*MINIREVIEW*

# TOMATO SPOTTED WILT VIRUS IN ORNAMENTAL PLANTS, VEGETABLES AND WEEDS IN THE CZECH REPUBLIC

J. MERTELÍK, V. MOKRÁ

Research Institute of Ornamental Gardening, 252 43 Průhonice, Czech Republic

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**Summary.** – The occurrence of tomato spotted wilt virus (TSWV) in horticulture crops and weeds in the Czech Republic has been studied in 1992–1997. During this period TSWV was established in 91 plant species. Virus identity was based on the host range, serology and electron microscopy. Natural TSWV infection was detected in glasshouses where the main vector *Frankliniella occidentalis* was present too. The most frequently TSWV-infected plant species were *Chrysanthemum morifolium* and *Zantedeschia sp.* Among vegetable crops, the TSWV infection was very frequently detected in tomatoes and peppers. In all cases these plants were nursed or grown in glasshouses together with different species of ornamental plants, many of which were TSWV-infected. Among weeds, the TSWV infection occurred very often in *Stellaria media* and *Galinsoga parviflora.* These two plant species were prevalent in glasshouses and were also good hosts of *F. occidentalis.*

**Key words:** tomato spotted wilt virus; Bunyaviridae; Tospovirus; Czech Republic; ornamental plants; vegetables; weeds

## Introduction

The disease known as „spotted wilt" was first observed in Australia in 1915 (Brittlebank, 1919) and was shown to have a viral etiology (Samuel *et al.,* 1930). Since that time TSWV was found in many other regions especially those with subtropical climate and in temperate regions throughout the Northern Hemisphere (Best, 1968).

Although TSWV had attracted a great interest of virologists because of causing serious diseases, it remained for years poorly characterised due to its instability *in vitro.* During the first fifty years since its discovery, TSWV has been considered the only member of the TSWV group of plant viruses (Ie, 1970; Matthews, 1982). The classification and unique status of TSWV were later challenged by moderne molecular techniques and production of some highly sensitive antisera in a few laboratories (Peters *et al.,* 1991). A second member of the TSWV group with serologically distinct nucleocapsid N protein was described by Law and Moyer (1990). Other *Tospovirus* species were recognised after serological and sequence analysis of the N protein (Peters *et al.,* 1996). Data on the molecular biology of TSWV group revealed its taxonomical relationship to the *Bunyaviridae*, a recognised family of animal viruses. As a result, the *Tospovirus* genus was established within the *Bunyaviridae* family and TSWV became the type species of this genus (Elliot, 1990; Francki *et al.,* 1991).

TSWV is an unusual virus that causes diseases both in dicotyledonous and monocotyledonous plants and is one of the few viruses transmitted by thrips. TSWV is further distinguished from other plant viruses by its quasispherical, enveloped virions 80 – 120 nm in size with tripartite RNA genome. While TSWV can be transmitted mechanically in the laboratory, in the nature it is transmitted from plant to

**Abbreviations:** ELISA = enzyme-linked immunosorbent assay; TSWV = tomato spotted wilt virus

plant almost exclusively by several species of thrips (*Thysanoptera, Tripidae*): *Frankliniella occidentalis* Pergrande, *Frankliniella intosa* Trybom, *Frankliniella fusca* Hinds, *Frankliniella schultzei* Trybom (dark form only), *Thrips setosus* Moulton and *Thrips tabaci* Lindeman (Peters *et al.*, 1996). The most efficient vector of TSWV is *F. occidentalis* (Broadbent and Allen, 1995; Wijkamp *et al.*, 1993). Only larval thrips can acquire TSWV, while both larval and adult thrips transmit the virus in a persistent fashion (German *et al.*, 1992). A midgut barrier to TSWV acquisition by adult *F. occidentalis* was demonstrated by Ullman *et al.* (1992). A propagative manner of TSWV transmission by thrips was proved by Ullman *et al.* (1993). Although a *F. occidentalis* biotype from the Netherlands acquires TSWV only during the first larval instar (van Wetering *et al.*, 1996), biotypes from other locations acquire TSWV during both larval instars (Bandla *et al.*, 1998).

TSWV has repeatedly caused some problems in Western Europe and North America. The virus practically disappeared in Western Europe in the fifties because of insecticide control of insect pests in glasshouses. However, a revival of TSWV infections in Europe occurred in the late eighties and early nineties as a result of almost world-wide expansion of *F. occidentalis* (Marchoux *et al.*, 1991; Vaira *et al.*, 1993). Whereas the first list of hosts of TSWV (Best, 1968) contained 163 plant species of 29 families, the latest list (Peters, 1998) contains 926 TSWV-susceptible plant species of 92 families.

## TSWV occurrence in the Czech Republic

The first occurrence of TSWV in the Czech Republic in 1992 was associated with imported ornamental plants (Mertelík *et al.*, 1994a). Although the infected plants were destroyed because of a quarantine measure the virus was found the next year in several glasshouse crops infested with *Frankliniella occidentalis*. TSWV soon became a serious problem in ornamental plants and vegetables (Mertelík *et al.*, 1994b, 1995, 1996, 1997). This article summarises the results of TSWV sample surveys performed in 1992–1997.

Enzyme-linked immunosorbent assay (ELISA) was commonly used for TSWV detection in plants. Plant samples with $A_{405}$ higher than 0.25 were scored as positive. $A_{405}$ values of 0.15 – 0.25 were evaluated as questionable and the respective samples were retested by inoculation onto indicator plants.

In biological tests, *Datura stramonium, Nicotiana benthamiana, N. debneyi, N. glutinosa* and *N. rustica* proved to be the best indicators of TSWV. These species developed local chlorotic and necrotic lesions and rings on inoculated leaves, mosaic, mottling and systemic necrosis. In *N. benthamiana*, the symptoms were very severe. For a longtime maintenance of TSWV, the isolates *Capsicum annuum* cv. Morava and Zlata were used.

Using electron microscopy, spherical enveloped particles varying in size from 80 to 110 nm in diameter were occasionally encountered in preparations from naturally infected leaves of horticulture crops but were regularly detected in extracts of infected *N. benthamiana* and *N. rustica* plants.

Natural TSWV infection was established in 91 plant species which comprised 58 ornamental plant species, 9 vegetable species, 2 agricultural crop species, 21 weed plant species and 1 woody plant species *(Sambucus nigra)*. All the resulting virus isolates from different sites in the Czech Republic belonged to TSWV – a member of *Tospovirus* serogroup I, type I (BR-01 strain). Five Czech isolates were included in the group of 96 isolates from all over the world tested with different polyclonal and monoclonal antibodies in the Tospovirus-Ringtest organised in Wageningen, The Netherlands (Adam *et al.*, 1996). TSWV has occurred in plants growing in glasshouses and their nearest vicinity. Results of our investigation on the TSWV epidemiology and symptoms of TSWV infection in indicator plants and ornamental crops are in agreement with findings published by Verhoeven and Roenhorst (1994) and Antignus *et al.* (1997). Identification of thrips in sites of TSWV infection revealed the presence of *F. occidentalis*, while *Thrips tabaci* was found only sporadically.

## TSWV in ornamental plants

TSWV was detected most commonly in *Chrysanthemum morifolium* (syn. *Dendranthema morifolium)* and *Zantedeschia sp.* It occurred rather often also in *Gerbera jamesonii, Dahlia sp., Impatiens New Guinea, Asparagus sprengeri, Alstroemeria sp., Cyclamen persicum, Hippeastrum hortorum, Begonia tuberhybrida* and *Sinningia x hybrida* (Table 1).

In *Chrysanthemum morifolium,* typical symptoms of TSWV infection were chlorotic to necrotic spots, occasionally rings and line patterns, stem necrosis and flower distortion. The symptom expression and its intensity differed not only among cultivars but also among individual plants of the same cultivar. A symptomless TSWV infection was detected sporadically too. Among frequently infected cultivars, there were Snowdon and Westland, the first one reacting mostly with severe symptoms while the other with mild or no symptoms.

In TSWV-infected *Zantedeschia sp.*, symptoms of chlorotic mosaic, rings and leaf malformation were unspecific because of common infection with other viruses. *Zantedeshia* sp. cultivated in our country as a long time crop for production of cut flowers and reacting with mild and unspecific symptoms to the TSWV infection represents an important virus reservoir.

**Table 1. List of ornamental plant species in which natural TSWV infection was established in 1992–1997**

| Plant species | Number of loci | Plant species | Number of loci |
|---|---|---|---|
| *Adenium obesum* | 1 | *Haemanthus albiflos* | 1 |
| *Aeschynanthus marmoratus* | 1 | *Haemanthus sp* | 1 |
| *Aeschynanthus sp.* | 1 | *Hippeastrum hortorum* | 9 |
| *Alstroemeria sp.* | 9 | *Hoya carnosa* | 2 |
| *Amaryllis belladona* | 1 | *Impatiens New Guinea* | 14 |
| *Anthurium andreanum* | 4 | *Impatiens walleriana* | 4 |
| *Anthurium hookeri* | 1 | *Kalanchoë blosfeldiana* | 3 |
| *Anthurium scherzerianum* | 1 | *Lotus berthelotii cv.Red Flash* | 2 |
| *Asparagus sprengeri* | 15 | *Nerium oleander* | 1 |
| *Begonia tuberhybrida* | 9 | *Opuntia sp.* | 1 |
| *B.semperflorens* | 1 | *Pelargonium peltatum* | 3 |
| *Bellis sp.* | 1 | *Peperomia caperata* | 1 |
| *Bidens ferulifolia* | 1 | *Phalaenopsis sp.* | 1 |
| *Calendula officinalis* | 1 | *Primula acaulis* | 3 |
| *Callistephus chinensis* | 2 | *Primula obconica* | 1 |
| *Campanula isophylla* | 3 | *Philodendron scandens* | 2 |
| *Chrysanthemum morifolium* | 53 | *Ranunculus x hybr* | 1 |
| *Cineraria cruenta* | 3 | *Rechsteineria sp.* | 2 |
| *Clerodendrum sp* | 1 | *Rheo discolor* | 1 |
| *Columnea gloriosa* | 5 | *Saxifraga stolonifera* | 1 |
| *Cyclamen persicum* | 9 | *Sinningia x hybr.* | 7 |
| *C. persicum „mini"* | 1 | *Smithiantha sp.* | 1 |
| *Dahlia sp.* | 15 | *Solanum sp.* | 1 |
| *Datura suaveolens* | 1 | *Solanum rantonneti* | 2 |
| *Dieffenbachia sp.* | 1 | *Spathiphyllum floribundum* | 1 |
| *Ficus benjamina* | 1 | *Stephanotis sp.* | 2 |
| *Gazania sp.* | 2 | *Tagetes sp* | 1 |
| *Gerbera jamesonii* | 14 | *Vinca sp* | 1 |
| *Gomphrena globosa* | 1 | *Zantedeschia sp.* | 36 |

**Table 2. List of vegetable species and field crops in which natural TSWV infection was established in 1992–1997**

| Plant species | Number of loci | Plant species | Number of loci |
|---|---|---|---|
| *Allium sativum* | 1 | *Lycopersicum esculentum* | 55 |
| *Brassica oleracea var. gongyloides* | 1 | *Petroselinum sativum f. crispum* | 1 |
| *Capsicum annuum* | 28 | *Pisum sativum* | 1 |
| *Cucumis sativus* | 2 | *Solanum muricatum* „Pepino" | 2 |
| *Lactuca sativa* | 1 | *Solanum tuberosum* | 2 |

Mixed infections of TSWV with other viruses were very common in *Begonia tuberhybrida, Hippeastrum hortorum* and *Dahlia sp.* It was difficult to find correlation between the presence of TSWV and typical symptoms of infection in these species. Severe leaf chlorosis and necrosis were observed in TSWV-infected *Sinningia x hybrida, Cyclamen persicum* and *Gerbera jamesonii.* In the latter host, TSWV caused also flower malformation.

## TSWV in vegetables and field crops

The results of TSWV detection tests in these crops are presented in Table 2. TSWV was detected most commonly in *Lycopersicum esculentum* (tomato) and *Capsicum annuum* (pepper). Young seedlings of these plant species became usually infected in the glasshouses where TSWV had been transmitted onto them from ornamental plants and weeds by TSWV carrying *F. occidentalis.*

In tomatoes, symptoms of TSWV infection were chlorotic and necrotic spots, bronzing of leaves and pale areas on fruits. The virus could be detected only in leaves damaged by thrips and in plant parts with systemic symptoms. The infection was never proved in symptomless tomato leaves but it was detected in symptomless fruits. In peppers, TSWV caused chlorotic and necrotic spots, concentric rings and patterns on leaves, chlorosis of small veins and leaf curl of top leaves, reduction of growth, pale spots on fruits and also their deformation. TSWV was detected in locally and systemically infected leaves and also in symptomless plants.

In *Cucumis sativus* (cucumber), TSWV was proved only in leaves damaged by *F. occidentalis.* In *Solanum muricatum,* TSWV was found in plants showing symptoms of mosaic and leaf deformation. In these plants, also particles resembling a carlavirus were detected by electrom microscopy.

In field crops, TSWV was detected in peas from one locus and in potatoes from two loci. These crops were grown in the near vicinity of glasshouses where TSWV and *F. occidentalis* were present.

## TSWV in weeds

The samples of weed plant species to be tested for TSWV were taken from plants with suspect symptoms in glasshouses where the infection had been already identified in ornamental or vegetable crops. In case TSWV was detected in a glasshouse, samples were collected also from plants growing in the vicinity of 5 – 50 m from the glasshouse. The survey of TSWV occurrence in weed plant species is shown in Table 3.

TSWV infection occurred most frequently in *Stellaria media* and *Galinsoga parviflora.* These two plant species are prevalent in glasshouses and are also good hosts of *F. occidentalis. S. media* reacted to the TSWV infection with mild chlorosis or mosaic, while *G. parviflora* with severe chlorosis, necrosis and stunt. TSWV infection was proved mostly in weed plants growing in glasshouses and sporadically in their nearest vicinity. In *Sambucus nigra* plants growin also in glasshouses and their vicinity, TSWV was proved only in the leaves with symptoms, while in the