Plant Protection Service
Ministry of Economic Affairs, Agriculture and Innovation

Pest Risk Analysis for *Xiphinema americanum s.l.*

November 2010

Plant Protection Service
Ministry of Economic Affairs, Agriculture and Innovation
P.O. BOX 9102
6700 EH Wageningen, The Netherlands

Pest Risk Analysis for *Xiphinema americanum s.l.*

Assessors: Dirk Jan van der Gaag, Gerrit Karssen, Arjen Werkman

Version: 1.0
Date: November 2010

PEST RISK ANALYSIS FOR *Xiphinema americanum s.l.*			
Pest risk analyst:			Mr. D.J. van der Gaag, Mr. G. Karssen, Mr. A. Werkman Plant Protection Service, P.O. Box 9102, 6700 HC, Wageningen, The Netherlands Email address for correspondence: d.j.van.der.gaag@minlnv.nl
Stage 1: Initiation			
1 What is the reason for performing the PRA?			The EU-quarantine nematode *Xiphinema americanum s.l.* (non-European populations) (IAI) is regularly found in soil attached to or associated with plants during import inspections (PPS, 2008; Annex C). It is likely that not all infested consignments are detected at import because only a sample of soil is taken and not each plant is being sampled (NPPO of the NL). *Xiphinema americanum s.l.* is a complex group of species and to date 51 species have been described within this group (Lamberti *et al*., 2000), including *X. californicum* which is also on the list of EU-quarantine organisms. The phytosanitary risk of non-European populations of *X. americanum s.l.* is the ability of certain of these populations (or vector species within the *X. americanum* group) to transmit American nepoviruses (EPPO, 1997a). The nepoviruses are: - *Tomato ringspot nepovirus* (ToRSV). Quarantine status in the EU: IAI - *Tobacco ringspot nepovirus* (TRSV). EU – IAI - *Cherry rasp leaf nepovirus* (CRLV). EU- IAI - *Peach rosette mosaic nepovirus* (PRMV). EU – IAI Within the EU, several species belonging to the *Xiphinema americanum* – group are present but these are not known as vector species except *X. rivesi* (Lamberti *et al*., 2000; Annex G). *X. rivesi* is present in several EU countries (Lamberti & Ciancio, 1993; Lamberti et al., 2000; EPPO, 2007; CABI, 2007; Sirca *et al*., 2007). *X. rivesi* was first described by Dalmasso in 1969 from specimens from eastern France where it may be an introduction from the French Antilles (see also Robbins & Brown, 1991). Lamberti & Cianco (1993) suggested that *X. rivesi* may have been introduced from North America into Europe. *X. rivesi* is known as a vector species of nepoviruses in North America (Robbins & Brown, 1991) and the ability to transmit ToRSV and TRSV has recently been demonstrated for a *X. rivesi* population in Slovenia. (Sirca *et al*., 2007). Thus, the *X. rivesi* populations present in Europe may well act as a vector of nepoviruses as non-European populations of *X. americanum s.l.*. Presently, no measures are taken to prevent spread of *X. rivesi* populations in the EU, although these populations may

		pose a threat comparable to those of non-European populations of *X. americanum s.l.* originating in areas where the viruses are absent. Thus, it is presently unclear which pathways are most important and to which extent non-European populations pose a threat to plant health in the EU as compared to European populations. The present PRA was, therefore, performed to identify and assess or evaluate: - pathways and risk potential of non-European populations of *X. americanum s.l.* able to transmit one or more of the four nepoviruses mentioned above; - pathways (spread within the EU) and risk potential of European *X. americanum s.l.* populations able to transmit one or more of the four nepoviruses mentioned above; - pathways and risk potential of *X. americanum s.l.* infected with one or more of the nepoviruses mentioned above; - management options to prevent introduction of non-European populations of (vector species of) *X. americanum* s.l. and further spread of populations of vector species of *X. americanum s.l* already present in Europe.
2 Enter the name of the pest		*Xiphinema americanum sensu lato*, i.e. a complex of morphological closely related species or sibling species. At present, this complex includes 51 species (*sensu* Lamberti *et al*., 2000). The reason for regulation of *X. americanum s.l*. is the ability of certain species within the *X. americanum* group to transmit one of more of four nepoviruses mentioned above (see Question 1). Therefore, the species within the *Xiphinema americanum* group that are of main concern within this PRA, are those that can act as vectors of nepoviruses. According to Lamberti *et al.* (2000), these species are: *X. americanum s.s*., *X. bricolensis, X. californicum, X. intermedium*, *X. rivesi* and *X. tarjanense*. Verma *et al*. (2003) have shown transmission of ToRSV by *X. inequale*, a *X. americanum s.l.* species not listed by Lamberti *et al*. (2000) as a vector species, and it is plausible that more *X. americanum* group species can transmit nepoviruses than currently known. Note than within Europe several *X. americanum* group species are present of which some occur fairly widespread (Lamberti *et al*., 2000; Annex G) <u>Uncertainty</u>: the species within the *X. americanum* group able to transmit nepoviruses.
2A Indicate the type of the pest		Free-living ecto-parasitic nematode
2B Indicate the taxonomic position		Nematoda: Longidoridae: Xiphinematinae: *Xiphinema*.
3 Clearly define the PRA area		EU

4 Does a relevant earlier PRA exist?		No Where relevant, information has been used from a PRA recently made for another nematode species, e.g. *Meloidogyne enterolobii* (PRA made by the NPPO of the Netherlands, available at http://www.minlnv.nl/. It will be referred to as Karssen *et al.*, 2008).
5 Is the earlier PRA still entirely valid, or only partly valid (out of date, applied in different circumstances, for a similar but distinct pest, for another area with similar conditions)?		NA (not applicable)
Stage 2A: Pest Risk Assessment - Pest categorization		
6 Specify the host plant species (for pests directly affecting plants) or suitable habitats (for non parasitic plants) present in the PRA area.		*X. americanum s.l.* is highly polyphagous and appears to be virtually non-specific with regard to range of host plants. The host plant species of particular quarantine significance are those to and from which *X. americanum s.l.* transmit nepoviruses (EPPO, 1997a). The host plant range of these nepoviruses is wide, including woody and ornamental plants, and several weed species; some host plants remain symptomless after infection (Annex E). Uncertainty: the host plant range of TRSV, ToRSV, CRLV and PRMV is probably wider than presently known as indicated by recent findings of new host plants (Annex E).

7. Specify the pest distribution		**<u>Distribution of vector species of *Xiphinema americanum s.l.*</u>** *X. americanum s.l.* is present on all continents (EPPO, 1997a; Lamberti *et al*., 2000; Annex G). The (main) reason for its EU quarantine status is its ability to transmit nepoviruses. According to EPPO (1997a), only North American populations are a risk for the EPPO-area (and thus also for the EU) because of their ability to transmit nepoviruses. It is stated "So far, none of the populations from outside North America have been shown to be virus vectors" and "So populations of *Xiphinema americanum sensu lato* from other parts of the world should not be considered to be quarantine pests for the EPPO region". However, several reports have indicated or confirmed that populations outside North America also have the ability to transmit nepoviruses and are present on all continents except Oceania and Antarctica (Annexes F and G). The EPPO datasheet will need to be revised based on the new information. Below, a summary is given of references that report transmission of nepoviruses or presence of vector species on different continents. **North America** *Xiphinema americanum sensu stricto*, *X. californicum* and *X. rivesi* have been reported to transmit the nepoviruses CLRV, TRSV and ToRSV in North America (Brown *et al*., 1994). Moreover, ToRSV is also transmitted by *X. bricolensis* (Brown *et al*., 1994). PRMV has been reported to be transmitted by *X. americanum* (Allen *et al*, 1984; EPPO, 1997a; see also below "Transmission ability of European populations of *X. rivesi*"). The exact importance of different nematode species acting as a vector of PRMV is not yet clear. It has also been reported that *Longidorus diadecturus* (EU IAI) can transmit PRMV (Allen *et al*., 1984). *L. breviannulatus* and *L. elongates* have been reported to transmit the virus albeit only occasionally (Allen, 1986; Allen *et al*, 1988). Klos *et al*. (1967) has also reported transmission of PRMV by *Criconemoides* sp. but according to Ramsdell & Gillett (1998) the record for *Criconemoides* needs confirmation. **Europe** The vector species *X. rivesi* is (probably) present in France, Bulgaria, Germany, Italy, Portugal, Spain and Slovenia (EPPO, 1997a; Lamberti *et al*., 1994; 2000; CABI, 2007; Sirca *et al*., 2007; EPPO, 2007). According to CABI (2007) and EPPO (2007), *X. rivesi* occurs widespread in Italy, Spain and Portugal. Lamberti *et al.* (2000) refers to reports about the presence of *X. rivesi* in France, Bulgaria, Germany, Portugal and Spain but stated that the identifications in Bulgaria, Germany, Portugal and Spain probably need confirmation. Since the publication of Lamberti et al (2000), the finding in Germany has been confirmed (pers. comm. D. Sturhan to G. Karssen, 2003) as well as the presence in Spain (Bello *et al.,* 2005). *X. rivesi* was already reported in France in 1969 (Dalmasso, 1969). *X. rivesi* was found in soil samples taken from different locations in Slovenia in 2002 (Urek *et al*., 2003, 2005). The nematode species was found close to the Slovenian - Italian border (Urek *et al*., 2005). *X. rivesi* was found in relatively high numbers, 5 – 100 nematodes per 100 ml soil, and in an approximately 30-years-old orchard. The species was found in peach orchards, a vineyard and was also isolated

		from persimmon and cherry plants. These data indicate that *X. rivesi* was already present in Slovenia many years before its first report in literature. It was suggested that earlier findings identified as *X. americanum* in 1964 and 1978 can be recognized as *X. rivesi* (Urek *et al*., 2005). Because *X. rivesi* is already present for several decades in Europe and may easily go undetected for many years, the species may already be more widespread than currently known. *Transmission ability of European populations of X. rivesi* Transmission of TRSV and ToRSV has been demonstrated with a *X. rivesi* population in Slovenia under experimental conditions (Sirca *et al*., 2007). There is no reason why European populations of *X. rivesi* would differ in their ability to transmit viruses than for example the North American populations (see also Annex E). According to EPPO (1997a), *X. rivesi* can transmit ToRSV, TRSV and CLRV but cannot transmit PRMV; it is implied that PRMV is only transmitted by *X. americanum sensu stricto*. This statement, however, is contradicted by Stobbs & Van Schagen (1996) who mentioned *X. rivesi* as a vector of PRMV: "*Xiphinema rivesi* (Dalmasso) (4 nematodes per liter of soil) were recovered from soil sampled around the roots of infected vines". In North America, *X. rivesi* occurs more frequently in many areas than *X. americanum s.s*. and is the most widespread *X. americanum* group species in North America (Robbins & Brown, 1991). Robbins & Brown (1991) stated that "several of the reports of *X. americanum* associated with nepovirus diseases in the eastern seaboard States published prior to about refer to *X. rivesi*". Thus, it is plausible that the reported transmission of PRMV by *X. americanum* (Klos *et al*.,1967) may actually have been transmission by *X. rivesi*. However, there is no evidence that *X. rivesi* can transmit PRMV. In conclusion, European populations of *X. rivesi* can transmit TRSV and ToRSV and very likely also CLRV; *X. rivesi* may also transmit PRMV but this is uncertain (see also Annex F for a comparison between European and non-European populations of vector species of *X. americanum s.l.*). **Asia** *X. americanum s.l., X. inaequale* and *X. rivesi* have been reported from Asian countries. In Japan, Iwaki & Komuro (1974) have shown transmission of ToRSV through soil containing *X. americanum s.l.*. In India (Himachal Pradesh), Verma *et al*. (2003) found transmission of ToRSV through *X. inaequale* on gladiolus and tomato. Fadaei *et al*. (2003) reported the presence of *X. rivesi* from Iran, Nasira & Maqbool (1994) from Pakistan. According to Lamberti *et al*. (2000), the occurrence of *X. inaequale* is rare in Asia. The vector species *X. rivesi* and *X. intermedium* also sporadically occur, and their presence requires confirmation (Lamberti *et al*., 2000). **South America and Central America** According to EPPO (1997a), *X. californicum* is present in Brasil, Chili and Peru. Auger (1989) isolated ToRSV from diseased plum trees in Chili and mentioned *X. americanum s.l.* as possible vector of the virus in the orchard. The ability of Chilean populations of *Xiphinema*

		rivesi to transmit ToRSV has recently been demonstrated (Auger & Leal, 2009). According to Lamberti *et al*. (2000) *X. californicum* and *X. rivesi* are widespread in Latin America and both species are able to transmit CRLV, ToRSV and TRSV. **Africa** There are many species within the *X. americanum s.l* complex reported from Africa. (Lamberti *et al*., 2000). Of these species, only *X. americanum s.s.* is known to transmit nepoviruses and it is present in South Africa: "The occurrence of *X. americanum sensu stricto* in South Africa has been confirmed by Loots & Heyns (1984) and Lamberti *et al*. (1995)"(Lamberti *et al*., 2000). **Oceania** Three *X. americanum s.l*. species are present in Oceania but these are not known as vector species (Lamberti *et al*., 2000). **<u>Conclusion distribution vector species</u>** *X. americanum s.l.* populations that are able to transmit nepoviruses are present on all continents, Oceania and Antarctica probably excepted and several references confirm or indicate that nepovirus transmission can occur in other geographical populations as well as in the North American populations. For this reason, not only the North American populations pose a threat but we consider all non-European populations as well as certain European populations of *X. americanum s.l.* as a potential risk for the whole EU (PRA area). The main risks are *X. americanum s.l.* species that are known vectors for nepoviruses. These are, *X. americanum s.s*., *X. bricolensis, X. californicum, X. intermedium*, *X. rivesi*, *X. tarjanense* and *X. inaequale.* (Lamberti *et al*., 2000; Verma *et al*., 2003). It is plausible however, that more *Xiphinema americanum s.l.* species are able to transmit nepoviruses (see Question 2). The European *X. rivesi* populations are a risk for other areas in Europe that are not yet infested by this species. *X. rivesi* may already be more widespread in the EU than presently known. **<u>Uncertainties</u>**: • The distribution of *X. americanum s.l*. and especially of vector species in the EU and worldwide. • The ability of *X. rivesi* to transmit PRMV. **<u>Distribution of the nepoviruses, ToRSV, TRSV, CRLV and PRMV</u>** Although, the PRA is made for *X. americanum s.l.* we will also include the risk potential for introduction of the four quarantine nepoviruses together with the introduction of non-European *X. americanum s.l.* populations because the (main) reason for the quarantine status of the nematode population is their ability to transmit one or more of the nepoviruses. According to EPPO (2007) and CABI (2007), CRLV is only present in the USA and Canada and PRMV in USA, Canada, Turkey and Egypt. ToRSV and TRSV have a wider distribution and are

		locally present in the EU. More details on the distribution of the four nepoviruses according to EPPO (2007) and CABI (2007) are presented in Annex A.
8. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?		There are roughly two morphological group definitions for the *X. americanum*-group (Loof & Luc, 1990 versus Lamberti *et al.*, 2000) which differ only slightly. The group as such is relatively easy to identify compared to other *Xiphinema* species and compared to other related genera within the Longidoridae (see also question 2).
9. Even if the causal agent of particular symptoms has not yet been fully identified, has it been shown to produce consistent symptoms and to be transmissible?		NA
10. Is the organism in its area of current distribution a known pest (or vector of a pest) of plants or plant products?		Yes
11. Does the organism have intrinsic attributes that indicate that it could cause significant harm to plants?		Yes
12 Does the pest occur in the PRA area?		Yes. *X. rivesi* (species within the *X. americanum* group) is present and transmission of ToRSV and TRSV by populations of this species has been demonstrated in Slovenia under experimental conditions (Sirca *et al.*, 2007). Several other *X. americanum* group species, not known to have the ability to transmit the viruses, are also present of which some occur (fairly) widespread (Lamberti et al., 2000; Annex G). Two out of the four nepoviruses that can be transmitted by *Xiphinema americanum s.l.* are locally present in several EU-countries (Annex A).
13. Is the pest widely distributed in the PRA area?		No
14. Does at least one host-plant species (for pests directly affecting plants) or one suitable habitat (for non parasitic plants) occur in the PRA area (outdoors, in protected cultivation or both)?		Yes

15. If a vector is the only means by which the pest can spread, is a vector present in the PRA area? (if a vector is not needed or is not the only means by which the pest can spread go to 16)		NA
16. Does the known area of current distribution of the pest include ecoclimatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?		Yes
17. With specific reference to the plant(s) or habitats which occur(s) in the PRA area, and the damage or loss caused by the pest in its area of current distribution, could the pest by itself, or acting as a vector, cause significant damage or loss to plants or other negative economic impacts (on the environment, on society, on export markets) through the effect on plant health in the PRA area?		Yes
18. This pest could present a risk to the PRA area.		Yes
19. The pest does not qualify as a quarantine pest for the PRA area and the assessment for this pest can stop.		NA

Section 2B: Pest Risk Assessment - Probability of introduction/spread and of potential economic consequences

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
		Note: If the most important pathway is intentional import, do not consider entry, but go directly to establishment. Spread from the intended habitat to the unintended habitat, which is an important judgement for intentionally imported organisms, is covered by questions 1.33 and 1.35.
1.1. Consider all relevant pathways and list them		i) Soil attached to or associated with plants for planting including propagation material like tubers and bulbs ii) Plant products for consumption that may have soil attached, such as ware potatoes iii) Soil as such iv) Soil as contaminant (for example attached to machinery, shoes or poles) *Xiphinema americanum s.l.* can as far as known not establish in growing media that do not contain sand or clay particles (a.o. Griffin & Barker, 1966) and, therefore, only soil consisting entirely or in part of soil particles (clay minerals and/or sand) are included in the pathways mentioned above.
1.2. Estimate the number of relevant pathways, of different commodities, from different origins, to different end uses.		-
1.3. Select from the relevant pathways, using expert judgement, those which appear most important. If these pathways involve different origins and end uses, it is sufficient to consider only the realistic worst-case pathways. The following group of questions on pathways is then considered for each relevant pathway in turn, as appropriate, starting with the most important.		i) <u>Soil attached to or associated with plants for planting including propagation material like tubers and bulbs</u> At present, specific requirements are included in Annex IVAI article 34 of the EU directive 2000/29/EC for soil attached to or associated with plants (see also remarks on EU-legislation below for “soil as such”). From most countries import of soil attached to or associated with plants is forbidden unless specific measures have been taken to exclude harmful organisms (see also Annex BI). Taking into account the present EU-legislation and the risk posed by North American populations (EPPO, 1997a), one could distinct the following “subpathways” within the pathway “ soil attached to or associated with plants for planting”: a. From Algeria, Egypt, Israel, Libya, Morocco and Tunisia (Import allowed without specific requirements. Note: Algeria is excepted in the EU-legislation for soil and growing medium attached to plants but not for soil or growing medium as such). b. From Turkey, Belarus, Georgia Moldova, Russia and Ukraine (specific requirements in place); c. From other countries in continental Europe (EU and non-EU-countries included with the exception of countries mentioned under b), including movement within the EU

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
		(presently import/trade allowed without specific requirements); d. From North America (according to EPPO (1997*), X. americanum s.l*. populations are especially a risk due to their ability to transmit nepoviruses) e. From continents or countries not mentioned above ii) Plant products for consumption (not to be planted in soil) that may have soil attached Little information is available on import of plant products into the EU that may be imported with soil attached. The pathway will be particularly relevant for spread of European populations of *X. americanum s.l.* for example by transport of potatoes, sugar beets, carrots etc. iii) Soil as such The import of soil is forbidden from most third countries, with the exception of Egypt, Israel, Libya, Morocco and Tunisia and non-EU countries belonging to continental Europe, with the exception of Turkey, Belarus, Moldavia, Russia and Ukraine (see Annex BI). The legislation may, however, change in the future and, therefore, there is a need to assess the probability of entry if no legislation would be in place. Such assessment is also needed to evaluate if the present legislation that exclude certain countries is risk-based. Taking into account the present EU-legislation and the risk posed by North American populations one could distinct the following "subpathways" within the pathway "soil as such": a. Soil from Egypt, Israel, Libya, Morocco and Tunisia (presently import into the EU allowed); b. Soil from Turkey, Belarus, Moldavia, Russia and Ukraine (presently import into the EU forbidden); c. Soil from continental Europe (EU and non-EU-countries included with the exception of countries mentioned under b), including movement of soil within the EU (presently free movement allowed); d. Soil from North America (according to EPPO (1997a)*, X. americanum s.l.* populations are especially a risk due to their ability to transmit nepoviruses) (import presently forbidden); e. Soil from continents or countries not mentioned above (a-d) (import presently forbidden) The above-mentioned subdivision of the pathways i. "soil attached to or associated with plants" and iii. "soil as such" is partly based on current legislation. However, we have no information that justify this legislation-based differentiation for entry risk of *X. americanum s.l.* since the pest is probably present on all continents except Antarctica (see

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
		question 7). For that reason, we will distinct the following “subpathways” in the present PRA: Soil and growing medium attached to or associated with plants from a. North America (North American populations may pose the highest risk, see question 7) b. Third countries other than North American c. EU-countries where a vector species, *X. rivesi*, is present The pest can survive in soil without a host plant for at least 1 year (Bitterlin & Gonsalves, 1987; Evans *et al.,* 2007) and, thus, can enter with soil. However, no data are available on trade of soil between EU member states and their use. Data may be available for peat or other materials used in potting mixtures or to increase soil quality (for example perlite). These materials/sources are not considered relevant pathways because of the very low probability of association of the pest (see Q 1.1). There are also no data on import of soil from countries such as Egypt, Israel, Libya, Morocco and Tunisia and the non-EU countries belonging to continental Europe that are excepted from the import prohibition. Probably, long distance transport of large volumes of mineral soil does not happen. It may occur only within a country and between neighbouring countries but this is uncertain. Because of the lack of data, we will not conduct a detailed analysis for this pathway but as it is a possible pathway, we will include it in the Pest Risk Management section. It will also be discussed in the “spread section” because movement of soil within the EU will add to further spread of *X. americanum s.l.* populations already present (see question 7). iv) <u>Soil as a contaminant, for example attached to equipment and machinery</u> Soil as a contaminant will especially be a risk for spread of the nematode from infested areas on continental Europe with a dispersal range of several (tenth’s of) kilometres (for example tractors, machinery visiting different fields The risk for long distance movement will be lower than that for movement of plants for planting. Therefore, soil as a contaminant will not be discussed as a separate pathway in the entry section of the present PRA but will be discussed as a pathway for spread within the EU (see the answer on question 1.33). **In general, each pathway by which infested soil may be moved into new areas is relevant and should be considered when formulating pest risk management options. In the present PRA, a detailed pathway analysis has only been conducted for the most important pathway:**

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
		<u>Soil attached to or associated with plants for planting, from</u> a. North America b. Third countries other than North American c. EU-countries where the *X. americanum s.l.* is present (Probably present in France, Bulgaria, Germany, Italy, Portugal, Spain and Slovenia) **Notes** Because *X. americanum* group species already occur (fairly widespread) within the EU (Annex G) and because the reason of the regulation of non-European populations is the ability of certain of these populations to transmit the nepoviruses ToRSV, TRSV, PRMV and/or CRLV we have assessed the probability of entry or spread of the known vector species of *X. americanum s.l.* and not of all species belonging to the *X. americanum* group. Seven species within the *X. americanum* group are known or have been reported as a vector of the viruses. A major uncertainty is that more species might be able to transmit the viruses. Another uncertainty is that it is unknown how long *X. americanum s.l.* can survive in (small amounts of) dry soil attached to for example plants, plant products or equipment. Griffin & Barker (1966) did not find survival in soil at moisture levels of 10% field capacity after 12 weeks in the absence of host plants. Iwaki & Komuro (1974) found that soil infested with a *X. americanum s.l.* populations that transmitted TRSV had lost its infectivity after air-dyring at 22-30°C for 1-3 weeks. In general, *Xiphinema* spp. do not or poorly survive dry conditions (Sutherland & Sluggett, 1974; Harris, 1979; Sultan & Ferris, 1991) and cosmetic small amounts of soil attached to equipments, plant products etc that rapidly dries may not be a risk for transfer of *X. americanum s.l.* but this is uncertain. In the present pathway-analyses, we focus on regular commercial imports of plants for planting. However, (illegal) imports of soil as such or soil attached to or associated with plant for planting by passengers are also a risk for introduction of *X. americanum s.l.* In 2009, the NPPO of the Netherlands intercepted *Xiphinema americanum s.l.* in soil from Suriname (South America) that had been sent in parcel post. In the beginning of 2010, the NPPO intercepted various nematode species (not *X. americanum s.l.*) in soil from Mozambique in passenger's luggage (source NPPO of the Netherlands).

Pathway n°: **This pathway analysis should be conducted for all relevant pathways**		<u>Soil attached to or associated with plants (including plant products that may have soil attached) from:</u> a. North America b. Third countries other than USA and Canada c. EU-countries/regions where the pest is present (Bulgaria, France, Germany, Italy, Portugal, Spain and Slovenia; note the presence in Bulgaria, Italy and Portugal may need confirmation, see question 7) Separate answers and ratings will be given for each sub-pathway where relevant.
1.4. How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	**a) Likely** **b) Likely** **c) Moderately likely** **uncertainty: high**	a, b, c) *X. americanum*-group members reproduce parthenogenetically and reproduce relatively slow (up to one year from egg to egg). In the field all life stages are present throughout the year. In adverse conditions (i.e. very high or low temperature), the reproduction is retarded with lower numbers of adult stages. However, also juveniles feed on roots and are able to transmit viruses, probably with equal efficiency (Taylor & Brown, 1997). a. <u>North America</u>: *X americanum s.l.* (including vector species such as *X. rivesi*, *X. californicum* and *X. americanum s.s.*) occur widespread (Robbins & Brown, 1991; EPPO, 1997a; Lamberti *et al.*, 2000). Likelihood of association: likely. b. <u>Third countries other North American</u>: likelihood of association will vary among countries and even fields and will probably range from very unlikely to very likely depending on the presence of vector species of *X. americanum s.l.*. Based on limited data about the presence of vector species (question 7, Annex G; Lamberti et al., 2000) the likelihood of association was assessed as follows for different continents/countries: - Africa: moderately likely, because a vector species have only been reported from South Africa - South America, Central America: likely, because some of the known vector species occur widespread - China and Japan, unlikely, because vector species are rare in Asia - Asia: unlikely, because vector species are rare Overall rating for third countries other than Canada and USA: likely. c. <u>EU-countries/regions where the pest is present</u>. A vector species (*X. rivesi*) is locally present but it is unknown if plants are traded from fields that are infested with this species. Moderately likely. The uncertainty is high in all cases because it is unknown if fields from which plants are traded/exported are actually infested with vector species of the *X. americanum*-group. Moreover, more species within the *X. americanum*-group might be able to transmit the nepoviruses ToRSV, TRSV, PRMV and/or CRLV than presently known (see also questions 2, 7

		and Annex F). Many interceptions of *Xiphinema americanum s.l.* are known especially on plants originating from China and Japan (see Annex C) and recently, *X. americanum s.l.* was found in soil attached to *Cycas* plants originating from Central America; source: NPPO of the Netherlands, 2010). However, it is unknown if the nematodes intercepted are actually able to transmit ToRSV, TRSV, PRMV and/or CRLV.
1.5. How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?	**Likely**	a, b, c) Compared to Tylenchida plant-parasitic nematodes, vector nematodes are usually present in lower numbers (less than 200 per 100 g soil). Nematicides have long been applied successfully to reduce *Xiphinema* numbers. However an almost complete kill of nematodes is required to prevent any virus transmission, making it very difficult to control particularly in perennial crops. Due to the relatively low numbers and the absence of clear symptoms in consignments these nematodes can easily remain undetected during inspection (Taylor & Brown, 1997; Lemos *et al*., 1997). The NPPO of the Netherlands usually finds less than 50 nematodes per 200 ml soil in imported consignments. Comparable low numbers are also found in consignments which have been treated with nematicides in the country of origin (NPPO of the Netherlands). Thus, compared with other nematode species relatively low concentrations are found on the pathway. However, *X. americanum s.l.* reproduces asexually and the relatively low numbers of nematodes found in consignments are likely sufficient to start a population. Therefore, we rate this question as “likely”.
1.6. How large is the volume of the movement along the pathway?	 **a) Minor** **uncertainty: high** **b) Major** **uncertainty: medium**	Limited data are available on the number of imported plants in the EU and no data are available on presence or absence of soil with these plants. Answers below are mainly based on the import database of the NPPO of the Netherlands and information obtained from inspectors. The Netherlands is one of the main importers of plants for planting in the EU and it is assumed that figures from the Netherlands are an indication of the order of magnitude of import volume of the EU. The database of the NPPO of the Netherlands does not indicate if plants were imported with soil. Total numbers of plants for planting of these plant species/genera (usually on genus level) can be derived from the database but the numbers with soil attached will be lower. Therefore, information was obtained from inspectors to identify those plant species/genera from the database which may be imported with soil attached. a) North America The Netherlands import plants for planting from North America but these are usually free of soil (NPPO of the Netherlands). One notification by another EU-country (year 2009) was found in Europhyt of a *Xiphinema* sp. (species not indicated) on plants for planting imported from the USA. Volume: minor, high uncertainty

		b) <u>Third countries other than North American</u> <u>Africa</u>: The Netherlands import plants for planting from African countries but these plants (including many unrooted cuttings) are (mostly) imported without soil. There are, however, interceptions of *Xiphinema* sp. (species not indicated) reported from an EU-country for plants originating from a country in northern Africa (Annex C) which indicate that plants with soil are imported or at least have been imported from Africa. Volume: minor, high uncertainty <u>South America, Central America</u>: - Especially palm plants are imported with soil via the Netherlands. We roughly assess the total import volume at about one thousand consignments every year. Volume: moderate - major, high uncertainty <u>China and Japan</u> Roughly one thousand consignments. Volume: moderate - major, high uncertainty <u>Asian countries other than China and Japan</u> Roughly one hundred consignments Volume: moderate, high uncertainty <u>Oceania</u> Vector species of *X. americanum s.l.* are not known to occur in Oceania (Lamberti *et al*., 2000) and, therefore, the pathway "plants for planting with soil attached from Oceania" is not considered further in this PRA. In conclusion, the volume of plants for planting with soil attached imported from third countries other than USA and Canda into the EU is assessed as major with a medium uncertainty.
	c) Massive **uncertainty: medium**	c) <u>From EU-countries where the pest is present</u>: Limited data are available for trade of plants between EU-countries. Italy is known as a country growing and trading many ornamental plants and was among the top 7 countries in the world for export of floricultural crops, including cut flowers (50%), plants (41%) and cut foliage (9%), in 2001. Italy accounted for 3% and Spain for 2% of the total world export (BCMAFF, 2003).

		Meeder *et al* (2009) give import and export data of nursery stock of the Netherlands, Germany, France and the UK. About 10 % of the total import value are rooted cuttings that may be traded without soil. The other products (for example trees, rosa, fruit trees, rhododendron, perennials) are generally traded with soil attached. The Netherlands, Germany, France and the UK import mainly from other EU countries: 97% of the total import value (figures for 2008). The Netherlands import nursery stock mainly from Italy (31%), Germany (21%), Belgium (16%) and Spain (5%) with a total import value in 2008 of about € 34 million (for comparison: import from China accounted for about 5% indicating that internal trade of tree nursery stock is much larger than import from third countries). In 2008, Germany imported for about € 216 million mainly from the Netherlands (72%) and Italy (13%). Import from France and Spain accounted for 1.4 and 0.7%, respectively. UK imported for about € 193 million mainly from the Netherlands (68%) and Italy (9%). Import from Germany, France and Spain accounted for 4, 3 and 0.9%, respectively. France imported for about € 238 million per year mainly from the Netherlands (29%), Italy (24%) and Belgium (22%). Import from Spain, Germany and Portugal accounted for 14, 7 and 1.1%, respectively. France and Germany where *X. rivesi* is present exported tree nursery stock to other EU-countries for a value of € 44,669 and € 171,873 million, respectively. In conclusion, several EU-countries where *X. rivesi* is present are important traders of nursery stock within the EU. We assess a major trade volume from countries/areas in the EU from where the pest is present with a medium uncertainty since *X. rivesi* is present in Germany and France and occurs widespread in Italy, Spain and Portugal (although the presence of *X. rivesi* in Italy need confirmation (see Question 7)). It is, however, uncertain if plants are traded from fields that are infested with *X. rivesi*.
1.7. How frequent is the movement along the pathway?	**a) rarely** **b) often** **c) very often**	a) rarely (see question 1.6) b) often. Plants are imported on a weekly basis c) very often. Plants are traded on a weekly basis. Internal movement will be more frequent than import from third countries.
1.8. How likely is the pest to survive during transport/storage?	**Very likely** **Uncertainty: low**	Conditions that are suitable to transport live plants to which soil is attached will also be suitable for survival of *Xiphinema americanum s.l. X. americanum s.l.* is regularly intercepted in the EU (Annex C) showing indeed that it can survive transport.

		Several studies have shown that populations of *X. americanum s.l.* infected with TRSV or ToRSV can survive in soil without a host plant for more than a half year and remain infective after that period: • A population of *X. americanum s.l.* infected with TRSV was still infective after 49 weeks storage at 10°C (Bergeson *et al.*, 1964). • *X. rivesi* survived in soil at 1-3°C during a 3-year study period although nematode numbers were greatly reduced after 2 years (Bitterlin & Gonsalves, 1987). *X. rivesi* was still able to transmit ToRSV after 2 years but not after 3 years of storage. • Soil infested with *X. americanum s.l.* populations that transmitted ToRSV remained infective after stored at 4 – 10°C for up to 14 months (Iwaki & Komuro, 1974).
1.9. How likely is the pest to multiply/increase in prevalence during transport /storage?	**Unlikely Uncertainty: low**	Members of the *X. americanum* group have long life cycles and low rates of reproduction and it is, therefore, not likely that they will increase during transport or storages which usually takes less than 4 weeks.
1.10. How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	**Likely Uncertainty: low**	Because of the usual absence of clear root or above ground symptoms and the fact that this nematode is regular present in low numbers, *Xiphinema* species can easily remain undetected. Their ability to feed on a wide range of hosts and to survive for a long period without a host increases their persistence and the change for small populations to remain undetected.
1.11. In the case of a commodity pathway, how widely is the commodity to be distributed throughout the PRA area?	**Very widely Uncertainty: low**	Plants for planting are distributed throughout the EU,
1.12. In the case of a commodity pathway, do consignments arrive at a suitable time of year for pest establishment?	**Yes Uncertainty: low**	Plants intended for planting are imported throughout the year (source: NPPO of the Netherlands).
1.13. How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	**Very likely Uncertainty: low**	*Xiphinema americanum s.l.* feeds on virtually every host plant species and reproduces parthenogenetically which will make transfer very likely to occur.
1.14. In the case of a commodity pathway, how likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	**Very likely Uncertainty: low**	The following situations may occur: • Import of plants that will be planted directly in soil and the soil will become infested. In such a situation transfer is very likely to occur. • Import of pot plants (including artificially of naturally dwarfed plants) that will be kept in greenhouses or in consumer's houses. The greenhouse may become infested by spread of the nematodes through the irrigation system. Garden soil may become infested if consumers plant pot plants temporarily in their garden (this happens sometimes). Transfer may also happen if soil attached to imported plants is mixed through field or greenhouse soil. Examples of transfer/spread from potted plants are actually not known. Therefore, we assess the probability of transfer in such a situation as "moderately likely" (see also Karssen

		et al., 2008). Imported plants may first be kept in pots on concrete floors or on tables in greenhouses in northern European countries but later be moved to southern European countries where they may be planted directly in soil. For example, Dutch companies import many millions of palm plants/seedlings (most of them without soil) every year of which many are traded to southern European countries where they may be planted outdoors (see EPPO PRA for *Metamasius hemipterus*, available at http://www.eppo.org/QUARANTINE/; accessed Novemeber 2009). In such a situation, planted outdoors, the probability of transfer is "very likely".

1.15. Do other pathways need to be considered?		No

Conclusion on the probability of entry. Risks presented by different pathways.	**A) entry** **a) medium** **b) high** **c) high** **High uncertainty**	Below, we assess: A. The probability of entry of vector species of *Xiphinema americanum s.l.* based on the answers of questions 1.5 – 1.14, B. The probability of association of the nematode species with one or more of the four nepoviruses which the nematode can transmit C. A combination of (A) and (B): the probability of entry of the nematode carrying one or more of the four nepoviruses. A. Probability of entry of vector species of *Xiphinema americanum s.l.* from: a. North America: medium (minor import volume and a high likelihood of association). High uncertainty because of the limited availability of import data and lack of information if plants are exported to the EU grown in production places infested with vector species of *Xiphinema americanum s.l.* b. Third countries other than North American: a distinction can be made between continents/regions/countries: • Africa: low (minor import volume and a vector species is only known from South Africa). High uncertainty because of the limited availability of import data. • South America, Central America: high, because the nematode is known to occur in several countries. High uncertainty because the pest status is unknown from the areas where plants are grown for export to Europe. • China and Japan: low, because the known vector species are rare in Asia. High uncertainty for reasons stated above (see 1.4). • Asian countries other than China and Japan: low, since the known vector species are rare. High uncertainty for reasons stated above (see 1.4). For import from all third countries together, other than USA and Canada: the probability of entry is assessed as high with a high uncertainty. c. EU-countries where the pest is present (France, Germany, Italy, Portugal, Spain and Slovenia): high (because of the massive trade volume and no (official) measures are taken to prevent spread. High uncertainty because it is unknown if plants are actually traded from fields infested with *X. rivesi*. Major uncertainties • The presence or absence of vector species of *Xiphinema americanum s.l.* in countries and regions world-wide. • *X. rivesi* (belonging to *X. americanum s.l.*) may be present in more EU-countries than presently known. *X. rivesi* is present or even widespread in several EU-countries and from these countries it may already have spread to other countries with movement of soil (attached to or associated with plants, equipment etc). The presence of *X. rivesi* in Spanish vineyards was for example already reported in 1973 (Arias & Navacerrada,

		1973) and in France already in 1969 (Dalmasso, 1969).
	B) association with nepoviruses **a) medium** **b) medium (most countries/ areas low or very low)** **c) low (most countries/areas very low)** **High uncertainty**	B. The probability of association of *Xiphinema americanum s.l.* with one or more the nepoviruses ToRSV, TRSV, CRLV, PRMV from: a. *North America* All four nepoviruses are present in Canada and USA although they have a limited distribution (Annex A). Several studies have shown the ability of American populations to transmit the nepoviruses (see for an overview: CABI, 2007, Question 7) and the nematode species was for example widely present in orchards infected with ToRSV (Forer & Stouffer, 1982). However, the nepoviruses have a limited distribution in Canada and USA and we do not known if they are present at production places from which plants are exported to the EU. Therefore, we rate the probability of association as medium with a high uncertainty. Probability of association: medium Uncertainty: high b. *Third countries other than North American* In countries where the nepoviruses are absent or only locally present and plants imported from these countries do not originate from the areas where one or more of the viruses is present, the probability of association is very low. In countries where one or more of the nepoviruses are present, the probability of association will depend on the frequency of occurrence of the nepoviruses and how widespread they occur. We assess the probability ranging from very low (countries/regions where none of the nepoviruses is present) to high (countries/regions where on or more nepoviruses are widespread and where the vector is present). Based on the known distribution of the nepoviruses the probability of association will be low for most countries. Few reports describe transmission of nepoviruses by *X. americanum s.l.* in countries/areas other than USA and Canada. Transmission may, however, occur but not been noticed or reported. Thus, generally there is a high uncertainty about the probability of association with nepoviruses. Many palm trees are imported from Central America with soil attached. Palm trees nor other monocotyledons are known as host plants of the nepoviruses. However, weeds may carry the nepoviruses and, therefore, there is a low risk (uncertainty: high) that *X. americanum s.l.* populations in the rhizosphere of palm trees carry one or more nepoviruses. Per continent/region/country: • Africa: very low. The four nepoviruses are not known to occur in South Africa, the only African country where the presence of a vector species of *X. americanum s.l.* has been confirmed. Medium uncertainty • South America, Central America and Mexico: medium. High uncertainty

		• China and Japan: low. High uncertainty • Asian countries other than China and Japan: low. High uncertainty In conclusion: Probability of association: ranging from very low to medium (depending on the country/region; probably low or very low for most countries/areas). Uncertainty: high *c. EU-countries where the pest is present (France, Germany, Italy, Portugal, Spain and Slovenia)* In the EU, no reports are known that indicate transmission of the nepoviruses by *X. americanum* s.l. in the field. Under experimental conditions, the ability to transmit ToRSV and TRSV have been shown in Slovenia. It is assumed that the *X. rivesi* populations present in other EU-countries are also able to transmit these nepoviruses but thus far there are no reports known that this presently happens. The nepoviruses are only locally present in some of these countries and are probably not associated with *X. rivesi*. Presently, the probability of association with one or more of the nepoviruses is assessed as "low". Low uncertainty since the viruses occur only locally in the EU and there are no reports of virus transmission in the field. Probability of association: low Uncertainty: medium
	C) entry of nematode with nepoviruses **a) medium** **b) medium (most countries or areas very low)** **c) low (most countries or areas very low)**	C. Probability of entry of *Xiphinema americanum s.l.* carrying one or more of the nepoviruses ToRSV, TRSV, CRLV, PRMV from (combination of "A" and "C"): a. North America: medium, because of the medium probability of entry of the nematode. High uncertainty (see above). b. Third countries other than North American: very low to medium depending on the country of origin. Per continent: • Africa: very low (a low probability of entry of the nematode and a very low probability of association). Medium uncertainty • South America, Central America: medium (a high probability of entry of the nematode and a medium probability of association). High uncertainty. • China and Japan: low (a low probability of entry of the nematode and a low probability of association). High uncertainty. • Asian countries other than China and Japan: low (a low probability of entry and a low probability of association). High uncertainty. The uncertainty is high because of the lack of data on the presence of the four nepoviruses in combination with the nematode vector. c. EU-countries where the pest is present (France, Germany, Italy, Portugal, Spain and

		Slovenia): low, because of the low probability of association of the nematode with the virus. Medium uncertainty. **Note:** in many countries or areas on the different continents the nepoviruses are absent and the probability of entry with import of plants from these countries/region is very low (see Annex A for the distribution of the nepoviruses).
1.16. Estimate the number of host plant species or suitable habitats in the PRA area (see question 6).	**Very many Uncertainty: low**	*X. americanum s.l.* is highly polyphagous and appears to be virtually non-specific with regard to host plant. It is more polyphagous than for example the root knot nematode *Meloidogyne enterolobii* (Karssen *et al*., 2008).
1.17. How widespread are the host plants or suitable habitats in the PRA area? (specify)	**Very widely Uncertainty: low**	See the answer on question 1.16
1.18. If an alternate host or another species is needed to complete the life cycle or for a critical stage of the life cycle such as transmission (e.g. vectors), growth (e.g. root symbionts), reproduction (e.g. pollinators) or spread (e.g. seed dispersers), how likely is the pest to come in contact with such species?	**Not relevant**	
1.19. How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the current area of distribution?	**Very similar Uncertainty: low**	*X. americanum s.l*. (vector and non-vector species) is present on all continents in a wide range of climates. The vector species *X. rivesi* is present in central European and southern European countries (see question 7). *X. americanum s.l.* can probably establish in most parts of the PRA area, the most northern regions possibly excepted. The European species *Xiphinema diversicaudatum* for example occurs widespread in the UK and Ireland with an apparent northerly limit in central Scotland (Taylor & Brown, 1976)
1.20. How similar are other abiotic factors that would affect pest establishment, in the PRA area and in the current area of distribution?	**Very similar Uncertainty: low**	Several studies are known on the effect or relationship between soil edaphic factors and *X. americanum*: In pot experiments, pathogenicity of *Xiphinema americanum* was significantly affected by soil texture and only reduced plant growth in sandy soil and not in clay, clay-sand soils (Griffin, 1996). Population dynamics was not affected by soil texture as the species did not increase in any soil texture. Jaffee *et al.* (1988) also conducted pot experiments. They amended apple orchard soil containing *X. americanum* and *X. rivesi* with sand or silt. *Xiphinema americanum* populations increased but the rate of increase was not significantly affected by soil amendment.

		Niblack & Bernard (1985) investigated the presence of nematode species in 92 Tennessee nursery sites and its relation with tree age, bulk density, pH, texture and organic matter in soil in 1981. Bulk density ranged from 1.07 to 2.07 g/cm, pH ranged from 4.3 to 7.3, organic mater ranged from 0.64 to 2.79%. Percentages of sand, silt and clay were highly variable among the 92 sites including sandy loam soils and silty clay loam soils. *X. americanum* was the second most commonly detected nematode species and was foundn 72 out of the 92 sites. Densities of *X. americanum* were positively correlated with tree age and weakly negatively with pH (r = -0.19). Results of above mentioned studies show that *X. americanum* is able to establish in various soil types which are present in the EU. This is also shown by the fact that *X. rivesi* belonging to the *X. americanum* group is present in several EU-countries and is the most widespread vector species in the world (Lamberti *et al*., 2000; see also question 7 and Annex F).
1.21. If protected cultivation is important in the PRA area, how often has the pest been recorded on crops in protected cultivation elsewhere?	**Not relevant**	Not relevant
1.22. How likely is it that establishment will occur despite competition from existing species in the PRA area?	**Very likely Uncertainty: low**	Co-existence of two or more vector nematodes in the field is well known, together with their wide host suggests strongly that competition between these nematode species is not relevant.
1.23. How likely is it that establishment will occur despite natural enemies already present in the PRA area?	**Very likely Uncertainty: low**	Natural enemies (like fungi) usually will only affect vector nematode populations slightly in temperate climate zones.
1.24. To what extent is the managed environment in the PRA area favourable for establishment?	**Highly favourable Uncertainty: low**	The pest *(X. rivesi*) is already present in several countries in the PRA-area in central and southern Europe. Vector species of *X. americanum s.l.* are present on all continents except in Oceania and Antarctica as far as known (see question 7).
1.25. How likely is it that existing pest management practice will fail to prevent establishment of the pest?	**Very likely Uncertainty: low**	In general, control measures against nematodes, such as crop rotation and nematicides reduce nematode population levels but will not prevent establishment (see also question 2.3 on control measures). Moreover, the pest attacks also non-agricultural plants and can also establish in natural vegetations.
1.26. Based on its biological characteristics, how likely is it that the pest could survive eradication programmes in the PRA area?	**Very likely Uncertainty: low**	The pest attacks virtually every plant species and can establish both in agricultural fields, urban areas and natural vegetation. X. americanum s.l. can go deep into soil. For example, Ramsdell & Myers (1978) found *X. americanum* at depths up to 213 cm beneath PRMV-infested grapevine sites. At such depths it is very difficult if not impossible to eradicate the nematode by treatment with nematicides.

1.27. How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment?	**Likely** **Uncertainty: high**	As an asexual organism with low offspring numbers, slow rate of reproduction but with a wide host range, it is likely that establishment will be a slow process. However, one individual can in principle start a new population.
1.28 How likely are relatively small populations to become established?	**Likely** **Uncertainty: high**	One asexual individual can establish a new population. See also 1.27. **Note** One single nematode of *X. americanum s.s.* and *X. rivesi* is able to transmit ToRSV (Bonsi *et al*., 1984; Teliz *et al*., 1966)
1.29. How adaptable is the pest?	**Medium** **Uncertainty: low**	Parthenogenetic nematodes, as *X. americanum s.l.* have in general a low amount of genetic variation. However, it is a complex of species, it has a very wide host range and it is present in a wide range of climates (see question 7).
1.30. How often has the pest been introduced into new areas outside its original area of distribution? (specify the instances, if possible)		There are no records available. Possibly, *X. rivesi* has been introduced to Europe from North America if we compare the local European distribution to the wide North American distribution. Visa versa it has also been suggested that *X. pachtaicum* has been introduced to the USA (Taylor & Brown, 1997).
1.31. If establishment of the pest is very unlikely, how likely are transient populations to occur in the PRA area through natural migration or entry through man's activities (including intentional release into the environment) ?		Not relevant.
Conclusion on the probability of establishment	**Very high** **Uncertainty: low**	The pest is already present in several parts of the PRA area in central and southern Europe for many years (France, Germany, Italy, Portugal, Spain and Slovenia; see question 7). Thus, the probability for establishment is very high with a low uncertainty.
1.32. How likely is the pest to spread rapidly in the PRA area by natural means?	**Very unlikely** **Uncertainty: low**	*X. americanum s.l.* can move at most 1 m per year in soil (EPPO, 1997a).
1.33. How likely is the pest to spread rapidly in the PRA area by human assistance?	**Spread: very likely** **Rapid spread: unlikely** **Uncertainty: low**	*X. americanum s.l.* can easily be spread throughout the EU in soil associated or attached to plants. The pest is already present in at least 6 EU-countries (question 7). Many plants are traded within the EU from these countries (question 1.6) and by which the pest can spread over large distances. Movement of soil can also spread the nematode species (soil attached to machinery visiting different fields or shoes, and movement of soil through irrigation, rain or erosion, etc). <u>Thus, the probability of spread is rated as "very likely"</u>. Nematodes, however, do usually not spread rapidly certainly not as you compare it with certain insects that can spread over large areas by natural means every year (for example *Diabrotica* spp., *Agrilus planipennis*, *Helicoverpa armigera* and *Tuta absoluta*). Nematodes can easily spread over large distances (hundreds or thousands of kilometres) by human assistance but the total

		infested area will usually not increase rapidly. The larger the infested area the higher the probability that the nematode will be moved by trade of plants but from an initial introduction rapid spread is unlikely. Therefore, we rate the probability of rapid spread (= rapid expansion of the infested area) as "unlikely".
1.34. Based on biological characteristics, how likely is it that the pest will not be contained within the PRA area?	**Very likely Uncertainty: low**	The pest attacks virtually every plant species and can survive in soil without a host plant for at least 1 year (Evans *et al.,* 2007).
Conclusion on the probability of spread		Probability of spread: very likely Natural spread occurs only over very small distances, 1 m at maximum, but the nematode can spread over many kilometres by human assistance. The probability of spread is rated as "very likely" since we expect that the nematode species will regularly be moved over shorter or longer distances by human assistance leading to new foci. However, the infested area will increase slowly since new foci will expand very slowly by natural spread.
Conclusion on the probability of introduction and spread **The overall probability of introduction and spread should be described. The probability of introduction and spread may be expressed by comparison with PRAs on other pests.**		Probability of introduction (entry and establishment): very likely A member of the *Xiphinema americanum* group, *X. rivesi*, is already present in at least 7 out of the 27 EU-countries although its presence in some of these countries may need confirmation (see question 7). The trade of plants for planting with soil attached from these countries is massive. The probability of introduction into not yet infested areas by internal trade is, therefore, rated as "very likely". At import, *X. americanum s.l.* is intercepted many times a year and possibly not all infested consignments are intercepted during import inspections. Introduction through import of plants for planting with soil attached is, therefore, likely despite current management measures. Without any phytosanitary measures the probability of introduction from third countries would be rated as "very likely".
Conclusion regarding endangered areas **1.35. Based on the answers to questions 1.16 to 1.34 identify the part of the PRA area where presence of host plants or suitable habitats and ecological factors favour the establishment and spread of the pest to define the endangered area.**		The endangered area: the whole EU. *X. americanum s.l.* can probably establish in all EU-countries and in all regions where fruit crops are commercially grown. It can possibly not establish in the most northern regions of Europe (e.g. northern half of Scotland, Sweden and Finland).
2. In any case, providing replies for all hosts (or all habitats) and all situations may be laborious, and it is desirable to focus the assessment as much as possible. The study of a single worst-case may be sufficient. Alternatively, it may be appropriate to consider all hosts/habitats together in		

answering the questions once. Only in certain circumstances will it be necessary to answer the questions separately for specific hosts/habitats.		
2.1. How great a negative effect does the pest have on crop yield and/or quality to cultivated plants or on control costs within its current area of distribution?	**Direct negative effect: low** **Uncertainty: low** **Indirect by acting as a vector:** **High (in combination with ToRSV)** **High in combination with TRSV,** **Low in combination with CRLV and/or PRMV** **Uncertainty: low**	*X. americanum s.l.* is an ectoparasite that can cause direct negative effects to host plants by damaging the roots and indirect effects by transmission of nepoviruses. Both kinds of effects are addressed here. <u>Direct damage</u> *Xiphinema* spp. feeds on the roots of host plants which may lead to reduced or stunted plant growth (e.g. Agrios, 1997; Pinkerton *et al*., 2008). Yield losses caused by *Xiphinema* spp. are difficult to determine since they generally occur together with several other plant pathogenic nematodes. Walters *et al*. (2008) performed a survey in Illinois (US) and found high densities of *Xiphinema* spp., *Mesocriconema* spp. and *Pratylenchus* spp. associated with yield losses in peach orchards indicating that these nematodes can limit peach production. Pinkerton *et al*. (1999) performed a survey in vineyards in Oregon (US) and found populations of *X. americanum* and *Mesocriconema xenoplax* associated with both healthy and stunted vines. In literature, it is stated that direct damage caused by *X. americanum s.l.* does generally not cause a major economic impact (EPPO, 1997a; Pinkerton *et al*., 2008). The related species *Xiphinema diversicaudatum* occurs widespread in the EU and causes similar effects on roots as *X. americanum s.l.* but is not known as an important pest by direct feeding on roots of his host plant (CABI, 2007). *Xiphinema rivesi* (member of the *X. americanum* group) is present in several EU-countries but no reports are known about direct economic damage of this nematode species to crop plants. Direct damage due to *X. americanum s.l*. in its present area of distribution is assessed to be low (locally or incidentally significant growth reduction can occur). <u>Indirect damage</u> The major effect of *X. americanum s.l.* is that certain species within the *X. americanum* group can transmit several nepoviruses (EPPO, 1997a; Pinkerton *et al*., 2008). The negative effects and impacts caused by the different nepoviruses are, therefore, discussed below. *Tomato ringspot virus (ToRSV)* ToRSV has a wide host range but negative effects are mainly reported for fruit crops especially grapes and raspberries:

		Grapes Disease incidence ranged in 4 out of 5 vineyards (cv. Cascade) from 37 – 63% in New York. Many diseased plants yielded no or little fruits (Uyemoto, 1975). Raspberry Converse & Stace-Smith (1971) found yield reductions in diseased plants of more than 50%. The virus can also cause reduction in fruit size (Freeman *et al*., 1975). Freeman *et al*. (1975) graft inoculated 10 raspberry cultivars with ToRSV. Several cultivars showed reduced growth and yield in the years after. The virus did not significantly affect growth or yield of some cultivars. Apple The presence of ToRSV has been related to apple union necrosis and decline in a survey in apple orchards in New York (Rosenberger *et al*., 1982). Other fruit crops ToRSV can also infect other *Prunus* spp. (like cherries and plum), *Ribes* and *Rubus* spp. (EPPO, 1997b; Annex E) but no reports were found on plant health effects on these crops. Potential yield losses and impact in these crops remains, therefore, highly uncertain. *Pelargonium* The virus caused symptoms on leaves of *Pelargonium hortorum* cv. Amansa (Rydén, 1972). Such symptoms will make plants unsalable. In the case described by Rydén in Sweden (1972), ToRSV was mechanically transmitted and *X. americanum s.l*. was probably not involved in transmission. Vector species of *X. americanum s.l*. are also not known to occur in Sweden. *Present impact in the USA* In the USA, ToRSV can be a major problem, in particular in eastern and western states. It is a major pathogen of blueberry in New York, of raspberry in western States (Oregon, Washington), and of apple and peach in Pennsylvania. ToRSV has been reported recently to cause a decline of grapes in Missouri but is not known to cause serious problems anywhere else grapes are grown. The use of vines grafted onto the rootstock 3309C seems to have solved problems associated with ToRSV in grapes. Similarly, the use of tolerant rootstocks M4 and M7 (instead of M6 and M126) in apple and of the rootstock Marianna 2624 in plum has help mitigate the impact of ToRSV. Soil fumigation remains an approach that growers use to control *Xiphinema americanum* populations (pers. comm. M. Fuchs, Cornell University, USA, 2009).

		Tobacco ringspot nepovirus (TRSV) Soybean Negative effects by TRSV have especially been reported for soybean in which it causes bud blight. In the Midwestern USA, 25 – 100% yield losses were reported from 1943 – 1947 (CABI, 2010). Much lower disease incidences have been reported by Dunleavy (1957) from Iowa in 1953 - 1956 : “bud blight is rarely reported on more than 1 per cent of the plants in a field and infection did not exceed 0.01 per cent in July over four years in Iowa”. In Ontario (Canada) in a survey between 1979 and 1981, the average incidence was 0.67% (Tu, 1986). In India, TRSV caused on average a yield loss of 66% after inoculation of soybean plants (Gopal, 1996). Thakur *et al*., (1993) reported incidence levels of up to 23% in soybean in India. Outbreaks of TRSV have also been reported from Brasil (e.g. Almeida & Corso, 1991; CABI, 2010). TRSV is seed-transmitted in soybean, it can also be transmitted by insects but transmission by *X. americanum s.l.* does not seem to play an important role (Alvaro *et al.,* 1991; CABI, 2000; McGuire & Douthit, 1978) and is, therefore, not further considered in this PRA. Fruit crops TRSV causes serious disease in blueberries in north-eastern region of the USA (Lister *et al*., 1963; Converse & Ramsdell, 1982). Uyemoto (1975) reported high disease incidences in grapes and “many diseased grapevines were moribund with little or no crop”. However, it was unclear to which extent TRSV contributed to the disease incidence and yield losses observed since ToRSV was also found in the fields. In EPPO’s datasheet the following is stated “on woody fruit crops, TRSV has a certain impact on grapevines in northeastern USA, causing a decline. *Vitis vinifera* is most readily affected, but is relatively little grown in that area compared with interspecific hybrids which are less affected (Gonsalves, 1988).” In EPPO’s datasheet (EPPO, 1997c), it is stated that “With the exception of *Vaccinium* and *Vitis*, TRSV has very minor impact on fruit crops, the records on some species being no more than scientific curiosities of no practical importance.” TRSV is not a major problem in the USA, except in blueberry in eastern States (New York, New Jersey, etc) (pers. comm. M. Fuchs, Cornell University, USA, 2009). Other crops Sastry & Nayudu (1978) have reported disease incidences in aubergine of 60 – 80% in fields around Tirupati and Bangalore. In field experiments, TRSV caused 55 – 70% yield losses after inoculation. In the USA, TRSV is of minor importance in cucurbits (Sinclair & Walker, 1956). Minor damage was reported in Capsicum (hot pepper) in Mexico (Campodonico & Montelongo, 1988). In some ornamental species TRSV is known to cause symptoms (Question 7). In these cases virus infection may result in cosmetic damage. It is unknown to which extent *X. americanum s.l.* plays a role in transmission of TRSV in crops other than soybean and fruit species (see also CABI, 2010).

		Cherry rasp leaf nepovirus (CRLV) Negative effects have been reported for peach trees, cherries and apples (CABI, 2007). Most information is available for cherries. Luepschen *et al*. (1974) reported data of a survey in cherries in Colorado. The disease increased with 5% over 6 years. Disease incidence was high in older cherry producing districts (23 and 38%) compared with an overall average of 15%. It was stated that the effect of the disease on yield was still undetermined. The disease is considered to be of little economic importance due to its relatively slow spread (CABI, 2007; Hansen et al., 1982). CRLV is not considered to cause serious economic damage in USA fruit orchards and vineyards; CLRV has been found in a very few apple trees in western States (Colorado and maybe Washington) (pers. comm. M. Fuchs, Cornell University, USA, 2009). *Peach rosette mosaic nepovirus (PRMV)* Major host of PRMV are the American grape species *Vitis labrusca* and peaches (*Prunus persica*) (EPPO, 1997c). Some cultivars of *V. vinifera*, and French-American *Vitis* spp. hybrids are also susceptible. Up to 60% of reduction in yield and growth of susceptible *Vitis* cultivars have been obtained in a field experiment in Michigan in the USA (Ramsdell *et al*., 1995). According to Camba *et al*. (2008), the virus is of limited economic importance in peach due to its limited distribution. It is stated in EPPO (1997a), that PRMV is economically less important than ToRSV, TRSV and CRLV. PRMV is not considered to cause serious economic damage in US fruit orchards and vineyards; PRMV may eventually be present in Michigan (pers. comm. M. Fuchs, Cornell University, USA, 2009). *Conclusion* In conclusion, most publications on negative effects on plant health by the four nepoviruses in combination with *X. americanum s.l.* are in fruit crops in the USA. Based on the information described above, we assess the impact of ToRSV in combination with *Xiphinema americanum s.l.* as high in various fruit crops in the USA although the use of resistant or tolerant rootstocks has decreased the impact of ToRSV in some fruit crops (e.g. grapes). We also assess the impact of TRSV as high in blueberry in the USA. The impact of both CRLV and PRMV is assessed as low in its the current area of distribution.

2.2. How great a negative effect is the pest likely to have on crop yield and/or quality in the PRA area without any control measures?	**Direct: low** **Uncertainty: low** **Indirect by acting as a vector:** **high** **in combination with ToRSV** **medium in combination with TRSV,** **low in combination with CLRV and PRMV** **Uncertainty: medium**	*X. americanum s.l.* on its own will likely have little negative effects on crop yield and/or quality when introduced. This assessment is based on the low impact the pest presently has in its current area of distribution (see question 2.1). Locally or incidentally significant growth reduction may occur. It should be noted that *X. americanum* s.l. (*X. rivesi*) is already present in parts of the PRA area (see question 7) and that the nematode may be present more widespread than currently known as no measures are being taken to prevent spread. Moreover, native *Xiphinema* spp., like *X. diversicaudatum*, are present which have similar direct effects on plant growth and the introduction of an additional *Xiphinema* sp. is not expected to have large additional negative effects. Like in its current area of distribution, negative effects on crop yield and quality are expected when the nematode and the nepoviruses, which it can transmit, occur together. Thus, introduction of *X. americanum s.l.* populations carrying one or more of the four nepoviruses will cause additional negative effects. The crop plants from which major yield losses have been reported by the nepoviruses are mainly fruit trees and berry crops (Table 1). Negative effects have also been reported for Pelargonium Rydén (1972). Pelargonium is grown in pots and natural spread by the nematode-vector is, therefore, not likely to occur. For pelargonium, the main risk will probably be transmission by the use of infected cuttings and not by the presence of the vector. Therefore impact on this crop plant is not included in the present PRA. In this PRA for *Xiphinema americanum* s.l., we assess the impact of a combination of *X. americanum* with one or more of the four nepoviruses it can transmit. The total potential economic impact of the nepoviruses can theoretically be very high considering for example the more than 3 million ha of grapes in the EU and disease incidences reported of more than 50% in certain orchards in New York (see question 2.1). However, a 50% disease incidence in all vineyards in the EU is unlikely to happen since the nematode species naturally spreads very slowly. The effects of the viruses seem to depend largely on the susceptibility of the cultivars used. A detailed analysis of cultivars of the main crops affected by the viruses (grapes, raspberry, peaches, cherry, blueberry), presently used in the EU and their resistance/tolerance to the nepoviruses was not conducted in this PRA. Some information was obtained for apple root stock and rootstocks of grapes used in the PRA area: M9 is the most common rootstock of apple in Europe (pers. comm. R. Steffek, 2009, Ages, Austria). There are no experiments known in which M9 was tested for tolerance/resistance for ToRSV. However, field observations in New York State indicate that M9 is substantially less susceptible to ToRSV than MM106 or M26. Circumstantial evidence indicate that M9 can become infected by ToRSV but the tree does not decline even when grafted with a hypersensitive scion such as Delicious (pers. comm. M. Fuchs, Cornell University, USA, 2009). Thus, the impact for apple orchards grown on M9 root stock may be limited in the EU.

		For grape root stocks commonly grown in France, no experimental data are known concerning their tolerance/resistance to ToRSV. Grape rootstocks 5 BB, 3309 C and 11O Richter, which are used on 34% of the total French grape acreage may have some tolerance to the *X. americanum* - complex and may limit the impact of ToRSV (pers. comm. M. Fuchs, Cornell University, USA, 2009; information on grape rootstocks from France was obtained from EPPO). After introduction into the PRA area, the vector-virus combination will spread slowly since the nematodes will spread naturally 1 m at maximum per year. The virus-vector combination may be spread over larger distances by trade of plants with soil attached by which new plots/points can become infested but the total infested area will nevertheless increase slowly. Thus, <u>on the short term</u>, e.g. the first 10 years after introduction the impact is assessed to be <u>low</u> and only very locally impact may occur. <u>On the long term</u> (decades), the virus-vector combination is expected to spread further mainly by human assistance and the impact may become similar to that in the USA where both the virus and vector are present (see question 2.1). In Europe the impact of ToRSV and TRSV in combination with the vector may become higher than in the USA because of the limited availability of soil fumigants in Europe (see also below: question 2.3). In conclusion the potential impact of the viruses in combination with the vector is assessed as follows: • ToRSV: high impact for several fruit crops • TRSV: high impact for blueberry and probably also for grapes. • CLRV and PRMV: low impact For many crops that can become infected by ToRSV and TRSV the relative importance of *Xiphinema americanum s.l.* as a vector is not known and the impact of the virus-vector combination could not be assessed. <u>Uncertainties</u>: • The resistance and tolerance of cultivars presently used in the EU against the four nepoviruses • The impact of ToRSV and TRSV in combination with *X. americanum s.l.* on crop plants other than fruit trees.

Table 1. EU-acreage of crop plants for which significant yield losses have been reported due to infection by one or more of the nepoviruses ToRSV, TRSV, CRLV or PRMV and where Xiphinema americanum s.l. is likely to play an import role in transmission.

Host plant species	Acreage EU (x 1000 ha)*
ToRSV	
Vitis sp. (grape)	> 3637
Rubus sp. (raspberry)	> 31
Malus domestica (apple)	> 747
Vaccinium corybosum (blueberry)	> 14
Prunus persica (peach)	> 260
TRSV	
Vitis spp. (grape)	see above (ToRSV)
Vaccinium corybosum (blueberry)	> 14
Solanum melongena (aubergine)	> 56
CRLV	
Prunus persica (peach)	> 260
Prunus avium (cherry)	> 159
Malus domestica (apple)	> 747
PRMV	
Prunus persica (peach)	see above (CRLV)
Vitis spp. (grape)	see above (ToRSV)

* Source: Eurostat and FAOstat. Since data are missing from certain EU-countries, values are consideres as the minimum acreage. See Annex D for details per member state.

2.3. How easily can the pest be controlled in the PRA area without phytosanitary measures?	**With much difficulty** **Uncertainty: low**	<u>**Control of *Xiphinema s.l.***</u> <u>Fumigation</u> CABI (2007) reviewed chemical control methods. Application of fumigant or non-fumigant nematicides decreased nematode populations and increased the growth of plants. Metam sodium and cis-dichlorpropene reduce the nematode population in soil by 60 to 90% (Anonymous, 1987). However, soil fumigants are not included in the list of active substances in the EU (http://ec.europa.eu/food/plant/protection/evaluation/database_act_subs_en.htm; website accessed 29/09/2009). In some EU-countries, metam sodium may be used as an "essential use" until 2014. Dazomet has been voluntarily withdrawn and its application resubmitted for inclusion and it might be included in the future. <u>Non-fumigant nematicides</u> Non-fumigant nematicides, aldicarb, ethoprophos, fosthiazate en oxamyl, are relatively easy to apply and may be an alternative for fumigants. They are, however, less effective than the fumigants since they do not kill nematodes but interfere with their mobility. Therefore, these pesticides are only effective during the first part of the growing season. Aldicarb may not be used in the EU since 2008 (http://ec.europa.eu/food/plant/protection/evaluation/database_act_subs_en.htm; website accessed 29/09/2009). <u>Resistant or tolerant cultivars</u> Cultivars could be chosen that are resistant or tolerant against the virus. Cultivars that are resistant against the nematode are probably not available. Ramsdell & Gillett (1985) found several cultivars of grapevine cultivars not infected by peach rosette mosaic virus when planted in soil under infected grapevines and infested with *X. americanum*. They concluded that this may have been resistance against virus infection rather than against the nematode. McKenry *et al.* (2004) did not found any resistance among 10 grape rootstocks against development of *X. americanum* populations in 2 vineyards. For orchards/fruit crops that stay for many years before being replanted the use of resistant/tolerant cultivars is not an option. <u>Crop rotation/fallow</u> Crop rotation is generally not very effective since the nematode survives in soil and on grasses and weeds (CABI, 2007). Some crops (e.g. wheat, rye, barley and millet), however, have shown to inhibit the development of *X. americanum* populations (Boldyrev & Borzykh, 1979, 1983). Evans *et al*. (2007) have shown that two years of continuous corn or grain sorghum reduced *X. americanum* populations in soil. <u>Biofumigation/organic soil amendments</u> Incorporation of organic materials with or without covering the soil with gas impermeable foil can be very effective against nematode populations comparable to that of commercial

		nematicides (Halbrendt *et al*., 1996; Blok *et al*., 2000). In combination with foil the method is called biological soil disinfestation (Blok *et al*., 2000). Degradation products formed under the anaerobic conditions kill nematodes and micro-organisms. The method can be as effective as the use of chemical fumigants but is relatively expensive and needs to be performed during summer and takes about 6 weeks. A shorter period of only a few weeks may be sufficient when fermented products are incorporated and this method may be feasible for more crops (Runia et al., 2009). <u>Steam sterilization</u> Steam sterilization is effective but even more expensive than biological soil disinfestation. <u>Soil solarisation</u> Soil solarisation may be used in tropical and sub-tropical regions. According to Noling (2005), lethal temperatures can be achieved up to a depth of 20 cm, but nematodes present in deeper soil layers will not be killed and may still be able to transmit viruses. This method will, therefore, not be very effective in controlling *X. americanum* s.l. which can be present in deep soil layers (see Q 1.26). ***Conclusion: control of Xiphinema americanum s.l.*** The use of nematicides has been limited in the EU. Incorporation of organic matter into the soil before replanting of an orchard can be an alternative but is relatively expensive. Certain crops have experimentally shown to inhibit or reduce *X. americanum* populations and could be included in a cropping system as part of an integrated control approach. Limitations for crop rotation will be that other plant pathogenic nematodes present in the soil may develop on these crops (e.g. *Meloidogyne chitwoodi* on corn) and intercrops may economically not be profitable. At present, no methods are available to control nematode populations in an established planting of fruit trees. Planting/sowing of plant species in an orchard that inhibit *Xiphinema* populations may be an option but has not yet investigated. All methods described above including soil fumigaton usually do not kill the entire field population. Therefore, these methods can at best slow down transmission of nepoviruses by *X. americanum s.l.* (EPPO, 1997a). **<u>Control of the virus</u>** Control of the virus in established plantings is not possible (see also above). The use of resistant or tolerant cultivars can reduce the disease (EPPO, 1997b; see also question 2.1). The use of certification schemes is an important measure to ensure production virus free starting material. **<u>Impact with measures to reduce the disease and prevent spread</u>** Hygienic measures and certification of propagation material will limit the spread by movement of the virus-vector combination and, thereby, limit the impact. The use of resistant/tolerant cultivars can largely reduce the effects by ToRSV, the most serious one of the

		four viruses, in apple and grapes (see question 2.1). Because of the slow spread of the disease growers can choose for resistant/tolerant root stocks when replanting an orchard. But for blueberry and raspberry no resistant/tolerant rootstocks are known and once a field is infested the impact can be high. Thus, preventive measures will result in a lower impact but locally the impact can still be high for ToRSV and TRSV in combination with the vector: • ToRSV: high impact for several fruit crops (high in cases where preventive measures fail and resistant/tolerant cultivars/root stocks are not grown); • TRSV: high for blueberry and probably also for grapes • CLRV and PRMV: low impact We do not expect high impacts on a large scale because of the slow natural spread of the vector and many growers will probably use certified planting material to prevent introduction of the viruses. The effects of ToRSV and TRSV in combination with the nematode vector on crop plants other than fruit trees and that are grown in field soil is highly uncertain. Both ToRSV and TRSV have a wide host range but yield effects have mainly been reported in fruit crops. In *Pelargonium,* ToRSV can relatively easily be controlled using virus-free planting material and potting mixtures free of the vector. Therefore, we assess the impact of ToRSV in *Pelargonium* as low with the use of control measures. As also stated above, the potential impact of ToRSV and TRSV in combination with the vector may be higher in Europe than in the USA because of the limited availability of soil fumigants in Europe.

2.4. How great an increase in production costs (including control costs) is likely to be caused by the pest in the PRA area?	**Moderate** **Uncertainty: high**	Because *X. americanum s.l.* is expected to have little negative effects on crop yield or quality (only incidentally or locally), it is expected that the presence of the pest will not or hardly lead to an increase in production costs in the PRA area. Note that in parts of the PRA area *X. americanum s.l.* (*X. rivesi*) is already present. In case *X. americanum s.l.* would be introduced together with one or more of the four nepoviruses it can transmit especially ToRSV (see question 2.1), the production costs may increase due to: • Early replanting of orchards; • Choice of cultivars/root stocks which are resistant/tolerant to the virus, but which may be less favourable concerning other characteristics (e.g .yield, quality etc); • Costs to control *X. americanum s.l.*; • Cost for certification schemes to ensure the production of virus free plants/propagation material.
2.5. How great a reduction in consumer demand is the pest likely to cause in the PRA area?	**Minimal** **Uncertainty: low**	In general, plant diseases have minimal effect on consumer demand of edible products. The pest will not have large or sudden effects on total yield and, therefore, not on consumer prices. Locally, some effect may appear, e.g. due to yield reduction in local fields.
2.6. How important is environmental damage caused by the pest within its current area of distribution?	**Minimal** **Uncertainty: low**	No reports found.
2.7. How important is the environmental damage likely to be in the PRA area (see note for question 2.6)?	**Minimal** **Uncertainty: low**	See question 2.6
2.8. How important is social damage caused by the pest within its current area of distribution?	**Minor** **Uncertainty: medium**	No reports found. Locally, large yield reduction may have social effects (change of income) .
2.9. How important is the social damage likely to be in the PRA area?	**Minor** **Uncertainty:**	The viruses will spread slowly by the vector and economic losses at a large scale are not expected. Locally, a grower may suffer a large income effect because once an orchard has become infected with both the vector and the virus the disease is difficult to control. In the

<table>
<tr><td></td><td>medium</td><td>worst case an infestation of an orchard may lead to bankruptcy of the grower. Growers may also want to cancel meetings with other growers to avoid infestation.</td></tr>
<tr><td>2.10. How likely is the presence of the pest in the PRA area to cause losses in export markets?</td><td>On its own: Unlikely

Uncertainty: low

If present as a vector of nepoviruses: Moderately likely

Uncertainty: medium</td><td>X. americanum s.l. or certain species within the X. americanum group and the 4 nepoviruses have a quarantine status in several countries (Table 2).

Table 2. Quarantine status of Xiphinema spp within the X.americanum group and nepoviruses which can be transmitted by X. americanum s.l. (source: EPPO PQR database, version 4.6)
<table>
<tr><th>Pest</th><th>Quarantine status in:</th></tr>
<tr><td>X. americanum sensu stricto</td><td>EU, Turkey</td></tr>
<tr><td>X. bricolense</td><td>EU, Turkey</td></tr>
<tr><td>X. rivesi</td><td>EU, Turkey</td></tr>
<tr><td>X. californicum</td><td>EU, Turkey, Uruguay</td></tr>
<tr><td>ToRSV</td><td>EU, Turkey, China, East Africa, Argentina, Canada, Paraguay, Uruguay</td></tr>
<tr><td>TRSV</td><td>EU, Turkey</td></tr>
<tr><td>CRLV</td><td>EU, Turkey, Russia, Canada</td></tr>
<tr><td>PRMV</td><td>EU, Russia, Canada</td></tr>
</table>
Introduction of the pest (nematode vector) on its own will probably have little affect on export since the pest (X. rivesi) is already present in several countries of the EU.

The presence of the pest in combination with one or more of the nepoviruses which it can transmit may have impact on the export markets since the nepoviruses are quarantine pests in several countries (Table 2). Presently, the nepoviruses are only locally present and in some EU-countries outbreaks have been eradicated (for example, in the Netherlands an outbreak of TRSV on Hemerocallis was eradicated by destruction of the infected plant material in 2006). The presence of the nematode-vector will, however, make eradication much more difficult if not impossible since no methods exist that can eradicate the nematode from a field (see question 2.3). Thus, once the vector is present and carries the virus eradication will hardly be possible and the virus can also spread naturally.

Fruits for consumption are not a relevant pathway and the presence of nepoviruses will not cause losses in export markets of fruits from host plants

Plants for planting grown in field soil: the presence of the vector-virus combination in the EU may not lead to loss of export markets but investments may be needed, e.g. the set-up of certification schemes, to guarantee pest freedom of the crop.</td></tr>
</table>

As noted in the introduction to section 2, the evaluation of the following questions may not be necessary if the responses to question 2.2 is "major" or "massive" and the answer to 2.3 is "with much difficulty" or "impossible" or any of the responses to questions 2.4, 2.5, 2.7, 2.9 and 2.10 is “major" or "massive” or "very likely" or "certain". You may go directly to point 2.16 unless a detailed study of impacts is required or the answers given to these questions have a high level of uncertainty.		
2.11. How likely is it that natural enemies, already present in the PRA area, will not reduce populations of the pest below the economic threshold?	**Very likely** **Uncertainty: low**	*X. rivesi* (member of the *X. americanum* group) is already present in the PRA area
2.12. How likely are control measures to disrupt existing biological or integrated systems for control of other pests or to have negative effects on the environment?	**Moderately likely** **Uncertainty: low**	Local use of nematicides will add to environmental impact by plant protection products.
2.13. How important would other costs resulting from introduction be?	**Moderate** **Uncertainty: low**	Research on control measures. Advise to farmers Certification schemes for producing virus free planting material
2.14. How likely is it that genetic traits can be carried to other species, modifying their genetic nature and making them more serious plant pests?	**Unlikely** **Uncertainty: medium**	No examples/reports are known of *Xiphinema* species that hybridise with other species.

2.15. How likely is the pest to cause a significant increase in the economic impact of other pests by acting as a vector or host for these pests?	**Very likely** **Uncertainty: low**	The main impact of *X. americanum s.l.* is its ability to transmit viruses as discussed above.
2.16. Referring back to the conclusion on endangered area (1.35), identify the parts of the PRA area where the pest can establish and which are economically most at risk.		Particularly on perennial crops like grapevine, stone fruits and bush fruits in any part of the PRA area. But also on many wild plants where it remains usually undetected (no symptoms) and acts as a potential virus source.
Degree of uncertainty **Estimation of the probability of introduction of a pest and of its economic consequences involves many uncertainties. In particular, this estimation is an extrapolation from the situation where the pest occurs to the hypothetical situation in the PRA area. It is important to document the areas of uncertainty (including identifying and prioritizing of additional data to be collected and research to be conducted) and the degree of uncertainty in the assessment, and to indicate where expert judgement has been used. This is necessary for transparency and may also be useful for identifying and prioritizing research needs.** **It should be noted that the assessment of the probability and consequences of environmental hazards of pests of uncultivated plants often involves greater uncertainty than for pests of cultivated plants. This is due to the lack of information, additional complexity associated with ecosystems, and variability associated with pests, hosts or habitats.**		The main uncertainties are: • The species within the *X. americanum* – group which are able to transmit ToRSV, TRSV, CRLV and/or PRMV • The distribution of *X. americanum s.l.* and especially vector species in the PRA area (EU) • The distribution of *X. americanum s.l.* and especially vector species worldwide • The distribution of ToRSV and TRSV worldwide • Survival of *X. americanum s.l.* in dry soil attached to equipment, machinery, plants, plant products etc. • Resistance/tolerance of current fruit tree varieties/root stocks of grape, raspberry, blueberry, peach, cherry presently used in the EU against ToRSV, TRSV, CRLV and PRMV • The effect of ToRSV and TRSV in combination with *X. americanum s.l.* on crop plants other than fruit trees. Other uncertainties are: • Host plant species of ToRSV, TRSV, CRLV and PRMV. Viruses may be symptomless present and the host plant list can be longer than presently known. • The ability of *X. rivesi* to transmit PRMV • *X. rivesi* which is present in Europe is known as an efficient vector of ToRSV, TRSV and CLRV but differences in transmission efficiency between European *X. rivesi* populations and non-European *X. americanum s.l.* populations might exist but there are no indications that European populations would be less efficient vectors than for example North American populations (see also Annex F)

Evaluate the probability of entry and indicate the elements which make entry most likely or those that make it least likely. Identify the pathways in order of risk and compare their importance in practice.		<u>Probility of entry (including spread from infested areas in the EU): very high (uncertainty medium)</u> In general, each pathway by which infested soil may be moved into new areas is relevant and should be considered when formulating pest risk management options. In the present PRA, a detailed pathway analysis has only been conducted for the most important pathway "Soil attached to or associated with plants for planting". This pathway can be subdivided based on the origin of the pathway: I . Soil attached to or associated with plants for planting from EU-countries/regions where vector species of *X. americanum s.l.* are present. Probability of entry/spread: high II. Soil attached to or associated with plants for planting from third countries where vector species of *X. americanum s.l.* are present. Probability of entry: high (ranging from very low to high depending on the country/region of origin) The probability of entry of vector species of *X. americanum s.l.* infected with one or more of the nepoviruses ToRSV, TRSV, CLRV and PRMV has also been assessed: I . Soil attached to or associated with plants for planting from EU-countries/regions where the vector species of *X. americanum s.l.* are present. Probability of entry/spread: low II. Soil attached to or associated with plants for planting from third countries where vector species of *X. americanum s.l.* are present. Probability of entry: medium (ranging from very low to medium depending on the country/region of origin). For a more detailed subdivision based on the area of origin see questions 1.3 – 1.15.
Evaluate the probability of establishment, and indicate the elements which make establishment most likely or those that make it least likely. Specify which part of the PRA area presents the greatest risk of establishment.		<u>Probability of establishment: very high (uncertainty: low)</u> The pest is already present in several EU-countries in central and southern Europe for many years (France, Bulgaria, Germany, Italy, Portugal, Spain and Slovenia), although the presence in some of these countries may need confirmation (see question 7). *X. americanum s.l.* can probably establish in most parts of the PRA area, the most northern regions possibly excepted. The European species, *Xiphinema diversicaudatum* for example occurs widespread in the UK and Ireland with an apparent northerly limit in central Scotland (Taylor & Brown, 1976). Thus, the probability for establishment is very high with a low uncertainty.

List the most important potential economic impacts, and estimate how likely they are to arise in the PRA area. Specify which part of the PRA area is economically most at risk.		<u>Economic impact of *X. americanum s.l.* on its own: low (uncertainty: low)</u> *X. rivesi*, member of the *X. americanum* group, is already present in the EU and, as far as known, does not cause (significant) economic losses. New introductions of *X. americanum s.l.* are not expected to lead to additional economic losses. <u>Economic impact of *X. americanum s.l.* in combination with:</u> The main impact of *X. americanum s.l.* is its ability to transmit the four nepoviruses ToRSV, TRSV, CRLV and PRMV. ToRSV and TRSV are presently only locally present in the PRA area and, thus far, transmission of these viruses by *X. americanum s.l.* in the field is not known to occur. The main risk of introductions or spread of *X. americanum s.l.* into new areas in the EU will be (i) an increased probability that the nematode will acquire one or more of the four nepoviruses and (ii) the introductions of populations from third countries already carrying on or more of the four nepoviruses. Virus transmission by the nematode will increase the impact of the viruses in the EU because removal of infected plants will no longer be sufficient to control or eradicate the viruses. ToRSV is considered the most serious one of the four nepoviruses mentioned above and is able to cause major losses in fruit orchards especially blueberry and raspberry while the other viruses are presently not considered as important pests in the USA (except TRSV in blueberry). TRSV and ToRSV have a very wide host range and may also impact other crops (uncertainty). After introduction in the PRA area, the vector-virus combination will spread slowly because the nematodes will naturally spread 1 m at maximum per year. The virus-vector combination can be spread over larger distances by trade of plants with soil attached by which new plots or points can become infested. Once an orchard is infested and the crop is susceptible high yield losses (>50%) can occur. However, the total infested area will increase slowly. Thus, the first 10 years after its introduction (assuming a local infestation) only locally yield losses may occur. Over a longer period the virus-vector combination is expected to spread further especially by human assistance and the impact will become higher. However, when the effects of the viruses are serious, growers will likely take hygienic measures and use certified propagation material. These measures will slow down the spread and, thereby, limit the impact. In the USA, problems with ToRSV in grapes seem to have been solved by the use of resistant/tolerant rootstocks. The most commonly used rootstock in European apple orchards M9 seems to have tolerance for ToRSV. Resistant/tolerant rootstocks/cultivars are, however, not known for all host plants suffering from infection by the nepoviruses. On the long term, we assess the direct impact as follows for the different virus-vector combinations with a medium uncertainty: • ToRSV: high for several fruit crops (only high in cases where preventive measures fail and the vector-virus combination is introduced in an orchard and resistant/tolerant cultivars/root stocks are not grown) • TRSV: high for blueberry and probably also for grapes when fields become infested • CLRV and PRMV: low For both ToRSV and TRSV, we do not expect a high impact on a large scale because of the slow natural spread of the vector. For many crops that can become infected by ToRSV and TRSV the

		relative importance of *Xiphinema americanum s.l.* as a vector is not known and the impact of the virus-vector combination could not be assessed. Indirect impact may occur through costs that need to be made to ensure export of plants for planting to countries where the nepoviruses are quarantine pests (certification and testing). In conclusion, the impact will generally be low on the short term (e.g. 10 years) but at the longer term locally high impacts can occur. <u>Environmental impact: low (uncertainty: medium)</u> *X. rivesi*, member of the *X. americanum* group, is already present in the EU and as far as known does not or have little environmental impact. Introduction of *X. americanum s.l* populations carrying one or more of nepoviruses ToRSV, TRSV, CRLV and PRMV is also expected to have no or little impact on the environment since the viruses are only known to cause significant negative effects on agricultural crops despite the fact that ToRSV and TRSV have been introduced in many countries in the world. <u>Social impact: generally low, incidentally or locally high (uncertainty: medium)</u> The viruses will spread slowly by the vector and economic losses at a large scale are not expected. The virus problem may increase slowly over time which will give growers the opportunity to take adequate measures to prevent infestation and/or use resistant/tolerant cultivates/rootstocks when replanting an orchard if available. Locally, a grower may suffer a large income effect because once an orchard has become infected with both the vector and the virus the disease is difficult to control. In the worst case an infestation of an orchard may lead to bankruptcy of the grower. Growers may also want to cancel meetings with other growers to avoid infestation.

The risk assessor should give an overall conclusion on the pest risk assessment and an opinion as to whether the pest or pathway assessed is an appropriate candidate for stage 3 of the PRA: the selection of risk management options, and an estimation of the associated pest risk.		Introduction on non-European populations of *X. americanum s.l.* on its own will have a low impact. The presence of vector species of *X. americanum s.l*. will, however, greatly increase the impact of the nepoviruses ToRSV and TRSV and to a lesser extent the impact of CLRV and PRMV when they would become introduced. Once the vector has acquired the virus, it will be very difficult or even impossible to eradicate the virus. A *X. americanum s.l*. species, *X. rivesi,* that is able to transmit the nepoviruses ToRSV, TRSV, CLRV and possibly PRMV is present in the PRA area (European Union). However, no measures are currently taken to prevent spread of this virus-vector species within the EU. Current phytosanitary measures are directed to prevent introduction of non-European populations of *X. americanum s.l.*. *X. americanum s.l.* is regularly intercepted on plants for planting and it is likely that despite inspection efforts *X. americanum s.l.* regularly enters the PRA area because of detection problems. It is, however, uncertain if the intercepted nematodes concern vector species of *X. americanum s.l*. The probability of spread within the EU of the vector species *X. rivesi* (member of the *X. americanum* group) may be higher than the probability of new introductions of vector species from third countries due to the lack of any official internal measures and the fact that this nematode species is present in several countries in central and southern Europe. Little information is available at the present distribution of *X. americanum s.l.* within the EU. It is probably present in 7 EU-countries but due to spread within the EU and/or due to introductions from third countries virus-vector species of the *X. americanum* group may already be more widespread in the EU. Therefore, a major uncertainty in the present PRA is the distribution of *X. americanum s.l*. vector species in the EU. It is, therefore, recommended to: • Conduct an EU-wide survey on the presence of vector species of *Xiphinema americanum s.l.* It is also recommended to reconsider current management options to prevent introduction of *X. americanum s.l*. for the following reasons: • At least one virus-vector species (*X. rivesi*) is already present in the PRA area (EU); • No measures are directed to prevent spread of this species within the EU although it is known as an efficient vector of at least 3 of the 4 nepoviruses including the two most serious ones ToRSV and TRSV; • Current management measures do not seem sufficiently effective to prevent introductions from outside the EU. Phytosanitary measures may be considered to prevent spread from the virus-vector species already present in Europe or may be limited to non-European populations carrying one or more of the nepoviruses ToRSV, TRSV, CLRV and PRMV. In that case, measures could be limited to countries/areas where both the vector and one or more of the four viruses are present which is further discussed in the Pest Risk Management part of this PRA.

This is the end of the Pest risk assessment	

Identification and evaluation of management options

Three main option are discussed: parts I – III. In part I measures to prevent introduction into and spread of vector species of *Xiphinema americanum s.l.* in the EU are discussed. In part II, measures are discussed to prevent introduction and spread of *Xiphinema americanum s.l.* infected with one or more of the nepoviruses ToRSV, TRSV, CRLV and PRMV. Part III combines measures from part I and part II: prevention of infestation of fruit orchards with vector species of *Xiphinema americanum s.l.* and prevention of introduction of vector species of *Xiphinema americanum s.l.* infected with one or more of the nepoviruses for other crops.

Presently, all non-European populations of *X. americanum s.l.* are regulated independent if they can act as a vector of the 4 viruses or not. *X. americanum s.l.* is, however, a complex group of 51 putative species of which 7 are known or have been reported to act as a vector of one or more of the 4 viruses mentioned above (Lamberti *et al*., 2000; Annex F, G). Within the EU, at least one vector species is present, *X. rivesi,* and several non-vector species, e.g. *X. pachtaicum* and *X. taylori* (Lamberti *et al*., 2000; Annex F). Measures could be directed to all *X. americanum* – group species within and outside the EU, thus including vector and non-vector species. This option would, however, greatly affect trade since many *X. americanum* – group species are present in Europe of which some occur widespread (Lamberti *et al*., 2000). Moreover, all known *X. americanum* – group species in Europe except *X. rivesi* are not considered a risk and, therefore, **the management options described below are limited to the vector species within the *X. americanum* – group** (which includes *X. rivesi*). The limitation of this approach is ,however, that more *X. americanum* group species than presently known may be able to act as an virus-vector (see also questions 2, 7 and Annex F in the PRA) and the identification of the different species within the *X. americanum* – group is difficult and new information and insights may result in adaptation of the classification described by Lamberti *et al.* (2000), e.g. lumping of species within the *X. americanum* group. Therefore, the possibility exsist that the names of the nematode species that are involved can change in time.

Part I: measures to prevent introduction and spread of vector species of *Xiphinema americanum s.l.*

<u>Pathway 1: import or internal trade of plants intended for planting with soil attached or associated with soil</u>

I. *Measures at place of production*

a. Plants should originate from a pest free production area, place of production of production site: highly effective
b. Plants should be grown in soilless medium: highly effective
c. Treatment of the plants: cannot guarantee absence of nematodes; see questions 1.5 and 2.3 in the Assessment part of this PRA
d. Use of resistant varieties: such varieties are not available for the large number of host plants

Measures a and b are sufficiently effective on their own. However, these measures may largely interfere with trade and will include many inspections, testing and certification (plant passports) since the nematode is highly polyphagous and is already present in several EU-countries (see question 7). The present distribution of a vector species of *X. americanum s.l.* (*X. rivesi*) within the EU is uncertain and may include more countries than presently known. Measures to prevent spread within the EU may limit or even stop trade of plants from areas where the nematode vector is already present. These measures may not be cost-effective since the direct damage of the pest is assessed as “low”.

II. *Measures on the commodity moving in trade*

Treatment (physical, thermal, chemical, irradiation) is no option: a treatment (physical, thermal or irradiation) that will eliminate the nematode will also destroy or harm the plants. Chemical treatment will probably not be fully effective (see above)

Removal of soil by shaking and rinsing of roots will decrease the risk but cannot guarantee absence of nematodes for 100% since small particles can easily remain on for example root hairs. Small soil particles will usually dry out rapidly and *X. americanum s.l.* poorly survives dry conditions. However, it is uncertain if some nematodes will survive rinsing, storage and transport conditions.

III. *Measures in the importing country*

a. Import inspection: visual inspection is not sufficiently effective since the pest can be symptomlessly present
b. Testing: not sufficiently effective to detect low infestation levels. It is not practicable to test all plants
c. Surveillance and eradication: not sufficiently effective (see question 1.26)

Conclusion:
The measures “plants should originate from a pest free production site” or “plants should be grown in soilless medium” are effective to prevent introduction or spread of vector species of *X. americanum* s.l. but may largely interfere with trade (depending on the present distribution of *X. rivesi* in the EU). The measures may not be cost-effective since the direct damage of the pest is assessed as “low”. However, when no measures are taken to prevent spread and new introductions of vector species of *X. americanum s.l* ,,the probability that nematode will acquire one or more of the nepoviruses, ToRSV, TRSV, CRLV and PRMV, following outbreaks of the nepoviruses, will increase. Once, the nematode vector has acquired one or more of the viruses, it will be very difficult or impossible to eradicate the viruses. Therefore, when no measures are taken against the vector species (which is presently the case for spread from infested areas within the EU), measures against the nepoviruses may need to be strengthened to lower the risk of introduction of these viruses.

Pathway 2: plant products for consumption (not to be planted in soil) with soil attached or associated with soil
Likewise for the pathway “plants for planting” the measures “products should originate from a pest free production site” or “plants should be grown in soilless medium” are effective measures. Within the EU, these measures may, however, largely interfere with trade and will include a lot of testing and certification.

For some products, treatment or rinsing may be an option to kill or remove nematodes, respectively, but data are lacking about the efficacy of such methods to guarantee that products are 100% free of *X. americanum s.l.* The probability of survival of *X. americanum s.l.* is low in dry soil and, therefore, products that are practically free of soil and on which the remaining soil particles are dry at arrival may not pose a phytosanitary risk for transfer of *X. americanum s.l.* but this is uncertain. Attached soil could be removed at the place where the products are being processed as long as there is no risk of transfer during transport and the waste soil is properly treated.

Pathway 3: soil as such
Presently import of soil is forbidden from most third countries. EU-internal movement of soil is, however, not regulated as well as import from several Mediterranean countries and continental European countries.

Options are:

a. soil may only be moved from sites that are free of vector species of *X. americanum* s.l.,
b. treatment of the soil that kill nematodes (e.g. steaming)

Because of the presence of a vector species of *X. americanum s.l.* in several EU-countries, the prohibition of movement of infested soil will include a lot of testing and certification and may not be feasible. Treatment of soil will not be feasible for large volumes of soil.

Part II: measures to prevent introduction and spread of *Xiphinema americanum s.l.* carrying one or more of the nepoviruses ToRSV, TRSV, CRLV and PRMV

Measures that are effective to prevent introduction of *Xiphinema americanum s.l.* are discussed above (Part I).

In Annex IV, Part A of EU directive 2000/29/EC, specific measures are formulated for plants of *Malus* Mill. (article 22.1), *Prunus* L. (article 23.2), *Rubus* L. (article 24), *Pelargonium* L'Herit. ex Ait. (article 31), intended for planting to assure freedom of Tomato ringspot virus (ToRSV), Cherry rasp leaf virus (CRLV) and/or Peach Rosette Mosaic Virus (PRMV). For Pelargonium, measures are more strict for areas where *Xiphinema americanum* Cobb *sensu lato* (non-European populations) (or other vectors of Tomato ringspot virus) are known to occur than for areas where vectors are not known to occur (Annex BII).

Pathway 1: import or internal trade of plants intended for planting with soil attached or associated with soil

I. *Measures at place of production*

a. Plants intended for planting, including seeds or other propagation material from which they have been derived, have been grown throughout their life in a production area, place or site free or free of ToRSV, TRSV, CRLV and PRMV (free in soil and plants).
b. Treatment of the crop and/or the use of resistant varieties: no good options because treatments are not effective and the viruses have a large host range and resistant varieties are not available at least not for many host plant species.

Measure (a) is sufficient effective on its own. The absence of symptoms will not be sufficient since certain host plants do not show any symptoms after infection (see question 6). Certification/official testing may need to be part of the measure to assure plants have been grown under appropriate conditions to guarantee freedom of the pest. The measure may affect trade from countries or regions where the viruses are present. Cost may need to be made by these countries/regions for certification programmes to guarantee pest freedom of the crop.

The absence of *Xiphinema americanum s.l.* at the production place would be sufficient to guarantee freedom of *Xiphinema americanum s.l.* carrying one or more of the nepoviruses but since the four nepoviruses are quarantine pests, plant for planting should be free of the 4 nepoviruses and, therefore, freedom of *X. americanum s.l.* alone is not sufficient.

II. *Measures on the commodity moving in trade*
Treatment (physical, thermal, chemical, irradiation) is no option: a treatment that will eliminate the virus will also destroy the plants.

III. *Measures in the importing country*

a. Import inspection: visual inspection is not sufficiently effective since the pest can be symptomlessly present.
b. Testing: extraction of nematodes and testing (PCR) for infection with ToRSV, TRSV, CRLV and/or PRMV. Such a method is presently not available but may be developed. The method on its own will not be sufficiently effective to detect low infestation levels since it is not practicable to test all plants. The measure could be used in combination with measures I a and I b to check on a random basis if the requirements are met.
c. Surveillance and eradication: not sufficiently effective, the viruses and the vector can be symptomless present; eradication is unlikely to be successful

<u>Pathway 2: plant products for consumption (not to be planted in soil) with soil attached or associated with soil</u>
The products do not necessarily need to be free of virus since they will be consumed and there will be a negligible risk of transfer to plants for planting. Associated soil may, however, be a means of transfer of nematodes carrying the viruses. For some products, treatment or rinsing may be an option to kill or remove nematodes, respectively, but data are lacking about the efficacy of such methods to guarantee that products are 100% of *X. americanum s.l.* The probability of survival of *X. americanum s.l.* is low in dry soil and, therefore, products that are practically free of soil and the remaining soil particles attached to the product are dry at arrival may be accepted but this is uncertain.

Options:

a. Plant products should originate from sites that are free of vector species of *X. americanum s.l.* or free of ToRSV, TRSV, CRLV and PRMV
b. Treatment or rinsing methods that kill or remove soil and nematodes (see Part I)

<u>Pathway 3: soil as such</u>
Presently, import of soil is forbidden from most third countries. EU-internal movement of soil is, however, not regulated as well as import from several Mediterranean countries and continental European countries.

Options:

a. Soil may only be moved from sites that are free of vector species of *X. americanum s.l.* or free of ToRSV, TRSV, CRLV and PRMV
b. Measures in the commodity in trade like steaming of soil is an option but not economically feasible for large volumes

Part III: Prevention of introduction and spread of vector species of *X. americanum s.l.* with fruit plant propagation material and fruit plants intended for planting of *Vitis* L., *Rubus* L., *Ribes* L., *Malus* Mill., *Vaccinium* L., *Pyrus* L. and *Prunus* L., and prevention of introduction of *X. americanum s.l* infected with ToRSV, TRSV, CRLV and/or PRMV for other plant species.

This option is a combination of options I and II. In option III, option I is limited to fruit plants to prevent infestation of fruit orchards with the vector nematode, while option II is in place for all other plant species, plant products and soil. The reasoning behind this option is that the viruses have the highest potential impact in fruit crops and the nematode vector is difficult to control in fruit orchards which are usually planted for many years. *Pyrus* L. is not known as a host plant of the viruses but *Pyrus* orchards may be replanted by apple (Malus). This option III decrease the probability of infestation of fruit orchards with vector species of *X. americanum s.l.* while its impact on trade will be limited as compared to option I. This option does, however, not prevent infestation of fields with vector species of *X. americanum s.l.* that are presently not used for one of the fruit crops mentioned above but may be used for that purpose in the future.

Conclusion management options *X. americanum s.l.*

Present measures in the EU against *X. americanum s.l.* are not consistent since a vector species of *X. americanum s.l.* is present in the EU and no measures are in place to prevent spread of this species while all non-European populations are regulated including those originating from areas where the viruses which it can transmit are absent and including those not known to act as a vector of the viruses. Three main management options have, therefore, been evaluated in this PRA:

I. Prevention of introduction and spread of vector species of *X. americanum s.l.* Internal measure could be taken to prevent spread of *X. americanum s.l.* within the EU and introduction from outside the EU. These measures may largely interfere with trade and may not be cost-effective. The impact of this option for internal trade and its cost-effectiveness will largely depend on the distribution of the vector species *X. rivesi* in the EU, which is presently uncertain.

II. Prevention of introduction of *X. americanum s.l* infected with ToRSV, TRSV, CRLV and/or PRMV. Measures directed to prevent introduction and spread of *X. americanum s.l.* carrying one or more the nepoviruses ToRSV, TRSV, CRLV and PRMV. These measures will presently not interfere with internal trade since no *Xiphinema americanum s.l.* populations infected with one or more of the four nepoviruses are known to be present in the EU. The absence of measures to prevent introduction and spread of *X. americanum s.l.* increases the probability that nematode populations will acquire the nepoviruses in case of an outbreak of the viruses as compared to option I. The probability that nematode populations acquire the viruses in the EU, may not or only increases to limited extent as compared to the present situation where no measures are in place to prevent spread of European populations and measures taken to prevent entry from third countries are likely not fully effective (see question 1 of the Assessment part of this PRA).

    Presently, specific measures are in place for a few host plants: *Malus* Mill., *Prunus* L., *Rubus* L.and *Pelargonium* L'Herit. ex Ait., to guarantee freedom of ToRSV, CRLV and/or PRMV but not for the majority of host plants (EU directive 2000/29/EC, Annex IV, Part A). Because the viruses can be symptomlessly present specific measures are required to guarantee pest freedom of the plants.

III. Prevention of introduction and spread of vector species of *X. americanum s.l.* with fruit plant propagation material and fruit plants intended for planting of *Vitis* L., *Rubus* L., *Malus* Mill., *Vaccinium* L. and *Prunus* L., and prevention of introduction of *X. americanum s.l* infected with ToRSV, TRSV, CRLV and/or PRMV for other plant species.
    This option is a combination of options I and II. In option III, option I is limited to fruit plants suffering most of infection by ToRSV, TRSV, CRLV and/or PRMV while option II is in place for all other plant species, plant products and soil. This option III decrease the probability of infestation of fruit orchards with *X. americanum s.l.* while its impact on trade will be limited as compared to option I. This option does, however, not prevent infestation of fields with *X. americanum s.l.* that are presently not used for one of the fruit crops mentioned above but may be used for that purpose in the future.

Note. Options I and III can be difficult to implement:

- Seven species within the *X. americanum* - group are known or have been reported as a vector species of one ore more of the 4 viruses mentioned aboven. More species may, however, be able to act as an vector (see also Annex F).
- Identification of the different species within the *X. americanum* – group is difficult and new information and insights may result in adaptation of the classification described by Lamberti *et al.* (2000), e.g. lumping of species within the *X. americanum* group. Therefore, the possibility exists that the names of the nematode species that are involved can change in time.

References

Alkemade, J.R.M., Loof, P.A.A., 1989. Observations on the ontogeny of some species of *Xiphinema* (Nematoda: Dorylaimida). Mededelingen van de Faculteit Landbouwwetenschappen Rijksuniversiteit Gent 54: 1177-1186

Allen, W.R., Van Schagen, J.G., Ebsary, B.A., 1984. Comparative transmission of the peach rosette mosaic virus by Ontario p[opulations of *Longidorus diadecturus* and *Xiphinema americanum* (Nematdoda:Longidoridae). Canadian Journal of Plant Pathology 6:29-32

Allen, W.R., 1986. Effectiveness of Ontario populations of *Longidorus diadecturus* and *L. breviannulatus* as vectors of peach rosette mosaic and tomato blackring viruses. Canadian Journal of Plant Pathology 8:49-53

Allen, W.R., Ebsary, B.A., 1988. Transmission of raspberry ringspot, tomato black ring, and peach rosette mosaic viruses by an Ontario population of *Longidorus elongatus*. Canadian Journal of Plant Pathology 10:1-5

Almeida, A.M.R., Corso, I.C., 1991. Effect of sowing time on the incidence of Bud blight in soybean (Glycine ,ax L. Merr.) Journal of Phytopathology 132 (3): 251-257.

Anonymous, 1987. Gids voor grondontsmetting in de praktijk. Shell Nederland Chemie B.V.

Arias, M., Navacerrada, G., 1973. Geographical distribution of *Xiphinema* Cobb in Spanish vineyards. Nematologia Mediterranea 1: 28-35

Auger, J., 1989. *Tomato ringspot virus* (TomRSV) associated with brownline disease or prune trees in Chile. Acta horticulturae 235:197 -204

Auger, J., Leal, G., 2009. *Xiphinema rivesi* from Chile Transmits *Tomato ringspot virus* to Cucumber. Plant Disease 93: 971

Baker, C.A., Atkins, S., 2007. *Tobacco ringspot virus* Found in the Cardboard Cycad (*Zamia furfuracea*) in Florida. Plant Disease 91: 112

Bergeson, G.B., Athow, K.L., Laviolette, F.A., Thomasine, M., 1964. Transmission, movement, and vector relationships of *Tobacco ringspot virus* in Soybean. Phytopathology 54: 723-728

BCMAFF, 2003. An Overview of the BC Floriculture Industry. Factsheet October 2003, Ministry of Agriculture, Food & Fisheries, British Columbia, Canada.

Bello, A. Robertson, L. Diez-Rojo, M. A. Arias, M., 2005. A re-evaluation of the geographical distribution of quarantine nematodes reported in Spain. Nematologia Mediterranea 33: 209-216

Bitterlin, M. W. Gonsalves, D., 1987. Spatial distribution of Xiphinema rivesi and persistence of *Tomato ringspot virus* and its vector in soil. Plant Disease 71: 408-411

Blok, W.J., Lamers, J.G., Termorshuizen, A.J. and G.J. Bollen, 2000. Control of soilborne plant pathogens by incorporating fresh organic amendments followed by tarping. Phytopathology 90: 253-259

Boldyrev, M. I. Borzykh, G. T., 1979. Development of agrotechnical methods of controlling nematodes -- carriers of viruses. Sbornik Nauchnykh Trudov Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Sadovodstva (Sovershenstvovanie sortimenta i agrotekhnicheskikh priemov v sadovodstve) 29: 84-88

Boldyrev, M. I. Borzykh, G. T., 1983. Plants in the control of nematodes. Zashchita Rastenii, Moscow 9: 30

Bonsi, Stouffer, R., Mountain, W., 1984. Efficiency of transmission of *Tomato ringspot virus* by *Xiphinema americanum* and *X. rivesi*. Phytopathology 74: 626 (Abstr.).

Brown, D.J.F., Halbrendt, J.M., Jones, A.T., Vrain, T.C., Robbins, R.T., 1994. Transmission of three North American nepoviruses by populations of four distinct species of the *Xiphinema americanum* group. Phytopathology 84: 646 -649

Brown, D.J.F., Trudgill, D.L., 1997. Longidorid nematodes and their associated viruses. Pp1-40 in: Santos, A de *et al.* (eds.). An introduction to virus vector nematodes and their associated viruses. Gráfia de Coimbra Lda, Coimbra, Portugal.

Converse, R. H. Ramsdell, D. C., 1982. Occurrence of tomato and tobacco ringspot viruses and of dagger and other nematodes associated with cultivated highbush blueberries in Oregon. Plant Disease 66: 8, 710-712.

Converse RH, Stace-Smith R, 1971. Rate of spread and effect of tomato ringspot virus on red raspberry in the field. Phytopathology, 61:1104-1106

CABI, 2007. CABI Crop Protection Compendium. Data sheets on *Xiphinema americanum*, *Xiphinema diversicaudatum*, *Tomato ringspot virus*, *Cherry rasp leaf mosaic virus*, *Peach rosette mosaic virus*. Accessed October 2009.

CABI, 2010. CABI Crop Protection Compendium. Data sheets on *Tobacco ringspot virus*. Accessed October 2010.

Camba, M., Flores, R., Pallás, V., Gentit, P., Candresse, T., 2008. Viruses and viroids of peach trees. Pp 435 – 466 in: Layne, D.R., Bassi, D. (eds.). The peach, botany, production and uses. CABI, Wallingford, UK.

Campodonico OP, Montelongo SQ, 1988. Hot pepper virus disease in the Gulf of Mexico. Capsicum Newsletter, No. 7: 67

Dalmasso, 1969. Étude anatomique et taxonomique des genres *Xiphinema*, *Longidorus* et *Paralongidorus* (Nematoda : Dorylaimida). Mémoires du Muséum National d'Histoire Naturelle, Paris, Serie A, Zoologie 61 : 33 – 82

Dunleavy JM, 1957. The grasshopper as a vector of tobacco ringspot virus in soybean. Phytopathology, 47:681-682

EPPO, 1997a. EPPO datasheet *Xiphinema americanum* sensu lato. In: Smith, I.M., McNamara, D.G., Scott, P.R., Holderness, M. Quarantine pests for Europe.. 2nd Edn., CABI/EPPO, Wallingford, 1425 pp.

EPPO, 1997b. EPPO datasheet *Tomato ringspot nepovirus*. In: Smith, I.M., McNamara, D.G., Scott, P.R., Holderness, M. Quarantine pests for Europe.. 2nd Edn., CABI/EPPO, Wallingford, 1425 pp.

EPPO, 1997c. EPPO datasheet *Tobacco ringspot nepovirus*. In: Smith, I.M., McNamara, D.G., Scott, P.R., Holderness, M. Quarantine pests for Europe.. 2nd Edn., CABI/EPPO, Wallingford, 1425 pp.

EPPO, 1997d. EPPO datasheet *Cherry rasp leaf virus*. In: Smith, I.M., McNamara, D.G., Scott, P.R., Holderness, M. Quarantine pests for Europe.. 2nd Edn., CABI/EPPO, Wallingford, 1425 pp.

EPPO, 1997e. EPPO datasheet *Peach rosette mosaic virus*. In: Smith, I.M., McNamara, D.G., Scott, P.R., Holderness, M. Quarantine pests for Europe.. 2nd Edn., CABI/EPPO, Wallingford, 1425 pp.

EPPO, 2007. EPPO plant quarantine information retrieval system, version 4.6 (2007-07).

Evans, T. A. Miller, L. C. Vasilas, B. L. Taylor, R. W. Mulrooney, R. P. 2007. Management of *Xiphinema americanum* and soybean severe stunt in soybean using crop rotation. Plant Disease. 91: 216-219

Fadaei, A. A. Coomans, A. Ahmad Kheiri, 2003. Three species of the *Xiphinema americanum* lineage (Nematoda: Longidoridae) from Iran. (Special issue: In Memoriam: Dr Pierre Baujard 13 June 1952 - 4 December 2001). Nematology 5: 453-461

Forer LB, Stouffer RF, 1982. *Xiphinema* spp. associated with tomato ringspot virus infection of Pennsylvania fruit crops. Plant Disease 66: 735-736

Freeman, J.A., Stace-Smith, R., Daubeny, H.A., 1975. Effects of *Tomato ringspot virus* on the growth and yield of red raspberry. Canadian Journal of Plant Science 55: 749 – 754

Georgi, L. L., 1988a.Transmission of tomato ringspot virus by *Xiphinema americanum* and *X. rivesi* from New York apple orchards. Journal of Nematology 20: 304-308

Georgi, L. L., 1988b. Effect of three plant species on population densities of *Xiphinema americanum* and *X. rivesi.* Journal of Nematology 20: 474-477

Gonsalves, D., 1988. Tomato ringspot virus decline; tobacco ringspot virus decline. In: *Compendium of grape diseases*, pp. 49-51. American Phytopathological Society, St. Paul, USA.

Gopal K, 1996. Effect of budblight (TRSV) on yield of soybean. Plant Disease Research, 11(1):105-107

Griffin, G.D., 1996. Importance of soil texture to the pathogenicity of plant-parasitic nematodes on rangeland grasses. Nematropica 26: 27-37

Griffin, G. D., and Barker, K. R. 1966. Effects of soil temperature and moisture on the survival and activity of *Xiphinema americanum*. Proc. Helminthol. Soc. Wash. 33: 126-130

Halbrendt, J.M., Brown, D.J.F., 1992. Morphometric evidence for three juvenile stages in some species of *Xiphinema americanum sensu lato*. Journal of Nematology 24: 305-309

Halbrendt JM, Jing GN, Princen LH, Rossi C, 1996. Cruciferous green manure as an alternative to nematicide: the effect of glucosinolate content. Proceedings of the Ninth international conference on jojoba and its uses and of the Third international conference on new industrial crops and products. USA: Association for the Advancement of Industrial Crops, 458-465

Hansen AJ, O'Reilly HJO, Yorston JM, 1982. Stone Fruit Virus Diseases of British Columbia. Victoria, British Columbia: Ministry of Agriculture and Food.

Harris, A. R., 1979. Seasonal populations of Xiphinema index in vineyard soils of north-eastern Victoria, Australia. Nematologica 25: 336-347

Hoy, J.W., Mircetisch, S.M., Lownsberry, B.F. (1984) Differential transmission of Prunus tomato ringspot virus strains *Xiphinema californicum.* Phytopathology 74: 332-335

Iwaki, M. Komuro, Y., 1974. Viruses isolated from narcissus (Narcissus spp.) in Japan. V. Arabis mosaic virus. Annals of the Phytopathological Society of Japan 40: 4, 344-353

Jaffee, B.A., 1986. Parasitism of *Xiphinema rivesi* and *X. americanum* by zoosporic fungi. Journal of Nematology 18: 87-93

Jaffee, B.A., Glenn, D.M., Forer, L.B., Shaffer, R.L., 1988. Effect of soil texture on *Xiphinema americanum* and *X. rivesi*. Nematologica 34: 226 – 237

Jaffee, B.A., Harrison, M.B., Shaffer, R.L., Strang, M.B., 1987. Seasonal population fluctuation of *Xiphinema americanum* and *X. rivesi* in New York and Pennsylvania orchards. Journal of Nematology 19: 369 – 378

Jaffee, B.A., Shaffer, R.L., 1987. Parasitism of *Xiphinema americanum* and *X. rivesi* by *Catenaria anguillulae* and other zoosporic fungi in soil solution, Baermann funnels, or soil. Nematologica 33: 220 - 231

Jossey, S., Babadoost, M., 2006. First Report of *Tobacco ringspot virus* in Pumpkin (*Cucurbita pepo*) in Illinois. Plant Disease 90: 1361

Karssen, G., Van der Gaag, D.J., Lammers, J.W., 2008. Pest Risk Analysis for *Meloidogyne enterolobii*. Available at http://www.minlnv.nl/; accessed November 2009

Katoch, M., Ram, R. and Zaidi A.A., 2003. First Report of Tobacco ringspot virus in Gladiolus in India. link: http://www.ndrs.org.uk/ndr.php?id=007011 (accessed 28 April 2010)

Klos, E.J., Fronek, F., Knierum, J.A., Cation, D., 1967. Peach rosette mosaic transmission and control. Quarterly Bulletin of Michigan State University Agricultural Experiment Station 49: 287-293.

Kropley, R., 1961. Viruses causing rasp-leaf and similar diseases of sweet cherry. Annales of Applied Biology 49: 530 - 534
Lamberti, F. Ciancio, A., 1993. Diversity of *Xiphinema americanum*-group species and hierarchial cluster analysis of morphometrics. Journal of Nematology 25: 332-343.
Lamberti, F. Bravo, M. A. Agostinelli, A. Lemos, R. M., 1994. The *Xiphinema americanum*-group in Portugal with descriptions of four new species (Nematoda, Dorylaimida). Nematologia Mediterranea. 1994. 22: 2, 189-218
Lamberti, F. Molinari, S. Moens, M. Brown, D. J. F., 2000. The *Xiphinema americanum* group. I. Putative species, their geographical occurrence and distribution, and regional polytomous identification keys for the group. Russian Journal of Nematology 8: 65-84
Lamos, R.M., Santos de, M.S.N., Santos O. de, I.M. 1997. Control strategies for virus vector nematodes and their associated viruses. Pp 381-420 in: Santos, A de *et al.* (eds.). An introduction to virus vector nematodes and their associated viruses. Gráfia de Coimbra Lda, Coimbra, Portugal.
Lister, R.M., Raniere. L.C., Varney, E.H., 1963. Relationships of viruses associated with ringspot diseases of blueberry. Phytopathology 53: 1031-1035
Luepschen, N.S., Harder, H.H., Rohrbach, K.G., Sisson, M.A., 1974. Sweet cherry raspleaf incidence in Colorado. Plant Disease Reporter 58: 26-27
Loof, P.A.A., Luc, M. 1990. A revised polytomous key for the identification of species of the genus *Xiphinema* Cobb, 1913 (Nematoda: Longidoridae) with the exclusion of the *X. americanum*-group. Systematic Parasitology 16: 35-66
McGuire, J.M., Douthit LB, 1978. Host effect on acquisition and transmission of *Tobacco ringspot virus* by Xiphinema americanum. Phytopathology, 68(3):457-459
McKenry, M. V. Luvisi, D. Anwar, S. A. Schrader, P. Kaku, S., 2004. Eight-year nematode study from uniformly designed rootstock trials in fifteen table grape vineyards. American Journal of Enology and Viticulture. 2004. 55: 218-227
Meeder, A., Slagboom, E., Van den Berg, W., 2009. Marktdata boomkwekerijproducten: Nederland, Duitsland, Verenigd Koninkrijk, Frankrijk. Rapport Productschap Tuinbouw PT2009/34, Zoetermeer, The Netherlands.
Nasira, K. Maqbool, M. A., 1994. Occurrence of virus vector nematodes in Pakistan. Pakistan Journal of Nematology 12: 79-85
Niblack, T.L., Bernard, E.C., 1985. Plant parasitic nematode communities in dogwood, maple and peach nurseries in Tennessee. Journal of Nematology 17: 132 – 139
Noling, J.W., 2005. Nematode Management in tomatoes, peppers and eggplant. Entomology & Nematology Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Document ENY-032.
Pinkerton, J.N., Forge, T.A., Ivors, K.L., Ingham, R.E., 1999. Plant parasitic nematodes associated with grapevines, Vitis vinifera, in Oregon vineyards. Journal of Nematology 31: 624 – 634
Pinkerton, J. N., Kraus, J., Martin, R. R., Schreiner, R. P., 2008. Epidemiology of *Xiphinema americanum* and *Tomato ringspot virus* on red raspberry, *Rubus idaeus.* Plant Disease 92: 364-371
PPS, 2008. Fytosanitaire signalering 2008. Plant Protection Service, The Netherlands. Available at http://www.minlnv.nl/portal/page?_pageid=142,2268041&_dad=portal&_schema=PORTAL&p_file_id=39922. Accessed September 2009.
Ramsdell, D.C., Gillett, J.M., 1985. Relative susceptibility of American, French hybrid and European grape cultivars to infection by peach rosette mosaic virus. Phytopathologia Mediterranea, 24: 41-43
Ramsdell, D.C., Myers, R.L., 1978. Epidemiology of *peach rosette mosaic virus* in a Concord grape vineyard. Phytopathology 68: 447 – 450
Ramsdell, D.C., Gillett, J.M., Bird, G.W., 1995. Susceptibility of American grapevine scion cultivars and French hybrid rootstock and scion cultivars to infection by peach rosette mosaic nepovirus. Plant Disease 79: 154 – 157
Ramsdell, D.C., Gillett, J.M., 1998. *Peach rosette mosaic virus*. In: descriptions of plant viruses. Available at http://www.dpvweb.net/dpv/showdpv.php?dpvno=364, accessed October 2010
Robbins, R.T., Brown, D.J.F., 1991. Comments on the taxonomy, occurrence and distribution of Longidoridae (Nematoda) in North America. Nematologica 37: 395 – 419
Rosenberger, D.A., Gonsalves, D., Cummins, J.N., Harrison, M.B., 1982. Survey for tomato ringspot virus in apple orchards in eastern New York. Acta Horticulturae 130: 199 – 206
Runia, W.T., Molendijk, L.P.G., Paternotte, S.J., 2009. Biologisch grond ontsmetten: doorontwikkeling BGO noodzaak voor brede toepassing in land- en tuinbouw. Nieuwe Oogst. *N*ieuwe oogst / Magazine gewas 5 (20). - p. 13.
Rydén, K., 1972. Pelargonium ringspot – a virus disease caused by *tomato ringspot virus* in Sweden. Phytopathologische Zeitschrift 73: 178 – 182
Sastry K.S., Nayudu, M.V., 1978. Studies on tobacco ring spot virus from brinjal (Solanum melongena L.) with particular reference to purification and assessment of losses. Current Science, 47(22):846-848
Sirca, S., Stare, B.G., Plesko, I.M., Marn, M.V., Urek, G., Javornik, B., 2007. *Xiphinema rivesi* from Slovania transmit Tobacco ringspot virus and Tomato ringspot virus to cucumber bait plants. Plant Disease 91: 770

Sinclair, J.B.; Walker, J.C., 1956. A survey of ringspot on cucumber in Wisconsin. *Plant Disease Reporter* **40**, 19-20

Stobbs, L.W., Schagen, J.G., 1996. Occurrence of peach rosette mosaic virus on grapevine in southern Ontario. Plant Disease 80: 105

Subikova, V.; Kollerova, E.; Slovakova, L., 2002. Occurrence of nepoviruses in small fruits and fruit trees in Slovakia. Plant Protection Science. 2002. 38: 367-369

Sutherland, J. R., Sluggett, L. J., 1974. Time, temperature, and soil moisture effects on Xiphinema bakeri: nematode survival in fallow soil. Phytopathology 64: 507-513.

Taylor, C.E., Brown, D.J.F., 1976. The geographical distribution of *Xiphinema* and *Longidorus* nematodes in the British Isles and Ireland. Annals of Applied Biology 84: 383 – 402

Taylor, C.E., Brown, D.J.F., 1997. Nematode vectors of plant viruses. CABI, Wallingford, UK. 286p

Teliz, D., Grogan, R.G., Lownsbery, B.F., 1966. Transmission of Tomato ringspot, Peach yellow bud mosaic, and Grape yellow vein viruses by Xiphinema americanum. Phytopathology 56: 658-663

Thakur, M. P. Agrawal, K. C. Tuteja, S. S., 1993. Incidence of yellow mosaic and bud blight disease at different fields, irrigation schedules and their effect on yield parameters of soybean. Indian Journal of Virology 9: 78-81.

Tu, J. C., 1986. Incidence of *soybean mosaic virus* and *tobacco ringspot virus* in southwestern Ontario. Canadian Plant Disease Survey 66: 49-50

Urek, G. Sirca, S. Karssen, G., 2005. Morphometrics of *Xiphinema rivesi* Dalmasso, 1969 (Nematoda: Dorylaimida) from Slovenia. Russian Journal of Nematology 13: 13-17

Urek, G. Sirca, S. Kox, L. Karssen, G., 2003. First report of the dagger nematode *Xiphinema rivesi*, a member of the *X. americanum* group, from Slovenia. Plant Disease. 2003. 87: 100

Uyemoto, J.K., 1975. A severe outbreak of virus-induced grapevine decline in Cascade grapevines in New York. Plant Disease Reporter 59: 98-101

Verma, A.K., Khan, M.L., Anil-Handa, 2003. Transmission of tomato ringspot virus by *Xiphinema inaequale* (Khan and Ahmed, 1975) Bajaj and Jairajpuri 1979, associated with gladiololus in Himachal Pradesh. Pest Management and Economic Zoology 11: 189 – 192

Weldekidan, T., Evans, T.A., Carroll, R.B., Mulrooney, R.P., 1992. Etiology of soybean severe stunt and some properties of the causal virus. Plant Disease 76(7): 747 – 750

Walters, S.A., Bond, J.P., Russell, J.B., Taylor, B.H., Handoo, Z.A., 2008. Incidence and influence of plant-parasitic nematodes in southern Illinois peach orchards. Nematropica 38: 63-74

Wang, S., Gergerich, R.C., Wickizer, S.L., Kim, K.S, 2002. Localization of transmissible and nontransmissible viruses in the vector nematode *Xiphinema americanum.* Phytopathology 92: 646-653

Ward, L.I., Delmiglio, C., Hill, C.F., Clover, G.R.G., 2009 First report of *Tobacco ringspot virus* on *Sophora microphylla*, a native tree of New Zealand. BSPP New Disease Reports http://www.bspp.org.uk/publications/new-disease-reports/ndr.php?id=019028. Accessed January 2010.

Annex A. Distribution of four nepoviruses which can be transmitted by *Xiphinema americanum* s.l.

Table A.1. Distribution of Tomato ringspot virus according to EPPO (2007) and CABI (2007)

Continent	Country	Source	
		EPPO, 2007	**CABI, 2007**[1]
North America	Canada	present, limited distribution	present, restricted distribution
	United States	present, limited distribution	present, restricted distribution
	Mexico		present, no further details
Central America	Puerto Rico	present, no details	present, restricted distribution
South America	Argentina	present, no details	present, no further details
	Chile	present, limited distribution	present, restricted distribution
	Peru	Present, no details	present, no further details
	Venezuela	present, no details	present, no further details
Asia	China	Present, limited distribution	present, restricted distribution
	Iran	Present, no details	present, no further details
	Japan	present, no details	present, no further details
	Jordan	present and widespread	present, widespread
	Korea, Republic	present, no details	present, no further details
	Oman	Present, no details	present, no further details
	Pakistan	present, no details	present, no further details
	Turkey	present, limited distribution	present, restricted distribution
Africa	Egypt	present, no details	present, no further details
	Togo	present, no details	present, no further details
	Tunisia	Present, limited distribution	present, restricted distribution
Oceania	Australia	Present, few records	present, few occurences
	New Zealand	present, few records	present, few occurences
Europe	Belarus	present, no details	present, no further details
	Bulgaria		absent, formerly present
	Croatia	present, few records	present, few occurences
	Finland		present, no further details
	France	present, no details	present, no further details
	Germany	present, few records	present, few occurences
	Greece		absent, unreliable record
	Italy	present, few records	present, few occurences
	Lithuania	present, no details	present, no further details
	Russia	present, no details	present, no further details
	Serbia	present, limited distribution	present, no further details
	Slovakia	present, limited distribution	present, restricted distribution
	Slovenia	present, limited distribution	present, restricted distribution
	United Kingdom	present, few records	present, few occurences

1) Data from CABI are mainly based on EPPO, 2006. PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. www.eppo.org.

Table A.2. Distribution of Tobacco ringspot virus according to EPPO (2007) and CABI (2007)

Continent	Country	Source	
		EPPO, 2007	CABI, 2007
Asia	China	present, limited distribution	present, restricted distribution
	Georgia	present, no details	present, no further details
	India	present, no details	present, no further details
	Indonesia	present, no details	present, no further details
	Iran	present, no details	present, no further details
	Japan	present, no details	present, no further details
	Kyrgyzstan	present, no details	present, no further details
	Oman		present, no further details
	Saudi Arabia	present, no details	present, no further details
	Sri lanka	present, no details	present, no further details
	Taiwan	present, no details	present, no further details
	Turkey	Present, no details	present, no further details
Africa	Congo		present, no further details
	Egypt	present, no details	present, no further details
	Malawi	present, no details	present, no further details
	Morocco	present, no details	present, no further details
	Nigeria	present, no details	present, no further details
	Zaire	present, no details	
North America	Canada	Present, limited distribution	present, restricted distribution
	USA	Present, limited distribution	present, restricted distribution
	Mexico	Present, no details	present, restricted distribution
Central America	Cuba	Present, no details	present, no further details
	Dominican Republic	Present, no details	present, no further details
Southern America	Argentina	Present, no details 1)	present, no further details
	Brazil	Present, limited distribution	present, restricted distribution
	Peru		present, no further details
	Uruguay	present, few reports	present, few occurences
	Venezuela	Present, no details	present, no further details
Oceania	Australia	present, no details	present, no further details
	New Zealand	present, no details	present, no further details
	Papua New Guinea	present, no details	present, no further details
Europe	Czech Republic	Present, limited distribution	present, restricted distribution
	Hungary	Present, limited distribution	present, restricted distribution
	Lithuania	Present, no details	present, no further details
	Netherlands 2)	Present, few records.	absent, formerly present
	Poland	Present, no details	present, no further details
	Romania	Present, no details	present, no further details
	Russia	present, limited distribution	restricted distribution
	Serbia	Present, no details	present, no further details
	Ukraine	Present, no details	present, no further details
	United Kingdom	present, few records	present, few occurences

1) absent (EPPO Reporting Service 2009-9)
2) official status: transient, under eradication (NPPO of the Netherlands)

Table A.3. Distribution of Cherry rasp leaf virus according to EPPO (2007) and CABI (2007)

Continent	Country	Source	
		EPPO, 2007	**CABI, 2007**
North America	Canada	present, few records	present, few occurrences
North America	USA	present, limited distribution	present, restricted distribution

Table A.4. Distribution of Peach rosette mosaic virus according to EPPO (2007) and CABI (2007)

Continent	Country	Source	
		EPPO, 2007	**CABI, 2007**
North America	Canada	present, limited distribution	present, restricted distribution
	USA	present, limited distribution	present, restricted distribution
Europe	Turkey	present, limited distribution	present, restricted distribution
Africa	Egypt	present, no details	Present, no further details

Annex BI: EU legislation concerning soil and growing medium

Directive 2000/29/EC, Annex III, part A,
PLANTS, PLANT PRODUCTS AND OTHER OBJECTS THE INTRODUCTION OF WHICH SHALL BE PROHIBITED IN ALL MEMBER STATES:

Article 14
Soil and growing medium as such, which consists in whole or in part of soil or solid organic substances such as parts of plants, humus including peat or bark, other than that composed entirely of peat

Turkey, Belarus, Moldavia, Russia, Ukraine and
third countries not belonging to continental Europe, other than the following: Egypt, Israel, Libya, Morocco, Tunisia

Directive 2000/29/EC, Annex IV, part A, Section I
PLANTS, PLANT PRODUCTS AND OTHER OBJECTS WHICH MUST BE SUBJECT TO A PLANT HEALTH INSPECTION (AT THE PLACE OF PRODUCTION IF ORIGINATING IN THE COMMUNITY, BEFORE BEING MOVED WITHIN THE COMMUNITY — IN THE COUNTRY OF ORIGIN OR THE CONSIGNOR COUNTRY, IF ORIGINATING OUTSIDE THE COMMUNITY) BEFORE BEING PERMITTED TO ENTER THE COMMUNITY

Article 34
Soil and growing medium, attached to or associated with plants, consisting in whole or in part of soil or solid organic substances such as parts of plants, humus including peat or bark or consisting in part of any solid inorganic substance, intended to sustain the vitality of the plants, originating in:

- Turkey,
- Belarus, Georgia, Moldova, Russia, Ukraine
- non-European countries other than Algeria, Egypt, Israel, Libya, Morocco, Tunisia

Official statement that:
(a) the growing medium, at the time of planting, was:
— either free from soil, and organic matter,
or
— found free from insects and harmful nematodes and subjected to appropriate examination or heat treatment or fumigation to ensure that it was free from other harmful organisms,
or
— subjected to appropriate heat treatment or fumigation to ensure freedom from harmful organisms, and

(b) since planting:
— either appropriate measures have been taken to ensure that the growing medium has been maintained free from harmful organisms,
or
— within two weeks prior to dispatch, the plants were shaken free from the medium leaving the minimum amount necessary to sustain vitality during transport, and, if replanted, the growing medium used for that purpose meets the requirements laid down in (a).

Annex BII: EU legislation, special requirements concerning ToRSV, TRSV, CRLV and/or PRMV

Annex IV, Part A of EU directive 2000/29/EC

Article 22.1
Plants of *Malus* Mill. intended for planting, other than seeds, originating in countries where the relevant harmful organisms are known to occur on *Malus* Mill. Without prejudice to the provisions applicable to the plants, listed in Annex III(A)(9) and (18), Annex III(B)(1) and Annex IV(A)(I)(15), (17) and (19.2), official statement that:

The relevant harmful organisms are:
— Cherry rasp leaf virus (American),
— Tomato ringspot virus,

(a) the plants have been:
— either officially certified under a certification scheme requiring them to be derived in direct line from material which has been maintained under appropriate conditions and subjected to
official testing for at least the relevant harmful organisms using appropriate indicators or equivalent methods and has been found free, in these tests, from those harmful organisms,

or

— derived in direct line from material which is maintained under appropriate conditions and subjected, within the last three complete cycles of vegetation, at least once, to official testing for at least the relevant harmful organisms using appropriate indicators or equivalent methods and has been found free, in these tests, from those harmful organisms;

(b) no symptoms of diseases caused by the relevant harmful organisms have been
observed on plants at the place of production, or on susceptible plants in its immediate vicinity, since the beginning of the last complete cycle of vegetation.

Article 23.2
Plants of *Prunus* L., intended for planting

(a) originating in countries where the relevant harmful organisms are known to occur on *Prunus* L.

(b) other than seeds, originating in countries where the relevant harmful organisms are known to occur

(c) other than seeds, originating in non-European countries where the relevant harmful organisms are known to occur

The relevant harmful organisms are:

— for the case under (a):
  — Tomato ringspot virus;

— or the case under (b):
  — Cherry rasp leaf virus (American),
  — Peach mosaic virus (American),
  — Peach phony rickettsia,
  — Peach rosette mycoplasm,
  — Peach yellows mycoplasm,
  — Plum line pattern virus (American),
  — Peach X-disease mycoplasm;

— or the case under (c):
  — Little cherry pathogen.

Without prejudice to the provisions applicable to the plants, where appropriate listed in Annex
III(A)(9) and (18) or Annex IV(A)(I)(15), (19.2) and (23.1), official statement that
(a) the plants have been:
— either officially certified under a certification scheme requiring them to be derived in direct line from material which has been maintained under appropriate conditions and subjected to official testing for at least the relevant harmful organisms using appropriate indicators or equivalent

methods and has been found free, in these tests, from those harmful organisms,

or
— derived in direct line from material which is maintained under appropriate conditions and has been subjected, within the last three complete cycles of vegetation, at least once, to official testing for at least the relevant harmful organisms using appropriate indicators or equivalent methods and has been found free, in these tests, from those harmful organisms, (b) no symptoms of diseases caused by the relevant harmful organisms have been observed on plants at the place of production or on susceptible plants in its immediate vicinity, since the beginning of the last three complete cycles of vegetation.

Article 24
Plants of *Rubus* L., intended for planting:

(a) originating in countries where harmful organisms are known to occur on *Rubus* L.
(b) other than seeds, originating in countries where the relevant harmful organisms are known to occur

The relevant harmful organisms are:
— in the case of (a):
    — Tomato ringspot virus,
    — Black raspberry latent virus,
    — Cherry leafroll virus,
    — Prunus necrotic ringspot virus,
— in the case of (b):
    — Raspberry leaf curl virus (American)
    — Cherry rasp leaf virus (American)

Without prejudice to the requirements applicable to the plants, listed in Annex IV(A) (I)(19.2),
(a) the plants shall be free from aphids, including their eggs

(b) official statement that:

(aa) the plants have been:
— either officially certified under a certification scheme requiring them to be derived in direct line from material which has been maintained under appropriate conditions and subjected to official testing for at least the relevant harmful organisms using appropriate indicators or equivalent methods and has been found free, in these tests, from those harmful organism,

or

— derived in direct line from material which is maintained under appropriate conditions and has been subjected, within the last three complete cycles of vegetation, at least once, to official testing for at least relevant harmful organisms using appropriate indicators for equivalent methods and has been found free, in these tests, from those harmful organism

(bb) no symptoms of diseases caused by the relevant harmful organisms have been observed on plants at the place of production, or on susceptible plants in its immediate vicinity, since the beginning of the last complete cycles of vegetation.

Article 31
Plants of *Pelargonium* L'Herit. ex Ait., intended for planting, other than seeds, originating in countries where Tomato ringspot virus is known to occur:

Without prejudice to the requirements applicable to the plants listed in Annex IV(A) (I)(27.1 and) (27.2),

(a) where *Xiphinema americanum* Cobb sensu lato (non-European populations) or other vectors of Tomato ringspot virus are not known to occur official statement that the plants:

    (a) are directly derived from places of production known to be free from Tomato ringspot virus;

    or

(b) are of no more than fourth generation stock, derived from mother plants found to be free from Tomato ringspot virus under an official approved system of virological testing.

(b) where Xiphinema americanum Cobb sensu lato (non-European populations) or other vectors of Tomato ringspot virus are known to occur official statement that the plants:

(a) are directly derived from places of production known to be free from Tomato ringspot virus in the soil or plants;

or

(b) are of no more than second generation stock, derived from mother plants found to be free from Tomato ringspot virus under an officially approved system of virological testing.

Annex C: Notifications of non-compliance for *Xiphinema* spp. from EU-countries from 2006 – 2008 (source: Europhyt; accessed 16 November 2009)

Year of inteception	Exporting country/region	*Xiphinema* sp.[1)]	Xiphinema americanum[2)]
2006	China	0	3
	Indonesia	0	1
	Japan	5	8
2007	Japan	4	16
2008	China	0	4
	Japan	0	15
	Northern Africa	5	0
	Spain	1	0

1) *Xiphinema* species not indicated in Europhyt
2) Interceptions by the Netherlands notified as *Xiphinema* sp. all concerned *X. americanum s.l.* (source: NPPO of the Netherlands)

Annex D: Crop acreage in the EU

Table D.1 Blueberry acreage (in 1000 ha)

Country	**2007 - FOA**
EU (27)	14.1
Austria	
Belgium	
Bulgaria	
Cyprus	
Czech Republic	
Denmark	0.0
Estonia	
Finland	
France	
Germany	1.4
Greece	
Hungary	0.0
Ireland	
Italy	0.2
Latvia	
Lithuania	5.0
Luxembourg	
Malta	
Netherlands	1.0
Poland	2.0
Portugal	
Romania	0.6
Slovakia	
Slovenia	0.0
Spain	
Sweden	4.0
United Kingdom	
* source data FAOstat	

Table D.2. Soybean acreage (in 1000 ha)

Country	2003-Eurostat	2004-Eurostat	2005-Eurostat	2006-Eurostat	2007-Eurostat	2007 - FAO	total avg 2007*
EU (27)							357,9
Austria	15.5	17.9	21,4	25	20.2	20.2	20.2
Belgium	:	:	:	:	:		
Bulgaria	0.5	0.3	0.3	0.1	0.1	0.1	0.1
Cyprus	:	:	:	:	:		
Czech Republic	7.7	9	9.3	9.6	7.5		7.5
Denmark	:	:	:	:	:		
Estonia	:	:	:	:	:		
Finland	:	:	:	:	:		
France	80.7	58.6	57.4	45.3	32.4	37.0	34.7
Germany	:	:	:	:	:	1.0	1.0
Greece	0	0	0	0	0	2.0	1.0
Hungary	30.3	27.3	33.6	35.9	32.9	30.9	31.9
Ireland	:	:	:	:	:		
Italy	152	150	152	178	130	132.6	131.5
Latvia	:	:	:	:	:	0.0	0.0
Lithuania	:	:	:	:	:		
Luxembourg	:	:	:	:	:		
Malta	:	:	:	:	:		
Netherlands	:	:	0	0	0		0.0
Poland	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Portugal	:	:	:	:	:		
Romania	129	121	143	191	133	109.3	121.3
Slovakia	11.1	8.6	10.7	12.3	7.9	7.8	7.8
Slovenia	0	0.1	0.2	0.2	0.1	0.1	0.1
Spain	0.3	0.1	1	0.6	0.6	0.6	0.6
Sweden	:	:	:	:	:		
United Kingdom	1.1	1	1	1	:		

***** Average of Eurostat and FAO stat values

Available flags:			Special values:
b break in series	p provisional value	:c confidential	- not applicable or real zero or zero by default
e estimated value	r revised value	:n not significant	0 less than half of the unit used
f forecast	s eurostat estimate	:u extremely unreliable data	: not available
i see explanatory notes	u unreliable/uncertain data		

Table D.3. Cherry acreage (in 1000 ha)

Country	2003-Eurostat	2004-Eurostat	2005-Eurostat	2006-Eurostat	2007-Eurostat	2007 – FAO	avg 2007*
EU (27)							159.1
Austria	0.1	0.1	0.1	0.1	0.2	0.1	0.2
Belgium	1.2	1.3	1.2	1.2	:	1.2	1.2
Bulgaria	12.9	13.7	13.5	14.9	15.8	12.1	14.0
Cyprus	0.2	0.2	0.2	0.3	0.2	0.2	0.2
Czech Republic	2.5	2.6	2.6	3	3.2	1.1	2.2
Denmark	2.5	2.5	1.9	1.9	:	0.1	0.1
Estonia	0	0	0	0	0	0.4	0.2
Finland	:	:	:	:	:		
France	12.2	12.2	12.1	12	11.1	11.1	11.1
Germany	9.6	9.7	9.8	9.8	8.9	5.4	7.2
Greece	10.7	10.6	10.3	10.3	8.2	10.0	9.1
Hungary	17.8	18	18.8	15.2	15.7	1.7	8.7
Ireland	:	:	:	:	:		
Italy	30.2	30	29.3	29.7	29.7	29.7	29.7
Latvia	1	0.9	0.9	0.8	0.7	0.7	0.7
Lithuania	0.8	0.8	1.3	2.1	1.2	1.5	1.4
Luxembourg	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Malta	:	:	:	:	:		
Netherlands	0.6	0.6	0.6	0.6	0.7	0.7	0.7
Poland	48.8	50	44	46.3	47.9	10.3	29.1
Portugal	6	6.3	6.3	6.4	6.3	6.4	6.4
Romania	9.9	9.6	8.7	7.2	7.7	7.7	7.7
Slovakia	0.3	0.2	0.2	0.3	0.3	0.1	0.2
Slovenia	0.2	0.2	0.2	0.2	0.1	0.1	0.1
Spain	28.7	25.9	24.1	24.3	24.1	32.9	28.5
Sweden	:	:	0.1	:	:	0.2	0.2
United Kingdom	0.4	0.4	0.4	0.4	0.4	0.4	0.4

***** Average of Eurostat and FAO stat values

Table D.4. Apple acreage (in 1000 ha)

Country	2003-Eurostat	2004-Eurostat	2005-Eurostat	2006-Eurostat	2007-Eurostat	2007 - FAO	avg 2007 1)
EU (27)							747.2
Austria	5.9	6.1	6.1	6.1	6.1	6.1	6.1
Belgium	8.4	8.3	8.9	8.6	8.5	8.5	8.5
Bulgaria	7.8	7.4	5.4	5.7	5.4	5.4	5.4
Cyprus	1.2	1.2	1.3	1.3	1.1	1.1	1.1
Czech Republic	9.3	9.1	9.1	9.5	9.9	12.5	11.2
Denmark	1.5	1.5	1.6	1.5	:	1.5	1.5
Estonia	0.6	0.9	1.4	1.4 (p)	1.1	4.3	2.7
Finland	0.6	0.6	0.6	0.6	0.6	0.6	0.6
France	59	58.1	57.7	55	53.4	53.8	53.6
Germany	31.2	32.3	32.3	32.5	31.8	31.7	31.8
Greece	10.9	10.8	10.7	10.7	12.2	13.0	12.6
Hungary	43.5	43.2	42	45.5	43.5	40.5	42.0
Ireland	:	:	:	:	:	0.7	0.7
Italy	61.3	61.7	61.7	61.7	60.6	61.2	60.9
Latvia	8.2	8.3	8.5	9.4	7.4	7.4	7.4
Lithuania	18.6	18.6	22.5	16.7	12.7	13.3	13.0
Luxembourg	1	1	1	1	1	1.0	1.0
Malta	:	:	:	:	:	0.0	0.0
Netherlands	10.3	10.2	9.7	9.6	9.4	9.4	9.4
Poland	159	175	170	162	176	175.6	175.6
Portugal	21.6	21.4	20.8	20.7	20.5	20.7	20.6
Romania	71.6	73.4	81.7	59.3	59	57.6	58.3
Slovakia	3.5	3.3	3.2	3.4	3.2	3.2	3.2
Slovenia	3.1	3.1	3.1	3.1	2.9	2.9	2.9
Spain	46	42.2	39	37.8	36.9	35.3	36.1
Sweden	1.5	1.4	1.4	1.6	1.4	1.5	1.5
United Kingdom	16.7	14.4	15	15.6	15	15.0	15.0

1) Average of Eurostat and FAO stat values

Table D.5. Peach acreage (in 1000 ha)

Country	2003-Eurostat	2004-Eurostat	2005-Eurostat	2006-Eurostat	2007-Eurostat	2007 - FAO	2007*
EU (27)							259.7
Austria	0.3	0.3	0.2	0.2	0.2	0.2	0.2
Belgium	0	0	0	0	0	6.2	3.1
Bulgaria	6.1	6.1	6	5.9	6.2	0.8	3.5
Cyprus	0.4	0.4	0.4	0.5	0.5	1.6	1.1
Czech Republic	1.2	1.3	1.3	1.3	1.2		1.2
Denmark	:	:	:	:	:		
Estonia	:	:	:	:	:		
Finland	:	:	:	:	:		
France	11.9	11.1	10.9	10	8.1	15.5	11.8
Germany	0.1	0.1	0.1	0	0	0.1	0.1
Greece	33.5	31.7	31.6	31.6	36.9	36.9	36.9
Hungary	8.2	8.1	8.2	8.1	8	6.7	7.4
Ireland	:	:	:	:	:		
Italy	64.6	63.8	62	61	60.3	93.2	76.7
Latvia	:	:	:	:	:		
Lithuania	:	:	:	:	:		
Luxembourg	:	:	:	:	:		
Malta	:	:	:	:	:	0.1	0.1
Netherlands	:	:	0	0	0		0.0
Poland	3.8	3.7	3.3	3.2	3.3	3.3	3.3
Portugal	6.5	6.3	6.2	5.9	5.8	5.9	5.9
Romania	2.9	2.8	2.6	1.9	1.8	1.8	1.8
Slovakia	0.8	0.8	0.7	0.8	0.7	0.7	0.7
Slovenia	0.6	0.6	0.6	0.6	0.5	0.5	0.5
Spain	78.5	58.3	58.5	57.2	54.9	77.0	65.9
Sweden	:	:	:	:	:		
United Kingdom	:	:	:	:	:		

***** Average of Eurostat and FAO stat values

Table D.6. Raspberry acreage (in 1000 ha)

Country	2003-Eurostat	2004-Eurostat	2005-Eurostat	2006-Eurostat	2007-Eurostat	2007 - FAO	avg 2007*
EU (27)							32.1
Austria	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Belgium	0	0	0	0	:	0.0	0.0
Bulgaria	1.2	1.7	2	2.1	1.4	1.4	1.4
Cyprus	:	:	:	:	:		
Czech Republic	0	0	0	0	:	0.0	0.0
Denmark	0	0	0	0	:	0.0	0.0
Estonia	0.2	0.1	0.2	0.2	0.1	0.4	0.3
Finland	0.5	0.5	0.5	0.5	0.5	0.4	0.5
France	1.5	1.3	1.3	1.3	1.2	1.2	1.2
Germany	:	:	1.1	1.1	1.1	1.1	1.1
Greece	:	:	:	:	:		
Hungary	1.8	1.7	1.7	1.5	1.5	1.5	1.5
Ireland	0	0	0	0	:	0.0	0.0
Italy	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Latvia	0.1	0.3	0.2	0.1	0.1		0.1
Lithuania	0.4	0.4	0.8	0.9	1	1.1	1.1
Luxembourg	:	:	:	:	:		
Malta	:	:	:	:	:		
Netherlands	0	0	0	0	0	0.1	0.0
Poland	13.3	14.2	17.8	17	20.6	20.6	20.6
Portugal	:	:	:	:	:		
Romania	:	0.1	0.1	0	0	0.0	0.0
Slovakia	0.1	0.1	0.1	0.1	0	0.0	0.0
Slovenia	0	0	0	0	0	0.0	0.0
Spain	:	:	:	:	:	1.4	1.4
Sweden	:	:	0.2	:	:	0.1	0.1
United Kingdom	1.3	1.3	1.4	1.5	1.6	1.6	1.6

***** Average of Eurostat and FAO stat values

Table D.7. Grape acreage (in 1000 ha)

Country	2003-Eurostat	2004-Eurostat	2005-Eurostat	2006-Eurostat	2007-Eurostat	2007 - FAO	avg 2007*
EU (27)							3637.0
Austria	45	43.5	45.7	45.7	43.9	44.2	44.1
Belgium	0	0	0	0	:	0.1	0.1
Bulgaria	131.1	129.6	126.8	: (c)	120.3	120.3	120.3
Cyprus	12.5	12.1	12	9.1	8.2	8.2	8.2
Czech Republic	11.8	13	14.3	15.5	17	17.0	17.0
Denmark	:	:	:	:	:		
Estonia	:	:	:	:	:		
Finland	:	:	:	:	:		
France	851.2	851.8	853.9	842.4	:	827.6	827.6
Germany	98.3	:	:	:	:	99.7	99.7
Greece	117.8	115.2	112.8	112.8	108.0 (p)	80.0	80.0
Hungary	93	93.2	86	83.7	82.4	75.3	78.8
Ireland	:	:	:	:	:		
Italy	791.3	786.7	792.7	786.1	782.2	770.0	776.1
Latvia	:	:	:	:	:		
Lithuania	:	:	:	:	:		
Luxembourg	1.3	1.2	1.2	1.4	1.4	1.4	1.4
Malta	:	:	:	:	:	0.8	0.8
Netherlands	0	0.1	0.1	0.1	0.1	0.1	0.1
Poland	0.2	0.2	0.3	0.2	0.4		0.4
Portugal	222.4	222.5	222.5	222.6	222.7	222.6	222.7
Romania	223.1	196.7	187.8	190.5	187.6	187.6	187.6
Slovakia	12.6	12	13.1	11.8	11.5	11.5	11.5
Slovenia	16.6	16.6	16.4	16.4	16.1	16.1	16.1
Spain	1165	1167	1160	1135	1130.7	1157.9	1144.3
Sweden	:	:	:	:	:		
United Kingdom	0	0.8	0	0	0	0.7	0.4

***** Average of Eurostat and FAO stat values

Table D.8. Egg plant acreage (in 1000 ha)

Country	2003-Eurostat	2004-Eurostat	2005-Eurostat	2006-Eurostat	2007-Eurostat	2007 - FAO	avg 2007*
EU (27)							56.0
Austria	0	0	0	0	0	0.0	0.0
Belgium	0	0	0	0	0	0.0	0.0
Bulgaria	1.3	1.6	0.5	0.3	0.4	0.4	0.4
Cyprus	0.1	0.1	0.1	0.1	0	0.0	0.0
Czech Republic	:	:	:	:	:		
Denmark	:	:	:	:	:		
Estonia	:	:	:	:	:		
Finland	:	:	:	:	:		
France	0.5	0.5	0.4	0.4	0.4	0.4	0.4
Germany	:	:	:	:	:		
Greece	3.1	3.1	3	2.7	2.9	2.9	2.9
Hungary	0.1	:	0	0.1	0.1	0.1	0.1
Ireland	:	:	:	:	:		
Italy	12.9	12.4	12.2	11.7	13	12.1	12.5
Latvia	:	:	:	:	:		
Lithuania	:	:	:	:	:	0.2	0.2
Luxembourg	:	:	:	:	:		
Malta	:	:	:	:	:	0.0	0.0
Netherlands	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Poland	:	:	0	0	0		0.0
Portugal	:	:	:	:	:	0.3	0.3
Romania	9.5	8.9	6.9	7.4	5.6	9.7	7.7
Slovakia	:	:	:	0	0		0.0
Slovenia	:	:	:	:	:		
Spain	3.9	3.9	3.7	3.4	3.6	4.3	3.9
Sweden	:	:	:	:	:		
United Kingdom	:	:	:	:	:		

* Average of Eurostat and FAO stat values

Annex E: Host plant of ToRSV, TRSV, CRLV and PRMV

Table E.1. Host plants of Tomato ringspot virus (ToRSV)

Host	Symptoms[x]	Source
Capsicum		CABI, 1997
Cornus		CABI, 1997
Fragaria		EPPO, 1997b; CABI, 2007
Fraxinus americana		EPPO, 1997b
Gladiolus	no	EPPO, 1997b; CABI, 2007; Notification Turkey, 2007; India (Katoch *et al*., 2003)
Hosta		Notification Germany, 2006
Hydrangea		EPPO, 1997b; CABI, 2007
Lilium		Notification China, 2006
Lotus corniculatus		CABI, 1997
Lycopersicon esculentum	yes	EPPO, 1997b; CABI, 1997
Malus domestica	yes	CABI, 1997
Nicotiana tabacum		CABI, 1997
Orchidaceae		CABI, 1997
Pelargonium	yes	EPPO, 1997b; CABI, 2007; Finding PPO Flower Bulbs, formerly LBO, NL, 1970; Notification Denmark, 2001.
Prunus armeniaca		CABI, 1997
Prunus avium		EPPO, 1997b; CABI, 1997
Prunus cerasus		EPPO, 1997b, CABI, 1997
Prunus domestica		CABI, 1997
Prunus persica	yes	EPPO, 1997b; CABI, 1997
Prunus salicina		CABI, 1997
Prunus spp.		EPPO, 1997b; CABI, 2007
Ribes nigrum		EPPO, 1997b; CABI, 2007
Ribes uva-crispa		EPPO, 1997b; CABI, 2007
Rubus idaeus	yes	EPPO, 1997b; CABI, 2007
Rubus laciniatus		EPPO, 1997b
Rubus procerus		CABI, 1997
Sanbucus		CABI, 1997
Taraxacum		CABI, 1997
Vaccinium corymbosum		CABI, 1997
Vitis vinifera	yes	EPPO, 1997b; CABI, 1997

[x] An empty box means unknown or unclear

Table E.2. Host plants of Tobacco ringspot virus (TRSV)

Host	**Symptoms**[x]	**Source**
Amorica rusticana		New Zealand (Ward *et al*., 2009)
Anemone		EPPO, 1997c
Bacopa	no	Finding NPPO of the NL, 2000, 2006
Capsicum		EPPO, 1997c; CABI, 2007
Carica papaya		EPPO, 1997c
Celosia	no	Finding NPPO of the NL, 2008
Citrullus lanatus		CABI, 2007
Cornus		EPPO, 1997c
Crocus		Finding PPO Flower Bulbs, formerly LBO, NL, 1956
Cucumis melo		CABI, 2007
Cucumis sativus		CABI, 2007
Cucurbita pepo	yes	CABI, 2007; Jossey & Babadoost, 2006
Cucurbitaceae	yes	EPPO, 1997c
Daphne		New Zealand (Ward et al., 2009)
Fraxinus		EPPO, 1997c
Gladiolus		EPPO, 1997c
Gladiolus hybrids		CABI, 2007
Glycine max	yes	EPPO, 1997c; CABI, 2007
Hemerocallis	yes	Finding NPPO of the NL, 2006
Hyacinthus		Finding PPO Flower Bulbs, formerly LBO, NL, 1974
Iris		EPPO, 1997c
Iris ensata	no	Finding NPPO of the NL, 2006
Iris germanica		Notification Romania, 2000
Iris siberica	no	Finding NPPO of the NL, 2006
Lobelia	no	Finding NPPO of the NL, 1997
Lupinus		EPPO, 1997c
Lycopersicon esculentum		CABI, 2007
Malus pumila		EPPO, 1997c
Mentha		EPPO, 1997c
Narcissus		EPPO, 1997c
Nicotiana tabacum	yes	EPPO, 1997c; CABI, 2007
Pelargonium		EPPO, 1997c; CABI, 2007
Petunia		EPPO, 1997c
Portulaca	yes/no[y]	Finding NPPO of the NL, 2000, 2006, 2007
Prunus		CABI, 2007
Prunus avium		EPPO, 1997c
Prunus cerasus	yes	EPPO, 1997c
Rubus fruticosus	yes	EPPO, 1997c; CABI, 2007
Rubus idaeus	yes	CABI, 2007
Sambucus		EPPO, 1997c
Solanum melongena		EPPO, 1997c; CABI, 2007
Solanum nigrum		CABI, 2007
Solanum tuberosum		CABI, 2007
Sophora microphylla	yes	New Zealand (Ward et al., 2009)
Tulipa		Finding PPO Flower Bulbs, formerly LBO, NL (1972, 1973); Notification China, 2006.
Vaccinium spp.	yes	EPPO, 1997c; CABI, 2007
Vitis vinifera		EPPO, 1997c; CABI, 2007
Zamia furfuracea	yes	Baker & Atkins, 2007

[x] An empty box means unknown or unclear
[y] Infected *Portulaca* plants have been found with and without symptoms (NPPO of the NL)

Table E.3. Host plants of Cherry rasp leaf virus (CLRV)

Host	Symptoms[x]	Source
Balsamorhiza	no	EPPO, 1997d; CABI, 2007
Malus domestica	yes	EPPO, 1997d; CABI, 2007
Plantago	no	EPPO, 1997d; CABI, 2007
Prunus avium	yes	CABI, 2007; Kropley, 1961
Prunus cerasus	yes	EPPO, 1997d; CABI, 2007
Prunus mahaleb	yes	EPPO, 1997d; CABI, 2007
Prunus persica	yes	EPPO, 1997d; CABI, 2007
Rubus idaeus	no	EPPO, 1997d; CABI, 2007
Taraxacum	no	EPPO, 1997d; CABI, 2007

[x] An empty box means unknown or unclear

Table E.4. Host plants of Peach rosette mosaic virus (PRMV)

Host	Symptoms[x]	Source
Prunus persica	yes	EPPO, 1997e; CABI, 2007
Prunus salicina		CABI, 2007
Rumex		EPPO, 1997e
Solanum carolinense		EPPO, 1997e
Taraxacum		EPPO, 1997e; CABI, 2007
Vaccinium corymbosum	yes	CABI, 2007
Vitis labrusca	yes	EPPO, 1997e; CABI, 2007
Vitis vinifera	yes	EPPO, 1997e; CABI, 2007

[x] An empty box means unknown or unclear

Annex F: Comparison between European and non-European populations of virus-vector species of *Xiphinema americanum s.l.*

Subject	European populations	Non-European populations	Source/Remark
Species and viruses	*X. rivesi* Transmission of TRSV and ToRSV have been demonstrated with a *X. rivesi* population in Slovenia under experimental conditions (Sirca *et al.*, 2007). European populations of *X. rivesi* can probably also transmit CLRV and possibly PRMV.	*X. americanum* s.s. CLRV, TRSV, ToRSV, PRMV(?) *X. bricolensis* ToRSV *X. californicum* CLRV, TRSV, ToRSV *X. intermedium* TRSV, ToRSV *X. rivesi* CLRV, TRSV, ToRSV *X. tarjanense* TRSV, ToRSV *X. inaequale* ToRSV More *X. americanum* group species than presently known might be able to act as an virus-vector (see also questions 2 and 7). It is possible that only those *X. americanum*-group species which have 3 juvenile stages are vectors of nepoviruses in the Americas (Brown & Trudgill, 1997). There is however at present only limited information available to confirm this statement. There are two reports (Alkemade & Loof, 1989; Halbrendt & Brown, 1992), describing the results of respectively a limited survey of data and direct observations on a few populations of *X. americanum*-group members; it appears that at least some North American *X. americanum*-group species have only 3 juvenile stages, while some European species (like *X. pachtaicum*) have 4 juvenile stages. *X. americanum* (species not indicated) can probably also transmit *Soybean severe stunt virus,* a nepovirus affecting soybean and only known to be present in Delaware (USA) (Weldekidan *et al.*, 1992; Evans *et al.*, 2007). Note that this virus is (currently) not listed in the Universal virus database of the international committee on taxonomy of viruses and thus not (yet) recognized as a single taxonomic entity (http://www.ictvdb.org/; accessed October 2010). It is also not listed as a quarantine organism in the EU (EU-directive 2000/29/EC).	Klos *et al.* (1967) Stobbs & Van Schagen (1996); Weldekidan *et al.* (1992); Lamberti *et al.* (2000); Verma *et al.* (2003); Evans *et al.* (2007) See also question 7 about transmission of PRMV by *X. americanum*
Regional occurrence	Present in Germany, France, Bulgaria, Germany, Italy (widespread), Portugal (widespread), Spain (widespread) and Slovenia. The identifications in Bulgaria, Portugal and Italy may need confirmation.	On all continents except Oceania and Antarctica. Of all vector species, *X. rivesi* occurs most widespread. It is widespread in North America and South America, present in Europe and probably present in some Asian countries. The second most widespread species are *X. americanum* s.s. and *X. californicum*.: *X. americanum* s.s.: widespread in North America (although less frequent than *X. rivesi*), locally present (or rare) in Africa. *X. californicum*: widespread in North America (although less frequent than *X. rivesi*) and South America. Other vector species are only known to be locally present on one or a few continents.	Forer & Stouffer (1982); Robbins & Brown (1991) ; EPPO (1997a); Lamberti *et al.* (2000); CABI (2007); Sirca *et al.* (2007). (See also question 7).

Subject	European populations	Non-European populations	Source/Remark
Transmission efficiency	Transmission of TRSV and ToRSV have been demonstrated with a *X. rivesi* population in Slovenia under experimental conditions (Sirca *et al*., 2007). No experiments are known in which transmission efficiency of European populations were compared with that of non-European populations of *X. americanum s.l*. Limited data are available that show that *X. rivesi*, the species which is present in Europe is at least as efficient as other species of *X. americanum s.l*. (see the next column).	*X. americanum* and *X. rivesi* transmit ToRSV with similar efficiency (Georgi, 1988a). No consistent differences were found between *X. americanum* and *X. rivesi* populations in transmission efficiency in experiments with "laboratory-acquired virus". In experiments with "orchard-acquired virus", a *X. rivesi* population transmitted ToRSV more frequently than a *X. americanum* population but these difference may reflect differences in concentrations of the virus in the *Xiphinema* populations rather than differences in transmission efficiency. Brown *et al.* (1994) compared three different *X. americanum* s.s. populations, and one population each of *X. bricolensis*, *X. californicum* and *X. rivesi* from North America for their ability to transmit CRLV, TRSV an two strains of ToRSV. *X. rivesi* and *X. californicum* nematodes were the only ones that transmitted all four viruses. *X. rivesi* was the most efficient virus vector. Allen *et al.* (1984) showed that transmission rate of PRMV by *X. americanum* strongly varied over the year. Nematodes that were used in these trials were collected from the same site over different years. In transmission experiments with *X. californicum* using different strains of ToRSV, it was shown that there is a difference in transmission efficiency between ToRSV strains (Hoy *et al.*, 1984). Wang *et al.* (2002) have shown a higher transmission efficiency of a *X. americanum* population for ToRSV than for TRSV. Virus-specific immunofluorescent labeling of the nematodes showed that the two viruses are localized in different regions of the food canal of the nematode possibly explaining the differences in transmission efficiency.	See also question 7.
Probability of association with nepoviruses	Low: ToRSV and TRSV are locally present, but no indications of infested vector populations	Very low – high, depending on the country/region of origin.	See "conclusion on the probability of entry"

Subject	European populations	Non-European populations	Source/Remark
Biology/Ecology	*X. rivesi* is present in central and southern European countries and assumed to be able to establish in large parts of the EU.	Little is known about variation in biological/ecological properties between the vector species mentioned above. *X. rivesi* is worldwide the most widespread vector species and, therefore, assumed to be able to establish in various soil types and climates. Jaffee *et al*. (1987) did not found differences in population structure or composition between in *X. americanum* s.s. and *X. rivesi* in an apple orchard in Pennsylvania. (Minor) differences may exist: Different host plants may affect populations of different species differently. In pot experiments with Sudan grass *X. americanum s.s.* populations increased while *X. rivesi* populations remained stable (Jaffee *et al*., 1988). Jaffee (1986) extracted *X. americanum s.s.* and *X. rivesi* from soil and found both species attacked by various mycoparasites but did not determine the relative susceptibility of the two species. Jaffee & Shaffer (1987) found that *X. rivesi* was more susceptible than *X. americanum* s.s. to attack by *Catenaria anguillulae* in dilute soil extract. Georgi (1988b) did not found consistent differences between population densities between *X. rivesi* and *X. americanum* in pot experiments with apple, dandelion and cucumber. In a mixed population of the two *Xiphinema* species, the proportion of *X. rivesi* increased from 70% to 94% on apple and to 88% on dandelion.	See above (regional occurrence) and question 1.20.
Direct damage to host plants	Generally low	Generally low	See question 2.1

Annex G: Distribution of *Xiphinema americanum* group species in the world according to Lamberti *et al.* (2000)

Pest status	Continent/region						
	Africa	**Asia**	**Europe**	**Former Sovjet Union**	**Latin America**	**North America**	**Oceania**
Widespread	*X. diffusum* *X. pachtaicum*	*X. diffusum* *X. pachtaicum* *X. thornei*	*X. pachtaicum* *X. taylori*	*X. pachtaicum* *X. taylori* *X. thornei*	*X. brevicollum* *X. californicum** *X. rivesi**	*X. americanum** *X. californicum** *X. rivesi**	*X. pseudoguirani*
Locally	*X. americanum** *X. oxycaudatum*	*X. incognitum* *X. sheri*	*X. brevisicum* *X. duriense* *X. incertum* *X. madeirense* *X. rivesi** *X. simile*	*X. paramonovi*	*X. diffusum* *X. ineaquale** *X. peruvianum*	*X. bricolensis** *X. citricolum* *X. georgianum* *X. intermedium** *X. occiduum* *X.tenuicutis* *X. thornei*	
Rare	*X. brevicollum* *X. franci* *X. incognitum* *X. luci* *X. santos* *X. simile*	*X. brevicollum* (?)[1] *X. himalayense* *X. ineaquale** *X. intermedium* (?)* *X. kosaigudense* *X. lambertii* *X. minor* *X. neoamericanum* *X. neolongatum* *X. ophisthohysterum* *X. oxycaudatum* *X. pachydermum* (?) *X. pakisatanense* *X. rivesi* (?)* *X. sharmai* *X. sheri* *X. taylori*	*X. brevicollum* (?) *X. diffusum* *X. fortuitum* *X. longistillum* *X. mesostillum* *X. microstillum* *X. pisthophysterum*(?) *X. pachydermum* *X. santos*	*X. brevicollum* (?)	*X. floridae* (?) *X. georgianum* (?) *X. pachtaicum* (?) *X. parvum* *X. utahense* (?)	*X. brevicollum* (?) *X. diffusum* *X. floridae* *X. laevistratum* *X. pacificum* *X. pachtaicum* (?) *X. sheri* (?) *X. tarjense** *X. luci* (?) *X. neoamericanum* *X. utahense*	*X. bacaniboia* *X. silvaticum*

1 (?) species reported but identification needs confirmation
2 * species known or reported as a vector of ToRSV, TRSV, PRMV and/or CRLV (see also Annex F and questions 2 and 7 in this PRA)