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Pest categorisation of tomato leaf curl New Delhi virus

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Abstract

Following a request from the European Commission, the Panel on Plant Health performed a pest categorisation on tomato leaf curl New Delhi virus (ToLCNDV). ToLCNDV is a well-defined bipartite Begomovirus species, sometimes associated with satellite molecules. It is transmitted by *Bemisia tabaci* to a wide range of hosts. ToLCNDV is reported from Estonia, Greece, Italy, Portugal and Spain, with limited distribution. The prevalent strain (ToLCNDV-ES) in these countries is particularly adapted to cucurbits and is different from isolates reported outside the EU, which are better adapted to solanaceous crops and could therefore pose additional risk for EU agriculture. The virus is regulated under Commission Implementing Regulation (EU) 2019/2072. The main pathway of entry identified is plants for planting of susceptible hosts, even if entry could also occur via commodities carrying viruliferous *B. tabaci* and possibly by seeds. While establishment and local spread rely on *B. tabaci*, the virus can also be dispersed over long distances by movement of infected plants for planting. Establishment and spread are limited to regions with ecoclimatic conditions suitable for the establishment of vector populations (southern regions of Europe) or can occur as outbreaks wherever crops are grown under protected cultivation. The main uncertainties associated with this pest categorisation are the distribution and prevalence of ToLCNDV in the EU, the magnitude of the virus impact particularly on hosts different from *Cucurbitaceae*, and seed transmission. ToLCNDV meets all the criteria evaluated by EFSA to qualify as potential Union Quarantine Pest (QP); conversely, ToLCNDV does not meet the criterion of being widespread in the EU to qualify as a Regulated Non-Quarantine Pest (RNQP). Should new data show that ToLCNDV is widespread in the EU, the possibility would exist for non-EU isolates to qualify as QP, while ToLCNDV EU isolates (ToLCNDV-ES) could qualify as RNQP.

Keywords: Begomovirus, virus satellite, *Bemisia tabaci*, Cucurbits, pest risk, quarantine, plant health

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

1.1.1. Background

Council Directive 2000/29/EC[1] on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community establishes the present European Union plant health regime. The Directive lays down the phytosanitary provisions and the control checks to be carried out at the place of origin on plants and plant products destined for the Union or to be moved within the Union. In the Directive's 2000/29/EC annexes, the list of harmful organisms (pests) whose introduction into or spread within the Union is prohibited, is detailed together with specific requirements for import or internal movement.

Following the evaluation of the plant health regime, the new basic plant health law, Regulation (EU) 2016/2031[2] on protective measures against pests of plants, was adopted on 26 October 2016 and will apply from 14 December 2019 onwards, repealing Directive 2000/29/EC. In line with the principles of the above mentioned legislation and the follow-up work of the secondary legislation for the listing of EU regulated pests, EFSA is requested to provide pest categorisations of the harmful organisms included in the annexes of Directive 2000/29/EC, in the cases where recent pest risk assessment/pest categorisation is not available.

1.1.2. Terms of reference

EFSA is requested, pursuant to Article 22(5.b) and Article 29(1) of Regulation (EC) No 178/2002,[3] to provide scientific opinion in the field of plant health.

EFSA is requested to prepare and deliver a pest categorisation (step 1 analysis) for each of the regulated pests included in the appendices of the annex to this mandate. The methodology and template of pest categorisation have already been developed in past mandates for the organisms listed in Annex II Part A Section II of Directive 2000/29/EC. The same methodology and outcome is expected for this work as well.

The list of the harmful organisms included in the annex to this mandate comprises 133 harmful organisms or groups. A pest categorisation is expected for these 133 pests or groups and the delivery of the work would be stepwise at regular intervals through the year as detailed below. First priority covers the harmful organisms included in Appendix 1, comprising pests from Annex II Part A Section I and Annex II Part B of Directive 2000/29/EC. The delivery of all pest categorisations for the pests included in Appendix 1 is June 2018. The second priority is the pests included in Appendix 2, comprising the group of *Cicadellidae* (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), the group of *Tephritidae* (non-EU), the group of potato viruses and virus-like organisms, the group of viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L., *Rubus* L. and *Vitis* L., and the group of *Margarodes* (non-EU species). The delivery of all pest categorisations for the pests included in Appendix 2 is end 2019. The pests included in Appendix 3 cover pests of Annex I part A section I and all pest categorisations should be delivered by end 2020.

For the above-mentioned groups, each covering a large number of pests, the pest categorisation will be performed for the group and not the individual harmful organisms listed under "such as" notation in the Annexes of the Directive 2000/29/EC. The criteria to be taken particularly under consideration for these cases, is the analysis of host pest combination, investigation of pathways, the damages occurring and the relevant impact.

Finally, as indicated in the text above, all references to 'non-European' should be avoided and replaced by 'non-EU' and refer to all territories with exception of the Union territories as defined in Article 1 point 3 of Regulation (EU) 2016/2031.

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[1] Council Directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community. OJ L 169/1, 10.7.2000, p. 1–112.

[2] Regulation (EU) 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants. OJ L 317, 23.11.2016, p. 4–104.

[3] Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. OJ L 31/1, 1.2.2002, p. 1–24.

1.1.2.1. Terms of Reference: Appendix 1

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

Annex IIAI

(a) Insects, mites and nematodes, at all stages of their development

Aleurocanthus spp.
Anthonomus bisignifer (Schenkling)
Anthonomus signatus (Say)
Aschistonyx eppoi Inouye
Carposina niponensis Walsingham
Enarmonia packardi (Zeller)
Enarmonia prunivora Walsh
Grapholita inopinata Heinrich
Hishomonus phycitis
Leucaspis japonica Ckll.
Listronotus bonariensis (Kuschel)
Numonia pyrivorella (Matsumura)
Oligonychus perditus Pritchard and Baker
Pissodes spp. (non-EU)
Scirtothrips aurantii Faure
Scirtothrips citri (Moultex)
Scolytidae spp. (non-EU)
Scrobipalpopsis solanivora Povolny
Tachypterellus quadrigibbus Say
Toxoptera citricida Kirk.
Unaspis citri Comstock

(b) Bacteria

Citrus variegated chlorosis
Erwinia stewartii (Smith) Dye
Xanthomonas campestris pv. *oryzae* (Ishiyama) Dye and pv. *oryzicola* (Fang. et al.) Dye

(c) Fungi

Alternaria alternata (Fr.) Keissler (non-EU pathogenic isolates)
Anisogramma anomala (Peck) E. Müller
Apiosporina morbosa (Schwein.) v. Arx
Ceratocystis virescens (Davidson) Moreau
Cercoseptoria pini-densiflorae (Hori and Nambu) Deighton
Cercospora angolensis Carv. and Mendes
Elsinoe spp. Bitanc. and Jenk. Mendes
Fusarium oxysporum f. sp. *albedinis* (Kilian and Maire) Gordon
Guignardia piricola (Nosa) Yamamoto
Puccinia pittieriana Hennings
Stegophora ulmea (Schweinitz: Fries) Sydow & Sydow
Venturia nashicola Tanaka and Yamamoto

(d) Virus and virus-like organisms

Beet curly top virus (non-EU isolates)
Black raspberry latent virus
Blight and blight-like
Cadang-Cadang viroid
Citrus tristeza virus (non-EU isolates)
Leprosis
Little cherry pathogen (non- EU isolates)
Naturally spreading psorosis
Palm lethal yellowing mycoplasm
Satsuma dwarf virus
Tatter leaf virus
Witches' broom (MLO)

Annex IIB

(a) Insect mites and nematodes, at all stages of their development

Anthonomus grandis (Boh.)
Cephalcia lariciphila (Klug)
Dendroctonus micans Kugelan
Gilphinia hercyniae (Hartig)
Gonipterus scutellatus Gyll.
Ips amitinus Eichhof
Ips cembrae Heer
Ips duplicatus Sahlberg
Ips sexdentatus Börner
Ips typographus Heer
Sternochetus mangiferae Fabricius

(b) Bacteria

Curtobacterium flaccumfaciens pv. flaccumfaciens (Hedges) Collins and Jones

(c) Fungi

Glomerella gossypii Edgerton
Gremmeniella abietina (Lag.) Morelet
Hypoxylon mammatum (Wahl.) J. Miller

1.1.2.2. Terms of Reference: Appendix 2

List of harmful organisms for which pest categorisation is requested per group. The list below follows the categorisation included in the annexes of Directive 2000/29/EC.

Annex IAI

(a) Insects, mites and nematodes, at all stages of their development

Group of Cicadellidae (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), such as:

1) *Carneocephala fulgida* Nottingham
2) *Draeculacephala minerva* Ball
3) *Graphocephala atropunctata* (Signoret)

Group of Tephritidae (non-EU) such as:

1) *Anastrepha fraterculus* (Wiedemann)
2) *Anastrepha ludens* (Loew)
3) *Anastrepha obliqua* Macquart
4) *Anastrepha suspensa* (Loew)
5) *Dacus ciliatus* Loew
6) *Dacus curcurbitae* Coquillet
7) *Dacus dorsalis* Hendel
8) *Dacus tryoni* (Froggatt)
9) *Dacus tsuneonis* Miyake
10) *Dacus zonatus* Saund.
11) *Epochra canadensis* (Loew)
12) *Pardalaspis cyanescens* Bezzi
13) *Pardalaspis quinaria* Bezzi
14) *Pterandrus rosa* (Karsch)
15) *Rhacochlaena japonica* Ito
16) *Rhagoletis completa* Cresson
17) *Rhagoletis fausta* (Osten-Sacken)
18) *Rhagoletis indifferens* Curran
19) *Rhagoletis mendax* Curran
20) *Rhagoletis pomonella* Walsh
21) *Rhagoletis suavis* (Loew)

(c) Viruses and virus-like organisms

Group of potato viruses and virus-like organisms such as:

1) Andean potato latent virus
2) Andean potato mottle virus
3) Arracacha virus B, oca strain
4) Potato black ringspot virus
5) Potato virus T
6) non-EU isolates of potato viruses A, M, S, V, X and Y (including Yo, Yn and Yc) and Potato leafroll virus

Group of viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L., *Rubus* L. and *Vitis* L., such as:

1) Blueberry leaf mottle virus
2) Cherry rasp leaf virus (American)
3) Peach mosaic virus (American)
4) Peach phony rickettsia
5) Peach rosette mosaic virus
6) Peach rosette mycoplasm
7) Peach X-disease mycoplasm
8) Peach yellows mycoplasm
9) Plum line pattern virus (American)
10) Raspberry leaf curl virus (American)
11) Strawberry witches' broom mycoplasma
12) Non-EU viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L., *Rubus* L. and *Vitis* L.

Annex IIAI

(a) Insects, mites and nematodes, at all stages of their development

Group of *Margarodes* (non-EU species) such as:

1) *Margarodes vitis* (Phillipi)
2) *Margarodes vredendalensis* de Klerk
3) *Margarodes prieskaensis* Jakubski

1.1.2.3. Terms of Reference: Appendix 3

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

Annex IAI

(a) Insects, mites and nematodes, at all stages of their development

Acleris spp. (non-EU)
Amauromyza maculosa (Malloch)
Anomala orientalis Waterhouse
Arrhenodes minutus Drury
Choristoneura spp. (non-EU)
Conotrachelus nenuphar (Herbst)
Dendrolimus sibiricus Tschetverikov
Diabrotica barberi Smith and Lawrence
Diabrotica undecimpunctata howardi Barber
Diabrotica undecimpunctata undecimpunctata Mannerheim
Diabrotica virgifera zeae Krysan & Smith
Diaphorina citri Kuway
Heliothis zea (Boddie)
Hirschmanniella spp., other than *Hirschmanniella gracilis* (de Man) Luc and Goodey
Liriomyza sativae Blanchard
Longidorus diadecturus Eveleigh and Allen
Monochamus spp. (non-EU)
Myndus crudus Van Duzee
Nacobbus aberrans (Thorne) Thorne and Allen
Naupactus leucoloma Boheman
Premnotrypes spp. (non-EU)
Pseudopityophthorus minutissimus (Zimmermann)
Pseudopityophthorus pruinosus (Eichhoff)
Scaphoideus luteolus (Van Duzee)
Spodoptera eridania (Cramer)
Spodoptera frugiperda (Smith)
Spodoptera litura (Fabricus)
Thrips palmi Karny
Xiphinema americanum Cobb sensu lato (non-EU populations)
Xiphinema californicum Lamberti and Bleve-Zacheo

(b) Fungi

Ceratocystis fagacearum (Bretz) Hunt
Chrysomyxa arctostaphyli Dietel
Cronartium spp. (non-EU)
Endocronartium spp. (non-EU)
Guignardia laricina (Saw.) Yamamoto and Ito
Gymnosporangium spp. (non-EU)
Inonotus weirii (Murril) Kotlaba and Pouzar
Melampsora farlowii (Arthur) Davis
Mycosphaerella larici-leptolepis Ito et al.
Mycosphaerella populorum G. E. Thompson
Phoma andina Turkensteen
Phyllosticta solitaria Ell. and Ev.
Septoria lycopersici Speg. var. *malagutii* Ciccarone and Boerema
Thecaphora solani Barrus
Trechispora brinkmannii (Bresad.) Rogers

(c) Viruses and virus-like organisms

Tobacco ringspot virus
Tomato ringspot virus
Bean golden mosaic virus
Cowpea mild mottle virus
Lettuce infectious yellows virus
Pepper mild tigré virus
Squash leaf curl virus
Euphorbia mosaic virus
Florida tomato virus

(d) Parasitic plants

Arceuthobium spp. (non-EU)

Annex IAII

(a) Insects, mites and nematodes, at all stages of their development

Meloidogyne fallax Karssen

Popillia japonica Newman

Rhizoecus hibisci Kawai and Takagi

(b) Bacteria

Clavibacter michiganensis (Smith) Davis et al. ssp. *sepedonicus* (Spieckermann and Kotthoff) Davis et al.

Ralstonia solanacearum (Smith) Yabuuchi et al.

(c) Fungi

Melampsora medusae Thümen

Synchytrium endobioticum (Schilbersky) Percival

Annex I B

(a) Insects, mites and nematodes, at all stages of their development

Leptinotarsa decemlineata Say

Liriomyza bryoniae (Kaltenbach)

(b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

1.2. Interpretation of the Terms of Reference

The terms of reference (ToR) (Section 1.1.2.3) lists seven viruses transmitted by *Bemisia tabaci*. Following the adoption of Regulation (EU) 2016/2031[4] on 14 December 2019 and the Commission Implementing Regulation (EU) 2019/2072 for the listing of EU regulated pests, the Plant Health Panel interpreted the original request (ToR in Section 1.1.2) as a request to provide pest categorisations for the pests in the Annexes of Commission Implementing Regulation (EU) 2019/2072[5]. This Implementing Regulation takes account of the full pest risk assessment of *Bemisia tabaci* and the viruses it transmits (EFSA PLH Panel, 2013).

Following clarification received from the European Commission, the Plant Health Panel is requested to do a pest categorisation of tomato leaf curl New Delhi virus (ToLCNDV), i.e. determine whether it fulfils the criteria of a quarantine pest or those of a regulated non-quarantine pest for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores.

Additional viruses named ToLCNDV 2, 4 and 5 are reported; according to the International Committee on Taxonomy of Viruses (ICTV, online), these are distinct species from ToLCNDV and they are therefore not further addressed in this pest categorisation.

[4] Regulation (EU) 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants, amending Regulations (EU) No 228/2013, (EU) No 652/2014 and (EU) No 1143/2014 of the European Parliament and of the Council and repealing Council Directives 69/464/EEC, 74/647/EEC, 93/85/EEC, 98/57/EC, 2000/29/EC, 2006/91/EC and 2007/33/EC.

[5] Commission Implementing Regulation (EU) 2019/2072 of 28 November 2019 establishing uniform conditions for the implementation of Regulation (EU) 2016/2031 of the European Parliament and the Council, as regards protective measures against pests of plants, and repealing Commission Regulation (EC) No 690/2008 and amending Commission Implementing Regulation (EU) 2018/2019.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on tomato leaf curl New Delhi virus was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name of the pest as search term. Relevant papers were reviewed, and further references and information were obtained from experts, as well as from citations within the references and grey literature.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the European and Mediterranean Plant Protection Organization (EPPO) Global Database (EPPO, online) and relevant publications.

Data about the import of commodity types that could potentially provide a pathway for the pest to enter the EU and about the area of hosts grown in the EU were obtained from EUROSTAT (Statistical Office of the European Communities).

The Europhyt database was consulted for pest-specific notifications on interceptions and outbreaks. Europhyt is a web-based network run by the Directorate General for Health and Food Safety (DG SANTÉ) of the European Commission, and is a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. The Europhyt database manages notifications of interceptions of plants or plant products that do not comply with EU legislation, as well as notifications of plant pests detected in the territory of the Member States (MS) and the phytosanitary measures taken to eradicate or avoid their spread.

2.2. Methodologies

The Panel performed the pest categorisation for tomato leaf curl New Delhi virus, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018) and in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

This work was initiated following an evaluation of the EU plant health regime. Therefore, to facilitate the decision-making process, in the conclusions of the pest categorisation, the Panel addresses explicitly each criterion for a Union quarantine pest and for a Union regulated non-quarantine pest (RNQP) in accordance with Regulation (EU) 2016/2031 on protective measures against pests of plants, and includes additional information required in accordance with the specific ToRs received by the European Commission. In addition, for each conclusion, the Panel provides a short description of its associated uncertainty.

Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. All relevant criteria have to be met for the pest to potentially qualify either as a quarantine pest or as a RNQP. If one of the criteria is not met, the pest will not qualify. A pest that does not qualify as a quarantine pest may still qualify as an RNQP that needs to be addressed in the opinion. For the pests regulated in the protected zones only, the scope of the categorisation is the territory of the protected zone; thus, the criteria refer to the protected zone instead of the EU territory.

It should be noted that the Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, the Panel will present a summary of the observed pest impacts. Economic impacts are expressed in terms of yield and quality losses and not in monetary terms, whereas addressing social impacts is outside the remit of the Panel.

Table 1: Pest categorisation criteria under evaluation, as defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Identity of the pest (Section 3.1)	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?
Absence/presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? Describe the pest distribution briefly!	Is the pest present in the EU territory? If not, it cannot be a protected zone quarantine organism	Is the pest present in the EU territory? If not, it cannot be an RNQP. (A regulated non-quarantine pest must be present in the risk assessment area)
Regulatory status (Section 3.3)	If the pest is present in the EU but not widely distributed in the risk assessment area, it should be under official control or expected to be under official control in the near future	The protected zone system aligns with the pest-free area system under the International Plant Protection Convention (IPPC) The pest satisfies the IPPC definition of a quarantine pest that is not present in the risk assessment area (i.e. protected zone)	Is the pest regulated as a quarantine pest? If currently regulated as a quarantine pest, are there grounds to consider its status could be revoked?
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in and spread within the EU territory? If yes, briefly list the pathways!	Is the pest able to enter into, become established in, and spread within, the protected zone areas? Is entry by natural spread from EU areas where the pest is present possible?	Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects? Clearly state if plants for planting is the main pathway!
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?	Would the pests' introduction have an economic or environmental impact on the protected zone areas?	Does the presence of the pest on plants for planting have an economic impact as regards the intended use of those plants for planting?
Available measures (Section 3.6)	Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?	Are there measures available to prevent the entry into, establishment within or spread of the pest within the protected zone areas such that the risk becomes mitigated? Is it possible to eradicate the pest in a restricted area within 24 months (or a period longer than 24 months where the biology of the organism so justifies) after the presence of the pest was confirmed in the protected zone?	Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA above for consideration as potential protected zone quarantine pest were met, and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential RNQP were met, and (2) if not, which one(s) were not met

The Panel will not indicate in its conclusions of the pest categorisation whether to continue the risk assessment process, but following the agreed two-step approach, will continue only if requested by the risk managers. However, during the categorisation process, experts may identify key elements and knowledge gaps that could contribute significant uncertainty to a future assessment of risk. It would be useful to identify and highlight such gaps so that potential future requests can specifically target the major elements of uncertainty, perhaps suggesting specific scenarios to examine.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible? (Yes or No)

Yes. The identity of tomato leaf curl New Delhi virus is well established.

Tomato leaf curl New Delhi virus (ToLCNDV) is a distinct virus species of the genus *Begomovirus* in the family *Geminiviridae*. Like all geminiviruses, viruses in this genus have unique twinned quasi-isometric particles encapsidating a single-stranded, circular, covalently closed DNA genome. The genera in the family *Geminiviridae* differ by genome organisation features and by their insect vectors. Begomoviruses are uniquely transmitted by *Bemisia tabaci* (Gennadius) whiteflies.

Begomoviruses can have either monopartite genomes or, like ToLCNDV, bipartite genomes consisting of two genome components, DNA A and DNA B, of approximately 2,700/2,600 nt in size, respectively. For taxonomy, the complete DNA A component (the entire genome for monopartite begomoviruses) is analysed to discriminate virus species having < 90% pairwise nucleotide identity with other members of the genus (Brown et al., 2015). Recombinations involving genome sequences of other begomoviruses or sequences of unknown origin occur frequently in this genus and are also evident in DNA A components of ToLCNDV isolates (Moriones et al., 2017). The taxonomic status of these recombinants is determined from the relatedness to the parental virus(es) and from putatively altered biological properties.

A number of complete ToLCNDV genomes are available to back the taxonomic status of this virus. An analysis of 285 complete DNA A sequences available at GenBank/NCBI (accessed March 2020) showed that the majority of ToLCNDV DNA A genomes share > 90% identical sequences. There are a few DNA A genome sequences at NCBI/Genbank beyond the species demarcation threshold and those may represent separate begomovirus species (Fortes et al., 2016). Nevertheless, while the sequence identity threshold set for begomoviruses follows comprehensible rules to identify and discriminate viruses, for particular isolates just below this threshold, biological properties of the isolate, i.e. pathogenicity, host range etc., would be crucial to justify their distinction as separate species. Despite some uncertainties about the ambiguous status of such divergent isolates, ToLCNDV is a well-established virus species, for which identity and taxonomic status are clear.

ToLCNDV is a bipartite begomovirus and only requires its two genome components DNA A and DNA B for plant infection and vector transmission. However, so-called satellite molecules being approx. half of the genome size of begomoviruses (ca. 1300 nt) have also been reported from ToLCNDV-diseased plants (Sivalingam and Varma, 2008, 2012). Those so-called alpha- and beta-satellites are not autonomous and rely on a helper virus for their replication and maintenance. They are mostly associated with monopartite begomoviruses and occur most frequently in Asia (China, India, Pakistan…) and in Africa. These satellites may not be specific for a virus, but can be associated with different viruses providing helper functions. Definite functions are not yet assigned to alphasatellites, but betasatellites can play key roles in begomovirus infections, increasing the expression of symptoms and severity, and contributing to plant defences repression and virus movement (Zhou, 2013; Gnanasekaran et al., 2019). Enhanced virus symptoms depend on the virus/satellite complex and on the particular host plant. Thus, the same betasatellite may enhance disease symptoms in one host but not in another (Kon et al., 2009; Zhou, 2013).

Overall, ToLCNDV is a well-characterised viral species. Its EPPO code[6] (Griessinger and Roy, 2015; EPPO, 2019) is TOLCND (EPPO, online).

3.1.2. Biology of the pest

ToLCNDV is transmitted by the whitefly *Bemisia tabaci*, a complex of cryptic species and a very efficient insect vector endemic in tropical and subtropical regions and in the Mediterranean Basin. It also occurs as transient populations in Northern regions of Europe under protected cultivation. The insect itself is a major threat to crops grown in open fields and under protected cultivation (EFSA PLH Panel, 2013). *Bemisia tabaci* transmits begomoviruses in a circulative persistent manner meaning that once the virus is acquired from an infected source plant, the insect stays viruliferous and able to transmit the virus throughout its lifespan. While the virus does not reproduce in *B. tabaci*, even in temporary absence of host plants, the virus can be maintained as the insect remains viruliferous during its whole life.

In nature, *B. tabaci* is responsible for ToLCNDV transmission and spread. Climatic conditions, warm temperatures and fluctuating humidity and environments with production of homogenous agricultural/horticultural crops favour large populations of whiteflies. The polyphagous nature of the *B. tabaci* MEAM1 (Middle East-Asia Minor 1) and MED (Mediterranean) species (Boykin et al., 2012; Lee et al., 2013), now prevalent throughout the world, and ToLCNDV with its broad host range favour virus spread and establishment in areas favourable for the insect vector. The polyphagous insect may create mixed virus infections of multiple begomoviruses and can also transmit satellite molecules that can be associated with ToLCNDV or with other begomoviruses.

ToLCNDV does not require satellite molecules for disease induction; no satellites are known to be specifically associated with the virus, but TolCNDV can provide helper function by transreplicating and even encapsidating satellites, so that complex infections are maintained. Experiments with ToLCNDV and the cotton leaf curl Multan betasatellite (CLCuMB) have shown that only ToLCNDV DNA A is required in interaction with CLCuMB to cause symptoms in tomato, while infections with ToLCNDV DNA A, DNA B and CLCuMB result in more severe symptoms than ToLCNDV single infections, with higher virus concentrations and whitefly transmissibility of the complex (Sivalingam and Varma, 2008, 2012; Saeed, 2010). Infectivity assays with ToLCNDV and chili leaf curl betasatellite (ChLCB) also proved that interactions of the betasatellite with the bipartite begomovirus can enhance symptoms (Akhter et al., 2014). This was also seen in natural infections of tomato with TolCNDV DNA A and ChLB (Agnihotri et al., 2018). Complex viral infections were reported from *Cucurbita pepo* in Pakistan involving ToLCNDV, the cucurbit yellow mosaic alphasatellite (CYMA) and the papaya leaf curl betasatellite (Anwar, 2017) and in *Luffa cylindrica*, where ToLCNDV was found associated with ageratum conyzoides symptomless alphasatellite and CLCuMB (Anwar et al., 2020). While different outcomes can be observed depending on the host and a particular satellite, currently available data suggest that there is a significant probability that the presence of betasatellites may result in more severe diseases. Recently, the cotton leaf curl gezira betasatellite (CLCuGB) was found associated with Tomato yellow leaf curl virus (TYLCV) infections in Israel and spreading with the virus (Gelbart et al., 2020). Infection studies with this virus/satellite combination showed that symptoms were expressed in *Ty*-1-resistant tomatoes and, by confirming earlier evidence (Conflon et al., 2018), proved that resistance can at least partly be compromised by the synergism provided by the satellite. The polyphagous *B. tabaci* vector-transmitting ToLCNDV has a broad host range and can create diverse virus and satellite mixes with a multitude of partners. So far, satellites associated with ToLCNDV were only reported from India and

[6] An EPPO code, formerly known as a Bayer code, is a unique identifier linked to the name of a plant or plant pest important in agriculture and plant protection. Codes are based on genus and species names. However, if a scientific name is changed, the EPPO code remains the same. This provides a harmonised system to facilitate the management of plant and pest names in computerised databases, as well as data exchange between IT systems.

Pakistan, where more diverse ToLCNDV isolates have been reported from crops like cotton, okra or luffa. In contrast, European ToLCNDV isolates are genetically uniform, forming a distinct cluster from the more diverse ToLCNDV isolates occurring outside the EU (see Section 3.1.3). In Europe, ToLCNDV diseases are not associated with satellites and none of these dispensable molecules have ever been reported in Europe (Moriones et al., 2017; Bertin et al., 2018).

ToLCNDV is mechanically transmitted using sap of infected plants through wounding. While this is efficient under experimental conditions, virus mechanical transmission from plant injury during crop management, e.g. pruning and deleafing, remains a possibility, but is likely ineffective. ToLCNDV is propagated with scions and cuttings used for vegetative propagation or grafting.

While seed transmissibility of begomoviruses is a recurring debate (Kil et al., 2016; Kothandaraman et al., 2016; Pérez-Padilla et al., 2020), seed transmission was reported for a distinct isolate of ToLCNDV found in chayote (*Sechium edule* L.) in Tamil Nadu, India (Sangeetha et al., 2018), and was recently reported for ToLCNDV in zucchini squash from Italy (Kil et al., 2020). Seeds germinating from leftover fruits that had fallen in the previous year developed into virus-infected seedlings and provided evidence that seed transmission can occur. Experimental results confirmed these observations. ToLCNDV was never found in commercial seed lots because of certified production processes, the use of healthy plants for seed production, seed health testing and treatment. ToLCNDV can reach high concentrations in infected plants and it is likely that ToLCNDV infections occur during germination from virus contaminations in/at the seed coat. Thus, ToLCNDV infections of seedlings may arise from contaminated seeds and while this is not very likely in commercial production processes, this mode of transmission exists for ToLCNDV. Vector transmission by *B. tabaci* is a major component for spread of ToLCNDV in nature.

3.1.3. Intraspecific diversity

The species demarcation threshold for begomoviruses is < 90% DNA A (full-length component) nucleotide sequence identity. Begomoviruses isolates having < 94% identity are considered strains. The genome diversity of ToLCNDV world isolates is not shaped by host plant association or year of sampling, and thus, there are no particular phylogenetic groups separating origin. Recombination is frequent in begomovirus genomes and is favoured by whitefly-mediated mixed infections. The diversity created can eventually result in the emergence of new isolates with original disease phenotypes, host switches or host range expansions (Garcia-Andres et al., 2006; Lefeuvre et al., 2007; Lefeuvre and Moriones, 2015). Recombination involves the exchange of genetic material with other virus strains/species or a replacement of viral sequences with sequences of unknown origin. Indeed, recombination events have been found in a number of ToLCNDV isolates resulting in genome diversity at the strain level and grouping world isolates of ToLCNDV in strains (< 94% nt identity) (Moriones et al., 2017). ToLCNDV isolates from Spain are quite distinct from the nearest ToLCNDV sequences from India and Pakistan and the strain ToLCNDV-ES was therefore proposed (Fortes et al., 2016; Ruíz et al., 2017). ToLCNDV-ES isolates are also the result of recombination (Fortes et al., 2016). While infective to tomato (Ruíz et al., 2017), TolCNDV-ES appears poorly adapted to this host; in contrast, it very efficiently infects *Cucurbitaceae* like squash, melon and pumpkin. To date, all TolCNDV-ES isolates are genetically uniform (> 99% identity) (Juárez et al., 2019) and all ToLCNDV isolates from Italy, Tunisia and Morocco have been shown to belong to ToLCNDV-ES (Panno et al., 2019), indicating a common origin and recent introduction and spread within Europe of this unique strain. The genetic uniformity of the European isolates may explain their preference and adaptation to *Cucurbitaceae* hosts. This particular ToLCNDV-ES strain has not been reported so far outside the Mediterranean Basin and is distinct from all other ToLCNDV isolates that have been found on diverse crops and wild plants outside Europe.

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, molecular methods (polymerase chain reaction, PCR...) are available for the detection and identification of ToLCNDV. Similarly, molecular tests using generic primers for alpha and beta satellites, as well as Rolling-Circle Amplification (RCA) and sequencing are available for the detection and identification of satellites that can be associated with ToLCNDV.

Most plants respond to begomovirus infections with pronounced symptoms on leaves and the entire plant. From its name, ToLCNDV causes leaf curl symptoms on tomato and a range of yellowing, spotting, yellow mottling, leaf deformation and stunting on other host plants (*Cucurbitaceae*, other crops and weeds). The symptoms can be indicative of infection by begomoviruses but are not informative because plants can be infected with diverse begomoviruses and respond with indistinguishable symptoms. In addition, tomato is particularly susceptible to begomoviruses, being affected by more than 100 begomovirus species including tomato yellow leaf curl virus(es) occurring worldwide (EFSA PLH Panel, 2014). For ToLCNDV, commercial ELISA tests (AGDIA, DSMZ) and a molecular test based on LAMP (Enbiotech srl) provide robust virus detection (Panno et al., 2019). Molecular tests based on PCR or RCA of circular genomes followed by sequencing provide effective virus detection and identification in virus surveys and disease monitoring (Figàs et al., 2017). Similarly, for detection of satellites that can be associated with ToLCNDV disease, molecular tests using generic primers for alpha and beta satellites, as well as RCA and sequencing are available for their unambiguous identification (Zaidi et al., 2016).

Diagnostic methods are available for the detection and identification of ToLCNDV. No specific assay is available for the detection of the ES strain, but the strain can be identified by sequencing of PCR or RCA products.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

As shown in Figure 1, ToLCNDV is reported in Algeria, Morocco and Tunisia, as well as in the Seychelles and several Asian countries (Bangladesh, India, Indonesia, Iran, Pakistan, Philippines, Sri Lanka, Taiwan and Thailand).

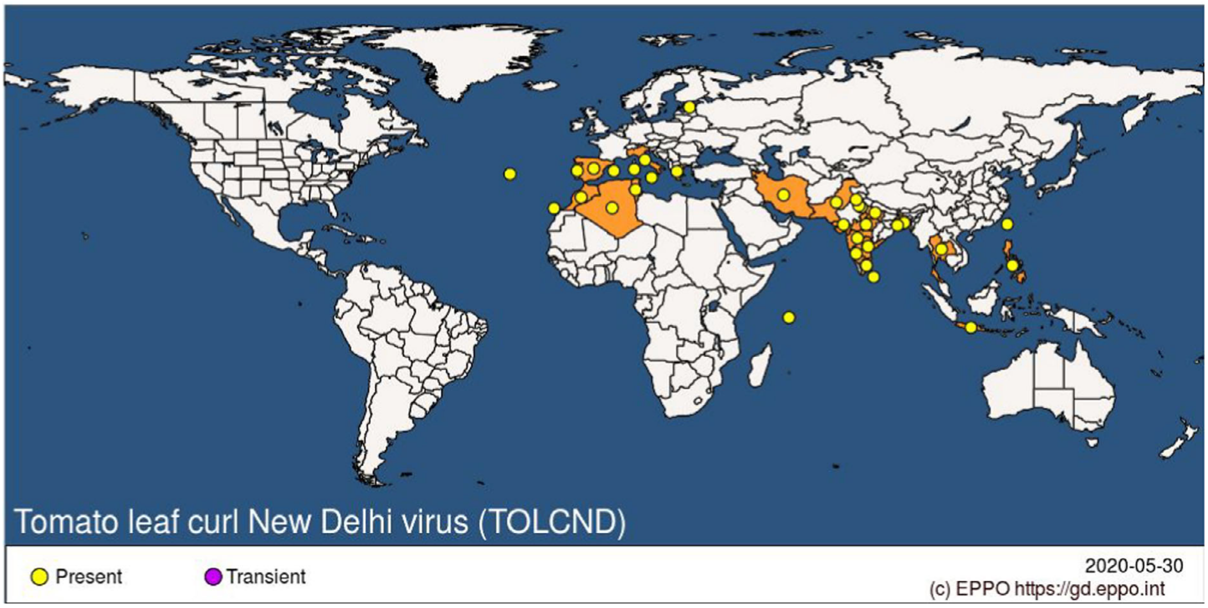

Figure 1: Global distribution map for ToLCND (extracted from the EPPO Global Database; last update 28/5/2020; last access on 4/6/2020)

3.2.2. Pest distribution in the EU

Source: EPPO GD.

Is the pest present in the EU territory? If present, is the pest widely distributed within the EU?

Yes, ToLCNDV is present, mostly in the south of Europe. The presence and the prevalence of the pest could be greater in some countries than currently reported in the EPPO Global Database

ToLCNDV is reported in the EU with a limited distribution (Table 2). ToLCNDV is listed in Annex IIB of Commission Implementing Regulation 2019/2072 (Section 3.3.1) and is therefore under official control, i.e. the pest has to be eradicated immediately if detected. However, the Panel notices the frequent report of outbreaks in Spain since 2013 (Table 3), and information from the literature suggesting that it might be more widespread in open field and in the environment than officially reported (Juárez et al., 2019; Panno et al., 2019).

Table 2: Current distribution of ToLCNDV in the EU based on the information of the EPPO Global Database (last update 9/3/2020; last access on 11/5/2020)

Country	Status	Details	References
Estonia	Present, restricted distribution	1st record in 2019; 2 glasshouses producing tomatoes and cucumbers (0.1 ha each); under eradication	NPPO of Estonia
Greece	Present, few occurrences	First found in one location in a cucurbit crop in October 2018 in the region of Elias; confirmed in *Cucurbita pepo* crops in the Ileia and Messinia regions	Orfanidou et al. (2019), Roditakis and Pappi (2018)
Italy	Present, restricted distribution	Found in 2015 on *Cucurbita pepo* in Sicilia, in 2016 on *C. pepo* in Sardegna. First found on the mainland in 2016 (Campania), in 2016/2017 in Lazio on C. pepo, and in 2020 in Campania on *Solanum melongena*	Bertin et al. (2018), Luigi et al. (2016), Panno et al. (2016), Parrella et al. (2018, 2020)
Portugal	Present, few occurrences	First found in July 2019 on *Cucurbita pepo* in a greenhouse located in the Algarve region and in Azores again on *C. pepo*	NPPO of Portugal
Spain	Present, restricted distribution	First observed in September 2012 on *Cucurbita pepo* in the province of Murcia In autumn 2013, the disease was widespread on C. pepo both in Murcia and Almería, and the virus was also detected in melon and cucumber crops, as well as in greenhouse tomato crops First found in spring 2018 on Cucumis melo, C. pepo, and Cucurbita maxima plants showing virus symptoms in several municipalities of Gran Canaria (Islas Canarias)	Anonymous (2016), Espino de Paz et al. (2019); Font San Ambrosio and Alfaro Fernández (2015), Juárez et al. (2014), Ruíz et al. (2017)

Source: EPPO GD, accessed on 24/2/2020.

Table 3: Outbreaks of ToLCNDV in the EU (source: Europhyt outbreak database (search done on 20/3/2020)

Country	Year	Title	Infested Plant
IT	2016	New Finding (confirmed) of TOLCND in ITALY	*Cucurbita pepo*
IT	2016	New Finding (confirmed) of TOLCND in ITALY	*Cucurbita pepo*
ES	2015	New Finding (confirmed) of TOLCND in SPAIN	*Cucumis melo*
IT	2016	New Finding (confirmed) of TOLCND in ITALY	*Cucurbita pepo*
ES	2015	New Finding (confirmed) of TOLCND in SPAIN	*Cucurbita pepo*
ES	2015	New Finding (confirmed) of TOLCND in SPAIN	*Solanum lycopersicum*
ES	2014	New Finding (confirmed) of TOLCND in SPAIN	*Cucurbita pepo*
ES	2014	New Finding (confirmed) of TOLCND in SPAIN	*Cucurbita pepo*
ES	2013	New Finding (confirmed) of TOLCND in SPAIN	*Cucurbita pepo*
ES	2013	First Finding (confirmed) of TOLCND in SPAIN	*Cucurbita pepo*
GR	2018	First Finding (confirmed) of TOLCND in Greece	Not specified
EE	2019	First Presence (confirmed) of TOLCND in ESTONIA (Halinga)	1) *Solanum lycopersicum* 2) *Cucumis sativus*
PT	2019	Update no 1. Presence (confirmed) of TOLCND in PORTUGAL (Paderne)	*Cucumis melo*

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

Tomato leaf curl New Delhi virus is listed in Annex II of Commission Implementing Regulation (EU) 2019/2072, the implementing act of Regulation (EU) 2016/2031. Details are presented in Tables 4 and 5.

Table 4: ToLCNDV in Commission Implementing Regulation 2019/2072

Annex II	**List of Union quarantine pests and their respective codes**
Part B	Pests known to occur in the Union territory
	Quarantine Pests and their codes assigned by EPPO
F	Viruses, viroids and phytoplasmas
2.	Tomato leaf curl New Delhi virus (TOLCND)

3.3.2. Legislation addressing the hosts of tomato leaf curl New Delhi virus

Table 5: Regulated hosts and commodities that may involve ToLCNDV in Annexes of Commission Implementing Regulation 2019/2072

Annex VI	List of plants, plant products and other objects whose introduction into the Union from certain third countries is prohibited	
	Description	Third country, group of third countries or specific area of third country
15.	Tubers of *Solanum tuberosum* L., seed potatoes	Third countries other than Switzerland
16.	Plants for planting of stolon- or tuber-forming species of *Solanum* L. or their hybrids, other than those tubers of *Solanum tuberosum* L. as specified in entry 15	Third countries other than Switzerland
17.	Tubers of species of *Solanum* L., and their hybrids, other than those specified in entries 15 and 16	Third countries other than: (a) Algeria, Egypt, Israel, Libya, Morocco, Syria, Switzerland, Tunisia and Turkey, or (b) those which fulfil the following provisions: (i) they are one of following: Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Faeroe Islands, Georgia, Iceland, Liechtenstein, Moldova, Monaco, Montenegro, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo- Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo- Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, and Ukraine and (ii) — they are either recognized as being free from *Clavibacter sepedonicus* (Spieckermann and Kottho) Nouioui et al., in accordance with the procedure referred to in Article 107 of Regulation (EU) No 2016/2031, or — their legislation, is recognised as equivalent to the Union rules concerning protection against *Clavibacter sepedonicus* (Spieckermann and Kottho) Nouioui et al. in accordance with the procedure referred to in Article 107 of Regulation (EU) No 2016/2031 have been complied with.

18.	Plants for planting of *Solanaceae* other than seeds and the plants covered by entries 15, 16 or 17	Third countries other than: Albania, Algeria, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Egypt, Faeroe Islands, Georgia, Iceland, Israel, Jordan, Lebanon, Libya, Liechtenstein, Moldova, Monaco, Montenegro, Morocco, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo-Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Syria, Tunisia, Turkey and Ukraine	
Annex VII	List of plants, plant products and other objects, originating from third countries and the corresponding special requirements for their introduction into the Union territory		
	Plants, plant products and other objects	Origin	Special requirements
7.	Plants for planting, other than dormant plants, plants in tissue culture, seeds, bulbs, tubers, corms and rhizomes The relevant Union quarantine pests are: — Begomoviruses other than: Abutilon mosaic virus, Sweet potato leaf curl virus, Tomato yellow leaf curl virus, Tomato yellow leaf curl Sardinia virus, Tomato yellow leaf curl Malaga virus, Tomato yellow leaf curl Axarquia virus	Third countries where the relevant Union quarantine pests are known to occur a) Where *Bemisia tabaci* Genn. (non-European populations) or other vectors of the Union quarantine pests are not known to occur (b) Where *Bemisia tabaci* Genn. (non-European populations) or other vectors of the Union quarantine pests are known to occur	Official statement that no symptoms of the relevant Union quarantine pests have been observed on the plants during their complete cycle of vegetation Official statement that no symptoms of the relevant Union quarantine pests have been observed on the plants during their complete cycle of vegetation and (a) the plants originate in areas known to be free from *Bemisia tabaci* Genn. and other vectors of the Union quarantine pests or (b) the site of production has been found free from *Bemisia tabaci* Genn. and other vectors of the relevant Union quarantine pests on official inspections carried out at appropriate times to detect the pest, or (c) the plants have been subjected to an effective treatment ensuring the eradication of *Bemisia tabaci* Genn and the other vectors of the Union quarantine pests and have been found free thereof prior to export
Annex VIII	List of plants, plant products and other objects, originating in the Union territory and the corresponding special requirements for their movement within the Union territory		
	Plants, plant products and other objects		*Requirements*

15.	Plants for planting of *Cucurbitaceae* and *Solanaceae* other than seeds, originating from areas: (a) where *Bemisia tabaci* Genn. or other vectors of Tomato leaf curl New Delhi Virus are not known to occur		Official statement that: (a) the plants originate in an area known to be free from Tomato leaf curl New Delhi Virus, or (b) no symptoms of Tomato leaf curl New Delhi Virus have been observed on the plants during their complete cycle of vegetation.
	(b) where *Bemisia tabaci* Genn. or other vectors of Tomato leaf curl New Delhi Virus are known to occur		Official statement that: (a) the plants originate in an area known to be free from Tomato leaf curl New Delhi Virus, or (b) no symptoms of Tomato leaf curl New Delhi Virus have been observed on the plants during their complete cycle of vegetation, and (i) their site of production has been found free from Bemisia tabaci Genn. and other vectors of Tomato leaf curl New Delhi Virus on official inspections carried out at appropriate times to detect the pest, or (ii) the plants have been subjected to an effective treatment ensuring the eradication of Bemisia tabaci Genn and other vectors of Tomato leaf curl New Delhi Virus.
Annex X	**List of plants, plant products and other objects, to be introduced into, or moved within protected zones and corresponding special requirements for protected zones** The protected zones listed in the fourth column of the following table respectively cover one of the following: (a) the whole territory of the Member State listed; (b) the territory of the Member State listed with the exceptions specified within brackets; (c) only the part of the territory of the Member State which is specified within brackets.		
	Plants, plant products and other objects	Special requirements for protected zones	Protected zones
14.	Plants for planting of *Begonia* L., other than seeds, tubers and corms, and plants for planting of *Ajuga* L., *Crossandra* Salisb., *Dipladenia* A.DC., *Ficus* L., *Hibiscus* L., *Mandevilla* Lindl. and *Nerium oleander* L., other than seeds	Official statement that: (a) the plants originate in an area known to be free from *Bemisia tabaci* Genn. (European populations), or (b) no signs of *Bemisia tabaci* Genn. (European populations) have been observed, including on	(a) Ireland (b) Sweden (c) United Kingdom

		plants, at the place of production on official inspections carried out at least once each three weeks during the nine weeks prior to marketing, or (c) in cases where *Bemisia tabaci* Genn. (European populations) has been found at the place of production, the plants, held or produced in this place of production, have undergone an appropriate treatment to ensure freedom from *Bemisia tabaci* Genn. (European populations) and subsequently this place of production shall have been found free from *Bemisia tabaci* Genn. (European populations) as a consequence of the implementation of appropriate procedures aiming at eradicating *Bemisia tabaci* Genn. (European populations), in both official inspections carried out weekly during the three weeks prior to the movement from this place of production and in monitoring procedures throughout the said period. The last inspection of the above weekly inspections shall be carried out immediately prior to the above movement; or (d) for those plants for which there shall be evidence by their packing or their flower development or by other means that they are intended for direct sale to final consumers not involved in professional plant production, the plants have been officially inspected and found free from *Bemisia tabaci* Genn. (European populations) immediately prior to their movement.	

35.	Seeds of *Gossypium* spp.	Official statement that the seed has been acid-delinted.	(a) Greece (b) Spain (Andalucia, Catalonia, Extremadura, Murcia, Valencia)

Annex XI - List of plants, plant products and other objects subject to phytosanitary certificates and those for which such certificates are not required for their introduction into the Union territory

PART A

List of plants, plant products and other objects, as well as the respective third countries of origin or dispatch, for which, pursuant to Article 72(1) of Regulation (EU) 2016/2031 phytosanitary certificates are required for their introduction into the Union territory

Plants, plant products and other objects	Country of origin or dispatch
2. General categories	
Plants for planting, other than seeds	Third countries other than Switzerland
Root and tubercle vegetables	Third countries other than Switzerland
3. Parts of plants, other than fruits and seeds of:	
Solanum lycopersicum L. and *Solanum melongena* L.	Third countries other than Switzerland
Convolvulus L., *Ipomoea* L., *Micromeria* Benth and *Solanaceae* Juss.	Americas, Australia, New Zealand,
5. Fruits of:	
Citrus L., *Fortunella* Swingle, *Poncirus* Raf., *Microcitrus* Swingle, *Naringi* Adans., *Swinglea* Merr. and their hybrids, *Momordica* L. and *Solanaceae* Juss. *Actinidia* Lindl., *Annona* L., *Carica papaya* L., *Cydonia* Mill., *Diospyros* L., *Fragaria* L., *Malus* L., *Mangifera* L., *Passiflora* L., *Persea americana* Mill., *Prunus* L., *Psidium* L., *Pyrus* L., *Ribes* L., *Rubus* L., *Syzygium* Gaertn., *Vaccinium* L., and *Vitis* L.	Third countries other than Switzerland
7. Tubers of:	
Solanum tuberosum L.	Third countries other than Switzerland
8. Seeds of:	
Citrus L., *Fortunella* Swingle and *Poncirus* Raf., and their hybrids, *Capsicum* spp. L., *Helianthus annuus* L., *Solanum lycopersicum* L., *Medicago sativa* L., *Prunus* L., *Rubus* L., *Oryza* spp. L., *Zea mays* L., *Allium cepa* L., *Allium porrum* L., *Phaseolus cocineus* sp. L., *Phaseolus vulgaris* L.	Third countries other than Switzerland.
Solanum tuberosum L.	All third countries
10. Seeds of oil and fibre plants of:	All third countries
Glycine max (L.) Merrill	

PART B

List of the respective CN codes of plants, as well as the respective third countries of their origin or dispatch, for which, pursuant to Article 73 of Regulation (EU) 2016/2031, phytosanitary certificates are required for their introduction into the Union territory

Plants	CN code and its respective description under Council Regulation (EEC) No 2658/87	Country of origin or dispatch
All plants, within the meaning of point 1 of Article 2 of Regulation (EU) 2016/2031, other than those specified in parts A and C of this Annex	Bulbs, tubers, tuberous roots, corms, crowns and rhizomes, dormant, and chicory plants and roots, other than for planting Cut flowers and flower buds of a kind suitable for bouquets or for ornamental	Third countries other than Switzerland

	purposes, fresh Foliage, branches and other parts of plants, without flowers or flower buds, and grasses, not mosses or lichens, being goods of a kind suitable for bouquets or for ornamental purposes, fresh Cucumbers and gherkins, fresh or chilled Asparagus, celery other than celeriac, spinach, New Zealand spinach and orache spinach (garden spinach), globe artichokes, olives, pumpkins, squash and gourds (*Cucurbita* spp.), salad vegetables, (other than lettuce (*Lactuca sativa*) and chicory (*Cichorium* spp.)), chard (or white beet) and cardoons, capers, fennel and other vegetables, fresh or chilled, other than planted in a growing substrate Dried leguminous vegetables, shelled, not skinned or split, for sowing Melons, fresh or chilled Seeds and fruit, of a kind used for sowing Plants, other than for planting, and parts of plants (including seeds for sowing and fruits), fresh or chilled, not cut nor crushed or powdered	
Annex XII - List of plants, plant products and other objects for which a phytosanitary certificate is required for their introduction into a protected zone from certain third countries of origin or dispatch		
5. Seeds and fruits (bolls) of:		
Gossypium L.	Cotton seeds, for sowing:	Third countries other than Switzerland

Jasminum multiflorum, one of the ornamental plant host of ToLCNDV is listed in Annex I (as *Jasminum* L.) of Commission Implementing Regulation (EU) 2018/2019, as a high-risk plant. As such, its introduction into the EU territory is prohibited, pending risk assessment.

3.3.3. Legislation addressing the organisms that vector ToLCNDV (Commission Implementing Regulation 2019/2072)

Annex II	**List of Union quarantine pests and their respective codes**
Part A	Pests not known to occur in the Union territory
	Quarantine Pests and their codes assigned by EPPO
C	Insect and mites
18.	*Bemisia tabaci* Genn. (non-European populations) known to be vector of viruses [BEMITA]

Annex III	List of protected zones and the respective protected zone quarantine pests and their respective codes		
	Protected zone quarantine pests	EPPO code	Protected zones
C	**Insect and mites**		
1.	*Bemisia tabaci* Genn. (European populations)	BEMITA	(a) Ireland; (b) Sweden; (c) United Kingdom.

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

The natural host range of ToLCNDV counts more than 58 plant species, including important vegetable and ornamental species that belong, among others, to the *Solanaceae*, *Cucurbitaceae*, *Fabaceae* and *Malvaceae* families (Fortes et al., 2016; Nagendran et al., 2017b; Zaidi et al., 2017b; Pant et al., 2018; Venkataravanappa et al., 2018, 2019; Juárez et al., 2019; Anwar et al., 2020; Ashwathappa et al., 2020; EPPO, online).

ToLCNDV was first described from India infecting tomato (*Solanum lycopersicum*) (Padidam et al., 1995) and has its main geographic distribution in Asia, where many diverse hosts are infected and diverse virus isolates exist. Solanaceous crops such as eggplant (*Solanum melongena*), chili pepper (*Capsicum annuum*, *C. frutescens*) and potato (*Solanum tuberosum*) are severely affected. The ToLCNDV-ES strain present in Europe appears more adapted to *Curcurbitaceae* hosts. In the Mediterranean basin, ToLCNDV-ES mainly affects melon (*Cucurbita melo*, C. *melo* var. *flexuosus*), pumpkin and zucchini (*Cucurbita pepo*) and cucumber (*Cucumis sativus*) crops, and it is only sporadically reported on tomato, eggplant and sweet pepper (Fortes et al., 2016; Zaidi et al., 2017b; Juárez et al., 2019; Luigi et al., 2019; Parrella et al., 2020).

Other important/major cultivated hosts of ToLCVND, belonging to the *Cucurbitaceae* family also reported (mainly in Asia) are: *Benincasa hispida* (wax gourd), *Citrullus lanatus* (watermelon), *Cucurbita maxima* (pumpkin), *Cucurbita moschata* (musky gourd), *Cucurbita pepo* var. giromontiina (courgette), *Lagenaria siceraria* (bottle gourd), *Luffa cylindrica* (sponge gourd), *Luffa acutangula* (ridge gourd), *Momordica charantia* (bitter gourd), *Coccinia grandis* (ivy gourd), *Momordica dioica* (spine gourd) and *Sechium edule* (chayote) (Nagendran et al., 2017a; Zaidi et al., 2017b; Venkataravanappa et al., 2019; Anwar et al., 2020; EPPO, online). The virus has been also found to infect cotton (*Gossypium hirsutum* – Malvaceae) (Zaidi et al., 2016). All cultivated hosts are confirmed hosts of *B. tabaci* (EFSA PLH Panel, 2013).

In Asia, there are a few records of ToLCVND on other crops such as *Hibiscus cannabinus* (kenaf – Malvaceae), *Carica papaya* (papaya – Caricaceae), *Daucus carota* (carrot – Apiaceae), *Vigna radiata* (mung bean – Fabaceae) *Abelmoschus esculentus* (okra – Malvaceae) and *Glycine max* (soyabean – Fabaceae) (Jamil et al., 2017; Moriones et al., 2017; Zaidi et al., 2017b; Pant et al., 2018; Venkataravanappa et al., 2018; EPPO, online), while habanero pepper (*Capsicum chinense* – *Solanaceae*) was infected when challenged with viruliferous whiteflies in laboratory studies (Ruíz et al., 2017). All these hosts of ToLCNDV are also confirmed hosts of *B. tabaci* (EFSA PLH Panel, 2013; Leite et al., 2005).

Several flower/ornamental plants are also included in the host list of ToLCNDV, including *Chrysanthemum indicum, Dahlia pinnata, Tagetes erecta* (*Asteraceae*), and *Crossandra infundibuliformis* (*Acanthaceae*), *Catharanthus roseus* and *Calotropis procera* (*Apocynaceae*), *Jatropha* spp (*Euphorbiaceae*), *Jasminum multiflorum* (*Oleaceae*), *Papaver somniferum* (*Papaveraceae*), *Sauropus androgynus (*Phyllanthaceae*)* and *Cestrum nocturnum* (*Solanaceae*) (Shih et al., 2013; Zaidi et al., 2017a; Pant et al., 2018; Ashwathappa et al., 2020; EPPO, online). Plants for planting of these species that, besides *P. somniferum,* are biannual or perennial, may be subject to international trade therefore, they may constitute a pathway for the introduction and spread ToLCNDV. *Dahlia pinnata* is traded as dry bulbs and *Chrysanthemum indicum* also as cut flowers. *Chrysanthemum indicum, Dahlia pinnata, Tagetes erecta*, *Catharanthus roseus, Jasminum multiflorum, Cestrum nocturnum* and some *Jatropha* or *Sauropus* species are also verified hosts of *B. tabaci.* The species *Crossandra infundibuliformis* is only reported as unconfirmed host of *B. tabaci* (EFSA PLH Panel, 2013).

ToLCNDV infects also a number of weeds/wild species belonging to different families. Currently reported weed hosts include: *Chenopodium album* (*Amaranthaceae*), *Ageratum* spp., *Eclipta prostrata*, *Parthenium hysterophorus* and *Sonchus oleraceus* (*Asteraceae*); *Commelina benghalensis* (*Commelinaceae*); *Convolvulus arvensis* (*Convolvulaceae*); *Cucurbita foetidissima*, *Cucurbita fraterna* (*C. pepo* var. *fraterna*), *Cucurbita lundelliana*, *Cucurbita okeechobeensis and Ecballium elaterium* (*Cucurbitaceae*); *Acalypha indica, Chrozophora hierosolymitana* (syn. *Chrozophora tinctoria)* and *Euphorbia hirta* (*Euphorbiaceae*); *Phyllanthus niruri* (*Phyllanthaceae*); *Rumex dentatus* (*Polygonaceae*); *Solanum nigrum* and *Datura stramonium* (*Solanaceae*) (Zaidi et al., 2017b; Pant et al., 2018; Juárez et al., 2019; EPPO, online), that are often associated with infected crops and may play an important role in virus epidemiology as overwintering or inter-crop virus reservoirs or as hosts contributing to the virus molecular evolution (Juárez et al., 2019). *Nicotiana tabacum* (cv. Xanthi), *N. glutinosa, N. benthamiana* were proven to be experimental hosts for the ToLCND-ES strain (Fortes et al., 2016). None of the weeds/wild species reported as hosts of ToLCNDV is traded, whereas ToLCNDV has not been reported to infect *Nicotiana* spp*.* in nature. Based on the above, the Panel focused the pest categorisation on the above listed vegetable and ornamental species, as the major cultivated/natural hosts of the pest. However, it must be considered that there is uncertainty about the possible existence of additional natural hosts that have not been reported so far.

3.4.2. Entry

Is the pest able to enter into the EU territory? (Yes or No) If yes, identify and list the pathways.

Yes. The pest is able to enter the EU territory; all the pathways of entry are regulated, however, considering the number of interceptions of *B. tabaci*, there is uncertainty whether the measures in place are sufficient to prevent the entry of ToLCNDV in the EU through the *B. tabaci* pathway.

The panel identified the following pathways for the entry of ToLCNDV host plants in the EU and reviewed the existing legislation (Sections 3.3.2 and 3.3.3) applicable to these pathways:

Plants for planting (P4P) other than seeds. This important pathway of entry is either closed or regulated:

- a phytosanitary certificate is required for all third countries except Switzerland (where ToLCNDV is not known to occur) (Annex XI, part A, point 2)
- for *Cucurbitaceae* and *Solanaceae,* entry is possible only with a statement that the P4P originate from an area known to be free of ToLCNDV, or indicating that no symptoms of ToLCNDV have been observed on the plants during their complete cycle of vegetation, and, should the P4P come from an area where *B. tabaci* is known to be present, with an additional statement that their site of production has been found free from *B. tabaci* or the plants have been subjected to an effective treatment ensuring the eradication of *B. tabaci* (Annex VII, point 7 and Annex VIII, point 15)
- for seed potatoes, import from third countries is banned, except for Switzerland (Annex VI point 15). Import derogations exist for *Solanum sp*. other than *S. tuberosum* and other Solanaceous hosts (Annex VI points 16 and 18) but, because of the requirement of the above-mentioned phytosanitary certificate (Annex XI, part A, point 2), the pathway of entry is regulated.
- the introduction of cucurbits, okra, kenaf and papaya P4P is also subject to specific requirements whether originating from an area where *B. tabaci* and/or ToLCNDV is/are present (Annex VII, point 7), and a phytosanitary certificate is also required (Annex XI, part A, point 2)
- ornamental plants for planting (belonging to families other than *Solanaceae* and *Cucurbitaceae*) such as *Chrysanthemum indicum, Dahlia pinnata* (traded also as dry tubers), *Tagetes erecta, Catharanthus roseus, Calotropis procera, Crossandra infundibuliformis, Jatropha spp, Jasminum multiflorum* and *Sauropus androgynus* are subject to specific requirements whether originating from areas where *B. tabaci* and/or ToLCND is/are present (Annex VII, point 7) and a phytosanitary certificate is also required (Annex XI, part A, point 2)
- the introduction of P4P other than seeds of *Crossandra* and *Hibiscus* species in Ireland and Sweden (protected zones) is possible only with a statement that the plants are free from *B. tabaci* (Annex X, point 14).

Seeds. The pathway of entry is regulated: a phytosanitary certificate is required for all seeds and fruits, of a kind used for sowing (Annex XI, part B). In addition, the regulation:

- specifies that import of true seeds of potato is forbidden from all third countries (Annex XI, part A, point 8)
- confirms that a phytosanitary certificate is required to import seeds of *S. lycopersicum* and *Capsicum sp.* from all third countries except Switzerland (Annex XI, part A, point 8), and seeds of G*lycine max* from all third countries (Annex XI, part A, point 10)
- A specific regulation exists for the import of cotton seeds in the protected zones of Greece and Spain (Andalusia, Catalonia, Extremadura, Murcia, Valencia): the seeds should be acid-delinted (Annex X, point 35) and a phytosanitary certificate is required from all third countries except Switzerland (Annex XII, point 5)

Roots and tubercle vegetables. Infected ware potatoes, if ultimately planted instead of being consumed, could also represent an entry pathway. Import derogations exist for ware potatoes (Annex VI, point 17), but a phytosanitary certificate is required for all third countries except Switzerland (Annex XI, part A, point 7). Phytosanitary certificates are also required for other roots and tubercle vegetables (Annex XI, part A, point 2). This pathway of entry is therefore regulated.

Fruits, vegetables and leafy herbs for consumption. The pathway of entry is regulated: a phytosanitary certificate is required for all plants, other than for planting, and parts of plants (Annex XI, part B). The legislation specifies further that such certificate is required for all third countries except Switzerland for the fruits of *Solanaceae*, *Momordica* sp., watermelons and *Carica papaya* (Annex XI, part A, point 5).

Cut flowers and flower buds, foliage and branches suitable for bouquets or for ornamental purposes. The pathway of entry is regulated: a phytosanitary certificate is required for import from all third countries except Switzerland (Annex XI, part B). Foliage, branches and other parts of *S. lycopersicum* and S*. melongena*, without flowers or flower buds, as well as cut flowers and flower buds of Solanaceous hosts, suitable for bouquets or for ornamental purposes, are subject to a specific article in the legislation (Annex XI, part A, point 3 – phytosanitary certificate required).

Parts (other than fruits and seeds) of *Solanaceae* from America, Australia and New Zealand for ornamental purposes are subject to a specific article in the legislation (Annex XI, part A, point 3 – phytosanitary certificate required).

The pathway of entry is currently closed for *Jasminum multiflorum*, which is listed in Annex I (as *Jasminum* L.) of Commission Implementing Regulation (EU) 2018/2019 as a high-risk plant. As such, its introduction into the EU territory is prohibited, pending risk assessment.

Viruliferous *B. tabaci* whiteflies. *B. tabaci* is listed in Annex II of Commission Implementing Regulation 2019/2072 as a Union quarantine pest (Annex II, part A, C18); as such, its introduction in the EU territory is forbidden. The pathway of entry of *B. tabaci* whiteflies is therefore closed by regulation.

Between 2000 and 2020, there was no interception from third countries of ToLCNDV in the Europhyt database, while over 5,000 interceptions involving *B. tabaci* have been reported for the same period. There is no corresponding interception information for ToLCNDV in the Europhyt database, but the Panel notes that there is usually no testing of the viruses that might be present in these vectors. The pathways of entry for the various hosts of ToLCNDV are regulated but, as analysed by the PLH Panel of EFSA (2013), there is uncertainty whether the measures in place are sufficient to prevent the entry of ToLCNDV in the EU through the *Bemisia* pathway.

3.4.3. Establishment

Is the pest able to become established in the EU territory? (Yes or No)

Yes, ToLCNDV is already established in parts of the EU. The ecoclimatic conditions in the EU being compatible with those of its host plants, the broader establishment of the virus is only limited by the availability of *B. tabaci* to spread it.

ToLCNDV-ES is already present in open fields in several southern European countries (Figure 1, Table 2) and found in tomato, eggplant, sweet pepper and cucurbits. Other strains of ToLCNDV are not expected to differ in their ecoclimatic requirements and would therefore be able to establish in the same areas. ToLCNDV is maintained in its systemically infected plant host, as long as the host continues to develop and grow. The broad host range of the virus makes survival in the environment likely, as common weeds such as *Datura stramonium*, *Solanum nigrum* and *Sonchus oleraceus* can serve as overwintering hosts and sources of inoculum (Juárez et al., 2019). Plant infection relies on the presence of whitefly vectors; in Europe, *B. tabaci* is endemic and established in open fields in few Mediterranean regions only (Figure 2). The long-term establishment of ToLCNDV is not possible outside the areas where *B. tabaci* can potentially establish. However, *B. tabaci* can also survive and establish in protected cultivations, under greenhouse conditions in northern regions. There, transient populations of this insect may develop during warm weather periods to transfer virus from crops grown inside and vice versa.

Because of the polyphagy of the insect and the broad host range of the virus, establishment of the virus in crops and in wild plants in regions where *B. tabaci* occurs can be anticipated.

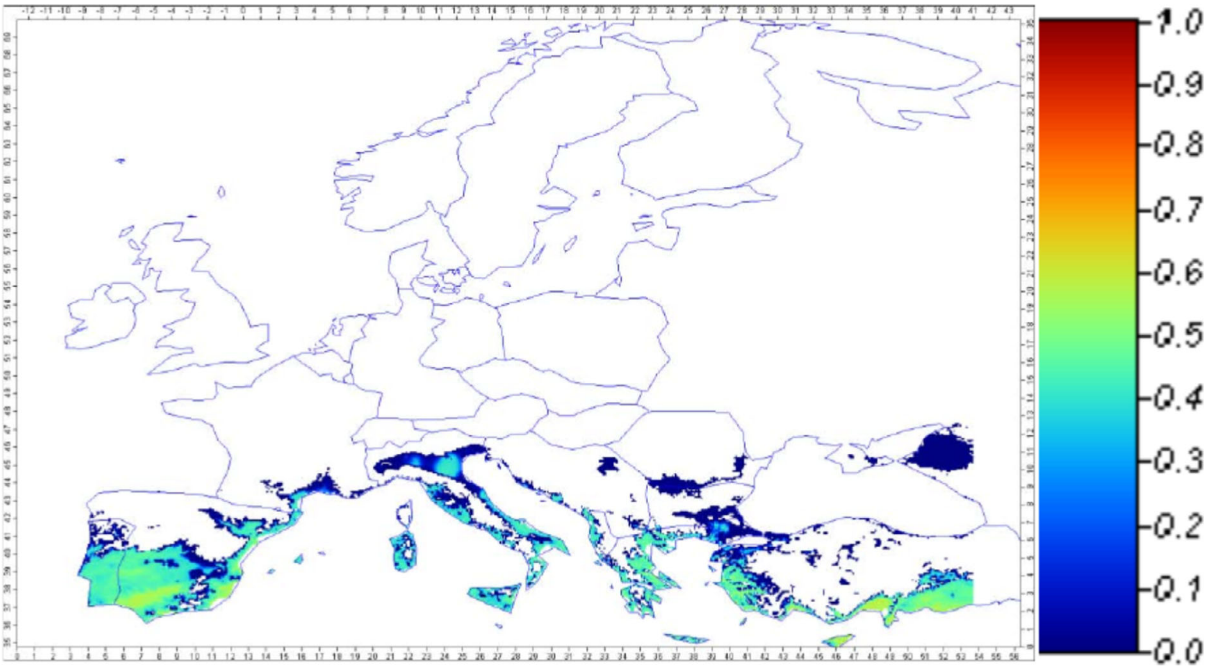

Figure 2: Distribution of the probability of virus establishment obtained considering the current temperature and climatic situation, as proposed in the scientific opinion on the risk assessment of *Bemisia tabaci* and viruses it transmits (Figure E.4, EFSA PLH Panel, 2013)

3.4.3.1. EU distribution of main host plants

ToLCNDV has a wide host range that includes cultivated and wild plant species (see Section 3.4.1). The major hosts of ToLCNDV identified in this pest categorisation are grown in the EU to the following extent (average for the years 2014–2018 – source: Eurostat, data extracted on 24/3/2020):

- Tomato: 246,000 ha, 78% of which located in countries where the pest is present
- Potato: 1,5 million ha, 11% of which located in countries where the pest is present
- Cucurbits (incl. squash, pumpkin, zucchini, gourds, cucumbers, melons and watermelons): 241,000 ha, 55% of which located in countries where the pest is present
- Eggplants: 22,000 ha, 46% of which located in countries where the pest is present
- Peppers: 57,000 ha, 51% of which located in countries where the pest is present
- Carrots: 105,500 ha, 17% of which located in countries where the pest is present

ToLCNDV has therefore the capacity to establish further in the EU territory.

3.4.3.2. Climatic conditions affecting establishment

ToLCNDV relies on its host plant for survival and remains associated with its host as long as the plant exists. The virus is spread by *B. tabaci,* either in open fields or in greenhouses; therefore, it is expected that ToLCNDV is able to establish wherever *B. tabaci* populations and its hosts are present, either in natural plant communities or cultivated crops. ToLCNDV hosts are widely cultivated in the EU and therefore the Panel considers that climatic conditions will not limit ability of ToLCNDV to establish in parts of the EU. However, the prevailing climatic conditions determine vector presence and abundance, and virus establishment in uncultivated host plants.

3.4.4. Spread

Is the pest able to spread within the EU territory following establishment?

***Yes**,* ToLCNDV is expected to be able to spread under a range of conditions in the EU.

RNQPs: Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects?

***Yes**,* Plants for planting of host plants, together with viruliferous *B. tabaci* vectors are considered the main means of long-distance spread of ToLCNDV

Bemisia tabaci is a very efficient vector of begomoviruses (one to few insects are able to cause an epidemy (EFSA PLH Panel, 2013)), and by far the most efficient means of spread of ToLCNDV on a local to regional scale. Therefore, the spread of ToLCNDV is linked to areas of *B. tabaci* presence. The high volume of intra-EU trade of the relevant commodities and the difficulty of controlling them increase the likelihood of virus spread, even to northern EU countries where ecoclimatic conditions are not suitable for *B. tabaci* in the open but where ToLCNDV outbreaks could still occur in crops grown under protected cultivation (EFSA PLH Panel, 2013). In open fields, the presence of this vector insect is limited by climatic factors, as population density and spatial distribution depend mainly on temperature and humidity. *B. tabaci* exists in the Mediterranean coastal regions of Spain, Italy, Greece, Malta, south of France, Cyprus and some parts of Portugal (EFSA PLH Panel, 2013). *B. tabaci* has been reported in Northern European countries, mostly as transient populations or from interceptions but also frequently under protected cultivation conditions. There, *B. tabaci* can occur in greenhouses only, or move outdoors when weather conditions in summer are favourable for insect populations to develop (EFSA PLH Panel, 2013); winter conditions are enough to eradicate *B. tabaci* outbreaks in north of Europe. The current distribution of ToLCNDV in open fields in Europe coincides significantly with the presence of *B. tabaci* and virus distribution is thus tightly linked to the spread potential of *B. tabaci*. In the Mediterranean coastal regions, numerous host crops and suitable environmental conditions support the spread of ToLCNDV. High adult whitefly populations visiting many plants favour the efficient spread of the virus. Long-distance spread of ToLCNDV is by transport of viruliferous *B. tabaci* and by trade of infected plants for planting, of parts of infected plants (e.g. cut flowers) and possibly of seeds. Virus transmission through seeds has been shown to be possible, but has not been reported for commercially produced seeds because of production processes. Seedling infections likely originate from virus contaminations of the seed coat and could possibly be prevented through appropriate seed treatment. ToLCNDV can also be experimentally mechanically transmitted but such transmission is only expected to be of minor significance under field conditions. Thus, mechanical and seed transmissions, while possible, are unlikely to contribute to efficient spread of ToLCNDV.

Overall, ToLCNDV is expected to be able to spread under a range of conditions in the EU. Plants for planting of host plants, together with viruliferous B*. tabaci* vectors are considered the main means of long-distance spread.

3.5. Impacts

Would the pests' introduction have an economic or environmental impact on the EU territory?

Yes, there is already impact on EU crops (cucurbits in particular) and additional impact is expected, should ToLCNDV-ES further spread to new EU areas. Should non-EU isolates of ToLCNDV be introduced and spread in the EU, additional impact is expected, with uncertainties, over the present situation.

RNQPs: Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?

Yes, the presence of ToLCNDV on plants for planting of host species would have a negative impact on their intended use.

ToLCNDV epidemics cause severe yield losses in tomato and other economically important crops such as potato, cucurbits and cotton. Symptoms of ToLCNDV infection are typical of begomoviral '*yellow leaf curl diseases*' that include chlorotic mottling, upward or downward curling and crinkling of leaves, vein clearing or thickening, puckering, purpling/darkening of leaf margins, leaf area reduction, internode shortening and severe stunting of the plants (Zaidi et al., 2017b).

On the Indian subcontinent, ToLCNDV is a very destructive epidemic virus, causing complete yield loss due to impaired fruit setting in elite tomato cultivars, especially when infected at a young age (Moriones et al., 2017; Zaidi et al., 2017b; Kumar and Kumar, 2018). In addition to tomato, this virus has been reported to be associated with the potato apical leaf curl disease characterised by a leaf crinkling, apical leaf curling and stunting accompanying by a conspicuous mosaic or chlorotic blotching of commercial potato varieties (Usharani et al., 2004). The disease can reach up to 100% infection, causing heavy yield losses by severely affecting tuber size in susceptible varieties (Chandel et al., 2010). ToLCNDV has also been associated along with several other monopartite begomoviruses, with cotton leaf curl disease, and proved to increase the pathogenicity of the causal complex of the disease consisting of the 'Burewala' strain of Cotton leaf curl Kokhran virus (CLCuKoV-Bur) and its associated recombinant form of Cotton leaf curl Multan betasatellite (CLCuMB) (Zaidi et al., 2016). On eggplant, the virus is associated with the 'eggplant yellow mosaic disease' (severe yellow mosaic and mottling of leaves) with an incidence in India of around 60–65% throughout the year (Pratap et al., 2011). The virus is also a major cause of yellow mosaic disease in sponge gourd (*Luffa cylindrica*), causing up to 100% yield losses in infected plants (Islam et al., 2011). On chrysanthemum typical begomovirus symptoms of mosaic, and a leaf curl disease (mottling and downward leaf curl, bushy appearance and bloom, reduction in flower number) were associated with the presence of ToLCNDV associated with betasatellites (Ashwathappa et al., 2020). Mixed infections of ToLCNDV with monopartite begomoviruses are common on the Indian subcontinent, resulting in most cases in enhanced symptoms and impact (Zaidi et al., 2017b).

In southern Europe (Spain, Italy, Greece) and North Africa (Tunisia, Algeria, Morocco), the virus (the ToLCNDV-ES strain) is rapidly spreading, causing a severe leaf curl disease of greenhouse and open-field cucurbit crops and severe damage in zucchini, cucumber and melon (López et al., 2015; Zaidi et al., 2017b; Panno et al., 2019). Besides the typical leaf distortion and mosaic symptoms, zucchini squash fruits are also of lower marketability due to roughness of the skin and reduced size (Panno et al., 2016). The ToLCNDV-ES strain has also been found to infrequently infect tomato and pepper (Juárez et al., 2019).

There is overall little ambiguity on the severity of the symptoms caused in many hosts by ToLCNDV, on the impact it already has on EU crops, and on the additional impact its further spread to new EU areas would cause.

Given the differences observed between the ToLCNDV-ES strain current impact in the EU and the impact of ToLCNDV in Asia, the panel concludes that, should non-EU isolates enter and spread in the EU, no additional risk to the cucurbit crops would be expected but an increased impact on EU tomato crops and some other hosts such as eggplant, potato and cotton could be expected, with uncertainties. This would also be expected, should ToLCNDV isolates and associated betasatellites not present in the EU be introduced and spread. This could compromise the resistance of tomato against TYLCV, and increase symptoms in other hosts.

3.6. Availability and limits of mitigation measures

Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?

YES, measures are already in place (see section 3.3) and additional measures could be implemented to further regulate the identified pathways or to limit entry, establishment, spread or impact

RNQPs: Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?

YES, measures are already in place (see section 3.3) and additional measures could be implemented to further prevent pest presence on plants for planting

3.6.1. Identification of additional measures

3.6.1.1. Additional control measures

Potential additional control measures are listed in Table 6.

Table 6: Selected control measures (a full list is available in EFSA PLH Panel, 2018) for pest entry/establishment/spread/impact in relation to currently unregulated hosts and pathways. Control measures are measures that have a direct effect on pest abundance

Information sheet title (with hyperlink to information sheet if available)	Control measure summary	Risk component (entry/establishment/spread/impact)
Growing plants in isolation	While growing all host crops under isolation is not feasible, producing plants for planting in protected nurseries such as in glass or plastic greenhouses or screenhouses to protect them against *B. tabaci* vector populations could be envisioned to prevent their contamination	Spread and impact
Chemical treatments on consignments or during processing	Insecticide treatment of plants for planting of host crops consignments to reduce or eliminate *B. tabaci* vector populations	Entry and spread
Roguing and pruning	Roguing is defined as the removal of infested plants and/or uninfested host plants in a delimited area, whereas pruning is defined as the removal of infested plant parts only, without affecting the viability of the plant Roguing may reduce the number of infected plants and slow down epidemics, in particular when applied in nurseries producing plants for planting of the host crops. Pruning is not expected to have any effect since the pathogen is systemic	Spread and impact
Crop rotation, associations and density, weed/volunteer control	Crop rotation, associations and planting density, weed/volunteer control are all partial effect option that are expected to have limited effects alone but can be part of IPM (Integrated Pest Management) strategies	Spread and impact
Timing of planting and harvesting	Modulating the time of planting of crops away from *B. tabaci* vector populations flight activity periods can be part of IPM (Integrated Pest Management) strategies	Spread and impact
Chemical treatments on crops including reproductive material	Chemical control of the *B. tabaci* vector populations	Spread and impact
Use of resistant and tolerant plant species/varieties	ToLCNDV has a wide host range and there is a very limited availability of resistant varieties in many host species. However, varieties offering at least some level of protection seem available for some species. In tomato, some lines with the Ty-2 and Ty-3 genes showed lower disease incidence to ToLCNDV (Prasanna et al., 2015; Akhtar et al., 2019). Some *C. maxima* varieties show delay in symptoms expression and resistance/tolerance (mild or no symptoms and low virus load) has also been identified in *C. moschata* accessions (Sáez et al., 2016). A monogenic resistance has been reported in a breeding line of sponge gourd (Islam et al., 2011) while in melon, five accessions were found to be resistant to ToLCNDV (Romay et al., 2019). In potato, the Indian cultivar Kufri Bahar is reported tolerant to the disease (Jeevalatha et al., 2017). Breeding efforts are ongoing and this option is seen as a major strategy over the long run, while its current applicability is still extremely limited	Impact
Biological control and behavioural manipulation	Biological control of the *B. tabaci* vector populations can be used as part of a global IPM control strategy	Spread and impact

Information sheet title (with hyperlink to information sheet if available)	Control measure summary	Risk component (entry/ establishment/ spread/impact)
Post-entry quarantine and other restrictions of movement in the importing country	Relevant commodities are plants and plant parts that may carry ToLCNDV, either as infection or infestation of viruliferous *B. tabaci*.	Entry and establishment

3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 7.

Table 7: Selected supporting measures (a full list is available in EFSA PLH Panel, 2018) in relation to currently unregulated hosts and pathways. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance

Information sheet title (with hyperlink to information sheet if available)	Supporting measure summary	Risk component (entry/ establishment/ spread/impact)
Inspection and trapping	Inspection is defined as the official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (ISPM 5) Inspections apply both to the observation of ToLCNDV symptoms and to the observation of *B. tabaci*. The effectiveness of inspections may be enhanced, in the case of *B. tabaci*, by including trapping techniques	Entry and spread
Laboratory testing	Examination, other than visual, to determine if ToLCNDV is present using available diagnostic protocols	Entry and spread
Certified and approved premises	Mandatory/voluntary certification/approval of premises is a process including a set of procedures and of actions implemented by producers, conditioners and traders contributing to ensure the phytosanitary compliance of consignments. It can be a part of a larger system maintained by a National Plant Protection Organization in order to guarantee the fulfilment of plant health requirements of plants and plant products intended for trade. Key property of certified or approved premises is the traceability of activities and tasks (and their components) inherent the pursued phytosanitary objective. Traceability aims to provide access to all trustful pieces of information that may help to prove the compliance of consignments with phytosanitary requirements of importing countries	Entry and spread
Sampling	According to ISPM 31, it is usually not feasible to inspect entire consignments, so phytosanitary inspection is performed mainly on samples obtained from a consignment. It is noted that the sampling concepts presented in this standard may also apply to other phytosanitary procedures, notably selection of units for testing For inspection, testing and/or surveillance purposes the sample may be taken according to a statistically based or a non-statistical sampling methodology	Entry and spread
Phytosanitary certificate and plant passport	An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (ISPM 5)	Entry and spread

Information sheet title (with hyperlink to information sheet if available)	Supporting measure summary	Risk component (entry/ establishment/ spread/impact)
	a) export certificate (import) b) plant passport (EU internal trade)	
Certification of reproductive material (voluntary/official)	–	Entry and spread
Surveillance	Official surveillance may contribute to early detection of ToLCNDV, favouring immediate adoption of control measures if it came to establish in new areas or if novel isolates with different biological properties came to establish	Establishment and spread

3.6.1.3. Biological or technical factors limiting the effectiveness of measures to prevent the entry, establishment and spread of the pest

- In some hosts, symptoms may be confused with those caused by other begomoviruses;
- Asymptomatic phase of virus infection which renders visual detection unreliable;
- Wide host range including some common weed species;
- Difficulties to control *B. tabaci* vector populations.

3.6.1.4. Biological or technical factors limiting the ability to prevent the presence of the pest on plants for planting

- In some hosts, symptoms may be confused with those caused by other begomoviruses;
- Asymptomatic phase of virus infection which renders visual detection unreliable;
- Wide host range including some common weed species;
- Difficulties to control *B. tabaci* vector populations.

3.7. Uncertainty

The main areas of uncertainty affecting the present categorisation concern:

- Biological information
  - Role of satellites in natural infections with ToLCNDV and on the outcome of infections
  - Host range with regard to the different intraspecies (i.e. strains) levels or in association with satellites
  - Seed transmission
- Distribution and prevalence of ToLCNDV in the EU
- Magnitude of the impact under EU conditions, particularly on hosts different from cucurbits

The specific uncertainties identified during the categorisation process are reported in the conclusion table below.

4. Conclusions

ToLCNDV meets all the criteria evaluated by EFSA to qualify as a Union quarantine pest (Table 8). The strongest uncertainties concern its distribution and prevalence and whether it can be considered as having a limited distribution in the EU. Conversely, ToLCNDV does not meet the criterion of being widespread in the EU to qualify as an RNQP.

Should new data show that ToLCNDV is widespread in the EU, there still are isolates outside the EU that (1) are not present in the EU and (2) could cause additional damage over the present situation, should they be introduced. The possibility would exist for these isolates to qualify as QP while, similar to the situation with TYLCV (Commission Implementing Regulation (EU) 2019/2072), the possibility would exist for ToLCNDV EU isolates (ToLNCDV-ES) to qualify as RNQP.

Table 8: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Identity of the pests (Section 3.1)	The identity of ToLCNDV is established and diagnostic techniques are available	The identity of ToLCNDV is established and diagnostic techniques are available	No uncertainty
Absence/ presence of the pest in the EU territory (Section 3.2)	ToLCNDV has been reported from several MSs (Spain, Italy, Portugal, Greece, Estonia) but with limited distribution	ToLCNDV has been reported from several MSs (Spain, Italy, Portugal, Greece, Estonia) but with limited distribution	Uncertainty as to whether ToLCNDV can still be considered as having a limited distribution in some EU Member States
Regulatory status (Section 3.3)	ToLCNDV is regulated under Commission Implementing Regulation (EU) 2019/2072	ToLCNDV is regulated under Commission Implementing Regulation (EU) 2019/2072. Should a more complete or later (re)evaluation of the situation conclude that ToLCNDV is too widespread its QP status could be revoked	No uncertainty
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	ToLCNDV is able to further enter, become established and spread in the EU. The main pathways identified are plants for planting of host species, in particular cucurbits, infected commodities (fruits...) from host species, viruliferous *B. tabaci* vectors and possibly seeds of some host species	Plants for planting constitute the main mean of spread for ToLCNDV	Host range and seed transmission of ToLCNDV Trade volumes for the identified pathways
Potential for consequences in the EU territory (Section 3.5)	Further introduction and spread of ToLCNDV would have additional negative impact on EU crops, in particular cucurbit crops In addition, introduction and spread of non-EU isolates could lead to additional impact on a range of crops, in particular Solanaceous ones	The presence of ToLCNDV on plants for planting of host species would have a negative impact on their intended use	Magnitude of the impact of ToLCNDV under EU conditions Magnitude of the additional impact caused by isolates not currently present in the EU, should they be introduced
Available measures (Section 3.6)	Phytosanitary measures are available to reduce the likelihood of entry and spread in the EU	Certification of planting materials of susceptible hosts is an efficient method against long distance spread	No uncertainty
Conclusion on pest categorisation (Section 4)	ToLCNDV meets all the criteria evaluated by EFSA to qualify as potential Union quarantine pest. Should a more complete or later evaluation of the situation conclude that ToLCNDV is too widespread to justify a QP status, there exists outside the EU isolates that (1) are not present in the EU and (2) could cause additional damage over the present situation	ToLCNDV does not meet one of the criteria evaluated by EFSA: it is considered to have a limited distribution in the EU. Should a more complete or later evaluation of the situation conclude that ToLCNDV is too widespread to justify a QP status, the possibility would exist for ToLCNDV to qualify as RNQP	Uncertainty as to whether ToLCNDV can still be considered as having limited distribution in some EU Member States

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
	should they be introduced. The possibility would therefore exist for these isolates to qualify as QP, while similar to the situation with TYLCV, the possibility would exist for ToLCNDV EU isolates to qualify as RNQP		
Aspects of assessment to focus on/ scenarios to address in future if appropriate	The main knowledge gaps or uncertainties identified concern: - More widespread and higher prevalence than reported in the EU; - Biology (host range, seed transmission); - Magnitude of additional impact under EU conditions. A more detailed appraisal of the distribution and prevalence of ToLCNDV could reduce the uncertainties and allow a better evaluation of its eligibility as a QP or as an RNQP		

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Abbreviations

EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
MS	Member State
PLH	EFSA Panel on Plant Health
PZ	Protected Zone
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 1995, 2017)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 1995, 2017)
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 2017)

Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2017)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2017)
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2017)
Measures	Control (of a pest) is defined in ISPM 5 (FAO 2017) as 'Suppression, containment or eradication of a pest population' (FAO, 1995). Control measures are measures that have a direct effect on pest abundance. Supporting measures are organisational measures or procedures supporting the choice of appropriate Risk Reduction Options that do not directly affect pest abundance
Pathway	Any means that allows the entry or spread of a pest (FAO, 2017)
Phytosanitary measures	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 2017)
Protected zones (PZ)	A Protected zone is an area recognised at EU level to be free from a harmful organism, which is established in one or more other parts of the Union
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2017)
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO, 2017)
Risk reduction option (RRO)	A measure acting on pest introduction and/or pest spread and/or the magnitude of the biological impact of the pest should the pest be present. A RRO may become a phytosanitary measure, action or procedure according to the decision of the risk manager
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO, 2017)