SCIENTIFIC OPINION

Pest categorisation of *Pseudocercospora pini-densiflorae*

EFSA Panel on Plant Health (PLH),

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Abstract

Following a request from the European Commission, the EFSA Plant Health (PLH) Panel performed a pest categorisation of *Pseudocercospora pini-densiflorae*, a well-defined and distinguishable fungal species of the family Mycosphaerellaceae. The regulated harmful organism is the anamorph *Cercoseptoria pini-densiflorae* (synonym *Cercospora pini-densiflorae*) with the corresponding teleomorph *Mycosphaerella gibsonii*. *P. pini-densiflorae* causes a needle blight of *Pinus* spp. also known as Cercospora blight of pines or Cercospora needle blight. *P. pini-densiflorae* is reported from sub-Saharan Africa, Central and South America, Asia and Oceania, but not from the EU. The pathogen is regulated in Council Directive 2000/29/EC (Annex IIAI) as a quarantine organism whose introduction into the EU is banned on plants (other than fruit and seeds) and wood of *Pinus*. The pest could enter the EU via plants for planting and other means (uncleaned seed, cut branches of pine trees, isolated bark, growing media accompanying plants, and mycorrhizal soil inocula). Hosts are widespread in the EU and favourable climatic conditions are present in Mediterranean countries. *Pinus halepensis*, *Pinus nigra*, *Pinus pinea*, *Pinus pinaster* and *Pinus sylvestris* are reported to be highly susceptible to the pathogen. The pest would be able to spread following establishment after introduction in the EU mainly on infected plants for planting. The pest introduction could have impacts in nurseries and young plantations. Cleaning seeds from needles and removing infected seedlings and pine litter from affected nurseries can reduce the risk of establishment in nurseries and of spread from nurseries to forests, especially given the limited scale of splash dispersal. The main knowledge gaps concern (i) the role of means of entry/spread other than plants for planting and (ii) the potential consequences in mature tree plantations and forests. The criteria assessed by the Panel for consideration as potential quarantine pest are met. For regulated non-quarantine pests, the criterion on the pest presence in the EU is not met.

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1. Introduction

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

1.1.1. Background

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

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

1.1.2. Terms of Reference

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

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

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

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

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

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

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

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

1.1.2.1. Terms of Reference: Appendix 1

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

Annex IIAI

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

Aleurocantus spp.

Anthonomus bisignifer (Schenkling)

Anthonomus signatus (Say)

Aschistonyx eppoi Inouye

Carposina niponensis Walsingham

Enarmonia packardi (Zeller)

Enarmonia prunivora Walsh

Grapholita inopinata Heinrich

Hishomonus phycitis

Leucaspis japonica Ckll.

Listronotus bonariensis (Kuschel)

Numonia pyrivorella (Matsumura)

Oligonychus perditus Pritchard and Baker

Pissodes spp. (non-EU)

Scirtothrips aurantii Faure

Scirtothrips citri (Moultex)

Scolytidae spp. (non-EU)

Scrobipalpopsis solanivora Povolny

Tachypterellus quadrigibbus Say

Toxoptera citricida Kirk.

Unaspis citri Comstock

(b) Bacteria

Citrus variegated chlorosis

Erwinia stewartii (Smith) Dye

Xanthomonas campestris pv. *oryzae* (Ishiyama) Dye and pv. *oryzicola* (Fang. et al.) Dye

(c) Fungi

Alternaria alternata (Fr.) Keissler (non-EU pathogenic isolates)

Anisogramma anomala (Peck) E. Müller

Apiosporina morbosa (Schwein.) v. Arx

Ceratocystis virescens (Davidson) Moreau

Cercoseptoria pini-densiflorae (Hori and Nambu) Deighton

Cercospora angolensis Carv. and Mendes

Elsinoe spp. Bitanc. and Jenk. Mendes

Fusarium oxysporum f. sp. *albedinis* (Kilian and Maire) Gordon

Guignardia piricola (Nosa) Yamamoto

Puccinia pittieriana Hennings

Stegophora ulmea (Schweinitz: Fries) Sydow & Sydow

Venturia nashicola Tanaka and Yamamoto

(d) Virus and virus-like organisms

Beet curly top virus (non-EU isolates)

Black raspberry latent virus

Blight and blight-like

Cadang-Cadang viroid

Citrus tristeza virus (non-EU isolates)

Leprosis

Little cherry pathogen (non- EU isolates)

Naturally spreading psorosis

Palm lethal yellowing mycoplasm

Satsuma dwarf virus

Tatter leaf virus

Witches' broom (MLO)

Annex IIB

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

Anthonomus grandis (Boh.)

Cephalcia lariciphila (Klug)

Dendroctonus micans Kugelan

Ips cembrae Heer

Ips duplicatus Sahlberg

Ips sexdentatus Börner

Gonipterus scutellatus Gyll.

Gilphinia hercyniae (Hartig)

Ips amitinus Eichhof

Ips typographus Heer

Sternochetus mangiferae Fabricius

(b) Bacteria

Curtobacterium flaccumfaciens pv. flaccumfaciens (Hedges) Collins and Jones

(c) Fungi

Glomerella gossypii Edgerton   *Hypoxylon mammatum* (Wahl.) J. Miller
Gremmeniella abietina (Lag.) Morelet

1.1.2.2. Terms of Reference: Appendix 2

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

Annex IAI

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

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

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

Group of Tephritidae (non-EU) such as:

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

(c) Viruses and virus-like organisms

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

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

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

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

Annex IIAI

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

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

1) *Margarodes vitis* (Phillipi)   3) *Margarodes prieskaensis* Jakubski

2) *Margarodes vredendalensis* de Klerk

1.1.2.3. Terms of Reference: Appendix 3

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

Annex IAI

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

Acleris spp. (non-EU)

Amauromyza maculosa (Malloch)

Anomala orientalis Waterhouse

Arrhenodes minutus Drury

Choristoneura spp. (non-EU)

Conotrachelus nenuphar (Herbst)

Dendrolimus sibiricus Tschetverikov

Diabrotica barberi Smith and Lawrence

Diabrotica undecimpunctata howardi Barber

Diabrotica undecimpunctata undecimpunctata Mannerheim

Diabrotica virgifera zeae Krysan & Smith

Diaphorina citri Kuway

Heliothis zea (Boddie)

Hirschmanniella spp., other than *Hirschmanniella gracilis* (de Man) Luc and Goodey

Liriomyza sativae Blanchard

Longidorus diadecturus Eveleigh and Allen

Monochamus spp. (non-EU)

Myndus crudus Van Duzee

Nacobbus aberrans (Thorne) Thorne and Allen

Naupactus leucoloma Boheman

Premnotrypes spp. (non-EU)

Pseudopityophthorus minutissimus (Zimmermann)

Pseudopityophthorus pruinosus (Eichhoff)

Scaphoideus luteolus (Van Duzee)

Spodoptera eridania (Cramer)

Spodoptera frugiperda (Smith)

Spodoptera litura (Fabricus)

Thrips palmi Karny

Xiphinema americanum Cobb sensu lato (non-EU populations)

Xiphinema californicum Lamberti and Bleve-Zacheo

(b) Fungi

Ceratocystis fagacearum (Bretz) Hunt

Chrysomyxa arctostaphyli Dietel

Cronartium spp. (non-EU)

Endocronartium spp. (non-EU)

Guignardia laricina (Saw.) Yamamoto and Ito

Gymnosporangium spp. (non-EU)

Inonotus weirii (Murril) Kotlaba and Pouzar

Melampsora farlowii (Arthur) Davis

Mycosphaerella larici-leptolepis Ito et al.

Mycosphaerella populorum G. E. Thompson

Phoma andina Turkensteen

Phyllosticta solitaria Ell. and Ev.

Septoria lycopersici Speg. var. *malagutii* Ciccarone and Boerema

Thecaphora solani Barrus

Trechispora brinkmannii (Bresad.) Rogers

(c) Viruses and virus-like organisms

Tobacco ringspot virus

Tomato ringspot virus

Bean golden mosaic virus

Cowpea mild mottle virus

Lettuce infectious yellows virus

Pepper mild tigré virus

Squash leaf curl virus

Euphorbia mosaic virus

Florida tomato virus

(d) Parasitic plants

Arceuthobium spp. (non-EU)

Annex IAII

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

Meloidogyne fallax Karssen

Popillia japonica Newman

Rhizoecus hibisci Kawai and Takagi

(b) Bacteria

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

Ralstonia solanacearum (Smith) Yabuuchi et al.

(c) Fungi

Melampsora medusae Thümen

Synchytrium endobioticum (Schilbersky) Percival

Annex I B

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

Leptinotarsa decemlineata Say

Liriomyza bryoniae (Kaltenbach)

(b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

1.2. Interpretation of the Terms of Reference

Cercoseptoria pini-densiflorae is one of a number of pests listed in the Appendices to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether it fulfils the criteria of a quarantine pest or those of a regulated non-quarantine pest (RNQP) for the area of the EU.

The regulated harmful organism is the anamorph *Cercoseptoria pini-densiflorae* (synonyms: *Cercospora pini-densiflorae, Pseudocercospora pini-densiflorae*) with the corresponding teleomorph *Mycosphaerella gibsonii* (EPPO, 1997). In accordance with the International Code of Nomenclature for Algae, Fungi and Plants, the dual nomenclature system for fungi has been abandoned since 1 January 2013. The choice of anamorph or teleomorph names is based on priority as determined by the International Commission on the Taxonomy of Fungi and its Working Groups. The recommended valid name for the fungus is *Pseudocercospora pini-densiflorae* (Quintero, 2015; Sullivan, 2016).

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *P. pini-densiflorae* was conducted at the beginning of the pest categorisation in the ISI Web of Science bibliographic database, using the scientific names (see Sections 1.2 and 3.1.1) of the pest as search terms. Relevant papers were reviewed, and further references and information were obtained from experts, from citations within the references and grey literature.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the EPPO Global Database (EPPO, 2017).

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

Information on EU Member States (MS) imports of *Pinus* plants for planting from North America were sought in the ISEFOR database (Eschen et al., 2017).

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

2.2. Methodologies

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

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

Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. All relevant criteria have to be met for the pest to potentially qualify either as a quarantine pest or as a RNQP. If one of the criteria is not met, the pest will not qualify. In such a case, the working group should consider the possibility to terminate the assessment early and to be concise in the sections preceding the question for which the negative answer is reached. Note that a pest that does not qualify as a quarantine pest may still qualify as a RNQP, which needs to be addressed in the opinion. For the pests regulated in the protected zones only, the scope of the categorisation is the territory of the protected zone, thus the criteria refer to the protected zone instead of the EU territory.

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

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

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Identity of the pest (Section 3.1)	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Absence/ presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? Describe the pest distribution briefly!	Is the pest present in the EU territory? If not, it cannot be a protected zone quarantine organism	Is the pest present in the EU territory? If not, it cannot be a regulated non-quarantine pest. (A regulated non-quarantine pes must be present in the risk assessment area)
Regulatory status (Section 3.3)	If the pest is present in the EU but not widely distributed in the risk assessment area, it should be under official control or expected to be under official control in the near future.	The protected zone system aligns with the pest free area system under the International Plant Protection Convention (IPPC) The pest satisfies the IPPC definition of a quarantine pest that is not present in the risk assessment area (i.e. protected zone)	Is the pest regulated as a quarantine pest? If currently regulated as a quarantine pest, are there grounds to consider its status could be revoked?
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways!	Is the pest able to enter into, become established in, and spread within, the protected zone areas? Is entry by natural spread from EU areas where the pest is present possible?	Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects? Clearly state if plants for planting is the main pathway!
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?	Would the pests' introduction have an economic or environmental impact on the protected zone areas?	Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?
Available measures (Section 3.6)	Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?	Are there measures available to prevent the entry into, establishment within or spread of the pest within the protected zone areas such that the risk becomes mitigated? Is it possible to eradicate the pest in a restricted area within 24 months (or a period longer than 24 months where the biology of the organism so justifies) after the presence of the pest was confirmed in the protected zone?	Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA above for consideration as potential protected zone quarantine pest were met, and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential regulated non-quarantine pest were met, and (2) if not, which one(s) were not met

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

3.   Pest categorisation

3.1.   Identity and biology of the pest

3.1.1.   Identity and taxonomy

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

Pseudocercospora pini-densiflorae is an ascomycete fungus in the family of Mycosphaerellaceae.

There are many species synonymies referred to the anamorphic stage: *Cercoseptoria pini-densiflorae, Cercospora pini-densiflorae, Mycosphaerella gibsonii* (teleomorph)*, Pseudocercospora pini-densiflorae* var. *pini-densiflorae* (Index Fungorum, http://www.indexfungorum.org/names/names.asp).

Asteromella spp. have been reported as spermatial anamorphs (Sullivan, 2016).

3.1.2.   Biology of the pest

P. pini-densiflorae causes a needle blight of pines (*Pinus* spp.) also known as Cercospora blight of pines or Cercospora needle blight.

P. pini-densiflorae overwinters as mycelium or immature stromata in host needles. The main infection source consists of airborne conidia produced in the spring from these needles. The stroma of the fungus erupts through stomata, and under humid conditions conidia develop on the stromata. Conidia are liberated and dispersed by rain splash during wet weather or by overhead irrigation (Sullivan, 2016). Two to three days of moist humid conditions are required for dispersal and infection (Ivory and Wingfield, 1986; Ivory, 1987), which occurs through stomata apertures. Due to the major role played by rain water rather than wind in dispersal, the pathogen spreads efficiently only locally, for instance through closely spaced seedlings in nursery beds. Dispersal has been reported to be less efficient between trees in plantations (Ivory, 1987). Conidia germinate between 10°C and 35°C, with 25°C being optimal (EPPO, 1997). A period of approximately 3–7 days can be enough for the production of conidia, their dispersal, and needle infection to occur (Ivory, 1987).

In general, about 5–6 weeks are needed for the symptoms to develop, although symptoms may develop faster in highly susceptible pine species (Ivory and Wingfield, 1986; EPPO, 1997; Sullivan, 2016). The production of stromata and conidia begins soon after the development of symptoms. In addition or instead to conidia, *P. pini-densiflorae* may develop spermatia, which are thought to be important for fertilisation, and subsequently sexual meiospores in ascomata (Ivory, 1987), although the role of sexual spores in the development of epidemics is unknown (Diekmann, 2002).

The fungus can remain viable for many months in dry infected needles and subsequently produce large numbers of conidia when wetted (Ivory, 1987). Conidia remain viable for approximately one month, but under moist conditions will promptly germinate and infect needles.

3.1.3.   Intraspecific diversity

Isolates from Asia have been reported to differ distinctly from African and Jamaican isolates. A third type was reported from *Pinus caribaea* in the Philippines (Ivory, 1994). Due to the differences in conidial morphology, Ivory (1994) suggested that they may be three different ecotypes (Asia, Africa-Central America, and Philippines)

Although findings of the species in Central America were reported as infrequent, it was speculated that the ecotype present there could be endemic to the region (Evans, 1984; Ivory, 1994). Findings of the Asian ecotype from remote native pine forests in Nepal suggest a Himalayan origin (Ivory, 1990).

3.1.4.   Detection and identification of the pest

> *Are detection and identification methods available for the pest?*
>
> **Yes**, detection and identification methods are available.

The symptoms caused by *P. pini-densiflorae* may be difficult to distinguish from closely related pine pathogens (e.g. *Lecanosticta acicola*), but the species has some specific morphological characteristics given

in the EPPO diagnostic protocol PM 7/46(3): *Lecanosticta acicola* (formerly *Mycosphaerella dearnessii),* *Dothistroma septosporum* (formerly *Mycosphaerella pini)* and *Dothistroma pini* (Anon, 2015).

The species can be identified and distinguished from other *Mycosphaerella* (sensu lato) species using molecular methods (Quaedvlieg et al., 2012; DNA sequence data given in Qbank-www.qbank.eu).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

P. pini-densiflorae is reported from sub-Saharan Africa, Central and South America, Asia and Oceania (Figure 1) (EPPO, 2017).
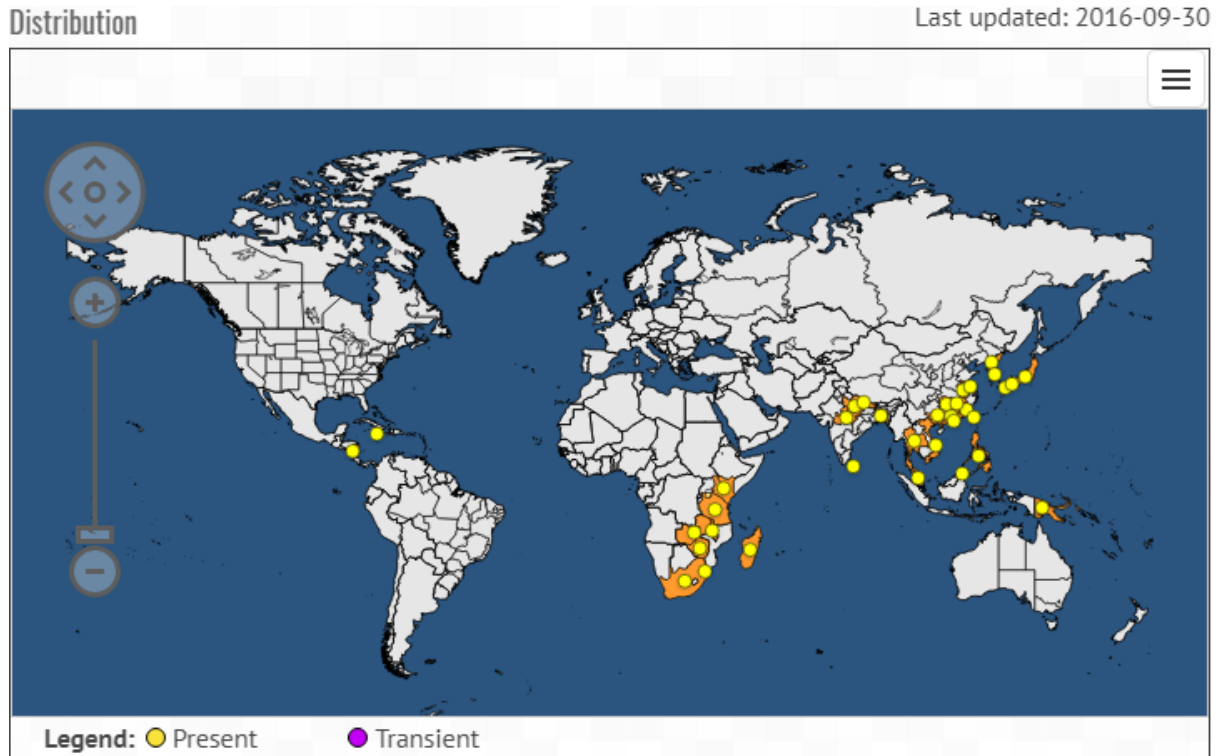
Figure 1: Global distribution map for *Pseudocercospora pini-densiflorae* (extracted from EPPO, 2017, accessed June 2017). There are no records of transient populations for this species

In Africa, the pathogen is reported from Kenya, Madagascar, Malawi, South Africa, Swaziland, Tanzania and Zambia (EPPO, 2017), as well as Zimbabwe (Sullivan, 2016).

In America, *P. pini-densiflorae* is reported from Jamaica and Nicaragua (EPPO Global Database), as well as Brazil, Chile, Costa Rica and Honduras (Sullivan, 2016).

In Asia, the pathogen is reported from Bangladesh, China, India, Japan, North and South Korea, Malaysia, Nepal, the Philippines, Sri Lanka, Taiwan, Thailand and Vietnam (Sullivan, 2016; EPPO, 2017).

In Oceania, *P. pini-densiflorae* is reported from Papua New Guinea (Sullivan, 2016; EPPO, 2017).

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest widely distributed within the EU?

No, the pest is not reported to be present in the EU.

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

P. pini-densiflorae is listed in Council Directive 2000/29/EC as *Cercoseptoria pini-densiflorae*. Details are presented in Tables 2 and 3.

Table 2: *Pseudocercospora pini-densiflorae* in Council Directive 2000/29/EC

Annex II, Part A	Harmful organisms whose introduction into, and spread within, all member states shall be banned if they are present on certain plants or plant products	
Section I	Harmful organisms not known to occur in the community and relevant for the entire community	
(c)	Fungi	
	Species	Subject of contamination
5.	*Cercoseptoria pini-densiflorae* (Hori and Nambu) Deighton	Plants of *Pinus* L., other than fruit and seeds, and wood of *Pinus* L.

3.3.2. Legislation addressing plants and plant parts on which *P. pini-densiflorae* is regulated

Table 3: Regulated hosts and commodities that may involve *Pseudocercospora pini-densiflorae* in Annexes III, IV and V of Council Directive 2000/29/EC

Annex III, Part A	Plants, plant products and other objects the introduction of which shall be prohibited in all Member States	
1.	Plants of *Abies* Mill., *Cedrus* Trew, *Chamaecyparis* Spach, *Juniperus* L., *Larix* Mill., *Picea* A. Dietr., *Pinus* L., *Pseudotsuga* Carr. and *Tsuga* Carr., other than fruit and seeds	Non-European countries
Annex V	Plants, plant products and other objects which must be subject to a plant health inspection (at the place of production if originating in the Community, before being moved within the Community—in the country of origin or the consignor country, if originating outside the Community) before being permitted to enter the Community	
Part A	Plants, plant products and other objects originating in the Community	
Section II	Plants, plant products and other objects produced by producers whose production and sale is authorised to persons professionally engaged in plant production, other than those plants, plant products and other objects which are prepared and ready for sale to the final consumer, and for which it is ensured by the responsible official bodies of the Member States, that the production thereof is clearly separate from that of other products	
1.1.	Plants of *Abies* Mill., *Larix* Mill., *Picea* A. Dietr., *Pinus* L. and *Pseudotsuga* Carr.	

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

Pseudocercospora pini-densiflorae infects several species within the genus *Pinus*, in particular *P. caribaea*, *P. densiflora*, *P. thunbergii*, *P. halepensis*, *P. pinaster*, *P. radiata*, *P. canariensis*, *P. luchuensis*, *P. massoniana*, *P. merkusii*, *P. resinosa*, *P. strobus* and *P. sylvestris* (EPPO, 1997). The fungus is known to infect at least 36 *Pinus* species (Quintero, 2015) (Appendix A).

Of these, the European native species *P. halepensis*, *P. nigra*, *P. pinaster*, and *P. sylvestris*, and the American species *P. radiata* are widely cultivated in European nurseries and present in European forests (EPPO, 1997).

P. halepensis, *P. nigra*, *P. pinea*, *P. pinaster*, *P. radiata* and *P. sylvestris* are reported to be highly susceptible to the pathogen (Quintero, 2015).

Through artificial inoculation, further conifer species have been successfully infected (*Abies veitchii, Abies sachalinensis, Cedrus deodara, Larix kaempferi, Picea glehnii, Picea jezoensis*) by Suto (1979) who also reports successful artificial inoculation for *Pseudotsuga menziesii*.

All the above named hosts are regulated at the genus level.

3.4.2. Entry

Is the pest able to enter into the EU territory?
Yes, the pest could enter the EU via plants for planting and other means (see below).

P. pini-densiflorae is currently reported as absent from the EU but is widely distributed in parts of Africa and Asia, with presence also reported in Jamaica, Nicaragua (EPPO, 2017) and South Africa (Ivory and Wingfield, 1986; EPPO, 2017). It is unlikely the pathogen could arrive in the EU naturally from these locations even though airborne conidia can be dispersed via the wind. However, it has been stated that it could enter as infected seedlings and on cut branches of *Pinus* (EPPO, 1997) facilitated by the long asymptomatic and latent periods of the pathogen. The asymptomatic period has been reported as about 5–6 weeks depending on environmental conditions (Ivory and Wingfield, 1986; EPPO, 1997; Sullivan, 2016).

The main pathway of entry would thus be:

- Plants for planting

However, under current regulation, this is a closed pathway.

Wood is currently regulated regarding *P. pini-densiflorae* in Annex IIAI (see Section 3.3.1), but there is no evidence that the pathogen can be present and viable on timber, especially as timber would not originate from young plantations, where the pathogen is most prevalent.

Other plant parts capable of carrying the pathogen in trade or transport include uncleaned seed, cut branches of pine trees, isolated bark, leaves, stems and growing media accompanying plants (Venette, 2008; Quintero, 2015). Mycorrhizal soil inocula can also assist in the transmission of the fungus (Singh et al., 1988).

There were no records of interception of *P. pini-densiflorae* in the Europhyt database as of June 2017.

3.4.3. Establishment

Is the pest able to become established in the EU territory?
Yes, the pest could establish in the EU, as hosts are widespread and favourable climatic conditions are found in Mediterranean countries.

3.4.3.1. EU distribution of main host plants

The pathogen can infect a wide range of native and exotic *Pinus* spp., as specified in Section 3.4.1, some of which are present in European forests, nurseries and as ornamental trees (EPPO, 1997) (Figure 2). Of the species that are particularly vulnerable (EPPO, 1997) natural and naturalised populations of *P. halepensis* and *P. pinaster* occur only in southern and south-western Europe (Figures 3 and 4) due to sensitivity to cold conditions.
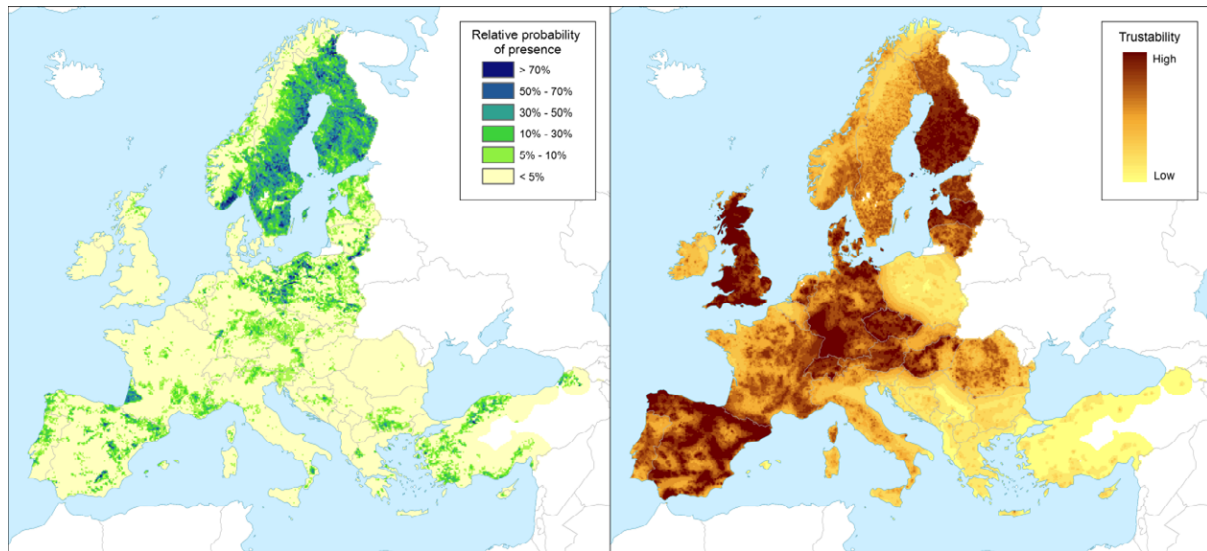
Figure 2: <u>Left-hand panel</u>: Relative probability of presence (RPP) of the genus *Pinus* (based on data from the species: *P. sylvestris, P. pinaster, P. halepensis, P. nigra, P. pinea, P. contorta, P. cembra, P. mugo, P. radiata, P. canariensis, P. strobus, P. brutia, P. banksiana, P. ponderosa, P. heldreichii, P. leucodermis, P. wallichiana*) in Europe, mapped at 100 km² pixel resolution. The underlying data are from European-wide forest monitoring data sets and from national forestry inventories based on standard observation plots measuring in the order of hundreds m². RPP represents the probability of finding at least one individual of the taxon in a standard plot placed randomly within the grid cell. For details, see Appendix B (courtesy of JRC, 2017). <u>Right-hand panel</u>: Trustability of RPP. This metric expresses the strength of the underlying information in each grid cell and varies according to the spatial variability in forestry inventories. The colour scale of the trustability map is obtained by plotting the cumulative probabilities (0–1) of the underlying index (for details see Appendix B).

Pinus pinaster

This distribution map, including both natural and naturalized occurrence of *Pinus pinaster* was compiled by members of the EUFORGEN Programme

Citation: Distribution map of Maritime pine (*Pinus pinaster*) EUFORGEN 2009, www.euforgen.org.

First published online on 2003   -   Updated on 30 July 2008

Figure 3: Native range of *Pinus pinaster* (map prepared by Euforgen in 2008). Blue dots represent isolated occurrences of the species

Pinus halepensis

This distribution map, showing the natural distribution area of *Pinus halepensis* was compiled by members of the EUFORGEN Networks based on an earlier map published by W.B.Critchfield & E.L.Little, Jr., Geographic Distibution, of the Pines of the World, . USDA Forest Service Misc. Publication 991, 1966 (http://dendrome.ucdavis.edu/treegenes/species/)

Citation: Distribution map of Aleppo pine (<ita>Pinus halepensis </ita>) EUFORGEN 2009, www.euforgen.org.

First published online in 2003   -   Updated on 24 July 2008

Figure 4: Native range of *Pinus halepensis* (map prepared by Euforgen in 2008). Blue dots represent isolated occurrences of the species

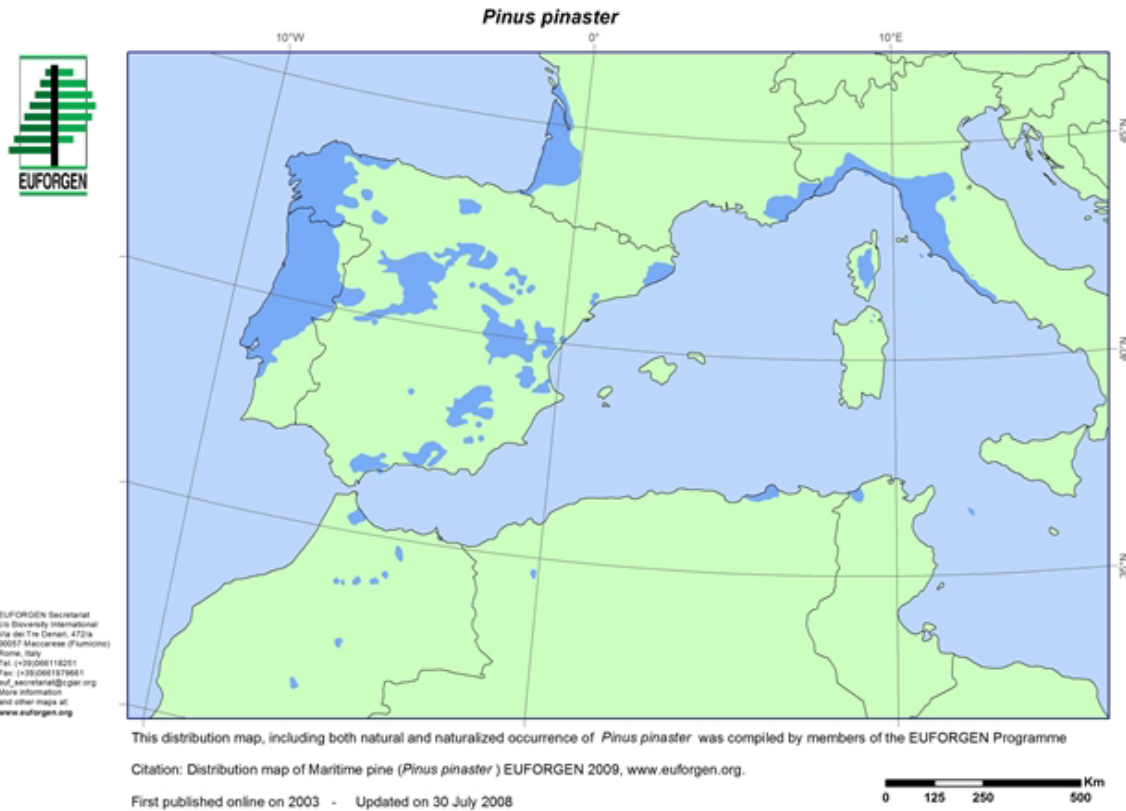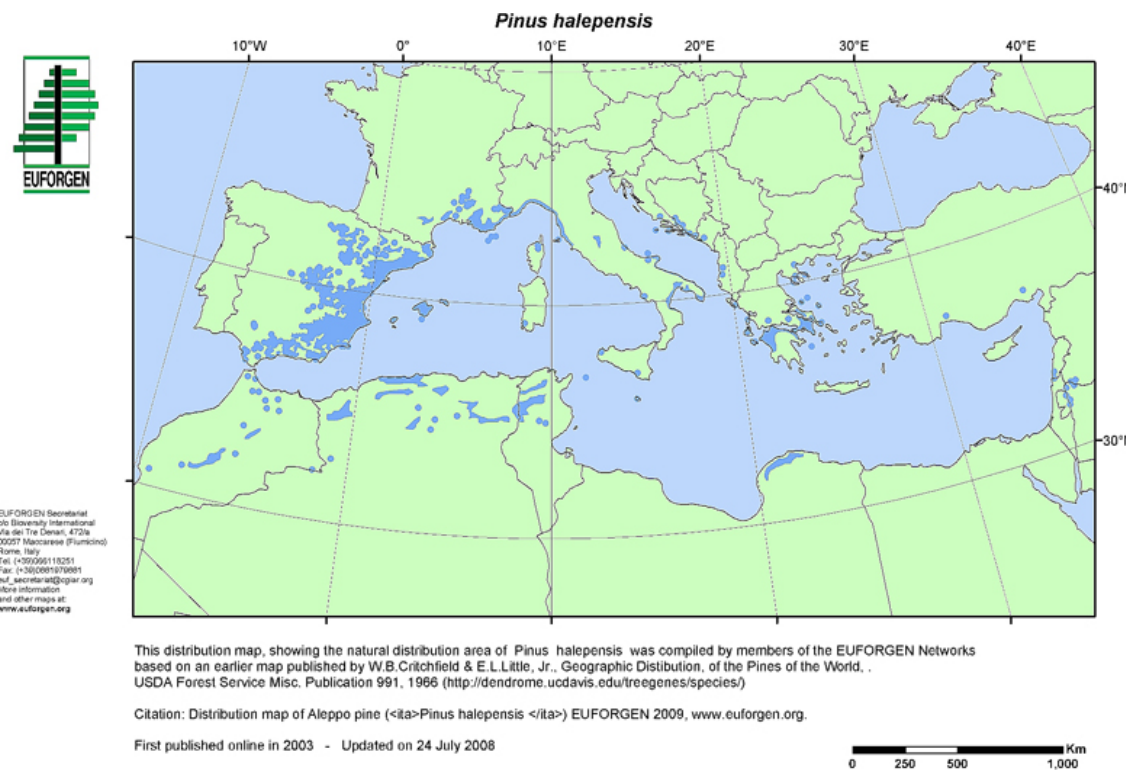### 3.4.3.2. Climatic conditions affecting establishment

The pathogen is mainly associated with tropical and sub-tropical climates (Ivory, 1994). In the EU, hosts are widespread and favourable climatic conditions are found in Mediterranean countries. In addition, the pathogen is reported also from North and South Korea (Mulder and Gibson, 1972; Quintero, 2015), where climatic conditions are similar to those found in continental parts of the EU.

Infection occurs mainly by airborne conidia which require wet conditions for splash dispersal (Singh et al., 1988). The optimum temperature for conidia germination is 25°C and occurs over the range 10–35°C (EPPO, 1997).

3.4.4. Spread

Is the pest able to spread within the EU territory following establishment? How?
Yes, mainly by human movement of infected plants for planting.

The pathogen is largely restricted to localised spread via splash dispersal during rainfall or irrigation events (Sullivan, 2016). Spread from plant to plant in closely spaced nursery beds has been observed but is less efficient between plantations (Ivory, 1987). Ivory (1994) observed that the pathogen had failed to occur in many countries with appropriate climates and abundant host species, suggesting that is dispersal-limited and cannot spread well. Longer range spread may occur by human movement of infected material. Symptoms can take about 5–6 weeks to occur and conidia remain viable for up to a month (Ivory and Wingfield, 1986; EPPO, 1997; Sullivan, 2016). Plants for planting may therefore be the main means of spread.

Other means of spread are possible (see Entry section), but with uncertainty on their role.

3.5. Impacts

Would the pests' introduction have an economic or environmental impact on the EU territory?
Yes, the pest introduction could have impacts in nurseries and young plantations.
RNQPs: Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?[4]
Yes, the introduction of the pest could have an impact on the intended use of plants for planting.

P. pini-densiflorae affects older leaves in young saplings (1–2 years old) of both exotic and native pine species (Figure 5). Thus, the pathogen is particularly damaging at the later nursery stage. It has been reported as a major obstacle to the production of pine seedlings (especially *P. pinaster*, *P. thunbergii*, and *P. densiflora*) in southern/central Japan and Taiwan (Ito, 1972; EPPO, 1997; Sullivan, 2016). The disease is important on *P. merkusii* and *P. caribaea* nurseries in West Malaysia (Ivory, 1975). Disease incidence of 100% and mortality rates as high as 85% have been reported (Ito, 1972; Ivory, 1987). Few pine species, including *P. halepensis*, *P. pinaster* and *P. radiata*, have been reported to be commonly attacked not only in nurseries but also in young plantations (Hidaka, 1932; Kiyohara and Tokushige, 1969 (both cited in Ito, 1972); Mulder and Gibson, 1972) up to 5 years of age (Ivory, 1987). Indeed, severe defoliations resulting in reduced growth and even tree death have been reported in young plantations of *P. radiata* in Tanzania (Mulder and Gibson, 1972).

Similar impacts can be expected in the EU if the pathogen will be introduced. The pathogen might not be limited by summer drought in Mediterranean nurseries because of irrigation. Moreover, *P. halepensis*, *P. nigra*, *P. pinea*, *P. pinaster* and *P. sylvestris* are reported to be highly susceptible to the pathogen.

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

Figure 5: *Pseudocercospora pini-densiflorae* causes a serious needle blight in both exotic and native pines, particularly at the later nursery stage, and can be a major obstacle to production of pine seedlings (Courtesy of H. Hashimoto, Bugwood.org. Available online at: https://www. forestryimages.org/browse/detail.cfm?imgnum=1949016)

3.6. Availability and limits of mitigation measures

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

Yes. Please see section 3.6.3.

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

- Due to the asymptomatic phase (5–6 weeks) in host plants*, P. pini-densiflorae* can be inadvertently introduced and can be moved during commercial exchanges (Ivory, 1987).
- The fungus can be introduced and moved not only through the movement of infected host plants or plant parts (e.g. bark, leaves and stems), but also through growing media accompanying plants (Venette, 2008) and mycorrhizal soil inocula (Singh et al., 1988).

3.6.2. Biological or technical factors limiting the ability to prevent the presence of the pest on plants for planting

- It is difficult to obtain seed completely clean from needle debris.
- Collecting and destroying diseased seedlings early enough may be difficult. This is also because needles can be infected but asymptomatic.
- Removing pine litter from nurseries is impractical.
- Chemical control in nurseries may result in masking the symptoms, thus making it more likely that infected asymptomatic plants for planting will carry the pathogen over long distances.

3.6.3. Control methods

- Seeds coming from infested areas should be completely free of needle debris before sowing in nurseries (Singh et al., 1988).
- Diseased seedlings should be collected and destroyed early in the season before infections occur (Ito, 1972).
- Pine litter in diseased nurseries should be collected and burnt (Singh et al., 1988).
- Young seedlings should be physically separated from older plants where the nursery cycle exceeds 12 months (Ivory, 1987).
- Planting schedules should be arranged outside of rainy months (Singh et al., 1988).

- Chemical control can be achieved by treating foliage with fungicides at 2–4 week intervals under optimal conditions for the spread of the fungus (Ivory, 1987). Several active ingredients have been reported to be effective and have hence been recommended (Singh et al., 1988).

3.7. Uncertainty

Although there are no reports of the pathogen in the risk assessment area, the pest may be present in the EU at low incidence, thus without causing damage and remaining undetected.

The plants for planting pathway is currently closed, but the importance of other means of entry and spread is unclear (there is a lack of data to ascertain their importance).

The documented damage comes from nurseries and young plantations; therefore there is uncertainty about the potential consequences in mature plantations and forests. There could be a lag phase between introduction and widespread/noticeable impacts.

It is uncertain whether chemical control in nurseries could mask symptoms, therefore favouring in easier dispersal of the pathogen via asymptomatic plants for planting.

4. Conclusions

P. pini-densiflorae meets the criteria assessed by EFSA for consideration as a potential quarantine pest (Table 4).

Table 4: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of the pest as a species is clear	The identity of the pest as a species is clear	None
Absence/presence of the pest in the EU territory (Section 3.2)	The pest is not reported to be present in the EU	The pest is not reported to be present in the EU	The pest may be present in the EU at low incidence, thus without causing damage and remaining undetected
Regulatory status (Section 3.3)	*P. pini-densiflorae* is regulated by Council Directive 2000/29/EC (Annex IIAI) on plants of *Pinus* (other than fruit and seeds), and wood of *Pinus*	*P. pini-densiflorae* is regulated by Council Directive 2000/29/EC (Annex IIAI) on plants of *Pinus* (other than fruit and seeds), and wood of *Pinus*	None
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Entry: the pest could enter the EU via the plants for planting pathway and other means (uncleaned seed, cut branches of pine trees, isolated bark, leaves, stems, growing media accompanying plants, and mycorrhizal soil inocula) Establishment: hosts are widespread in the risk assessment (RA) area and favourable climatic conditions are present in Mediterranean countries Spread: the pest would be able to spread following establishment mainly on infected plants for planting	Entry: the pest could enter the EU via the plants for planting pathway and other means (uncleaned seed, cut branches of pine trees, isolated bark, leaves, stems, growing media accompanying plants, and mycorrhizal soil inocula) Establishment: hosts are widespread in the RA area and favourable climatic conditions are present in Mediterranean countries Spread: the pest would be able to spread following establishment mainly on infected plants for planting	The importance of the means of entry and spread other than plants for planting is unclear The need to regulate wood as a pathway of entry is questionable, given that the pathogen is unlikely to be present on timber

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Potential for consequences in the EU territory (Section 3.5)	The pest introduction could have impacts in nurseries and young plantations. Extensive defoliation and death of young trees could lead to additional stress in semi-natural forest environments	The introduction of the pest could have an impact on the intended use of plants for planting	There is uncertainty about the potential consequences in mature plantations and forests
Available measures (Section 3.6)	Cleaning seeds from needles, removing infected seedlings and pine litter from affected nurseries and chemical control can reduce the risk of establishment in nurseries and of spread from nurseries to forests	Cleaning seeds from needles, removing infected seedlings and pine litter from affected nurseries and chemical control can reduce the risk of establishment in nurseries	It is uncertain how effective chemical control in nurseries can be and whether it might just mask symptoms, hence allowing the movement of the pathogen via the trade in plants for planting
Conclusion on pest categorisation (Section 4)	The criteria assessed by the Panel for consideration as potential quarantine pest are met	The criterion on the pest presence in the EU is not met	
Aspects of assessment to focus on/ scenarios to address in future if appropriate	The main knowledge gaps concern (i) the presence of the pest in EU MS, (ii) the role of means of entry/spread other than plants for planting and (iii) the potential consequences in mature tree plantations and forests Given that the present categorisation has explored most if not all of the available data on these points, a more complete assessment is unlikely to provide much clearer conclusions		

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Abbreviations

CLC	Corine Land Cover
EPPO	European and Mediterranean Plant Protection Organization
EU MS	European Union Member State
EUFGIS	European Information System on Forest Genetic Resources
FAO	Food and Agriculture Organization
GD^2	Georeferenced Data on Genetic Diversity
IPPC	International Plant Protection Convention
JRC	Joint Research Centre of the European Commission
PLH	EFSA Panel on Plant Health
RA	risk assessment
RNQP	regulated non-quarantine pest
RPP	relative probability of presence
SMFA	spatial multiscale frequency analysis
ToR	Terms of Reference

Appendix A – List of host species of *Pseudocercospora pini-densiflorae*

Table A.1: An overview of the host species of *P. pini-densiflorae* (modified from Quintero, 2015)

Host	Comments	References
Abies procera Rehder		Farr and Rossman (2017)
Abies sachalinensis (F. Schmidt) Mast.	Artificially inoculated	Suto (1979)
Abies veitchii Lindl.	Artificially inoculated	Suto (1979)
Cedrus deodara (Roxb. ex D. Don) G. Don	Artificially inoculated	Suto (1979)
Larix kaempferi (Lamb.) Carriére	Discrepancy in inoculation examinations; Ito (1972) demonstrated no symptomatology on needles inoculated with *C. pini-densiflorae*, while Suto (1979) demonstrated the opposite	Suto (1979)
Picea glehnii (F. Schmidt) Mast.	Artificially inoculated	Suto (1979)
Picea jezoensis (Siebold & Zucc.) Carriére		Suto (1979)
Pinus aristata Engelmann		Ito (1972)
Pinus attenuata Lemmon		Ivory (1994)
Pinus canariensis C. Smith ex de Candolle	Highly susceptible	Mulder and Gibson (1972)
Pinus caribaea Morelet		Mulder and Gibson (1972)
Pinus cembra L.		Farr and Rossman (2017)
Pinus contorta Douglas ex Loudon	Highly susceptible	Ito (1972)
Pinus densiflora Siebold & Zuccarini	Susceptible	Ito (1972)
Pinus echinata Mill.	Susceptible	Chen (1965)
Pinus elliottii Engelmann		Ivory (1994)
Pinus flexilis Edwin James		Ito (1972)
Pinus greggii Engelmann ex Parl.		Singh et al. (1983)
Pinus halepensis Mill.	Highly susceptible	Ito (1972)
Pinus jeffreyi Balfour	Highly susceptible	Ito (1972)
Pinus kesiya Royle ex Gordon		Kobayashi et al. (1979)
Pinus lambertiana Douglas	Highly susceptible	Ito (1972)
Pinus luchuensis Mayr	Susceptible	Mulder and Gibson (1972)
Pinus massoniana Lambert	Susceptible	Chen (1965)
Pinus maximinoi H.E. Moore	Slightly susceptible	Ivory (1987)
Pinus merkusii Jungh. & de Vriese		Kobayashi et al. (1979)
Pinus morrisonicola Hayata		Chen (1965)
Pinus muricata D. Don	Highly susceptible	Ivory (1987)
Pinus nigra J.F. Arnold	Highly susceptible	Ito (1972)
Pinus oocarpa Schiede ex Schlechtendal		Ivory (1994)
Pinus palustris Mill.		Chen (1965)
Pinus patula Schlechtendal & Chamisso		Ito (1972)
Pinus pinaster Aiton	Highly susceptible	Mulder and Gibson (1972)
Pinus pinea L.	Highly susceptible	Ito (1972)
Pinus ponderosa P. Lawson & C. Lawson	Highly susceptible	Ito (1972)
Pinus pseudostrobus Lindl.		Ivory (1987)
Pinus radiata D. Don	Highly susceptible	Mulder and Gibson (1972)
Pinus resinosa Aiton		Ito (1972)

Host	Comments	References
Pinus roxburghii Sargent		Ivory (1994)
Pinus taeda L.		Ito (1972)
Pinus taiwanensis Hayata		Chen (1965)
Pinus tecunumanii Eguiluz & J.P. Perry	Slightly susceptible	Ivory (1987)
Pinus thunbergii Parlatore	Susceptible	Mulder and Gibson (1972)
Pinus strobus L.		Mulder and Gibson (1972)
Pinus sylvestris L.	Highly susceptible	Ito (1972)
Pinus wallichiana A.B. Jacks		Ivory (1994)

Appendix B – Methodological notes on Figure 2

The relative probability of presence (RPP) reported here for *Pinus* spp. in Figure 2 and in the European Atlas of Forest Tree Species (de Rigo et al., 2016; San-Miguel-Ayanz et al., 2016) is the probability of that genus to occur in a given spatial unit (de Rigo et al., 2017). In forestry, such a probability for a single taxon is called 'relative'. The maps of RPP are produced by spatial multiscale frequency analysis (C-SMFA) (de Rigo et al., 2017) of species presence data reported in geolocated plots by different forest inventories (de Rigo et al., 2014).

B.1. Geolocated plot databases

The RPP models rely on five geodatabases that provide presence/absence data for tree species and genera (de Rigo et al., 2014, 2016, 2017). The databases report observations made inside geolocalised sample plots positioned in a forested area, but do not provide information about the plot size or consistent quantitative information about the recorded species beyond presence/absence.

The harmonisation of these data sets was performed within the research project at the origin of the European Atlas of Forest Tree Species (de Rigo et al., 2016; San-Miguel-Ayanz, 2016; San-Miguel-Ayanz et al., 2016). Given the heterogeneity of strategies of field sampling design and establishment of sampling plots in the various national forest inventories (Chirici et al., 2011a,b), and also given legal constraints, the information from the original data sources was harmonised to refer to an INSPIRE compliant geospatial grid, with a spatial resolution of 1 km^2 pixel size, using the ETRS89 Lambert Azimuthal Equal-Area as geospatial projection (EPSG: 3035, http://spatialreference.org/ref/epsg/etrs89-etrs-laea/).

B.1.1. European National Forestry Inventories database

This data set was derived from National Forest Inventory data and provides information on the presence/absence of forest tree species in ∼ 375,000 sample points with a spatial resolution of 1 km^2/pixel, covering 21 European countries (de Rigo et al., 2014, 2016).

B.1.2. Forest Focus/Monitoring data set

This project is a Community scheme for harmonised long-term monitoring of air pollution effects in European forest ecosystems, normed by EC Regulation No 2152/2003[5]. Under this scheme, the monitoring is carried out by participating countries on the basis of a systematic network of observation points (Level I) and a network of observation plots for intensive and continuous monitoring (Level II). For managing the data, the JRC implemented a Forest Focus Monitoring Database System, from which the data used in this project were taken (Hiederer et al., 2007; Houston Durrant and Hiederer, 2009). The complete Forest Focus data set covers 30 European Countries with more than 8,600 sample points.

B.1.3. BioSoil data set

This data set was produced by one of a number of demonstration studies initiated in response to the 'Forest Focus' Regulation (EC) No 2152/2003 mentioned above. The aim of the BioSoil project was to provide harmonised soil and forest biodiversity data. It comprised two modules: a Soil Module (Hiederer et al., 2011) and a Biodiversity Module (Houston Durrant et al., 2011). The data set used in the C-SMFA RPP model came from the Biodiversity module, in which plant species from both the tree layer and the ground vegetation layer were recorded for more than 3,300 sample points in 19 European Countries.

B.1.4. European Information System on Forest Genetic Resources (EUFGIS)

EUFGIS (http://portal.eufgis.org) is a smaller geodatabase that provides information on tree species composition in over 3,200 forest plots in 34 European countries. The plots are part of a network of

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[5] Council of the European Union, 2003. Regulation (EC) No 2152/2003 of the European Parliament and of the Council of 17 November 2003 concerning monitoring of forests and environmental interactions in the Community (Forest Focus). Official Journal of the European Union 46 (L 324), p. 1–8.

forest stands managed for the genetic conservation of one or more target tree species. Hence, the plots represent the natural environment to which the target tree species are adapted.

B.1.5. Georeferenced Data on Genetic Diversity (GD^2)

GD^2 (http://gd2.pierroton.inra.fr) provides information about 63 species of interest for genetic conservation. The database covers 6,254 forest plots located in stands of natural populations that are traditionally analysed in genetic surveys. While this database covers fewer species than the others, it covers 66 countries in Europe, North Africa, and the Middle East, making it the dataset with the largest geographic extent.

B.2. Modelling methodology

For modelling, the data were harmonised in order to have the same spatial resolution (1 km^2) and filtered to a study area that comprises 36 countries in the European continent. The density of field observations varies greatly throughout the study area and large areas are poorly covered by the plot databases. A low density of field plots is particularly problematic in heterogeneous landscapes, such as mountainous regions and areas with many different land use and cover types, where a plot in one location is not representative of many nearby locations (de Rigo et al., 2014). To account for the spatial variation in plot density, the model used here (C-SMFA) considers multiple spatial scales when estimating RPP. Furthermore, statistical resampling is systematically applied to mitigate the cumulated data-driven uncertainty.

The presence or absence of a given forest tree species then refers to an idealised standard field sample of negligible size compared with the 1 km^2 pixel size of the harmonised grid. The modelling methodology considered these presence/absence measures as if they were random samples of a binary quantity (the punctual presence/absence, not the pixel one). This binary quantity is a random variable having its own probability distribution which is a function of the unknown average probability of finding the given tree species within a plot of negligible area belonging to the considered 1 km^2 pixel (de Rigo et al., 2014). This unknown statistic is denoted hereinafter with the name of 'probability of presence'.

C-SMFA performs spatial frequency analysis of the geolocated plot data to create preliminary RPP maps (de Rigo et al., 2014). For each 1 km^2 grid cell, the model estimates kernel densities over a range of kernel sizes to estimate the probability that a given species is present in that cell. The entire array of multiscale spatial kernels is aggregated with adaptive weights based on the local pattern of data density. Thus, in areas where plot data are scarce or inconsistent, the method tends to put weight on larger kernels. Wherever denser local data are available, they are privileged ensuring a more detailed local RPP estimation. Therefore, a smooth multiscale aggregation of the entire arrays of kernels and data sets is applied instead of selecting a local 'best preforming' one and discarding the remaining information. This array-based processing, and the entire data harmonisation procedure, are made possible thanks to the semantic modularisation which defines the Semantic Array Programming modelling paradigm (de Rigo, 2012).

The probability to find a single species (e.g. a particular coniferous tree species) in a 1 km^2 grid cell cannot be higher than the probability of presence of all the coniferous species combined. The same logical constraints applied to the case of single broadleaved species with respect to the probability of presence of all the broadleaved species combined. Thus, to improve the accuracy of the maps, the preliminary RPP values were constrained so as to not exceed the local forest-type cover fraction with an iterative refinement (de Rigo et al., 2014). The forest-type cover fraction was estimated from the classes of the Corine Land Cover (CLC) maps which contain a component of forest trees (Bossard et al., 2000; Büttner et al., 2012).

The resulting probability of presence is relative to the specific tree taxon, irrespective of the potential co-occurrence of other tree taxa with the measured plots, and should not be confused with the absolute abundance or proportion of each taxon in the plots. RPP represents the probability of finding at least one individual of the taxon in a plot placed randomly within the grid cell, assuming that the plot has negligible area compared with the cell. As a consequence, the sum of the RPP associated with different taxa in the same area is not constrained to be 100%. For example, in a forest with two co-dominant tree species which are homogeneously mixed, the RPP of both may be 100% (see e.g. the Glossary in San-Miguel-Ayanz et al. (2016), http://forest.jrc.ec.europa.eu/media/atlas/Glossary.pdf).

The robustness of RPP maps depends strongly on sample plot density, as areas with few field observations are mapped with greater uncertainty. This uncertainty is shown qualitatively in maps of 'RPP trustability'. RPP trustability is computed on the basis of the aggregated equivalent number of sample plots in each grid cell (equivalent local density of plot data). The trustability map scale is relative, ranging from 0 to 1, as it is based on the quantiles of the local plot density map obtained using all field observations for the species. Thus, trustability maps may vary among species based on the number of databases that report a particular species (de Rigo et al., 2014, 2016).

The RPP and relative trustability range from 0 to 1 and are mapped at a 1 km spatial resolution. To improve visualisation, these maps can be aggregated to coarser scales (i.e. 10×10 pixels or 25×25 pixels, respectively, summarising the information for aggregated spatial cells of 100 and 625 km^2) by averaging the values in larger grid cells.