

Definition of the head turner virus.

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Head turner (TSWV) is a disease caused by a complex of viruses belonging to the Bunyaviridae family, Tospovirus genus (orthotospovirus). In the past, TSWV was considered a unique species of the group, however, recent studies on tomato plants in Brazil have shown the occurrence of other species of this genus. The epidemiology of this virus is associated with persistent transmission by thrips. Head turner is a globally important disease in potato crops, which can spread rapidly to others with incidence rates between 30-40% and lead to plant death. In Brazil, three species of tospovirus capable of infecting potatoes are present: Tomato spotted wilt virus, Groundnut Ringspot Virus, and Tomato chlorotic spot virus. Turnip is caused by the virus, which is transmitted by a small insect called thrips (Figure 1) [1-7].

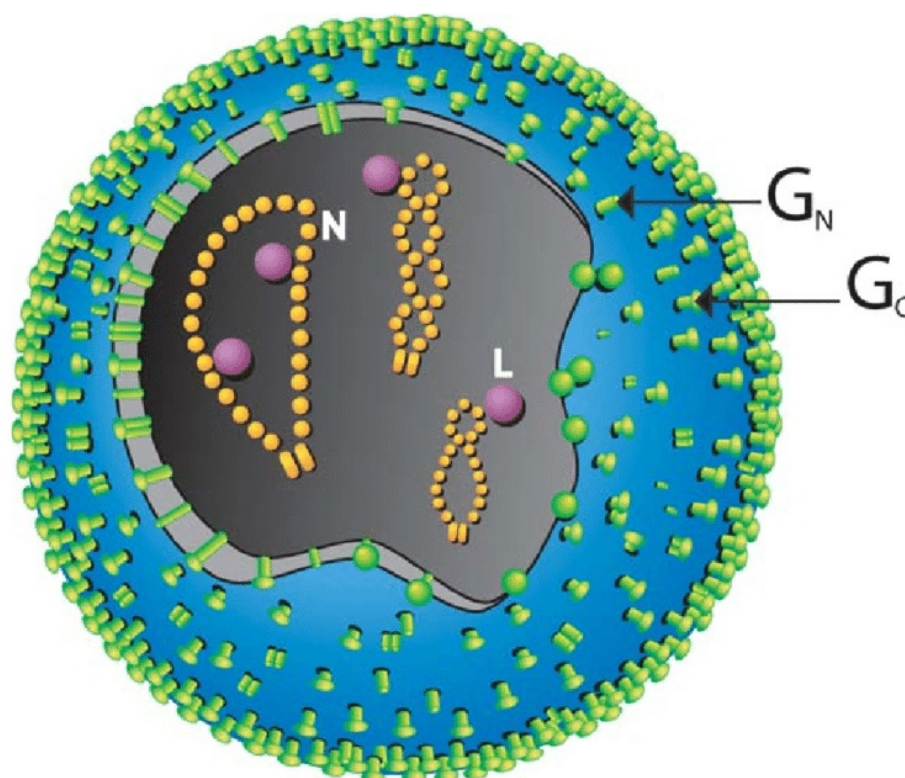


Figure 1. Diagram of TSWV virion. A double-layered membrane of host origin (blue) is shown with the viral-encoded proteins G_N and G_C (green) projecting from the surface in monomeric and dimeric configurations. The genomic RNA is presented as noncovalently closed circles in the form of a ribonucleoprotein (RNP) complex created by its association with many copies of N protein (peach). A few copies of the virion-associated RNA-dependent RNA polymerase (RdRp or L) is shown (purple) in association with the RNPs.

Source: https://www.researchgate.net/figure/Diagram-of-TSWV-virion-A-double-layered-membrane-of-host-origin-blue-is-shown-with-the_fig5_7680920.

The damage can be worrying considering that this virus can lead to the death of the plant. The later the infection, the less damage will be caused. If infection occurs near or during flowering, losses will be very small. There are no cultivars resistant to this disease and therefore preventive measures must be adopted, especially in areas with a history of the disease. To prevent the disease, it is important to eliminate plants that host thrips in areas close to beds and crops. Thrips can remain on many invasive plant species, especially broadleaf ones. The preventive application of insecticides that control this insect from the sowing stage to the crop is essential [1-7].

Diseases caused by plant viruses have no cure, in addition to being capable of rapid dissemination through crops. In potato cultivation, where plants are produced by vegetative propagation, the risk of introducing viruses into the field from contaminated seed potatoes is even greater than in the cultivation of other vegetables. Furthermore, infestations by insect vectors – particularly aphids, thrips, and whiteflies – contribute to the spread of viral diseases across crops, even when populations of these insects are low [1-7].

Recently, tubers with necrosis and necrotic rings have been observed with high frequency. In addition to the potato necrotic virus Y, the potato Turner virus has been causing this symptom, which has worried producers. Infected plants may become stunted, and symptoms are usually most severe on one side of the plant and the apical bud, which may become distorted and curve toward one side of the plant. Young leaves have yellowish spots that can become reddish-brown necrotic spots. When the infection is close to flowering, plants may present concentric spots along the stem forming dark stripes on one side of the plant [1-7].

Head turner is a globally important disease in potato crops, which can spread rapidly in the crop with incidence rates between 30-40% and lead to plant death. Symptoms of the disease may vary according to climatic conditions, cultivar, and age of the plant. However, the most common symptoms include necrotic leaf spots, stem necrosis, and ring-shaped necrotic leaf lesions. Tubers may present symptoms of necrotic rings on the surface, deformations, and necrotic lesions inside. In national potato farming, these viruses are transmitted by thrips of the genera *Frankliniella* Karny, 1910, and *Thrips* Linnaeus, 1758. The female lays eggs inside the plant tissue, and the larvae develop in leaves and flowers, followed by pre-pupa. and pupa stages, the latter being in the soil. The adult represents the most important stage for the transmission of tospoviruses [1-7].

One of the main diseases that affect lettuce is lettuce, caused by species of virus from the *Tospovirus* genus, from the *Bunyaviridae* family. Currently, the most important viral complexes infecting lettuce are: "Tomato Spotted Wilt Virus" (TSWV), "Groundnut Ringspot Virus" (GRSV), "Tomato Chlorotic Spot Virus" (TCSV), and "Chrysanthemum Stem Necrosis Virus" (CNSV).).). The most common symptoms are first observed on the petiole and inner blade of the youngest leaves, where light brown lesions appear, which darken over time. The control measures for the tripod are based on the production of healthy seedlings, application of the insecticide in the field and in the period before planting, as well as crop rotation and elimination of host plants, to reduce the tripod population. "Concomitantly with all these

measures, it is essential to use more resistant varieties, such as Milena curly green lettuce, which has a moderate level of resistance to turnip (tospovirus) and pythium (Figure 2) [1-7].

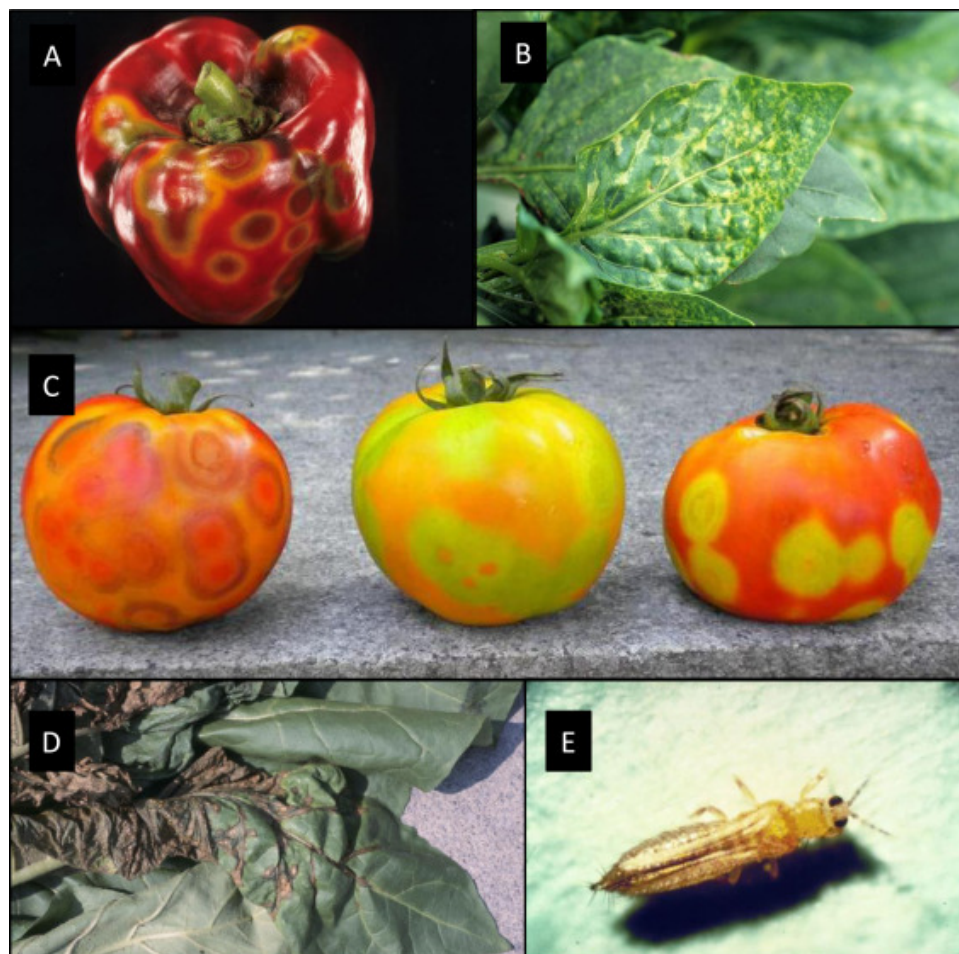


Figure 2. Symptoms caused by TSWV in plants and the thrips *Frankliniella occidentalis* (Pergande, 1895). Pepper fruit (A) and (B) leaf (C) Tomatoes. (D) Tobacco leaves (E) *F. occidentalis*.

Sources: photographed by Gerald Holmes, California Polytechnic State University at San Luis Obispo, photographed by Elizabeth Bush, Virginia Polytechnic Institute and State University (VT), photographed by Mary Ann Hansen, VT, and photographed by Jack T. Reed, Mississippi State University.

Tomato head turner is caused by several species of viruses in the topovirus genus: TSWV, TCSV, GRSV, and CSNV. Generally, plants from the families Solanaceae (tomato, eggplant, jilo, potato, pepper, and others), Asteraceae (lettuce, chicory, endive, and others), and Cucurbitaceae (cucumbers, pumpkins), and others are hosts of the virus. The virus vector is Thrips tabaci Lind. 1888, and Frankliniella paucispinosa Moulton, 1933. Plants attacked by thrips are silvery in color, with twisted leaves and flowers that fall prematurely. As the row spacing decreases and the soil becomes more humid, the disease does not spread (Figure 3) [1-7].



Figure 3. *Frankliniella occidentalis* (Pergande, 1895) Western flower thrips. Source: Photo Jack T. Reed, bugwood.org.

Applying neem oil, a natural insect repellent, helped prevent the spread of the disease. The other resource is leaf vitamin, which protects vegetables against insect attacks. The plant becomes more resistant, and the healthier plant gets fewer diseases. Tomato leaf rust is a well-known disease present in tomato cultivation. It is a viral disease whose main causal agent is the Tomato Spotted Wilt Virus (TSWV) of the Tospovirus genus, a disease considered one of the most important in culture, causing numerous economic impacts. Thripes *Frankliniella schultzei* (Trybom, 1910) is the transmission vector (Figure 4) [1-7].

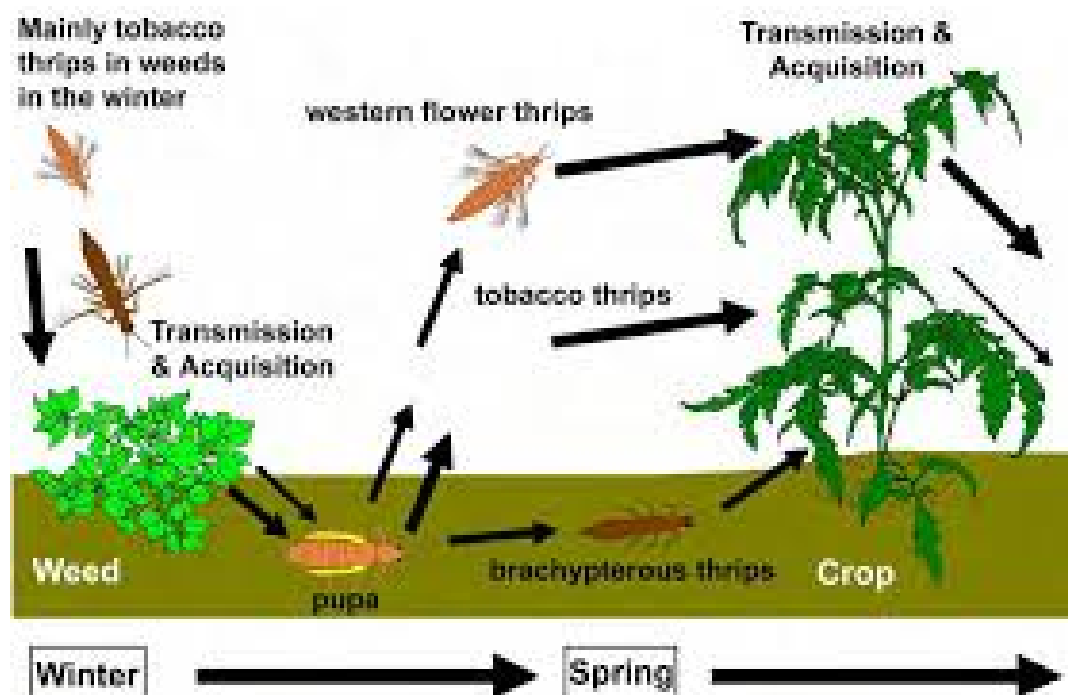


Figure 4. Illustration of thrips' movement of TSWV in the spring. The nymphs acquire the virus from weeds before the fully developed adults transmit the virus to a springtime crop, like a tomato. Sources: Drawing by Angelika Pia Schmid-Riley and file:///C:/Users/USUARIO/Downloads/B1354.pdf.

Planting soybeans after potato harvesting, for example, can act as a bridge for dissemination. Wind is also a factor that contributes to the dispersion of the pest as this insect has a low ability to fly over long distances. Furthermore, the elimination of weeds is an essential part of management, as they serve as a source of inoculum for the virus and the permanence of the disease in the field. Agricultural pesticides are the most effective tool, and in this sense, it is necessary to have an insecticide with a broad spectrum of action, which acts on both insects and invasive plants and possible hosts. [1-7].

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