SCIENTIFIC OPINION

EFSA Journal

ADOPTED: 20 September 2018

doi: 10.2903/j.efsa.2018.5445

Pest categorisation of *Thecaphora solani*

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Abstract

The Panel on Plant Health performed a pest categorisation of the fungus *Thecaphora solani*, the causal agent of smut of potato, for the EU. The identity of the pest is well established and reliable methods exist for its detection and identification. *T. solani* is present in Bolivia, Chile, Colombia, Ecuador, Mexico, Panama, Peru and Venezuela. The pathogen is not known to occur in the EU and is listed in Annex IAI of Directive 2000/29/EC, meaning its introduction into the EU is prohibited. The major host is *Solanum tuberosum* (potato), but various other tuber-forming *Solanum* species are also affected. The pest has also been reported on *Solanum lycopersicum* (tomato), and wild solanaceous plants are also affected. All the major hosts and pathways of entry are currently regulated. Host availability and climate matching suggest that *T. solani* could establish in parts of the EU and further spread by human-assisted means. The disease induces gall formation on potato tubers, stolons and underground stem parts, reducing yield and making tubers unmarketable. The pest introduction in the EU would potentially cause impacts to potato production. In the infested areas, the only available strategy to control the disease and prevent it from spreading is the application of quarantine and sanitation measures and the cultivation of resistant varieties. The main uncertainties concern the host range, the biology and epidemiology of the pest, and the potential of the pest to enter the EU through three unregulated minor pathways. *T. solani* meets all the criteria assessed by EFSA for consideration as potential Union quarantine pest. The criteria for considering *T. solani* as a potential Union regulated non-quarantine pest are not met, since the pest is not known to occur in the EU.

Keywords: European Union, impacts, phytosanitary measures, quarantine, smut of potato, *Solanum tuberosum*

Requestor: European Commission

Question number: EFSA-Q-2018-00015

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Suggested citation: EFSA PLH Panel (EFSA Panel on Plant Health), Bragard C, Dehnen-Schmutz K, Di Serio F, Gonthier P, Jacques M-A, Jaques Miret JA, Justesen AF, MacLeod A, Sven Magnusson C, Milonas P, Navas-Cortes JA, Parnell S, Potting R, Reignault PL, Thulke H-H, Van der Werf W, Yuen J, Zappalà L, Rossi V, Vloutoglou I, Bottex B and Vicent Civera A, 2018. Scientific Opinion on the pest categorisation of *Thecaphora solani*. EFSA Journal 2018;16(10):5445, 26 pp. https://doi.org/10.2903/j.efsa.2018.5445

ISSN: 1831-4732

Table of contents

1. Introduction

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

1.1.1. Background

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

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

1.1.2. Terms of reference

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

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

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

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

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

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

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

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

1.1.2.1. Terms of Reference: Appendix 1

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

Annex IIAI

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

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

(b) Bacteria

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

(c) Fungi

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

(d) Virus and virus-like organisms

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

Annex IIB

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

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

(b) Bacteria

Curtobacterium flaccumfaciens pv. flaccumfaciens (Hedges) Collins and Jones

(c) Fungi

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

1.1.2.2. Terms of Reference: Appendix 2

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

Annex IAI

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

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

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

Group of Tephritidae (non-EU) such as:

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

(c) Viruses and virus-like organisms

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

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

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

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

Annex IIAI

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

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

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

1.1.2.3. Terms of Reference: Appendix 3

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

Annex IAI

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

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

(b) Fungi

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

(c) Viruses and virus-like organisms

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

(d) Parasitic plants

Arceuthobium spp. (non-EU)

Annex IAII

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

Meloidogyne fallax Karssen
Popillia japonica Newman
Rhizoecus hibisci Kawai and Takagi

(b) Bacteria

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

(c) Fungi

Melampsora medusae Thümen
Synchytrium endobioticum (Schilbersky) Percival

Annex I B

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

Leptinotarsa decemlineata Say
Liriomyza bryoniae (Kaltenbach)

(b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

1.2. Interpretation of the Terms of Reference

Thecaphora solani 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 excluding Ceuta, Melilla and the outermost regions of Member States referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

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

2.1.2. Database search

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

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

The Europhyt database was consulted for pest-specific notifications on interceptions and outbreaks. Europhyt is a web-based network run by the Directorate General for Health and Food Safety (DG SANTÉ) of the European Commission, 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 Member States (MS) and the phytosanitary measures taken to eradicate or avoid their spread.

2.2. Methodologies

The Panel performed the pest categorisation for *T. solani*, following guiding principles and steps in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

This work was initiated following an evaluation of the EU plant health regime. Therefore, to facilitate the decision-making process, in the conclusions of the pest categorisation, the Panel addresses explicitly each criterion for a Union quarantine pest and for a Union RNQP in accordance with Regulation (EU) 2016/2031 on protective measures against pests of plants, and includes additional information required in accordance with 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. A pest that does not qualify as a quarantine pest may still qualify as a RNQP that needs to be addressed in the opinion. For the pests regulated in the protected zones only, the scope of the categorisation is the territory of the protected zone; thus, the criteria refer to the protected zone instead of the EU territory.

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

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

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

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
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. The identity of the pest is well-established.

T. solani is a soil-borne fungus of the family Glomosporiaceae. The Index Fungorum database (www.indexfungorum.org) provides the following taxonomical identification:

Current scientific name: *Thecaphora solani* (Thirumulachar & M.J. O'Brien) Mordue, 1988

Family – Glomosporiaceae
Genus – *Thecaphora*
Species – *solani*

Other reported synonyms (EPPO, online): *Angiosorus solani* Thirumulachar & M.J. O'Brien

Common name: smut of potato

Other common names (CABI online; EPPO, online): potato smut, thecaphora smut, thecaphora smut of potato

3.1.2. Biology of the pest

T. solani is a biotrophic plant pathogen and survives in soil for more than 7 years (O'Brien and Thirumalachar, 1972; Torres, 2002). There is limited information on the biology of the pest or the epidemiology of the disease (CABI, online). Except for roots, all underground plant parts are susceptible to infection by the pest (Torres, 2001). Infection takes place where there is high soil moisture (Torres, 2001). After penetration of the cortex, hyphae ramify profusely, growing toward the phloem and parenchyma. Upon reaching the cambium, the mycelium stimulates cell proliferation. This massive invasion by the fungus causes hypertrophy of the inner phloem and parenchyma tissues. Spores originate by compaction of the thick-walled hyphae at certain intervals. Uncertainty exists about the temperatures favouring infection and disease development because of lack of information in the available literature (Torres, 2001). The disease occurs in cool, mountainous areas, but it has also been found in warmer, coastal climates. It is also favoured by high humidity and saline soils, with its incidence increasing in the absence of crop rotation (Torres, 2001). Formation of galls is observed 45–60 days after planting (Torres, 2001).

Andrade et al. (2004) reported that isolates of the pest were grown *in vitro* on potato dextrose agar and malt yeast peptone agar at 18–20°C. However, *T. solani* teliospores have a very low germination capability. Only 27% of the isolates studied by Andrade et al. (2004) yielded cultures *in vitro*. Germination of teliospores did not involve the production of basidia and basidiospores or growth of a yeast-like anamorph. Mycelium grew slowly and produced both teliospores and chlamydospore-like structures. Zachmann and Baumann (1975) reported that teliospores did not germinate in water, soil extract, potato root extract or in the presence of potato growing roots, or on internal tissue of tubers of a susceptible variety. Based on the above and the observation that, in the coastal region of Peru, potato tubers were simultaneously infected with both the pest and nematodes of the genus *Meloidogyne* (root-knot nematodes), Zachmann and Baumann (1975) suggested a possible interaction between *T. solani* and nematodes. However, the disease has also been found at altitudes of 3,500 m in Peru, where the above-mentioned nematodes are not present (Torres, 2002).

3.1.3. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes. *Thecaphora solani* can be detected and identified based on host association, symptomatology, morphology and molecular methods.

T. solani can be detected and identified on a potato plant material based on symptomatology and morphology of its teliospores produced in galls.

T. solani can also be identified in culture by polymerase chain reaction (PCR) amplification of ribosomal DNA (LSU rDNA) from mycelium produced by germinating teliospores, and subsequent DNA sequencing (Andrade et al., 2004). Nevertheless, the low germination rate of teliospores makes the application of this method difficult. No official diagnostic protocols exist for the detection and identification of the pest.

Symptoms

The main symptom is galls developing below the soil line on stems, stolons and tubers of potato plants (Torres, 2001). Symptoms do not occur on aerial parts or roots of the infected plants (Torres, 2001). In general, the size and shape of galls depend mostly on the time of infection (Torres, 2001). The biggest galls are formed on underground stems, which are infected first. Their size varies from a few centimetres up to 10 cm or more (Torres et al., 1998), and may weigh over 300 g (Untiveros and de Icoechea, 1980). Galls on stolons may form anywhere along the length of the stolon and generally are smaller than those on stems. The galls formed on stems and stolons start as small lateral outgrowths but with time, they surround the organs to which they are attached.

On tubers, two types of symptoms are observed: (a) small galls, mostly at the apical end, which appear as secondary growths partially attached to the tubers and (b) slight protuberances on the surface of the tubers, which may appear in some varieties but not in others. In some cases, the latter symptoms look similar to those caused by the root-knot nematodes. After 2–3 months in storage, the protuberances become sunken and suberised (Torres, 2001). When these tubers sprout, new galls develop on the young sprouts or on the tuber surface near sprouts. The size of the galls formed on tubers varies from less than 1 mm to 4 cm or more in diameter (Acuña, 1981). Infected tubers are hard and misshapen (Chalkley, 2018). The whole or only part of the tuber may be infected. As symptoms appear mainly on underground parts of potato plants, the disease is often not noticed before harvest.

A very distinctive symptom is the presence of oval to irregular locular sori of variable sizes within the galls which contain a reddish-dark, granular-powdery mass of teliospores (Mordue, 1988; Vánky, 1988). Completely infected tubers later turn into dry, brown powdery masses of numerous spores (Chalkley, 2018).

Susceptibility of potato varieties to infection by *T. solani* varies (Bazan de Segura, 1960; Zachmann and Baumann, 1975). Several resistant accessions are available in the Potato Germplasm Collection of the International Potato Centre (CIP) (Torres and Martin, 1986; Torres, 2001).

On tomato, galls develop particularly at the junction of the stem and roots (Andrade, 2012; Chalkley, 2018).

Symptoms caused on potato tubers by *T. solani* may appear similar to those caused by powdery scab (*Spongospora subterranea* f. sp. *subterranea*), common scab (*Actinomyces scabies*), potato wart disease (*Synchytrium endobioticum*) or the damage caused by the root-knot nematode (*Meloidogyne incognita*). The smut fungus *Polysaccopsis hieronymi,* which affects wild *Solanum* species in South America, has sori similar to those of *T. solani*, however the spore balls of the former are black and consist of viable spores surrounded by sterile cells, whereas in the case of *T. solani*, the spores are not surrounded by sterile cells (O'Brien and Thirumalachar, 1972). Therefore, reliable detection and identification of the pest on potato plant material is only possible by laboratory examination.

Morphology

The sori are locular, 1–4 mm in diameter (EPPO, online). The sporiferous hyphae lining locules produces spore balls in the flesh of the galls. Immature locules are usually surrounded by brown corky tissue of potato. Mature spore balls comprise of 2–8 teliospores (rarely solitary), cinnamon to rust-brown, 15–50 × 12–40 μm in diameter (Zachmann and Baumann, 1975). Spores are pressed together but they can often be teased apart (EPPO, online). They are globose to angular, smooth on the contiguous side and densely verrucose on the free side, 7.5–20 × 8–18 μm.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

T. solani is indigenous to the Andean region of South America (EPPO, online) (Figure 1 and Table 2). At the end of the 1980s, the disease was widely distributed in South America (Bolivia, Chile, Colombia, Ecuador, Peru and Venezuela) and in the southern part of North America (Mexico) (Mordue, 1988; Torres, 2001; Andrade et al., 2004). It has also been reported from Panama (McGuire and Crandall, 1967). The pest has not been reported from any other part of the world.

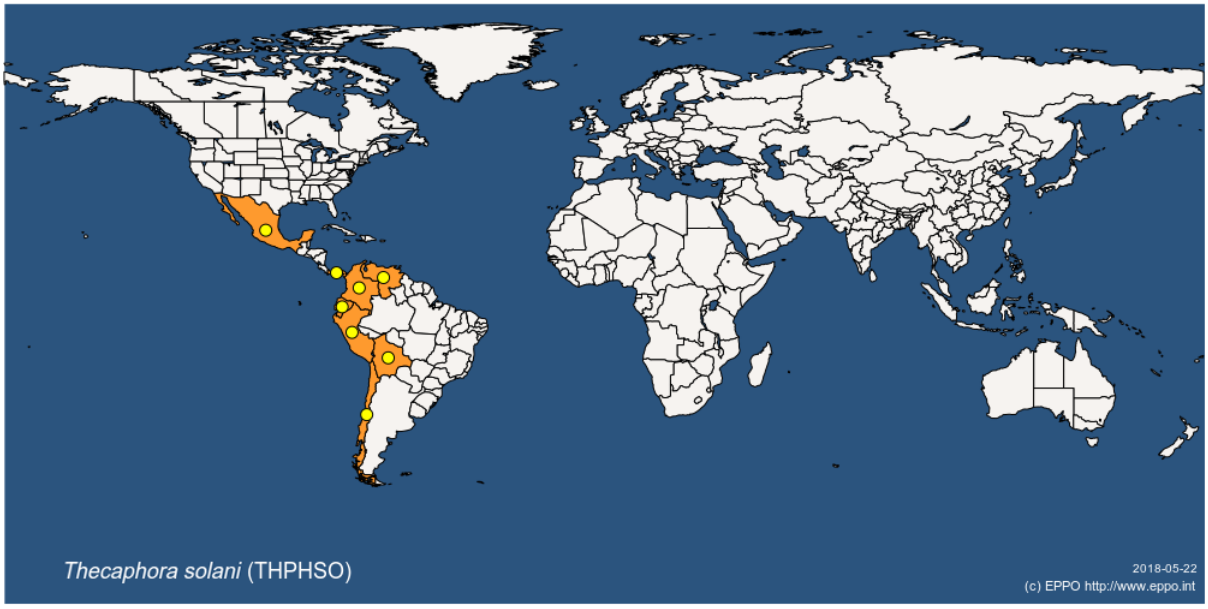

Figure 1: Global distribution of *Thecaphora solani* (extracted from the EPPO Global Database accessed on 22 May 2018)

Table 2: Global distribution of *Thecaphora solani* based on information extracted from the EPPO Global Database (last updated: 12/9/2017; last accessed: 22/5/2018)

Continent	Country	Status
America	Bolivia	Present, no details
	Chile	Present, restricted distribution
	Colombia	Present, no details
	Ecuador	Present, restricted distribution
	Mexico	Present, no details
	Panama	Present, no details
	Peru	Present, no details
	Venezuela	Present, no details

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 in not known to be present in the EU territory.

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

Thecaphora solani is listed in Council Directive 2000/29/EC. Details are presented in Tables 3 and 4.

Table 3: *Thecaphora solani* in Council Directive 2000/29/EC

Annex I, Part A	**Harmful organisms whose introduction into, and spread within, all member states shall be banned**
Section I	**Harmful organisms not known to occur in any part of the community and relevant for the entire community**
(c)	**Fungi**
15.	*Thecaphora solani* Barrus

3.3.2. Legislation addressing the hosts of *Thecaphora solani*

Table 4: Regulated hosts and commodities that may involve *Thecaphora solani* 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**	
	Description	Country of origin
10.	Tubers of *Solanum tuberosum* L., seed potatoes	Third countries other than Switzerland
11.	Plants of stolon- or tuber-forming species of *Solanum* L. or their hybrids, intended for planting, other than those tubers of *Solanum tuberosum* L. as specified under Annex III A (10)	Third countries
13.	Plants of *Solanaceae* intended for planting, other than seeds and those items covered by Annex III A (10), (11) or (12)	Third countries, other than European and Mediterranean countries
14.	Soil and growing medium as such, which consists in whole or in part of soil or solid organic substances such as parts of plants, humus including peat or bark, other than that composed entirely of peat	Turkey, Belarus, Moldavia, Russia, Ukraine and third countries not belonging to continental Europe, other than the following: Egypt, Israel, Libya, Morocco, Tunisia
Annex IV, Part A	**Special requirements which shall be laid down by all member states for the introduction and movement of plants, plant products and other objects into and within all Member States**	
Section I	**Plants, plant products and other objects originating outside the Community**	
	Plants, plant products and other objects	Special requirements
34.	Soil and growing medium, attached to or associated with plants, consisting in whole or in part of soil or solid organic substances such as parts of plants, humus including peat or bark or consisting in part of any solid inorganic substance, intended to sustain the vitality of the plants, originating in: – Turkey, – Belarus, Georgia, Moldova, Russia, Ukraine, – non-European countries, other than Algeria, Egypt, Israel, Libya, Morocco, Tunisia	Official statement that: a) the growing medium, at the time of planting, was: – either free from soil, and organic matter, or – found free from insects and harmful nematodes and subjected to appropriate examination or heat treatment or fumigation to ensure that it was free from other harmful organisms, or – subjected to appropriate heat treatment or fumigation to ensure freedom from harmful organisms, and b) since planting: – either appropriate measures have been taken to ensure that the growing medium has been maintained free from harmful organisms, or – within two weeks prior to dispatch, the plants were shaken free from the medium leaving the minimum amount necessary to sustain vitality during transport, and, if replanted, the growing medium used for that purpose meets the requirements laid down in (a)

Section II	Plants, plant products and other objects originating in the Community	
	Plants, plant products and other objects	Special requirements
18.2	Tubers of *Solanum tuberosum* L., intended for planting, other than tubers of those varieties officially accepted in one or more Member States pursuant to Council Directive 70/457/EEC of 29 September 1970 on the common catalogue of varieties of agricultural plant species (1)	Without prejudice to the special requirements applicable to the tubers listed in Annex IV(A)(II) (18.1), official statement that the tubers: – belong to advanced selections such a statement being indicated in an appropriate way on the document accompanying the relevant tubers, – have been produced within the Community, and – have been derived in direct line from material which has been maintained under appropriate conditions and has been subjected within the Community to official quarantine testing in accordance with appropriate methods and has been found, in these tests, free from harmful organisms.
18.3	Plants of stolon or tuber-forming species of *Solanum* L., or their hybrids, intended for planting, other than those tubers of *Solanum tuberosum* L. specified in Annex IV(A)(II) (18.1) or (18.2), and other than culture maintenance material being stored in gene banks or genetic stock collections	(a) The plants shall have been held under quarantine conditions and shall have been found free of any harmful organisms in quarantine testing; (b) the quarantine testing referred to in (a) shall: (aa) be supervised by the official plant protection organisation of the Member State concerned and executed by scientifically trained staff of that organisation or of any officially approved body; (bb) be executed at a site provided with appropriate facilities sufficient to contain harmful organisms and maintain the material including indicator plants in such a way as to eliminate any risk of spreading harmful organisms; (cc) be executed on each unit of the material, – by visual examination at regular intervals during the full length of at least one vegetative cycle, having regard to the type of material and its stage of development during the testing programme, for symptoms caused by any harmful organisms, – by testing, in accordance with appropriate methods to be submitted to the Committee referred to in Article 18: – in the case of all potato material at least for: – Andean potato latent virus, – Arracacha virus B. oca strain, – Potato black ringspot virus, – Potato spindle tuber viroid, – Potato virus T, – Andean potato mottle virus, – common potato viruses A, M, S, V, X and Y (including Yo, Yn and Yc) and Potato leaf roll virus,

		– *Clavibacter michiganensis* ssp. *sepedonicus* (Spieckermann and Kotthoff) Davis et al., – *Ralstonia solanacearum* (Smith) Yabuuchi et al., – in the case of true seed potato of least for the viruses and viroid listed above; (dd) by appropriate testing on any other symptom observed in the visual examination in order to identify the harmful organisms having caused such symptoms; (c) any material, which has not been found free, under the testing specified under (b) from harmful organisms as specified under (b) shall be immediately destroyed or subjected to procedures which eliminate the harmful organism(s); (d) each organisation or research body holding this material shall inform their official Member State plant protection service of the material held.
18.4	Plants of stolon, or tuber-forming species of *Solanum* L., or their hybrids, intended for planting, being stored in gene banks or genetic stock collections	Each organisation or research body holding such material shall inform their official Member State plant protection service of the material held.
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 I	**Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community and which must be accompanied by a plant passport**	
1.3.	Plants of stolon- or tuber-forming species of *Solanum* L. or their hybrids, intended for planting.	
Part B	**Plants, plant products and other objects originating in territories, other than those territories referred to in Part A**	
Section I	**Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community**	
4.	Tubers of *Solanum tuberosum* L.	
7.	(a) Soil and growing medium as such, which consists in whole or in part of soil or solid organic substances such as parts of plants, humus including peat or bark, other than that composed entirely of peat. (b) Soil and growing medium, attached to or associated with plants, consisting in whole or in part of material specified in (a) or consisting in part of any solid inorganic substance, intended to sustain the vitality of the plants, originating in: —Turkey, — Belarus, Moldova, Russia, Ukraine, — non-European countries, other than Algeria, Egypt, Israel, Libya, Morocco, Tunisia.	

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

The major host of *T. solani* is cultivated potato (*Solanum tuberosum*) (EPPO, online), but various other tuber-forming species of *Solanum* are also affected, particularly *S. tuberosum* subsp. *andigenum* and *Solanum stoloniferum* (Mordue, 1988; EPPO, online). The pest has also been reported to affect

Solanum lycopersicum (tomato) (Andrade, 2012), and solanaceous wild plants/weeds, such as *Datura stramonium,* a common weed in potato fields of the Andean region (Mordue, 1988; Torres, 2001; Andrade, 2012; EPPO, online).

S. tuberosum, which is the only major host of *T. solani* (EPPO, online), is regulated in the EU. Therefore, the Panel decided to focus this pest categorisation on *S. tuberosum*.

3.4.2. Entry

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

YES., however, all the pathways associated with host plants for planting and soil as commodity or substrate originating in infested third countries are regulated under the current EU legislation (Council Directive 2000/29/EEC).

The PLH Panel identified the following pathways for the entry of *T. solani* from infested third countries into the EU territory, in the absence of the current EU legislation:

1) potato tubers intended for planting (seed tubers),
2) potato tubers intended for consumption or processing (ware potatoes), that may be planted (especially in small holdings and private gardens) or discarded (as whole potatoes or peels) or used for livestock feed,
3) host plant species of the genus *Solanum* intended for planting, other than *S. tuberosum* seed tubers,
4) soil adhering to potato tubers (seed and ware potatoes),
5) soil adhering to underground parts (tubers, bulbs, roots, etc.) of host and non-host plants for planting, other than potato seed tubers,
6) soil and growing media containing soil or organic substances not attached to or associated with plants (soil as commodity),
7) soil adhering to farm machinery and implements, footwear, vehicles, etc. (soil as contaminant)
8) waste (plant material and water) of potato processing industries used as fertiliser or irrigation, and
9) manure derived from livestock fed on infected potato tubers (whole tubers or peels) or having grazed in infested fields.

T. solani is not known to be seed-borne. The pest is unlikely to enter the EU territory by natural means (wind, water) because of the distance between the infested third countries and the risk assessment area, and the limited capacity of the pest for natural spread.

The following pathways of entry of *T. solani* into the EU territory are regulated by the current EU legislation (Table 3):

- potato tubers intended for planting (seed tubers) originating in third countries,
- tubers of *S. tuberosum* (ware potatoes) originating in infested third countries,
- stolon- or tuber-forming plants for planting of *Solanum* spp., or their hybrids, other than *S. tuberosum* seed tubers, originating in third countries,
- plants for planting of the family Solanaceae, other than *S. tuberosum* seed tubers and stolon- or tuber-forming *Solanum* species, originating in third countries, other than European non-EU-28 countries and Mediterranean countries,
- plants with roots, planted or intended for planting, grown in the open air in infested third countries,
- soil and growing media attached to or associated with plants originating in Turkey, Belarus, Georgia, Moldova, Russia, Ukraine and non-European countries, other than Algeria, Egypt, Israel, Libya, Morocco and Tunisia
- soil and growing media not attached to or associated with plants originating in Turkey, Belarus, Moldavia, Russia, Ukraine and third countries not belonging to continental Europe other than Egypt, Israel, Libya, Morocco and Tunisia.

Based on the above, all the pathways associated with host plants for planting, and soil as commodity or substrate, originating in infested third countries are regulated (Council Directive 2000/29/EEC).

Three of the potential pathways of entry are currently not regulated:

- soil adhering to agricultural machinery and implements, footwear, vehicles, etc.,

- manure of livestock fed on infected potato tubers or having grazed in infested fields in third countries,
- waste of potato processing industries originating in infested third countries and used as fertiliser.

The Panel considers these three potential pathways as uncertain because of the distance between the infested countries and the risk assessment area, and due to the absence of import data in the Eurostat database (accessed on 2/5/2018). These pathways are therefore not considered as major pathways and not further addressed in the following sections.

According to Eurostat, during the period 2011–2015, an average of around 360 000 tonnes of potato tubers was imported from third countries yearly; the amount of potato tubers originating in infested countries is negligible (Table 5).

Table 5: Volume (in tonnes) of potato tubers imported during the period 2011–2015 into the EU from third countries (Source: Eurostat, extracted on 3/5/2018)

EU-28 potato tuber importation (in tonnes)	2011	2012	2013	2014	2015
From non-EU countries	402,036	349,711	455,497	288,063	306,179
From non-EU infested countries	0	1.8	2.5	3.3	0

There is no record of interception of *T. solani* in the Europhyt database (online; search performed on 22 May 2018).

3.4.3. Establishment

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

YES. The biotic (host availability) and abiotic (climate suitability) factors occurring in the risk assessment area are favourable for the establishment of *T. solani*.

3.4.3.1. EU distribution of main host plants

Potatoes are widely grown in the EU territory (Table 6).

Table 6: Area (in 1,000 ha) cultivated with *Solanum tuberosum* in the 28 EU Member States between 2011 and 2015 (Source: Eurostat, extracted on 3/5/2018).

Countries	2011	2012	2013	2014	2015	Mean of EU area grown with *Solanum tuberosum* (in 1,000 ha) during the period 2011–2015
European Union (EU-28)	1,922	1,798	1,741	1,663	1,656	1,756
Poland	393	373	337	267	293	333
Germany	259	238	243	245	237	244
Romania	248	229	208	203	196	217
France	159	154	161	168	167	162
Netherlands	159	150	156	156	156	155
United Kingdom	146	149	139	141	129	141
Belgium	82	67	75	80	79	77
Spain	80	72	72	76	72	74
Italy	62	59	50	52	50	55
Denmark	42	40	40	20	42	36
Lithuania	37	32	28	27	23	29
Portugal	27	25	27	27	25	26
Sweden	28	25	24	24	23	25
Greece	28	24	25	24	21	24
Czech Republic	26	24	23	24	23	24

Countries	2011	2012	2013	2014	2015	Mean of EU area grown with *Solanum tuberosum* (in 1,000 ha) during the period 2011–2015
Finland	24	21	22	22	22	22
Austria	23	22	21	21	20	22
Hungary	21	25	21	21	19	21
Bulgaria	16	15	13	10	11	13
Latvia	14	12	12	11	10	12
Croatia	11	10	10	10	10	10
Ireland	10	9	11	9	9	10
Slovakia	10	9	9	9	8	9
Estonia	6	6	5	4	4	5
Cyprus	5	5	5	5	5	5
Slovenia	4	3	3	4	3	3
Malta	1	1	1	1	1	1
Luxembourg	1	1	1	1	1	1

3.4.3.2. Climatic conditions affecting establishment

T. solani is known to occur in the Andean region of South America, Mexico and Panama. These areas are characterised by different Köppen–Geiger climate types (Peel et al., 2007) (Figure 2). The prevalent climate type is the tropical (mainly: Af, rainforest; Am, monsoon; Aw, savannah). Arid (mainly: BWh, desert, hot; BWk, desert, cold; BSk, steppe, cold) and, to a lesser extent, temperate (mainly: Cfb, without dry season, warm summer; Csb, dry and warm summer; Cwb, dry winter, warm summer; Cwc, dry winter, cold summer) climate types are also present.

In the EU, tropical climate types are not present. However, Cfb, Csb and BSk are present in central Europe, the UK, Ireland and in the Iberian Peninsula. Therefore, the climate is suitable for the establishment of *T. solani* in parts of the EU.

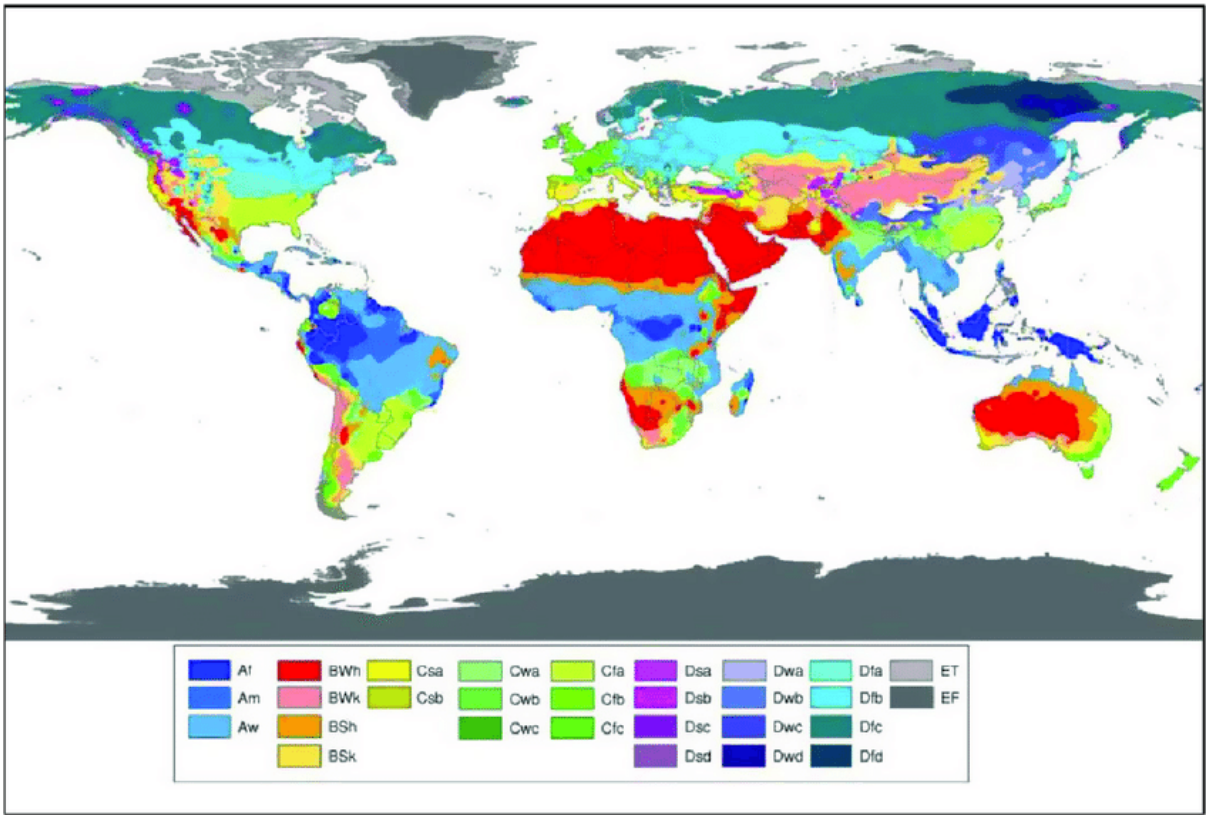

Figure 2: Köppen–Geiger climate type world map, from Peel et al. (2007)

3.4.4. Spread

3.4.4.1. Vectors and their distribution in the EU (if applicable)

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

How? Mainly by human-assisted means

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

NO. Spread of the pest is mainly via the movement of (i) infected potato seed tubers, and (ii) soil adhering to underground parts of host and non-host plants for planting, other than potato seed tubers

Spread by natural means. *T. solani* has limited capacity for spread by natural means (EPPO, online). Torres (2001) reported that teliospores can be dispersed within a field or between neighbouring fields by irrigation water.

Spread by human-assisted means. The pest can spread over long distances through the trade/ movement of infected potato tubers (Abbott, 1932) and infested soil adhering to potato tubers or below ground parts of host and non-host plants (e.g. roots, bulbs, stolons, etc.) or any other object (e.g. farm machinery, implements and footwear used in infested fields, vehicles visiting infested areas, etc.). Since 1984, *T. solani* has been intercepted by the USDA over 125 times in tubers of *S. tuberosum* and *S. stoloniferum*, almost all from Mexico (CABI, online).

T. solani could also be spread via hoofs of animals moving from one field to another as well as through manure from livestock fed on infected potato tubers or having grazed in infested fields (Torres, 2001; Andrade, 2012). The pest could potentially be spread via waste (e.g. discarded potatoes, soil, water) from potato processing industries used as fertiliser, land fill or irrigation water (Efremenko and Yakovleva, 1981; Langerfeld, 1984; Steinmöller et al., 2004). Potato processing is an important industrial sector in many EU MSs, including Germany, where 3 million tonnes of waste are produced of which the major part is used as fertiliser (Steinmöller et al., 2012).

3.5. Impacts

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

YES. The introduction of the pest would potentially cause direct and indirect impacts to potato production in the EU territory.

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?

YES. The presence of the pest on potato seed tubers has an economic impact as regards their intended use for planting.

Potatoes rank fourth on the list of world food crops, after maize, rice and wheat (FAOSTAT, online). The total world potato production was estimated at 381.7 million tonnes in 2014. The EU ranks third in fresh potato production after China and India (FAOSTAT, online). In 2015, the EU produced 53.2 million tonnes of potatoes, with Germany, France and the Netherlands as the largest producers (Table 7). The value of EU potato production, including seed potatoes, at basic prices was EUR 10 billion, representing 2.5% of the total EU agricultural output and 4.7% of the crop output at EU level (de Cicco and Jeanty, 2017). Most potatoes are traded in the internal EU market. The EU is a net potato exporter, but potatoes are imported into its territory in winter and spring from southern and eastern non-EU Mediterranean countries (de Cicco and Jeanty, 2017), and rarely from infested areas in Latin and Central America (Table 5).

Table 7: Potato production, including potato seed tubers, in the 28 EU Member States in 2015 (Source: Eurostat; extracted on 2/5/2018)

Country	Harvested production (in 1,000 tonnes)	Share of 28 EU MSs harvested production (%)
EU-28	53,160	100.00
Germany	10,370	19.51
France	7,114	13.38
Netherlands	6,652	12.51
Poland	6,152	11.57
United Kingdom	5,598	10.53
Belgium	3,665	6.89
Romania	2,625	4.94
Spain	2,284	4.30
Denmark	1,748	3.29
Italy	1,355	2.55
Sweden	803	1.51
Greece	556	1.05
Austria	536	1.01
Finland	532	1.00
Czech Republic	505	0.95
Portugal	487	0.92
Hungary	452	0.85
Lithuania	392	0.74
Ireland	360	0.68
Latvia	204	0.38
Croatia	171	0.32
Bulgaria	165	0.31
Slovakia	145	0.27
Cyprus	96	0.18
Slovenia	91	0.17
Estonia	81	0.15
Luxembourg	13	0.02
Malta	8	0.02

With regard to the impact of *T. solani* in infested areas, Torres and Henfling (1984) indicated that the disease can reduce yields of susceptible potato varieties by up to 85%. In Peru, production losses between 50% and 89% were reported during 1958 and 1959 in susceptible potato varieties (Bazan de Segura, 1960). Later, Zachmann and Baumann (1975) reported incidences between 11% and 42% of diseased tubers in susceptible potato varieties in Peru. In Chile, Andrade (2012) indicated yield losses ranging from 20% to 75%, depending on the region and inoculum sources (i.e. infested soil, infected tubers). Likewise, in Chile, Torres et al. (1998) reported disease incidence of 80% on harvested tubers of susceptible varieties. In Colombia, incidences of 21–46% on harvested tubers of susceptible varieties were reported by Sotelo and García (2001).

The introduction of the pest in the EU territory would potentially cause direct and indirect impacts to potato production.

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 3.3.

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

YES. The presence of *T. solani* on host and non-host plants for planting could be prevented by sourcing them in pest-free areas or places of production

3.6.1. Identification of additional measures

Phytosanitary measures are currently applied to potato seed or ware tubers and non-host plants or plant parts (bulbs, roots, tubers, etc.) for planting, including the soil attached to them: sourcing from pest-free areas or pest-free places of production, inspection and lab testing at the place of origin and at the EU entry point, quarantine and sanitation measures (See Section 3.3). There are no additional unregulated major hosts or pathways of entry.

Section 3.4.2 lists three minor pathways of entry currently unregulated and uncertain. Should the pest be introduced in the risk assessment area, these three pathways should be assessed as potential means of spread and possible mitigation measures be evaluated (EFSA PLH Panel, 2018).

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

The following factors can limit the feasibility and effectiveness of measures to prevent the entry, establishment and spread of *T. solani*:

- Inspection: (i) the similarity of symptoms caused by *T. solani* on underground parts of potato plants with those caused by other potato pathogens (e.g. *Spongospora subterranea* f. sp. *subterranea, Synchytrium endobioticum*, *Actinomyces scabies,* etc.) or pests (nematodes) makes visual inspection for the detection of the pathogen difficult and unreliable (see Section 3.1.3), (ii) inconspicuous galls present on potato tubers may go undetected during visual inspection, (iii) teliospores carried as contaminants on the surface of potato tubers, underground parts of non-host plants and other objects (e.g. farm machinery and implements, footwear, etc.) cannot be detected by visual inspection, and (iv) the long incubation period (45–60 days) and the development of symptoms on below ground parts of potato plants (tubers, stolons) reduces the effectiveness of visual inspection during the growing season for the early detection of the pest.
- Laboratory testing: the low germination capability of the teliospores and the lack of official diagnostic protocols make detection and identification of the pest on plant material and in soil difficult (see Section 3.1.3).
- Chemical control: the lack of effective chemical substances to be used as soil disinfectants or on the crop reduces the effectiveness of eradication of the pest.

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

Lack of effective plant protection products that can be applied to the crop or soil to prevent the presence of the pest on potato seed tubers (Sotelo and García, 2001; Andrade, 2012).

3.7. Uncertainty

1) Host range. It is not known whether wild species of the genus *Solanum* present in the EU territory are hosts of the pest.
2) Entry. Uncertainty exists on whether the pest could enter the EU territory on (i) soil adhering to agricultural machinery and implements, footwear, vehicles, etc., (ii) manure of livestock fed on infected potato tubers or having grazed in infested fields in third countries, and (iii) waste of potato processing industries originating in infested third countries and intended to be used as fertiliser because of the distance between the infested countries and the risk assessment area, and due to the absence of import data in the Eurostat database.

4. Conclusions

T. solani meets all the criteria assessed by EFSA for consideration as potential Union quarantine pest (Table 8). The criteria for considering *T. solani* as a potential Union RNQP are not met since the pest is not known to be present in the EU.

Table 8: 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 (*Thecaphora solani*) is clearly defined and there are reliable methods for its detection and identification	The identity of the pest (*Thecaphora solani*) is clearly defined and there are reliable methods for its detection and identification	None
Absence/ presence of the pest in the EU territory (Section 3.2)	The pest is not known to be present in the EU territory	The pest is not known to be present in the EU territory	None
Regulatory status (Section 3.3)	The pest is currently officially regulated in the EU as a quarantine pest (Council Directive 2000/29/EC)	The pest is currently officially regulated in the EU as a quarantine pest (Council Directive 2000/29/EC). There are no grounds to consider its status could be revoked	None
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	All the major hosts and pathways of entry are currently regulated (Council Directive 2000/29/EC)	The pest can spread in the EU territory through the movement of potato tubers (seed tubers, ware potatoes) and soil as commodity or contaminant [attached to potato tubers, or below ground parts of non-host plants, or other objects (e.g. farm machinery and implements, footwear, etc.] Therefore, potato seed tubers are not the only major means of spread	1) The host status of wild *Solanum* plant species present in the EU territory is not known (Uncertainty 1) 2) Uncertainty exists on whether the pest could enter the EU territory on (i) soil adhering to agricultural machinery and implements, footwear, vehicles, etc., (ii) manure of livestock fed on infected potato tubers or having grazed in infested fields in third countries, and (iii) waste of potato processing industries originating in infested third countries and intended to be used as fertiliser (Uncertainty 2)
Potential for consequences in the EU territory (Section 3.5)	The introduction of the pest in the EU territory would potentially cause direct and indirect impacts to potato production.	The presence of the pest on potato seed tubers has an economic impact, as regards the intended use of that plant material	None

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
Available measures (Section 3.6)	There are measures available to prevent the entry into, establishment and spread of the pest within the EU. These include pest-free areas or places of production, inspection and lab testing of imported potato tubers and soil adhering to them or below ground parts of non-host plants, cultivation of resistant potato varieties, waste management, cleaning and disinfecting farm machinery and implements, etc. The currently applied phytosanitary measures (Council Directive 2000/29/EC) are effective in preventing the entry but not the establishment or spread of the pest in the EU	The presence of the pest on host and non-host plants for planting could be prevented by sourcing them in pest-free areas or places of production The currently applied phytosanitary measures (Council Directive 2000/29/EC) are effective in preventing the entry but not the establishment or spread of the pest in the EU	None
Conclusion on pest categorisation (Section 4)	*Thecaphora solani* meets all the criteria assessed by EFSA for consideration as potential Union quarantine pest	The criteria for considering *T. solani* as a potential Union regulated non-quarantine pest are not met since the pest is not known to be present in the EU and plants for planting is not its only major means of spread	None
Aspects of assessment to focus on/ scenarios to address in future if appropriate	None		

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Abbreviations

CIP	Collection of the International Potato Centre
DG	SANTÉ Directorate General for Health and Food Safety
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
MS	Member State

PCR	polymerase chain reaction
PLH	EFSA Panel on Plant Health
RNQP	regulated non-quarantine pest
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference