

## SCIENTIFIC OPINION

### **Scientific opinion on the risk to plant health posed by *Arabid mosaic virus*, *Raspberry ringspot virus*, *Strawberry latent ringspot virus* and *Tomato black ring virus* to the EU territory with the identification and evaluation of risk reduction options<sup>1</sup>**

**EFSA Panel on Plant Health (PLH)<sup>2,3</sup>**

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#### ABSTRACT

The Panel on Plant Health assessed the risk to plant health of *Arabid mosaic virus* (ArMV), *Strawberry latent ringspot virus* (SLRSV), *Raspberry ringspot virus* (RpRSV) and *Tomato black ring virus* (TBRV) for the European Union (EU) territory, and evaluated the current EU legislation and possible risk reduction options. These viruses are largely restricted to Europe and their vector nematodes and at-risk hosts occur widely in Europe. Plants for planting were identified as the most significant entry pathway and the probability of entry is rated as unlikely to moderately likely for ArMV and as very unlikely to unlikely for RpRSV, SLRSV and TBRV. These ratings have moderate uncertainty. The probability of establishment is rated very likely with low uncertainty. The probability of local spread by natural means is likely, with low to medium uncertainty, whereas that of human-assisted long-distance spread is unlikely to moderately likely, with high uncertainty. Potential impact is rated minimal to minor in all hosts, with the exception of ArMV in grapevine, for which it is minor to moderate. These ratings have medium or high uncertainty. The current legislation addresses only two of the many host species of these viruses, but other weaknesses were also identified. If the current legislation were removed, no major consequences would be expected unless the industry simultaneously ceased its voluntary certification activity. Prohibition and the use of phytosanitary certificates, if covering the complete host ranges of the viruses and relying on appropriate tests, are the options with highest effectiveness against the risk of introduction whereas certification schemes and pest-free areas or production sites are those with the highest effectiveness against the spread and impact risks. All options have limitations in feasibility, with uncertainty ratings from moderate to high. The combination of partially effective options may be highly effective in some crops.

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#### KEY WORDS

*Arabid mosaic virus*, *Strawberry latent ringspot virus*, *Raspberry ringspot virus*, *Tomato black ring virus*, neopvirus, risk assessment, risk reduction options

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## SUMMARY

Following a request from the European Commission (EC), the EFSA Panel on Plant Health (PLH) was asked to deliver a scientific opinion on the pest risk of *Arabis mosaic virus* (ArMV), *Strawberry latent ringspot virus* (SLRSV), *Raspberry ringspot virus* (RpRSV) and *Tomato black ring virus* (TBRV) for the European Union (EU) territory and to identify risk reduction options and evaluate their effectiveness in reducing the risk to plant health posed by the organisms. In particular, the Panel was asked to provide an opinion on the effectiveness of the current EU requirements against these organisms, which are laid down in Council Directive 2000/29/EC, in reducing the risk of introduction of these pests into, and their spread within, the EU territory.

The Panel conducted the pest risk assessment following the general principles of the “Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options” (EFSA PLH Panel, 2010) and of the “Guidance on evaluation of risk reduction options” (EFSA PLH Panel, 2012). As ArMV, SLRSV, RpRSV and TBRV are already present in some EU Member States and have been regulated by the EU for many years, the Panel conducted the pest risk assessment taking into account the current EU plant health legislation.

After consideration of the evidence, the Panel reached the following conclusions:

**With regard to the assessment of the risk to plant health of *Arabis mosaic virus*, *Strawberry latent ringspot virus*, *Raspberry ringspot virus* and *Tomato black ring virus* for the EU territory**, all four viruses are currently established in the risk assessment area. With the possible exception of ArMV, which has a broader distribution outside the EU, the viruses considered are largely restricted to Europe and reported from few countries outside the risk assessment area. These four viruses have vector nematodes that occur widely in the risk assessment area and that have the potential to contribute to the local spread of the viruses. The major crops at risk, *Fragaria*, *Rubus*, *Ribes* and *Vitis*, are cultivated throughout the EU.

With regards to entry, three pathways were identified: plants for planting, plant parts of host plants and soil. The most significant pathway, plants for planting, was analysed in detail. The probability of survival during transport and storage, of survival of management procedures or of transfer to a suitable host are rated as likely to very likely and the only limiting factors are, therefore, the trade volume and the probability of association with the pathway at origin, the second of which is impacted by the limited distribution of these viruses outside the EU. As a consequence, the probability of entry is rated as unlikely to moderately likely for ArMV and as very unlikely to unlikely for RpRSV, SLRSV and TBRV. These ratings are associated with moderate uncertainty.

With regard to establishment, the probability was evaluated as very likely with low uncertainty for all four viruses owing to their broad host range comprising widely distributed cultivated and wild hosts, the general suitability of ecoclimatic conditions and the wide presence of the nematode vectors.

With regard to spread, two scenarios were analysed. The probability of local spread by natural means was rated as likely as it is not considered possible to prevent nematode-transmitted viruses from spreading in the fields where vector nematodes are present, and because local spread can also occur through seed-transmission in a range of susceptible species. The associated uncertainties are rated as low to medium owing to incomplete information on the distribution of vectors. The probability of long-distance spread through human-assisted means is rated as unlikely to moderately likely because not all hosts are covered by certification systems, leaving open the possibility of spread through the trade of infected planting materials and seeds. The uncertainties are rated as high owing to the lack of information on many aspects.

The magnitude of impact is rated as minimal to minor in *Fragaria*, *Rubus* and *Ribes* because, although these four viruses have the potential to cause important damage and losses in those crops, the actual impact is limited by the existence of efficient voluntary certification systems for strawberry and raspberry and by modern cultivation practices. The impact is rated as minimal to minor in other hosts, with the exception of ArMV in grapevine, for which it is rated as minor to moderate. These ratings

derive from the fact that, although these viruses have the potential to cause important damage and losses in many crops, mitigating factors exist, including efficient voluntary certification systems for important host crops such as *Prunus* and grapevine. These ratings are associated with medium uncertainty for the *Fragaria*, *Rubus* and *Ribes* hosts and with high uncertainty for the other hosts.

**With regard to risk reduction options**, the Panel evaluated the phytosanitary measures formulated in Council Directive 2000/29/EC and identified additional risk reduction options where relevant.

The Panel evaluated the phytosanitary measures against the introduction and spread of ArMV, SLRSV, RbRSV and TBRV listed in Council Directive 2000/29/EC, explored the possible consequences if these measures were to be removed and identified additional risk reduction options to enhance the current measures.

The Panel considered that the key weakness of the current legislation is that, in Annex II AII, it addresses only the two vegetatively propagated hosts in which the viruses are most detrimental and it fails to address other actual and potential host species, thus leaving open the possibility of entry and spread within the EU of the four viruses in those alternative host species. A minor weakness concerns the failure to regulate seeds of *Fragaria* and *Rubus*, when the viruses considered are known to be seed-transmissible in these hosts and when small-volume trade might occur as a consequence of amateur gardeners buying seeds on the internet. In addition, the Annex III legislation is seen by the Panel as being considerably weakened by import derogations (in particular for strawberry plants for planting) offered to several countries which are among the few where the viruses are reported outside the EU.

If the current regulation was to be removed, no major consequences of or changes in the potential impact of the four viruses considered here would be expected. This is largely owing to the important level of protection afforded to the industry by the efficient and widely used certification scheme for *Fragaria*, *Rubus*, *Prunus* and *Vitis*, which is regarded by the Panel as reducing the risk of introduction, the risk of spread and the magnitude of impact in a very significant way. The absence of control of other hosts of the four viruses in the current legislation also limits the consequences predicted if these measures were to be removed.

If, however, the current legislation were removed and the industry simultaneously ceased or reduced its voluntary certification activity, or excluded the four viruses considered from the list of organisms addressed, a return to a high prevalence of these viruses in *Fragaria*, *Rubus* and other vegetatively propagated susceptible crops would be expected.

The effectiveness of risk reduction options that could further reduce the risk of introduction and spread was evaluated. None of the risk reduction options explored were considered to have a very high effectiveness in reducing the risk of introduction, in particular because of the wide and uncertain host range of the four viruses concerned. However, prohibition and the use of phytosanitary certificates, if covering an extended host range and relying on appropriate tests and not on visual inspection alone, were rated as having a moderate to high or high effectiveness. Their technical feasibility was rated as moderate to high (prohibition) or very high (certificates). The associated uncertainty was rated as medium to high (prohibition) and medium (certificates). Concerning spread and impact, no option was evaluated as having very high effectiveness. The three options with high effectiveness are the implementation of certification schemes, the use and maintenance of pest-free areas and the use and maintenance of pest-free production sites. All three options, nevertheless, have limitations in their technical feasibility in many situations. In particular, certification has high technical feasibility for individual host species but only moderate feasibility if considering the entire host range of the viruses. In addition, it should be noted that the combination of partially effective options (cultural practices, physical control, resistant varieties, certification, use of exclusion conditions) may, for some crops such as strawberry, have an overall high to very high level of effectiveness.

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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.1).

The Directive lays down, amongst other things, 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.

Arabic mosaic virus, Tomato black ring virus, Raspberry ringspot virus, Strawberry latent ringspot virus, Strawberry crinkle virus, Strawberry mild yellow edge virus, *Daktulosphaira vitifoliae* (Fitch), *Eutetranychus orientalis* Klein, *Parasaissetia nigra* (Nietner), *Clavibacter michiganensis* spp. *michiganensis* (Smith) Davis *et al.*, *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye, *Didymella ligulicola* (Baker, Dimock and Davis) v. Arx, and *Phytophthora fragariae* Hickmann var. *fragariae* are regulated harmful organisms in the EU. They are all listed in Annex II, Part A, Section II of Council Directive 2000/29/EC, which means that they are organisms known to occur in the EU and whose further introduction into and spread within the EU is banned if they are found present on certain plants or plant products.

Given the fact that these organisms are already locally present in the EU territory and that they are regulated in the EU for a long time, it is considered to be appropriate to evaluate whether these organisms still deserve to remain regulated under Council Directive 2000/29/EC, or whether, if appropriate, they should be regulated in the context of the marketing of plant propagation material, or be deregulated. In order to carry out this evaluation a pest risk analysis is needed which takes into account the latest scientific and technical knowledge of these organisms, including data on their agronomic and environmental impact, as well as their present distribution in the EU territory.

The revision of the regulatory status of these organisms is also in line with the outcome of the recent evaluation of the EU Plant Health Regime, which called for a modernisation of the system through more focus on prevention and better risk targeting (prioritisation).

## 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 Arabic mosaic virus, Tomato black ring virus, Raspberry ringspot virus, Strawberry latent ringspot virus, Strawberry crinkle virus, Strawberry mild yellow edge virus, *Daktulosphaira vitifoliae* (Fitch), *Eutetranychus orientalis* Klein, *Parasaissetia nigra* (Nietner), *Clavibacter michiganensis* spp. *michiganensis* (Smith) Davis *et al.*, *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye, *Didymella ligulicola* (Baker, Dimock and Davis) v. Arx, and *Phytophthora fragariae* Hickmann var. *fragariae*, for the EU territory.

For each organism EFSA is asked to identify risk management options and to evaluate their effectiveness in reducing the risk to plant health posed by the organism. EFSA is also requested to provide an opinion on the effectiveness of the present EU requirements against those organisms, which are laid down in Council Directive 2000/29/EC, in reducing the risk of introduction of these pests into, and their spread within, the EU territory.

Even though a full risk assessment is requested for each organism, in order to target its level of detail to the needs of the risk manager, and thereby to rationalise the resources used for its preparation and to speed up its delivery, EFSA is requested to concentrate in particular on the analysis of the present spread of the organism in comparison with the endangered area, the analysis of the observed and

potential impacts of the organism as well as the availability of effective and sustainable control methods.

## ASSESSMENT

### 1. Introduction

#### 1.1. Purpose

This document presents a pest risk assessment prepared by the Panel on Plant Health (PLH; hereinafter referred to as the Panel) for *Arabid mosaic virus* (hereinafter referred to as ArMV), *Strawberry latent ringspot virus* (hereinafter referred to as SLRSV), *Raspberry ringspot virus* (hereinafter referred to as RpRSV) and *Tomato black ring virus* (hereinafter referred to as TBRV), in response to a request from the European Commission (EC). The scientific opinion includes the identification and evaluation of risk reduction options in terms of their effectiveness and technical feasibility in reducing the risk posed by the viruses mentioned above.

#### 1.2. Scope

The scope of the opinion is to assess the risks posed by ArMV, SLRSV, RpRSV and TBRV to the risk assessment area and to identify and evaluate risk reduction options.

The Panel prepared its opinion taking into account the current EU legislation and the existing industry certification systems for *Fragaria*, *Rubus*, *Prunus* and *Vitis*.

The pest risk assessment area is the EU territory.

### 2. Methodology and data

For the purpose of this opinion, *Fragaria* and *Rubus* should be understood as comprising all species of these two plant genera. In some instances, the terms strawberry and raspberry are used when referring, respectively, to *Fragaria × ananassa* and *Rubus idaeus*.

#### 2.1. Methodology

##### 2.1.1. The guidance documents

The risk assessment was conducted in line with the principles described in the “Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options” (EFSA PLH Panel, 2010) and in the “Guidance of the Scientific Committee on Transparency in the Scientific Aspects of Risk Assessments carried out by EFSA” (EFSA, 2009).

The detailed questions in the EFSA-adapted EPPO risk assessment scheme, presented in the former guidance document mentioned above, have been used as a checklist to ensure that all elements are included. However, as the terms of reference require the opinion to “concentrate in particular on the analysis of the present spread of the organism in comparison with the endangered area, the analysis of the observed and potential impacts of the organism as well as the availability of effective and sustainable control methods”, the opinion provides only a limited assessment of entry and establishment.

The evaluation of risk reduction options was conducted in line with the principles described in the “Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options” (EFSA PLH Panel, 2010), as well as with those in “Guidance on methodology for evaluation of the effectiveness of options to reduce the risk of introduction and spread of organisms harmful to plant health in the EU territory” (EFSA PLH Panel, 2012).

In order to follow the principle of transparency, as described under paragraph 3.1 of the guidance document on the harmonised framework for pest risk assessment (EFSA PLH Panel, 2010)—“Transparency requires that the scoring system to be used is described in advance. This includes the number of ratings, the description of each rating ... the Panel recognises the need for further



*development ...*”—the Plant Health Panel developed rating descriptors to provide clear justification when a rating is given, which are presented in Appendix A of this opinion.

### **2.1.2. Methods used for conducting the risk assessment**

Since ArMV, SLRSV, RpRSV and TBRV are already present in the EU territory and have been regulated for a long time (Annex IIAII of Council Directive 2000/29/EC<sup>4</sup>), the assessment of the probability of entry (section 3.2) focuses on the potential for further entry of the organisms into the risk assessment area, whereas the assessment of the probability of spread (section 3.4) is conducted with regard to further spread of the organisms within and between the EU Member States. The Panel took into account the existing legislation when conducting the pest risk assessment.

The conclusions for entry, establishment, spread and impact are presented separately and the descriptors used to assign qualitative ratings are provided in Appendix A.

### **2.1.3. Methods used for evaluating the risk reduction options**

The Panel identified potential risk reduction options and evaluated them with respect to their effectiveness and technical feasibility, i.e. consideration of technical aspects that influence their practical application. The sustainability of the options is considered based on the definition of “sustainable agriculture” such as “capable of being continued with minimal long-term effect on the environment/capable of being maintained at a steady level without exhausting natural resources or causing severe ecological damage”.<sup>5</sup> The evaluation of the efficiency of risk reduction options in terms of the potential cost-effectiveness of measures and their implementation is not within the scope of the Panel’s evaluation.

The descriptors used to assign qualitative ratings for the evaluation of the effectiveness and technical feasibility of risk reduction options are provided in Appendix A.

### **2.1.4. Level of uncertainty**

For the risk assessment conclusions on entry, establishment, spread and impact and for the evaluation of the effectiveness of the risk reduction options, the levels of uncertainty have been rated separately.

The descriptors used to assign qualitative ratings to the level of uncertainty are provided in Appendix A.

## **2.2. Data**

### **2.2.1. Literature search**

An extensive literature search was performed on ArMV, SLRSV, RpRSV and TBRV at the beginning of the mandate, using the names of the four viruses as key words. The literature search followed the first three steps (preparation of protocols and questions, search, selection of studies) of the EFSA guidance on systematic review methodologies (EFSA, 2010). Further references and information were obtained from experts and from citations within the references found.

### **2.2.2. Data collection**

In seeking data and information concerning the current situation of the four pests, their distribution, the damage caused to plants and management, the PLH Panel undertook two actions:

<sup>4</sup> Council Directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community. OJ L 169/1, 10.7.2000, p. 1–112.

<sup>5</sup> Dictionary.com, “sustainable”, in Collins English Dictionary —Complete & Unabridged 10th Edition. Source location: HarperCollins Publishers. <http://dictionary.reference.com/browse/sustainable>. Available online: <http://dictionary.reference.com>. Accessed 2 March 2013.

1. The National Plant Protection Organization (NPPO) contacts of all the EU Member States were requested to confirm or update the current status of the organisms in their territory (contacted on 24 January 2013, with answers received until 21 March 2013). The NPPOs' replies are provided in section 3.1.2.2.
2. A hearing of technical experts from the small fruit sector was organised in order to obtain data and information on the production, trade, propagation, certification and disease management in Europe of strawberry and raspberry plant propagation material. The meeting took place in Parma on 22 May 2013, and a technical report of the data and information received from the industry experts is under preparation to be published (EFSA, in press).

For the evaluation of the probability of entry, the Europhyt database was consulted, searching for pest-specific notifications on interceptions. Europhyt is a web-based network launched by the Directorate General for Health and Consumers (DG SANCO), and is a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. The Europhyt database manages notifications of interceptions of plants or plant products that do not comply with EU legislation.

### 3. Pest risk assessment

#### 3.1. Pest categorisation

Because of similarities in the biology and ecology of the considered viruses, *Arabis mosaic virus* (ArMV), *Raspberry ringspot virus* (RpRSV), *Strawberry latent ringspot virus* (SLRSV) and *Tomato black ring virus* (TBRV), and because the viruses can often be found in association, the present opinion addresses all four viruses as a single group. Where specific features exist, those will be highlighted.

##### 3.1.1. Identity of the pests

###### 3.1.1.1. Taxonomy, detection and identification

ArMV, RpRSV, SLRSV and TBRV belong to the family *Secoviridae* and have bipartite ssRNA genomes (RNA1 and RNA2) packed in icosahedral particles of 28–30 nm diameter. In nature, these viruses are efficiently transmitted by species of *Xiphinema*, *Longidorus* and *Paralongidorus* nematodes and via pollen and seeds (Lister, 1960). All these viruses are also mechanically transmitted, through wounding and by grafting or vegetative propagation of their hosts. These viruses have broad host ranges and because they infect diverse plant species, diseases caused by isolates or strains of the same virus have sometimes been referred to with different names (see section 3.1.1.3). In contrast, recent revision of the taxonomy provided evidence that a former strain of TBRV (TBRV-Scottish, TBRV-S) is now to be considered as a distinct virus species to which the name *Beet ringspot virus* (BRSV) was assigned (Sanfaçon et al., 2012). Because the taxonomic grouping of BRSV as a distinct virus is recent and TBRV and BRSV are closely related viruses, this opinion also includes BRSV when TBRV is considered.

Virus species differentiation in the *Secoviridae* family is based on the degree of nucleotide sequence similarity, coat protein amino acid sequence identity, serological relationships, host range, vector specificity, possibility of re-assortment between RNA1 and RNA2 and cross-protection between agents (Sanfaçon et al., 2012). ArMV, RpRSV and TBRV belong to the genus *Nepovirus* (Nematode transmitted Polyhedral viruses) (Sanfaçon et al., 2012). From its sequence, genome organisation and relationship with other taxa, the nematode-transmitted SLRSV is an unassigned species in the *Secoviridae* family (most closely related to viruses in the genus *Sadwavirus*). It has many similarities to nepoviruses (Sanfaçon et al., 2012). Thus, although all four viruses are genetically distinct from one another, they share a similar ecology and are often found in association because of their common nematode vectors in the *Xiphinema* and *Longidorus* genera. Each of the viruses is represented by different strains whose sequence diversity may be the result of adaptations to the wide range of hosts that can be infected by these viruses.

For nepoviruses, the length of RNA2 provides a rationale for their subdivision into three subgroups (A, B and C), which places ArMV and RpRSV in subgroup A and TBRV in subgroup B (Sanfaçon et al., 2012). Evidence for recombination within subgroup A viruses, between ArMV and *Grapevine fanleaf virus* (GFLV), has been found (Vigne et al., 2008). In addition, some nepoviruses (including ArMV, SLRSV and TBRV) are sometimes associated with large or small satellite RNAs. These have little effect on symptoms or yield and are not necessary for plant infection (Fritsch et al., 1984, 1993).

The sequences of several isolates and strains of these four viruses are available (Sanfaçon et al., 2012), enabling them to be detected and identified in host plants and nematode vectors by specific reverse transcription polymerase chain reaction assays (RT-PCR) and/or sequencing. Antisera are also available and widely used for virus surveys and monitoring as well as for indexing of planting materials to ensure freedom from viruses.

Because of significant nucleotide sequence diversity among isolates and strains, the reliability of all existing detection and diagnostic assays needs to be considered, especially when new host plants for the viruses are discovered (Martin et al., 2013). However, efficient and specific diagnostic techniques are available for all four viruses (Faggioli et al., 2002; Digiario et al., 2007; Wei et al., 2008; Basso et al., 2010).

### 3.1.1.2. Host range and transmission

All four viruses are found naturally in temperate regions where they occur in many hosts (Table 1). It should be stressed that no specific efforts were made by the Panel to ensure that the information in this table is fully up to date, so that even if the major natural hosts are listed, there remains the possibility that other natural hosts may exist for these viruses. Besides known natural hosts, these viruses have an even more extensive range of herbaceous host plants that are susceptible to infection under experimental conditions.

In reaching its conclusions, the Panel considered two types of information regarding the host range of ArMV, RpRSV, SLRSV and TBRV. 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.

**Table 1:** Host range of *Arabid mosaic virus*, *Strawberry latent ringspot virus*, *Raspberry ringspot virus* and *Tomato black ring virus* (table compiled from the following sources: Schmelzer, 1963; Murant, 1970a, b, 1974, 1978)

Host type	Hosts			
	<i>Arabid mosaic virus</i>	<i>Raspberry ringspot virus</i>	<i>Strawberry latent ringspot virus</i>	<i>Tomato black ring virus</i>
Regulated	<i>Fragaria</i> <i>Rubus</i>	<i>Fragaria</i> <i>Rubus</i>	<i>Fragaria</i> <i>Rubus</i>	<i>Fragaria</i> <i>Rubus</i>
Cultivated hosts	<i>Prunus</i> spp. ( <i>avium</i> , <i>armeniaca</i> , <i>cerasus</i> , <i>domestica</i> , <i>dulcis</i> , <i>laurocerasus</i> , <i>persica</i> )  Grapevine  Bean, celery, cucumber, horseradish, lettuce, rhubarb	<i>Prunus</i> spp. ( <i>avium</i> , <i>armeniaca</i> , <i>cerasus</i> , <i>domestica</i> , <i>dulcis</i> , <i>laurocerasus</i> , <i>persica</i> )  Grapevine  Red currant	<i>Prunus</i> spp. ( <i>avium</i> , <i>armeniaca</i> , <i>cerasus</i> , <i>domestica</i> , <i>dulcis</i> , <i>laurocerasus</i> , <i>persica</i> )  Grapevine  Asparagus, celery, red and black currant, rhubarb	<i>Prunus</i> spp. ( <i>avium</i> , <i>armeniaca</i> , <i>cerasus</i> , <i>domestica</i> , <i>dulcis</i> , <i>laurocerasus</i> , <i>persica</i> )  Grapevine  Artichoke, bean, cabbage, celery, leek, lettuce, onion, red and black currant, tomato

Host type	Hosts			
	<i>Arabis mosaic virus</i>	<i>Raspberry ringspot virus</i>	<i>Strawberry latent ringspot virus</i>	<i>Tomato black ring virus</i>
	Sugarbeet, hop, olive, white clover		Olive	Lucerne, potato, sugarbeet
	<i>Forsythia intermedia</i> , <i>Gladiolus</i> , <i>Narcissus</i> , rose	<i>Narcissus</i>	<i>Gladiolus</i> , mint, <i>Narcissus</i> , rose	
Weeds/trees/non-cultivated	Elderberry, <i>Ligustrum vulgare</i> , <i>Acer</i> sp., <i>Fraxinus</i> sp.		Elderberry, <i>Euonymus europaeus</i> , <i>Robinia pseudoacacia</i> , <i>Aesculus carnea</i>	Elderberry, <i>Robinia pseudoacacia</i>
Experimental	93 dicot species in 28 families	“Many dicot species”	126 dicot species in 27 families	76 dicot species in 29 families

Besides their transmission by nematodes, discussed in more details in section 3.1.1.5, ArMV, RpRSV, SLRSV and TBRV are also all mechanically transmissible viruses. ArMV was shown to be mechanically transmissible to 93 species of 28 different dicotyledonous plant genera, SLRSV to 126 species out of 27 families (Schmelzer, 1969), RpRSV to species belonging to 12 families and TBRV to 76 species from 29 dicotyledonous plant families (Schmelzer, 1963).

These viruses are often transmitted through infected seeds, sometimes with efficiencies approaching 100 % (Lister and Murrant, 1967; Murrant, 1970b). ArMV was shown to be seed transmitted in 15 species from 12 families, with a 10 % transmission rate in strawberry but no transmission in raspberry in parallel experiments (Lister and Murrant, 1967). RpRSV was seed transmissible in six species from five families, including raspberry and strawberry (18 % and 49 % transmission rates, respectively). SLRSV was seed transmissible in raspberry (75 % transmission rate), mint and celery (Murrant, 1974). TBRV was seed transmissible in 24 species from 15 families, including both raspberry (1–3 % transmission rate) and strawberry (34 % transmission rate) (Lister and Murrant, 1967; Walkey et al., 1985).

### 3.1.1.3. Diseases and symptomatology

The three nepoviruses and SLRSV cause severe diseases in a number of crops (Table 2), while in others, virus infections remain latent or only mild symptoms are expressed. Depending on the cultivar, strawberry plants show a variety of symptoms of ArMV infection with plants generally being stunted and with chlorotic mottling and mosaic symptoms. In severe cases, plant death occurs within two years (Murrant and Lister, 1987). Similar symptoms are reported for SLRSV infections in strawberry (Lister, 1970) with severe stunting occurring often as a result of mixed infections with ArMV (Murrant and Lister, 1987). ArMV strains differ in their ability to infect raspberry cultivars (Murrant, 1987). In many cases, symptoms are only shown two to three years after planting when young canes are severely stunted and little or no fruit is produced (Murrant and Taylor, 1965). In raspberry, SLRSV and ArMV usually occur together. Depending on the cultivar, SLRSV infections either remain symptomless (Lister, 1970) or resemble ArMV infections with severe stunting and vein yellowing of leaves (Taylor and Murrant, 1969). Mixed infections of ArMV and RpRSV cause a significant disease of grapes (Wetzel et al., 2006).

**Table 2:** The scientific name and taxonomic position of the viruses, and the common names of the diseases caused by them (EPPO PQR, 2012)

Scientific name (Lister, 1970)	Taxonomic position	Common name of the disease caused by the pathogen
<i>Arabis mosaic virus</i>	Family <i>Secoviridae</i> , genus <i>Nepovirus</i>	Bare bine of hop, mosaic of arabis, mosaic of rhubarb, mosaic of strawberry, nettlehead of hop, split leaf blotch of hop, yellow dwarf of raspberry, yellow net of forsythia
<i>Raspberry ringspot virus</i>	Family <i>Secoviridae</i> , genus <i>Nepovirus</i>	European rasp leaf of cherry, Lloyd George yellow blotch of raspberry, Pfeffinger disease of sweet cherry, Scottish leaf curl of raspberry, leaf distortion of gooseberry, ring spot of raspberry, ring spot of red currant, ring spot of strawberry, spoon leaf of red currant
<i>Strawberry latent ringspot virus</i>	Family <i>Secoviridae</i> , unassigned virus in the family	Latent ring spot of strawberry
<i>Tomato black ring virus</i>	Family <i>Secoviridae</i> , genus <i>Nepovirus</i>	Black ring of tomato, bouquet of potato, ring spot of bean, ring spot of beet, ring spot of lettuce, yellow vein of celery

All four viruses infect small fruits where they typically cause systemic symptoms on leaves comprising chlorotic ringspots, mottling and leaf deformation and distortion, eventually with reduced growth and stunting of shoots in severe systemic infections (Murant, 1987; Murant and Lister, 1987). ArMV was reported to cause symptomatic disease outbreaks in *Rubus* (Jones et al., 1984). SLRSV causes leaf mottling and decline in strawberry and in raspberry. However, particularly in raspberry, there is a wide range of reactions of different varieties to infection by nepoviruses and SLRSV, with some being immune to infection whereas others display very severe symptoms and produce little or no fruit (Murant, 1987; Murant and Lister, 1987). Because nematodes play a significant role in the survival and spread of the viruses, a patchy distribution of declining plants is often found in affected fields (Murant and Lister, 1987).

#### 3.1.1.4. Vector species and transmission

##### *Life cycle of longidorid nematodes that vector the nepoviruses and SLRSV*

The four viruses are transmitted by nematodes belonging to the family *Longidoridae*, commonly referred to as longidorids, which are long (length varies from about 1.5 to c. 13 mm), slender, sluggish nematodes that are recognised by the posterior enlargement of the oesophagus and the greatly attenuated stylet (odontostyle) situated in the stomodaeum (Coomans, 1975; Taylor and Brown, 1997). Globally they are an economically important group of nematodes that can cause damage to many economically important crops. Longidorids are migratory root ectoparasites, responsible for substantial direct damage to a wide variety of plants (Decraemer and Geraert, 2006). *Longidorus* and the related genus *Paralongidorus* (needle nematodes) show a distinct preference for feeding on the roots of herbaceous plants, whereas *Xiphinema* species (dagger nematodes) are better adapted to feed on the roots of woody plants (Brown and Taylor, 1987; Taylor and Brown, 1997). Some longidorid species can also transmit plant viruses to a wide range of fruit and vegetable crops (Oliveira and Neilson, 2006). Three genera of the family *Longidoridae* (*Longidorus*, *Paralongidorus*, *Xiphinema*) include species that are vectors of plant viruses (Taylor and Brown, 1997).



**Table 3:** Taxonomic hierarchy of longidorids (after Oliveira and Neilson, 2006)

Rank	Name
Phylum	Nematoda
Family	<i>Longidoridae</i>
Genus	<i>Longidorus</i>
Genus	<i>Paralongidorus</i>
Genus	<i>Xiphinema</i>

Among longidorids, *Xiphinema* is the most widely distributed and largest genus, comprising 258 species (Coomans et al., 2001; Oliveira and Neilson, 2006). The genus *Longidorus* currently comprises 145 species (Širca et al., 2007; Širca and Urek, 2009), whereas *Paralongidorus*, *sensu stricto*, comprises 53 species (Palomares-Rius et al., 2008).

The majority of longidorids are assumed to have a parthenogenetic mode of reproduction as males are either not known or rare. However, reproduction by cross-fertilization (amphimixis) is also known to occur in some species where males have been recorded (Oliveira and Neilson, 2006).

As with other nematodes, the longidorid life cycle consists of six stages: the egg, four juvenile stages and the sexually mature adult male or female. A first-stage juvenile develops inside an egg, then hatches. Hatching is mainly influenced by soil moisture and temperature. Nematodes moult four times (although three times in some longidorids) during each life cycle with a moult occurring at the end of each juvenile stage. At each moult, the old cuticle, including the lining of the oesophagus together with the odontostyle, is shed and the new cuticle is formed (Taylor and Brown, 1997).

The life cycles of longidorids are generally long and the time required for development from egg to adult varies, for example from nine weeks at 28 °C and 30 °C for *Longidorus africanus* and *L. elongatus*, respectively (Wyss, 1970; Kolodje et al., 1987), to 16–23 weeks at 20 °C for *L. elongatus* (Yassin, 1969). The life cycle of *Xiphinema index* has been variously reported and may require 2–14 months to complete under controlled conditions, depending on biotic and abiotic factors (Taylor and Brown, 1997; Demangeat et al., 2005) but can require more than 14 months in the field where temperatures are low and/or variable (Weischer, 1975; Demangeat et al., 2005). The optimal temperature for the reproduction of *X. index* is 24 °C and the life cycle is interrupted below 16 °C (Cohn and Mordechai, 1969). *X. index* can, however, survive in soil at extreme temperatures, including –11 °C for 62 days and 37 °C for 32 days, but not –22 °C or 45 °C (Harris, 1979).

Climate (temperature, moisture), soil structure and the presence of host plants determine the occurrence and distribution of soil-inhabiting, plant-parasitic nematodes. The most important physical characteristics of soils which determine their suitability as habitat for longidorids are soil porosity and moisture capacity (Taylor and Brown, 1997). Generally, longidorids are more abundant in sandy or coarse-structured soils, although the smaller species can be more abundant in heavier soils (Hunt, 1993).

Populations of longidorids are generally highest at depths below 20 cm and depths of over 1 m can be achieved (Hunt, 1993). Populations of *X. index* have been reported to be distributed to a depth of 3.6 m in the more fertile and deeper soils of Napa Valley, California, USA (Raski et al., 1965, cited in Taylor and Brown, 1997).

#### *Virus transmission by nematodes*

In addition to causing direct feeding damage, some longidorid species also transmit plant viruses, which greatly increased the scientific interest in these nematodes (Hewitt et al., 1958; Sol and



Seinhorst, 1961; Lamberti and Roca, 1987; De Waele and Coomans, 1990) and added to their importance as economically significant plant parasites (Širca and Urek, 2009).

Longidorids are ectoparasitic and they feed from the outside the root. They use a stylet located in the oesophageal region to penetrate into the plant cell and feed from the cell contents. By ingesting the infected cell content, some virus particles may become adsorbed at specific retention sites on the feeding apparatus that differ between longidorids. In *Longidorus*, virus particles are adsorbed in a single layer to the inner surface of the odontostyle and between the odontostyle and the guiding sheath, whereas in *Xiphinema*, virus particles are associated with the cuticular lining of the odontophore and the pharynx (Decraemer and Geraert, 2006). Once an adult nematode acquires the virus, it remains infective over long (months to years) periods of time, even in fallow soil (O'Bannon and Inserra, 1990; Taylor and Brown, 1997). However, the virus particles are lost during moulting, and females do not pass them to progeny when laying eggs. The nematodes must, therefore, after moulting, feed on infected plants before transmission is again possible (Hunt, 1993).

The process of transmission is thought to occur by the release of virus particles during the feeding process. The virus is not thought to circulate within the nematode and particles that are not retained in the oesophagus pass into the gut and are excreted. Thus far, no information is available on the nature of the nematode components involved in binding virus particles. However, it is suspected that for transmission the release process is more important than the retention process as, although both Scottish and English strains of RpRSV were retained in *L. macrosoma*, only the English strain was transmitted (Trudgill et al., 1981; Brown and Trudgill, 1983). Similarly, variations in ArMV transmission efficiency by *X. diversicaudatum* have been reported (Brown and Taylor, 1979; Brown, 1986). An increase in ArMV and TBRV infection of plants has been associated with an increase of the nematode populations in the soil (Weischer, 1975).

#### *Nematode species transmitting the four viruses addressed in the present opinion*

In the past, many reports were published world-wide on the ability of different nematode species to transmit a variety of plant viruses. However, many of these reports were based on laboratory experiments that frequently did not include appropriate safeguards to exclude the possibility of transmission by an alternative vector or experimental contamination (Trudgill et al., 1983). Consequently, techniques and criteria for assessing the transmission of plant viruses by longidorid nematodes were developed by Trudgill et al. (1983), including accurate identification of the virus and of the nematode and the use of small numbers of hand-picked nematodes. This led to two-thirds of the then reported virus–nematode associations being rejected (Brown and Trudgill, 1998). Those which fulfilled the criteria revealed the existence of a high degree of specificity between the vector species and its associated virus.

Five longidorid species belonging to three genera of the *Longidoridae* family are known to transmit at least one of the viruses discussed in the present opinion.

1. Genus *Longidorus*—three vector species;
2. Genus *Paralongidorus*—one vector species;
3. Genus *Xiphinema*—one vector species.

As presented in Table 4, ArMV is transmitted by *X. diversicaudatum* (Jha and Posnette, 1959). The same is true of SLRSV (Lister, 1964; Taylor and Brown, 1997). RpRSV is transmitted by *L. elongatus*, *L. macrosoma* and *L. attenuatus* (Taylor, 1962; Taylor and Murant, 1969). TBRV is transmitted by *L. elongatus* and *L. attenuatus* (Harrison et al., 1961; Taylor and Murant, 1969). There is evidence that nematode vector specificity may differ between the English (TBRV-E, now TBRV *sensu stricto*) and the Scottish (TBRV-S, now BRSV) strains of TBRV, with the former being preferentially vectored by *L. attenuatus* and the latter by *L. elongatus* (Harrison, 1964). As TBRV and

RpRSV are both vectored by the same nematode species, they are often found in association and in mixed infections causing, for example, raspberry leaf curl disease.

All five nematode species have broad host ranges and are able to parasitise a wide range of herbaceous and woody perennial plants (Heyns, 1975; Hunt, 1993; CABI, 2013).

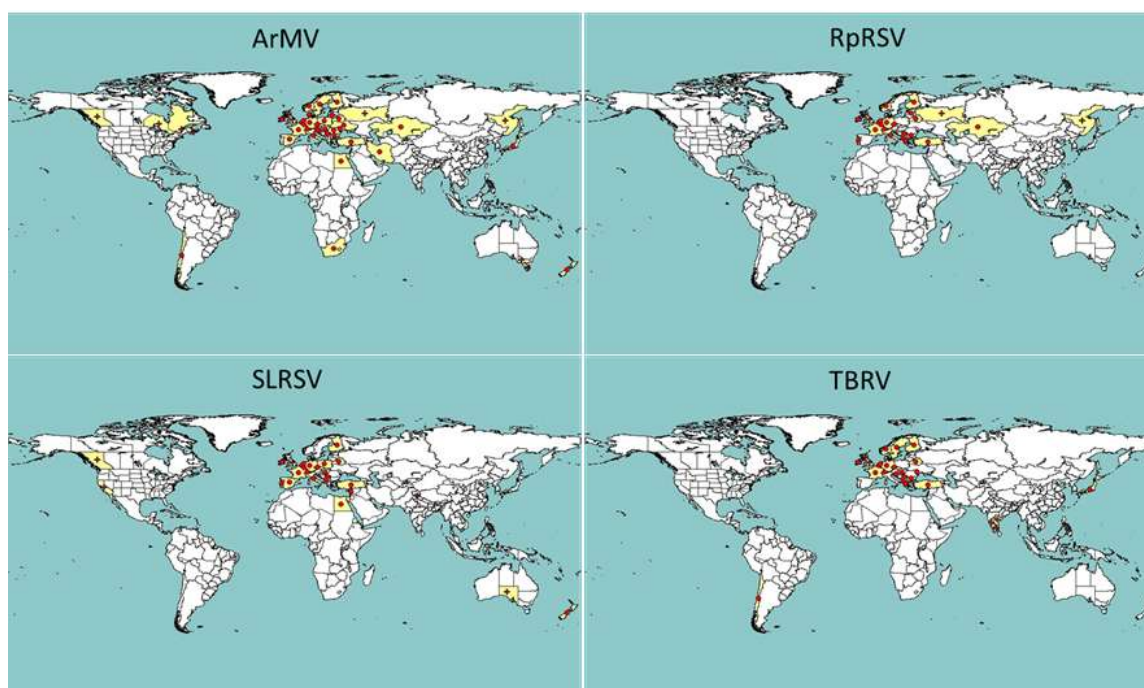
**Table 4:** List of longidorid nematode species known to be vectors of *Arabis mosaic virus*, *Raspberry ringspot virus*, *Strawberry latent ringspot virus* and *Tomato black ring virus* and relevant references

Virus	Vector species identified	References
<i>Arabis mosaic virus</i>	<i>Xiphinema diversicaudatum</i>	Jha and Posnette (1959); Taylor and Brown (1997)
<i>Raspberry ringspot virus</i>	<i>Longidorus elongatus</i>	Taylor (1962); Taylor and Brown (1997)
	<i>Longidorus macrosoma</i>	Harrison (1964); Taylor and Brown (1997)
	<i>Paralongidorus maximus</i>	Taylor and Brown (1997)
<i>Strawberry latent ringspot virus</i>	<i>Xiphinema diversicaudatum</i>	Lister (1964); Taylor and Brown (1997)
<i>Tomato black ring virus</i>	<i>Longidorus attenuatus</i>	Harrison (1964); Taylor and Brown (1997)
	<i>Longidorus elongatus</i>	Harrison et al. (1961); Taylor and Brown (1997)

### 3.1.2. Current distribution

#### 3.1.2.1. Distribution of viruses outside the risk assessment area

The viruses differ in their occurrence outside Europe. ArMV is the most widely distributed, being reported in the five continents. The next most widespread is SLRSV, followed by RpRSV and finally by TBRV, which has the most restricted reported distribution (Figure 1, Appendix B).



**Figure 1:** Global distribution maps for *Arabis mosaic virus*, *Strawberry latent ringspot virus*, *Raspberry ringspot virus* and *Tomato black ring virus* (extracted from EPPO PQR, version 5.0 accessed in January 2013). Red circles represent pest presence as national records and red crosses represent pest presence as subnational records (note that this figure combines information from different dates, some of which could be out of date).

### 3.1.2.2. Distribution of viruses in the risk assessment area

All four viruses were first reported in the UK (Smith, 1946; Lister, 1964) and are currently widely reported in Europe. ArMV is present in 20 Member States, RPRSV is present in 14 Member States, SLRSV in 15 Member States and TBRV in 11 Member States (Table 5). Data on the presence or absence of the organisms are not available in Croatia. All four viruses are absent in Iceland and present in Norway.

Overall, all four viruses can be considered as European viruses with little occurrence outside the risk assessment area, with the possible exception of ArMV.

**Table 5:** The current distribution of *Arabid mosaic virus*, *Strawberry latent ringspot virus*, *Raspberry ringspot virus* and *Tomato black ring virus* in the risk assessment area, based on answers received from the 28 Member States, Iceland and Norway

Member State	<i>Arabid mosaic virus</i>	<i>Raspberry ringspot virus</i>	<i>Strawberry latent ringspot virus</i>	<i>Tomato black ring virus</i>
Austria	<b>Present</b> , restricted distribution	<b>Absent</b> , pest no longer present	<b>Absent</b> , no pest record	<b>Absent</b> , no pest record
Belgium	<b>Present</b> , no details. Pest status left unchanged in 2007. No recent survey data available to specify status at that time or at the moment	<b>Present</b> , at low prevalence. Old NPPO status in PQR5 is “present, limited distribution”. This was left unchanged in 2007 (and in 2011). At that time it had been reported in fruit trees but no recent data were available on strawberry and soft fruit. Therefore, a survey was carried out in 2011 and 2012 during an NPPO research project (QUARANSTAT) on strawberry, soft fruit ( <i>Rubus idaeus</i> , <i>Rubus fruticosus</i> , <i>Ribes rubrum</i> , <i>Ribes uva-crispa</i> , <i>Vitis vinifera</i> , <i>Vaccinium myrtillus</i> ) and cherry ( <i>Prunus avium</i> ). In total, 856 samples were taken from 72 growers in Flanders and 85 samples were taken in the Walloon Region. The pest was not detected during the survey	<b>Present</b> , at low prevalence. Old NPPO status in PQR5 is “present, no details”. This was left unchanged in 2007. A survey was carried out in 2011 and 2012 during an NPPO research project (QUARANSTAT) in the production of strawberry, soft fruit ( <i>Rubus idaeus</i> , <i>Rubus fruticosus</i> , <i>Ribes rubrum</i> , <i>Ribes uva-crispa</i> , <i>Vitis vinifera</i> , <i>Vaccinium myrtillus</i> ) and cherry ( <i>Prunus avium</i> ). In total, 856 samples were taken from 72 growers in Flanders and 85 samples were taken in the Walloon Region. The pest was detected twice on strawberry (2012: 1 × province of West Flanders and 1 × province of East Flanders), but no nematode vector was found in these locations	<b>Present</b> , no details. Pest status left unchanged in 2007. No recent survey data available to specify status at that time or at the moment
Bulgaria	<b>Present</b> , few occurrences	<b>Present</b> , restricted distribution	<b>Present</b> , no details	<b>Present</b> , no details
Croatia <sup>(b)</sup>	<b>Present</b> , restricted distribution	–	–	<b>Present</b> , no details
Cyprus	<b>Absent</b> , based on surveys	<b>Absent</b> , based on surveys	<b>Absent</b> , based on surveys	<b>Absent</b> , based on surveys
Czech Republic	<b>Present</b> , widespread	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution	<b>Present</b> , restricted

Member State	<i>Arabid mosaic virus</i>	<i>Raspberry ringspot virus</i>	<i>Strawberry latent ringspot virus</i>	<i>Tomato black ring virus</i>
				distribution
Denmark	<b>Present</b> , at low prevalence	<b>Absent</b> , pest eradicated	<b>Absent</b> , no pest records	<b>Absent</b> , pest records unreliable
Estonia	<b>Absent</b> , no pest record	<b>Absent</b> , no pest record	<b>Absent</b> , no pest record	<b>Absent</b> , no pest record
Finland	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution
France	<b>Present</b> , restricted distribution	<b>Present</b> , widespread	<b>Present</b> , no details	<b>Present</b> , widespread
Germany	<b>Present</b> , in parts of the area	<b>Present</b> , restricted distribution	<b>Present</b> , few occurrences	<b>Present</b> , few occurrences, only in some areas
Greece	<b>Absent</b> , not known to occur <sup>(a)</sup>	<b>Absent</b> , not known to occur <sup>(a)</sup>	<b>Absent</b> , not known to occur <sup>(a)</sup>	<b>Absent</b> , not known to occur <sup>(a)</sup>
Hungary	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution
Ireland	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution
Italy	<b>Present</b> , restricted distribution. Some sporadic reports of <i>Vitis</i> (virus included in the certification scheme of <i>Vitis</i> )	<b>Present</b> , few occurrences	<b>Present</b> , no details. Detected on olive trees	<b>Absent</b> , invalid record
Latvia <sup>(b)</sup>	—	<b>Present</b> , no details	—	—
Lithuania	<b>Absent</b> , no pest records	<b>Absent</b> , no pest records	<b>Absent</b> , no pest records	<b>Absent</b> , no pest records
Luxembourg <sup>(b)</sup>	<b>Present</b> , no details	<b>Present</b> , no details	<b>Present</b> , no details	—
Malta	<b>Absent</b> , not known to occur	<b>Absent</b> , not known to occur	<b>Absent</b> , not known to occur	<b>Absent</b> , not known to occur
Netherlands	<b>Present</b> , widespread	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution	<b>Present</b> , restricted distribution
Poland	<b>Present</b> , restricted distribution (confirmed by surveys)	<b>Absent</b> , pest no longer present	<b>Present</b> , restricted distribution	<b>Absent</b> , pest no longer present
Portugal	<b>Present</b> , few occurrences in grapevine; tested routinely in grapevine and ornamentals ( <i>Solanaceae</i> and <i>Verbenaceae</i> ); no detection on	<b>Present</b> , few occurrences, tested very occasionally in grapevine; no detection in the last seven years	<b>Present</b> , reported in few grapevine plants. Tested very occasionally in grapevine; no detection in the last seven years	<b>Absent</b> , tested routinely in ornamentals ( <i>Solanaceae</i> ). No detection on ornamentals in the last seven years

Member State	<i>Arabid mosaic virus</i>	<i>Raspberry ringspot virus</i>	<i>Strawberry latent ringspot virus</i>	<i>Tomato black ring virus</i>
	ornamentals in the last seven years			
Romania	<b>Present</b> , restricted distribution	<b>Absent</b> , confirmed by survey	<b>Absent</b> , confirmed by survey	<b>Absent</b> , confirmed by survey
Slovakia	<b>Absent</b>	<b>Absent</b>	<b>Absent</b>	<b>Absent</b>
Slovenia	<b>Present</b> , only in some areas	<b>Absent</b> , pest no longer present	<b>Absent</b> , no pest records	<b>Absent</b> , intercepted only
Spain <sup>(b)</sup>	<b>Present</b> , few occurrences	<b>Absent</b> , intercepted only	<b>Present</b> , few occurrences	<b>Absent</b> , unreliable record
Sweden	<b>Present</b> , few occurrences. We agree with the information presented in EPPO PQR, although referring to the situation in 1993. We lack data in order to provide a more updated current status	<b>Absent</b> , not known to occur, no pest records ( <i>preliminary, to be verified</i> )	<b>Absent</b> , not known to occur, no pest records ( <i>preliminary, to be verified</i> )	<b>Present</b> , few occurrences. We agree with the information presented in EPPO PQR, although referring to the situation in 1993. We lack data in order to provide a more updated current status
United Kingdom <sup>(c)</sup>	UK: <b>Present</b> , few occurrences. Channel Islands and IOM: <b>Absent</b> , pest no longer present	UK: <b>Present</b> , few occurrences. Channel Islands and IOM: <b>Absent</b> , pest no longer present	England, Scotland and Wales: <b>Present</b> , few occurrences. Northern Ireland, Channel Islands and IOM: <b>Absent</b> , pest no longer present	UK: <b>Present</b> , few occurrences. Channel Islands and IOM: <b>Absent</b> , pest no longer present
Iceland	<b>Absent</b> , no records	<b>Absent</b> , no records	<b>Absent</b> , no records	<b>Absent</b> , no records
Norway	<b>Present</b> , restricted distribution <sup>(d)</sup>	<b>Present</b> , restricted distribution <sup>(d)</sup>	<b>Present</b> , restricted distribution <sup>(d)</sup>	<b>Present</b> , restricted distribution <sup>(d)</sup>

(a): Based on the records kept in the archives of the Department of Entomology and Agricultural Zoology, the Laboratory of Bacteriology, the Laboratory of Mycology, the Laboratory of Virology of the Benaki Phytopathological Institute. The archives refer to the results of the laboratory examination of diseased plant specimens sent to the Institute by the Extension Services of the Hellenic Ministry of Rural Development and Food, Agricultural Cooperatives, farmers, agronomists, private companies, etc., and also on other national records. No systematic survey data are available.

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

(c): Unless otherwise stated, the UK includes England, Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man. The Channel Islands refers to the states of Guernsey and Jersey.

(d): The virus is under official control and is included in the testing program of the nuclear stock program for strawberry in Norway.

NPPO: National Plant Protection Organization; –: no information available; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System; IOM: Isle of Man.

### 3.1.2.3. Distribution of nematode vectors in the risk assessment area

The five longidorid species briefly described below are present in Europe (Table 6, Appendix C). It should be noted that for some nematode species–country combinations there are inconsistencies between references that cannot be easily reconciled.



*Longidorus attenuatus* is endemic in several, mainly northern, European countries. It is locally distributed in Austria (Tiefenbrunner and Tiefenbrunner, 2004), Hungary (Nagy, 1999), Belgium, England, France, Germany, the Netherlands (Alphey and Taylor, 1986), Poland (Szczygiel and Brezeski, 1985) and the Slovak Republic (Liskova and Brown, 2003). It has also been recorded from the Voronezh region, the Tambov and Tula provinces and from Mordovskaya in the Russian Federation (Brown et al., 1990). The reports of this species from Bulgaria, Croatia, southern France, Italy, Nigeria, Portugal, Sardinia and Spain are probably erroneous and refer to other species as indicated by (Taylor and Brown, 1997).

*Longidorus elongatus* was described in 1876 by de Man as the first (type) *Longidorus* species (Ye and Robbins, 2004). It is considered as a cosmopolitan species associated with different hosts and various soil types (Kumari and Decraemer, 2007), ranging from sandy to sandy loams to fen peat (Hunt, 1993). This nematode has been recorded mainly from the temperate regions, occurring most frequently in northern European countries: British Isles, Scandinavian countries, Germany, the Netherlands, Belgium, northern France, northern Italy (Alphey and Taylor, 1986; Brown and Taylor, 1987), Latvia, Estonia (Brown et al., 1990), Lithuania (Stanelis, 2003) and Poland (Szczygiel and Brezeski, 1985). It has also been reported from Slovakia (Liskova et al., 2007), Czech Republic (Kumari and Decraemer, 2007), Austria (Tiefenbrunner and Tiefenbrunner, 2004), Switzerland (Lamberti et al., 2001) and Slovenia (Širca and Urek, 2009); isolated populations, originating from poplar and the invasive plant species *Amorpha fruticosa*, have also been discovered in Serbia (Barsi and De Luca, 2006). Furthermore, this species has been reported from many southern European regions (southern Italy, Bulgaria, Greece, Spain and Portugal), but several of these identifications are considered of doubtful validity (Taylor and Brown, 1997). *L. elongatus* is widespread in the former Soviet Union and has been also reported from Canada, USA (Oregon), India, Pakistan, South Africa and New Zealand. Reports on the occurrence of *L. elongatus* in the latter countries refer mainly to introductions of this species with plants for planting to these countries (Taylor and Brown, 1997).

*Longidorus macrosoma* has been recovered from grapevine in Tajikistan and from raspberry and wild strawberry in the Voronezh region of Russia (Brown et al., 1990). It has been reported from several European countries and is fairly common in Belgium, England, France, Germany, the Netherlands and Switzerland. Its geographical distribution does not extend northwards beyond southern England and the Netherlands (Taylor and Brown, 1997). This species has been infrequently recorded also from Ireland, Italy (Brown and Taylor, 1987), Slovakia (Liskova and Brown, 2003), Spain (Brown and Taylor, 1987; Andrés et al., 1991), Austria (Tiefenbrunner and Tiefenbrunner, 2004) and Bulgaria, where it has been discovered in the rhizosphere of raspberry infected with RpRSV and TBRV (Brown et al., 1990). *L. macrosoma* has also been reported from Poland as a less frequently occurring species; however, no data on the morphology and morphometrics of the Polish populations are available (Kornobis and Peneva, 2011), thus these reports must be regarded as only tentative.

*Paralongidorus maximus* is the most common and widely distributed species of the genus *Paralongidorus* (Palomares-Rius et al., 2008). It has been reported from South Africa (Swart et al., 1996), Kazakhstan, Moldavia (where it was originally described as *L. glutosus* (Brown et al., 1990)) and Europe. It was first described as *Dorylaimus maximus* in 1874 by Bütschli in Germany and was transferred to the genus *Longidorus* and subsequently to *Paralongidorus* by Siddiqi in 1964 (McElroy et al., 1977). *P. maximus* has a wide but sporadic distribution throughout Europe (Taylor and Brown, 1997). Its occurrence has been reported from Austria, France, Germany, Hungary, Poland, the UK (Heyns, 1975; Brown and Taylor, 1987), Bulgaria (Lamberti et al., 1983; Brown and Taylor, 1987), Portugal (Macara, 1988), Greece (Brown and Taylor, 1987), Italy (Roca et al., 1988) and Slovakia (Liskova and Brown, 2003).

*Xiphinema diversicaudatum* was described from specimens recovered in western Russia where it is widely distributed (Taylor and Brown, 1997). It is considered to be the most widely distributed longidorid in Europe (Taylor and Brown, 1997) and has been reported from most European countries except Finland, Romania and some of the southern Mediterranean countries (Brown and Taylor, 1987). Outside Europe, this species has been confirmed as being present in New Zealand, North America and South Africa. In New Zealand, it is present in localised areas (Hay and Close, 1992) and



appears to have been introduced with berry and top fruit planting material (Taylor and Brown, 1997). It is a relatively rare, non-indigenous species in North America, where it was introduced from Europe, most probably with commercial rose stocks (Robbins and Brown, 1991; Hunt, 1993). *X. diversicaudatum* has also been reported from South Africa, having been found in peach and pear orchards in two localities in the south-western Cape Province (Heyns and Coomans, 1984).

**Table 6:** Distribution of longidorid nematodes in Europe

Country	Species				
	<i>Longidorus attenuatus</i> Hooper (1961)	<i>Longidorus elongatus</i> de Man (1876)	<i>Longidorus macrosoma</i> Hooper (1961)	<i>Paralongidorus maximus</i> Butschli (1874)	<i>Xiphinema diversicaudatum</i> Micoletzky (1927)
Austria	E <sup>(a)</sup>	B, C, E <sup>(a)</sup>	E <sup>(a)</sup>	D	B, E <sup>(a)</sup>
Belgium	A	A, B, C	A, D	–	A, B, C
Bulgaria	A, D	A, B, C	E <sup>(b)</sup>	A, D	A, B, C
Croatia	–	–	–	–	B, C
Cyprus	–	–	–	–	–
Czech Republic	A	A, B, C	–	–	A, C
Denmark	–	–	–	–	C
Estonia	–	A, B, C	–	–	–
Finland	–	A, B, C	–	–	–
France	A, D	A, B, C	A	D	A, B, C
Germany	A, D	A, B, C	A, D	A, D	A, B, C
Greece	–	B, C	–	–	–
Hungary	–	A, B, C	–	A, D	A
Ireland	–	B, C	A	–	B, C
Italy	A, D	A, B, C	A	A	A, B, C
Latvia	D	C	–	–	–
Lithuania	B	A	–	–	–
Luxembourg	–	–	–	–	–
Malta	–	–	–	–	–
Poland	A, D	A, B, C	A	A, D	A, B, C
Portugal	–	B, C	A	A, D	A, B, C
Romania	–	A, B, C	–	–	–
Slovakia	A	A, B	A	A	A, B, C
Slovenia	D	A, B	D	–	A, B
Spain	A, D	A, B	A	A, D	A, B, C
Sweden	–	A, B	–	–	A, B, C
The Netherlands	A	A, B	A	A	A, B, C
United Kingdom	A, D	A, B	A, D	A, D	A, B, C

–: no data or absent; A: present (listed in Fauna Europaea); B: present (listed in CABI, 2013); C: present (listed in EPPO PQR, 2012); D: present (listed in Global Biodiversity Information Facility (GBIF)); E<sup>(a)</sup>: present (listed in Tiefenbrunner and Tiefenbrunner, 2004); E<sup>(b)</sup>: present (listed in Peneva et al., 2012).

It has been suggested that the distribution of *Longidoridae* reflects the distribution of nematologists with a particular interest in these nematodes (Brown et al., 1990), so that biases may exist in our knowledge of the distribution of these species. In addition, it is difficult to provide comprehensive information on the distribution of longidorids over all of Europe owing to the lack of scientific expertise in some countries. Consequently, it can probably be considered that the distribution of these nematodes is actually broader than is currently known and reflected in the literature.

### 3.1.3. Regulatory status in the risk assessment area

#### 3.1.3.1. Legislation directly addressing the pathogens

The four virus species are regulated, harmful organisms in the EU and are listed in Council Directive 2000/29/EC in the following sections:

Annex II, Part A—Harmful organisms whose introduction into, and spread within, all Member States shall be banned if they are present on certain plants or plant products

Section II—Harmful organisms known to occur in the Community and relevant for the entire Community

(d) Viruses and virus-like organisms

Species	Subject of contamination
1. Arabis mosaic virus	Plants of <i>Fragaria</i> L. and <i>Rubus</i> L., intended for planting, other than seeds
9. Raspberry ringspot virus	Plants of <i>Fragaria</i> L. and <i>Rubus</i> L., intended for planting, other than seeds
12. Strawberry latent ringspot virus	Plants of <i>Fragaria</i> L. and <i>Rubus</i> L., intended for planting, other than seeds
14. Tomato black ring virus	Plants of <i>Fragaria</i> L. and <i>Rubus</i> L., intended for planting, other than seeds

Annex IV, Part A—Special requirements which must be laid down by all Member States for the introduction and movement of plants, plant products and other objects into and within all Member States

Section I—Plants, plant products and other objects originating outside the Community

Plant products and other objects	Special requirements
19.2. Plants of ... <i>Fragaria</i> L., ... <i>Rubus</i> L. intended for planting, other than seeds, originating in countries where the relevant harmful organisms are known to occur on the genera concerned The relevant harmful organisms are — on <i>Fragaria</i> L.: — <i>Arabis mosaic virus</i> — <i>Raspberry ringspot virus</i> — <i>Strawberry latent ringspot virus</i> — <i>Tomato black ring virus</i> — on <i>Rubus</i> L.: — <i>Arabis mosaic virus</i> — <i>Raspberry ringspot virus</i> — <i>Strawberry latent ringspot virus</i> — <i>Tomato black ring virus</i>	Without prejudice to the provisions applicable to the plants where appropriate listed in Annex III(A)(9) and (18), and Annex IV(A)(I)(15) and (17), official statement that no symptoms of diseases caused by the relevant harmful organisms have been observed on the plants at the place of production since the beginning of the last complete cycle of vegetation

Section II—Plants, plant products and other objects originating in the Community

Plant products and other objects	Special requirements
12. Plants of <i>Fragaria</i> L., ... and <i>Rubus</i> L., intended for planting, other than seeds	Official statement that: (a) the plants originate in areas known to be free from the relevant harmful organisms; or (b) no symptoms of diseases caused by the relevant harmful organisms have been observed on plants at the place of production since the beginning of the last complete cycle of vegetation.

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The relevant harmful organisms are:

— on *Fragaria* L.:

- *Arabis mosaic virus*
- *Raspberry ringspot virus*
- *Strawberry latent ringspot virus*
- *Tomato black ring virus*

— on *Rubus* L.:

- *Arabis mosaic virus*
  - *Raspberry ringspot virus*
  - *Strawberry latent ringspot virus*
  - *Tomato black ring virus*
- 

### 3.1.3.2. Legislation addressing hosts of the pathogens

In addition, other legislation, though targeted at other pests or hosts, may have an indirect effect in limiting the risk of further entry of ArMV, RpRSV, SLRSV and TBRV into the risk assessment area, and are listed below.

- Annex III, Part A—Plants, plant products and other objects the introduction of which shall be prohibited in all Member States
  - 9. Plants of *Prunus* L., and *Rosa* L., intended for planting, other than dormant plants free from leaves, flowers and fruit originating from non-European countries;
  - 11. Plants of stolon- or tuber-forming species of *Solanum* L. or their hybrids, intended for planting, other than those tubers of *Solanum tuberosum* L. as specified under Annex IIIA (10), originating from third countries;
  - 13. Plants of *Solanaceae* intended for planting, other than seeds and those items covered by Annex IIIA (10), (11) or (12), originating from third countries, other than European and Mediterranean countries;
  - 15. Plants of *Vitis* L., other than fruits, originating from third countries other than Switzerland;
  - 18. Plants of *Cydonia* Mill., *Malus* Mill., *Prunus* L., *Pyrus* L. and their hybrids, and *Fragaria* L., intended for planting, other than seeds, originating from non-European countries, other than Mediterranean countries, Australia, New Zealand, Canada, the continental states of the USA.
- Annex IV, Part a—Special requirements which must be laid down by all Member States for the introduction and movement of plants, plant products and other objects into and within all Member States.
 

Section I—Plants, plant products and other objects originating outside the Community

  - 15. Plants of *Prunus* L. intended for planting, other than seeds, originating in non-European countries which are free (or from an area recognised as being free) from *Monilinia fructicola*;
  - 16. From 15 February to 30 September, fruits of *Prunus* L., originating in non-European countries which are free (or from an area recognised as being free) from *Monilinia fructicola*;
  - 21.1–3. Plants of *Fragaria* L. intended for planting, other than seeds, originating from places of production recognised as being free from Strawberry latent “C” virus, Strawberry vein banding virus, Strawberry witches’ broom mycoplasma, *Aphelenchoides besseyi* Christie, *Anthonomus bisignifer* (Schenkling);
  - 23.1–2. Plants of *Prunus* L. intended for planting, other than seeds, originating from places of production recognised as being free from Plum pox virus and the other relevant harmful organisms;

- 25.5–6. Plants of Solanaceae, intended for planting, other than seeds, originating from places of production recognised as being free from Potato stolbur mycoplasma, Potato spindle tuber viroid;
  - 39. Trees and shrubs, intended for planting, other than seeds and plants in tissue culture, originating in third countries other than European and Mediterranean countries, free from fruits, grown in nurseries and free from harmful organisms;
  - 40. Deciduous trees and shrubs, intended for planting, other than seeds and plants in tissue culture, originating in third countries other than European and Mediterranean countries which are dormant and free from leaves;
  - 41. Annual and biennial plants, other than *Gramineae*, intended for planting, other than seeds, originating in countries other than European and Mediterranean countries, free from fruits, grown in nurseries and free from harmful organisms;
  - Herbaceous perennial plants, intended for planting, other than seeds, of the *Rosaceae* (except *Fragaria* L.), originating in third countries, other than European and Mediterranean countries, free from fruits, grown in nurseries and free from harmful organisms.
- Annex V—Plants, plant products and other objects which must be subject to a plant health inspection before being permitted to enter the Community
    - Part B—Plants, plant products and other objects originating in territories other than those referred to in Part A (i.e. the Community)
      - I. Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community:
        - 1. Plants, intended for planting, other than seeds, of *Prunus* L., *Phaseolus* L.;
        - 2. Parts of plants, other than fruits and seeds of *Prunus* L., cut flowers of *Rosa* L., originating in non-European countries;
        - 3. Fruits of *Prunus* L. originating in non-European countries.
      - II. Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for certain protected zones:
        - 6.a Fruits of *Vitis* L.

In addition to Council Directive 2000/29/EC, some plant species which are potential hosts of ArMV, RpRSV, SLRSV and TBRV are further regulated:

- under Council Directive 2008/72/EC<sup>6</sup> on the marketing of vegetable propagating and planting material;
- under Council Directive 2008/90/EC<sup>7</sup> on the marketing of fruit plant propagating material: *Fragaria* L., *Rubus* L.

### 3.1.4. Potential for establishment and spread in the risk assessment area

#### 3.1.4.1. Availability of suitable hosts in the risk assessment area

ArMV, RpRSV, SLRV and TBRV have a wide host range and cause different diseases on numerous plants (Table 2), all of which are present in the risk assessment area. This host range includes a number of crop species such as grapevine, hop, raspberry, rhubarb and strawberry, as well as several shrubs and trees that are widely grown all over Europe.

<sup>6</sup> Council Directive 2008/72/EC of 15 July 2008 on the marketing of vegetable propagating and planting material, other than seed. OJ L 205/28, 1.8.2008, p. 28–39.

<sup>7</sup> Council Directive 2008/90/EC of 29 September 2008 on the marketing of fruit plant propagating material and fruit plants intended for fruit production. OJ L 267/8, 8.10.2008, p. 8–22.

#### 3.1.4.2. Availability of suitable vectors in the risk assessment area

Likewise, the nematode vectors are also reported to be widely distributed in the risk assessment area, although knowledge about the extent and precise distribution of longidorids remains scarce. The major vector species, *Longidorus elongatus* and *Xiphinema diversicaudatum*, have been found in both southern and northern European countries (Table 6).

#### 3.1.4.3. Suitability of the environment

All four viruses and their nematode vectors occur or have been reported in the past in many countries of the risk assessment area, indicating that they are well adapted to the diverse ecoclimatic conditions found in Europe. These viruses are found only sporadically and appear to have a limited prevalence. Only ArMV and RpRSV are reported to be widely distributed in the Czech Republic, Germany, the Netherlands, Poland, France and Switzerland. There is no indication that the ecoclimatic requirements for the viruses differ substantially from those of their host plants. The nematode vectors also have a broad distribution in Europe which demonstrates that they can adapt to diverse ecoclimatic conditions. However, local pedoclimatic factors (longidorid nematodes thrive in light sandy soils under humid conditions) and plant coverage may affect their local distribution.

#### 3.1.5. Potential for consequences in the risk assessment area

All four viruses can be found in a wide range of cultivated crops (including small fruits) and in wild hosts. Damage is reported only for crop species, mostly *Rubus*, *Fragaria* and grapevine. Mixed virus infections occur frequently and result in more severe diseases. RpRSV and TBRV together cause a ringspot or leaf curl disease in raspberry with variable symptom severity depending on the cultivar. Like GFLV, ArMV and, to a lesser extent, RpRSV cause grapevine fanleaf disease in grapevine which is considered one of the two most important grapevine viral diseases (Wetzel et al., 2006). ArMV and SLRSV, which are commonly found in mixed infections, can cause serious diseases in strawberry and in raspberry. ArMV infections of strawberry usually result in stunting and dwarfing leading to decline of the plant and rendering the crop unsustainable within one to two years (Murant and Lister, 1987). Similarly, crop losses of raspberry owing to ArMV and SLRSV can be considerable when the outbreak is large because infected plants will produce little or no fruit (Murant, 1987).

Infections with these viruses can result in diseases with severe symptoms but in production plots the incidence of virus-infected plants generally remains localised because of limited spread by the nematode vectors. In artichoke, TBRV can cause a serious disease resulting in yield losses of up to 40 % (Gallitelli et al., 2004).

Overall, *Rubus*, *Ribes*, *Fragaria*, grapevine and other susceptible hosts are widely grown in the risk assessment area hence the four viruses have potential to cause significant crop yield reductions in the risk assessment area.

#### 3.1.6. Conclusion on pest categorisation

All four viruses are currently established in the risk assessment area. Vector nematodes also widely occur in the risk assessment area and have the potential to contribute to the local spread of the viruses. The major crops at risk, *Fragaria*, *Rubus*, *Ribes* and grapevine, are cultivated throughout the EU and virus infections in those hosts are potentially damaging. It should be stressed that a lot of the literature on these viruses and their vectors is rather old, with only limited information published in more recent years. As a consequence, many of the aspects analysed in the present opinion carry significant uncertainty. The lack of recently published data on the viruses and the almost complete absence of interception reports suggest that they do not occur with any frequency in traded plant material and/or that specific diagnostic procedures for these agents are not routinely used. To determine the real extent to which these pests pose a threat to European crops and to fulfil the terms of reference of this risk assessment, a detailed risk assessment is required.

### 3.2. Probability of entry

ArMV, RpRSV, SLRSV and TBRV are present in several Member States (Table 5). The assessment of the probability of entry considers the potential for further entry from third countries.

#### 3.2.1. Identification of pathways

The Panel identified the following pathways for entry of ArMV, RpRSV, SLRSV and TBRV from infested areas into the risk assessment area:

1. Plants for planting (including vegetative plant propagation material, seeds and live pollen of host plants);
2. Plant parts of host plants (not intended for planting);
3. Soil.

##### 3.2.1.1. Selection of the most important pathways

The selection of the most important pathways from those listed above for further assessment was based on the EFSA “Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options” (EFSA PLH Panel, 2010) which states that the most relevant pathways should be selected using expert judgement and, where there are different origins and end uses, it is sufficient to consider only realistic worst-case pathways.

There is very limited interception data (one entry each for ArMV, SLRSV and TBRV) in the Europhyt database; therefore, the assessment of the significance of the identified pathways has been carried out based on historical literature data and information on the biology of the pest and hosts.

*Pathway 1: Plants for planting (including vegetative plant propagation material, seeds and live pollen of host plants)*

Considering (1) the wide host range of ArMV, RpRSV, SLRSV and TBRV, and the importation of several host plants and (2) the fact that establishment is greatly facilitated when entry is associated with plants for planting, plants for planting is considered to be the major entry pathway for the considered viruses. Therefore, this pathway was further analysed by the Panel.

*Pathway 2: plant parts of host plants (not intended for planting)*

Plant parts of host plants (not intended for planting) can be considered a pathway of less importance because successful establishment following entry requires transfer of the virus to (a) suitable host(s) by vector transmission or, rather inefficiently, by mechanical transmission through wounding. This requires the concomitant presence, in close vicinity, of vectors and susceptible host plants. Although the risk of such a scenario exists, the overall efficacy of this transfer is likely to be low compared with the entry of virus-infected plant material intended for planting, for which establishment is immediate. Therefore, the Panel considers the pathway as minor and did not analyse it in detail.

*Pathway 3: soil*

It should be noted that, owing to the persistence of the viruses for significant periods of time within their nematode vectors, soil might be a source of entry, whether imported as such or as a substrate, or as a contaminant of plants for planting or even of plant products. Considering the limited volume of soil imported into the risk assessment area, as well as the existing regulation for soil importation, this pathway is, however, considered as minor by the Panel, and therefore was not further analysed.



### 3.2.2. Detailed analysis of pathway 1: plants for planting

#### 3.2.2.1. Probability of association with the pathway at origin

Plants for planting comprise vegetative propagation material and seeds. They also comprise live pollen that may be introduced for pollination purposes, such as for breeding programmes. All three nepoviruses and SLRSV have a wide host range (Table 1). Owing to the widespread occurrence of the nematode vectors throughout Europe facilitating the potential spread from one host to another, all host plants have been considered, including both *Fragaria* and *Rubus*, which are currently under regulation (Council Directive 2000/29/EC, annex IIAII), as well as non-regulated hosts.

As analysed in section 3.1.2.1 (Figure 1), with the possible exception of ArMV, which has a broader distribution outside the EU, the viruses considered are largely restricted to Europe and reported from few countries outside the risk assessment area. For example, ArMV, RpRSV and SLRV were discovered in epidemiological surveys conducted recently in Belarus (Valasevich and Kolbanova, 2010) and ArMV was discovered in Lithuania (Stankiene et al., 2012) and Chile (Medina et al., 2006). However, it should be stressed that most of the virus reports outside the EU refer to hosts other than the EU-regulated *Fragaria* and *Rubus* species, e.g. detection from hop and tamarillo in New Zealand (Pethybridge et al., 2009), mint in the USA (Postman et al., 2004), rose and apple in India (Kulshrestha et al., 2004; Tanuja et al., 2011) and olive trees in North Africa and the Middle East (Caglayan et al., 2004; Fadel et al., 2005).

Both *Fragaria* and *Rubus*, as well as a range of other host plants intended for planting, are produced under strict certification schemes. However, for some other hosts there is no certification scheme and seeds will not necessarily be controlled for these four viruses. As symptoms are often absent in infected plants, visual examination alone may not identify the presence of these viruses.

Eurostat data on the movement of plants for planting along the pathway from third countries to the EU are not available as data are aggregated in the category of “Vegetable and Strawberry plants”.

Europhyt reports the importation of only a very limited number of ArMV-, SLRSV- and TBRV-contaminated plants into Europe, and does not report contamination of either *Fragaria* or *Rubus*. Similarly, the reports of interceptions of longidorids mostly concern importation of *Ficus* and *Phoenix* spp. from North African countries and not *Fragaria* or *Rubus*.

As indicated by the hearing of industry experts (EFSA, in press), most of the *Fragaria* and *Rubus* plants for planting material used in the risk assessment area are produced within Europe, although international trade of material between California, Canada and Europe is reported.

Overall, considering (1) the wide host range of the concerned viruses but their limited presence outside Europe (with the exception of ArMV), (2) the low number of import interceptions and (3) the limited volumes of imported *Fragaria* and *Rubus* plants for planting, the probability that plants for planting grown outside Europe would be associated with the movement of these viruses is estimated to be limited. Therefore, the Panel evaluated the probability of association with the pathway at origin for RpRSV, SLRSV and TBRV to be very unlikely to unlikely, and for ArMV to be unlikely to moderately likely, with moderate uncertainty in both cases.

#### 3.2.2.2. Probability of survival during transport or storage

Whether present in plants for planting, in seeds or in live pollen, the viruses are transported in living planting material and will therefore survive transport and storage as long as their hosts remain alive. In some cases, roots of plants for planting may be contaminated directly by eggs or juvenile or adult stages of nematodes, or indirectly by soil or soil remnants that may contain viruliferous nematodes, which may escape detection and are likely to survive transport and storage. Low-temperature or even controlled atmospheres applied to ensure product quality will have only limited effects on nematode mortality (Sutherland and Ross, 1971; Cotten, 1975; Pinkerton et al., 2008). Nevertheless, transporting

plant material at temperatures lower than 16 °C will ensure that nematode populations do not increase and practices such as washing roots of imported material will decrease the quantity of nematodes associated with plants for planting.

Overall, the probability of the viruses or viruliferous nematodes surviving transport and storage is considered as very likely, with low uncertainty.

### 3.2.2.3. Probability of surviving existing pest management procedures

Two different situations have to be considered here. ArMV, RpRSV, SLRSV and TBRV are regulated in Annex IIAII of the Council Directive 2000/29/EC, listing only plants of the genera *Fragaria* and *Rubus*, but excluding seeds. Both *Fragaria* and *Rubus* plants for planting are produced under non-mandatory certification schemes (EFSA, in press).

In addition to these two plant species that are specified in Annex IIAII of Council Directive 2000/29/EC, ArMV, RpRSV, SLRSV and TBRV also have a much wider host range for which management procedures are likely to consist only of visual inspections of plants for suspicious symptoms. This measure does not detect infected plants that are symptomless or that express symptoms only in a limited manner. Asymptomatic or poorly symptomatic plants can escape inspection and, therefore, ArMV, RpRSV, SLRSV and TBRV may be overlooked in a range of situations. Furthermore, ArMV, RpRSV, SLRSV and TBRV are also seed-transmitted in many plant species. Under the current legislation, there is no particular management procedure specified for seed importation.

Overall, the Panel therefore concludes that the probability of the four viruses surviving existing pest management procedures is likely to very likely, with low uncertainty.

### 3.2.2.4. Probability of transfer to a suitable host

When ArMV, RpRSV, SLRSV and TBRV enter into the risk assessment area with infected propagation material, the virus is already in a suitable host that will be planted and grown. If infected propagation material is planted into fields where virus-transmitting longidorids are present, transfer to other/additional suitable host plants may readily happen.

Longidorids within soil or growing media that is attached to the roots of host or non-host plants for planting and which originated from fields where the viruses are present can transfer the viruses to a suitable host when replanted at a new location.

The probability of transfer of ArMV, RpRSV, SLRSV and TBRV to a suitable host is therefore evaluated as very likely, with low uncertainty.

## 3.2.3. Conclusions on the probability of entry

The probability of entry was estimated based on the most restrictive step of the entry process, with an association with the pathway at origin estimated as very unlikely to unlikely, except for ArMV for which this probability was estimated as unlikely to moderately likely.

Rating	Justification
Unlikely to moderately likely for ArMV	<ul style="list-style-type: none"> <li>The entire host range of ArMV was taken into consideration, based on the risk of introduction owing to the large presence of the nematode vector in Europe.</li> <li>The probability of survival during transport or storage, of survival of management procedures or of transfer to a suitable host are rated as likely</li> </ul>

Rating	Justification
	to very likely.
	<ul style="list-style-type: none"> <li>ArMV is present outside Europe and in areas where <i>Fragaria</i> and <i>Rubus</i> are grown, but the probability of ArMV to be associated with the plants grown outside Europe is considered as unlikely to moderately likely.</li> <li>Importation of plants for planting of <i>Fragaria</i> and <i>Rubus</i> into the risk assessment area is limited</li> </ul>
<b>Very unlikely to unlikely for RpRSV, SLRSV and TBRV</b>	<ul style="list-style-type: none"> <li>The same reasoning as for ArMV applies but TBRV, RpRSV and SLRSV are mostly found in the risk assessment area and are seldom reported elsewhere. The probability that viruses will be associated with plants grown outside Europe is considered as very unlikely to unlikely</li> </ul>

### 3.2.4. Uncertainties on the probability of entry

Rating	Justification
<b>Medium</b>	<p>The main uncertainties concern:</p> <ul style="list-style-type: none"> <li>the exact host range for the viruses;</li> <li>the estimation of the exact quantities of plants for planting imported within Europe;</li> <li>the distribution of the viruses outside the EU and their association with imported plants.</li> </ul> <p>Nevertheless, owing to the large presence of the viruses and vectors in Europe, the uncertainty is assessed as medium</p>

## 3.3. Probability of establishment

### 3.3.1. Availability of suitable hosts, alternate hosts and vectors in the risk assessment area

All the nepoviruses and SLRSV have wide host ranges comprising wild and cultivated plants, perennial trees and shrubs that are present throughout the EU and cover all ecological zones. The viruses have been reported from a number of EU countries (Table 5). Overall, suitable hosts are widely available in the risk assessment area.

Likewise, although soil conditions might be locally inadequate, the broad distribution of the nematode vector species indicates that vectors are largely available in the risk assessment area.

### 3.3.2. Suitability of the environment

The biological functions of the viruses are connected with, and not significantly different from, those of their hosts. Because of their broad range of cultivated and wild host plants which are found all over Europe, the entire risk assessment area has suitable environmental conditions for the four viruses to establish.

### 3.3.3. Cultural practices and control measures

In general, the currently used cultural practices across the range of the host species of the four viruses are not expected to significantly impede their establishment in the EU territory. In particular, no agrochemicals are known that have an anti-virus, a preventative or a curative action.

In strawberry and in some production systems of raspberry, the short production cycles of plantations, with removal and renewal of the entire crop and rapid crop rotation, have the potential to limit establishment of the viruses in areas from which the nematode vectors are absent.

It should be noted that eradication efforts, although difficult for nematode-borne viruses with a wide host range, can be successful at least under protected cultivation conditions, demonstrating that timely and rigorously administered measures can contain outbreaks and the further spread of the four viruses under consideration.

Given that they address only two of the many hosts of the viruses, which are already reported in many EU Member States, the provisions of Annex IIAII laid down in Council Directive 2000/29/EC are not expected to significantly reduce the potential establishment of the viruses in the EU-28.

### 3.3.4. Other characteristics of the pest affecting the probability of establishment

Because virus diseases are often associated with inconspicuous or mild symptoms in some hosts, viruses may remain undetected when plants are inspected for symptoms only. Hence, virus-infected plants are unlikely to be identified unless appropriate detection methods are used.

### 3.3.5. Conclusions on the probability of establishment

Rating	Justification
Very likely	The broad host range comprising cultivated and wild hosts leads to probable under-reporting of the virus presence; nevertheless, the possibility of virus establishment is confirmed from virus reports from many EU Member States.
	Suitable climatic conditions for the viruses and their host plants are found throughout the EU and the nematode vectors are widely present so that all preconditions are met for the viruses to become established in the EU.
	Currently used cultural practices and control measures are unlikely to significantly impede establishment.

### 3.3.6. Uncertainties on the probability of establishment

Rating	Justification
Low	There are only uncertainties related to reports on the current distribution of the viruses throughout the EU territory. However, because ecoclimatic conditions and the availability of host plants are not limiting factors for virus establishment, the probability rating for establishment is associated with low uncertainties.

### 3.4. Probability of spread

#### 3.4.1. Spread by natural means

Nepoviruses and SLRSV are naturally associated with wild plants and have developed specific relationships with nematode species that serve as their vectors. The most important route of natural spread of the viruses is by longidorid nematodes and these have a wide host range among wild and cultivated plants. Because of their limited mobility, nematode populations tend to be localised in discrete territorial areas in which they become specifically associated with viruses through interdependent ecological factors.

Nematode movement is limited and the distances they move are dependent on the physical and chemical properties of the soil matrix (Pitcher, 1975). Nematode species move at different rates (Thomas, 1981). Horizontal spread for *X. diversicaudatum* estimated in laboratory experiments was 64 cm per year in heavy clay soil but only 14 cm per year in sandy soil (Fritzche, 1968). The rate of spread of *L. macrosoma* was similar to that of *X. diversicaudatum*, but the rate of spread for *X. coxi* was estimated to be 71 cm per year in sandy soil and 25 cm per year in clay soil. From laboratory experiments, Thomas (1981) concluded that the spread of *X. diversicaudatum* and *L. elongatus* in the absence of plants is very limited but in the presence of suitable host plants both species disperse at a rate of about 10 cm per month. Thus, because of their limited mobility, nematodes are not efficient agents of long-distance virus spread (Martelli, 1978).

Dissemination of the four viruses over greater distances can occur if nematode vectors are dispersed with soil movements caused by rain or erosion. Nematodes may be carried in the soil adhering to farm equipment and machinery or, occasionally, to the feet of birds and other animals (Boag, 1986). Some nematodes can also be dispersed by wind-blown soil dust; however, this is unlikely for longidorids which generally do not withstand desiccation (Taylor and Brown, 1997).

Seeds can play a significant role in virus dissemination over greater distances and also serve as reservoirs for the viruses in the soil. Every seed from a particular virus-infected wild plant can be infected and be capable of survival in soil for many years (Murant and Taylor, 1965; Lister and Murant, 1967). Wild plants play a significant role in the ecology of nematode-borne viruses and provide a continuing source of viruses to infect economically important crop plants. Even though there are only a few reports on virus epidemics caused by nematode-transmitted viruses, a recent study by Tang et al. (2013) showed that such viruses were present but may have gone undetected owing to asymptomatic infections.

Some plant viruses are able to infect the pollen grains of their host plants, and in some instances the infected pollen is able to spread the virus infection to another plant, either directly during fertilisation or mechanically by feeding damage caused by pollen-contaminated insects (Card et al., 2007). Some nematode-transmitted viruses, including RpRSV, TBRV and SLRSV are known to infect pollen but evidence that they are transmitted to plants via such contaminated pollen is inconclusive (Lister and Murant, 1967; Card et al., 2007).

Overall, because of the widespread presence of nematode vectors and the existence of other natural means of spread through seed-transmission in some hosts, the Panel concludes that the probability of spread on a local scale through natural means is likely, with low to medium uncertainty mostly linked to the patchy and incompletely known distribution of the vectors.

#### 3.4.2. Spread by human assistance

Infected propagating plant material (plants for planting or seeds) is the most effective way to spread nepoviruses and SLRSV over long distances (Brown et al., 1994). If such material is planted into fields where virus-transmitting longidorids are present, those plants will be important sources for further local virus dissemination (see section 3.4.1). Although movement of infected planting material will be limited in some host species by existing certification systems, not all cultivated host species are

covered by such certification systems. In addition, the four viruses are unlikely to be systematically assayed in seed lots of some of their host plants.

Long-distance dispersal of longidorids occurs when plants intended for planting (seed potatoes, nursery stock, flower bulbs, etc.) with soil adhering to the roots are harvested from infested fields and transported to new areas. However, it is not known how long longidorids can survive in (small amounts of) dry soil attached to plants or plant products. Griffin and Barker (1966) did not find living nematodes in soil at moisture levels of 10 % of field capacity after 12 weeks of storage in the absence of host plants. In general, *Xiphinema* spp. do not survive or survive only at very low rates in dry conditions (Sutherland and Sluggett, 1974; Harris, 1979; Sultan and Ferris, 1991), and extremely small amounts of soil attached to equipment or plant products that dries rapidly may not be a risk for transfer of longidorids, but this is uncertain. In any case, there is evidence that several *Longidorus* and *Xiphinema* species and their associated viruses (e.g. *X. diversicaudatum* with ArMV and *X. index* with GFLV) have inadvertently been transported by human activities from their areas of origin to other regions (Brown et al., 1994).

Although some host species (*Fragaria*, *Rubus*, *Prunus*, grapevine) are covered by certification systems that will limit human-assisted spread, such systems are not available for all host species and do not cover the seeds of other host species. In addition, human-assisted movement of contaminated nematodes may also occur. The Panel therefore concludes that the probability of human-assisted, long-distance spread of the four viruses is unlikely to moderately likely. This rating is, however, associated with a high level of uncertainty because of a lack of data on many aspects including the precise host range of the agents considered, the volumes of intra-EU trade of plants for planting or seeds in which the presence of the viruses is not controlled and the efficiency with which nematodes may move through human-assisted means.

### 3.4.3. Containment of the pest within the risk assessment area

Comprehensive certification programmes that include the use of virus-free planting material are very effective in containing diseases and minimising the risk of dissemination of nematode-transmitted viruses through vegetative propagation. However, certification programmes are not implemented for all cultivated hosts and do not generally consider the seeds; thus, the movement of plant propagating material that is not certified as virus-free poses the risk of disseminating the four viruses. Overall, given their wide host range which would complicate any containment efforts, these viruses are unlikely to be contained, as illustrated by their current wide distribution in Europe.

### 3.4.4. Conclusions on the probability of spread

Rating	Justification
<b>Likely for local spread by natural means</b>	On a local scale, it is not considered possible to prevent nematode-transmitted viruses from spreading in fields where vector nematodes are present. However, the infested area will increase only very slowly because nematodes transmitting and spreading the viruses have a very limited mobility.  Local spread can also occur through seed-transmission in a range of the susceptible species.
<b>Unlikely to moderately likely for long distance spread through human-assisted</b>	Trade of infected hosts, in particular vegetatively propagated planting materials and seeds, is efficient in spreading the viruses over long distances.  Certification programmes such as those covering <i>Fragaria</i> , <i>Rubus</i> , <i>Prunus</i> and grapevine are very effective in ensuring the absence of viruses in planting materials and thus limit virus dispersion via propagation material.



Rating	Justification
<b>means</b>	However, hosts less frequently associated with the four viruses are not covered by certification programmes and seeds of at least some hosts are unlikely to be checked for the presence of the four viruses.

### 3.4.5. Uncertainties on the probability of spread

Rating	Justification
<b>Low to medium for local spread by natural means</b>	Uncertainties are mostly linked to the patchy and incompletely known distribution of the vectors.
<b>High for long-distance spread through human-assisted means</b>	<p>The uncertainties are important because of the lack of information on several key aspects including:</p> <ul style="list-style-type: none"> <li>the precise host range of the agents considered;</li> <li>the volume of intra-EU trade of plants for planting or seeds in which the presence of the viruses is not controlled;</li> <li>the efficiency with which nematodes may move through human-assisted channels.</li> </ul>

### 3.5. Conclusion regarding endangered areas

Throughout Europe, susceptible host plant species are present in wild and cultivated environments, and the nematodes that transmit these viruses are also commonly found. Favourable environmental conditions for the viruses and their vectors exist in all 28 EU Member States and there are reports of historical or current distributions of the viruses. Thus, the whole EU territory is considered as the endangered area.

### 3.6. Assessment of consequences

#### 3.6.1. Direct pest effects

Most of the publications considering pest effects are historical reports and date back to the 1950s and 1960s when the viruses under consideration were characterised, showing that a number of diverse hosts and diseases in strawberry, *Rubus* and *Ribes*, but also *Prunus*, grapevine and other hosts, could be associated with those viruses. It was then reported that infection of strawberry or raspberry with nematode-transmitted viruses can be extremely damaging to crop production (Murant and Lister, 1987) and can cause large outbreaks leading to considerable economic losses. Because virus diseases are maintained and persist in vegetatively propagated crops, a common effect of “chronic” and of secondary infections with these viruses is that crops can become progressively stunted and eventually die. Virus infections of susceptible strawberry and raspberry cultivars can severely reduce yields to the extent that flower and fruit development are aborted (Murant, 1987). A study in a plantation with a virus-sensitive raspberry cultivar over a period of seven years showed that natural infection by TBRV resulted in a 13.6 % decrease in fruit yield but a much greater reduction in fruit size and height of the canes (Taylor, Chambers and Pattullo, 1965). From experiments applying nematicides, which after three years led to an increase in fruit yields of 30 % compared with untreated fields (Murant and Taylor, 1965; Taylor and Murant, 1968), it can be concluded that limiting virus spread by nematodes

can have a major impact on overall productivity of a field. The longer a *Rubus* plantation is kept in production, the higher the impact will become. In addition, the severity of the symptoms observed can be further increased in cases of mixed infection.

There is therefore very little doubt that the four viruses considered in the present opinion have the potential to have an important impact on *Fragaria* and *Rubus* host plants. However, currently used cultivation practices strongly limit this potential for impact. The most significant factor is certainly that efficient voluntary certification schemes for strawberry and raspberry are in place and ensure that healthy planting materials are used by growers. Additional factors contributing to a reduction of the impact are (1) the significantly shorter cycles of modern strawberry and raspberry cultivation practices (one to two seasons) (EFSA, in press), which limit the potential for disease build-up, (2) the increasingly frequent use of soil-less cultivation practices, which limit the impact of nematode vectors and (3) the availability of resistant or tolerant cultivars of raspberry. As a consequence of the conjunction of these various factors, these nematode-transmitted viruses are found only occasionally in these crops (EFSA, in press) and the diseases they cause are considered of minor significance by growers as illustrated during the hearing of industry experts. As a consequence, the current impact of these viruses in *Fragaria*, *Rubus* and *Ribes* hosts is considered to be minimal to minor, with low uncertainty.

There is very little precise information in the literature about the losses that may be caused by these four viruses in their other host crops. The potential for damage is, however, significant, as illustrated by the fact that like GFLV, ArMV and, to a lesser extent, RpRSV cause grapevine fanleaf disease in grapevine which is considered to be one of the two most important grapevine viral diseases. In mixed infection these two viruses cause a significant disease of grapes (Wetzel et al., 2006). Likewise, TBRV can cause serious disease in artichoke resulting in yield losses up to 40 % (Gallitelli et al., 2004). Therefore, infections with these viruses can result in diseases with severe symptoms in a range of hosts. However, in production plots, particularly with annual or bi-annual crop cycles of strawberries or raspberries, the incidence of virus-infected plants generally remains localised because of limited spread by the nematode vectors (Martelli, 1978). In addition, for the most important perennial hosts, grapevine and *Prunus*, certification programmes exist that greatly limit the prevalence and the actual impact of these viruses. As a consequence of these various factors, the actual impact of these four viruses in their various hosts, other than *Fragaria*, *Rubus* and *Ribes*, appears to be minimal to minor, with the possible exception of ArMV in grapevine, for which the impact is evaluated as minor to moderate. Given the near absence of precise data, these evaluations are, however, associated with high uncertainty.

### 3.6.2. Environmental consequences

The use of planting material certified to be free of viruses, with phytosanitary measures to rogue infected plants and with short production cycles means that these viruses have a negligible impact on the environment and on biodiversity. Likewise, although they are able to infect a range of wild plants, these viruses do not appear to have a significant environmental impact on those hosts or, more broadly, on plant communities. However, when control measures to limit nematode populations involve the application of nematicides, environmental consequences are expected, related to effects on non-target species and through the persistence of chemical residues.

### 3.6.3. Conclusions on the assessment of consequences

Rating	Justification
<b>Minimal to minor</b> <i>Fragaria</i> , <i>Rubus</i> <i>Ribes</i>	<p>The viruses have a potential to cause important damage and losses in these crops but the actual impact is limited by several factors including:</p> <ul style="list-style-type: none"> <li>the existence of efficient voluntary certification systems for strawberry and raspberry;</li> </ul>

Rating	Justification
	<ul style="list-style-type: none"> <li>the use of short crop cycles for modern strawberry and raspberry cultivation, limiting the potential for disease build-up;</li> <li>the increasingly frequent use of soil-less cultivation practices, limiting the impact of nematode vectors;</li> <li>the availability of resistant or tolerant cultivars of raspberry.</li> </ul> <p>There are no identified environmental consequences besides the use of nematicides to limit vector populations,</p>
<b>Minimal to minor in other hosts (except ArMV in grapevine)</b>	<p>The viruses have a potential to cause important damage and losses in those crops but the actual impact is limited by several factors including:</p> <ul style="list-style-type: none"> <li>the existence of efficient voluntary certification systems for important host crops such as <i>Prunus</i> and grapevine;</li> <li>the limited spread of the disease by nematode vectors generally resulting in a limited number of infected plants in affected plots, in particular concerning annual host crops.</li> </ul> <p>There are no identified environmental consequences besides the use of nematicides to limit vector populations.</p>
<b>Minor to moderate ArMV in grapevine</b>	<p>ArMV causes the grapevine fanleaf disease and in combination with other viruses, especially RpRSV, can cause severe diseases in grapevine.</p>

#### 3.6.4. Uncertainties on the assessment of consequences

Rating	Justification
<b>Medium impact in <i>Fragaria</i>, <i>Rubus</i> and <i>Ribes</i></b>	<p>There is a lack of detailed information on crop losses.</p>
<b>High impact in other hosts</b>	<p>Very little precise information is available.</p>

### 3.7. Conclusion of the pest risk assessment including uncertainties

#### 3.7.1. Entry

Rating	Justification
Unlikely to moderately likely for ArMV	<ul style="list-style-type: none"> <li>The entire host range of ArMV was taken into consideration, based on the risk of introduction owing to the large presence of the nematode vector in Europe.</li> <li>The probability of survival during transport or storage, of survival of management procedures or of transfer to a suitable host are rated as likely to very likely.</li> <li>ArMV is present outside Europe and in areas where <i>Fragaria</i> and <i>Rubus</i> are grown, but the probability of ArMV to be associated with the plants grown outside Europe is considered as unlikely to moderately likely.</li> <li>Importation of plants for planting of <i>Fragaria</i> and <i>Rubus</i> into the risk assessment area is limited</li> </ul>
Very unlikely to unlikely for RpRSV, SLRSV and TBRV	<ul style="list-style-type: none"> <li>The same reasoning as for ArMV applies but TBRV, RpRSV, SLRSV are mostly found in the risk assessment area and are seldom reported elsewhere. The probability of viruses to be associated with plants grown outside Europe is considered as very unlikely to unlikely</li> </ul>

Uncertainties rating	Justification
Medium	<p>The main uncertainties concern:</p> <ul style="list-style-type: none"> <li>the exact host range for the viruses;</li> <li>the estimation of the exact quantities of plants for planting imported within Europe;</li> <li>the distribution of the viruses outside the EU and their association with imported plants.</li> </ul> <p>Nevertheless, owing to the large presence of the viruses and vectors in Europe, the uncertainty is assessed as medium.</p>

### 3.7.2. Establishment

Rating	Justification
<b>Very likely</b>	<p>The broad host range comprising cultivated and wild hosts leads to probable under-reporting of the virus presence; nevertheless, the possibility of virus establishment is confirmed from virus reports from many EU Member States.</p> <p>Suitable climatic conditions for the viruses and their host plants are found throughout the EU and the nematode vectors are widely present so that all preconditions are met for the viruses to become established in the EU.</p> <p>Currently used cultural practices and control measures are unlikely to significantly impede establishment.</p>

Uncertainties rating	Justification
<b>Low</b>	<p>There are only uncertainties related to reports on the current distribution of the viruses throughout the EU territory. However, because ecoclimatic conditions and availability of host plants are not limiting factors for virus establishment, the probability rating for establishment is associated with low uncertainties.</p>

### 3.7.3. Spread

Rating	Justification
<b>Likely for local spread by natural means</b>	<p>On a local scale, it is not considered possible to prevent nematode-transmitted viruses from spreading in fields where vector nematodes are present. However, the infested area will increase only very slowly because nematodes transmitting and spreading the viruses have a very limited mobility.</p> <p>Local spread can also occur through seed-transmission in a range of the susceptible species.</p>
<b>Unlikely to moderately likely for long distance spread through human-assisted means</b>	<p>Trade of infected hosts, in particular vegetatively propagated planting materials and seeds, is efficient in spreading the viruses over long distances.</p> <p>Certification programmes such as those covering <i>Fragaria</i>, <i>Rubus</i>, <i>Prunus</i> and grapevine are very effective in ensuring the absence of viruses in planting materials and thus limit virus dispersion via propagation material.</p> <p>However, hosts less frequently associated with the four viruses are not covered by certification programmes and seeds of at least some hosts are unlikely to be checked for the presence of the four viruses.</p>

Uncertainties rating	Justification
<b>Low to medium for local spread by natural means</b>	Uncertainties are mostly linked to the patchy and incompletely known distribution of the vectors.
<b>High for long-distance spread through human-assisted means</b>	<p>The uncertainties are important because of the lack of information on several key aspects including:</p> <ul style="list-style-type: none"> <li>• the precise host range of the agents considered;</li> <li>• the volume of intra-EU trade of plants for planting or seeds in which the presence of the viruses is not controlled;</li> <li>• the efficiency with which nematodes may move through human-assisted channels.</li> </ul>

### 3.7.4. Impact

Rating	Justification
<b>Minimal to minor in <i>Fragaria</i>, <i>Rubus</i> and <i>Ribes</i></b>	<p>The viruses have a potential to cause important damage and losses in these crops but the actual impact is limited by several factors including:</p> <ul style="list-style-type: none"> <li>• the existence of efficient voluntary certification systems for strawberry and raspberry;</li> <li>• the use of short crop cycles for modern strawberry and raspberry cultivation, limiting the potential for disease build-up;</li> <li>• the increasingly frequent use of soil-less cultivation practices, limiting the impact of nematode vectors;</li> <li>• the availability of resistant or tolerant cultivars of raspberry.</li> </ul> <p>There are no identified environmental consequences besides the use of nematicides to limit vector populations.</p>
<b>Minimal to minor in other hosts (except ArMV in grapevine)</b>	<p>The viruses have a potential to cause important damage and losses in these crops but the actual impact is limited by several factors including:</p> <ul style="list-style-type: none"> <li>• the existence of efficient voluntary certification systems for important host crops such as <i>Prunus</i> and grapevine;</li> <li>• the limited spread of the disease by nematode vectors generally resulting in a limited number of infected plants in affected plots, in particular concerning annual host crops.</li> </ul> <p>There are no identified environmental consequences besides the use of nematicides to limit vector populations.</p>



Rating	Justification
<b>Minor to moderate impact of ArMV in grapevine</b>	ArMV causes the grapevine fanleaf disease and in combination with other viruses, especially RpRSV, can cause severe diseases in grapevine.
<b>Uncertainties rating</b>	<b>Justification</b>
<b>Medium impact in <i>Fragaria</i>, <i>Rubus</i> and <i>Ribes</i></b>	There is lack of detailed information on crop losses.
<b>High impact in other hosts</b>	Very little precise information is available.

#### 4. Identification and evaluation of risk reduction options

The structure of this section is as follows. The current regulations to prevent the introduction and spread of ArMV, RpRSV, SLRSV and TBRV are presented and evaluated in section 4.1. The consequences of deregulation are discussed in section 4.2. Phytosanitary measures to prevent the entry of ArMV, RpRSV, SLRSV and TBRV from third countries into the EU are addressed in section 4.3. Measures to prevent establishment are outlined in section 4.4. Measures to prevent spread within the EU and those to reduce the impact of the pathogens are outlined in section 4.5. The conclusions are given in section 4.6.

##### 4.1. Evaluation of current phytosanitary measures to prevent the introduction and spread of ArMV, RpRSV, SLRSV and TBRV

Phytosanitary measures to prevent the introduction and spread of ArMV, RpRSV, SLRSV and TBRV are listed in Annex II and IV of Council Directive 2000/29/EC (see section 3.1.3). In Annex II AII, these viruses are listed as harmful organisms known to occur in the Community and to be relevant to the entire Community. The introduction of these viruses into, and the spread within, all Member States shall be banned if they are present on plants of *Fragaria* L. and *Rubus* L. intended for planting, other than seeds. Annexes IV A I and IV A II describe the special requirements which must be followed by all Member States for the introduction and movement of plants, plant products and other objects into and within all Member States. They require that an official statement is made that *Fragaria* L. and *Rubus* L. plants originate in areas known to be free from ArMV, RpRSV, SLRSV and TBRV, or that no symptoms of diseases caused by ArMV, RpRSV, SLRSV and TBRV have been observed on *Fragaria* L. and *Rubus* L. plants at the place of production since the beginning of the last complete cycle of vegetation.

In addition, Annex V, which lists plants, plant products and other objects which must be subject to a plant health inspection before being moved within the Community or permitted to enter the Community, mandates that plants intended for planting other than seeds of the genera *Fragaria* and *Rubus* must be accompanied by a plant passport. Such a passport would need to include information on the absence of the four viruses addressed in the present opinion given their listing in Annex II AII.

Finally, Annex IIIA, independently of Annex IIAlI, lists plants, plant products and other objects, the introduction of which is prohibited in all Member States. Among the listed plants are a range of host plants of the four viruses considered in the present opinion, including:

- plants of *Rosa* L. intended for planting, other than dormant plants free from leaves, flowers and fruit originating from Non-European countries;
- tubers of *Solanum tuberosum* L. and seed potatoes originating from third countries other than Switzerland;
- plants of *Solanaceae* intended for planting, other than seeds and of the above mentioned tubers of *Solanum tuberosum* L., originating from third countries other than European and Mediterranean countries;
- plants of *Vitis* L., other than fruits originating from third countries other than Switzerland;
- plants of *Prunus* L. and *Fragaria* L., intended for planting, other than seeds originating from non-European countries other than Mediterranean countries, Australia, New Zealand, Canada and the continental states of the USA. A more restrictive status applies to non-dormant plants of *Prunus* L. harbouring leaves, flowers or fruit, as their import is banned from all non-European countries.

In addition, Annex III also bans the import of soil and growing medium as such, which consists in whole or in part of soil or solid organic substances such as parts of plants and humus including peat or bark, other than that composed entirely of peat originating from Turkey, Belarus, Moldavia, Russia, Ukraine and third countries not belonging to continental Europe, other than Egypt, Israel, Libya, Morocco and Tunisia.

The Panel's opinion on the effectiveness of the present EU requirements in reducing the risk of introduction of these pests into, and their spread within, the EU territory is based on the analysis of Annexes IIAlI, III, IV and V.

- The viruses under consideration in this risk assessment are reported from only a few countries outside the EU and where they are infrequently found in crops. The viruses are, however, present in nature both in and outside Europe (see Tang et al., 2013).
- Imports of the commodities *Fragaria* L. and *Rubus* L. from third countries are limited.
- Although these viruses have a rather wide host range (see section 3.1.1.2), the legislation covers these viruses only on plants of *Fragaria* and *Rubus*, which are principal, but not the only, hosts for these viruses. Other host plants for the viruses are not considered in the regulation, and thus virus entry on those host plants into the EU is possible. Likewise, the current legislation does not take into account the seeds of *Fragaria* and *Rubus*. Although it is unlikely that professional growers would buy seeds for these plants, strawberry seeds can readily be purchased in small amounts on the internet for amateur gardeners. Given that ArMV, RpRSV and TBRV are known to be seed-transmitted at very significant rates in strawberry (see section 3.1.1.2), entry of these pathogens might occur through this minor possibility.
- Similarly, Annex IV and V requirements, which derive from the Annex IIAlI requirements, concern only *Fragaria* and *Rubus* and do not address other host plants or seeds.
- The countries which have a derogatory status for commodities relevant for the present opinion in Annex III are frequently among the few countries from which the viruses considered have been reported outside the EC. This includes, in particular, Switzerland (for *Vitis* and seed

potatoes when all four agents are known to be present), Australia, New Zealand, Canada and the USA (for *Fragaria* and dormant *Prunus* plants for planting). The same situation applies to the ban on the import of soil and related media with derogation for Egypt from where SLRSV is reported, with a risk of importing viruliferous nematodes. The protective value of the Annex III regulation is therefore viewed as extremely limited.

- In the current situation, a relevant contribution to reducing the risks of the four viruses considered is made by certification schemes adopted by a well-developed nursery industry to improve the phytosanitary status of *Fragaria* and *Rubus* plant material for planting. The four viruses are among the pathogens regularly tested for within the certification protocols applied, and *Fragaria* and *Rubus* planting material are strictly monitored for the absence of these pathogens.

Overall the key weakness of the current legislation identified by the Panel is that it addresses only the two vegetatively propagated hosts in which the viruses are most detrimental and fails to address other host species, thus leaving open the possibility of entry and spread within the EU of the four viruses in those alternative host species. A minor weakness concerns the failure to regulate seeds of *Fragaria* and *Rubus*, when the viruses considered are known to be seed-transmissible in these hosts and when small volume trade might occur as a consequence of amateur gardeners buying seeds on the internet.

As explained above, the Annex III legislation is seen by the Panel as being considerably weakened by import derogations (in particular for strawberry plants for planting) offered to countries among the few where the viruses are reported outside the EU.

#### 4.2. Consequences of removing the pests from Annex II AII

If the current legislation aimed at preventing the introduction and spread of ArMV, RpRSV, SLRSV and TBRV was to be removed, the ban on the introduction into and the movement within the EU of these viruses in plant materials of *Fragaria* and *Rubus* would be withdrawn. Such deregulation may have a benefit for exporters outside and within the EU (for intra-EU trade) of *Fragaria* and *Rubus* plants because trade would be less restricted.

In its analysis of the consequences of removing the four viruses addressed by the present opinion from Annex II AII, the Panel considered that:

- The viruses considered are mostly present within the EU and have a restricted to very restricted distribution outside the EU.
- Imports of *Fragaria* L. and *Rubus* L. from third countries into the EU are limited.
- Hosts of these viruses other than *Fragaria* and *Rubus* are not covered by the current II AII legislation.
- The protection afforded by Annex III is considered to be extremely limited (see section 4.1).
- In the current situation, a significant contribution to reducing the risks of the four viruses considered is made by certification schemes adopted by a well-developed nursery industry to improve the phytosanitary status of *Fragaria* and *Rubus* plant material for planting. The four viruses are among the pathogens regularly tested for within the certification protocols, and *Fragaria* and *Rubus* planting material is monitored for the absence of these pathogens.
- Further protection against the impact of these viruses is provided by new crop production practices that are more and more widely used (short production cycles, soilless cultivation, etc.).

In reaching its conclusions, the Panel considered that revoking the IIAII regulation would have consequences for other elements of the Council Directive 2000/29/EC, particularly on the specific requirements laid down in Annexes IV and V, and that the mandatory requirements for official statements on pest freedom of production areas, plant inspection activities and freedom from symptoms in traded plants would therefore be correspondingly relaxed.

*Fragaria*, *Rubus*, *Ribes* and *Vitis* are covered by several regulations specified in Annexes of the Council Directive 2000/29/EC. Those listings concern other pathogens, viruses and virus-like organisms listed in Annexes IAI (non-European viruses and virus-like organisms) and IIAII. Revoking of the regulation for the four viruses analysed in the present opinion would not affect these other regulations, and therefore does not mean that planting materials of these species would arrive and move within the EU without being indexed for pathogens.

Plants for planting of *Fragaria*, *Rubus*, *Vitis*, *Prunus* and *Ribes* genera are produced following comprehensive certification schemes for propagation materials voluntarily applied by the industry. These are also specified in an EPPO certification scheme for the production of healthy plants of *Rubus* (EPPO, 2009) and an EPPO certification scheme for pathogen-tested strawberry (EPPO, 2008). The EPPO standards also recommend laboratory testing (enzyme-linked immunosorbent assay (ELISA), PCR) in addition to regular visual monitoring of the general status of the plants with respect to pests, diseases or unknown symptoms. It is likely that the industry adheres to those standards partly to comply with Council Directive 2000/29/EC and partly to ensure product quality. Given the strong potential impact of the four viruses considered in the present opinion on *Fragaria* and *Rubus*, it can be assumed that even if the current IIAII regulation was lifted, the industry would continue to include these viruses in the present voluntary certification schemes.

If the current regulation were to be removed, no major consequences or changes in the potential impact of the four viruses considered here would be expected. This is largely owing to the important level of protection afforded to the industry by the efficient and widely used certification scheme for *Fragaria*, *Rubus*, *Ribes*, *Prunus* and *Vitis*, which is regarded by the Panel as reducing the risks of introduction, spread and impact in a very significant fashion. The absence of control of other hosts of the four viruses in the current measures also limits the consequences predicted if these measures were to be removed.

If, on the other hand, the current legislation were removed and the industry simultaneously ceased or reduced its voluntary certification activity or excluded the four viruses considered from the list of organisms addressed, a return to a high prevalence of these viruses in *Fragaria*, *Rubus* and other vegetatively propagated susceptible crops might be expected.

#### **4.3. Options to reduce the probability of entry**

In this section, the options for consignments are addressed. The options to prevent or reduce infestation in the crop are discussed in detail in section 4.5 (options to reduce the probability of spread and the magnitude of impact) and are not repeated here, although they can be applied also at the country of origin.

##### **4.3.1. Prohibition**

The prohibition of importation of all ArMV-, RpRSV-, SLRSV- and TBRV-infected plants, whatever their species (see section 3.1.3), from third countries into the risk assessment area is a possible measure to reduce the risk of entry of the pathogens. Such a measure is already in place for strawberry and raspberry plants for planting.

*Effectiveness:* in assessing the effectiveness of such a measure, several factors have to be integrated, including the widespread occurrence of the considered viruses in Europe, the relative absence of such viruses outside Europe and the relatively low rate of detection of the viruses in imported consignments. Expanding the list of plants regulated by the current IIAII legislation would therefore

increase the level of protection for entry. Overall, the effectiveness of prohibiting the currently listed host plant species is rated as negligible to low, and that of prohibiting an expanded list of host plant species is considered as moderate to high depending on the completeness of the expanded list.

*Technical feasibility:* the technical feasibility of prohibiting the entry of all potential host plant species is moderate to high because prohibition is already in place for some hosts; however, our knowledge of the host range of the viruses considered is likely to be incomplete.

*Uncertainty:* the limited knowledge of the host plants of these viruses results in a medium to high uncertainty because the viruses can enter the risk assessment area undetected on an unregulated plant not known to be a host or viruses may enter with viruliferous nematodes carried on a non-host plant.

#### **4.3.2. Pest freedom, inspection or testing**

##### **4.3.2.1. Visual inspection**

Currently, the production scheme of strawberry and raspberry plants for planting includes visual inspection for viral disease symptoms as well as screening mother plants for the presence of viruses. International Standards for Phytosanitary Measures (ISPM) 31 (IPPC, 2009) provides guidance on appropriate sampling methodologies for inspection or testing of consignments. However, the effectiveness of inspection for ArMV, RpRSV, SLRSV and TBRV depends on the ease of visual detection and/or manifestation of symptoms. Sometimes virus infections remain latent or only mild symptoms are expressed. Owing to the possibility of latent and mixed infections, this measure is not fully reliable.

*Effectiveness:* when relying only on visual inspection, effectiveness of this measure is low.

*Technical feasibility:* high because visual inspection is common practice for import control.

*Uncertainty:* uncertainties associated with these ratings are low.

##### **4.3.2.2. Testing**

The presence of viruses can be tested by using appropriate techniques such as ELISA and PCR. The latter method is more sensitive and can detect the virus at low concentrations, even in asymptomatic hosts. Tests could be performed on all plants in the case of a limited number of plants. However, in the case of large numbers of plants, only random samples can be tested. In addition, to be fully effective, this measure should be applied to all putative host species of the viruses considered and should not be limited to a few of them.

Inspection of consignments for nematode vector infestation is also not fully efficient as nematological analyses of plant material or soil are often not feasible at points of entry because such analyses are time consuming and require specific equipment, expertise and quarantine conditions for effective nematode testing (Hockland et al., 2006).

*Effectiveness:* the effectiveness of testing is high in the case of testing of all imported plants. However, where high volumes of material arrive, only a limited number of individuals can be tested, which decreases the effectiveness to moderate. The overall effectiveness is therefore rated as moderate.

*Technical feasibility:* the feasibility of testing a limited number of entities is considered high, but it decreases to low for large volumes of imported planting material.

*Uncertainty:* uncertainties associated with these ratings are low.

#### **4.3.3. Pre-entry or post-entry quarantine systems**

Pre- and post-entry quarantine can be very effective for verifying the presence of harmful organisms. EU Member States may impose a post-entry quarantine in the case of a substantiated suspicion that particular consignments may harbour harmful organisms. Quarantine controls can be applied to



demonstrate freedom from disease over a period of time, allowing the plants to grow in strict isolation from other plant material, followed by inspections and/or tests to ensure the absence of the suspected disease. In the case of asymptomatic infection by ArMV, RpRSV, SLRSV and TBRV, the quarantine period would also allow more time for symptoms to develop.

Host plants often do not develop obvious symptoms following infection. Therefore, if this control measure was to be used based only on visual inspection, its effectiveness would be low. However, the quarantine efficacy would be high if all plants held under quarantine conditions were tested specifically for ArMV, RpRSV, SLRSV and TBRV. The feasibility is therefore high for nuclear stocks for vegetative propagation.

However, feasibility is low for the large number of plants involved in the late cycles of multiplication, close to commercialisation, as these measures can only be applied to a very limited number of sampled plants. Given the large number of ArMV, RpRSV, SLRSV and TBRV hosts, the feasibility of this measure is considered as low if it is to be applied to all known hosts. Uncertainty on these ratings is low.

*Effectiveness:* the overall effectiveness is considered as low if quarantine is applied based only on visual inspection, but it is considered as high if, through the quarantine process, plants are systematically tested for the presence of viruses by the use of detection techniques.

*Technical feasibility:* the technical feasibility is rated as low if considering the large number of plants involved at the commercial level, but high if applied to a limited number of plants or for nuclear stocks used for vegetative propagation.

*Uncertainty:* the uncertainty is considered as low because the techniques and procedures for virus detection are well known.

#### **4.3.4. Phytosanitary certificates and other compliance measures**

To reflect that consignments originate from a country, area or place of production that is free of ArMV, RpRSV, SLRSV and TBRV, phytosanitary certificates and other documentary guarantees concerning the consignment to be imported can be required from exporting countries. Alternatively, a “freedom from ArMV, RpRSV, SLRSV and TBRV” declaration can be demanded for specific consignments.

To fulfil such demands, exporting countries have to implement inspection at the place of production, and inspection and/or testing of parental plant material. Alternatively, they may concentrate on inspection and/or testing of the specific consignment. Quality requirements are under discussion at the Sanitary and Phytosanitary (SPS) Measures Committee of the World Trade Organisation. The demand for guarantees of pest freedom from the exporting country is supported by the ISPM 7 (IPPC, 2011a) and ISPM 12 (IPPC, 2011b).

*Effectiveness:* effectiveness is considered high if phytosanitary certificates are delivered based on inspection, monitoring, sampling and testing. Otherwise, if based only on visual inspection, the effectiveness is low.

*Technical feasibility:* technical feasibility is very high, as the measure is already in place.

*Uncertainty:* uncertainty is rated as medium because of possible variation in the way the exporting country will implement inspections and, in particular, exactly how the inspection, sampling and testing to substantiate the phytosanitary certificate will be performed.

#### **4.3.5. Preparation of the consignment and specified treatment of the consignment reducing pest prevalence in the consignment**

The conditions of preparation of the consignment and specified treatment of the consignment to reduce pest prevalence in the consignment are specified in ISPM 11 (IPPC, 2013). Options to eliminate



ArMV, RpRSV, SLRSV and TBRV from the growing crop are not available because these viruses remain alive throughout the life of the infected host as the viral functions are strongly integrated with those of their host plants. Similarly, treatments to sanitise botanical seeds are also considered to be of little use in preventing seed-borne transmission of ArMV, RpRSV, SLRSV and TBRV. Likewise, measures that would be fully effective in eliminating viruliferous vector nematodes from a contaminated consignment do not exist. Overall, the feasibility and effectiveness of this option is rated as low, with low uncertainty.

*Effectiveness:* effectiveness is considered low because no effective actions exist against viruses and because no fully effective actions exist against nematodes.

*Technical feasibility:* technical feasibility is considered low because no effective actions exist against viruses.

*Uncertainty:* uncertainty is considered low.

#### **4.4. Options to reduce the probability of establishment**

##### **4.4.1. Eradication**

The eradication of nepoviruses and SLRSV from open fields and fields under protected cultivation would be possible only by the complete destruction of the infected plant material and its removal from the plantations. By eliminating all potential sources of inocula, including weeds or infested debris from the fields as well as any viruliferous nematodes, this measure would be effective to prevent further spread of viruses. However, the four viruses are widespread in the EU and have a very wide host range and this makes them very difficult to completely eradicate from fields where they are already established.

Because nepoviruses and SLRSV are transmitted by soil-borne nematodes, it is necessary that such eradication efforts also target these nematodes. However, no control measures exist to eradicate nematodes from deep soil layers. According to Hunt (1993), longidorids are present in the greatest numbers at depths below 20 cm and can be found at depths of over 1 m. Thus, once viruliferous longidorids are present in the soil, nematode, and thereby also virus, eradication is virtually impossible to achieve. Currently, the most common measures used in the attempt to eradicate vector nematodes are soil sterilisation using steam or chemical treatment using nematicides.

*Effectiveness:* effectiveness is considered moderate to high in protected cultivation and low to moderate in the field because of the difficulty in eradicating nematodes from deep soil layers.

*Technical feasibility:* technical feasibility is considered moderate.

*Uncertainty:* uncertainty is considered medium.

#### **4.5. Options to reduce the probability of spread and the magnitude of impact**

##### **4.5.1. Treatment of the crop, field or place of production in order to reduce pest prevalence and possibly achieve areas of low pest prevalence**

Different risk reduction options such as chemical, biological and/or physical control methods and/or cultural practices may be applied in the fields where vector nematodes are present to halt their spread in the infested soil or to reduce their density and consequently to reduce the incidence of the viruses.

###### **4.5.1.1. Chemical control**

Chemical treatment of the soil with nematicides can give relatively good control of the nematode vectors (80–90 % reduction of the nematode population in the upper 40–60 cm of soil at commercial application rates) (Thomason and McKenny, 1975), but the nematodes that remain can still transmit viruses to the roots of the crop. At best, soil treatment can delay virus infection of newly planted crops. Owing to the long nematode life cycle, this level of chemical control is only sufficient to protect

annual and short-term perennial crops against direct damage by virus vector nematodes. For long-term perennial crops an almost complete removal of the nematode population is required to prevent virus transmission. This can only be achieved if nematicide treatment is combined with some other control measures such as fallowing or using resistant hosts before planting the perennial crops (Taylor and Brown, 1997).

Based on their behaviour in the soil, two types of nematicides, fumigant and non-fumigant, can be distinguished (Thomason and McKenny, 1975). Fumigant nematicides are formulated as liquids which rapidly vaporise and move through open air spaces in soil as a gas (Noling, 2005) and permeate relatively large volumes of the soil from the point of application. They require application in large quantities (100–600 kg/ha) (Taylor and Brown, 1997). Fumigants used in the past included 1,3-dichloropropene (DD), methyl-isothiocyanate (MIT) and methyl bromide. Their use is being phased out because of their threat to human health and of pollution of groundwater. There are no true soil fumigants currently available for use in the EU<sup>8</sup>. However, dazomet (available in granular form) and metham sodium (available as a wettable powder) are grouped with fumigants as they are precursors of methyl isothiocyanate which diffuses through the soil, but in water rather than in the gaseous phase (Thomason and McKenny, 1975; Brown and Taylor, 1979).

In contrast to the fumigants, non-fumigant nematicides have low volatility and diffuse through soil dissolved in soil water. They are generally formulated as either granules or liquids. The non-fumigant nematicides are often further classified as contact or systemic nematicides depending on whether they kill nematodes in soil by contact or are taken up by the plant first and affect nematodes when they feed from cellular fluids within the plant (Noling, 2005). They are required in smaller doses than fumigant nematicides and are relatively easy to apply. Granular nematicides, especially the organophosphates, are considered to be very harmful to human health and their use is also gradually being phased out. These compounds are less effective than the fumigant nematicides as they do not kill nematodes but only interfere with their mobility for a certain period of time. Therefore, these pesticides are only effective during the first part of the growing season when the plant is starting to grow. Non-fumigant nematicides that are currently included in the EU pesticide list are ethoprophos, fosthiazate, oxamyl, phenamiphos and iprodione<sup>9</sup>.

One of the advantages of chemical control is that it acts faster than any of the other control measures used to reduce pest populations. However, there are concerns about the sustainability of this strategy owing to possible ecological problems caused by these chemicals. The Panel concludes that chemical control is moderately effective with very high feasibility, although it is difficult to evaluate whether the chemicals concerned will still be available for use in the future. The uncertainty is medium.

*Effectiveness:* the effectiveness of chemical control is considered moderate because it is almost impossible to eradicate all viruliferous nematodes by treatment with the available nematicides. The nematodes that remain in the soil can still transmit viruses to the roots of the crop and soil treatment can only delay virus infection of newly planted crops. This level of control is therefore only sufficient to protect annual and short-term perennial crops against direct damage of virus vector nematodes.

*Technical feasibility:* the technical feasibility of chemical control is very high because chemicals are relatively easy to apply.

*Uncertainty:* the level of uncertainty is considered medium because of concerns about the sustainability of this strategy owing to possible ecological problems. It is difficult to evaluate whether such chemicals will still be on the market in the future.

<sup>8</sup> [http://ec.europa.eu/food/plant/protection/evaluation/database\\_act\\_subs\\_en.htm](http://ec.europa.eu/food/plant/protection/evaluation/database_act_subs_en.htm); website accessed 05 May 2013

<sup>9</sup> [http://ec.europa.eu/food/plant/protection/evaluation/database\\_act\\_subs\\_en.htm](http://ec.europa.eu/food/plant/protection/evaluation/database_act_subs_en.htm); website accessed 05 May 2013

#### 4.5.1.2. Biological control

Numerous natural enemies of plant parasitic nematodes have been described and studied, including predators, nematophagous fungi (endoparasitic and nematode-trapping fungi), endophytic fungi (e.g. arbuscular mycorrhizal fungi) and bacteria (Viaene et al., 2006). However, there are no effective, commercially available biological control agents which can be successfully used to control nematodes (Noling, 2005).

*Effectiveness:* the effectiveness of biological control is rated as low because no biological agents that control nematodes efficiently are available at present.

*Technical feasibility:* technical feasibility of biological control is low for the same reason.

*Uncertainty:* the uncertainty is low.

#### 4.5.1.3. Cultural practices

Cultural practices such as crop rotation, cover cropping, green manuring, organic amendments, tillage and weed control are considered as alternatives to chemical nematicides. However, a single risk reduction option rarely leads to the sustainable management of nematode problems. Therefore, a combination of individual practices, providing they are applicable, compatible and economical, should be used to successfully manage nematodes (Viaene et al., 2006).

Crop rotation alone cannot be used as an effective control measure for many of the nepoviruses and SLRSV as most of them have wide host ranges, their nematode vectors are polyphagous and both virus and vector can therefore survive on many volunteer plants and weeds (Taylor and Brown, 1997). However, this strategy may limit disease build up and consequently damage, in particular when using short crop cycles and frequent plant replacement with certified plants as in the case of strawberry.

Weed management should minimise the risk of virus infection/spread within a crop through reducing the presence of virus-infected weed seedlings, particularly if the crop itself is a poor host for the vector, as found with *L. elongatus* and RpRSV in raspberry (Taylor, 1967; Taylor and Brown, 1997). However, with a good host for *L. elongatus* (e.g. strawberry), weed control did not affect *L. elongatus* numbers and it only slightly delayed infection with RpRSV and TBRV (Taylor and Murrant, 1968).

Incorporation of organic materials into the soil can be very effective against plant parasitic nematodes because some materials release or produce compounds toxic to nematodes as they decompose in the soil (D'Addabbo, 1995). Amendments may also provide favourable substrates that promote the growth of soil microflora and microfauna which can suppress nematode populations through the production of enzymes or toxic metabolites (D'Addabbo, 1995). However, the impact of such practices on longidorid nematodes has been little studied and the use of organic amendments for their control seems inappropriate in situations where high-value perennial crops are involved and where a very high level of nematode control is required to prevent the spread of viruses (Taylor and Brown, 1997).

*Effectiveness:* the effectiveness of crop rotation and of other cultural practices to limit the spread of the viruses addressed here and associated vector nematodes is considered low. However, these practices have a moderate effectiveness to limit the impact of these pests in particular when used in combination with the use of certified planting material and of short cropping cycles.

*Technical feasibility:* the technical feasibility of crop rotation and of other cultural practices is moderate to high as they are currently used for strawberry production but low for perennial hosts including raspberry.

*Uncertainty:* the level of uncertainty is considered medium.

#### 4.5.1.4. Physical control methods

Physical control strategies aim to prevent or reduce nematode spread and generally involve sterilisation (steaming or soil solarisation) of the growing medium or removal of soil from plants for

planting by shaking and rinsing of roots. Soil steaming is among the most effective, but unfortunately the most expensive, soil pest control methods.

The efficacy of soil solarisation is directly correlated with soil type, water-holding capacity and soil depth, and is also dependent on the intensity and duration of sunlight and ambient temperature (Noling, 2005). The depth to which a lethal temperature can be achieved using soil solarisation is up to 20 cm (Noling, 2005). Because longidorids can be present in deeper soil layers, they are unlikely to be fully controlled by soil solarisation.

Removal of soil contaminated with longidorid nematodes by shaking and rinsing the roots of plants prior to replanting will decrease the risk of nematode spread and consequently also virus transmission, but cannot guarantee the removal of virus vector nematodes because extremely small amounts of soil can easily remain attached to the plant roots. However, it is uncertain if longidorids can survive and be transferred in such small amounts of soil.

*Effectiveness:* the effectiveness of physical control measures against nematode vectors is considered moderate to high.

*Technical feasibility:* the technical feasibility is rated as moderate because steaming is among the most expensive control methods; when using soil solarisation, the lethal temperature can be achieved at depths only up to 20 cm.

*Uncertainty:* the uncertainty is medium because physical control methods are dependent mostly on the ambient conditions that are locally available.

#### **4.5.2. Resistant or less susceptible species (varieties)**

Converse (1987) describes the susceptibility of more than 30 strawberry cultivars to RpRSV, TBRV and ArMV. The majority of these varieties were susceptible to one or more of the viruses, with the reactions of many cultivars not being known. From these lists only one variety (Huxley) was stated as being resistant to one of the viruses (TBRV). The authors also stated that “the reactions of strawberry cultivars to infection with SLRSV are largely unknown”, except that this virus was originally found in plants of the cultivar “Cambridge Favourite” and that “because spread of the viruses is now effectively controlled in Britain, the field reaction of newer cultivars is unknown”. This statement has been reiterated more recently by Martin and Tzanetakis (2006), who wrote that “because the (nematode) vectors of these viruses have been controlled (by fumigation of soil and other approaches), the diseases they cause have been very rare since 1975. As a result, the reaction of strawberry cultivars grown today to these viruses is largely unknown.” Overall, it seems, therefore, that that few if any resistant strawberry varieties are available.

The scientific literature for the study of infection of raspberry by the four viruses considered in the present opinion is more complete and includes reports of the field or experimental reaction of various raspberry cultivars to virus challenge.

For example, the cultivar Glen Clova was susceptible in the field and sites were identified where this variety was affected (symptomatically with ArMV (England) and RpRSV (Scotland)) (Jones et al., 1985). Other cultivars were also affected at these sites and both viruses were detected in symptomatic and asymptomatic plants of all cultivars.

In another study, the results of field trials (natural infection by nematodes assessed in 1989) and graft challenge (assessed in 1984) showed some conflicting results (Jones, 1984; Jones et al., 1989). In grafting challenges (which deliver high concentrations of virus over a prolonged period), the varieties Glen Prosen, Leo, Malling Landmark and Orion were not infected by ArMV, but following inoculation by nematodes (where the inoculum pressure is variable, and probably lower than via grafting) the varieties Delight, Glen Moy, Joy, Leo, Malling Landmark and Orion did not become infected by ArMV. In the same study, Glen Prosen, Joy and Leo were not infected by RpRSV following graft inoculation, and Joy, Leo, Malling Landmark and Orion were not infected by RpRSV

following nematode challenge. However, failure of any plant to become infected, whether by grafting or via nematodes, is not necessarily a demonstration of genetic resistance in that plant but might be the result of low population numbers of vector nematodes, low efficiency of transmission by the nematodes, mechanical failure of the graft junction, poor susceptibility of the host plant or a variety of other potential problems. Overall, although there is evidence that some old varieties of raspberry might be resistant to at least some of the viruses considered in the present opinion, this assessment is associated with significant uncertainties.

Since the 1970s there has been no reported work on the identification of sources of resistance to the viruses considered in the present opinion in *Fragaria* or *Rubus* or of the deliberate deployment of resistance to these viruses in new commercial varieties of these plants. Very few commercial companies and research organisations currently have the necessary technical resources, germplasm collections and expertise that would be required to initiate and oversee breeding efforts to develop new nepovirus-/SLRSV-resistant varieties of *Fragaria* and *Rubus*.

Lastly, there are no reports on the availability of resistant varieties in the other commercially grown host species of the four viruses considered in the present opinion.

*Effectiveness*: effectiveness is rated as moderate for deploying resistance to the viruses in raspberry where some older resistant cultivars are known, although the reaction of modern cultivars is mostly unknown. Effectiveness is low in other host species, including strawberry, as cultivars have not been tested for resistance or as resistance has not been reported.

*Technical feasibility*: technical feasibility is low if all hosts are considered as resistant cultivars are available only in older varieties of raspberry. Identification of sources of resistance in strawberry and other hosts, and their incorporation into commercial varieties would be a time consuming and expensive exercise.

*Uncertainty*: uncertainty is moderate to high as the resistance status of modern raspberry cultivars is mostly unknown and as resistance availability in other hosts remains largely unknown. The uncertainty rises with the appearance of resistance-breaking strains of the viruses, some of which are already known to occur in raspberry.

#### **4.5.3. Growing plants under exclusion conditions (glasshouse, screen, isolation)**

Growing host plants of ArMV, RpRSV, SLRSV and TBRV under exclusion conditions may be effective in the management of viruses and the nematode vectors in the field and in protected growing environments.

Examples of exclusion conditions for growing, ranked from highest to lowest effectiveness, include (1) growth chamber, (2) greenhouse, (3) screen house, (4) field grown in containers, (5) field grown and (6) plants collected from the wild. Enclosures such as growth chambers, greenhouses and screen houses provide better opportunities for pest exclusion than outdoor cultivation does (ISPM 36—IPPC, 2012).

Plants intended for production under exclusion conditions should originate from a pest-free production area or pest-free production site and should be grown in soil-less medium. In general, use of soil as a growing medium is likely to pose a greater pest risk because soil is more likely to carry soil-borne pests (including virus-transmitted nematodes). Sterilisation, pasteurisation or other effective methods for treating the growing medium prior to planting may manage some pest risk (ISPM 36—IPPC, 2012). Plants grown in nursery beds or pots using sterile potting media can be used efficiently to reduce the threat of virus (Viaene et al., 2006). Excluding the soil as a growing medium and growing plants (e.g. strawberries) hydroponically avoids soil pests and eliminates the need for chemical treatment against soil-borne pests.

The Panel concludes that growing plants under exclusion conditions, particularly if they are grown in soil-less medium, could be highly effective, but this is sometimes technically challenging in



production settings. However, this option may not be technically feasible for all crops susceptible to the four viruses considered, in particular when considering the larger perennial hosts such as *Prunus* or grapevine.

*Effectiveness*: the effectiveness of growing plants under exclusion conditions is considered high when growing plants in soil-less culture, but negligible for perennial hosts when grown in the open field.

*Technical feasibility*: the technical feasibility of this option is rated as moderate to high for regulated small fruit hosts, but negligible for some of the other perennial hosts.

*Uncertainty*: the uncertainty is considered low.

#### 4.5.4. Certification scheme

The selection of healthy propagating material for use in soil free of nematodes is a useful strategy. The use of certification schemes is an important measure in ensuring planting with virus-free starting material. Voluntary or compulsory (official) certification of virus-free mother plants is an essential part of the nursery supply chain, employing a constant programme of indexing to guarantee substantial freedom from viruses (Jarvis, 1993). The phytosanitary certificates are the documentary assurance that the phytosanitary certification process as described under the IPPC has been undertaken (ISPM 7—IPPC, 2011). ISPM 7 (IPPC, 2011) lists requirements and describes components of a phytosanitary certification system to be established by national plant protection organisations.

A large variety of certification schemes exist, but they are usually based on the same principles (Commission Communication 2010/C 341/04; EPPO schemes, available online: <http://archives.eppo.int/EPPOstandards/certification.htm>). For strawberry and *Rubus*, the discussed viruses (ArMV, RpRSV, SLRSV and TBRV) are on the list of the most important viruses to be tested for in virus-free certification schemes (EPPO schemes, online).

Management of ArMV, RpRSV, SLRSV and TBRV requires the production of healthy plants for certification to be done in soils known to be free of their nematode vectors. Sampling of the soil before planting should be done to ensure the absence of vector nematodes. The results of these tests (EPPO PM 4/35(1) online), together with the knowledge of the ecology of the vectors and their association with the viruses that they transmit, can help to decide whether there is a need for control measures (Taylor and Brown, 1997).

The Panel concludes that certification schemes as a risk reduction option are highly effective and feasible with low uncertainty. However, not all cultivated host plants of ArMV, RpRSV, SLRSV and TBRV are currently included in such schemes, which exist only for some hosts (e.g. strawberry, *Rubus*, *Ribes* spp., grapevine, olive trees, hop). Considering the large numbers of host plants of the four viruses under consideration, developing certification schemes as a general strategy for all vegetatively propagated hosts would, however, involve significant complexity.

*Effectiveness*: the effectiveness of certification schemes is considered high.

*Technical feasibility*: the technical feasibility of certification schemes is very high for individual species, but is moderate when considering the entire host range of the four viruses.

*Uncertainty*: the uncertainty is low.

#### 4.5.5. Maintaining a pest-free area

A pest-free area is an area in which a specific pest does not occur, as demonstrated by scientific evidence, and in which, where appropriate, this condition is officially maintained. The delimitation of a pest-free area should be relevant to the biology of the pest concerned. In principle, the pest-free area should only be established by applying the criteria for establishing freedom from pests as set out in ISPM 4 (IPPC, 1995) “Requirements for the Establishment of Pest-Free Areas.”



In the production areas where ArMV, RpRSV, SLRSV and TBRV and their vector nematodes have not been recorded, and where surveillance is carried out to confirm the pest-free status, a pest-free area could be declared. This could then be used to limit the spread of infected plants to the wider area by legitimately imposing local or regional legislation to restrict trade in high-risk commodities such as propagation materials. Planting material coming from such a protected area could be declared as pest-free material.

Because the viruses as well as their vector nematodes are present in a wide range of host plants in the EU (natural and planted), it would be very difficult to establish and maintain a pest-free area. The Panel therefore concludes that this measure cannot be fully reliable because the present distribution of the viruses and of their nematode vectors within the EU is uncertain and may include more countries/areas than is currently known.

*Effectiveness:* the effectiveness of this option is high in the case of regularly organised surveillance.

*Technical feasibility:* the technical feasibility of maintaining a pest-free area is considered low to moderate because of the wide distribution of the viruses and their vectors in the risk assessment area.

*Uncertainty:* the uncertainty is considered low.

#### **4.5.6. Pest-free production site**

A pest-free production site is a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period (ISPM 10—IPPC, 1999). Requirements for the establishment and maintenance of a pest free production site as an approved phytosanitary measure by the NPPO, include:

- systems to establish pest freedom;
- systems to maintain pest freedom;
- verification that pest freedom has been attained or maintained;
- product identity and phytosanitary security of the consignment.

Where necessary, a pest-free place of production or a pest-free production site also includes the establishment and maintenance of an appropriate buffer zone.

Pre-plant site preparation, combined with the use of healthy planting material, is the key to controlling nematode-transmitted viruses. All infected material (infected host plants, weeds, seeds, root residues) that might act as virus reservoirs for the vector nematodes must be removed. Soil must be tested for and shown to be free from virus-transmitting nematodes. The surrounding areas should be checked for the presence of plants infected with nepoviruses and SLRSV. Only healthy planting material (certified virus-free seed or vegetative propagating material) must be used.

*Effectiveness:* the effectiveness of this option is high in preventing the introduction or spread of nepoviruses and SLRSV and their soil-borne vectors in the case of regularly organised surveillance.

*Technical feasibility:* this option is highly feasible for sites where nematodes are not present and where regular inspections and surveillance are part of the certification system but moderate if nematodes are present.

*Uncertainty:* the level of uncertainty is medium because of the limited accuracy of surveys.

#### 4.5.7. Inspections and surveillance

ArMV, RpRSV, SLRSV and TBRV and their nematode vectors are already established in large parts of the risk assessment area (EU). Information on the proportion of the area or number of fields infested within each Member State is, however, generally not available. As there is almost certainly still a considerable proportion of fields without nepoviruses and SLRSV and virus-transmitting nematodes in the Member States, the Panel concludes that inspections and surveillance are essential measures in reducing the phytosanitary risk of further spread of harmful organisms in the risk assessment area, and that they play an important role when combined with other risk reduction options. ISPM 6 (IPPC, 1997) provides guidelines for general and specific surveys. Because inspection is always necessary to confirm pest freedom, it is an integral part of several other options such as establishment of pest-free areas (ISPM 4—IPPC, 1995) and places of production (ISPM 10—IPPC, 1999), pre-export checking of consignments (ISPM 31—IPPC, 2008) and pre-entry or post-entry quarantine.

*Effectiveness:* the effectiveness of this option varies from moderate (visual inspections of plants—symptomless infection is common) to high (testing of planting material). The testing of soil for the presence of virus vector nematodes is rated as moderate because it is not sufficiently effective to detect low infestation levels.

*Technical feasibility:* visual inspection is highly feasible. Technical feasibility of testing is rated as moderate because it is not practicable to test all plants.

*Uncertainty:* the uncertainty is considered low.

#### 4.5.8. Hygiene best practice to control spread by human activities

To implement best practices, the staff should be well-trained in the use of disposable clothes, the restriction of the movement of equipment and tools, the chemical disinfection of equipment and small tools and in limiting the access of people to the place of production, in sequential work in the compartments with seedlings, followed by those with young plants.

*Effectiveness:* the effectiveness of this option is considered moderate because the risk of infestation or infection can only be limited and cannot be completely eliminated. Furthermore, deficient advisory services and poor producer awareness of problems relating to hygiene practices often result in continued problems with virus infections.

*Technical feasibility:* when the staff are well-trained to perform efficient monitoring for ArMV, RpRSV, SLRSV, TBRV and their vectors and to respect best practices of plant hygiene, the technical feasibility of this option is rated as high to very high.

*Uncertainty:* the uncertainty is considered low.

**Table 7:** Summary of the risk reduction options identified and evaluated under chapter 4

Level of action of option (entry, establishment, spread, impact)	Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Effectiveness	Technical feasibility	Uncertainty
Entry	Options for consignments	Prohibition	Negligible to low (regulated hosts) Moderate to high (expanded host list)	Moderate to high	Medium to high
		Pest freedom, inspection or testing			
		Visual inspection	Low	High	Low
		Testing	Moderate	High (limited number of entities) Low (large volumes)	Low
		Pre-entry or post-entry quarantine systems	Low (based on visual inspection only) High (laboratory tests)	Low (large number of plants) High (limited number of plants or nuclear stocks)	Low
		Phytosanitary certificates and other compliance measures	High (if based on inspection, monitoring, sampling and testing) Low (if based on visual inspection)	Very high	Medium
		Preparation of the consignment and specified treatment of the consignment reducing pest prevalence in the consignment	Low	Low	Low
Establishment	Eradication		Moderate to high (in protected cultivation) Low to moderate (in the field)	Moderate	Medium

Level of action of option (entry, establishment, spread, impact)	Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Effectiveness	Technical feasibility	Uncertainty
Spread/impact	Options preventing or reducing infestation in the crop	Treatment of the crop, field, or place of production in order to reduce pest prevalence and possibly achieve areas of low pest prevalence			
		Chemical control	Moderate	Very high	Medium
		Biological control	Low	Low	Low
		Cultural practices	Low (in limiting spread	Moderate to high (for strawberry)	Medium
			Moderate (in limiting impact)	Low (for perennial hosts)	
		Physical control	Moderate to high	Moderate	Medium
		Resistant or less susceptible species (varieties)	Moderate (in raspberry)	Low (if all hosts are considered)	Moderate to high
			Low (in other hosts and including strawberry)		
		Growing plants under exclusion conditions (glasshouse, screen, isolation)	High (in soilless culture)	Moderate to high (regulated hosts)	Low
			Negligible (in open field)	Negligible (other perennial hosts)	
	Options ensuring that the area, place or site of production or crop is free from	Certification scheme	High	Very high (for individual species)	Low
				Moderate (for entire host range)	
		Maintaining a pest-free area	High	Low to moderate	Low
		Pest-free production site	High	High (in absence of nematodes)	Medium
				Moderate (in presence of	

Level of action of option (entry, establishment, spread, impact)	Category of options	Type of measure (for details, see EFSA PLH Panel, 2012)	Effectiveness	Technical feasibility	Uncertainty
	the pest			nematodes)	
		Inspections and surveillance	Moderate (visual inspection of plants; testing of soil for presence of nematodes)	High (visual inspection)	Low
			High (testing of planting material)	Moderate (testing)	
		Hygiene best practice to control spread by human activities	Moderate	High to very high	Low

#### 4.6. Conclusions on the analyses of risk reduction options and of the current phytosanitary measures

The Panel evaluated the phytosanitary measures against the introduction and spread of ArMV, SLRSV, RpRSV and TBRV listed in Council Directive 2000/29/EC, explored the possible consequences if these measures were to be removed and identified additional risk reduction options to enhance the current measures.

The Panel considered that the key weakness of the current legislation is that, in Annex II A II, it addresses only the two vegetatively propagated hosts in which the viruses are most detrimental and it fails to address other actual and potential host species, thus leaving open the possibility of entry and spread within the EU of the four viruses in those alternative host species. A minor weakness concerns the failure to regulate seeds of *Fragaria* and *Rubus*, when the viruses considered are known to be seed-transmissible in these hosts and when small-volume trade might occur as a consequence of amateur gardeners buying seeds on the internet. In addition, the Annex III legislation is seen by the Panel as being considerably weakened by import derogations (in particular for strawberry plants for planting) offered to several countries which are among the few where the viruses are reported outside the EU.

If the current regulation was to be removed, no major consequences or changes in the potential impact of the four viruses considered here would be expected. This is largely owing to the important level of protection afforded to the industry by the efficient and widely used certification scheme for *Fragaria*, *Rubus*, *Prunus* and *Vitis*, which is regarded by the Panel as reducing the risk of introduction, the risk of spread and the magnitude of impact in a very significant way. The absence of control of other hosts of the four viruses in the current legislation also limits the consequences predicted if these measures were to be removed.

If, however, the current legislation were removed and the industry simultaneously ceased or reduced its voluntary certification activity, or excluded the four viruses considered from the list of organisms addressed, a return to a high prevalence of these viruses in *Fragaria*, *Rubus* and other vegetatively propagated susceptible crops would be expected.

The effectiveness of risk reduction options that could further reduce the risk of introduction and spread was evaluated. None of the risk reduction options explored were considered to have a very high effectiveness in reducing the risk of introduction, in particular because of the wide and uncertain host range of the four viruses concerned. However, prohibition and the use of phytosanitary certificates, if covering an extended host range and relying on appropriate tests and not on visual inspection alone, were rated as having a moderate to high or high effectiveness. Their technical feasibility was rated as moderate to high (prohibition) or very high (certificates). The associated uncertainty was rated as medium to high (prohibition) and medium (certificates). Concerning spread and impact, no option was evaluated as having very high effectiveness. The three options with high effectiveness are the implementation of certification schemes, the use and maintenance of pest-free areas and the use and maintenance of pest-free production sites. All three options, nevertheless, have limitations in their technical feasibility in many situations. In particular, certification has high technical feasibility for individual host species but only moderate feasibility if considering the entire host range of the viruses. In addition, it should be noted that the combination of partially effective options (cultural practices, physical control, resistant varieties, certification, use of exclusion conditions) may, for some crops such as strawberry, have an overall high to very high level of effectiveness.



## CONCLUSIONS

After consideration of the evidence, the Panel reached the following conclusions:

**With regard to the assessment of the risk to plant health of *Arabis mosaic virus*, *Strawberry latent ringspot virus*, *Raspberry ringspot virus* and *Tomato black ring virus* for the EU territory**, all four viruses are currently established in the risk assessment area. With the possible exception of ArMV, which has a broader distribution outside the EU, the viruses considered are largely restricted to Europe and reported from few countries outside the risk assessment area. These four viruses have vector nematodes that occur widely in the risk assessment area and that have the potential to contribute to the local spread of the viruses. The major crops at risk, *Fragaria*, *Rubus*, *Ribes* and grapevine, are cultivated throughout the EU.

With regards to entry, three pathways were identified: plants for planting, plant parts of host plants and soil. The most significant pathway, plants for planting, was analysed in detail. The probability of survival during transport and storage, of survival of management procedures or of transfer to a suitable host are rated as likely to very likely and the only limiting factors are, therefore, the trade volume and the probability of association with the pathway at origin, the second of which is impacted by the limited distribution of these viruses outside the EU. As a consequence, the probability of entry is rated as unlikely to moderately likely for ArMV and as very unlikely to unlikely for RpRSV, SLRSV and TBRV. These ratings are associated with moderate uncertainty.

With regard to establishment, the probability was evaluated as very likely with low uncertainty for all four viruses owing to their broad host range comprising widely distributed cultivated and wild hosts, the general suitability of ecoclimatic conditions and the wide presence of the nematode vectors.

With regard to spread, two scenarios were analysed. The probability of local spread by natural means was rated as likely as it is not considered possible to prevent nematode-transmitted viruses from spreading in the fields where vector nematodes are present, and because local spread can also occur through seed-transmission in a range of susceptible species. The associated uncertainties are rated as low to medium owing to incomplete information on the distribution of vectors. The probability of long distance spread through human-assisted means is rated as unlikely to moderately likely because not all hosts are covered by certification systems, leaving open the possibility of spread through the trade of infected planting materials and seeds. The uncertainties are rated as high owing to the lack of information on many aspects.

The magnitude of impact is rated as minimal to minor in *Fragaria*, *Rubus* and *Ribes* because, although these four viruses have the potential to cause important damage and losses in those crops, the actual impact is limited by the existence of efficient voluntary certification systems for strawberry and raspberry and by modern cultivation practices. The impact is rated as minimal to minor in other hosts, with the exception of ArMV in grapevine, for which it is rated as minor to moderate. These ratings derive from the fact that, although these viruses have the potential to cause important damage and losses in many crops, mitigating factors exist, including efficient voluntary certification systems for important host crops such as *Prunus* and grapevine. These ratings are associated with medium uncertainty for the *Fragaria*, *Rubus* and *Ribes* hosts and with high uncertainty for the other hosts.

**With regard to risk reduction options**, the Panel evaluated the phytosanitary measures formulated in Council Directive 2000/29/EC and identified additional risk reduction options where relevant.

The Panel evaluated the phytosanitary measures against the introduction and spread of ArMV, SLRSV, RpRSV and TBRV listed in Council Directive 2000/29/EC, explored the possible consequences if these measures were to be removed and identified additional risk reduction options to enhance the current measures.

The Panel considered that the key weakness of the current legislation is that, in Annex IIAII, it addresses only the two vegetatively propagated hosts in which the viruses are most detrimental and it

fails to address other actual and potential host species, thus leaving open the possibility of entry and spread within the EU of the four viruses in those alternative host species. A minor weakness concerns the failure to regulate seeds of *Fragaria* and *Rubus*, when the viruses considered are known to be seed-transmissible in these hosts and when small-volume trade might occur as a consequence of amateur gardeners buying seeds on the internet. In addition, the Annex III legislation is seen by the Panel as being considerably weakened by import derogations (in particular for strawberry plants for planting) offered to several countries which are among the few where the viruses are reported outside the EU.

If the current regulation was to be removed, no major consequences of or changes in the potential impact of the four viruses considered here would be expected. This is largely owing to the important level of protection afforded to the industry by the efficient and widely used certification scheme for *Fragaria*, *Rubus*, *Prunus* and *Vitis*, which is regarded by the Panel as reducing the risk of introduction, the risk of spread and the magnitude of impact in a very significant way. The absence of control of other hosts of the four viruses in the current legislation also limits the consequences predicted if these measures were to be removed.

If, however, the current legislation were removed and the industry simultaneously ceased or reduced its voluntary certification activity, or excluded the four viruses considered from the list of organisms addressed, a return to a high prevalence of these viruses in *Fragaria*, *Rubus* and other vegetatively propagated susceptible crops would be expected.

The effectiveness of risk reduction options that could further reduce the risk of introduction and spread was evaluated. None of the risk reduction options explored were considered to have a very high effectiveness in reducing the risk of introduction, in particular because of the wide and uncertain host range of the four viruses concerned. However, prohibition and the use of phytosanitary certificates, if covering an extended host range and relying on appropriate tests and not on visual inspection alone, were rated as having a moderate to high or high effectiveness. Their technical feasibility was rated as moderate to high (prohibition) or very high (certificates). The associated uncertainty was rated as medium to high (prohibition) and medium (certificates). Concerning spread and impact, no option was evaluated as having very high effectiveness. The three options with high effectiveness are the implementation of certification schemes, the use and maintenance of pest-free areas and the use and maintenance of pest-free production sites. All three options, nevertheless, have limitations in their technical feasibility in many situations. In particular, certification has high technical feasibility for individual host species but only moderate feasibility if considering the entire host range of the viruses. In addition, it should be noted that the combination of partially effective options (cultural practices, physical control, resistant varieties, certification, use of exclusion conditions) may, for some crops such as strawberry, have an overall high to very high level of effectiveness.

## DOCUMENTATION PROVIDED TO EFSA

Request (see Background and Terms of Reference) to provide a scientific opinion on the risks to plant health of *Arabid mosaic virus*, *Tomato black ring virus*, *Raspberry ringspot virus*, *Strawberry latent ringspot virus*, *Strawberry crinkle virus*, *Strawberry mild yellow edge virus*, *Daktulosphaira vitifoliae* (Fitch), *Eutetranychus orientalis* Klein, *Parasaissetia nigra* (Nietner), *Clavibacter michiganensis* spp. *michiganensis* (Smith) Davis et al., *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye, *Didymella ligulicola* (Baker, Dimock and Davis) v. Arx, and *Phytophthora fragariae* Hickmann var. *fragariae*, for the EU territory; SANCO.E2 GC/ap (2012) 1011925, 19 July 2012. Submitted by European Commission, DG SANCO (Directorate General for Health and Consumers).

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## APPENDICES

### Appendix A. Ratings and descriptors

In order to follow the principle of transparency as described under Paragraph 3.1 of the Guidance document on the harmonised framework for risk assessment (EFSA PLH Panel, 2010)—“Transparency requires that the scoring system to be used is described in advance. This includes the number of ratings, the description of each rating ... the Panel recognizes the need for further development”—the Plant Health Panel has developed specifically for this opinion rating descriptors to provide clear justification when a rating is given.

#### 1. Ratings used in the conclusion of the pest risk assessment

In this opinion of EFSA’s Plant Health Panel for the risk assessment of *Arabid mosaic virus*, *Strawberry latent ringspot virus*, *Raspberry ringspot virus* and *Tomato black ring virus* and the evaluation of the effectiveness of the risk reduction options, a rating system of five levels with their corresponding descriptors has been used to formulate separately the conclusions on entry, establishment, spread and impact as described in the following tables.

##### 1.1. Rating of probability of entry

Rating for entry	Descriptors
<i>Very unlikely</i>	The likelihood of entry would be very low because the pest: 1. is not or is only very rarely associated with the pathway at the origin; 2. cannot survive during transport or storage; 3. cannot survive the current pest management procedures existing in the risk assessment area; 4. cannot transfer to a suitable host in the risk assessment area
<i>Unlikely</i>	The likelihood of entry would be low because the pest: 1. is rarely associated with the pathway at the origin; 2. can survive at a very low rate during transport or storage; 3. is strongly limited by the current pest management procedures existing in the risk assessment area; 4. has effective limitations for transfer to a suitable host in the risk assessment area
<i>Moderately likely</i>	The likelihood of entry would be moderate because the pest: 1. is occasionally associated with the pathway at the origin; 2. can survive at a low rate during transport or storage; 3. is limited by the current pest management procedures existing in the risk assessment area; 4. has some limitations for transfer to a suitable host in the risk assessment area
<i>Likely</i>	The likelihood of entry would be high because the pest: 1. is frequently associated with the pathway at the origin; 2. can survive during transport or storage; 3. is unlikely to be limited by the current pest management procedures existing in the risk assessment area; 4. has very few limitations for transfer to a suitable host in the risk assessment area
<i>Very likely</i>	The likelihood of entry would be very high because the pest: 1. is always or almost always associated with the pathway at the origin; 2. always survives during transport or storage; 3. is not limited by the current pest management procedures existing in the risk assessment area; and/or 4. has no limitations for transfer to a suitable host in the risk assessment area

## 1.2. Rating of probability of establishment

Rating for establishment	Descriptors
<i>Very unlikely</i>	The likelihood of establishment would be very low because of the absence or very limited availability of host plants; the unsuitable environmental conditions; and the occurrence of other considerable obstacles preventing establishment
<i>Unlikely</i>	The likelihood of establishment would be low because of the limited availability of host plants; the unsuitable environmental conditions over the majority of the risk assessment area; and the occurrence of other obstacles preventing establishment.
<i>Moderately likely</i>	The likelihood of establishment would be moderate because hosts plants are abundant in few areas of the risk assessment area; environmental conditions are suitable in few areas of the risk assessment area; and no obstacles to establishment occur.
<i>Likely</i>	The likelihood of establishment would be high because hosts plants are widely distributed in some areas of the risk assessment area; environmental conditions are suitable in some areas of the risk assessment area; and no obstacles to establishment occur. Alternatively, the pest has already established in some areas of the risk assessment area.
<i>Very likely</i>	The likelihood of establishment would be very high because hosts plants are widely distributed; environmental conditions are suitable over the majority of the risk assessment area; and no obstacles to establishment occur. Alternatively, the pest has already established in the risk assessment area.

## 1.3. Rating of probability of spread

Rating for spread	Descriptors
<i>Very unlikely</i>	The likelihood of spread would be very low because: <ol style="list-style-type: none"> <li>1. the pest has only one specific way to spread (e.g. a specific vector, specific assisting virus...) which is not present in the risk assessment area;</li> <li>2. highly effective barriers to spread exist;</li> <li>3. the hosts are not or very rarely present in the area of possible spread</li> </ol>
<i>Unlikely</i>	The likelihood of spread would be low because: <ol style="list-style-type: none"> <li>1. the pest has one to few specific ways to spread (e.g. specific vectors, specific assisting virus) and the occurrence of the pest in the risk assessment area is rare;</li> <li>2. effective barriers to spread exist;</li> <li>3. the hosts are occasionally present</li> </ol>
<i>Moderately likely</i>	The likelihood of spread would be moderate because: <ol style="list-style-type: none"> <li>1. the pest has few specific ways to spread (e.g. specific vectors, specific assisting virus) and the occurrence of the pest in the risk assessment area is limited;</li> <li>2. partially effective barriers to spread exist;</li> <li>3. the hosts are abundant in few parts of the risk assessment area.</li> </ol>
<i>Likely</i>	The likelihood of spread would be high because: <ol style="list-style-type: none"> <li>1. the pest has some non-specific ways to spread (mechanical transmission...), which occur in the risk assessment area;</li> <li>2. no effective barriers to spread exist;</li> <li>3. the hosts are widely present in some parts of the risk assessment area</li> </ol>
<i>Very likely</i>	The likelihood of spread would be very high because: <ol style="list-style-type: none"> <li>1. the pest has multiple non-specific ways to spread (mechanical transmission...), which all occur in the risk assessment area;</li> <li>2. no effective barriers to spread exist;</li> <li>3. the hosts are widely present in the whole risk assessment area</li> </ol>



## 1.4. Rating of magnitude of the potential consequences

Rating of potential consequences	Descriptors
<i>Minimal</i>	Differences in crop production (saleable fruits, tubers, plants for planting, seed, etc.) are within normal day-to-day variation; no additional control measures are required
<i>Minor</i>	Crop production (saleable fruits, tubers, plants for planting, seed, etc.) is rarely reduced or at a limited level; additional control measures are rarely necessary
<i>Moderate</i>	Crop production (saleable fruits, tubers, plants for planting, seed, etc.) is occasionally reduced to a limited extent; additional control measures are occasionally necessary
<i>Major</i>	Crop production (saleable fruits, tubers, plants for planting, seed, etc.) is frequently reduced to a significant extent; additional control measures are frequently necessary
<i>Massive</i>	Crop production (saleable fruits, tubers, plants for planting, seed, etc.) is always or almost always reduced to a very significant extent (severe crop losses that compromise the harvest); additional control measures are always necessary

## 2. Ratings used for the evaluation of the risk reduction options

The Panel developed the following ratings with their corresponding descriptors for evaluating the effectiveness of the risk reduction options to reduce the level of risk.

### 2.1 Rating of the effectiveness of risk reduction options

Rating	Descriptors
<i>Negligible</i>	The risk reduction option has no practical effect in reducing the probability of entry, establishment or spread, or the magnitude of potential consequences.
<i>Low</i>	The risk reduction option reduces, to a limited extent, the probability of entry, establishment or spread, or the magnitude of potential consequences.
<i>Moderate</i>	The risk reduction option reduces, to a substantial extent, the probability of entry, establishment or spread, or the magnitude of potential consequences.
<i>High</i>	The risk reduction option reduces the probability of entry, establishment or spread, or the magnitude of potential consequences, by a major extent.
<i>Very high</i>	The risk reduction option essentially eliminates the probability of entry, establishment or spread, or any potential consequences.

### 2.2 Rating of the technical feasibility of risk reduction options

Rating	Descriptors
<i>Negligible</i>	The risk reduction option is not in use in the risk assessment area, and the many technical difficulties involved (e.g. changing or abandoning the current practices, implementing new

	practices and or measures) make their implementation in practice impossible.
<i>Low</i>	The risk reduction option is not in use in the risk assessment area, but the many technical difficulties involved (e.g. changing or abandoning the current practices, implementing new practices and or measures) make its implementation in practice very difficult.
<i>Moderate</i>	The risk reduction option is not in use in the risk assessment area, but it can be implemented (e.g. changing or abandoning the current practices, implementing new practices and or measures) with some technical difficulties
<i>High</i>	The risk reduction option is not in use in the risk assessment area, but it can be implemented in practice (e.g. changing or abandoning the current practices, implementing new practices and or measures) with limited technical difficulties.
<i>Very high</i>	The risk reduction option is already in use in the risk assessment area or can be easily implemented with no technical difficulties.

### 3. Ratings used for describing the level of uncertainty

For the risk assessment chapter—entry, establishment, spread and impact—as well as for the evaluation of the effectiveness of the risk reduction options, the level of uncertainty has been rated separately in coherence with the descriptors that have been defined specifically by the Panel in this opinion.

<b>Rating</b>	<b>Descriptors</b>
<i>Low</i>	No or little information or no or a small amount of data is missing, incomplete, inconsistent or conflicting. No subjective judgement is introduced. No unpublished data are used.
<i>Medium</i>	Some information is missing or some data are missing, incomplete, inconsistent or conflicting. Subjective judgement is introduced with supporting evidence. Unpublished data are sometimes used.
<i>High</i>	Most information is missing or most data are missing, incomplete, inconsistent or conflicting. Subjective judgement may be introduced without supporting evidence. Unpublished data are frequently used.

## REFERENCES

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## Appendix B. Distribution of *Arabid mosaic virus*, *Strawberry latent ringspot virus*, *Raspberry ringspot virus* and *Tomato black ring virus* in the EU

**Table 1:** The status of *Arabid mosaic virus* in the EU-28 as gathered from different sources (CABI, EPPO PQR, EFSA questionnaire)

Member State	CABI Current stats of pest (presence/absence)	EPPO PQR Current status of pest (presence/absence)	Information provided by Member State
Austria	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Belgium	Present, no further details	Present, no details	Present, no details
Bulgaria	Present, few occurrences	Present, few occurrences	Present, few occurrences
Cyprus	Absent, formerly present	Absent, no pest record	Absent based on surveys
Croatia	Present, restricted distribution	Present, restricted distribution	No data available
Czech Republic	Widespread	Present, widespread	Present, widespread
Denmark	Restricted distribution	Present, restricted distribution	Present, at low prevalence
Estonia	No information on CABI	No information	Absent, no pest record
Finland	Present, few occurrences	Present, restricted distribution	Present, restricted distribution
France	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Germany	Widespread	Present, widespread	Present, in parts of the area
Greece	No information on CABI	No information	Absent (not known to occur)
Hungary	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Ireland	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Italy	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Latvia	Present, no further details	No information	No information provided
Lithuania	Restricted distribution	Present, restricted distribution	Absent, no pest records
Luxembourg	Present, no further details	Present, no details	No information provided
Malta	No information on CABI	No information	Not known to occur
The Netherlands	Restricted distribution	Present, widespread	Present, widespread
Poland	Widespread	Present, widespread	Present, restricted distribution
Portugal	No information on CABI	No information	Present, few occurrences
Romania	Present, no further details	Present, restricted distribution	Present, restricted distribution
Slovakia	Present, no further details	Absent, unreliable record	Absent
Slovenia	Restricted distribution	Present, restricted distribution	Present, only in some areas
Spain	Present, no further details	Present, few occurrences	No information provided
Sweden	Present, few occurrences	Present, few occurrences	Present, few occurrences
United Kingdom	Present, few occurrences	Present, few occurrences	Present, few occurrences

CABI: Centre for Agricultural Bioscience International; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System.

**Table 2:** The status of *Arabis mosaic* virus outside the EU

Continent	Country	Pest status EPPO PQR	Pest status CABI
Africa	Egypt	Present, no details	
	South Africa	Present, few occurrences	Present, few occurrences
America	Canada	Present, restricted distribution	Restricted distribution
	Canada, British Columbia	Present, no details	Present, no further details
	Canada, Nova Scotia	Present, no details	Present, no further details
	Canada, Ontario	Present, no details	Present, no further details
	Canada, Quebec	Present, no details	Present, no further details
	Chile	Present, no details	
	Mexico		Present, no further details
	USA		Present, no further details
	USA, Connecticut	Absent, intercepted only	Present, no further details
	USA, Florida		Present, no further details
	USA, Michigan	Absent, intercepted only	Present, no further details
	USA, Minnesota		Present, no further details
	USA, Missouri		Present, no further details
	USA, Nebraska		Present, no further details
	USA, South Carolina		Present, no further details
Asia	China		Absent, intercepted only
	India		Present, no further details
	India, Himachal Pradesh		Present, no further details
	Iran	Present, no details	Present, no further details
	Israel		Present, no further details
	Japan	Present, no details	Present, no further details
	Japan, Honshu		Present, no further details
	Kazakhstan	Present, no details	Present, no further details
	Lebanon		Present, no further details
	Syria		Present, no further details
Europe (non-EU)	Croatia	Present, restricted distribution	Restricted distribution
	Belarus	Present, no details	Present, no further details

CABI: Centre for Agricultural Bioscience International; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System.

**Table 3:** The status of *Raspberry ringspot virus* in the EU-28 as gathered from different sources (CABI, EPPO PQR, EFSA questionnaire)

Member State	CABI Current stats of pest (presence/absence)	EPPO PQR Current status of pest (presence/absence)	Information provided by Member State
Austria	Absent, formerly present	Absent, pest no longer present	Absent, pest no longer present
Belgium	Restricted distribution	Present, restricted distribution	Present, at low prevalence
Bulgaria	Present, few occurrences	Present, restricted distribution	Present, restricted distribution
Croatia	No data available	No data available	No data available
Czech Republic	Restricted distribution	Present, no details	Present, restricted distribution
Denmark	Eradicated	Absent, pest eradicated	Absent, pest eradicated
Estonia	No information on CABI	Present, no details	Absent, no pest record
Finland	Present, few occurrences	Present, restricted distribution	Present, restricted distribution
France	Widespread	Present, widespread	Present, widespread
Germany	Present, few occurrences	Present, restricted distribution	Present, restricted distribution
Greece	Restricted distribution	Present, restricted distribution	Absent (not known to occur)
Hungary	Absent, unreliable record	Absent, unreliable record	Present, restricted distribution
Ireland	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Italy	Present, few occurrences	Present, few occurrences	Present, few occurrences
Latvia	Widespread	Present, no details	No information provided
Lithuania	No information on CABI	No information	Absent, no pest records
Luxembourg	Present, no details	Present, no details	No information provided
Malta	No information on CABI	No information	Not known to occur
The Netherlands	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Poland	Present, no further details	Absent, pest no longer present	Absent, pest no longer present
Portugal	No information on CABI	Present, few occurrences	Present, few occurrences
Romania	Present, no further details	Absent, pest no longer present	Absent, confirmed by survey
Slovakia	Present, no further details	Absent, unreliable record	Absent
Slovenia	Restricted distribution	Absent, pest no longer present	Absent, pest no longer present
Spain	Restricted distribution	Absent, intercepted only	No information provided
Sweden	No information on CABI	No information	Not known to occur
United Kingdom	Present, few occurrences	Present, few occurrences	Present, few occurrences

CABI: Centre for Agricultural Bioscience International; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System.

**Table 4:** The status of *Raspberry ringspot virus* outside the EU

Continent	Country	Pest status EPPO PQR	Pest status CABI
Asia	Iran		Present, further details
	Kazakhstan	Present, no details	
	Uzbekistan	Absent, no pest record	
Europe (non-EU)	Albania	Present, no details	Present, no further details
	Belarus	Present, no details	Present, no further details
	Guernsey	Absent, no pest record	
	Norway	Present, restricted distribution	Restricted distribution
	Russia	Present, restricted distribution	Restricted distribution
	Russia Central Russia	Present, no details	Present, no further details
	Russia Far East	Present, no details	Present, no further details
	Serbia	Present, no details	Present, no further details
	Switzerland	Present, widespread	Restricted distribution
	Turkey	Present, restricted distribution	Restricted distribution
	Ukraine	Absent, unreliable record	Present, no further details

CABI: Centre for Agricultural Bioscience International; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System.



**Table 5:** The status of *Strawberry latent ringspot virus* in the EU-28 as gathered from different sources (CABI, EPPO PQR, EFSA questionnaire)

Member State	CABI Current status of pest (presence/absence)	EPPO PQR Current status of pest (presence/absence)	Information provided by Member State
Austria	Present, no further details	No information	Absent, no pest record
Belgium	Present, no further details	Present, no details	Present, at low prevalence
Bulgaria	No information on CABI	No information	Present, no details
Croatia	No data available	No data available	No data available
Czech Republic	Present, few occurrences	Present, few occurrences	Present, restricted distribution
Cyprus			Absent based on surveys
Denmark	No information on CABI	No information	Absent, no pest records
Estonia	No information on CABI	No information	Absent, no pest record
Finland	Restricted distribution	Present, restricted distribution	Present, restricted distribution
France	Present, no further details	Present, no details	Present, no details
Germany	Present, few occurrences	Present, few occurrences	Present, few occurrences
Greece	No information on CABI	No information	Absent (not known to occur)
Hungary	Present, no further details	Present, no details	Present, restricted distribution
Ireland	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Italy	Present, no further details	Present, no details	Present, no details
Latvia	No information on CABI	No information	No information provided
Lithuania	No information on CABI	No information	Absent, no pest records
Luxembourg	Present, no further details	Present, no details	No information provided
Malta	No information on CABI	No information	Not known to occur
The Netherlands	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Poland	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Portugal	Restricted distribution	Present, no details	Present
Romania	Present, no further details	Absent, pest no longer present	Absent, confirmed by survey
Slovakia	No information on CABI	No information	Absent
Slovenia	No information on CABI	No information	Absent, no pest records
Spain	Present, no further details	Present, few occurrences	No information provided
Sweden	No information on CABI	No information	Not known to occur
United Kingdom	Present, few occurrences	Present, few occurrences	Present, few occurrences

CABI: Centre for Agricultural Bioscience International; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System.

**Table 6:** The status of *Strawberry latent ringspot* virus outside the EU

Continent	Country	Pest status EPPO PQR	Pest status CABI
Africa	Egypt	Present, no details	
	South Africa	Absent, pest no longer present	Absent, formerly present
America	Canada	Present, restricted distribution	Restricted distribution
	Canada British Columbia	Present, no details	Present, no further details
	Canada Nova Scotia	Absent, invalid record	Absent, invalid record
	Canada Ontario	Absent, pest no longer present	Absent, formerly present
	USA	Present, restricted distribution	Restricted distribution
	USA California	Present, no details	Present, no further details
	USA Maryland		Present, no further details
	USA Nebraska		Present, no further details
	USA Ohio		Present, no further details
	USA Oregon		Present, no further details
Asia	India	Present, restricted distribution	Restricted distribution
	India Himachal Pradesh	Present, no details	Present, no further details
	Israel	Absent, pest no longer present	Absent, formerly present
	Lebanon	Present, no details	Present, no further details
	Syria		Present, no further details
Europe (non-EU)	Albania	Present, no details	Present, no further details
	Belarus	Present, no details	Present, no further details
	Croatia		Present, no further details
	Serbia	Present, no details	Present, no further details
	Switzerland	Present, no details	Present, no further details
	Turkey	Present, few occurrences	Present, few occurrences
Oceania	Australia	Present, few occurrences	Present, few occurrences
	Australia South Australia	Present, few occurrences	Present, few occurrences
	New Zealand	Present, few occurrences	Present, few occurrences

CABI: Centre for Agricultural Bioscience International; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System.

**Table 7:** The status of *Tomato black ring virus* in the EU-28 as gathered from different sources (CABI, EPPO PQR, EFSA questionnaire)

Member State	CABI Current stats of pest (presence/absence)	EPPO PQR Current stats of pest (presence/absence)	Information provided by Member State
Austria	No information on CABI	No information	Absent, no pest record
Belgium	Present, no further details	Present, no details	Present, no details
Bulgaria	Present, no further details	Present, no details	Present, no details
Croatia	Present, no further details	Present, no details	No data available
Cyprus	No information on CABI	No information	Absent based on surveys
Czech Republic	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Denmark	Absent, unreliable record	Absent, unreliable record	Absent, pest records unreliable
Estonia	No information on CABI	No information	Absent, no pest record
Finland	Present, few occurrences	Present, restricted distribution	Present, restricted distribution
France	Widespread	Present, widespread	Present, widespread
Germany	Present, few occurrences	Present, few occurrences	Present, few occurrences
Greece	Restricted distribution	Present, restricted distribution	Absent (not known to occur)
Hungary	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Ireland	Restricted distribution	Present, restricted distribution	Present, restricted distribution
Italy	Absent, invalid record	Absent, invalid record	Absent, invalid record
Latvia	No information on CABI	No information	No information provided
Lithuania	No information on CABI	No information	Absent, no pest records
Luxembourg	No information on CABI	No information	No information provided
Malta	No information on CABI	No information	Not known to occur
The Netherlands	Present, few occurrences	Present, restricted distribution	Present, restricted distribution
Poland	Restricted distribution	Absent, pest no longer present	Absent, pest no longer present
Portugal	Absent, intercepted only	Absent, intercepted only	Absent
Romania	Present, no further details	Absent, pest no longer present	Absent, confirmed by survey
Slovakia	Present, no further details	No information	Absent
Slovenia	No information on CABI	No information	Absent, intercepted only
Spain	Absent, unreliable record	Absent, unreliable record	No information provided
Sweden	Present, few occurrences	Present, few occurrences	Present, few occurrences
United Kingdom	Present, few occurrences	Present, few occurrences	Present, few occurrences

CABI: Centre for Agricultural Bioscience International; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System.

**Table 8:** The status of *Tomato black ring virus* outside the EU

Continent	Country	Pest status EPPO PQR	Pest status CABI
Africa	Kenya	Absent, intercepted only	Absent, intercepted only
	Morocco	Absent, unreliable record	Absent, unreliable record
America	Brazil	Absent, intercepted only	Absent, intercepted only
	Canada	Absent, pest no longer present	Absent, formerly present
	Canada Ontario	Absent, pest no longer present	Absent, formerly present
	Chile	Present, no details	Present, no further details
	USA	Absent, intercepted only	Absent, intercepted only
Asia	China	Absent, unreliable record	Absent, unreliable record
	China Hebei	Absent, unreliable record	Absent, unreliable record
	India	Present, no details	Present, no further details
	India Andhra Pradesh	Present, no details	Present, no further details
	India Karnataka	Present, no details	Present, no further details
	India Tamil Nadu	Present, no details	Present, no further details
	Japan	Present, no details	Present, no further details
Europe (non-EU)	Albania	Present, no details	Present, no further details
	Belarus	Present, no details	Present, no further details
	Croatia	Present, no details	Present, no further details
	Moldova	Present, no details	Present, no further details
	Norway	Present, restricted distribution	Restricted distribution
	Russia	Present, restricted distribution	Restricted distribution
	Russia European Russia	Present, no details	Present, no further details
	Serbia	Present, no details	Present, no further details
	Switzerland	Present, no details	Present, no further details
	Turkey	Present, restricted distribution	Restricted distribution

CABI: Centre for Agricultural Bioscience International; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System.

## Appendix C. The distribution of longidorid nematodes in the EU

**Table 9:** The distribution of *Longidorus attenuatus* in the EU-28

Country/region	Present, no further details				Reference
	Listed in Fauna Europaea	Listed in CABI	Listed in EPPO PQR	Listed in GBIF	
Austria	–	–	–	–	Tiefenbrunner and Tiefenbrunner, 2004
Belgium	+	–	–	–	
Bulgaria	+	–	–	+	Peneva et al., 2012
Croatia	–	–	–	–	
Cyprus	–	–	–	–	
Czech Republic	+	–	–	–	
Denmark	–	–	–	–	
Estonia	–	–	–	–	
Finland	–	–	–	–	
France	+	–	–	+	
Germany	+	–	–	+	
Greece	–	–	–	–	
Hungary	–	–	–	–	
Ireland	–	–	–	–	
Italy	+	–	–	+	
Latvia	–	–	–	+	
Lithuania	–	+	–	+	
Luxembourg	–	–	–	–	
Malta	–	–	–	–	
Poland	+	–	–	+	
Portugal	–	–	–	–	
Romania	–	–	–	–	
Slovakia	+	–	–	–	
Slovenia	–	–	–	+	
Spain	+	–	–	+	
Sweden	–	–	–	–	
The Netherlands	+	–	–	–	
United Kingdom	+	–	–	+	

CABI: Centre for Agricultural Bioscience International; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System; GBIF: Global Biodiversity Information Facility. Source: (Tiefenbrunner and Tiefenbrunner, 2004)

**Table 10:** The distribution of *Longidorus elongatus* in the EU-28

Country/region	Present, no further details				Reference
	Listed in Fauna Europaea	Listed in CABI	Listed in EPPO PQR	Listed in GBIF	
Austria	–	+	+	–	Tiefenbrunner and Tiefenbrunner, 2004
Belgium	+	+	+	–	
Bulgaria	+	+	+	–	
Croatia	–	–	–	–	
Cyprus	–	–	–	–	
Czech Republic	+	–	+	–	
Denmark	–	–	–	–	
Estonia	+	+	+	–	
Finland	+	+	+	–	
France	+	+	+	–	
Germany	+	+	+	–	
Greece	–	+	+	–	
Hungary	+	+	+	–	
Ireland	–	+	+	–	
Italy	+	+	+	–	
Latvia	–	–	+	–	
Lithuania	+	–	–	–	
Luxembourg	–	–	–	–	
Malta	–	–	–	–	
Poland	+	+	+	–	
Portugal	–	+	+	–	
Romania	+	+	+	–	
Slovakia	+	+	–	–	
Slovenia	+	+	–	–	
Spain	+	+	–	–	
Sweden	+	+	–	–	
The Netherlands	+	+	–	–	
United Kingdom	+	+	–	–	

CABI: Centre for Agricultural Bioscience International; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System; GBIF: Global Biodiversity Information Facility.



**Table 11:** The distribution of *Longidorus macrosoma* in the EU-28

Country/region	Present, no further details				Reference
	Listed in Fauna Europaea	Listed in CABI	Listed in EPPO PQR	Listed in GBIF	
Austria	–	–	–	–	Tiefenbrunner and Tiefenbrunner, 2004
Belgium	+	–	–	+	
Bulgaria	–	–	–	–	Peneva et al., 2012
Croatia	–	–	–	–	
Cyprus	–	–	–	–	
Czech Republic	–	–	–	–	
Denmark	–	–	–	–	
Estonia	–	–	–	–	
Finland	–	–	–	–	
France	+	–	–	–	
Germany	+	–	–	+	
Greece	–	–	–	–	
Hungary	–	–	–	–	
Ireland	+	–	–	–	
Italy	+	–	–	–	
Latvia	–	–	–	–	
Lithuania	–	–	–	–	
Luxembourg	–	–	–	–	
Malta	–	–	–	–	
Poland	+	–	–	–	
Portugal	+	–	–	–	
Romania	–	–	–	–	
Slovakia	+	–	–	–	
Slovenia	–	–	–	+	
Spain	+	–	–	–	
Sweden	–	–	–	–	
The Netherlands	+	–	–	–	
United Kingdom	+	–	–	+	

CABI: Centre for Agricultural Bioscience International; EPPO PQR: European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System; GBIF: Global Biodiversity Information Facility.

**Table 12:** The distribution of *Paralongidorus maximus* in the EU-28

Country/region	Present, no further details				Reference
	Listed in Fauna Europaea	Listed in CABI	Listed in EPPO PQR	Listed in GBIF	
Austria	–	–	–	+	
Belgium	–	–	–	–	
Bulgaria	+	–	–	+	Peneva et al., 2012
Croatia	–	–	–	–	
Cyprus	–	–	–	–	
Czech Republic	–	–	–	–	
Denmark	–	–	–	–	
Estonia	–	–	–	–	
Finland	–	–	–	–	
France	–	–	–	+	
Germany	+	–	–	+	
Greece	–	–	–	–	
Hungary	+	–	–	+	
Ireland	–	–	–	–	
Italy	+	–	–	–	
Latvia	–	–	–	–	
Lithuania	–	–	–	–	
Luxembourg	–	–	–	–	
Malta	–	–	–	–	
Poland	+	–	–	–	
Portugal	+	–	–	+	
Romania	–	–	–	–	
Slovakia	+	–	–	–	
Slovenia	–	–	–	–	
Spain	+	–	–	+	
Sweden	–	–	–	–	
The Netherlands	+	–	–	–	
United Kingdom	+	–	–	–	

CABI, Centre for Agricultural Bioscience International; EPPO PQR, European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System; GBIF, Global Biodiversity Information Facility.

**Table 13:** The distribution of *Xiphinema diversicaudatum* in EU-28

Country/region	Present, no further details				Reference
	Listed in Fauna Europaea	Listed in CABI	Listed in EPPO PQR	Listed in GBIF	
Austria	–	+	–	–	Tiefenbrunner and Tiefenbrunner, 2004
Belgium	+	+	+	–	
Bulgaria	+	+	+	–	
Croatia	–	+	+	–	
Cyprus	–	–	–	–	
Czech Republic	+	–	+	–	
Denmark	–	–	+	–	
Estonia	–	–	–	–	
Finland	–	–	–	–	
France	+	+	+	–	
Germany	+	+	+	–	
Greece	–	–	–	–	
Hungary	+	–	–	–	
Ireland		+	+	–	
Italy	+	+	+	–	
Latvia	–	–	–	–	
Lithuania	–	–	–	–	
Luxembourg	–	–	–	–	
Malta	–	–	–	–	
Poland	+	+	+	–	
Portugal	+	+	+	–	
Romania	–	–	–	–	
Slovakia	+	+	+	–	
Slovenia	+	+	–	–	
Spain	+	+	+	–	
Sweden	+	+	+	–	
The Netherlands	+	+	+	–	
United Kingdom	+	+	+	–	

CABI, Centre for Agricultural Bioscience International; EPPO PQR, European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System; GBIF, Global Biodiversity Information Facility.

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