EPPO Datasheet: *Nepovirus lycopersici*

Last updated: 2024-01-24

IDENTITY

Preferred name: *Nepovirus lycopersici*
Taxonomic position: Viruses and viroids: Riboviria: Orthornavirae: Pisuviricota: Pisoniviricetes: Picornavirales: Secoviridae
Other scientific names: *Blackberry (Himalaya) mosaic virus*, *Grapevine yellow vein virus*, *Nicotiana virus 13*, *Peach yellow bud mosaic virus*, *ToRSV*, *Tomato ringspot nepovirus*, *Tomato ringspot virus*, *Winter peach mosaic virus*
Common names: chlorosis mosaic of raspberry, chlorosis of pelargonium, crumbly fruit of raspberry, decline of raspberry, eola rasp leaf of cherry, ringspot of tomato, stem pitting of prunus, stub head of gladiolus, stunt of gladiolus, union necrosis of apple, yellow blotch curl of raspberry, yellow bud mosaic of peach, yellow vein of grapevine
view more common names online...
EPPO Categorization: A2 list
view more categorizations online...
EU Categorization: A1 Quarantine pest (Annex II A)
EPPO Code: TORSV0

more photos...

Notes on taxonomy and nomenclature

The name ‘tomato ringspot’ was initially applied to two apparently unrelated viruses. Price's isolate is now considered to be ToRSV, while that described by Samson & Imle (1942) is probably related to tomato top necrosis virus (Stace-Smith, 1984, Sanfaçon and Fuchs, 2011).

HOSTS

ToRSV occurs mostly in fruit, ornamental, and vegetable crops. Important fruit crop and ornamental plant hosts include stone fruits such as almond (*Prunus dulcis*), apricot (*Prunus armeniaca*), nectarine (*Prunus persica* var. *nucipersica*), plum (*Prunus domestica*), Japanese plum (*Prunus salicina*), sweet cherry (*Prunus avium*), sour cherry (*Prunus cerasus*), myrobalan cherry(*Prunus cerasifera*), Nanking cherry (*Prunus tomentosa*); berries such as black currants (*Ribes nigrum*), red currants (*Ribes rubrum*), blackberries (*Rubus laciniatus*), blueberries (*Vaccinium corymbosum*), raspberries (*Rubus idaeus*), strawberries (*Fragaria* sp.); other fruit crops such as apples (*Malus* sp.), grapes (*Vitis* sp.), pawpaws (*Asimina triloba*); trees such as white ash (*Fraxinus americana)*; flowers such as *Pelargonium, Hydrangea*, and *Gladiolus*; and vegetables such as tomato (*Solanum Lycopersicum*), cucumber (*Cucumis sativus*), and pepper (*Capsicum* sp.). Many weeds such as dandelion (*Taraxacum officinale*) can constitute reservoirs for the virus in field settings. Chickweed (*Stellaria media*) and sheep sorrel (*Rumex acetosella*) are also commonly infected, often sustaining symptomless infection (Brown *et al*., 1984).

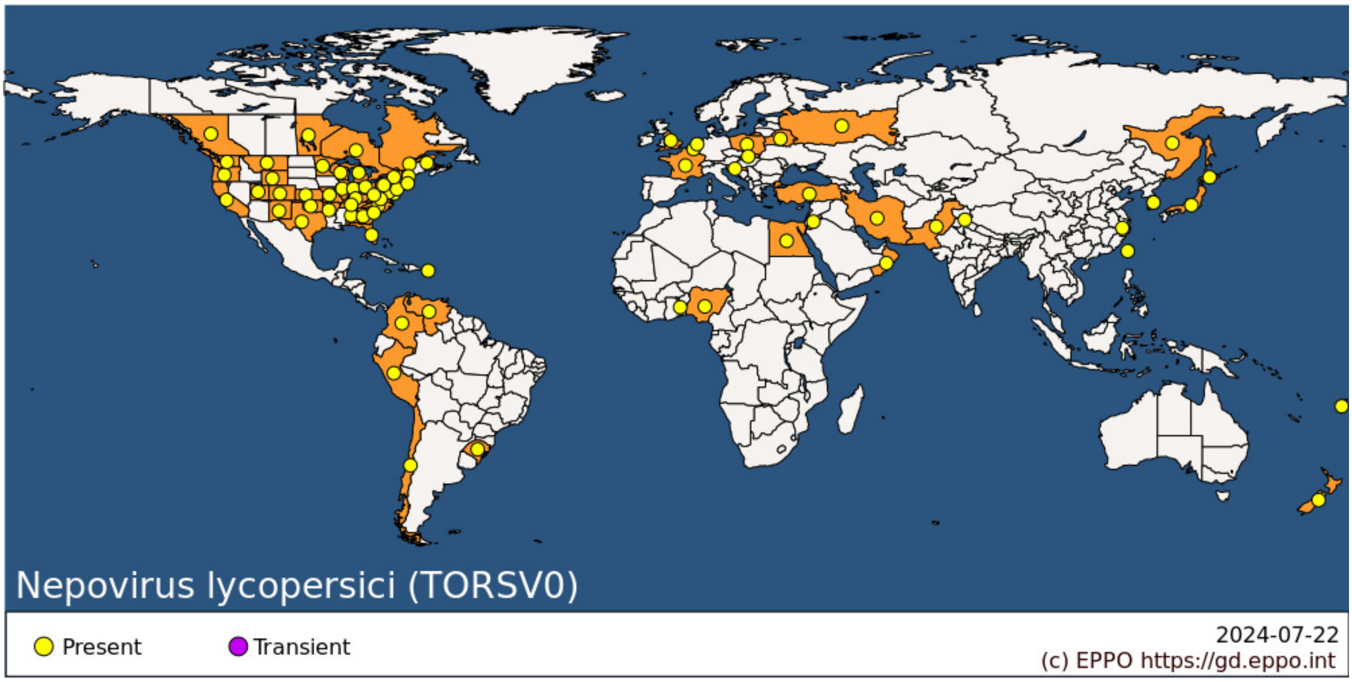
The experimental host range is very wide, with species in more than 35 dicotyledonous and monocotyledonous plant families.

Host list: *Acanthospermum hispidum*, *Ageratum conyzoides*, *Amaranthus spinosus*, *Aquilegia vulgaris*, *Asimina triloba*, *Bidens pilosa*, *Boerhavia diffusa*, *Capsicum sp.*, *Chenopodium album*, *Commelina erecta*, *Corchorus trilocularis*, *Cucumis sativus*, *Delphinium sp.*, *Fragaria chiloensis*, *Fragaria x ananassa*, *Fraxinus americana*, *Gladiolus sp.*, *Gomphrena celosioides*, *Helleborus foetidus*, *Hosta sp.*, *Hydrangea macrophylla*, *Ipomoea eriocarpa*, *Iris sp.*, *Iris x germanica*, *Lactuca serriola*, *Laggera aurita*, *Malus sp.*, *Mitracarpus hirtus*, *Nelsonia canescens*, *Pelargonium sp.*, *Pelargonium x hortorum*, *Phlox stolonifera*, *Physalis angulata*, *Ponthieva racemosa*, *Portulaca oleracea*, *Prunus avium*, *Prunus domestica*, *Prunus dulcis*, *Prunus persica*, *Punica granatum*, *Ribes nigrum*, *Ribes rubrum*, *Rosa sp.*, *Rubus fruticosus*, *Rubus idaeus*, *Rumex acetosa*, *Senna obtusifolia*, *Senna occidentalis*, *Solanum lycopersicum*

, *Solanum nigrum*, *Stellaria media*, *Taraxacum officinale*, *Trifolium sp.*, *Vaccinium corymbosum*, *Viola cornuta*, *Vitis vinifera*

GEOGRAPHICAL DISTRIBUTION

ToRSV is widespread in temperate regions of North America where the ectoparasitic nematode vector, *Xiphinema americanum senso lato*, occurs. The virus has also been reported from ornamentals and berry crops in other parts of the world. Of note, it has a restricted distribution in the EPPO region with some records referring to interceptions on plant material, particularly *Pelargonium*, imported from North America. Where virus occurrence is confirmed, it is often not clear which host is concerned, although it is agreed that ToRSV does not occur in fruit trees in the EPPO region. Older records based on the use of indicator plants should be considered with caution because they relate to a disease rather than a virus. ToRSV appears to have been eradicated in most of the EU countries based on recent surveys.



EPPO Region: Belarus, Belgium, Croatia, France (mainland), Jordan, Netherlands, Poland, Russia (Central Russia, Far East), Slovakia, Türkiye, United Kingdom (England)
Africa: Egypt, Nigeria, Togo
Asia: China (Zhejiang), India (Himachal Pradesh), Iran, Japan (Hokkaido, Honshu), Jordan, Korea, Republic, Oman, Pakistan, Taiwan
North America: Canada (British Columbia, Manitoba, New Brunswick, Ontario, Québec), United States of America (Alabama, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Virginia, Washington, West Virginia, Wisconsin, Wyoming)
Central America and Caribbean: Puerto Rico
South America: Brazil (Rio Grande do Sul), Chile, Colombia, Peru, Venezuela
Oceania: Fiji, New Zealand

BIOLOGY

ToRSV is occasionally transmitted to raspberry seed via the maternal tissue with no evidence of healthy mother plants becoming infected via infected pollen (Braun & Keplinger, 1973). However, pollen transmission to seed has been demonstrated in *Pelargonium* (Scarborough & Smith, 1977). The virus has also been transmitted occasionally through seed of tomatoes, tobacco (*Nicotiana tabacum*), and grapes, and frequently through seed of globe amaranth (*Gomphrena globosa*

), strawberries, and *Pelargonium*. Transmission experiments with dodder (*Cuscuta* spp.) have proved negative. The virus is readily transmissible by grafting and by sap inoculation to herbaceous hosts; sap transmission from the latter to *Rubus* has not been achieved. In raspberry fields, spread is predominantly from an infected plant to adjoining healthy ones, with an average annual rate of spread of about 2 m. Spread by root grafts may occur, but nematode vectors are the most important transmission agents. Infected seeds may be important as a continuing source of virus in the soil.

The ectoparasitic nematode vector of ToRSV is *Xiphinema americanum sensu lato*, the American dagger nematode. This is a species complex that may contain 64 distinct species, although there is extensive discussion on the validity of some of the species described (Lamberti & Bleve-Zacheo, 1979; EPPO 2023). It is therefore not possible to provide a definitive list of vector species. Nonetheless, the following nematode species have been suggested as possible vectors: *X. americanum senso stricto*, *X. bricolense*, *X. tarjanense*, *X. intermedium*, *X. inaequale*, *X. californicum, X. rivesi* (Brown, 1989; EPPO, 2023).

Adults, as well as the juvenile stages of the nematode, can transmit ToRSV, acquiring it within 1 h and inoculating it into healthy plants within 1 h. *X. americanum* requires at least one year to complete its life cycle and can survive (but not multiply) in soil in the absence of a host plant. It does not survive for long periods in frozen soil, and numbers decline at high and low moisture levels. The optimum temperature for nematode reproduction is 20-24°C.

For additional information, see Teliz *et al.* (1966), Keplinger *et al*. (1968), Converse & Stace-Smith (1971), Brown *et al*. (1993; 1995; 1996), Macfarlane (2003), MacFarlane *et al*. (2016), Mobasseri *et al*. (2019), Lazarova *et al*., (2019), Vazifeh *et al*. (2019).

DETECTION AND IDENTIFICATION

Symptoms

In general, the below described symptoms cannot be taken as proof of the presence of ToRSV; further tests, such as sap transmission to herbaceous indicator hosts, and more effectively, serological and/or molecular tests are essential for positive identification.

On raspberries

Symptom development is variable, but canes are stunted, and both fruit size and yield are reduced. Chlorotic ringspots may be evident on leaves of young plants. In subsequent years, very few foliar markings are apparent but leaves on new canes show epinasty and early abscission. By the third year of infection, 10-80% of fruiting canes may be killed (Smith, 1972). There is usually a border of symptomless plants around a group of visibly infected plants. Raspberry genes involved in the oxidation-reduction process, cell wall biogenesis, terpene synthase activity, and lyase activity are more abundantly expressed upon infection by ToRSV (Gonzáles *et al*., 2020).

On grapes

Symptoms are usually diagnosed early in the season with vines exhibiting many winter-killed buds and weak, stunted shoot growth. A few weeks after the start of vine growth, shoot and foliage symptoms are conspicuous on one or more shoots. Leaves develop chlorosis, ringspots, and mottling, are reduced in size, and rosetted due to the shortening of internodes (Yang *et al.*, 1986). Fruit clusters are reduced in size with many berries aborting. Removal of bark from trunks and stems of diseased vines may reveal thickened, spongy phloem tissue with numerous necrotic pits (Uyemoto, 1975).

On field-grown tomatoes

There is a conspicuous curling and necrosis of the terminals of one or more actively growing shoots. The basal portions of younger leaves develop brown, clearly defined, necrotic rings and sinuous lines. The petioles of the necrotic leaves and adjacent stem tissue are often marked with necrotic streaks and rings. If fruits are infected early, they develop faint to conspicuous, grey to brown, corky, superficial and frequently concentric rings or portions of rings (Smith, 1972).

On peaches

With the peach yellow bud mosaic strain of ToRSV, pale-green to pale-yellow, oblong, feather-edged blotches develop along the main vein or large lateral veins of the leaves. Buds either produce rosettes of small and often distorted leaves, with or without mottling, or are pale-yellow and later die. No flower symptoms are known, but fruit may be dwarfed and malformed. Some strains of ToRSV cause stem-pitting symptoms in peach and other *Prunus* spp. (Teliz *et al*., 1966).

On Pelargonium

Young leaves may develop ringspot symptoms or faint systemic, chlorotic flecks and a mottle with slight leaf distortion. Older leaves may show chlorotic bands in an oak-leaf pattern, or symptoms may fade, so that plants show only a slight dwarfing compared with healthy ones (although plants are still infective). Flowers show no definite colour break, but may be uneven and distorted (Rydén, 1972). However, these symptoms are rare and more commonly no symptoms are seen at all.

For additional information, see Price (1936), Converse & Stace-Smith (1971), Rydén (1972), Uyemoto (1975).

Morphology

ToRSV has relatively unstable, isometric particles with angular outlines, about 28 nm in diameter, sedimenting as three components and containing two single-stranded RNA molecules (Sanfaçon & Fuchs, 2011; Stace-Smith, 1966).

Detection and inspection methods

Guidance for the inspection of consignment of strawberry plants for planting, tomato seeds (EPPO, 2008b; 2021b), and apple, grapevine, strawberry and vegetable places of production (EPPO, 2017; 2018; 2021a; 2022) are available at https://gd.eppo.int/taxon/TORSV0/documents.

Mechanical transmission to herbaceous plants can be used as a detection method. *Chenopodium amaranticolor* and *C. quinoa* develop small chlorotic local lesions and a systemic apical necrosis. Cucumbers show local chlorotic spots, systemic chlorosis, and mottle. Other herbaceous hosts such as tobacco, *Petunia hybrida*, *Phaseolus vulgaris* and cowpeas can also be used. For the detection of ToRSV on almonds, cherries, peaches and plums, woody indicators (e.g. *Prunus persica* cv. Elberta or GF 305, *Prunus tomentosa* IR 473/1 or IR 474/1) can be used. However, serological methods, such as direct and indirect ELISA, and Immunosorbent Electron Microscopy (IEM), as well as RT-PCR (Griesbach, 1995; Stewart *et al*., 2007; Tang *et al*., 2014) are the recommended diagnostic methods based on their higher sensitivity and specificity compared with biological assays. Serological or molecular tests are also necessary to identify and characterize the viral agent(s) causing reactions on indicator plants. Finally, the advent of high-throughput sequencing is offering new avenues to identify ToRSV in infected fruit crop samples (Dias-Lara *et al*., 2021; Choi *et al*., 2022; Yao *et al*., 2018). All these tests have been described in EPPO Standard PM 7/49 (EPPO, 2005) which is currently under revision.

PATHWAYS FOR MOVEMENT

Long-range dispersal in trade is via host plants for planting (including seeds but excluding pollen, except for *Pelargonium*); accompanying soil may harbour infective seeds and viruliferous nematode vectors. It is uncertain how much host pollen is disseminated after ToRSV-infected *Pelargonium* is planted and how efficient it is as a pathway of transmission in imported material (DEFRA, 2018).

PEST SIGNIFICANCE

Economic impact

ToRSV can be of economic importance where it occurs. In grapes in New York, the virus has led to a serious decline, particularly of the cultivar Cascade (Siebel 13053) (Uyemoto, 1975). In Oregon, fruit from ToRSV-infected raspberry canes weighed 21% less individually than from healthy canes, and the yield was more than halved, since ToRSV has a particularly adverse effect on drupelet set of certain cultivars (Daubeny *et al*., 1975; Freeman *et al*., 1975). In addition, fruit quality is reduced, the fruits being crumbly and therefore unmarketable (Mircetich, 1973). The progressive decline in raspberries is such that, by the third year of infection, up to 80% of fruiting canes may be killed.

It is possible that European *Xiphinema* species, such as *X. pachtaicum*, which is widespread in the EPPO region, could transmit the virus. This nematode species has a wide host range, including many hosts of ToRSV. However, there are no reports of transmission experiments with *X. pachtaicum* and ToRSV. In North America, *X. rivesi* has been implicated as a vector of ToRSV; although present in Europe, it has a very limited host range and would not probably play a significant role in virus distribution beyond its area of occurrence (EPPO, 2023; Sirca *et al*., 2007).

Control

Control of ToRSV in established fruit tree orchards, vineyards, or fields of berry crops is difficult. The use of resistant cultivars or nematode-tolerant rootstocks (e.g. for grapes), and the use of healthy planting material can mitigate the impact of the virus. In addition, it is necessary to achieve good control of weeds in orchards, vineyards, and berry patches.

Phytosanitary risk

ToRSV can establish via clonal propagation of infected plants, seed of raspberries, tomatoes, tobacco and grapes, and pollen for *Pelargonium*. In EPPO countries, entry of the virus on plants for planting is considered likely, entry on seed of some hosts is moderately likely, and entry with import of pollen is unlikely. As ToRSV can persist in its nematode vectors for extended time, vector populations imported with growing medium or non-host plants may also introduce the virus, but this entry is considered unlikely in some EPPO countries (e.g. the United Kingdom) because of existing phytosanitary measures (DEFRA, 2018).

In the EU, the impacts of ToRSV are limited in the few countries where it is present. ToRSV could establish in ornamentals and eventually in fruit crops, although with limited risk concerns in the latter because the virus has not been found on fruit stocks yet in the EPPO region.

PHYTOSANITARY MEASURES

An appropriate phytosanitary measure to import plants for planting (including seeds) of host plants of ToRSV into the EPPO region could require that these plants are produced in a pest free area, among other measures (EU, 2019).

As presented by DEFRA (2018), additional measures to limit the entry of ToRSV in host plants for planting originating from countries/areas where the virus is known to occur may consist of introducing virus-tested, certified material, or material deriving from tested material, and maintained under appropriate conditions. This material should be free from ToRSV and produced in a pest free place/site of production (for ToRSV as well as for the nematode vector *Xiphinema americanum sensu lato*) with no disease symptoms.

EPPO recommends certification schemes for *Pelargonium* PM 4/3 (EPPO, 2002a), *Ribes* PM 4/9 (EPPO, 2008a), *Petunia* PM 4/26 (EPPO, 2002b) and herbaceous ornamentals PM 4/34 (EPPO, 2007). This latter Standard could be expanded to ornamentals in which ToRSV has been found in the EPPO region, including in the Netherlands and the United Kingdom.

Additionally, testing these ornamentals on a more systematic basis when moved within and between countries would help to trace the origins of (symptomless) infections.

Soil tests to guarantee the absence of nematode vectors may be applied to imported plant material with adherent soil or growing media, or on soil used for planting.

In several EPPO countries, ToRSV is regulated as a quarantine virus. Therefore, statutory regulatory action is taken against any findings to contain or eradicate outbreaks, particularly in cases where the nematode vectors are also detected. Eradication or containment measures are dependent on the infected crop. These include the destruction of infected plants and prohibition on the movement of soil if vectors are present.

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Datasheet history

This datasheet was first published in the EPPO Bulletin in 1982 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2024. 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.

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