberosa*, *Solanum tuberosum hybrids*, *Solanum tuberosum subsp. andigenum*, *Solanum tuberosum*, *Tropaeolum tuberosum*, *Ullucus tuberosus*

GEOGRAPHICAL DISTRIBUTION

PVT has been reported infecting potato in Bolivia (Abad, 1979, Fuentes *et al*., 2019), Chile (Silvestre & Cuellar,

2012), Costa Rica (Vásquez *et al*., 2006) and Peru (Salazar, 1972). Although it was also intercepted at CIP in true potato seed germplasm imported from Bangladesh (Salazar, 1996) there are no further reports of it occurring in this country. Additionally, it has been detected infecting *in vitro* accessions in CIP's Germplasm Collection of Andean Root and Tuber Crops of mashua and oca from Peru, and ulluco from Argentina, Bolivia and Peru (Lizárraga *et al*., 2000).



Central America and Caribbean: Costa Rica
South America: Argentina, Bolivia, Peru

BIOLOGY

PVT infects potato plants systemically and is efficiently transmitted in susceptible potato cultivars through clonal/vegetative propagation to the progeny tubers. PVT has been detected in a true potato seed (TPS) germplasm collection at the International Potato Centre (CIP, 1991) and in imported potato germplasm (Salazar, 1996). PVT was transmitted experimentally through botanical seed in two families: Chenopodiaceae (*Chenopodium quinoa*) (Jones, 1982) and Solanaceae (*Datura stramonium* (transmission rate of 5%), *Nicandra physalodes* (28%), *Solanum villosum* (2%), and the wild tuber forming species *Solanum demissum* 'A6' (39%) (Salazar & Harrison, 1978). In the potato cultivar Cara, the transmission rate through TPS was 33–59%, for the Bolivian strain of PVT but only 0–2% for clone D42/8 (Jones, 1982). Transmission also occurred with pollen infecting ovules but without infecting the parent plant in *S. demissum* using the PVT type strain (Salazar & Harrison, 1978) and also in the potato cv. Cara using the Bolivian strain (Jones, 1982). PVT is transmitted mechanically (e.g. via machinery) and by plant-to-plant contact (Salazar, 1966; Jeffries, 1998), although the importance of this for field transmission is not known.

Vectors responsible for spreading PVT are unknown. Experimentally it was not transmitted from *Chenopodium quinoa* to *C. quinoa* by *Myzus persicae* or *Macrosiphum euphorbiae* or from *N. clevelandii* to *Datura stramonium* by *M. persicae* (Salazar & Harrison, 1978). Moreover, it does not have the nucleic acid binding protein generally seen in other vector-transmitted species in the family Betaflexiviridae (ICTV, 2012).

DETECTION AND IDENTIFICATION

Symptoms

Although yellow (calico) symptoms have been reported in naturally infected potato (Abad, 1979) and these were

reproduced in one inoculated potato plant (Salazar, 1996), these symptoms have not been observed since (Jeffries, 1998). Under glasshouse conditions variable symptoms have been produced. Following grafting of the type strain, plants of potato of cv. Cara showed primary symptoms of top necrosis followed by recovery and mosaic while cv. King Edward developed primary symptoms of chlorotic spots and slight vein necrosis. Progeny tubers gave rise to infected plants, but secondary symptoms were absent. The cultivars Arran Pilot and Maris Bard did not produce primary symptoms but secondary symptoms were systemic necrosis followed by recovery (Salazar & Harrison, 1978). The Bolivian strain of PVT induced only mild symptoms rather than the necrosis previously reported for the type of strain of PVT in the cv. Cara. No symptoms were seen in clone D4/28. No symptoms developed in potato seedlings infected with PVT through the seed (Jones, 1982). Additionally, Kreuze *et al*. (2020) reports that only mild mosaic or no symptoms are seen in potato plants.

Morphology

The virus has flexuous filamentous particles about 640 nm long and 12 nm wide which show a characteristic substructure of either a crisscross pattern or cross-banding, depending on whether they are stained with uranyl acetate or sodium phosphotungstate (Salazar & Harrison, 1977).

The PVT genome is single-stranded, positive-sense RNA. It is 6 539 nucleotides in size, excluding the poly(A) tail with three ORFs coding for replication-associated proteins (185 kDa, ORF 1), movement protein (40 kDa, ORF 2) and coat protein (24 kDa, ORF 3) (Russo *et al*., 2009).

Detection and inspection methods

In the probable absence of symptoms under natural conditions, field inspection is unlikely to detect the virus. However, PVT is reliably detected in *in vitro* plants (4–6 weeks old and with stems of at least 5 cm) and plants grown from infected tubers using indicator plants and serological and molecular methods. The reliability of testing tubers has not been reported.

Indicator plants

EPPO Standard PM 3/21 *Post-entry quarantine for potato* (EPPO, 2019) recommends a number of indicator plants for detection including: *Chenopodium giganteum* (synonym *Chenopodium amaranticolor)* and *C. quinoa* which give chlorotic local lesions (sometimes) followed by systemic apical and axillary shoot-tip necrosis and mottle or mosaic (Salazar & Harrison, 1978; Verhoeven & Roenhorst, 2000) and; *Nicotiana occidentalis* -P1 which give systemic symptoms of chlorotic and necrotic lesions, holes and leaf deformation (Verhoeven & Roenhorst, 2000).

Serological

PVT is moderately immunogenic. The production of polyclonal antiserum is difficult due to low virus yields but this can be overcome by successive sampling of purified virus and by storing in liquid nitrogen until a sufficient quantity has been obtained for inoculation. ELISA is useful for virus detection (Schroeder & Weidemann, 1990; Vernon-Shirley *et al.*, 1993) and monoclonal and polyclonal antibodies are available commercially.

Molecular

RT-PCR may be used with primers PVT-1, PVT-2 which give a PCR product of 330 bp (Lizárraga, 2000).

PATHWAYS FOR MOVEMENT

Plants for planting (including tubers) of mashua, oca, potato and ulluco moved locally or internationally constitute a major pathway for movement. Additionally, for potato it may be spread by true potato seed (TPS) through the movement of potato germplasm, although the significance of this in practice is less clear since it has only been rarely reported infecting gene bank accessions. However, the increasing interest in use of TPS for commercial potato production means that care should be taken to ensure that parent plants used to produce the TPS are free from PVT. Additionally, infected pollen moved for potato breeding may introduce the virus to breeding programmes. Whether PVT may be spread by seed and pollen of other hosts has not been reported. Also, the importance of local mechanical transmission in field conditions remain uncertain (Section Biology).

PEST SIGNIFICANCE

Economic impact

Although PVT seems relatively uncommon (Kreuze *et al*., 2020) and is not considered to be economically important in the Andes, its effect on yield does not appear to have been reported. Similarly, the potential economic impact on potato production, and the production of other hosts in the EPPO region has not been studied in detail. Although EFSA (2020) considered that any foliar symptoms were likely to affect photosynthesis, and thus yield and/or quality of tubers, the magnitude of the effect remains unknown under conditions in the EPPO region. However, if PVT was introduced and then established, export of potatoes to counties where it was categorized as a quarantine pest would be affected resulting in economic loss.

Control

Control depends on the production of high-quality planting material from virus-free nuclear stock or true potato seed that is produced from PVT-free parents in a pest free area or facility. Until the importance of mechanical transmission is further investigated measures to minimize spread by this means should be used.

Phytosanitary risk

Climatic conditions will not impair the ability of PVT to establish in the EPPO region. Potato is widely grown and is the main crop at risk in the EPPO region. Although EFSA (2020) concluded that PVT met the criteria to qualify as an EU quarantine pest, the magnitude of potential impact in the EPPO region remains unclear.

PHYTOSANITARY MEASURES

EPPO recommends that countries prohibit the import of all breeding material of potato, of whatever origin, except under a special permit, subject to post?entry quarantine (EPPO, 2017; 2019a). Once tested and found to be free from pests it may be released from quarantine and moved within the EPPO region.

Certified seed potatoes (micropropagative material and minitubers) may be traded if they meet the requirements of PM 3/62 *Production of pathogen-free microplants of potato* (EPPO 2019c) and PM 3/63 *Production of pathogen-free minitubers of pot*ato (EPPO 2019d) respectively. For import of seed potatoes and ware potatoes EPPO recommends that trade should be subject to transitional arrangements described in PM 8/1 *Commodity-specific phytosanitary measures for potato* (EPPO, 2017), which requires for countries where PVT occurs, import from a pest-free area and from a pest-free potato production and distribution system, according to EPPO Standard PM 3/61 *Pest-free areas and pest-free production and distribution systems for quarantine pests of potato* (EPPO, 2019b). Additionally, for countries in Central and South America where PVT does not occur recommendations are confirmation by detection survey that PVT does not occur and inspection or testing of tubers on import.

It should be noted that import of several of the hosts of PVT is already regulated/prohibited in many EPPO countries. In the EU, import of seed potatoes and plants for planting of stolon-or tuber-forming species of *Solanum* L. or their hybrids is prohibited by Annex VI of Commission Implementing Regulation (EU) 2019/2072 and *Ullucus tuberosus* by Commission Implementing Regulation (EU) 2018/2019. However, import of other potential hosts is not yet regulated, and no measures are in place for pollen.

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CABI and AAB resources used when preparing this datasheet

CABI Datasheet on PVT: https://www.cabi.org/isc/datasheet/43686

AAB description of plant viruses: https://www.dpvweb.net/dpv/showdpv/?dpvno=187

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Datasheet history

This datasheet was first published in the EPPO Bulletin in 1984 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2022. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', 'Hosts', and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

CABI/EPPO (1992/1997) *Quarantine Pests for Europe (1st and 2nd edition)*. CABI, Wallingford (GB).

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