European and Mediterranean Plant Protection Organization
Organisation Européenne et Méditerranéenne pour la Protection des Plantes

Data sheets on quarantine pests
Fiches informatives sur les organismes de quarantaine

Tomato chlorosis crinivirus

Identity

Name: *Tomato chlorosis crinivirus*
Synonym: Tomato chlorosis virus
Taxonomic position: Viruses: *Closteroviridae*: *Crinivirus*
Common names: ToCV (acronym); yellow leaf disorder of tomato (English)
EPPO code: TOCV00
Phytosanitary categorization: EPPO A2 list no. 323; before its establishment in the some EU member states, ToCV was considered in the EU Directive as a non-European virus transmitted by *Bemisia tabaci* (EU, 2000)

Hosts

ToCV naturally infects tomato (Wisler *et al*., 1998a). Although there were preliminary indications by experimental inoculation that capsicum is not a host of ToCV, natural infections have been detected in Spain (Lozano *et al*., 2004). In Taiwan, *Zinnia* was also reported as a host (Tsai *et al*., 2004). The weeds *Datura stramonium* and *Solanum nigrum* have been identified as natural hosts in Portugal. The experimental host range includes species in the families *Aizoaceae*, *Amaranthaceae*, *Apocynaceae*, *Asteraceae*, *Chenopodiaceae*, *Plumbaginaceae*, *Solanaceae*. ToCV, unlike *Tomato infectious chlorosis virus* (TICV), another *Crinivirus* that infects tomato, does not infect lettuce (Wisler *et al*., 1998a).

Geographical distribution

EPPO region: France (a few local outbreaks were detected in 2002 in the south, under eradication; Decoin, 2003), Greece (found in glasshouses on the mainland and the islands of Poros, Rhodos and Kriti; Dovas *et al*., 2002); Italy (Sardegna – found in 6 glasshouses, Sicilia – found in 2 glasshouses; Puglia – found in 1 glasshouse) (Acotto *et al*., 2001); Portugal (Algarve only; Louro *et al*., 2000); Morocco (since 2000; has spread widely in tomato crops grown in glasshouses in the Souss valley; Hanafi, 2002); Spain: Málaga and Almería provinces (Navas-Castillo *et al*., 2000); Islas Canarias (Tenerife, Gran Canaria) (EWSN, 1999)
Asia: Taiwan (Tsai *et al*., 2004)
Africa: South Africa
North America: USA (Colorado, Connecticut, Florida, Louisiana, New York, Virginia) (Wisler *et al*., 1998b)
Central America and Caribbean: Puerto Rico (Wintermantel *et al*., 2001)
EU: see above

Biology

ToCV is transmitted locally by the whiteflies *Trialeurodes vaporariorum*, *Bemisia tabaci* and *Trialeurodes abutiloneus* (Wisler *et al*., 1998a). *T. vaporariorum* is common in glasshouses throughout the EPPO region and is also found outdoors in the summer months. *B. tabaci*, which is on the EPPO A2 List (EPPO/CABI, 1997), is present in glasshouses in many EPPO countries. It is also found in the field in southern Europe in the summer months. *T. abutiloneus* is found in the USA and Cuba (CABI, 2000). Like almost all viruses in the *Closteroviridae*, ToCV is unlikely to be seedborne.

Detection and identification

Symptoms

Tomato plants infected with ToCV show an irregular chlorotic mottle that develops first on lower leaves and gradually advances toward the growing point. Interveinal yellow areas on leaves also develop red and brown necrotic flecks. No obvious symptoms develop on fruit and flowers, but fruit size and numbers are reduced due to a loss of photosynthetic area. Significant yield losses occur as a result. Other symptoms include rolling of lower leaves and thickened crispy leaves, while the upper leaf canopy appears normal. Symptoms of ToCV are very similar to those of *Tomato infectious chlorosis virus* (TICV) (Wisler *et al*., 1998a, 1998b).

Symptoms caused by ToCV, like other members of the *Closteroviridae*, are easily attributed to other causes, such as physiological or nutritional disorders, or even phytotoxicity of plant protection products.

Morphology

ToCV particles are filamentous and slightly flexuous with a normal length of about 850 nm (Wisler *et al*., 1996). Cross-banding patterns seen are typical of members of the family *Closteroviridae* (Wisler *et al*., 1998b).

Detection and inspection methods

Inclusion bodies that stained red-violet with azure A have been seen under the light microscope in the cytoplasm of *Nicotiana clevelandii* infected with ToCV. These inclusions were similar to those observed for TICV and were often seen as fibrous aggregates that appeared as vacuolate bodies in phloem cells. Large plug-like inclusion bodies that stained violet have also been observed. Phloem cells from healthy plants were not found to stain with azure A (Wisler *et al*., 1998b). Ultrastructural observations have revealed an accumulation of cytoplasmic vesicles in phloem tissue of *N. clevelandii* infected with ToCV similar to that reported for other closterovirus infections. Virus particles were often associated with these vesicles (Wisler *et al*., 1998b). Cloned cDNAs have been made from double-stranded RNAs from ToCV-infected plants and probes specific to RNA 1 and RNA2 of ToCV have been produced using digoxigenin-11-UTP-labelled transcripts. These probes have been used to determine the bipartite nature of ToCV, to show that ToCV is distinct from TICV, and to detect ToCV in infected tomato tissue and other selected host plants (Wisler *et al*., 1998b).

ToCV can be distinguished from TICV by symptoms on the indicator plants *Nicotiana benthamiana* and *N. clevelandii*. Whereas both species show interveinal yellowing when infected with either virus, only TICV causes necrotic flecking in these hosts (Wisler *et al*., 1998b). Dot-blot hybridization with ToCV-specific probes and RT-PCR with ToCV-specific primers have also been used for reliable ToCV diagnostic (Louro *et al*., 2000; Vaira *et al*., 2001).

Pathways for movement

In international trade, ToCV may be carried by infected plants for planting. In Spain, outbreaks of ToCV have been associated with the main spread of *B. tabaci* populations during the summer months (Navas-Castillo *et al*., 2000). However, natural spread of ToCV to other countries by migration of *B. tabaci* and *T. vaporariorum* vectors carrying the virus would be expected to be slow. Viruliferous whiteflies could be carried long distances on plants of hosts or non-hosts transported by man.

Pest significance

Economic impact

There is little information available on crop losses due to ToCV. The appearance of ToCV in tomato fields in Málaga and Almería provinces in southern Spain has been viewed with alarm by Spanish scientists. Severe yield losses have been recorded due to reduced fruit growth and delayed ripening. During the 1998 and 1999 growing seasons, the yellowing syndrome became widespread and occurred at a high incidence in Málaga Province. The outbreaks were associated with high populations of *B. tabaci* and have been described as epidemics. Incidences of over 30% symptomatic plants in individual fields were frequent (Navas-Castillo & Moriones, 2000; Navas-Castillo *et al*., 2000). Hanafi (2002) reports that ToCV has already caused significant damage in tomato glasshouses in 2002. The severity of symptoms and damage vary according to the cultivar.

Control

Control of ToCV is centred on the control of its whitefly vectors. Regarding chemical control, *B. tabaci* appears to develop resistance to all groups of insecticides. A rotation of insecticides that offer no cross resistance must therefore be used to control *B. tabaci* infestations. The biocontrol agent *Encarsia formosa* (parasitic wasp) is used to control *T. vaporariorum*, but is less efficient against *B. tabaci*. Repeated introductions of larger numbers of *E. formosa* than *B. tabaci* are necessary if eradication is required. The predatory beetle *Delphastus pusillus* is very effective against *B. tabaci* (MAFF, 2000). Roguing of severely infested plants reduces whitefly populations.

Tomato seedlings for transplanting should be kept free from infection. There are no resistant tomato cultivars as no resistance to ToCV has yet been identified in tomato. No differences in the incidence of yellowing due to ToCV in fields containing different cultivars of tomato were observed in southern Spain (Navas-Castillo *et al*., 2000).

Eradication of isolated outbreaks in glasshouse-grown tomatoes can probably be achieved by destruction of affected hosts and of the vector(s). However, it is difficult to envisage that eradication could be achieved for outbreaks in the field in southern Europe. Weed hosts may act as reservoirs for ToCV.

Phytosanitary risk

ToCV presents a significant risk of further spread in the EPPO region. The risk to the tomato industry is high since *T. vaporariorum*, a known vector, is present and widespread in glasshouses and in the field in northern and southern Europe in the summer (CABI, 2000). In addition, *B. tabaci*, another known vector of ToCV, occurs in many EPPO countries. This whitefly is found on outdoor crops in southern Europe in the summer and in glasshouse in northern Europe. It is frequently intercepted on plant and plant products. ToCV would be expected to cause considerable damage to glasshouse tomato crops in EPPO countries. Outdoor crops in Mediterranean countries are also at risk.

Phytosanitary measures

ToCV was added in 2005 to the EPPO A2 action list, and endangered EPPO member countries are thus recommended to regulate it as a quarantine pest.

At present, there are no specific measures against ToCV in Europe and in particular there are no restrictions on the movement of tomato seedlings from areas where the disease occurs. Possible measures would be equivalent to those proposed for CVYV (OEPP/EPPO, 2005).

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