List of non-EU phytoplasmas of tuber-forming Solanum spp.

EFSA Panel on Plant Health (PLH),
Claude Bragard, Katharina Dehnen-Schmutz, Paolo Gonthier, Josep Anton Jaques Miret, Annemarie Fejer Justesen, Alan MacLeod, Christer Sven Magnusson, Panagiotis Milonas, Juan A Navas-Cortes, Stephen Parnell, Roel Potting, Philippe Lucien Reignault, Hans-Hermann Thulke, Wopke Van der Werf, Antonio Vicent Civera, Jonathan Yuen, Lucia Zappalà, Domenico Bosco, Michela Chiumenti, Francesco Di Serio, Luciana Galetto, Cristina Marzachi, Marco Pautasso and Marie-Agnès Jacques

Abstract

Following a request from the European Commission, the EFSA Panel on Plant Health prepared a list of non-EU phytoplasmas of tuber-forming Solanum spp. A systematic literature review and search of databases identified 12 phytoplasmas infecting S. tuberosum. These phytoplasmas were assigned to three categories. The first group (a) consists of seven non-EU phytoplasmas, known to occur only outside the EU (‘Candidatus Phytoplasma americanum’, ‘Ca. P. australiense’, ‘Ca. P. fragariae’-related strain (YN-169, YN-10G) and ‘Ca. P. hispanicum’) or having only limited presence in the EU (‘Ca. P. aurantifolia’-related strains, ‘Ca. P. pruni’-related strains and ‘Ca. P. trifolii’). The second group (b) consists of three phytoplasmas originally described or reported from the EU. The third group (c) consists of two phytoplasmas with substantial presence in the EU, whose presence in S. tuberosum is not fully supported by the available literature. Phytoplasmas of categories (b) and (c) were excluded at this stage from further categorisation efforts. Three phytoplasmas from category (a) (‘Ca. P. australiense’, ‘Ca. P. hispanicum’ and ‘Ca. P. trifolii’) were excluded from further categorisation, as a pest categorisation has already been performed by EFSA. Comments provided by the EU Member States were integrated in the opinion. The main uncertainties of this listing concern: the taxonomy, the geographic distribution and prevalence and host range. The following phytoplasmas considered as non-EU and whose presence in S. tuberosum is fully supported by literature (category (a)) are categorised in the Panel in a separate opinion: ‘Ca. P. americanum’, ‘Ca. P. fragariae’-related strain (YN-169, YN-10G), ‘Ca. P. aurantifolia’-related strains and ‘Ca. P. pruni’-related strains.

© 2020 European Food Safety Authority. EFSA Journal published by John Wiley and Sons Ltd on behalf of European Food Safety Authority.

Keywords: Clover yellow edge, pest risk, plant health, plant pest, potato hair sprouts, Potato purple top, quarantine

Requestor: European Commission

Question number: EFSA-Q-2020-00732

Correspondence: alpha@efsa.europa.eu
Panel members: Claude Bragard, Katharina Dehnen-Schmutz, Francesco Di Serio, Paolo Gonthier, Marie-Agnès Jacques, Josep Anton Jaques Miret, Annemarie Fejer Justesen, Alan MacLeod, Christer Sven Magnusson, Panagiotis Milonas, Juan A Navas-Cortes, Stephen Parnell, Roel Potting, Philippe L Reignault, Hans-Hermann Thulke, Wopke Van der Werf, Antonio Vicent Civera, Jonathan Yuen and Lucia Zappalá.

Acknowledgements: This document was prepared in cooperation with the Istituto per la Protezione Sostenibile delle Pianta, Consiglio Nazionale delle Ricerche (Italy) under the tasking grant (GP/EFSA/ALPHA/2017/02). The Panel thanks for the information provided to this scientific output: Franco Finelli (Phytosanitary Service, Italy). The Panel acknowledges Jan van der Wolf for his review of a previous draft and all European competent institutions, Member State bodies and other organisations that provided data for this scientific output.

Competing interests: In line with EFSA’s policy on declarations of interest, Panel member Francesco Di Serio did not participate in the adoption of this scientific output.

Suggested citation: EFSA PLH Panel (EFSA Panel on Plant Health), Bragard C, Dehnen-Schmutz K, Gonthier P, Jaques Miret JA, Justesen AF, MacLeod A, Magnusson CS, Milonas P, Navas-Cortes JA, Parnell S, Potting R, Reignault PL, Thulke H-H, Van der Werf W, Vicent Civera A, Yuen J, Zappalá L, Bosco D, Chiumenti M, Di Serio F, Galetto L, Marzachi C, Pautasso M and Jacques M-A, 2020. Scientific Opinion on the list of non-EU phytoplasmas of tuber-forming Solanum spp. EFSA Journal 2020;18(12):6355, 22 pp. https://doi.org/10.2903/j.efsa.2020.6355

ISSN: 1831-4732

© 2020 European Food Safety Authority. EFSA Journal published by John Wiley and Sons Ltd on behalf of European Food Safety Authority.

This is an open access article under the terms of the Creative Commons Attribution-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited and no modifications or adaptations are made.

The EFSA Journal is a publication of the European Food Safety Authority, an agency of the European Union.
Table of contents

Abstract ................................................................................................................................................... 1
1. Introduction ........................................................................................................................................ 4
   1.1. Background and Terms of Reference as provided by the requestor .................................................. 4
      1.1.1. Background ................................................................................................................................ 4
      1.1.2. Terms of Reference ..................................................................................................................... 4
      1.1.2.1. Terms of Reference: Appendix 1 .............................................................................................. 5
      1.1.2.2. Terms of Reference: Appendix 2 .............................................................................................. 6
      1.1.2.3. Terms of Reference: Appendix 3 .............................................................................................. 7
      1.1.3. Interpretation of the Terms of Reference ....................................................................................... 8
2. Data and methodologies ......................................................................................................................... 9
   2.1. Data ........................................................................................................................................... 9
      2.1.1. Literature search ......................................................................................................................... 9
      2.1.2. Database search ......................................................................................................................... 9
   2.2. Methodology ............................................................................................................................... 9
3. Listing of phytoplasmas ....................................................................................................................... 10
   3.1. Phytoplasmas considered as non-EU ............................................................................................. 10
   3.2. Phytoplasmas excluded from further categorisation in the frame of the present mandate ................. 10
   3.3. Uncertainties ............................................................................................................................... 10
4. Conclusions ......................................................................................................................................... 10

References ............................................................................................................................................... 11

Abbreviations ........................................................................................................................................... 14

Appendix A – Non-EU phytoplasmas of Solanum tuberosum ...................................................................... 15
Appendix B – Phytoplasmas of Solanum tuberosum excluded from further categorisation as they have substantial presence in the EU or are originally described or reported from the EU .......................................................... 19
Appendix C – Phytoplasmas of Solanum tuberosum excluded from further categorisation as their presence in the species is not fully supported by available literature ................................................................................................................................. 21
Annex A – List of phytoplasmas considered in the opinion ........................................................................ 22
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.

---

\(^1\) 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 a pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

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

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

(b) Bacteria

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

(c) Fungi

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

(d) Virus and virus-like organisms

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

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

| Insects | Mites | Nematodes |
|---------|-------|-----------|
| Anthonomus grandis (Boh.) | Ips cembrae Heer | |
| Cephalia lariciphila (Klug) | Ips duplicatus Sahlberg | |
| Dendroctonus micans Kugelan | Ips sexdentatus Börner | |
| Gilphinia hercyniae (Hartig) | Ips typographus Heer | |
| Gonipterus scutellatus Gyll. | Sternotectus mangiferae Fabricius | |
| Ips amitinus Eichhof | | |
1.1.2.2. Terms of Reference: Appendix 2

List of harmful organisms for which a 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

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) Epocha 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 indifferentens 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

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 a 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

- *Acleris* spp. (non-EU)
- *Amauromyza maculosa* (Malloch)
- *Anomala orientalis* Waterhouse
- *Arrhenodes minutus* Drury
- *Choristoneura* spp. (non-EU)
- *Conotrachelus nenuphar* (Herbst)
- *Dendrolimus sibiricus* Tsetcheverikov
- *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)
- *Liriomyza sativae* Blanchard

(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 weini* (Murril) Kotlaba and Pouzar
- *Melampsora farlowii* (Arthur) Davis

(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
List of non-EU phytoplasmas of potato

(d) Parasitic plants

*Arceuthobium* spp. (non-EU)

**Annex IAI**

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

*Meloidogyne fallax* Karssen

*Rhizococcus hibisci* Kawai and Takagi

*Popillia japonica* Newman

(b) Bacteria

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

1.1.3. Interpretation of the Terms of Reference

This opinion provides a list of non-EU phytoplasmas of tuber-forming *Solanum* spp., for which the EFSA Plant Health Panel (from now on: “the Panel”) then conducted a pest categorisation in a separate opinion (EFSA PLH Panel et al., 2020b). This list is based on information collected from databases up to January 2020, as well as information received from EU Member States (MS) during the period April-June 2020.

The search conducted for this list made it clear that the only tuber-forming species of *Solanum* genus reported to be infected by phytoplasmas is *S. tuberosum*.

Non-EU phytoplasmas of *S. tuberosum* are pests listed in the Appendices to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether they fulfill the criteria of quarantine pests or those of regulated non-quarantine pests for the area of the EU excluding Ceuta, Melilla and the outermost regions of MS referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores.

As a first step toward this goal, the Panel prepared a list of phytoplasmas infecting *S. tuberosum*. In the process, three groups of phytoplasmas were distinguished:

a) non-EU phytoplasmas with presence in *S. tuberosum* fully supported by literature,

b) phytoplasmas (affecting *S. tuberosum*) with widespread presence in the EU (known to occur in several MS, frequently reported in the EU, widespread in some MS) or originally described or reported from the EU, and

c) phytoplasmas of category (b) but with presence in *S. tuberosum* not fully supported by the literature.

A non-EU phytoplasma is defined by its geographical origin outside of the EU. Therefore, phytoplasmas not reported from the EU and occurring only outside of the EU are considered as non-EU phytoplasmas. Likewise, phytoplasmas occurring outside the EU and having only a limited presence in the EU (reported in only one or few MSs, with restricted distribution) are also considered as non-EU phytoplasmas.

This opinion provides the methodology and results for this classification, thus preparing the ground for the pest categorisation linked to the present mandate (EFSA PLH Panel et al. 2020b). This means that the Panel then performed a pest categorisation for the non-EU phytoplasmas with confirmed
ability to infect \textit{S. tuberosum}. The phytoplasmas with uncertain ability to infect \textit{S. tuberosum} and the phytoplasmas with significant presence in the EU or originally described or reported from the EU are excluded from further categorisation efforts, unless this will be requested by the risk managers in the future.

In this opinion, to capture the broadest possible range of phytoplasmas, even the poorly characterised ones for which very partial molecular or biological data are available, were considered. As in some cases there is uncertainty about the ‘\textit{Ca. P.} species definition’, related strains were considered if they infect \textit{S. tuberosum}. Instead, phytoplasma-like diseases of unknown aetiology or caused by viruses and formerly associated to mycoplasma-like organisms (MLO) or by other graft-transmissible bacteria are not addressed in this opinion.

## 2. Data and methodologies

### 2.1. Data

#### 2.1.1. Literature search

The literature considered to generate the list of phytoplasmas infecting \textit{S. tuberosum} (see Section 1.1.3) and to fill in the extraction tables on their distribution (see Appendices A–C and Annex A) was obtained from expert knowledge and extensive literature searches performed in Web of Science (WoS, last access January 2020). The search in WoS was performed using as keywords: phytoplasma/mycoplasma/witch/spiroplasma combined with the scientific name of the genus OR the common name of the crop. Therefore, the search in WoS was performed according to the following strategy:

\textbf{TOPIC:}\{(Phytoplasma* OR mycoplasma* OR witch* OR spiroplasma*) AND (Solanum OR potato*)\}

All the references were screened by title, abstract and, if needed, full paper with the specific objective of selecting those providing additional information regarding distribution and host range of the phytoplasmas included in the list or not yet included.

Information on phytoplasma taxonomy was gathered from either the original reference to species description or IRPCM (International Research Programme on Comparative Mycoplasmology) Phytoplasma/Spiroplasma Working Team–Phytoplasma Taxonomy Group (IRPCM, 2004).

Further references and data were obtained from experts, EU National Plant Protection Organisations and from citations within primary references.

#### 2.1.2. Database search

Data on \textit{S. tuberosum} as natural host and distribution of the phytoplasmas were retrieved from the EPPO Global Database (GD) (EPPO, 2020), the Centre for Agriculture and Biosciences International (CABI) Crop Protection Compendium (CABI, 2020) and relevant publications.

GenBank accessions referring to phytoplasmas were added.

### 2.2. Methodology

A preliminary list of phytoplasmas infecting \textit{S. tuberosum} (see Section 1.1.3) was generated by screening for phytoplasma diseases of the species present in the EPPO Lists A1 and A2. Further, all phytoplasma diseases listed in the EPPO GD were also screened for their association with \textit{S. tuberosum}. Finally, the relevant phytoplasmas resulting from the literature search in WoS (as previously described) were included in the list.

The collected information was used to fill an extraction table (Annex A) with data regarding the taxonomy, geographical distribution of each \textit{S. tuberosum}-infecting phytoplasma and key references and sources used to obtain that information. Taxonomy and distribution are reported in the table using the following scheme:

- the taxonomy was reported according to the ‘\textit{Ca. P.} species’ description, when available. Although phytoplasmas have not yet been cultivated \textit{in vitro}, phylogenetic analyses based on various conserved genes have shown that they represent a distinct, monophyletic clade within the class Mollicutes. Phytoplasmas are therefore accommodated within the ‘\textit{Candidatus Phytoplasma}’ genus. Within this genus, several subtaxa have been described to accommodate organisms sharing less than 97.5% similarity among their 16S rRNA gene sequences. Additional species are described to accommodate organisms that, despite their 16S rRNA gene sequence being > 97.5% similar to those of other ‘\textit{Ca. Phytoplasma}’ species,
are characterised by distinctive biological, phytopathological and genetic properties. Conversely, some organisms, despite their 16S rRNA gene sequence being < 97.5% similar to that of any other ‘Ca. Phytoplasma’ species, are not presently described as Candidatus species, due to their poor overall characterisation (IRPCM, 2004). When a phytoplasma has not been classified yet, information on a tentative classification was included based on the original literature source in which the pathogen was reported; to facilitate data retrieval from the literature and available databases, also the 16S rRNA group and subgroups were reported.

Data on distribution and on S. tuberosum as natural host of phytoplasmas were first searched in EPPO (2020) and in CABI (2020). Whenever conclusive information was not identified in the two databases or the information retrieved was at odds with expert knowledge, or in the absence of any information, extensive literature searches according to the protocol reported in Section 2.1 were performed.

Because only the non-EU phytoplasmas were subject of further categorisation efforts in the frame of the present mandate, it was decided to have consultation phases with EU Member States (MS) so that they could provide additional input if necessary. The information provided by EU MS was then considered by the Panel to determine the non-EU phytoplasmas that were further categorised (Section 3.1). The phytoplasmas excluded from this group are referred to here as phytoplasmas excluded from further categorisation in the frame of the present mandate (Section 3.2).

3. Listing of phytoplasmas

3.1. Phytoplasmas considered as non-EU

The phytoplasmas considered as non-EU (Appendix A) belong to two subcategories:

- Phytoplasmas not known to be present in the EU (‘Ca. P. americanum’, ‘Ca. P. australiense’, ‘Ca. P. fragariae’-related strain (YN-169, YN-10G), and ‘Ca. P. hispanicum’)
- Phytoplasmas known to be present outside the EU and with only limited presence (i.e. reported in only one or few MSs or known to have a restricted distribution) in the EU (‘Ca. P. aaurantiifolia’-related strains, ‘Ca. P. pruni’-related strains and ‘Ca. P. trifolii’).

These phytoplasmas are categorised in EFSA PLH Panel et al., (2020b), with the exception of ‘Ca. P. australiense’, ‘Ca. P. hispanicum’ and ‘Ca. P. trifolii’, for which a pest categorisation is already available (EFSA PLH Panel et al., 2020a).

3.2. Phytoplasmas excluded from further categorisation in the frame of the present mandate

The phytoplasmas excluded from further categorisation in the frame of the present mandate are listed in Appendices B and C. Phytoplasmas listed in Appendix B are originally described or reported from the EU. For the phytoplasmas listed in Appendix C, the ability to infect the host plants is not conclusively supported by the available literature.

3.3. Uncertainties

Uncertainties potentially affecting the current list of non-EU potato phytoplasmas include:

- The geographic distribution and prevalence of the phytoplasmas.
- The taxonomy and biological status of poorly characterised phytoplasmas.
- The ability to infect S. tuberosum for some phytoplasmas.

4. Conclusions

The Panel was requested by the European Commission to produce a categorisation of 133 harmful organisms or groups listed in annexes of Directive 2000/29/EC. One of the groups for which a categorisation was needed is non-EU phytoplasmas of tuber-forming Solanum spp. As a first step, a systematic approach identified 12 phytoplasmas reported to naturally infect S. tuberosum (Annex A).

Among these phytoplasmas, based on information on distribution and prevalence both inside and outside the EU, the Panel identified seven non-EU phytoplasmas, known to occur only outside the EU
or having only a limited presence in the EU (Appendix A). These phytoplasmas are categorised in EFSA PLH Panel et al. (2020b), with the exception of 'Ca. P. australiense', 'Ca. P. hispanicum' and 'Ca. P. trifolii', for which a pest categorisation is already available (EFSA PLH Panel et al., 2020a).

The remaining five phytoplasmas (which have a substantial presence in the EU or are originally described or reported from the EU (Appendix B, three phytoplasmas), or whose ability to infect S. tuberosum is not fully confirmed by available literature (Appendix C, two phytoplasmas)) were not categorised within the current mandate. However, the European Commission may request EFSA to categorise some or all the phytoplasmas excluded from the present exercise.

The main uncertainties of this listing concern the taxonomy, geographic distribution and prevalence and the ability to infect S. tuberosum for some phytoplasmas.

References
Alfaro-Fernandez A, Verdeguer M, Rodriguez-Leon F, Ibanez I, Hernandez D, Teresani GR, Bertolini E, Cambra M and Font M, 2017. Search for reservoirs of 'Candidatus Liberibacter solanacearum' and mollicutes in weeds associated with carrot and celery crops. European Journal of Plant Pathology, 147, 15–20. https://doi.org/10.1007/s10658-016-0984-9

Arnaud G, Malembic-Maher S, Salar P, Bonnet P, Maixner M, Marcone C, Boudon-Padieu E and Foissac X, 2007. Multilocus sequence typing confirms the close genetic interrelatedness of three distinct flavescence doree phytoplasma strain clusters and group 16SrV phytoplasmas infecting grapevine and alder in Europe. Applied and Environmental Microbiology, 73, 4001–4010.

Arocha Y, Antesana O, Montellano E, Franco P, Plata G and Jones P, 2007. 'Candidatus Phytoplasma lycopersici', a phytoplasma associated with 'hoja de perrel' disease in Bolivia. International Journal of Systematic and Evolutionary Microbiology, 57, 1704–1710. https://doi.org/10.1099/ijs.0.64851-0

Bertaccini A, Bellardi MG, Botti S, Paltrinieri S and Restuccia P, 2006. Phytoplasma infection in Asclepias physoarpa. Acta Horticulturae, 722, 349–354.

Borrotto Fernandez EG, Calari A, Hanzer V, Katinger H, Bertaccini A and Laimer M, 2007. Phytoplasma infected plants in Austrian forests: role as a reservoir? Bulletin of Insectology, 60, 391.

CABI, 2020. Crop Protection Compendium. Available online: https://www.cabi.org/ [Accessed: November 2020].

Castillo Carrillo C, Paltrinieri S, Bustamante JB and Bertaccini A, 2018. Detection and molecular characterization of a 16Srl-F phytoplasma in potato showing purple top disease in Ecuador. Australasian Plant Pathology, 47, 311–315. https://doi.org/10.1007/s13313-018-0557-9

Castro S and Romero J, 2002. The association of clover proliferation phytoplasma with stolbur disease of pepper in Spain. Journal of Phytopathology, 150, 25–29.

Cheng MY, Dong JH, Lee IM, Bottner-Parker KD, Zhao Y, Davis RE, Laski PJ, Zhang ZK and McBeath JH, 2015. Group 16SrXII phytoplasma strains, including subgroup 16SrXII-E ('Candidatus Phytoplasma fragariae') and a new subgroup, 16SrXII-I, are associated with diseased potatoes (Solanum tuberosum) in the Yunnan and Inner Mongolia regions of China. European Journal of Plant Pathology, 142, 305–318. https://doi.org/10.1007/s10658-015-0616-9

Cheng M, Dong J, Han C, Zhang Z and McBeath JH, 2019. First Report of Phytoplasma 'Candidatus Phytoplasma aurantifolia' associated with purple topped diseased potatoes (Solanum tuberosum) in Guangdong province, China. Plant Disease, 103, 1015. https://doi.org/10.1094/pdis-04-18-0701-pdn

Davino S, Calari A, Davino M, Tessitori M, Bertaccini A and Bellardi MG, 2007. Virosence of ten weeks stock associated to phytoplasma infection in Sicily. Bulletin of Insectology, 60, 279–280.

Davis RE, Daily EL, Gundersen DE, Lee IM and Habil N, 1997. 'Candidatus Phytoplasma australiense', a new phytoplasma taxon associated with Australian grapevine yellows. International Journal of Systematic Bacteriology, 47, 262–269.

Davis RE, Zhao Y, Daily EL, Lee IM, Jomantiene R and Douglas SM, 2013. 'Candidatus Phytoplasma pruni', a novel taxon associated with X-disease of stone fruits, Prunus spp.: multilocus characterization based on 16S rRNA, secY, and ribosomal protein genes. International Journal of Systematic and Evolutionary Microbiology, 63, 766. https://doi.org/10.1099/ijs.0.041202-0

Davis RE, Harrison NA, Zhao Y, Wei W and Daily EL, 2016. 'Candidatus Phytoplasma hispanicum', a novel taxon associated with Mexican periwinkle virosence disease of Catharanthus roseus. International Journal of Systematic and Evolutionary Microbiology, 66, 3463–3467.

Dong J, Zhang L, Wang D, McBeath JH and Zhang Z, 2011. Potato virus and phytoplasma diseases in Yunnan, China. Phytopathology, 101, 544.

EFSA PLH Panel (EFSA Panel on Plant Health), Bragard C, Dehnen-Schmutz K, Gontichert P, Miret JAI, Fejer Justesen A, MacLeod A, Magnusson CS, Milonas P, Navas-Cortes JA, Parnell S, Potting R, Reignault PL, Thulke H-H, Van der Werf W, Civera AV, Yuen J, Zappalá L, Bosco D, Chiumenti M, Di Serio F, Gaitetto L, Marzachi C, Pautasso M and Jacques M-A, 2020a. Pest categorisation of the non-EU phytoplasmas of Phytoplasma australiense and other non-EU phytoplasmas infecting phyto specific plant species: report 15. EFSA Journal 2020;18(5):5929, 97 pp. https://doi.org/10.2903/j.efsa.2020.5929
List of non-EU phytoplasmas of potato

EFSA PLH Panel (EFSA Panel on Plant Health), Bragard C, Dehnen-Schmutz K, Gonthier P, Miret JA, Fejer Justesen A, MacLeod A, Magnusson CS, Milonas P, Navas-Cortes JA, Parnell S, Potting R, Reignault PL, Thulke H-H, van der Werf W, Civera AV, Yuan J, Zappalà L, Bosco D, Chiumenti M, Di Serio F, Galetto L, Marzachi C, Pautasso M and Jacques M-A, 2020b. Pest categorisation of the non-EU phytoplasmas of tuber-forming Solanum spp. EFSA Journal 2020;18(1):6356, 59 pp. https://doi.org/10.2903/j.efsa.2020.6356

EPPO (European and Mediterranean Plant Protection Organization), 2020. EPPO Global Database. Available online: https://gd.eppo.int [Accessed: November 2020]

Faggioli F, Pasquini G, Lumia V, Campobasso G, Widmer TL and Quimby PC, 2004. Molecular identification of a new member of the clover proliferation Phytoplasma group (16SrVI) associated with Centaurea solstitialis virescence in Italy. European Journal of Plant Pathology, 110, 353–360.

Fahmeed F, Rosete YA, Perez KA, Boa E and Lucas J, 2009. First report of ‘Candidatus Phytoplasma asteris’ (Group 16SrI) infecting fruits and vegetables in Islamabad, Pakistan. Journal of Phytopathology, 157, 639–641. https://doi.org/10.1111/j.1439-0434.2009.01549.x

Firrao G, Carraro L, Gobbi E and Locci R, 1996. Molecular characterization of a phytoplasma causing phylloxy in clover and other herbaceous hosts in northern Italy. European Journal of Plant Pathology, 102, 817–822.

Franova J, Spak J and Simkova M, 2013. First report of a 16SrIII-B subgroup phytoplasma associated with leaf reddening, virescence and phylloxy of purple coneflower. European Journal of Plant Pathology, 136, 7–12.

Girsona NV, Bottner-Parker KD, Bogoutdinov DZ, Meshkov YI, Mozhaeva KA, Kastalyeva TB and Lee IM, 2016. Diverse phytoplasmas associated with potato stolbur and other related potato diseases in Russia. European Journal of Plant Pathology, 145, 139–153. https://doi.org/10.1007/s10658-015-0824-3

Granata G, Paltrinieri S, Botti S and Bertaccini A, 2006. Aetiology of Phytoplasma sp. in Lithuania. Plant Disease, 84, 198.

Hodgetts J, Chuquillangi C, Muller G, Arocha Y, Gamarra D, Pinillos O, Velit E, Lozada P, Boa E, Boonham N, Mumford R, Barker I and Dickinson M, 2009. Surveys reveal the occurrence of phytoplasmas in plants at different geographical locations in Peru. Annals of Applied Biology, 155, 15–27. https://doi.org/10.1111/j.1744-7348.2009.00316.x

Hosseini P, Bahar M, Madani G and Zirak L, 2011. Molecular characterization of phytoplasmas associated with potato purple top disease in Iran. Journal of Phytopathology, 159, 241–246. https://doi.org/10.1111/j.1439-0434.2010.01757.x

IRPCM (International Research Programme on Comparative Mycoplasmology), 2004. ‘Candidatus Phytoplasma’, a taxon for the wall-less, non-helical prokaryotes that colonize plant phloem and insects. International Journal of Systematic and Evolutionary Microbiology, 54, 1243–1255.

Jomantiene R, Davis RE, Antoniuk L and Staniulis J, 2000. First report of phytoplasmas in soybean, alfalfa, and Lupinus sp. in Lithuania. Plant Disease, 84, 198.

Jones P and Arocha Y, 2006. A natural infection of Hebe is associated with an isolate of ‘Candidatus Phytoplasma asteris’ causing a yellowing and little-leaf disease in the UK. Plant Pathology, 55, 821.

Lee IM, Gundersen-Rindal DE, Davis RE, Bottner KD, Marcone C and Seemuller E, 2004a. ‘Candidatus Phytoplasma asteris’, a novel phytoplasma taxon associated with aster yellows and related diseases. International Journal of Systematic and Evolutionary Microbiology, 54, 1037–1048.

Lee IM, Martini M, Marcone C and Zhu SF, 2004b. Classification of phytoplasma strains in the elm yellows group (16SrV) and proposal of ‘Candidatus Phytoplasma ulmi’ for the phytoplasma associated with elm yellows. International Journal of Systematic and Evolutionary Microbiology, 54, 337–347. https://doi.org/10.1099/ijs.0.02697-0

Lee IM, Bottner KD, Secor G and Rivera-Varas V, 2006. ‘Candidatus Phytoplasma americanum’ a phytoplasma associated with potato purple top wilt disease complex. International Journal of Systematic and Evolutionary Microbiology, 56, 1593–1597.

Leyva-Lopez NE, Ochoa-Sanchez JC, Leal-Klevezas DS and Martinez-Soriano JP, 2002. Multiple phytoplasmas associated with potato diseases in Mexico. Canadian Journal of Microbiology, 48, 1062–1068. https://doi.org/10.1139/w02-109

Lindner K, Haase NU, Roman M and Seemuller E, 2011. Impact of stolbur phytoplasmas on potato tuber texture and sugar content of selected potato cultivars. Potato Research, 54, 267–282. https://doi.org/10.1007/s11540-011-9192-3

Longoria-Espinosa RM, Doutre-Gamez NR, Lopez-Meyer M, Quiroz-Figueroa F, Bueno-Ibarra M, Mendez-Lozano J, Santos-Cervantes ME, Felix-Gastelum R, Chavez-Medina JA and Leyva-Lopez NE, 2013. Differentially regulated genes in Solanum tuberosum in response to “Mexican potato purple top phytoplasma” infection. Physiological and Molecular Plant Pathology, 81, 33–44. https://doi.org/10.1016/j.pmpp.2012.10.001

Mehle N, Mermal S, Vidmar S, Marn MV, Dreo T and Dermastia M, 2018. First report of carrot infection with phytoplasmas in Slovenia. pp. 2–3.

Mejia JF, Contaldo N, Paltrinieri S, Pardo JM, Rios CA, Alvarez E and Bertaccini A, 2011. Molecular detection and identification of group 16SrV and 16SrXII phytoplasmas associated with potatoes in Colombia. Bulletin of Insectology, 64, 597–598.
Nisbet C, Ross S, Monger WA, Highton F and Jeffries C, 2014. First report of ‘Candidatus Phytoplasma asteris’ in commercial carrots in the United Kingdom. New Disease Reports, 30, 16.

Omar AF, Aljmahan KA, Alsohaim AS and Perez-Lopez E, 2018. Potato purple top disease associated with the novel subgroup 16SrI-X phytoplasma. International Journal of Systematic and Evolutionary Microbiology, 68, 3678–3682. https://doi.org/10.1099/ijsem.0.03033

Palermo S, Elekes M, Botti S, Ember I, Alma A, Orosz A, Bertaccini A and Kolber M, 2004. Presence of stolbur phytoplasma in Cichideae in Hungarian vineyards. Vitis, 43, 201–203.

Pałtrinierna S and Bertaccini A, 2007. Detection of phytoplasmas in plantlets grown from different batches of seed potatoes. Bulletin of Insectology, 60, 379–380.

Pałtrinierna S, Bertaccini A and Lugaresi C, 2008. Phytoplasmas in declining cherry plants. Acta Horticulturae, 781, 409–416.

Parrella G, Pałtrinierna S, Botti S and Bertaccini A, 2008. Molecular identification of phytoplasmas from virescent Ranunculus plants and from leafhoppers in Southern Italian crops. Journal of Plant Pathology, 90, 537–543.

Príbylova J, Petrick K and Spak J, 2009. The first detection of ‘Candidatus Phytoplasma trifolii’ in Rhododendron hybridum. European Journal of Plant Pathology, 124, 181–185. https://doi.org/10.1007/s10658-008-9391-1

Prota VA, Garau R, Pałtrinierna S, Botti S, Nahdi S, Calari A, Sechi A and Bertaccini A, 2007. Molecular identification of phytoplasmas infecting myrtle plantations in Sardinia (Italy). Bulletin of Insectology, 60, 383–384.

Quaglini F, Zhao Y, Casati P, Bulgaria D, Bianco PA, Wei W and Davis RE, 2013. ‘Candidatus Phytoplasma solani’, a novel taxon associated with stolbur and bois noir-related diseases of plants. International Journal of Systematic and Evolutionary Microbiology, 63, 2879–2894.

Radisek S, Ferant N, Jakse J and JVorník B, 2009. Identification of a phytoplasma from the aster yellows group infecting purple coneflower (Echinacea purpurea) in Slovenia. Plant Pathology, 58, 392. https://doi.org/10.1111/j.1365-3059.2008.02005.x

Reeder R and Arocha Y, 2008. ‘Candidatus Phytoplasma asteris’ identified in Senecio jacobaeae in the United Kingdom. Plant Pathology, 57, 769. https://doi.org/10.1111/j.1365-3059.2008.01849.x

Romanazzi G, D’Ascanzo D and Murolo S, 2009. Tussilago farfara: a new natural host of stolbur phytoplasma. Plant Pathology, 58, 392. https://doi.org/10.1111/j.1365-3059.2008.01994.x

Salem NM, Tahzima R, Abdeen AO, Bianco PA, Massart S, Goedefroit T and De Jonghe K, 2019. First report of ‘Candidatus Phytoplasma aurantifolia’–related strains infecting potato (Solanum tuberosum) in Jordan. Plant Disease, 103, 1406. https://doi.org/10.1094/pdis-04-18-0705-pdn

Samuïtiené M, Jomantienë R, Vallinia D, Navalinskiene M and Davis RE, 2007. Phytoplasma strains detected in ornamental plants in Lithuania. Bulletin of Insectology, 60, 137–138.

Santos-Cervantes ME, Chavez-Medina JA, Acosta-Pardini J, Flores-Zamora GL, Mendez-Lozano J and Leyva-Lopez NE, 2010. Genetic diversity and geographical distribution of phytoplasmas associated with potato purple top disease in Mexico. Plant Disease, 94, 388–395. https://doi.org/10.1094/pdis-94-4-0388

Seemuller E and Schneider B, 2004. ‘Candidatus Phytoplasma malli’, ‘Candidatus Phytoplasma pyri’ and ‘Candidatus Phytoplasma prunorum’, the causal agents of apple proliferation, pear decline and European stone fruit yellows, respectively. International Journal of Systematic and Evolutionary Microbiology, 54, 1217–1226.

Staniulis JB, Davis RE, Jomantienë R, Kalvelyte A and Dally EL, 2000. Single and mixed phytoplasma infections in phyllody- and dwarf-diseased clover plants in Lithuania. Plant Disease, 84, 1061–1066.

Tiwari AK, Khan MS, Iqbal A, Chun SC and Priya M, 2013. Molecular identification of ‘Candidatus Phytoplasma asteris’ (16SrI-B) associated with the little leaf disease of potato in India. Journal of Plant Pathology, 95, 662.

Tolu G, Botti S, Garau R, Prota VA, Sechi A, Prota U and Bertaccini A, 2006. Identification of a 16SrI-E phytoplasma in Calendula arvensis, Solanum nigrum, and Chenopodium spp. Plant Disease, 90, 325–330.

Urbonaitë IL, Jomantienë R, Vallinia D and Davis RE, 2016. First report of ‘Candidatus Phytoplasma asteris’ subgroup 16SrI-A associated with a disease of potato (Solanum tuberosum) in Lithuania. Plant Disease, 100, 207. https://doi.org/10.1094/pdis-05-15-0575-pdn

Vallinias D, Staniulis J and Davis RE, 2006. ‘Candidatus Phytoplasma fragariae’, a novel phytoplasma taxon discovered in yellows diseased strawberry, Fragaria x ananassa. International Journal of Systematic and Evolutionary Microbiology, 56, 277–281.

Vallinias D, Samuïtiené M, Rasomavicius V, Navalinskiene M, Staniulis J and Davis RE, 2007. Subgroup 16SrIII-F phytoplasma strains in an invasive plant, Heracleum sosnowskyi, and an ornamental, Dictamnus albus. Journal of Plant Pathology, 89, 137–140.

White DT, Blackall LL, Scott PT and Walsh KB, 1998. Phylogenetic positions of phytoplasmas associated with dieback, yellow crinkle and mosaic diseases of papaya, and their proposed inclusion in ‘Candidatus Phytoplasma australiensis’ and a new taxon, ‘Candidatus Phytoplasma australasiae’. International Journal of Systematic Bacteriology, 48, 941–951.

Zambon Y, Canel A, Bertaccini A and Contaldo N, 2018. Molecular diversity of phytoplasmas associated with grapevine yellows disease in North-Eastern Italy. Phytopathology, 108, 206–214. https://doi.org/10.1094/phyto-07-17-0253-r
### Abbreviations

| Abbreviation | Description |
|--------------|-------------|
| Ca. P.       | Candidatus Phytoplasma |
| CYE          | Clover yellow edge |
| EPPO         | European and Mediterranean Plant Protection Organization |
| GD           | Global Database |
| IRPCM        | International Research Programme on Comparative Mycoplasmology |
| MS           | Member State |
| PCR          | Polymerase Chain Reaction |
| PHS          | Potato hair sprouts |
| PHYPA       | Candidatus Phytoplasma australasia |
| PHYPAE      | Candidatus Phytoplasma americanum |
| PHYPAE      | Candidatus Phytoplasma asteris |
| PHYPAU      | Candidatus Phytoplasma australiense |
| PHYPFG      | Candidatus Phytoplasma fragariae |
| PHYPM       | Candidatus Phytoplasma mali |
| PHYPTR      | Candidatus Phytoplasma trifoli |
| PHYP07      | Candidatus Phytoplasma hispanicum |
| PHYP19      | Clover yellow edge phytoplasma |
| PHYP74      | Alder yellows phytoplasma |
| PLH         | Plant Health |
| PPT         | Potato purple top |
| RFLP        | Restriction Fragment Length Polymorphism |
| TFEU        | Treaty on the Functioning of the European Union |
| ToR         | Terms of Reference |
| WoS         | Web of Science |
## Appendix A – Non-EU phytoplasmas of *Solanum tuberosum*

| ID | Phytoplasma name | Related strain name(1) | Abbreviation (EPPO code) | 16S rRNA | Reasoning for considering non-EU | Uncertainties | References |
|----|------------------|------------------------|--------------------------|---------|---------------------------------|-------------|-----------|
| 1  | *Candidatus Phytoplasma americanum* | –                      | PHYPAE                   | XVIII   | Not reported to be present in the EU | –           | Species description: (Lee et al., 2006); *S. tuberosum*: (EPPO, 2020) |
| 2  | *Candidatus Phytoplasma aurantifolia* | GD32; St_JO_10, 14, 17; PPT-SA; Rus-343F; PPT-GTO29, PPT-GTO30, PPT-SINTV; Potato Huayao Survey 2; Potato hair sprouts, PHS | PHYPAA, PHYP01, PHYP39 | II     | Italian reports refer to few infected individuals; present in Greece, Portugal; present in EU neighbouring Countries | Cheng et al. (2019) (despite identification of the phytoplasma as belonging to 16SrII by sequencing identity, in silico RFLP, neighbour-joining phylogenetic, in the text it is named as 'Ca. P. australiense'); Omar et al. (2018), Girsova et al. (2016), Hodgetts et al. (2009), Leyva-Lopez et al. (2002) (unclear subgroup assignment); Paltrinieri and Bertaccini (2007) (12 nested PCR-positive plants over 600 asymptomatic seed potato plants in Italy, no accession numbers available); Parrella et al. (2008) (one batch of 10 *Empoasca decipiens* in Italy); Tolu et al. (2006) (3 plants from 3 species in Italy); Prota et al. (2007) (less than 20 *Myrtus communis* plants and possibly in mixed infection in Italy); Granata et al. (2006) (in two *Opuntia ficus-indica* plants in Italy); Davino et al., 2007 (in one *Matthiola incana* plant in Italy) | Species description: (White et al., 1998; IRPCM, 2004); Strain descriptions and *S. tuberosum*: 'GD32 (Cheng et al., 2019); St_JO_10, 14, 17 (Salem et al., 2019); PPT-SA (Omar et al., 2018); Rus-343F (Girsova et al., 2016); PPT-GTO29, PPT-GTO30, PPT-SINTV (Santos-Cervantes et al., 2010); Potato Huayao Survey 2 (Hodgetts et al., 2009); Potato hair sprouts, PHS (Leyva-Lopez et al., 2002) Solanum tuberosum in Italy (Paltrinieri and Bertaccini, 2007); *Empoasca decipiens* in Italy (Parrella et al., 2008); *Calendula arvensis*, *Solanum nigrum*, and *Chenopodium* spp. in Italy (Tolu et al., 2006); *Matthiola incana* in Italy (Davino et al., 2007) |
| ID | Phytoplasma name | Related strain name(1) | Abbreviation (EPPO code) | 16S rRNA | Reasoning for considering non-EU | Uncertainties | References |
|----|-----------------|------------------------|--------------------------|----------|--------------------------------|---------------|------------|
| 3  | Candidatus Phytoplasma australiense | – | PHYPAU | XII-B | Not reported to be present in the EU | – | Species description: (Davis et al., 1997); S. tuberosum: (EPPO, 2020) |
| 4  | Candidatus Phytoplasma fragariae | YN-169, YN-10G | XII | Not reported to be present in the EU | Cheng et al., 2015 (several strains ascribed to 16SrXII-I, YN-169, but not identical to each other, plus other 16SrXII strains not assigned to any subgroup, YN-10G) | Species description: (Cheng et al., 2015); S. tuberosum: (Dong et al., 2011; Cheng et al., 2015) |
| 5  | Candidatus Phytoplasma hispanicum | – | PHYP07 | XIII | Not reported to be present in the EU | Strawberry multiplier disease phytoplasma (STRAWB1) [PHYP75] is classified as RNQP (Annex IV; updated 2019). The phytoplasma is a strain of Ca. P. hispanicum, and the latter is not known to be present in the EU (EFSA PLH Panel et al., 2020a) | Species description: (Davis et al., 2016); S. tuberosum: (Santos-Cervantes et al., 2010) |
| ID | Phytoplasma name | Related strain name(1) | Abbreviation (EPPO code) | 16S rRNA Reasoning for considering non-EU | Uncertainties | References |
|----|-----------------|------------------------|--------------------------|-------------------------------------------|--------------|------------|
| 6  | Candidatus Phytoplasma pruni | Clover yellow edge, CYE (Girsova et al., 2016); Potato purple top, AKpot7, MT117, AKpot6 (Davis et al., 2013); Potato purple top, PPT-COAHP, PPT-GTOP (Santos-Cervantes et al., 2010) | PHYP19 (CYE) | III-B (CYE); III-F (AKpot7); III-M (MT117); III-N (AKpot6);III-U (PPT-COAHP, PPT-GTOP) | In the EU reported in four MSs: Czech Republic (two reports), Italy (three reports), Hungary (one report), Lithuania (four reports) | The pest was reported: in eight symptomatic Echinacea purpurea (Franova et al., 2013) and eight Trifolium spp. plants in the Czech Republic (Franova et al., 2004); in less than 50 symptomatic weed samples (Leucanthemum vulgare, Taraxacum officinale and Crepis biennis) (Firrao et al., 1996), in three Prunus spp. (cherry) plants (Paltrinieri et al., 2008) and in an undefined number (few samples) of Asclepias physocarpa plants (Bertaccini et al., 2006) in Italy; in an undefined number of Cirsium arvense and Convolvulus arvensis (Palermo et al., 2004) in Hungary; in two Trifolium spp. plants and in mixed infections (Staniulis et al., 2000), in an undefined number of Gaillardia sp., Dictamnus albus (Samuitiene et al., 2007), Heracleum sosnowskyi, Dictamnus albus (Valiunas et al., 2007), Glycine max and Lupinus spp. (Jomantiene et al., 2000), in Lithuania | Species description: (Davis et al., 2013); Strain descriptions and S. tuberosum: CYE (Girsova et al., 2016); AKpot7, MT117, AKpot6 (Davis et al., 2013); PPT-COAHP, PPT-GTOP (Santos-Cervantes et al., 2010); CYE in Lithuania (Staniulis et al., 2000) |
| ID | Phytoplasma name | Related strain name(1) | Abbreviation (EPPO code) | 16S rRNA | Reasoning for considering non-EU | Uncertainties | References |
|----|-----------------|------------------------|--------------------------|----------|---------------------------------|--------------|------------|
| 7  | Candidatus Phytoplasma trifolii | – | PHYPTR | VI-A | Reports from EU MS refer to few infected plants, ranging from 1 to 28 | Reports from EU MS refer to few infected plants (Castro and Romero, 2002; Faggioli et al., 2004; Borroto Fernandez et al., 2007; Pribylova et al., 2009; Alfaro-Fernandez et al., 2017; Zambon et al., 2018); unclear subgroup assignation (Girsova et al., 2016) | Species description: (Hiruki and Wang, 2004); *S. tuberosum*: (EPPO, 2020); *Vitis* in Italy (Zambon et al., 2018); *Centaurea solstitialis* in Italy (Faggioli et al., 2004); *Amaranthus blitoides* and *Setaria adhaerens* in Spain (Alfaro-Fernandez et al., 2017); *Capsicum annuum* in Spain (Castro and Romero, 2002); *Rhododendron* spp. in Czech Republic (Pribylova et al., 2009); *Vaccinium myrtillus* in Austria (Borroto Fernandez et al., 2007) |

(1): Reference isolate of "Candidatus Phytoplasma species" is indicated by ‘–’.
# Appendix B – Phytoplasmas of *Solanum tuberosum* excluded from further categorisation as they have substantial presence in the EU or are originally described or reported from the EU

| ID | Phytoplasm name | Related strain name(1) | Abbreviation (EPPO code) | 16S rRNA | EU MS in which the pathogen has been reported | Non-EU European and neighbouring countries | Reasoning for not considering as non-EU | Uncertainties | References |
|----|----------------|------------------------|--------------------------|---------|-----------------------------------------------|-------------------------------------------|------------------------------------------|-------------|------------|
| 8  | *Candidatus Phytoplasma asteris* | –                       | PHYPAS                   | I       | Germany, Hungary, Italy (Present widespread); Czech Republic, Spain (Present, restricted distribution); Belgium Denmark, France, Romania (Present, no details); Slovenia(2) | Russia (Present, restricted distribution; Belarus (Present, no details); UK(2)) | Reported in the EU (several MS) | –           | Species description: (Lee et al., 2004a); *S. tuberosum*; (Lee et al., 2006; Arocha et al., 2007; Fahmeed et al., 2009; Hodgetts et al., 2009; Dong et al., 2011; Hosseini et al., 2011; Longoria-Espinoza et al., 2013; Tiwari et al., 2013; Girsova et al., 2016; Castillo Carrillo et al., 2018); *S. tuberosum* in Italy: (Paltrinieri and Bertaccini, 2007); *S. tuberosum* in Lithuania (Urbonaite et al., 2016); UK (Jones and Arocha, 2006; Reeder and Arocha, 2008; Nisbet et al., 2014), Slovenia: (Radisek et al., 2009; Romanazzi et al., 2009; Mehle et al., 2018) |
| 9  | *Candidatus Phytoplasma fragariae* | –                       | PHYPFG                   | XII-E   | Slovenia (EPPO report 2018/085); Belgium(2) | UK (EPPO report 2015/031) | Originally described in the EU | –           | Species description: (Valiunas et al., 2006) |
| ID | Phytoplasma name | Related strain name(1) | Abbreviation (EPPO code) | 16S rRNA | EU MS in which the pathogen has been reported | Non-EU European and neighbouring countries | Reasoning for not considering as non-EU | Uncertainties | References |
|----|-----------------|------------------------|--------------------------|---------|-----------------------------------------------|-------------------------------------------|---------------------------------------|-------------|----------------|
| 10 | *Candidatus Phytoplasma solani* | – | PHPSO | XII-A | Italy (Present, widespread); Bulgaria, Croatia, France, Germany, Greece, Hungary, Slovakia, Slovenia, Spain, (Present, restricted distribution); Austria, Czech Republic, Poland (Present, few occurrences); Romania; Belgium(2); Portugal(3) | Macedonia, Montenegro (Present, widespread); Russia, Serbia, Switzerland, Turkey (Present, restricted distribution); Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Georgia, Ukraine (Present, no details) | Originally described in the EU (several MS) | – | Species description: (Quaglino et al., 2013); *S. tuberosum*: (EPPO, 2020); *S. tuberosum* in Romania: (Lindner et al., 2011) |

(1): Reference isolate of *Candidatus Phytoplasma species* is indicated by ‘–’.
(2): Information provided by MS during commenting phase.
### Appendix C – Phytoplasmas of *Solanum tuberosum* excluded from further categorisation as their presence in the species is not fully supported by available literature

| ID | Phytoplasma name | Related strain name(1) | Abbreviation (EPPO code) | 16S rRNA | EU MS in which the pathogen has been reported | Non-EU European and neighbouring countries | Reasoning for not considering as non-EU | Uncertainties | References |
|----|------------------|------------------------|--------------------------|----------|-----------------------------------------------|--------------------------------------------|----------------------------------------|--------------|------------|
| 11 | Candidatus Phytoplasma mali | – | PHYPM | X | Czech Republic, Germany, Hungary, Italy, Slovakia, Slovenia (Present widespread); Austria, Belgium, Bulgaria, Croatia, Finland, France, Greece, Spain (Present, restricted distribution); Poland, Romania (Present, no details); Lithuania, Netherlands (Present, few occurrences) | Switzerland (Present widespread); Belarus, Norway, Serbia (Present, restricted distribution); Albania, Bosnia and Herzegovina, Moldova, Russia, Turkey, Ukraine (Present, no details) | Originally described in the EU (several MS) | Only one nested PCR positive plant from 600 seed potato asymptomatic plants, probably in mixed infections and no accession number of the isolate available (Paltrinieri and Bertaccini, 2007) | Species description: (Seemuller and Schneider, 2004); *S. tuberosum* in Italy: (Paltrinieri and Bertaccini, 2007) |
| 12 | Unclassified | Potato Colombia M/V | PHYP74 | V-C | France | – | Reported in the EU | Only one report from 8 potato plants, 4 in mixed infections with *Ca. P. solani*; no accession number of the isolate available; taxonomic status uncertain within the 16SrV-C subgroup (Mejia et al., 2011) | Species description: (Lee et al., 2004b); Strain description and *S. tuberosum*: (Mejia et al., 2011); *Alnus* in France: (Arnaud et al., 2007) |

(1): Reference isolate of ‘*Candidatus Phytoplasma species*’ is indicated by ‘–’.
Annex A – List of phytoplasmas considered in the opinion

See Excel file in Supplementary Information online.