EPPO Datasheet: *Begomovirus solanumdelhiense*

Last updated: 2020-10-06

IDENTITY

Preferred name: *Begomovirus solanumdelhiense*
Taxonomic position: Viruses and viroids: Monodnaviria: Shotokuvirae: Cressdnaviricota: Repensiviricetes: Geplafuvirales: Geminiviridae
Other scientific names: *BGYVV, Bitter gourd yellow vein virus, ToLCNDV, Tomato leaf curl New Delhi begomovirus, Tomato leaf curl New Delhi virus*
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EPPO Categorization: A2 list, Alert list (formerly)
view more categorizations online...
EU Categorization: Quarantine pest ((EU) 2019/2072 Annex II B)
EPPO Code: TOLCND



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Notes on taxonomy and nomenclature

Tomato leaf curl New Delhi virus, ToLCNDV, is a virus species with a single-stranded DNA genome, in the genus *Begomovirus*, family *Geminiviridae*. Isolates of this virus can be grouped into several strains based on the molecular diversity of their DNA-A genome components (Moriones *et al.*, 2017). The virus isolates reported from Europe comprise the strain ToLCNDV-ES (Fortes *et al.*, 2016; Juarez *et al.*, 2019; Panno *et al.*, 2019; Ruiz *et al.*, 2017) which is genetically stable and distinct from other ToLCNDV isolates.

HOSTS

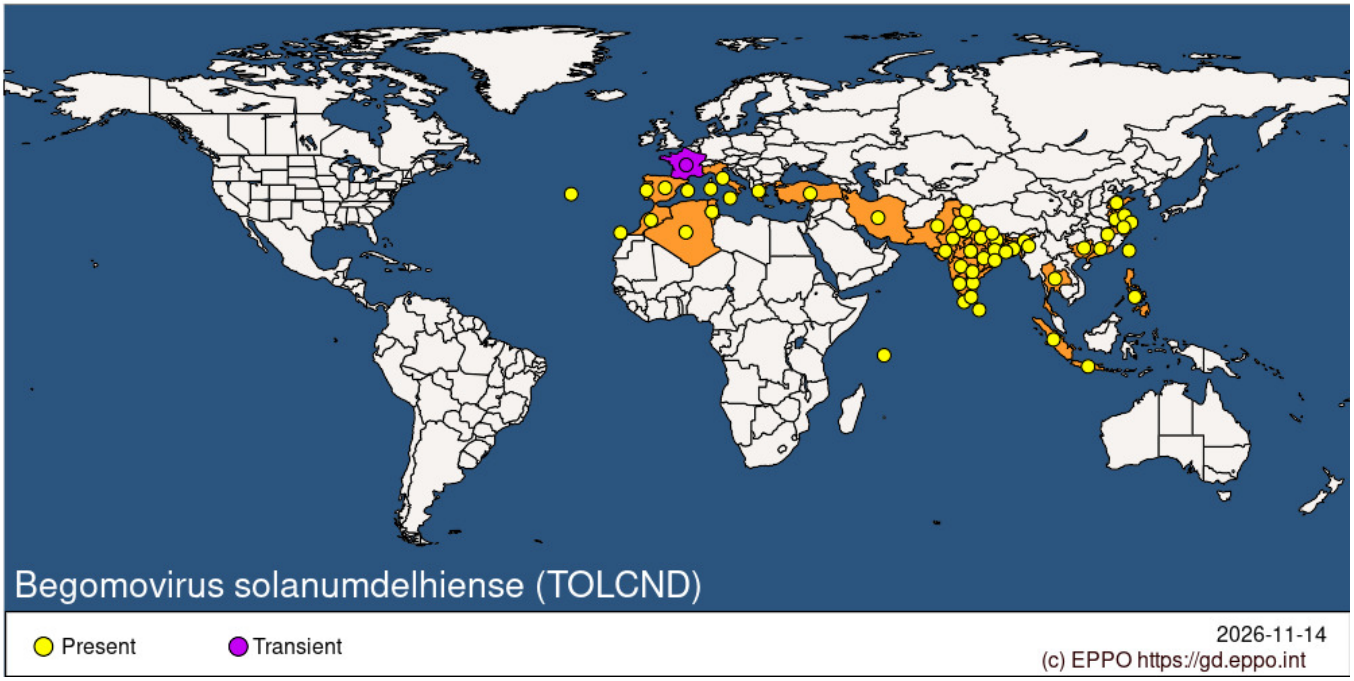
ToLCNDV has a broad host range encompassing Solanaceae, Cucurbitaceae, Fabaceae and Malvaceae species many of which are important crops and ornamental plants as well as wild species (weeds). The main crop hosts of ToLCNDV are tomato and cucurbits in particular zucchini, cucumber and melon. Wild plant hosts may not show conspicuous symptoms but can serve as virus reservoirs. Because of the broad host range and the polyphagous nature of its vector *Bemisia tabaci,* the range of susceptible plant species may be larger than reported.

The range of susceptible host plants and those found to be infected in nature may not correspond. Thus, the virus strain ToLCNDV-ES present in Europe is predominantly found on Cucurbitaceae plants and while the virus strain infects tomato (Janssen *et al.*, 2017; Ruiz *et al.*, 2017) it appears to be poorly adapted to this host and is better adapted to cucurbits which are efficiently infected by ToLCNDV-ES (Juarez *et al.*, 2019; Panno *et al.*, 2019).

Host list: *Abelmoschus esculentus, Acalypha indica, Benincasa fistulosa, Benincasa hispida, Calotropis procera, Capsicum annuum, Capsicum chinense, Capsicum frutescens, Carica papaya, Catharanthus roseus, Cestrum nocturnum, Chenopodium album, Chenopodium giganteum, Chrysanthemum indicum, Citrullus lanatus, Coccinia grandis, Commelina benghalensis, Convolvulus arvensis, Crossandra infundibuliformis, Cucumis anguria, Cucumis melo subsp. agrestis, Cucumis melo subsp. melo var. cantaloupensis, Cucumis melo var. flexuosus, Cucumis melo, Cucumis sativus, Cucurbita maxima, Cucurbita melopepo, Cucurbita moschata, Cucurbita pepo var. giromontiina, Cucurbita pepo, Cyamopsis tetragonoloba, Dahlia pinnata, Datura stramonium, Daucus carota, Duranta erecta, Ecballium elaterium, Eclipta prostrata, Euphorbia hirta, Glycine max, Gossypium hirsutum, Hibiscus cannabinus, Ipomoea cairica, Jasminum multiflorum, Jatropha, Lagenaria siceraria, Luffa acutangula, Luffa aegyptiaca, Mangifera indica, Momordica charantia, Momordica dioica, Papaver somniferum, Parthenium hysterophorus, Phaseolus vulgaris, Phyllanthus niruri, Physalis minima, Physalis peruviana, Ricinus communis, Rumex dentatus, Sauropus androgynus, Sicyos edulis, Solanum lycopersicum, Solanum melongena, Solanum nigrum, Solanum tuberosum, Sonchus oleraceus, Tagetes erecta, Tragia involucrata, Trichosanthes cucumerina, Trifolium repens, Vicia lens, Vigna radiata*

GEOGRAPHICAL DISTRIBUTION

ToLCNDV was first described from India (Padidam *et al.*, 1995) and it is mainly present in Asia where many host plants and various virus isolates (strains) are described. The occurrence of the virus coincides with the presence of the *Bemisia tabaci* whitefly vector and the availability of suitable host plants. ToLCNDV occurs in the Mediterranean regions, in areas where *B. tabaci* is present. ToLCNDV findings outside the climate suitable for the insect vector are linked with the horticulture pathway and plants produced under protected cultivation (glasshouses).



EPPO Region: Algeria, France (mainland), Greece (mainland), Italy (mainland, Sardegna, Sicilia), Morocco, Portugal (mainland, Azores), Spain (mainland, Islas Baleares, Islas Canárias), Tunisia, Türkiye
Africa: Algeria, Morocco, Seychelles, Tunisia
Asia: Bangladesh, China (Anhui, Guangdong, Guangxi, Jiangsu, Jiangxi, Shandong, Shanghai, Zhejiang), India (Andhra Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Odisha, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttarakhand, Uttar Pradesh, West Bengal), Indonesia (Java, Sumatra), Iran, Islamic Republic of, Nepal, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand

BIOLOGY

ToLCNDV is transmitted by *Bemisia tabaci* whiteflies and persists in the vector insect. Adult insects acquire the virus by sucking on phloem sap, and once ingested the virus circulates in the insect body. The insect can further transmit the virus to another plant when feeding. The virus does not replicate in the insect and transmission efficiency decreases with age but the vector remains viruliferous throughout its life span. Even in the temporary absence of host plants suitable for ToLCNDV, the virus can persist in the vector and when hosts are again present then virus transmission by sap sucking is generally very effective and even a few insects can cause disease outbreaks. The broad host range of the virus and the polyphagous nature of the whitefly vector, in particular the invasive MEAM1 (Middle East-Asia Minor) and MED (Mediterranean) species present in Southern Europe and the Mediterranean Basin, assure virus establishment in the environment.

Seedling infection arising from germinating seeds of ToLCNDV-infected zucchini fruits was reported (Kil *et al.*, 2020). It is likely that this happened by wounding of the germinating seeds and mechanical transmission of the virus present on the seed coat. While rare cases of mechanical virus infection through wounding exist, insect transmission is the primary mode of ToLCNDV spread and virus incidence is closely linked to the geographical distribution of *B. tabaci*, which is determined by climate variables, temperature and humidity (EFSA, 2013; Gilioli *et al.*, 2014). *B. tabaci*

has short acquisition and inoculation access periods (< 30 min) for efficient virus transmission and virus spread and disease incidence is linked to the density of whitefly populations.

DETECTION AND IDENTIFICATION

Symptoms

Symptoms become apparent on plants infected with ToLCNDV approximately 10 to 14 days after vector feeding. ToLCNDV causes systemic infections in its hosts and early symptoms become visible in youngest uppermost plant parts showing leaf curling, distortion, and blistering. In cucurbit hosts this is associated with discoloration, chlorotic mottling and vein banding followed by upward rolling and general chlorosis of older leaves. In tomato, leaf curling of the apical portions of the plant are the first signs of a developing begomovirus infection, somewhat similar to symptoms caused by *Tomato yellow leaf curl virus* (TYLCV) and other begomoviruses. In later infections, chlorotic spots and mottling can be observed on older leaves. Early infections with ToLCNDV interferes with flowering and fruit development resulting in reduced flower setting and low numbers of fruits. Fruits are small with unappealing discoloration, indents or blisters and lacking in taste, and may prematurely drop, which can eventually result in complete crop failure (EFSA, 2020a, b).

ToLCNDV can occur in mixed infection with other viruses, in particular other begomoviruses, and with alpha- and betasatellites. Mixed infections can result in synergism and more severe symptoms than ToLCNDV infections alone.

ToLCNDV causes pronounced symptoms in infected plants and while uncertainty exists on symptoms on wild hosts, virus-infected crops are generally recognised.

Morphology

ToLCNDV has distinctive virus particles composed of two incomplete icosahedra fused to form a paired (geminate) particle of 18x30 nm. The virus particles are unique and characteristic for geminiviruses only.

Detection and inspection methods

ToLCNDV causes obvious symptoms in most infected hosts however, these symptoms are not adequate to identify the virus because they are similar to those caused by other begomoviruses and because of other viruses present in mixed infections. Thus, for unambiguous virus detection and identification, laboratory methods are required. Inspection and tracing of symptomatic plants guide sampling with leaves of apical portions of plants being used for virus testing. Even when symptoms are mild or absent, ToLCNDV can be detected. ToLCNDV can be reliably detected using commercial ELISA tests (DAS-ELISA) which can be used for surveillance to trace infections (Juarez *et al.*, 2019). Subsequent identification of ELISA positive samples can be done using molecular tests to identify ToLCNDV (Figas *et al.*, 2017; Panno *et al.*, 2019; Parrella *et al.*, 2018; Ruiz *et al.*, 2015; Saez *et al.*, 2016). For identification of virus strains and in particular to identify the European strain ToLCNDV-ES, sequence analysis of the complete DNA-A genome component ToLCNDV is required. This is achieved by combining DNA amplification (Rolling circle amplification RCA or PCR) with sequencing (Fortes *et al.*, 2016; Moriones *et al.*, 2017).

Testing of *B. tabaci* for the presence of ToLCNDV and other circulative, persistent plant viruses is critical to detect and intercept viruliferous insects which may, for example, be carried along with imported plant materials. Virus detection and identification in vectors is achieved by molecular methods including real-time PCR (Bertin *et al.*, 2018; Luigi *et al.*, 2020).

An EPPO Diagnostic Protocol for Begomoviruses in under development and will cover detection and identification of ToLCNDV. As surveys should be carried out in all the EU member countries, a pest survey card was prepared by the European Food Safety Authority (EFSA, 2020b) to assist EU Member States in planning their annual survey activities for ToLCNDV.

PATHWAYS FOR MOVEMENT

ToLCNDV spread is predominantly with viruliferous whiteflies thus virus distribution coincides with the geographic distribution of its vector and is limited by the spread capacity of the insect. The insect carrying the virus can transmit it throughout its lifetime thus passive transport of viruliferous adults through wind, or infesting host or non-host plants and other materials (cut flowers and fresh herbs) traded internationally constitute means of virus long-distance movement and virus introduction into new areas. Import of many host plants of ToLCNDV and other commodities are regulated in the EU and in many EPPO countries and the introduction of *B. tabaci* is forbidden. However, the number of whiteflies intercepted at points of entry indicate a putative pathway for ToLCNDV to enter the EPPO region.

PEST SIGNIFICANCE

Economic impact

In the regions where ToLCNDV occurs, the virus presents a threat to solanaceous and cucurbit plants including economically important crops, such as tomato, eggplant, pepper, potato, zucchini, cucumber and melon. In addition, the virus also causes serious economic losses in vegetable and fibre crops grown in Asia, potato (Jeevalatha *et al.*, 2017a,2017b; Usharani *et al.*, 2004) cotton and okra (Venkataravanappa *et al.*, 2015, 2018; Zaidi *et al.*, 2016) and many other food crops. It is assumed that ToLCNDV causes serious economic losses wherever it occurs and has severe impacts on quality and yield of the vegetable harvest. These products are important sources of healthy diets and income security. Plant protection products used for vector control may have negative impacts on the environment and biodiversity if they are not used appropriately.

Control

Effective control of ToLCNDV rely on the control of the insect vector *B. tabaci*. In regions where *B. tabaci* occurs in nature and open fields, control should both exclude the insect (physical barriers, protected cultivation) and reduce whitefly populations using IPM practices combining biological and chemical control strategies (Crespo *et al.*, 2019; Rodriguez *et al.*, 2019; Tellez *et al.*, 2017) to suppress virus spread. Eliminating virus-infected plants or groups of plants is only relevant in the absence of established *B. tabaci*, this is the case for example when outbreaks occur in protected cultivation and temporary whitefly populations can be eradicated. Managing ToLCNDV and whitefly-transmitted viruses in general is challenging in open-field crops. Thus, in open-field horticulture, the control of whitefly transmitted viruses relies on insecticides to reduce vector populations and host plant resistance to the virus combined with selected IPM strategies (Lapidot *et al.*, 2014). Crop rotation and planting outside of periods with high vector populations may contribute to reduce impact from virus diseases.

Genetic resistance is the most promising strategy for ToLCNDV control and resistance provided by Ty-2 and Ty-3 genes conferring resistance against TYLCV can provide a level of protection against ToLCNDV (Akhtar *et al.*, 2019; Lata *et al.*, 2019; Prasanna *et al.*, 2015). In cucurbits, *Cucurbita moschata* lines that had little or no symptoms of ToLCNDV infections may be potential sources of ToLCNDV resistance (Saez *et al.*, 2017,2016). Resistance has been reported in sponge gourd (Islam *et al.*, 2010) and in five accessions of melon (Romay *et al.*, 2019). Breeding ToLCNDV resistant crops may be a long-term solution but currently no ToLCNDV resistant crops are cultivated.

Phytosanitary risk

ToLCNDV is present in several countries of the EPPO region, in Southern European and neighbouring countries bordering the Mediterranean Sea, in areas where *B. tabaci*, its insect vector, is established. Virus dissemination and spread is bound to the geographic range distribution of the vector and this is limited by suitable eco-climatic conditions (EFSA, 2020, 2013). In open fields, adequate pest management often is not possible and adaption of whiteflies to less favourable conditions and range expansion triggered by climate change and intensified agriculture aggravates ToLCNDV damage (Bertin *et al.*, 2018). Outside the areas where *B. tabaci* is endemic, the virus may spread if the vector expands its range due to adaptation to less favourable conditions or climate change. In climates less suitable for the vector and where crop production is under protected conditions, ToLCNDV infections can occur but are transient because vector populations only occurs during part of the year and cannot establish.

In Europe, all ToLCNDV isolates described so far belong to one strain, ToLCNDV-ES, which is genetically

homogenous and probably derived from a single introduction. This ToLCNDV strain comprises virus isolates that are adapted to cucurbit hosts (cucumber, melon, and zucchini), and which circulate mainly in cucurbits whereas tomato and other solanaceous crops are less important host plants. An increased risk to crop production in the EPPO region would arise from additional virus diversity introduced from Asia where various isolates of the virus are reported and in addition the virus is associated with other viruses and satellite molecules. In this case additional host plants, such as tomato, potato could be strongly affected and current crop management strategies may be jeopardized.

PHYTOSANITARY MEASURES

The import of some host plants for planting (e.g. Solanaceae) is prohibited in many EPPO countries. Other host plants for planting should only be imported from pest-free areas for the virus. They may also come from areas where the virus occurs if they are produced in pest-free sites of production e.g. under isolation or where measures are implemented to avoid the presence of *B. tabaci* (e.g. green/ screenhouses, trapping) and no symptoms of the virus are observed during the cycle of vegetation. Surveillance (visual inspection followed by laboratory testing) contributes to early detection of ToLCNDV infected plants and assessment of vectors for targeted insecticide application.

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Datasheet history

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