SCIENTIFIC OPINION

Scientific Opinion on the pest categorisation of the tospoviruses[1]

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

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ABSTRACT

The European Commission requested EFSA's Panel on Plant Health to perform the pest categorisation for the 24 viruses of the *Tospovirus* genus for the EU territory. The following tospoviruses were analysed: *Tomato spotted wilt virus* (TSWV), *Impatiens necrotic spot virus* (INSV), *Iris yellow spot virus* (IYSV), *Polygonum ringspot virus* (PolRSV), *Groundnut ringspot virus* (GRSV), *Tomato chlorotic spot virus* (TCSV), *Alstroemeria necrotic streak virus* (ANSV), *Chrysanthemum stem necrosis virus* (CSNV), *Melon severe mosaic virus* (MSMV), *Tomato yellow (fruit) ring virus* (TYRV), *Tomato zonate spot virus* (TZSV), *Groundnut yellow spot virus* (GYSV), *Groundnut chlorotic fan-spot virus* (GCFSV), *Groundnut bud necrosis virus* (GBNV), *Zucchini lethal chlorosis virus* (ZLCV), *Capsicum chlorosis virus* (CaCV), *Watermelon bud necrosis virus* (WBNV), *Watermelon silver mottle virus* (WSMoV), *Tomato necrotic ringspot virus* (TNRV), *Calla lily chlorotic spot virus* (CCSV), *Melon yellow spot virus* (MYSV), *Soybean vein necrosis associated virus* (SVNaV), *Bean necrotic mosaic virus* (BeNMV) and *Pepper necrotic spot virus* (PNSV). In reaching its conclusions, the Panel considered four parameters to be of critical importance in the risk assessment area: (i) the presence of a tospovirus, (ii) the existence of host plants, (iii) the existence of thrips vector species and (iv) the potential for damage to crops grown in Europe. Based on its analysis, the Panel concluded that the 24 viruses analysed could be allocated to four different risk groups. Seven viruses (GRSV, TCSV, ANSV, CSNV, MSMV, TYRV, TZSV) for which both thrips species vectors and natural or experimental hosts crops are present in the EU territory were considered by the Panel to represent the highest risk to the EU territory. In contrast, three viruses (INSV, IYSV and PolRSV) already present in the risk assessment area were not considered by the Panel to pose a risk justifying the development of full risk assessments.

KEY WORDS

Pest categorisation, tospovirus, thrips, vector

1 On request from the European Commission, Question No EFSA-Q-2011-01156, adopted on 15 June 2012.
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SUMMARY

Following a request from European Commission, the Panel on Plant Health was asked to deliver a scientific opinion on the pest categorisation of the tospoviruses. The Panel identified 24 tospoviruses that are considered in this scientific opinion.

Considering the whole genus, tospoviruses are among the most damaging plant viruses worldwide. There are several reasons for this, most significantly the severity of the symptoms they induce, the efficiency of their vectors in virus transmission and the difficulty of controlling vectors and viruses. However, as analysed in the present opinion, significant biological differences exist between different tospoviruses, in particular concerning their geographical distribution, their host range and their vector thrips species.

The Panel considered four parameters as being particularly relevant. For each virus, these are:

- the presence of the virus in the risk assessment area;
- the presence of host plants in the risk assessment area;
- the presence of thrips vector species in the risk assessment area;
- the potential for damage to crops grown in Europe.

The relevant parameters are summarised for each virus in Table 1.

Table 1: Summary of tospoviruses parameters considered in the pest categorisation

Tospovirus species	Abbreviation	Presence of the virus in the risk assessment area	Existence of host plants in the risk assessment area	Existence of vectors in the risk assessment area	Potential for damage to EU crops
Tomato spotted wilt virus	TSWV	Yes	Yes	Yes	Yes
Impatiens necrotic spot virus	INSV	Yes	Yes	Yes	Yes
Iris yellow spot virus	IYSV	Yes	Yes	Yes	Yes
Polygonum ringspot virus	PolRSV	Yes	Yes	Yes	No
Groundnut ringspot virus	GRSV	No	Yes	Yes	Yes
Tomato chlorotic spot virus	TCSV	No	Yes	Yes	Yes
Alstroemeria necrotic streak virus	ANSV	No	Yes	Yes	Yes
Chrysanthemum stem necrosis virus	CSNV	No	Yes	Yes	Yes
Melon severe mosaic virus	MSMV	No	Yes	Yes	Yes
Tomato yellow (fruit) ring virus	TYRV	No	Yes	Yes	Yes
Tomato zonate spot virus	TZSV	No	Yes	Yes	Yes
Groundnut yellow spot virus	GYSV	No	Yes	No or limited	Yes
Groundnut chlorotic fan-spot virus	GCFSV	No	Yes	No or limited	Yes
Groundnut bud necrosis virus	GBNV	No	Yes	No or limited	Yes
Zucchini lethal chlorosis virus	ZLCV	No	Yes	No or limited	Yes?
Capsicum chlorosis virus	CaCV	No	Yes	No or limited	Yes
Watermelon bud necrosis virus	WBNV	No	Yes	No or limited	Yes
Watermelon silver mottle virus	WSMoV	No	Yes	No or limited	Yes
Tomato necrotic ringspot virus	TNRV	No	Yes	No or limited	Yes
Calla lily chlorotic spot virus	CCSV	No	Yes	No or limited	Yes
Melon yellow spot virus	MYSV	No	Yes	No or limited	Yes
Soybean vein necrosis-associated virus	SVNaV	No	Yes	?	Yes
Bean necrotic mosaic virus	BeNMV	No	Yes	?	Yes
Pepper necrotic spot virus	PNSV	No	YES	?	Yes

Only four tospoviruses are so far definitely known to be present in the risk assessment area (TSWV, INSV, IYSV and PolRSV). CSNV was transiently present and has been eradicated. There is little uncertainty about the presence of TSWV, INSV, IYSV and PolRSV in Europe whereas the rating of absence for the other viruses is accompanied by uncertainties.

Almost all tospoviruses either have natural hosts that are important crops grown in Europe (tomato, pepper, lettuce, cucurbits, ornamentals, beans, soybean, etc.) or have been shown experimentally to infect some of these crops and cause symptoms in some following artificial inoculation. In the case of viruses known to infect crop plants grown in Europe, uncertainties are limited, except in particular cases in which the susceptibility of a crop has been demonstrated only through experimental inoculations.

Ten tospovirus species (TSWV, INSV, IYSV, PolRSV, GRSV, TCSV, ANSV, CSNV, MSMV and TYRV) are transmitted by one or more of the thrips species distributed widely in Europe. The other tospovirus species are transmitted by thrips species that are not present or have a limited distribution in Europe, or the vector species are currently unknown. Uncertainties result from incomplete information on the precise situation of thrips species currently assumed to be absent or of limited distribution in Europe. Uncertainties also concern viruses with unknown vectors as these viruses could still conceivably be transmitted by thrips species present in the EU.

Finally, almost all tospovirus species, with the exception of PolRSV, clearly have the potential to cause some degree of damage to crops grown in Europe. Although PolRSV is present in Europe and is associated with a thrips vector species also present in Europe, this tospovirus has never been observed to cause damage, even in crops growing close to their native weed host. Uncertainties affect both the capacity to cause damage (PolRSV) and the extent of the damage that could be caused (all tospovirus species but with lower uncertainty for viruses already present in Europe).

Considering all factors, the Panel concluded that the 24 tospovirus species can be allocated to four broad categories based on the risk they could present to the EU territory:

- Viruses present in the risk assessment area but apparently without the potential to cause damage to crops. This category includes only PolRSV, for which the risk is considered minimal. As a consequence, PolRSV does not appear to fit the criteria needed for development of a full risk assessment.

- Viruses absent from the risk assessment area but whose natural or experimental hosts are crops grown in Europe and whose known thrips vector species are not widely distributed in Europe. This category comprises 13 tospoviruses: GBNV, GYSV, GCFSV ZLCV, CaCV, WBNV, WSMoV, CCSV, MYSV, TNRV, SVNaV, BeNMV and PNSV. If introduced, the damage potential of these viruses would be mitigated by the absence (or limited distribution) of vector(s); thus, the risk from these viruses is assessed as limited but with significant uncertainty.[4] In particular, it should be stressed that new experimental data on the vector range of a particular virus, or changes in the geographical distribution or prevalence of vector species, could necessitate the reallocation of viruses in this category to a higher risk category.

- Viruses absent from the risk assessment area but whose natural or experimental hosts are crops grown in Europe and whose thrips species vectors are present in Europe. This category comprises seven tospoviruses: GRSV, TCSV, ANSV, CSNV, MSMV, TYRV and TZSV. Of these viruses, only CSNV is currently regulated in the risk assessment area (Annex IIAI and

[4] The pest risk analysis (CSL, 1997) for WSMoV concluded that potential for damage exists for cucurbit crops (cucumber in particular) under protected conditions should the virus be introduced together with its exotic vector species. As a consequence, WSMoV is currently included by EPPO in its A1 list.

Annex IVAI of Council Directive 2000/29/EC) and included in EPPO's A1 list of quarantine pests not present in the EPPO area. If introduced, these tospoviruses have the potential to cause damage to at least some crops grown in Europe. This analysis carries uncertainties as to the level of damage that would result from their introduction but, according to the information available, viruses in this category have the highest potential for damage if introduced in the risk assessment area.

- The last category comprises TSWV, INSV and IYSV, which are already present in the risk assessment area. Both the host(s) and vector(s) of these viruses are present in at least a large part of the risk assessment area and they currently affect crops in several Member States. They have already demonstrated their potential for damage. However, there are some differences between these agents, in particular in terms of their regulatory status and of the extent to which they currently occupy their full potential range in the risk assessment area. Of these three viruses, TSWV is the only one that is regulated. It has the broadest range of host and insect vectors and is commonly found in the risk assessment area. Although regulated and broadly distributed both inside and outside the risk assessment area, interception reports are extremely limited (on average fewer than two per year), which suggests low effectiveness of controls or poor reporting of the interceptions. Development of a full risk assessment may, however, provide a clearer picture in terms of geographical distribution and an evaluation of the potential consequences of repealing the current legislation. Both INSV and IYSV are also present in the risk assessment area but are not under official control. As such, they do not meet the criteria for the development of a full risk assessment. IYSV seems to be a recent introduction and may not have yet achieved its full potential range in the risk assessment area. However, because of the limited impact caused by IYSV, in 2009 the EPPO Panel on phytosanitary measures concluded that the pest should not be recommended for regulation and IYSV was consequently removed from the EPPO lists. As a consequence of these various findings, the Panel concludes that INSV and IYSV do not meet the criteria for the development of full risk assessments.

Finally, the Panel wishes to stress that many of the viruses analysed here have been discovered and described very recently; thus the information available is extremely limited (only one or few, i.e. 5–10, peer-reviewed scientific publications). In theses cases, the full range of the available literature as scrutinised when preparing the present opinion so that development of a full risk assessment is unlikely to bring any further understanding. This situation concerns in particular ANSV, GCFSV, ZLCV, CCSV, MSMV, PolRSV, TNRV, TZSV, WBNV, SVNaV, BeNMV and PNSV.

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BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION

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.l).

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 genus of plant-infecting viruses *Tospovirus* (tospoviruses) takes its name from the *Tomato spotted wilt virus*, which was the first species to be described in 1915. The development of molecular genetic techniques has allowed the identification since the 1990s of several additional species.

Tospoviruses are capable of infecting a very large number of plant species, including both food crops and ornamental species. They are usually vectored by thrips. Infection with tospoviruses leads to tissue necrosis in leaves and fruits, wilting, reduced vegetative growth and eventually death of the host plant. *Tospoviruses* rank therefore among the most detrimental plant viruses worldwide.

Presently one member of the genus *Tospovirus* (*Tomato spotted wilt virus*) and a proposed member of this genus (*Chrysanthemum stem necrosis virus*) are regulated in the EU. *Chrysanthemum stem necrosis virus* is listed in Annex IIAI of Council Directive 2000/29/EC, as a harmful organism not known to occur in the EU and whose introduction into and spread within the EU is banned if it is found present on certain plants or plant products. On the other hand, *Tomato spotted wilt virus* is listed in Annex IIAII, since it is known to occur in the EU. Other Annexes of Council Directive 2000/29/EC lay down requirements for the introduction and movement of plants and plant products that could be carriers of these viruses and their vectors.

Given the fact that *Tomato spotted wilt virus* is already locally present in the EU territory and that is regulated in the EU since a long time, it is considered to be appropriate, similarly as for other Annex IIAII organisms, to evaluate whether it deserves to remain regulated under Council Directive 2000/29/EC. At the same time it is considered relevant to determine whether more recently identified tospoviruses would require EU regulation due to the risk they pose to plant health. In order to carry out this work a recent pest risk analysis of *Tomato spotted wilt virus* as well as of the other tospoviruses, covering the EU territory, is needed.

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 *Tomato spotted wilt virus* as well as of the other tospoviruses for the EU territory.

EFSA is asked to identify risk management options and to evaluate their effectiveness in reducing the risk to plant health posed by the tospoviruses. EFSA is also requested to provide an opinion on the effectiveness of the present EU requirements against *Tomato spotted wilt virus* and *Chrysanthemum stem necrosis virus*, which are laid down in Council Directive 2000/29/EC, in reducing the risk of introduction of these organisms into, and their spread within, the EU territory.

ASSESSMENT

1. Introduction

1.1. Scope and purpose

In this opinion, the Panel limits the pest risk assessment of the tospoviruses to the pest categorisation stage. In the conclusions of this opinion the Panel recommends which of the tospoviruses should be the subject of a more detailed and complete risk assessment.

The complete pest risk assessment of the tospoviruses, and in particular of the *Tomato spotted wilt virus* (TSWV), including the identification and evaluation of risk reduction options as requested in the terms of reference, is not part of this opinion and will be provided separately.

1.2. Methodology

The Panel performed the pest categorisation stage of the tospoviruses following the guiding principles and steps presented in EFSA guidance on the harmonised framework for risk assessment (EFSA Panel on Plant Health (PLH), 2010) and as defined in the International Standard for Phytosanitary Measures No 11 (FAO, 2004).

The evidence considered by the Panel in its assessment was obtained from:

i) expert knowledge in the field;
ii) specific literature searches, where expert knowledge was not sufficient; and
iii) a questionnaire sent to the National Plant Protection Organisations (NPPOs) of the 27 EU Member States (see Appendix C).

For this opinion on pest categorisation of tospoviruses, the Panel identified four key questions for which a specific search strategy was developed. These questions are:

i) Is the virus present in the risk assessment area?
ii) Are the virus's host plants present in the risk assessment area?
iii) Are the virus's thrips vector species present in the risk assessment area?
iv) What is the potential for damage to crops grown in Europe?

Whenever relevant and robust evidence was identified that would provide a positive answer to one of these questions, it was considered by the Panel that sufficient information had been obtained to allow robust conclusions on pest categorisation. Therefore, in such cases, literature searches were not further extended, as the identification of additional information would have been unlikely to change the conclusions reached by the Panel. As a consequence, in some cases, the information provided, such as the precise distribution of particular virus or thrips vector species within the risk assessment area or the host or vector range of a particular virus species, is not necessarily exhaustive.

In contrast, if negative answers to the above questions were obtained after the initial evaluation of the literature, extensive literature searches were performed in order to be as certain as possible that evidence in support of positive answers had not been missed.

The EUROPHYT database[5] was consulted in March 2012, searching specifically on tospoviruses and thrips species.

[5] EUROPHYT is a web-based network launched by DG Health and Consumers Protection, and is a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. EUROPHYT database manages notifications of interceptions of plants or plant products that do not comply with EU legislation.

2. Stage 1: initiation

2.1. Reason for performing the pest risk assessment

Following a request from the European Commission, the Panel was asked to deliver a scientific opinion on the pest categorisation of the tospoviruses in order to better focus pest risk assessments on the organisms identified as posing a risk to the pest risk assessment area.

2.2. The risk assessment area

The pest risk assessment area is the EU territory restricted to the continental EU territory including the Mediterranean islands, the British islands, Madeira and the Azores islands.

2.3. Earlier pest risk assessments and validity

Pest risk analyses have already been performed on several tospoviruses and their vectors. The following pest risk analyses were taken into account by the Panel in formulating this opinion:

- *Chrysanthemum stem necrosis virus* (CNSV) (CSL, 2003)
- *Watermelon silver mottle virus* (WSMoV) (CSL, 1997)
- *Impatiens necrotic spot virus* (INSV) (EPPO, 1997)
- *Iris yellow spot virus* (IYSV) (CSL, 2007; EPPO, 2006, 2009)
- *Scirtothrips dorsalis* (CSL, 2006; PPS NL, 2009).

2.4. Host plant species in the risk assessment area

Some tospoviruses have an extremely wide host range (for example *Tomato spotted wilt virus* or *Impatiens necrotic spot virus*). Current knowledge of the host range of the other viruses is limited as a consequence of their rather recent discovery. However, the identification, for any given virus species, of at least one significant host crop grown in Europe is sufficient to ensure that host plants are available in the risk assessment area.

In reaching its conclusions the Panel considered two types of information regarding the host range of tospoviruses. The preferred information concerned the natural host range, provided by records of natural infection. When such information was limited or unavailable, the Panel considered information obtained through experimental inoculation of plants (experimental host range) as an alternative.

2.5. Pest distribution

As explained in section 1.2, the Panel considered the key parameter for pest categorisation to be the presence of a particular virus in the pest risk assessment area and that precise information on the distribution of the virus within the pest risk assessment area was of less importance. Thus, the Panel limited its literature searches to confirmation of the presence or absence of each tospovirus in each of the 27 Member States. Further details and more precise information on pest presence at national and regional level in the EU Member States were requested from NPPO representatives by sending them a questionnaire (see Appendix C).

As initial literature searches failed to demonstrate the presence of some viruses in the pest risk assessment area, the Panel performed an extensive literature search in order to ascertain that evidence in support of the virus presence had not been missed.

The Panel consulted the database EUROPHYT in March 2012 for the tospoviruses and their vectors. This database includes the notifications of interceptions of plants or plants products not complying with EU legislation.

3. Stage 2: pest risk assessment – pest categorisation

3.1. Identity of the pest

Tospoviruses are enveloped viruses with genomes consisting of three molecules of negative and ambisense RNA. Tospoviruses constitute the only genus of plant pathogenic viruses in the family *Bunyaviridae*; the other viruses in this family exclusively infect animals. Tospoviruses have spherical particle morphology (80–120 nm diameter) and projections displayed on the surface of virions are embedded in a lipid envelope. These surface spikes are made of glycoproteins (GPs) and are the major determinants of specificity and transmission by the thrips vectors (Sin et al., 2005; Ullman et al., 2005).

The three unique single-stranded RNA (ssRNA) segments, designated L, M and S, are tightly encapsidated by the nucleoprotein subunits, forming a ribonucleoprotein complex surrounded by the lipoprotein envelope. RNA genome segment L encodes the RNA-dependent RNA polymerase (L) involved in transcription and replication (Chapman et al., 2003). The glycoprotein precursor, which is cleaved into the two glycoproteins, G_N and G_C, implicated in virus transmission and particle assembly, is located on the M RNA. G_N and G_C are located on the viral surface and are probably the first components to interact with receptor molecules in the vector midgut. A virus with a mutation in the glycoprotein open reading frame (GP ORF) is still able to infect plants, but is no longer transmissible by thrips. Therefore, GPs play important roles in the virus infection of thrips and are necessary for acquisition (Whitfield et al., 2005). On this M segment, the non-structural protein NS_M is the viral movement protein involved in cell-to-cell transport in the host plant (Kikkert et al., 1999, 2001). The ambisense S RNA genome segment contains the nucleoprotein (N) responsible for particle structure and transcription regulation (de Haan et al., 1990; Snippe et al., 2007) and a non-structural protein NS_S in viral sense which is the suppressor of RNA silencing (Takeda et al., 2002; Bucher et al., 2003).

Tospoviruses have multisegmented genomes, and exchange of genetic material between viruses can occur when two viruses are present in co-infection. This exchange involves recombination of portions and/or reassortment of complete genome segments, a mechanism used by multisegmented viruses to adapt to changing environments (Tentchev et al., 2011). Reassortment of genomic RNAs occurs in all genera of the *Bunyaviridae* and has been experimentally shown to occur in several tospoviruses (Best, 1961; Qiu et al., 1998; Okuda et al., 2003; Plyusnin et al., 2011). It leads to new genotypes such that the new virus resulting from reassortment may show biological characteristics different from those of its parents. The tomato-infecting tospovirus $L_GM_TS_G$, described from Florida (Webster et al., 2011), was first identified using enzyme-linked immunosorbent assay (ELISA) and reverse transcription polymerase chain reaction (RT-PCR), and results of a natural reassortment between two virus species, GRSV and TCSV (Webster et al., 2011). Although the biological features (transmission, resistance breaking) of the chimeric $L_GM_TS_G$ isolate resemble those of its parents, in other cases, mixed disease phenotypes have been observed (Okuda et al., 2003) or resistance found to be broken (Qiu and Moyer, 1999).

The nucleoprotein (N) located on the small S RNA is a key criterion for species demarcation within the genus, defining a distinct tospovirus species with N protein identity to other described species of less than 90 % (de Avila et al., 1993). Other criteria for species demarcation in the genus *Tospovirus* are the (or lack of) serological relationship of the N protein and biological data on plant host range and vector specificity (King et al., 2012). Host and vector ranges are often poorly known and difficult to analyse and in particular the range of virus vectors often is not explored or explored only poorly. Thus, molecular criteria for species demarcation tend to have significant weight. However, in light of reports about genome reassortment among the *Bunyaviridae,* using N gene sequences only may not be sufficient for identification of tospovirus species.

3.1.1. Tospovirus species

Currently 23 tospoviruses, 8 definite species and 15 not yet approved species, are listed in the Ninth Report of the International Committee on Taxonomy of Viruses (King et al., 2012; Plyusnin, 2012).

Three new putative species, *Soybean vein necrosis-associated virus* (Zhou et al., 2011), *Bean necrotic mosaic virus* (de Oliveira et al., 2011) and *Pepper necrotic spot virus* (Torres et al., 2012), have recently been described. Moreover, two viruses, *Tomato necrosis virus* and *Physalis severe mottle virus,* can be considered as isolates of previously described species.

The Panel therefore considered a total of 24 tospoviruses (Table 2).

Table 2: *Tospovirus* species

3.2. Tospovirus	Abbreviation	Synonyms	References
Alstroemeria necrotic streak virus	ANSV		Plyusnin et al., 2011
Bean necrotic mosaic virus	BeNMV		de Oliveira et al., 2011
Calla lily chlorotic spot virus	CCSV		Plyusnin et al., 2011
Capsicum chlorosis virus	CaCV	*Tomato necrosis virus*	Plyusnin et al., 2011
Chrysanthemum stem necrosis virus	CSNV		Plyusnin et al., 2011
Groundnut bud necrosis virus	GBNV	*Peanut bud necrosis virus*	Satyanarayana et al., 1996; Plyusnin et al., 2011
Groundnut chlorotic fan-spot virus	GCFSV	*Peanut chlorotic fan-spot virus*	Chen and Chiu, 1996; Plyusnin et al., 2011
Groundnut ringspot virus	GRSV		Plyusnin et al., 2011
Groundnut yellow spot virus	GYSV	*Peanut yellow spot virus*	Reddy et al., 1991; Plyusnin et al., 2011
Impatiens necrotic spot virus	INSV		Plyusnin et al., 2011
Iris yellow spot virus	IYSV		Plyusnin et al., 2011
Melon severe mosaic virus	MSMV		Plyusnin et al., 2011
Melon yellow spot virus	MYSV	*Physalis severe mottle virus*	Plyusnin et al., 2011
Pepper necrotic spot virus	PNSV		Torres et al., 2012
Polygonum ring spot virus	PolRSV		Plyusnin et al., 2011
Soybean vein necrosis-associated virus	SVNaV		Zhou et al., 2011
Tomato chlorotic spot virus	TCSV		Plyusnin et al., 2011
Tomato necrotic ringspot virus	TNRV		Plyusnin et al., 2011
Tomato spotted wilt virus	TSWV		Plyusnin et al., 2011
Tomato yellow ring virus	TYRV		Plyusnin et al., 2011
Tomato zonate spot virus	TZSV		Plyusnin et al., 2011
Watermelon bud necrosis virus	WBNV		Plyusnin et al., 2011
Watermelon silver mottle virus	WSMoV		Plyusnin et al., 2011
Zucchini lethal chlorosis virus	ZLCV		Plyusnin et al., 2011

3.2.1. Uncertainties about tospovirus taxonomy

There are two areas of uncertainty concerning tospovirus taxonomy and identification. The first arises from the fact that there are significant serological cross-relationships between some members of the genus. In fact, some serogroups within the genus have been described on this basis in the past. A consequence is that in several publications viral species may have been poorly or incorrectly assigned, with the ensuing potential for confusion in the literature.

Conversely, new virus species have sometimes been proposed on the basis of partial and incomplete efforts to characterise virus isolates. In a few cases, these species have later been been shown to be identical to existing validated species. Such a scenario occurred in the case of, for example, *Physalis severe mottle virus*, which was later shown to be a strain of *Melon yellow spot virus* (Okuda et al., 2006).

Finally, new tospoviruses are continually being described in publications, sometimes, unfortunately, on the basis of limited data, which clearly complicates (i) evaluation of whether the isolates described really represent new viral species and (ii) evaluation of the risks associated with agents for which biological information may be extremely limited.

The discovery of a reassorted virus originating from TCSV and GRSV and named $L_GM_TS_G$ suggests that caution should be exercised when defining species within the family *Bunyaviridae* based on their ability to reassort (Webster et al., 2011).

3.2.2. The tospovirus vector species

3.2.2.1. Life cycle of thrips

Thrips are small (1–2 mm in length), slender insects belonging to the order Thysanoptera (Mound, 2005). Of the 5 500 known thrips species, only relatively few, mainly members of family Thripidae, are serious crop pests (Lewis, 1997). They affect plants by direct feeding, which may leave visible signs of damage, such as leaf silvering (Palmer et al., 1989). Most thrips are highly polyphagous species with an extensive geographical distribution.

Frankliniella occidentalis provides a good general example of the life cycle of phytophagous thrips. Its lifespan varies with abiotic factors and host plants. Eggs are inserted singly by the female into leaf or petal tissue in an incision made by the saw-like ovipositor (Brødsgaard, 1989). Adult females oviposit up to 50 eggs (Reitz, 2008).

There are two larval instars. The first instar hatches within 5 days and moults into the second instar within 1–2 days at 30 °C. Second instars develop within 3–4 days into prepupae, which usually fall into the soil and pupate within 2 days (Lowry et al., 1992). Some prepupae can remain on the plant (Broadbent et al., 2003). The non-feeding pupal stages are almost immobile and develop distinct wing pads (Lewis, 1997). Adults emerge within 3 days at 30 °C (Lowry et al., 1992). After emergence the adults resume feeding and are readily dispersed by wind currents or through active flight (Brødsgaard, 1989).

Populations of most thrips species are bisexual, but females often predominate. Female thrips are always diploid and males haploid (arrhenotoky). Virgin females produce only male offspring, whereas fertilised females produce mostly females and fewer males from non-inseminated eggs. In contrast, reproduction in species/populations without males results only in females by parthenogenesis (thelotoky). Occasionally, both reproduction mechanisms are found in the same population (Moritz, 1997).

3.2.2.2. Virus transmission by thrips

Besides direct damage to plants, thrips are known to transmit tospoviruses in a persistent propagative manner (Ullman et al., 1997). So far 14 thrips species belonging to five genera of family Thripidae, subfamily Thripinae, have been reported as vectors of tospoviruses (see Table 3): *Frankliniella* (8), *Thrips* (3), *Scirtothrips* (1), *Dictyothrips* (1) and *Ceratothripoides* (1) (Jones, 2005; Whitfield et al., 2005; Persley et al., 2006; Riley et al., 2011). There is ample evidence that the virus–vector relationships linking tospoviruses to their thrips vectors demonstrate a high level of specificity, which also determines vector competence (Wijkamp et al., 1995; Cabrera-La Rosa and Kennedy, 2007; Riley et al., 2011). Tospoviruses can be transmitted by a single or several vector species (Wijkamp et al., 1995). Thrips transmit tospoviruses in a persistent propagative mode. TSWV replicates in the thrips vector (Ullman et al., 1993; Wijkamp et al., 1996), suggesting that TSWV and tospoviruses in general may have evolved from viruses infecting thrips (Goldbach and Peters, 1994). Larval and adult stages of thrips vectors can actively feed on virus-infected host plants and acquire viruses, but only L1 and early L2 instars become transmitters. Virus transmission is achieved by late L2 instars or adults after a latent period of circulation and multiplication in the vector (Wijkamp and Peters, 1993; van de Wetering et al., 1996; Ullman et al., 1997; Whitfield et al., 2005; Persley et al., 2006; Peters, 2008).

It is still unclear why only individuals which have acquired the virus at the larval stages can transmit. There are several hypotheses to explain the translocation of tospoviruses in thrips, which is relevant to their transmission ability (Nagata et al., 1999, 2002; de Assis et al., 2004; Whitfield et al., 2005). The most compelling one, proposed by Moritz et al. (2004), suggests that, after ingestion, viruses move from the midgut to the primary salivary glands only when direct contact occurs between the midgut, the visceral muscles and the glands. This direct contact exists at an early stage of the larval development, when these structures are compressed into the thorax. The connection is lost when the wings start to develop during the second larval stage.

Tospoviruses are also transmitted mechanically by wounding, a process that is only of experimental significance. Like all viruses, tospoviruses are disseminated with infected plant tissues used for vegetative propagation hence all plants infected with tospoviruses contribute to virus spread when cuttings are taken for vegetative propagation. Tospoviruses are not transmitted through seeds of infected plants (Mumford et al., 1996; Kormelink et al., 1998).

3.2.2.3. Thrips species transmitting tospoviruses

Table 3: Thrips species transmitting tospoviruses

Tospovirus	Abbreviation	Vector species identified	References
Alstroemeria necrotic streak virus	ANSV	*Frankliniella occidentalis*	Hassani-Mehraban et al., 2010
Bean necrotic mosaic virus	BeNMV	Unknown	de Oliveira et al., 2011
Calla lily chlorotic spot virus	CCSV	*Thrips palmi*	Chen et al., 2005
Capsicum chlorosis virus	CaCV	*Ceratothripoides claratis*	Premachandra et al., 2005
		T. palmi	Chiemsombat et al., 2008
		F. schultzei[(a)]	Persley et al., 2006[(a)]
Chrysanthemum stem necrosis virus	CSNV	*F. occidentalis, F. schultzei*	Bezzera et al., 1999; Nagata and de Ävila, 2000; Nagata et al., 2004
Groundnut bud necrosis virus	GBNV	*F. schultzei, T. palmi*	Amin et al., 1981; Lakshmi et al., 1995
		S. dorsalis	Meena et al., 2005
Groundnut chlorotic fan-spot virus	GCFV	*S. dorsalis*	Chen and Chiu, 1996; Chu et al., 2001
Groundnut ringspot virus	GRSV	*F. occidentalis*	Wijkamp et al., 1995
		F. schultzei	Nagata et al., 2004
		F. gemina	de Borbon et al., 2006
Groundnut yellow spot virus	GYSV	*S. dorsalis*	Reddy et al., 1991; Gopal et al., 2010
Impatiens necrotic spot virus	INSV	*F. occidentalis, F. intonsa, F. fusca*	Wijkamp et al., 1995; Sakurai et al., 2004; Naidu et al., 2001
Iris yellow spot virus	IYSV	*T. tabaci*	Cortes et al., 1998
		F. fusca	Srinivasan et al., 2012
Melon severe mosaic virus	MSMV	Unknown	
Melon yellow spot virus	MYSV	*T. palmi*	Kato et al., 2000
Pepper necrotic spot virus	PNSV	Unknown	
Polygonum ring spot virus	PolRSV	*Dictyothrips betae*	Ciuffo et al., 2010
Soybean vein necrosis-	SVNaV	Unknown	Zhou et al., 2011

Tospovirus	Abbreviation	Vector species identified	References
associated virus			
Tomato chlorotic spot virus	TCSV	*F. occidentalis, F. schultzei, F. intonsa*	Wijkamp et al., 1995
Tomato necrotic ringspot virus	TNRV	*C. claratis, T. palmi*	Seepiban et al., 2011
Tomato spotted wilt virus	TSWV	*T. tabaci, F. occidentalis, F. schultzei, F. intonsa*	Wijkamp et al., 1995
		F. bispinosa	Avila et al., 2006
		F. cephalica	Ohnishi et al., 2006
		F. fusca	Sakimura, 1963
		F. gemina	de Borbon et al., 2006
		T. setosus, T. palmi(a)	Fujisawa et al., 1988; Persley et al., 2006(a)
Tomato yellow ring virus	TYRV	*T. tabaci*	Rasoulpour and Izadpanah, 2007
Tomato zonate spot virus	TZSV	Unknown	
Watermelon bud necrosis virus	WBNV	*T. palmi*	Jain et al., 1998; Pappu et al., 2009
Watermelon silver mottle virus	WSMoV	*T. palmi*	Yeh et al., 1992; Chiemsombat et al., 2008
Zucchini lethal chlorosis virus	ZLCV	*F. zucchini*	Nakahara and Monteiro, 1999

(a) In Persley et al. (2006), which reports transmission of CaCV by *F schultzei* and TSWV by *T. palmi,* no experimental data are provided.

All 14 known virus-transmitting thrips species belong to five genera of family Thripidae, subfamily Thripinae:

I. Genus *Frankliniella*—eight vector species
II. Genus *Thrips*—three vector species
III. Genus *Scirtothrips*—one vector species
IV. Genus *Ceratothripoides*—one vector species
V. Genus *Dictyothrips*—one vector species.

- **Thrips present in Europe**

The four thrips species briefly described below are present in Europe and are considered in order of importance to the EU (Table 6 and Appendix A).

1. *Frankliniella occidentalis* (Pergande) (western flower thrips)

Origin and distribution. *F. occidentalis* originates from the western USA (Mound, 2002). In Europe, the species was first found in a glasshouse in the Netherlands on *Saintpaulia ionantha* (Mantel and van de Vrie, 1988) and then spread rapidly across the continent, mostly under protected cultivation (Smith, 1999). This thrips species was believed to survive and overwinter in the field in warmer climate (Tommassini and Maini, 1995). *F. occidentalis* has a cosmopolitan distribution in temperate areas on all continents (see Appendix A). It spreads through international shipments of ornamental plants (Perrings et al., 2005).

Important host plants. *F. occidentalis* attacks over 200 plant species from 60 families, including important crop plants such as ornamentals, vegetables (cucumber, aubergine, lettuce, onion, pepper, tomato, beans) and fruits (Yudin et al., 1986; Jones, 2005).

Tospoviruses transmitted. The western flower thrips is considered to be the most important thrips vector of tospoviruses (Goldbach and Peters, 1994; Wijkamp et al., 1995; Pappu et al., 2009; Riley et al., 2011). *F. occidentalis* has the highest transmission efficiency among Thripidae and is known to transmit the following six tospoviruses: ANSV, CSNV, GRSV, INSV, TCSV and TSWV.

2. *Frankliniella intonsa* (Trybom) (Eurasian flower thrips)

Origin and distribution. *F. intonsa* probably originates from Europe to Asia (Mound, 2011). The species is widespread throughout the Palaearctic and has also been reported from the USA, Canada and Australia (Moritz, 2006; Pappu et al., 2009; CABI, 2011c; Mound, 2011) (see Appendix A).

Important host plants. *F. intonsa* is a polyphagous species feeding primarily on the flowers of many vegetables, ornamentals, clover and lucerne (alfalfa) (Moritz et al., 2001).

Tospoviruses transmitted. According to Wijkamp et al. (1995) and Sakurai et al. (2004), this species is not a very efficient vector of tospoviruses. It is known to transmit the following three tospoviruses: TSWV, INSV and TCSV.

3. *Thrips tabaci* Lindeman (onion thrips)

Origin and distribution. *T. tabaci* probably originated in the eastern Mediterranean (Mound, 2002), and has currently a cosmopolitan distribution and is common throughout Africa, Australia, North, Central and South America, Asia, and Europe (Moritz et al., 2001; Mound, 2011; CABI, 2011d) (see Appendix A). The species is abundant in warm, dry areas, particularly when its preferred host plant, onion, is grown as an extensive monoculture, e.g. in southern Brazil (Mound, 1997).

Important host plants. *T. tabaci* infest plants from 25 families and is a pest of onion, cabbage, tobacco, cotton vegetables and ornamentals (Palmer et al., 1989; CABI, 2011d).

Tospoviruses transmitted. Although *T. tabaci* has long been recorded as a vector of TSWV (Pittman, 1927), only some populations are able to transmit tospoviruses (Zawirska, 1983; Wijkamp et al., 1995; Chatzivassiliou et al., 2002). *T. tabaci* is known to transmit the following three tospoviruses: TSWV, IYSV and TYRV.

Zawirska (1983) stated that there are two subspecies of *T. tabaci*. Later, Wijkamp et al. (1995) and Chatzivassiliou et al. (2002) tested different populations of *T. tabaci* and establish that the arrhenotokous populations transmit TSWV, whereas thelotokous populations do not. Brunner et al. (2004) report that *T. tabaci* forms a cryptic species complex with three genetically distinct lineages.

4. *Dictyothrips betae* (Uzel)

Origin and distribution. *D. betae* is distributed in the Palaearctic region and is found in many European countries. It has been reported from the Czech Republic, Hungary, Romania, Russia, Ukraine, the Netherlands, Italy and Bulgaria, but is considered a rare species (zur Strassen, 2003) (see Appendix A).

Important host plants. The host range of *D. betae* is unknown (zur Strassen, 2003). Recently, it has been reported on sugar beet (Ciuffo et al., 2010).

Tospoviruses transmitted. *D. betae* has been reported to transmit a recently described tospovirus, PolRSV (Ciuffo et al., 2008 and 2010).

- **Tospovirus thrips vectors absent from Europe or transient or under eradication**

Ten thrips vector species are absent from Europe or transient or under eradication (Table 6 and Appendix A):

1. *Scirtothrips dorsalis* (Hood) (chilli thrips, yellow tea thrips)

Origin and distribution. *S. dorsalis* probably originates from South-East Asia (Mound, 2002) and is widespread throughout Asia from Pakistan through Malaysia and Indonesia to Taiwan and Japan, and is also found Australia and Africa (Chu et al., 2001; Mound, 2007, 2011; CABI 2012e) (see Appendix A). In Europe, *S. dorsalis* has been reported only indoors in the Netherlands (Fytosignalering, 2009), where it has been eradicated, and in southern England in May, 2008 (IPPC, 2009). However, information from the UK from February, 2012 (Richard McIntosh, Plant Health Division, Defra, York, UK, personal communication, 2012), reveals that the local outbreak of *S. dorsalis* from 2008 is still ongoing. Hence, the pest is not known to have spread to new locations. *S. dorsalis* is listed in Annex IIAI of Council Directive 2000/29.

Important host plants. *S. dorsalis* is a polyphagous pest on 150 plant species in 40 families including cut flowers, fruits and vegetables (Jones, 2005; Riley et al., 2011). The main hosts are acacia, chilli, tea, groundnut, citrus and cotton (Palmer et al., 1989).

Tospoviruses transmitted. *S. dorsalis* is an efficient vector of three tospoviruses: GBNV, GCFSV and GYSV.

2. *Thrips palmi* (Karny) (melon thrips)

Origin and distribution. *T. palmi* is a tropical species and probably originates from South-East Asia (Mound, 2002). The pest is listed in Annex IAI of Council Directive 2000/29/EC. It is widespread throughout Asia, northern Australia, Pacific, the Caribbean and Central America, Florida, Sudan and Nigeria (Murai, 2001; Moritz, 2006; Pappu et al., 2009; Mound, 2011) (see Appendix A). It is frequently intercepted in Europe, particularly on imported ornamentals (EUROPHYT database consulted in March 2012), and has caused a few outbreaks in glasshouses. *T. palmi* has also been reported on an outdoor crop in north-west Portugal (Jones, 2005), but no further details are available. Successful eradication programmes have been implemented in the Netherlands and the United Kingdom (England and Wales) (Jones, 2005; CABI, 2011f).

Important host plants. *T. palmi* is a polyphagous pest of 20 plant families including Cucurbitaceae and Solanaceae. The species is known to feed on chilli and sweet pepper, cucumber, aubergine, melon, potato, pumpkin, squash and watermelon (Palmer et al., 1989; Jones, 2005). In Portugal, it has been found on kiwi (Jones, 2005).

Tospoviruses transmitted. According to Pappu et al. (2009) *T. palmi* is the most efficient vector of tospoviruses in Asia and it is currently known to transmit eight tospoviruses.

T. palmi was first reported to transmit TSWV by Fujisawa et al. (1988). However, several later studies have failed to confirm this (Murai, 2001; Nagata et al., 2004). Persley et al. (2006) confirmed the record of transmission of TSWV by *T. palmi*; however, the authors do not provide experimental data. The possibility cannot be excluded that the first research was performed with another tospovirus (e.g. WSMoV) at a time when identification tools were not as advanced. *T. palmi* is known to transmit the following eight tospoviruses: TSWV[6], CCSV, GBNV, MYSV, WSMoV, CaCV, WBNV and TNRV.

3. *Frankliniella schultzei* (Trybom) (tomato thrips)

Origin and distribution. *F. schultzei* originates from South America (Mound, 2002) and is a common pest in the tropics (Sakurai, 2004). The species is currently found throughout Africa, Asia, Australia, the Caribbean and the Pacific regions and Europe (Mound, 1996; Moritz, 2006) (see Appendix A). In Europe, it has been occasionally reported in Belgium, the Netherlands and Spain (Mantel and van de Vrie, 1988; CABI, 2011a), and incidentally reported in Italy (see Appendix C, Table 17) and Great Britain (CABI, 2011a).

Important host plants. *F. schultzei* is polyphagous and feeds on plants belonging to 35 families and 83 species including cotton, pea, peanuts, pepper, onion, tomatoes and several ornamentals (Palmer et al., 1989).

[6] Persley et al. (2006) reports transmission of TSWV by *T. palmi,* however no experimental data are provided.

Tospoviruses transmitted. *F. schultzei* has two forms: pale (yellow with brownish blotches) and dark (dark brown) (Sakimura, 1969). The dark form transmits TSWV, TCSV and GRSV more efficiently than the light form, which seems to transmit only TSWV and TCSV (Wijkamp et al., 1995). Persley et al. (2006) reported that Australian isolates of TSWV were transmitted by the yellow form of *F. schultzei*. *F. schultzei* transmits the following six tospoviruses: CSNV, GRSV, GBNV, TCSV, TSWV and CaCV.[7]

4. *Frankliniella fusca* (Hinds) (tobacco thrips)

Origin and distribution. *F. fusca* is native to eastern USA, but is now spread throughout North America, Mexico and Japan (Palmer et al., 1989; Mound, 2002; CABI, 2011b; Nakao et al., 2011) (see Appendix A). In the Netherlands, ornamental plants of the genera *Hippeastrum* and *Narcissus* are hosts for this species (Mantel and van de Vrie, 1988; Jones, 2005).

Important host plants. *F. fusca* is a common pest in grasslands and on groundnut, tobacco, cotton and onion (Palmer et al., 1989).

Tospoviruses transmitted. *F. fusca* is one of the main vectors responsible for TSWV outbreaks in south-eastern USA (McPherson et al., 1999). The following three tospoviruses are transmitted by this species: TSWV, INSV and IYSV.

5. *Ceratothripoides claratris* (Shumsher) (oriental tomato thrips)

According to Mound and Nickle (2009), *C. claratris* is possibly a variant of *C. cameroni*.

Origin and distribution. *C. claratris* originates from India (Mound and Kibby, 1998). It is currently distributed in South and South-East Asia, South America and Cuba (Mound, 2005; Suris and Rodriguez-Romero, 2009; Riley et al., 2011) (see Appendix A).

Important host plants. *C. claratris* is the most prevalent pest thrips species of tomato in Thailand (Premachandra et al., 2005) and has also been recorded on cucurbits (Mound and Kirby, 1998).

Tospoviruses transmitted. *C. claratris* is known to transmit the following two tospoviruses: CaCV and TNRV.

6. *Frankliniella gemina* (Bagnall)

Origin and distribution. *F. gemina* has been reported from Brazil (Cavalleri et al., 2006; Carrizo et al., 2008) and Argentina (de Borbon et al., 1999).

Important host plants. *F. gemina* feeds on flowers of various plant species, including avocado, tomato, lucerne, lettuce and strawberries (de Borbon et al., 1999; Pinent et al., 2006, 2007).

Tospoviruses transmitted. *F. gemina* is known to transmit the following two tospoviruses: TSWV and GRSV.

7. *Frankliniella zucchini* (Nakahara and Monteiro)

Origin and distribution. *F. zucchini* probably originates from South America (Mound, 2002) and its known distribution is limited to Brazil (Nakahara and Monteiro, 1999; Moritz et al., 2001).

Important host plants. *F. zucchini* is reported as a pest of courgette (zucchini) (*Cucurbita pepo* L.) (Nakahara and Monteiro, 1999) and other cucurbits such as watermelon and cucumber (Nagata et al., 1998; Nakahara and Monteiro, 1999).

Tospoviruses transmitted. *F. zucchini* transmits only ZLCV.

[7] In Persley et al. (2006) which reports transmission of CaCV by *F. schultzei,* no experimental data is provided.

8. *Thrips setosus* (Moulton) (Japanese flower thrips)
Origin and distribution. *T. setosus* originates from Japan (Mound, 2002) and has been recorded in Japan and Korea (Palmer et al., 1989; Mound, 2002; Riley et al., 2011).

Important host plants. The most important host crops of *T. setosus* are tomato, tobacco (Mound, 2007), citrus, tea and ornamentals (Miyazaki and Kudo, 1988).

Tospoviruses transmitted. *T. setosus* transmits only TSWV.

9. *Frankliniella cephalica* (Crawford) (Florida flower thrips)
According to CABI (2011g), *F. cephalica* is a synonym of *F. bispinosa*. However, they are two separate species according to Mound (2011).

Origin and distribution. *F. cephalica* originates from Mexico and the Caribbean (Mound, 2011). It has expanded its distribution to Florida and Japan (Masumoto and Okajima, 2004; Diffie et al., 2008; Riley et al., 2011) (see Appendix A).

Important host plants. *F. cephalica* has been found on *Ipomoea batatas* (L.), tomato and citrus (Frantz and Mellinger, 1990; Masumoto and Okajima, 2004; Childers and Nakahara, 2006; Riley et al., 2011).

Tospovirus transmitted. *F. cephalica* transmits only TSWV.

10. *Frankliniella bispinosa* (Morgan) (Florida flower thrips)
Origin and distribution. *F. bispinosa* probably originates from south-eastern USA (Mound, 2002). It is currently distributed in the states of Florida, Georgia, Alabama and South Carolina and has also been recorded in the Bahamas and Bermuda (Moritz, 2006; CABI, 2011g) (see Appendix A).

Important host plants. *F. bispinosa* feeds on citrus (Childers and Nakahara, 2006) and vegetables such as tomato, pepper, aubergine, potato, cucumber and beans (Frantz and Mellinger, 1990).

Tospoviruses transmitted. *F. bispinosa* is known to transmit TSWV.

3.2.3. Host range of tospoviruses

Tospoviruses are important pathogens of greenhouse and field-grown crops, with tomato, pepper, cucurbits and potato, but also onion, lettuce, beans and peas, being most significant to European food production. Table 4 shows a non-exhaustive list of susceptible crops grown in Europe for each tospovirus.

Table 4: Examples of some natural and experimental host crops of the tospoviruses

Tospovirus species	Abbreviation	Examples of susceptible crops found naturally infected	Examples of experimentally susceptible crops	References
Alstroemeria necrotic streak virus	ANSV	*Alstroemeria*	Tomato, pepper	Hassani-Mehraban et al., 2010
Bean necrotic mosaic virus	BeNMV	*Phaseolus* sp.	No reports	de Oliveira et al., 2011
Calla lily chlorotic spot virus	CCSV	*Zantedeschia*	Cucurbits	Chen et al., 2005

Capsicum chlorosis virus	CaCV	Groundnut, pepper, tomato orchids	Cucurbits, legumes	McMichael et al., 2002; Zheng et al., 2011; Mandal et al., 2012
Chrysanthemum stem necrosis virus	CSNV	Chrysanthemum	Solanaceae	Bezzera et al., 1999; Takeshita et al., 2011
Groundnut bud necrosis virus	GBNV	Groundnut, pepper, tomato	Legumes	Reddy et al., 1991, 1995
Groundnut chlorotic fan-spot virus	GCFSV	Groundnut	Legumes	Chen and Chiu, 1996
Groundnut ringspot virus	GRSV	Groundnut, tomato	Legumes, pepper	de Ävila et al., 1993
Groundnut yellow spot virus	GYSV	Groundnut	Legumes	Reddy et al., 1992
Impatiens necrotic spot virus	INSV	Ornamentals	Ornamentals	Law and Moyer, 1990; de Ävila et al., 1992; Daughtrey et al. 1997
Iris yellow spot virus	IYSV	Iris, onion and other *Allium* species	No reports	Cortes et al., 1998; Pozzer et al., 1999
Melon severe mosaic virus	MSMV	Melon	Sugar beet, pepper	Ciuffo et al., 2009
Melon yellow spot virus	MYSV	Melon, watermelon	Cucurbit species	Kato et al., 2000; Peng et al., 2011
Pepper necrotic spot virus	PNSV	Pepper	No reports	Torres et al., 2012
Polygonum ring spot virus	PolRSV	*Polygonum* sp.	Solanaceous hosts	Ciuffo et al., 2008
Soybean vein necrosis-associated virus	SVNaV	Soybean	No reports	Zhou et al., 2011
Tomato chlorotic spot virus	TCSV	Tomato	Pepper, tobacco	de Ävila et al., 1992
Tomato necrotic ringspot virus	TNRV	Tomato	Pepper, tomato	Chiemsombat et al., 2010; Hassani-Mehraban et al., 2011; Seebipan et al., 2011
Tomato spotted wilt virus	TSWV	Bean, groundnut, lettuce, potato, pepper, tobacco, tomato	Many other plant species	Brittlebank, 1919; Samuel et al., 1930
Tomato yellow ring virus	TYRV	Tomato	Various other plant species	Ghotbi et al., 2005; Hassani-Mehraban et al., 2005
Tomato zonate spot virus	TZSV	Tomato	Tobacco, bean, lettuce	Dong et al., 2008, 2009

Watermelon bud necrosis virus	WBNV	Watermelon	Solanaceous and fabaceous species, cucurbits	Singh and Krishnareddy, 1996
Watermelon silver mottle virus	WSMoV	Watermelon, tomato	Cucurbits, pepper, Tomato	Iwaki et al., 1984; Yeh and Chang, 1995
Zucchini lethal chlorosis virus	ZLCV	Zucchini	Cucurbits	Bezzera et al., 1999; Giampan et al., 2007

TSWV was the first tospovirus described, first in Australia in 1915 (Brittlebank, 1919; Samuel et al., 1930) and later in Europe in 1932 (Smith, 1932). It became widespread with the introduction of *F. occidentalis* in Europe during the 1980s. Now TSWV is present throughout the world and infects a wide range of plants, with more than 1 300 plant species—dicots and monocots, crop plants, ornamentals and weeds—susceptible to this virus (Peters, 2003). Most of the plant species susceptible to TSWV belong to the families Asteraceae and Solanaceae. INSV also has a broad host range of more than 300 species, mostly ornamentals. Although INSV presents a serious problem to the ornamentals industry (Daughtrey et al., 1997; Elliott et al., 2009), the virus can occasionally also infect, at a low level, field crops such as lettuce, cucumber and pepper (Vicchi et al., 1999) and potato (Perry et al., 2005). The host ranges of GBNV, IYSV and TYRV comprises, respectively, 61, 56 and 56 names. Extensive studies of the host ranges of most of the other tospovirus species have not been carried out. Most studies that have been performed have been restricted to a limited number of test plants, usually reported in the first paper describing the detection and identification of the virus in question.

3.2.4. Tospoviruses and symptoms

Tospoviruses cause serious diseases in crops and, with the exception of PolRSV, all were initially isolated from a diseased agricultural or horticultural crop. All are generally very damaging since, in addition to an overall reduction in yield, the marketing quality of the harvested product is seriously affected by pronounced symptoms on fruits (tomato and pepper), tubers (potato) and leaves (onion scapes and lettuce).

Symptoms of tospovirus infection vary according to the developmental stage of the plant at the time of inoculation, the virus strain, plant age and environmental (growth) factors. Most plants respond to tospovirus infections with systemic symptoms. In general, early infections can result in severe stunting (groundnut), wilting, leaf distortion and top necrosis (tomato), chlorotic/necrotic patches on leaves and plant death (lettuce), and tuber necrosis (potato). The symptoms on leaves and stems of infected crop plants include mosaic, mottle, ring spots and line patterns as well as wilting of leaves, leaf deformation, and stem and top necrosis. The most striking symptoms of tospoviruses are found on fruits, e.g. tomatoes, which can be the only parts of the plant to show symptoms, especially when virus infections are introduced late in the crop cycle. Chlorotic and necrotic rings and blotches, fruit discoloration and deformation caused by TSWV, GRSV, TCSV, TYRV and CaCV render affected fruits of tomato and pepper unmarketable. Tospoviruses, especially INSV, are a major problem in the ornamental industry (Daughtrey et al., 1997). Symptoms in ornamentals vary significantly since local and systemic infections depend on the host species. On some hosts, they can be found on few leaves only (Baker et al., 2007; Zheng et al., 2008), e.g. chrysanthemum, while on other hosts with systemic infection, spots and rings on leaves and systemic necrosis are observed (Kritzman et al., 2000). On leaves, the most striking symptoms indicating tospovirus infection are concentric chlorotic to necrotic rings or ring patterns, which can also be found on stems (Daughtrey et al., 1997). On stalks and bulbs of *Allium* spp. necrotic and/or chlorotic lesions (diamond shape) and twisting and bending of flower-bearing stalks mark infections with IYSV (Persley et al., 2006).

3.3. Determining whether the organism is a pest

Tospoviruses are serious plant pathogens and cause significant crop losses in many crops throughout the world (Goldbach and Peters, 1994), many of which are significant for the European food supply. TSWV has a worldwide occurrence and is one of the 10 most economically destructive plant viruses described to date (Scholthof et al., 2011). Many tospoviruses, such as GBNV, GRSV, TCSV, TYRV, TNRV and CaCV, cause diseases similar to those due to TSWV and hence should be considered as potentially serious pathogens of crops grown in Europe.

3.4. Presence or absence in the risk assessment area and regulatory status (pest status)

Although some tospoviruses, such as TSWV and INSV, occur worldwide, many have a more restricted known geographical distribution encompassing from one country to several continents. Table 5 provides information on the distribution by continent of the various tospoviruses.

Table 5: Geographic distribution of tospoviruses (modified and updated from Pappu et al., 2009)

Africa	Asia	Australasia	Europe	North America	South America
GRSV	CaCV	CaCV	CSNV[(a)]	GRSV	ANSV
INSV	CCSV	INSV	INSV	INSV	BeNMV
IYSV	CSNV	IYSV	IYSV	IYSV	CSNV
TSWV	GBNV	TSWV	PolRSV	MSMV	GRSV
	INSV		TSWV	SVNaV	INSV
	IYSV			TSWV	IYSV
	MYSV				TCSV
	TSWV				TSWV
	TYRV				ZLCV
	TZSV				
	WBNV				
	WSMoV				

(a) Not present in the EU, intercepted and eradicated

3.4.1. Occurrence of tospoviruses in the risk assessment area

Four tospoviruses have been reported as present in the risk assessment area (see distribution maps in Appendix A; see NPPO reporting in Appendix C, Table 8).

TSWV was first identified in Europe in 1932 (Smith, 1932) and is prevalent throughout the EU territory (Mumford et al., 1996) with the exception of several of the northern-most Member States[8] (see Appendix A and Appendix C, Table 8).

INSV was first reported from the Netherlands in 1992 (de Avila et al., 1992; Verhoeven and Roenhorst, 1995; Peters et al., 1996) and is found mostly in protected crops. Out of the 18 Member States that completed the questionnaire, 10 reported the presence of INSV, with local to nationwide distribution (see Appendix C, Table 8).

[8] There are some discrepancies between the answers received from the NPPO and the OEPP/EPPO distribution map, so that the precise situation in the northern states of the EU remains uncertain.

IYSV is a recently emerging tospovirus, with outbreaks in onions recorded from Spain (Cordoba-Selles et al., 2005), Germany (Leinhos et al., 2007), Greece (Chatzivassiliou et al., 2009), Italy (Tomassoli et al., 2009), Serbia (Bulajic et al., 2008), the Netherlands (Hoedjes et al., 2011) and the UK (Mumford et al., 2008). *T. tabaci* is the only reported vector of IYSV (Cortes et al., 1998;Kritzman et al., 2001), but recently *F. fusca* has been described as a second vector in the USA (Srinavasan et al., 2012). However, out of the 18 Member States returning the questionnaire, only Greece, Spain and Italy reported the presence of IYSV, with local to nationwide distribution (see Appendix C, Table 8).

PolRSV is a recently described tospovirus species from wild buckwheat collected in Piedmont, Italy (Ciuffo et al., 2008); however, although *Dictyothrips betae* was identified as vector species (Ciuffo et al., 2010) this virus was not found on nearby crop plants.

CSNV has been intercepted and eradicated in the UK (Mumford et al., 2003) and in other European countries (Verhoeven et al., 1996).

In its response to the questionnaire, the Hungarian NPPO reported GRSV as first detected in 2006 in open field and protected cultivations and indicated as current situation as “present, no details” (see Appendix C, Table 8). The Panel did not find any supporting evidence or reference substantiating this finding and considers that this record could result from false virus identification since serological cross-reactions exist between some tospoviruses (Kormelink et al., 1998; Plyusnin et al., 2011).

3.4.2. Uncertainties concerning the evaluation of the presence/absence of tospoviruses in the risk assessment area

Uncertainties affect conclusions on either presence or absence status of a particular virus. Even if it is the case that reliable information has been obtained demonstrating the presence of a given virus in the risk assessment area, uncertainties concern the precise status of the agents in each of the 27 Member States. This is largely due to the strategy adopted in the literature searches (as described in section 1.2), with the consequence that the virus may be present in more European countries than reported here. These uncertainties are well illustrated by discrepancies between the answers received from the NPPOs and the EPPO distribution maps.

The possibility also remains that a virus may already be present, permanently or transiently, in the risk assessment area, despite the fact that the Panel has not been able to identify any evidence to that effect.

3.4.3. Regulatory status of the tospoviruses and their vectors in the risk assessment area

3.4.3.1. Tospoviruses

- **Council Directive 2000/29/EC**

TSWV and CSNV are the only tospoviruses that are regulated by Council Directive 2000/29/EC in the pest risk assessment area:

i) TSWV

- TSWV is listed in Annex I B of Council Directive 2000/29/EC. Annex I B includes the harmful organisms whose introduction into and whose spread within certain protected zones shall be banned. Here Sweden and Finland are indicated as protected zones for TSWV.

- TSWV is listed in Annex II A II of the Council Directive 2000/29/EC. Annex II A includes the 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 of Annex II A includes the harmful organisms known to occur in the community and relevant for the entire community. The plants and plants products regulated for TSWV are plants of *Apium graveolens* L., *Capsicum annuum* L., *Cucumis melo* L., *Dendranthema* (DC.) Des Moul., all varieties of New Guinea hybrids *Impatiens*, *Lactuca sativa* L., *Lycopersicon lycopersicum* (L.) Karsten ex Farw., *Nicotiana tabacum* L., of which there shall be evidence that they are intended for sale to professional tobacco production, *Solanum melongena* L. and *Solanum tuberosum* L., intended for planting, other than seeds.

ii) CSNV

- CSNV is listed in Annex II A I of Council Directive 2000/29/EC. Annex II A includes the 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 I of Annex II A includes the harmful organisms not known to occur in the community and relevant for the entire community. The plants and plants products regulated for CNSV are plants of *Dendranthema* (DC.) Des Moul. and *Lycopersicon lycopersicum* (L.) Karsten ex Farw., intended for planting, other than seeds.

- CSNV is listed in Annex IV A I of Council Directive 2000/29/EC. Annex IV A indicates the 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 includes plants, plant products and other objects originating outside the community, namely plants of *Dendranthema* (DC.) Des Moul. and *Lycopersicon lycopersicum* (L.) Karsten ex Farw., intended for planting, other than seeds. Without prejudice to the requirements applicable to the plants listed in Annex III(A) (13), Annex IV(A)(I) (25.5), (25.6), (25.7), (27.1), (27.2) and (28), official statement that: (a) the plants have been grown throughout their life in a country free from *Chrysanthemum stem necrosis virus*; or (b) the plants have been grown throughout their life in an area established by the national plant protection organisation in the country of export as being free from *Chrysanthemum stem necrosis virus* in accordance with the relevant International Standards for Phytosanitary Measures; or (c) the plants have been grown throughout their life in a place of production, established as being free from *Chrysanthemum stem necrosis virus* and verified through official inspections and, where appropriate, testing.

- **EPPO A1 and A2 Lists** (EPPO, 2011)

The EPPO A1 list (quarantine pests not present in the EPPO area) includes CSNV and WSMoV.

The EPPO A2 list (quarantine pests present in the EPPO area but not widely distributed there and being officially controlled) includes INSV and TSWV.

3.4.3.2. Vectors

- **Council Directive 2000/29/EC**

T. palmi and *S. dorsalis* are the only vectors of tospoviruses regulated in the pest risk assessment area:

i) *Thrips palmi*

- *T. palmi* is listed in Annex I A I of Council Directive 2000/29/EC. Annex I A includes the harmful organisms whose introduction into, and spread within, all Member States shall be banned. Section I includes the harmful organisms not known to occur in any part of the community and relevant for the entire community.

- *T. palmi* is listed in Annex IV A I of Council Directive 2000/29/EC. Annex IV A indicates the 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 indicates the plants, plant products and other objects originating outside the community.

ii) *Scirtothrips dorsalis*

- *S. dorsalis* is listed in Annex II A I of Council Directive 2000/29/EC. Annex II A includes the 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 I of Annex II A includes the harmful organisms not known to occur in the community and relevant for the entire community.

- **EPPO A1 and A2 Lists (EPPO, 2011)**

The EPPO A1 list (quarantine pests not present in the EPPO area) includes *T. palmi.*

The EPPO A2 list (quarantine pests present in the EPPO area but not widely distributed there and being officially controlled) includes *F. occidentalis* and *S. dorsalis.*

3.5. Potential for establishment and spread in the risk assessment area

3.5.1. Host plant occurrence in the risk assessment area (outdoors, in protected cultivation or both)

Although the host range for most tospoviruses is not as extensive as for TSWV, tomato is very susceptible to the most important tospoviruses not present in Europe, CaCV, GRSV, TNRV, TYRV, TZSV WBNV (Tables 4 and 5). With tomato being produced in open-field and protected cultivation (plastic house, greenhouse) from the Mediterranean region to the northernmost countries within the EU, a main host plant for tospoviruses is present. Similarly, pepper, often cultivated along with tomato, is susceptible to tomato-infecting viruses and is found naturally infected with CaCV and TNRV, which also infects tomato.

Several tospoviruses are found infecting a range of ornamental plants, and INSV has a particularly wide host range. Although, experimentally, some typical ornamental tospoviruses, ANSV CCSV, CSNV or INSV can also infect tomato, pepper or cucurbits, this has in fact never been reported in nature.

Thus, with tomato, pepper, cucurbits and ornamentals being economically important horticultural crops and present throughout Europe, the most significant host plants for the most damaging tospoviruses are present in the risk assessment area.

3.5.1.1. Uncertainties about host plant occurrence in the risk assessment area

In the case of all tospoviruses analysed, at least one significant or more crop grown in Europe has been identified as a host species. Although they do not seriously compromise this overall conclusion, several uncertainties affect the analysis. The first concerns the fact that other crops than those listed above may also prove to be hosts for a given virus species, since no systematic efforts were made to identify all potential host species once a crop of European significance was identified as host.

The second uncertainty concerns hosts that have been identified on the basis of artificial inoculation experiments. Although there is little doubt that the corresponding species can indeed allow the replication and accumulation of the inoculated virus under the conditions used, this cannot be considered proof that significant epidemics may develop in the corresponding crops, even in the presence of suitable vectors. For example, PolRSV, although its experimental host range includes tomato, has not been observed to infect tomato crops neighbouring its natural host, the wild buckwheat (*Polygonum convolvulus*) (Ciuffo et al., 2008).

Finally, even when a plant species has been described as a host for a given virus species, the possibility remains that some varieties or ecotypes may prove resistant to viral infection. Resistance to some tospoviruses has been described in several plant species and has been exploited for the breeding of resistant varieties, as in the case of tomato and pepper varieties carrying the Sw-5 and TSw resistance genes to TSWV (Moury et al., 1998; Jahn et al., 2000; Soler et al., 2003).

3.5.2. Presence of vectors in the risk assessment area

The presence/absence in the risk assessment area of the 14 tospovirus vectors is shown in Table 6. Although many of these vectors have a tropical distribution, *T. tabaci*, *F. occidentalis* and *F. intonsa* are widely distributed in the EU. *F. schultzei* and *F. fusca* have limited distribution and *D. betae* has been reported mainly from non-cultivated crops.

Outbreaks of *S. dorsalis* and *T. palmi* have been reported several times in the EU, but the species are not established permanently. The other six species have never been reported in the EU.

Table 6: Tospovirus vectors presence/absence in the risk assessment area

Tospovirus	Tospovirus vectors widely distributed in Europe	References	Tospovirus vectors absent or transient or under eradication in Europe	References
Groundnut bud necrosis virus (GBNV)			*T. palmi*	Lakshmi et al., 1995; Mound, 2011
			F. schultzei	Mantel et al., 1988; Lakshmi et al., 1995
			S. dorsalis	Mantel et al., 1988; Mound, 2002; Meena et al., 2005
Groundnut ringspot virus (GRSV)	*F. occidentalis*	Mound, 2002; Nagata et al., 2004	*F. gemina*	de Borbon et al., 2006; Pinent et al., 2007
			F. schultzei	Mantel et al., 1988; de Borbon et al., 2006
Impatiens necrotic spot virus (INSV)	*F. occidentalis*	de Angelis et al., 1993; Mound, 2002	*F. fusca*	Mantel et al., 1988; Naidu et al., 2001; Pappu et al., 2009
	F. intonsa	Sakurai et al., 2004; Mound, 2011		
Tomato chlorotic spot virus (TCSV)	*F. occidentalis*	Mound, 2002; Nagata et al., 2004	*F. schultzei*	Mantel et al., 1988; Mound, 1996; Moritz, 2006
	F. intonsa	Wijkamp et al., 1995; Mound, 2011		
Tomato spotted wilt virus (TSWV)	*T. tabaci*	Wijkamp et al., 1995; Moritz et al., 2001	*T. palmi*	Fujisawa et al., 1988; Mound, 2011
	F. occidentalis	Mound, 2002; Medeiros et al., 2004; Nagata et al., 2004	*T. setosus*	Fujisawa et al., 1988; Tsuda et al., 1996; Mound, 2002
			F. bispinosa	Webb et al., 1998; Mound, 2002; Moritz, 2006;
			F. gemina	de Borbon et al., 2006; Pinent et al., 2007

			F. cephalica	Mound, 2011; Ohnishi et al., 2006
	F. intonsa	Wijkamp et al., 1995; Mound, 2011	*F. schultzei*	Sakimura, 1969, 2004; Moritz, 2006
			F. fusca	Sakimura, 1963; Mantel et al., 1988
Alstroemeria necrotic streak virus (ANSV)	*F. occidentalis*	Perrings et al., 2005; Hassani-Mehraban et al., 2010		
Chrysanthemum stem necrosis virus (CSNV)	*F. occidentalis*	Bezzera et al., 1999; Nagata and de Ävila, 2000; Nagata et al., 2004	*F. schultzei*	Mantel et al., 1988; Nagata et al., 2004; Moritz, 2006
Iris yellow spot virus (IYSV)	*T. tabaci*	Nagata et al., 1999; Moritz et al., 2001	*F. fusca*	Mound, 2002; Srinivasan et al., 2012
Polygonum ringspot virus (PolRSV)	*D. betae*	zur Strassen, 2003; Ciuffo et al., 2010		
Tomato yellow (fruit) ring virus (TYRV)	*T. tabaci*	Moritz et al., 2001; Golnaraghi et al., 2007		
Groundnut (peanut) yellow spot virus (GYSV)			*S. dorsalis*	Mound, 2002; Gopal et al., 2010
Watermelon silver mottle virus (WSMoV)			*T. palmi*	Iwaki et al. 1984; Mound, 2011
Zucchini lethal chlorosis virus (ZLCV)			*F. zucchini*	Nakahara and Monteiro, 1999; Mound, 2002;
Calla lily chlorotic spot virus (CCSV)			*T. palmi*	Chen et al., 2005; Mound, 2011
Capsicum chlorosis virus (CaCV)			*C. claratris*	Premachandra et al., 2005
			T. palmi	McMichael et al., 2002; Chiemsombat et al., 2008 ; Mound, 2011
			F. schultzei	Mound, 1996; Persley et al., 2006[a]
Groundnut chlorotic fan-spot virus (GCFSV)			*S. dorsalis*	Chen and Chiu, 1996; Mound, 2002, 2011
Melon yellow spot virus (MYSV)			*T. palmi*	Kato et al., 2000; Mound, 2011;
Tomato necrotic ringspot virus (TNRV)			*T. palmi*	Mound, 2011; Seepiban et al., 2011
			C. claratris	Mound and Kibby, 1998; Seepiban et al., 2011
Watermelon bud necrosis virus (WBNV)			*T. palmi*	Pappu et al., 2009; Rajasekharam, 2010; Mound, 2011
Melon severe mosaic virus (MSMV)	Vector unknown	Ciuffo et al., 2009	Vector unknown	Ciuffo et al., 2009
Tomato zonate spot virus (TZSV)	Vector unknown	Dong et al., 2008	Vector unknown	Dong et al., 2008

Bean necrotic mosaic virus (BeNMV)	Vector unknown	de Oliveira et al., 2011	Vector unknown	de Oliveira et al., 2011
Soybean vein necrosis-associated virus (SVNaV)	Vector unknown	Zhou et al., 2011	Vector unknown	Zhou et al., 2011
Pepper necrotic spot virus (PNSV)	Vector unknown	Torres et al., 2012	Vector unknown	Torres et al., 2012

(a) In Persley et al. (2006), which reports transmission of CaCV by *F. schultzei*, no experimental data are provided.

3.5.2.1. Uncertainties on presence of vector species in the risk assessment area

Besides problems potentially associated with false virus identification, uncertainties concerning the presence of a given virus or vector thrips species in the risk assessment area could have various origins.

The first concerns vector misidentification or problems of thrips taxonomy (doubts about synonymy and identification exist owing to the small differences in the determination characters). For example, *Thrips flavus* (Schrank) was initially described as a vector of WBNV in India (Singh and Krishnareddy, 1996) but, according to Mound (1996), the thrips species studied in this work was more likely *T. palmi*, which is morphologically very similar to *T. flavus*. Another example of uncertainty in the literature concerning *F. bispinosa*, presented as a synonym for *F. cephalica* according to CABI (2012g), but considered by Mound (2011) to be a distinct species.

Moreover, experimental demonstrations of the abilities of thrips to act as virus vectors vary significantly (Van de Wetering et al., 1999; Whitfield et al., 2005; Riley et al., 2011).

In the case of some *Tospovirus* species, the identification of thrips as virus vectors awaits experimental verification by transmission experiments in the laboratory. In these cases, owing to the lack of information on thrips species acting as vectors, a conclusion on the presence in the EU of vector species for that particular virus cannot be drawn.

Further uncertainties concern the conclusion of the presence or absence status of a particular thrips species in the risk assessment area. The literature search strategy adopted for the pest categorisation by the Panel (described in section 1.2) would detect the presence of a thrips species in part of the risk assessment area; however, uncertainties remain about the precise status of the organism in each of the 27 Member States. In the opposite situation, there is a low uncertainty when a thrips species is found to be present in the risk assessment area.

Moreover, despite the fact that the Panel has not been able to identify the appropriate evidence, a thrips species may already be present, permanently or transiently, in the risk assessment area.

3.5.3. Eco-climatic limitations in the risk assessment area (including protected conditions)

Eco-climatic factors are not known to impose any direct limits on the potential geographical distribution of tospoviruses. Generally, direct eco-climatic effects, known or unknown, are assumed to be negligible. However, eco-climatic limitations act indirectly on tospoviruses by limiting the potential geographical distributions of their host plants and their thrips species vectors. If the virus is transmitted by more than one vector to one or multiple hosts, the potential geographical distribution is limited to those areas where at least one vector organism and one tospovirus host plant attractive to the vector(s) are present. For some groups of viruses, such as the nanovirus *Banana bunchy top virus*, it is known that temperature directly affects virus transmission efficiency (Anhalt and Almeida, 2008).

For pest categorisation, the eco-climatic limitations are of particular importance for 10 of the 13 tospoviruses that are absent from the risk assessment area but which have either natural or experimental host crops in Europe and do not have known thrips vector species in Europe, these 10 being transmitted by at least one of the thrips species *T. palmi*, *F. zucchini, S. dorsalis* or *C. claratris*, which are absent in the EU. Regarding the vectors for the remaining 3 viruses of this category they are unknown.

The current distribution of *T. palmi*, *F. zucchini, S. dorsalis* and *C. claratris* in open-field conditions is in areas with a much warmer climate than the EU (see section 3.1.3.3). For example, in Japan, *T. palmi* cannot overwinter outdoors except in the very far south of the country, where winters are not cold. Further north, populations overwintering in glasshouses may act as foci for summer field infestations (Sakimura et al., 1986). The literature describing climatic requirements of *T. palmi*, *F. zucchini*, *S. dorsalis* and *C. claratris* is relatively sparse, and no specific information was found for *F. zucchini* (see Appendix B). The studies on climatic requirements of *T. palmi*, *S. dorsalis* and *C. claratris* (see Appendix B) mainly provide information on the temperature requirements and their optimum for population growth and development for these species, and no specific information was identified on tolerance to adverse conditions (e.g. lethal temperature limits). Because of the limited knowledge on the climatic requirements of these thrips vector species, an assessment of their potential for establishment outdoors in the EU must rely mainly on climatic comparisons with their current area of distribution.

Protected environments, such as glasshouses, in the risk assessment area provide conditions for the establishment of tospovirus thrips vectors in areas where the outdoor environment is not suitable for the vector to survive during the winter. McDonald et al. (1999) predicted the potential establishment of *T. palmi* in the UK, initially in glasshouses, but postulated further that in the summer months there would be sufficient warmth for several generations of the pest outside. In winter months re-infestation back into the glasshouses could occur. MacLeod et al. (2004) described the difficulties of eradicating an outbreak of *T. palmi* on chrysanthemum in the UK and the significant losses to protected crops that would be expected if this thrips species became established more widely.

Based on the above brief review, and taking into account the uncertainties regarding the climatic requirements for establishment of the thrips vector species currently absent from Europe, it can be concluded that these organisms, particularly *T. palmi* and *S. dorsalis*, could become established in the risk assessment area in protected cultivation conditions year-round, but will most likely have only a transient presence outdoors in the summer.

When performing a full pest risk assessment, a more detailed approach could be followed, e.g. by comparing the climatic requirements of those tospovirus vectors that are established in the EU and those that are absent.

3.5.3.1. Conclusions

Eco-climatic factors indirectly limit the potential area of tospovirus establishment outdoors in the EU by influencing the potential geographical distributions of their host plants and thrips vector.

Since the current area of distribution outdoors for the thrips vector species *T. palmi*, *F. zucchini, S. dorsalis* and *C. claratris* generally does not have the prolonged cold winter periods that occur in the EU territory, it is unlikely that these species can establish outdoors. However, these species may establish in protected crops and it is possible that transient populations can develop outdoors in summer months.

3.6. Potential for consequences in risk assessment area

Tospoviruses are reported from many parts of the world and cause harmful diseases in food crops and ornamentals grown under glasshouse conditions or in open fields. Losses attributable to tospovirus infection manifest as yield reductions, and are especially severe in the case of early infections.

Pronounced symptoms on fruits, flowers and leaves are serious quality deficiencies and result in unmarketable products.

Table 7: Examples of host crops grown in Europe potentially affected by tospoviruses and their vectors

Tospovirus	Abbreviation	Examples of crops currently affected by tospoviruses in Europe	Examples of crops that could be affected after introduction of a tospovirus species in Europe	References
Alstroemeria necrotic streak virus	ANSV		Alstroemeria, pepper, tomato	Hassani-Mehraban et al., 2010
Bean necrotic mosaic virus	BeNMV		Bean	de Oliveira et al., 2011
Calla lily chlorotic spot virus	CCSV		Cucurbits	Chen et al., 2005
Capsicum chlorosis virus	CaCV		Aubergine, pepper, tomato, orchids	McMichael et al., 2002; Zheng et al., 2010; Mandal et al., 2012
Chrysanthemum stem necrosis virus	CSNV		Chrysanthemum, aubergine, pepper, tomato	Bezzera et al., 1999; Takeshita et al., 2011
Groundnut bud necrosis virus	GBNV		Aubergines, pepper, tomato	Reddy et al., 1992
Groundnut chlorotic fan-spot virus	GCFSV		Legumes	Chen and Chiu, 1996
Groundnut ringspot virus	GRSV		Tomato, pepper	de Ävila et al., 1993
Groundnut yellow spot virus	GYSV		Legumes	Reddy et al., 1992
Impatiens necrotic spot virus	INSV	Ornamentals		Daughtrey et al, 1997
Iris yellow spot virus	IYSV	Onion		Leinhos et al., 2007
Melon severe mosaic virus	MSMV		Melon, tomato, pepper	Ciuffo et al., 2009
Melon yellow spot virus	MYSV		Melon	Kato et al., 2000; Peng et al., 2011
Pepper necrotic spot virus	PNSV		Pepper, tomato	Torres et al., 2012
Polygonum ring spot virus	PolRSV		Tomato	Ciuffo et al., 2010
Soybean vein necrosis-associated virus	SVNaV		Soybean	Zhou et al., 2011
Tomato chlorotic spot virus	TCSV		Tomato, pepper	De Ävila et al., 1993

Tomato necrotic ringspot virus	TNRV		Tomato, pepper	Chiemsombat et al., 2008; Hassani-Mehraban et al., 2011; Seebipan et al., 2011
Tomato spotted wilt virus	TSWV	Tobacco, tomato, pepper, lettuce, potato, beans, ornamentals		
Tomato yellow ring virus	TYRV		Tomato, pepper	Ghotbi et al., 2005; Hassani-Mehraban et al., 2005;
Tomato zonate spot virus	TZSV		Pepper, tomato, tobacco, bean	Dong et al., 2008
Watermelon bud necrosis virus	WBNV		Cucurbits	Singh and Krishnareddy et al., 1996
Watermelon silver mottle virus	WSMoV		Cucurbits	Iwaki et al., 1984; Yeh and Chang, 1995
Zucchini lethal chlorosis virus	ZLCV		Cucurbits	Bezerra et al., 1999; Giampan et al., 2007

3.6.1. Direct effects of the tospovirus

Direct effects of tospovirus infections of horticultural crops mainly affect tomato, pepper and cucurbits, but also field crops lettuce, onions, legumes and potato. Floricultural plants are the principal hosts for some tospoviruses, such as INSV, ANSV CSNV and CCSV; however, the natural host range of these viruses is not confined to ornamentals, and thus food crops are also prone to infections with these tospoviruses. Thus, although INSV causes significant disease in many glasshouse-grown ornamentals (Daughtrey et al., 1997), it has also been reported to infect cucumber, pepper and lettuce crops in Italy.

Direct effects of the tospovirus diseases include:

- stunted growth, reduced yield, and mortality of infected plants;
- reduced fruit quality, unappealing symptoms on fruits and leaves.

TSWV is the most ubiquitous tospovirus worldwide, causing harmful diseases in a wide range of floricultural and horticultural crops. Tomato and cucurbits are economically the most significant food crops hence tospoviruses infecting these crops are especially critical. Apart from TSWV, several tospovirus species causing tomato diseases have been described, from Asia, South America and Australia (de Avila et al., 1990; McMichael et al., 2002; Hassani-Mehraban et al., 2005, 2011; Chiemsombat et al., 2008; Dong et al., 2008; Huang et al., 2010; Seepiban et al., 2011). Although genetically distinct, most of these viruses cause symptoms similar to those associated with TSWV infection, with stunted plants, chlorotic and necrotic spots on leaves and petioles and a range of symptoms on fruits leading to unmarketable products. Although quantitative data on yield loss in crops and ornamentals are generally missing for these viruses, for tomato at least losses similar to those associated with TSWV diseases can be assumed. Moreover, serious consequences resulting from infections with tospoviruses other than TSWV in tomato and pepper can arise from breaking introgressed resistance, as reported for TSWV resistance Sw-5 (Jahn et al., 2000).

TSWV infections in tomato occurring at an early stage in development result in severe stunting of plants and abortion of flowers; in addition, when fruits eventually develop, they are small and have necrotic spots or rings and abnormal coloration. TSWV infections at later stages result in apical necrosis and irregular ripening with abnormal discoloration and necrotic ring or spot symptoms on fruits. Serious losses in yield and quality were reported by Moriones et al. (1998) in studies of natural TSWV infections in experimental plots in northern Spain. Yield losses were correlated with the onset of TSWV infection, and early infections resulted in significant reductions in numbers of fruit and fruit weight. Nevertheless, late infections of plants still had devastating effects on fruit quality, and severe losses were attributed to unmarketable fruits (Moriones et al., 1998). Field experiments in Turkey, involving natural infections of TSWV in experimental plots, resulted in crop losses up to 42 % with almost entire loss of marketable tomatoes because of unappealing fruit and decay (Sevik and Arli-Sokmen, 2012). Although extrapolation from studies in experimental stations to actual field situations is difficult, TSWV is considered a most serious pathogen for tomatoes and serious losses have been estimated for tomato production in different countries (Sevik and Arli-Sokmen, 2012).

Serious diseases in cucurbits (watermelon, melon, cucumber and courgette) crops caused by tospoviruses have been reported from India (WBNV), Mexico (MSMV), Brazil (ZLCV), Japan (MYSV) and Taiwan (WSMoV). Symptoms are similar to tospovirus infections in solanaceous crops and range from chlorotic mottling, blistering and mosaic to necrosis of buds, dieback and wilting on leaves, stems and stalks. Early infections lead to unmarketable fruits, with unappealing produce chlorotic/necrotic ring symptoms, uneven surfaces, scars and cracks or necrotic splitting of the fruit. In India, WBNV was not confined to cucurbits but was also reported as a serious pathogen of tomato and chilli (Kunkalikar et al., 2011). Regarding the tospoviruses for which host crops are grown in the EU, predominantly tomato, pepper and cucurbits, the Panel considers that the potential consequences could be major.

Tospovirus diseases, predominantly caused by TSWV and INSV, affect the ornamental industry, with INSV frequently found in greenhouse flower crops. Symptoms ranging from necrotic spots, necrotic veins, ringspots, white spots and blotches on leaves to stem necrosis render potted plants of begonia, impatiens, cyclamen and chrysanthemum rather unalluring and thus unmarketable. However, although serious losses have been reported for some very sensitive ornamentals, such as *Gloxina* (Daughtrey et al., 1997), the impact of tospovirus diseases on ornamental crop production can be considered moderate since damage may be restricted to a few leaves and flowers and does not necessarily affect entire plants.

In onions, IYSV can cause necrotic and/or chlorotic lesions (diamond shape) on stalks, which can be mistakenly attributed to fungal infection. However, symptoms occur only in foci of inoculation and infection remains localised to these areas; hence virus spread is not systemic throughout the plant, bulbs are not implicated and in general plants can compensate for the negative effects of virus infections. IYSV diseases, although common, are considered minor, and damage affecting production of onion bulbs is minimal. This was also reflected in an EPPO expert consultation (EPPO, 2006). The potential consequences of IYSV infection can be considered minimal.

With regards to PolRSV, no impact on crops is expected as the virus is only known to be hosted by weeds. This assessment is based on observation in nature. Uncertainty remains as PolRSV is known to infect several species from the Solanaceae family in experimental conditions (Ciuffo et al., 2010).

In the case of those tospoviruses present in the EU, and the impact of which can therefore be evaluated, the responses of the NPPOs to the questionnaire indicate that TSWV has the strongest impact (three countries report severe problems—Italy, Hungary, Greece—and nine countries report moderate or minimal problems).

The impact of INSV (nine countries with minimal or moderate problems) and IYSV (two countries with minimal problems) appears to be more limited (see Appendix C, Table 11).

3.6.2. Indirect effects of tospoviruses

Outbreaks of tospoviruses in food crops and ornamentals result in loss of marketable product. As a consequence, additional efforts are needed for the crop management. When infected with tospoviruses, plant propagation material, such as potato tubers, rootstocks and other grafting material, can no longer be used.

3.6.3. Conclusion of the assessment of consequences

Direct pest effects from tospovirus infections are expected to be major for viruses infecting tomatoes and cucurbits. The impact of tospovirus diseases on ornamentals can be considered moderate since damage may be restricted to a few leaves and flowers and does not affect entire plants.

Indirect pest effects are mostly linked to the additional crop management measures needed to control spread and impact in the infected crops.

3.6.4. Uncertainties

Uncertainties affecting the evaluation of the potential direct impact of tospoviruses are of several kinds. The first concerns the extent of the damage that could be caused to the crops identified in Table 7. In particular, some of the listed hosts are not natural but experimental hosts (in particular GCFSV and GYSV, which are almost exclusively found infecting groundnut but have been experimentally shown to also infect and cause symptoms in bean). Thus, the potential impact of the viruses on these plants could be extremely limited, if not non-existent. Furthermore, many factors, including climatic conditions, cropping practices and plant variety, are known to affect the extent of damage caused by viruses to their hosts, and hence a precise evaluation of the extent of damage is very difficult. However, because the entire range of plant hosts for many of the tospoviruses addressed here is not precisely known, there exists also the possibility that significant damage is caused in crops not listed in Table 4. Overall, however, there is little uncertainty about the fact that all tospoviruses, with the possible exception of PolRSV, have the potential to cause some level of damage to at least some crops grown in the risk assessment area.

CONCLUSION OF PEST CATEGORISATION

Following a request from European Commission, the Panel on Plant Health was asked to deliver a scientific opinion on the pest categorisation of the tospoviruses. The Panel identified 24 tospoviruses that are considered in this scientific opinion.

Considering the whole genus, tospoviruses are among the most damaging plant viruses worldwide. There are several reasons for this, most significantly the severity of the symptoms they induce, the efficiency of their vectors in virus transmission and the difficulty of controlling vectors and viruses. However, as analysed in the present opinion, significant biological differences exist between different tospoviruses, in particular concerning their geographical distribution, their host range and their vector thrips species.

The Panel considered four parameters as being particularly relevant. For each virus, these are:

- the presence of the virus in the risk assessment area;
- the presence of host plants in the risk assessment area;
- the presence of thrips vector species in the risk assessment area;
- the potential for damage to crops grown in Europe.

The relevant parameters are summarised for each virus in Table 8.

Table 8: Summary of tospoviruses parameters considered in the pest categorisation

Tospovirus species	Abbreviation	Presence of the virus in the risk assessment area	Existence of host plants in the risk assessment area	Existence of vectors in the risk assessment area	Potential for damage to EU crops
Tomato spotted wilt virus	TSWV	Yes	Yes	Yes	Yes
Impatiens necrotic spot virus	INSV	Yes	Yes	Yes	Yes
Iris yellow spot virus	IYSV	Yes	Yes	Yes	Yes
Polygonum ringspot virus	PolRSV	Yes	Yes	Yes	No
Groundnut ringspot virus	GRSV	No	Yes	Yes	Yes
Tomato chlorotic spot virus	TCSV	No	Yes	Yes	Yes
Alstroemeria necrotic streak virus	ANSV	No	Yes	Yes	Yes
Chrysanthemum stem necrosis virus	CSNV	No	Yes	Yes	Yes
Melon severe mosaic virus	MSMV	No	Yes	Yes	Yes
Tomato yellow (fruit) ring virus	TYRV	No	Yes	Yes	Yes
Tomato zonate spot virus	TZSV	No	Yes	Yes	Yes
Groundnut yellow spot virus	GYSV	No	Yes	No or limited	Yes
Groundnut chlorotic fan-spot virus	GCFSV	No	Yes	No or limited	Yes
Groundnut bud necrosis virus	GBNV	No	Yes	No or limited	Yes
Zucchini lethal chlorosis virus	ZLCV	No	Yes	No or limited	Yes?
Capsicum chlorosis virus	CaCV	No	Yes	No or limited	Yes
Watermelon bud necrosis virus	WBNV	No	Yes	No or limited	Yes
Watermelon silver mottle virus	WSMoV	No	Yes	No or limited	Yes
Tomato necrotic ringspot virus	TNRV	No	Yes	No or limited	Yes
Calla lily chlorotic spot virus	CCSV	No	Yes	No or limited	Yes
Melon yellow spot virus	MYSV	No	Yes	No or limited	Yes
Soybean vein necrosis-associated virus	SVNaV	No	Yes	?	Yes
Bean necrotic mosaic virus	BeNMV	No	Yes	?	Yes
Pepper necrotic spot virus	PNSV	No	YES	?	Yes

Only four tospoviruses are so far definitely known to be present in the risk assessment area (TSWV, INSV, IYSV and PolRSV). CSNV was transiently present and has been eradicated. There is little uncertainty about the presence of TSWV, INSV, IYSV and PolRSV in Europe whereas the rating of absence for the other viruses is accompanied by uncertainties.

Almost all tospoviruses either have natural hosts that are important crops grown in Europe (tomato, pepper, lettuce, cucurbits, ornamentals, beans, soybean, etc.) or have been shown experimentally to infect some of these crops and cause symptoms in some following artificial inoculation. In the case of viruses known to infect crop plants grown in Europe, uncertainties are limited, except in particular cases in which the susceptibility of a crop has been demonstrated only through experimental inoculations.

Ten tospovirus species (TSWV, INSV, IYSV, PolRSV, GRSV, TCSV, ANSV, CSNV, MSMV and TYRV) are transmitted by one or more of the thrips species distributed widely in Europe. The other tospovirus species are transmitted by thrips species that are not present or have a limited distribution in Europe, or the vector species are currently unknown. Uncertainties result from incomplete information on the precise situation of thrips species currently assumed to be absent or of limited distribution in

Europe. Uncertainties also concern viruses with unknown vectors as these viruses could still conceivably be transmitted by thrips species present in the EU.

Finally, almost all tospovirus species, with the exception of PolRSV, clearly have the potential to cause some degree of damage to crops grown in Europe. Although PolRSV is present in Europe and is associated with a thrips vector species also present in Europe, this tospovirus has not been observed to cause damage, even in crops growing close to their native weed host. Uncertainties affect both the capacity to cause damage (PolRSV) and the extent of the damage that could be caused (all tospovirus species but with lower uncertainty for viruses already present in Europe).

Considering all factors, the Panel concluded that the 24 tospovirus species can be allocated to four broad categories based on the risk they could present to the EU territory:

- Viruses present in the risk assessment area but apparently without the potential to cause damage to crops. This category includes only PolRSV, for which the risk is considered minimal. As a consequence, PolRSV does not appear to fit the criteria needed for development of a full risk assessment.

- Viruses absent from the risk assessment area but whose natural or experimental hosts are crops grown in Europe and whose known thrips vector species are not widely distributed in Europe. This category comprises 13 tospoviruses: GBNV, GYSV, GCFSV ZLCV, CaCV, WBNV, WSMoV, CCSV, MYSV, TNRV, SVNaV, BeNMV and PNSV. If introduced, the damage potential of these viruses would be mitigated by the absence (or limited distribution) of vector(s); thus, the risk from these viruses is assessed as limited but with significant uncertainty.[9] In particular, it should be stressed that new experimental data on the vector range of a particular virus, or changes in the geographical distribution or prevalence of vector species, could necessitate the reallocation of viruses in this category to a higher risk category.

- Viruses absent from the risk assessment area but whose natural or experimental hosts are crops grown in Europe and whose thrips species vectors are present in Europe. This category comprises seven tospoviruses: GRSV, TCSV, ANSV, CSNV, MSMV, TYRV and TZSV. Of these viruses, only CSNV is currently regulated in the risk assessment area (Annex IIAI and Annex IVAI of Council Directive 2000/29/EC) and included in EPPO's A1 list of quarantine pests not present in the EPPO area. If introduced, these tospoviruses have the potential to cause damage to at least some crops grown in Europe. This analysis carries uncertainties as to the level of damage that would result from their introduction but, according to the information available, viruses in this category have the highest potential for damage if introduced in the risk assessment area.

- The last category comprises TSWV, INSV and IYSV, which are already present in the risk assessment area. Both the host(s) and vector(s) of these viruses are present in at least a large part of the risk assessment area and they currently affect crops in several Member States. They have already demonstrated their potential for damage. However, there are some differences between these agents, in particular in terms of their regulatory status and of the extent to which they currently occupy their full potential range in the risk assessment area. Of these three viruses, TSWV is the only one that is regulated. It has the broadest range of host and insect vectors and is commonly found in the risk assessment area. Although regulated and broadly distributed both inside and outside the risk assessment area, interception reports are extremely limited (on average fewer than two per year), which suggests low effectiveness of controls or poor reporting of the interceptions. Development of a full risk assessment may,

[9] The pest risk analysis (CSL, 1997) for WSMoV concluded that potential for damage exists for cucurbit crops (cucumber in particular) under protected conditions should the virus be introduced together with its exotic vector species. As a consequence, WSMoV is currently included by EPPO in its A1 list.

however, provide a clearer picture in terms of geographical distribution and an evaluation of the potential consequences of repealing the current legislation. Both INSV and IYSV are also present in the risk assessment area but are not under official control. As such, they do not meet the criteria for the development of a full risk assessment. IYSV seems to be a recent introduction and may not have yet achieved its full potential range in the risk assessment area. However, because of the limited impact caused by IYSV, in 2009 the EPPO Panel on phytosanitary measures concluded that the pest should not be recommended for regulation and IYSV was consequently removed from the EPPO lists. As a consequence of these various findings, the Panel concludes that INSV and IYSV do not meet the criteria for the development of full risk assessments.

Finally, the Panel wishes to stress that many of the viruses analysed here have been discovered and described very recently; thus the information available is extremely limited (only one or few, i.e. 5–10, peer-reviewed scientific publications). In theses cases, the full range of the available literature as scrutinised when preparing the present opinion so that development of a full risk assessment is unlikely to bring any further understanding. This situation concerns in particular ANSV, GCFSV, ZLCV, CCSV, MSMV, PolRSV, TNRV, TZSV, WBNV, SVNaV, BeNMV and PNSV.

DOCUMENTATION PROVIDED TO EFSA

1. Letter requesting a scientific opinion (Ref: SANCO.E2 GC/ap (2011) 1200518). 24 October 2011. Submitted by the European Commission.

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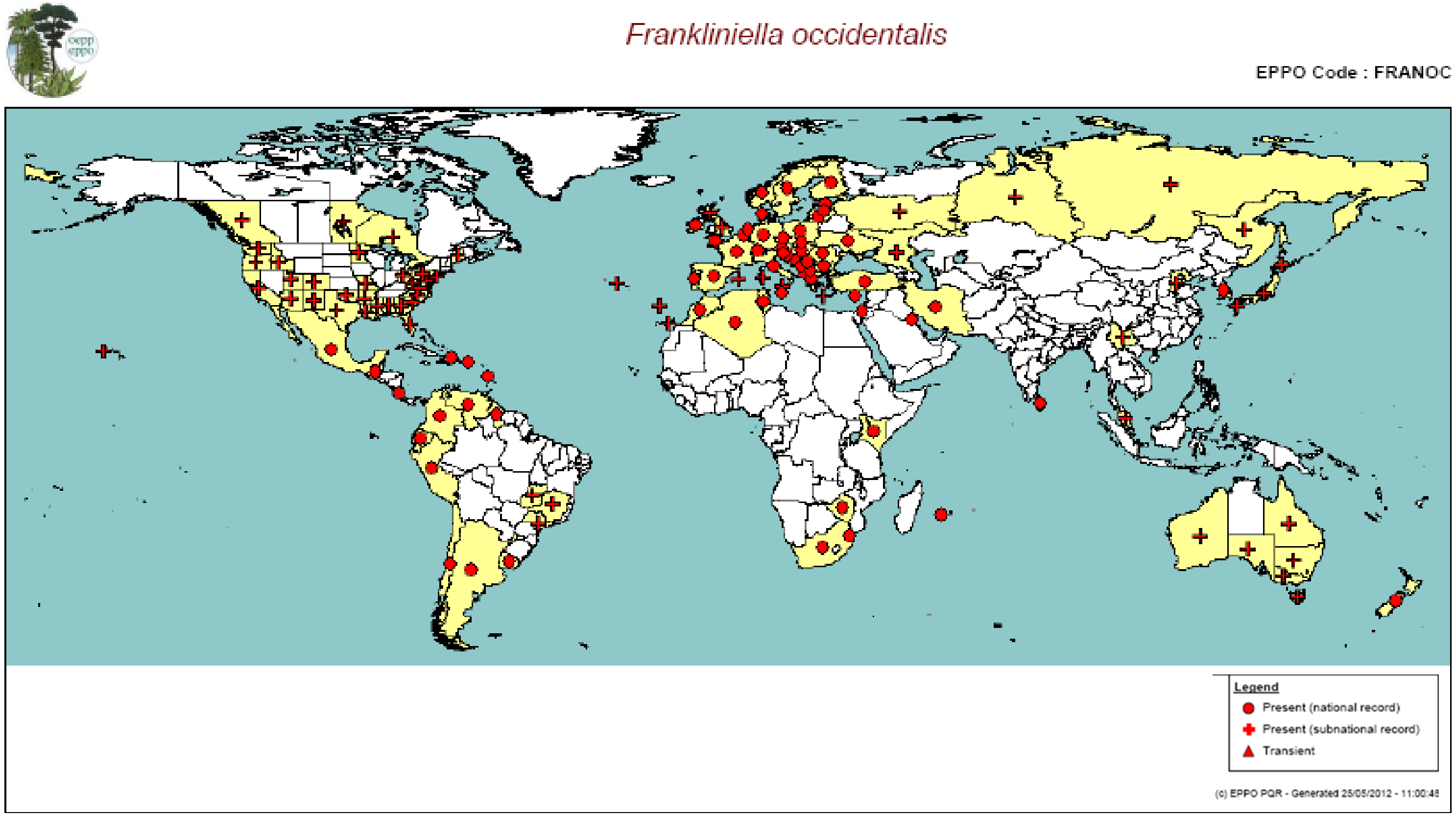
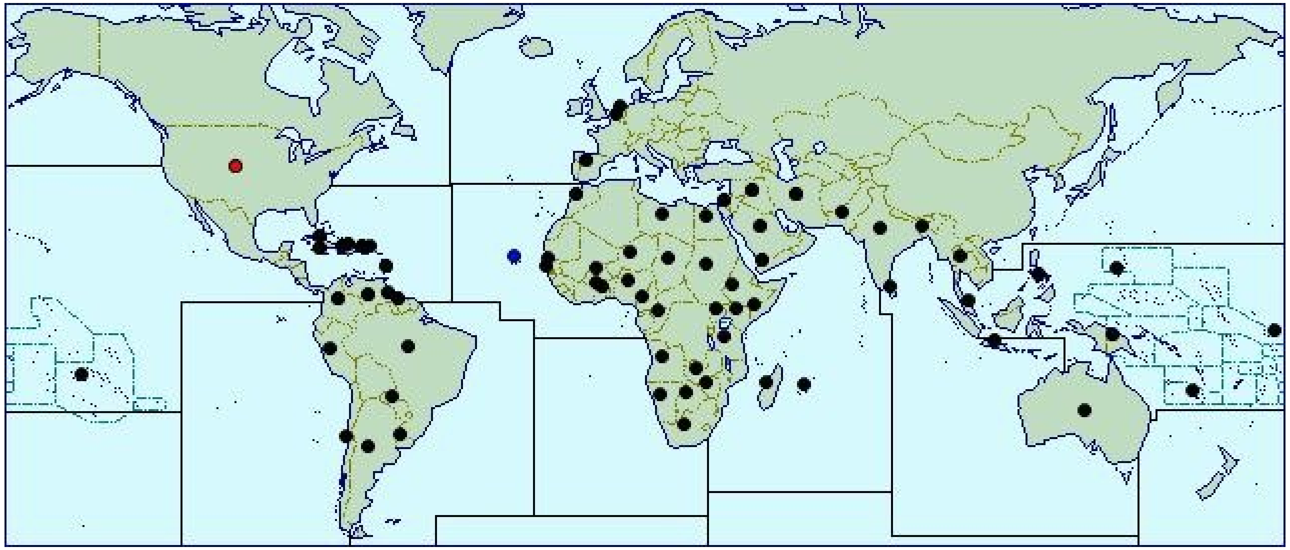
APPENDICES

A. DISTRIBUTION MAPS OF THE TOSPOVIRUSES AND THEIR VECTORS

1. World distribution maps of some tospovirus vector thrips species (CAB International 2011a–g; PQR-EPPO, 2012)



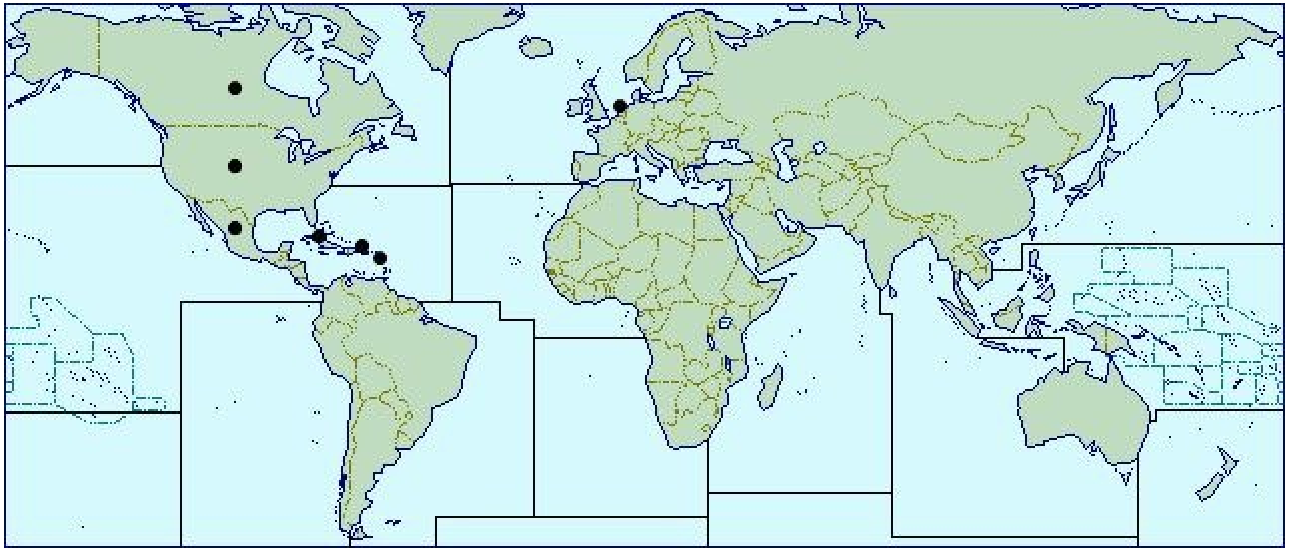
Frankliniella schultzei **(**CABI, 2011a)



●=Present, no further details ●=Widespread ●=Localised
●=Confined and subject to quarantine ●=Occasional or few reports
●= See regional map for distribution within the country

Date of report: 01/02/2012

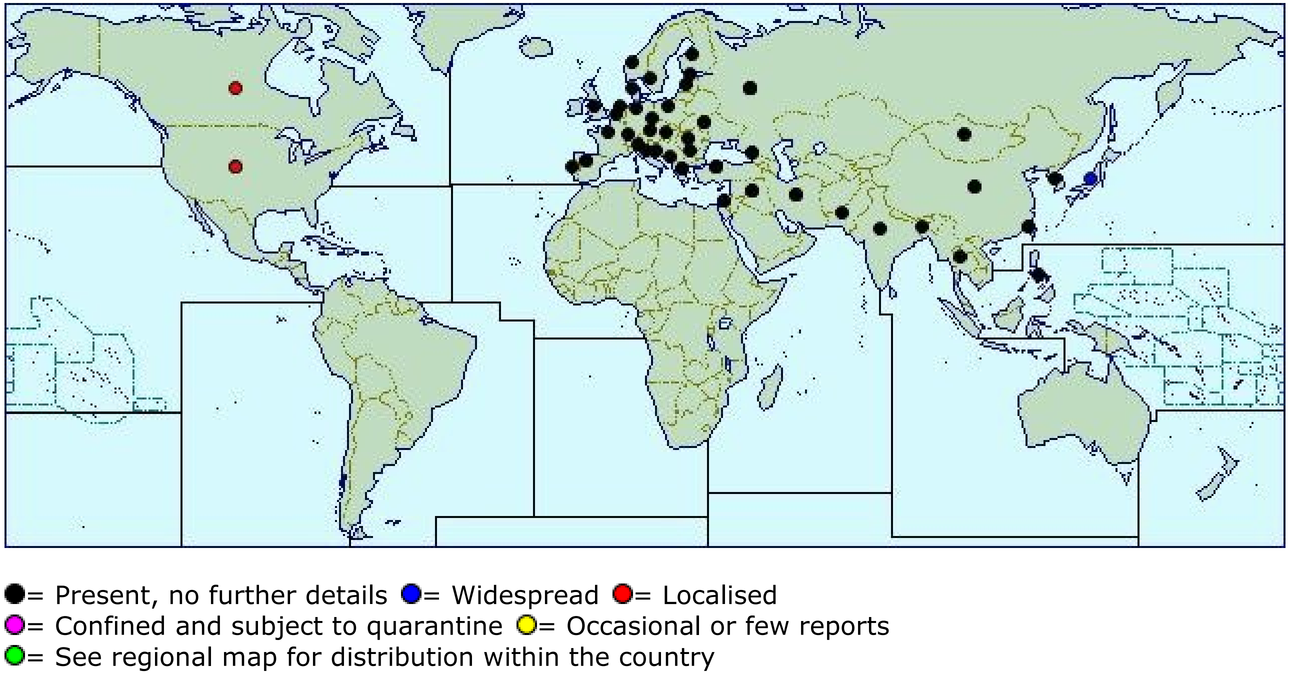
Frankliniella fusca (CABI, 2011b)



●= Present, no further details ●= Widespread ●= Localised
●= Confined and subject to quarantine ●= Occasional or few reports
●= See regional map for distribution within the country

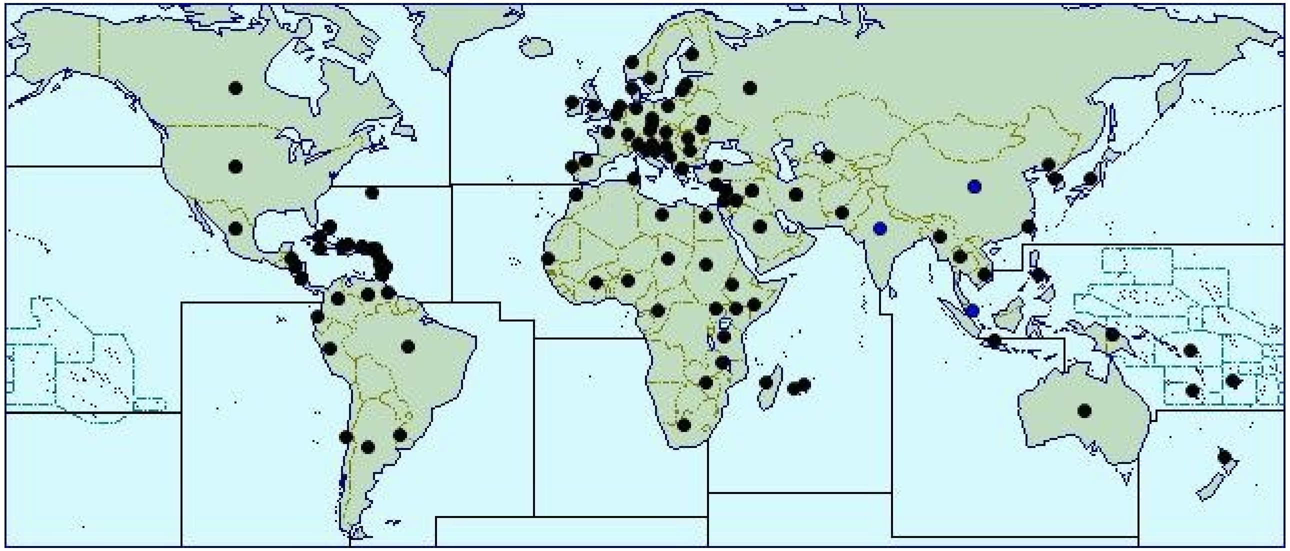
Date of report: 01/02/2012

Frankliniella intonsa (CABI, 2011c)



Date of report: 01/02/2012

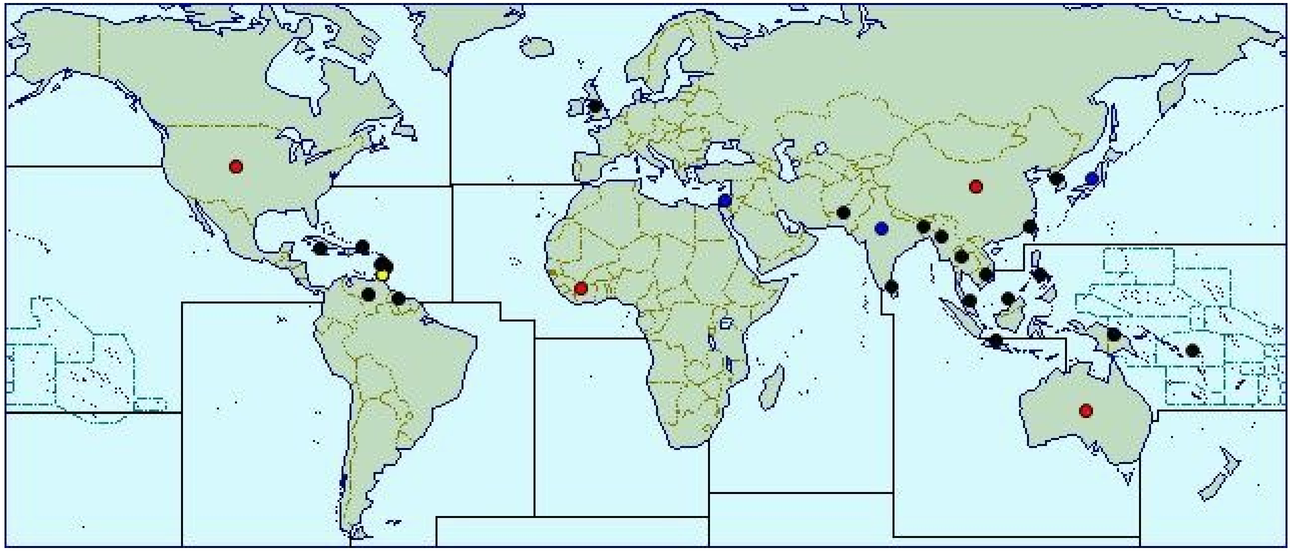
Thrips tabaci (CABI, 2011d)



●= Present, no further details ●= Widespread ●= Localised
●= Confined and subject to quarantine ●= Occasional or few reports
●= See regional map for distribution within the country

Date of report: 01/02/2012

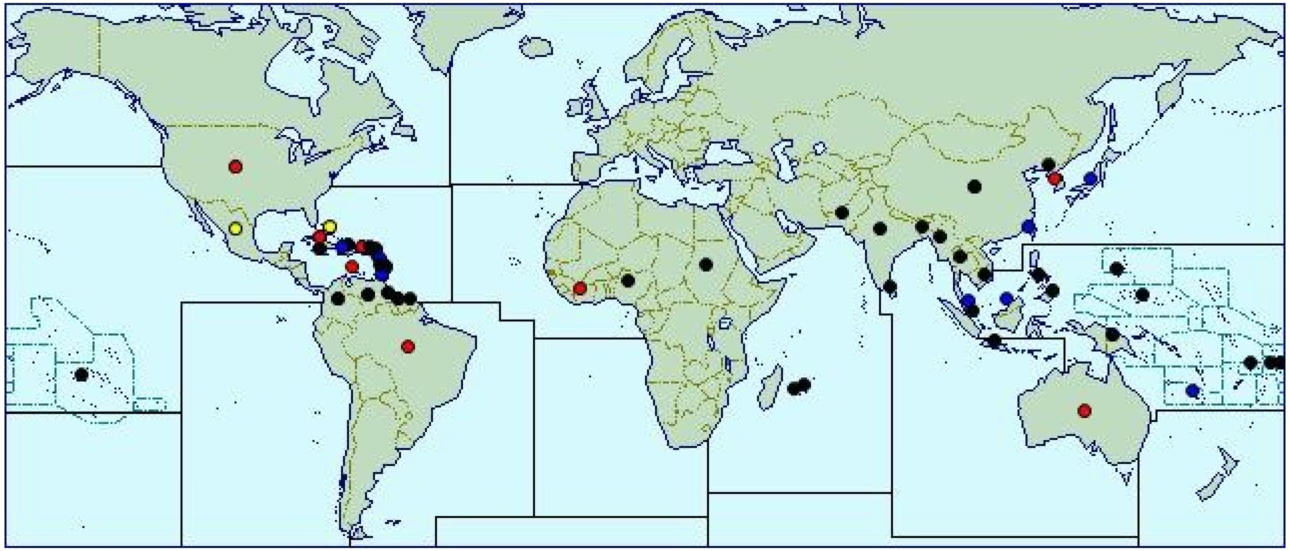
Scirtothrips dorsalis (CABI, 2011e)



●= Present, no further details ●= Widespread ●= Localised
●= Confined and subject to quarantine ●= Occasional or few reports
●= See regional map for distribution within the country

Date of report: 01/02/2012

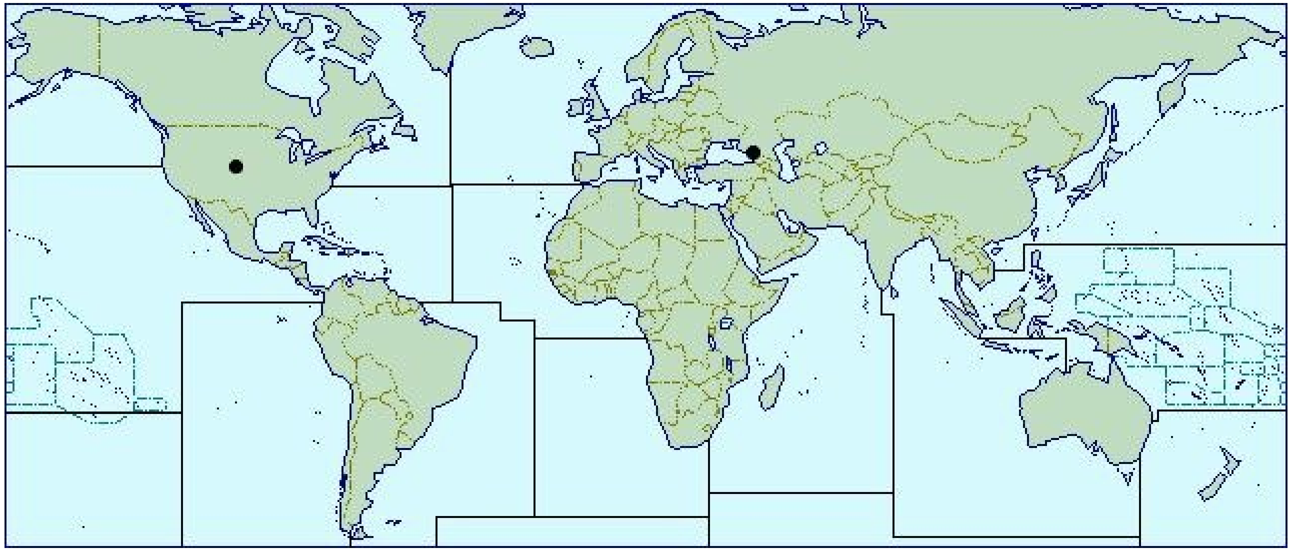
Thrips palmi (CABI, 2011f)



(black)= Present, no further details (blue)= Widespread (red)= Localised
(magenta)= Confined and subject to quarantine (yellow)= Occasional or few reports
(green)= See regional map for distribution within the country

Date of report: 01/02/2012

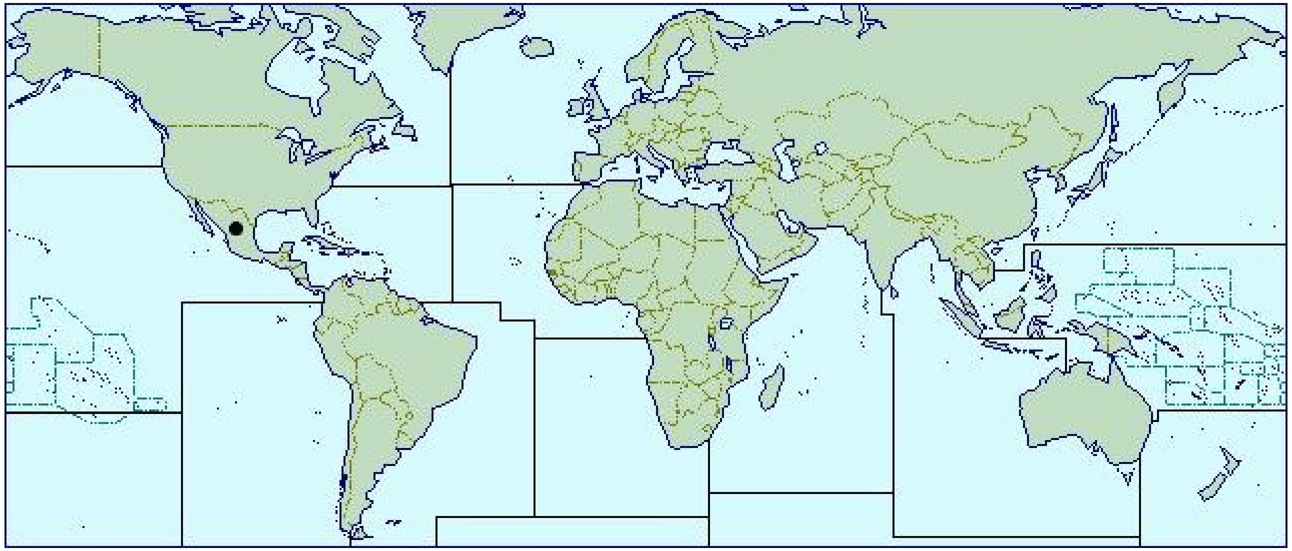
Frankliniella bispinosa (CABI, 2011g)



●= Present, no further details ●= Widespread ●= Localised
●= Confined and subject to quarantine ●= Occasional or few reports
●= See regional map for distribution within the country

Date of report: 01/02/2012

Frankliniella cephalica (CABI, 2011g)



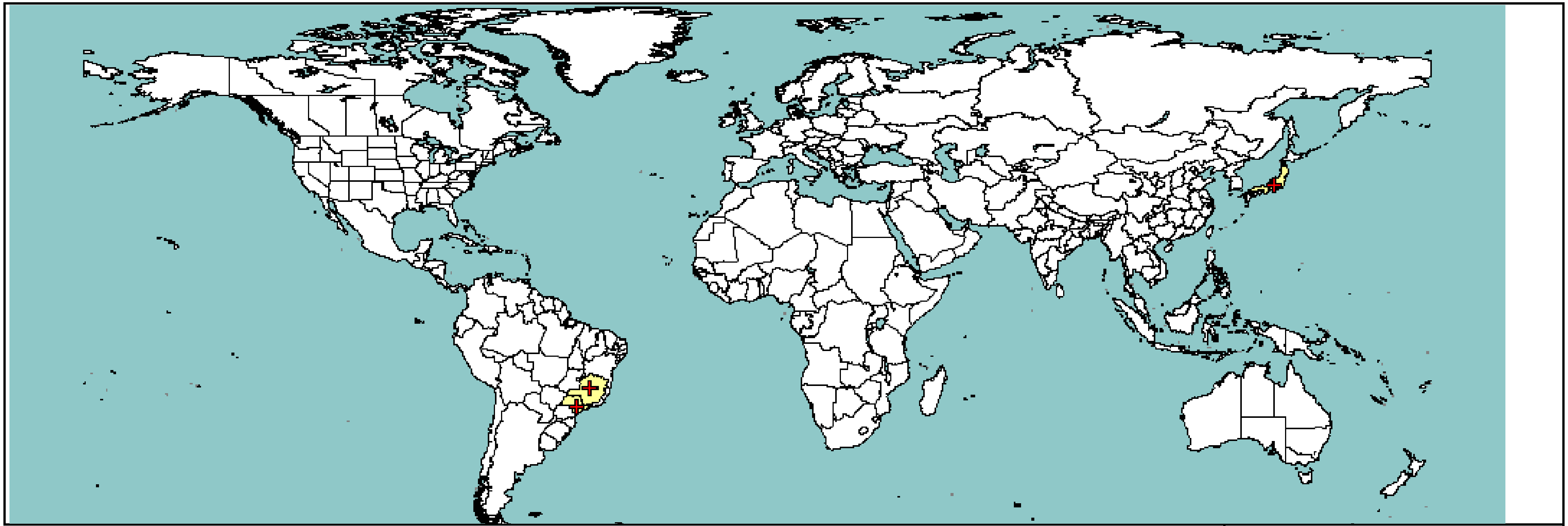
●= Present, no further details ●= Widespread ●= Localised
●= Confined and subject to quarantine ●= Occasional or few reports
●= See regional map for distribution within the country

Date of report: 01/02/2012

2. World distribution maps of some tospoviruses (PQR-EPPO, 2012)

Chrysanthemum stem necrosis virus

EPPO Code: CSNV00



Legend

Present (national record)

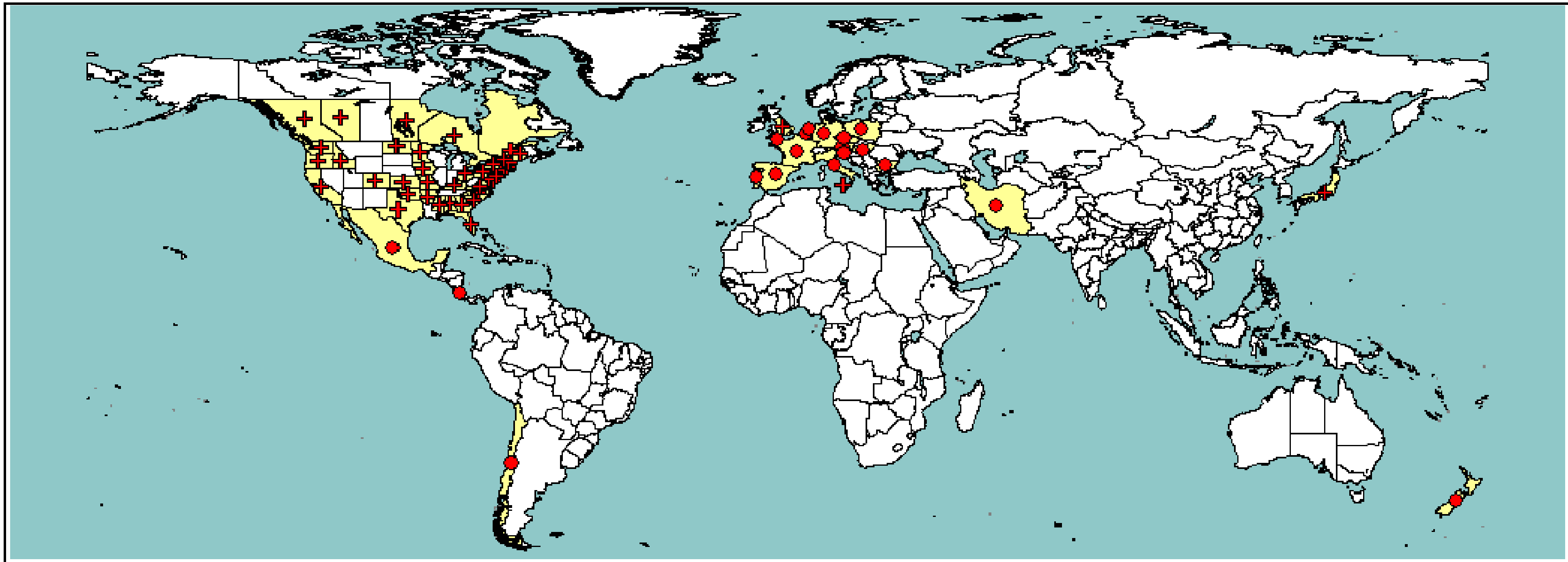
Present (subnational record)

Transient

(c) EPPO PQR - Generated 10/05/2012 - 16:31:19

Impatiens necrotic spot virus

EPPO Code: INSV00



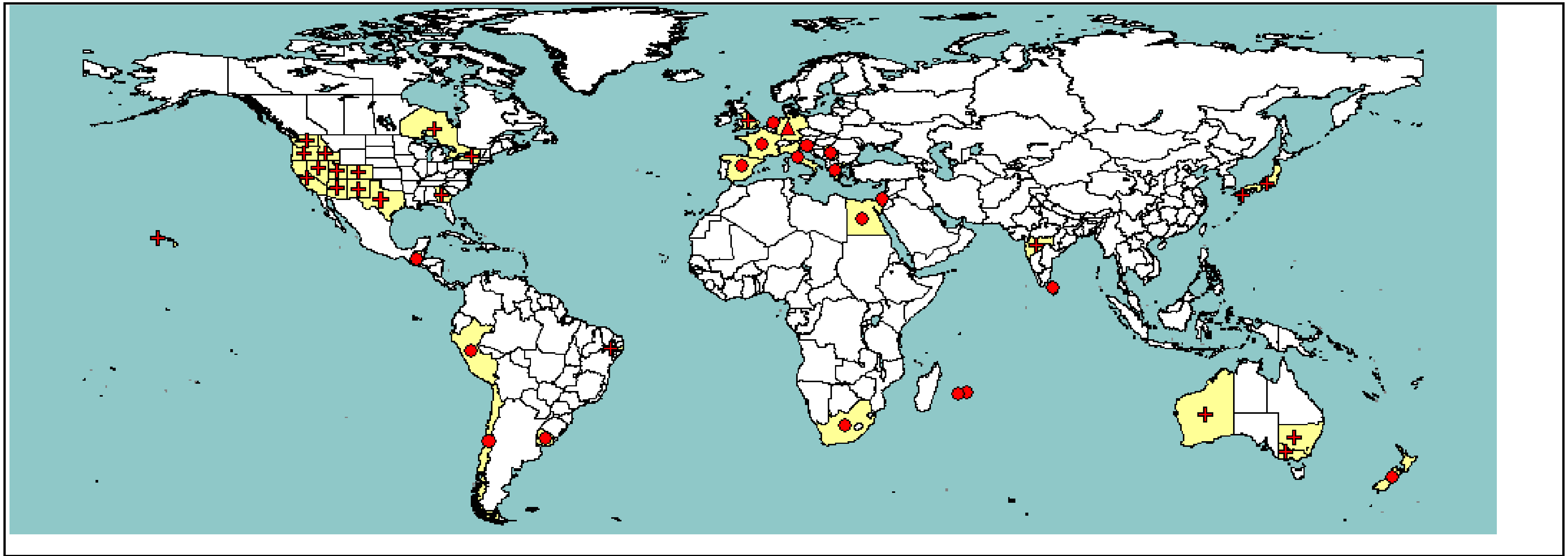
Legend

- Present (national record)
- Present (subnational record)
- Transient

(c) EPPO PQR - Generated 10/05/2012 - 16:32:14

Iris yellow spot virus

EPPO Code: IYSV00



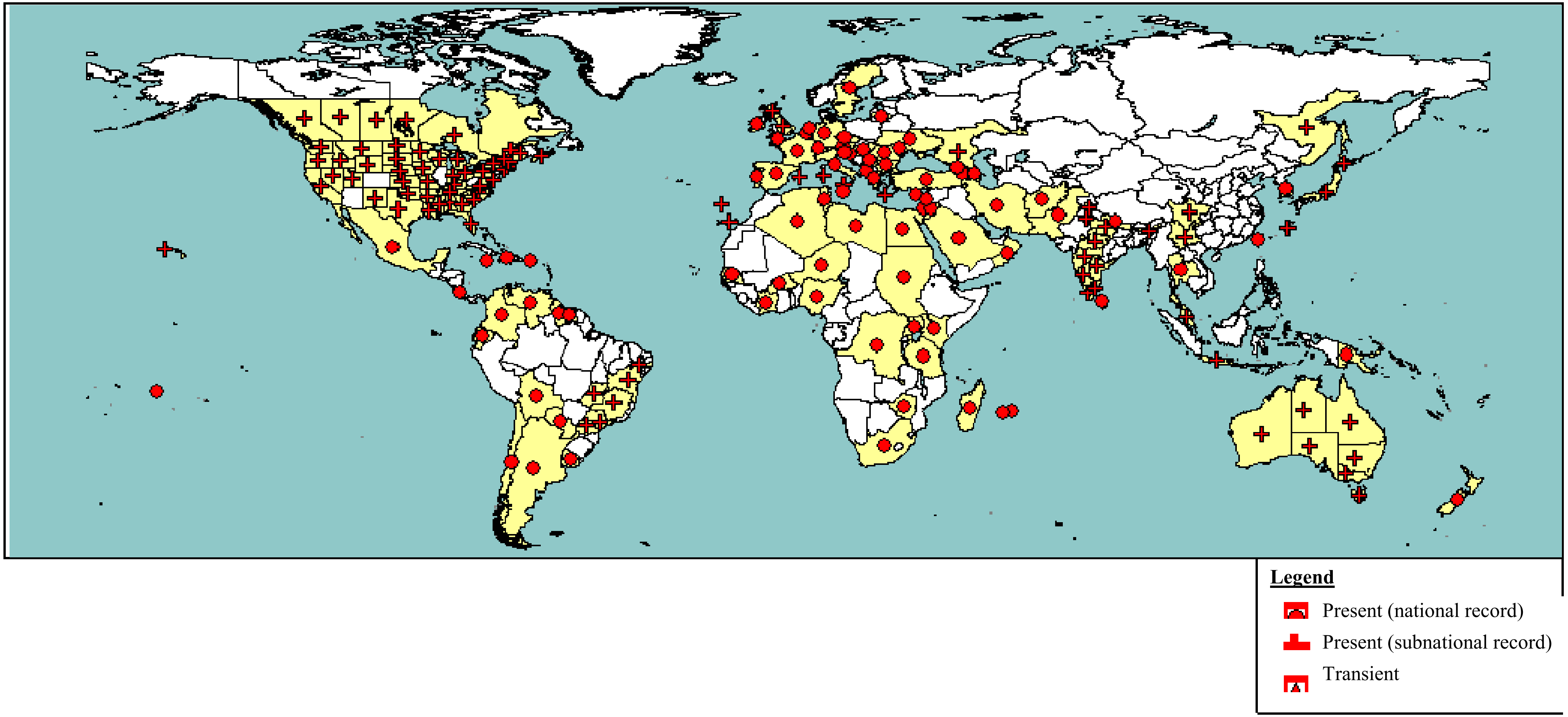
Legend

- Present (national record)
- Present (subnational record)
- Transient

(c) EPPO PQR - Generated 10/05/2012 - 16:34:08

Tomato spotted wilt virus

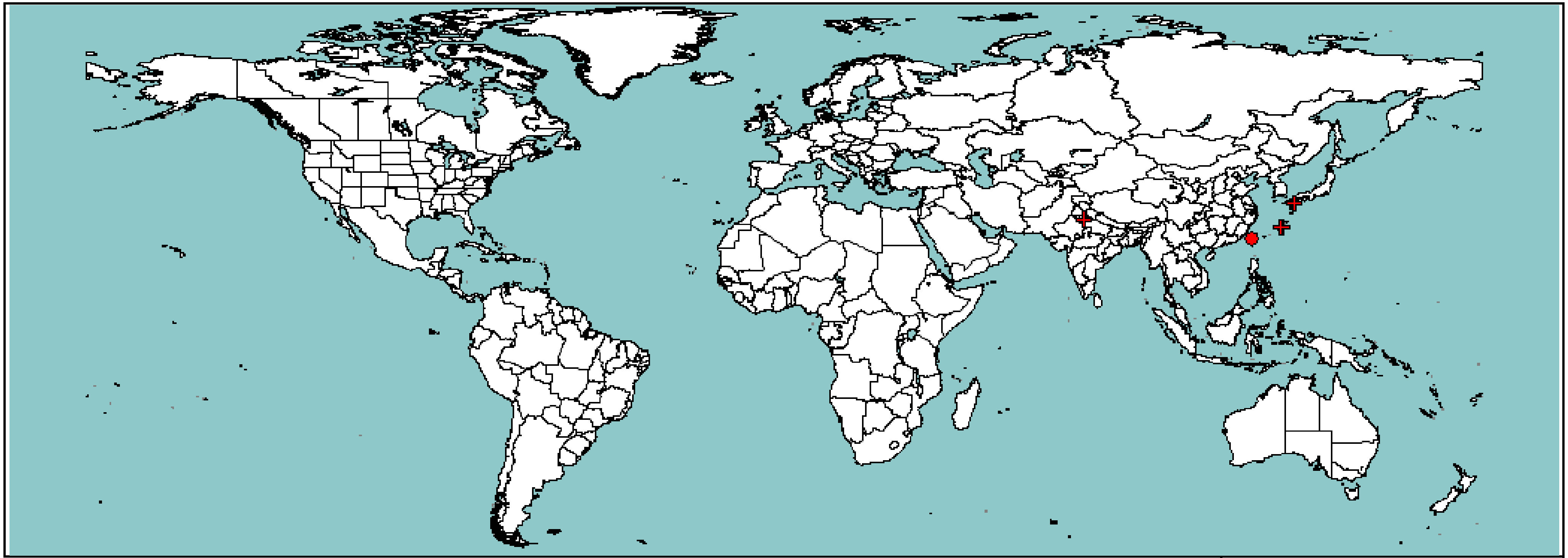
EPPO Code: TSWV00



(c) EPPO PQR - Generated 10/05/2012 - 16:29:12

Watermelon silver mottle virus

EPPO Code: WMSMOV



Legend

Present (national record)

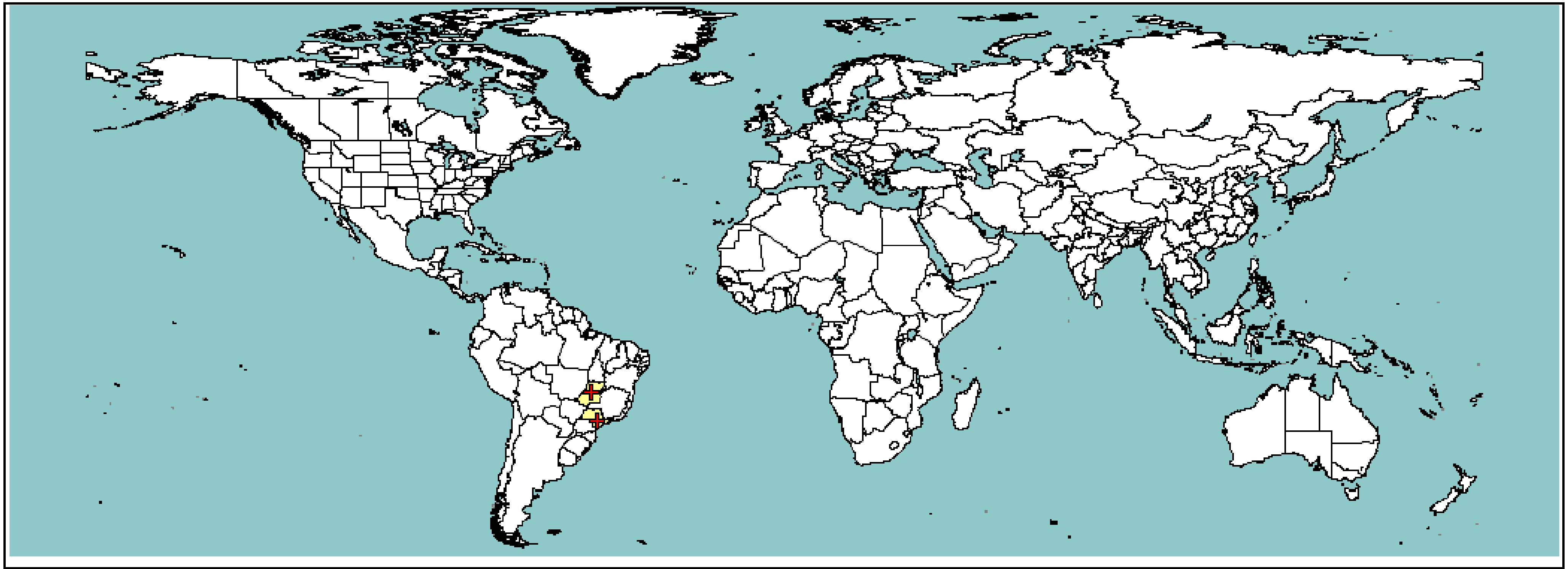
Present (subnational record)

Transient

(c) EPPO PQR - Generated 10/05/2012 - 16:36:52

Zucchini lethal chlorosis virus

EPPO Code: ZLCV00



Legend

- Present (national record)
- Present (subnational record)
- Transient

B. CLIMATIC REQUIREMENTS OF THOSE TOSPOVIRUS VECTOR THRIPS SPECIES THAT ARE NOT PRESENT IN THE EU

A brief review of the climatic requirements of the tospovirus vectors that are not present in the EU is given below.

- *Thrips palmi*

McDonald et al. (1999) reported the temperature requirements for development of *T. palmi* and compared them with UK temperatures to estimate its potential for development under UK conditions. The authors concluded that development of *T. palmi* would be possible outdoors during the summer, when a maximum of up to four or five generations could develop, and that establishment of *T. palmi* in the UK is unlikely to be limited by the inability to complete the life cycle during the favourable season. The lower developmental temperature threshold of *T. palmi* has been calculated as approximately 10.1 °C, and a sum of effective temperatures of 194 degree-days per generation (McDonald et al., 1999). Dentener et al. (2002) studied eco-climatic limitations to the potential geographical distribution of *T. palmi* in New Zealand using CLIMEX. They predicted that *T. palmi* could establish in the upper half of the North Island of New Zealand based on the eco-climatic index (EI). The remainder of New Zealand was found to be unsuitable for *T. palmi* because of cold stress in winter.

- *Frankliniella zucchini*

Currently, *F. zucchini* is known to occur only in São Paulo State in Brazil (Nakahara and Monteiro, 1999). No specific study on the climate responses of this organism was found in the literature.

- *Scirtothrips dorsalis*

Tatara (1994) calculated the temperature threshold for development as 9.7 °C, with 265 degree-days (DD) required for complete development. Shibao (1996) gives the developmental threshold, on *Vitis*, as 8.5 °C and the effective accumulative temperature required for oviposition to adult emergence as 294.1 DD. Both results suggest that *S. dorsalis* is most likely to establish in the warmer, e.g. southern, regions of Europe and that the climate in central and northern European regions is unfavourable for the establishment of *S. dorsalis*, despite hosts being present. *S. dorsalis* has recently become established in continental USA. The potential for establishment in North America was analysed by Nietschke et al. (2008) based on a degree-day model and cold temperature survival. The analysis concluded that *S. dorsalis* could potentially produce up to 18 generations and was likely to survive in the southern and western coastal plains and therefore will become a serious pest in the southern United States. In Japan *S. dorsalis* is one of the most serious pests on citrus plants because large numbers of adults immigrate into citrus orchards from host plants surrounding the orchards (Tatara, 1994) and damage the fruit surface during a long period, typically from June to October.

- *Ceratothripoides claratris*

Premachandra et al. (2004) studied the temperature-dependent development of *C. claratris* at seven constant temperatures, i.e. 22, 25, 27, 30, 34, 35 and 40 °C. Pre-adult survivorship was greatest (95 %) at 25 and 30 °C and shortest at 22 °C. Egg-to-adult time decreased within the range of 20–30 °C, and at 34 °C it started to increase. The lower thermal threshold for egg-to-adult development was estimated at 16 and 18 °C by linear regression and the modified Logan model, respectively. The optimum temperature for egg-to-adult development was estimated at 32–33 °C by the modified Logan model. The influence of temperature on reproduction and longevity of *C. claratris* was determined at 25, 30 and 35 and 40 °C. Both inseminated and virgin females failed to reproduce at 40 °C. Virgin females produced only male offspring, confirming arrhenotoky. The sex ratio of the offspring of fertilised females was strongly female biased, except at 25 °C. Mean total fecundity per female and mean daily total fecundity per female were highest for both virgin and inseminated females at 30 °C.

Female longevity was longest at 25 °C and shortest at 40 °C. Male longevity was longest at 30 °C and shortest at 40 °C. The net reproductive rate and intrinsic rate of natural increase was greatest at 30 °C while, mean generation time and the doubling time were highest at 25 °C. The finite rate of increase was fairly constant (1.1–1.5 days) over the three temperatures tested. Premachandra et al. (2004) conclude from their data on development, reproduction and longevity of *C. claratris* that this species is better adapted to high temperatures (i.e. 30–35 °C) than other important tropical thrips species such as *T. palmi* and *S. dorsalis*. Assessing the pest potential of *C. claratris* for Asia, Premachandra et al. (2004) conclude that the insect has the potential to become a serious constraint for tomato production in tropical Asia.

C. National Plant Protection Organisations answers to EFSA's tospovirus questionnaire

Table of contents

1. Description of the data collection

To prepare the scientific opinions on the pest categorisation of tospoviruses and pest risk assessments on specific tospoviruses for the EU territory, EFSA's Plant Health Unit created a questionnaire on tospoviruses in MS Excel format and sent it to representatives of the National Plant Protection Organisations (NPPOs) of the 27 EU Member States. The aim of this request to the Member States was to confirm the pest status and the experience of measures taken against these pathogens in the EU territory to enable the Panel to provide advice based on the updated status of these viruses in the EU Member States.

The Panel acknowledges the usefulness and quality of the responses received and would like to thank all Member States for their interest and input to its current and future work.

The questionnaire on tospoviruses was developed in the context of the harmonised questionnaire on harmful organisms listed in EC 2000/29/EC Annex II A II. The questionnaires were harmonised to facilitate the reporting activity of the Member States by following the same support and answers structure.

Two types of answers could be provided, the first type in free text and the second type corresponding to predefined answers to be chosen from a list. In the case of the latter, guidance and rating descriptors are provided in the questionnaire itself. These tables are presented at the end of this appendix.

The questionnaire on tospoviruses consists of 12 items, each in a different sheet of an Excel file. The questionnaires were prefilled for the Member States with the following information:

- The contact details of the Chief Plant Health Officer of the NPPOs. This information was included in the first sheet, "Contact Details".

- Information from the European and Mediterranean Plant Protection Organization (EPPO) Plant Quarantine data retrieval system (PQR), version 5.5.5540 (2012–01–19), consulted on 25 February 2012. When information was available the relevant parts of the questionnaire were prefilled.

The questionnaires were sent out on 12 March 2012 and 16 March 2012. The deadline for response was extended from 31 March 2012 to 24 April 2012. However, some answers were received after the revised deadline. In this appendix, answers received up to 31 May 2012 are considered.

Each questionnaire was checked for consistency of answers. If necessary, free text answers were categorised according to the ratings and their descriptors provided together with the questionnaire. All the resulting questionnaires were transferred to a single database.

2. Data analysis

The main objective of this data analysis was the collection of information on the presence and relevance of the tospoviruses and their hosts plants and vectors in the EU.

The data analysis is mainly descriptive, summarising the individual information provided by the Member States.

3. Results

3.1. Response rate

Table 1: Responses of the Member States and their coverage

EU Member State	Abbreviation	Replied	
		Yes, coverage	No[(1)]
Austria	AT	National	
Belgium	BE	National	
Bulgaria	BG	National	
Cyprus	CY	National	
Czech Republic	CZ	National	
Denmark	DK	National	
Estonia	EE	National	
Finland	FI	National	
France	FR		Missing
Germany	DE		Missing
Greece	GR	National	
Hungary	HU	National	
Ireland	IE		Missing
Italy	IT	National	
Latvia	LV	National	
Lithuania	LT	National	
Luxembourg	LU		Missing
Malta	MT	National	
Netherlands	NL		Missing
Poland	PL	National	
Portugal	PT		Missing
Romania	RO		Missing
Slovakia	SK	National	
Slovenia	SL		Missing
Spain	ES	National	
Sweden	SE	National	
United Kingdom	GB	National	
Total	*n* = 27	19	8
	100 %	70 %	30 %

[1]Some of the NPPOs have advised EFSA that missing answers to the questionnaires will still be provided. When EFSA receives them, they will be processed and considered in the full risk assessments on tospoviruses that will be performed in the near future

3.2. Pest

Table 2: Importance of the tospoviruses, in the past, present and future

Pest	Pest relevance																	
	In the last 10 years					Currently					Expectation for the next 5 years					Development		
	Total MS answers	No problems	Minimal problems	Moderate problems	Severe problems	Total MS answers	No problems	Minimal problems	Moderate problems	Severe problems	Total MS answers	No problems	Minimal problems	Moderate problems	Severe problems	Current → Past	Future → Current	Future → MAX(Current, Past)
Alstroemeria necrotic streak virus	8	100 %	0 %	0 %	0 %	8	100 %	0 %	0 %	0 %	6	100 %	0 %	0 %	0 %	0	0	0
Bean necrotic mosaic virus	9	100 %	0 %	0 %	0 %	9	100 %	0 %	0 %	0 %	7	100 %	0 %	0 %	0 %	0	0	0
Calla lily chlorotic spot virus	8	100 %	0 %	0 %	0 %	8	100 %	0 %	0 %	0 %	6	83 %	17 %	0 %	0 %	0	1	1
Capsicum chlorosis virus or Tomato necrosis virus	10	90 %	10 %	0 %	0 %	10	100 %	0 %	0 %	0 %	8	88 %	13 %	0 %	0 %	0	1	0
Chrysanthemum stem necrosis virus	17	94 %	6 %	0 %	0 %	18	100 %	0 %	0 %	0 %	15	60 %	33 %	7 %	0 %	0	6	4
Groundnut bud necrosis virus	8	100 %	0 %	0 %	0 %	8	100 %	0 %	0 %	0 %	7	100 %	0 %	0 %	0 %	0	0	0
Groundnut chlorotic fan-spot virus	9	100 %	0 %	0 %	0 %	9	100 %	0 %	0 %	0 %	7	100 %	0 %	0 %	0 %	0	0	0
Groundnut ringspot virus	10	90 %	10 %	0 %	0 %	10	90 %	10 %	0 %	0 %	8	88 %	13 %	0 %	0 %	0	0	0
Groundnut yellow spot virus	8	100 %	0 %	0 %	0 %	8	100 %	0 %	0 %	0 %	7	100 %	0 %	0 %	0 %	0	0	0
Impatiens necrotic spot virus	17	29 %	53 %	18 %	0 %	18	44 %	39 %	17 %	0 %	17	29 %	53 %	18 %	0 %	0	3	0
Iris yellow spot virus	18	78 %	17 %	6 %	0 %	18	83 %	17 %	0 %	0 %	16	44 %	50 %	6 %	0 %	1	7	6

Pest	Pest relevance																	
	In the last 10 years					Currently					Expectation for the next 5 years					Development		
	Total MS answers	No problems	Minimal problems	Moderate problems	Severe problems	Total MS answers	No problems	Minimal problems	Moderate problems	Severe problems	Total MS answers	No problems	Minimal problems	Moderate problems	Severe problems	Current → Past	Future → Current	Future → MAX(Current, Past)
Melon severe mosaic virus	10	100 %	0 %	0 %	0 %	10	100 %	0 %	0 %	0 %	8	100 %	0 %	0 %	0 %	0	0	0
Melon yellow spot virus or Physalis severe mottle virus	10	100 %	0 %	0 %	0 %	10	100 %	0 %	0 %	0 %	8	100 %	0 %	0 %	0 %	0	0	0
Pepper necrotic spot virus	11	100 %	0 %	0 %	0 %	11	100 %	0 %	0 %	0 %	9	100 %	0 %	0 %	0 %	0	0	0
Polygonum ringspot virus	7	86 %	14 %	0 %	0 %	7	100 %	0 %	0 %	0 %	6	83 %	17 %	0 %	0 %	0	1	0
Soybean vein necrosis-associated virus	8	100 %	0 %	0 %	0 %	8	100 %	0 %	0 %	0 %	6	100 %	0 %	0 %	0 %	0	0	0
Tomato chlorotic spot virus	16	100 %	0 %	0 %	0 %	17	100 %	0 %	0 %	0 %	13	92 %	8 %	0 %	0 %	0	1	1
Tomato necrotic ringspot virus	10	100 %	0 %	0 %	0 %	10	100 %	0 %	0 %	0 %	8	100 %	0 %	0 %	0 %	0	0	0
Tomato spotted wilt virus	19	11 %	32 %	32 %	26 %	19	32 %	21 %	32 %	16 %	18	17 %	33 %	33 %	17 %	0	4	1
Tomato yellow (fruit) ring virus	10	90 %	0 %	0 %	0 %	10	90 %	0 %	0 %	0 %	9	100 %	0 %	0 %	0 %	0	0	0
Tomato zonate spot virus	10	100 %	0 %	0 %	0 %	10	100 %	0 %	0 %	0 %	8	100 %	0 %	0 %	0 %	0	0	0
Watermelon bud necrosis virus	9	100 %	0 %	0 %	0 %	9	100 %	0 %	0 %	0 %	8	100 %	0 %	0 %	0 %	0	0	0
Watermelon silver mottle virus	10	100 %	0 %	0 %	0 %	10	100 %	0 %	0 %	0 %	8	88 %	13 %	0 %	0 %	0	1	1
Zucchini lethal chlorosis virus	10	100 %	0 %	0 %	0 %	10	100 %	0 %	0 %	0 %	8	100 %	0 %	0 %	0 %	0	0	0

3.3. Relevance of the pest in time

The trend over the next 5 years is expected to be as follows:

- *Tomato spotted wilt virus:* in two Member States from no problems to minimal problems, in one Member State from no problems to moderate problems, in one Member State from minimal problems to moderate problems and in one Member State from moderate problems to minimal problems. Nine Member States consider the trend to evolve from moderate to severe problems in the near future.
- *Chrysanthemum stem necrosis virus:* five Member States from no problems to minimal problems and in one Member State to moderate problems.
- *Iris yellow spot virus* in six Member States from no problems to minimal problems and in one Member State from minimal problems to moderate problems.
- *Impatiens necrotic spot virus:* in three Member States from no problems to minimal problems.
- *Calla lily chlorotic spot virus*, *Capsicum chlorosis virus* or *Tomato necrosis virus*, *Polygonum ringspot virus*, *Tomato chlorotic spot virus*, *Watermelon silver mottle virus.* Considered as a problem in one Member State for each virus.

Table 3: Past, present and expected future importance of *Tomato spotted wilt virus* in each Member State

	In the last 10 years	Currently	Expectation for the next 5 years
Greece	Severe problems	Severe problems	Severe problems
Hungary	Severe problems	Severe problems	Severe problems
Italy	Severe problems	Severe problems	Severe problems
Austria	Moderate problems	Moderate problems	Minimal problems
Belgium	Moderate problems	Moderate problems	Moderate problems
Bulgaria	Severe problems	Moderate problems	Moderate problems
Cyprus	Moderate problems	Moderate problems	Moderate problems
Poland	Moderate problems	Moderate problems	Moderate problems
Spain	Severe problems	Moderate problems	
Czech Republic	Minimal problems	Minimal problems	Minimal problems
Malta	Minimal problems	Minimal problems	Moderate problems
Sweden	Minimal problems	Minimal problems	Minimal problems
United Kingdom	Moderate problems	Minimal problems	Minimal problems
Denmark	Minimal problems	No problems	Minimal problems
Estonia	No problems	No problems	No problems
Finland	Moderate problems	No problems	Moderate problems
Latvia	Minimal problems	No problems	No problems
Lithuania	No problems	No problems	No problems
Slovakia	Minimal problems	No problems	Minimal problems

Table 4: Past, present and expected future importance of *Chrysanthemum stem necrosis virus* in each Member State

	In the last 10 years	Currently	Expectation for the next 5 years
Finland	No problems	No problems	Moderate problems
Belgium	No problems	No problems	Minimal problems
Bulgaria		No problems	Minimal problems
Denmark	No problems	No problems	Minimal problems
Italy	No problems	No problems	Minimal problems
United Kingdom	Minimal problems	No problems	Minimal problems
Austria	No problems[1]	No problems[1]	
Cyprus	No problems	No problems	No problems
Czech Republic	No problems	No problems	No problems
Estonia	No problems	No problems	No problems
Hungary	No problems	No problems	No problems
Latvia	No problems	No problems	No problems
Lithuania	No problems	No problems	No problems
Malta	No problems	No problems	No problems
Poland	No problems[1]	No problems[1]	No problems
Slovakia	No problems[1]	No problems[1]	
Spain	No problems	No problems	
Sweden	No problems	No problems	No problems

[1]Austria, "does not occur"; Poland, "absent"; Slovakia, "no pest record".

Table 5: Past, present and expected future importance of *Impatiens necrotic spot virus* in each Member State

	In the last 10 years	Currently	Expectation for the next 5 years
Finland	Moderate problems	Moderate problems	Moderate problems
Hungary	Moderate problems	Moderate problems	Moderate problems
Italy	Moderate problems	Moderate problems	Moderate problems
Austria	Minimal problems	Minimal problems	Minimal problems
Belgium	Minimal problems	Minimal problems	Minimal problems
Czech Republic	Minimal problems	Minimal problems	Minimal problems
Poland	Minimal problems	Minimal problems	Minimal problems
Slovakia	Minimal problems	Minimal problems	Minimal problems
Spain	Minimal problems	Minimal problems	
Sweden	Minimal problems	Minimal problems	Minimal problems
Bulgaria		No problems	Minimal problems
Cyprus	No problems	No problems	No problems
Denmark	Minimal problems	No problems	Minimal problems
Estonia	No problems	No problems	No problems
Latvia	No problems	No problems	No problems
Lithuania	No problems	No problems	No problems
Malta	No problems	No problems	No problems
United Kingdom	Minimal problems	No problems	Minimal problems

Table 6: Past, present and expected future importance of *Iris yellow spot virus* in each Member State

	In the last 10 years	Currently	Expectation for the next 5 years
Austria	Minimal problems	Minimal problems	Minimal problems
Greece	Minimal problems	Minimal problems	Minimal problems
Italy	No problems	Minimal problems	Moderate problems
Belgium	No problems	No problems	Minimal problems
Bulgaria		No problems	
Cyprus	No problems	No problems	No problems
Czech Republic	No problems	No problems	Minimal problems
Denmark	No problems	No problems	Minimal problems
Estonia	No problems	No problems	No problems
Finland	No problems	No problems	
Hungary	No problems	No problems	Minimal problems
Latvia	No problems	No problems	No problems
Lithuania	No problems	No problems	No problems
Malta	No problems	No problems	No problems
Poland	No problems[1]		No problems
Slovakia	No problems	No problems[1]	Minimal problems[1]
Spain	Moderate problems	No problems	
Sweden	No problems	No problems	No problems
United Kingdom	Minimal problems	No problems	Minimal problems

[1]Poland, "absent"; Slovakia = "it can be a problem".

3.4. Hosts

Table 7: Importance of host plants in the Member States

Host	Host importance[1]														
	In crop production (open-air or protected cultivations, orchards or vineyards or forests)					In nurseries (for production of plant propagation material)					In private gardens, urban sites or other sites (e.g. storehouses, markets, border stations or transport)				
	Total MS answers	Absent	Only local	Only regional	Nationwide	Total MS answers	Absent	Only local	Only regional	Nationwide	Total MS answers	Absent	Only local	Only regional	Nationwide
Tomatoes	14	0 %	7 %	29 %	64 %	13	8 %	46 %	8 %	38 %	12	0 %	8 %	0 %	92 %
Peppers	14	0 %	21 %	36 %	43 %	12	25 %	25 %	17 %	33 %	12	8 %	17 %	0 %	75 %
Other Solanaceae[2]	11	9 %	0 %	9 %	73 %	10	10 %	30 %	20 %	40 %	10	10 %	0 %	0 %	90 %
Squash, courgette	12	0 %	50 %	17 %	33 %	11	27 %	45 %	9 %	18 %	12	0 %	17 %	25 %	58 %
Cucumber	2	0 %	0 %	50 %	50 %										
Other Cucurbitaceae (watermelon, melon)	13	38 %	38 %	8 %	15 %	12	58 %	33 %	0 %	8 %	12	42 %	17 %	0 %	42 %
Lettuce	12	0 %	17 %	42 %	42 %	11	18 %	27 %	36 %	18 %	11	0 %	9 %	9 %	82 %
Onion, leek	13	0 %	15 %	23 %	62 %	10	20 %	40 %	10 %	30 %	11	0 %	9 %	9 %	82 %
Leguminosae (beans, peas)	12	0 %	17 %	33 %	50 %	10	40 %	20 %	30 %	10 %	11	0 %	9 %	0 %	91 %
Chrysanthemum	13	0 %	31 %	15 %	54 %	11	9 %	45 %	9 %	36 %	11	0 %	18 %	0 %	82 %
Other ornamentals (flowers)	14	0 %	29 %	29 %	43 %	11	9 %	55 %	18 %	18 %	12	0 %	17 %	0 %	83 %

[1]Answers from Cyprus, Estonia, Italy and Slovakia not considered.
[2]Answers for other Solanaceae not considered for Sweden, as potato crops were not included.

Some Member States added to the predefined list of hosts crops the following potential hosts: artichokes, basil, endive, stevia, *Asplenium nidus-avis*, cactus (*Opuntia*) and *Plantago coronopus*.

3.5. Presence of the pest

Table 8: List of pest–host combinations reported to be present or present in the past

Host	Region	Production type	Protection	Year of first detection	Current distribution	Remarks
Chrysanthemum stem necrosis virus						
Chrysanthemum	United Kingdom/specific region	Nurseries	Protected conditions	2002	Absent, pest eradicated	Mumford et al., 2003) NDR, Plant Path 52,779
Groundnut ringspot virus						
Multiple hosts	Hungary	All production areas	Both open and protected	2006	Present, no details	
Impatiens necrotic spot virus						
Multiple hosts	United Kingdom	Nurseries	Protected conditions	1996	Present, no details	Weekes et al., 1998. Journal of Phytopathology, 146, 201–203
Multiple hosts	Finland	Fields	Protected conditions	1998	Transient, under eradication	
Multiple hosts	Czech Republic	Nurseries	Protected conditions	1999	Present, few occurrences	
Multiple hosts	Austria		Protected conditions	2004	Transient, under eradication	Detected three times in glasshouses in Tyrol, Styria, Lower Austria
Multiple hosts	Hungary	All production areas	Protected conditions	2006	Present, widespread	
Multiple hosts	Italy	All production areas	Protected conditions		Present, few occurrences	
Other ornamentals (flowers)	United Kingdom/specific region	At borders or transport means	NA	1996	Present, no details	Gatwick Airport
Other ornamentals (flowers)	Sweden/specific region	Fields	Protected conditions	2001	Absent, pest no longer present	
Other ornamentals (flowers)	Slovakia/specific region	Field production, orchards or vineyards		2004	Present, no details	Import

Host	Region	Production type	Protection	Year of first detection	Current distribution	Remarks
Other ornamentals (flowers)	Bulgaria	All production areas (field production, orchards or vineyards)			Present, restricted distribution	
Other ornamentals (flowers)	Denmark	Nurseries	Protected conditions		Present, no details	
Other ornamentals (flowers)	Italy	Nurseries	Protected conditions		present, no details	
Other ornamentals (flowers)	Italy	Private gardens/public sites	NA		Present, no details	
Plantago coronopus, Asplenium nidus-avis	Spain/specific region	Fields	Protected conditions	1993	Present, few occurrences	
Imported plants for planting chrysanthemums and other ornamental plants	Poland/specific region	Glasshouses	NA	1994	Present, few occurrences	Occurs mainly in glasshouses which base their production on imported plants for planting chrysanthemums and other ornamental plants
Monstera, *Cineraria*	Belgium	Fields	Protected conditions		Present, no details	Also official status. Findings on samples sent in for analysis by growers observing problems. In the period 2009–2010 one finding on *Monstera* and one on *Cineraria*. No new findings reported since 2010.
	Belgium	Nurseries			Present, no details	Official status, there are only a limited number of findings reported, no specific information on findings in nurseries
	Belgium	Gardens/public sites, storehouses/markets, border stations/transport means	NA		Present, no details	We do not have data on findings in private gardens etc. We suppose situation is the same as for production
	Czech Republic	Fields	Protected conditions		Present, restricted distribution	
	Lithuania	Nurseries			Absent, confirmed by survey	

NA, not applicable.

3.6. Pest surveys

Table 9: List of pest–host combinations reported to be absent, confirmed by survey

Host	Region	Production type	Protection (open air/protected cultivation)	Year of first detection	Current distribution	Remarks
Chrysanthemum stem necrosis virus						
Chrysanthemum	Bulgaria	Field production, orchards or vineyards			Absent, confirmed by survey	
Impatiens necrotic spot virus						
Multiple hosts	Hungary	Nurseries	Protected conditions		Absent, confirmed by survey	
Multiple hosts	Latvia	Nurseries			Absent, confirmed by survey	
Iris yellow spot virus						
Onion, leek	Hungary/specific region	Fields	Open-air conditions		Absent, confirmed by survey	
Tomato spotted wilt virus						
Multiple hosts	Hungary	Nurseries	Protected conditions		Absent, confirmed by survey	
Multiple hosts	Latvia	Nurseries			Absent, confirmed by survey	
Tomatoes	Poland/specific region	Nurseries	Protected conditions	2005	Absent, confirmed by survey	No data on further occurrence of the pest in nurseries based on results of official surveys and literature data

Table 10: List of surveys for specific pests

Host	Region	Production type	Year of latest survey	Name of survey/control program/certification scheme	Remarks
				Chrysanthemum stem necrosis virus	
Multiple hosts	Belgium	Multiple locations	2012	Survey by Federal Agency for the Safety of the Food Chain (FASFC)	This is taken up from 2012 in the annual control programme. To date no findings
Chrysanthemum	Bulgaria	Multiple locations	2011	Monitoring programme for quarantine pests	
				Groundnut ringspot virus	
Multiple hosts	Hungary	Multiple locations	2010	Nationwide surveys of tospoviruses on vegetables and ornamentals	
				Impatiens necrotic spot virus	
Multiple hosts	Hungary	Multiple locations	2004	Nationwide surveys of tospoviruses on vegetables and ornamentals	
Multiple hosts	Latvia	Multiple locations		Surveys in accordance with annual plans of Plant Protection Service	The surveys were carried out in 1998–2006
Multiple hosts	Sweden	Multiple locations	2011	EU survey	2012 ongoing—survey table TSWV and INSV, Sweden 2011
Multiple hosts	Finland	Fields	2012	Routine survey on greenhouse production	The survey is targeted at main commercial greenhouses. The survey is not targeted exclusively at INSV but also at other quarantine pests
Multiple hosts	Czech Republic	Nurseries	2004	Detection survey targeted on the presence of INSV in the CZ territory	The organism is officially controlled (inspections, measures in case of findings) according to NPPOs' internal guidelines—see documentation cited
Multiple hosts	Denmark	Nurseries	1998	Protected zone survey	
Other Solanaceae	Lithuania	Nurseries	2011	National survey	
Basil	Italy/specific region	Fields	2009	Regional monitoring	
Other ornamentals (flowers)	Bulgaria	Multiple locations	2011	Monitoring programme for quarantine pests	
				Iris yellow spot virus	
Onion, leek	Greece	Fields	2008		http://apsjournals.apsnet.org/doi/abs/10.1094/PDIS-93-7-0761A
Onion, leek	Hungary/specific region	Fields	2010	Nationwide survey for IYSV on onion	

Host	Region	Production type	Year of latest survey	Name of survey/control program/certification scheme	Remarks
Onion, leek	Italy/specific region	Fields	2011	National monitoring STRA.TE.CO.	
Host	**Region**	**Production type**	**Year of latest survey**	**Name of survey/control program/certification scheme**	**Remarks**
			Tomato spotted wilt virus		
Multiple hosts	Belgium	Multiple locations	2012	Survey by Federal Agency for the Safety of the Food Chain (FASFC) + NPPO Research project Fyquarstat (October 2009 to September 2011)	TSWV is taken up in the yearly FASFC control programme, also in 2012. In 2010–2011 an additional specific survey was carried out during an NPPO research project. Positive samples were found on chrysanthemum within the project
Multiple hosts	Bulgaria	Multiple locations	2011	Monitoring programme for quarantine pests	
Multiple hosts	Cyprus	Multiple locations	2011	Incidence of viruses affecting tomato crops in Cyprus	
Multiple hosts	Hungary	Multiple locations	2011	Nationwide survey for TSWV on pepper and tomato plants	
Multiple hosts	Latvia	Multiple locations	2005	Surveys in accordance with annual plans of PPS	The surveys were carried out in 1998–2008
Multiple hosts	Sweden	Multiple locations	2011	EU survey	2012 ongoing—survey table TSWV and INSV Sweden 2011
Multiple hosts	Finland	Fields	2012	Routine survey on greenhouse production	The survey is targeted at main commercial greenhouses. The survey is not targeted exclusively at TSWV but also at other quarantine pests.
Multiple hosts	Czech Republic	Nurseries	2004	Detection survey targeted on the presence of TSWV in the CZ territory	The organism is officially controlled (inspections, measures in case of findings) according to the NPPOs' internal guidelines—see documentation cited
Multiple hosts	Denmark	Nurseries	1998	Protected zone survey	
Multiple hosts	Estonia	Nurseries	2003	TSWV survey	
Other Solanaceae	Lithuania	Nurseries	2011	National survey	
Hosts mentioned in Annex II/A2 to the Directive 2000/29/EC	Poland	Both outdoor and indoor crops	Currently	SPHIS (NPPO) official survey and control programme	Until accession of Poland to EU (2004) surveys concerned all available hosts of this virus
Tomatoes	Malta	Fields	2012	National Tomato Survey	These were actually greenhouse tomatoes. There is no option for GH tomatoes. Tests still pending
Artichoke	Italy/specific region	Fields	2011	Artichoke virus sanitation	

3.7. Impact per host and type of production

Table 11: Impact on specific pest–host combinations

Host	Region	Production type	Protection	Year	Impact (yield and/or quality loss)
Chrysanthemum stem necrosis virus					
Tomatoes	Bulgaria	All production areas	Protected conditions		
Groundnut ringspot virus					
Multiple hosts	Hungary	All production areas	Both open and protected	2006	Minor
Impatiens necrotic spot virus					
Multiple hosts	Austria		Protected conditions		Massive
Multiple hosts	Italy	All production areas	Protected conditions	Before 1990	Major
Multiple hosts	Hungary	All production areas	Protected conditions	2006	Moderate
Multiple hosts	Poland/specific region	Crops; mainly places of production of pot plants	Protected conditions (glasshouses)	1994	Minor
Multiple hosts	Belgium	Fields	Protected conditions		Moderate
Multiple hosts	Finland	Fields	Protected conditions		Moderate
Multiple hosts	Spain/specific region	Fields	Protected conditions	1993	Minor
Peppers	Czech Republic/specific region	Fields	Protected conditions	2005	
Peppers	Czech Republic/specific region	Nursery	Protected conditions	2006	Major
Other ornamentals (flowers)	Bulgaria	All production areas	Protected conditions	Before 1990	Moderate
Other ornamentals (flowers)	Sweden/specific region	Fields	Protected conditions	2009	Moderate
Other ornamentals (flowers)	Italy	Nursery	Protected conditions	Before 1990	Minor
Iris yellow spot virus					
Onion, leek	Austria/specific region		Open-air conditions		Moderate

Host	Region	Production type	Protection	Year	Impact (yield and/or quality loss)
Onion, leek	Italy	Fields	Open-air conditions	2008	Moderate
Onion, leek	Spain/specific region	Fields	Open-air conditions	2003	Minimal
Host	Region	Production type	Protection	Year	Impact (yield and/or quality loss)
		Tomato spotted wilt virus			
Multiple hosts	Austria		Protected conditions		Massive
Multiple hosts	Bulgaria	All production areas	Protected conditions	Before 1990	Major
Multiple hosts	Italy	All production areas	Both open and protected	Before 1990	Major
Multiple hosts	Poland/specific region	Crops under protected conditions (glasshouses); places of production of fresh vegetables	NA	1990	Moderate
Multiple hosts	Belgium	Fields	Protected conditions		Major
Multiple hosts	Hungary	Fields	Both open and protected	1996	Major
Multiple hosts	Estonia	Fields	Both open and protected	Before 1990	Major
Multiple hosts	Finland	Fields	Protected conditions		Moderate
Multiple hosts	Estonia	Nursery	Protected conditions	2002	Minimal
Tomatoes	Cyprus	All production areas	Both open and protected	2011	Minor
Tomatoes	Czech Republic/specific region	Fields	Protected conditions	2005	
Tomatoes	Malta	Imported material	Protected conditions	2011	Minimal
Tomatoes	Bulgaria	Nursery	Both open and protected	Before 1990	Moderate
Tomatoes	Cyprus	Nursery	Protected conditions	2011	Moderate

Host	Region	Production type	Protection	Year	Impact (yield and/or quality loss)
Tomatoes	Poland/specific region	Nursery	Protected conditions	Confirmed in 2005	
Tomatoes	Malta	Storehouses or markets	NA	2011	Minimal
Peppers	Cyprus	Fields	Open-air conditions	2011	Minimal
Peppers	Czech Republic/specific region	Fields	Protected conditions	2005	
Lettuce	Cyprus	Fields	Open-air conditions	2011	Minor
Tobacco	Greece/specific region	Fields	Open-air conditions	2004–2005	Major
Chrysanthemum	Latvia	Private gardens/public sites	NA	2005	Minimal
Other ornamentals (flowers)	Sweden/specific region	Fields	Protected conditions	2009	Moderate
Other ornamentals (flowers)	Italy	Nursery	Protected conditions	Before 1990	Minor
Other ornamentals (flowers)	Cyprus	Private gardens/public sites	NA	2011	Minimal
	Belgium	Nursery	Protected conditions		Major

NA, not applicable.

3.8. Vectors

Table 12: Importance of the vectors, in the past, present and future

Vector	Vector relevance									
	Under open-air conditions					Under protected conditions				
	Total MS answers	Absent	Only local	Only regional	Nationwide	Total MS answers	Absent	Only local	Only regional	Nationwide
Ceratotripoides claratris	13	100 %	0 %	0 %	0 %	12	100 %	0 %	0 %	0 %
Frankliniella bispinosa	13	100 %	0 %	0 %	0 %	12	100 %	0 %	0 %	0 %
Frankliniella cephalica	13	100 %	0 %	0 %	0 %	12	100 %	0 %	0 %	0 %
Frankliniella fusca	13	100 %	0 %	0 %	0 %	12	100 %	0 %	0 %	0 %
Frankliniella gemina	13	100 %	0 %	0 %	0 %	12	100 %	0 %	0 %	0 %
Frankliniella intonsa	16	31 %	6 %	6 %	56 %	16	38 %	19 %	6 %	38 %
Frankliniella occidentalis	17	53 %	12 %	6 %	29 %	17	6 %	18 %	0 %	76 %
Frankliniella schultzei	17	88 %	12 %	0 %	0 %	16	88 %	13 %	0 %	0 %
Frankliniella zucchini	13	100 %	0 %	0 %	0 %	12	100 %	0 %	0 %	0 %
Scirtothrips dorsalis	14	100 %	0 %	0 %	0 %	13	92 %	8 %	0 %	0 %
Thrips palmi	18	94 %	6 %	0 %	0 %	15	100 %	0 %	0 %	0 %
Thrips setosus	13	100 %	0 %	0 %	0 %	12	100 %	0 %	0 %	0 %
Thrips tabaci	16	13 %	6 %	0 %	81 %	16	13 %	19 %	6 %	63 %

"No pest record" is interpreted as "absent".

"Only interceptions" is interpreted as "only local".

The vectors confirmed as present in the EU Member States that responded to the questionnaire are *Frankliniella intonsa*, *Frankliniella occidentalis* and *Thrips tabaci*. *Frankliniella schultzei* has been reported in the Canary Islands in Spain (outside the risk assessment area) and incidentally reported in Italy. *Scirtothrips dorsalis* has been reported in the UK in a single outbreak in a protected environment and is under eradication.

Table 13: Importance of *Frankliniella intonsa* under open-air and protected conditions

	Under open-air conditions	Under protected conditions
Austria	Absent	Absent
Belgium	Nationwide	Nationwide
Bulgaria	Only regional	Only regional
Cyprus	Absent	Absent
Czech Republic	Nationwide	Only local
Denmark	Absent	Absent
Estonia		Nationwide
Spain	Nationwide	
Finland	Nationwide	Nationwide
Hungary	Nationwide	Nationwide
Italy	Nationwide	Nationwide
Lithuania	Nationwide	Nationwide
Latvia	Only local	Only local
Malta	Absent	Absent
Poland	Nationwide	Only local
Sweden	Absent	Absent
United Kingdom	Nationwide	Absent

Table 14: Importance of *Frankliniella occidentalis* under open-air and protected conditions

	Under open-air conditions	Under protected conditions
Austria		Nationwide
Belgium	Only local	Nationwide
Bulgaria	Absent	Nationwide
Cyprus	Nationwide	Nationwide
Czech Republic	Absent	Nationwide
Denmark	Absent	Only local
Estonia		Nationwide
Spain	Nationwide	
Finland	Absent	Nationwide
Greece	Nationwide	Nationwide
Hungary	Absent	Nationwide
Italy	Nationwide	Nationwide
Lithuania	Absent	Only local
Latvia	Only local	Only local
Malta	Nationwide	Nationwide
Poland	Absent	Nationwide
Sweden	Absent	Absent
Slovakia	Only regional	
United Kingdom	Absent	Nationwide

Table 15: Importance of *Thrips tabaci* under open air and protected conditions

	Under open-air conditions	**Under protected conditions**
Austria		Nationwide
Belgium	Nationwide	Nationwide
Bulgaria	Nationwide	Only local
Cyprus	Nationwide	Only regional
Czech Republic	Nationwide	Nationwide
Denmark	Nationwide	Nationwide
Estonia		Nationwide
Spain	Nationwide	
Finland	Nationwide	Nationwide
Greece	Nationwide	
Hungary	Nationwide	Nationwide
Italy	Nationwide	Nationwide
Lithuania	Nationwide	Nationwide
Latvia	Only local	Only local
Malta	Absent	Absent
Poland	Nationwide	Only local
Sweden	Absent	Absent
United Kingdom	Nationwide	Nationwide

3.9. Hosts of the vectors

The member states added lucerne, cabbage, gladiolus, roses and weeds as possible hosts of the vectors.

Table 16: Importance of vector host plants in the member states

Host	Host importance									
	Under open-air conditions					Under protected conditions				
	Total MS answers	Absent	Only local	Only regional	Nationwide	Total MS answers	Absent	Only local	Only regional	Nationwide
Chrysanthemum	12	25 %	25 %	8 %	42 %	12	0 %	33 %	8 %	58 %
Cucurbitaceae	13	0 %	23 %	23 %	54 %	13	0 %	8 %	38 %	54 %
Leguminosae	13	0 %	15 %	23 %	62 %	13	31 %	0 %	54 %	15 %
Lettuce	14	14 %	14 %	14 %	57 %	13	0 %	23 %	31 %	46 %
Onion, leek	11	0 %	27 %	0 %	73 %	11	27 %	27 %	18 %	27 %
Ornamentals (flowers)	14	0 %	29 %	14 %	57 %	14	0 %	7 %	43 %	50 %
Solanaceae	14	7 %	7 %	0 %	86 %	14	0 %	7 %	14 %	79 %

3.10. Presence of the vector

Table 17: List of vector–host combinations reported to be present or present in the past

Host	Region	Production type	Protection	Year of first detection	Current distribution	Remarks
Frankliniella intonsa						
Multiple hosts	Belgium	Multiple locations	Open-air conditions		Present, widespread	
Multiple hosts	Belgium	Multiple locations	Protected conditions		Present, widespread	Considered as native but never diagnosed in samples from growers experiencing problems
Multiple hosts	Czech Republic	Multiple locations	Protected conditions	Before 1990	Present, restricted distribution	
Multiple hosts	Czech Republic	Multiple locations	Open-air conditions	Before 1990	Present, widespread	
Multiple hosts	Estonia	Nurseries	Protected conditions		Present, widespread	
Multiple hosts	Finland	Multiple locations	Open-air conditions	Before 1990	Present, widespread	
Multiple hosts	Finland	Multiple locations	Protected conditions		Present, widespread	Mainly in greenhouses
Multiple hosts	Hungary	Multiple locations	Open-air conditions	Before 1990	Present, widespread	
Multiple hosts	Hungary	Multiple locations	Protected conditions	Before 1990	Present, widespread	
Multiple hosts	Italy	Multiple locations	Open-air conditions	Before 1990	Present, widespread	
Multiple hosts	Italy	Multiple locations	Protected conditions	Before 1990	Present, widespread	
Multiple hosts	Latvia	Multiple locations	Open-air conditions	1994	Present, no details	Only seasonally or in greenhouses
Multiple hosts	Latvia	Multiple locations	Protected conditions	1994	Present, no details	
Multiple hosts	Poland	Fields	Open-air conditions	Not known	Present, no details	
Multiple hosts	Poland	Fields	Protected conditions	Not known	Present, no details	
Ornamentals (flowers)	Bulgaria/specific region	Private gardens or public sites	Open-air conditions	before 1990	Present, restricted distribution	

Host	Region	Production type	Protection	Year of first detection	Current distribution	Remarks
Frankliniella occidentalis						
Multiple hosts	Belgium	Multiple locations	Open-air conditions		Present, few occurrences	Mainly causing problems in protected or semiprotected environment
Multiple hosts	Belgium	Multiple locations	Protected conditions		Present, widespread	*F. occidentalis* and *T. tabaci* are the main organisms reported to cause problems
Multiple hosts	Cyprus	Multiple locations	Open-air conditions		Present, widespread	No data available for first year of detection
Multiple hosts	Cyprus	Multiple locations	Protected conditions		Present, widespread	No data available for first year of detection
Multiple hosts	Czech Republic	Multiple locations	Protected conditions	Before 1990	Present, restricted distribution	
Multiple hosts	Estonia	Nurseries	Protected conditions		Present, widespread	
Multiple hosts	Finland	Multiple locations	Protected conditions		Present, widespread	Mainly in greenhouses
Multiple hosts	Hungary	Multiple locations	Protected conditions	1990	Present, widespread	
Multiple hosts	Italy	Multiple locations	Open-air conditions	Before 1990	Present, widespread	
Multiple hosts	Italy	Multiple locations	Protected conditions	Before 1990	Present, widespread	
Multiple hosts	Latvia	Multiple locations	Open-air conditions	1994	Present, no details	Only seasonally or in greenhouses
Multiple hosts	Latvia	Multiple locations	Protected conditions	1994	Present, no details	
Multiple hosts	Poland	Fields	Protected conditions	1986	Present, widespread	
Multiple hosts	Slovakia	Multiple locations	Open-air conditions		Present, no details	
Ornamentals (flowers)	Denmark	Nurseries	Protected conditions		Present, few occurrences	
Solanaceae	Malta	Multiple locations	Open-air conditions		Present, no details	Surveys are not conducted for this pest. Information was extracted as from EPPO datasheet
	Austria		Open-air conditions		Present, widespread	EPPO PQR: present, widespread
	Austria		Protected conditions		present, widespread	EPPO PQR: present ,widespread
Frankliniella schultzei						
Multiple hosts	Italy	Multiple locations	Open-air conditions	Before 1990	Present, few occurrences	
Multiple hosts	Italy	Multiple locations	Protected conditions	Before 1990	Present, few occurrences	

Thrips tabaci						
Multiple hosts	Belgium	Multiple locations	Open-air conditions		Present, widespread	
Multiple hosts	Belgium	Multiple locations	Protected conditions		Present, widespread	*F. occidentalis* and *T. tabaci* are the main organisms reported to cause problems.
Multiple hosts	Bulgaria	Multiple locations	Open-air conditions	Before 1990	Present, widespread	
Multiple hosts	Cyprus	Multiple locations	Open-air conditions		Present, no details	No data available for first year of detection
Multiple hosts	Cyprus	Multiple locations	Protected conditions		Present, no details	No data available for first year of detection
Multiple hosts	Czech Republic	Multiple locations	Protected conditions	Before 1990	Present, restricted distribution	
Multiple hosts	Czech Republic	Multiple locations	Open-air conditions	Before 1990	Present, widespread	
Multiple hosts	Denmark	Nurseries	Protected conditions		Present, no details	
Multiple hosts	Denmark	Fields	Open-air conditions		Present, widespread	
Multiple hosts	Estonia	Nurseries	Protected conditions		Present, widespread	
Multiple hosts	Finland	Multiple locations	Open-air conditions	Before 1990	Present, widespread	
Multiple hosts	Finland	Multiple locations	Protected conditions		Present, widespread	Mainly in greenhouses
Multiple hosts	Hungary	Multiple locations	Open-air conditions	Before 1990	Present, widespread	
Multiple hosts	Hungary	Multiple locations	Protected conditions	Before 1990	Present, widespread	
Multiple hosts	Italy	Multiple locations	Open-air conditions	Before 1990	Present, widespread	
Multiple hosts	Italy	Multiple locations	Protected conditions	Before 1990	Present, widespread	
Multiple hosts	Latvia	Multiple locations	Open-air conditions	Before 1990	Present, no details	Only seasonally or in greenhouses
Multiple hosts	Latvia	Multiple locations	Protected conditions	Before 1990	Present, no details	
Multiple hosts	Poland	Fields	Open-air conditions	Not known	Present, no details	
Multiple hosts	Poland	Fields	Protected conditions	Not known	Present, no details	
Onion, leek	Malta	Multiple locations	Open-air conditions		Present, no details	Unreliable record in 1963
	Austria		Open-air conditions		Present, widespread	New disease reports (2011) 23, 13 Bulletin OILB/SROP. 2007. 30: 8, 1–8. 19 ref Bulletin OILB/SROP. 1992. 15: 4, 28–35. 3 ref

	Austria		Protected conditions		Present, widespread	New disease reports (2011) 23, 13 Bulletin OILB/SROP. 2007. 30: 8, 1–8. 19 ref Bulletin OILB/SROP. 1992. 15: 4, 28–35. 3 ref

3.11. Vector surveys

Table 18: List of vector–host combinations reported to be absent, confirmed by a survey

Host	Region	Production type	Protection	Year of first detection	Current distribution	Remarks
			Thrips palmi			
Multiple hosts	Estonia	Nurseries	Protected conditions		Absent, confirmed by survey	

Table 19: List of surveys for specific vectors

Host	Region	Production type	Year of latest survey	Name of survey	Remarks
			Frankliniella intonsa		
Multiple hosts	Sweden	Multiple locations	2011	Yearly production control	2012 ongoing. The plant health inspectors search for/assess pests and diseases in general
Solanaceae	Hungary/specific region	Fields	2008	Investigation of *Thysanoptera* population of sweet peppers in greenhouses and in their surroundings	
Multiple hosts	Italy/specific region	Nurseries	2008	Indagine sulla presenza di Thrips palmi in Friuli Venezia Giulia nel 2008	Survey detection of *T. palmi*, with several records on other tripids
Ornamentals (flowers)	Bulgaria/specific region	Private gardens or public sites	2011	Monitoring of quarantine pests	
			Frankliniella occidentalis		
Multiple hosts	Bulgaria	Multiple locations	2011	Monitoring of quarantine pests	

Host	Region	Production type	Year of latest survey	Name of survey	Remarks
Multiple hosts	Latvia	Multiple locations	1994	Surveys for the quarantine pests	It was listed as a quarantine pest in the country up to 2004.
Multiple hosts	Sweden	Multiple locations	2011	Yearly production control	2012 ongoing. The plant health inspectors search for/assess pests and diseases in general
Multiple hosts	Italy/specific region	Multiple Locations	2008	Indagine sulla presenza di Thrips palmi in Friuli Venezia Giulia nel 2008	Survey detection of *T. palmi*, with several records on other Tripids
	Czech Republic				Thrips as a group are monitored annually in the whole territory of the Czech Republic. Species identification is carried out in specific cases only.
Solanaceae	Hungary/specific region	Fields	2008	Investigation of Thysanoptera population of sweet pepper greenhouses and in their surroundings	
Multiple hosts	Denmark	Nurseries	1998	TSWV Protected zone survey	Blue sticky traps
Multiple hosts	Estonia	Nurseries	2004	Glasshouse pests survey 2002–2004	
all host plants	Poland	Plants for export to third countries with pest quarantine status	currently	official survey - SPHIS (NPPO) Inspections	
Frankliniella schultzei					
Multiple hosts	Sweden	Multiple locations	2011	Yearly production control	2012 ongoing. The plant health inspectors search for/assess pests and diseases in general
Multiple hosts	Italy/specific region	Nurseries	2008	Indagine sulla presenza di Thrips palmi in Friuli Venezia Giulia nel 2008	Survey detection of *T. palmi*, with several records on other tripids

Host	Region	Production type	Year of latest survey	Name of survey	Remarks
Thrips palmi					
Multiple hosts	Belgium	Multiple locations		Taken up in the control programme of the FASFC	This vector is not present in domestic production but samples at import as well as thrips samples found in domestic production are determined to check if it concerns this species
Multiple hosts	Sweden	Multiple locations	2011	Yearly production control	2012 ongoing. The plant health inspectors search for/assess pests and diseases in general
	Bulgaria		2011	Monitoring of quarantine pests	
Multiple hosts	Latvia			Surveys for the quarantine pests	Listed as a quarantine pest in the country since 1998
Multiple hosts	Hungary	Fields	2004	Survey for the distribution of *F. occidentalis*, *T. tabaci*, *T. palmi*	
Multiple hosts	Estonia	Nurseries	2004	Glasshouse pests survey 2002–2004	
Multiple hosts	Italy/specific region	Nurseries	2008	Indagine sulla presenza di Thrips palmi in Friuli Venezia Giulia nel 2008	Survey detection of *T. palmi*, with several records on other tripids
All host plants	Poland	At borders or transport means	Currently	official survey - SPHIS (NPPO) Inspections	
Multiple hosts	Denmark	At borders or transport means		No surveys but import inspections	If thrips are found in a nursery, they are identified to confirm absence of *T. palmi*
Thrips tabaci					
Multiple hosts	Bulgaria	Multiple locations	2011	Monitoring of quarantine pests	
Multiple hosts	Sweden	Multiple locations	2011	Yearly production control	2012 ongoing. The plant health inspectors search for/assess pests and diseases in general

Host	Region	Production type	Year of latest survey	Name of survey	Remarks
Multiple hosts	Italy/specific region	Multiple Locations	2008	Indagine sulla presenza di Thrips palmi in Friuli Venezia Giulia nel 2008	Survey detection of *T. palmi*, with several records on other tripids
Solanaceae	Hungary/specific region	Fields	2008	Investigation of *Thysanoptera* population of sweet peppers in greenhouses and in their surroundings	
Multiple hosts	Estonia	Nurseries	2004	Glasshouse pests survey 2002–2004	

3.12. Measures for each vector host and type of protection

Table 20: List of impact and measures applied on specific vector–host combinations

Host	Region	Production type	Protection	Year	Category of control measure applied	Please specify the measure applied	Effectiveness	Implementation	Remarks
				Frankliniella intonsa					
Multiple hosts	Poland	Horticultural crops	Protected conditions	currently	Chemical pest control	No specified plant protection products recommended for control of this pest. It is controlled with plant protection products used for thrips control	Moderate	At local level only	No obligatory official measures
Multiple hosts	Finland	Multiple locations	Protected conditions		Chemical pest control		Moderate	At national level	
Multiple hosts	Czech Republic	Multiple locations	Open-air conditions	Before 1990	Combination of measures	Sticky traps + chemical pest control + biological pest control or integrated pest management			
Multiple hosts	Czech Republic	Multiple locations	Protected conditions	Before 1990	Combination of measures	Sticky traps + chemical pest control + biological pest control or integrated			

Host	**Region**	**Production type**	**Protection**	**Year**	**Category of control measure applied**	**Please specify the measure applied**	**Effectiveness**	**Implementation**	Remarks
						pest management			
Multiple hosts	Hungary	Multiple locations	Open-air conditions	2008	Combination of measures	Chemical pest control, biological pest control, without protection	Moderate	At local level only	
Multiple hosts	Hungary	Multiple locations	Protected conditions	2008	Combination of measures	Chemical pest control, biological pest control, without protection	Moderate	At local level only	
Multiple hosts	Latvia	Multiple locations	Protected conditions	1994	Combination of measures				
Multiple hosts	Italy	Multiple locations	Protected conditions	Before 1990	Integrated pest management	Monitoring, and biological control or insecticide treatments	Moderate	At national level	
	Belgium		Protected conditions			No specific information, control probably as for other Thrips vectors.			
Ornamentals (flowers)	Bulgaria/specific region	Private gardens or public sites	Open-air conditions	2010	Chemical pest control				
Host	Region	Production type	Protection	Year	Category of control measure applied	Please specify the measure applied	Effectiveness	Implementation	Remarks
Frankliniella occidentalis									
Multiple hosts	Poland	Horticultural crops	Protected conditions	Currently	Chemical pest control	Insecticide application	Moderate	At local level only	No obligatory official measures
Multiple hosts	Finland	Multiple locations	Protected conditions		Chemical pest control		Moderate	At national level	
Multiple hosts	Belgium	Multiple locations	Open-air conditions		Combination of measures	Chemical and biological control			Only few occurrences in open air
Multiple hosts	Belgium	Multiple locations	Protected conditions		Combination of measures	Chemical and biological control (e.g. *Amblyseius*, *Orius* and *Hypoaspis*)			Control of *F. occidentalis* can be achieved by chemical and biological means. In general, control is

Host	Region	Production type	Protection	Year	Category of control measure applied	Please specify the measure applied	Effectiveness	Implementation	Remarks
									becoming more difficult, e.g. because of a lack of recognised products
Multiple hosts	Cyprus	Multiple locations	Open-air conditions		Combination of measures	Chemical spray	High	At national level	Measures are applied when vector detected
Multiple hosts	Cyprus	Multiple locations	Protected conditions		Combination of measures	Chemical spray, biological control, IPM	High	At national level	Measures are applied when vector detected
Multiple hosts	Czech Republic	Multiple locations	Protected conditions	Before 1990	Combination of measures	Sticky traps + chemical pest control + biological pest control or integrated pest management			
Multiple hosts	Hungary	Multiple locations	Protected conditions	2008	Combination of measures	Chemical pest control, biological pest control, without protection	Moderate	At local level only	
Multiple hosts	Latvia	Multiple locations	Protected conditions	1994	Combination of measures				
Multiple hosts	Italy	Multiple locations	Open-air conditions	Before 1990	Integrated pest management	Monitoring and insecticide treatments	Low	At national level	
Multiple hosts	Italy	Multiple locations	Protected conditions	Before 1990	Integrated pest management	Monitoring, and biological control or insecticide treatments	Moderate	At national level	
	Austria		Open-air conditions			Insecticide application	Moderate		
	Austria		Protected conditions			Insecticide application	Moderate		
Solanaceae	Malta	Multiple locations	Open-air conditions		Chemical pest control	Spraying with insecticides	Moderate	At national level	
Ornamentals (flowers)	Denmark	Nurseries	Protected conditions		Chemical pest control		High	At local level only	Important crops: pot plants

Host	Region	Production type	Protection	Year	Category of control measure applied	Please specify the measure applied	Effectiveness	Implementation	Remarks
					Thrips tabaci				
Multiple hosts	Denmark	Fields	Open-air conditions		Chemical pest control		High	At national level	Important crops: leeks, onion
Multiple hosts	Poland	Horticultural crops	Protected conditions	Currently	chemical pest control	Plant protection products, e.g. alpha-cypermethrin	moderate	At local level only	No obligatory official measures
Multiple hosts	Bulgaria	Multiple locations	Open-air conditions	2011	Chemical pest control				
Multiple hosts	Finland	Multiple locations	Protected conditions		Chemical pest control		Moderate	At national level	
Multiple hosts	Belgium	Multiple locations	Open-air conditions		Combination of measures	Chemical and biological control			
Multiple hosts	Belgium	Multiple locations	Protected conditions		Combination of measures	Chemical and biological control			In general, control is becoming more difficult e.g. because of a lack of recognised products.
Multiple hosts	Cyprus	Multiple locations	Open-air conditions		Combination of measures	Chemical spray	High	At national level	Measures are applied when vector detected
Multiple hosts	Cyprus	Multiple locations	Protected conditions		Combination of measures	Chemical spray, biological control, IPM	High	At national level	Measures are applied when vector detected
Multiple hosts	Czech Republic	Multiple locations	Open-air conditions	Before 1990	Combination of measures	Sticky traps + chemical pest control + biological pest control or integrated pest management			
Multiple hosts	Czech Republic	Multiple locations	Protected conditions	Before 1990	Combination of measures	Sticky traps + chemical pest control + biological pest control or integrated pest management			

Host	Region	Production type	Protection	Year	Category of control measure applied	Please specify the measure applied	Effectiveness	Implementation	Remarks
Multiple hosts	Hungary	Multiple locations	Open-air conditions	2008	Combination of measures	Chemical pest control, biological pest control, without protection	Moderate	At local level only	
Multiple hosts	Hungary	Multiple locations	Protected conditions	2008	Combination of measures	Chemical pest control, biological pest control, without protection	Moderate	At local level only	
Multiple hosts	Latvia	Multiple locations	Protected conditions	Before 1990	Combination of measures				
Multiple hosts	Italy	Multiple locations	Open-air conditions	Before 1990	Integrated pest management	Monitoring and insecticide treatments	Low	At national level	
Multiple hosts	Italy	Multiple locations	Protected conditions	Before 1990	Integrated pest management	Monitoring, and biological control or insecticide treatments	Moderate	At national level	
Multiple hosts	Denmark	Nurseries	Protected conditions		Chemical pest control		High	At local level only	Important crops: pot plants, cucumber
	Austria		Open-air conditions			Insecticide application	Moderate		
	Austria		Protected conditions			Insecticide application	Moderate		

4. Ratings and descriptors used in the questionnaire

Pests	
Relevance criteria	
Relevant in the past	Outbreaks, presence, interceptions or impact in the past (last 10 years)
Currently relevant	Current outbreaks, presence, interceptions or impact
Relevant in near future	Expected outbreaks, expected presence, expected interceptions, expected impact, increasing production or trade of hosts plants in the future (next 5 years)
Categories	
Severe problems	Widespread presence and/or high impact; ineffective risk management options (i.e. phytosanitary measures and/or pest management practices)
Moderate problems	Limited distribution and/or moderate impact; ineffective or partially effective risk management options (i.e. phytosanitary measures and/or pest management practices)
Minimal problems	Few occurrences and/or low impact (due to natural enemies, competitors, effective risk management options)
No problems	Absence or decreasing presence or no impact (due to natural enemies, competitors, effective risk management options)
Hosts and vector hosts	
Categories	
Nationwide	Nationwide cultivation/occurrence/transport
Only regional	Only regional cultivation/occurrence/transport
Only local	Only local cultivation/occurrence/transport
Absent	Absence or scarce occurrence
Presence of the pests or vectors	
Categories for location	
Fields	Arable herbaceous crops (including vegetables and ornamentals) or pasture land
Orchards/vineyards/forests	Land planted with trees or other perennial woody plant (fruit trees, grapevines, forest stands, etc.)
Nurseries	Sites where plant propagation material, young plants and trees are grown

Private gardens or public sites	Private or public areas where plants are grown for non-commercial purposes
Storehouses or markets	Sites devoted to the temporal storage, and market of plants and parts of plants
At borders or transport means	Sites at border or means devoted to the movement of plants and parts of plants
Categories for type of protection (open-air/protected cultivation)	
Open-air conditions	Produced under open-air conditions, including temporary protection, e.g. low tunnels
Protected conditions	Produced under permanent or semi-permanent protection structures, e.g. tunnel, greenhouses
Categories for pest distribution	
Present, no details	
Present, widespread	
Present, restricted distribution	
Present, few occurrences	
Transient, under eradication	
Absent, intercepted only	
Absent, pest eradicated	
Absent, pest no longer present	
Absent, no pest record	
Absent, confirmed by survey	
Pest and pest vector surveys	
Categories for location	
Fields	Arable herbaceous crops (including vegetables and ornamentals) or pasture land
Orchards/vineyards/forests	Land planted with trees or other perennial woody plants (fruit trees, grapevines, forest stands, etc.)
Nurseries	Sites where plant propagation material, young plants and trees are grown

Private gardens or public sites	Private or public areas where plants are grown for non-commercial purposes
Storehouses or markets	Sites devoted to the temporary storage and marketing of plants and parts of plants
At borders or transport means	Sites at border or means devoted to the movement of plants and parts of plants
Impact and measures against the pests	
Categories for location	
Fields	Arable herbaceous crops (including vegetables and ornamentals) or pasture land
Orchards/vineyards/forests	Land planted with trees or other perennial woody plants (fruit trees, grapevines, forest stands, etc.)
Nurseries	Sites where plant propagation material, young plants and trees are grown
Private gardens or public sites	Private or public areas where plants are grown for non-commercial purposes
Storehouses or markets	Sites devoted to the temporary storage and marketing of plants and parts of plants
At borders or transport means	Sites at border or means devoted to the movement of plants and parts of plants
Categories for type of protection (open-air/protected cultivation)	
Open-air conditions	Produced under open-air conditions, including temporary protection, e.g. low tunnels
Protected conditions	Produced under permanent or semi-permanent protection structures, e.g. tunnel, greenhouses
Categories for impact	
Minimal	Effects on yield (quantity and/or quality) are not distinguishable from normal variation; no control measures are required
Minor	Yield (quantity and/or quality) is not or occasionally reduced; control measures are not necessary
Moderate	Yield (quantity and/or quality) is rarely reduced; control measures are sometimes necessary
Major	Yield (quantity and/or quality) is frequently reduced; control measures are frequently necessary
Massive	Yield (quantity and/or quality) is always reduced; control measures are always necessary
Categories for effectiveness	
Negligible	The management has no practical effect in reducing the probability of entry or establishment or spread, or the potential consequences

Very low	The management options make it possible to reduce the probability of entry or establishment or spread, or the potential consequences, by a very little extent
Low	The management options make it possible to reduce the probability of entry or establishment or spread, or the potential consequences, by a little extent
Moderate	The management options make it possible to reduce the probability of entry or establishment or spread, or the potential consequences, by a moderate extent
High	The management options make it possible to highly reduce the probability of entry or establishment or spread, or the potential consequences
Categories of control measures:	
Combination of measures	
Phytosanitary measures	
Chemical pest control	
Biological pest control	
Integrated pest management	
Other treatments (heat, irradiation, etc.)	
No measure/not applicable	
Categories for implementation	
At national level	The management options are already in use in the risk assessment area as a part of the current crop management actions and/or of the existing phytosanitary measures
At regional level only	
At local level only	
In experimental settings	
Not implemented	The management options are not in use in the risk assessment area
Vectors	
Importance criteria	
Open-air conditions	Produced under open-air conditions, including temporary protection, e.g. low tunnels
Protected conditions	Produced under permanent or semi-permanent protection structures, e.g. tunnels, greenhouses