BRITISH COLUMBIA | Ministry of Agriculture

Emerging Virus Diseases of Greenhouse Crops

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There have been several new viral diseases reported on greenhouse vegetable crops worldwide, and some of them are of great concern to greenhouse vegetable production in British Columbia. Information given below focuses only on a few potential new diseases caused by viruses that have been reported on greenhouse vegetable crops in North and Central America, and, therefore, these diseases are very likely to be introduced into Canada. The purpose of this factsheet is to bring awareness to the greenhouse vegetable growers and to engage them in active surveillance and biosecurity measures to prevent the introduction, establishment and spread of such damaging viral diseases.

Early detection of diseases caused by viruses is critical to prevent or minimize the spread of the pathogens and potential crop losses in greenhouses. If a new viral-like symptom(s) or a potential virus-vector is suspected in a greenhouse, then, it is critical to confirm the presence of it by following a proper identification process through a recognized plant diagnostic laboratory. Viruses are too small to be seen and identified with a light microscope. Therefore, specialized techniques such as ELISA (enzyme-linked-immunosorbent-assay) and RT-PCR (reverse transcriptase polymerase chain reaction) are required in order to confirm the viruses. Once the identity of the pathogen is confirmed, specific control strategies must be implemented immediately.

Columbian Datura Virus (Potyvirus)

Virus Description and Distribution

Columbian datura virus (CDV), a member of the family Potyvirus, is known to infect plants in the family Solanaceae, and many ornamentals (*Brugmansia, Juanulloa, Petunia, Pepino* etc.). Initially, CDV was detected in *Datura* species imported from Columbia to the United States in 1968. Since then, the virus has been reported from Australia, Germany, Hungary, Japan, Netherlands, Poland and the United States. In 2003 and 2004, CDV was detected in several States on ornamental plants (*Spiranthes* orchids, *Brugmansia* spp. etc.). In Canada, CDV was first detected on *Brugmansia* spp. from B.C. in 2007. CDV is on the US Regulated Plant Pest list but not on the Canadian Regulated Plant Pest List. It appears that CDV is more widespread than originally thought. Economically important Solanaceous crops, including field- and greenhouse-grown tomato and field potato can be at risk. It is important that growers pay close attention to the disease and engage in periodic monitoring for symptoms on greenhouse tomato.

Figure 1. Typical symptoms on Brugmansia sp. infected with Columbian datura virus showing vein-banding, chlorotic (yellowing) and mottling of leaves

Symptoms

Infected tomato plants can remain symptomless but the symptoms are expressed when plants are stressed. Symptoms are most commonly seen on activity growing plants. Although the typical symptoms on greenhouse tomato are not well characterized, the symptoms may mimic those expressed on other solanaceous plants such as *Brugmansia* spp. (Figure 1). Common symptoms on greenhouse tomato in the Netherlands are reduction in leaf size, chlorotic flecking (mosaic) and mottling on leaves, shrivelling of leaves, vein-banding, stunting of plants and discolouration of flowers.

Spread

CDV is transmitted by the common Green Peach Aphid (*Myzus persicae*) in a non-persistent manner (i.e. the aphid picks up the virus while feeding a virus-infected plant and carries the virus in its mouth-parts and transmits to a healthy plant). CDV can also be transmitted mechanically by grafting (between healthy root-stocks and virus-infected scions), wound-inoculation and vegetative propagation. Very little is known about the other pathways of mechanical transmission, particularly by workers, leaf pruners, greenhouse equipment or plant-to-pant contact.

Tomato Infectious Chlorosis Virus (Closterovirus)

Virus Description and Distribution

Tomato infectious chlorosis virus (TICV) is a member of genus Crinivirus (family Closterovirus). It was first reported in 1993 on field tomatoes and then in greenhouse tomatoes in California and North Carolina, USA. Subsequently, the virus was detected on greenhouse tomatoes in Europe (Italy, Spain, Greece and France) and Asia (Indonesia, Japan and Taiwan). It has been shown to have a moderately wide host range (26 plant species in 8 plant families), including vegetables such as tomato, potato, lettuce and artichoke, ornamentals such as petunia, and several weeds.

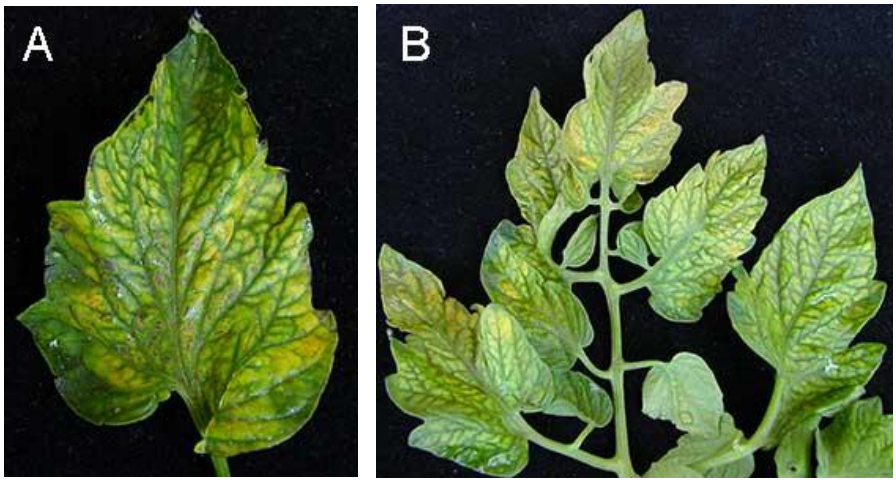

Figure 2. Tomato plant infected with Tomato infectious chlorosis virus showing interveinal chlorosis and mild necrosis on leaflet (A) and leaf (B). Photo credit: W. M. Wintermantel, USDA-ARS, Salinas, CA, USA.

Symptoms

Symptoms can be confused with nutritional disorders, poor growing conditions, natural senescence, or pesticide toxicity. Initial symptoms appear as interveinal yellowing with green veins mostly on mature lower leaves (Figure 2), while the rest of the plant tends to appear "normal". As the disease progresses, the similar symptoms can be observed on young upper leaves. Subsequently, the symptomatic leaves become pale-white, necrotic, dry and curled. Infected leaves (especially older ones) may also turn red. Early infection can also affect the fruit set, colour and quality, resulting in substantial yield loss. Similar symptoms can also be expressed by tomato plants infected with Tomato chlorosis virus, ToCV.

Spread

TICV is transmitted in a semi-persistent manner by the greenhouse whitefly, *Trialeurodes vaporariorum* (Figure 7). Therefore, the movement of virus in the host-plant is restricted to phloem tissue only. TICV is not known to be transmitted by other whiteflies (*Trialeurodes* spp. and *Bemisia* spp.). The virus is not seed-borne or transmitted mechanically.

Tomato Chlorosis Virus (Closterovirus)

Virus Description and Distribution

Tomato chlorosis virus (ToCV) is also a member of genus Crinivirus (family Closterovirus) which is closely related to *Tomato infectious chlorosis virus* (TICV). ToCV causes symptoms on tomatoes that are very similar to the symptoms caused by TICV and, thus, cannot be distinguished. However, ToCV and TICV can be differentiated based on the symptoms expressed on the indicator plants, *Nicotiana benthamiana* and *N. clevelandii*. The major difference between ToCV and TICV is that ToCV is transmitted by the greenhouse whitefly (*Trialeurodes vaporariorum*), the banded-wing whitefly (*T. abutilonea*) and silverleaf whiteflies (*Bemisia* spp.), biotypes A (*B. tabaci*) and B (*B. argentifolii*), while TICV is transmitted solely by the greenhouse whitefly. Like TICV, ToCV is also transmitted in a semi-persistent manner by whiteflies and its movement in host plants is restricted to phloem tissue. ToCV has been shown to have a moderately wide host range (24 plant species in 7 plant families), including tomato and sweet pepper, as well as some weeds.

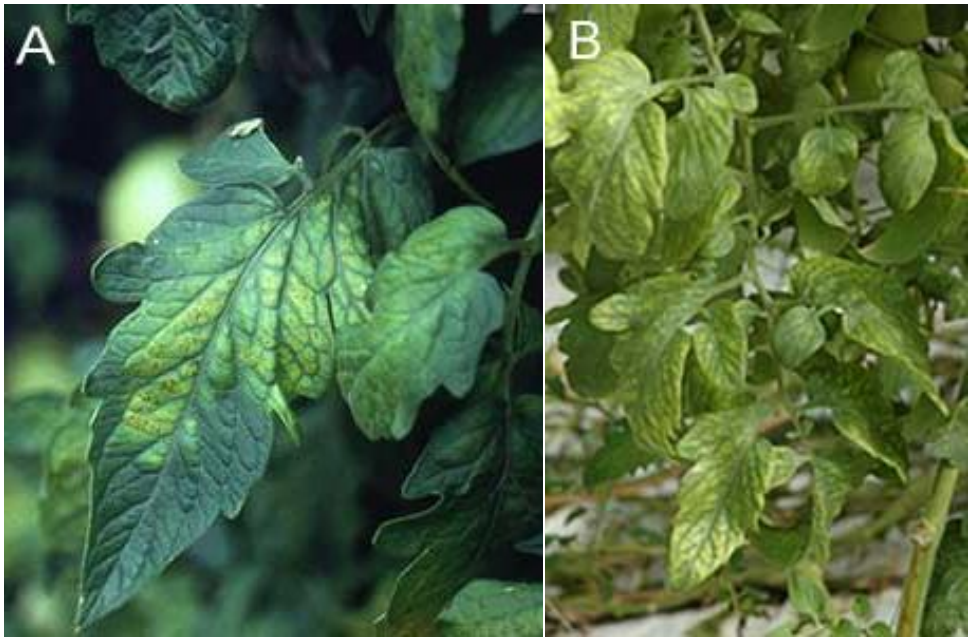

Figure 3. Tomato plant infected with Tomato chlorosis virus showing interveinal chlorosis and mild necrosis on leaflet (A) and leaf (B).
Photo credit: W. M. Wintermantel, USDA-ARS, Salinas, CA, USA.

Although ToCV first appeared in 1989 in greenhouse-grown tomatoes in Florida, USA, and, later, in Colorado and Louisiana, it wasn't confirmed as ToCV until 1996. Subsequently, ToCV has been reported on greenhouse-grown tomatoes in many countries of the Caribbean, East Asia, Southern Africa, Europe and the Mediterranean. In 2003, sweet pepper was identified as a natural host for ToCV in Spain.

Symptoms

Tomato plant infected with ToCV expresses symptoms similar to those expressed by TICV (Figure 3). Therefore, it is difficult to diagnose plants infected with these viruses based on the symptoms. It is also possible that a single tomato plant can also be co-infected with both ToCV and TICV. It is, therefore, critical to submit suspected plant samples to a recognized plant pest diagnostic laboratory for accurate identification.

Spread

TICV is transmitted in a semi-persistent manner by the greenhouse whitefly (*T. vaporariorum*), (Figure 7), the banded-wing whitefly (*T. abutilonea*) and silverleaf whiteflies (*Bemisia* spp.); biotypes A (*B. tabaci*) and B (*B. argentifolii*), (Figure 6). The movement of virus in the host-plant is restricted to phloem tissue. Studies have shown that persistence and efficacy of transmission of ToCV is variable depending on the type of virus-vector involved. Although all ToCV vectors are capable of transmission, the banded-wing whitefly and silverleaf whitefly-biotype B are highly efficient vectors of ToCV. The virus is not seed-borne or transmitted mechanically.

Tomato Yellow Leaf Curl Virus (Bigeminivirus)

Virus Description and Distribution

Tomato yellow leaf curl virus (TYLCV) is known to infect many vegetable crops including tomato, pepper and bean as well as many ornamental plants such as poinsettia. TYLCV can cause severe economic losses to tomato production, where yield losses of up to 100% in greenhouse tomato production have been reported in Southern Europe and the Middle East. TYLCV spreads systemically in the host plant and is limited to phloem tissue.

TYLCV has been a major threat to tomato production in Israel since 1930. It was introduced into the Dominican Republic, Cuba, and Jamaica in the early 1990s'. Since then, TYLCV has been reported from Africa, Asia, Australia, Caribbean, Europe and North and Central America. In North America, TYLCV is known to occur in Florida, Georgia, Louisiana, and has recently been detected in California and Arizona.

Figure 4: Leaf symptoms of a tomato plant infected with Tomato yellow leaf curl virus. Photo credit: T. Schubert, Florida Department of Agriculture.

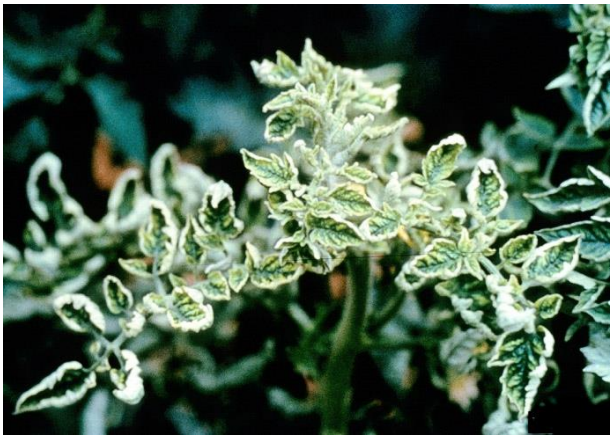

Figure 5: Severe symptoms of a tomato plant infected with Tomato yellow leaf curl virus. Photo credit: T. Schubert, Florida Department of Agriculture.

Symptoms

Visible symptoms can be seen on tomato plants 2-3 weeks after initial infection by TYLCV. Symptoms can vary slightly depending on the tomato cultivar and amount of virus infection (Figure 4 & 5). Generally, infected plants have smaller-than-normal leaves that are cupped upward, thick and rubbery with chlorotic margins (Figure 5). Young infected plants become severely stunted. Infected plants drop up to 90% of their flowers resulting in major yield losses.

Spread

TYLCV is transmitted by adult silverleaf whiteflies, *Bemisia argentifolii* (Figure 6), previously known as *Bemisia tabaci* biotype B, (Figure 6). The silverleaf whitefly is a different species than the common greenhouse whitefly which does not transmit TYLCV. Silverleaf whiteflies are rarely seen in British Columbia. They are small, phloem-

feeding insects which pick up the virus while feeding on infected host plants. Since TYLCV has a broad host range, it can be spread by silverleaf whiteflies that feed on other infected host plants, including cultivated and wild plants. Not all host plants infected with TYLCV show visible symptoms, however the virus can be acquired by silverleaf whiteflies from symptomless infected plants and transmitted to tomato. The virus can also be transmitted through cuttings taken from infected plants or it can be introduced into a greenhouse with virus-infected transplants. TYLCV cannot be transmitted mechanically or by workers and is not transmitted by seeds. Even if TYLCV shows up in British Columbia, it may not become established due to the unlikely survival of silverleaf whiteflies in winter months. On the other hand, there is evidence to suggest that TYLCV can be persistent and can overwinter in infected plants and plant materials.

Figure 6: Adult Silverleaf whiteflies, Bemisia argentifolii, feeding on the underside of a leaf. Wings are usually folded vertically along the body while feeding. Nymphs do not have filaments or fringe around their body. Photo credit: Scott Bauer, USDA Agricultural Research Service, www.forestryimages.org

Figure 7: Greenhouse whitefly, Trialeurodes vaporariorum, feeding on the underside of a leaf. Wings tend to lie parallel to the body. Nymphs have filaments around their body. Photo credit: Whitney Cranshaw, Colorado State University, www.forestryimages.org

General Virus Control Measures

Virus diseases are very difficult to control once they become established. The possible presence of a potential virus on other host plants (including weeds) in the absence of a host crop, and the ability of virus-vectors (the greenhouse whitefly, the banded-whitefly and silverleaf whiteflies) to feed and reproduce on crop plants make it difficult to control the disease successfully. It is highly recommended that a collective management approach, i.e. a combining of cultural practices, biosecurity measures, greenhouse sanitation and disinfection practices, and insect-vector control strategies, should be adopted to reduce the impact of virus diseases on a crop.

- Use virus-free transplants that come from certified transplant nurseries
- Use tomato cultivars, if any, that are resistant to TICV, ToCV, TYLCV and CDV
- Monitor for whitefly and aphid populations throughout the tomato growing season (spring to fall) and, if present, apply appropriate insecticides that are registered in British Columbia for greenhouse tomato. Protection of young tomato plants from aphid- and whitefly-feeding is essential to reduce potential yield losses.

- If whiteflies are detected in B.C. greenhouses, use reflective or coloured (yellow) mulches that may reduce the whitefly populations feeding on tomato leaves.
- Use trap plants, preferably cucurbits that are preferred by whiteflies, to reduce infection rate on tomato.
- Maintain periodic scouting for virus symptoms, particularly on young tomato plants, and remove and deep-bury or incinerate the infected or suspected tomato plants.
- Maintain healthy growth of tomato plants to minimize virus damage.

Since viruses have a broad host range, including many weeds that are symptomless, maintain a rigorous weed control program in and around the greenhouse during the growing season and winter months.

TICV, ToCV, TYLCV and CDV are not yet detected on greenhouse tomato in B.C. and it is very difficult to eradicate once established. Therefore, preventing the introduction and establishment of these viruses is very important. Submit any suspected virus-infected plant samples or plants showing virus-like symptoms and any suspected virus-vectors (e.g. whiteflies and aphids) to the Ministry of Agriculture Plant Health Laboratory or to a recognized plant pest diagnostic laboratory for proper diagnosis and confirmation.

To prevent the introduction and spread of potential diseases of greenhouse vegetable crops, please refer the factsheets on "On-Farm and Greenhouse Sanitation and Disinfection Practices" and "Biosecurity Guidelines".

For Further Information

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