Data Sheets on Quarantine Pests

Tomato yellow leaf curl bigeminivirus

IDENTITY

Name: Tomato yellow leaf curl bigeminivirus
Taxonomic position: Viruses: Geminiviridae: Bigeminivirus
Common names: TYLCV (acronym)
EPPO computer code: TMYLCX
EPPO A2 list: No. 182

HOSTS

The main host of TYLCV is tomatoes (*Lycopersicon esculentum*). *Datura stramonium* and tobacco (*Nicotiana* spp.) can be artificially infected. Ornamentals such as *Eustoma grandiflorum* can be severely damaged by natural infection (Cohen *et al*., 1995). No symptoms are expressed on tobacco (Mansour & Al-Musa, 1992). The plants which can be infected by the virus include 15 species in five different families.

GEOGRAPHICAL DISTRIBUTION

TYLCV is an Old World geminivirus, first described in the Middle East in the 1960s. It remained of limited importance, and presumably of limited geographical distribution, until biotype B of its vector *B. tabaci* started to spread dramatically through the EPPO region in the 1980s (Czosnek *et al*., 1990). The similar spread of this vector in the New World was accompanied by the spread of other geminiviruses of Solanaceae (e.g. tomato mottle bigeminivirus; EPPO/CABI, 1996b), but TYLCV was also found in America in 1994. The situation concerning tomato geminiviruses in America is now very complex and will only gradually become clear.
EPPO region: Cyprus, Egypt, Israel, Italy (Gallitelli *et al*., 1991; including Sardinia and Sicily), Lebanon, Malta, Portugal (mainland), Russia (southern), Spain (Moriones *et al*., 1993; including Canary Islands), Tunisia, Turkey.
Asia: Bahrain, Cyprus, India, Iran, Iraq, Israel, Jordan, Lebanon, Oman, Philippines (unconfirmed), Saudi Arabia, Taiwan, Thailand, Turkey, United Arab Emirates, Yemen.
Africa: Burkina Faso, Cape Verde, Côte d'Ivoire, Egypt, Libya, Mali, Nigeria, Senegal, Tunisia.
Central America and Caribbean: Dominican Republic (recently introduced; Nakhla *et al*., 1994), Jamaica, Martinique.
Oceania: Australia (Northern Territory).
EU: Present.

BIOLOGY

Tomato yellow leaf curl geminivirus is transmitted by *Bemisia tabaci* (EPPO/CABI, 1996a) in a persistent manner. Biotype B is usually the form of *B. tabaci* involved (Mehta *et al*., 1994) which transmits with high frequency (McGrath & Harrison, 1995). Acquisition and inoculation feeding periods range from 20 to 60 min and from 10 to 30 min, respectively,

depending on the isolates (Cohen & Nitzany, 1966; Ioannou, 1985; Mansour & Al-Musa, 1992). The latent period inside the insect is 20-24 h. TYLCV can persist in the vector for 10-12 days and only rarely for up to 20 days. No transovarial transmission of the virus has been found. Nymphs can acquire the virus and transmit it when they reach the adult stage. The phenomenon of periodic acquisition has been established, by which the ability to reacquire the virus and resume infectivity is possible only after total loss of infectivity. Most whiteflies lose their ability to transmit within 10-12 days after an acquisition period of 24-28 h.

In the plant, the virus develops within the phloem and induces cytological changes. For details on these changes, see Channarayappa *et al.*, 1992. Symptoms appear only 15 days after inoculation (Ber *et al.*, 1990).

There are strain variations in TYLCV. In particular, the virus from India (Abou-Jawdah, 1995; Padidam *et al.*,, 1995), from subsaharan Africa (Nigeria, Senegal; Deng *et al.*, 1994) and from southeast Asia may prove to be different from the Mediterranean virus, which in turn is referred to as western Mediterranean, Sardinian, Israeli and eastern Mediterranean strain (Nakhla *et al.*, 1993). Kegler (1994) provides a general review of the virus.

DETECTION AND IDENTIFICATION

Symptoms

Tomato plants infected at an early stage are severely stunted; their terminal and axillary shoots are erect, and their leaflets are reduced in size and abnormally shaped. Leaves that develop soon after infection are cupped downward, whereas leaves developing later are prominently chlorotic and deformed, with leaf margins rolled upwards and curling between the veins. The effect on fruits depends on the age of the plant when infected. If infected early, plants lose vigour and stop producing marketable fruits. When infections occur at a later stage of development, additional fruits fail to set, but fruits already present ripen in a nearly normal manner. No flower symptoms are observed but dropping of flowers is common.

Morphology

TYLCV has geminate particles which are isometric, ca. 20 nm in diameter (Channarayappa *et al.*, 1992). The genome has been found to contain single-stranded circular DNA (Czosnek *et al.*, 1988). This DNA has been shown to be bipartite (DNA A and B) (Rochester *et al.*, 1994). The length of the DNA is in all cases about 2800 nucleotides. The DNA of several strains has been sequenced (Antignus & Cohen, 1994; Noris *et al.*, 1994).

Detection and inspection methods

The disease is difficult to identify due to the great variation in symptoms. For example, an agent causing TYLCV-like symptoms in the Dominican Republic was first considered to be only a TYLCV-like geminivirus (Polston *et al.*, 1994), before later being identified as the Israeli strain of TYLCV, with slight variations in the DNA (Nakhla *et al.*, 1994). Assays based on molecular hybridization have been developed (Navot *et al.*, 1989, Zilberstein *et al.*, 1989; Martino *et al.*, 1993; Abou-Jawdah *et al.*, 1995). Certain serological tests, such as ELISA, need further development to be usable, especially concerning the use of antisera against the various strains. Al-Bitar & Luisoni (1995) obtained better results with ELISA after improved purification.

MEANS OF MOVEMENT AND DISPERSAL

TYLCV moves only in its vector *Bemisia tabaci*, which can spread it between fields (and presumably glasshouses) in infested areas. In international trade, young tomato seedlings for transplanting might constitute a pathway, if they were infected very early. Tomato fruits would not be likely to carry *B. tabaci*, and TYLCV is not seed-transmitted. There is a certain risk of movement in *B. tabaci* to other host plants (e.g. ornamentals), given the fact that the vector moves readily from one host to another and that such viruses are known to persist in the vector for some time after acquisition.

PEST SIGNIFICANCE

Economic impact

The vector *Bemisia tabaci*, and especially its biotype B, is now very widely distributed throughout the world (EPPO/CABI, 1996a). TYLCV is a major problem affecting tomato production in many Old World tropical and subtropical countries. Field cropping of tomato in the coastal plains of Lebanon stopped because of TYLCV (Abou-Jawdah & Shebaro, 1993). Yield losses reached 80% according to Mazyad *et al.* (1979). Whenever TYLCV is introduced into a new country where the vector is already present, it rapidly spreads throughout commercial tomato crops.

Control

Chemical control of the vector *B. tabaci* is difficult because of the problem of residues on vegetable crops. Research is being conducted on methods of biological control but it will be a long and difficult task to find a suitable natural enemy. Cultural control measures include the choice of planting dates in order to avoid periods of high whitefly populations, the use of screens to exclude the vector, the elimination of primary or secondary virus sources, and the use of healthy transplants. Research is being carried out on resistance (Laterrot, 1993), and cultivars showing increased resistance have been found. Transgenic tomato plants with the capsid protein of TYLCV are resistant to the virus (Kunik *et al*., 1994).

Phytosanitary risk

TYLCV is listed as an A2 quarantine pest by EPPO. The wide distribution of the vector *Bemisia tabaci*, together with the unreliable means of control available, indicate the likelihood of serious crop damage and economic losses if the virus should be introduced into a country. Quarantine requirements to prevent introduction from one country to another within the EPPO region may, however, be difficult to apply because of the lack of a cheap, rapid and reliable method of detection and because *B. tabaci* is already widely distributed. If TYLCV is introduced into a country, the only possibilities for avoiding serious damage would be to encourage careful monitoring of the situation within the country and the use of prophylactic measures by the growers.

BIBLIOGRAPHY

Abou-Jawdah, Y. (1995) Serological reactivity of tomato yellow leaf curl geminivirus isolates from Lebanon with heterologous monoclonal antibodies. *Phytopathologia Mediterranea* **34**, 35-37.

Abou-Jawdah, Y.; Shebaro, W.A. (1993) Situation of TYLCV in Lebanon. *Tomato Leaf Curl Newsletter* **4**, 2-3.

Abou-Jawdah, Y.; Shebaro, W.A.; Soubra, K.H. (1995) Detection of tomato yellow leaf curl geminivirus (TYLCV) by a digoxigenin-labelled DNA probe. *Phytopathologia Mediterranea* **34**, 52-57.

Al-Bitar, L.; Luisoni, E. (1995) Tomato yellow leaf curl geminivirus: serological evaluation of an improved purification method. *Bulletin OEPP/EPPO Bulletin* **25**, 267-276.

Antignus, Y.; Cohen, S. (1994) Complete nucleotide sequence of an infectious clone of a mild isolate of tomato yellow leaf curl virus (TYLCV). *Phytopathology* **84**, 707-712.

Ber, R.; Navot, N.; Zamir, D.; Antignus, Y.; Cohen, S.; Czosnek, H. (1990) Infection of tomato by the tomato yellow leaf curl virus: susceptibility to infection, symptom development and accumulation of viral DNA. *Archives of Virology* **112**, 169-180.

Channarayappa; Muniyappa, V.; Schwegler-Berry, D.; Shivashankar, G. (1992) Ultrastructural changes in tomato infected with tomato leaf curl virus, a whitefly-transmitted geminivirus. *Canadian Journal of Botany* **70**, 1747-1753.

Cohen, S.; Nitzany, F.E. (1966) Transmission and host range of tomato yellow leaf curl virus. *Phytopathology* **56**, 1127-1131.

Cohen, J.; Gera, A.; Ecker, R.; Ben-Joseph, R.; Perlsman, M.; Gokkes, M.; Lachman, O.; Antignus, Y. (1995) Lisianthus leaf curl - a new disease of lisianthus caused by tomato yellow leaf curl virus. *Plant Disease* **79**, 416-420.

Czosnek, H.; Ber, R.; Antignus, Y.; Cohen, S.; Navot, N.; Zamir, D. (1988) Isolation of tomato yellow leaf curl virus, a geminivirus. *Phytopathology* **78**, 508-512.

Czosnek, H.; Navot, N.; Laterrot, H. (1990) Geographical distribution of tomato yellow leaf curl virus. A first survey using a specific DNA probe. *Phytopathologia Mediterranea* **24**, 1-6.

Deng, D.; McGrath, P.F.; Robinson, D.J.; Harrison, B.D. (1994) Detection and differentiation of whitefly-transmitted geminiviruses in plants and vector insects by the polymerase chain reaction with degenerate primers. *Annals of Applied Biology* **125**, 327-336.

EPPO/CABI (1996a) *Bemisia tabaci*. In: *Quarantine pests for Europe*. 2nd edition (Ed. by Smith, I.M.; McNamara, D.G.; Scott, P.R.; Holderness, M.). CAB INTERNATIONAL, Wallingford, UK.

EPPO/CABI (1996b) Tomato mottle bigeminivirus. In: *Quarantine pests for Europe*. 2nd edition (Ed. by Smith, I.M.; McNamara, D.G.; Scott, P.R.; Holderness, M.). CAB INTERNATIONAL, Wallingford, UK.

Gallitelli, D.; Luisoni, E.; Martinelli, G.P.; Caciagli, P.; Milne, R.G.; Accotto, G.P.; Antignus, Y. (1991) [Tomato yellow leaf curl disease in Sardinia]. *Informatore Fitopatologico* **41** (7-8), 42-46.

Ioannou, N. (1985) Yellow leaf curl and other virus disease of tomato in Cyprus. *Plant Pathology* **34**, 428-434.

Kegler, H. (1994) Incidence, properties and control of tomato yellow leaf curl virus - a review. *Archives of Phytopathology and Plant Protection* **29**, 119-132.

Kunik, T.; Salomon, R.; Zamir, D.; Navot, N.; Zeidan, M.; Michelson, I.; Gafni, Y.; Czosnek, H. (1994) Transgenic tomato plants expressing the tomato yellow leaf curl virus capsid protein are resistant to the virus. *Bio/Technology* **12**, 500-504.

Laterrot, H. (1993) Present state of the genetic control of tomato yellow leaf curl virus and of the EEC-supported breeding programme. In: *Proceedings of the XIIth Eucarpia meeting on tomato genetics and breeding*, pp. 19-24. Maritsa Vegetable Crops Research Institute, Plovdiv, Bulgaria.

Mansour, A.; Al-Musa, A. (1992) Tomato yellow leaf curl virus: host range and virus-vector relationships. *Plant Pathology* **41**, 122-125.

Martino, M.T., di; Albanese, G.; Silvestro, I., di; Catara, A. (1993) Rapid detection of tomato yellow leaf curl virus in plants by polymerase chain reaction. *Rivista di Patologia Vegetale* **3**, 35-40.

Mazyad, H.M.; Omar, F.; Al-Taher, K.; Salha, M. (1979) Observations on the epidemiology of tomato yellow leaf curl disease on tomato plants. *Plant Disease Reporter* **63**, 695-698.

McGrath, P.F.; Harrison, B.D. (1995) Transmission of tomato leaf curl geminiviruses by *Bemisia tabaci*: effect of virus isolate and vector biotype. *Annals of Applied Biology* **126**, 307-316.

Mehta, P.; Wyman, J.A.; Nakhla, M.K.; Maxwell, D.P. (1994) Transmission of tomato yellow leaf curl geminivirus by *Bemisia tabaci*. *Journal of Economic Entolomogy* **87**, 1291-1297.

Moriones, E.; Arno, J.; Accotto, G.P.; Noris, E.; Cavallarin, L. (1993) First report of tomato yellow leaf curl virus in Spain. *Plant Disease* **77**, 953.

Nakhla, M.K.; Mazyad, H.M.; Maxwell, D.P. (1993) Molecular characterization of four tomato yellow leaf curl virus isolates from Egypt and development of diagnostic methods. *Phytopathologia Mediterranea* **32**, 163-173.

Nakhla, M.K.; Maxwell, D.P.; Martinez, R.T.; Carvalho, M.G.; Gilbertson, R.L. (1994) Widespread occurrence of the Eastern Mediterranean strain of tomato yellow leaf curl geminivirus in tomatoes in the Dominican Republic. *Plant Disease* **78**, 926.

Navot, N.; Ber, R.; Czosnek, H. (1989) Rapid detection of tomato yellow leaf curl virus in squashes of plants and insect vectors. *Phytopathology* **79**, 562-568.

Noris, E.; Hidalgo, E.; Accotto, G.P.; Moriones, E. (1994) High similarity among the tomato yellow leaf curl virus isolates from the West Mediterranean Basin: the nucleotide sequence of an infectious clone from Spain. *Archives of Virology* **135**, 165-170.

Padidam, M.; Beachy, R.N.; Fauquet, C.M. (1995) Tomato leaf curl geminivirus from India has a bipartite genome and coat protein is not essential for infectivity. *Journal of General Virology* **76**, 25-35.

Polston, J.E.; Bois, D.; Serra, C.A.; Conceptíon, S. (1994) First report of a tomato yellow leaf curl-like geminivirus in the western hemisphere. *Plant Disease* **78**, 831.

Rochester, D.E.; DePaulo, J.J.; Fauquet, C.M.; Beachy, R.N. (1994) Complete nucleotide sequence of the geminivirus tomato yellow leaf curl virus, Thailand isolate. *Journal of General Virology* **75**, 477-485.

Zilberstein, A.; Navot, N.; Ovadia, S.; Reinhartz, A.; Herzberg, M.; Czosnek, H. (1989) Field-usable assay for diagnosis of the tomato yellow leaf curl virus in squashes of plants and insects by hybridization with a chromogenic DNA probe. *Technique* **1**, 118-124.

Zitter, T.A. (1991) Tomato yellow leaf curl. In: *Compendium of tomato diseases* (Ed. by Jones, J.B; Jones J.P.; Stall, R.E.; Zitter, T.A.) pp. 40-41. APS Press, St. Paul, USA.