

EPPO Datasheet: *Orthospovirus impatiensnecromaculae*

Last updated: 2022-09-19

IDENTITY

Preferred name: *Orthospovirus impatiensnecromaculae*

Taxonomic position: Viruses and viroids: Riboviria: Orthornavirae: Negarnaviricota: Polyploviricotina: Bunyaviricetes: Elliovirales: Tospoviridae

Other scientific names: *INSV*, *Impatiens necrotic spot orthospovirus*, *Impatiens necrotic spot tospovirus*, *Impatiens necrotic spot virus*

Common names: necrotic spot of impatiens

[view more common names online...](#)

EPPO Categorization: A2 list

[view more categorizations online...](#)

EU Categorization: RNQP (Annex IV)

EPPO Code: INSV00



[more photos...](#)

Notes on taxonomy and nomenclature

The virus strains previously constituting serogroup III of tomato spotted wilt tospovirus (TSWV) were subsequently distinguished as the separate species INSV (de Avila *et al.*, 1992; Vaira *et al.* 1993). In 1995, INSV was assigned to the genus *Tospovirus*, which was later renamed *Orthospovirus* (family *Tospoviridae*, order *Bunyavirales*; [ICTV online](#); Abudurexiti *et al.*, 2019). Species demarcation within the genus is based on nucleoprotein (N) sequence (new species are defined as having less than 90% amino acid sequence similarity to all other described species within the genus); in addition, species are often biologically distinguished by their host range and vector specificity (Plyusnin *et al.*, 2011; Kormelink *et al.*, 2021).

HOSTS

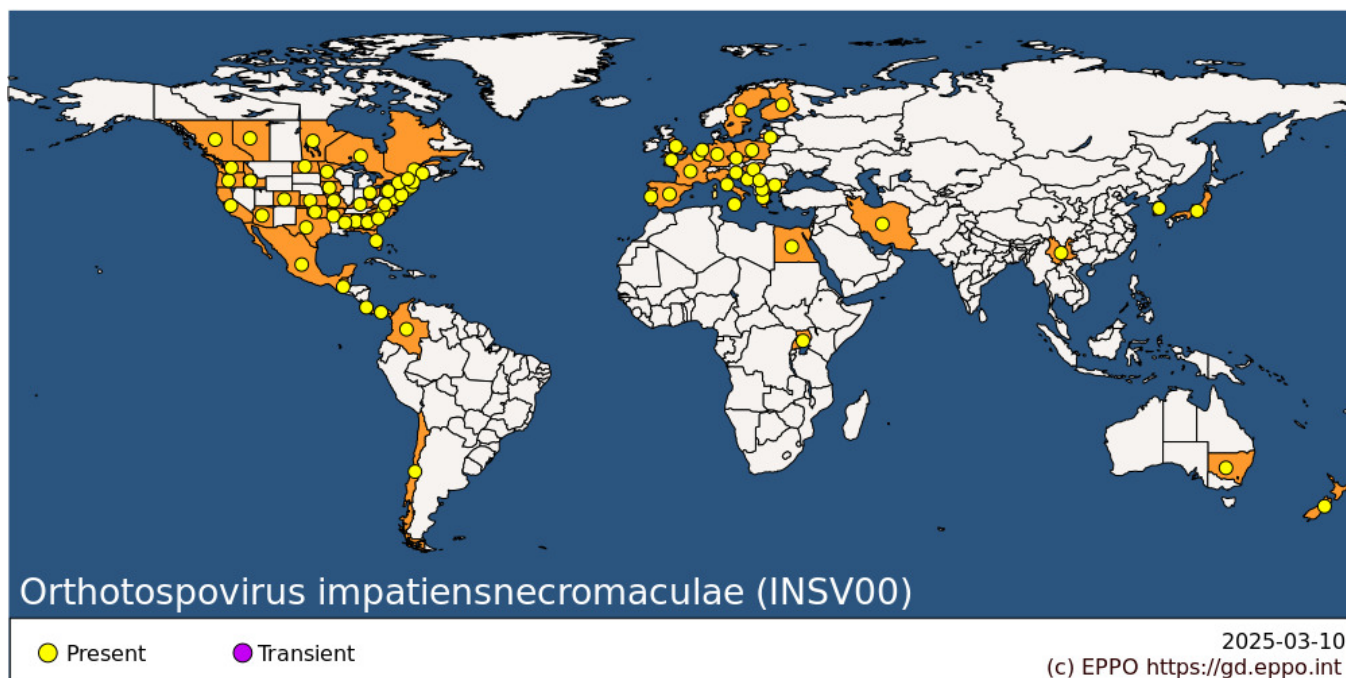
INSV has been reported to infect more than 300 plant species belonging to 85 different dicotyledonous and monocotyledonous families (Lebas & Ochoa-Corona, 2007). The main hosts of INSV are ornamentals such as *Aconitum*, *Alstroemeria*, *Anemone*, *Antirrhinum*, *Begonia*, *Bouvardia*, *Calceolaria*, *Callistephus*, *Chrysanthemum* (*Dendranthema x grandiflorum*), *Cineraria*, *Columnnea*, *Cyclamen persicum*, *Dahlia*, *Dianthus*, *Dracaena*, *Eustoma russellianum* (synonym *Eustoma grandiflorum*), *Exacum affine*, *Ficus*, *Freesia*, *Gardenia*, *Gentiana*, *Gerbera*, *Gladiolus*, *Impatiens*, *Iris*, *Kalanchoe*, *Limonium*, *Lobelia*, *Pelargonium*, *Pericallis cruenta* (synonym *Senecio cruentus*), *Petunia*, *Phalaenopsis*, *Pittosporum*, *Primula*, *Ranunculus*, *Sinningia speciosa* (synonym *Gloxinia speciosa*), *Spathiphyllum*, *Tulipa*, *Verbena*, *Zantedeschia aethiopica*, *Zinnia*. INSV is the first virus to be recorded from a fern (the glasshouse ornamental *Asplenium nidus-avis*). Vegetable hosts include *Allium cepa*, *A. porrum*, *A. sativum*, *Capsicum annum*, *Cucumis sativus*, *Lactuca sativa*, *Ocimum basilicum* and *Solanum lycopersicum*. It has also been shown to infect potatoes (*Solanum tuberosum*) and tobacco (*Nicotiana tabacum*). Weed species such as *Cardamine scutata*, *Stellaria media* and *Cerastium glomeratum* can be important reservoirs for INSV (Okuda *et al.*, 2010).

Host list: *Abelia x grandiflora*, *Acanthospermum hispidum*, *Aconitum sp.*, *Adenium obesum*, *Aeschynanthus sp.*, *Ageratum houstonianum*, *Agrostemma githago*, *Allium cepa*, *Allium cernuum*, *Allium cristophii*, *Allium lusitanicum*, *Allium moly*, *Allium oleraceum*, *Allium oreophilum*, *Allium porrum*, *Allium rotundum*, *Allium sativum*, *Allium scorodoprasum*, *Allium sphaerocephalon*, *Allium tuberosum*, *Allium zebdanense*, *Alstroemeria aurea*, *Alstroemeria sp.*, *Althaea sp.*, *Amaryllis sp.*, *Anemone coronaria*, *Anemone sp.*, *Anthemis sp.*, *Anthriscus cerefolium*, *Anthurium andraeanum*, *Anthurium scherzerianum*, *Anthurium sp.*, *Antirrhinum majus*, *Antirrhinum sp.*, *Aphelandra sp.*, *Arabidopsis sp.*, *Arachis hypogaea*, *Ardisia sp.*, *Asparagus densiflorus*, *Asplenium nidus*, *Begonia cucullata*, *Begonia leathermaniae*, *Begonia peltata*, *Begonia semperflorens hybrids*, *Begonia sp.*, *Begonia tuberhybrida hybrids*, *Begonia x hiemalis*, *Bougainvillea sp.*, *Bougainvillea spectabilis*, *Bouvardia sp.*, *Browallia sp.*, *Browallia speciosa*, *Calceolaria herbeohybrida hybrids*

, *Calceolaria* sp., *Calendula* sp., *Callistephus* sp., *Calycanthus floridus*, *Canna x generalis*, *Capsicum annuum*, *Cardamine hirsuta*, *Cardamine scutata*, *Cerastium glomeratum*, *Chenopodium album*, *Chrysanthemum* sp., *Chrysanthemum x morifolium*, *Cichorium intybus*, *Cineraria* sp., *Cissus* sp., *Clarkia amoena* subsp. *lindleyi*, *Clivia* sp., *Codiaeum variegatum*, *Coleus scutellarioides*, *Columnnea* sp., *Cordyline fruticosa*, *Cucumis sativus*, *Curcuma longa*, *Curcuma* sp., *Cycas* sp., *Cyclamen persicum*, *Cyclamen* sp., *Cyperus esculentus*, *Cyperus rotundus*, *Cyrtomium falcatum*, *Dahlia* sp., *Datura innoxia*, *Datura stramonium*, *Delphinium* sp., *Dendrobium* sp., *Desmodium tortuosum*, *Dianthus caryophyllus*, *Dianthus chinensis*, *Dianthus* sp., *Diascia rigescens*, *Diascia* sp., *Dieffenbachia seguine*, *Digitalis* sp., *Dischidia* sp., *Dracaena fragrans*, *Dracaena* sp., *Echeveria* sp., *Epipremnum pinnatum*, *Episcia cupreata*, *Erica* sp., *Erigeron canadensis*, *Eruca vesicaria* subsp. *sativa*, *Erysimum x cheiri*, *Eupatorium capillifolium*, *Euphorbia seguieriana*, *Eustoma russellianum*, *Eustoma* sp., *Exacum affine*, *Fatsia* sp., *Ficaria verna*, *Ficus benjamina*, *Ficus elastica*, *Franklinia alatamaha*, *Freesia refracta*, *Freesia* sp., *Gardenia jasminoides*, *Gazania* sp., *Gentiana macrophylla*, *Gentiana* sp., *Geranium carolinianum*, *Geranium* sp., *Gerbera jamesonii*, *Gerbera* sp., *Gladiolus* sp., *Gladiolus x gandavensis*, *Gnaphalium* sp., *Gomphrena globosa*, *Halesia carolina*, *Hedera helix*, *Helianthus annuus*, *Helichrysum* sp., *Heptapleurum actinophyllum*, *Hibiscus rosa-sinensis*, *Hippeastrum hybrids*, *Hippeastrum* sp., *Hosta* sp., *Hoya carnosa*, *Hoya* sp., *Hoya wayetii*, *Hydrangea quercifolia*, *Hydrangea* sp., *Hymenocallis littoralis*, *Ilex glabra*, *Impatiens New Guinea hybrids*, *Impatiens hawkeri*, *Impatiens* sp., *Impatiens walleriana*, *Ipomoea tricolor*, *Iris pumila*, *Iris x hollandica*, *Isotoma axillaris*, *Jacquemontia tamnifolia*, *Kalanchoe blossfeldiana*, *Kalanchoe farinacea*, *Kalanchoe* sp., *Kalanchoe thyrsiflora*, *Kohleria* sp., *Lactuca sativa*, *Lavandula* sp., *Leucanthemum* sp., *Limonium sinuatum*, *Limonium* sp., *Lobelia erinus*, *Lobelia* sp., *Lysimachia congestiflora*, *Maranta leuconeura*, *Matricaria chamomilla*, *Mollugo verticillata*, *Monarda didyma*, *Nemesia strumosa*, *Nepenthes x coccinea*, *Nicotiana benthamiana*, *Nicotiana tabacum*, *Ocimum basilicum*, *Oncidium* sp., *Opuntia microdasys*, *Osteospermum* sp., *Oxydendrum arboreum*, *Pelargonium peltatum*, *Pelargonium radens*, *Pelargonium* sp., *Pelargonium x hortorum*, *Penstemon* sp., *Peperomia obtusifolia*, *Peperomia rotundifolia*, *Pericallis cruenta*, *Pericallis x hybrida*, *Petunia hybrids*, *Petunia* sp., *Phalaenopsis amabilis*, *Phalaenopsis hybrids*, *Philodendron* sp., *Phlox* sp., *Photinia x fraseri*, *Physalis ixocarpa*, *Pilea cadierei*, *Pittosporum* sp., *Plantago asiatica*, *Platycodon grandiflorus*, *Portulaca grandiflora*, *Portulaca oleracea*, *Primula obconica*, *Primula* sp., *Ranunculus asiaticus*, *Ranunculus* sp., *Raphanus raphanistrum*, *Rhaphiolepis indica*, *Richardia scabra*, *Rosa* sp., *Rubus* sp., *Rubus*, *Ruscus* sp., *Salvia* sp., *Salvia splendens*, *Saxifraga stolonifera*, *Schefflera* sp., *Schizanthus* sp., *Schizanthus x wisetonensis*, *Scindapsus* sp., *Sinningia* sp., *Sinningia speciosa*, *Solanum brevicaulis*, *Solanum lycopersicum*, *Solanum mochiense*, *Solanum muricatum*, *Solanum tuberosum*, *Sonchus oleraceus*, *Spathiphyllum* sp., *Spinacia oleracea*, *Stachys floridana*, *Stellaria media*, *Stephanotis* sp., *Streptocarpus ionanthus*, *Streptocarpus* sp., *Syngonium podophyllum*, *Torenia fournieri*, *Trachelium* sp., *Tradescantia albiflora*, *Tripleurospermum maritimum*, *Tulbaghia violacea*, *Tulipa* sp., *Verbena hybrids*, *Verbena rigida*, *Verbena* sp., *Viola* sp., *Wahlenbergia marginata*, *Zantedeschia aethiopica*, *Zantedeschia albomaculata*, *Zantedeschia odorata*, *Zantedeschia* sp., *Zingiber* sp., *Zinnia elegans*, *Zinnia* sp.

GEOGRAPHICAL DISTRIBUTION

INSV was first isolated from *Impatiens* sp. in North America in 1989 (described as TSWV-*Impatiens* strain; Law & Moyer, 1990; Law et al., 1991). Since then, INSV has been detected in many countries worldwide, including several countries in the EPPO region.



EPPO Region: Belgium, Bosnia and Herzegovina, Bulgaria, Czech Republic, Finland, France (mainland), Germany, Greece (mainland), Guernsey, Hungary, Italy (mainland, Sicilia), Lithuania, Netherlands, North Macedonia, Poland, Portugal (mainland), Serbia, Slovenia, Spain (mainland), Sweden, United Kingdom (England)

Africa: Egypt, Uganda

Asia: China (Yunnan), Iran, Japan (Honshu), Korea, Republic

North America: Canada (Alberta, British Columbia, Manitoba, Ontario, Québec), Mexico, United States of America (Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Texas, Vermont, Virginia, Washington)

Central America and Caribbean: Costa Rica, Guatemala, Panama

South America: Chile, Colombia

Oceania: Australia (New South Wales), New Zealand

BIOLOGY

INSV exhibits some genetic diversity, but epidemiological studies indicated no evidence of host specificity among INSV isolates and demonstrated that isolates introduced via different routes can be circulating within the same areas (Kuo *et al.*, 2014, Nekoduka *et al.*, 2015; Adegbola *et al.*, 2019).

Orthospovirus particles are transmitted and spread in natural conditions by thrips - insects of the genera *Frankliniella* and *Thrips* (family Thripidae). Thrips species known to transmit INSV are *Frankliniella fusca*, *F. occidentalis* and *F. intonsa* (Naidu *et al.*, 2001; Sakurai *et al.*, 2004; Jones, 2005; Rotenberg & Whitfield, 2018). In the EPPO region, *F. occidentalis* and *F. intonsa* are widely distributed (EFSA, 2012b). Both thrips species are very polyphagous. Orthospoviruses are transmitted by thrips in a persistent manner. Only individuals which have acquired the virus at the larval stages can transmit it. Virus transmission occurs after a latent period of circulation and multiplication of the virus in the thrips vector. Once acquired, the virus is transmitted transstadially and thrips remain infectious for life, however there is no evidence of transovarial transmission (Wijkamp & Peters, 1993; Jones, 2005; Rotenberg & Whitfield, 2018).

Orthospoviruses are also transmitted mechanically by wounding, a process that is only of experimental significance (EFSA, 2012b). Like all viruses, orthospoviruses are disseminated with infected plant tissues used for vegetative propagation hence all plants infected with orthospoviruses contribute to virus spread when cuttings are used for vegetative propagation (EFSA, 2012b). Although orthospoviruses are considered not to be seed-transmitted (Pappu *et al.*, 2009), an as yet unconfirmed first report of seed transmission of an orthospovirus (soybean vein necrosis virus) has been published by Groves *et al.* (2016).

DETECTION AND IDENTIFICATION

Symptoms

INSV can cause a variety of symptoms that may vary in the same host species depending on the variety and age as well as the nutritional and environmental conditions of the plant. Symptoms of INSV infection also vary depending on the developmental stage of the plant at the time of inoculation and on the virus isolate. INSV symptoms include necrosis, chlorosis, ring patterns, mottling, stunting, local lesions, and death of the plant. Several other orthospoviruses, as well as even more genetically distinct viruses, can cause symptoms similar to those seen in INSV infection. However, it should be noted that infection of host plants by INSV may be asymptomatic in some host plants, or the symptoms may be mild due to environmental conditions, or the infection may be too recent to reach full symptom expression (Daughtrey *et al.*, 1997; Roggero *et al.*, 1999; Lebas & Ochoa-Corona, 2007; Okuda *et al.*, 2010; EFSA, 2012b; Nekoduka & Sano, 2018).

Symptomatology of some ornamentals:

- *Begonia x hiemalis*: yellow mottling of leaf, large brown circular necrotic spots, browning of the veins at the petiole end of the leaf; petiole may turn brown or necrotic (Lebas & Ochoa-Corona, 2007)
- *Begonia tuberhybrida* hybrids: foliar chlorotic rings and zonal spots accompanied by leaf necrosis and distortion of (Trkulja *et al.*, 2013)
- *Chrysanthemum*: chlorotic mottle and necrosis on the leaves (Kondo *et al.*, 2011)
- *Eustoma russellianum*: necrotic ringspots, leaf distortion, systemic necrosis, wilting, stunting, and death of the plant (Lebas & Ochoa-Corona, 2008)
- *Impatiens New Guinea hybrids*: brown or purple leaf spots, ringspots on petals, black diffuse spotting on leaves, black stem sections, leaf distortion, chlorotic mottling, and stunting (Lebas & Ochoa-Corona, 2008)
- *Phalaenopsis* orchids: chlorotic and necrotic ringspots (Baker *et al.*, 2007; Cheng *et al.*, 2010)
- *Primula* spp.: necrotic veins, irregular necrotic lesions, mottling, and stunting (Lebas & Ochoa-Corona, 2008)
- *Sinningia speciosa* (synonym *Gloxinia speciosa*): chlorosis, necrosis streaking, brown spots, ringspots, wilting, and death of the plant (Lebas & Ochoa-Corona, 2008)
- *Spathiphyllum*: concentric chlorotic ringspots, line patterns, and irregular chlorotic blotches on leaves, which developed into localized necrosis (Materazzi & Triolo, 2001)

Symptomatology of some vegetables, aromatic herbs and other crops:

- *Capsicum annum* (pepper): dark necrotic spots on some leaves and on the stems (Gonzalez-Pacheco & Silva-Rosales, 2013), dwarfing, leaf chlorotic ringspots, and distorted apical buds (Chen *et al.*, 2016)
- *Lactuca sativa* (lettuce): leaf chlorosis, brown ringspots, necrotic lesions, vein necrosis, leaf distortion and/or plant stunting (Koike *et al.*, 2008; Beris *et al.*, 2020; Hasegawa *et al.*, 2022)
- *Ocimum basilicum* (basil): foliar symptoms consisting of chlorotic spots, ring spots, leaf distortion, and stem necrosis (Poojari & Naidu, 2013)
- *Solanum lycopersicum* (tomato): small necrotic spots to large circular blotches on leaves and sometimes on fruit (Lebas & Ochoa-Corona, 2008)
- *Solanum tuberosum* (potato): leaves of greenhouse-grown potato exhibiting necrotic lesions with a concentric pattern (Perry *et al.*, 2005)

Morphology

Orthospoviruses form enveloped spherical particles with a diameter of 80-120 nm. The lipid envelope of orthospoviruses contains transmembrane tips composed of two glycoproteins that form oligomeric structures on the outside of the envelope. The cytoplasmic tails of the glycoproteins interact with the nucleoproteins encapsulating at least one copy of the three linear ssRNA segments (Butkovič *et al.*, 2021).

Detection and inspection methods

The plants, especially the leaves, should be examined for symptoms. Particular attention should be paid if thrips are present. If necessary, samples should be taken for laboratory testing for definitive identification of the pest.

The tests recommended for the detection and identification of INSV are described in EPPO Standard PM 7/139 Tospoviruses (genus *Orthospovirus*) (EPPO, 2020). Electron microscopy can be used for the detection of INSV and other viruses of the same genus, as they share a typical morphology. Mechanical inoculation of test plants can be used for detection and subsequent identification by other methods. Several ELISA kits and serological tests for on-site detection are commercially available and can be used as screening tools for INSV. Several molecular tests have been described for the detection of INSV, and some for identification. Sequence analysis of amplicons obtained by the generic conventional PCR tests can also be used for INSV identification. The definitive identification should be based on the sequence of the complete N gene according to the species demarcation criteria of ICTV. In addition, high-throughput sequencing is a technology that can obtain (nearly) complete genome sequences, and analysis of these sequences can be used to identify a virus isolate.

PATHWAYS FOR MOVEMENT

INSV is a systemic pathogen and as such it is transmitted very efficiently by all vegetative propagation techniques. In international trade, INSV can be transmitted by susceptible host plants for planting (whether potted or not), and is particularly able to spread further if these plants also carry vectors. Thrips are easily transported on above-ground fresh plant parts (e.g. cut foliage, cut flowers and cut branches) hidden under bracts, in buds and leaf bases. Insect vectors that have acquired INSV and that invade new areas can transmit INSV to new hosts. Short distance spread of thrips vectors by natural means within and between adjacent greenhouses, orchards, and other production sites is likely, but long-distance spread, even in strong winds is less common. Weeds can provide a virus reservoir from which thrips vectors can migrate into cultivated ornamentals or crop fields, which then become heavily infected. Mechanical transmission of INSV only plays a limited role in virus epidemiology in the ornamental industry and agriculture. Transmission through seeds is considered not to be a pathway or to be a highly unlikely pathway (see Biology) (Mound, 1983; Kirk & Terry, 2003; Okuda *et al.*, 2010; EFSA, 2012b; Joseph & Koike, 2021).

PEST SIGNIFICANCE

Economic impact

The greatest economic losses due to INSV infection have been reported in crops of cut flowers and potted plants,

especially when infested with *F. occidentalis* (Lebas & Ochoa-Corona, 2008). Severe losses due to INSV infection have been reported in *Cineraria*, *Ranunculus*, *Impatiens*, *New Guinea Impatiens*, *Cyclamen*, *Exacum*, *Begonia*, *Primula*, and *Sinningia* (synonym *Gloxinia*) (Daughtrey *et al.*, 1997). This was due to symptoms such as necrotic spots, necrotic veins, ringspots and stem necrosis, which make ornamental plants quite unattractive and thus unsaleable (EFSA, 2012b). However, EFSA (2012b) classified the impact of orthospovirus diseases on ornamental plant production as moderate; as damage may be limited to a few leaves and flowers and does not necessarily affect entire plants.

Although INSV is found in vegetable crops, its impact is not apparently as great on these hosts as that of TSWV. However, there are some cases in which important damage is reported. For example, due to INSV infection, 30 to 40% of lettuce plants in four fields in Greece were affected (Beris *et al.*, 2020), and severe outbreaks were recorded in lettuce crops in California (Kuo *et al.*, 2014).

Control

The use of healthy planting material and a management strategy based on a combination of thrips and weed control, the use of resistant plant varieties and other measures is considered crucial for orthospovirus control (EFSA, 2012b; Zhang *et al.*, 2021).

INSV is included in the certification scheme for herbaceous ornamentals (EPPO, 2008), among which there are specific certification schemes for chrysanthemums, pelargoniums, begonias, New Guinea hybrids of impatiens, kalanchoe and petunias (EPPO, 2000a-f). This reduces the impact and spread associated with the plants for the planting pathway.

The same control measures as for TSWV (EPPO, 2022) are suggested and described further on: Seedling beds should be separated from flowering ornamental plants or susceptible crops and surrounding areas kept free of weeds. Greenhouse and outdoor crops should be inspected regularly and as often as possible after planting, and can be tested during the entire propagation scheme. The presence of thrips in crops should be monitored with yellow sticky card traps. If the disease appears in a crop, infected plants should be immediately uprooted and destroyed, and the greenhouse/ field treated with an insecticide against thrips.

Thrips are difficult to control because they can become resistant to several insecticides used (Gao *et al.*, 2012). To avoid the development of resistance mechanisms, it is important to rotate insecticides with different active ingredients (Bielza, 2008). The prevalence of thrips vectors under protected conditions can be reduced by introducing biocontrol agents. These include predatory mites, entomopathogenic fungi and nematodes, parasitic wasps and generalist predators (Sánchez & Lacasa, 2002; Blaeser *et al.*, 2004; Ansari *et al.*, 2008; Messelink *et al.*, 2008; Cloyd, 2009). To prevent infestation of a new crop with a thrips population, it is recommended that greenhouses be kept completely free of crop residues and weeds for at least six weeks prior to planting and that seedlings be treated with insecticides before planting (EFSA, 2012a). In addition, fine-mesh netting can be potentially useful to exclude thrips in greenhouses (EFSA, 2012a).

Cultivation of INSV resistant (tolerant/immune) cultivars would reduce the incidence of the disease, but unfortunately, resistant varieties of the vast majority INSV host plants are not available (Peng *et al.*, 2014; Sears, 2017; Simko *et al.*, 2018).

Phytosanitary risk

Originally, INSV was thought to be of importance only to ornamentals. However, subsequent reports have shown that the host range of the virus has expanded to include several horticultural, agricultural, and field crops. It is reported from many European and Mediterranean countries. In addition, its thrips vector species are widely distributed in these countries. Spread can occur through thrips vector activity and through movement of infected hosts. Because INSV can cause both yield and quality losses in a variety of hosts, significant impacts are expected in regions where thrips vectors are present if appropriate control measures are not taken.

PHYTOSANITARY MEASURES

To prevent the introduction, spread and impact of INSV, requirements at production and/or import for different host species apply worldwide. These requirements can vary with regards to crop and prevalence at the place of origin.

EPPO countries where INSV does not occur or is not widespread may consider regulation as a quarantine pest. If they do so, these countries may require that plants have been produced in a pest free area, in a pest-free place/site of production or be subject to inspection and/or testing e.g. as performed in certification schemes.

In areas where INSV does occur, it was assessed during the EU Quality pest project as fulfilling the minimum criteria for listing as a regulated non-quarantine pest (RNQP) for propagating and planting material (other than seeds) of *Begonia x hiemalis* and *Impatiens* New Guinea hybrids (Picard *et al.*, 2018). In particular, before starting the propagation and/or production of plants, it should be ensured that the planting material is free from INSV (INSV is included in certification schemes for various ornamental plants, see Control section). During the EU Quality pest project, in addition to the monitoring and treatments to ensure effective suppression of populations of relevant thrips vectors, it was recommended that no symptoms have been observed at the site of production during the current growing period, or that any plants at the production site showing symptoms of INSV during the current growing period have been rogued out and a representative sample of the plants to be marketed has been tested and found free from INSV. In the EU, INSV is regulated as a Union RNQP for such material.

REFERENCES

- Abudurexiti A, Adkins S, Alioto D Alkhovsky SV, Avšič-Županc T, Ballinger MJ, Bente DA, Kuhn JH *et al.* (2019) Taxonomy of the order Bunyavirales: update 2019. *Archives of Virology* **164**. <https://doi.org/10.1007/s00705-019-04253-6>
- Adegbola RO, Marshall SH, Batuman O, Ullman DE, Gilbertson RL, Adkins S, Naidu RA (2019) Sequence analysis of the medium and small RNAs of impatiens necrotic spot virus reveals segment reassortment but not recombination. *Archives of Virology* **164**, 2829–2836.
- Ansari M, Brownbridge M, Shah F & Butt T (2008) Efficacy of entomopathogenic fungi against soil-dwelling life stages of western flower thrips, *Frankliniella occidentalis*, in plant-growing media. *Entomologia Experimentalis et Applicata* **127**, 80–87.
- Baker CA, Davison D & Jones L (2007) Impatiens necrotic spot virus and Tomato spotted wilt virus diagnosed in *Phalaenopsis* orchids from two Florida nurseries. *Plant Disease* **91**(11), 1515.
- Beris D, Malandraki I, Kektsidou O, Vassilakos N & Varveri C (2020) First report of impatiens necrotic spot virus infecting lettuce in Greece. *Plant Disease* **104**(10), p 2742.
- Bielza P (2008) Insecticide resistance management strategies against the western flower thrips, *Frankliniella occidentalis*. *Pest Management Science* **64**, 1131–1138.
- Blaeser P, Sengonca C & Zegula T (2004) The potential use of different predatory bug species in the biological control of *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae). *Journal of Pest Science* **77**, 211–219.
- Butkovič A, González R & Elena SF (2021) Revisiting Orthotospovirus phylogeny using full-genome data and testing the contribution of selection, recombination and segment reassortment in the origin of members of new species. *Archives of Virology* **166**, 491–499.
- Chen X-J, Huang Y, Li J, Huang C-J, Liu Y, Zhu M & Tao X-R (2016) First report of *Impatiens necrotic spot virus* causing chlorotic ringspots on pepper in Yunnan, China. *Plant Disease* **100**(5), 1029.
- Cheng XF, Dong JH, Fang Q, Ding M, McBeath JH & Zhang ZK (2010) Detection of Impatiens necrotic spot virus infecting *Phalaenopsis* in Yunnan. *Journal of Plant Pathology* **92**(2), 545.
- Cloyd RA (2009) Western flower thrips (*Frankliniella occidentalis*) management on ornamental crops grown in greenhouses: Have we reached an impasse? *Pest Technology* **3**, 1–9.

- Daughtrey ML, Jones RK, Moyer JW, Daub ME & Baker JR (1997) Tospoviruses strike the greenhouse industry; INSV has become a major pathogen on flower crops. *Plant Disease* **81**(11), 1220-1230.
- de Avila AC, de Haan P, Kitajima EW, Kormelink R, Resende RO, Goldbach RW & Peters D (1992) Characterization of a distinct isolate of tomato spotted wilt virus (TSWV) from *Impatiens* sp. in the Netherlands. *Journal of Phytopathology* **134**, 133-151.
- EFSA Panel on Plant Health (2012a) Scientific Opinion on the risk to plant health posed by Tomato spotted wilt virus to the EU territory with identification and evaluation of risk reduction options. *EFSA Journal* 10(12), 3029. <https://doi.org/10.2903/j.efsa.2012.3029>
- EFSA Panel on Plant Health (2012b) Scientific Opinion on the pest categorisation of the tospoviruses. *EFSA Journal* 10(7), 2772. <https://doi.org/10.2903/j.efsa.2012.2772>
- EPPO (2000a) Production of healthy plants for planting. PM 4/6 (2) Certification scheme for chrysanthemum. *EPPO Bulletin* **32**, 105-114.
- EPPO (2000b) Production of healthy plants for planting. PM 4/3 (3) Certification scheme for pelargonium. *EPPO Bulletin* **32**, 67-78.
- EPPO (2000c) Production of healthy plants for planting. PM 4/19 (2) Certification scheme for begonia. *EPPO Bulletin* **32**, 135-145.
- EPPO (2000d) Production of healthy plants for planting. PM 4/20 (2) Certification scheme for New Guinea hybrids of impatiens. *EPPO Bulletin* **32**, 147-157.
- EPPO (2000e) Production of healthy plants for planting. PM 4/25 (2) Certification scheme for kalanchoe. *EPPO Bulletin* **32**, 199-210.
- EPPO (2000f) Production of healthy plants for planting. PM 4/26 (2) Certification scheme for petunia. *EPPO Bulletin* **32**, 211-221
- EPPO (2008) Schemes for the production of healthy plants for planting. PM 4/34 (1) Production of pathogen-tested herbaceous ornamentals. *EPPO Bulletin* **38**, 31-52.
- EPPO (2020) PM 7/139(1) Tospoviruses (Genus Orthotospovirus). *EPPO Bulletin* **50**, 217-240.
- EPPO (2022) *Tomato spotted wilt virus*. EPPO datasheets on pests recommended for regulation. Available online. <https://gd.eppo.int>
- Gao Y, Lei Z & Reitz SR (2012) Western flower thrips resistance to insecticides: detection, mechanisms and management strategies. *Pest Management Science* **68**, 111-1121.
- Gonzalez-Pacheco BE & Silva-Rosalez L (2013) First report of *Impatiens necrotic spot virus* in Mexico on tomatillo and pepper plants. *Plant Disease* **97**(8), 1124.
- Groves C, German T, Dasgupta R, Mueller D & Smith DL (2016) Seed transmission of *Soybean vein necrosis virus*: The first Tospovirus implicated in seed transmission. *PLoS One* **11**(1), e0147342. <https://doi.org/10.1371/journal.pone.0147342>
- Hasegawa DK, Hladky LJ, Wintermantel WM, Putman AI, Dr. Barman AK, Slinski S, Palumbo J & Poudel B (2022) First report of *impatiens necrotic spot virus* infecting lettuce in Arizona and Southern desert regions of California. *Plant Disease* **106**(8). <https://doi.org/10.1094/PDIS-09-21-2118-PDN>
- Jones DR (2005) Plant viruses transmitted by thrips. *European Journal of Plant Pathology* **113**, 119-157.
- Joseph SV & Koike ST (2021) Could broccoli and cauliflower influence the dispersal dynamics of Western flower

- thrips (Thysanoptera: Thripidae) to lettuce in the Salinas Valley of California? *Environmental Entomology* **50**(4) 995–1005.
- Kirk WDJ & Terry LI (2003) The spread of the western flower thrips *Frankliniella occidentalis* (Pergande). *Agricultural and Forest Entomology* **5**, 301–310.
- Koike ST, Kuo Y-W, Rojas MR & Gilbertson RL (2008) First report of *Impatiens necrotic spot virus* infecting lettuce in California. *Plant Disease* **92**(8), 1248.
- Kondo T, Yamashita K & Sugiyama S (2011) First report of *Impatiens necrotic spot virus* infecting chrysanthemum (*Chrysanthemum morifolium*) in Japan. *Journal of General Plant Pathology* **77**, 263–265.
- Kormelink R, Verchot J, Tao X & Desbiez C (2021) The Bunyavirales: the plant-infecting counterparts. *Viruses* **13**, 842, <https://doi.org/10.3390/v13050842>
- Kuo Y-W, Gilbertson RL, Turini T, Brennan EB, Smith RF & Koike ST (2014) Characterization and epidemiology of outbreaks of *Impatiens necrotic spot virus* on lettuce in coastal California. *Plant Disease* **98**(8), 1050–1059.
- Law MD, Moyer JW (1990) A tomato spotted wilt-like virus with a serologically distinct N protein. *Journal of General Virology* **71**, 933–938.
- Law MD, Speck J, Moyer JW (1991) Nucleotide sequence of the 30 non-coding region and N gene of the S RNA of a serologically distinct tospovirus. *Journal of General Virology* **72**, 2597–2601.
- Lebas BSM & Ochoa-Corona FM (2007) *Impatiens necrotic spot virus*. In: Rao GP, Bragard C & Lebas BSM (editors) *Characterisation, Diagnosis & Management of Plant Viruses; Vol 4: Grain Crops & Ornamentals*. Studium Press LLC, Texas, USA, 221–243.
- Materazzi A & Triolo E (2001) *Spathiphyllum* sp.: a new natural host of *impatiens necrotic spot virus*. *Plant Disease* **85**(4), 448. <https://apsjournals.apsnet.org/doi/abs/10.1094/PDIS.2001.85.4.448B>
- Messelink GJ, Maanen R, van Steenpaal SEF & Janssen A (2008) Biological control of thrips and whiteflies by a shared predator: two pests are better than one. *Biological Control* **44**, 372–379.
- Mound LA (1983) Natural and disrupted patterns of geographical distribution in Thysanoptera (Insecta). *Journal of Biogeography* **10**(2), 119–133.
- Naidu RA, Deom CM & Sherwood JL (2001) First report of *Frankliniella fusca* as a vector of *Impatiens necrotic spot tospovirus*. *Plant Disease* **85**(11), 1211.
- Nekoduka S & Sano T (2018) Symptom development, in planta distribution, and transmission of *Impatiens necrotic spot virus* in gentian: evidence for survival in roots and winter buds. *Journal of General Plant Pathology* **84**, 279–283.
- Nekoduka S, Kobayashi K, Fuji S-I, Okuda M & Sano T (2015) Molecular epidemiology of *Impatiens necrotic spot virus* on greenhouse ornamental plants in a local area of Japan. *Journal of General Plant Pathology* **81**, 429–438.
- Okuda M, Fuji S, Okuda S, Sako K & Iwanami T (2010) Evaluation of the potential of thirty two weed species as infection sources of *Impatiens necrotic spot virus*. *Journal of Plant Pathology* **92**(2), 357–361.
- Pappu HR, Jones RAC & Jain RK (2009) Global status of tospovirus epidemics in diverse cropping systems: successes achieved and challenges ahead. *Virus Research* **141**, 219–236.
- Peng J-C, Chen T-C, Raja JAJ, Yang C-F, Chien W-C, Lin C-H, Liu F-L, Wu H-W & Yeh S-D (2014) Broad-spectrum transgenic resistance against distinct Tospovirus species at the genus level. *PLoS ONE* **9** (5), e96073. <https://doi.org/10.1371/journal.pone.0096073>
- Perry KL, Miller L & Williams L (2005) *Impatiens necrotic spot virus* in greenhouse-grown potatoes in New York

State. *Plant Disease* **89**(3), 340.

Picard C, Afonso T, Benko-Beloglavec A, Karadjova O, Matthews-Berry S, Paunovic SA, Pietsch M, Reed P, van der Gaag DJ & Ward M (2018) Recommended regulated non-quarantine pests (RNQPs), associated thresholds and risk management measures in the European and Mediterranean region. *EPPO Bulletin* **48**, 552-558.

Plyusnin AMQ, Beaty BJ, Elliott RM, Goldbach R, Kormelink R, Lundkvist A, Schmaljohn CS & Tesh RB (2011) Bunyaviridae. In: *Virus taxonomy, ninth report of the International Committee on Taxonomy of Viruses*. Elsevier Academic Press (Eds.: King MJA, Adams MJ, Carstens EB & Lefkowitz EJ) London, UK, 725-741.

Poojari S & Naidu RA (2013) First Report of *Impatiens necrotic spot virus* (INSV) Infecting Basil (*Ocimum basilicum*) in the United States. *Plant Disease* **97**(6), 850.

Roggero P, Dellavalle G, Ciuffo M & Pennazio S (1999) Effects of temperature on infection in *Capsicum* sp. and *Nicotiana benthamiana* by *Impatiens necrotic spot tospovirus*. *European Journal of Plant Pathology* **105**, 509-512.

Rotenberg D & Whitfield AE (2018) Molecular interactions between tospoviruses and thrips vectors. *Current Opinion in Virology* **33**, 191-197.

Sakurai T, Inoue T & Tsuda S (2004) Distinct efficiencies of *Impatiens necrotic spot virus* transmission by five thrips vector species (Thysanoptera: Thripidae) of tospoviruses in Japan. *Applied Entomology and Zoology* **39**(1), 71-78.

Sánchez JA & Lacasa A (2002) Modelling population dynamics of *Orius laevigatus* and *O. albidipennis* (Hemiptera: Anthocoridae) to optimise their use as biological control agents of *Frankliniella occidentalis* (Thysanoptera:Thripidae). *Bulletin of Entomological Research* **92**, 77- 78.

Sears P (2017) *Impatiens Necrotic Spot Virus* Resistance in Transgenic *Impatiens walleriana* & *Lycopersicon esculentum*. Master of Science In *Horticulture*, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 83 p.

Simko I, Richardson CE & Wintermantel WM (2018) Variation within *Lactuca* spp. for resistance to *Impatiens necrotic spot virus*. *Plant Disease* **102**(2), 341-348. <https://apsjournals.apsnet.org/doi/full/10.1094/PDIS-06-17-0790-RE>

Trkulja V, Mihić Salapura J, Ćurković B, Stanković I, Bulajić A, Vučkurović A & Krstić B (2013) First report of *Impatiens necrotic spot virus* on *Begonia* in Bosnia and Herzegovina. *Plant Disease* **97**(7), 1004.

Vaira AM, Roggero P, Luisoni E, Masenga V, Milne RG & Lisa V (1993) Characterization of two tospoviruses in Italy: tomato spotted wilt and *impatiens necrotic spot*. *Plant Pathology* **42**, 530-542.

Wijkamp I & Peters D (1993) Determination of the median latent period of 2 Tospoviruses in *Frankliniella occidentalis*, using a novel leaf disk assay. *Phytopathology* **83**, 986-991.

Zhang Z, Zheng K, Zhao L, Su X, Zheng X & Wang T (2021) Occurrence, distribution, evolutionary relationships, epidemiology, and management of orthotospoviruses in China. *Frontiers in Microbiology* **12**; 686025. <https://doi.org/10.3389/fmicb.2021.686025>

ACKNOWLEDGEMENTS

This datasheet was extensively revised in 2022 by Nataša Mehle (National Institute of Biology, Slovenia). Her valuable contribution is gratefully acknowledged.

How to cite this datasheet?

EPPO (2025) *Orthotospovirus impatiensnecromaculae*. EPPO datasheets on pests recommended for regulation. Available online. <https://gd.eppo.int>

Datasheet history

This datasheet was first published in the EPPO Bulletin in 1999 and revised 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.

EPPO (1999) EPPO Data sheets on quarantine pests - *Impatiens necrotic spot tospovirus*. *EPPO Bulletin* **29**(4), 473-476. <https://doi.org/10.1111/j.1365-2338.1999.tb01421.x>



Co-funded by the
European Union