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SCIENTIFIC OPINION

Scientific Opinion on the pest categorisation of *Tomato yellow leaf curl virus* and related viruses causing tomato yellow leaf curl disease in Europe[1]

EFSA Panel on Plant Health (PLH)[2,3]

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ABSTRACT

The Panel on Plant Health performed for the European Union (EU) territory a pest categorisation of *Tomato yellow leaf curl virus* (TYLCV) and three related viruses, *Tomato yellow leaf curl Sardinia virus* (TYLCSV), *Tomato yellow leaf curl Axarquia virus* (TYLCAxV) and *Tomato yellow leaf curl Malaga virus* (TYLCMaV), which collectively cause the tomato yellow leaf curl disease (TYLCD) in Europe. The viruses are well-defined species of the genus *Begomovirus*, are exclusively transmitted by members of the *Bemisia tabaci* species complex and have tomato, as well as a few other crops or weeds, as their hosts. TYLCV is listed on tomato plants for planting, other than seeds, in Annex IIAII of Directive 2000/29/EC. While establishment and local spread rely on the *Bemisia* vector, the viruses can also be disseminated over long distances by movement of infected plants for planting or by consignments of non-host plants carrying viruliferous whiteflies. Establishment outdoors and spread are limited to regions with ecoclimatic conditions suitable for the establishment of vector populations in the open. Outbreaks can nevertheless occur in other regions under protected cultivation conditions. Because of the very high potential impact of TYLCD, tomato production in affected regions requires intensive crop management efforts to reduce impact. TYLCV appears to be present in almost all EU regions with suitable ecoclimatic conditions for its establishment in open fields, while the other three viruses do not appear to have reached their full establishment potential. All four viruses are absent from other regions of the EU but have the potential to cause temporary outbreaks there.

KEY WORDS

Tomato yellow leaf curl virus complex, *Tomato yellow leaf curl Sardinia virus*, *Tomato yellow leaf curl Axarquia virus*, *Tomato yellow leaf curl Malaga virus*, *Bemisia tabaci*, whitefly transmission

[1] On request from the European Commission, Question No EFSA-Q-2014-00287, adopted on 25 September 2014.

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The current European Union plant health regime is established by Council Directive 2000/29/EC 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, 10.7.2000, p. 1).

The Directive lays down, amongst others, the technical phytosanitary provisions to be met by plants and plant products 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, the list of harmful organisms whose introduction into or spread within the Union is prohibited and the control measures to be carried out at the outer border of the Union on arrival of plants and plant products.

The Commission is currently carrying out a revision of the regulatory status of organisms listed in the Annexes of Directive 2000/29/EC. This revision targets mainly organisms which are already locally present in the EU territory and that in many cases are regulated in the EU since a long time. Therefore it is considered to be appropriate to evaluate whether these organisms still deserve to remain regulated under Council Directive 2000/29/EC, or whether, if appropriate, they should be regulated in the context of the marketing of plant propagation material, or be deregulated. The revision of the regulatory status of these organisms is also in line with the outcome of the recent evaluation of the EU Plant Health Regime, which called for a modernisation of the system through more focus on prevention and better risk targeting (prioritisation).

In order to carry out this evaluation, a recent pest risk analysis is needed which takes into account the latest scientific and technical knowledge on these organisms, including data on their agronomic and environmental impact, as well as their present distribution in the EU territory. In this context, EFSA has already been asked to prepare risk assessments for some organisms listed in Annex IIAII. The current request concerns 23 additional organisms listed in Annex II, Part A, Section II as well as five organisms listed in Annex I, Part A, Section I, one listed in Annex I, Part A, Section II and nine organisms listed in Annex II, Part A, Section I of Council Directive 2000/29/EC. The organisms in question are the following:

Organisms listed in Annex II, Part A, Section II:

- *Ditylenchus destructor* Thorne
- *Circulifer haematoceps*
- *Circulifer tenellus*
- *Helicoverpa armigera* (Hübner)
- *Radopholus similis* (Cobb) Thorne (could be addressed together with the IIAI organism *Radopholus citrophilus* Huettel, Dickson and Kaplan)
- *Paysandisia archon* (Burmeister)
- *Clavibacter michiganensis* spp. *insidiosus* (McCulloch) Davis *et al*.
- *Erwinia amylovora* (Burr.) Winsl. *et al*. (also listed in Annex IIB)
- *Pseudomonas syringae* pv. *persicae* (Prunier *et al*.) Young *et al*.
- *Xanthomonas campestris* pv. *phaseoli* (Smith) Dye
- *Xanthomonas campestris* pv. *pruni* (Smith) Dye
- *Xylophilus ampelinus* (Panagopoulos) Willems *et al*.
- *Ceratocystis fimbriata* f. sp. *platani* Walter (also listed in Annex IIB)
- *Cryphonectria parasitica* (Murrill) Barr (also listed in Annex IIB)
- *Phoma tracheiphila* (Petri) Kanchaveli and Gikashvili
- *Verticillium albo-atrum* Reinke and Berthold
- *Verticillium dahliae* Klebahn
- *Beet leaf curl virus*
- *Citrus tristeza virus* (European isolates) (also listed in Annex IIB)
- Grapevine flavescence dorée MLO (also listed in Annex IIB)

- Potato stolbur mycoplasma
- *Spiroplasma citri* Saglio *et al*.
- Tomato yellow leaf curl virus

Organisms listed in Annex I, Part A, Section I:

- *Rhagoletis cingulata* (Loew)
- *Rhagoletis ribicola* Doane
- *Strawberry vein banding virus*
- Strawberry latent C virus
- Elm phloem necrosis mycoplasm

Organisms listed in Annex I, Part A, Section II:

- *Spodoptera littoralis* (Boisd.)

Organisms listed in Annex II, Part A, Section I:

- *Aculops fuchsiae* Keifer
- *Aonidiella citrina* Coquillet
- *Prunus necrotic ringspot virus*
- *Cherry leafroll virus*
- *Radopholus citrophilus* Huettel, Dickson and Kaplan (could be addressed together with IIAII organism *Radopholus similis* (Cobb) Thorne)
- *Scirtothrips dorsalis* Hendel
- *Atropellis* spp.
- *Eotetranychus lewisi* McGregor
- *Diaporthe vaccinii* Shaer.

TERMS OF REFERENCE AS PROVIDED BY THE EUROPEAN COMMISSION

EFSA is requested, pursuant to Article 29(1) and Article 22(5) of Regulation (EC) No 178/2002, to provide a pest risk assessment of *Ditylenchus destructor* Thorne, *Circulifer haematoceps*, *Circulifer tenellus*, *Helicoverpa armigera* (Hübner), *Radopholus similis* (Cobb) Thorne, *Paysandisia archon* (Burmeister), *Clavibacter michiganensis* spp. *insidiosus* (McCulloch) Davis *et al*., *Erwinia amylovora* (Burr.) Winsl. *et al*., *Pseudomonas syringae pv*. *persicae* (Prunier *et al.)* Young *et al*. *Xanthomonas campestris* pv. *phaseoli* (Smith) Dye, *Xanthomonas campestris* pv. *pruni* (Smith) Dye, *Xyîophilus ampelinus* (Panagopoulos) Willems *et al*., *Ceratocystis fimbriata* f. sp. *platani* Walter, *Cryphonectria parasitica* (Murrill) Barr, *Phoma tracheiphila* (Petri) Kanchaveli and Gikashvili, *Verticillium albo-atrum* Reinke and Berthold, *Verticillium dahliae* Klebahn, Beet leaf curl virus, Citrus tristeza virus (European isolates), Grapevine flavescence dorée MLO, Potato stolbur mycoplasma, *Spiroplasma citri* Saglio *et al*., Tomato yellow leaf curl virus, *Rhagoletis cingulata* (Loew), *Rhagoletis ribicola* Doane, Strawberry vein banding virus, Strawberry latent C virus, Elm phloem necrosis mycoplasma, *Spodoptera littoralis* (Boisd.), *Aculops fuchsiae* Keifer, *Aonidiella citrina* Coquillet, Prunus necrotic ringspot virus, Cherry leafroll virus, *Radopholus citrophilus* Huettel Dickson and Kaplan (to address with the IIAII *Radopholus similis* (Cobb) Thorne), *Scirtothrips dorsalis* Hendel, *Atropellis* spp., *Eotetranychus lewisi* McGregor and *Diaporthe vaccinii* Shaer., for the EU territory.

In line with the experience gained with the previous two batches of pest risk assessments of organisms listed in Annex II, Part A, Section II, requested to EFSA, and in order to further streamline the preparation of risk assessments for regulated pests, the work should be split in two stages, each with a specific output. EFSA is requested to prepare and deliver first a pest categorisation for each of these 38 regulated pests (step 1). Upon receipt and analysis of this output, the Commission will inform EFSA for which organisms it is necessary to complete the pest risk assessment, to identify risk reduction options and to provide an assessment of the effectiveness of current EU phytosanitary requirements (step 2). *Clavibacter michiganensis* spp. *michiganensis* (Smith) Davis *et al*. and *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye, from the second batch of risk assessment requests for Annex IIAII organisms requested to EFSA (ARES(2012)880155), could be used as pilot cases for this approach, given that the working group for the preparation of their pest risk assessments has been constituted and it is currently dealing with the step 1 "pest categorisation". This proposed modification of previous request would allow a rapid delivery by EFSA by May 2014 of the first two outputs for step 1 "pest categorisation", that could be used as pilot case for this request and obtain a prompt feedback on its fitness for purpose from the risk manager's point of view.

As indicated in previous requests of risk assessments for regulated pests, in order to target its level of detail to the needs of the risk manager, and thereby to rationalise the resources used for their preparation and to speed up their delivery, for the preparation of the pest categorisations EFSA is requested, in order to define the potential for establishment, spread and impact in the risk assessment area, to concentrate in particular on the analysis of the present distribution of the organism in comparison with the distribution of the main hosts and on the analysis of the observed impacts of the organism in the risk assessment area.

ASSESSMENT

1. Introduction

1.1. Purpose

This document presents a pest categorisation prepared by the EFSA Scientific Panel on Plant Health (hereinafter referred to as the Panel) for the species *Tomato yellow leaf curl virus* (TYLCV) in response to a request from the European Commission.

1.2. Scope

The risk assessment area is the territory of the European Union (hereinafter referred to as the EU) with 28 Member States (hereinafter referred to as MSs), restricted to the area of application of Council Directive 2000/29/EC.

The pest risk assessment focuses on TYLCV *sensu stricto* and on related viruses present in Europe. TYLCV was initially considered as a single virus species with several related strains, however research over the past years has provided a better understanding of the diversity of this virus which consequently changed TYLCV taxonomy. Thus, TYLCV in Europe to date comprises, in addition to TYLCV itself (formerly TYLCV-Israel), further three unique species: *Tomato yellow leaf curl Sardinia virus* (TYLCSV), *Tomato yellow leaf curl Axarquia virus* (TYLCAxV) and *Tomato yellow leaf curl Malaga virus* (TYLCMaV). All four viruses have unique and distinguishable genomes but have highly similar biological properties. They are present in Europe and cause the indistinguishable leaf curl disease in tomato. In the present opinion, and unless specifically mentioned, *Tomato yellow leaf curl virus* and TYLCV will be used *sensu lato*, to encompass the four viruses causing the tomato yellow leaf curl disease in Europe. The *Tomato yellow leaf curl New Delhi virus* recently discovered in Spain in 2013 (Juárez et al., 2014) is a clearly distinct agent and is not addressed in the present pest categorisation.

2. Methodology and data

2.1. Methodology

The Panel performed the pest categorisation for TYLCV following guiding principles and steps presented in the EFSA Guidance on a harmonised framework for pest risk assessment (EFSA PLH Panel, 2010) and as defined in the International Standards for Phytosanitary Measures (ISPM) No 11 (FAO, 2013) and ISPM No 21 (FAO, 2004).

In accordance with the Guidance on a harmonised framework for pest risk assessment in the EU (EFSA PLH Panel, 2010), this work is initiated as result of the review or revision of phytosanitary policies and priorities. As explained in the background of the European Commission request, the objective of this mandate is to provide updated scientific advice to the European risk managers for their evaluation of whether these organisms listed in the Annexes of the Directive 2000/29/EC still deserve to remain regulated under Council Directive 2000/29/EC, or whether they should be regulated in the context of the marketing of plant propagation material, or be deregulated. Therefore, to facilitate the decision making process, in the conclusions of the pest categorisation, the Panel addresses explicitly each criterion for quarantine pest according to ISPM 11 (FAO, 2013) but also for regulated non-quarantine pest according to ISPM 21 (FAO, 2004) and includes additional information required as per the specific terms of reference received by the European Commission. In addition, for each conclusion the Panel provides a short description of its associated uncertainty.

Table 1 presents the ISPM 11 (FAO, 2013) and ISPM 21 (FAO, 2004) pest categorisation criteria against which the Panel provides its conclusions. It should be noted that the Panel's conclusions are formulated respecting its remit and particularly with regards to the principle of separation between risk

assessment and risk management (EFSA founding regulation[4]), 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, in agreement with the Guidance on a harmonised framework for pest risk assessment (EFSA PLH Panel, 2010).

Table 1: International Standards for Phytosanitary Measures ISPM 11 (FAO, 2013) and ISPM 21 (FAO, 2004) pest categorisation criteria under evaluation

Pest categorisation criteria	ISPM 11 for being a potential quarantine pest	ISPM 21 for being a potential regulated non-quarantine pest
Identity of the pest	The identity of the pest should be clearly defined to ensure that the assessment is being performed on a distinct organism, and that biological and other information used in the assessment is relevant to the organism in question. If this is not possible because the causal agent of particular symptoms has not yet been fully identified, then it should have been shown to produce consistent symptoms and to be transmissible	The identity of the pest is clearly defined
Presence (ISPM 11) or absence (ISPM 21) in the PRA area	The pest should be **absent from all or a defined part of the PRA area**	The pest is **present** in the PRA area
Regulatory status	If the pest is present but not widely distributed in the PRA area, it should be under official control or expected to be under official control in the near future	The pest is under official control (or being considered for official control) in the PRA area with respect to the specified plants for planting
Potential for establishment and spread in the PRA area	The PRA area should have ecological/climatic conditions including those in protected conditions suitable for the establishment and spread of the pest and, where relevant, host species (or near relatives), alternate hosts and vectors should be present in the PRA area	–
Association of the pest with the plants for planting and the effect on their intended use	–	Plants for planting are a pathway for introduction and spread of this pest
Potential for consequences (including environmental consequences) in the PRA area	There should be clear indications that the pest is likely to have an unacceptable economic impact (including environmental impact) in the PRA area	–

[4] 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.

Pest categorisation criteria	ISPM 11 for being a potential quarantine pest	ISPM 21 for being a potential regulated non-quarantine pest
Indication of impact(s) of the pest on the intended use of the plants for planting	–	The pest may cause severe economic impact on the intended use of the plants for planting
Conclusion	If it has been determined that the pest has the potential to be a quarantine pest, the PRA process should continue. If a pest does not fulfil all of the criteria for a quarantine pest, the PRA process for that pest may stop. In the absence of sufficient information, the uncertainties should be identified and the PRA process should continue	If a pest does not fulfil all the criteria for an regulated non-quarantine pest, the PRA process may stop

In addition, in order to reply to the specific questions listed in the terms of reference, three issues are specifically discussed only for pests already present in the EU: the analysis of the present EU distribution of the organism in comparison with the EU distribution of the main hosts, the analysis of the observed impacts of the organism in the EU and the pest control and cultural measures currently implemented in the EU.

The Panel will not indicate in its conclusions of the pest categorisation whether to continue the risk assessment process as it is clearly stated in the terms of reference that at the end the pest categorisation the European Commission will indicate if further risk assessment work is required following their analysis of the Panel's scientific opinion.

2.2. Data

2.2.1. Literature search

A literature search on TYLCV was conducted at the beginning of the mandate. The search was conducted for the scientific name of the pest together with the most frequently used common names on the ISI Web of Knowledge database. Further references and information were obtained from experts, from citations within the references as well as from grey literature

2.2.2. Data collection

To complement the information concerning the current situation of the pest provided by the literature and online databases on pest distribution, damage and management, the PLH Panel sent a short questionnaire on the current situation at country level, based on the information available in the European and Mediterranean Plant Protection Organization (EPPO) Plant Quarantine Retrieval (PQR) system, to the National Plant Protection Organisation (NPPO) contacts of the 28 EU MSs, and of Iceland and Norway. Iceland and Norway are part of the European Free Trade Association (EFTA) and are contributing to EFSA data collection activities, as part of the agreements EFSA has with these two countries. A summary of the pest status based on EPPO PQR and NPPO replies is presented in Table 2.

Information on distribution of the main host plants were obtained from the EUROSTAT database.

3. Pest categorisation

3.1. Identity and biology of *Tomato yellow leaf curl virus*

3.1.1. Taxonomy

Tomato yellow leaf curl virus (TYLCV) was first discovered in Israel in the late 1930s and later described as a whitefly-transmitted virus in 1964 (Cohen and Harpaz, 1964). TYLCV from Israel (Navot et al., 1991) and TYLCV from Sardinia (Kheyr-Pour et al., 1991) were then described as strains of a whitefly-transmitted virus of the genus *Begomovirus* in the family *Geminiviridae* (Brown et al., 2012). The virus genome is monopartite, single-stranded DNA and is encapsidated in virus particles with typical twinned quasi-isometric morphology (Brown et al., 2012). The genus *Begomovirus* is consistently growing, with new species regularly discovered and added. The taxonomy of this genus takes into account the sequence of the entire DNA genome, with a nucleotide identity level of less than 89 % considered as a demarcation criterion for distinct virus species (Brown et al., 2012). Because intraspecific and interspecific recombination is frequent, the taxonomic status of viral recombinants is determined from the relatedness to the parental viruses, the frequency and extent of recombination events and the biological properties compared with those of the parental viruses. Species identification also considers, among others, natural host range and symptomatology, but these criteria are mostly used for virus strains (Brown et al., 2012). Because of the significance of TYLCV and of related begomoviruses, there is abundant genome information available, clarifying the taxonomic status of TYLCV and of related species, strains and isolates and providing for a clear demarcation of species (Brown et al., 2012).

According to the current taxonomy, TYLCV-IL is now considered the type strain of the TYLCV species, while TYLCV-Sardinia is now considered a separate virus species, with the name *Tomato yellow leaf curl Sardinia virus* (TYLCSV). From studies in Europe to resolve TYLCV populations in disease outbreaks, recombinants between TYLCV and TYLCSV were identified and from the complete genomes analysed, two additional viruses, *Tomato yellow leaf curl Malaga virus* (TYLCMaV) (Monci et al., 2002) and *Tomato yellow leaf curl Axarquia virus* (TYLCAxV) (Garcia-Andres et al., 2006), are acknowledged as distinct virus species (Brown et al., 2012).

Phylogenetic analysis of TYLCV *sensu stricto* separated two clades, one formed by TYLCV-IL and one comprising the strain TYLCV-Mld (Lefeuvre et al., 2007a). Notwithstanding, yellow leaf curl viruses and their geographic strains cannot be distinguished by symptoms produced in tomato and it is generally considered that all four viruses have largely similar biological properties and cause an indistinguishable leaf curl disease in tomato. They are collectively addressed in this opinion and, unless specifically mentioned, *Tomato yellow leaf curl virus* and TYLCV will be used *sensu lato*, to encompass the four viruses causing the tomato yellow leaf curl disease (TYLCD) in Europe.

3.1.2. Biology of *Tomato yellow leaf curl virus*

TYLCV is the archetype of similar viruses causing TYLCD, a very serious threat to tomato production in tropical and subtropical regions worldwide. TYLCV is considered one of the top 10 most serious plant viruses (Scholthof et al., 2011). Like all other begomoviruses, TYLCV is exclusively transmitted by insects of the *Bemisia tabaci* species complex (Boykin et al., 2007; De Barro et al., 2011) and its significance is directly linked to the worldwide emergence of *B. tabaci* as a major pest (EFSA PLH Panel, 2013).

TYLCV is not mechanically transmitted and nor is it seed or pollen transmitted. Because of its systemic infections in plants, it is transmitted by vegetative propagation of infected host plants and by grafting of infected scions or rootstocks. As a consequence, TYLCV spread in nature is essentially the result of vector transmission, and establishment and spread of TYLCV is essentially sympatric with that of its *B. tabaci* vector. Long-distance spread of the virus can also occur through trade of infected tomato seedlings for planting.

3.1.3. Intraspecific and interspecific diversity

While leaf curl diseases in tomato are also caused by other begomoviruses, the monopartite tomato yellow leaf curl viruses comprise more than 15 distinct virus species (EFSA PLH Panel, 2013), with a growing number of new species identified. The unique genome replication strategy of geminiviruses facilitates intra- or interspecific recombination, thus generating further diversity (Jeske et al., 2001; Preiss and Jeske, 2003). As a consequence, recombination plays a significant role in the evolution of these viruses and this eventually results in the emergence of new disease phenotypes (Melgarejo, 2011; Kon and Gilbertson, 2012). Therefore, it is not surprising that recombinant begomoviruses have been reported in all tomato production areas of the world (Kirthi et al., 2002, 2004; Garcia-Andres et al., 2007; Lefeuvre et al., 2007b; Prasanna and Rai, 2007; Ribeiro et al., 2007; Kon and Gilbertson, 2012).

The viruses causing TYLCD in Europe are TYLCV and TYLCSV, a distinct virus species first reported in Italy in 1989. In Spain, in addition to TYLCV and TYLCSV, the recombinants TYLCMaV (Monci et al., 2002) and TYLCAxV (Garcia-Andres et al., 2006) occur. Within each species, various strains may exist, such as, for TYLCV *sensu stricto*, strains TYLCV-IL and TYLCV-Mld. These can be discriminated by molecular assays but not by their symptoms on tomato (Lefeuvre et al., 2007a).

3.1.4. Detection and identification of *Tomato yellow leaf curl virus*

Symptoms of TYLCD consist of a more or less prominent upwards curling of leaflet margins, reduction of leaflet area, leaf yellowing and a general stunting. The symptoms are most prominent on young newly developing leaves in the apical parts of the plant. Early infections result in severe symptoms while late plant infections generally cause milder symptoms. Early infections also result in reduced flowering, flower abortion and production can be almost entirely lost. While TYLCD symptoms are very characteristic and cannot be misidentified, they can be overseen in case of late infections, and the causal *Begomovirus* cannot be identified on the sole basis of symptomatology.

TYLCV is an intensively studied virus complex and although novel begomoviruses are frequently described, known ones are well characterised and complete genome sequences are available. For detection and differentiation of begomoviruses in general and of TYLCV species and strains, efficient molecular tools based on polymerase chain reaction (PCR) are available and generally used (Lefeuvre et al., 2007a, b). Serological methods, such as enzyme-linked immunosorbent assay (ELISA), are also available; however, they cannot differentiate closely related virus species, such as the members of the TYLCV complex. Molecular assays are available in an extensive range of formats and are recommended for the identification and discrimination of virus species. All serological and molecular methods recommended, with detailed prescriptions of sample preparation and testing, are comprehensively compiled in EPPO/OEPP diagnostic protocol 7/50 (1) (EPPO, 2005).

3.2. Current distribution of *Tomato yellow leaf curl virus*

3.2.1. Global distribution of *Tomato yellow leaf curl virus*

TYLCV was first described in the Middle East (Israel and Jordan) (Cohen and Harpaz, 1964), emerged as a serious pest of tomato from the 1970s (Hanssen et al., 2010) and was then introduced in the Mediterranean Basin, the Far East, the Caribbean, South America, North America and Australia. It is currently reported in all continents (Figure 1).

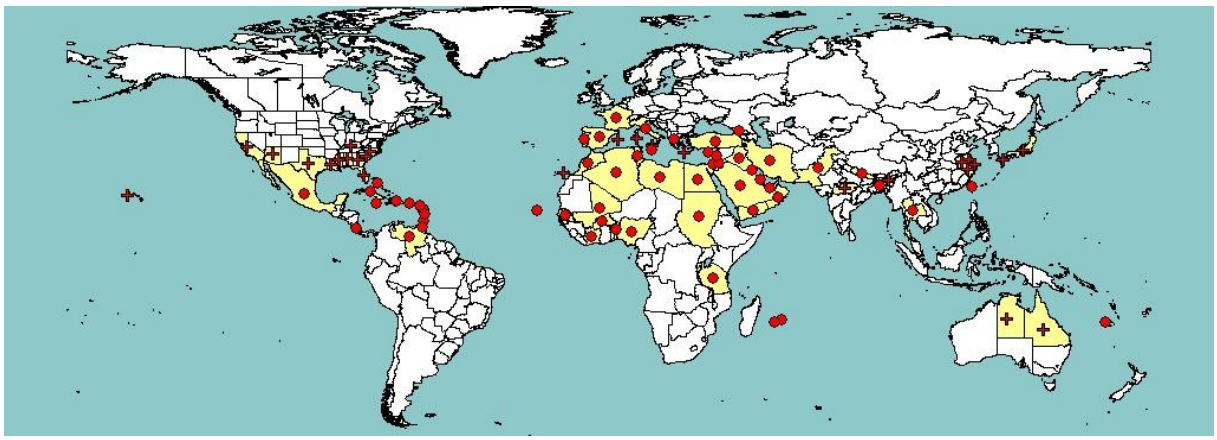

Figure 1: Global distribution map for *Tomato yellow leaf curl virus* (*sensu stricto*) (extracted from EPPO Plant Quarantine Retrieval system, version 5.3.1, accessed in August 2014). Red circles represent pest presence as national records and red crosses represent pest presence as subnational records (note that this figure combines information from different dates, some of which could be out of date)

The rapid worldwide spread of TYLCV is most likely the result of international movement of virus-infected plants and of plants harbouring viruliferous whiteflies (including plants that are not host to TYLCV). The Mediterranean region is considered the source of the TYLCV global epidemic (Lefeuvre et al., 2010), while a second, more recent, global wave of dissemination of TYLCV occurred from Asia (Duffy and Holmes 2007). The type TYLCV and its strains TYLCV-IL and TYLCV-Mld have the broadest geographical range of all begomoviruses infecting tomato (Lefeuvre et al., 2007b, 2010).

On the other hand, TYLCSV, TYLCMaV and TYLCAxV have much more restricted distributions. TYLCMaV and TYLCAxV have only been reported so far in Spain (see below), while outside the EU TYLCSV has only been reported in Tunisia, Jordan and Israel (EPPO PQR, version 5.3.1 accessed in August 2014).

3.2.2. Distribution of *Tomato yellow leaf curl virus* in the EU

TYLCV is reported in seven EU MSs (Table 2). TYLCV was first reported in the EU in Cyprus in 1982. Other reports followed: Portugal in 1995, Spain in 1997, France in 1999 and Greece in 2000 (Navas-Castillo et al., 2011). The agent causing TYLCD, which was observed in Italy in 1989, was initially named TYLCV-Sar (Sardinia strain) but later found sufficiently different from TYLCV to justify its naming as a separate species, TYLCSV. TYLCV itself was only identified in Italy in 2002. Both viruses are now present in, Greece, Spain and Italy. The recombinant viruses TYLCMaV (Monci et al., 2002) and TYLCAxV (Garcia-Andres et al., 2006) have so far only been reported in Spain (Table 3).

Table 2: Current distribution of *Tomato yellow leaf curl virus* in the 28 EU MSs, Iceland and Norway, based on the answers received via email from the NPPOs or, in absence of reply, on information from EPPO PQR

Country	NPPO answer	NPPO comment
Austria	**Absent**, no pest records	
Belgium	**Absent**, confirmed by survey	Official survey by the Federal Agency for the Safety of the Food Chain since 2011
Bulgaria	**Absent**	
Croatia	**Absent**, confirmed by survey	National surveys conducted in 2012 and from 2001 to 2009
Cyprus	**Present**, widespread	

Country	NPPO answer	NPPO comment
Czech Republic	**Absent**, no pest records	
Denmark	**Absent**, not known to occur	
Estonia	–	
Finland	**Absent**, no pest records	
France	**Present**, few occurrences	
Germany	**Absent**, no pest records	
Greece [(a)]	**Present**, widespread (including Crete)	
Hungary	**Absent**, no pest records	
Ireland	**Absent**, no pest records	
Italy	**Present**, no details	Present in South Italy where the vector *B. tabaci* is common outdoors
Latvia [(a)]	–	
Lithuania [(a)]	–	
Luxembourg [(a)]	–	
Malta	**Present**, restricted distribution	
Netherlands	**Absent**, pest eradicated (2008), confirmed by survey	
Poland	**Absent**	
Portugal	**Present**, restricted distribution	
Romania [(a)]	–	
Slovakia	**Absent**, no pest records	
Slovenia	**Absent**, no pest records	No pest records on *Lycopersicon lycopersicum* (L.)
Spain	**Present**	*Tomato yellow leaf curl virus* is considered one of the most problematic tomato diseases in Southern Spain and Canary islands. In 1997–1998 and 2010–2011 campaigns over 350 ha and 200 ha, respectively, had to be uprooted
Sweden	**Absent**, not known to occur	Found on imported tomato fruit for consumption
United Kingdom	**Absent**	
Iceland [(a)]	–	
Norway [(a)]	–	

–, no information available.
(a): When no information was made available to EFSA, the pest status in the EPPO PQR (2012) was used.

Table 3: Distribution of *Tomato yellow leaf curl virus* species present in Europe (EFSA PLH Panel, 2013)

Genus, species	Reference	Countries
Genus: *Begomovirus*		
Tomato yellow leaf curl virus (TYLCV)	Accotto et al. (2000), Louro et al. (2000), Moriones et al. (1993)	Greece, Spain, France, Italy, Cyprus, Malta, Portugal
Tomato yellow leaf curl Sardinia virus (TYLCSV)	Crescenzi et al. (2004), Kheyr-Pour et al. (1991), Nannini et al. (2009a, b)	Greece, Spain, Italy
Tomato yellow leaf curl Malaga virus (TYLCMaV)	(Monci et al., 2002)	Spain
Tomato yellow leaf curl Axarquia virus (TYLCAxV)	(Garcia-Andres et al., 2006)	Spain

There are only a few regions or EU MSs where conditions are suitable for the establishment of *B. tabaci* in open fields (EFSA PLH Panel, 2013) and where TYLCV *sensu stricto* has not been reported to date, including Madeira (*Bemisia*-free protected zone), Corsica, Slovenia and Croatia. However, the absence of TYLCV from these areas carries significant uncertainties.

The reduced distribution of TYLCSV, TYLCMaV and TYLCAxV compared with that of TYLCV could be an indication that they have not yet reached their full establishment potential in the EU. Alternatively, this situation could also be an indication that these three viruses may have a lower competitiveness than TYLCV and that their establishment could be limited by the pre-existing presence of TYLCV. In any case, establishment of any of those three viruses in areas where TYLCV is already established is not expected to significantly contribute to a further deterioration of the TYLCD situation.

3.2.3. Vectors and their distribution in the EU

Like all other begomoviruses, TYLCV is transmitted by members of the *B. tabaci* species complex in a persistent circulative manner (Czosnek et al., 2002; Hogenhout et al., 2008). Intrinsic interactions between whiteflies and viruses exist, which determine the efficiency of transmission (Markham et al., 1994; Bedford et al., 1998). For TYLCV, a single insect can acquire and transmit sufficient virus to cause infection in tomato plants. Nymphs can ingest and transmit the virus but mobile adult whiteflies are responsible for spreading the disease. Once acquired, TYLCV is retained in the insects for several weeks and up to their entire life. This means that, even in the temporary absence of host plants, the virus can remain in the environment and that spread can again occur once susceptible host plants are planted or become available to viruliferous whiteflies. Transovarial transmission of TYLCV to the offspring was reported once (Ghanim et al., 1998), however this has not been confirmed in later independent studies (Bosco et al., 2004) and from all further evidence reported, begomoviruses are unlikely to be transovarially passed to *B. tabaci* progenies.

B. tabaci has been reported in most of the countries in the risk assessment area. In countries where *B. tabaci* is established, density and spatial distribution depend on prevailing climatic conditions. Except in the Mediterranean coastal regions (Cyprus, Greece, Malta, Italy, south of France, certain parts of Spain and Portugal…), *B. tabaci* occurrence is restricted to greenhouses (EFSA PLH Panel, 2013). In several European countries (Denmark, Estonia, Ireland, Latvia, Lithuania, Romania, Slovenia, Slovakia, Finland, Sweden, the United Kingdom) and in central and northern parts of Portugal, *B. tabaci* is reported as absent. Sweden, Ireland, the United Kingdom, Finland and parts of Portugal, Madeira and the Azores archipelagos are officially free of *B. tabaci* and have a declared Protected Zone status (PZ; Annex IB of the Council Directive 2009/29/EC). However, *B. tabaci* is frequently intercepted in these Protected Zones (Cuthbertson et al., 2011; EPPO, 2012a) and is subject to eradication in the event of an outbreak.

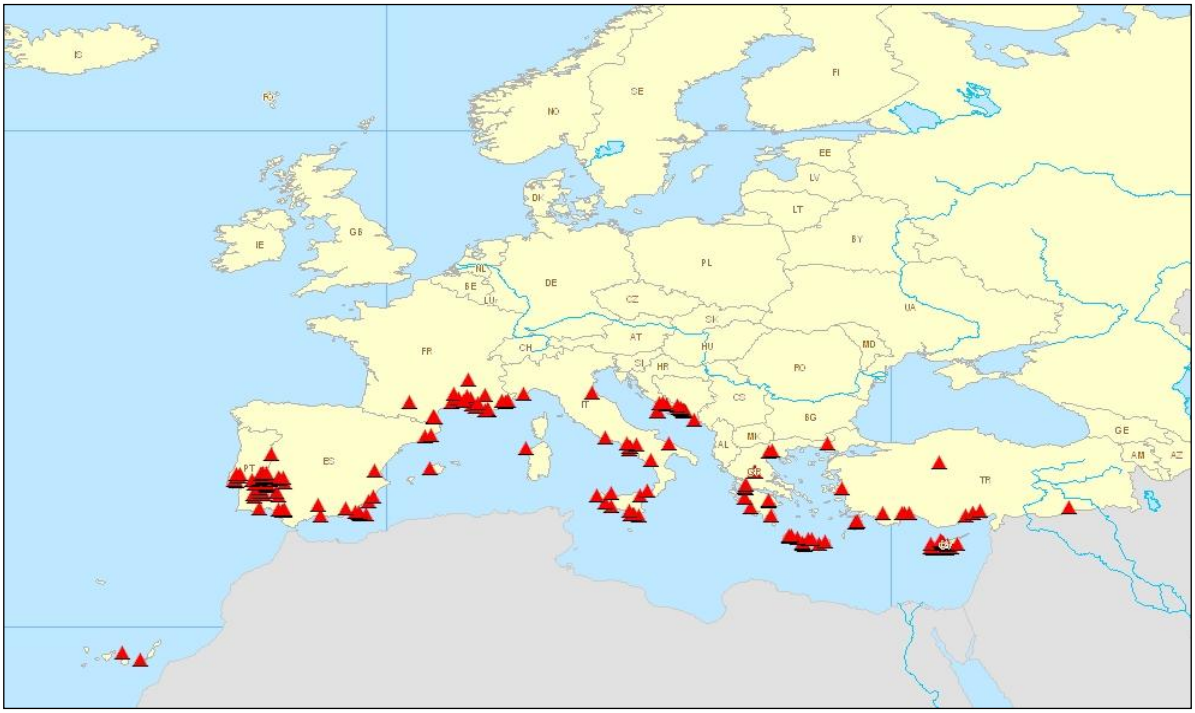

Figure 2: Distribution map of *Bemisia tabaci* in open fields in the risk assessment area including information from Croatia, Bosnia and Herzegovina, and Turkey (data and references from EFSA PLH Panel, 2013)

3.3. Regulatory status in the EU

3.3.1. Council Directive 2000/29/EC

3.3.1.1. Harmful organism

TYLCV is a regulated harmful organism in the EU and is currently listed in Annex II, Part A, Section II of Council Directive 2000/29/EC (Table 4).

Table 4: *Tomato yellow leaf curl virus* in Council Directive 2000/29/EC

Annex II, Part A	Harmful organisms whose introduction into, and spread within, all Member States shall be banned if they are present on certain plants or plant products	
Section II	Harmful organisms known to occur in the community and relevant for the entire community	
(d)	Virus and virus-like organisms	
	Species	**Subject of contamination**
16	Tomato yellow leaf curl virus	Plants of *Lycopersicon lycopersicum* (L.) Karsten ex Farw., intended for planting, other than seeds

Even though TYLCSV, TYLCMaV and TYLCAxV are not specifically mentioned in the Directive, they were initially considered as strains of TYLCV and can therefore be considered as covered by the IIAII listing of TYLCV. If not considered as being covered by this listing, these three viruses would still be covered by the general listing in Annex IAI of "viruses transmitted by *Bemisia tabaci*".

3.3.1.2. Regulated hosts of *Tomato yellow leaf curl virus*

TYLCV has more potential hosts than those for which it is regulated in Annex IIAII (see section 3.4.1). In addition, it is important to mention that other specific commodities could also be a pathway for introduction of the pest in the risk assessment area.

Below, specific requirements of Annex IV and Annex V of Council Directive 2000/29/EC are presented for only the host plants and commodities regulated for TYLCV in Annex IIAII (Table 5).

Table 5: *Tomato yellow leaf curl virus* host plants in Council Directive 2000/29/EC

Annex IV, Part A	Special requirements which must be laid down by all Member States for the introduction and movement of plants, plant products and other objects into and within all Member States	
Section I	plants, plant products and other objects originating outside the Community	
	Plants, plant products and other objects	**Special requirements**
45.3	Plants of *Lycopersicon lycopersicum* (L.) Karsten ex Farw. intended for planting, other than seeds, originating in countries where Tomato yellow leaf curl virus is known to occur	Without prejudice to the requirements applicable to plants listed in Annex III(A)(13) and Annex IV(A)(I)(25.5), (25.6) and 25.7 where appropriate
	(a) Where *Bemisia tabaci* Genn. is not known to occur	Official statement that no symptoms of Tomato yellow leaf curl virus have been observed on the plants
	(b) Where *Bemisia tabaci* Genn. is known to occur	Official statement that: (a) no symptoms of Tomato yellow leaf curl virus have been observed on the plants and (aa) the plants originate in areas known to be free from *Bemisia tabaci* Genn., or (bb) the place of production has been found free from *Bemisia tabaci* Genn. on official inspections carried out at least monthly during the three months prior to export; or (b) no symptoms of Tomato yellow leaf curl virus have been observed on the place of production and the place of production has been subjected to an appropriate treatment and monitoring regime to ensure freedom from *Bemisia tabaci* Genn.
	Plants, plant products and other objects originating in the Community	
	Plants, plant products and other objects	**Special requirements**
26.1	Plants of *Lycopersicon lycopersicum* (L.) Karsten ex Farw., … intended for planting, other than seeds	Without prejudice to the requirements applicable to the plants, where appropriate, listed in Annex IV(a)(II)(18.6) and (23) official statement that: (a) the plants originate in areas known to be free from Tomato yellow leaf curl virus; or (b) no symptoms of Tomato yellow leaf curl virus have been observed on the plants; and (aa) the plants originate in areas known to be free from *Bemisia tabaci* Genn.; or (bb) the place of production has been found free from *Bemisia tabaci* Genn. on official inspections carried out at least monthly during the three months prior to export; or

		(c) no symptoms of Tomato yellow leaf curl virus have been observed on the place of production and the place of production has been subjected to an appropriate treatment and monitoring regime to ensure freedom from *Bemisia tabaci* Genn.
Annex V	Plants, plant products and other objects which must be subject to a plant health inspection (at the place of production if originating in the Community, before being moved within the Community—in the country of origin or the consignor country, if originating outside the Community) before being permitted to enter the Community	
Part A	Plants, plant products and other objects originating in the Community	
Section I	Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community and which must be accompanied by a plant passport	
2	Plants, plant products and other objects produced by producers whose production and sale is authorised to persons professionally engaged in plant production, other than those plants, plant products and other objects which are prepared and ready for sale to the final consumer, and for which it is ensured by the responsible official bodies of the Member States, that the production thereof is clearly separate from that of other products	
2.2	Plants of Solanaceae, other than those referred to in point 1.3 intended for planting, other than seeds	
Part B	Plants, plant products and other objects originating in territories, other than those territories referred to in Part A	
Section I	Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community	
1	Plants, intended for planting, other than seeds but including seeds of […] *Lycopersicon lycopersicum* (L.) Karsten ex Farw.	

3.3.1.3. Vectors

B. tabaci, the vector of TYLCV, is currently listed in Annex I, Part A, Section I and Annex I, Part B of Council Directive 2000/29/EC (Table 6).

Table 6: *Bemisia tabaci*, the vector of *Tomato yellow leaf curl virus*, in Council Directive 2000/29/EC

Annex I, Part A	Harmful organisms whose introduction into, and spread within, all Member States shall be banned	
Section I	Harmful organisms not known to occur in any part of the community and relevant for the entire community	
(a)	Insects, mites and nematodes, at all stages of their development	
7	*Bemisia tabaci* Genn. (non-European populations)	
Annex I, Part B	Harmful organisms whose introduction into, and spread within, certain protected zones shall be banned	
(a)	Insects, mites and nematodes, at all stages of their development	
	Species	**Protected zone(s)**
1	*Bemisia tabaci* Genn. (European populations)	IRL, P (Azores, Beira Interior, Beira Litoral, Entre Douro e Minho, Madeira, Ribatejo e Oeste (communes of Alcobaça, Alenquer, Bombarral, Cadaval, Caldas da Rainha, Lourinhã, Nazaré, Obidos, Peniche and Torres Vedras) and Trás-os-Montes), UK, S, FI

3.3.2. Marketing directives

Host plants of TYLCV that are regulated in Annex IIAII of Council Directive 2000/29/EC are explicitly mentioned in the following Marketing Directives:

- Council Directive 2002/55/EC[5]

[5] Council Directive 2002/55/EC of 13 June 2002 on the marketing of vegetable seed. OJ L 193/33, 20.7.2002, p. 33–59.

3.4. Elements to assess the potential for establishment and spread in the EU

3.4.1. Host range

The main host of TYLCV in Europe is tomato (*Lycopersicon lycopersicum*), which is equally susceptible to all four viruses addressed in the present opinion. Besides tomato, common bean (*Phaseolus vulgaris*) and sweet pepper (*Capsicum annuum*) (Díaz-Pendón et al., 2010) are also major crops susceptible to TYLCV. Several ornamental solanaceous plants, such as *Petunia* spp. are also hosts of TYLCV but information is lacking for many other species. A number of wild solanaceous hosts plants, in particular *Solanum nigrum* or *Datura stramonium*, as well as other wild plant species and weeds, can be infected by TYLCV and thus serve as natural virus reservoirs (Cohen et al., 1988; Bedford et al., 1998; Sanchez-Campos et al., 2000; Garcia-Andres et al., 2006; Fanigliulo et al., 2007; Díaz-Pendón et al., 2010; Papayiannis et al., 2011). There are, however, some differences reported in the host range of particular agents. *Solanum nigrum* and *S. luteum* appear to be poor hosts of TYLCV *sensu stricto* (Monci et al., 2002; Garcia-Andres et al., 2006), while TYLCSV does not appear to be able to infect bean (Monci et al., 2002; Garcia-Andres et al., 2006). All these plants appears to be hosts of the recombinants TYLCMaV and TYLCAxV which therefore seem to cumulate the host ranges of their two parents (Monci et al., 2002; Garcia-Andres et al., 2006).

3.4.2. EU distribution of main host plants

Tomato is of high economic value and widely grown both in the field and under protected cultivation in many EU MSs (Table 7). In addition, sweet pepper and common bean are also grown in the major regions of tomato production thus providing alternative hosts. A similar situation applies to the weed hosts.

Table 7: Area of production in (1 000 ha) of tomatoes in 2012, as extracted from the EUROSTAT database (crops products – annual data (apro_cpp_crop) accessed on 18 March 2014)

Country	Tomatoes	Tomatoes for fresh consumption under glass or high accessible covers
Austria	0.2	0.2
Belgium	0.5	0.5
Bulgaria	3.4	0
Croatia	0.4	0.1
Cyprus	0.2	–
Czech Republic	0.4	0
Denmark	0	0
Estonia	0	0
Finland	0.1	0.1
France	5.2	2
Germany	0.3	0.3
Greece	16	2.8
Hungary	1.8	0.4
Ireland	0	0
Italy	91.9	6.4
Latvia	0	0
Lithuania	0.6	0
Luxembourg	0	0
Malta	0.3	–
Netherlands	1.7	1.7
Poland	13.1	2.2
Portugal	15.4	1
Romania	29.8	1.4
Slovakia	0.5	0
Slovenia	0	0
Spain	48.6	18.5

Country	Tomatoes	Tomatoes for fresh consumption under glass or high accessible covers
Sweden	0	0
United Kingdom	0	0
EU-28	230.4	37.6

–, data not available.

3.4.3. Analysis of the potential distribution of *Tomato yellow leaf curl virus* in the EU

TYLCV is adapted to tropical and subtropical climates. High temperatures favour virus replication while low temperatures lead to delayed infections and only mild symptoms. Efficient virus spread is by *B. tabaci* only thus the distribution of TYLCV is linked to the area of *B. tabaci* establishment. Because *B. tabaci* establishment in open fields is mostly limited by climatic factors, TYLCV is present outdoors in the Mediterranean regions of the EU (EFSA PLH Panel, 2013; Gilioli et al., 2014). As the *B. tabaci* complex members already present in the Mediterranean are among the most efficient TYLCV vectors, introduction of other *B. tabaci* biotypes in the EU is not expected to further contribute to a degradation of the TYLCV situation. TYLCV can also be disseminated with infected plants for planting or by viruliferous *B. tabaci* present in plant consignments. When introduced into greenhouses where susceptible crops are grown, the virus can establish and spread because these conditions permit a year-round presence of *B. tabaci* and of susceptible crops. Consequently, the glasshouse production areas in northern European countries are also suitable for TYLCV. However, given the restricted range of susceptible hosts and the survival of *B. tabaci* for only short periods outdoors in northern Europe, TYLCV is unlikely to establish and spread outdoors for extended periods in these areas.

3.4.4. Spread capacity

TYLCV spread occurs only through the activity of the *B. tabaci* vector and the commercial trade of plants for planting. Local spread by *B. tabaci* in the risk assessment area is contingent on suitable climatic conditions (see above; EFSA PLH Panel, 2013; Gilioli et al., 2014). In the Mediterranean coastal regions, ample availability of host plants and suitable environmental conditions support spread of TYLCV and because *B. tabaci* and TYLCV are established outdoors, spread of TYLCV is inevitable. As shown by the many reports of TYLCV invasion around the world, the efficiency of virus spread is favoured by high adult whitefly populations visiting many plants. Long-distance spread of TYLCV is by transport of viruliferous *B. tabaci* and of virus-infected plants for planting (tomato seedlings or grafted tomato hybrid seedlings). Owing to the high volume of intra-EU or extra-EU trade and of the difficulty of controlling this pathway, spread of TYLCV to northern EU countries can therefore occur. Even if local ecoclimatic conditions outdoors are not suitable for *B. tabaci* vector populations, TYLCV spread can still occur under protected cultivation conditions.

3.5. Elements to assess the potential for consequences in the EU

3.5.1. Potential effects of *Tomato yellow leaf curl virus*

Symptoms of TYLCD are leaf curling and deformation of uppermost plant parts, severe stunting of the plants and flower and fruit abscission, especially when plants are infected at an early stage, leading to serious yield losses. TYLCV is considered the most severe tomato virus disease around the world and, in particular, in Mediterranean Europe (Lapidot and Friedmann, 2002; Morales, 2007; Hanssen et al., 2010; Navas-Castillo et al., 2011). Therefore, the potential effects of TYLCV on horticultural crops, especially tomato, pepper and beans, are very serious.

3.5.2. Observed impact of *Tomato yellow leaf curl virus* in the EU

In Europe, TYLCD is a limiting factor to tomato production (Lapidot and Friedmann, 2002), especially in Mediterranean countries where *B. tabaci* and TYLCV are established outdoors and the main crop host, tomato, is widely produced both in protected cultivation and in open fields. When present, TYLCSV, TYLCMaV and TYLCAxV have similarly high impact, with a potential for high

production losses. Therefore, where both virus and vector are established, protection measures need to be in place to limit yield losses. In many areas of intensive tomato production in Europe, the development of a comprehensive crop management regime integrating an ensemble of partially effective control methods has resulted in sustainable management of TYLCD. The observed pest impact can still be significant but is far reduced from the devastating potential effects of TYLCV.

In greenhouse productions in northern European countries, temporary populations of *B. tabaci* along with outbreaks of TYLCV have been reported and subsequently eradicated. Because of the limited scale and infrequent occurrence of these outbreaks, their overall impact can, however, be considered limited.

There are no reports of TYLCV effects on wild plants in cultivated or natural environments and the most commonly expected environmental effects are those resulting from the use of pesticides to control vector populations. Overall, TYLCV environmental effects are considered negligible.

3.6. Currently applied control methods in the EU

TYLCD is a very serious disease with high impact and appropriate protection measures need to be in place to limit yield losses. In Europe, wherever *B. tabaci* is established outdoors, that is in the Mediterranean coastal regions of Europe (EFSA PLH Panel, 2013), TYLCV is present, and tomato, as well as pepper and bean, production is possible only under a complex pest and disease management regime to reduce vector populations, virus incidence and severity of the disease. This comprises the concerted action of all growers in a region administering integrated pest management strategies, the intelligent use of biological control measures and pesticide applications to minimise whitefly populations, the use of virus-tolerant varieties (available only for tomato) and the use of physical barriers for vector exclusion (summarised in EFSA PLH Panel, 2013). The combination of measures and the development of a comprehensive crop management regime in many regions of intensive tomato production in Europe have resulted in the sustainable management of TYLCD.

3.7. Uncertainty

TYLCD is caused by four virus species in Europe, the most significant being TYLCV. TYLCD is a serious constraint on tomato production in the Mediterranean coastal regions of Europe, where *B. tabaci* and TYLCV are established outdoors. There are, however, some uncertainties about the precise distribution of TYLCV and its absence from some specific southern European areas. There is very little uncertainty regarding the identity of the viruses and their potential impact on tomato cultivation and yield. There are, however, some uncertainties as to the actual overall impact, given the variety of situations and the fact that control of the disease may not be as efficiently applied in all areas, especially when it comes to open field tomato production.

Establishment and spread of TYLCV is linked to *B. tabaci*, an efficient vector whereby the area of insect distribution is limited by climatic factors. Therefore, there is very little uncertainty regarding the geographical limits of vector establishment (EFSA PLH Panel, 2013; Gilioli et al., 2014); however, uncertainties exist concerning TYLCV establishment outdoors in northern European regions once it is introduced via transient *B. tabaci* populations.

There are also uncertainties as to the establishment and impact potential of TYLCSV, TYLCMaV and TYLCAxV in areas where TYLCV is already present.

CONCLUSIONS

The Panel summarised in Table 8 its conclusions on the key elements addressed in this scientific opinion in consideration of the pest categorisation criteria defined in ISPM 11 and ISPM 21 and of the additional questions formulated in the terms of reference.

Table 8: The Panel's conclusions on the pest categorisation criteria defined in the International Standards for Phytosanitary Measures (ISPM) No 11 and No 21 and on the additional questions formulated in the terms of reference (ToR)

Criterion of pest categorisation	Panel's conclusions on ISPM 11 criterion *Provide answers to the questions in the column below*	Panel's conclusions on ISPM 21 criterion *Provide answers to the questions in the column below*	List of main uncertainties *List key uncertainties*
Identity of the pest	*Is the identity of the pest clearly defined? Do clearly discriminative detection methods exist for the pest?* TYLCV, TYLCSV, TYLCMaV and TYLCAxV are well characterised and the taxonomy is clear. Reliable detection and identification tests are available		Only very limited uncertainties
Absence/presence of the pest in the risk assessment area	*Is the pest absent from all or a defined part of the risk assessment area?* TYLCV, TYLCSV, TYLCMaV and TYLCAxV are absent or only transient in northern European MSs where tomato is grown in glasshouses only. In addition, TYLCSV, TYLCMaV and TYLCAxV are only reported in a few MSs or a single MS	*Is the pest present in the risk assessment area?* TYLCV, TYLCSV, TYLCMaV and TYLCAxV are present in the risk assessment area	Some uncertainties on distribution of individual virus species
Regulatory status	*Mention in which annexes of 2000/29/EC and the marketing directives the associated hosts are listed without further analysis Indicate also whether the hosts and/or commodities for which the pest is regulated in AIIAI or II are comprehensive of the host range* TYLCV is listed in Annex IIAII of Directive 2000/29/EC, but only regulated in *Lycopersicon lycopersicum* plants for planting despite having a larger host range Although TYLCSV, TYLCMaV and TYLCAxV are not specifically mentioned in the Directive, they were initially considered as strains of TYLCV and can therefore be considered as covered by the IIAII listing of TYLCV. If not considered as being covered by this listing, these three viruses would still be covered by the general listing in Annex IAI of "viruses transmitted by Bemisia tabaci"		Uncertainties on the interpretation of the Directive 2000/29/EC by MS regarding the inclusion of TYLCSV, TYLCMaV and TYLCAxV
Potential establishment and spread	*Does the risk assessment area have ecological conditions (including climate and those in protected conditions) suitable for the establishment and spread of the pest?* *Indicate whether the host plants are also grown in areas of the EU where the pest is absent.* *And, where relevant, are host species (or near relatives), alternate hosts and vectors present in the risk assessment area?* Tomato is widely cultivated in the EU, in open fields, under protected cultivation in the Mediterranean regions and in glasshouses in northern European	*Are plants for planting a pathway for introduction and spread of the pest?* Tomato seedlings from nurseries constitute a pathway for virus spread. The same applies to plants for planting of non-host plants carrying viruliferous *B. tabaci*	Only limited uncertainties. There are however some uncertainties about the establishment potential of TYLCSV, TYLCMaV and TYLCAxV in areas where TYLCV is already present

Criterion of pest categorisation	**Panel's conclusions on ISPM 11 criterion** *Provide answers to the questions in the column below*	**Panel's conclusions on ISPM 21 criterion** *Provide answers to the questions in the column below*	**List of main uncertainties** *List key uncertainties*
	countries, including several MSs where TYLCV has not been reported. Establishment and spread of all four viruses is linked to presence of *B. tabaci* which is limited outdoors by climatic factors. In northern European countries, transient establishment of both *B. tabaci* and the viruses is possible		
Potential for consequences in the risk assessment area	*What are the potential for consequences in the risk assessment area?* *Provide a summary of impact in terms of yield and quality losses and environmental consequences* TYLCD is considered a major constraint on tomato production and without appropriate measures in place, production of tomato in areas where *B. tabaci* is endemic is not possible	*If applicable is there indication of impact(s) of the pest as a result of the intended use of the plants for planting?* Virus movement with infected plants for planting or with viruliferous *B. tabaci* can have significant impact on crop production in areas where the viruses are not present	Only limited uncertainties. There are, however, uncertainties about the impact potential of TYLCSV, TYLCMaV and TYLCAxV upon their establishment in areas where TYLCV is already present
Conclusion on pest categorisation	*Provide an overall summary of the above points* TYLCV, TYLCSV, TYLCMaV and TYLCAxV are present in the risk assessment area Tomato is widely cultivated in the EU, in open fields, under protected cultivation in the Mediterranean regions and in glasshouses in northern European countries. Establishment and spread of all four viruses is linked to presence of *B. tabaci* which is limited outdoors by climatic factors. In northern European countries, transient establishment of both *B. tabaci* and the viruses is possible TYLCD is considered a major constraint on tomato production and without appropriate measures in place, production of tomato in areas where *B. tabaci* is endemic is not possible	*Provide an overall summary of the above points* TYLCV, TYLCSV, TYLCMaV and TYLCAxV are present in the risk assessment area Tomato seedlings from nurseries constitute a pathway for virus spread. The same applies to plants for planting of non-host plants carrying viruliferous *B. tabaci* Virus movement with infected plants for planting or with viruliferous *B. tabaci* can have significant impact on crop production in areas where the viruses are not present	Significant uncertainties exist concerning (1) TYLCV distribution and its absence from some regions and (2) its actual current impact in affected areas

Criterion of pest categorisation	Panel's conclusions on ISPM 11 criterion *Provide answers to the questions in the column below*	Panel's conclusions on ISPM 21 criterion *Provide answers to the questions in the column below*	List of main uncertainties *List key uncertainties*
Conclusion on specific ToR questions	*If the pest is already present in the EU, provide a brief summary of* – *the analysis of the present distribution of the organism in comparison with the distribution of the main hosts, and the distribution of hardiness/climate zones, indicating in particular if in the risk assessment area, the pest is absent from areas where host plants are present and where the ecological conditions (including climate and those in protected conditions) are suitable for its establishment, and* – *the analysis of the observed impacts of the organism in the risk assessment area* TYLCV is widely distributed in regions where *B. tabaci* is present outdoors and tomato is grown. TYLCV *sensu stricto* appears to be still absent from a few regions or MS suitable for the establishment of *B. tabaci*, including Madeira, Corsica, Croatia and Slovenia. TYLCSV has, so far, a more restricted distribution while TYLCMaV and TYLCAxV distribution is, so far, restricted to Spain. All three viruses have the potential to establish and spread wherever TYLCV *sensu stricto* has been able to do so. TYLCV is only transient in northern European countries where *B. tabaci* cannot establish outdoors and all three of the other agents have the potential to result in similar outbreaks Overall, TYLCV appears to be present in almost all EU regions with suitable ecoclimatic conditions for its establishment in open fields while the other three viruses do not appear to have reached their full establishment potential All four viruses have the potential to have major impact on tomato production in the Mediterranean area were *B. tabaci* populations are established in the open. In many such areas of intensive tomato production, the development of a comprehensive crop management regime has resulted in sustainable management of TYLCD. The observed pest impact can still be significant but is far reduced from the devastating potential effects of TYLCV Given the limited scale and infrequent nature of the outbreaks in northern European countries, the impact there can be considered as limited		Significant uncertainties exist concerning (1) TYLCV distribution and its absence from some regions and (2) its actual current impact in affected areas

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ABBREVIATIONS

EFSA	European Food Safety Authority
EPPO	European and Mediterranean Plant Protection Organization
EPPO-PQR	European and Mediterranean Plant Protection Organization Plant Quarantine Retrieval system
EU	European Union
ISPM	International Standards for Phytosanitary Measures
MS	Member State
NPPO	National Plant Protection Organisation
PLH Panel	Plant Health Panel
PRA	Pest Risk Analysis
TYLCAxV	*Tomato yellow leaf curl Axarquia virus*
TYLCD	Tomato yellow leaf curl disease
TYLCMaV	*Tomato yellow leaf curl Malaga virus*
TYLCSV	*Tomato yellow leaf curl Sardinia virus*
TYLCV	*Tomato yellow leaf curl virus*