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SCIENTIFIC OPINION

Commodity risk assessment of *Cornus alba* and *Cornus sanguinea* plants from the UK

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Abstract

The European Commission requested the EFSA Panel on Plant Health to prepare and deliver risk assessments for commodities listed in Commission Implementing Regulation (EU) 2018/2019 as 'high risk plants, plant products and other objects'. Taking into account the available scientific information, including the technical information provided by the applicant country, this Scientific Opinion covers the plant health risks posed by the following commodities: *Cornus alba* and *Cornus sanguinea* bare-root plants and rooted plants in pots up to 7 years old imported into the EU from the UK. A list of pests potentially associated with the commodities was compiled. The relevance of any pest was assessed based on evidence following defined criteria. Four EU quarantine pests (*Meloidogyne fallax*, *Phytophthora ramorum* (non-EU isolates), tobacco ringspot virus, and tomato ringspot virus) and one EU non-regulated pest (*Discula destructiva*), were selected for further evaluation. For the selected pests, the risk mitigation measures implemented in the technical dossier from the UK were evaluated taking into account the possible limiting factors. For these pests, an expert judgement is given on the likelihood of pest freedom taking into consideration the risk mitigation measures acting on the pest, including uncertainties associated with the assessment. The degree of pest freedom varies among the pests evaluated, with *P. ramorum* being the pest most frequently expected on the imported *C. alba* and *C. sanguinea* plants. The Expert Knowledge Elicitation indicated, with 95% certainty, that between 9823 and 10,000 bare-root *C. alba* and *C. sanguinea* plants per 10,000 will be free from *P. ramorum*.

KEYWORDS

Commodity risk assessment, Dogwood, European Union, Plant health, Plant pests

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1 | INTRODUCTION

1.1 | Background and Terms of Reference as provided by European Commission

1.1.1 | Background

The Plant Health Regulation (EU) 2016/2031,[1] on the protective measures against pests of plants, has been applied from December 2019. Provisions within the above Regulation are in place for the listing of 'high risk plants, plant products and other objects' (Article 42) on the basis of a preliminary assessment, and to be followed by a commodity risk assessment. A list of 'high risk plants, plant products and other objects' has been published in Regulation (EU) 2018/2019.[2] Scientific Opinions are therefore needed to support the European Commission and the Member States in the work connected to Article 42 of Regulation (EU) 2016/2031, as stipulated in the terms of reference.

1.1.2 | Terms of Reference

In view of the above and in accordance with Article 29 of Regulation (EC) No 178/2002,[3] the Commission asks EFSA to provide Scientific Opinions in the field of plant health.

In particular, EFSA is expected to prepare and deliver risk assessments for commodities listed in the relevant Implementing Act as 'high risk plants, plant products and other objects'. Article 42, paragraphs 4 and 5, establishes that a risk assessment is needed as a follow-up to evaluate whether the commodities will remain prohibited, removed from the list and additional measures will be applied or removed from the list without any additional measures. This task is expected to be ongoing, with a regular flow of dossiers being sent by the applicant required for the risk assessment.

Therefore, to facilitate the correct handling of the dossiers and the acquisition of the required data for the commodity risk assessment, a format for the submission of the required data for each dossier is needed.

Furthermore, a standard methodology for the performance of 'commodity risk assessment' based on the work already done by Member States and other international organizations needs to be set.

In view of the above and in accordance with Article 29 of Regulation (EC) No 178/2002, the Commission asked EFSA to provide Scientific Opinion in the field of plant health for *Cornus alba* and *Cornus sanguinea* plants from the UK taking into account the available scientific information, including the technical dossier provided by the UK.

1.2 | Interpretation of the Terms of Reference

The EFSA Panel on Plant Health (from this point onwards referred to as 'the Panel') was requested to conduct a commodity risk assessment of *C. alba* and *C. sanguinea* plants from the UK following the Guidance on commodity risk assessment for the evaluation of high-risk plant dossiers (EFSA PLH Panel, 2019) taking into account the available scientific information, including the technical information provided by the UK. In accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, and in particular Article 5(4) of the Windsor Framework in conjunction with Annex 2 to that Framework, for the purposes of this Opinion, references to the United Kingdom do not include Northern Ireland.

The EU quarantine pests that are regulated as a group in the Commission Implementing Regulation (EU) 2019/2072[4] were considered and evaluated separately at species level.

Annex II of Implementing Regulation (EU) 2019/2072 lists certain pests as non-European populations or isolates or species. These pests are regulated quarantine pests. Consequently, the respective European populations, isolates or species are non-regulated pests.

Annex VII of the same Regulation, in certain cases (e.g. point 32) makes reference to the following countries that are excluded from the obligation to comply with specific import requirements for those non-European populations, isolates or species: Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Faeroe Islands, Georgia, Iceland, Liechtenstein, Moldova, Monaco, Montenegro, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (SeveroZapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga

[1]Regulation (EU) 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants, amending Regulations (EU) 228/2013, (EU) 652/2014 and (EU) 1143/2014 of the European Parliament and of the Council and repealing Council Directives 69/464/EEC, 74/647/EEC, 93/85/EEC, 98/57/EC, 2000/29/EC, 2006/91/EC and 2007/33/EC. OJ L 317, 23.11.2016, pp. 4–104.

[2]Commission Implementing Regulation (EU) 2018/2019 of 18 December 2018 establishing a provisional list of high risk plants, plant products or other objects, within the meaning of Article 42 of Regulation (EU) 2016/2031 and a list of plants for which phytosanitary certificates are not required for introduction into the Union, within the meaning of Article 73 of that Regulation C/2018/8877. OJ L 323, 19.12.2018, pp. 10–15.

[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, 1.2.2002, pp. 1–24.

[4]Commission Implementing Regulation (EU) 2019/2072 of 28 November 2019 establishing uniform conditions for the implementation of Regulation (EU) 2016/2031 of the European Parliament and the Council, as regards protective measures against pests of plants, and repealing Commission Regulation (EC) No 690/2008 and amending Commission Implementing Regulation (EU) 2018/2019. OJ L 319, 10.12.2019, pp. 1–279.

Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Turkey, Ukraine, and the UK (except Northern Ireland[5]).

Consequently, for those countries,

(i) Any pests identified, which are listed as non-European species in Annex II of Implementing Regulation (EU) 2019/2072 should be investigated as any other non-regulated pest.
(ii) Any pest found in a European country that belongs to the same denomination as the pests listed as non-European populations or isolates in Annex II of Implementing Regulation (EU) 2019/2072, should be considered as European populations or isolates and should not be considered in the assessment of those countries.

Pests listed as 'Regulated Non-Quarantine Pest' (RNQP) in Annex IV of the Commission Implementing Regulation (EU) 2019/2072, and deregulated pests (i.e. pest which were listed as quarantine pests in the Council Directive 2000/29/EC and were deregulated by Commission Implementing Regulation (EU) 2019/2072) were not considered for further evaluation. In case a pest is at the same time regulated as a RNQP and as a protected zone quarantine pest, in this Opinion it should be evaluated as quarantine pest.

In its evaluation the Panel:

- Checked whether the provided information in the technical dossier (from this point onwards referred to as 'the Dossier') provided by the applicant (UK, Department for Environment Food and Rural Affairs – from this point onwards referred to as 'DEFRA') was sufficient to conduct a commodity risk assessment. When necessary, additional information was requested to the applicant.
- Selected the relevant Union quarantine pests and protected zone quarantine pests [as specified in Commission Implementing Regulation (EU) 2019/2072,[6] from this point onwards referred to as 'EU quarantine pests'] and other relevant pests present in the UK and associated with the commodity.
- Did not assess the effectiveness of measures for Union quarantine pests for which specific measures are in place for the import of the commodity from the UK in Commission Implementing Regulation (EU) 2019/2072 and/or in the relevant legislative texts for emergency measures and if the specific country is in the scope of those emergency measures. The assessment was restricted to whether or not the applicant country implements those measures.
- Assessed the effectiveness of the measures described in the Dossier for those Union quarantine pests for which no specific measures are in place for the importation of the commodity from the UK and other relevant pests present in the UK and associated with the commodity.

Risk management decisions are not within EFSA's remit. Therefore, the Panel provided a rating based on expert judgement on the likelihood of pest freedom for each relevant pest given the risk mitigation measures proposed by DEFRA of the UK.

2 | DATA AND METHODOLOGIES

2.1 | Data provided by DEFRA of the UK

The Panel considered all the data and information in the Dossier provided by DEFRA of the UK in April 2023. The Dossier is managed by EFSA.

The structure and overview of the Dossier are shown in Table 1. The number of the relevant section is indicated in the Opinion when referring to a specific part of the Dossier.

TABLE 1 Structure and overview of the Dossier.

Dossier section	Overview of contents	Filename
1.0	Technical dossiers	*Cornus alba* commodity information final.pdf *Cornus sanguinea* commodity information final.pdf
2.0	Pest list	*Cornus* pest list_checked_UK.xlsx
3.0	Nursery distribution map	*Cornus_alba*_distribution_map.pdf *Cornus_sanguinea*_distribution_map.pdf
4.0	List of plants produced in the *Cornus* nurseries	*Cornus_alba*_producers_sample_product_list_UK.xlsx *Cornus_sanguinea*_producers_sample_product_list_UK.xlsx

[5]In accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, and in particular Article 5(4) of the Protocol on Ireland/Northern Ireland in conjunction with Annex 2 to that Protocol, for the purposes of this Opinion, references to Member States include the United Kingdom in respect of Northern Ireland.

[6]Commission Implementing Regulation (EU) 2019/2072 of 28 November 2019 establishing uniform conditions for the implementation of Regulation (EU) 2016/2031 of the European Parliament and the Council, as regards protective measures against pests of plants, and repealing Commission Regulation (EC) No 690/2008 and amending Commission Implementing Regulation (EU) 2018/2019, OJ L 319, 10.12.2019, pp. 1–279.

2.2 | Literature searches performed by DEFRA

The data and supporting information provided by DEFRA of the UK formed the basis of the commodity risk assessment. Table 2 shows the main data sources used by DEFRA of the UK to compile the Dossier (Dossier Sections 1.0 and 2.0).

TABLE 2 Databases used in the literature searches by the DEFRA of the UK.

Database	Platform/link
Aphids on the World's Plants	https://www.aphidsonworldsplants.info/
Aphid Species File	https://aphid.speciesfile.org/
The American Phytopathological Society	https://www.apsnet.org/Pages/default.aspx
Beetles of Britain and Ireland	https://www.coleoptera.org.uk/
Biological Records Centre	https://www.brc.ac.uk/
British Bugs	https://www.britishbugs.org.uk/gallery.html
British Leafminers	https://www.leafmines.co.uk/html/plants.htm
CABI Crop Protection Compendium	https://www.cabi.org/cpc/
CABI Plantwise Knowledge Bank	https://www.plantwise.org/knowledgebank/
CABI Publishing	https://www.cabi.org/what-we-do/publishing/
Checklist of Aphids of Britain	https://influentialpoints.com/aphid/Checklist_of_aphids_in_Britain.htm
Database of the World's Lepidopteran Hostplants	https://www.nhm.ac.uk/our-science/data/hostplants/
EPPO Global Database	https://gd.eppo.int/
Field Mycology	https://basidiochecklist.science.kew.org/BritishFungi/index.htm
Flat Mites of the World	https://idtools.org/tools/1074/index.cfm
The Fungal Records Database of Britain and Ireland	https://www.frdbi.info/
Global Biodiversity Information Facility	https://www.gbif.org/
Indian Council of Agricultural Research – National Bureau of Agricultural Insect Resources	https://www.nbair.res.in/
Index Fungorum	https://www.indexfungorum.org/
3I Interactive Keys and Taxonomic Databases	https://dmitriev.speciesfile.org/
L'Inventaire national du patrimoine naturel	https://inpn.mnhn.fr/accueil/index
MycoBank	https://www.mycobank.org/
National Collection of Plant Pathogenic Bacteria	https://www.fera.co.uk/ncppb
NBA Atlas	https://species.nbnatlas.org/
Norfolkmoths	https://www.norfolkmoths.co.uk/
Plant Parasites of Europe	https://bladmineerders.nl/
Scalenet	https://scalenet.info/
The British Mycological Society Fungal Records Database	https://www.britmycolsoc.org.uk/field_mycology/fungal_recording
The GB Checklist of Fungal Names	https://basidiochecklist.science.kew.org/BritishFungi/GBCHKLST/gbchklst.htm
The Leaf and Stem Mines of British Flies and Other Insects	https://www.ukflymines.co.uk/
The Sawflies (Symphyta) of Britain and Ireland	https://www.sawflies.org.uk/
UK Butterflies	https://www.ukbutterflies.co.uk/index.php
UK Moths	https://ukmoths.org.uk/
UK Plant Health Information Portal	https://planthealthportal.defra.gov.uk/
USDA Forest Service	https://www.srs.fs.usda.gov/
USDA Fungal Database	https://nt.ars-grin.gov/fungaldatabases/

2.3 | Literature searches performed by EFSA

Literature searches in different databases were undertaken by EFSA to complete a list of pests potentially associated with the genus *Cornus*. The following searches were combined: (i) a general search to identify pests reported on the genus *Cornus* in the databases, and subsequently (ii) a tailored search to identify whether the above pests are present or not in the UK. The searches were run on 9 May 2023. No language, date or document type restrictions were applied in the search strategy.

The Panel used the databases indicated in Table 3 to compile the list of pests associated with the genus *Cornus*. As for Web of Science, the literature search was performed using a specific, ad hoc, established search string (see Appendix B). The string was run in 'All Databases' with no range limits for time or language filters.

TABLE 3 Databases used by EFSA for the compilation of the pest list associated with *Cornus* spp.

Database	Platform/link
Aphids on World Plants	https://www.aphidsonworldsplants.info/C_HOSTS_AAIntro.htm
CABI Crop Protection Compendium	https://www.cabi.org/cpc/
Database of Insects and their Food Plants	https://www.brc.ac.uk/dbif/hosts.aspx
Database of the World's Lepidopteran Hostplants	https://www.nhm.ac.uk/our-science/data/hostplants/search/index.dsml
EPPO Global Database	https://gd.eppo.int/
EUROPHYT	https://webgate.ec.europa.eu/europhyt/
Global Biodiversity Information Facility	https://www.gbif.org/
Google Scholar	https://scholar.google.com/
Leafminers	https://www.leafmines.co.uk/html/plants.htm
Nemaplex	https://nemaplex.ucdavis.edu/Nemabase2010/PlantNematodeHostStatusDDQuery.aspx
Plant Parasites of Europe	https://bladmineerders.nl/
Plant Pest Information Network	https://www.mpi.govt.nz/news-and-resources/resources/registers-and-lists/plant-pest-information-network/
Plant Viruses Online	https://www1.biologie.uni-hamburg.de/b-online/e35/35tmv.htm#Range
Scalenet	https://scalenet.info/associates/
Spider Mites Web	https://www1.montpellier.inra.fr/CBGP/spmweb/advanced.php
USDA ARS Fungal Database (version 2021)	https://nt.ars-grin.gov/fungaldatabases/fungushost/fungushost.cfm
Web of Science: All Databases (Web of Science Core Collection, CABI: CAB Abstracts, BIOSIS Citation Index, Chinese Science Citation Database, Current Contents Connect, Data Citation Index, FSTA, KCI-Korean Journal Database, Russian Science Citation Index, MEDLINE, SciELO Citation Index, Zoological Record)	Web of Science https://www.webofknowledge.com
World Agroforestry	https://www.worldagroforestry.org/treedb2/speciesprofile.php?Spid=1749
The American Phytopathological Society	https://www.apsnet.org/Pages/default.aspx

Additional searches, limited to retrieve documents, were run when developing the Opinion. The available scientific information, including previous EFSA opinions on the relevant pests and diseases and the relevant literature and legislation (e.g. Regulation (EU) 2016/2031; Commission Implementing Regulations (EU) 2018/2019; (EU) 2018/2018; and (EU) 2019/2072), was taken into account.

2.4 | Methodology

When developing the Opinion, the Panel followed the EFSA Guidance on commodity risk assessment for the evaluation of high-risk plant dossiers (EFSA PLH Panel, 2019).

In the first step, pests potentially associated with the commodity in the country of origin (EU-regulated pests and other pests) that may require risk mitigation measures are identified. The EU non-regulated pests not known to occur in the EU were selected based on evidence of their potential impact in the EU. After the first step, all the relevant pests that may need risk mitigation measures were identified.

In the second step, if applicable, the implemented risk mitigation measures for each relevant pest are evaluated.

A conclusion on the pest freedom status of the commodity for each of the relevant pests, if any, are determined and uncertainties identified using expert judgements.

Pest freedom was assessed by estimating the number of infested/infected:

1. Bare-root plants (single or up to 50 plants per bundle) out of 10,000 exported plant units.
2. Rooted plants in pots/cells (single or up to 5 plants per bundle) out of 10,000 exported plant units.

2.4.1 | Commodity data

Based on the information provided by DEFRA of the UK, the characteristics of the commodity are summarised in Section 3 of this Opinion.

2.4.2 | Identification of pests potentially associated with the commodity

To evaluate the pest risk associated with the importation of the commodity from the UK, a pest list was compiled. The pest list is a compilation of all identified plant pests reported as associated with all species of *Cornus* based on information provided in the Dossier Sections 1.0 and 2.0 and on searches performed by the Panel. The search strategy and search syntax were adapted to each of the databases listed in Table 3, according to the options and functionalities of the different databases and Centre for Agriculture and Bioscience International (CABI) keyword thesaurus.

The scientific names of the host plants (i.e. *Cornus*) were used when searching in the European and Mediterranean Plant Protection Organization (EPPO) Global database (EPPO GD, online) and CABI Crop Protection Compendium (CABI, online). The same strategy was applied to the other databases (see Table 3) excluding EUROPHYT and Web of Science. The notifications of interceptions of EU member states were consulted for the years 2009 to 2023 (EUROPHYT, online, from 2009 to 2020 and TRACES-NT, online, from May 2020 to March 2023, Accessed: 14 November 2023). To check whether *Cornus* spp. can act as a pathway, all notifications (all origins) for *Cornus* spp. were evaluated. For each selected pest, it was checked if there were any notification records for UK (all commodities).

The search strategy used for Web of Science Databases was designed combining English common names for pests and diseases, terms describing symptoms of plant diseases and the scientific and English common names of the commodity and excluding pests which were identified using searches in other databases. The established search string is detailed in Appendix B and was run on 9 May 2023.

The titles and abstracts of the scientific papers retrieved were screened, and the pests associated with *Cornus* genus were included in the pest list. The pest list was eventually further compiled with other relevant information (e.g. EPPO code per pest, taxonomic information, categorisation and distribution) useful for the selection of the pests relevant for the purposes of this Opinion.

The compiled pest list (see Microsoft Excel® in Appendix C) includes all identified pests that use the genus *Cornus* as a host.

The evaluation of the compiled pest list was done in two steps: first, the relevance of the EU quarantine pests was evaluated (Section 4.1); second, the relevance of any other plant pest was evaluated (Section 4.2).

2.4.3 | Listing and evaluation of risk mitigation measures

All proposed risk mitigation measures were listed and evaluated. When evaluating the likelihood of pest freedom at origin, the following types of potential infestation/infection sources for *C. alba* and *C. sanguinea* in nurseries were considered (see also Figure 1):

- Pest entry from surrounding areas,
- Pest entry with new plants/seeds,
- Pest spread within the nursery.

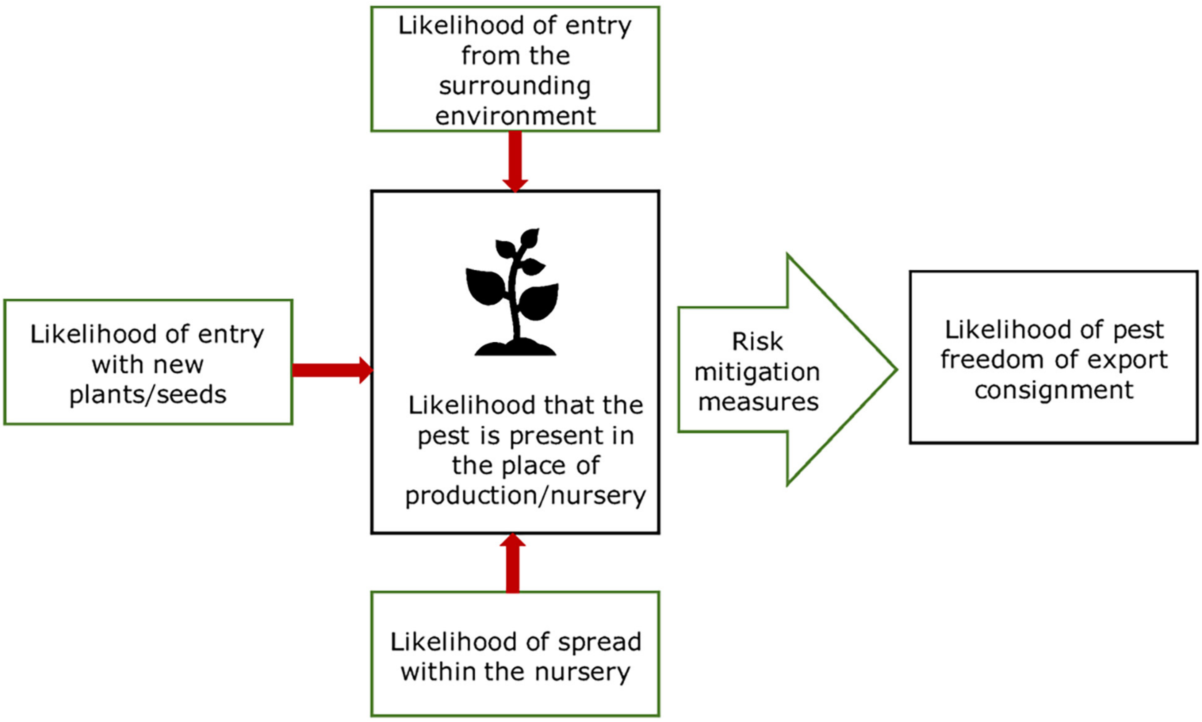


FIGURE 1 Conceptual framework to assess likelihood that plants are exported free from relevant pests. *Source*: EFSA PLH Panel (2019).

Information on the biology, estimates of likelihood of entry of the pest into the nursery and spread within the nursery, and the effect of the measures on a specific pest is summarised in pest data sheets compiled for each pest selected for further evaluation (see Appendix A).

2.4.4 | Expert knowledge elicitation

To estimate the pest freedom of the commodities, an Expert Knowledge Elicitation (EKE) was performed following EFSA guidance (Annex B.8 of EFSA Scientific Committee, 2018).

The specific question for EKE was defined as follows: 'Taking into account (i) the risk mitigation measures listed in the Dossier, and (ii) other relevant information (reported in the specific pest datasheets), how many of 10,000 plants, either single or in bundles will be infested with the relevant pest/pathogen when arriving in the EU?'

The risk assessment considers bare-root plants (Figure 2A,B) (bundles of 25 or 50 for seedlings or transplants; bundles of 5, 10 or 15 for whips; or single bare-root trees) and rooted plants in pots/cells (Figures 3A,B, 4) (single or up to 5 plants per bundle [Figure 3B]).

Before the elicitation, the pests were grouped if they had similar characteristics, such as: closely taxonomically related; biology/life history; behavioural ecology; effect of management measures (e.g. mesh size); plant/pathogen/vector (if applicable) interactions.

The uncertainties associated with the EKE were taken into account and quantified in the probability distribution applying the semi-formal method described in section 3.5.2 of the EFSA PLH Guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018). Finally, the results were reported in terms of the likelihood of pest freedom. The lower 5% percentile of the uncertainty distribution reflects the opinion that pest freedom is, with 95% certainty, above this limit.

3 | COMMODITY DATA

3.1 | Description of the commodity

The commodity consists of the following type of deciduous plants of *C. alba* or *C. sanguinea* (Table 4, Figures 2–4):

TABLE 4 Type of *C. alba* and *C. sanguinea* plants to be exported to the EU (Dossier Section 1.0).

Type of plants	Age	Stem diameter (cm)	Height (cm)
Bare-root plants (whips*)	1–3 years old	0.4–1.0	20–120
Bare-root plants	2–7 years old	0.4–4.0	20–150
Cell-grown plants (small containers)	1–2 years old	0.4–1.0	20–60
Rooted plants in pots	1–5 years old	1.0–4.0	20–150

*Whips are slender, unbranched trees that can be bare-root or containerised.

FIGURE 2 Field-grown (A) *C. alba* and (B) *C. sanguinea* for bare-root plant production (*Source*: Dossier Section 1.0).

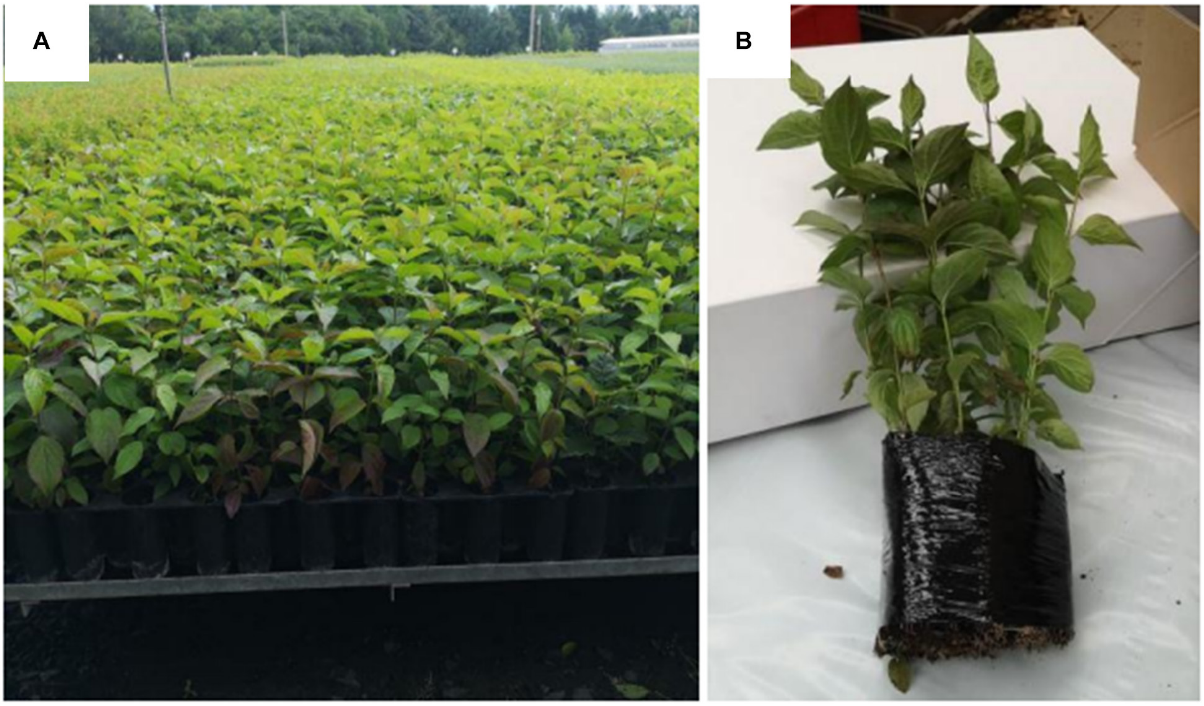


FIGURE 3 (A) Cell-grown plants grown on metal frames; (B) Cell-grown plants bundled prior to dispatch of *C. alba* and *C. sanguinea* plants (*Source*: Dossier Section 1.0).

FIGURE 4 Rooted plants in pots grown in plastic trays on top of gravel (*Source*: Dossier Section 1.0).

Rooted plants in pots may be exported with leaves, depending on the timing of the export and the life cycle of the species. Bare-root plants exported to the EU may also have some leaves at the time of export, in particular when exported in November (Dossier Section 1.0).

According to International Standards for Phytosanitary Measures (ISPM) 36 (FAO, 2019), the commodity can be classified as 'bare-root plants' or 'rooted plants in pots'.

According to the Dossier Section 1.0, the trade volume for both *C. alba* and *C. sanguinea* are listed in Table 5.

TABLE 5 Trade volume and seasonal timing for *C. alba* and *C. sanguinea* plants.

Type of plant	Number of items	Seasonal timing
Bare-root plants	10,000 (*C. sanguinea*), 15,000 (*C. alba*)	October to April
Rooted plants in pots	20,000 (*C. sanguinea*), 25,000 (*C. alba*)	Mainly September to May

Trade of all plant types will mainly be to Northern Ireland and the Republic of Ireland.

- Bare-root plants will be lifted from late autumn until early spring (October to April), as this is the best time to move/export dormant plants (Dossier Section 1.0).
- Rooted plants in pots can be moved/exported at any time in the year to fulfil consumer demand, but more usually from September to May. These will probably be destined for amenity or garden centre trade rather than nurseries (Dossier Section 1.0).

3.2 | Description of the production areas

The nurseries producing the commodity are distributed in the Eastern part of Great Britain. All nurseries are registered as professional operators with the UK National Plant Protection Organization (NPPO), either by the Animal and Plant Health Agency (APHA) in England and Wales or by the Scottish Government, and are authorised to issue UK plant passports and phytosanitary certificates for export (Dossier Section 1.0).

Producers do not set aside separate areas for export production. All plants within UK nurseries are grown under the same phytosanitary measures, meeting the requirements of the UK Plant Passporting regime (Dossier Section 1.0). The production areas designated for export to the EU are indicated in the map below (Figure 5).

FIGURE 5 Location of the nurseries designated for export of *C. alba* and *C. sanguinea* to the European Union (*Source*: Dossier Section 1.0).

Nurseries

The minimum and maximum sizes of nurseries growing *C. alba* and *C. sanguinea* for export are as follows.

- Container grown stock: minimum 8 ha/maximum 150 ha.
- Field-grown stock (for bare-root plants): maximum 325 ha.

The exporting nurseries grow a range of other plant species. The production area where *C. alba* and *C. sanguinea* plants are grown is around 1%–5% of the total area of the nurseries. None of the nurseries expected to export to the EU produce plants from grafting; they use seed (no certification) and seedlings (UK plant passports); therefore, there are no mother plants of *C. alba* and *C. sanguinea* present in the nurseries. None of the nurseries expected to export to the EU have mother plants of other tree species present in the nurseries. Approximately 20% of the nurseries likely to export to the EU also sell plants within the UK to final users as ornamental plants, for example to the Local Authorities/Landscape Architects (Dossier Section 1.0).

As the plants are intended for outdoor cultivation, only early growth stages are normally maintained under protection, such as young plants/seedlings, where there is an increased vulnerability due to climatic conditions, including frost. The commodity to be exported should therefore be regarded as outdoor grown. Growth under protection is primarily to protect against external climatic conditions rather than protection from pests. The early stages of plants grown under protection are maintained in plastic polytunnels or in glasshouses, which typically consist of a metal or wood frame construction and glass panels (Dossier Section 1.0).

Surrounding area

Exporting nurseries are predominately situated in rural areas. The surrounding land is mainly arable farmland, with some pasture for animals and small areas of woodland. Hedges are often used to define field boundaries and grown along road-sides (Dossier Section 1.0).

Arable crops

These are rotated in line with good farming practice but could include oilseed rape (*Brassica napus*), wheat (*Triticum*), barley (*Hordeum vulgare*), turnips (*Brassica rapa* subsp. *rapa*), potatoes (*Solanum tuberosum*) and maize (*Zea mays*) (Dossier Section 1.0).

Pasture

Predominantly ryegrass (*Lolium*) (Dossier Section 1.0).

Woodland

Woodlands tend to be a standard UK mixed woodland, with a range of UK native trees such as oak (*Quercus robur*), pine (*Pinus*), poplar (*Populus*), ash (*Fraxinus*), sycamore (*Acer pseudoplatanus*), holly (*Ilex*), Norway maple (*Acer platanus*) and field maple (*Acer campestre*) (Dossier Section 1.0).

Hedges

Hedges are made up of a range of species, including hazel (*Corylus avellana*), yew (*Taxus baccata*), holly (*Ilex*), ivy (*Hedera*), alder (*Alnus glutinosa*), laurel (*Prunus laurocerasus*), hawthorn (*Crataegus*), blackthorn (*Prunus spinosa*) and leylandii (*Cupressus x leylandii*) (Dossier Section 1.0).

The map provided (Figure 5) included the locations of those nurseries that have contributed the technical information required to prepare the dossier. While these nurseries are likely to be responsible for most UK movements to Northern Ireland and the EU, the information they have contributed is intended to be representative of general industry practice. As with any market access application submitted in line with IPPC guidance, we assume, unless specifically stated otherwise, that the application is made at the country-to-country level. It may therefore be possible that other nurseries in the UK could produce these commodities and would want to export in the future. Such nurseries would need to meet the import requirements set out in any subsequent EU legislation as the nurseries that have contributed technical information to the dossiers.

3.3 | Production and handling processes

3.3.1 | Source of planting material

The starting material is a mix of seeds and seedlings depending on the nursery. Some seedlings may be obtained from the EU (mostly the Netherlands). This is the only source of the plants obtained from abroad (Dossier Section 1.0).

C. alba seeds purchased in the UK are not covered by a certification scheme; seedlings sourced in the UK are certified with UK Plant Passports; seedlings from the EU countries are certified with phytosanitary certificates (Dossier Section 1.0).

C. sanguinea seeds purchased in the UK may be certified under the Forestry Commission's Voluntary Scheme for the Certification of Native Trees and Shrubs. This allows certification of seeds not covered by Schedule 1 of The Forest Reproductive Material (Great Britain) Regulations 2002 (legislation.gov.uk) (Dossier Section 1.0).

3.3.2 | Production cycle

The growing conditions are as follows (as defined in Annex 1 of ISPM 36 (FAO, 2019)):

- Grown outdoors/in the open air in containers (cells and pots) on protected plastic membranes, or on raised benches to prevent contact with the soil;
- Field grown.

Cell-grown trees may be grown in cells at one plant per cell. These may be grown under protection initially; however, most plants will be field grown, or field grown in containers.

Any plants in pots with organic growing medium being exported from the UK to the EU need to meet the requirements for growing media in EU Regulation 2019/2072, Annex VII, and the UK already has exports to EU MS meeting this requirement.

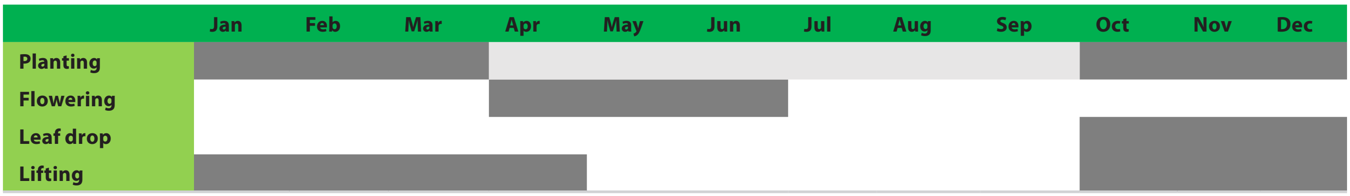
In the production or procurement of plants, the use of growing media is assessed for the potential to harbour and transmit plant pests. Growers use virgin peat or peat-free compost, which is a mixture of coir, tree bark, wood fibre etc. This compost is heat-treated by commercial suppliers during production to eliminate pests and diseases. It is supplied in sealed bulk bags or shrink-wrapped bales and stored off the ground on pallets, these are completely hygienic and free from contamination. Where delivered in bulk, compost is kept in a dedicated bunker, either indoors or covered by tarpaulin outdoors, and with no risk of contamination with soil or other material (Dossier Section 1.0).

Plants for bare-root plant production are planted from late autumn until early spring (November to March); rooted plants in pots can be planted at any time of year, though winter is most common. Flowering occurs during late spring (April to June), depending upon the variety and weather conditions (Dossier Section 1.0) (Table 6).

Lifting:

- Bare-root plants will be harvested in winter. The plants are then root-washed on site and stored prior to export. Bare-root plants exported to the EU may also have some leaves at the time of export, in particular when exported in November (Dossier Section 1.0).
- Rooted plants in pots can be traded at any point in the year. These plants may be exported with leaves, depending on the timing of the export and the life cycle of the species (Dossier Section 1.0).

TABLE 6 Period of the year when the commodity is produced and the phenology of the crop (including sowing/planting, flowering and harvesting periods).



The irrigation is done on a need basis and could be overhead, sub-irrigation or drip irrigation. Water used for irrigation can be drawn from several sources, the mains supply, bore holes or from rainwater collection/water courses. Growers are required to assess water sources, irrigation and drainage systems used in the plant production for the potential to harbour and transmit plant pests. Water is routinely sampled and sent for analysis. No quarantine pests have been found so far (Dossier Section 1.0).

Growers must assess weeds and volunteer plants for the potential to host and transmit plant pests and have an appropriate programme of weed management in place at the nursery (Dossier Section 1.0). Growing areas are kept clear of non-cultivated herbaceous plants. In access areas, non-cultivated herbaceous plants are kept to a minimum and only exist at nursery boundaries. Non-cultivated herbaceous plants grow on less than 1% of the nursery area (Dossier Section 1.0).

General hygiene measures are undertaken as part of routine nursery production, including disinfection of tools and equipment between batches/lots. Tools are disinfected after operation on a stock and before being used on a different plant species. The tools are dipped and wiped with a clean cloth between trees to reduce the risk of virus and bacterial transfer between subjects. Virkon S (active substances: potassium peroxymonosulfate and sodium chloride) was reported as the most commonly used disinfectant. Growers keep records, allowing traceability for all plant material handled (Dossier Section 1.0).

Plant material is regularly monitored for plant health issues. This monitoring is carried out by trained nursery staff via regular crop walking and records kept of this monitoring. Qualified agronomists also undertake regular crop walks to verify the producer's assessments. Curative or preventative actions are implemented together with an assessment of phytosanitary risk. Unless a pest can be immediately and definitively identified as non-quarantine growers are required to treat it as a suspect quarantine pest and notify the competent authority (Dossier Section 1.0).

Additional specific phytosanitary measures apply against *Phytophthora ramorum* (EU QP (Non-EU isolates)). At growing sites, infected plants are destroyed, and potentially infected plants are 'held' (prohibited from moving). The UK has a containment policy in the wider environment, with official action taken to remove infected trees. As part of an annual survey of ornamental retail and production sites (frequency of visits determined by a decision matrix), *P. ramorum* is inspected on common host plants. An additional inspection, during the growing period, is carried out at plant passport production sites. Inspections are carried out in a survey of 300 non-woodland wider environment sites annually (Dossier Section 1.0).

Pest and disease pressures vary from season to season. Biological control or chemical treatments are reported to be applied when required and depend on the situation at that time (disease pressure, growth stage etc., and environmental factors) (Dossier Section 1.0).

There are no specific measures/treatments against soil pests. However, containerised plants are grown in trays on top of protective plastic membranes to prevent contact with soil. Membranes are regularly refreshed when needed. Alternatively, plants may be grown on raised galvanised steel benches stood on gravel as a barrier between the soil and bench feet and/or concreted surfaces (Dossier Section 1.0, Point 5.1).

3.3.3 | Export procedure

The UK NPPO carries out inspections and testing (where required by the country of destination's plant health legislation) to ensure all requirements are fulfilled and a valid phytosanitary certificate with the correct additional declarations is issued (Dossier Section 1.0).

The following processes are typical of all exporting nurseries.

Bare-root plants are lifted and washed free from soil with a low-pressure washer in the outdoors nursery area away from packing/cold store area. In some cases, the plants may be kept in a cold storage for up to 5 months after harvesting prior to export (Dossier Section 1.0).

Prior to export, bare-root plants may be placed in bundles, depending on the size of the plants (25 or 50 for seedlings or transplants; 5, 10 or 15 for whips; or single bare-root trees). They are then wrapped in polythene and packed and distributed on ISPM 15 certified wooden or metal pallets (FAO, 2018) (Figure 6). Alternatively, they may be placed in pallets, which are then wrapped in polythene. Small-volume orders may be packed in waxed cardboard cartons or polythene bags and dispatched via courier (Dossier Section 1.0).

Rooted plants in pots are transported on Danish trolleys for smaller containers or ISPM 15 certified pallets, or individually in pots for larger containers. Small-volume orders may be packed in waxed cardboard cartons or polythene bags and dispatched via courier (Dossier Section 1.0) (Figure 6).

The preparation of the commodities for export is carried out inside the nurseries in a closed environment, for example packing shed (Dossier Section 1.0).

Plants are transported by lorry (size dependent on load quantity). Sensitive plants will occasionally be transported by temperature-controlled lorry if weather conditions during transit are likely to be very cold (Dossier Section 1.0).

FIGURE 6 The preparation of the plants for export to the EU (*Source*: Dossier Section 1.0).

4 | IDENTIFICATION OF PESTS POTENTIALLY ASSOCIATED WITH THE COMMODITY

The search for potential pests associated with *Cornus* spp. rendered 887 species (see Microsoft Excel® file in Appendix C).

4.1 | Selection of relevant EU quarantine pests associated with the commodity

The EU listing of Union quarantine pests and protected zone quarantine pests (Commission Implementing Regulation (EU) 2019/2072) is based on assessments concluding that the pests can enter, establish, spread and have potential impact in the EU.

The 18 EU quarantine species that are reported to use *Cornus* spp. as a host plant were evaluated (Table 7) for their relevance of being included in this Opinion.

The relevance of an EU quarantine pest for this Opinion was based on evidence that:

a. the pest is present in the UK;
b. the commodity is a host of the pest;
c. one or more life stages of the pest can be associated with the specified commodity.

Pests that fulfilled all criteria are selected for further evaluation.

Of the 18 EU quarantine pest species evaluated, four pests were selected for further assessment.

TABLE 7 Overview of the evaluation of the 18 EU quarantine pest species known to use *Cornus* species as host plants for their relevance for this Opinion.

No.	Pest name according to EU legislation[a]	EPPO code	Group	Pest present in the UK	*Cornus* confirmed as a host (reference)	Pest can be associated with the commodity (NA = not assessed)	Pest relevant for the opinion
1	*Anoplophora chinensis*	ANOLCN	Insects	No	*Cornus* sp. (EPPO GD)	NA	No
2	*Anthonomus quadrigibbus*	TACYQU	Insects	No	*Cornus sericea* (EPPO GD)	NA	No
3	*Choristoneura conflictana*	ARCHCO	Insects	No	*Cornus alternifolia* (EPPO GD)	NA	No
4	*Choristoneura rosaceana*	CHONRO	Insects	No	*Cornus* sp., *Cornus florida, Cornus racemosa* (EPPO GD)	NA	No
5	*Euwallacea fornicatus* sensu lato	XYLBFO	Insects	No	*Cornus controversa* (EPPO GD)	NA	No
6	*Lopholeucaspis japonica*	LOPLJA	Insects	No	*Cornus controversa, Cornus florida, Cornus kousa, Cornus macrophylla, Cornus mas, Cornus officinalis, Cornus x rutgergensis* (artificial hybrid of *Cornus kousa* and *Cornus florida*) (EPPO GD)	NA	No
7	*Lycorma delicatula*	LYCMDE	Insects	No	*Cornus* sp., *Cornus controversa, Cornus florida, Cornus kousa, Cornus officinalis* (EPPO GD)	NA	No
8	*Meloidogyne chitwoodi*	MELGCH	Nematodes	No	*Cornus sanguinea* (NEMAPLEX)	NA	No
9	*Meloidogyne fallax*	MELGFA	Nematodes	Yes	*Cornus sanguinea* (NEMAPLEX)	Yes	Yes
10	*Oemona hirta*	OEMOHI	Insects	No	*Cornus nattallii* (EPPO GD)	NA	No
11	*Phyllosticta solitaria*	PHYSSL	Fungi	No	*Cornus walteri* (USDA)	NA	No
12	*Phymatotrichopsis omnivora*	PHMPOM	Fungi	No	*Cornus drummondii, Cornus florida* (EPPO GD)	NA	No
13	*Phytophthora ramorum*	PHYTRA	Oomycetes	Yes	*Cornus capitata*, *Cornus* hybrids, *Cornus kousa* (EPPO GD)	Yes	Yes
14	*Rhagoletis mendax*	RHAGME	Insects	No	*Cornus canadensis* (WoS)	NA	No
15	*Rhagoletis pomonella*	RHAGPO	Insects	No	*Cornus florida* (WoS)	NA	No
16	Tobacco ringspot virus	TRSV00	Viruses	Yes	*Cornus florida, Cornus racemosa, Cornus sericea* (EPPO GD)	Yes	Yes
17	Tomato ringspot virus	TORSV0	Viruses	Yes	*Cornus florida* (Encyclopedia of Plant Viruses and Viroids)	Yes	Yes
18	*Xylella fastidiosa*	XYLEFA	Bacteria	No	*Cornus florida* (WoS)	NA	No

[a]Commission Implementing Regulation (EU) 2019/2072.

4.2 | Selection of other relevant pests (non-quarantine in the EU) associated with the commodity

The information provided by the UK, integrated with the search performed by EFSA, was evaluated in order to assess whether there are other relevant pests potentially associated with the commodity species present in the country of export. For these potential pests that are non-regulated in the EU, pest risk assessment information on the probability of entry, establishment, spread and impact is usually lacking. Therefore, these pests were also evaluated to determine their relevance for this Opinion based on evidence that:

a. the pest is present in the UK;
b. the pest is (i) absent or (ii) has a limited distribution in the EU;
c. *Cornus* spp. is a host of the pest;
d. one or more life stages of the pest can be associated with the *Cornus* spp.;
e. the pest may have an impact in the EU.

For non-regulated species with a limited distribution (i.e. present in one or a few EU member states) and fulfilling the other criteria (i.e. c, d and e), and either one of the following conditions should be additionally fulfilled for the pest to be further evaluated:

- official phytosanitary measures have been adopted in at least one EU member state;
- any other reason justified by the working group (e.g. recent evidence of presence).

Based on the information collected, 869 potential pests (non-EU quarantine) known to be associated with *Cornus* spp. were evaluated for their relevance to this Opinion.

Species were excluded from further evaluation when at least one of the conditions listed above (a–e) was not met. Details can be found in the Appendix C (Microsoft Excel® file). One of the evaluated EU non-quarantine pests, *Discula destructiva,* was selected for further evaluation.

4.3 | Summary of pests selected for further evaluation

Five pests that were identified to be present in the UK and having potential for association with *Cornus* plants designated for export to the EU are listed in Table 8. The efficacy of the risk mitigation measures applied to the commodity was evaluated for these selected pests.

TABLE 8 List of relevant pests selected for further evaluation.

No.	Current scientific name	EPPO code	Taxonomic information	Group	Regulatory status
1	*Meloidogyne fallax*	MELGFA	Rhabditida, Meloidogynidae	Nematodes	EU Quarantine Pest
2	*Phytophthora ramorum*	PHYTRA	Peronosporales, Peronosporaceae	Oomycetes	EU Quarantine Pest
3	Tobacco ringspot virus	TRSV00	Secoviridae, Nepovirus	Viruses	EU Quarantine Pest
4	Tomato ringspot virus	TORSV0	Secoviridae, Nepovirus	Viruses	EU Quarantine Pest
5	*Discula destructiva*	DISCDE	Diaporthales, Gnomoniaceae	Fungi	Not regulated in the EU

5 | RISK MITIGATION MEASURES

For the selected pests (Table 8), the Panel evaluated the likelihood that it could be present in the *C. alba* and *C. sanguinea* nurseries by evaluating the possibility that the commodity in the export nurseries is infested either by:

- Introduction of the pest from the environment surrounding the nursery;
- Introduction of the pest with new plants/seeds;
- Spread of the pest within the nursery.

The information used in the evaluation of the effectiveness of the risk mitigation measures is summarised in pest data sheets (see Appendix A).

5.1 | Risk mitigation measures applied in the UK

With the information provided by the UK (Dossier Sections 1.0, 2.0, 3.0, & 4.0), the Panel summarised the risk mitigation measures (see Table 9) that are implemented in the production nursery.

TABLE 9 Overview of implemented risk mitigation measures for *C. alba* and *C. sanguinea* plants designated for export to the EU from the UK.

No.	Risk mitigation measure	Evaluation and uncertainties
1	Registration of production sites	All nurseries are registered as professional operator with the UK NPPO, by the APHA and is authorised to issue UK plant passports (Dossier Section 1.0)
2	Certified plant material	Seeds of *C. alba* are not certified, while seeds of *C. sanguinea* purchased in the UK may be certified under the Forestry Commission's Voluntary Scheme for the Certification of Native Trees and Shrubs. Seedlings for *Cornus* spp. production sourced in the UK are certified with UK Plant Passports; seedlings from the EU countries are certified with phytosanitary certificates (Dossier Section 1.0)
3	Certification of substrates (rooted plant in pots)	Rooted plants in pots: In the production or procurement of these plants, the use of growing media is assessed for the potential to harbour and transmit plant pests. Growers most commonly use virgin peat or peat-free compost, which is a mixture of coir, tree bark, wood fibre etc. The compost is heat-treated by commercial suppliers during production to eliminate pests and diseases. It is supplied in sealed bulk bags or shrink-wrapped bales and stored off the ground on pallets, these are completely hygienic and free from contamination. Where delivered in bulk, compost is kept in a dedicated bunker, either indoors or covered by tarpaulin outdoors, and with no risk of contamination with soil or other material (Dossier Section 1.0)
4	Surveillance, monitoring and sampling	In the last 3 years there has been a substantial level of inspection of registered *Cornus* spp. producers, both in support of the Plant Passporting scheme (checks are consistent with EU legislation, with a minimum of once a year for authorised operators) and as part of the Quarantine Surveillance programme (Great Britain uses the same framework for its surveillance programme as the EU). The Competent Authority inspects crops at least once a year to check if they meet the standards set out in the guides (Dossier Section 1.0). UK(GB) surveillance is based on visual inspection with samples taken from symptomatic material, and where appropriate, samples are also taken from asymptomatic material (e.g. plants, tubers, soil, watercourses) (Dossier Section 1.0)
5	Hygiene measures	According to the Dossier Section 1.0, all the nurseries have plant hygiene and housekeeping rules and practices in place, which are communicated to all relevant employees. The rules will be dependent on the plants handled and the type of business but will include: • Growing media • Weed management • Water usage • Cleaning and sterilisation • Waste treatment and disposal • Visitors
6	Irrigation water quality and/or treatments	Growers are required to assess water sources, irrigation and drainage systems used in the plant production for the potential to harbour and transmit plant pests. Water is routinely sampled and sent for analysis. No quarantine pests have been found (Dossier Section 1.0)
7	Application of pest control products	Crop protection is achieved using a combination of measures including approved plant protection products, biological control or physical measures. Plant protection products are only used when necessary and records of all plant protection treatments are kept (Dossier Section 1.0)
8	Washing of the roots (bare-root plants)	Bare-root plants are lifted from the field in winter and then root-washed on site and stored prior to export (Dossier Section 1.0)
9	Inspections and management of plants before export	The UK NPPO carries out inspections and testing where required by the country of destination's plant health legislation, to ensure all requirements are fulfilled and a valid phytosanitary certificate with the correct additional declarations is issued Separate to any official inspection, plant material is checked by growers for plant health issues before dispatch Special provision for inspection of *P. ramorum* is in place

5.2 | Evaluation of the current measures for the selected pests including uncertainties

The relevant risk mitigation measures acting on the selected pests were identified. Any limiting factors on the efficacy of the measures were documented. All the relevant information, including the related uncertainties deriving from the limiting factors used in the evaluation, is summarised in the pest datasheets provided in Appendix A.

Based on this information, an expert judgement has been given for the likelihood of pest freedom of the commodity, taking into consideration the risk mitigation measures acting on the pest and their combination.

An overview of the evaluation of the selected pests is given in the sections below (Sections 5.2.1–5.2.4). The outcome of EKE on pest freedom after the evaluation of the proposed risk mitigation measures is summarised in the Section 5.2.5.

5.2.1 | Overview of the evaluation of *Meloidogyne fallax*

Overview of evaluation of *Meloidogyne fallax* for the bare-root plants					
Rating of the likelihood of pest freedom	**Pest free with some exceptional cases** (based on the median)				
Percentile of the distribution	5%	25%	Median	75%	95%
Proportion of pest-free plants	9849 out of 10,000 plants	9930 out of 10,000 plants	9973 out of 10,000 plants	9993 out of 10,000 plants	10,000 out of 10,000 plants
Proportion of infested plants	0 out of 10,000 plants	7 out of 10,000 plants	27 out of 10,000 plants	70 out of 10,000 plants	151 out of 10,000 plants
Summary of the information used for the evaluation	**Possibility that the pest could become associated with the commodity** *M. fallax* is a polyphagous nematode with a wide host range, including several major horticultural and agricultural crops and a few species of trees, shrubs and herbaceous plants. The pest can spread via passive human-assisted transport with plants for planting with infested roots, infested soil and/or growing media, and possibly via contaminated tools and machinery. The bare-root *Cornus* spp. plants could become infested during their growth in the field soil **Measures taken against the pest and their efficacy** General measures taken by the growers are effective against the nematode. These measures include (a) registration of production sites; (b) the use of certified plant material; (c) surveillance, monitoring and sampling; (d) hygiene measures; (e) irrigation water testing; and (f) inspection and management of plants before export **Shortcomings of current measures/procedures** No major shortcomings were identified in the evaluation. If all the described measures are implemented correctly, it is unlikely that the pest is present on the exported *Cornus* spp. plants **Main uncertainties** – The efficacy of pest detection in the Plant Passport scheme is not known. – The frequency of inspection of root systems for nematodes. – The efficiency of the hygiene measures, especially concerning the cleaning of the machinery and the possible movement of soil within the nursery. – In case of irrigation water, the frequency and the method used for the detection of this pest.				

Overview of evaluation of *Meloidogyne fallax* for the rooted plants in pots					
Rating of the likelihood of pest freedom	**Pest free with few exceptional cases** (based on the median)				
Percentile of the distribution	5%	25%	Median	75%	95%
Proportion of pest-free plants	9963 out of 10,000 plants	9981 out of 10,000 plants	9991 out of 10,000 plants	9997 out of 10,000 plants	10,000 out of 10,000 plants
Proportion of infested plants	0 out of 10,000 plants	3 out of 10,000 plants	9 out of 10,000 plants	19 out of 10,000 plants	37 out of 10,000 plants
Summary of the information used for the evaluation	**Possibility that the pest could become associated with the commodity** *M. fallax* is a polyphagous nematode with a wide host range, including several major horticultural and agricultural crops and a few species of trees, shrubs and herbaceous plants. The pest can enter into the nurseries and spread within the nurseries with passive human-assisted transport with plants for planting with infested roots, infested soil and growing media, and possibly via contaminated tools and machinery. The rooted *Cornus* spp. plants in pots could become infested when in contact with infested soil **Measures taken against the pest and their efficacy** General measures taken by the nurseries are effective against the nematode. These measures include (a) registration of production sites; (b) the use of certified plant material; (c) the use of certified (heat-treated) growing media; (d) surveillance, monitoring and sampling; (e) hygiene measures (avoid contact with soil); (f) irrigation water testing; and (g) inspection and management of plants before export **Shortcomings of current measures/procedures** No major shortcomings were identified in the evaluation. If all the described measures are implemented correctly, it is unlikely that the pest is present on the exported *Cornus* spp. plants **Main uncertainties** – The efficacy of pest detection in the plant passport scheme is not known. – The temperature–time of the heat treatment of the growing media and the efficacy on *M. fallax* are not known. In another species (*Meloidogyne incognita*), egg sacs protect eggs and juveniles from heat, and 72°C for 4 days is required sanitation. The heat tolerance of *M. fallax* is not known. – The frequency of inspection of root systems for nematodes. – The efficiency of the hygiene measures, especially concerning the cleaning of the machinery and the possible movement of soil within the nursery. – In case of irrigation water, the frequency and the method used for the detection of this pest.				

5.2.2 | Overview of the evaluation of *Phytophthora ramorum*

Overview of evaluation of *Phytophthora ramorum* for the bare-root plants					
Rating of the likelihood of pest freedom	**Pest free with some exceptional cases** (based on the median)				
Percentile of the distribution	5%	25%	Median	75%	95%
Proportion of pest-free plants	9823 out of 10,000 plants	9908 out of 10,000 plants	9968 out of 10,000 plants	9994 out of 10,000 plants	9999 out of 10,000 plants
Proportion of infected plants	1 out of 10,000 plants	6 out of 10,000 plants	32 out of 10,000 plants	92 out of 10,000 plants	177 out of 10,000 plants
Summary of the information used for the evaluation	**Possibility that the pest could become associated with the commodity** *P. ramorum* is present in the UK; it has been found in most regions of the UK, but it is more often reported in wetter, western regions. *P. ramorum* has a wide host range. The possible entry of *P. ramorum* from the surrounding environment may occur through wind, water and infested soil propagules on the feet of animals/humans entering the field (if any). The pathogen can also enter with new seedlings of *Cornus* spp. and new plants of other species used for plant production in the nurseries **Measures taken against the pest and their efficacy** *P. ramorum* is a quarantine pest in the UK and is under official control. General measures taken by the growers are effective against this pathogen. These measures include (a) registration of production sites; (b) the use of certified plant material; (c) surveillance, monitoring and sampling; (d) hygiene measures; (e) irrigation water testing; (f) washing of the roots of the bare-root plants; (g) application of pest control products; and (h) inspection and management of plants before export **Shortcomings of current measures/procedures** No major shortcomings were identified in the evaluation. If all the described measures are implemented correctly, it is unlikely that the pest is present on the exported *Cornus* spp. plants **Main uncertainties** – It is not clear if the propagation material of alternative host is covered in the certification of plant material scheme. – The efficiency of the hygiene measures, especially concerning the cleaning of the machinery and the possible movement of soil within the nursery. – In case of irrigation water, the frequency and the method used for the detection of the pathogen. – The health status of the other plant species cultivated/traded in the nurseries.					

Overview of evaluation of *Phytophthora ramorum* for the rooted plants in pots					
Rating of the likelihood of pest freedom	**Pest free with few exceptional cases** (based on the median)				
Percentile of the distribution	5%	25%	Median	75%	95%
Proportion of pest-free plants	9971 out of 10,000 plants	9984 out of 10,000 plants	9992 out of 10,000 plants	9996 out of 10,000 plants	9999 out of 10,000 plants
Proportion of infected plants	1 out of 10,000 plants	4 out of 10,000 plants	8 out of 10,000 plants	16 out of 10,000 plants	29 out of 10,000 plants
Summary of the information used for the evaluation	**Possibility that the pest could become associated with the commodity** *P. ramorum* is present in the UK; it has been found in most regions of the UK, but it is more often reported in wetter, western regions. *P. ramorum* has a wide host range. The possible entry of *P. ramorum* from the surrounding environment to the nurseries may occur through wind, water and infested soil propagules on the feet of animals/humans entering the nurseries. The pathogen can also enter the nurseries with new seedlings of *Cornus* spp. and new plants of other species used for plant production in the nurseries **Measures taken against the pest and their efficacy** *P. ramorum* is a quarantine pest in the UK and is under official control. General measures taken by the nurseries are effective against this pathogen. These measures include (a) registration of production sites; (b) the use of certified plant material; (c) the use of certified growing media; (d) surveillance, monitoring and sampling; (d) hygiene measures; (e) irrigation water testing; (f) application of pest control products; and (g) inspection and management of plants before export **Shortcomings of current measures/procedures** No major shortcomings were identified in the evaluation. If all the described measures are implemented correctly, it is unlikely that the pest is present on the exported *Cornus* spp. plants **Main uncertainties** – It is not clear if the propagation material of alternative host is covered in the certification of plant material scheme. – The efficiency of the hygiene measures, especially concerning the cleaning of the machinery and the possible movement of soil within the nursery. – In case of irrigation water, the frequency and the method used for the detection of the pathogen.					

5.2.3 | Overview of the evaluation of nepoviruses

Overview of evaluation of nepoviruses [tobacco ringspot virus (TRSV) and tomato ringspot virus (ToRSV)] for the bare-root plants					
Rating of the likelihood of pest freedom	**Pest free with few exceptional cases** (based on the median)				
Percentile of the distribution	5%	25%	Median	75%	95%
Proportion of pest-free plants	9970 out of 10,000 plants	9986 out of 10,000 plants	9995 out of 10,000 plants	9999 out of 10,000 plants	10,000 out of 10,000 plants
Proportion of infected plants	0 out of 10,000 plants	1 out of 10,000 plants	5 out of 10,000 plants	14 out of 10,000 plants	30 out of 10,000 plants
Summary of the information used for the evaluation	**Possibility that the pest could become associated with the commodity** TRSV and ToRSV have a wide natural host range. They are widely transmitted by the nematode vectors belonging to the genus *Xiphinema*. Species of *Xiphinema* vectoring these viruses are not known to occur in the UK, although there is no evidence of TRSV/ToRSV eradication. Their occurrence in the UK is restricted to *Pelargonium* (ornamentals) at very low levels. Infected plants may not show symptoms, and TRSV/ToRSV can still establish via seed and pollen transmission. TRSV/ToRSV can also establish by clonal vegetative propagation of infected mother plants. Although potted plants are isolated from soil, bare-root plants are field grown; hence, TRSV/ToRSV can be naturally transmitted by *Xiphinema* vectors, which may be present in undetected populations. **Measures taken against the pest and their efficacy** In the UK, TRSV is a quarantine pest, and ToRSV is a regulated non-quarantine pest with 0% tolerance on findings on propagating material of ornamental plants and fruit propagating material and fruit plants intended for fruit production. Thus, there is a set of standard precautions to ensure that no plants other than certified plants are present in the production facilities. General measures taken by the growers are effective against these viruses/vectors. These measures include (a) registration of production sites; (b) the use of certified plant material; (c) surveillance, monitoring and sampling; (d) hygiene measures; (e) irrigation water testing; (f) washing of the roots in case of the bare-root plants; and (g) inspection and management of plants before export. **Shortcomings of current measures/procedures** No major shortcomings were identified in the evaluation. If all the described measures are implemented correctly it is unlikely that the pest is present on the exported *Cornus* spp. plants. **Main uncertainties** – The presence of small undetected populations of nematode vectors. – The efficiency of the detection and sampling strategies in detecting asymptomatic infections. – The health status of the other plant species cultivated/traded in the nurseries.				

Overview of evaluation of nepoviruses [TRSV and TORSV] for the rooted plants in pots					
Rating of the likelihood of pest freedom	**Almost always pest free** (based on the median)				
Percentile of the distribution	5%	25%	Median	75%	95%
Proportion of pest-free plants	9996 out of 10,000 plants	9997 out of 10,000 plants	9998 out of 10,000 plants	9999 out of 10,000 plants	10,000 out of 10,000 plants
Proportion of infected plants	0 out of 10,000 plants	1 out of 10,000 plants	2 out of 10,000 plants	3 out of 10,000 plants	4 out of 10,000 plants
Summary of the information used for the evaluation	**Possibility that the pest could become associated with the commodity** TRSV and ToRSV have a wide natural host range. They are widely transmitted by nematode vectors belonging to the genus *Xiphinema*. Species of *Xiphinema* vectoring these viruses are not known to occur in the UK, although there is no evidence of TRSV/ToRSV eradication. Its occurrence in the UK is restricted to *Pelargonium* (ornamentals) at very low levels. Infected plants may not show symptoms, and TRSV/ToRSV can still establish via seed and pollen transmission. TRSV/ToRSV can also establish by clonal vegetative propagation of infected mother plants. Although potted plants are isolated from soil, bare-root plants are field grown; hence, TRSV/ToRSV can be naturally transmitted by nematode vectors, which may be present in undetected populations. **Measures taken against the pest and their efficacy** TRSV is a quarantine pest in the UK, and ToRSV is a regulated non-quarantine pest with 0% tolerance on findings on propagating material of ornamental plants and fruit propagating material and fruit plants intended for fruit production. Thus, there is a set of standard precautions to ensure that no plants other than certified plants are present in the production facilities. General measures taken by the nurseries are effective against these viruses/vectors. These measures include (a) registration of production sites; (b) the use of certified plant material; (c) the use of certified growing media; (d) surveillance, monitoring and sampling; (d) hygiene measures; (e) irrigation water testing; and (f) inspection and management of plants before export. **Shortcomings of current measures/procedures** No major shortcomings were identified in the evaluation. If all the described measures are implemented correctly, it is unlikely that the pest is present on the exported *Cornus* spp. plants **Main uncertainties** – The presence of small undetected populations of nematode vectors. – The efficiency of the detection and sampling strategies in detecting asymptomatic infections. – The health status of the other plant species cultivated/traded in the nurseries, including the possible nematode (vector) infestation of the growing media.				

5.2.4 | Overview of the evaluation of *Discula destructiva*

Overview of evaluation of *Discula destructiva* for the bare-root plants					
Rating of the likelihood of pest freedom	**Pest free with some exceptional cases** (based on the median)				
Percentile of the distribution	5%	25%	Median	75%	95%
Proportion of pest-free plants	9925 out of 10,000 plants	9961 out of 10,000 plants	9979 out of 10,000 plants	9990 out of 10,000 plants	9996 out of 10,000 plants
Proportion of infected plants	4 out of 10,000 plants	10 out of 10,000 plants	21 out of 10,000 plants	39 out of 10,000 plants	75 out of 10,000 plants
Summary of the information used for the evaluation	**Possibility that the pest could become associated with the commodity** *D. destructiva* is present and widespread in the UK. *D. destructiva* is known to infect several plants belonging to the genus *Cornus,* including *C. alba*. The fungus may remain in a dormant stage for extended periods in leaves, twigs, leaf debris and branches. *D. destructiva* persists in cankers on the trunks and branches of its hosts, or in twigs or dead leaves carrying conidiomata. Furthermore, several species of arthropods are known to acquire and transport even for long distances viable conidia of *D. destructiva*, thereby contributing to the spread of dogwood anthracnose. **Measures taken against the pest and their efficacy** General measures taken by the growers are effective against this pathogen. These measures include (a) registration of production sites; (b) the use of certified plant material; (c) surveillance, monitoring and sampling; (d) hygiene measures; (e) application of pest control products; and (f) inspection and management of plants before export. **Shortcomings of current measures/procedures** No major shortcomings were identified in the evaluation. If all the described measures are implemented correctly, it is unlikely that the pest is present on the exported *Cornus* spp. plants. **Main uncertainties** – It is not clear if the inspection of registered *Cornus* spp. producers include and will report this pathogen. – The efficiency of the hygiene measures, especially concerning the cleaning of the machinery. – Latent, asymptomatic infections are likely to occur in the propagating plant material, and *D. destructiva* cannot be detected. In addition, infection of seeds is not visible or easy to detect. – The frequency and efficacy of the treatment (application of pest control products) on the pathogen are unknown.				

Overview of evaluation of *Discula destructiva* for the rooted plants in pots					
Rating of the likelihood of pest freedom	**Pest free with some exceptional cases** (based on the median)				
Percentile of the distribution	5%	25%	Median	75%	95%
Proportion of pest-free plants	9902 out of 10,000 plants	9949 out of 10,000 plants	9971 out of 10,000 plants	9985 out of 10,000 plants	9995 out of 10,000 plants
Proportion of infected plants	5 out of 10,000 plants	15 out of 10,000 plants	29 out of 10,000 plants	51 out of 10,000 plants	98 out of 10,000 plants
Summary of the information used for the evaluation	**Possibility that the pest could become associated with the commodity** *D. destructiva* is present and widespread in the UK. *D. destructiva* is known to infect several plants belonging to the genus *Cornus,* including *C. alba*. The fungus may remain in a dormant stage for extended periods in leaves, twigs, leaf debris and branches. *D. destructiva* persists in cankers on the trunks and branches of its hosts, or in twigs or dead leaves carrying conidiomata. Furthermore, it is likely that the fungus could be present in the neighbouring environment of the nursery and enter the nursery mainly via insects and seeds, which can transmit the fungus. Several species of arthropods are known to acquire and transport even for long distances viable conidia of *D. destructiva*, thereby contributing to the spread of dogwood anthracnose. **Measures taken against the pest and their efficacy** General measures taken by the nurseries are effective against this pathogen. These measures include (a) registration of production sites; (b) the use of certified plant material; (c) surveillance, monitoring and sampling; (d) hygiene measures; (e) application of pest control products; and (f) inspection and management of plants before export. **Shortcomings of current measures/procedures** No major shortcomings were identified in the evaluation. If all the described measures are implemented correctly, it is unlikely that the pest is present on the exported *Cornus* spp. plants. **Main uncertainties** – It is not clear if the inspection of registered *Cornus* spp. producers include and will report this pathogen. – The efficiency of the hygiene measures, especially concerning the cleaning of the machinery. – Latent, asymptomatic infections are likely to occur in the propagating plant material, and *D. destructiva* cannot be detected. In addition, infection of seeds is not visible or easy to detect. – The frequency and efficacy of the treatment (application of pest control products) on the pathogen are unknown.				

5.2.5 | Outcome of EKE

Table 10 and Figure 7 show the outcome of the EKE regarding pest freedom after the evaluation of the currently proposed risk mitigation measures for the selected pests.

Figure 8 provides an explanation of the descending distribution function describing the likelihood of pest freedom after the evaluation of the currently proposed risk mitigation measures for *P. ramorum* on *Cornus* spp. Bare-root plants designated for export to the EU.

TABLE 10 Assessment of the likelihood of pest freedom following evaluation of current risk mitigation measures against pests on *C. alba* and *C. sanguinea* plants designated for export to the EU. In panel A, the median value for the assessed level of pest freedom for each pest is indicated by 'M', the 5% percentile is indicated by 'L' and the 95% percentile is indicated by 'U'. The percentiles together span the 90% uncertainty range regarding pest freedom. The pest freedom categories are defined in panel B of the table.

Number	Group	Pest species	Sometimes pest free	More often than not pest free	Frequently pest free	Very frequently pest free	Extremely frequently pest free	Pest free with some exceptional cases	Pest free with few exceptional cases	Almost always pest free
1	Nematodes	*Meloidogyne fallax*/bare-root plants				**L**		**M**		**U**
2	Nematodes	*Meloidogyne fallax*/rooted plants in pots						**L**	**M**	**U**
3	Fungi	*Phytophthora ramorum*/bare-root plants				**L**		**M**		**U**
4	Fungi	*Phytophthora ramorum*/rooted plants in pots						**L**	**M**	**U**
5	Virus	Nepoviruses (ToRSV & TRSV)/bare-root plants						**L**	**M**	**U**
6	Virus	Nepoviruses (ToRSV & TRSV)/rooted plants in pots								**LMU**
7	Fungi	*Discula destructiva*/bare-root plants					**L**	**M**		**U**
8	Fungi	*Discula destructiva*/rooted plants in pots					**L**	**M**	**U**	

PANEL A

	Pest freedom category	Pest fee plantsout of 10,000	Legend of pest freedom categories	
	Sometimes pest free	≤ 5000	**L**	Pest freedom category includes the elicited lower bound of the 90% uncertainty range
	More often than not pest free	5000 – ≤ 9000	**M**	Pest freedom category includes the elicited median
	Frequently pest free	9000 – ≤ 9500	**U**	Pest freedom category includes the elicited upper bound of the 90% uncertainty range
	Very frequently pest free	9500 – ≤ 9900		
	Extremely frequently pest free	9900 – ≤ 9950		
	Pest free with some exceptional cases	9950 – ≤ 9990		
	Pest free with few exceptional cases	9990 – ≤ 9995		
	Almost always pest free	9995 – ≤ 10,000		

PANEL B

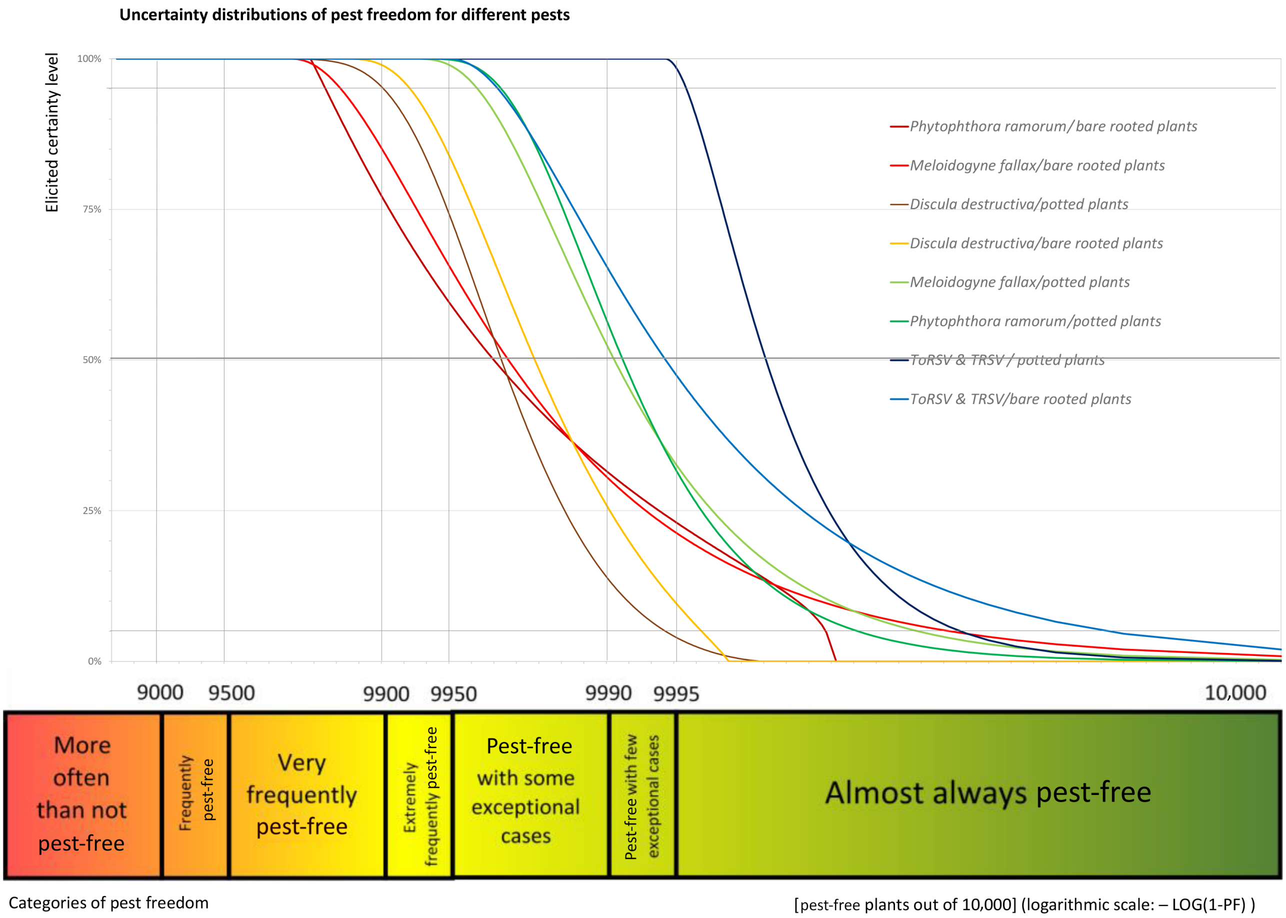


FIGURE 7 The elicited certainty (*y*-axis) of the number of pest-free *C. alba* and *C. sanguinea* plants (*x*-axis; log-scaled) out of 10,000 plants designated for export to the EU introduced from the UK for all evaluated pests visualised as descending distribution function. Horizontal lines indicate the percentiles (starting from the bottom 5%, 25%, 50%, 75% and 95%).

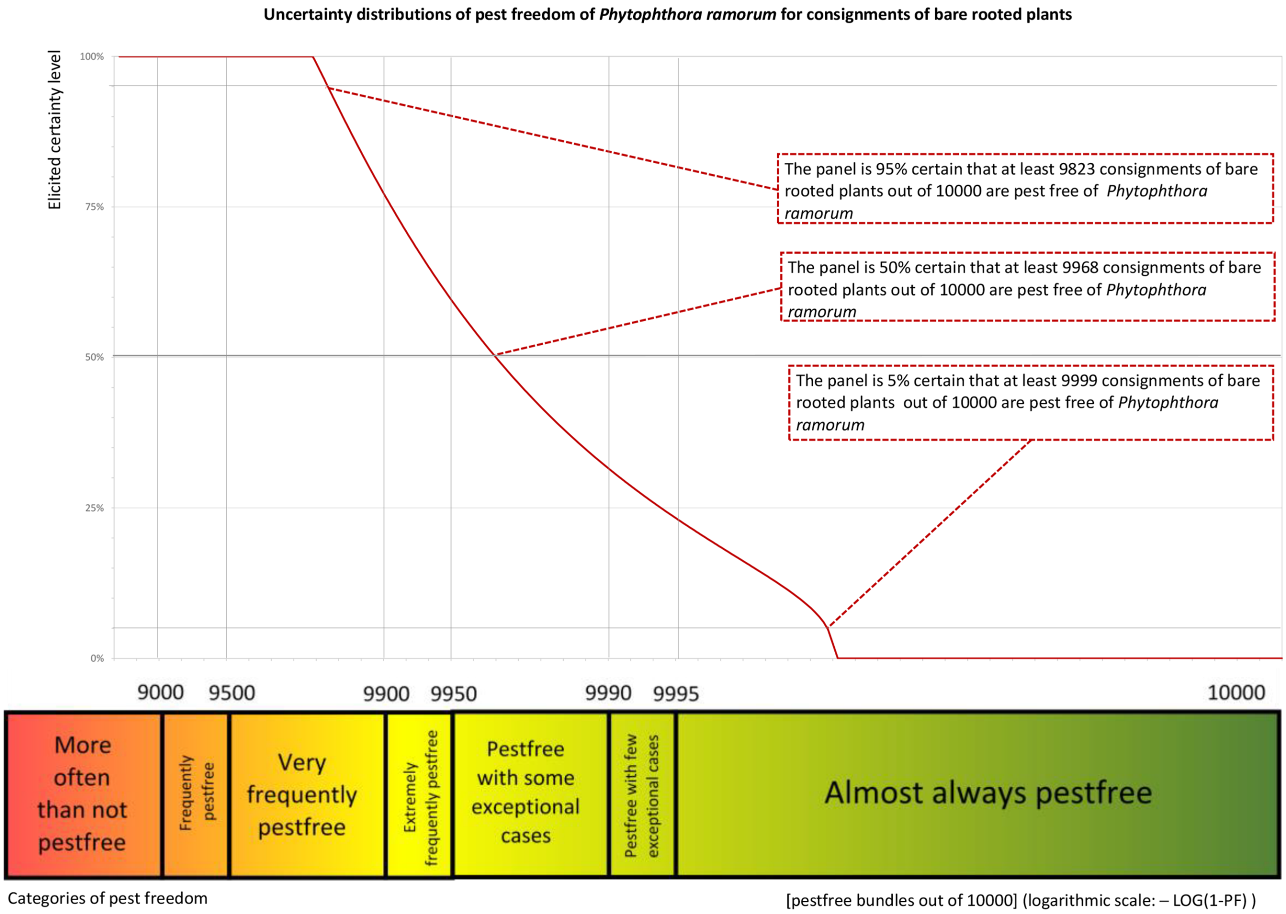


FIGURE 8 The explanation of the descending distribution function describing the likelihood of pest freedom after the evaluation of the currently proposed risk mitigation measures for *C. alba* and *C. sanguinea* bare-root plants designated for export to the EU based on the example of *P. ramorum*.

6 | CONCLUSIONS

There are five pests (*Meloidogyne fallax*, *Phytophthora ramorum* (non-EU isolates), tobacco ringspot virus, tomato ringspot virus and *Discula destructiva*) identified to be present in the UK and considered to be potentially associated with the *C. alba* and *C. sanguinea* plants imported from the UK and relevant for the EU. The likelihood of the pest freedom after the evaluation of the implemented risk mitigation measures for bare roots and rooted *C. alba* and *C. sanguinea* plants in pots designated for export to the EU was estimated.

For *M. fallax*, the likelihood of pest freedom for bare-root *C. alba and C. sanguinea* plants following evaluation of current risk mitigation measures was estimated as 'pest free with some exceptional cases' with the 90% uncertainty range reaching from 'very frequently pest free' to 'almost always pest free'. The EKE indicated, with 95% certainty, that between 9849 and 10,000 bare-root *C. alba and C. sanguinea* plants per 10,000 will be free from *M. fallax*. The likelihood of pest freedom for rooted *C. alba and C. sanguinea* plants in pots was estimated 'pest free with few exceptional cases' with the 90% uncertainty range reaching from 'pest free with some exceptional cases' to 'almost always pest free'. The EKE indicated, with 95% certainty, that between 9963 and 10,000 rooted *C. alba and C. sanguinea* plants in pots per 10,000 will be free from *M. fallax*.

For *P. ramorum*, the likelihood of pest freedom for bare-root *C. alba and C. sanguinea* plants following evaluation of current risk mitigation measures was estimated as 'pest free with some exceptional cases' with the 90% uncertainty range reaching from 'very frequently pest free' to 'almost always pest free'. The EKE indicated, with 95% certainty, that between 9823 and 10,000 bare-root *C. alba and C. sanguinea* plants per 10,000 will be free from *P. ramorum*. The likelihood of pest freedom for rooted *C. alba and C. sanguinea* plants in pots was estimated 'pest free with few exceptional cases' with the 90% uncertainty range reaching from 'pest free with some exceptional cases' to 'almost always pest free'. The EKE indicated, with 95% certainty, that between 9971 and 10,000 rooted *C. alba and C. sanguinea* plants in pots per 10,000 will be free from *P. ramorum*.

For selected nepoviruses (tobacco ringspot virus and tomato ringspot virus), the likelihood of pest freedom for bare-root *C. alba and C. sanguinea* plants following evaluation of current risk mitigation measures was estimated as 'pest free with few exceptional cases' with the 90% uncertainty range reaching from 'pest free with some exceptional cases' to 'almost always pest free'. The EKE indicated, with 95% certainty, that between 9970 and 10,000 bare-root *C. alba and C. sanguinea* plants per 10,000 will be free from the selected nepoviruses. The likelihood of pest freedom for rooted *C. alba and C. sanguinea* plants in pots was estimated 'almost always pest free' with the 90% uncertainty range reaching from 'almost always pest free' to 'almost always pest free'. The EKE indicated, with 95% certainty, that between 9996 and 10,000 rooted *C. alba and C. sanguinea* plants in pots per 10,000 will be free from selected nepoviruses.

For *D. destructiva*, the likelihood of pest freedom for bare-root *C. alba and C. sanguinea* plants following evaluation of current risk mitigation measures was estimated as 'pest free with some exceptional cases' with the 90% uncertainty range reaching from 'extremely frequently pest free' to 'almost always pest free'. The EKE indicated, with 95% certainty, that between 9925 and 10,000 bare-root *C. alba and C. sanguinea* plants per 10,000 will be free from *D. destructiva*. The likelihood of pest freedom for rooted *C. alba and C. sanguinea* plants in pots was estimated 'pest free with some exceptional cases' with the 90% uncertainty range reaching from 'extremely frequently pest free' to 'pest free with few exceptional cases'. The EKE indicated, with 95% certainty, that between 9902 and 10,000 rooted *C. alba and C. sanguinea* plants in pots per 10,000 will be free from *D. destructiva*.

ABBREVIATIONS

APHA	Animal and Plant Health Agency
CABI	Centre for Agriculture and Bioscience International
DEFRA	Department for Environment Food and Rural Affairs
EKE	Expert Knowledge Elicitation
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
ISPM	International Standards for Phytosanitary Measures
NPPO	National Plant Protection Organization
PLH	Plant Health
PRA	Pest Risk Assessment
PZQPs	Protected Zone Quarantine Pests
RNQPs	Regulated Non-Quarantine Pests
UK	United Kingdom

GLOSSARY

Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 1995, 2017).
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 2017).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2017).
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units.
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2017).
Measures	Control (of a pest) is defined in ISPM 5 (FAO, 2017) as 'Suppression, containment or eradication of a pest population' (FAO, 1995). Control measures are measures that have a direct effect on pest abundance. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk mitigation measures that do not directly affect pest abundance.
Pathway	Any means that allows the entry or spread of a pest (FAO, 2017).
Phytosanitary measures	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 2017).
Protected zone	A Protected zone is an area recognised at EU level to be free from a harmful organism, which is established in one or more other parts of the Union.
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2017).
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO, 2017).
Risk mitigation measure	A measure acting on pest introduction and/or pest spread and/or the magnitude of the biological impact of the pest should the pest be present. A risk mitigation measure may become a phytosanitary measure, action or procedure according to the decision of the risk manager.
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO, 2017).

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CONFLICT OF INTEREST

If you wish to access the declaration of interests of any expert contributing to an EFSA scientific assessment, please contact interestmanagement@efsa.europa.eu.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A

Datasheets of pests selected for further evaluation

A.1 | *MELOIDOGYNE FALLAX*

A.1.1 | Organism information

Taxonomic information	Current valid scientific name: *Meloidogyne fallax* Synonyms: *Meloidogyne chitwoodi* (Baexem) B-type. Name used in the EU legislation: *Meloidogyne fallax* Karssen [MELGFA] Order: Rhabditida Family: Meloidogynidae Common name: false Columbia root-knot nematode, root gall nematode Name used in the Dossier: *Meloidogyne fallax*
Group	Nematodes
EPPO code	MELGMA
Regulated status	The pest is listed in Annex II of Regulation (EU) 2019/2072 as *Meloidogyne fallax* Karssen [MELGFA] The pest is included in the EPPO A2 list (EPPO, online_a) *M. fallax* is quarantine in Morocco, Moldova and Norway. It is on A1 list of Argentina, Bahrain, Brazil, Egypt, Georgia, Kazakhstan, Russia, Ukraine and EAEU (=Eurasian Economic Union – Armenia, Belarus, Kazakhstan, Kyrgyzstan and Russia). It is on A2 list of COSAVE (=Comite de Sanidad Vegetal del Cono Sur – Argentina, Brazil, Chile, Paraguay, Peru and Uruguay) (EPPO, online_b). *M. fallax* is also quarantine pest in the USA (Kantor et al., 2022) In the UK, *M. fallax* is regulated non-quarantine pest on potato only, as this is considered to be the main host at risk (EPPO, online_b; DEFRA, online), and it is regulated quarantine pest in Northern Ireland (DEFRA, online)
Pest status in the UK	*M. fallax* is present in the UK (CABI, online; EPPO, online_c) with a restricted distribution in England and Wales, being more present in the western areas of UK. There are no findings associated to trees. *M. fallax* was also detected in Northern Ireland in 2011 (EPPO, 2015); however, its presence is currently not confirmed. The pest is present and shows symptoms on sport turf in UK that could act as source for a wider spread
Pest status in the EU	Not relevant for EU Quarantine pests
Host status on *Cornus*	*Cornus* spp. is reported as a host plant for *M. fallax* (Nemaplex, online; den Nijs LJMF et al., 2004)
PRA information	Available Pest Risk Assessments: – Pest risk assessment for the European Community plant health: a comparative approach with case studies. Cases: *Meloidogyne chitwoodi* and *M. fallax*. (MacLeod et al., 2012); – UK Risk Register Details for *M. fallax* (DEFRA, online); – Scientific Opinion on the commodity risk assessment of *Acer* spp. plants from New Zealand (EFSA PLH Panel, 2020).
Other relevant information for the assessment	
Biology	*M. fallax* is a highly polyphagous root-knot nematode first described from the Netherlands and mostly distributed in temperate regions of the world. It is present in Africa (South Africa), Asia (Indonesia), Europe (Belgium, France, Germany, the Netherlands, Switzerland, Sweden, UK), Oceania (Australia, New Zealand) and South America (Chile) (EPPO, online_c; CABI, online). According to MacLeod et al. (2012), *M. fallax* may be more widespread because it is frequently confused with similar species as *M. hapla* and *M. chitwoodi*, and not causing clear external symptoms on host plants *M. fallax* has three development stages: eggs, juveniles (four stages) and adults. The nematode mainly reproduces parthenogenetically, and sexual reproduction can possibly occur under adverse conditions; like other *Meloidogyne* species, *M. fallax* has 1–3 generations per year depending on temperature and host availability (EFSA, 2019; MacLeod et al., 2012). Females lay up to 800–1000 eggs in gelatinous masses (egg sacs) on the root surface, in galls and tubers. Hatching can occur at temperatures below 10°C, so that *M. fallax* is considered cryophilic (EFSA PLH Panel, 2020; MacLeod et al., 2012). The second-stage juveniles move in the soil and penetrate host roots, start feeding on cortical tissues, inducing giant cells as a feeding site and the formation of root galls (root-knots); they become sedentary and develop to successive stages by quick moults. The nematode can stay infective in the soil for long time, being also able to survive for more than 300 days at temperatures of 5 and 10°C, and 140 days at higher temperatures (15–25°C). Survival and infectivity may also be related to high soil humidity (100% survival with 98% RH), although in moderate dry soil conditions, *M. fallax* may survive for more than 9 weeks (MacLeod et al., 2012) As other nematode species living in the soil, *M. fallax* has only little spread capacity, the juvenile stages moving 1–2 m maximum per year depending on the type of soil, water availability and other parameters (EFSA, 2019). Water could also disperse the nematode (mainly eggs and juveniles) at short distances. The human-assisted spread on medium-long distance is very frequent and effective by passive transport. Possible pathways are mainly plants for planting with infected roots; tubers and bulbs; soil and growing media; contaminated tools, machinery, shoes and packaging material (EFSA 2019)

(Continued)

Symptoms	**Main type of symptoms**	*M. fallax* is a root-knot nematode. Heavily infested plants show stunting and yellowing on above-ground parts and galling on roots (Moens et al., 2009; MacLeod et al., 2012; EFSA, 2019). Symptoms of root-knot nematodes on hardwood trees may show as slow growth, sparse foliage, chlorotic leaves and crown dieback (Riffle, 1963). Symptoms on roots vary with species but should be visible as galls in advanced infections On potato tubers, *M. fallax* causes numerous small pimple-like areas on the surface. These are caused by tuber infection in the second juvenile generation (EPPO, 2019) No specific information about symptoms on *Cornus* sp. was found
	Presence of asymptomatic plants	At the early stages of infection, plants may not show any apparent symptoms on the above-ground parts and do not show galls on the roots. In some cases, plants are wilted and lack vigour. The main impact of the pest is on root growth, and on the quality and growth of the plant (EFSA, 2019; Moens et al., 2009; MacLeod et al., 2012)
	Confusion with other pests	*M. fallax* is morphologically very similar to *M. chitwoodi* and may also be easily confused with other species as *M. hapla* and *M. minor*, often found in the same habitat. *M. fallax* cannot be identified on the basis of galls only, since other soil nematode cause similar damage and some insects and bacteria can induce comparable galls on roots as well (EFSA, 2019) The nematode can be identified by laboratory tests on morphometric characters, electrophoresis or sequencing/DNA barcoding (EPPO, 2016)
Host plant range	*M. fallax* is a polyphagous nematode with a wide host range, including several major horticultural and agricultural crops and a few species of trees, shrubs and herbaceous plants Main horticultural/agricultural hosts are: *Apium graveolens, Allium porrum, Asparagus officinalis, Avena strigosa, Beta vulgaris, Cicorium endivia, Cynara scolymus, Daucus carota, Foeniculum vulgare, Fragaria ananassa, Hordeum vulgare, Lactuca sativa, Lycopersicum esculentum, Medicago sativa, Phaseolus vulgaris, Secale cereale, Solanum nigrum, S. tuberosum, Solanum* spp., *Triticum aestivum* and *Zea mays* (CABI, online; EPPO, online_e; MacLeod et al., 2012) Woody hosts of *M. fallax* are *Acer palmatum, Betula pendula, Cornus sanguinea, Laburnum anagyroides* and *Lonicera xylosteum* (MacLeod et al., 2012; Nemaplex, online) For a more exhaustive list of hosts, see CABI (online), EPPO (online_e), Nemaplex (online), de Nijs et al. (2004) and MacLeod et al. (2012)	
Evidence that the commodity is a pathway	*Meloidogyne* spp. nematodes, although rarely identified at species level, are frequently intercepted on plants for planting (EUROPHT/TRACES, online); therefore, the bare-root and potted plants of *Cornus* spp. are a possible pathway of entry for *M. fallax*	
Surveillance information	According to the Dossier Section 1.0, *M. fallax* is not under official surveillance, and has no quarantine pest status in the UK	

A.1.2 | Possibility of pest presence in the nursery

A.1.2.1 | Possibility of entry from the surrounding environment

M. fallax is present in the UK territory with restricted distribution in agricultural lands and sports turf (EPPO, online).

The nematode has a very limited capacity of movement in the soil (1–2 m) and can only spread by passive human-assisted transport with plants for planting with infected roots, infected soil and growing media, and possibly via contaminated tools and machinery. No other possibility of entry in the nurseries is known.

Uncertainties:

- The occurrence of the pest in south-eastern England.
- Pest presence and pressure in the surrounding.

Taking into consideration the above evidence and uncertainties, the Panel considers that it is possible for *M. fallax* to enter the nurseries from surrounding environment. In the surrounding area, suitable hosts are present, and the nematode can enter through the human-assisted spread of infested seedlings and infested soil accidentally introduced into the nurseries

A.1.2.2 | Possibility of entry with new plants/seed

The starting materials are either seeds or seedlings. Seed purchased in the UK is not covered by a certification scheme; seedlings sourced in the UK are certified with UK Plant Passports; seedlings from the EU countries are certified with phytosanitary certificates. Some seedlings may be obtained from the EU (mostly the Netherlands). This is the only source of the plants obtained from abroad (Dossier Section 1.0). Seeds are not a pathway for the nematode.

In addition to *Cornus* spp., the nurseries also produce other plants (Dossier Section 1.0). However, there is no information on how and where the plants are produced. Besides, *M. fallax* may also spread on soil adhering to the roots of non-host plants (MacLeod et al., 2012). Therefore, if the plants are first produced in another nursery, the nematode could possibly travel with them.

The nurseries are using virgin peat or peat-free compost (a mixture of coir, tree bark, wood fibre etc.) as a growing media (Dossier Section 1.0). *M. fallax* is able to survive in the soil for a long time and therefore could potentially enter with infested soil/growing media. However, the growing media is heat-treated by commercial suppliers during production to eliminate pests and diseases (Dossier Section 1.0). In another species (*Meloidogyne incognita*), egg sacs protect eggs and juveniles from heat, and 72° C for 4 days is required sanitation. The heat tolerance of *M. fallax* is not known.

Uncertainties:

- No information is available on the origin of new plants used for plant production in the area of the nurseries.
- No specific indication on how heat treatment is realised (temperature, time).

Taking into consideration the above evidence and uncertainties, the Panel considers that it is possible for the nematode to enter the nurseries via the infected roots of new seedlings of *Cornus* spp. and the other plant species used for plant production in the area. The Panel considers the entry of the nematode with seeds and the growing media as not possible.

A.1.2.3 | Possibility of spread within the nursery

Cornus spp. plants are either grown in containers (cells, pots, tubes etc.) outdoors in the open air or in fields.

The nematode can infect other host plants that could be present in the nurseries.

M. fallax can spread within the nurseries by movement of soil, water, infested plant material and infected tools, contaminated shoes and machinery. Tools used in the nurseries are disinfected after operation on a stock and before being used on a different plant species (Dossier Section 1.0); however, no information is available on the measures to reduce the risk of contamination of machinery, shoes or other material (i.e. package, bags etc.).

Uncertainties:

- Possibility that the pest can spread via contaminated soil adhering to shoes, machinery or other material.

Taking into consideration the above evidence and uncertainties, the Panel considers that the spread of the nematode within the nurseries is possible either by movement of infested soil (also via machinery, shoes and other material), water or plant material.

A.1.3 | Information from interceptions

In the EUROPHYT/TRACES-NT database, there are no records of interceptions of *M. fallax* on *Cornus* spp. from third countries or on any other plant from the UK.

A.1.4 | Evaluation of the risk mitigation measures

In the table below (Table A.1), all risk mitigation measures currently applied in the UK are listed, and an indication of their effectiveness on *M. fallax* is provided. The description of the risk mitigation measures currently applied in the UK is provided in the Table 9.

TABLE A.1 Evaluation of the risk mitigation measures.

Number	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
1	Registration of production sites	Yes	All nurseries are registered as professional operator with the UK NPPO, by the APHA and is authorised to issue UK plant passports (Dossier Section 1.0) Evaluation: The registration of production sites is expected to contribute in reducing the phytosanitary risks within the facility Uncertainties: none
2	Certified plant material	Yes	Seeds of *C. alba* are not certified, while seeds of *C. sanguinea* purchased in the UK may be certified under the Forestry Commission's Voluntary Scheme for the Certification of Native Trees and Shrubs. Seedlings for *Cornus* spp. production sourced in the UK are certified with UK Plant Passports; seedlings from the EU countries are certified with phytosanitary certificates. Seedlings could be a pathway for the nematode especially with regard to early, symptomless infections Evaluation: *M. fallax* is an regulated non-quarantine pests (RNQP) for UK on potato only. Inspections associated to the release of Plant Passport may help in reducing infestations. Seeds are not a pathway for *M. fallax* Uncertainties: The efficacy of pest detection in the Plant Passport scheme is not known
3	Growing media composition and treatment	Yes	In the production or procurement of plants, the use of growing media is assessed for the potential to harbour and transmit plant pests. Growers most commonly use virgin peat or peat-free compost, which is a mixture of coir, tree bark, wood fibre etc. The compost is heat-treated by commercial suppliers during production to eliminate pests and diseases. It is supplied in sealed bulk bags or shrink-wrapped bales and stored off the ground on pallets, these are completely hygienic and free from contamination. Where delivered in bulk, compost is kept in a dedicated bunker, either indoors or covered by tarpaulin outdoors, and with no risk of contamination with soil or other material (Dossier Section 1.0) Evaluation: The measures for growing media can reduce infestation rates Uncertainties: The temperature–time of the heat treatment of the growing media and the efficacy on *M. fallax*. In another species (*M. incognita*), egg sacs protect eggs and juveniles from heat, and 72°C for 4 days is required sanitation. The heat tolerance of *M. fallax* is not known
4	Surveillance, monitoring and sampling	Yes	In the last 3 years there has been a substantial level of inspection of registered *Cornus* spp. producers, both in support of the Plant Passporting scheme (checks are consistent with EU legislation, with a minimum of once a year for authorised operators) and as part of the Quarantine Surveillance programme (Great Britain uses the same framework for its surveillance programme as the EU). The Competent Authority inspects crops at least once a year to check if they meet the standards set out in the guides (Dossier Section 1.0) UK(GB) surveillance is based on visual inspection with samples taken from symptomatic material, and where appropriate, samples are also taken from asymptomatic material (e.g. plants, tubers, soil, watercourses) (Dossier Section 1.0) Evaluation: This measure can reduce the infestation rates Uncertainties: The frequency of inspection of root systems
5	Hygiene measures	Yes	All nurseries have plant hygiene and housekeeping rules and practices in place, which are communicated to all relevant employees. The rules will be dependent on the plants handled and the type of business but will include: • Growing media • Weed management • Water usage • Cleaning and sterilisation • Waste treatment and disposal • Visitors Evaluation: This measure can reduce the infestation rates Uncertainties: The efficiency of the hygiene measures especially concerning the cleaning of the machinery and the with the possible movement of soil within the nursery
6	Irrigation water quality and/or treatments	Yes	Growers are required to assess water sources, irrigation and drainage systems used in the plant production for the potential to harbour and transmit plant pests. Water is routinely sampled and sent for analysis. No quarantine pests have been found (Dossier Section 1.0) Evaluation: The irrigation water is routinely checked and can reduce the risk Uncertainties: The frequency and the method used for the detection of the pest

(Continues)

TABLE A.1 (Continued)

Number	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
7	Application of pest control products	Yes	Crop protection is achieved using a combination of measures including approved plant protection products, biological control or physical measures. Plant protection products are only used when necessary and records of all plant protection treatments are kept. (Dossier Section 1.0) Evaluation: There is no indication of use of nematicides Uncertainties: No
8	Root washing	No	Bare-root plants are lifted from the field in winter and then root-washed on site and stored prior to export Evaluation: Root washing can remove infective juveniles of *M. fallax*, occurring in adhering soil, but has no effect on nematode stages inside roots Uncertainties: Using low-pressure water for cleaning the roots may not fully be effective in removing the *M. fallax*
9	Inspections and management of plants before export	Yes	The UK NPPO carries out inspections and testing where required by the country of destination's plant health legislation, to ensure all requirements are fulfilled and a valid phytosanitary certificate with the correct additional declarations is issued Separate to any official inspection, plant material is checked by growers for plant health issues before dispatch Evaluation: Helpful in reducing rates of infestation Uncertainties: The frequency of inspection of root system

A.1.5 | Overall likelihood of pest freedom for *Cornus* spp. plants (bare-root and rooted plants in pots)

A.1.5.1 | Reasoning for a scenario which would lead to a reasonably low number of infested *Cornus* spp. plants (bare-root and rooted plants in pots)

- *M. fallax* has restricted distribution in the UK. It is more prevalent in the Western part of the UK (more humid/suitable) than in the Eastern part (dry), where the nurseries are located.
- *M. fallax* exhibits limited reproductive activity on *Cornus* spp.
- The symptoms of the nematode infestation are clearly visible on the leaves.
- Low spread rate of nematodes in the nursery.
- Seeds are not a pathway for *M. fallax,* and the seedlings of *Cornus* spp. are certified with the UK plant passport.
- The growing medium is heat-treated and separated from soil.
- Tools are properly disinfected.
- Root washing removes the soil.
- Irrigation water is regularly checked.
- Official inspection before the export.

A.1.5.2 | Reasoning for a scenario which would lead to a reasonably high number of infested *Cornus* spp. plants (bare-root and rooted plants in pots)

- *M. fallax* is widespread in the UK.
- *Cornus* is an experimental host/host.
- The knots are not easily visible on roots, making the detection difficult.
- There may not be clear symptoms on the plants, and it is easy to confuse with other species.
- Woody host plants may be present in the surrounding environment.
- There can be a human-assisted spread of nematode in the nursery.
- Unclear check for nematodes in case of propagation material.
- Heat treatment may not be efficient as the heat tolerance of *M. fallax* is not known.
- Disinfection of machinery is unknown, so there can be a movement of soil.
- Root washing may not completely remove the soil; therefore, it is not effective against the pest.
- Overhead irrigation/excess water may spread *M. fallax*.
- No application of nematicides.
- Unclear details and efficiency of inspection before the export of *Cornus* spp. plants.

A.1.5.3 | Reasoning for a central scenario equally likely to over- or underestimate the number of infested *Cornus* spp. plants (bare-root and rooted plants in pots) (median)

The scenario assumes a limited presence of the pest in the nurseries and the surroundings and that the plants are exposed to the nematode for only a short period of time. The movement of soil from the surrounding into the nurseries is not expected to be significant.

A.1.5.4 | Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile/interquartile range)

The limited information on occurrence of the pests in the UK, including the nurseries and the surroundings, results in a high level of uncertainties for infestation rates below the median. Otherwise, the pest pressure from the surroundings is expected to be low giving less uncertainties for rates above the median.

A.1.6 | Elicitation outcomes of the assessment of the pest freedom for *Meloidogyne fallax*

The elicited and fitted values for *M. fallax* agreed by the Panel are shown in Tables A.2–A.5 and in Figures A.1, A.2

TABLE A.2 Elicited and fitted values of the uncertainty distribution of pest infestation by *M. fallax* per 10,000 bare-root *Cornus* spp. plants.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Elicited values	0					10		20		75					200
EKE	0.0134	0.0782	0.296	1.13	3.03	6.67	11.79	27.2	51.9	69.6	93.3	121	151	176	200

Note: The EKE results are the *BetaGeneral (0.52062, 2.3955, 0, 255)* distribution fitted with @Risk version 7.6.

Based on the numbers of estimated infested bare-root *Cornus* spp. plants, the pest freedom was calculated (i.e. = 10,000 – number of infested plants per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.3.

TABLE A.3 The uncertainty distribution of plants free of *M. fallax* per 10,000 bare-root *Cornus* spp. plants calculated by Table A.2.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Values	9800					9925		9980		9990					10,000
EKE results	9800	9824	9849	9879	9907	9930	9948	9973	9988	9993	9997	9998.9	9999.7	9999.9	10,000

Note: The EKE results are the fitted values.

TABLE A.4 Elicited and fitted values of the uncertainty distribution of pest infestation by *M. fallax* per 10,000 rooted *Cornus* spp. plants in pots.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Elicited values	0					4		8		20					50
EKE	0.053	0.170	0.411	1.00	1.96	3.37	5.03	9.21	15.0	18.9	24.2	30.2	37.4	43.5	50.1

Note: The EKE results are the *BetaGeneral (0.78848, 3.8978, 0, 76)* distribution fitted with @Risk version 7.6.

Based on the numbers of estimated infested rooted *Cornus* spp. plants in pots,, the pest freedom was calculated (i.e. = 10,000 – number of infested plants per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.5

TABLE A.5 The uncertainty distribution of plants free of *M. fallax* per 10,000 rooted *Cornus* spp. plants in pots calculated by Table A.4.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Values	9950					9980		9992		9996					10,000
EKE results	9950	9957	9963	9970	9976	9981	9985	9991	9995	9997	9998	9999	9999.6	9999.8	9999.9

Note: The EKE results are the fitted values.

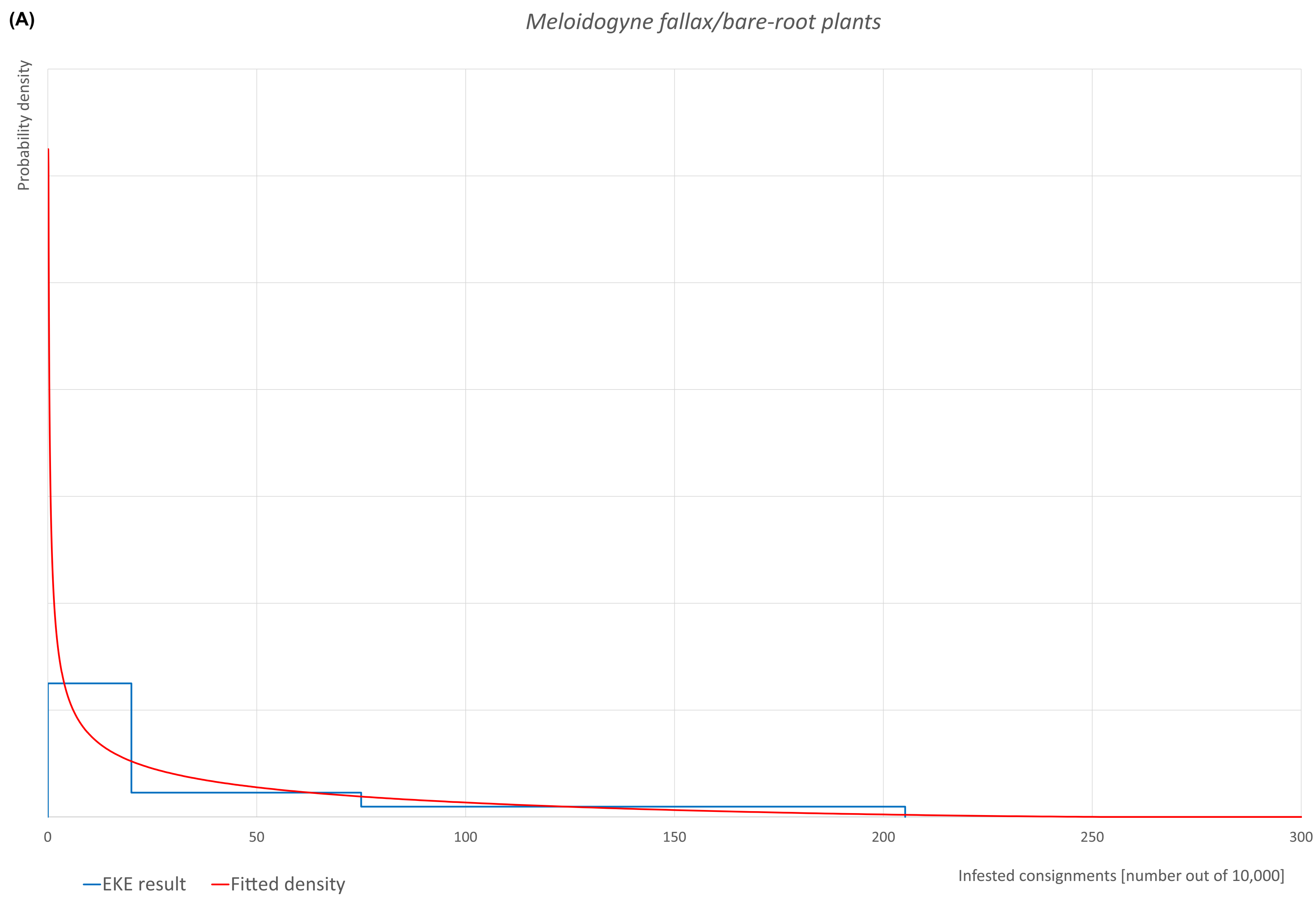

FIGURE A.1 (Continued)

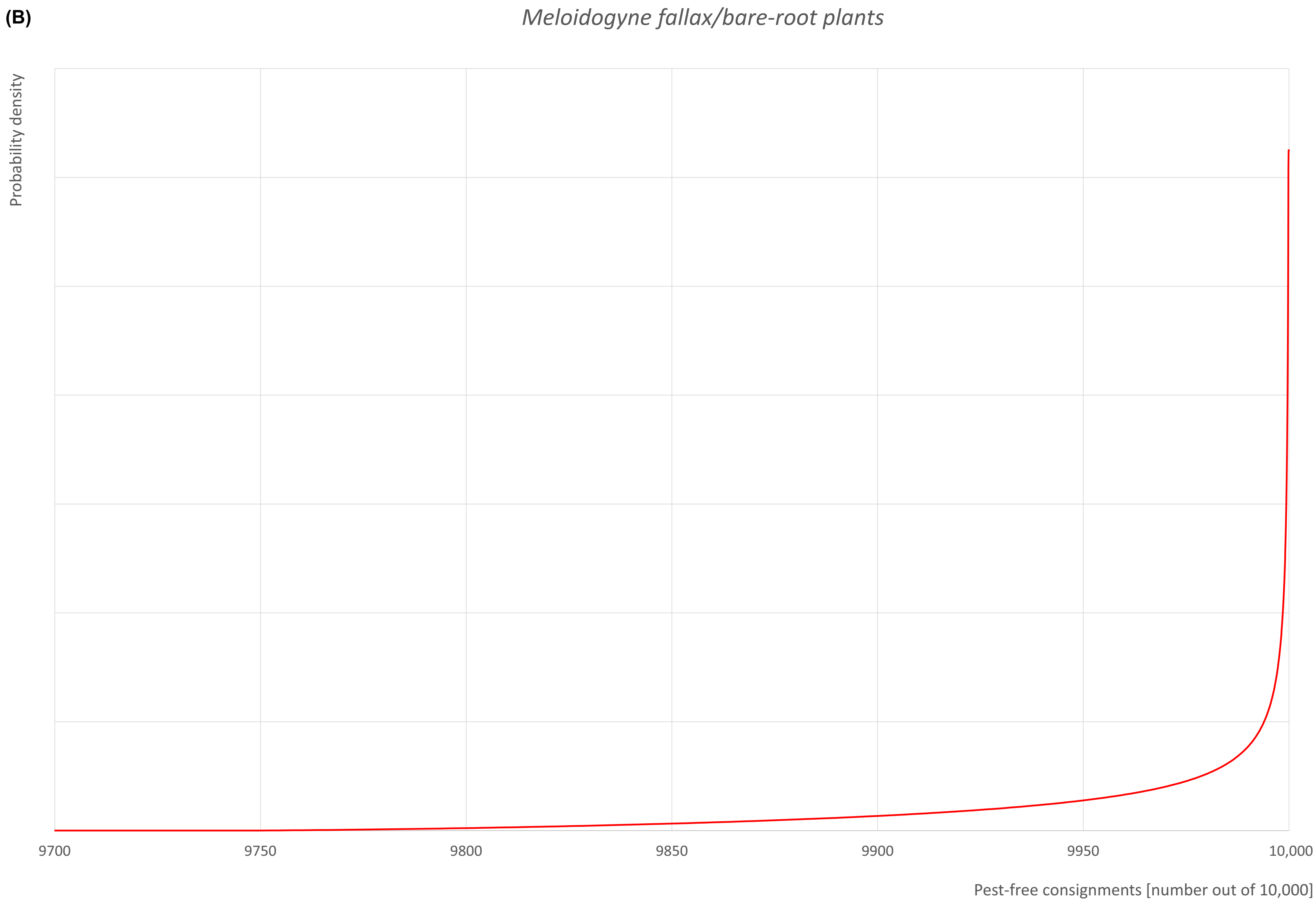

FIGURE A.1 (Continued)

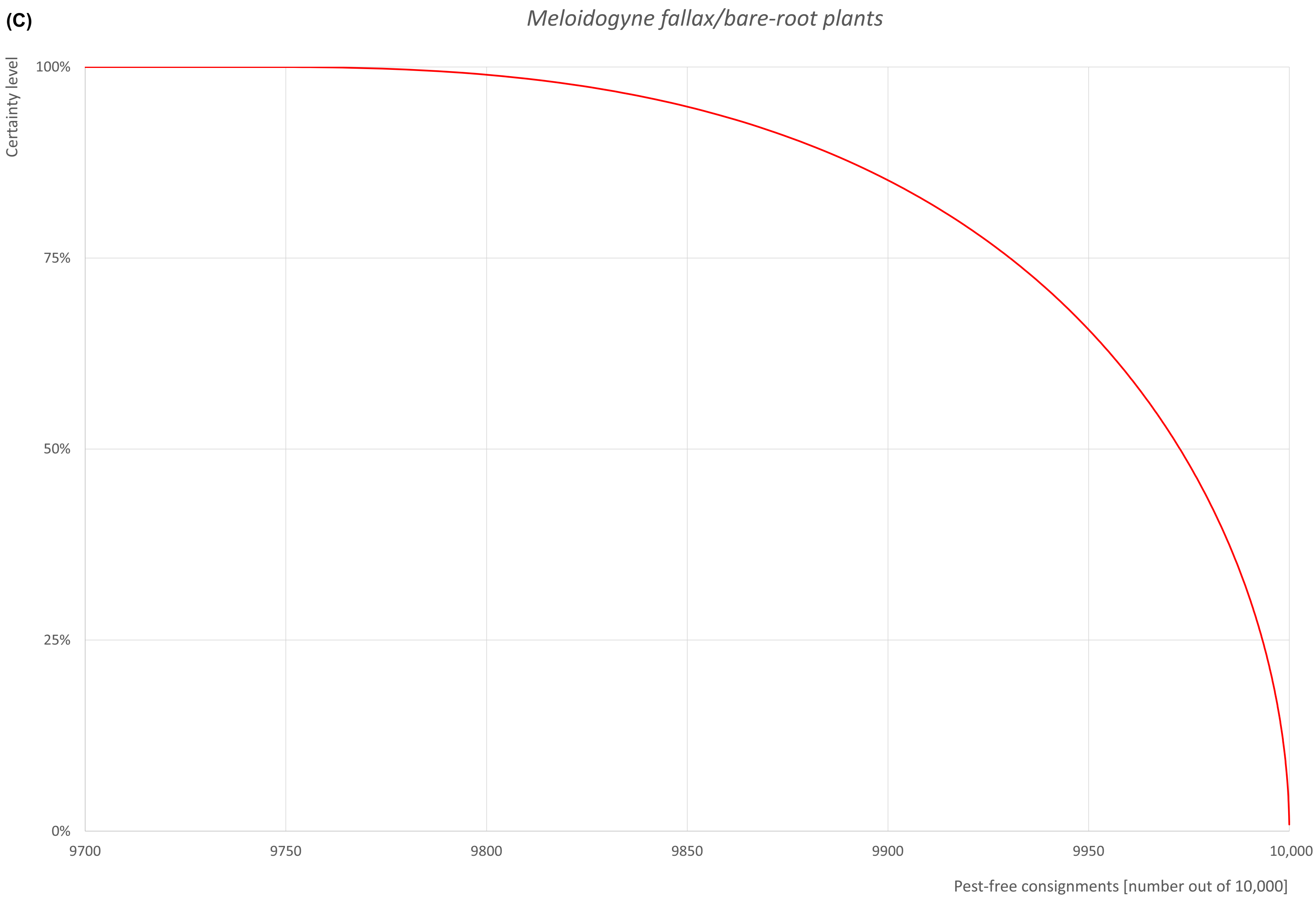

FIGURE A.1 (A) Elicited uncertainty of pest infestation per 10,000 bare-root *Cornus* spp. plants (histogram in blue–vertical blue line indicates the elicited percentile in the following order: 1%, 25%, 50%, 75%, 99%) and distributional fit (red line); (B) uncertainty of the proportion of pest-free plants per 10,000 (i.e. = 1 – pest infestation proportion expressed as percentage); (C) descending uncertainty distribution function of pest infestation per 10,000 plants.

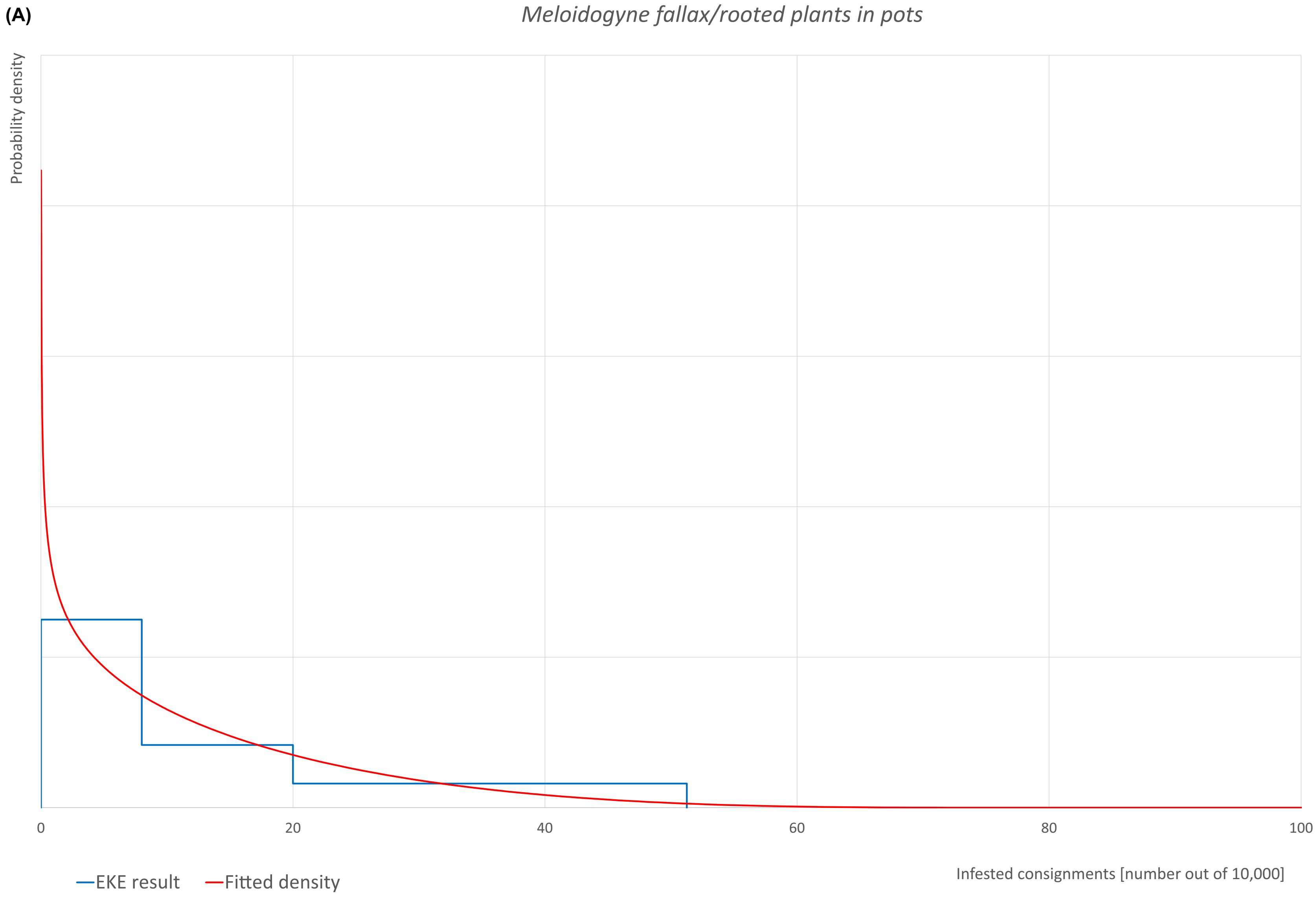

FIGURE A.2 (Continued)

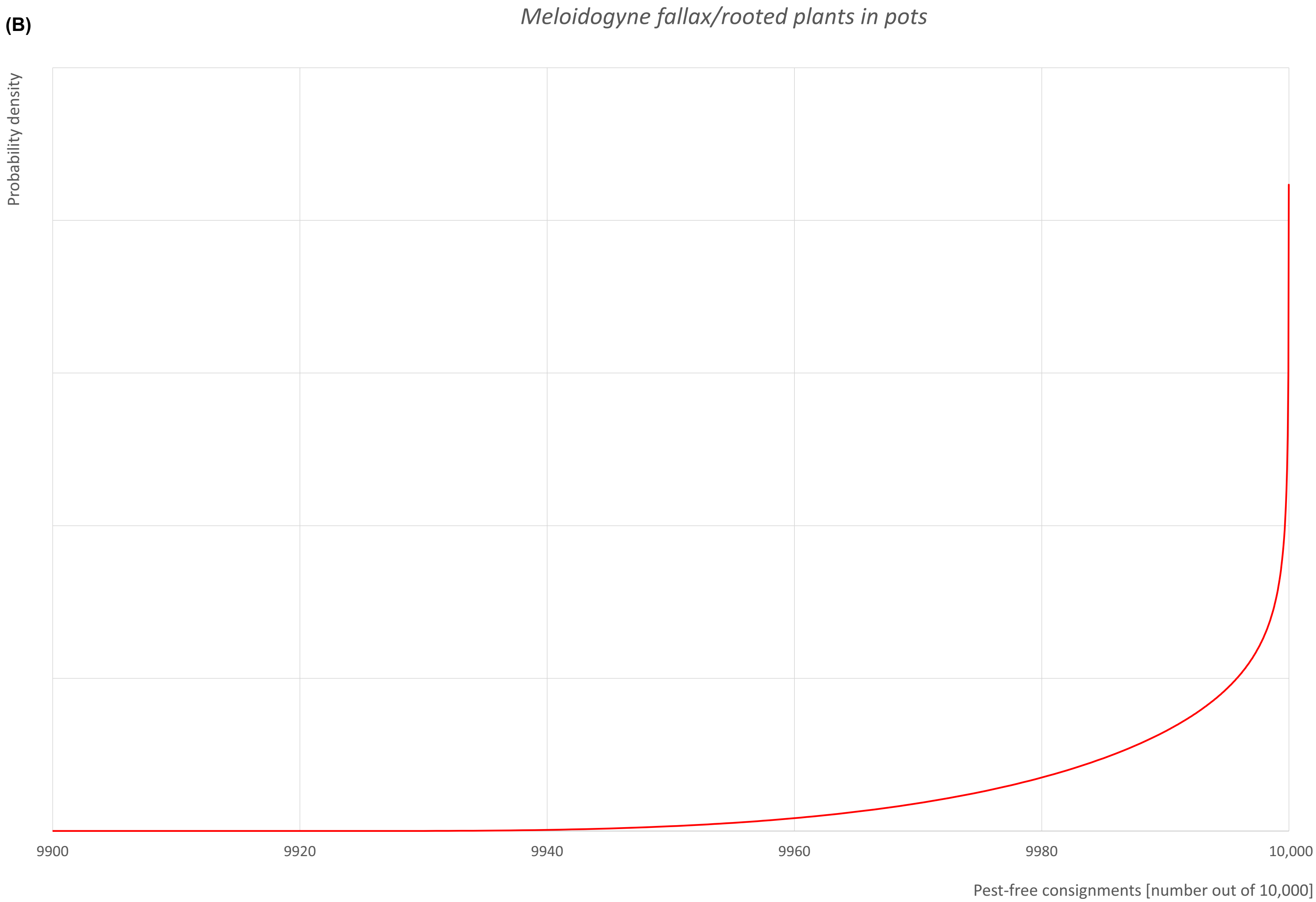

FIGURE A.2 (Continued)

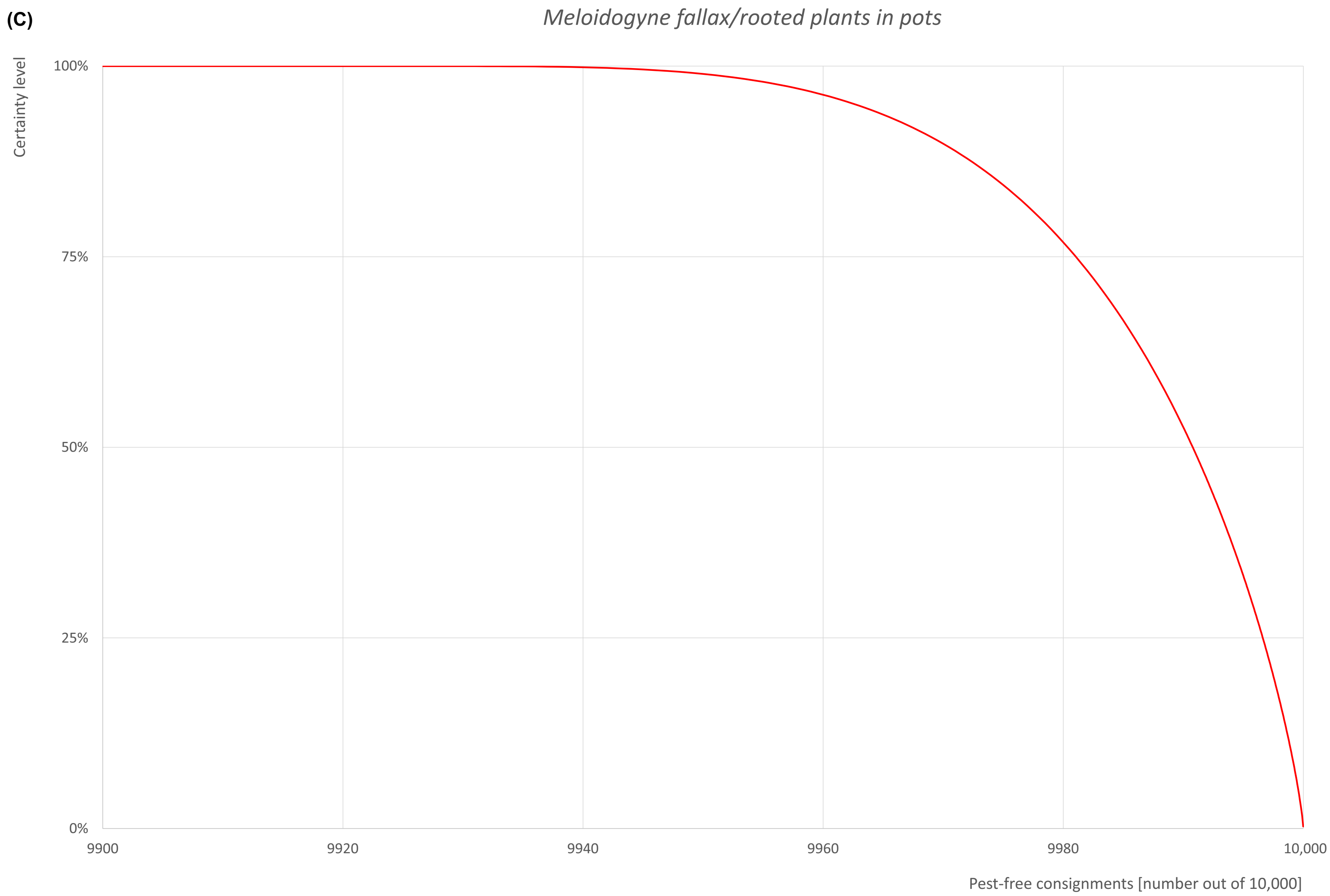

FIGURE A.2 (A) Elicited uncertainty of pest infestation per 10,000 rooted *Cornus* spp. plants in pots (histogram in blue–vertical blue line indicates the elicited percentile in the following order: 1%, 25%, 50%, 75%, 99%) and distributional fit (red line); (B) uncertainty of the proportion of pest-free plants per 10,000 (i.e. = 1 – pest infestation proportion expressed as percentage); (C) descending uncertainty distribution function of pest infestation per 10,000 plants.

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A.2 | *PHYTOPHTHORA RAMORUM*

A.2.1 | Organism information

Taxonomic information	Current valid scientific name: *Phytophthora ramorum* Synonyms: – Name used in the EU legislation: *Phytophthora ramorum* (non-EU isolates) Werres, De Cock & Man in 't Veld [PHYTRA] Order: Peronosporales Family: Peronosporaceae Common name: Sudden oak death (SOD), ramorum bleeding canker, ramorum blight, ramorum leaf blight, twig and leaf blight Name used in the Dossier: *Phytophthora ramorum*
Group	Oomycetes
EPPO code	PHYTRA
Regulated status	*P. ramorum* is listed in Annex II of Commission Implementing Regulation (EU) 2019/2072 as *Phytophthora ramorum* (non-EU isolates) Werres, De Cock & Man in 't Veld [PHYTRA]. The EU isolates of *P. ramorum* are listed as regulated non-quarantine pest (RNQP) *P. ramorum* is included in the EPPO A2 list (EPPO, online_a) *P. ramorum* is quarantine in Canada, Israel, Mexico, Morocco and the United Kingdom. It is on A1 list of Brazil, Chile, Egypt, Kazakhstan, Türkiye and EAEU (=Eurasian Economic Union: Armenia, Belarus, Kazakhstan, Kyrgyzstan and Russia) (EPPO, online_b)

(Continues)

(Continued)

Pest status in the UK	*P. ramorum* is present in the UK (Brown and Brasier, 2007; Dossier Sections 1.0 and 2.0; CABI, online; EPPO, online_c) According to the Dossier Section 2.0, *P. ramorum* is present in the UK (non-EU isolates): not widely distributed and under official control. It has been found in most regions of the UK, but it is more often reported in wetter, western regions
Pest status in the EU	*P. ramorum* is present in the EU and it is currently reported in the following EU Member States: Belgium, Croatia, Denmark, Finland, France, Germany, Ireland, the Netherlands, Poland, Portugal and Slovenia (EPPO, online_c)
Host status on *Cornus*	Some *Cornus* species are reported as natural hosts of the pathogen and *Cornus sanguinea* showed susceptibility (low) (Cave et al., 2008; EPPO, online; Goss et al., 2011)
PRA information	Pest Risk Assessments available: – Risk analysis for *P. ramorum* Werres, de Cock & Man in't Veld, causal agent of sudden oak death, ramorum leaf blight and ramorum dieback (Cave et al., 2008); – Risk analysis of *P. ramorum*, a newly recognised pathogen threat to Europe and the cause of sudden oak death in the USA (Sansford et al., 2009); – Scientific opinion on the pest risk analysis on *P. ramorum* prepared by the FP6 project RAPRA (EFSA PLH Panel, 2011); – Pest risk management for *P. kernoviae* and *P. ramorum* (EPPO, 2013); – UK Risk Register Details for *P. ramorum* (DEFRA, online_a). Risk analysis for *P. ramorum* Werres, de Cock & Man in't Veld, causal agent of sudden oak death, ramorum leaf blight and ramorum dieback. US Department of Agriculture, Animal and Plant Health Inspection Service, Raleigh, NC (Cave et al., 2008)
Other relevant information for the assessment	
Biology	*P. ramorum* is most probably native to East Asia (Jung et al., 2021; Poimala and Lilja, 2013). The pathogen is present in Asia (Japan, Vietnam), Europe (Belgium, Croatia, Denmark, Finland, France, Germany, Guernsey, Ireland, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovenia, the UK), North America (Canada, US) and South America (Argentina) (EPPO, online_c). So far, there are 12 known lineages of *P. ramorum*: NA1 and NA2 from North American, EU1 from Europe (including the UK) and North America (Grünwald et al., 2009), EU2 from Northern Ireland and western Scotland (Van Poucke et al., 2012), IC1 to IC5 from Vietnam and NP1 to NP3 from Japan (Jung et al., 2021) *P. ramorum* is heterothallic oomycete species belonging to clade 8c (Blair et al., 2008) with two mating types: A1 and A2 (Boutet et al., 2010) *Phytophthora* species generally reproduce through: (a) dormant (resting) spores, which can be either sexual (oospores) or asexual (chlamydospores); and (b) fruiting structures (sporangia), which contain zoospores (Erwin and Ribeiro, 1996) *P. ramorum* produces sporangia on the surfaces of infected leaves and twigs of host plants. These sporangia can be splash-dispersed to other close or carried by wind and rain to longer distances. The sporangia germinate to produce zoospores that penetrate and initiate an infection on new hosts. In infected plant material the chlamydospores are produced and can serve as resting structures (Davidson et al., 2005; Grünwald et al., 2008). Trunk cankers (e.g. on *Quercus, Fagus*) are not known to support sporulation and therefore do not transmit the pathogen (DEFRA, online_a). The pathogen is also able to survive in soil (Shishkoff, 2007). In the west of Scotland, it persisted in soil for at least 2 years after its hosts were removed (Elliot et al., 2013). Oospores were only observed in pairing tests under controlled laboratory conditions (Brasier and Kirk, 2004). Optimal temperatures under laboratory conditions were 16–26°C for growth, 14–26°C for chlamydospore production and 16–22°C for sporangia production (Englander et al., 2006) *P. ramorum* is mainly a foliar pathogen; however, it was also reported to infect shoots, stems and occasionally the roots of various host plants (Grünwald et al, 2008, Parke and Lewis, 2007). According to Brown and Brasier (2007), *P. ramorum* commonly occupies xylem beneath phloem lesions and may spread within xylem and possibly recolonise the phloem from the xylem. *P. ramorum* can remain viable within xylem for two or more years after the overlying phloem had been excised *P. ramorum* can disperse by aerial dissemination, water, movement of infested plant material and soil containing propagules on footwear, tires of trucks and mountain bikes or the feet of animals (Brasier, 2008; Davidson et al., 2002) Infected foliar hosts can be a major source of inoculum, which can lead to secondary infections on nearby host plants. Important foliar hosts in Europe are *Rhododendron* spp. and *Larix kaempferi* (Brasier and Webber, 2010, Grünwald et al., 2008). Possible pathways of entry for *P. ramorum* are plants for planting (excluding seed and fruit) of known susceptible hosts; plants for planting (excluding seed and fruit) of non-host plant species accompanied by contaminated attached growing media; soil/growing medium (with organic matter) as a commodity; soil as a contaminant; foliage or cut branches; susceptible (isolated) bark; and susceptible wood (EFSA PLH Panel, 2011). *P. ramorum* caused rapid decline of *Lithocarpus densiflorus* and *Quercus agrifolia* in forests of California and Oregon (Rizzo et al., 2005) and *Larix kaempferi* in plantations of southwest England (Brasier and Webber, 2010)

(Continued)

Symptoms	**Main type of symptoms**	*P. ramorum* causes different types of symptoms depending on the host species and the plant tissue infected According to DEFRA (online_a) *P. ramorum* causes three different types of disease: a. 'Ramorum bleeding canker' – cankers on trunks of trees, which emit a dark ooze. As they increase in size they can lead to tree death. b. 'Ramorum leaf blight' – infection of the foliage, leading to discoloured lesions on the leaves. c. 'Ramorum dieback' – shoot and bud infections which result in wilting, discolouration and dying back of affected parts. Symptoms on *Cornus capitata* and *C. kousa* x *C. capitata* have been described as leaf blight (DEFRA, online_b).
	Presence of asymptomatic plants	If roots are infected by *P. ramorum,* the plants can be without above-ground symptoms for months until developmental or environmental factors trigger disease expression (Roubtsova and Bostock, 2009; Thompson et al., 2021) Application of some fungicides may reduce symptoms and therefore mask infection, making it more difficult to determine whether the plant is pathogen-free (DEFRA, online_a)
	Confusion with other pests	Various symptoms caused by *P. ramorum* can be confused with other pathogens, such as canker and foliar symptoms caused by other *Phytophthora* species (*P. cinnamomi*, *P. cambivora, P. citricola* and *P. cactorum*); leaf lesions caused by rust in early stages; leafspots caused by sunburn; and dieback of twigs and leaves caused by *Botryosphaeria dothidea* (Davidson et al., 2003) *P. ramorum* can be easily distinguished from other *Phytophthora* species based on morphology (Grünwald et al., 2008) and molecular tests
Host plant range	*P. ramorum* has a very wide host range, which is expanding Main host plants include *Camellia* spp., *Larix decidua*, *L. kaempferi*, *Pieris* spp., *Rhododendron* spp., *Syringa vulgaris, Viburnum* spp. and the North American trees species, *Lithocarpus densiflorus* and *Quercus agrifolia* (EPPO online_d) Further proven hosts confirmed by Koch's postulates are *Abies grandis*, *A. magnifica*, *Acer circinatum*, *A. macrophyllum, A. pseudoplatanus*, *Adiantum aleuticum*, *A. jordanii, Aesculus californica*, *A. hippocastanum*, *Arbutus menziesii*, *Arbutus unedo*, *Arctostaphylos columbiana*, *Agrostis glauca*, *A. hooveri*, *A. manzanita*, *A. montereyensis*, *A. morroensis*, *A. pilosula*, *A. pumila*, *A. silvicola*, *A. viridissima*, *Calluna vulgaris*, *Castanea sativa*, *Ceanothus thyrsiflorus*, *Chamaecyparis lawsoniana*, *Chrysolepis chrysophylla*, *Cinnamomum camphora*, *Cornus kousa*, *Cornus hybrids*, *Corylus cornuta*, *Fagus sylvatica*, *Frangula californica*, *Frangula purshiana*, *Fraxinus excelsior*, *Gaultheria procumbens*, *G. shallon*, *Griselinia littoralis*, *Hamamelis virginiana*, *Heteromeles arbutifolia*, *Kalmia* spp., *Larix* × *eurolepis*, *Laurus nobilis*,, *Lonicera hispidula*, *Lophostemon confertus*, *Loropetalum chinense*, *Magnolia* × *loebneri*, *M. oltsopa*, *M. stellata*, *Mahonia aquifolium*, *Maianthemum racemosum*, *Parrotia persica*, *Photinia fraseri*, *Phoradendron serotinum* subsp. *macrophyllum*, *Photinia* × fraseri, *Prunus laurocerasus*, *Pseudotsuga menziesii* var. *menziesii*,, *Quercuscerris*, *Q. chrysolepis*, *Q. falcata Q. ilex*, *Q. kelloggii*, *Q. parvula* var. *shrevei*,, *Rosa gymnocarpa*, *Salix caprea*, *Sequoia sempervirens*,, *Taxus baccata*, *Trientalis latifolia*, *Umbellularia californica*, *Vaccinium myrtillus*, *V. ovatum*, *V. parvifolium* and *Vinca minor* (APHIS USDA, 2022; Cave et al., 2008; EPPO, online d)	
Reported evidence of impact	*P. ramorum* is an EU quarantine pest	
Evidence that the commodity is a pathway	*P. ramorum* is continuously intercepted in the EU on different plant species intended for planting (EUROPHYT/TRACES-NT, online), and according to EFSA PLH Panel (2011), *P. ramorum* can travel with plants for planting. Therefore, plants for planting of Cornus are possible pathway for *P. ramorum*	
Surveillance information	*P. ramorum* at growing sites: infested plants are destroyed, and potentially infested plants are 'held' (prohibited from moving). The UK has a containment policy in the wider environment, with official action taken to remove infected trees (Dossier Section 1.0) As part of an annual survey at ornamental retail and production sites (frequency of visits determined by a decision matrix), *P. ramorum* is inspected on common host plants. An additional inspection, during the growing period, is carried out at plant passport production sites. Inspections are carried out at a survey to 300 non-woodland wider environment sites annually (Dossier Sections 1.0)	

A.2.2 | Possibility of pest presence in the nursery

A.2.2.1 | Possibility of entry from the surrounding environment

P. ramorum is present in the UK, it has been found in most regions of the UK, but it is more often reported in wetter, western regions (Dossier Sections 1.0 and 2.0).

The possible entry of *P. ramorum* from surrounding environment to the nurseries may occur through aerial dissemination, water and animals (Davidson et al., 2002).

P. ramorum has a wide host range and can infect a number of different plants. Suitable hosts of *P. ramorum* like *Fagus* spp., *Ilex* spp., *Quercus* spp., *Taxus* spp., *Castanea* spp., spp. (especially *L. kaempferi*), *Magnolia* spp., *Prunus* spp., *Quercus* spp., spp., *Rosa* spp., *Salix* spp., *Syringa* spp. and *Viburnum* spp. are present in the areas surrounding the nurseries (Dossier Section 1.0).

Uncertainties:

- The dispersal range of *P. ramorum* sporangia.
- No information available on the distance of the nurseries to sources of pathogen in the surrounding environment.

Taking into consideration the above evidence and uncertainties, the Panel considers that it is possible for the pathogen to enter the nurseries from surrounding environment. In the surrounding area, suitable hosts are present, and the pathogen can spread by wind, rain and infested soil propagules on the feet of animals entering the nurseries.

A.2.2.2 | Possibility of entry with new plants/seeds

The starting materials are either seeds or seedlings. Seedlings are either from the UK or the EU (the Netherlands) (Dossier Section 1.0). Seeds are not a pathway for the pathogen.

In addition to *Cornus* spp. plants, the nurseries also produce other plants (Dossier Section 6.0). Out of them, there are many suitable hosts for the pathogen (such as *Abies* spp., *Acer* spp., *Aesculus* spp., *Arbutus* spp., *Calluna* spp., *Castanea* spp., Fagus spp., *Viburnum* spp. etc.). However, there is no information on how and where the plants are produced. Therefore, if the plants are first produced in another nursery, the pathogen could possibly travel with them.

For the potted plants, the nurseries are using virgin peat or peat-free compost (a mixture of coir, tree bark, wood fibre etc.) as a growing media (Dossier Section 1.0). *P. ramorum* is able to survive in soil (Shishkoff, 2007) and therefore could potentially enter with infested soil/growing media. However, the growing media is certified and heat-treated by commercial suppliers during production to eliminate pests and diseases (Dossier Section 3.0).

Uncertainties:

- No information is available on the origin of plants other than *Cornus* spp. used for plant production in the nurseries.
- The effectiveness of removing all soil with a low-pressure washer.

Taking into consideration the above evidence and uncertainties, the Panel considers that it is possible for the pathogen to enter the nurseries with new seedlings of *Cornus* spp. and new plants of other species used for plant production in the area. The Panel considers the entry of the pathogen with seeds and the growing media as not possible.

A.2.2.3 | Possibility of spread within the nursery

Cornus spp. plants are either grown in containers (cells, pots, tubes etc.) or in field. Cell-grown trees may be grown in greenhouses; however, most plants will be field grown, or grown in open air in containers (Dossier Section 1.0).

The pathogen can infect other suitable plants (such as *Abies* spp., *Aesculus* spp., *Castanea* spp., *Larix* spp., *Viburnum* spp. etc.) present within the nurseries and hedges surrounding the nurseries (*Prunus* spp.) (Dossier Sections 1.0).

P. ramorum can spread within the nurseries by aerial dissemination/water splash: via soil, water, movement of infested plant material (e.g. infested leaves) and animals/humans (Davidson et al., 2002).

Uncertainties: None.

Taking into consideration the above evidence and uncertainties, the Panel considers that the spread of the pathogen within the nurseries is possible either by aerial dissemination, animals, movement of infected plant material, soil or water.

A.2.3 | Information from interceptions

In the EUROPHYT/TRACES-NT database, there are no records of interceptions of *P. ramorum* on *Cornus* spp. from third countries or on any other plant from the UK.

A.2.4 | Evaluation of the risk mitigation measures

In the table below (Table A.6), all risk mitigation measures currently applied in the UK are listed, and an indication of their effectiveness on *P. ramorum* is provided. The description of the risk mitigation measures currently applied in the UK is provided in the Table 9.

TABLE A.6 Evaluation of the risk mitigation measures.

Number	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
1	Registration of production sites	Yes	All nurseries are registered as professional operator with the UK NPPO, by the Animal and Plant Health Agency (APHA) and is authorised to issue UK plant passports (Dossier Section 1.0) Evaluation: The registration of production sites is expected to contribute in reducing the phytosanitary risks within the facility Uncertainties: None
2	Certified plant material	Yes	Seeds of *C. alba* are not certified, while seeds of *C. sanguinea* seed purchased in the UK may be certified under the Forestry Commission's Voluntary Scheme for the Certification of Native Trees and Shrubs. Seedlings for Cornus production sourced in the UK are certified with UK Plant Passports; seedlings from the EU countries are certified with phytosanitary certificates Evaluation: *P. ramorum* is a quarantine pest and targeted by this measure and could reduce the infection level. Seeds are not a pathway Uncertainties: – The details of the procedure are not clear – If propagation material of alternative hosts is covered is not clear
3	Certification of substrates/ (rooted plant in pots)	Yes	Rooted plants in pots: In the production or procurement of these plants, the use of growing media is assessed for the potential to harbour and transmit plant pests. Growers most commonly use virgin peat or peat-free compost, which is a mixture of coir, tree bark, wood fibre etc. The compost is heat-treated by commercial suppliers during production to eliminate pests and diseases. It is supplied in sealed bulk bags or shrink-wrapped bales and stored off the ground on pallets, these are completely hygienic and free from contamination. Where delivered in bulk, compost is kept in a dedicated bunker, either indoors or covered by tarpaulin outdoors, and with no risk of contamination with soil or other material (Dossier Section 1.0) Evaluation: The measure is efficient in preventing the entry of the pathogen via the substrate into the nursery Uncertainties: None
4	Surveillance, monitoring and sampling	Yes	In the last 3 years, there has been a substantial level of inspection of registered *Cornus* spp. producers, both in support of the Plant Passporting scheme (checks are consistent with EU legislation, with a minimum of once a year for authorised operators) and as part of the Quarantine Surveillance programme (Great Britain uses the same framework for its surveillance programme as the EU). The Competent Authority inspects crops at least once a year to check if they meet the standards set out in the guides (Dossier Section 1.0) UK(GB) surveillance is based on visual inspection with samples taken from symptomatic material, and where appropriate, samples are also taken from asymptomatic material (e.g. plants, tubers, soil, watercourses) (Dossier Section 1.0) Evaluation: The surveillance, monitoring and sampling can detect the pathogen Uncertainties: – The efficiency of the surveillance, monitoring and sampling – No results are reported.
5	Hygiene measures	Yes	All nurseries have plant hygiene and housekeeping rules and practices in place, which are communicated to all relevant employees. The rules will be dependent on the plants handled and the type of business but will include: • Growing media • Weed management • Water usage • Cleaning and sterilisation • Waste treatment and disposal • Visitors Evaluation: These measures could be effective in reducing the risk of introduction and/or spread of the pathogen Uncertainties: The efficiency of the hygiene measures
6	Irrigation water quality and/or treatments	Yes	Growers are required to assess water sources, irrigation and drainage systems used in the plant production for the potential to harbour and transmit plant pests. Water is routinely sampled and sent for analysis. No quarantine pests have been found (Dossier Section 1.0) Evaluation: The irrigation water is routinely checked and can reduce the risk Uncertainties: The frequency and the method used for the detection on the pathogen

(Continues)

TABLE A.6 (Continued)

Number	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
7	Application of pest control products	Yes	Crop protection is achieved using a combination of measures including approved plant protection products, biological control or physical measures. Plant protection products are only used when necessary and records of all plant protection treatments are kept. (Dossier Section 1.0). Evaluation: The listed treatments are not sufficiently effective against *P. ramorum* Uncertainties: The details about the products applied and the application scheme are unknown and the efficiency is unclear
8	Washing of the roots (bare-root plants)	Yes	Bare-root plants are lifted from the field in winter and then root-washed on site and stored prior to expert Evaluation: The washing of the roots removes (parts of) the soil and thus also the pathogen Uncertainties: The effectiveness of the washing to remove all soil with the pathogen
9	Inspections and management of plants before export	Yes	The UK NPPO carries out inspections and testing where required by the country of destination's plant health legislation, to ensure all requirements are fulfilled and a valid phytosanitary certificate with the correct additional declarations is issued Separate to any official inspection, plant material is checked by growers for plant health issues before dispatch Special provision for inspection of *P. ramorum* is in place Evaluation: The inspections and management of plants before export can detect the pathogen Uncertainties: The efficiency of the inspections

A.2.5 | Overall likelihood of pest freedom for *Cornus* spp. plants (bare-root and rooted plants in pots)

A.2.5.1 | Reasoning for a scenario which would lead to a reasonably low number of infected *Cornus* spp. plants (bare-root and rooted plants in pots)

- *P ramorum* outbreaks are more frequent in the Western part of the country (the nurseries are in the Eastern part).
- The climate suitability for the pathogen in the Eastern UK, where the nurseries are located, is low (dryer climate compared to the Western part).
- The pathogen has not been found on *C. alba* and *C. sanguinea*. *Cornus alba* has shown to be resistant to the pathogen in experiments.
- The pathogen is causing clear symptoms (leave blight), and it is easy to detect.
- There is official surveillance of *Cornus* spp. nurseries.
- Seeds are not a pathway, seedlings of *Cornus* spp. are certified with the UK plant passport.
- Clean new material is used for potted plants.
- Root washing effectively removes the soil aggregates.
- Irrigation water is regularly checked.
- Some of the applied Plant Protection Products may be effective in controlling the pathogen.
- Official inspections.

A.2.5.2 | Reasoning for a scenario which would lead to a reasonably high number of infected *Cornus* spp. plants (bare-root and rooted plants in pots)

- *P. ramorum* is present in all regions of the UK (including nurseries).
- Some *Cornus* species are natural hosts of the pathogen, and *Cornus sanguinea* showed susceptibility (low) in experiments.
- Plants can be symptomless with a latent period of some months.
- The pathogen can be confused with other *Phytophthora* species.
- The measures adopted after the detection of the pathogen are unclear, nor results are reported; unclear efficiency.
- Other host plants can be present in the surrounding.
- Irrigation is applied (also overhead), and pathogens can be spread.
- Contamination during production (in the nursery) is possible.
- Root washing does not effectively remove the soil aggregates.
- The Plant Protection Products used in the nurseries are not targeted to the control of *P. ramorum*.
- Unclear details and efficiency of the inspections.

A.2.5.3 | Reasoning for a central scenario equally likely to over-or underestimate the number of infected *Cornus* spp. plants (bare-root and rooted plants in pots) (median)

The scenario assumes a limited presence of the pathogen in the nurseries and the surroundings, and a limited susceptibility of *Cornus* spp. The pathogen is a regulated quarantine pest in the UK and under official control.

A.2.5.4 | Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile/interquartile range)

The limited information on the susceptibility of *Cornus* spp. and on the occurrence of the pathogen in the nurseries and the surroundings results in a high level of uncertainties for infestation rates below the median. Otherwise, the pest pressure from the surroundings is expected to be low, giving less uncertainties for rates above the median.

A.2.6 | Elicitation outcomes of the assessment of the pest freedom for *Phytophthora ramorum*

The elicited and fitted values for *P. ramorum* agreed by the Panel are shown in Tables A.7–A.10 and in Figures A.3, A.4.

TABLE A.7 Elicited and fitted values of the uncertainty distribution of pest infection by *P. ramorum* per 10,000 bare-root *Cornus* spp. plants.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Elicited values	1					10		20		100					200
EKE	0.991	1.00	1.06	1.41	2.65	5.83	11.4	31.6	67.4	92.2	123	152	177	191	200

Note: The EKE results are the *BetaGeneral (0.37655, 1.0565, 0.99, 207)* distribution fitted with @Risk version 7.6.

Based on the numbers of estimated infected bare-root *Cornus* spp. plants, the pest freedom was calculated (i.e. = 10,000 – number of infected plants per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.8.

TABLE A.8 The uncertainty distribution of plants free of *P. ramorum* per 10,000 bare-root *Cornus* spp. plants calculated by Table A.7.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Values	9800					9900		9980		9990					9999
EKE results	9800	9809	9823	9848	9877	9908	9933	9968	9989	9994	9997	9998.6	9998.9	9999.00	9999.01

Note: The EKE results are the fitted values.

TABLE A.9 Elicited and fitted values of the uncertainty distribution of pest infection by *P. ramorum* per 10,000 rooted *Cornus* spp. plants in pots.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Elicited values	0					4		8		16					40
EKE	0.167	0.395	0.762	1.49	2.48	3.77	5.17	8.43	12.7	15.6	19.4	23.8	29.3	34.2	40.0

Note: The EKE results are the *BetaGeneral (1.0764, 6.8505, 0, 80)* distribution fitted with @Risk version 7.6.

Based on the numbers of estimated infected rooted *Cornus* spp. plants in pots, the pest freedom was calculated (i.e. = 10,000 – number of infected plants per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.10.

TABLE A.10 The uncertainty distribution of plants free of *P. ramorum* per 10,000 rooted *Cornus* spp. plants in pots calculated by Table A.9.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Values	9960					9984		9992		9996					10,000
EKE results	9960	9966	9971	9976	9981	9984	9987	9992	9995	9996	9997.5	9998.5	9999.2	9999.6	9999.8

Note: The EKE results are the fitted values.

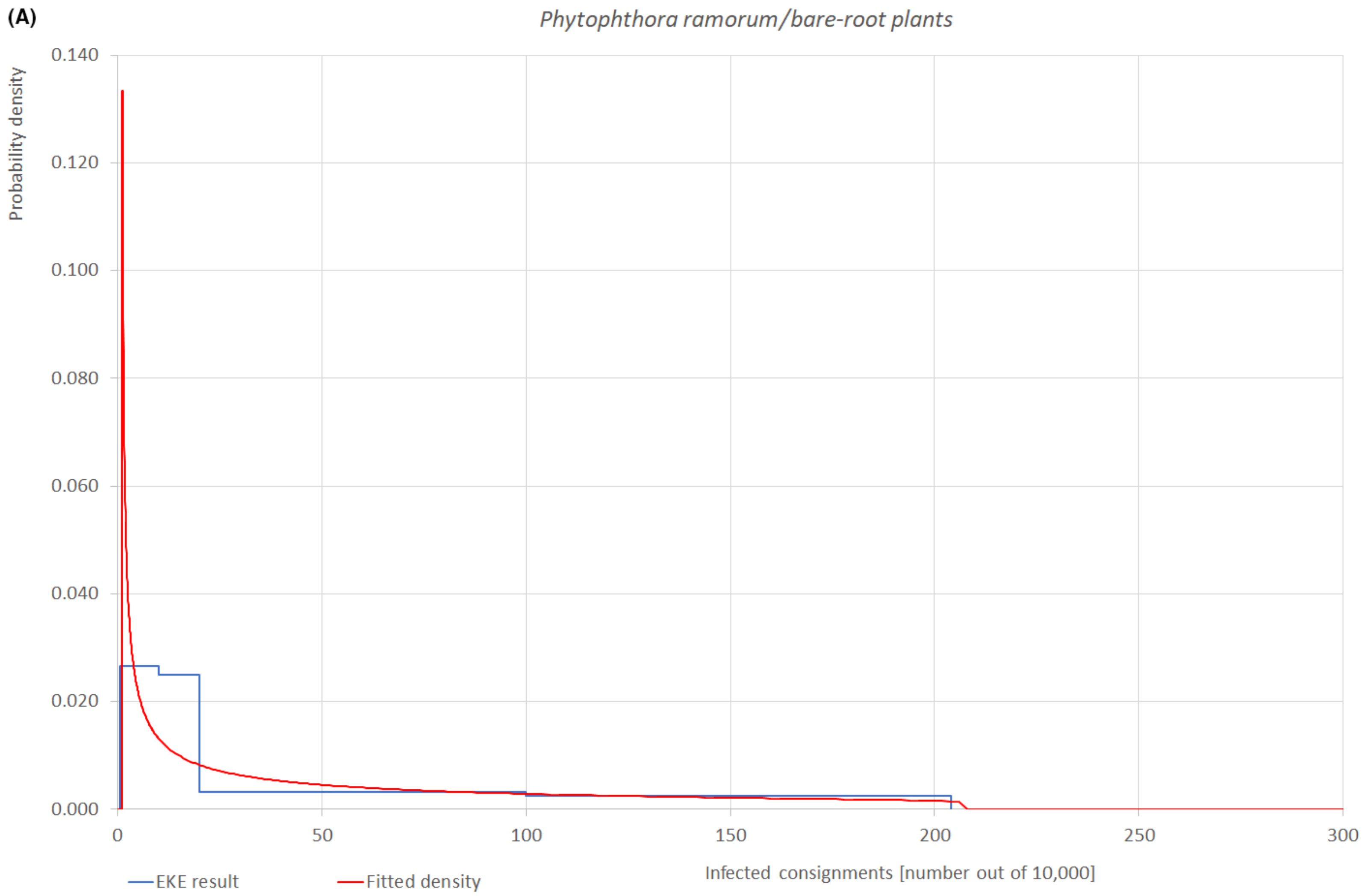

FIGURE A.3 (Continued)

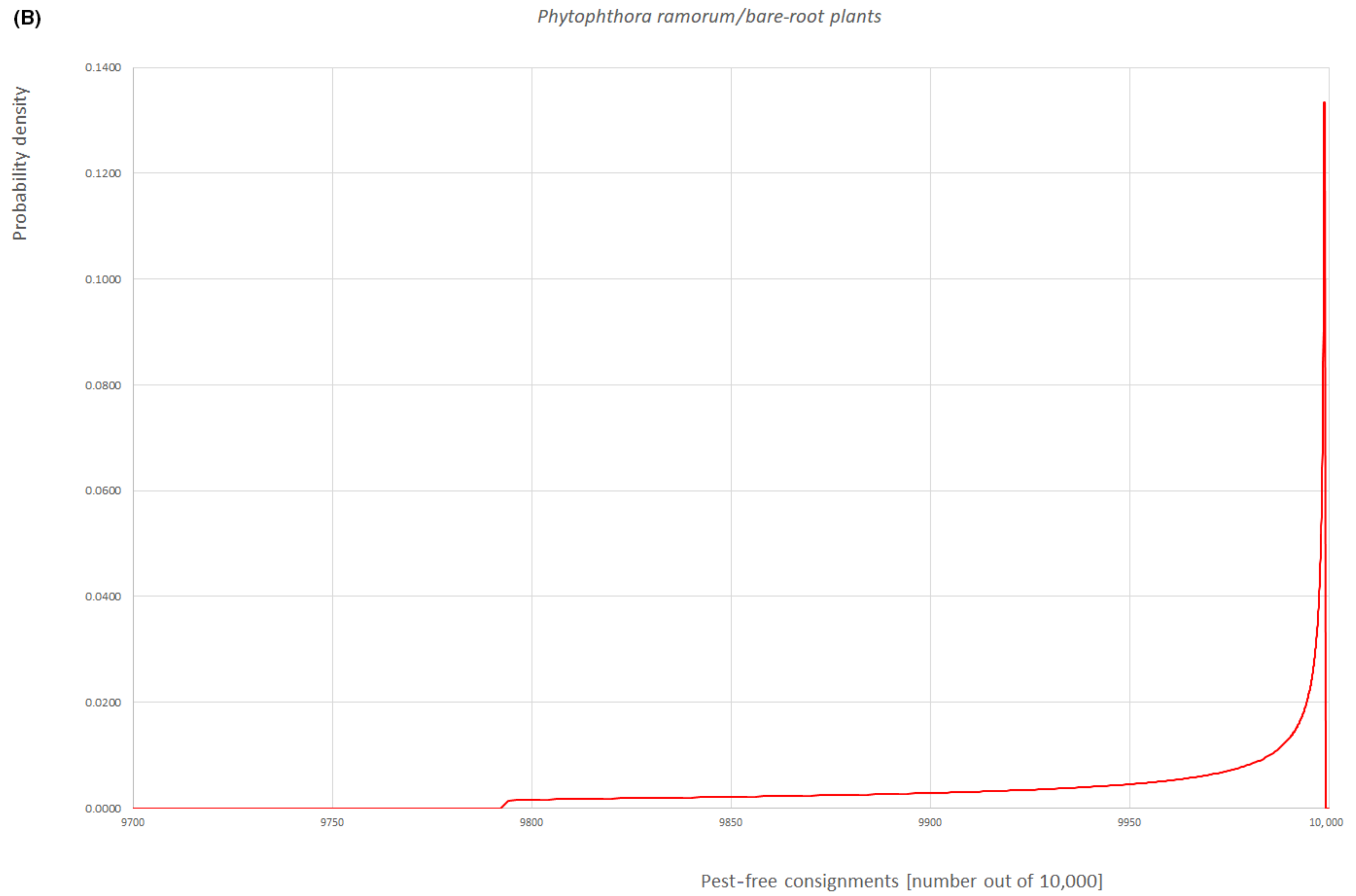

FIGURE A.3 (Continued)

(C)

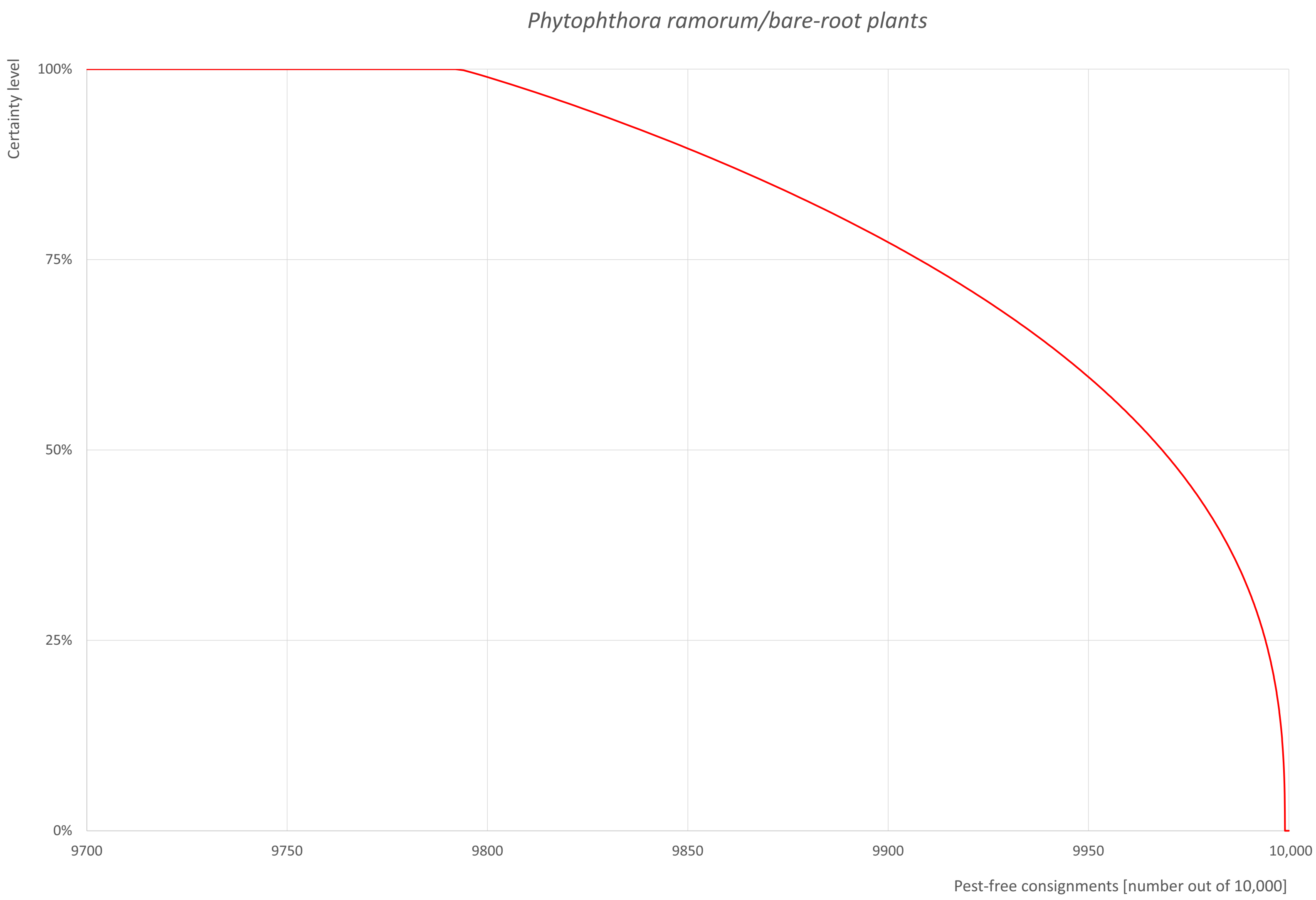

FIGURE A.3 (A) Elicited uncertainty of pest infection per 10,000 bare-root plants *Cornus* spp. (histogram in blue–vertical blue line indicates the elicited percentile in the following order: 1%, 25%, 50%, 75%, 99%) and distributional fit (red line); (B) uncertainty of the proportion of pest-free plants per 10,000 (i.e. = 1 – pest infection proportion expressed as percentage); (C) descending uncertainty distribution function of pest infection per 10,000 plants.

(A)

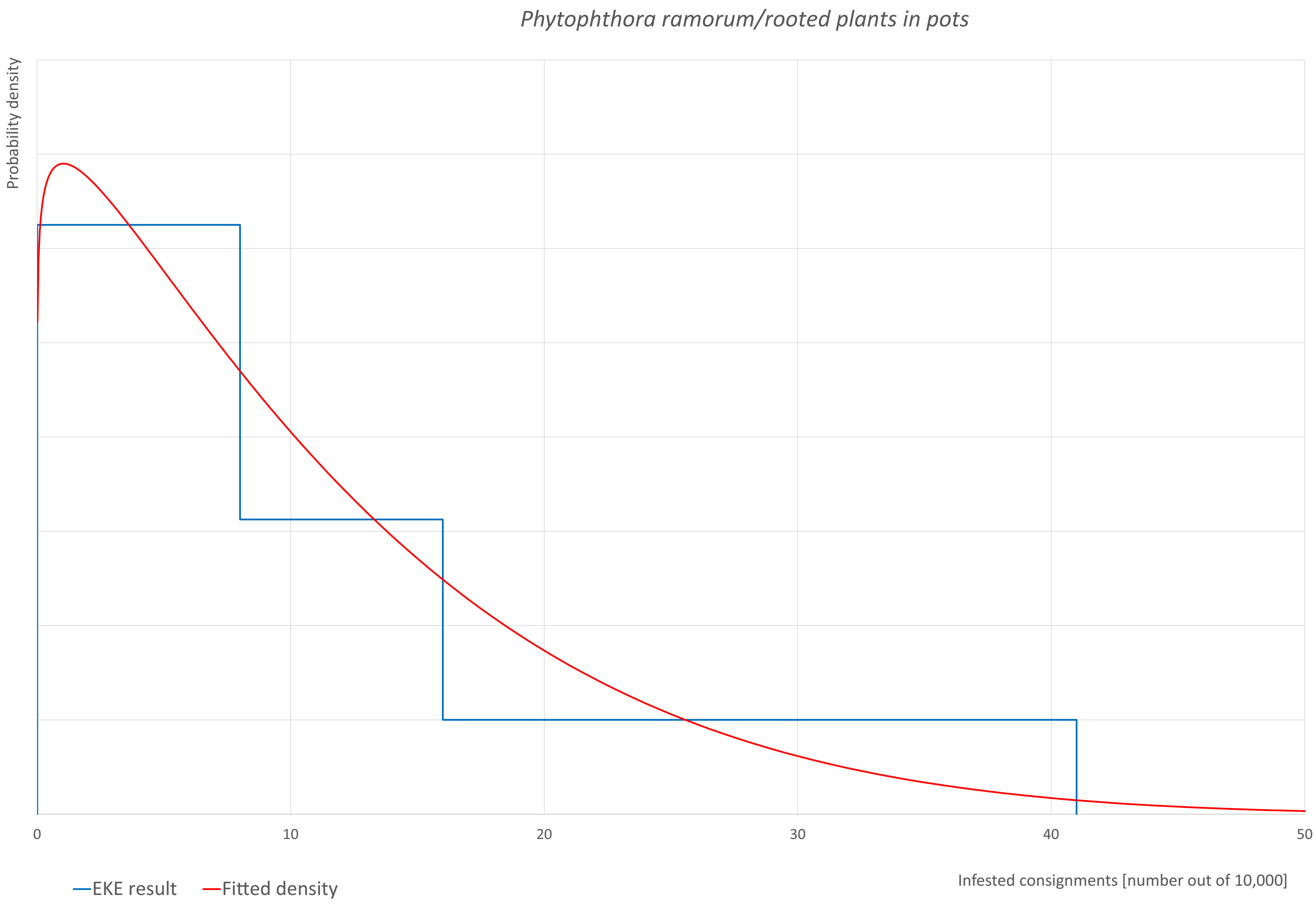

FIGURE A.4 (Continued)

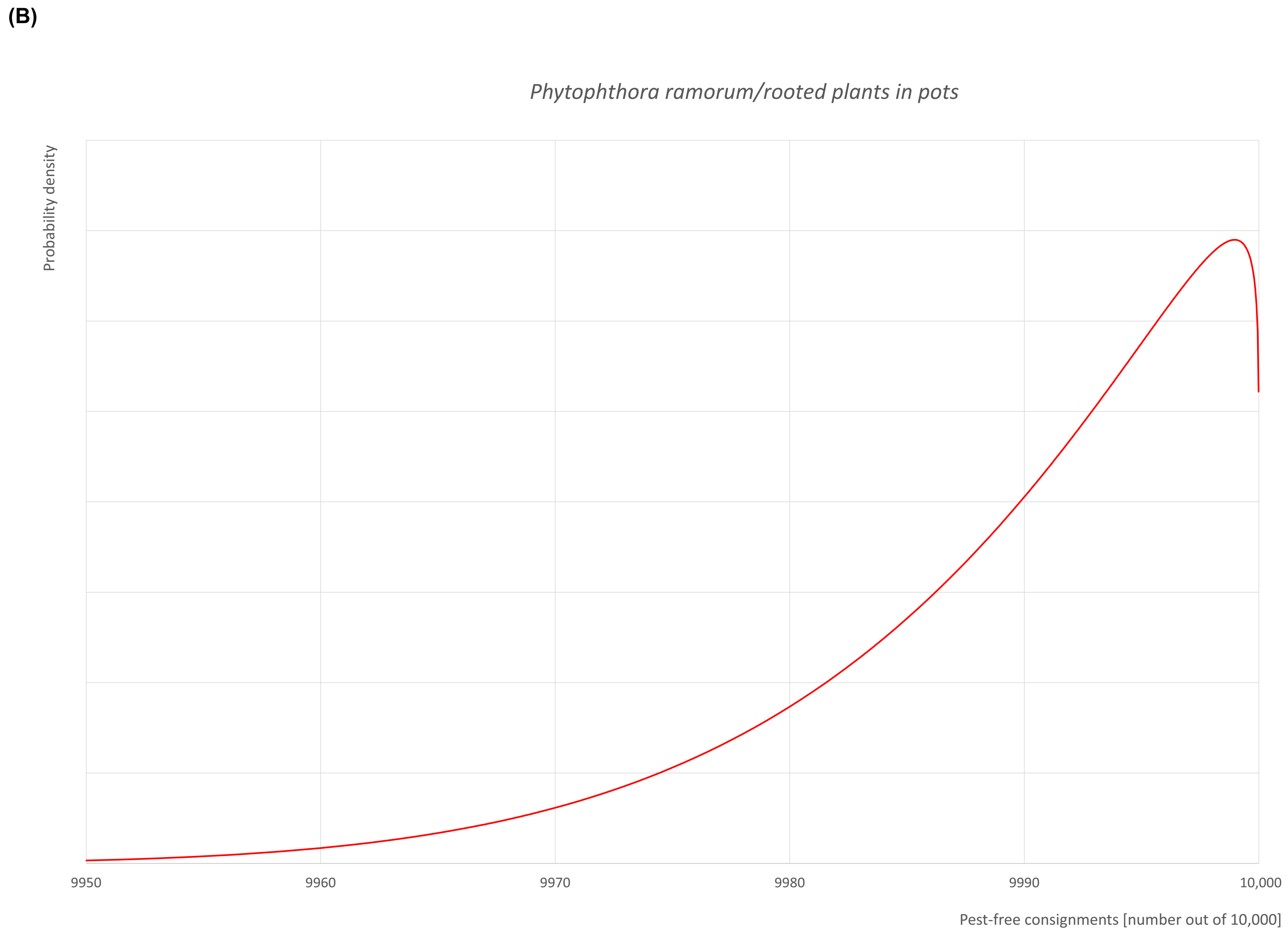

FIGURE A.4 (Continued)

(C)

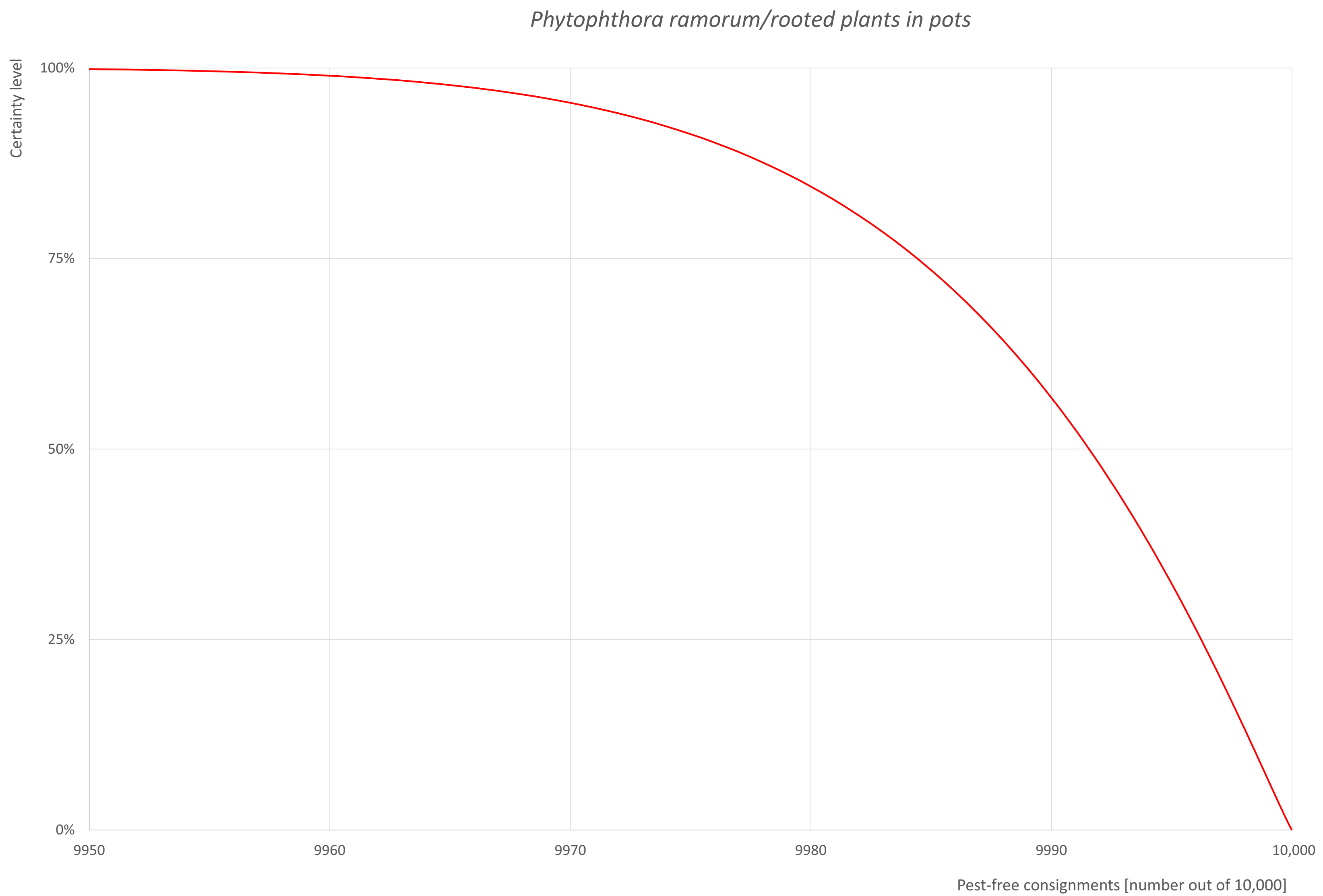

FIGURE A.4 (A) Elicited uncertainty of pest infection per 10,000 rooted *Cornus* spp. plants in pots (histogram in blue–vertical blue line indicates the elicited percentile in the following order: 1%, 25%, 50%, 75%, 99%) and distributional fit (red line); (B) uncertainty of the proportion of pest-free plants per 10,000 (i.e. = 1 – pest infection proportion expressed as percentage); (C) descending uncertainty distribution function of pest infection per 10,000 plants.

A.2.7 | References

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A.3 | NEPOVIRUSES [TOMATO RINGSPOT VIRUS (TORSV) AND TOBACCO RINGSPOT VIRUS (TRSV)]

A.3.1 | Organism information

Taxonomic information	Order: *Picornavirales* Family: *Secoviridae* Genus: *Nepovirus* **Reasons for clustering:** The below listed viruses belong in the same genus (*Nepovirus*) and they share the same biology and epidemiology characteristics. The cluster contains tomato ringspot virus (ToRSV) and tobacco ringspot virus (TRSV). **1. Tomato ringspot virus (ToRSV)** Synonyms: ToRSV, Tomato ringspot, *Tomato ringspot nepovirus*. Name used in the EU legislation: Tomato ringspot virus [ToRSV] Category: Virus (Proposed) Species: *Nepovirus lycopersici* Common name: ringspot of tomato, union necrosis of apple, chlorosis mosaic of raspberry, chlorosis of pelargonium, stem pitting of Prunus, yellow vein of grapevine. Name used in the Dossier: Tomato ringspot virus (ToRSV) **2. Tobacco ringspot virus (TRSV)** Synonyms: *TRSV, Tobacco ringspot, Tobacco ringspot nepovirus*. Name used in the EU legislation: Tobacco ringspot virus [TRSV00] Category: Virus Order: Picornavirales Family: Secoviridae Genus: *Nepovirus* Species: *Nepovirus nicotianae* Common name: ringspot of tobacco Name used in the Dossier: Tobacco ringspot virus (TRSV)
Group	Viruses and Viroids
EPPO code	The EPPO code for tomato ringspot virus (ToRSV) is ToRSV0 and for tobacco ringspot virus (TRSV) is TRSV00
Regulated status	ToRSV and TRSV are both listed as EU Quarantine pests (Annex II, Part A of Commission Implementing Regulation (EU) 2019/2072); Pests not known to occur in the EU Union territory (2019)
Pest status in UK	ToRSV is reported as 'Present, few occurrences' (EPPO, online a) or absent, eradicated (CABI, 2015). TRSV is reported as 'Present, few occurrences' (EPPO, online b) According to the UK NPPO (EPPO, online a), both nepoviruses are present at very low levels, ToRSV only detected in pelargonium (ornamental) and TRSV in pelargonium (ornamental) and anemome (wild plant) in the UK (DEFRA, 2018a, 2018b)
Pest status in the EU	Not relevant for EU Quarantine pest
Host status on *Cornus spp.*	*Cornus* spp. is reported as host of ToRSV (Encyclopedia for Viruses and Viroids) while *Cornus florida, C. racemossa* and *C. sericea* are reported as hosts of TRSV (EPPO, Onlinec,d)
PRA information	Rapid Pest Risk Analysis (PRA) for Tobacco ringspot virus (TRSV) (DEFRA, 2018a) Rapid Pest Risk Analysis for ToRSV in UK (DEFRA, 2018b) Scientific Opinion on the pest categorization of non-EU viruses and viroids of *Cydonia* Mill., *Malus* Mill. and *Pyrus* L. (EFSA PLH Panel, 2019a) Scientific Opinion on the pest categorization of non-EU viruses and viroids of *Vitis* L. (EFSA PLH Panel, 2019b)

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Other relevant information for the assessment		
Biology	ToRSV and TRSV are bipartite positive-sense RNA viruses belonging in the *Nepovirus* genus, *Secoviridae* family (Sanfaçon et al., 2006) **Transmission** Both ToRSV and TRSV are transmitted by the ectoparasitic dagger nematodes in the *Xiphinema americanum* sensu lato group; both are transmitted by *X. americanum* sensu stricto, *X. californicum*, *X. intermedium*, *X. rivesi* and *X. tarjanense*, while the species *X. bricolense* and *X. inaequale* are additionally reported to transmit ToRSV (EFSA PLH Panel, 2018). Nepoviruses are transmitted by both the adult and larval stages of *X. americanum* (sensu lato), being acquired within 1 h and can be inoculated into healthy plants within 1 h (Stace-Smith, 1984). However, usually nepoviruses can be acquired in less than 15 min and persist up to several years when nematodes are not feeding (Fuchs et al., 2017). Local spread of nepoviruses due to the nematode vectors activity is slow and appear in parches. In raspberry plantings, the average rate of ToRSV spread is ca. 2 m per year (Converse & Stace-Smith, 1971) Seed transmission has been proved for ToRSV in soybean, strawberry, raspberry, pelargonium and *Taraxacum officinale* and pollen transmission to seed in pelargonium (Stace-Smith, 1984). TRSV can be seed transmitted in at least 12 species of herbaceous (crop and weed) hosts, such as soybean and cucumber, and by pollen in some species (Stace-Smith, 1985; Card et al., 2007; Rowhani et al., 2017). However, no seed/pollen transmission has been reported for these nepoviruses in woody hosts (EFSA PLH Panel, 2013) **Uncertainly on biology** The vector ability of additional nematode species The seed and pollen transmission of nepoviruses in woody plants **Host range and distribution of host plants in the environment:** In nature, **ToRSV** occurs mostly in vegetable and perennial crops, including ornamental and woody plants, such as *Solanum lycopersicum* (tomato), *Cucumis sativus* (cucumber), *Nicotiana tabacum* (tobacco), *Solanum tuberosum* (potato), *Vitis vinifera* (grapevine), *Vaccinium corymbosum* (blueberry), *Fragaria vesca* (strawberry), *Pelargonium domesticum* (geranium), raspberry *(Rubus idaeus*), *Rubus fruticosus, Rubus* sp. (blackberry), *Malus* sp. (apple), *Hosta* sp., *Aquilegia vulgaris*, *Delphinium* sp., *Fragaria ananassa*, *Fraxina americana*, *Gladiolus* sp., *Heleborus foetidus*, *Hydrangea macrophylla*, *Iris* sp., *Punica granatum*, *Phaseolus vulgaris*, *Prunus persica*, *Prunus* sp., *Rosa* sp., *Trifolium* sp., *Vigna unguiculate*, *Viola cornuta;* to these hosts ToRSV cause systemic infections (Stace-Smith, 1984; Powell et al., 1984; Samuitienė & Navalinskienė, 2001; Sanfaçon et al., 2006; EFSA PLH Panel, 2013; EPPO, 2013). Furthermore, ToRSV can infect weeds, including *Taraxacum officinale, Rumex acetosella, Stellaria* spp., among other 21 species (Mountain et al., 1983; Powell et al., 1984). In addition, the experimental host range of ToRSV is very wide, including species in more than 35 dicotyledonous and monocotyledonous families (Stace-Smith, 1984) **TRSV** infects also a wide range of herbaceous and woody hosts and can cause significant yield loss in soybeans (*Glycine max*), tobacco (*Nicotiana tabacum*), *Vaccinium* spp. and Cucurbitaceae (Stace-Smith, 1985). In addition, many other hosts have also been found naturally infected, such as *Anemone*, apples (*Malus domestica*), aubergines (*Solanum melongena*), blackberries (*Rubus fruticosus*), Capsicum, cherries (*Prunus avium*), ***Cornus***, *Fraxinus*, *Gladiolus*, grapes (*Vitis vinifera*), *Iris*, *Lupinus*, *Mentha*, *Narcissus pseudonarcissus*, pawpaws (*Carica papaya*), *Pelargonium*, *Petunia*, *Sambucus* and various weeds (Gonsalves, 1988) **Uncertainly on host range** The actual host range of most nepoviruses **Ecology and biology of the vectors:** Nematodes belonging to the *X. americanum* sensu lato group are migratory ectoparasites of plant roots. All nematode stages are found in soil, but there is no specialised survival stage except in *X. pachtaicum*, which may survive under dry conditions in an anhydrobiotic state. Their life cycle lasts approximately 1 year, and they are assumed to reproduce parthenogenetically; males do not exist or are extremely rare. Optimum temperatures for reproduction are 20–24°C. Some species are important vectors of some American nepoviruses, including TRSV and ToRSV (EFSA PLH Panel, 2018)	
Symptoms	**Main type of symptoms**	ToRSV occurs in nature mostly in perennial plants, and it is associated with serious diseases of fruit and ornamental crops. Infected grapevines exhibit stunted shoot growth, shortened internodes, leaf ringspot and mottling, reduced size of fruit clusters and abortion of many berries, as well as thickened, spongy phloem tissue with numerous necrotic pits. In *Malus*, ToRSV causes graft union necrosis, woody pitting and decline in apples. In stone fruit trees, stem pitting and decline (in peach and cherry), yellow bud mosaic (in peach and almond) and brown line and decline (in plum) are observed. The red raspberry plants of some cultivars showing decline in vigour, stunting and significant fruit yield and quality reduction. Infected Rubus plants often die 4–5 years after infection (EFSA PLH Panel 2019a). Infected tomato plants may exhibit a conspicuous curling and shoot terminal necrosis, while younger leaves develop brown, clearly defined necrotic rings and sinuous lines with petioles often marked with necrotic streaks and rings. Tomato fruits may develop faint to conspicuous, grey to brown, corky, superficial and frequently concentric rings or portions of rings (EPPO, 2013). TRSV causes a significant bud blight disease in soybeans (*Glycine max*), a necrotic ringspot disease in tobacco (*Nicotiana tabacum*) and *Vaccinium* spp., especially *V. corymbosum*, and Cucurbitaceae. Infected grapevine develops symptoms of decline with shortened internodes, small and distorted leaves and decreased berry yield. Foliar symptoms (chlorotic spots, rings or areas surrounded by necrotic tissues) may be induced in infected stone fruit trees (EFSA PLH Panel 2019a). In several ornamentals, TRSV infections also cause chlorotic and necrotic spots, streaks and ringspots (Samuitienė & Navalinskienė, 2001).
	Presence of asymptomatic plants	Many virus hosts may be asymptomatic, depending on the virus strain or host species and/or variety or may not exhibit symptoms in the early stages of infection, especially under low temperature conditions. In addition, plants infected with nepoviruses may exhibit symptoms recovery (Ghoshala and Sanfaçon, 2015).
	Confusion with other pathogens/pests	The geographical distribution, natural host range and vector relations of ToRSV and TRSV are closely parallel to each other (Stace-Smith, 1984 and 1985). The two viruses can be distinguished only in the laboratory by proper testing.

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Reported evidence of impact	These nepoviruses are listed as EU Quarantine pest according to Annex II, Part A of Commission Implementing Regulation (EU) 2019/2072
Pathways and evidence that the commodity is a pathway	Nepoviruses infect their hosts, including *Cornus* spp. systemically; therefore, bare-root (including dormant) and potted plants for planting coming from a country where these nepoviruses occur can be the main pathway of entry. In addition, infected nematodes may be carried over in soil attached to bare-root plants or in potted plants (EFSA PLH Panel, 2019a, 2019b)
Surveillance information	**ToRSV.** According to the information dated on 2021 from EPPO, ToRSV has a restricted presence in the UK, with only a few reported occurrences in *Pelargonium* (ornamentals). A survey in 1979–1980 found that ToRSV was distributed throughout the UK pelargonium industry, but only a small number of infected cultivars were present on individual holdings. Surveys conducted in the late 1990s found that ToRSV was present in *Pelargonium* cultivars and was found in seven nurseries across 17 varieties. Surveys conducted in the early 2000s found eight positive findings for ToRSV. Recent survey indicates that ToRSV has not been eradicated, since it has been found in pelargonium from old nursery stock plants, despite the nematode vectors responsible for transmission are not known to occur in the UK (Defra, 2018b). **TRSV.** According to the information dated on 1984 and 2018 from CABI and EPPO, TRSV has a restricted presence in UK, with only a few reported occurrences. TRSV was first reported from an outbreak of Anemone necrosis in Somerset in 1957 (Hollings, 1965). In 1979, TRSV was detected in *Pelargonium* in the UK (Stone et al. 1980), and also from amenity grasses (Cooper and Edwards, 1985). In 2011, during pre-export testing, TRSV was found on lettuce seeds originated from France. Several findings have been reported in Pelargonium stocks in the UK, results of surveys reported in the Rapid Pest Risk Analysis for TRSV indicating no evidence of eradication, despite the nematode vectors responsible for transmission are not known to occur in the UK (Defra, 2018a).

A.3.2 | Possibility of pest presence in the nursery

A.3.2.1 | Possibility of entry from the surrounding environment

ToRSV and TRSV have a wide natural host range. They are naturally transmitted by some nematode species of the *Xiphinema americanum* sensu *lato* group (EFSA PLH Panel, 2018). These species are not known to occur in UK, although there is no evidence of ToRSV and TRSV eradication (Defra, 2018). The occurrence of these viruses in the UK is restricted to ornamentals at very low levels (NPPO, 2021). Thus, there is a set of standard precautions to ensure that only certified plants are present in the production facilities. Seed and pollen transmission of these nepoviruses have been reported in some herbaceous species (Stace-Smith, 1984) but remains highly uncertain for woody hosts species (EFSA, 2019a, 2019b). Infected plants may not show symptoms, and both viruses can be established by vegetative propagation of infected mother plants. There have been no other records in the UK, on any other hosts, including *Cornus* spp.

Uncertainties:

- The presence of alternative hosts for nepoviruses in the surrounding of the nurseries.
- The presence of small undetected populations of the vectors in, *Xiphinema americanum* sensu lato group.
- The efficiency of nepoviruses transmission in woody plants including *Cornus* spp. trees.
- The efficiency of the detection and sampling strategies in detecting asymptomatic infections.

Taking into consideration the above evidence and uncertainties, the Panel considers that the possibility of entry into the nursery infecting *Cornus* spp. plants from surrounding orchards is unlikely.

A.3.2.2 | Possibility of entry with new plants/seeds

Seed purchased in the UK is not covered by a certification scheme. Seedlings sourced in the UK are certified with UK Plant Passports; seedlings from the EU countries are certified with phytosanitary certificates.

ToRSV and TRSV host range is wide, and despite some hosts can be infected asymptomatically, symptoms expression is often severe enough to ensure its detection. There is evidence that nepoviruses are capable of establishing via seed/pollen transmission in some herbaceous species (Stace-Smith, 1984; 1985) but remains highly uncertain for woody host species (EFSA, 2019a, 2019b). Nepoviruses can also spread via vegetatively propagated material.

Uncertainties:

- The efficiency of the detection and sampling strategies in detecting asymptomatic infections.
- Certification scheme applied to the seedlings.
- Seed and pollen transmission in woody plants including *Cornus* spp. trees.
- The health status of other species possibly cultivated/traded in the nurseries, including possible nematode infestation of the growing media.

Taking into consideration the above evidence and uncertainties, the Panel considers that the possibility of entry with new plants of other ornamental species must be considered.

A.3.2.3 | Possibility of spread within the nursery

Cornus spp. plants are produced in open fields and under a certification scheme in nurseries, and they are monitored and inspected during the vegetation period. Although potted plants are isolated from soil, bare-root plants are field grown. ToRSV and TRSV are naturally transmitted by some nematode species in the *X. americanum* sensu lato group (EFSA PLH Panel, 2018), which may be present in undetected populations. Also, the virus may be transmitted by pollen. However, there is a lack of data on the efficiency of pollen transmission in woody plants.

<u>Uncertainties:</u>

- Seed and pollen transmission in woody plants including *Cornus* spp. trees.
- The presence in the nursery of small undetected populations of vector species in the *X. americanum* sensu lato group.

Taking into consideration the above evidence and uncertainties, the Panel considers that the spread of the pathogen within the nursery is possible but very unlikely.

A.3.3 | Information from interceptions

In the EUROPHYT/TRACES-NT database, there are no records of interceptions of Nepoviruses on *Cornus* spp. from third countries or on any other plant from the UK.

A.3.4 | Evaluation of the risk mitigation measures

In the table below (Table A.11), all risk mitigation measures currently applied in UK are listed, and an indication of their effectiveness on nepoviruses is provided. The description of the risk mitigation measures currently applied in UK is provided in the Table 9.

TABLE A.11 Evaluation of the risk mitigation measures.

Number	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
1	Registration of production sites	Yes	All nurseries are registered as professional operator with the UK NPPO, by the Animal and Plant Health Agency (APHA) and is authorised to issue UK plant passports (Dossier Section 1.0) Evaluation: The registration of production sites is expected to contribute in reducing the phytosanitary risks within the facility Uncertainties: None
2	Certified plant material	Yes	Seeds of *C. alba* are not certified, while seeds of *C. sanguinea* purchased in the UK may be certified under the Forestry Commission's Voluntary Scheme for the Certification of Native Trees and Shrubs. Seedlings for *Cornus* spp. production sourced in the UK are certified with UK Plant Passports; seedlings from the EU countries are certified with phytosanitary certificates Evaluation: Nepoviruses can be seed transmitted in some of their host plant species. ToRSV is a quarantine pest and targeted by this measure that could reduce the infection level Uncertainties: – The details of the procedure are not clear. – If propagation material of alternative hosts is covered is not clear.
3	Certification of substrates/ (rooted plant in pots)	Yes	Rooted plants in pots: In the production or procurement of these plants, the use of growing media is assessed for the potential to harbour and transmit plant pests. Growers most commonly use virgin peat or peat-free compost, which is a mixture of coir, tree bark, wood fibre etc. The compost is heat-treated by commercial suppliers during production to eliminate pests and diseases. It is supplied in sealed bulk bags or shrink-wrapped bales and stored off the ground on pallets, these are completely hygienic and free from contamination. Where delivered in bulk, compost is kept in a dedicated bunker, either indoors or covered by tarpaulin outdoors, and with no risk of contamination with soil or other material (Dossier Section 1.0). Evaluation: The measure is efficient in preventing the entry of the pathogen via the substrate containing infected nematode vectors into the nursery Uncertainties: None
4	Surveillance, monitoring and sampling	Yes	In the last 3 years there has been a substantial level of inspection of registered *Cornus* spp. producers, both in support of the Plant Passporting scheme (checks are consistent with EU legislation, with a minimum of once a year for authorised operators) and as part of the Quarantine Surveillance programme (Great Britain uses the same framework for its surveillance programme as the EU). The Competent Authority inspects crops at least once a year to check if they meet the standards set out in the guides (Dossier Section 1.0) UK(GB) surveillance is based on visual inspection with samples taken from symptomatic material, and where appropriate, samples are also taken from asymptomatic material (e.g. plants, tubers, soil, watercourses) (Dossier Section 1.0) Evaluation: The surveillance, monitoring and sampling can detect the symptoms (if present) of the pathogen. Uncertainties: – The efficiency of the surveillance, monitoring and sampling, especially in detecting asymptomatic infections. – No results are reported.

(Continues)

TABLE A.11 (Continued)

Number	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
5	Hygiene measures	Yes	All nurseries have plant hygiene and housekeeping rules and practices in place, which are communicated to all relevant employees. The rules will be dependent on the plants handled and the type of business but will include: • Growing media • Weed management • Water usage • Cleaning and sterilisation • Waste treatment and disposal • Visitors Evaluation: These measures could be effective in reducing the risk of introduction and/or spread of the pathogens and its infected nematode vectors Uncertainties: The efficiency of the hygiene measures
6	Irrigation water quality and/or treatments	Yes	Growers are required to assess water sources, irrigation and drainage systems used in the plant production for the potential to harbour and transmit plant pests. Water is routinely sampled and sent for analysis. No quarantine pests have been found (Dossier Section 1.0). Evaluation: the irrigation water is routinely checked and this can reduce the risk via the spread of infected nematode vectors. Uncertainties: – The frequency and the method used for the detection of the nematode vectors.
7	Application of pest control products	Yes	Crop protection is achieved using a combination of measures including approved plant protection products, biological control or physical measures. Plant protection products are only used when necessary and records of all plant protection treatments are kept. (Dossier Section 1.0). Evaluation: The listed treatments are not effective against the vectors of nepoviruses. Uncertainties: None.
8	Washing of the roots (bare-root plants)	Yes	Bare-root plants are lifted from the field in winter and then root-washed on site and stored prior to export. Evaluation: The washing of the roots removes (parts of) the soil and thus also the nematode-vector of nepoviruses (if present). Uncertainties: The effectiveness of the washing to completely remove soil with the nematodes.
9	Inspections and management of plants before export	Yes	The UK NPPO carries out inspections and testing where required by the country of destination's plant health legislation, to ensure all requirements are fulfilled and a valid phytosanitary certificate with the correct additional declarations is issued. Separate to any official inspection, plant material is checked by growers for plant health issues before dispatch. Evaluation: The inspections and management of plants before export could detect the pathogen. Uncertainties: The efficiency of the inspections, especially to detect asymptomatic infections.

A.3.5 | Overall likelihood of pest freedom for *Cornus* spp. plants (bare-root and rooted plants in pots)

A.3.5.1 | Reasoning for a scenario which would lead to a reasonably low number of infected *Cornus* spp. plants (bare-root and rooted plants in pots)

- The vectors of nepoviruses in the *X. americanum* sensu lato group is not reported in UK.
- Nepoviruses are not present in the surrounding environment of the nurseries.
- Low occurrence of nepoviruses, only in UK ornamental (pelargonium) production sites with vegetative reproduction.
- There is no vegetative propagation of the *Cornus* spp. plants in the nursery.
- No reported seed transmission of nepoviruses for woody plants.
- The spreading capacity of nematodes therefore of the viruses they transmit is limited.
- The traded *Cornus* species may be resistant/tolerant (ToRSV).
- The symptoms of nepoviruses are consisted of rings on the leaves, easy to be visually detected either in field surveys and/or before export.

A.3.5.2 | Reasoning for a scenario which would lead to a reasonably high number of infected *Cornus* spp. plants (bare-root and rooted plants in pots)

- Vector species in the *X. americanum* sensu *lato* group could be present in some undetected spots in the nursery or could be imported by propagation material of other plants with soil.
- *Cornus* spp. are reported as natural hosts of nepoviruses.
- Nepoviruses have a wide host range therefore, it is highly possible that other host species are also present in the nursery.
- Nepovirus could efficiently spread via infected nematodes in the field and/or the use/exchange/spread of soil infested with infected nematodes, and/or transmission via pollen.
- ToRSV can spread via pollen in weeds and seeds.

- Asymptomatic infections are common for nepoviruses during the latent period of infection, in plants that recover with few symptoms and in dormant plants without leaves.
- Asymptomatic infections remain unnoticed in visual inspections.
- There are no surveys for nepoviruses in the surrounding environment.
- Seeds from UK and not certified and nepoviruses could be pollen and seed transmitted in *Cornus* spp.

A.3.5.3 | Reasoning for a central scenario equally likely to over-or underestimate the number of infected *Cornus* spp. plants (bare-root and rooted plants in pots) (median)

- ToRSV has not been reported in *Cornus* spp. in the UK, but only associated with the vegetative propagation of ornamental plants.
- Presence of the nematode vectors is very unlikely.
- Introduction of the virus from the surrounding areas or from propagation material within the nurseries is very unlikely.
- The scenario assumes a limited presence of the nepoviruses in the nurseries and the surroundings, and a limited susceptibility of *Cornus* spp. ToRSV is RNQP in the UK and TRSV is a quarantine pest in the UK.

A.3.5.4 | Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile/interquartile range)

The limited information on the susceptibility of *Cornus* spp. and on the unknown status of the nepoviruses in the nurseries and the surroundings results in high level of uncertainties for infestation rates below the median.

A.3.6 | Elicitation outcomes of the assessment of the pest freedom for tomato ringspot virus and tobacco ringspot virus

The elicited and fitted values for nepoviruses agreed by the Panel are shown in Tables A.12–A.15 and in Figures A.5, A.6

TABLE A.12 Elicited and fitted values of the uncertainty distribution of pest infection by tomato ringspot virus and tobacco ringspot virus per 10,000 bare-root *Cornus* spp. plants.

Percentile	1%	3%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	98%	99%
Elicited values	0					2		4		15					40
EKE	0.00269	0.0156	0.0593	0.225	0.607	1.33	2.36	5.45	10.4	13.9	18.7	24.1	30.3	35.2	40.0

Note: The EKE results are the *BetaGeneral (0.52062, 2.3955, 0, 51)* distribution fitted with @Risk version 7.6.

Based on the numbers of estimated infected bare-root *Cornus* spp. plants, the pest freedom was calculated (i.e. = 10,000 – number of infected plants per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.13.

TABLE A.13 The uncertainty distribution of plants free of tomato ringspot virus and tobacco ringspot virus per 10,000 of bare-root *Cornus* spp. plants calculated by Table A.12.

Percentile	1%	3%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	98%	99%
Values	9960					9985		9996		9998					10,000
EKE results	9960	9965	9970	9976	9981	9986	9990	9995	9997.6	9998.7	9999	9999.39	9999.94	9999.984	9999.997

Note: The EKE results are the fitted values.

TABLE A.14 Elicited and fitted values of the uncertainty distribution of pest infection by tomato ringspot virus and tobacco ringspot virus per 10,000 rooted *Cornus* spp. plants in pots.

Percentile	1%	3%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	98%	99%
Elicited values	0					1		2		3					5
EKE	0.0729	0.152	0.267	0.471	0.724	1.03	1.33	1.95	2.65	3.04	3.50	3.96	4.41	4.72	5.00

Note: The EKE results is the *BetaGeneral (1.2575,2.033, 0, 5.48)* distribution fitted with @Risk version 7.6.

Based on the numbers of estimated infected rooted *Cornus* spp. plants in pots, the pest freedom was the pest freedom was calculated (i.e. = 10,000 – number of infected plants per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.15

TABLE A.15 The uncertainty distribution of plants free of tomato ringspot virus and tobacco ringspot virus per 10,000 rooted *Cornus* spp. plants in pots calculated by Table A.14.

Percentile	1%	3%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	98%	99%
Values	9995					9997		9998		9999					10,000
EKE results	9995	9995	9995.6	9996	9996.5	9997	9997.4	9998	9998.7	9999	9999.3	9999.5	9999.7	9999.8	9999.93

Note: The EKE results are the fitted values.

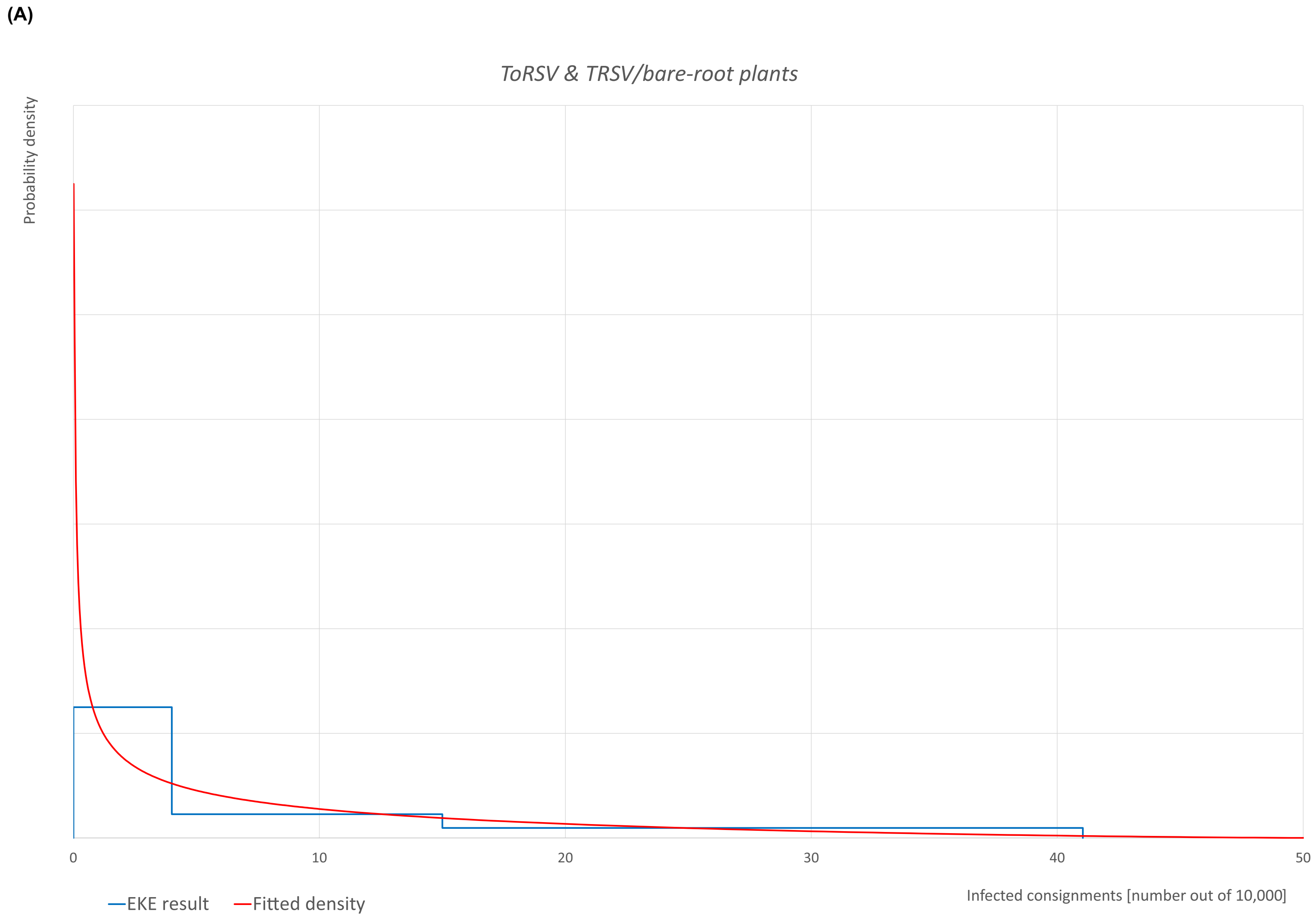

FIGURE A.5 (Continued)

(B)

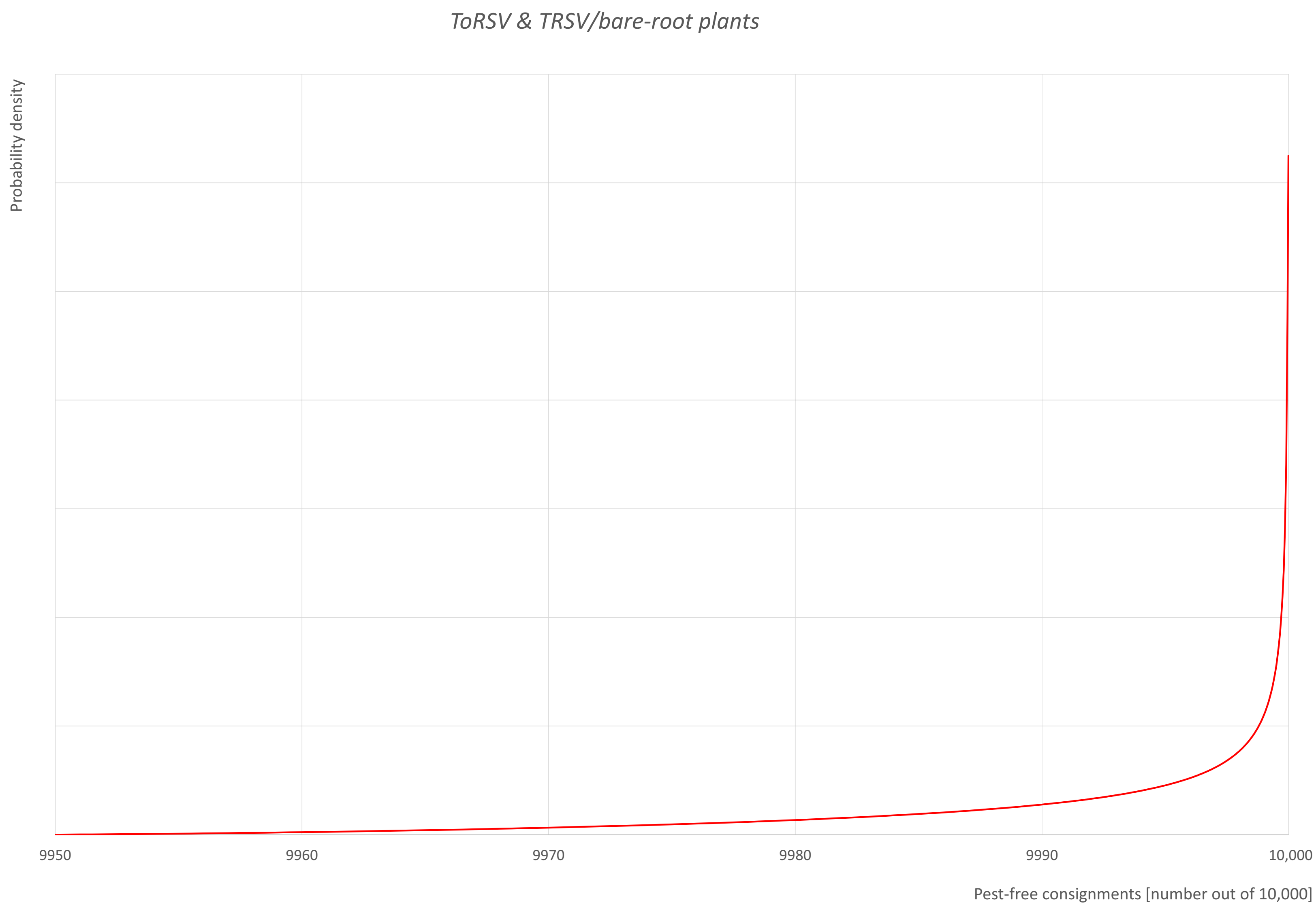

FIGURE A.5 (Continued)

(C)

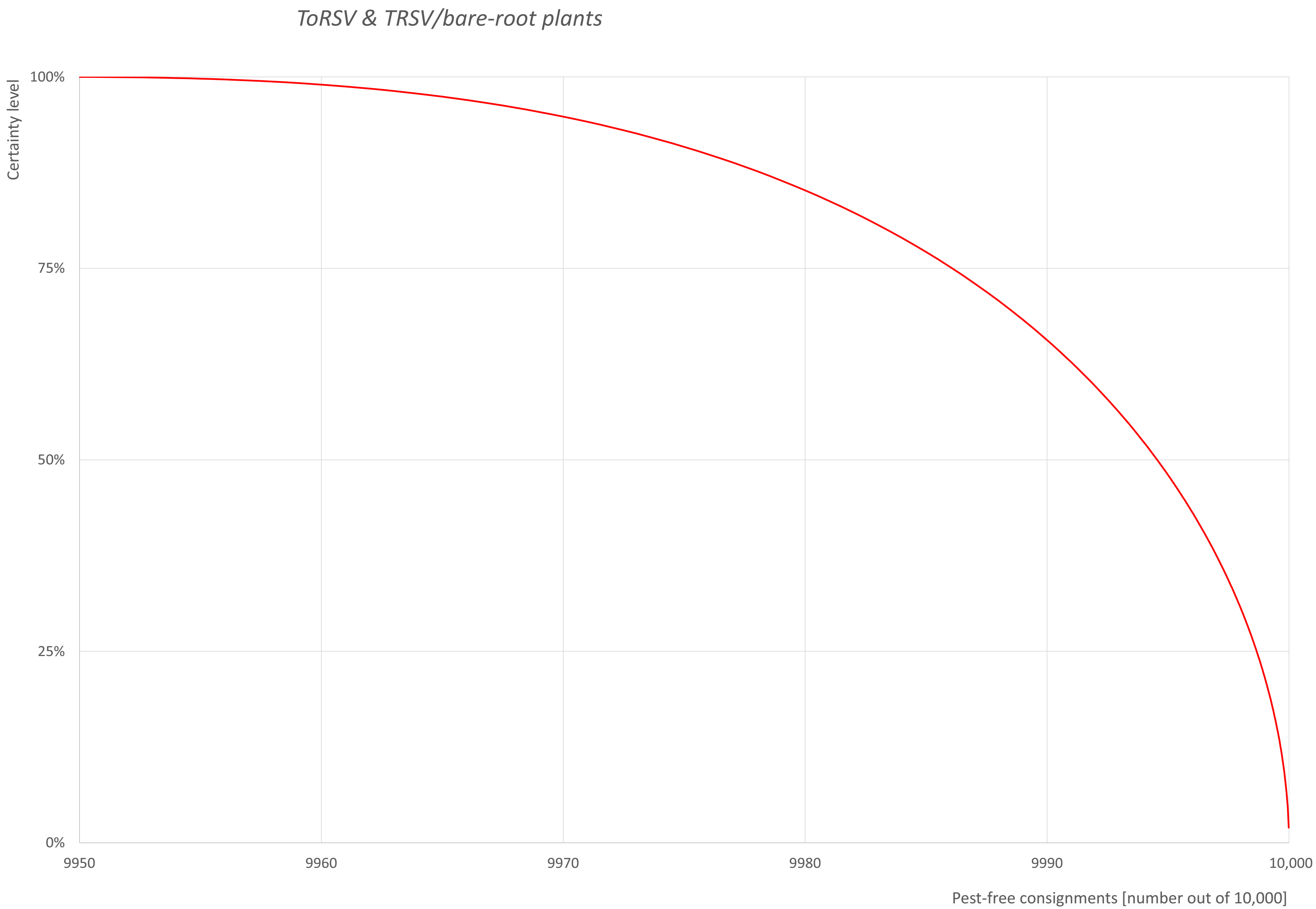

FIGURE A.5 (A) Elicited uncertainty of pest infection per 10,000 bare-root plants *Cornus* spp. (histogram in blue–vertical blue line indicates the elicited percentile in the following order: 1%, 25%, 50%, 75%, 99%) and distributional fit (red line); (B) uncertainty of the proportion of pest-free plants per 10,000 (i.e. = 1 – pest infection proportion expressed as percentage); (C) descending uncertainty distribution function of pest infection per 10,000 plants.

(A)

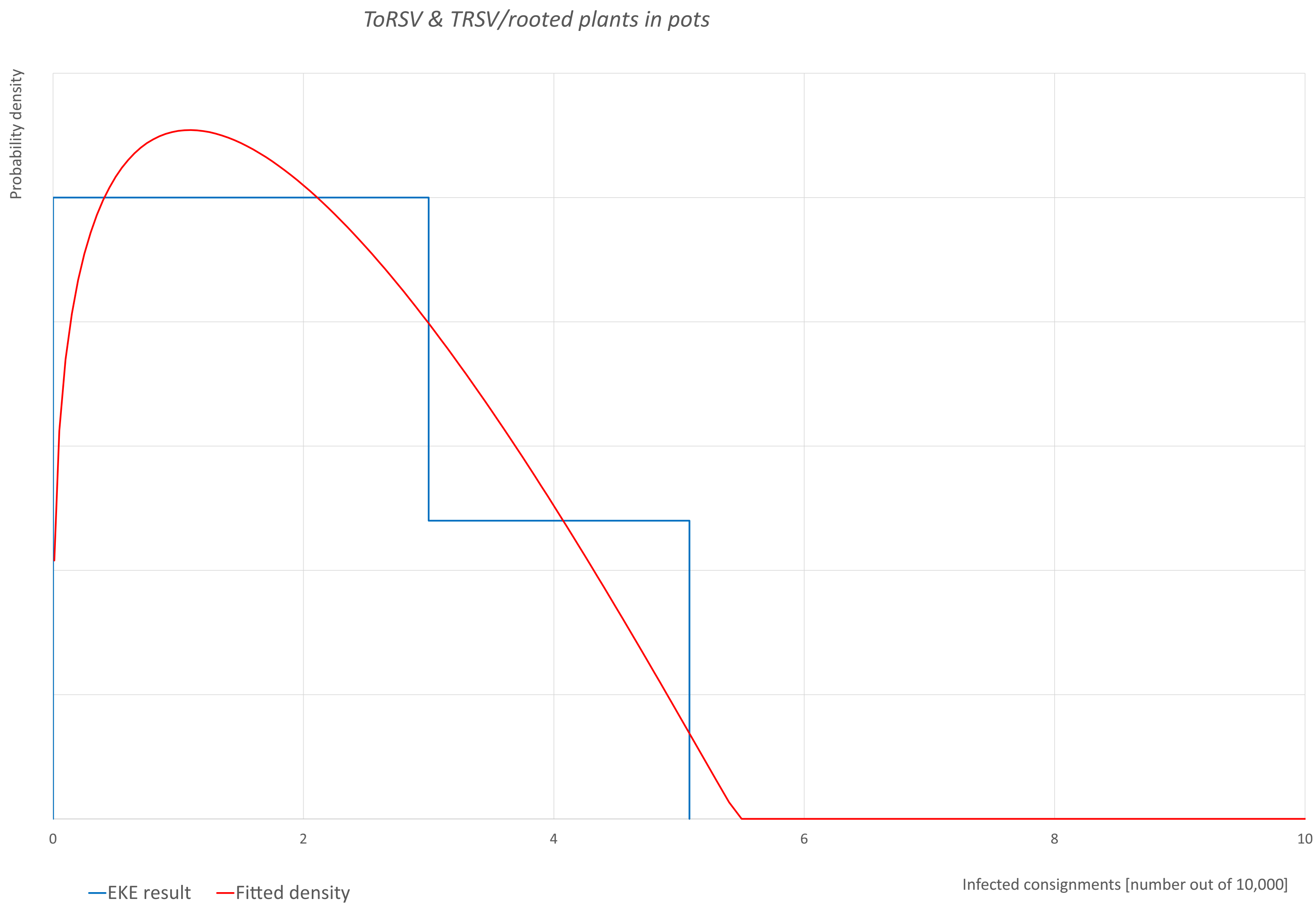

FIGURE A.6 (Continued)

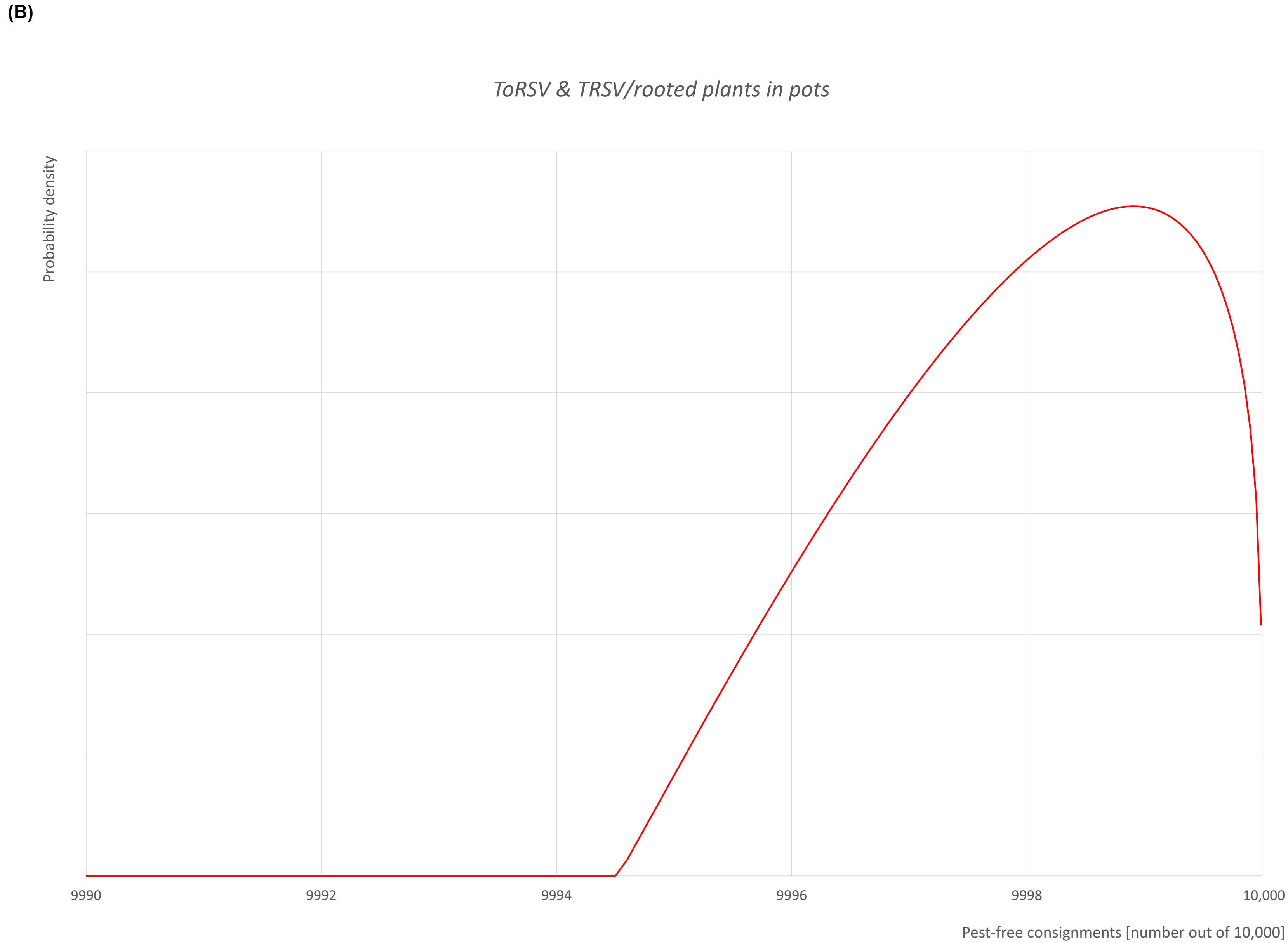

FIGURE A.6 (Continued)

(C)

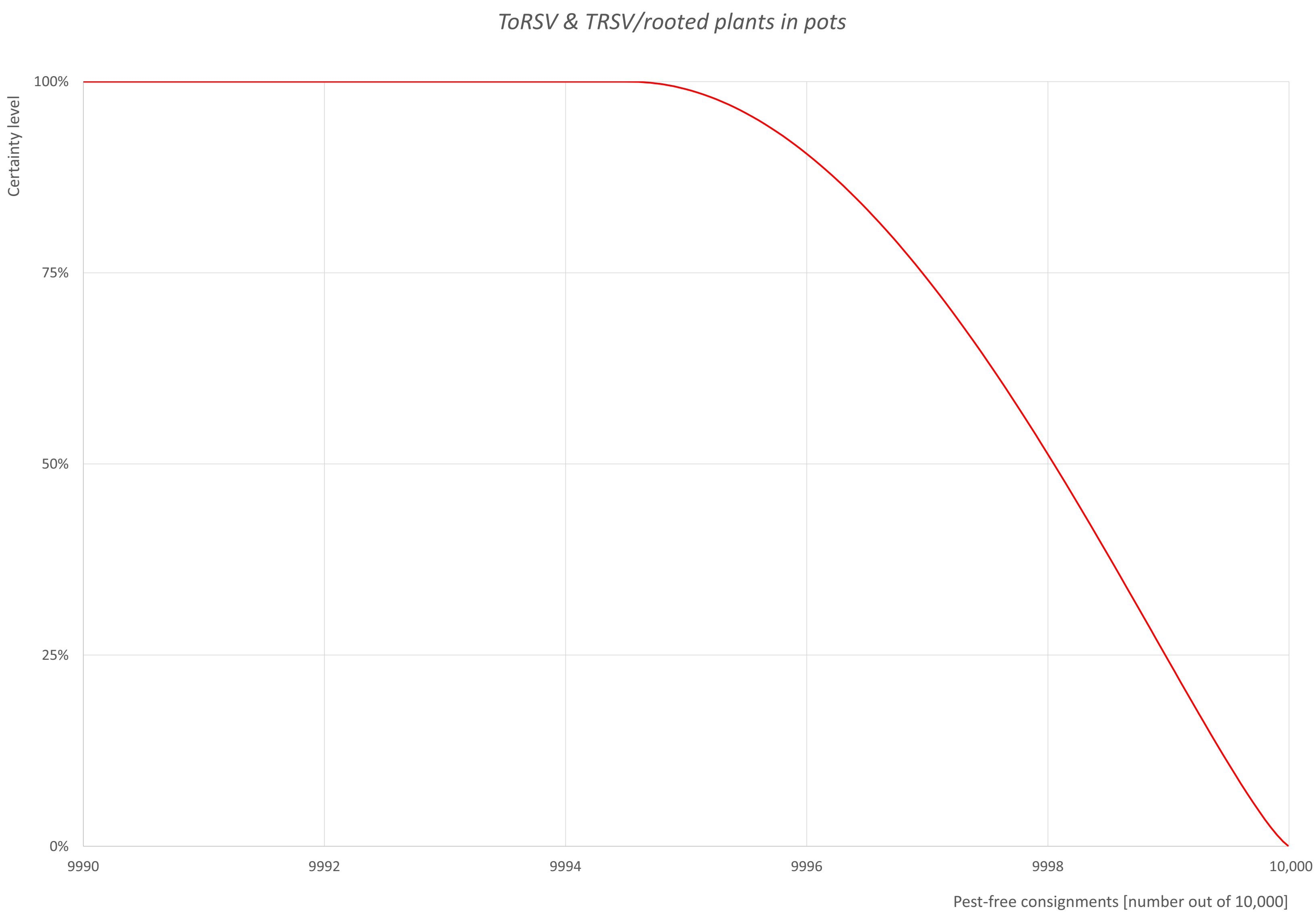

FIGURE A.6 (A) Elicited uncertainty of pest infection per 10,000 rooted *Cornus* spp. plants in pots (histogram in blue–vertical blue line indicates the elicited percentile in the following order: 1%, 25%, 50%, 75%, 99%) and distributional fit (red line); (B) uncertainty of the proportion of pest-free plants per 10,000 (i.e. = 1 – pest infection proportion expressed as percentage); (C) descending uncertainty distribution function of pest infection per 10,000 plants.

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A.4 | *DISCULA DESTRUCTIVA*

A.4.1 | Organism information

Taxonomic information	Current valid scientific name: *Discula destructiva* Redlin (1991) (Index Fungorum, https://www.speciesfungorum.org/Names/SynSpecies.asp?RecordID=355233) Synonyms: – Name used in the EU legislation: – Order: Diaporthales Family: Gnomoniaceae Common name: Dogwood anthracnose Name used in the Dossier: *Discula destructiva*
Group	Fungi
EPPO code	DISCDE
Regulated status	The pest is not regulated in the EU territory and not listed in Commission Implementing Regulation (EU) 2019/2072 Formerly listed in the EPPO Alert List (2003–2007)
Pest status in UK	Present, widespread (EPPO, CABI; online)

(Continues)

(Continued)

Pest status in the EU	Present in Germany (few occurrences) and in Italy (restricted distribution) (EPPO, CABI; online)	
Host status on *Cornus* spp.	*Cornus florida* (flowering dogwood) and *C. nuttallii* (Pacific dogwood) are the main hosts of *D. destructiva* and particularly susceptible. *Cornus kousa*, *C. alternifolia* and *C. amomum* are reported as relatively resistant hosts (Sherald et al., 1994), *Cornus mas* is considered resistant host (Stinzing and Lam, 2003).*C. alba* is mentioned as a host species by CABI (online), and Brown et al. (1996). There is no information about the host status of *C. sanguinea* Uncertainties: the host status of *C. sanguinea*	
PRA information	EPPO (2005) Pest risk analysis *Discula destructiva (draft)* https://pra.eppo.int/pra/849c2c2f-939e-48dd-bcd4-9852aeb9c4b6	
Other relevant information for the assessment		
Biology	The fungus may remain in a dormant stage for extended periods in leaves, twigs, leaf debris and branches (Baysal-Gurel et al., 2017). *D. destructiva* persists in cankers on the trunks and branches of its hosts, or in twigs or dead leaves carrying conidiomata. *D. destructiva* produces acervuli and subcuticular conidiomata on leaves and twigs of the host. Conidia are ellipsoidal and non-septate (Daughtrey and Hibben, 1994; Daughtrey et al., 1996). The sexual state of the fungus is unknown (Redlin, 1991). Conidia formed in conidiomata (acervuli) on cankers are dispersed by rain-splashing to newly expanded leaves during the spring, that are infected under humid conditions (CABI, 2020). Fruiting structures of *D. destructiva* form underneath leaf spots and on the surface of twig cankers. Huge amounts of conidia are formed inside and, in the spring, ooze out in slimy beige clusters. Short distance dispersal of the conidia occurs via rain splash. For long-distance dispersal, Colby et al. (1996) demonstrated that the coccinellid, *Hippodamia convergens* can transport viable conidia of *D. destructiva* externally for as many as 16 days under laboratory conditions. Several other species of arthropods have been found with viable conidia of the fungus in a natural environment in periods with humidity and cool temperatures. Of them, curculionids, formicids, hemipterans, homopterans and immature and adult orthopterans are mobile enough to move from tree to tree (Holt et al., 1998). Infected seeds could provide a mechanism for long-distance dispersal of *D. destructiva* by animals or birds by consuming infected fruits and excreting the seeds (Britton et al., 1993; Cornell University, Plant Disease Diagnostic Clinic, 2015). The fungus survives the winter in the host and leaf symptoms generally begin to occur in the early spring of the next year (Daughtrey and Hibben, 1994). Lesions on the leaves may remain as small spots, expand to form larger blotches or lead to the complete blighting of the leaf, spreading into the petiole and result in the infection of the shoot. At flowering, bracts are also infected. Conidia may infect the current season's shoots directly, forming small cankers which are usually rapidly delimited by callus tissue. However, shoots infected from previously blighted leaves develop more severe cankering and die back (CABI, online). The shoot dieback often results in the development of epicormic shoots on both branches and trunk, which become infected in turn. In cases of severe infection, young trees may die but, if conditions become less favourable for disease development in subsequent seasons, branch and trunk cankers may be contained and the tree recovers. *D. destructiva* is slow growing in culture and the identification process may take more than 2 weeks. It does not sporulate readily in conventional media, making morphological identification challenging (Daughtrey and Hibben, 1994). The optimal growth and sporulation in culture is at 21–24°C, with no growth occurring at 27°C. Infection is favoured by cool, wet spring and autumn, but can occur throughout the growing season. Predisposing factors for infection include low light intensity and drought stress (Daughtrey and Hibben, 1994, 1996; Erbaugh et al., 1995)	
Symptoms	**Main type of symptoms**	Initial symptoms include small leaf spots with a purple margin, which then progress into large necrotic blotches. In many cases, infected mature leaves die prematurely. Sometimes, they can remain attached to the stems after the usual leaf fall. Infection expands from leaves to small twigs and then to branches (CABI, online). Infected shoots show fruiting bodies of the fungus on the dead tissue. Twig and branch dieback start in the lower crown (hence the original name of the disease 'lower branch dieback'). Numerous epicormic shoots often form at the base of the trunk or on branches of infected plants. These shoots frequently become infected and die, with infections advancing from the shoots into the trunk. *D. destructiva* causes cankers which can kill the tree. Cankers may not be present on all dead trees (Anderson et al., 1994). The fungus can kill dogwoods of all sizes, but it is particularly severe on young seedlings and in understorey forest dogwoods. Infection of dogwoods is most likely to occur during cool, wet weather in spring and fall, but can occur at any time during the growing season. Ornamentals especially those in open, sunny sites, may be disfigured without necessarily being killed (Anderson et al., 1994; Mielke and Daughtrey, 1989)
	Presence of asymptomatic plants	Plants may be infected with the pathogen without exhibiting visible and conspicuous signs or symptoms of the disease. The fungus survives in the form of latent overwintering structures (conidiomata) on wood. The fungus may persist in a dormant stage for extended periods in aerial plant parts before the infection becomes visible and the presence of the pathogen detected (Baysal-Gurel et al., 2017)
	Confusion with other pathogens/ pests	In the early stages of the disease, the symptoms can be confused with: 1. Spot anthracnose, caused by *Elsinoe corni* 2. Leaf spots, caused by *Septoria cornicola* 3. The dogwood twig borer *Oberea tripunctata* (Swederus) 4. Mechanical injuries and drought (Anderson et al., 1994). *D. destructiva* was initially confused with the anamorph of *Glomerella cingulata*, already well known on this host. Various other fungi that cause leaf spots on *Cornus* (*Elsinoë corni*, species of *Septoria*, *Ascochyta cornicola*, *Botryotinia fuckeliana*), can be easily distinguished microscopically (CABI, online) or using molecular methods

(Continued)

Host plant range	The host plant range of the fungus includes: *Cornus alba* (red-barked dogwood), *Cornus controversa* (giant dogwood), *Cornus sericea* (red osier dogwood) and *Cornus stolonifera* (CABI, online)
Evidence that the commodity can be a pathway	Plant parts liable to carry the hyphae or conidia of the fungus are leaves, twigs and branches. Therefore, it is possible that the exported bare-root plants or potted plants of *Cornus* spp. can act as a pathway for *D. destructiva* Several records confirm that *Cornus* spp. are hosts of *D. destructiva*. Plants for planting or plant parts (wood, fruit, seeds), nursery stock and propagation material originated from infested areas are could carry the fungus via trade and transport (Daughtrey et al. 1996; Holt et al. 1998). The infection of plants and movement of infected tissues ensures the long-distance dispersal of the pathogen. *D. destructiva* can be disseminated through conidia on all aerial plant parts. Conidia production can be accelerated by rain and humidity (e.g. CABI, online; Redlin, 1991; Smith, 2021)
Reported evidence of impact	In the USA, a significant proportion of woodland dogwood populations has been killed. The disease now presents a considerable problem for nursery production of healthy plants (CABI, online)
Surveillance information	According to the Dossier Section 1.0, *D. destructiva* is not under official surveillance, and has no quarantine pest status in UK

A.4.2 | Possibility of pest presence in nursery

A.4.2.1 | Possibility of entry from the surrounding environment

Considering that the pathogen has widespread distribution in the UK (EPPO, 2022) and hosts *Cornus* spp. (native or cultivated) are present, it is likely that the fungus could be present in the neighbouring environment of the nursery and enters the nursery mainly via insects or seeds who can transmit the fungus. Several species of arthropods are known to contribute to the spread of dogwood anthracnose, that can acquire and transport even for long distances viable conidia of *D. destructiva*. Assuming that there are no host plants present directly connected with the nursery that can act as an inoculum reservoir of the fungus, the main pathway of entry of the fungus from the surrounding environment is through insects.

Uncertainties:

The possible role of insects as vector of the disease. The possibility that wind-driven rain splash or aerial dispersal from host plants in the environment reach the nurseries.

A.4.2.2 | Possibility of entry with new plants/seeds

Infected seed could be a pathway.

Infected asymptomatic seedlings introduced into the nurseries can also be a pathway. The fungus has no regulatory status in the UK and therefore there are no compulsory testing for this fungus. Latent, asymptomatic infections are likely to occur in the propagating plant material and *D. destructiva* could not be detected. In addition, infection or infestation of seeds are not visible or easy to detect.

Uncertainties:

The detection of the asymptomatic infections in the propagation material.

A.4.2.3 | Possibility of spread within the nursery

If *D. destructiva* has entered into the nursery the pathogen can spread to other plants through dispersal of conidia. Conidia can be dispersed from infected to healthy plant tissues via splash of water during irrigation or currents of air inside the nursery. If the environmental conditions (relative humidity and temperature) are favourable for disease development the pathogen thrives and spreads the disease.

Planting of infected seeds, movement of soil with plant debris with fruiting bodies, deficient insect control, workers and tools may also contribute to the spread of the pathogen.

Removal of symptomatic material would reduce the availability of inoculum reducing the probability of disease spread. Furthermore, the spread of the disease could be reduced if non-host plants are grown in the nursery.

Uncertainties:

There is uncertainty on the duration of a possible latent stage of the fungus and the early detection of *D. destructiva* on infected tissues.

The proportion of host plants grown in the nurseries is not known.

The proportion of host plants grown in the nurseries is not known.

A.4.3 | Information from interceptions

There were no interceptions of *Discula destructiva* on commodities imported into the EU Member States from third countries (EUROPHYT and TRACES, online, [Accessed: 22 November 2023]). The disease in EPPO region was intercepted in 1995 by United Kingdom on imported *Cornus florida* from USA (EPPO, 2007).

A.4.4 | Evaluation of the risk mitigation measures

In the table below (Table A.16), all risk mitigation measures currently applied in the UK are listed and an indication of their effectiveness on *D. destructiva* is provided. The description of the risk mitigation measures currently applied in the UK is provided in Table 9.

TABLE A.16 Evaluation of the risk mitigation measures.

Number	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
1	Registration of production sites	Yes	All nurseries are registered as professional operator with the UK NPPO, by the Animal and Plant Health Agency (APHA) and is authorised to issue UK plant passports (Dossier Section 1.0) Evaluation: The registration of production sites is expected to contribute to reducing the phytosanitary risks within the facility Uncertainties: None
2	Certified plant material	Yes	Seeds of *C. alba* are not certified, while seeds of *C. sanguinea* seed purchased in the UK may be certified under the Forestry Commission's Voluntary Scheme for the Certification of Native Trees and Shrubs. Seedlings for Cornus production sourced in the UK are certified with UK Plant Passports; seedlings from the EU countries are certified with phytosanitary certificates Evaluation: *D. destructiva* is not a quarantine and therefore there are no compulsory testing for this fungus. Seeds and seedlings can be a pathway Uncertainties: The duration of the asymptomatic phase in seedlings
3	Certification of substrates/ (rooted plant in pots)	No	Rooted plants in pots: In the production or procurement of these plants, the use of growing media is assessed for the potential to harbour and transmit plant pests. Growers most commonly use virgin peat or peat-free compost, which is a mixture of coir, tree bark, wood fibre etc. The compost is heat-treated by commercial suppliers during production to eliminate pests and diseases. It is supplied in sealed bulk bags or shrink-wrapped bales and stored off the ground on pallets, these are completely hygienic and free from contamination. Where delivered in bulk, compost is kept in a dedicated bunker, either indoors or covered by tarpaulin outdoors, and with no risk of contamination with soil or other material (Dossier Section 1.0)
4	Surveillance, monitoring and sampling	Yes	In the last 3 years there has been a substantial level of inspection of registered Cornus producers, both in support of the Plant Passporting scheme (checks are consistent with EU legislation, with a minimum of once a year for authorised operators) and as part of the Quarantine Surveillance programme (Great Britain uses the same framework for its surveillance programme as the EU). The Competent Authority inspects crops at least once a year to check if they meet the standards set out in the guides (Dossier Section 1.0) Evaluation: The fungus has no quarantine status in UK and in the EU Uncertainties: It is not clear if the inspection of registered *Cornus* spp. producers include and will report this pathogen
5	Hygiene measures	Yes	All nurseries have plant hygiene and housekeeping rules and practices in place, which are communicated to all relevant employees. The rules will be dependent on the plants handled and the type of business but will include: • Growing media • Weed management • Water usage • Cleaning and sterilisation • Waste treatment and disposal • Visitors Evaluation: Pruning, water usage and waste treatment and disposal of plant residues measures could be effective in reducing the risk of introduction and/or spread of the pathogen. Uncertainties: The application and efficiency of the hygiene measures

TABLE A.16 (Continued)

Number	Risk mitigation measure	Effect on the pest	Evaluation and uncertainties
6	Irrigation water quality and/or treatments	No	Growers are required to assess water sources, irrigation and drainage systems used in the plant production for the potential to harbour and transmit plant pests. Water is routinely sampled and sent for analysis. No quarantine pests have been found (Dossier Section 1.0) Evaluation: Only the type of irrigation applied (overhead or sub-irrigation) is relevant for the spread of the pathogen Uncertainties: None
7	Application of pest control products	Yes	Crop protection is achieved using a combination of measures including approved plant protection products, biological control or physical measures. Plant protection products are only used when necessary and records of all plant protection treatments are kept. (Dossier Section 1.0). Evaluation: – Combination of systemic and contact fungicides are used. – Fungicides are used as both preventive and curative purpose, depending on the situation. Uncertainties: The efficacy of the treatment on the pathogen is unknown
8	Washing of the roots (bare-root plants)	No	Bare-root plants are lifted from the field in winter and then root-washed on site and stored prior to export
9	Inspections and management of plants before export	Yes	The UK NPPO carries out inspections and testing where required by the country of destination's plant health legislation, to ensure all requirements are fulfilled and a valid phytosanitary certificate with the correct additional declarations is issued. Separate to any official inspection, plant material is checked by growers for plant health issues before dispatch. Evaluation: The inspections and management of plants before export can detect the disease only in symptomatic plants (symptoms on branches or stems/trunks). Uncertainties: – The efficiency of the inspections. – The possibility of detecting asymptomatic infected plants, symptoms on dormant plants and initial symptoms on branches and stems/trunks are unknown

A.4.5 | Overall likelihood of pest freedom for *Cornus* spp. plants (bare-root and rooted plants in pots)

A.4.5.1 | Reasoning for a scenario which would lead to a reasonably low number of infected *Cornus* spp. plants (bare-root and rooted plants in pots)

- The pathogen occurs only on a few *Cornus* species, where *C. alba* is a confirmed host but not a major host and while *C. sanguinea* is less susceptible.
- There is high proportion of *C. sanguinea* (less susceptible) plants than *C. alba*.
- The pathogen is widespread in the UK, but there is either a low pest pressure in the surroundings or that *Cornus* species are less susceptible to this pathogen.
- The pathogen can spread only short distances by rain splash and there is no spread of the pathogen by insects.
- In Spring, the infections develop visible symptoms on leaves and cankers are also present.
- There is a regular monitoring for this pathogen.
- Seedlings are partly sourced from the EU.
- The combination of systemic and contact fungicides are effective against the leaf asymptomatic and symptomatic infections.
- The nurseries are protected by the hedges that can reduce the risk of pathogen spread from the environment.
- The drip system of irrigation is used.
- Leaves on top of the soil are cleaned before export and official inspections before export are carried out and the symptoms of the infection are visible.

A.4.5.2 | Reasoning for a scenario which would lead to a reasonably high number of infected *Cornus* spp. plants (bare-root and rooted plants in pots)

- All *Cornus* spp. are hosts for this pathogen and are widespread in UK (*C. sanguinea* less than *C. alba*).
- There is high proportion of *C. alba* plants than *C. sanguinea* (less susceptible).
- The pathogen is widespread in the UK with high pest pressure and the *Cornus* species are tolerant.

- The pathogen spreads to long distances by insects, seeds and birds.
- Latent or late (in autumn) infections occur without visible symptoms.
- The symptoms may not develop visible symptomatic infections for longer time, and there can be confused with symptoms induced by other fungi.
- The latent and late infections may be overlooked.
- The seedlings can be asymptomatic and there is no obligatory testing.
- The fungicides are not effective against cankers and the curative applications are not effective.
- The pathogen can spread from the close environment via the wind or rain.
- The overhead irrigation system is used (can spread the inoculum).
- Infected debris can be on the soil.
- Official inspections before export are carried out but asymptomatic plants, infections on dormant plants and early infections on branches and stems maybe overlooked.

A.4.5.3 | Reasoning for a central scenario equally likely to over-or underestimate the number of infected *Cornus* spp. plants (bare-root and rooted plants in pots) (median)

The scenario assumes a limited presence of the pest in the nurseries and the surroundings. As there are no reports of impact in the UK, the pest pressure may not be so high. *C. alba* is a poor host and *C. sanguinea* is not a host and the nursery is protected by hedges. The symptoms on the leaves should make the detection easy.

A.4.5.4 | Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile/interquartile range)

The limited information on the status of the *D. destructiva* in the nurseries and the surroundings results in high level of uncertainties for infestation rates below the median.

A.4.6 | Elicitation outcomes of the assessment of the pest freedom for *Discula destructiva*

The elicited and fitted values for *D. destructiva* agreed by the Panel are shown in Tables A.17–A.20 and in Figures A.7, A.8.

TABLE A.17 Elicited and fitted values of the uncertainty distribution of pest infection by *D. destructiva* per 10,000 bare-root *Cornus* spp. plants.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Elicited values	3					10		20		40					100
EKE	3.00	3.26	3.77	4.99	6.90	9.65	12.8	20.8	31.8	39.2	49.1	60.6	74.5	86.6	100

Note: The EKE results is the *BetaGeneral (0.82642, 4.4331, 2.87, 160)* distribution fitted with @Risk version 7.6.

Based on the numbers of estimated infected bare-root *Cornus* spp. plants, the pest freedom was calculated (i.e. = 10,000 – number of infected plants per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.18.

TABLE A.18 The uncertainty distribution of plants free of *D. destructiva* per 10,000 bare-root *Cornus* spp. plants calculated by Table A.17.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Values	9900					9960		9980		9990					9997
EKE results	9900	9913	9925	9939	9951	9961	9968	9979	9987	9990	9993	9995	9996.2	9996.7	9997

Note: The EKE results are the fitted values.

TABLE A.19 Elicited and fitted values of the uncertainty distribution of pest infection by *D. destructiva* per 10,000 rooted *Cornus* spp. plants in pots.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Elicited values	3.0					15.0		30.0		50.0					150.0
EKE	3.00	4.02	5.46	8.03	11.3	15.3	19.5	29.3	42.1	50.9	63.0	77.9	97.8	117	143

Note: The EKE results is the *BetaGeneral (1.3478, 377.97, 1.99, 10,000)* distribution fitted with @Risk version 7.6.

Based on the numbers of estimated infected rooted *Cornus* spp. plants in pots, the pest freedom was calculated (i.e. = 10,000 – number of infected plants per 10,000). The fitted values of the uncertainty distribution of the pest freedom are shown in Table A.20.

TABLE A.20 The uncertainty distribution of plants free of *D. destructiva* per 10,000 rooted *Cornus* spp. plants in pots calculated by Table A.19.

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Values	9850					9950		9970		9985					9997
EKE results	9857	9883	9902	9922	9937	9949	9958	9971	9980	9985	9989	9992	9995	9996	9997

Note: The EKE results are the fitted values.

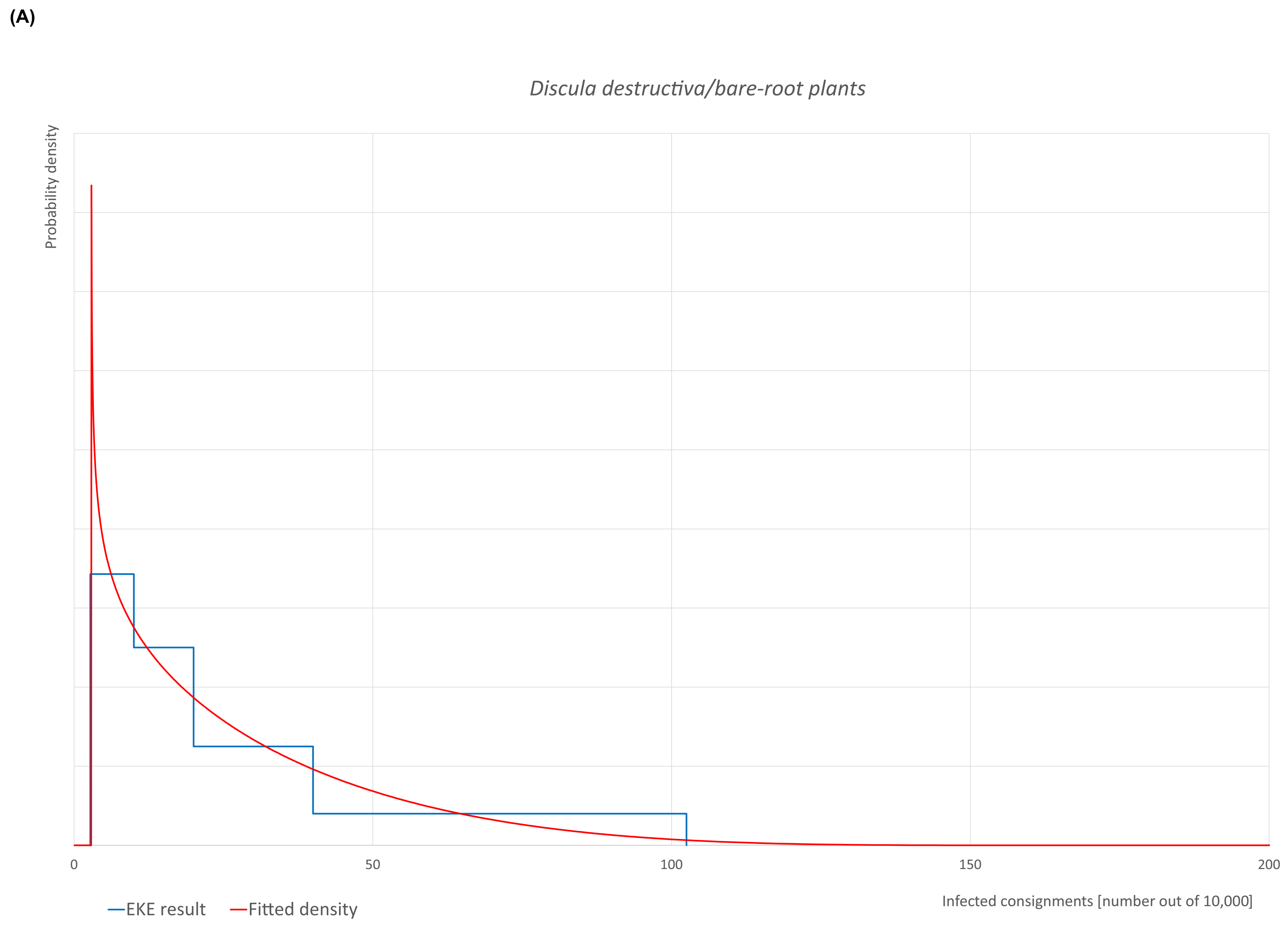

FIGURE A.7 (Continued)

(B)

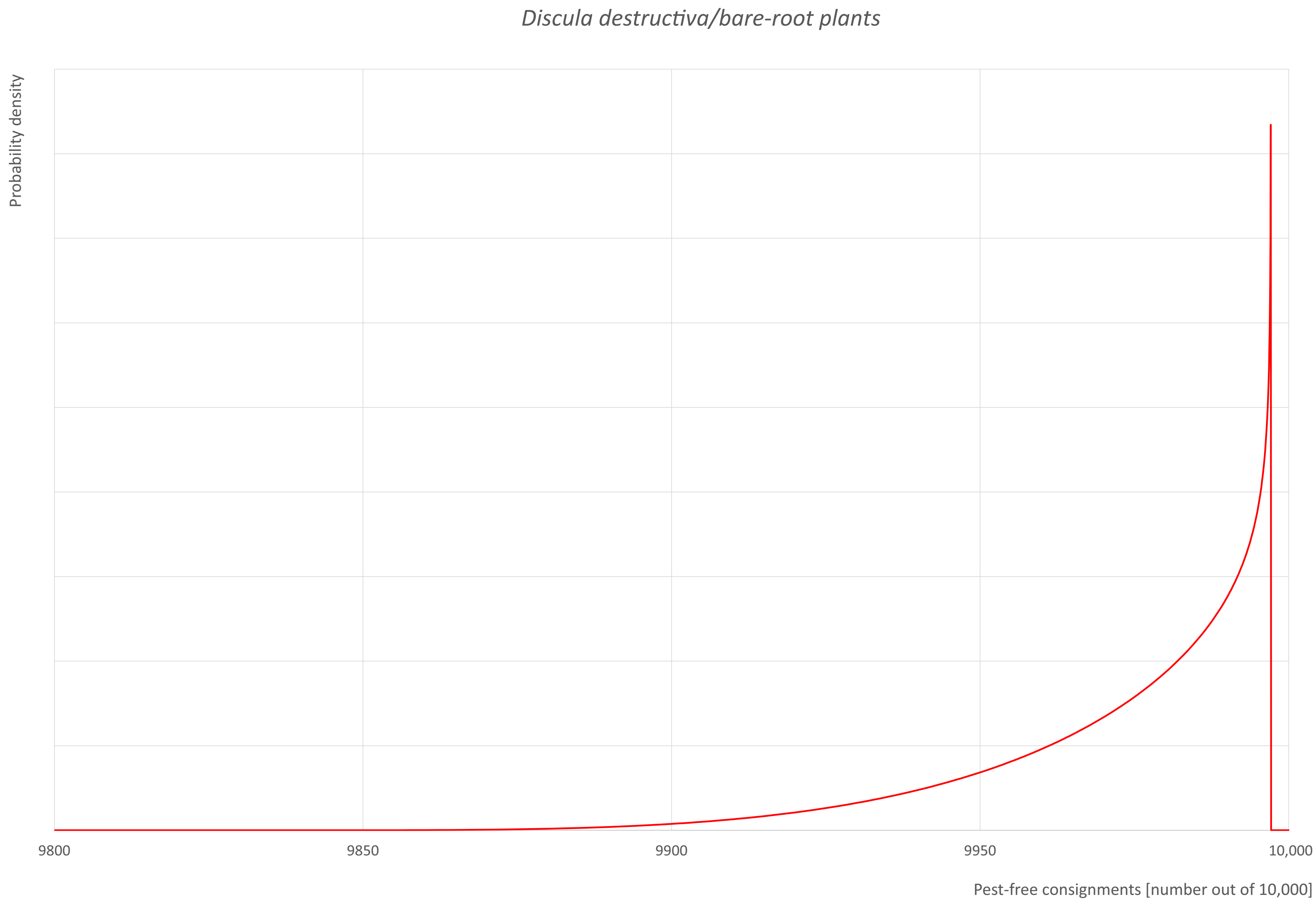

FIGURE A.7 (Continued)

(C)

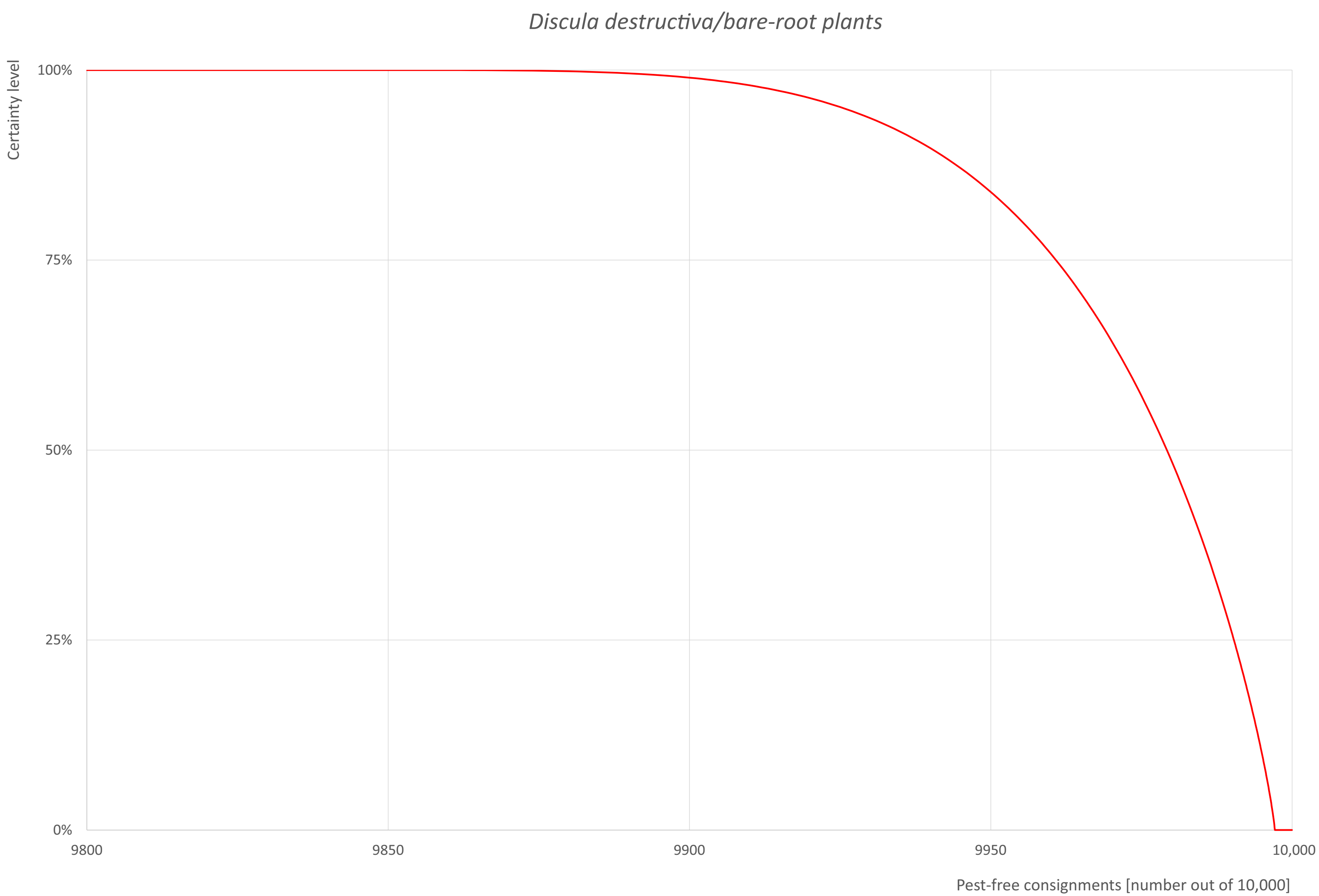

FIGURE A.7 (A) Elicited uncertainty of pest infection per 10,000 bare-root *Cornus* spp. plants (histogram in blue–vertical blue line indicates the elicited percentile in the following order: 1%, 25%, 50%, 75%, 99%) and distributional fit (red line); (B) uncertainty of the proportion of pest-free plants per 10,000 (i.e. = 1 – pest infection proportion expressed as percentage); (C) descending uncertainty distribution function of pest infection per 10,000 plants.

(A)

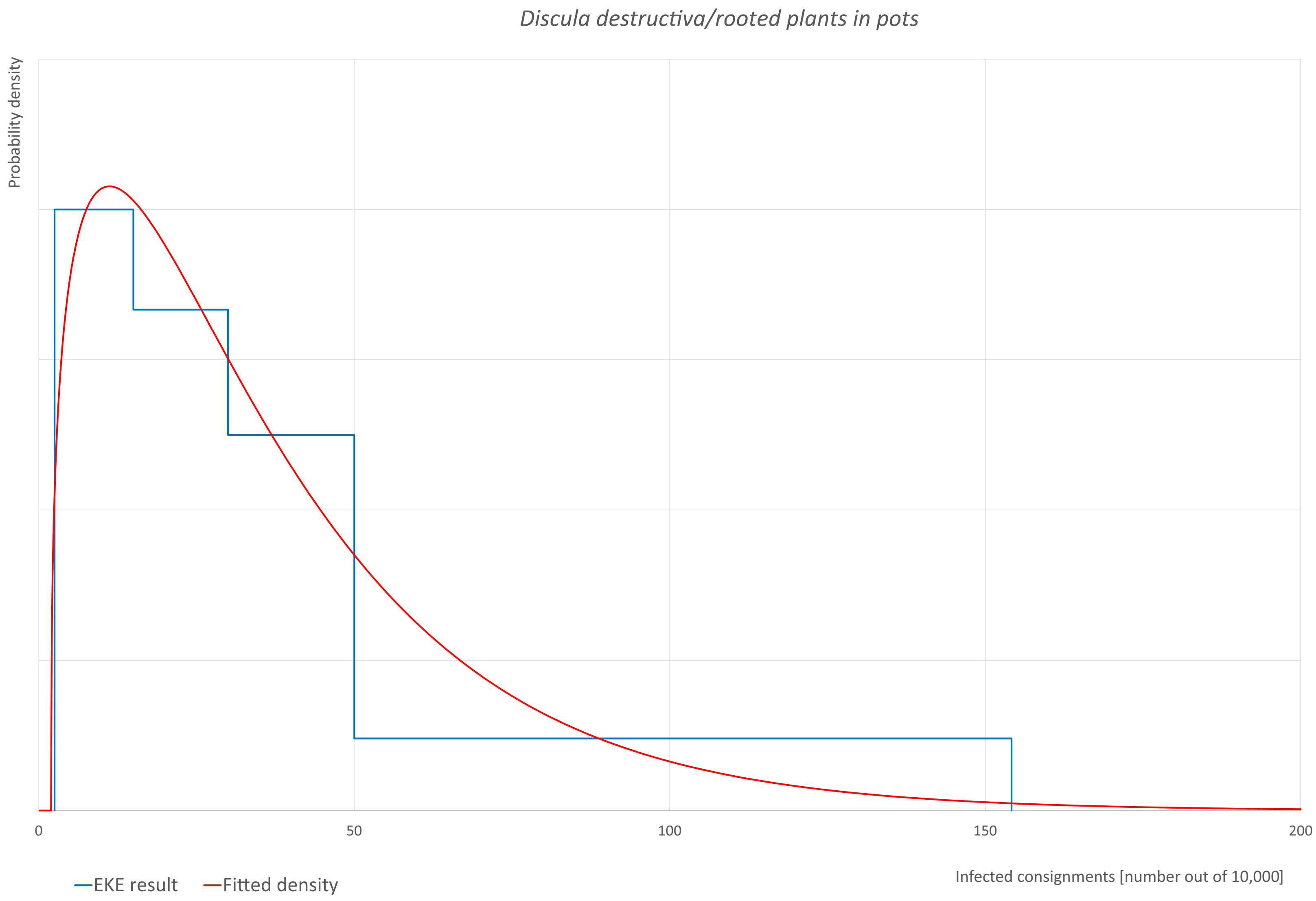

FIGURE A.8 (Continued)

(B)

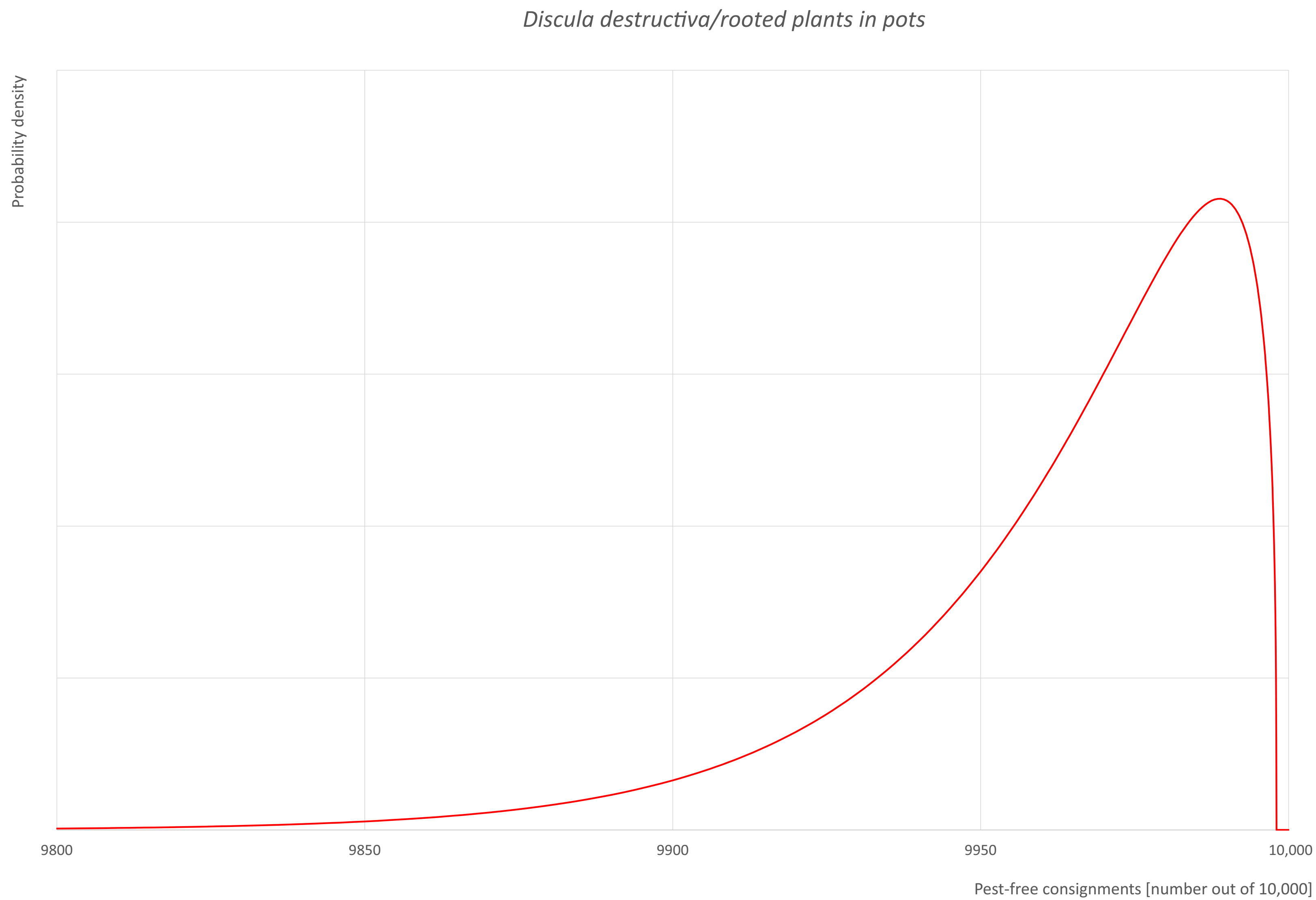

FIGURE A.8 (Continued)

(C)

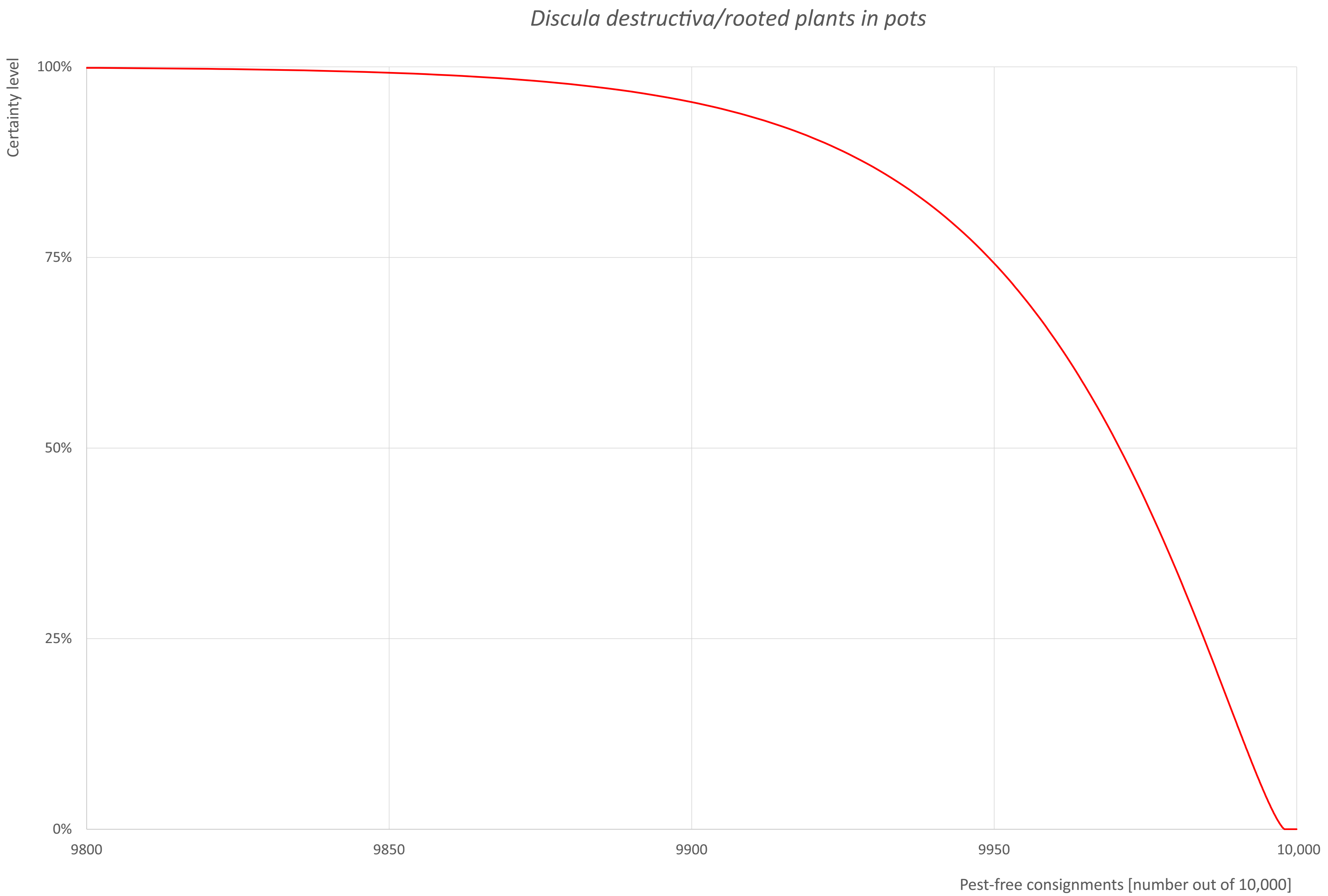

FIGURE A.8 (A) Elicited uncertainty of pest infection per 10,000 rooted *Cornus* spp. plants in pots (histogram in blue–vertical blue line indicates the elicited percentile in the following order: 1%, 25%, 50%, 75%, 99%) and distributional fit (red line); (B) uncertainty of the proportion of pest-free plants per 10,000 (i.e. = 1 – pest infection proportion expressed as percentage); (C) descending uncertainty distribution function of pest infection per 10,000 plants.

A.4.7 | References

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APPENDIX B

Web of Science all databases search string

In the table below, the search string for Cornus used in Web of Science is reported. Totally, 596 papers were retrieved. Titles and abstracts were screened, and 28 pests were added to the list of pests (see Appendix C) (Table B.1).

TABLE B.1 String for *Cornus*.

Web of Science All databases	**TOPIC:** ("*Cornus*" OR "dogwood") AND **TOPIC:** ("pathogen*" OR "pathogenic bacteria" OR "fung*" OR "oomycet*" OR "myce*" OR "bacteri*" OR "virus*" OR "viroid*" OR "insect$" OR "mite$" OR "phytoplasm*" OR "arthropod*" OR "nematod*" OR "disease$" OR "infecti*" OR "damag*" OR "symptom*" OR "pest$" OR "vector" OR "hostplant$" OR "host plant$" OR "host" OR "root lesion$" OR "decline$" OR "infestation$" OR "damage$" OR "symptom$" OR "dieback*" OR "die back*" OR "malaise" OR "aphid$" OR "curculio" OR "thrip$" OR "cicad$" OR "miner$" OR "borer$" OR "weevil$" OR "plant bug$" OR "spittlebug$" OR "moth$" OR "mealybug$" OR "cutworm$" OR "pillbug$" OR "root feeder$" OR "caterpillar$" OR "foliar feeder$" OR "virosis" OR "viruses" OR "blight$" OR "wilt$" OR "wilted" OR "canker" OR "scab$" OR "rot" OR "rots" OR "rotten" OR "damping off" OR "damping-off" OR "blister$" OR "smut" OR "mould" OR "mold" OR "damping syndrome$" OR "mildew" OR "scald$" OR "root knot" OR "root-knot" OR "rootkit" OR "cyst$" OR "dagger" OR "plant parasitic" OR "parasitic plant" OR "plant$parasitic" OR "root feeding" OR "root$feeding" OR "acari" OR "host$" OR "gall" OR "gall$" OR "whitefly" OR "whitefl*" OR "aleyrodidae" OR "thysanoptera" OR "moths" OR "scale" OR "scale$" OR "thripidae" OR "leafhoppers" OR "leafhopper$" OR "plant pathogens" OR "fungal" OR "aphididae" OR "Scolytinae" OR "bark beetle"") NOT ("heavy metal$" OR "pollut*" OR "weather" OR "propert*" OR "probes" OR "spectr*" OR "antioxidant$" OR "transformation" OR "Secondary plant metabolite$" OR "metabolite$" OR "Postharvest" OR "Pollin*" OR "Ethylene" OR "Thinning" OR "fertil*" OR "Mulching" OR "Nutrient$" OR "human virus" OR "animal disease$" OR "plant extracts" OR "immunological" OR "purified fraction" OR "traditional medicine" OR "medicine" OR "mammal$" OR "bird$" OR "human disease$" OR "*cancer*" OR "*therapeutic*" OR "*psoriasis*" OR "blood" OR "medicinal ethnobotany" OR "Nitrogen-fixing" OR "patients" OR "Probiotic drugs" OR "Antioxidant" OR "Anti-Inflammatory" OR "plasma levels" OR "ethnomedicinal" OR "traditional uses of medicinal plants" OR "Antitumor" OR "Neuroprotective" OR "Hypoglycemic" OR "ozone sensitivity" OR "cardiotonic") NOT **TOPIC:** *"Acanalonia conica" OR "Acanthosoma haemorrhoidale" OR "Acarosporium austriacum" OR "Acasis viretata" OR "Acherontia atropos" OR "Acleris cornana" OR "Acleris forbesana" OR "Acleris umbrana" OR "Acronicta americana" OR "Acronicta dactylina" OR "Acronicta funeralis" OR "Acronicta grisea" OR "Acronicta impleta" OR "Acrospeira mirabilis" OR "Acrospermum compressum" OR "Acrostaphylus pulvereus" OR "Actebia fennica" OR "Agnocoris reclairei" OR "Agnocoris rubicundus" OR "Agriopis aurantiaria" OR "Agriopis bajaria" OR "Allantus melanarius" OR "Alternaria alternata" OR "Alternaria tenuissima" OR "Altica cornivorax" OR "Ambrosiodmus rubricollis" OR "Amorbia humerosana" OR "Amphinema arachispora" OR "Amphipyra pyramidea" OR "Amphipyra pyramidoides" OR "Amphisphaerella alpigena" OR "Anavitrinella pampinaria" OR "Ancylis apicana" OR "Ancylis muricana" OR "Ancylis unculana" OR "Angerona prunaria" OR "Anisandrus sayi" OR "Anisota virginiensis" OR "Anoecia corni" OR "Anoecia cornicola" OR "Anoecia cornimaris" OR "Anoecia fulviabdominalis" OR "Anoecia furcate" OR "Anoecia haupti" OR "Anoecia himalayensis" OR "Anoecia ilicicola" OR "Anoecia japonica" OR "Anoecia major" OR "Anoecia oenotherae" OR "Anoecia takahashii" OR "Anoecia tanakai" OR "Anoecia vagans" OR "Anoplophora chinensis" OR "Antaeotricha leucillana" OR "Anthaxia fulgurans" OR "Anthaxia podolica" OR "Anthaxia salicis" OR "Anthaxia scutellaris" OR "Anthaxia semicuprea" OR "Antheraea polyphemus" OR "Anthocoptes cornicolus" OR "Anthocoptes platynotus" OR "Anthonomus quadrigibbus" OR "Anthostomella cornicola" OR "Anthostomella nitidula" OR "Antipspila metallella" OR "Antispila aurirubra" OR "Antispila cornifoliella" OR "Antispila freeman" OR "Antispila metallella" OR "Antispila petryi" OR "Antispila treitschkiella" OR "Aonidiella aurantii" OR "Aonidiella citrina" OR "Aphelenchoides fragariae" OR "Aphelia alleniana" OR "Aphis asclepiadis" OR "Aphis caliginosa" OR "Aphis cirsiioleracei" OR "Aphis cornifoliae" OR "Aphis fabae" OR "Aphis frangulae" OR "Aphis gossypi" OR "Aphis impatientis" OR "Aphis maculatae" OR "Aphis neogillette" OR "Aphis nigratibialis" OR "Aphis odinae" OR "Aphis salicariae" OR "Aphis spiraecola" OR "Apiognomonia errabunda" OR "Apiognomonia rigniacensis" OR "Apioporthe corni" OR "Aplopsora corni" OR "Arabis mosaic virus" OR "Archips argyrospila" OR "Archips podana" OR "Archips purpurana" OR "Archips rileyana" OR "Archips rosana" OR "Archips xylosteana" OR "Arctia caja" OR "Arcyria incarnata" OR "Argyrotaenia velutinana" OR "Armillaria mellea" OR "Artomyces pyxidatus" OR "Ascochyta cornicola" OR "Ascochyta medicaginicola" OR "Aspergillus flavus" OR "Asterococcus muratae" OR "Asteroma corni" OR "Asteromella bacteriiformis" OR "Asthena anseraria" OR "Athelia rolfsii" OR "Aulacaspis projecta" OR "Aulacorthum solani" OR "Aurantioporthe corni" OR "Aureobasidium pullulans" OR "Automeris io" OR "Baltazaria galactina" OR "Barrmaelia oxyacanthae" OR "Basiseptospora fallax" OR "Batophila fallax" OR "Belonolaimus longicaudatus" OR "Beltrania rhombica" OR "Bipolaris oryzae" OR "Biscogniauxia mediterranea" OR "Biston betularia" OR "Bitylenchus maximus" OR "Bjerkandera adusta" OR "Boczekiana celtidis" OR "Botryosphaeria dothidea" OR "Botrytis cinerea" OR "Broad bean wilt virus" OR "Bryobia praetiosa" OR "Bryobia ulmophila" OR "Byssomerulius corium" OR "Callimorpha dominula" OR "Callophrys rubi" OR "Calonectria morganii" OR "Caloptilia belfrageella" OR "Caloptilia burgessiella" OR "Caloptilia canadensisella" OR "Caloptilia cornusella" OR "Calycina vulgaris" OR "Camarographium koreanum" OR "Camarosporium incrustans" OR "Candidatus Phytoplasma asteris" OR "Candidatus Phytoplasma fragariae" OR "Capnodium citri" OR "Carcina quercana" OR "Carpatolechia decorella" OR "Carpocoris purpureipennis" OR "Carposina niponensis" OR "Catocala ultronia" OR "Celastrina argiolus" OR "Cenopalpus spinosus" OR "Cepphis advenaria" OR "Ceratobasidium ochroleucum" OR "Cerioporus scutellatus" OR "Ceriporia tarda" OR "Cerococcus parrotti" OR "Ceroplastes ceriferus" OR "Ceroplastes japonicus" OR "Ceuthospora corni" OR "Chalceopla dietziella" OR "Cheimophila salicella" OR "Cheirospora botryospora" OR "Cherry leaf roll virus" OR "Chionaspis corni" OR "Chionaspis lintneri" OR "Chionaspis salicis" OR "Chloroclystis v-ata" OR "Chondrostereum purpureum" OR "Choristoneura conflictana" OR "Choristoneura rosaceana" OR "Chrysobothris affinis" OR "Chrysobothris femorata" OR "Chrysomphalus dictyospermi" OR "Cilioplea coronata" OR "Cladosporium cladosporioides" OR "Cladosporium cornigenum" OR "Cladosporium herbarum" OR "Cladosporium sphaerospermum" OR "Clavaspis disclusa" OR "Clavaspis ulmi" OR "Clepsis persicana" OR "Clypeosphaeria mamillana" OR "Cnestus*

(Continues)

TABLE B.1 (Continued)

	mutilatus" OR "Coccus hesperidum" OR "Coccus malloti" OR "Coleophora ahenella" OR "Coleophora albiantennaella" OR "Coleophora anatipennella" OR "Coleophora cornivorella" OR "Coleophora salicivorella" OR "Coleophora violacea" OR "Colletotrichum acutatum" OR "Colletotrichum gloeosporioides" OR "Colletotrichum godetiae" OR "Colotois pennaria" OR "Comstockaspis perniciosa" OR "Coniosporium peziza" OR "Conistra torrida" OR "Conoplea globosa" OR "Conoplea olivacea" OR "Coprinellus disseminatus" OR "Cornicularìella urceola" OR "Corticium koleroga" OR "Corynespora cambrensis" OR "Coryneum corni-albae" OR "Coryneum corni-asperifoliae" OR "Cosmia trapezina" OR "Craneiobia corni" OR "Crepidotus epibryus" OR "Criconema demani" OR "Criconema mutabile" OR "Cristulariella corni" OR "Cristulariella depraedans" OR "Cristulariella moricola" OR "Cryptosphaeria moravica" OR "Cucumber mosaic virus" OR "Cucurbitaria callista" OR "Cydia molesta" OR "Cylindrocarpon ianthothele" OR "Cylindrosporium corni" OR "Cytospora corni" OR "Cytospora ceratosperma" OR "Cytospora fallax" OR "Cytospora leucosperma" OR "Cytospora populina" OR "Cytospora pruinose" OR "Cytospora pulcherrima" OR "Cytospora salicina" OR "Daedalea confragosa" OR "Daldinia vernicosa" OR "Daphnis nerii" OR "Daruvedia bacillata" OR "Dasystoma salicella" OR "Dematophora necatrix" OR "Dendrothele amygdalispora" OR "Diaporthe amygdali" OR "Diaporthe cornicola" OR "Diaporthe eres" OR "Diaporthe lagerstroemiae" OR "Diaporthe oncostoma" OR "Diaporthe pardalota" OR "Diaporthe rudis" OR "Diaspidiotus ancylus" OR "Diaspidiotus forbesi" OR "Diaspidiotus juglansregiae" OR "Diaspidiotus osborni" OR "Diaspidiotus ostreaeformis" OR "Diaspidiotus spiraspinae" OR "Diatrype albopruinosa" OR "Diderma radiatum" OR "Didymella glomerata" OR "Didymella pinodella" OR "Didymosphaeria decolorans" OR "Didymosphaeria oblitescens" OR "Diplodia corni" OR "Diplodia mamillana" OR "Diplodina macrospora" OR "Diptacus corni" OR "Discohainesia oenotherae" OR "Discosia artocreas" OR "Discostroma corticola" OR "Discostroma fuscellum" OR "Discula destructiva" OR "Dogwood mosaic nepovirus" OR "Dothichiza ambigua" OR "Dothiorella sarmentorum" OR "Dothioropsis corni" OR "Drepanopeziza populi" OR "Drosicha corpulenta" OR "Drosophila suzukii" OR "Dysmicoccus wistariae" OR "Eacles imperialis" OR "Echinosphaeria canescens" OR "Ectropis crepuscularia" OR "Edwardsiana diversa" OR "Elasmopalpus lignosellus" OR "Elsinoe corni" OR "Elsinoe fawcettii" OR "Empoasca decipiens" OR "Endopiza rhoifructana" OR "Ennomos subsignaria" OR "Eotetranychus cornicola" OR "Epiblema similana" OR "Epicoccum nigrum" OR "Epidiaspis leperii" OR "Epinotia lindana" OR "Erannis defoliaria" OR "Erannis tiliaria" OR "Erysiphe cornicola" OR "Erysiphe penicillate" OR "Erysiphe pulchra" OR "Erysiphe tortilis" OR "Euchlaena effecta" OR "Euchlaena irraria" OR "Euchlaena johnsonaria" OR "Euchlaena serrata" OR "Eucosma landana" OR "Eudeilinia herminiata" OR "Eugraphe sigma" OR "Eulecanium tiliae" OR "Eulithis xylina" OR "Eupithecia exiguata" OR "Euplexia benesimilis" OR "Euplexia lucipara" OR "Eupoecilia ambiguella" OR "Eupoecilia angustana" OR "Euproctis chrysorrhoea" OR "Euproctis similis" OR "Eurydema ornata" OR "Euthyatira pudens" OR "Eutrapela clemataria" OR "Eutypa flavovirens" OR "Eutypa lata" OR "Eutypa ludibunda" OR "Eutypa maura" OR "Eutypella stellulata" OR "Euwallacea fornicatus sensu lato" OR "Exidia cystidiata" OR "Exosporium occidentale" OR "Ferrisia gilli" OR "Flagelloscypha libertiana" OR "Floricola ulema" OR "Fomitiporia mediterranea" OR "Fusarium haematococcum" OR "Fusarium lateritium" OR "Fusarium oxysporum" OR "Fusarium sambucinum" OR "Fusarium solani" OR "Fuscoporia ferrea" OR "Fuscoporia ferruginosa" OR "Fuscoporia scruposa" OR "Fuscoporia torulosa" OR "Ganoderma applanatum" OR "Gliocephalotrichum simplex" OR "Globisporangium irregulare" OR "Globisporangium splendens" OR "Gloeodes pomigena" OR "Gloeosporium corni" OR "Glomopsis corni" OR "Glyphium corrugatum" OR "Gnophos furvata" OR "Godronia fuliginosa" OR "Graphiphora augur" OR "Grovesinia moricola" OR "Grovesinia pyramidalis" OR "Hainesia marsdeniae" OR "Halyomorpha halys" OR "Hapalocystis corni" OR "Haploa confusa" OR "Haploa lecontei" OR "Haradamyces foliicola" OR "Hedya corni" OR "Hedya nubiferana" OR "Helicobasidium mompa" OR "Helicotylenchus canadensis" OR "Helicotylenchus pseudorobustus" OR "Heliococcus osborni" OR "Heliococcus stachyos" OR "Helminthosporium velutinum" OR "Hemiberlesia cyanophylli" OR "Hemiberlesia diffinis" OR "Hemileuca nevadensis" OR "Hemithea aestivaria" OR "Hendersonia alternifoliae" OR "Hendersonia fiedleri" OR "Herpetogramma pertextalis" OR "Hesperumia sulphuraria" OR "Heterocampa biundata" OR "Heterocampa guttivitta" OR "Heterocampa subrotata" OR "Heterodera zeae" OR "Hoplolaimus stephanus" OR "Hyalophora cecropia" OR "Hydnophlebia chrysorhiza" OR "Hydrelia albifera" OR "Hydria undulata" OR "Hymenoscyphus serotinus" OR "Hypagyrtis unipunctata" OR "Hypena abalienalis" OR "Hypena bijugalis" OR "Hyphantria cunea" OR "Hyphoderma rimosum" OR "Hypoderma commune" OR "Hypomecis punctinalis" OR "Hypoxylon albocinctum" OR "Hypoxylon fuscum" OR "Hypoxylon rubiginosum" OR "Hysterium pulicare" OR "Hysterobrevium mori" OR "Hysteropatella prostii" OR "Icerya purchasi" OR "Ilyonectria destructans" OR "Incurvaria oehlmaniella" OR "Incurvaria pectinea" OR "Iridopsis larvaria" OR "Irpex lacteus" OR "Irpicomyces cornicola" OR "Jattaea allantospora" OR "Jattaea cornina" OR "Jodis lactearia" OR "Kretzschmaria frustulosa" OR "Lachnella corni" OR "Laestadia systema-solare" OR "Lambertella corni-maris" OR "Lasiocampa quercus" OR "Lasiodiplodia theobromae" OR "Lecanodiaspis prosopidis" OR "Leiosphaerella vexata" OR "Lepidosaphes corni" OR "Lepidosaphes kuwacola" OR "Lepidosaphes malicola" OR "Lepidosaphes tubulorum" OR "Lepidosaphes ulmi" OR "Lepidosaphes yanagicola" OR "Leptographium profanum" OR "Leptosphaeria borealis" OR "Leptosphaeria platycarpa" OR "Leptosphaeria rugosa" OR "Leptosphaeria vagabunda" OR "Leptostroma herbarum" OR "Leucostoma translucens" OR "Linospora carpini" OR "Linospora elata" OR "Liothrips austriacus" OR "Lithophane georgii" OR "Lithophane laticinerea" OR "Lithophane vivida" OR "Lobesia botrana" OR "Lobesia reliquana" OR "Lojkania decorticate" OR "Lomographa bimaculata" OR "Lophiostoma oreophilum" OR "Lophiostoma prominens" OR "Lophiostoma vagabundum" OR "Lopholeucaspis japonica" OR "Lycia rachelae" OR "Lycia ursaria" OR "Lycorma delicatula" OR "Lymantor aceris" OR "Lymantria dispar" OR "Lyomyces crustosus" OR "Machimia tentoriferella" OR "Macrophoma paniculata" OR "Macrophomina phaseolina" OR "Macrosiphum cornifoliae" OR "Macrosiphum euphorbiae" OR "Macrosiphum hamiltoni" OR "Macrosiphum manitobense" OR "Malacosoma americanum" OR "Malacosoma disstria" OR "Massaria gigantispora" OR "Massarina albocarnis" OR "Massarina polymorpha" OR "Massariovalsa sudans" OR "Melanaspis nigropunctata" OR "Melanaspis obscura" OR "Melanaspis tenebricosa" OR "Melanolophia canadaria" OR "Melanolophia imitata" OR "Melanomma aspegrenii" OR "Melanomma populicola" OR "Melaspilea proximella" OR "Meliola nidulans" OR "Meloidogyen fallax" OR "Meloidogyne chitwoodi" OR "Meloidogyne hapla" OR "Meloidogyne platani" OR "Melomastia mastoidea" OR "Merlinius brevidens" OR "Meruliopsis corium" OR "Mesocriconema xenoplax" OR "Metarranthis warnerae" OR "Metasphaeria fiedleri" OR "Microdiplodia papillosa" OR "Mollisia discolor" OR "Mollisia propinqua" OR "Mollisia rosae" OR "Monilinia corni" OR "Monilinia fructicola" OR "Monilinia fructigena" OR "Monochaetia cornicola" OR "Mononychellus caribbeanae" OR "Morrisonia confusa" OR "Mycosphaerella auerswaldii" OR "Mycosphaerella cornicola" OR "Mycosphaerella corni" OR "Mycosphaerella punctiformis" OR "Myrmaecium harperianum" OR "Myxosporium corni" OR "Myxosporium everhartii" OR "Myxosporium nitidum" OR "Myxosporium roumeguerei" OR "Myzus persicae" OR "Naeviopsis pusilla" OR "Nectria cinnabarina" OR "Nectria rehmiana" OR "Nectriella atrorubra" OR "Nemania albocincta" OR "Nemania serpens" OR "Neocoenorrhinus germanicus" OR "Neocucurbitaria cava" OR "Neocosmospora rehmiana" OR "Neofusicoccum luteum" OR "Neofusicoccum parvum" OR "Neofusicoccum ribis" OR "Neonectria coccinea" OR "Neonectria ditissima" OR "Neopinnaspis harperi" OR "Neopulvinaria innumerabilis" OR "Nigrospora oryzae" OR "Niptera stictella" OR "Noctua comes" OR "Noctua janthe" OR "Odontopera bidentata" OR "Oemona hirta" OR "Olethreutes connectus" OR "Olethreutes exaeresimum" OR "Olethreutes inornatana" OR "Olethreutes punctanum" OR

TABLE B.1 (Continued)

	"Olethreutes quadrifidum" OR "Olethreutes subnubilum" OR "Olethreutes valdanum" OR "Olethreutes versicolorana" OR "Oligia mactata" OR "Oligonychus coniferarum" OR "Oligonychus endytus" OR "Oligonychus propetes" OR "Operophtera brumata" OR "Orgyia antiqua" OR "Orgyia leucostigma" OR "Orientus ishidae" OR "Orthosia garmani" OR "Orthosia hibisci" OR "Orthotaenia undulana" OR "Ostropa barbara" OR "Otiorhynchus apenninus" OR "Otiorhynchus crataegi" OR "Ourapteryx sambucaria" OR "Palomena prasina" OR "Palthis angulalis" OR "Pammene rhediella" OR "Pandemis canadana" OR "Pandemis corylana" OR "Pandemis limitata" OR "Pandemis pyrusana" OR "Paramyrothecium roridum" OR "Parasa indetermina" OR "Paratylenchus projectus" OR "Parlatoreopsis chinensis" OR "Parlatoreopsis pyri" OR "Parlatoria octolobata" OR "Parlatoria oleae" OR "Parlatoria theae" OR "Parthenolecanium corni" OR "Passalora angelicae" OR "Passalora corni" OR "Passalora cornicola" OR "Patellaria clavispora" OR "Pavonia pavonia" OR "Pelionella kansui" OR "Penicillium brevicompactum" OR "Penicillium chrysogenum" OR "Penicillium citrinum" OR "Penicillium miczynskii" OR "Penicillium simplicissimum" OR "Penicillium spinulosum" OR "Penicillium thomii" OR "Peniophora cinerea" OR "Peniophora versiformis" OR "Peniophora violaceolivida" OR "Perenniporia tenuis" OR "Perenniporia unita" OR "Pero mizon" OR "Peroneutypa scoparia" OR "Pestalotia cornifolia" OR "Pestalotiopsis guepinii" OR "Pestalotiopsis mangiferae" OR "Pestalotiopsis microspora" OR "Pestalotiopsis monochaeta" OR "Pestalotiopsis versicolor" OR "Pestalotiopsis zahlbruckneriana" OR "Petunia asteroid mosaic virus" OR "Peyronellaea obtuse" OR "Pezicula corni" OR "Pezicula cornicola" OR "Pezicula cornina" OR "Pezicula ocellata" OR "Pezicula rubi" OR "Phaeoacremonium minimum" OR "Phaeoisariopsis pruni-grayanae" OR "Phaeosphaeria guttulata" OR "Phanerochaete laevis" OR "Phellinus igniarius" OR "Phenacoccus aceris" OR "Phialocephala fortinii" OR "Phigalia titea" OR "Phlebia fascicularia" OR "Phoma candidula" OR "Phoma corni-albae" OR "Phoma florida" OR "Phoma paniculata" OR "Phomopsis corni" OR "Phyllachora subcuticularis" OR "Phyllactinia corni" OR "Phyllactinia guttata" OR "Phyllobius glaucus" OR "Phyllobius pyri" OR "Phyllobius virideaeris" OR "Phyllocoptes depressus" OR "Phyllosticta capitalensis" OR "Phyllosticta corni-canadensis" OR "Phyllosticta cornicola" OR "Phyllosticta fallopiae" OR "Phyllosticta globifera" OR "Phyllosticta minima" OR "Phyllosticta pervincae" OR "Phyllosticta solitaria" OR "Phyllosticta starbaeckii" OR "Phyllosticta taurica" OR "Phymatotrichopsis omnivora" OR "Physalospora corni" OR "Physalospora everhartii" OR "Phytocoris longipennis" OR "Phytomyza agromyzina" OR "Phytophthora cactorum" OR "Phytophthora cinnamomi" OR "Phytophthora citricola" OR "Phytophthora citrophthora" OR "Phytophthora cryptogea" OR "Phytophthora megasperma" OR "Phytophthora nicotianae" OR "Phytophthora palmivora" OR "Phytophthora plurivora" OR "Phytophthora ramorum" OR "Pilidium lythri" OR "Pinnaspis hikosana" OR "Pinnaspis indivisa" OR "Placosphaeria cornicola" OR "Plagiostoma salicellum" OR "Plemyria georgii" OR "Pleomassaria swidae" OR "Pleospora atromaculans" OR "Pleospora laricina" OR "Pleuroceras tenellum" OR "Pochazia shantungensis" OR "Podosphaera corni" OR "Polia bombycina" OR "Polia nebulosa" OR "Polydrusus cervinus" OR "Polyphaenis sericata" OR "Pratylenchus crenatus" OR "Pratylenchus neglectus" OR "Pratylenchus penetrans" OR "Pratylenchus vulnus" OR "Probole alienaria" OR "Probole amicaria" OR "Probole nepiasaria" OR "Prociphilus cornifoliae" OR "Prosthecium platanoidis" OR "Pseudaonidia duplex" OR "Pseudaonidia paeoniae" OR "Pseudasiphonaphis corni" OR "Pseudaulacaspis biformis" OR "Pseudaulacaspis cockerelli" OR "Pseudaulacaspis pentagona" OR "Pseudocamarosporium corni" OR "Pseudomassaria corni" OR "Pseudomassaria foliicola" OR "Pseudomassaria necans" OR "Pseudomonas syringae pv. syringae" OR "Pseudovalsa titan" OR "Puccinia acuminata" OR "Puccinia porphyrogenita" OR "Pucciniastrum coriariae" OR "Pucciniastrum corni" OR "Pulvinaria acericola" OR "Pulvinaria corni" OR "Pulvinaria hazeae" OR "Pulvinaria hydrangeae" OR "Pulvinaria idesiae" OR "Pulvinaria kuwacola" OR "Pulvinaria nishigaharae" OR "Pulvinaria occidentalis" OR "Pulvinaria regalis" OR "Pyrrhocoris apterus" OR "Quaternaria dissepta" OR "Ramularia angustissima" OR "Ramularia gracilipes" OR "Ramularia stolonifer" OR "Refractohilum achromaticum" OR "Rhaphigaster nebulosa" OR "Rhizobium radiobacter" OR "Rhizobium rhizogenes" OR "Rhizochaete filamentosa" OR "Rhizoctonia anceps" OR "Rhizoctonia solani" OR "Rhopobota myrtillana" OR "Rhynchites germanicus" OR "Rhyparia purpurata" OR "Rosellinia aquila" OR "Rosellinia mammiformis" OR "Rotylenchus robustus" OR "Saccothecium sepincola" OR "Saissetia coffeae" OR "Saissetia miranda" OR "Samia cynthia" OR "Sanghuangporus ligneus" OR "Sarcinella heterospora" OR "Sarcinella pulchra" OR "Sarocladium kiliense" OR "Saturnia pavonia" OR "Schiffnerula corni" OR "Schizopora paradoxa" OR "Schizothyrium jamaicense" OR "Schizothyrium pomi" OR "Schizoxylon compositum" OR "Schizura concinna" OR "Schizura unicornis" OR "Sclerotinia sclerotiorum" OR "Sebacina incrustans" OR "Seimatosporium corni" OR "Seimatosporium salicinum" OR "Seiridium corni" OR "Seiridium cupressi" OR "Seiridium venetum" OR "Selenia dentaria" OR "Septobasidium bogoriense" OR "Septobasidium castaneum" OR "Septobasidium cokeri" OR "Septobasidium fumigatum" OR "Septobasidium pseudopedicellatum" OR "Septobasidium tanakae" OR "Septonema secedens" OR "Septoria canadensis" OR "Septoria cornicola" OR "Septoria corni-maris" OR "Septoria cornina" OR "Septoria floridae" OR "Septosporium fuliginosum" OR "Sheathospora cornuta" OR "Shevtchenkella bulgarica" OR "Shevtchenkella cornifoliae" OR "Shevtchenkella glabratae" OR "Simplicillium lanosoniveum" OR "Siphocoryne cornicolum" OR "Sirosporium corni" OR "Spatalistis bifasciana" OR "Sphaeropsis atra" OR "Sphaeropsis cornicola" OR "Sphaerulina cornicola" OR "Sphinx chersis" OR "Sphinx gordius" OR "Spilosoma lutea" OR "Spiramater grandis" OR "Spiramater lutra" OR "Sporidesmium toruloides" OR "Sporocadus cornicola" OR "Stagonopsis pallida" OR "Stauropus fagi" OR "Stephanitis pyri" OR "Stereum gausapatum" OR "Stereum gausapatum" OR "Stictis mollis" OR "Stictis sphaeroboloidea" OR "Stictis stigma" OR "Stictophacidium carniolicum" OR "Stigmina cornicola" OR "Sunira verberata" OR "Synanthedon geliformis" OR "Synanthedon scitula" OR "Synaxis jubararia" OR "Synchytrium aureum" OR "Synchytrium corni" OR "Syndemis afflictana" OR "Takahashia japonica" OR "Talaromyces assiutensis" OR "Talaromyces cecidicola" OR "Talaromyces trachyspermus" OR "Tegonotus acutilobus" OR "Teichospora ignavis" OR "Teichospora winteriana" OR "Tenthredo atra" OR "Tetracis cachexiata" OR "Tetranychus urticae" OR "Thaxteriella pezizula" OR "Thekopsora lanpingensis" OR "Thekopsora triangula" OR "Thelonectria discophora" OR "Thyridopteryx ephemeraeformis" OR "Thyrostroma cornicola" OR "Tilletiopsis lilacina" OR "Tobacco ringspot virus" OR "Togninia cornicola" OR "Tomato bushy stunt virus" OR "Tomato mosaic virus" OR "Tomato ringspot virus" OR "Tomato spotted wilt orthotospovirus" OR "Trametes gibbosa" OR "Trametes versicolor" OR "Trematosphaeria cornina" OR "Tremella lutescens" OR "Tremella mesenterica" OR "Trichoderma lixii" OR "Trichoferus campestris" OR "Trirhacus biokovensis" OR "Tylenchorhynchus claytoni" OR "Tympanis fasciculata" OR "Tympanopsis confertula" OR "Tyromyces chioneus" "Valsaria anserina" OR "Valsaria cornicola" OR "Vanderbylia fraxinea" OR "Velataspis dentata" OR "Venturia clintonii" OR "Venturia corni" OR "Venturia systema-solare" OR "Venusia pearsalli" OR "Verpa digitaliformis" OR "Vitreoporus dichrous" OR "Vuilleminia comedens" OR "Xanthotype sospeta" OR "Xanthotype urticaria" OR "Xenocriconemella macrodora" OR "Xenosporium berkeleyi" OR "Xestia ditrapezium" OR "Xestia triangulum" OR "Xiphinema americanum" OR "Xyleborinus saxesenii" OR "Xyleborus affinis" OR "Xyleborus dispar" OR "Xyleborus xylographus" OR "Xylodon radula" OR "Xylosandrus compactus" OR "Xylosandrus crassiusculus" OR "Xylosandrus germanus" OR "Zale aeruginosa" OR "Zale undularis" OR "Zaranga permagna" OR "Zygophiala jamaicensis" OR "Zythia aurantiaca"

APPENDIX C

Excel file with the pest list of *Cornus* species

Appendix C can be found in the online version of this output in the 'supporting information section'.