National Pest Alert

Tospoviruses

(Family *Bunyaviridae*, Genus *Tospovirus*)

Viruses in the genus *Tospovirus* cause significant worldwide crop losses. The genus name is derived from the name of its first member, tomato spotted wilt virus (TSWV). Initially observed in Australia in 1915, the spotted wilt disease of tomato was later shown to be of viral origin. The causal agent was designated TSWV, and considered to be the sole member of the tomato spotted wilt group of plant viruses until the identification and characterization of several similar viruses, including impatiens necrotic spot virus (INSV), in the early 1990's. More than a dozen tospoviruses have since been identified and characterized. Three tospoviruses, TSWV, INSV and iris yellow spot virus (IYSV), are known to occur in the United States.

Transmission and Biology

Tospoviruses are transmitted from plant to plant in a very specific manner by ten species of thrips. *Frankliniella occidentalis* (Western flower thrips) is a major vector of tospoviruses worldwide including those currently present in the United States (TSWV, INSV and IYSV), although under certain conditions *F. fusca* (tobacco thrips) and *Thrips tabaci* (onion thrips) may have a more significant role as a vector than *F. occidentalis*. These and other thrips species may be more or less important as vectors on a regional basis within the United States or in other parts of the world. In the case of TSWV, thrips can only transmit the virus if it is acquired during their larval stages although both larval and adult thrips are able to transmit the virus. Seed transmission is not known to occur.

Host Range

The host range of tospoviruses varies greatly with the virus species. TSWV has one of the widest host ranges of any plant virus, infecting more than 800 plant species, both dicots and monocots, in more than 80 plant families. The Solanaceae and Asteraceae families contain the largest numbers of TSWV-susceptible plant species. Major crops susceptible to TSWV infection are tomato, pepper, lettuce, potato, papaya, peanut, tobacco and chrysanthemum. TSWV also replicates in its thrips vector. In contrast, IYSV has a relatively restricted host range and is commonly found only in monocots such as onion, chive and leek. INSV has a more intermediate host range, commonly infecting annual and perennial ornamental crops. Many tospovirus species also infect weeds, which are epidemiologically important hosts.

Symptoms and Disease Development

Leaf symptoms caused by most tospoviruses consist of necrotic (brown) and/or chlorotic (yellow) rings or ring patterns on many hosts (Fig. 1A, D-I). Necrotic and/or chlorotic lesions may also form on stems and wilting of leaves and stems can occur. Young leaves of TSWV-infected plants frequently turn bronze and later develop numerous small, dark brown lesions (Fig. 1A). TSWV-infected plants may develop a one-sided growth habit or the entire plant maybe be stunted with drooping leaves suggestive of a vascular wilt. Growing tips may also die. Plants infected early in the season may produce no fruit, whereas plants infected after fruit set has occurred produce fruits with chlorotic or necrotic ringspots. In tomatoes, green fruit have slightly raised areas with faint concentric rings (Fig. 1B); on ripe fruit, these turn into obvious rings which become red and yellow/white (Fig. 1C). The chlorotic lesions are difficult to observe at the 'breaker' stage of picking but are highly visible at full color. Similar undesirable fruit color also may be observed with TSWV infection of pepper. INSV infection induces chlorotic or necrotic ringspots on leaves and stems (Fig. 1F). IYSV infection leads to chlorotic (sometimes with a distinct diamond shape) or necrotic lesions on the seed stalk and bulb leaves of onion, chive and leek (Fig. 1G).

Identification of Tospoviruses

Viruses in general and tospoviruses in particular can cause very similar symptoms requiring identification of the causal virus through the use of serological (antibody-based) or molecular tests at a disease diagnostic laboratory. It is important to consider that a single tospovirus species may vary greatly around the world. Thus, strains from different areas may differ in their reactions to antibodies against viral structural proteins. Light microscopy of viral inclusion bodies is also useful for tospovirus diagnosis.

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Distribution

TSWV has caused serious losses in tomatoes and peppers in Australia for many years and is still a serious problem. More recently, TSWV has become economically important in North America (especially in the southeastern United States), South America and Europe. INSV may be found wherever ornamentals (especially greenhouse-grown) are produced in North America and Europe, and more recently in Asia. IYSV is currently found in the United States onion and onion seed production areas but has also been identified in South America, the Middle East, Europe and Australia.

Recently, capsicum chlorosis virus (CaCV) was identified in Australia where it has displaced TSWV in pepper and tomato in some areas. CaCV has also been detected in Southeast Asia. Symptoms induced by CaCV in pepper and tomato are similar to those induced by TSWV in these crops (Fig. 1H and I). In South America, Asia and Africa, tospoviruses infecting peanut (such as peanut bud necrosis virus and groundnut ringspot virus) and cucurbits (such as watermelon silver mottle virus and zucchini lethal chlorosis virus) cause severe economic losses. Distribution of these other tospovirus species is currently restricted to other regions of the world but could expand via trade as tospoviruses and their vectors can be spread by the transport of infected plant material.

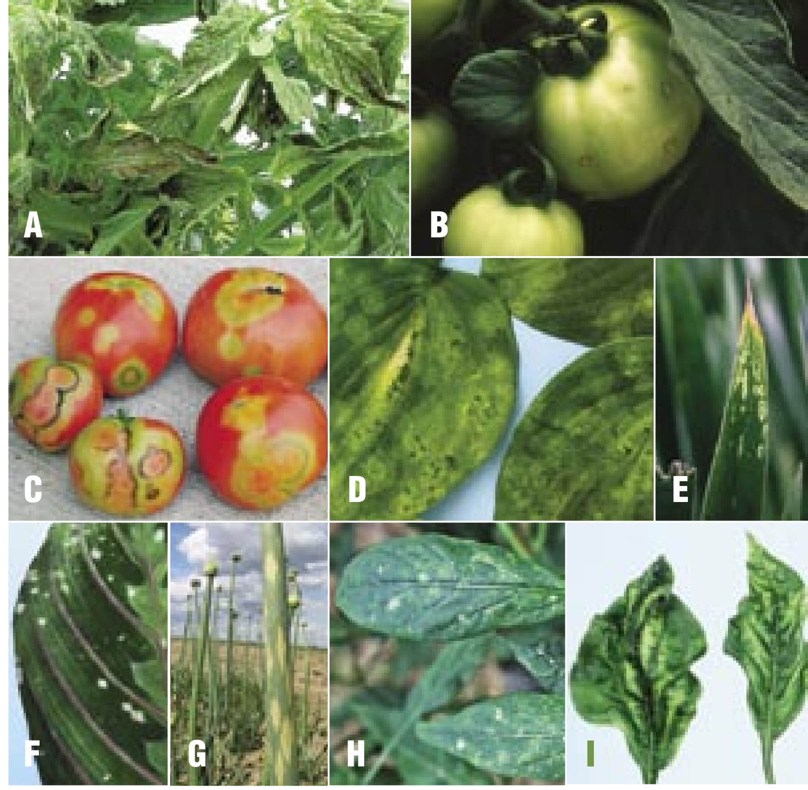

Figure 1. Tospovirus symptoms. TSWV symptoms on tomato leaves (A), immature (B) and mature (C) tomato fruit, hosta leaves (D) and blackberry lily leaf (E). INSV symptoms on prayer plant leaf (F). IYSV symptoms on onion seed stalk (G). CaCV symptoms on chili (H) and bell (I) pepper leaves.

Management Strategies

Once a plant is infected, no chemical treatments can cure it of a virus. Thus, avoidance is a common management strategy, for instance, exclusion of thrips from vegetable transplant production areas to reduce infection. TSWV is extremely difficult to manage because of the wide and overlapping host ranges for this virus and its vectors and its presence in perennial weeds and ornamentals. TSWV overwinters in a relatively few abundant winter annual weeds, and dispersal of infectious thrips from these sources to susceptible crops and weeds occurs over a brief period in the spring. Use of this information in concert with variety selection and crop planting date is being used to minimize infections. However, the effects of planting date often vary with location and crop. An integrated management approach has been successfully implemented in several crops and locations. Insecticides have been used to reduce thrips larval development and thus limit secondary virus spread although these are not consistently effective with all crops. The use of UV reflective mulches, systemic acquired resistance inducers and insecticides has provided excellent management of TSWV in commercial tomato fields.

Resistant tomato and pepper cultivars with single dominant gene resistance are currently being used to reduce losses to TSWV. However, symptoms are frequently more evident on fruit (immature and ripening) than on foliage thus limiting the commercial usefulness of these cultivars. Transgenic resistance has been developed, generally with the virus nucleocapsid gene, and demonstrated to be effective in the field. Unfortunately, resistance breaking isolates of TSWV overcoming both conventional and transgenic resistance have been identified.

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