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Pest categorisation of *Xiphinema californicum*

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Abstract

The Panel on Plant Health performed a pest categorisation of *Xiphinema californicum* (Nematoda: Longidoridae) for the EU. The nematode is a well-defined taxon belonging to a group of morphologically similar species called *Xiphinema americanum* sensu lato. The nematode was described from the USA and is present in some North and South American countries. The nematode is not present in the EU and is regulated by Council Directive 2000/29/EC, listed in Annex I A I as *X. californicum* Lamberti and Bleve-Zacheo. It is a polyphagous pest found in soil associated with a number of plant species. As a migratory ectoparasitic species, it punctures the cells of plant roots. *X. californicum* is in principle able to cause direct damage to plants, but its main damage is caused by vectoring the American nepoviruses: *Tobacco ringspot virus* (TRSV), *Tomato ringspot virus* (ToRSV) and *Cherry rasp leaf virus* (CRLV). Soil is a potential pathway for this nematode for entry into the EU. Moist soil, such as soil attached to plants for planting, increases survival of the nematode. The viruses may persist over prolonged periods inside the nematode and viruliferous nematodes may introduce American nepoviruses. Climatic conditions in the EU are similar to those found in the areas where the pest is currently present. Hosts of the nematode (and of associated viruses) are, e.g. grapes, apples and plums, which are also widely cultivated in the EU. The nematode only moves short distances (around 1 m) but may be spread with soil moving activities. Measures are available to inhibit entry via soil as such. Entry of the nematode with soil attached to plants for planting that are not regulated is possible. *X. californicum* does satisfy all the criteria that are within the remit of EFSA to assess to be regarded as a Union quarantine pest.

Keywords: European Union, pest risk, plant health, plant pest, quarantine, American dagger nematode, tobacco ring nematode

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1. Introduction

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

1.1.1. Background

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

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

1.1.2. Terms of Reference

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

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

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

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

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

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

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

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

1.1.2.1. Terms of Reference: Appendix 1

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

Annex IIAI

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

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

(b) Bacteria

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

(c) Fungi

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

(d) Virus and virus-like organisms

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

Annex IIB

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

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

(b) Bacteria

Curtobacterium flaccumfaciens pv. flaccumfaciens (Hedges) Collins and Jones

(c) Fungi

Glomerella gossypii Edgerton

Gremmeniella abietina (Lag.) Morelet

Hypoxylon mammatum (Wahl.) J. Miller

1.1.2.2. Terms of Reference: Appendix 2

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

Annex IAI

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

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

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

Group of Tephritidae (non-EU) such as:

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

(c) Viruses and virus-like organisms

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

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

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

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

Annex IIAI

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

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

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

1.1.2.3. Terms of Reference: Appendix 3

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

Annex IAI

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

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

(b) Fungi

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

(c) Viruses and virus-like organisms

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

(d) Parasitic plants

Arceuthobium spp. (non-EU)

Annex IAII

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

Meloidogyne fallax Karssen
Popillia japonica Newman
Rhizoecus hibisci Kawai and Takagi

(b) Bacteria

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

(c) Fungi

Melampsora medusae Thümen
Synchytrium endobioticum (Schilbersky) Percival

Annex I B

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

Leptinotarsa decemlineata Say
Liriomyza bryoniae (Kaltenbach)

(b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

1.2. Interpretation of the Terms of Reference

Xiphinema californicum is one of a number of pests listed in the Appendices to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether it fulfils the criteria of a quarantine pest or those of a regulated non-quarantine pest for the area of the European Union (EU) excluding Ceuta, Melilla and the outermost regions of Member States (MSs) referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *X. californicum* was conducted at the beginning of the categorisation in the ISI Web of Science, Scopus and Google bibliographic database, using the scientific name of the pest as search term. Relevant papers were reviewed, and further references and information were obtained from experts, from citations within the references and grey literature.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the European and Mediterranean Plan Protection Organization (EPPO) Global Database (EPPO, 2017a,b) and relevant publications.

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

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

2.2. Methodologies

The Panel performed the pest categorisation for *X. californicum*, following guiding principles and steps presented in the EFSA guidance on the harmonised framework for pest risk assessment (EFSA PLH Panel, 2010) and as defined in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

In accordance with the guidance on a harmonised framework for pest risk assessment in the EU (EFSA PLH Panel, 2010), this work was initiated following an evaluation of the EU plant health regime. Therefore, to facilitate the decision-making process, in the conclusions of the pest categorisation, the Panel addresses explicitly each criterion for a Union quarantine pest and for a Union regulated non-quarantine pest in accordance with Regulation (EU) 2016/2031 on protective measures against pests of plants, and includes additional information required in accordance with the specific ToR received by the European Commission. In addition, for each conclusion, the Panel provides a short description of its associated uncertainty.

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

It should be noted that the Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, the Panel will present a summary of the observed pest impacts. Economic impacts are expressed in terms of yield and quality losses and not in monetary terms, whereas addressing social impacts is outside the remit of the Panel, in agreement with EFSA guidance on a harmonised framework for pest risk assessment (EFSA PLH Panel, 2010).

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

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Identity of the pest (Section 3.1)	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?
Absence/ presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? Describe the pest distribution briefly!	Is the pest present in the EU territory? If not, it cannot be a protected zone quarantine organism.	Is the pest present in the EU territory? If not, it cannot be a regulated non-quarantine pest. (A regulated non-quarantine pest must be present in the risk assessment area).
Regulatory status (Section 3.3)	If the pest is present in the EU but not widely distributed in the risk assessment area, it should be under official control or expected to be under official control in the near future.	The protected zone system aligns with the pest-free area system under the International Plant Protection Convention (IPPC). The pest satisfies the IPPC definition of a quarantine pest that is not present in the risk assessment area (i.e. protected zone).	Is the pest regulated as a quarantine pest? If currently regulated as a quarantine pest, are there grounds to consider its status could be revoked?

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in and spread within the EU territory? If yes, briefly list the pathways!	Is the pest able to enter into, become established in and spread within the protected zone areas? Is entry by natural spread from EU areas where the pest is present possible?	Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects? Clearly state if plants for planting is the main pathway!
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?	Would the pests' introduction have an economic or environmental impact on the protected zone areas?	Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?
Available measures (Section 3.6)	Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?	Are there measures available to prevent the entry into, establishment within or spread of the pest within the protected zone areas such that the risk becomes mitigated? Is it possible to eradicate the pest in a restricted area within 24 months (or a period longer than 24 months where the biology of the organism so justifies) after the presence of the pest was confirmed in the protected zone?	Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met.	A statement as to whether (1) all criteria assessed by EFSA above for consideration as potential protected zone quarantine pest were met, and (2) if not, which one(s) were not met.	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential regulated non-quarantine pest were met, and (2) if not, which one(s) were not met.

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

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?

Yes, *Xiphinema californicum* has been recognized as a single taxonomic entity.

Xiphinema californicum (Longidoridae) was originally described from specimens extracted from the rhizosphere of olive trees in Riverside, California, USA (Lamberti and Bleve-Zacheo, 1979). It is a virus-transmitting nematode belonging to a group of morphologically closely related species. This group is called *Xiphinema americanum* sensu lato and comprises around 50 species (FAO, 2016). The species differentiation of this group is extremely difficult due to only minor morphological and morphometrical differences. Griesbach and Maggenti (1990) synonymised this species with *X. americanum sensu stricto* based on morphometric analyses of nematode populations from Pennsylvania, New York and California. Cho and Robbins (1991) also using morphometric analyses were able to distinguish *X. californicum* from *X. americanum*. Because of the difficulties in the morphological identification of species of *X. americanum* sensu lato, the use of molecular approaches to discriminate species within the *X. americanum* group is recommended (Brown et al., 1995; Lamberti et al., 2000). Based on molecular (by sequencing of D2–D3 of 28S rRNA, ITS rRNA and mitochondrial COI genes) and morphological characterization of the *X. americanum* group species, Orlando et al. (2016) recognised *X. californicum* as a distinct taxonomic entity.

3.1.2. Biology of the pest

Xiphinema californicum is a migratory ectoparasite of plant roots. The life cycle of *X. californicum* - starting with an egg – consists of three juvenile stages (which is unusual for most nematodes that typically have four juvenile stages) and the adult stage. It reproduces parthenogenetically, males are therefore uncommon (Halbrendt and Brown, 1992). All stages are found in the soil. A first-stage juvenile (J1) develops within the egg, then hatches (Nemaplex, 26.10.2017). All juvenile stages and adults have a stylet typical for the family Longidoridae consisting of two parts: the anterior odontostyle and a supporting structure (odontophore). *Xiphinema* species have a long odontostyle (up to 150 μm; stylet length in *Ditylenchus dipsaci* is ca. 13 μm in contrast) and with this they feed on epidermal cells near the root tips.

Although *X. californicum* is a valid species, little information on the biology of this species is available. Therefore, the information on biology and ecology relates to *X. americanum* sensu lato. As a free-living ectoparasite, this nematode lives and moves in soil and/or growing media where it can survive for several years producing only one generation per year (Halbrendt and Brown, 1993). *X. californicum* is recognised as an important vector of the plant viruses: *Tobacco ringspot virus* (TRSV), *Tomato ringspot virus* (ToRSV) and *Cherry rasp leaf virus* (CRLV) (Brown et al., 1993, 1994). Viruses are transmitted by juveniles and adult specimens during feeding. *Xiphinema* species are known to retain viruses for long periods, and transmission after 9 months has been experimentally proven.

3.1.3. Intraspecific diversity

Several molecular studies on the diversity of the *X. americanum* group have been carried out. Low intraspecific and large interspecific diversity was found using mitochondrial DNA to distinguish populations of *Xiphinema* spp. (Lazarova et al., 2006; Kumari et al., 2010; Gutiérrez-Gutiérrez et al., 2011). Low intraspecific variability was also demonstrated by Ye et al. (2004) for the ITS1 rDNA gene, Oliveira et al. (2004) for 18S rRNA gene and He et al. (2005) for D2–D3 expansion regions of 28S rRNA gene sequences.

Differences in virus transmission have been reported by Hoy et al. (1984). According to these authors, *X. californicum* is an efficient vector for some strains of TRSV but not for other strains of the same virus. Griesbach and Maggenti (1989) also reported differences in populations of *X. americanum* sensu lato (probably *X. californicum*) to transmit different viruses.

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, the organism can be detected. Identification using the key developed by Lamberti et al. (2000) is possible but is difficult and can only be carried out by trained personnel.

Nematodes can be isolated from the soil or growing media by different extraction techniques, e.g. the Flegg-modified Cobb technique, Oostenbrink elutriator or other elutriation methods (EPPO, 2013). Identification of *X. americanum* group species is based on morphological and morphometric analyses (Lamberti et al., 2000; FAO, 2016). Identification of *X. californicum*, and in particular distinguishing it

from other species of *X. americanum* sensu lato is extremely difficult and can only be carried out by trained personnel. Molecular diagnostic method to distinguish between species within *X. americanum* sensu lato are mentioned in the Q-bank website (http://www.q-bank.eu/Nematodes/DefaultInfo.aspx?Page=MolecularDS) but have not been included in the relevant IPPC and EPPO diagnostic protocols (FAO, 2016; EPPO, 2017a,b).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

Xiphinema californicum is present in the USA, where it is widely distributed in California and Washington and has a restricted distribution in Oregon. The pest is widespread across California, in association with a very wide host range of woody and herbaceous plants. In a study by Lownsbery and Lownsbery (1985), *X. californicum* was among the most frequently found nematode species associated with forest trees in California. It is present also in Hawaii, however, no details about its distribution are available (EPPO GD, 26.10.2017). In Central and South America, *X. californicum* has been reported from Mexico, Brazil, Chile and Peru (no details about its exact distribution are available (EPPO GD, 26.10.2017) (Figure 1). According to Erum and Shahina (2010), the nematode is present also in Asia (Pakistan); because of no other reports in Asia, the unusual association with wheat and no other reports of wheat as a host plant, there is some uncertainty regarding this report. The EPPO GD does not consider the Pakistan report.

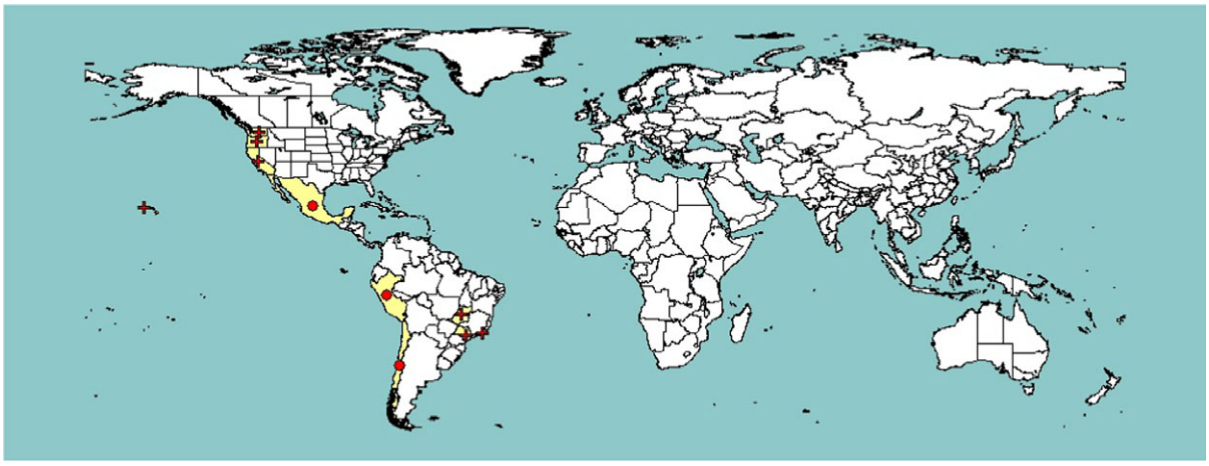

Figure 1: Global distribution map for *X. californicum* (extracted from the EPPO PQR accessed on 23 November 2017)

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest widely distributed within the EU?
No, *X. californicum* is not known to occur in the EU.

There is no evidence that *X. californicum* is present in the EU.

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

X. californicum is listed in Council Directive 2000/29/EC. Details are presented in Tables 2 and 3.

Table 2: *Xiphinema californicum* in Council Directive 2000/29/EC

Annex I, Part A	**Harmful organisms whose introduction into, and spread within, all member states shall be banned**
Section I	Harmful organisms not known to occur in any part of the community and relevant for the entire community
(a)	Insects, mites and nematodes, at all stages of their development
	Species
27.	*Xiphinema californicum* Lamberti and Bleve-Zacheo

3.3.2. Legislation addressing the hosts of *X. californicum*

Xiphinema californicum belongs to a complex of closely related species called *X. americanum* sensu lato group. Therefore, the regulations presented in Table 3 are also relevant.

Table 3: Regulated hosts and commodities that may involve *X. californicum* in Annexes III, IV and V of Council Directive 2000/29/EC

Annex IV, Part A	**Special requirements which must be laid down by all member states for the introduction and movement of plants, plant products and other objects into and within all member states**	
Section I	Plants, plant products and other objects originating outside the Community	
	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 fourth generation stock, derived from mother plants found to be free from Tomato ringspot virus under an official approved system of virological testing.

3.3.3. Legislation addressing the organisms vectored by *Xiphinema californicum* (Directive 2000/29/EC)

Three plant viruses are vectored by *X. californicum*:

- *Tobacco ringspot virus* (TRSV) is listed in Annex I, AI, position (d) 3.
- *Tomato ringspot virus* (ToRSV) is listed in Annex I, AI, position (d) 4.
- ToRSV is also listed in Annex IV, Part AI:
  - 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.
  - 24 – Plants of *Rubus* L. intended for planting (a) originating in countries where harmful organisms are known to occur on *Rubus* L.
  - 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

- *Cherry rasp leaf virus* (CRLV) is listed in Annex I, AI, position (d) 5b.
- CRLV is also listed in Annex IV, AI:
  - 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.
  - 23.2 – Plants of *Prunus* L. intended for planting (b) other than seeds, originating in countries where the relevant harmful organisms are known to occur
  - 24 – Plants of *Rubus* L. intended for planting (b) other than seeds, originating in countries where the relevant harmful organisms are known to occur

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

The pest is a migratory ectoparasitic nematode and has been found associated with a wide range of herbaceous and woody host plants (see Table 4). However, the association with those plants is not always clear. Plants may be major or incidental hosts (see EPPO PQR).

Table 4: Plants reported to be associated with *Xiphinema californicum*

Host plant	Sources
19 forest tree species[(a)]	Lownsbery and Lownsbery (1985)
***Buphthalmum* sp. L.**	Cho and Robbins (1991).; Nemaplex
***Canna* spp. L.**	Alkemade and Loof (1990); Nemaplex
***Carica papaya* L.**	Lamberti et al. (1988)
***Citrus* sp.**	Alkemade and Loof (1990); Cho and Robbins (1991); Nemaplex
***Cocos nucifera* L.**	Alkemade and Loof (1990); Nemaplex
***Ipomea batatas* Lam.**	Alkemade and Loof (1990); Nemaplex
***Malus* sp.**	Hafez et al. (1992)
***Medicago sativa* L.**	Alkemade and Loof (1990); Cho and Robbins (1991); Nemaplex
***Olea europaea* L.**	Lamberti and Bleve-Zacheo (1979); Nemaplex
***Persea americana* Mill.**	Alkemade and Loof (1990); Nemaplex
***Prunus* spp. (cherries)**	Lamberti and Golden (1986)
***Rosa* sp. L.**	Cho and Robbins (1991); Nemaplex
***Sorghum* sp. Moench.**	Alkemade and Loof (1990); Nemaplex
***Triticum* spp. (wheat)**[(b)]	Erum and Shahina (2010)
***Vitis sp,* L.**	McKenry (1995); Nemaplex
***Vitis vinifera* L.**	Cho and Robbins (1991); Nemaplex
***Zea mays* L.**	Alkemade and Loof (1990); Nemaplex

(a): Full list of tree species can be found in Lownsbery and Lownsbery (1985).
(b): There is some uncertainty regarding host status of wheat, because there are no other reports of wheat as a host plant. Moreover, the report is from Pakistan, and there are no other reports from Asian countries.

3.4.2. Entry

Is the pest able to enter into the EU territory? If yes, identify and list the pathways!

Yes, soil and growing media, soil and growing media attached to planting material and soil and growing media attached to machinery and packaging material.

The pest does not invade plant tissue (only puncturing cells from the outside); it is, therefore, not found inside plants. The following pathways have been identified:

- Soil and growing media as such from areas where the nematode occurs. This pathway is closed because of Annex III, Part A, No. 14 of EU 2000/29.
- Soil and growing media attached to plants (hosts or non-host plants) from areas where the nematode occurs. This pathway is very difficult to control as plants may be imported with soil or growing media attached to sustain their live.

- Soil and growing media attached to (agricultural) machinery, tools, packaging materials. This pathway is not considered as an important pathway for entry because the volume of trade of used machinery is considered low. Furthermore, soil adhering to agricultural machinery during transport (if relevant) may dry and subsequently lead to decreased viability of the pest.

Until 18 July 2017, there was one interception of *X. californicum* in the Europhyt database reported by the United Kingdom. The pest was intercepted on *Phyllostachys* sp. intended for planting from South Carolina (USA).

3.4.3. Establishment

Is the pest able to become established in the EU territory?

Yes, the pest is able to establish in the EU territory.

3.4.3.1. EU distribution of main host plants

The nematode has a wide host range (see also Section 3.4.1) and is associated with several herbaceous and woody host plants (see Table 4). The host status is not always clear as the relationship has in many cases not been studied in detail. Nevertheless, plants which have been found associated with *X. californicum*, such as grapes, apple and plums, are present throughout the EU territory. The pest could find suitable host plants and may therefore be able to establish in the EU.

Distribution maps of the area of economically important host plants (grapes, apples and plums) are provided in Appendix A and the production area is presented in Table 5.

Table 5: Production area of grapes, apples and plums in the EU (EU 28) in the years 2011–2016 (thousands of hectares)

Country	2011	2012	2013	2014	2015	2016
Grapes	3,253.19	3,219.46	:	:	3,173.83	:
Apples	548.36	558.62	536.75	524.50	537.91	520.45
Plums	169.56	166.39	162.01	157.36	154.18	:

Source: EUROSTAT (26.10.2017).

3.4.3.2. Climatic conditions affecting establishment

The pest is present in North, Central and South America where climatic conditions (warm temperate) similar to those in the EU can be found. It should be noted that the pest is not present throughout, e.g. the USA (see uncertainties). According to the Köppen–Geiger Climate Classification (Figure 2), the pest occurs in the warm temperate climate. The climate in many parts of the EU is suitable for pest establishment.

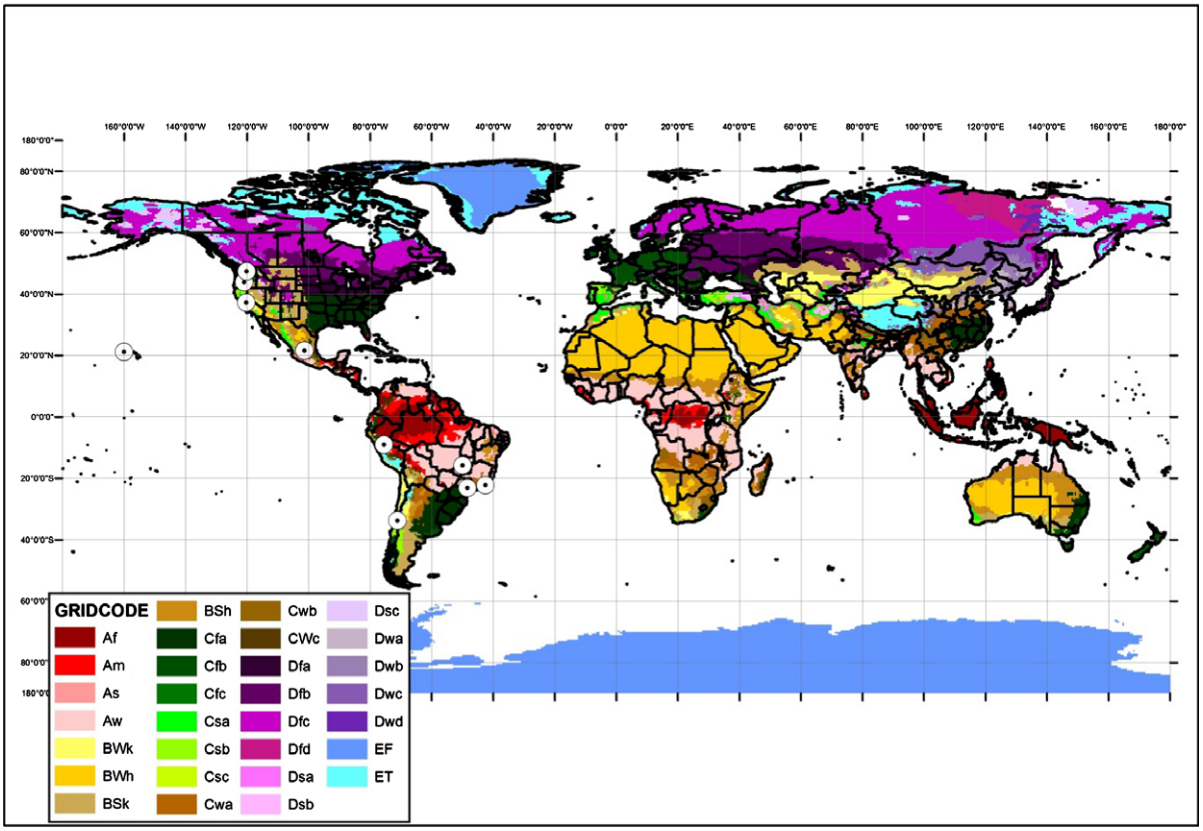

Figure 2: The current distribution of *Xiphinema californicum* presented by white dots on the Köppen–Geiger climate classification map (Kottek et al., 2006)

3.4.4. Spread

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

Yes, soil and growing media, soil and growing media attached to planting material and soil and growing media attached to machinery and packaging material.

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

No, the pest is not generally spread via specific plants for planting.

The pest is classified as a migratory ectoparasitic nematode found in the soil; however, movement in soil is restricted to short (< 1 m) distances (EPPO GD 26.10.2017). The pest never invades plant tissue (except by puncturing root plant cells with its stylet). Spread may therefore mainly occur with moist soil or growing media (soil as such or soil attached to plants, machinery, tools, shoes, animals, packaging material) or run-off water but not by plants without soil. Soil attached to agricultural machinery, tools, etc. may contribute to spread, but this may be mostly relevant for within field spread or spread to adjacent fields.

Xiphinema californicum is a vector of nepoviruses (TRSV, ToRSV and CRLV) and spread of the nematode may also lead to spread of those viruses. According to EPPO PQR, TRSV and ToRSV are present in some EU MS, but exact distribution of those viruses is not known. CRLV is not known to be present in the EU according to EPPO PQR. Viruliferous nematodes may be a pathway for the entrance of CLRV in the EU, but also for the entry of additional isolates or spread in new areas of both TRSV and ToRSV.

3.5. Impacts

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

Yes, the nematode may cause damage to plant roots but data on the extent of damage are lacking. Most important is the fact that the nematode transmits important quarantine viruses of grapes, apples and plums.

RNQPs: Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?[4]

Yes, if the pest is present in soil associated with plants for planting of important host plants such as grapes, apples and plums.

Xiphinema californicum, as other *Xiphinema* species, may cause direct damage to the root system such as bent or swollen root tips (EPPO GD, 26.10.2017). Above ground symptoms are similar to those resulting from any kind of root damage and are shown as stunted plant growth and patchy fields (Heve et al., 2015). However, direct damage may only occur at high population densities. No direct damage is reported for this nematode species so far. The main damage is caused by the transmission of nepoviruses. *X. californicum* is able to transmit TRSV, ToRSV and CRLV (Brown et al., 1993).

3.6. Availability and limits of mitigation measures

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

Yes, prohibition of import of soil and growing media and plants for planting with soil attached from areas where the pest is present would prevent introduction of this pest into and spread within the PRA area.

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

Yes, soil free plants for planting would prevent the presence of the nematode. However all plants for planting (not only host plants) need to be considered. Not all pathways can be addressed (e.g., soil attached to machinery).

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

- Prohibition of import of plants for planting with soil attached – not all plants for planting with soil attached are addressed within current legislation.
- Sampling and testing procedures – detection of nematodes in soil depends on many factors (sampling intensity and sample volume).
- Diagnostic procedures based on morphological identification of the pest and availability of appropriate molecular tools for species identification may indirectly affect the effectiveness of measures to prevent the entry, establishment and spread of *X. californicum.* Species identification of *X. americanum* sensu lato is based on accurate observations of morphological characteristics and the measurements of different parameters and is a challenge even for experienced, well-trained personnel due to similarity of morphological and morphometric characteristics of these nematodes (Taylor and Brown, 1997). No reliable routine technique for molecular identification of *X. californicum* is currently recognised by the relevant diagnostic protocols (FAO, 2016; EPPO, 2017a,b).

3.6.2. Control methods

- To prevent infestation of production sites within PRA area by TRSV, ToRSV and CRLV and their vector nematode (*X. californicum*), it may be required to use certified and tested plants for planting derived from certified production schemes. Only planting material originating from areas where nepoviruses (TRSV, ToRSV and CRLV) as well as their vector nematode (*X. californicum*) have not been reported, and where surveillance is carried out to confirm the pest-free status (PFA, PFPS) could be declared as pest-free material and could be therefore used in the PRA area.

[4] See Section 2.1 on what falls outside EFSA's remit.

- Surveillance and soil testing can be used to detect the presence of vector nematode, *X. californicum* and to avoid planting susceptible plants on a field containing viruliferous nematodes. Soil sampling should be done before planting. The results of such tests can help to decide which measures are best suited to control this pest (Taylor and Brown, 1997).
- Soil steaming is among the most effective but unfortunately the most expensive and energy consuming control methods to eliminate pests from the soil (Neshev et al., 2008). Disinfection of soil by physical measures (heat, steam) – the efficacy of this measure is limited because of vertical distribution of this pest within the soil (field conditions) which depends on availability of roots of host plants and moisture regime (*X. americanum* sensu lato in California occurred at the depth of up to 45 cm) (Taylor and Brown, 1997).

3.7. Uncertainty

- *Xiphinema californicum* has been described as a new species in the *X. americanum* sensu lato group and some virus–vector associations may have been linked with *X. americanum*. The importance of *X. californicum* as a virus vector may be therefore underestimated. Similarly, data on damage, interceptions and distribution may be underrepresented. However, if phytosanitary measures address *X. americanum* sensu lato as a group (including *X. californicum*), then this uncertainty may not be relevant from a phytosanitary perspective.
- The distribution of viruses and vectors in countries of origin is not exactly known (partly because of the difficulties in identifying the nematodes as mentioned above). There is, however, no indication that *X. californicum* is present in the EU.
- Specificity of virus transmission has been reported but is unclear whether the American species *X. californicum* is able to transmit European virus isolates. New virus–vector association may cause severe damage hitherto unreported. Also, new host plant species may be affected after introduction to a new environment (i.e. the EU).
- Efficiency of virus transmission has not been studied in detail. It is not clear how important virus transmission is under field conditions. The nematodes move only over short distances and within field spread is largely unknown but may require several years. Uncertainty exists about population build-up (one generation per year) which may affect virus transmission. Although *Xiphinema* species are known to retain viruses for long periods (transmission after 9 months has been experimentally proven), uncertainty on virus persistence in *X. californicum* exists.
- The extent of direct damage caused by the nematode is not known. *Xiphinema* species are able to damage root systems (galling and stunting) leading to considerable crop losses (Taylor, 1978). Although there is some uncertainty on the extent of damage caused, this may not influence the assessment as the main damage is the transmission of viruses. Direct damage may be similar to direct damage caused by indigenous (European) *Xiphinema* species.

4. Conclusions

Xiphinema californicum meets the criteria assessed by EFSA for consideration as a potential Union quarantine pest (Table 6).

Table 6: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of the pest is established; *Xiphinema californicum* Lamberti and Bleve-Zacheo. It is a nematode in the family Longidoridae. Taxonomic keys are available to identify the pest.	The identity of the pest is established; *Xiphinema californicum* Lamberti and Bleve-Zacheo. It is a nematode in the family Longidoridae. Taxonomic keys are available to identify the pest.	Identification is possible but is difficult and can only be carried out by trained personnel.

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Absence/ presence of the pest in the EU territory (Section 3.2)	The pest is not known to occur in the EU.	The pest is not known to occur in the EU.	None
Regulatory status (Section 3.3)	*Xiphinema californicum* is currently regulated by Council Directive 2000/29/EC as a harmful organism whose introduction into and spread within all member states shall be banned.	*Xiphinema californicum* is currently regulated by Council Directive 2000/29/EC as a harmful organism whose introduction into and spread within all member states shall be banned.	None
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	*Xiphinema californicum* is able to enter and spread with soil, soil attached to plants for planting or to machinery, tools, etc. Natural spread is only over short distances and slow.	*Xiphinema californicum* is spread in soil which may be associated with plants for planting. Plants for planting are not the only pathway.	Temperature requirements for nematode establishment.
Potential for consequences in the EU territory (Section 3.5)	*Xiphinema californicum* would have direct impact on crops, but virus transmission will be much more important for plant health status and production of grapes, apples and plums.	The pest is not directly on (or in) plants for planting, but if the nematode is present in soil attached to host plants of the nepoviruses, then the use of those plants for planting may be affected.	Lack of information regarding direct impact. Lack of information on transmission of European nepoviruses by this nematode.
Available measures (Section 3.6)	Measures are available to inhibit entry via traded commodities (e.g. prohibition on the importation of soil and the introduction of plants for planting with soil or growing media attached).	The pest is not directly on (or in) plants for planting but measures on the importation of plants for planting with soil or growing media attached would mitigate impacts.	None
Conclusion on pest categorisation (Section 4)	*Xiphinema californicum* does satisfy all the criteria that are within the remit of EFSA to assess to be regarded as a Union quarantine pest.	*Xiphinema californicum* does not meet the criteria of (a) occurring in the EU territory, and (b) plants for planting being the principal means of spread to qualify for a RNQP.	The importance of *X. californicum* as a virus vector may be underestimated as virus–vector associations may have been linked with *X. americanum*.
Aspects of assessment to focus on/ scenarios to address in future if appropriate	Impacts on grapes, apples and plum (direct or due to virus transmission).		

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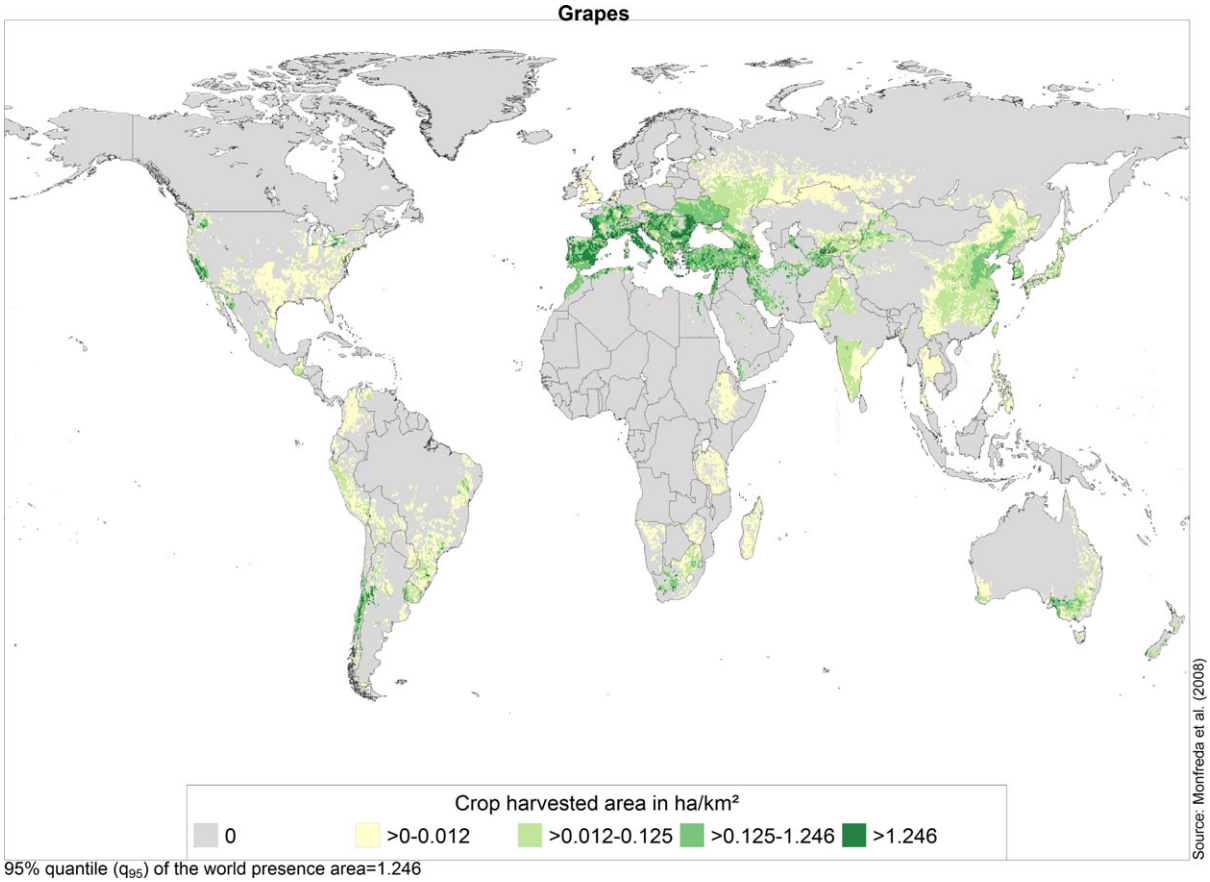
Abbreviations

CRLV	*Cherry rasp leaf virus*
DG SANCO	Directorate General for Health and Consumers
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
MS	Member State
PLH	EFSA Panel on Plant Health
RNQP	Regulated Non-Quarantine Pest
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference
ToRSV	*Tomato ringspot virus*
TRSV	*Tobacco ringspot virus*

Appendix A – Global distribution of the density of harvested grapes, apples and plums

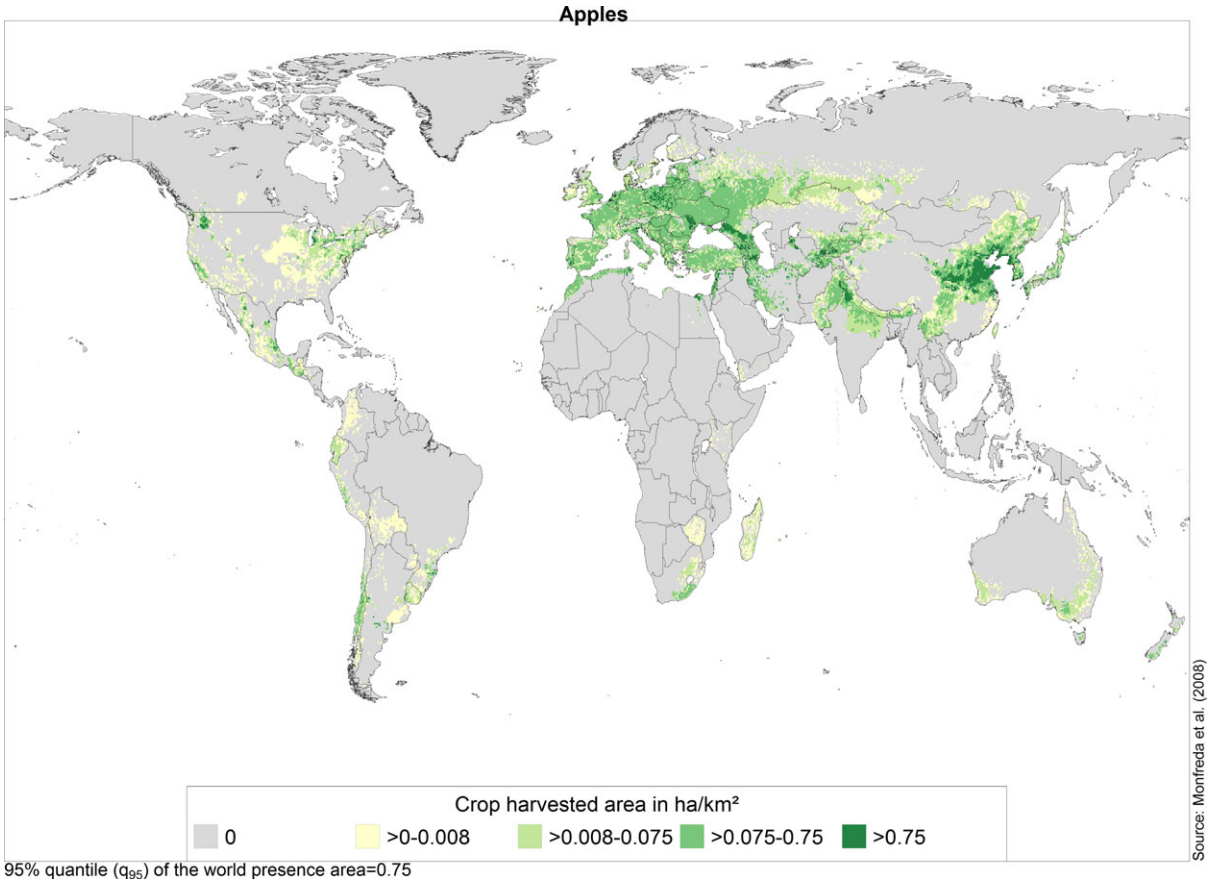
A.1. Global distribution of the density of harvested grapes (ha crop/km^2)



95% quantile (q_{95}) of the world presence area=1.246

Source: CAPRA database accessed on 29 September 2017.

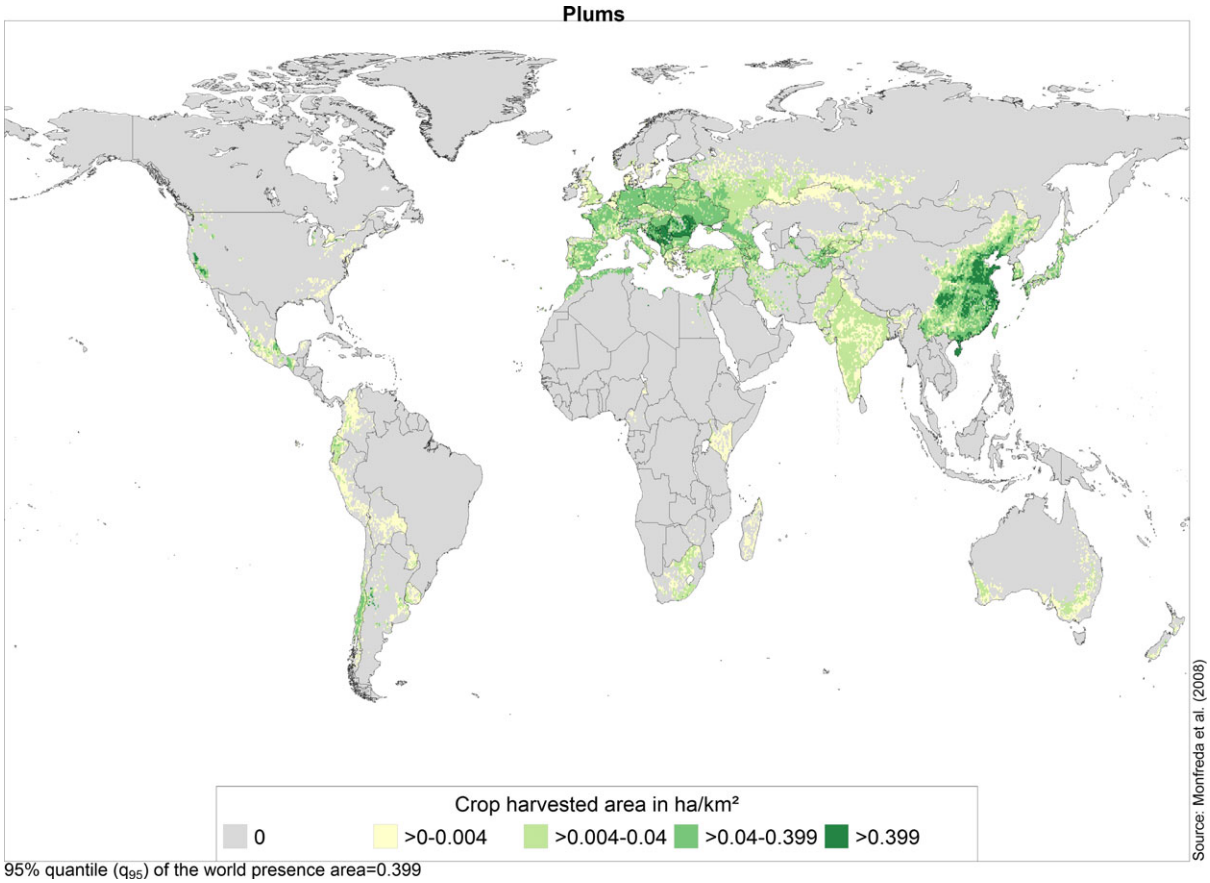
A.2. Global distribution of the density of harvested apples (ha crop/km^2)



95% quantile (q_{95}) of the world presence area=0.75

Source: CAPRA database accessed on 29 September 2017.

A.3. Global distribution of the density of harvested plums (ha crop/km^2)



95% quantile (q_{95}) of the world presence area=0.399

Source: CAPRA database accessed on 29 September 2017.